SENCORE NEWS

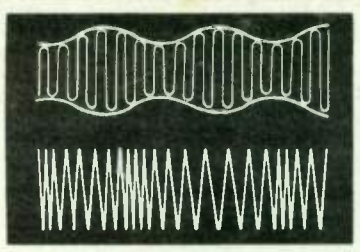
SPECIAL STEREO SERVICE REVIEW

REVISED AND UPDATED
DUE TO POPULAR REQUEST

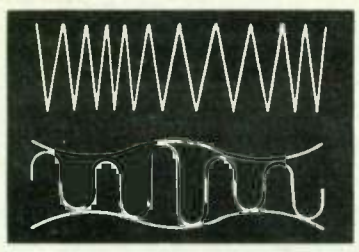
CASH IN ON PROFITABLE HOME AND AUTO STEREO SERVICE

SG165 AM - FM STEREO ANALYZER

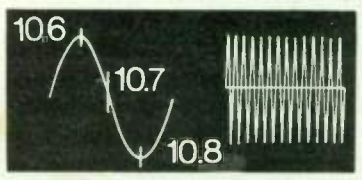
THE ONLY ANALYZER WITH ALL 12 SIGNALS NEEDED TO MAKE COMPLETE PERFORMANCE CHECKS IN MINUTES ON ANY STEREO AM - FM RECEIVER



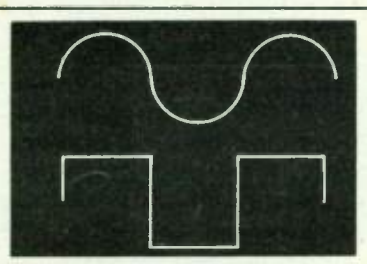
FULL RANGE AM RF
FULL RANGE FM RF



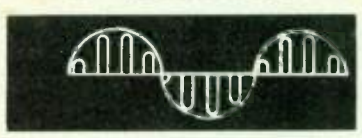
MODULATED 10.7MHz FM IF
MODULATED 455KHz AM IF
MODULATED 262KHz AM IF



10.7 SWEEP & MARKER
10.7MHz CRYSTAL
CONTROLLED CW



400Hz SINE WAVE AUDIO
400Hz SQUARE WAVE AUDIO



FULL STEREO MPX
VARIABLE LEVEL 19KHz PILOT
67KHz SCA OUTPUT

PLUS: DUMMY
SPEAKER LOADS
OF 4, 8, 16, 32 OHMS

PLUS: SEPARATION &
PWR OUTPUT METERS

BACKED BY SENCORE'S 100% MADE RIGHT LIFETIME GUARANTEE

SPECIAL FEATURE

WALKING THE TROUBLES OUT OF AM-FM STEREO

$595

WALKING THE TROUBLES OUT OF AM-FM STEREO

One of the areas of greatest concentration by the home entertainment manufacturers is in the service training and assistance in servicing AM-FM stereo equipment. This is understandable, since the American public is buying and using over twice as many stereo units as all television receivers combined. According to EIA (Electronic Industries Association) figures released in September of last year, the sales of AM/FM radios and AM/FM stereo units during just 1974 and 1975 totaled well over 50 million units. Compare this to the some 18 million television receivers, both black and white and color, and you can readily see the tremendous market for this segment of home entertainment equipment. The service industry is being faced with the greatest upswing in any area of service in the stereo systems. Therefore, it is easy to understand why such effort is being put forth by the manufacturers to assure efficient service of these units.

How do you go about servicing these units and do a good job in a reasonable period of time? Obviously, you must be familiar with the systems involved to be able to quickly troubleshoot and repair them. Many good articles and manuals have been prepared in just this area. This issue of the Sencore News is devoted to this same thought, explaining in simple terms the FM stereo system and how to troubleshoot it.

In order to troubleshoot any item of electronics equipment, you must have some means of evaluating its performance. Without this means, you will be "wandering around lost" in the unit and troubleshooting time will be drastically increased. If troubleshooting time is increased, profits are sure to go down. It is necessary, then, to have some standard to use in servicing any electronic device. Sweep generators and color generators serve as the standards when working on television receivers, but what type of standard do you have to check out an AM-FM Stereo unit? You may say that you use the broadcast signal, but is that really what you would like to use for most efficient troubleshooting? By your own requests, we do not feel that it is.

ELECTRONIC INDUSTRIES ASSOCIATION NEWS RELEASE

ELECTRONIC INDUSTRIES ASSOCIATION 2001 EYE ST. N.W. WASHINGTON, D.C. 20006 PUBLIC RELATIONS (202) 659-2200

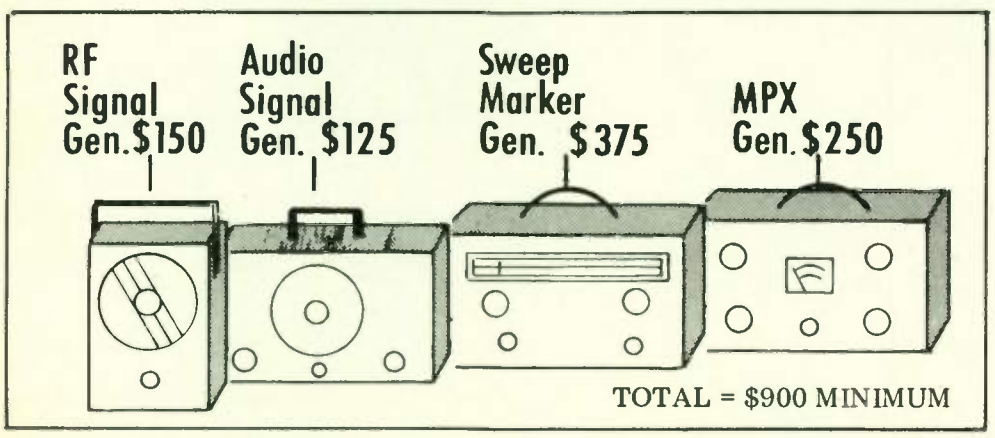
EIA ELECTRONIC MARKETING TRENDS (SEPT., 1975)
FACTORY SALES OF CONSUMER ELECTRONIC PRODUCTS
(Add 000 Units)

DESCRIPTION	SEPTEMBER 1975 Units	SEPTEMBER 1974 Units	YEAR TO DATE 1975 Units	YEAR TO DATE 1974 Units
TELEVISION				
Monochrome	564	689	3,578	4,728
Color	839	897	4,757	5,998
Total Television	1,403	1,586	8,335	10,726
RADIOS				
Table	176	359	1,432	2,067
Clock	583	1,479	4,862	5,791
Portable	1,386	3,528	11,926	16,428
Sub Total	2,145	5,366	18,220	24,340
Auto	1,027	1,278	6,388	7,680
Total Radios	3,172	6,644	24,608	32,020
No. Of FM In Above	2,140	3,934	15,671	17,632
PHONOGRAPHS				
Table & Portable *	339	742	2,218	3,003
Console	69	124	366	612
Total Phonographs	408	866	2,584	3,615
GRAND TOTAL **	4,983	9,096	35,527	46,361

* Includes compact and component phonograph systems.
** Excludes sales of all other consumer electronic products not indicated above.

THE DATA SHOWN ABOVE REFLECTS TOTAL MARKET STATISTICS FOR ALL PRODUCTS PRODUCED AND/OR SOLD IN THE UNITED STATES REGARDLESS OF THE BRAND NAME OR COUNTRY OF ORIGIN.

Warranty cards and field contact with service technicians have indicated that you want an accurate standard for working on FM stereo units. You have said that you need an AM and FM RF generator when you run into tuner problems. An IF generator for both AM and FM has also been high on the request list. An FM sweep and marker generator is a very important tool when



working on FM Stereo units, to assure proper bandpass for the stereo signal. A multiplex signal generator has been on top of the list of requests. A known standard stereo signal would sure beat the station signal when you are trying to dog out a stereo decoder problem. Audio generators have been asked for often, for use in amplifier testing and troubleshooting. All these instruments are service standards that make your job easier and your work better. But, consider what this array of equipment would cost.

Sencore has been answering the challenge for standard test instruments for the service industry for many years, and the requests just mentioned are some that really whet our engineering appetites. Engineering looked over the various items that were being asked for and started thinking how these needs could be answered. "If all these items are necessary for stereo AM-FM service, as we know they are, why don't we see if we can include them all in a single analyzer and keep the initial investment for the technician as low as possible.

SPECIFICATIONS

FM RF

Frequency range	86 to 110MHz
Dial calibration at 88 and 108MHz	± 200KHz at 20 degrees C
Dial tracking	± 300KHz any mark, 20 degrees C
Frequency change with temperature	± 200KHz, 10-40 degrees C
Amplitude (MICROVOLT OUTPUT set to 10 x 10) at 98MHz	100uV 10%
Amplitude tracking	20% 86 to 110MHz
Modulation	STD: 30% (22.5KHz) 20% IHF 100% (75KHz) 20%

10.7MHz IF

Frequency (center detent)	10.7MHz 1%
Rocker range	250KHz above and below center
Amplitude	.1V RMS 10%
Modulation percentage	STD: 30% (22.5KHz) 20% IHF: 100% (75KHz) 20%

10.7MHz CRYSTAL

Frequency	10.7MHz, .05%
Amplitude	.065V RMS 40%

10.7 SWEEP AND MARKER

Sweep width	500KHz typical
Center frequency	Rocker will center sweep to 10.7MHz
10.7MHz marker	
Frequency	10.7MHz .05%
Amplitude	1V p-p minimum
100KHz limit markers	
Frequency	100KHz 3%
Amplitude	40% of 10.7MHz marker typical

MPX SIGNAL

Frequency of 19KHz pilot	19KHz ± 2Hz
Phase of 19KHz vs 38KHz	Permanently locked to exceed FCC specifications with Sencore exclusive (Patented) phase lock circuit
Amplitude (modulation set to IHF)	2.5V p-p 25%

SCA 67KHz

Frequency	67KHz 3%
Amplitude	1V RMS 40%
Distortion	5% maximum

AM RF

Frequency range	525KHz to 1625KHz
Dial calibration at 560 and 1600KHz	± 5KHz at 20 degrees C; ± 10KHz 10 to 40 degrees C
Amplitude	100mV 5% at 1000KHz, 20% 525KHz to 1625KHz
Modulation percentage	25% to 45%, 30% typical

262KHz AND 455KHz IF

Frequency (in center detent)	262KHz or 455KHz 2%
Rocker frequency range	25KHz above and below center
Amplitude	.1V RMS 30%
Modulation percentage	25% to 45%; 30% typical

400Hz SINE WAVE

Frequency	400Hz 20%
Amplitude	1V RMS 5%
Distortion	5% Maximum

400Hz SQUARE WAVE

Frequency	400Hz 20%
Amplitude	2.8V p-p 30%
Rise Time	2uSec. Maximum

EXTRA CRYSTAL

Holder type	HC6U
Frequency range	3Hz - 12MHz
Circuit loading to crystal	15pf

ATTENUATOR

Step attenuator	calibrated 20db (x10) steps
Variable attenuator	
FM RF	0 to 18db typical
All other outputs	0 to 20db minimum

Output Meters: SEPARATION SCALE: Range: 0 to -40db. 0db Reference = 2.1V RMS.
Wattmeter: 0 - 10, 100 watts RMS power into selectable 4, 8, 16, or 32 ohm loads. Accuracy: ± 8%.
General: Vinyl-covered steel and aluminum case construction
FUSE: .2A (3AG slow-blow type).
SIZE: 12¼"x10"x9" (32.2x25.4x22.9 cm) HWD
WEIGHT: 18 lbs (8.2Kg).
POWER: 105-130VAC, 50/60Hz, 7W. CSA approved wiring.

Accessories:

39G43	Matching Pad with RF cable (supplied)
39G45	Detector Probe (supplied)
39G53	Auto Radio antenna adapter (supplied)
39G44	Phono plug to alligator clip cable (supplied)
39G47	BNC to Phono Plug (optional)

Most shops cannot afford all these necessary items if they must be purchased individually." So that is just what they have done. The Sencore Engineering Department has put it all together for you. The SG165 AM-FM Stereo Analyzer is the only instrument that produces all 12 signals you need for Stereo Servicing. Whether it is a small portable AM radio or a large home theater costing thousands of dollars, the SG165 will do the job. And, the most remarkable part of the instrument is the price tag, only $595.00. Compare it with units that cost up to $2500.00 (and do less) and you'll see what we mean.

The stereo business is the fastest growing part of the electronics field. If you are not now servicing these units, a look into this field might prove to be very profitable. Most stereo units cost several hundreds of dollars, some sophisticated units several thousands of dollars. When something happens, the customer wants it repaired and original performance restored. They are willing to pay to have it fixed right. They do not expect to have full service performed and new set performance from the unit for a small price. They have a goodly investment and simply want good performance.

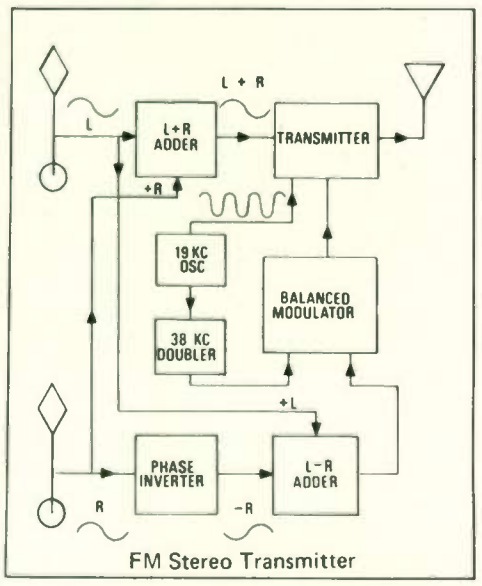
You can give them just what they want, and increase your profits this year, by investing in just one instrument; the SG165 AM-FM Stereo Analyzer. It is the only one to go all the way for full stereo servicing. The combined efforts of Motorola and Sencore have put together every test signal and convenience you will need. This includes features normally found on high priced lab gear like calibrated RF tuning, calibrated RF output level, tunable IF frequencies with the IF Rocker control, Standard and IHF modulation for FM, and separation and power output meters.

Let us show you how easy it is to get into the FM stereo servicing business and explain a little about how these units can be serviced quickly. The SG165 will "walk those troubles right out of any radio. . . . from the largest home theater to the smallest AM portable. . . .fast and easy."

WHAT IS FM STEREO? HOW DOES IT WORK?

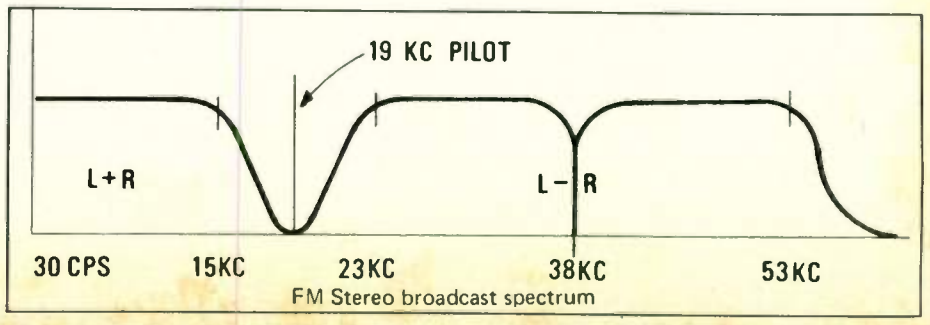
The FM stereo system is really quite simple when broken down into its basic parts. It compares quite closely with the system of transmitting color television. Let's take a close look and see how it is done.

The block diagram shown here is typical of the basic FM stereo transmitter. Since the transmission is to be stereo (or two channel), we must have two sound sources. This can be microphones, tape heads, or pickup cartridge of a turntable. The two signals are added together, in phase, to produce what is called the L + R signal. The L + R signal (Left channel input plus Right channel input, in phase) is the monophonic FM signal. This part of the transmission makes FM stereo 'compatible'. By compatible, we mean that FM stereo receivers must be able to receive and reproduce either stereo or mono broadcasts. The mono receiver must also be able to receive and reproduce a mono broadcast, and reproduce the stereo broadcast in monophonic.



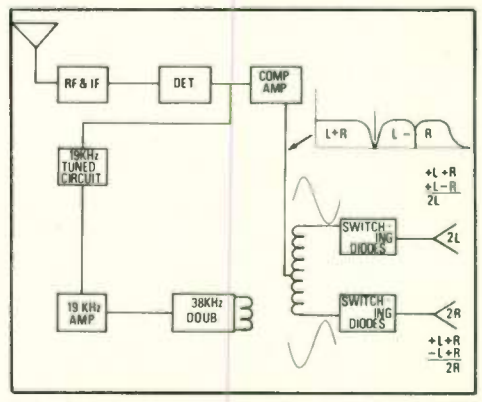
FM Stereo Transmitter

The stereo portion of the broadcast is made up of the left channel signal with the right channel signal phase shifted 180 degrees and added to the left channel information. This produces the L - R signal----left channel with minus (180 degree phase shifted) right channel added. Both the L + R and L - R signals are audio, in the range of 20Hz to 15KHz. Obviously if they were simply added together and applied to the modulator, there would be no way to separate the signals in the receiver to reproduce the original two channels of information. Therefore, it is necessary to treat one of the signals in a different manner, so it can be identified and separated by the receiver. This is the L - R signal. It is first AM modulated by a 38KHz subcarrier to produce 38KHz sidebands, corresponding to the audio information. It now has a completely different identity compared to the L + R signal. The modulator used is a balanced type that cancels the carrier frequency leaving only the sidebands. These sidebands cover a frequency range from 23 to 53KHz. The modulated L - R signal is now applied to the FM modulator, along with the L + R audio signal. We do need one other component though. Since the L - R signal is sideband information only, we must have some way for the receiver to reconstruct the subcarrier for demodulation purposes, as we do with the burst pulse in color television transmission. To permit the regeneration of the 38 KHz subcarrier, a 19KHz pilot signal (one-half the subcarrier frequency) is added to the L + R and L - R signals at the FM modulator. The complete FM broadcast spectrum is pictured here showing the relationship of the various signals.



FM Stereo broadcast spectrum

Now for the receiver. The Stereo receiver tuner, IF's and detector really are little different from the monophonic FM receiver. The only real difference is greater sensitivity needed for good FM stereo reception and a wider IF pass band to pass the full stereo signal. The major difference comes in the addition of the stereo decoder in the signal path from the FM detector to the audio amplifiers. This decoder must demodulate the signals and recover the original right and left channel information. The block diagram here is representative of a typical FM stereo receiver.



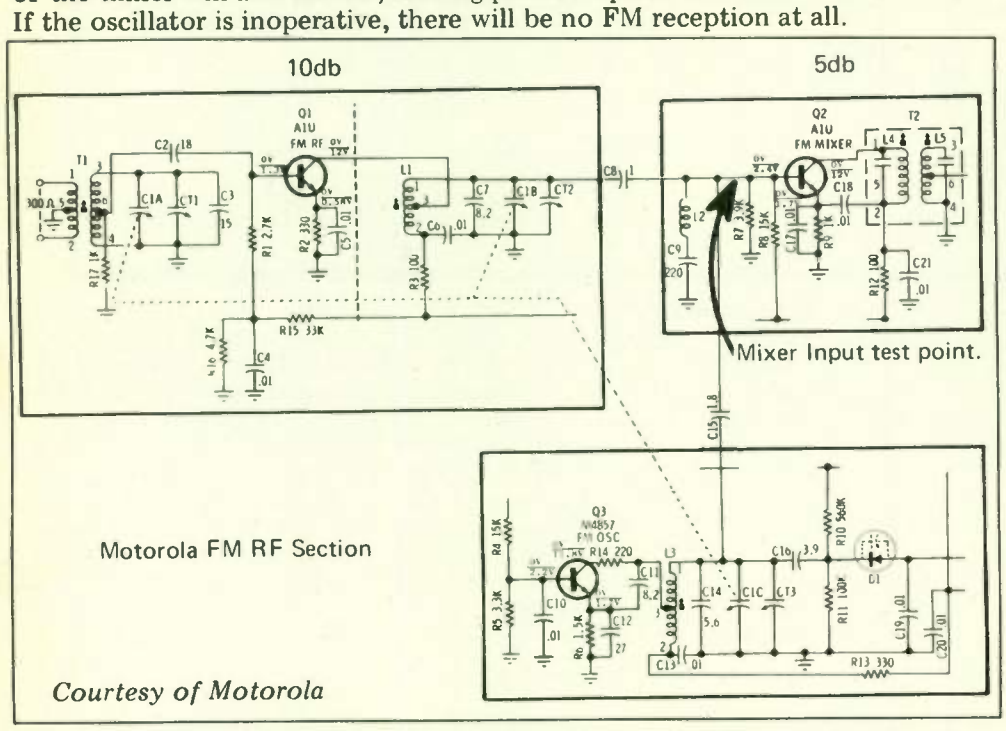
The signal present at the output of the FM detector is a composite signal made up of the L + R signal, the 38KHz sidebands of the L-R signal, and the 19KHz pilot signal. The signal is generally amplified by a stage called a composite amplifier and then signal separation begins. The 19KHz pilot signal is removed from the composite signal by sharply tuned circuits. The pilot signal is amplified and doubled to reproduce the 38KHz subcarrier necessary for L-R demodulation. The composite stereo signal is injected into the secondary of the 38KHz demodulation transformer, containing a quad diode demodulator. The L + R signal, being audio, is unaffected by the 38KHz demodulating signal and is passed through the switching diodes as they are turned on by the 38KHz signal. Therefore, the L + R signal will be present in the output of both sets of diodes. The L - R signal is demodulated by the 38KHz signal. When the 38KHz signal causes the upper end of the transformer secondary to be positive, the lower end will be negative, due to the transformer secondary.

The diodes tied to the top of the secondary will conduct and pass the L-R signal into the output. Here it is added algebraically to the L + R signal, producing 2L or left channel output. The next alternation of the 38KHz signal will turn off the upper diodes and open the diodes connected to the lower end of the transformer. These diodes will conduct and pass the L - R signal present during their on time. This signal will be 180 degrees out of phase with the L - R signal present at the top of the transformer and the diode output will be - (L - R) or - L + R. This signal is added to the L + R present in the output producing 2R or the right channel signal. (More detail on the operation of the stereo decoder is contained in the section of this issue related to troubleshooting the decoder.) The outputs are fed through a de-emphasis network and then on to the audio amplifiers.

Understanding the bandwidth, sensitivity and decoding system used for FM stereo, points out how important a standard set of signals is for correct troubleshooting, servicing and alignment. This is the purpose of the SG165 AM-FM Stereo Analyzer. Let us show you how it will help walk the trouble out of the various circuits of the AM-FM Stereo receiver.

WALKING THE TROUBLE OUT OF RF CIRCUITS

The block diagram presentation shown here is from a Motorola model FH200-HW receiver, and will be the unit used throughout the troubleshooting sections. The RF circuits are straight-forward, containing an RF amplifier, FM oscillator, and FM mixer stages. These are critical stages for several reasons. These stages are responsible for the initial selectivity and sensitivity of the receiver. If the RF amplifier stage is not performing correctly, the sensitivity will be poor. The result will be noise in the output or poor reception of more distant stations. The oscillator normally operates 10.7MHz above the incoming RF signal. If the oscillator output is low, the signal present in the output of the mixer will also be low, causing poor reception and much lower volume. If the oscillator is inoperative, there will be no FM reception at all.



Motorola FM RF Section

Courtesy of Motorola

The mixer is the first conversion for the signal in the receiver. The mixer stage heterodynes with the signal generated by the local oscillator, producing the 10.7MHz IF difference signal. From a standpoint of gain values, the RF amplifier will usually have a gain of about 10db, and the mixer will give a conversion gain of about 5 to 6db. We will show a bit later how these values can be checked.

One of the most important considerations for the RF stages is that they be correctly aligned. If they are not, performance of the system will suffer greatly. They must be able to pass the entire signal component that is broadcast, and amplify it. The tracking of the FM oscillator must be correctly set or the tuning dial will be practically useless. The range of the local oscillator must be greater than the range of the FM broadcast band if its performance is to be acceptable.

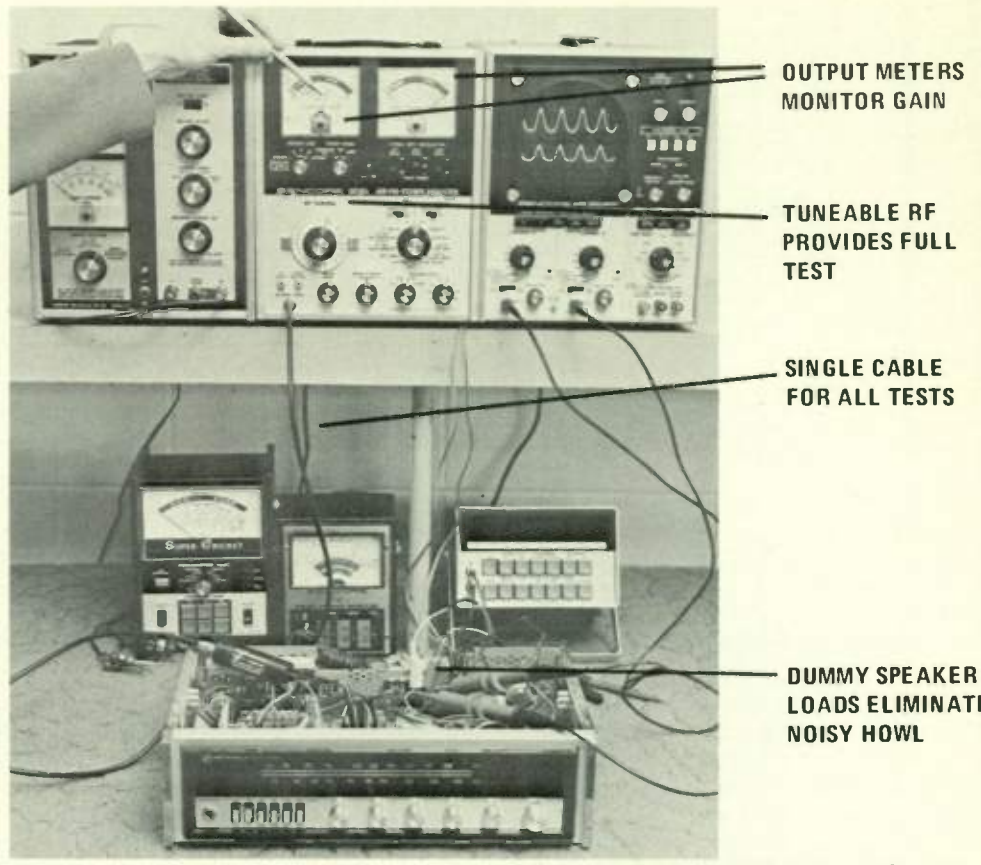
The SG165 has all the RF signals necessary to check and align the complete tuner of the FM receiver. Calibrated RF signals with calibrated microvolt output controls make it possible to set the tuner and test it precisely as the manufacturer suggests. The SG165 is the only instrument that provides you with 100% (IHF) modulation level called for by many manufacturers. Easy to read db scales on the separation meters make it possible to determine the db gain of each stage as easily as you would take a voltage measurement. The SG165 can help you lick any FM RF problem you may have.

A look at the schematic diagram for the Motorola tuner will give us the type of information needed to judge performance. The db gain of each stage has been added, as well as the alignment points and frequencies called for by Motorola. Now let us put a trouble into the tuner to show how the SG165 will help walk the trouble right out.

WHAT ABOUT RF TROUBLESHOOTING?

The problem we have placed in the tuner of the Motorola receiver is an open vari-cap diode in the AFC circuit, D1. We should note at this point that the trouble inserted for troubleshooting explanation in this and other sections of this issue do not indicate problems that are associated with this brand of tuner. These are problems that could be encountered in any unit, and many are problems that you may have faced in the past. The problems are in no way intended to reflect on the quality of Motorola products.

The symptoms explained by the customer are: Reception seems OK on the lower end of the band, near 90MHz, but nothing on the high end. Well, lets see what we can find out by making some quick checks with the SG165. We first connect the dummy speaker loads, 16 ohms for this tuner/amplfiier, and switch the Power Range switch to the Separation Test position. This gets rid of the howl and also gives us a good indicator for set performance. Next, we tune the dial to 90MHz and inject a modulated stereo signal from the SG165 to check operation on the low end. Turn receiver volume to full clockwise, (maximum) and adjust the SG165 Microvolt output controls for full scale reading on the Separation meters. This occurs at a setting of X10 and about 3.2 for the SG165 controls. This gives us a base for sensitivity tests at other points on the band. Now, lets see about the high end of the band. Change SG165 RF setting to 106MHz and tune the receiver dial to the



same point. Nothing! Even with full RF output of 10,000 microvolts. Retuning the receiver dial around 106MHz gets us nowhere. . . . . .until we reach 102MHz. Now we are picking up the SG165, but gee whiz the frequency of the tuner is off. The sensitivity is also down since it takes twice as much output from the SG165 to get full scale on the meters. Something is really off base. With the tuning that far off, something must have happened in the oscillator circuit.

DC voltages show everything to be alright so the problem must be the AC type, but what? Semiconductors are the first suspect, but the oscillator is running with the right voltages so it should be good. The only other device in the circuit is the vari-cap diode. The ohmmeter shows it open. Replacing the diode gets the dial back to approximately where it should be. Now all we have left is to realign the RF section to get it back to exactly where it should be.

The SG165 with its fully variable, calibrated RF tuning and calibrated RF output made short work of what could be a real sticky problem. The SG165 is the only stereo generator or analyzer that will help you with RF problems in this way. *It is the only* instrument to give you FM RF tuning across the entire FM band.

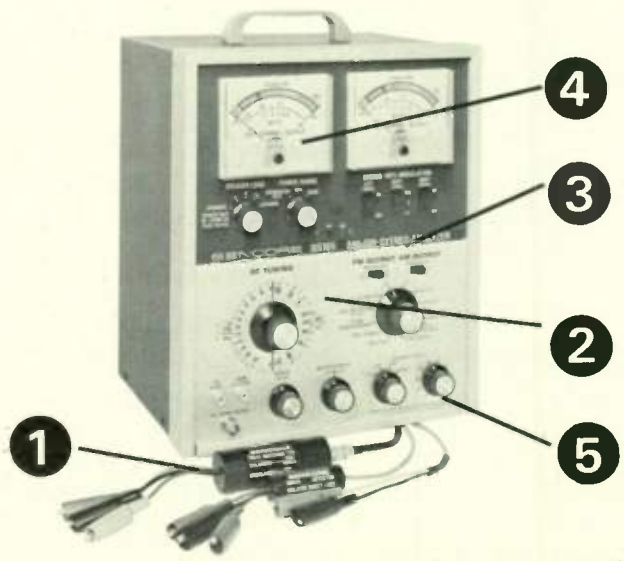
WHAT ABOUT RF ALIGNMENT?

The SG165 makes alignment of FM RF circuits a snap. The calibrated FM RF tuning, the calibrated RF output level, and choice of either standard

STEP	GENERATOR CONNECTION	GENERATOR FREQUENCY	GANG SETTING	FUNCTION SWITCH	OUTPUT INDICATOR	ADJUST	REMARKS
FM RF ALIGNMENT							
5 (1)	Antenna thru matching pad (see detail) (2)	108.5MHz 75KHz Dev.	Full open (3)	FM Mono-stereo switch to mono. AFC switched off	Output meter across speakers or 16 ohm loads (4)	FM oscillator trimmer CT3	Adjust for maximum. Reduce generator output as required to prevent limiting. (5)
6	Same	87.5MHz 75KHz Dev.	Full closed	Same	Same as Step 5	FM Oscillator coil L3	Adjust for maximum.
7	Same	106MHz 75KHz Dev.	Rock gang at 106MHz	Same	Same as Step 5	FM RF & ANT trimmer capacitor CT2 & CT1	Adjust for maximum.
8	Same	90MHz 75KHz	Rock gang at 90MHz	Same	Same as Step 5	FM antenna & RF coils L1 & T1	Adjust for maximum. Check for proper tracking.

Repeat Steps 5, 6, 7 & 8 until no further increase.

Courtesy of Motorola



A complete RF Analyzer and alignment generator.

(22½KHz deviation) or IHF (75KHz deviation) gives you everything you need for front end alignment. The built in separation and power meters serve as a convenient output monitor to further simplify the procedure. No need for extra meters to do the RF alignment. A quick run through the alignment of the RF section of the Motorola tuner will show how quickly and easily it is done.

The alignment procedure for virtually every brand of tuner calls for adjustments at both the high and low end of the band for proper tracking. Some manufacturers, such as this Motorola, call for checkpoints which are outside the FM RF band. An instrument that does not provide tunable RF extending beyond the normal FM band will leave you holding the bag when it comes to accurate RF alignment. The SG165 is the only instrument that gives you full stereo analyzing capability, including calibrated, tunable RF output that covers the full FM band. The SG165 covers a range from 86 to 110MHz to make sure you can set the bandspread adjustments on any tuner you may be working on.
The SG165 takes all the drudgery out of FM servicing!

WHAT IS THIS SENSITIVITY TEST?

The sensitivity test indicates the input signal level required to provide a signal output 30 db above the noise level. This is a measure of how well the receiver will perform in weak signal areas, and also a final check on alignment and tuner performance. The procedure is very simple and requires no equipment other than the SG165 and an oscilloscope. Here is the procedure for checking receiver sensitivity as given in the SG165 Instruction manual.

CHECKING THE SENSITIVITY OF AN FM RECEIVER

Sensitivity test from SG165 Service Manual.

The sensitivity test as made with the SG165 is a measurement of the signal (measured in microvolts) necessary to produce a 30db signal plus noise to noise ratio. Results of this test will be of sufficient accuracy to compare with the published IHF sensitivity of the receiver for test and troubleshooting purposes.

The graph in Fig. 33 shows the effect on the level of the noise and signal outputs of a receiver with respect to the input signal. Note that the noise decreases and the signal increases as the input signal increases. At some point, while the output signal is increasing and the noise is decreasing, the ratio between them will be

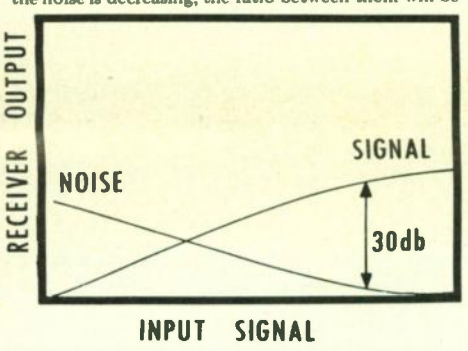


Fig. 33 Effect of Input Signal on Receiver Outputs

31 to 1 (30db). This is the point at which the sensitivity measurement is made. To make the sensitivity test, proceed as follows:

1. Set up the receiver and the SG165, and make connections as in steps 1 through 8 in CHECKING A RECEIVERS STEREO SEPARATION.

2. Switch the LEFT and RIGHT 400Hz ON and and the PILOT 19KHz to zero. Set the FM MODULATION to IHF MPX, and connect the vertical input of an oscilloscope to one of the receivers speaker terminals.

3. Fine tune the receiver as necessary to produce an undistorted output as shown in Fig. 34A, and adjust the receivers volume control for 3 volts p-p.

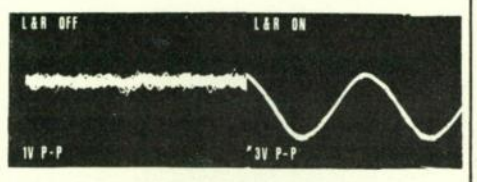


Fig. 34 db Signal to Noise = 3.0 x .1 or 30db

NOTE: If it is not possible to eliminate the third harmonic distortion from the output signal by careful fine tuning, insufficient FM IF band width is indicated. Refer to the FM IF Alignment section of this manual.

4. Switch the LEFT and RIGHT 400Hz OFF, and measure the ratio between the signal and the noise. A measured ratio of greater than 30db indicates excessive input signal. Reduce the settings of the MICROVOLT OUTPUT controls until the ratio equals 30db. A measured ratio of less than 30db indicates insufficient input signal. Increase the setting of the MICROVOLT OUTPUT controls until the ratio equals 30db. Refer to the graph in Fig. 33 to understand the input signals affect on output signal and noise.

5. Note the setting of the MICROVOLT OUTPUT controls, and multiply the setting of the coarse control times the corrected output of the fine control from the table below. When using the 39G43 pad, or the 39G53 dummy antenna, multiply the result by .5 to find the actual input signal to the receiver. This is the sensitivity in microvolts.

CONTROL SETTING	CORRECTED OUTPUT
10	10
9	8.1
8	6.4
7	5.1
6	4.0
5	3.0
4	2.4
3	1.8
2	1.4
1	1.2

NOTE: Output level specifications only valid when ALL SIGNALS OUTPUT terminated in 75 ohms.

The SG165 is a complete analyzer and alignment generator for the RF section of any FM receiver. It really walks those troubles out fast, and then realigns and tests the receiver for its performance. You know its right when you use the SG165.

WALKING THE TROUBLES OUT OF IF CIRCUITS

The IF circuits of the FM receiver play essentially the same roles as the IF's in the television receiver. They are responsible for the majority of the signal gain of the receiver (sensitivity) and the rejection of unwanted transmitted signals (selectivity). The IF's also set the signal bandpass for the desired RF signal. When dealing with FM stereo, the performance of the IF's is more critical than in mono receivers. Any phase shift in the IF's or poor response will greatly degrade the stereo signal. It is important, therefore, to have some

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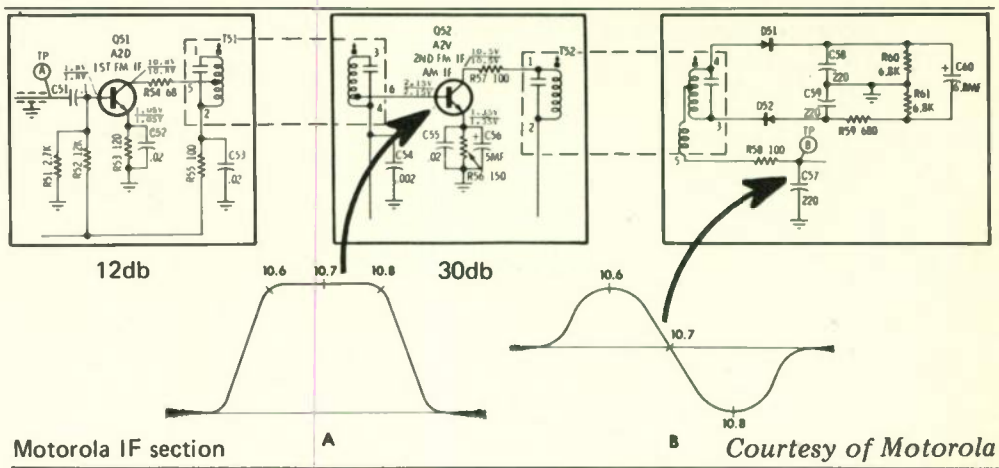
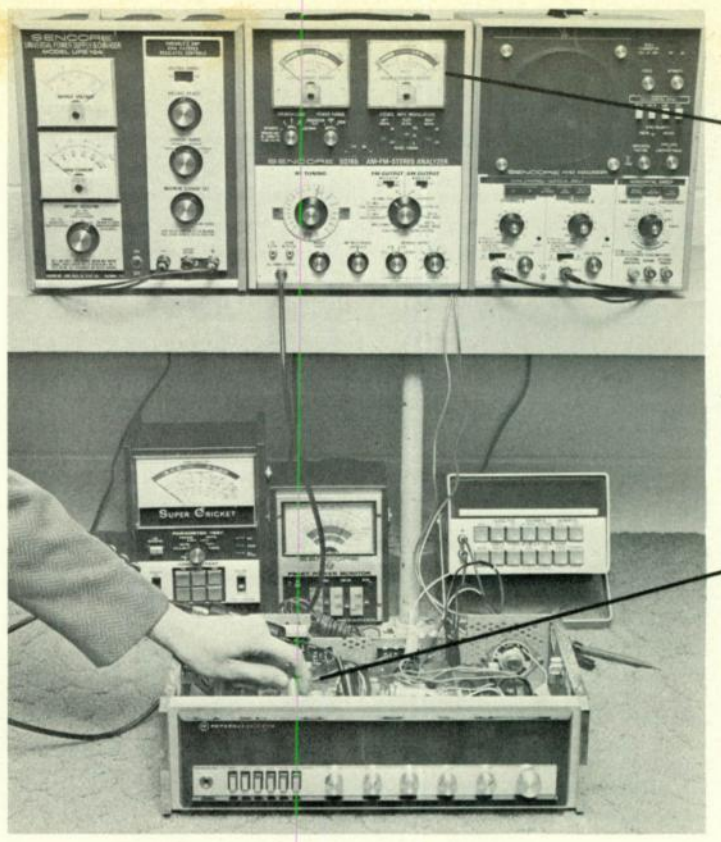


Motorola IF section *Courtesy of Motorola*

means of checking the IF's very thoroughly. Here is the IF section of the Motorola tuner.
It is typical of the systems used in the current receivers, with the exception of the newer sets with crystal filter IF's. Gain figures have been given in addition to the normal schematic information so you can relate to individual stage gain. The diagram also shows the normal signals expected from the IF's. The sweep response is shown for both the IF's and the ratio detector output. The important points to observe are the overall amplitude of the response curve, which indicates gain, and the proper marker positions, which tells us the bandpass of the IF's. The ratio detector "S" curve should be very linear (i.e. a straight line between the band limit markers at 10.6 and 10.8MHz) and the carrier marker, 10.7MHz, should be exactly on the baseline. The SG165 with its full compliment of IF outputs, 10.7MHz modulated or unmodulated, 10.7MHz crystal controlled CW, and 10.7MHz sweep with markers, gives you every signal you need for IF troubleshooting & alignment.

WHAT ABOUT IF TROUBLESHOOTING?

We will use another trouble example to show how the SG165 can really help you walk the troubles out of the IF section. The trouble we will use is an open emitter bypass capacitor on the first IF stage. The symptoms are: normal AM, FM has poor reception, especially on distant stations, and low volume. This type of problem turns out to be a bit of a dog trouble. DC voltage checks show everything normal. The fact that AM is ok indicates that the trouble is not in the 2nd IF, which is common to both AM and FM. Signal injection with the SG165 gives us the opportunity to find the trouble



fast. First, we connect the SG165 dummy speaker loads to the output terminals, so we don't have to listen to all the noise and squeals. This also gives us the dual meters for monitoring the receiver output during tests. We will walk through looking at the gain of the individual stages. Set the SG165 to 10.7MHz IF and full stereo modulation. Inject the signal into the base of the 2nd IF and adjust the Microvolt Output controls of the SG165, and the volume control of the receiver, until the meters indicate 0db. Now move the signal injection to the collector of the 2nd IF. The meters indicate -30db, showing the gain of the 2nd IF stage to be 30db. This should be an acceptable gain figure. The 1st IF is next. Inject signal into the base of the first IF and adjust SG165 output and receiver volume for 0db indication on the meters. Now move to the collector of the stage and observe the meters. Full scale plus! This shows that there is more output from the amplifier with the signal input at the collector than there is with signal input at the base, the reverse of a normally operating stage. Resetting the meters to 0 db with the signal at the collector we move back to the base. The meters now show

-8db, or a signal loss of 8db in the stage. Here is our culprit! Now to find the problem.

As we said earlier, the voltages all check ok. The transistor checks ok too. Something is preventing the stage from providing full gain - and the most likely thing is the emitter bypass cap. Substitute a capacitor from the RC167 "The Substitutor" and the gain returns to normal. A trouble of this type could really cause you to pull out your hair if you didn't have the SG165 to evaluate the performance of each stage. It will really help pinpoint the troubles fast.

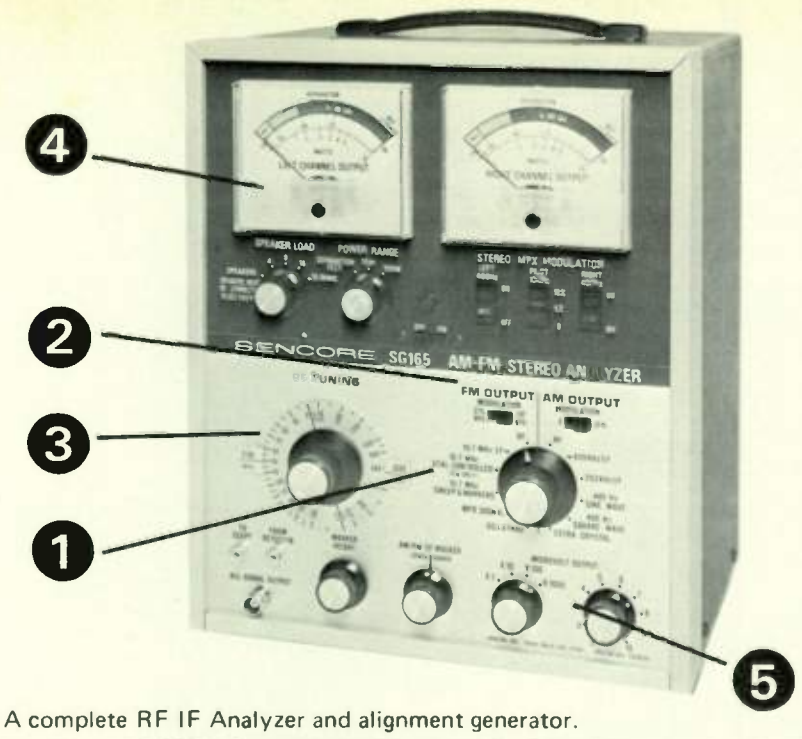
WHAT ABOUT IF ALIGNMENT?

IF alignment in FM receivers is very much the same as that of a television receiver. The SG165 has full capability of FM IF alignment, using either a crystal controlled CW signal for straight through peaking of the coils, or 10.7MHz sweep with post-injected crystal controlled markers. The Motorola procedure shown here calls for peak alignment of the IF's using a 75KHz deviation signal. This is the 100% modulation or IHF position of the SG165. The procedure is very simple and easy to follow. The first two steps require an FET meter to be connected to test point B as the signal monitor. The last two steps use the output meters of the SG165 as the indicator. Those meters sure keep coming in handy for all kinds of things.

FM IF ALIGNMENT

1.	Test point Ⓐ 1st FM-IF Amp input through a .01 mf capacitor. Ground side to gang frame.	10.7MHz ❶ 75KHz dev. ❷	Closed	FM Mono-stereo switch to mono. AFC switched off.	VTVM to test point Ⓑ	Detune ratio detector secondary (top slug of T52)	Switch AFC off. Detune until an output is obtained on the VTVM. Place 2.7 ohm resistor across generator (refer to preliminary procedure)
2.	Same as Step 1	Same as Step 1.	Same as Step 1.	Same as Step 1.	Same as Step 1	Adjust T51 (top & bot) & T52 bottom	Adjust for maximum. Reduce output of generator.
3.	Antenna thru matching pad (see detail)	❸ 98MHz 75KHz Dev.	98MHz 75KHz Dev.	Same as Step 1	Output meter across speaker or 16 ohm load. ❹	T2, top & bottom (mixer output)	Adjust for maximum. Keep generator output below limiting level. ❺
4.	Same as Step 3	Same	Same	Same	VTVM to test point Ⓑ	Adjust ratio detector secondary (top slug of T52)	Adjust for zero output, a positive or negative reading will be obtained on either side of the correct setting.

Courtesy of Motorola



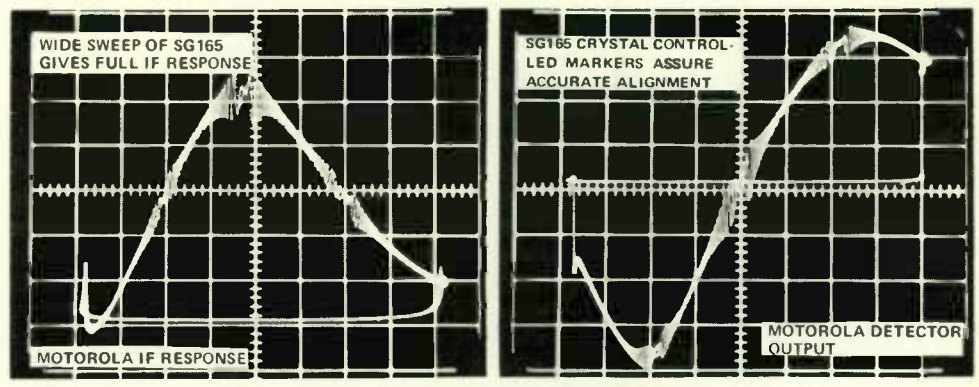
SG165 - A complete RF IF Analyzer and alignment generator.

Other manufacturers, such as Zenith, call for sweep alignment of the IF's. The following note from their service manual re-emphasizes the importance of bandpass in the IF stage of FM stereo units.

> Because of the wide band pass required in the multiplex FM tuner, it is desirable to use an FM signal generator having a deviation of 400 KHz with a sweep rate of 60 Hertz as well as an oscilloscope when aligning both the IF and RF FM portions of this receiver. It is not only necessary to obtain maximum amplitude in the IF amplifier stages, but also necessary to maintain symmetry. To help achieve this symmetry, it is desirable to have 10.6, 10.7 and 10.8 megacycle markers in obtaining IF curve symmetry.
>
> *Courtesy of Zenith*

The SG165 provides both the 400KHz deviation and 60Hz sweep called for in the Zenith instructions. The markers are the exact 10.6, 10.7, and 10.8 MHz recommended by Zenith and virtually all other manufacturers.

After aligning the Motorola IF's by the procedure listed in the Motorola service manual, we switched over to 10.7MHz sweep and markers to see what the response curve looked like. Sweep alignment of FM is generally much simpler than alignment of the color television IF's because there are less stages involved and no traps to set. The IF response of the Motorola receiver is shown here.



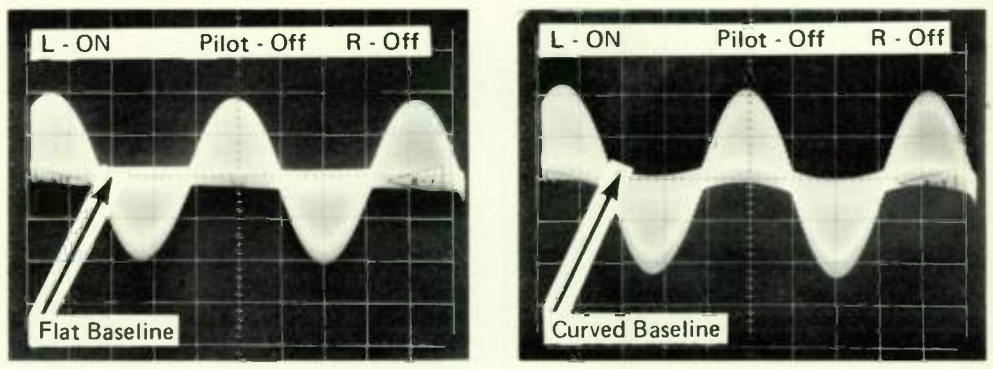
The IF response signal was observed at the base of the 2nd IF, using the SG165 detector probe, and sweep signal injection at the base of the mixer. The "S" curve of the ratio detector shown here was observed with the SG165 detector probe connected to the audio output test point TPB. These are the type of response curves that should be seen when the receiver is performing correctly.

We have said that the SG165 is a complete AM-FM Stereo Analyzer. We have designed it to be complete, including all the necessary RF, IF multiplex, and audio signals needed, including the crystal controlled 10.7MHz and 10.7MHz sweep with markers for complete alignment. Aligning the IF sections according to the manufacturer's procedures is a snap because you just turn the one function control for all the signals you need.

IS THERE A QUICK METHOD FOR IF TOUCH-UP?

The SG165 can be used with the PS163 Dual Trace Scope to "eyeball" the IF touch-up alignment with the "flat baseline" method developed by Sencore's Field Engineering Department. A picture is worth a thousand words, they say, and getting this "picture" is easy with the SG165.

First, peak the IF's using the 10.7MHz crystal controlled signal from the SG165 injected at the mixer test point, and use the output meters as the monitor. Now we switch to the FM RF output and put the RF signal into the antenna terminals. The SG165 is set for the left channel 400Hz modulation ON and the 19KHz pilot is turned OFF. We use the PS163 Dual Trace Scope to pick up the signal at the FM Detector test point, and sync the scope to the B channel connected to the speaker terminal. The composite multiplex signal we see should have a flat baseline, like that shown in the left photo.



FLAT - BASELINE IF TOUCH – UP

If there is curvature present in the baseline, like the waveform at the right, it shows that there is a phase shift occuring in the IFs. The bandpass of the IF has been peaked, but it is not centered to the correct frequency for linear amplification of all the FM sidebands. The non-linear amplification causes the phase shift. What we want to do is align for minimum phase shift. The less phase shift we have in the IFs, the better the stereo separation, since the decoding is dependent on proper phasing for best separation. We just adjust each of the IF slugs slightly until the scope display shows a flat baseline. Now the IFs are set up. This method is easier and faster than the procedures they give in the receiver manuals, and it really works because the SG165 has both the crystal controlled IF frequency, and the RF signal, plus the output meters we need to perform this alignment.

WHAT ABOUT SETS WITH CRYSTAL FILTER IF'S?

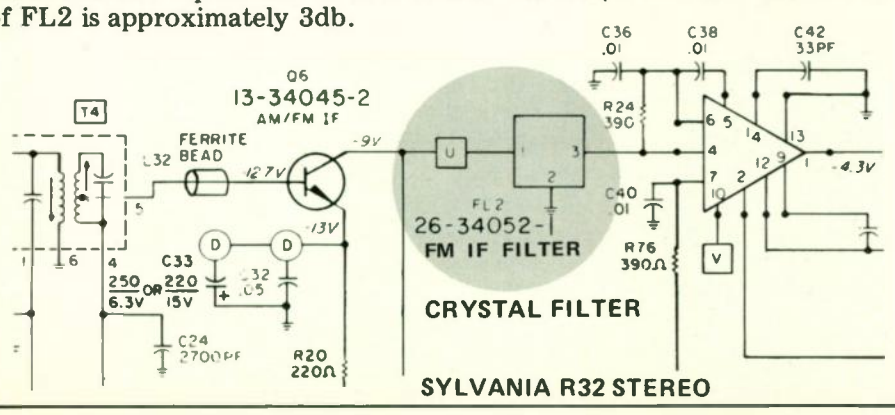
The new trend in receivers is to use non-tunable crystal or ceramic filters in place of IF transformers. These filters are specially designed crystal units giving a very accurate bandpass for the FM IF frequencies. The IF filters used in a given receiver are matched, to provide the same IF frequency. The IF frequency may not be the 10.7MHz we are accustomed to, but will fall in the frequency range between 10.625 and 10.775MHz. The following excerpt from the Sylvania service manual for the R32 stereo chassis should sum up the nature of crystal filters for you.

FM IF, LIMITING AND DETECTION

The key to the IF section is FL2. The resonant frequency of this ceramic filter is between 10.625MHz and 10.775MHz — exact frequency is indicated by the color dot on the case.

Let us assume that in this case the color dot on FL2 is violet, indicating a resonant frequency of 10.775MHz. This will be the IF frequency of this particular receiver. Therefore, T4 primary and secondary are tuned to 10.775MHz. The signal induced in T4 secondary is direct-coupled to the base of Q6 for further amplification. A ferrite bead (L32) on the base lead of Q6 provides parasitic suppression.

The next stage is the ceramic filter (FL2). The filter shows band-pass characteristics equivalent to two double-tuned L/C circuits. Insertion loss of FL2 is approximately 3db.



Now here is where a problem might develop. Since the IF filters are fixed (not tunable) and their frequency is not 10.7MHz exactly, how do you check to see if they are working right or not? The generators providing only a fixed 10.7MHz output will not permit accurate checking of these IF's. This is why the SG165 has the IF ROCKER control. This control varies the center IF frequency of the generator in the range between 10.450 and 10.950MHz, specifically to allow tuning of the generator output to match the frequency of the crystal filters.

A glance at the Sylvania alignment procedure for their R32 chassis will show why this is so important with many sets going to fixed IF's. The note given in step one to "tune generator sweep frequency to obtain maximum indication" will become a commonplace term in alignment procedures. The SG165 is equipped for the new crystal filter sets, with exclusive IF Rocker to vary the IF frequency over the range used by crystal filters. This is one of the up-to-date features added to the SG165 by cooperative engineering between Motorola and Sencore. It also varies the frequency of the AM IF output as well, as many companies have indicated that they will be using the same type of fixed filters in their AM products. The SG165 is up to date for every stereo servicing need.

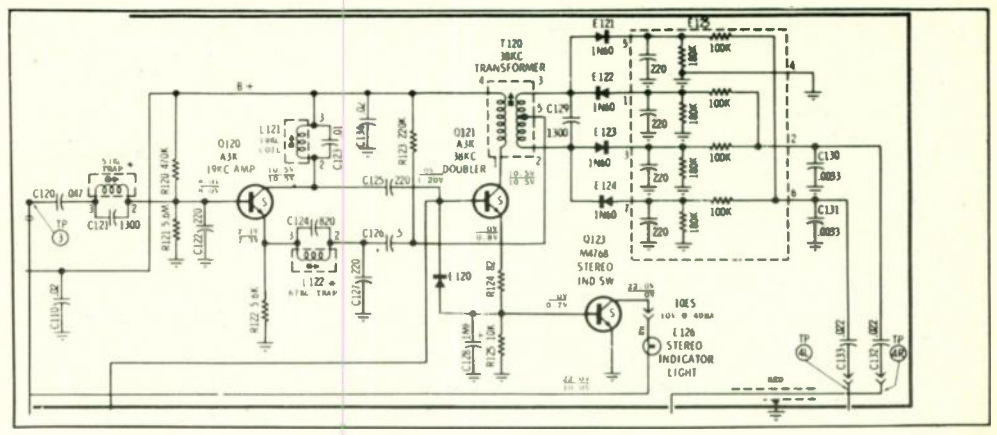
FM ALIGNMENT PROCEDURE — SYLVANIA R32 ALIGNMENT					
STEP	TUNING INDICATOR SETTING	TEST EQUIPMENT HOOK-UP	GENERATOR FREQUENCY	ADJUSTMENT POINT	ADJUST FOR
FM IF					
1	At point of no interference.	SWEEP GENERATOR - To emitter of Q4 through probe #2. Use approx. 10mV RF sig. level. SCOPE - To pin [V] through probe #3.	Approximately 10.7MHz - adjust sweep frequency for max. indication before aligning T4. (Use 75kHz deviation)	[T4] Bottom [T4] Top	Maximum waveform amplitude and symmetry. See Fig. "A", pg. 23

Only the Sencore SG165 provides IF Rocker for aligning Crystal Filter Receivers.

Courtesy of Sylvania

WALKING THE TROUBLE OUT OF STEREO DECODERS

The MPX decoder is the heart of the FM stereo receiver. This section must be able to separate the L + R and modulated L - R signals, add them correctly, and produce left and right channel output signals with a high degree of separation. The separation between the two channels, as far as crosstalk is concerned, determines the stereo effect heard by the listener. Let us run through a typical stereo decoder to get a better idea of what takes place.



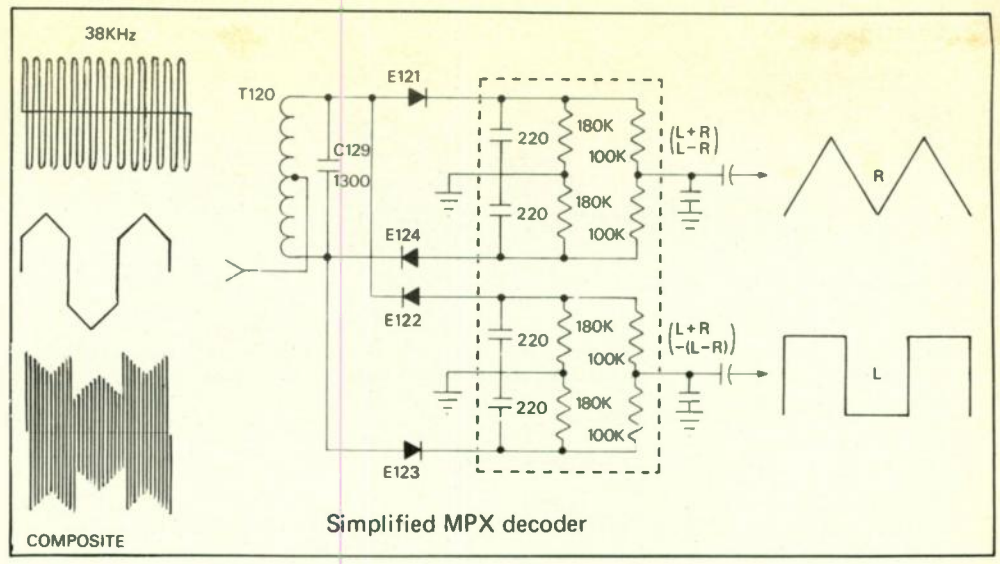
Courtesy of Motorola

The composite signal input to Q120 contains L + R audio signals, modulated L - R signal (38KHz sideband information) and the 19KHz pilot signal. The schematic/block diagram shown is from an older Motorola receiver using discreet components rather than an IC, to help clarify the MPX decoder. The first stage, 19KHz Amp, is actually both a 19KHz amplifier and a composite amplifier.

The composite signal is taken off at the emitter of the stage and passed through a 67KHz SCA trap to remove any storecast information. The composite is then applied to the center of the 38KHz transformer secondary.

The 19KHz pilot signal is amplified by the transistor, Q120, and applied to the 38KHz doubler. The doubler is simply an amplifier stage with its collector transformer tuned to the second harmonic of the 19KHz pilot, 38KHz. The 38KHz signal developed is applied to the detector diodes, along with the composite signal. The important consideration for the 19 and 38KHz stages is that the output signal amplitude be maximum and the phase be correct. If either is not right, the separation and stereo output will be poor.

Now the stereo detector. The L + R signal is audio at this point and is not affected by the demodulation process used to recover the L - R signal. Since the signal is injected at the center tap of the secondary of the transformer, it will be the same phase at both the right and left channel output load resistors. The modulated L - R signal is applied to the center tap of the secondary also, and is gated or switched at a 38KHz rate between right and left outputs.



Simplified MPX decoder

Looking at a sample signal as shown here, using a square wave signal on the left channel and a triangular signal for the right channel, we can more easily explain the action of the decoder. When the 38KHz signal is positive on the top of the transformer secondary, diode E121 will be switched on. During this same time, the bottom of the secondary will be negative with respect to the centertap and diode E124 will be conducting. The composite signals is positive going at both points and the resultant output would be a positive going L - R signal. This would be added to the L + R audio signal passed by the diodes during their on time. The result would be Left channel signal. (L - R plus L + R equals 2L)

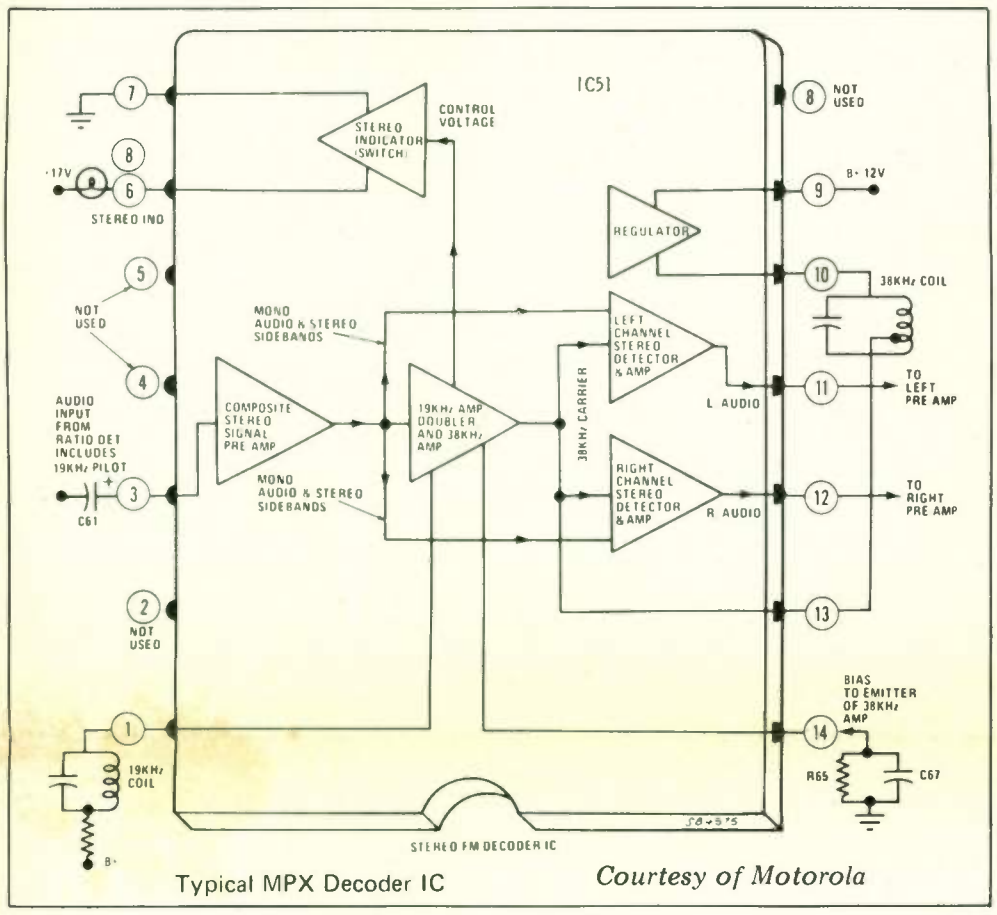
During the next alternation of the 38KHz switching signal, the diodes E122 and E123 will be on. The composite signal is negative going during this time and the result will be negative going L - R signal in the output or -(L - R). The additive result of the -(L - R), and the L + R audio signal passed during diode on time will be the right channel signal. L + R plus -(L - R) equals L + R plus -L + R or 2R. Obviously, if the phase of the 38KHz switching signal does not correspond exactly to the phase of the 38KHz modulating subcarrier in the transmitter, some right channel information will appear on the left channel and vice versa. This will cause poor separation. This is why it is so important to be sure the phasing or separation controls are properly set. Good separation will be above 20db between channels, with some of the newer IC jobs having separation capability above 40db.

The right and left audio signals are then applied to the audio amplifiers. This is how it works, now lets see how to get it going again if it should quit.

WHAT ABOUT TROUBLESHOOTING THE DECODER?

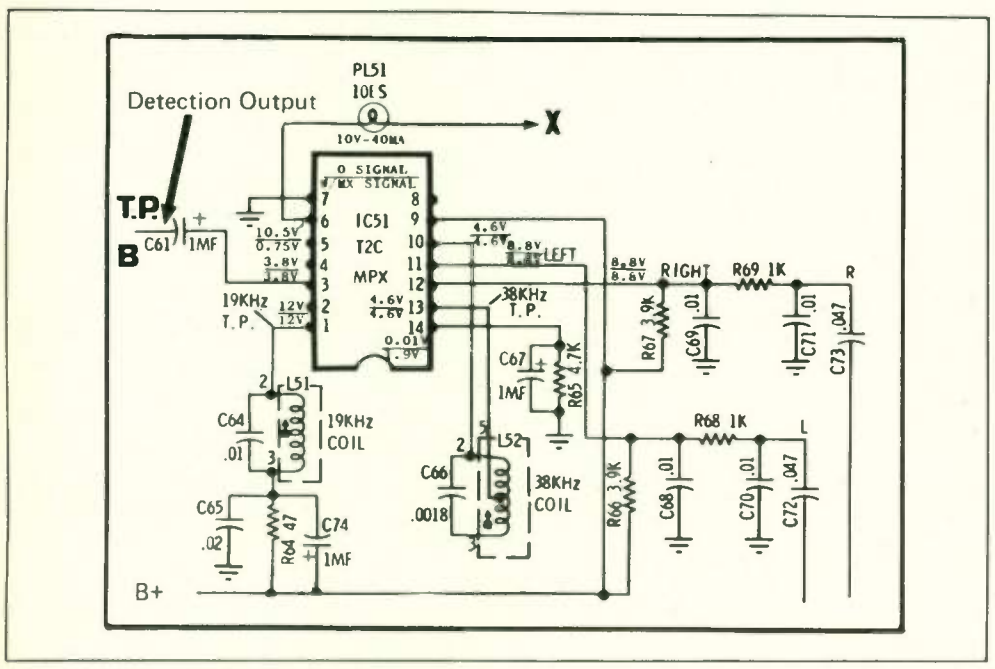
From the above explanation, we should have determined that we must have composite signal, 19KHz signal, 38KHz signal and right and left audio output. These are the key things to look for when working in the decoder area. Without the 19 or 38KHz signal, there can be no demodulation of the L - R signal and the output of the receiver will be strictly monaural. If the composite is low or missing, the output will be at a low level or missing entirely. The stereo indicator lamp or meter will usually show us if the 19KHz pilot is present and if the 19KHz amplifier is working. In many receivers, such as the older Motorola shown above, it will indicate the presence of 38KHz signal as well. The stereo light is an important indicator for fast stereo troubleshooting.

Now we will put a trouble in to show you how the SG165 will help you find it and get it going fast. The Motorola tuner being used contains an IC with the complete multiplex decoder in a single clip. The block diagram of the IC shows that it performs the same functions as the discreet components in the schematic used for decoder explanation.



Typical MPX Decoder IC *Courtesy of Motorola*

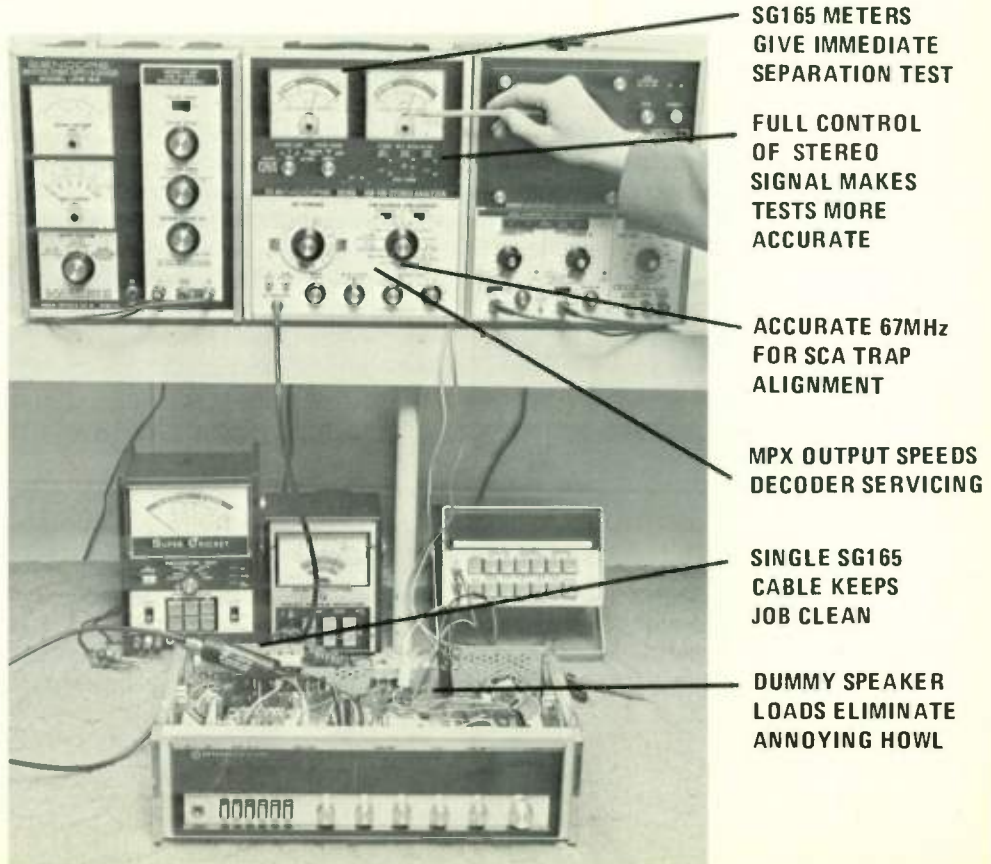
If the trouble is suspected to be in the IC, scope checks for the correct signals and DC voltage measurements should isolate it for you.



Motorola FM Stereo decoder circuit *Courtesy of Motorola*

The problem we will use is an open 19KHz transformer. The symptoms are no stereo, FM monaural ok. Stereo indicator light on. Since the stereo indicator lamp is on, the problem should be somewhere in the stereo decoder circuit. To troubleshoot this section, we will inject a composite multiplex signal from the SG165 to the output of the FM detector, test point B. The dummy loads are connected and the meter range is set for Separation Test so we may monitor the separation of the receiver. SG165 Stereo MPX Modulation controls have both right and left channels on and the pilot is 10%.

The first check is for actual separation so we can see what we have at the beginning. We adjust the Microvolt Output controls to X1000 and 5 to provide sufficient composite input. Next we adjust the volume control of the receiver until both meters indicate 0db. Switching the right channel off for a separation test causes both meters to drop to about minus 7db, indicating absolutely no separation. Now it is time to get the PS163 into the act. The composite signal at the input to the IC, pin 3, looks normal. The 19KHz pilot test point shows zero signal. DC checks with the DVM38 3½ digit Digital Multimeter shows 0 volts DC at pin 3 of the IC and normal voltage at the junction of the 19KHz transformer and R64. Has to be the transformer. Replace the defective transformer and readjust the alignment of the MPX decoder. Having a known standard signal with full control of right and left signals and pilot level sure makes walking the trouble out of stereo decoders easy. This SG165 is some kind of machine!



WHAT ABOUT MPX ALIGNMENT?

The alignment of the stereo decoder usually consists of adjusting the 19 and 38KHz transformers for maximum signal, and then tuning them slightly for best channel separation. The adjustment for best separation sets the phasing of the 38KHz signal to the correct point for optimum demodulation and, as a result, the best separation. This procedure is accomplished accurately only by using a multiplex signal from a generator, and the SG165 makes it easy. The alignment should be done from the antenna terminals with an RF signal, to be most accurate, since some phase shifting can take place between the tuner and the MPX decoder. Many manuals carry a note similar to the one shown here taken from the Zenith service manual HF25.

> Multiplex generators provide a composite multiplex signal as well as an RF signal, which is FM modulated by the composite multiplex signal. The composite signal is very useful since it is an excellent tool that can be used in signal tracing the multiplex portion of the receiver. We do not recommend that multiplex alignment be made using only the composite signal injected at the output terminal of the ratio detector tertiary winding, since there is always some phase shift occurring in the RF, IF or Ratio Detector circuits. As a result, multiplex alignment made by a signal injected at the Ratio Detector would not be correct. For proper multiplex alignment the composite signal must FM modulate the RF carrier and then be fed into the FM antenna terminals. With the signal injected in this manner, the multiplex alignment would then be the best that could possibly be obtained, and separation would be at the maximum for this receiver.
>
> *Courtesy of Zenith*

Obviously, a multiplex generator that does not have stereo multiplexed FM RF will not be able to give accurate alignment results. The SG165 has this modulated FM RF, at both standard and IHF modulation levels. The SG165 helps you get the job done the way the manufacturers suggest, for consistantly good results.

The multiplex alignment procedure itself is quite easy. Just connect the SG165 to the antenna terminals and adjust for IHF or 100% modulation (75KHz deviation) of the multiplexed signal. Adjust the 19KHz transformer

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DROP-PROOF AND BURN-OUT PROOF FOR TRULY PROTECTED ACCURACY.

DVM32 SPECIFICATIONS

All accuracies expressed as percentage of reading ± 1 digit.
DC Voltage: 0 to ± 2, 20, 200, 2000 volts. ACCURACY: .5%. INPUT IMPEDANCE: 15 megohm.
AC Voltage: 0 to 2, 20, 200, 1000 volts. ACCURACY: 1.5%. INPUT IMPEDANCE: 1.8 megohms shunted by 18pF.
Ohms, Low Power: (.08V max. test voltage): 0 to 200, 2K, 20K, 200K, 2000K ohms. ACCURACY: 1%.
Ohms, High Power: (.8V max. test voltage): 0 to 2K, 20K, 200K, 2000K, 20 megohm. ACCURACY: 1%.
DC, AC Current: 0 to 2, 20, 200, 2000 mAmp. ACCURACY: 1% DC, 1.5% AC.
Input Protection: 2000V (DC + peak) on DCV, 1000V on all other functions. Internal protection with back-up fuses.
Readout: 3½ digit, 7 segment L.E.D. Automatic Polarity, Decimal, and Over–range.
Mechanical: SIZE: 7"x5"x4". WEIGHT: 2¼ lbs. with batteries.
3-Way Power: Battery-saving Auto Off Display turns display off when reading is 010 or less. Uses 4 "C" cells.
Accessories: 39A90 Power Adapter for 115/230 VAC line operation . . . $9.95
HP200 50KV High Voltage Probe (slips on test probe for extended range) . $25.00

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NEW ACCURACY STANDARD – 3½ digit, .1% DCV accuracy, backed with 15 megohm input impedance, is more accurate in more circuits for readings you can trust every time.
NEW MEASURING CAPABILITIES – sensitive, with .01 ohm and .1 milliVolts resolution, yet fully protected to 2000 VDC. Hi-Lo Power Ohms for unparalleled accuracy in solid state circuits.
NEW STANDARD IN SPEED AND OPERATING EASE – Auto-Ranging, Auto-Zero, and big pushbutton panel for fast, automatic digital readings.

DVM38 SPECIFICATIONS

Single Step Auto-Ranging: Each voltage range automatically increases sensitivity ten times when reading is less than 1/10th of Full Scale.
DC Voltage: 0 to ± 200mV (lower scale only), 2, 20, 200, 2000 Volts. ACCURACY: ± .1% of Rdg. ± 1 digit. INPUT IMPEDANCE: 15 megohms.
AC Voltage: 0 to 200mV (lower scale only), 2, 20, 200, 1000 Volts. ACCURACY: ± .5% of Rdg., ± 2 digits. INPUT IMPEDANCE: 1.5 megohms shunted by less than 40pF.
DC Current: 0 to ± 200μA, 2, 20, 200, 2000mA. ACCURACY: ± .3% of Rdg., ± 2 digits.
AC Current: 0 to 200μA, 2, 20, 200, 2000mA. ACCURACY: ± 1% of Rdg., ± 2 digits.
Resistance (Low Power): 0 to 20, 200, 2K, 20K, 200K, 2000K ohm. ACCURACY: ± .2% ± 3 digits. MAX. VOLTAGE: 200mV at full scale.
Resistance (High Power): 0 to 2K, 20K, 200K, 2000K, 20 megohm . ACCURACY: ± .2% ± 2 digits. MAX. VOLTAGE: 2V at full scale.
Protection: 2000 Volts (DC + peak) on DCV, 1000 Volts on all other functions and ranges. Internal diode and back-up fuse protection.
Display: 3½ digit, 7 segment L.E.D. numerals. V, mV indicators, Automatic Polarity, Decimal, Zero and Overrange.
Mechanical: SIZE: 5½"x7 7/8"x9". WEIGHT: 6½ lbs. POWER: 105 - 130 VAC, 50/60Hz, 7 watts.
Accessory: HP200 50KV High Voltage Probe (slips on test probe for extended range). $25.00

DVM38 3½ DIGIT DVM $348

TUBE TESTERS

TC162

TC162 MIGHTY MITE VII

Find those "tough dogs" others miss —

THE STANDARD IN TUBE TESTERS, with over 70,000 Mighty Mites in use.
FULL LOAD CATHODE CURRENT check finds the weak tubes other testers might miss.
100 MEGOHM GRID LEAKAGE SENSITIVITY finds the "tough dog" tubes fast that can otherwise cause hours of wasted time.
STETHOSCOPIC SHORTS TEST with 300K sensitivity tests each element against all others to locate any shorts in the tube.
FET BALANCED BRIDGE CIRCUITRY for instant-on action, greater accuracy and dependability.

TC162 SPECIFICATIONS

Cathode Emission Test: Full load current drawn. Life test reduces filament voltage by 15%.
Grid Leakage Test: BAD AREA: 100 megohms or less.
Shorts Test: 300K ohms or less.
General: POWER: 105 - 125VAC, 50/60Hz, 32 watts max. SIZE: 10"x9"x4". WEIGHT: 9 lbs.

TC162 MIGHTY MITE VII. $175

MU150

MU150 CONTINENTAL II

It's the only complete tube analyzer on the market.

TRUE MUTUAL CONDUCTANCE TEST using a 5000 Hertz square wave for true tube test.
TWO TESTERS IN ONE. The MU150 can be used to make the Mighty Mite tests as well as mutual conductance.
FULL RATED CATHODE EMISSION TEST.
100 MEGOHM GRID LEAKAGE TEST.
SENSITIVE STETHOSCOPIC SHORTS TEST.

MU150 SPECIFICATIONS

Tests: SHORTS: 300K ohms or less. GRID LEAKAGE: 100 megohm. EMISSION: Full rated cathode emission. MUTUAL CONDUCTANCE: True mutual conductance (Gm) amplifier measurement using 5KHz square wave input, with Automatic Bias Control.
General: POWER: 105 - 130 VAC, 50/60Hz, 50 watts max. SIZE: 18"x14"x4¾". WEIGHT: 18 lbs.

MU150 CONTINENTAL II Gm TUBE TESTER . . $395

TC28

TC28 "THE HYBRIDER"

The only hybrid amplifier checker on the market today for tube, solid state and hybrid circuits.

IT'S AN IMPROVED MIGHTY MITE TUBE TESTER that checks over 3000 tubes with one simplified test procedure, including the 100 megohm grid leakage sensitivity check.
IT'S A PATENTED CRICKET in and out of circuit transistor checker, for fast, reliable in-circuit troubleshooting without a reference book.
ALL TESTS READ ON ONE METER, including tube shorts, combining the two most popular Sencore testers for one total tester, and at less cost than buying them separately.

TC28 SPECIFICATIONS

Tube Tests: EMISSION: Full load currents. GRID LEAKAGE: 100 megohms or less. SHORTS: 300K ohms or less.
Transistor Tests: GAIN: (In or out of circuit). V_{ce} = ± 5V. LEAKAGE: (out of circuit only): Meter indicates leakage.
General: POWER: 105 - 125 VAC, 50/60Hz. SIZE: 14¼"x12"x14½". WEIGHT: 13¾ lbs.

TC28 THE HYBRIDER $275

OSCILLOSCOPES

PS148

PS148 WIDEBAND OSCILLOSCOPE/VECTORSCOPE

"the workhorse" of the single trace service scope.

WIDEBAND 5Hz to 6MHz - 3db.
HIGH SENSITIVITY 17mV RMS per inch.
HIGH INPUT IMPEDANCE 27 megohm shunted by 11pf.
SEVEN THOUSAND VOLT input rating with low cap probe, not 600 volts like other scopes.
DIRECT VERTICAL PEAK-TO-PEAK VOLTAGE READING with input controls calibrated directly in volts P-P.
CONVERTS TO PROFESSIONAL VECTORSCOPE with the flip of a switch.
FULL RANGE HORIZONTAL SWEEP frequencies from 5Hz to 500KHz in five overlapping ranges.
POSITIVE SYNC with variable control locks onto complex waveforms.
EXTERNAL INPUTS for sync, sweep, Z axis and direct connections to deflection plates.

PS148 SPECIFICATIONS

Vertical Amplifier: SENSITIVITY: .017 V/in direct. Front panel calibrated in P-P Volts. ACCURACY: ± 5%. BANDWIDTH: 5Hz to 6.5MHz (-3dB). INPUT IMPEDANCE: 27 megohm shunted by 11pF using Low-Cap probe. MAX. INPUT VOLTAGE: 7KV AC P-P, using Low-Cap probe.
Horizontal Amplifier: RANGE: 5Hz to 500KHz in 5 overlapping ranges.
Sync: Semi-triggered phantastron-type circuit.
Vector, X-Y Mode: Rear panel inputs to CRT plates.
General: SIZE: 11"x9"x15½". WEIGHT: 22 lb. POWER: 105 - 130VAC, 50/60Hz, 100 watts.
Accessories: 39G11 Direct/Lo-Cap Probe (supplied).
39G3 Demodulator Probe $5.75

PS148 OSCILLOSCOPE/VECTORSCOPE $395

PATENT PENDING PS29

PS29 MINUTE MAN PUSHBUTTON OSCILLOSCOPE

The first and only completely automatic triggered scope for any color TV and video service.

PUSHBUTTON DISPLAY for every critical video and color signal. TV Vertical, TV Horizontal, 3.58MHz color, 5X Expand, 60Hz Line Sweep for sweep generator alignment, and Vector Mode with complete front panel hook-up.
AUTOMATIC TRIGGERING with guaranteed solid sync is backed by TV sync separators on TV Vertical and TV Horizontal. You simply connect to the test point and push a button.
PLUS, IT'S A COMPLETE GENERAL PURPOSE BROADBAND SCOPE for any non-video signal from DC to 10MHz.
EXCLUSIVE 5000VAC INPUT PROTECTION backed by 10 milli-Volt per division sensitivity lets you measure circuits with confidence.

PS29 SPECIFICATIONS

Pushbutton Display Selectors: Automatically selects preset TV Vertical, TV Horizontal with TV sync separator; 3.58MHz Color; Sweep Generator 60Hz; Vector B-Y; 5X Expand.
Vertical Amplifier: SENSITIVITY: 10mV/cm to 50V/cm, AC-DC coupled. ACCURACY: ± 5%. BANDWIDTH: DC to 8MHz (-3dB). INPUT IMPEDANCE: 10 megohms shunted by 11pF using Low-Cap probe. MAX. INPUT VOLTAGE: 5KV P-P AC using Low-Cap probe.
Horizontal Amplifier: RANGE: 0.1 sec/cm to 0.2μsec/cm. VECTOR INPUT: 2 or 20V/cm.
Triggering: AUTOMATIC: Baseline displayed in absence of input signal. TVV, TVH: Uses sync separator for stable display of video waveforms.
Vector, X-Y Mode: Front panel inpufs.
General: SIZE: 10½"x8"x16". WEIGHT: 25 lbs. POWER: 105 - 130 VAC, 50/60Hz, 60 watts.
Accessories: 39G80 Lo-Cap Probe : X10 with 5KV rating (supplied).
39G81 Demodulator Probe. $20.00

PS29 AUTOMATIC PUSHBUTTON SCOPE. $595

PS163

PS163 DUAL TRACE OSCILLOSCOPE

Big performance with 1% phase-locked waveforms at 1/3 the cost of others.

PHASE LOCKED MATCHED CHANNELS allow comparisons of any simultaneous waveforms within 1% lab accuracy.
HIGH SENSITIVITY of 5 milliVolts per centimeter, allows accurate display of low level signals.
TRUE BANDWIDTH using no peaking coils or other gimmicks to cause ringing or signal distortions. Gives clean waveforms from DC to 8MHz.
PROTECTED TO 5000VAC. Most other scopes are rated to 600V. You're protected with Sencore.
TIME SAVING INSTANT MODE SELECTION for free running, manual and automatic triggered sweep, with selectable A or B channel triggering.
TV VERTICAL AND TV HORIZONTAL SWEEP settings with sync separator stability for viewing video signals.
IT'S ALSO A VECTORSCOPE with a simple front panel push-button control.

PS163 SPECIFICATIONS

Display: Channel A; B; Dual Alternate; Dual Chopped; Vector.
Vertical Amplifier: SENSITIVITY: 5mV/cm to 50V/cm. AC-DC coupled. ACCURACY: ± 2%. BANDWIDTH: DC to 8MHz (-3dB). INPUT IMPEDANCE: 10 megohms shunted by 11pF using Low-Cap probe. MAX. INPUT VOLTAGE: 5KV P-P AC using Low-Cap probe.
Horizontal Amplifier: RANGE: .1 sec/cm to .1μ sec/cm. Special TVV and TVH, 60Hz Line.
Triggering: Manual; Automatic: Baseline displayed in absence of input signal; Free Run. TVV, TVH: Uses Sync-separator for stable display of video waveforms.
Vector, X-Y Mode: Front panel inputs. Channel A Vertical, Channel B Horizontal.
General: SIZE: 12"x10"x15½". WEIGHT: 30 lb. POWER: 105 - 130 VAC, 60Hz, 60 watts.
Accessories: 39G80 Lo-Cap Probe: X10 with 5KV rating (2 supplied).

PS163 DUAL TRACE TRIGGERED SCOPE. $895

FIELD EFFECT MULTIMETERS

FE23

FE23 "LITTLE HENRY" PORTABLE FIELD EFFECT MULTIMETER

Toughest little multimeter in the whole wide world eliminates downtime, repair and replacement costs

COMPACT AND HANDY TO GO ANYWHERE – even in the dark – with illuminated meter.
1.5% FET ACCURACY with high 15 megohm input impedance that minimizes circuit loading errors experienced with VOMs.
DROP-PROOF with tough acrylic case, shock-proof meter mounting.
BURN-OUT PROOF protection to 1000V on all functions and ranges, including ohms, with back-up fuse protection.
NO MESSY, DANGLING LEADS with built-in lead storage compartment with auto-shutoff switch.

FE23 SPECIFICATIONS

DC Voltage: 0 to 3, 30, 300, 1000, 6000 volts. ACCURACY: 1.5% F.S. (3% – 6V range). INPUT IMPEDANCE: 15 megohm.
AC Voltage: 0 to 3, 30, 300, 1000 volts. ACCURACY: 3% F.S. INPUT IMPEDANCE: 900K shunted by 27pf.
Ohms: Rx1, x100, x10K, x1 megohm. 10 ohm center scale. ACCURACY: 2° arc.
DC Current: 0 to 1 Amp. ACCURACY: 3% F.S.
Input Protection: 1000V (DC + peak) all ranges.
Meter: 3½" illuminated. Shock-proof mounted. Sliding protective cover.
Battery Power: 1 - 9V and 3 - 1.5V "AA" cells.
General: SIZE: 6½"x4½"x2¾". WEIGHT: 2½ lbs.

FE23 "LITTLE HENRY" $124

FE27

FE27 "BIG HENRY" PORTABLE FIELD EFFECT MULTIMETER

Most dependable multimeter on the market today

RUGGED AND PORTABLE to go anywhere.
1.5% FET ACCURACY on DC volts with high 15 megohm input impedance that minimizes circuit loading errors experienced with VOMs.
TOUGH ACRYLIC CASE, sliding meter cover, and shock-proof meter mounting means less costly downtime.
1000V PROTECTION on all functions and ranges – including ohms.
EXCLUSIVE P-P AND RMS reading scales for accurate AC measurements in any circuit.
AUTOMATIC SHUT-OFF for longer battery life when lead compartment cover is closed.

FE27 SPECIFICATIONS

DC Voltage: 0 to ± .3, 1, 3, 10, 30, 100, 300, 1000, 3000 volts. Zero center scale. ACCURACY: 1.5% F.S. INPUT IMPEDANCE: 15 megohm.
AC Voltage: 0 to .3, 1, 3, 10, 30, 100, 300, 1000 volts. True RMS or P-P detecting. ACCURACY: 3% F.S. INPUT IMPEDANCE: 2.4 megohm shunted by 95pf.
Ohms: Rx1, x10, x1K, x100K, x1M ohms. 10 ohms center scale. ACCURACY: 2° arc.
DC Current: 0 to ± 10mA, 100mA, 1A. ACCURACY: 3%. Optional 3A shunt No. 39G82 – $4.00.
Input Protection: 1000V (DC + peak) all ranges.
Meter: 4½" illuminated. Shock-proof mounted. Sliding protective cover.
Battery Power: 2 - 9V and 2 - 1.5V "C" cells.
General: SIZE: 10"x5½"x3½". WEIGHT: 4½ lbs.

FE27 "BIG HENRY" $195

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(219) 397-8681
ELKHART
WARREN RADIO
742 South Main
(219) 523-2398
EVANSVILLE
HUTCH & SONS, INC.
300 North Main Street
(812) 425-7201
Star Store Located In:
*MADISONVILLE, KY.
212 North Franklin
(502) 821-4334
INDIANAPOLIS
GRAHAM ELECT. SUPPLY INC.
133 South Pennsylvania Street
(317) 634-8486
Star Stores Located In:
*MUNCIE
Muncie Electronic Supply
222 North Madison Street
(317) 288-8837
*FORT WAYNE
Fort Wayne Elect. Supply
3606 East Maumee Avenue
(219) 423-3422
WARREN RADIO
732 North Capitol Street
(317) 634-5566

IOWA

DAVENPORT
KLAUS RADIO
322 East Fourth Street
(319) 323-9761
WARREN RADIO
1205 East River Drive
(319) 323-8051
DES MOINES
MID–STATE DISTRIBUTORS
2511 Bell Avenue
(515) 288-7231
Star Store Located In:
*APPLETON, WIS.
1037 West Wisconsin Avenue
(414) 731-4181
SIDLES
2205 Bell Avenue
(515) 280-1722
SIOUX CITY
MOLSTAD ELECTRONICS
1110 Dace Street
(712) 255-8023

KANSAS

TOPEKA
● ACME RADIO
135 Kansas Avenue
(913) 235-1363
WICHITA
RADIO SUPPLY CO., INC.
131 Laura Street
(316) 267-5216
Star Store Located In:
*SALINA
809 South Broadway
(913) 823-6353

KENTUCKY

BOWLING GREEN
RANDOLPH, HALE & MEREDITH
319 State Street
(502) 781-1460
Star Store Located In:
*HOPKINSVILLE
729 East 4th Street
(502) 885-5357
LEXINGTON
SERVICE ELECTRONIC SUPPLY
1046 "A" New Circle Road, N.E.
(606) 254-5786
LOUISVILLE
P.I. BURKS, INC.
842 South 7th Street
(502) 589-3960
THE COLLINS CO.
829 South Floyd Street
(502) 583-1791
PEERLESS ELECTRONICS EQUIP.
1815 South 7th Street
(502) 637-7677
OWENSBORO
HUTCH & SON
1421 Triplet
(502) 684-6285
PADUCAH
WARREN RADIO
455 South 31st
(502) 442-4367

LOUISIANA

ALEXANDRIA
RALPH'S RADIO
601 North 3rd Street
(318) 443-4517
LAFAYETTE
RALPH'S RADIO
3004 Cameron Street
(318) 234-4507
Star Stores Located In:
*BATON ROUGE
1732 Plank Road
(504) 344-3761
*BEAUMONT, TX.
1293 Broadway
(713) 833-9443
*MORGAN CITY
715 Brashear
(504) 384-9831
*PASCAGOULA, MS
2102 Ingalls Avenue
(601) 769-1672
LAKE CHARLES
RALPH'S RADIO
911 4th Avenue
(318) 439-2493
NEW ORLEANS
WILLIAM B. ALLEN
1601 Orleans Avenue
(504) 525-8222
SHULER SUPPLY CO., INC.
2504 - 06 Tulane Avenue
(504) 822-2251
Star Stores Located In:
*GRETNA
1728 Hancock
(504) 368-2455
*METAIRIE
112 Woodlawn
(504) 834-1174
SOUTHERN RADIO
1909 Tulane Avenue
(504) 524-2343
Star Store Located In:
*BATON ROUGE
2610 Scenic Hwy.
(504) 355-0396
SHREVEPORT
AMERICAN ELECTRONICS
2618 Southern Avenue
(318) 424-6591

MARYLAND

BALTIMORE
A.R. SPARTANA CO., INC.
239 North Gay Street
(301) 727-5762
CUMBERLAND
ALLEGHENY ELECTRONICS
1100 East Old Town Road
(301) 734-6460
HYATTSVILLE
MARK ELECTRONICS
3003 Hamilton Street
(301) 559-7700
KENSINGTON
FAIRWAY ELECTRONICS
4210 Howard
(301) 933-4420
Star Store Located In:
*BALTIMORE
178 Alco Place
(301) 247-8383
SALISBURY
STANDARD ELECTRONICS
701 Snow Hill Road
(301) 749-7593

MASSACHUSETTS

BROCKTON
WARE RADIO SUPPLY CO.
913 Center Street
(617) 583-0810
NORTH WILBURHAM
INDUSTRIAL COMPONENTS CORP.
2551 Boston Road
(413) 596-3854
WORCESTER
R.M. ELECTRONICS
315 Grove Street
(617) 756-8311
Star Store Located In:
*FITCHBURG
1334 Water Street
(617) 343-7473

MISSISSIPPI

HATTIESBURG
N & H ELECTRONIC SUPPLY
402 East Pine Street
(601) 582-5571
JACKSON
STUART C. IRBY
P.O. Box 1819
(601) 355-4532
MERIDIAN
HOOPER ELECTRONICS
1917 Sixth Street
(601) 693-2668
Star Store Located In:
*PASCAGOULA
1406 East Live Oak
(601) 762-9383

MICHIGAN

BATTLE CREEK
WARREN RADIO
93 Bidwell W.
(616) 965-3338
DEARBORN
WEST SIDE RADIO & TV SUPPLY
7521 Wyoming Avenue
(313) 933-6972
DETROIT
● R.S. ELECTRONICS CO., INC.
12775 Lyndon Street
(313) 491-1000
Star Store Located In:
*GRAND RAPIDS
300 36th Street S.E.
(616) 241-3483

RADIO SUPPLY & ENGINEERING
85 Selden Avenue
(313) 831-3174
Star Stores Located In:
*DETROIT
10001 Chalmers
(313) 371-9050
*CLAWSON
1203 West 14 Mile Road
(313) 435-5660
GRAND RAPIDS
T& W ELECTRONICS
1045 South Division Avenue
(616) 241-3645
Star Store Located In:
*MUSKEGON
2100 Henry Street
(616) 759-7666
J.A. WHITE DISTRIBUTING
755 36th Street S.E.
(616) 241-6581
KALAMAZOO
● WARREN RADIO
1710 South Westnedge
(616) 381-4203
Star Store Located In:
*GRAND RAPIDS
320 Michigan N.E.
(616) 456-5383
LIVONIA
NORWEST ELECTRONICS
33611 Plymouth Road
(313) 261-4551
MADISON HEIGHTS
HOWARD & SMITH, INC.
31270 Stephenson Hwy.
(313) 585-2300
WARREN RADIO
32707 John Road
(313) 588-3327
MUSKEGON
FITZPATRICK ELECT. SUPPLY
444 Irwin Avenue
(616) 722-6621
WESTERN ELECTRONICS SUPPLY
1781 Fifth Street
(616) 722-7628
NILES
NILES RADIO
933 North 5th
(616) 684-0550
OWOSSO
WARREN RADIO CO.
311 South Cedar
(517) 723-5239
ROYAL OAK
SATULLO CO.
4514 North Woodward
(313) 549-3910

MINNESOTA

MINNEAPOLIS
NESS ELECTRONICS
3743 Nicollet
(612) 824-2646
STARK ELECTRONICS
112 3rd Avenue North
(612) 332-1325
Star Stores Located In:
*DULUTH
18 North Second Avenue
(218) 722-1766
*LA CROSSE, WIS.
131 South 6th
(608) 782-3186
*ST. PAUL
154-160 University
(612) 222-4781
TEAM CENTRAL, INC.
720 29th Avenue S.E.
(612) 331-8511
Star Stores Located In:
● *NO. 1 MINNEAPOLIS
2460 Hennepin
(612) 377-9840
*NO. 4 ST. CLOUD
119 Fifth Avenue South
(612) 251-1335
● *NO. 5 MINNEAPOLIS
6413 Lyndale Avenue South
(612) 869-3288
*NO. 8 MADISON, WIS.
3365 East Washington
(608) 244-1339
*NO. 19 WATERTOWN, SD
223 9th Avenue S.E.
(605) 886-4725
*NO. 22 ROCK ISLAND, ILL.
1714 5th Avenue
(309) 788-9595
*NO. 26 GRAND FORKS, ND
1503 11th Avenue North
(701) 772-5575
SATTERLEE CO.
220 East Franklin Avenue
(612) 333-1141
ROCHESTER
SM SUPPLY CO.
902 7th Street N.W.
(507) 288-2037
Star Store Located In:
● *MANKATO
115 Byron Street
(507) 388-6245

MISSOURI

CAPE GIRARDEAU
SUEDEKUM ELECT. SUPPLY
2215 Broadway
(314) 335-8202
Star Store Located In:
*CARBONDALE, ILL.
Hwy. 13 Reeds Station Road
(618) 549-7361
JOPLIN
FOUR STATE RADIO SUPPLY
402 Wall Street
(417) 624-0368
KANSAS CITY
BURSTEIN-APPLEBEE
3199 Mercier
(816) 756-2525
● ELECTRONIC SUPPLY CO., INC.
4100 Main Street
(816) 931-3383
ROLLA
SHOW ME ELECTRONICS
Hwy. 72 East
(314) 364-3896
ST. JOHN
TREPCO
3632 Woodson Road
(314) 426-3260
ST. JOSEPH
● ST. JOSEPH RADIO & SUPPLY
720 South 9th Street
(816) 233-3118
ST. LOUIS
DELTRONICS DISTRIBUTING CO.
864 Hodiamont Avenue
(314) 725-6060
Star Stores Located In:
*BELLEVILLE, ILL.
3726 West Main
(618) 398-2188

*ST. CHARLES
202 First Capitol Plaza
(314) 946-6766

SPRINGFIELD
REED RADIO SUPPLY CO.
805 - 09 Boonville Avenue
(417) 869-0752

UNIVERSITY CITY
OLIVE ELECTRONICS SUPPLY CO.
6662 Olive Blvd.
(314) 863-7800

MONTANA

BILLINGS
ELECTRONIC SUPPLY CO.
250 Eleventh Street West
(406) 252-2197

NEBRASKA

LINCOLN
SCOTT ELECTRONICS
4040 Adams Street
(402) 464-8308

OMAHA
● OMAHA ELECTRONICS
222 Leavenworth
(402) 341-3440
RADIO EQUIPMENT
625 North 18th Street
(402) 341-7700
Star Store Located In:
*LINCOLN
2619 Holdrege Avenue
(402) 475-7668

SCOTTS BLUFF
D & H ELECTRONICS
1913 Broadway
(308) 632-2181
Star Store Located In:
*STERLING, COLORADO
117 Ash Street
(303) 522-3033

NEVADA

LAS VEGAS
KIESUB ELECTRONICS
3185 South Highland
(702) 732-2395

NEW HAMPSHIRE

MANCHESTER
RSL DISTRIBUTORS, INC.
670 Chestnut Street
(603) 625-5444
Star Stores Located In:
*BANGOR, MAINE
14 Perry Road
(207) 947-7396
*PORTLAND, MAINE
117 Anderson Street
(207) 773-0297

NEW JERSEY

CAMDEN
GENERAL RADIO SUPPLY CO.
600 Penn Street
At Bridge Plaza
(609) 964-8560

EATONTOWN
ATKINSON & SMITH
17 Lewis Street
(201) 542-2447

EDISON
WILLIAM ELECTRONIC SUPPLY
1863 Woodbridge Avenue
(201) 985-3700

HILLSIDE
LEADER ELECTRONICS
5 Evans Terminal Road
(201) 354-4200

MOUNT EPHRIAM
ALMO ELECTRONICS
301 North Black Horse Pike
(609) 933-3800

NEW BRUNSWICK
BAY ELECTRONICS DISTRIBUTORS
226 Talamadge Street
(212) 295-8100

NEWARK
AARON LIPPMAN
99 Newark Street
(201) 621-9300
Star Store Located In:
*PATERSON
170 21st Avenue
(201) 274-3277

SPRINGFIELD
ROUTE ELECTRONICS, INC.
Echo Plaza
40 U.S. Route 22
(201) 467-0166

TRENTON
JACKSON DISTRIBUTORS
1900 Genessee Street
(609) 392-8008
NIDISCO, INC.
985 Princeton
(609) 396-3505

UNION CITY
NIDISCO, INC.
2812 Kennedy Blvd.
(201) 863-2111
Star Stores Located In:
*HACKENSACK
55 State Street
(201) 343-8411
*JERSEY CITY
713 Newark Street
(201) 653-2360
*RIDGEFIELD
484 Bergen Blvd.
(201) 943-0510
*PASSAIC
294 Passaic Street
(201) 779-4962
*UNION
2401 Vauxhall Road
(201) 964-7070

WEST ATLANTIC CITY
ALMO ELECTRONICS
1800 Verona Avenue
(609) 646-1300

NEW MEXICO

ALBURQUERQUE
ELECTRONIC PARTS CO.
2620 Rhode Island Street N.E.
(505) 293-6161
Star Store Located In:
*PHOENIX, ARIZONA
1903 North 22nd Avenue
(602) 257-1040

SANTE FE
A–1 COMMUNICATIONS SUPPLY CO.
441 Corrillas Road
(505) 982-4488

NEW YORK

BINGHAMTON
HARVEY ELECTRONICS
Vestal Parkway
(607) 748-8211

BRONX
FORDHAM ELECTRONIC SUPPLY
558 Morris Avenue
(212) 585-0330
RIM ELECTRONICS
2755 Webster Avenue
(212) 295-4300

BUFFALO
RADIO EQUIPMENT CORP.
196 Vulcan Street
(716) 874-2690
Star Store Located In:
*NIAGARA FALLS
1720 Pierce Avenue
(716) 285-9366
STANDARD ELECTRONICS
3519 Union Road
(716) 685-4330
Star Stores Located In:
*ENDICOTT
107 Duane Avenue
(607) 754-3102
*NIAGARA FALLS
2201 Pine Avenue
(716) 284-0437
*OLEAN
2828 West State Street
(716) 372-1800
*ROCHESTER
1800 Lyell Avenue
(716) 254-7950
*SYRACUSE
839 Hiawatha Blvd.
(315) 422-0421

FARMINGDALE
HARRISON RADIO CORP.
20 Smith Street
(516) 293-7990

GLEN FALLS
RAY SUPPLY, INC.
Upper Glen Street
(518) 792-5848

GREAT NECK
BROMPTON SERVICE CORP.
39 Allenwood Road
(516) 487-9591

KINGSTON
GREYLOCK ELECTRONICS
763 Albany Avenue
(914) 338-7900

LATHAM
SEIDEN SOUND
4 Northway Lane
(518) 462-9501

MIDDLETOWN
CERTIFIED ELECTRONICS
Wickham Avenue Ext.
Certified Drive Route 211
(914) 342-1054

NEW YORK
DALE ELECTRONICS
244 West 14th Street
(212) 255-3660

ROCHESTER
GOLDCREST ELECTRONICS
482 St. Paul Street
(716) 546-8464
Star Stores Located In:
*ALBANY
Everett Road
(518) 489-5406
*SYRACUSE
1920 Park Street
(315) 471-7115

SCHENECTADY
GRIMMERS ELECT. PARTS SUPPLY
41 North Brandywine Avenue
(518) 374-8480

SYRACUSE
SALINA ELECTRONICS, INC.
2100 Park Street
(315) 422-2336
Star Store Located In:
*ROME
Rome Electronics
216 Erie Blvd. East
(315) 337-5440

TROY
TROY TELEVISION, INC.
76 2nd Avenue
(518) 235-1521

VALLEY STREAM
HARRISON RADIO
10 East Sunrise & Rockway
(516) 872-9565

NORTH CAROLINA

ASHVILLE
SOUTHEASTERN RADIO SUPPLY
1065 Patton Avenue
(704) 253-1446

CONCORD
MACVICTOR ELECT. SUPPLY
P.O. Box 3236
1094 Hwy. 29 North
(704) 786-4175
Star Stores Located In:
*HIGH POINT
1506 South Main
(919) 883-7423
*STATEVILLE
1128 Shelton Avenue
(704) 872-8949

FAYETTEVILLE
SOUTHEASTERN RADIO SUPPLY
325 Rowan Street
(919) 483-0371
Star Store Located In:
*WILMINGTON
1002 South College Road
(919) 791-7365

GREENSBORO
GUILFORD
315 Asheboro
(919) 275-1385
SOUTHEASTERN RADIO SUPPLY
445 English Street
(919) 273-8675
Star Stores Located In:
*SALISBURY
316 North Depot Street
(704) 633-0741
*WINSTON-SALEM
200 South Marshall Street
(919) 724-0504

HICKORY
SOUTHEASTERN RADIO SUPPLY
907 Second Avenue N.W.
(704) 322-9493

KINSTON
SOUTHEASTERN RADIO SUPPLY
1005 East Highland Avenue
(919) 523-5113
Star Store Located In:
*JACKSONVILLE
1009 LeJeune Blvd.
(919) 347-5137

RALEIGH
SOUTHEASTERN RADIO SUPPLY
414 Hillsborough Street
(919) 828-2311
Star Stores Located In:
*DURHAM
401 Foster Street
(919) 688-8204
*WILSON
321 South Goldsboro Street
(919) 237-6375

NORTH DAKOTA

FARGO
RADIO & TV EQUIPMENT
2014 1st Avenue South
(701) 232-8993

MINOT
JOHN IVERSON
330 North Broadway
(701) 838-5466

OHIO

AKRON
WARREN RADIO
71 South Broadway
(216) 434-6668

ASHTABULA
MORRISON RADIO SUPPLY
331 Center Street
(216) 997-6161

CLEVELAND
BRODHEAD GARRETT
4650 East 71st Street
(216) 341-0248
WINTERADIO ELECT. SUPPLY
1468 West 25th Street
(216) 621-9383
Star Stores Located In:
*NORTH OLMSTEAD
4579 Grand-Northern Blvd.
(216) 779-7272
*PARMA
5373 Ridge Road
(216) 884-9696

COLUMBUS
WHITEHEAD RADIO CO.
124 North Grant Avenue
(614) 224-1186

DAYTON
SREPCO ELECTRONICS
314 Leo Street
(513) 224-0871
Star Store Located In:
*COLUMBUS
1045 Ridge Street
(614) 486-9483
V.J. MCGRANAHAN, INC.
1415 Stanley Avenue
(513) 224-9623
Star Store Located In:
*TOLEDO
McGranahan Dist. Co.
1717 Madison Avenue
(419) 241-8271
THE STOTTS-FRIEDMAN CO.
108-112 North Jefferson Street
(513) 224-1111

DOVER
TV SPECIALTIES, INC.
320 West 3rd Street
(216) 364-6678

ELYRIA
EL-A-CO ELECTRONICS
235 Lodi Street
(216) 322-2526 or
(216) 323-1805

LIMA
LIMA RADIO PARTS CO., INC.
150 West Grand Avenue
(419) 228-1220

STEUBENVILLE
LOU'S ELECTRONICS
408 Washington
(614) 282-7535

TOLEDO
LIFETIME ELECTRONICS
1501 - 1505 Adams Street
(419) 241-5643
WARREN RADIO
1002 Adams Street
(419) 248-3364

YOUNGSTOWN
ROSS RADIO
325 West Federal Street
(216) 746-8881

WARREN
REM ELECTRONICS
515 South Park
(216) 399-2777

OKLAHOMA

LAWTON
MILLER JACKSON CO.
1701 "C" Avenue
(405) 355-5220

OKLAHOMA CITY
● MILLER JACKSON CO.
121 East California
(405) 235-8426
● THURMAN MAGBEE
530 South Broadway
(405) 236-4351

TULSA
● RADIO, INC.
1000 South Main
(918) 587-9123

OREGON

EUGENE
CENTRAL DISTRIBUTORS
1035 Conger
(503) 342-1101

MEDFORD
CENTRAL DISTRIBUTORS
605 North Fir Street
(503) 773-6677

PORTLAND
CENTRAL DISTRIBUTORS
955 N.E. Union Avenue
(503) 234-0711
AL SMITH COMPANY
3422 Halsey N.E.
(503) 234-7877

PENNSYLVANIA

ALLENTOWN
RESCO of Le HIGH VALLEY
425 Hanover Avenue
(215) 435-6743

ALTOONA
ALLEGHENY ELECTRONICS
800 Chestnut Avenue
(814) 946-0871
Star Stores Located In:
*JOHNSTOWN
46 Valley Pike
(814) 536-3589
*STATE COLLEGE
University Electronics
258 East Beaver
(814) 238-3093

COATESVILLE
COUNTY SUPPLY
301 Fleetwood Street
(215) 384-4585

DREXEL HILL
KASS ELECTRONICS DIST.
2502 Township Line Road
(215) 449-2300

ERIE
J.V. DUNCOMBE ELECT. CORP.
721 Parade Street
(814) 455-4735

HARRISBURG
CUMBERLAND ELECTRONICS, INC.
1345 South 12th Street
(717) 233-5883

NORRISTOWN
PHILADELPHIA ELECTRONICS, INC.
624 West Airy Street
(215) 275-5550
Star Stores Located In:
*EASTON
Radio Electronic Service Co.
1700 North Hampton
(215) 253-3569
*READING
Electronic TV & Distributing
201 South 4th Street
(215) 376-4841

PARKSIDE
COUNTY SUPPLY
2903 Edgemont Avenue
(215) 872-2439

PHILADELPHIA
ALMO ELECT. CORP.
Roosevelt Blvd. & Blue Grass Road
(215) 676-6000
Star Store Located In:
*SALISBURY, MD
317 Park Heights Avenue
(301) 742-1393
PITTSBURGH
CRS ELECTRONICS CO.
818 Brownsville Road
(412) 431-7700
HAMBURG BROTHERS, INC.
24th Street & A.V.R.R.
(412) 471-0808
TRIANGLE ELECTRONICS
6580 Frankstown Avenue
(412) 441-9659
SCRANTON
CONSOLIDATED DISTRIBUTING
1148 - 1150 Capouse Avenue
(717) 346-3831
KEY RADIO & TV SUPPLY CO.
340 Phelp Street
(717) 342-0161
TREVOSE
TREVOSE ELECT. TV CO.
4033 Brownville Road
(215) 757-5300
WILLIAMSPORT
WILLIAMSPORT RADIO SUPPLY, INC.
518 West 3rd Street
(717) 326-1534

RHODE ISLAND

CRANSTON
JABBOUR ELECTRONICS SUPPLY
1744 Cranston Street
(401) 944-2570
Star Store Located In:
*NEW LONDON, CT
227 Jefferson Avenue
(203) 442-4386
PROVIDENCE
BALLOU-JOHNSON & NICHOLS
128-134 Dorrance Street
(401) 331-8320

SOUTH CAROLINA

CHARLESTON
WHOLESALE RADIO SUPPLY
515 East Bay Street
(803) 722-2634
Star Store Located In:
*NORTH CHARLESTON
3847 Rivers Avenue
(803) 747-9672
COLUMBIA
DIXIE RADIO SUPPLY CO., INC.
1900 Barnwell Street
P.O. Box 408
(803) 779-5332
Star Stores Located In:
*ANDERSON, SC
1206 South Murray Avenue
P.O. Box 176
(803) 226-3421
*AUGUSTA, GA
1234 Gordon Park Road
P.O. Box 702
(404) 722-2055
*CHARLOTTE, NC
2220 South Tryon Street
P.O. Box 10563
(704) 377-5413
*FLORENCE, SC
531 East Palmetto Street
(803) 669-8201
*GASTONIA, NC
507 West Airline Avenue
(704) 864-3281
*GREENVILLE
500 Pendleton Street
P.O. Box 46
(803) 232-5357
*GREENWOOD, SC
116 Circular Street
(803) 229-4954
*SUMTER, SC
25 Guignard Drive
(803) 775-2306
SPARTENBURG
DIXIE RADIO SUPPLY CO., INC.
208 East St. John Street
P.O. Box 2746
(803) 583-3681

SOUTH DAKOTA

MITCHELL
ELECTRONIC SUPPLY
119 East 1st Avenue
(605) 996-4300
RAPID CITY
CHRIS SUPPLY CO.
403 West Blvd.
(605) 342-5900
SIOUX FALLS
● GOURLEY DISTRIBUTING CO.
324 North Main
(605) 336-1466
WARREN RADIO SUPPLY
196 East 6th Street
(605)336-1830

TENNESSEE

BRISTOL
BRISTOL ELECTRONICS
830 State Street
(615) 764-0157
KNOXVILLE
GRAYBAR ELECTRIC
1723 Grand Avenue
(615) 546-7550
BONDURANT BROS.
P.O. Box 2069
906 Sevier Avenue
(615) 577-0473
SHIELDS ELECTRONICS, INC.
704 North Central
(615) 524-7338
Star Store Located In:
*CHATTANOOGA
1817 Dodds Avenue
(615) 624-0071
MEMPHIS
FRANK G. UFFER & CO.
1318 Madison Avenue
(901) 725-6743
WARREN RADIO CO.
190 - 192 South Cooper
(901) 274-2460
Star Store Located In:
*DYERSBURG
Hwy. 51 North
(901) 285-3850
WOODSON-BOZMAN
3870 New Getwell
(901) 362-1500
NASHVILLE
KEITH-SIMMONS CO., INC.
621 Davison Street
(615) 259-3600

TEXAS

AMARILLO
AMARILLO HARDWARE
500 - 622 Grant Street
(806) 376-4726
AUSTIN
WHOLESALE ELECTRONIC SUPPLY
507 Pressler Street
(512) 478-9568
CORPUS CHRISTI
DOUGLAS ELECTRONICS
1118 South Staples
(512) 883-5103
DALLAS
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Action Request Card

IF YOU ARE INTERESTED IN A SENCORE PRODUCT AND WOULD LIKE FURTHER ACTION TAKEN, SIMPLY COMPLETE THIS COUPON AND MAIL TO: SENCORE CUSTOMER SERVICE DEPARTMENT, 3200 SENCORE DRIVE, SIOUX FALLS, SOUTH DAKOTA 57107

10 DAY TRIAL: I AM INTERESTED IN TRYING THE SENCORE UNIT, MODEL NUMBER _____

ON A NO OBLIGATION, 10 DAY TRIAL. I UNDERSTAND THAT SENCORE HAS NO REFURBISHING CHARGES SHOULD I DAMAGE THE UNIT IN ANY WAY.

I WOULD LIKE FURTHER INFORMATION ON SENCORE MODEL NUMBER _____

PLEASE FORWARD AS SOON AS POSSIBLE.

I AM READY TO PURCHASE THE FOLLOWING SENCORE UNIT(S), MODEL NUMBER _____

I WOULD LIKE A DEMONSTRATION ON THE FOLLOWING SENCORE UNIT(S), MODEL NUMBER _____

ALL ACTION REQUESTS WILL BE FORWARDED TO YOUR NEAREST SENCORE FLPD DISTRIBUTOR, UNLESS YOU SPECIFY YOUR PARTICULAR FLPD DISTRIBUTOR HERE:

_____
DISTRIBUTOR CITY STATE

MY NAME IS: _____

ADDRESS: _____

_____
CITY STATE ZIP

TELEPHONE _____

1235P

COLOR GENERATORS

CG169

CG169 DELUXE COLOR KING DIGITAL COLOR BAR GENERATOR.

It's the industry's only all channel, all weather color generator.

EXCLUSIVE ALL-CHANNEL TUNING for operation in any part of the U.S.

EXCLUSIVE TEMPERATURE CONTROL to warm power supply up on cold days or dry out moisture in humid areas.

EXCLUSIVE CONVERGENCE PATTERNS. Moveable single dot and single cross makes convergence a snap.

75 OHM OUTPUT for MATV, CATV systems, with 300 ohm balun for conventional antenna systems.

100% DIGITAL for Rock Solid patterns.

THE ONLY ALL-CHANNEL, ALL-WEATHER DIGITAL COLOR BAR GENERATOR.

CG169 SPECIFICATIONS

TV Channels: VHF: Channel 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13. UHF: Channel 23, 26, 29, 32, 35, 38, 41.
Output Levels: 1000 μV $\pm$ 5db into 300 ohm. Adjustable.
Patterns: Color bars, Horizontal lines, Vertical lines, Crosshatch, Dots, Adjustable Single lines or Single dot.
General: POWER: 70 - 135VAC, 50/60Hz, 25 watts. SIZE: 10½"x10½"x4 1/8". WEIGHT: 8 lb.

CG169 DELUXE COLOR KING $225

CG25

CG25 "LITTLE HUEY" DIGITAL COLOR BAR GENERATOR

The most dependable digital IC generator on the market under $100.

ALL THE PATTERNS you'll need. Standard color bar, Vert. lines, Horiz. lines, Crosshatch, Dots and Blank raster.

DIGITAL TIMING for locked in patterns that just can't bounce.

BIG GENERATOR FEATURES with color adjust and channel tuning.

LOW POWER DRAIN for long battery life. Automatic shutoff after 15 minutes to back you up.

CABLE STORAGE COMPARTMENT. No messy cords to untangle.

PUSHBUTTON OPERATION for fast and easy pattern selection.

CG25 SPECIFICATIONS

TV Channel: Adjustable to 2, 3, 4, 5, or 6. PATTERNS: Color bars, Horizontal lines, Vertical lines, Crosshatch, Dots and Blank raster.
Battery: One 5.6 volt mercury.
General: AUTOMATIC TURN OFF TIME: 20 minutes typical. SIZE: 2"x4"x6". WEIGHT: 2 lb.

CG25 "LITTLE HUEY" $99

TRANSISTOR TESTERS

PATENTED

TF26

TF26 TOUCH TONE CRICKET

Hop through solid state circuits in seconds.

LETS ANYONE TROUBLESHOOT ENTIRE SOLID STATE BOARDS IN SECONDS – WITHOUT SET-UP INFORMATION.

ONE SIMPLIFIED PATENTED IN OR OUT OF CIRCUIT TEST for all NPN, PNP transistors and N-Channel or P-Channel FETs.

NO SET-UP DATA OR TECHNICAL KNOWLEDGE REQUIRED. Just hook the three "E-Z" Hooks up to the transistor leads in any order, and push the 6 buttons for a 99.9% reliable "GOOD-BAD" readout.

SENSITIVE OUT - OF - CIRCUIT LEAKAGE CHECK lets you measure all interelement leakage values to catch marginal transistors.

RUGGED PORTABILITY with tough acrylic and vinyl clad steel case, sliding meter cover and lead storage compartment.

TF26 SPECIFICATIONS

Devices Tested: Diodes, transistors, Darlingtons and single gate FETs.
Gain Test (In or out of circuit): $V_{ce} = \pm$ 3V p-p.
Leakage Test (Out of circuit): 0 - 3000 microamps.
General: SIZE: 10"x5½"x3½". WEIGHT: 4 lbs. POWER: 105-130 VAC, 50/60Hz , 5 watts.

TF26 TOUCH TONE CRICKET $150

PATENTED

TF30

TF30 SUPER CRICKET

Completely analyze any transistor or FET in seconds.

NOW COMPLETELY ANALYZE ANY TRANSISTOR OR FET IN SECONDS – WITHOUT ANY KNOWLEDGE ABOUT THE TRANSISTOR WHEN YOU START.

IT'S A PATENTED CRICKET for fast, 99.9% reliable, in circuit troubleshooting without a reference book.

IT'S AN AUTOMATIC TRANSISTOR ANALYZER. Simply rotate the function control and push for complete parameter tests, including Beta, Icbo, Gm, Igss and Idss, without zeroing or calibrating.

IT AUTOMATICALLY IDENTIFIES ALL THREE LEADS in seconds with front panel roll chart.

IT WILL IDENTIFY A TRANSISTOR FROM AN FET without a reference book.

TF30 SPECIFICATIONS

Devices Tested: Diodes, transistors, Darlingtons, single and dual gate FETs.
In-Circuit Test: Dynamic gain indication with patented phase inversion circuit. $V_{ce} = \pm$ 5.6VDC.
Transistor Gain Test (Out of circuit): Self zeroing dynamic AC Beta. $V_{ce} = \pm$ 5.6VDC.
Leakage Test: 0 - 2500 microamps.
FET Gain Test (Out of circuit): Dynamic mutual conductance. $V_{ds} = \pm$ 5.6VDC.
Leakage Test (Igss): 0 - 25,000 microamps.
General: POWER: 105 - 130VAC, 50/60Hz, 8.5 watts. SIZE: 9¾"x7½"x7¼". WEIGHT: 6 lbs.

TF30 SUPER CRICKET. $240

TIME SAVERS

NEW!

YF33 PATENT PENDING

YF33 "RINGER" YOKE & FLYBACK TESTER

Save hours of frustrating guesswork on TV sweep circuits.

PATENT PENDING RINGING TEST checks yokes, flybacks and most other air core coils in seconds with one simplified pushbutton test.

100% RELIABLE – If the Ringer says a coil is GOOD, you're 100% sure.

IN OR OUT OF CIRCUIT testing on both tube and solid state sets – It's the only universal yoke and flyback tester available today.

COMPLETE SWEEP CIRCUIT ANALYZER including 30V p-p and 300V p-p scales for drive signals, plus 10KV and 50KV scales, for focus and high voltage.

YF33 SPECIFICATIONS

Ringing Tests: Dynamic Ringing test counts number of cycles coil rings before reaching a pre-set damping point after a given exciting pulse has been applied. Meter calibrated to give "GOOD" reading for 10 or more cycles.
P-P Drive Scale: 0 - 30VAC p-p; 0 - 300VAC p-p.
High Voltage Scale: 0 - 10KV DC (with optional FP201 probe). 0 - 50KV DC (with optional 39G89 probe used with FP201 probe).
General: POWER: 105 - 130VAC, 50/60Hz, 10 watts. SIZE: 10"x5½"x3½". WEIGHT: 4¾ lbs.
Accessories: High Voltage Probe Set: FP201 and 39G89 . . . . . $35.00

YF33 RINGER $195

FS134

FS134 PORTABLE FIELD STRENGTH METER

Equip yourself for CATV, MATV and additional antenna work.

HIGHLY SENSITIVE all the way down to 30 microvolts.

STANDARD REFERENCE of zero dB = 1000 microvolts for direct signal strength reading.

COMPLETELY PORTABLE with battery operation.

FS134 SPECIFICATIONS

General: POWER: Nine "C" cell batteries or 39G15 Accessory battery charger. SIZE: 9½"x10"x5". WEIGHT: 9 lbs.

FS134 PORTABLE FIELD STRENGTH METER . . . $395

SUBSTITUTORS

RC24 RC167

RC24 "PARTS PAK"

It's a tube caddy janitor

COMPACT AND TRULY PORTABLE to fit in any tool box or parts caddy, neatly and conveniently, to clean up messy loose resistors and capacitors.

FULL SURGE PROTECTION just like the RC167, for increased uptime – less downtime.

RC24 PARTS PAK $45

RC167 THE SUBSTITUTOR

It's a real time saver with a full range of resistors, capacitors, and electrolytics.

SURGE PROTECTION switch eliminates surge current so the electrolytic cannot be healed, plus eliminates arcing. Warning light next to switch indicates if more than 75 volts is applied to any 75 volt position or if polarity on any electrolytic is reversed for double protection.

EXCLUSIVE PARTS IN A DRAWER for easy access to common substitute parts, plus doubles as a mount for bench installation.

UPDATED FOR SOLID STATE WORK with 2000mfd electrolytic.

RC167 THE SUBSTITUTOR $99

STEREO ANALYZER

SG165

SG165 AM-FM STEREO ANALYZER

It's the only complete stereo analyzer with specs better than your FM station.

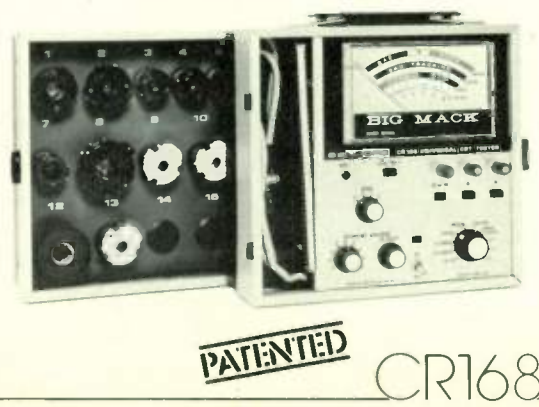
THE ONLY INSTRUMENT YOU NEED to service any brand of stereo equipment.
CHECKS EVERY STAGE of a receiver from antenna to speaker, with all 12 signals for complete testing.
SINGLE OUTPUT CABLE for all functions eliminates confusing bench tangle.
EXCLUSIVE FULL RANGE AM-FM tuning with broadcast quality signals.
10.7MHz CRYSTAL CONTROLLED and adjustable for the latest receivers.
DIRECT-READING OUTPUT meters to 100 watts RMS for power testing or - 40db for separation.
BUILT-IN SPEAKER LOADS save the output stages and your ears.
PATENTED 19KHz PILOT is phase-locked to guarantee you are aligning to a signal identical to your station.

SG165 SPECIFICATIONS

FM RF: 86 to 110MHz, modulated or unmodulated CW.
FM IF: 10.7MHz, modulated or unmodulated crystal controlled CW (FM Modulation: FCC or IHF level, 400Hz sine wave).
FM IF Sweep: 10.7MHz with post injected markers at 10.7, 10.6, and 10.8MHz. Two lead hook-up from receiver to scope.
Multiplex: FCC or IHF level stereo.
SCA: 67KHz for setting subscription signal traps.
AM RF: 525 to 1625KHz, 400Hz sine modulated or unmodulated.
AM IF: 262 or 455KHz, 400Hz sine modulated or unmodulated.
Audio: 400Hz sine or square wave for amplifier power and frequency tests.
Dual Monitoring Meters for constant check of each stereo channel.
Meters: 3½", D'Arsonval, calibrated from 0 to - 40dB, 0 to 10 watts, and 0 to 100 watts RMS.
Speaker Dummy Loads: Up to 100 watts RMS for full power test. Speaker direct, 4, 8, 16, or 32 ohms to match receiver being tested.
Output: Single cable for RF, IF, Sweep, Audio – all one common cable. All cables, auto radio adaptor included.

SG165 AM-FM STEREO ANALYZER $595

CRT TESTERS



CR168

CR168 BIG MACK

Big Mack is there to help you make that big sale.

IT'S YOUR NUMBER ONE CUSTOMER CONVINCER.
TESTS THEM ALL including new RCA 110° color tube, the thin neck inline tubes and the 17" Japanese Trinitron.
PATENTED AUTOMATIC TRACKING: You simply read tracking on the big meter after making emission tests.
LARGE 7 INCH METER with easy to read "GOOD-BAD" test that convinces your customer "she" needs a new CRT.
SAFE REJUVENATION with RC timed voltages. Takes all the guesswork and hazard out of rejuvenation.

CR168 AUTOMATIC CRT TESTER $275

CR31A

CR31A SUPER MACK

It completely equips you to test and restore more CRTs than any other tester.

COMPLETE, PATENTED, AUTOMATIC CRT TESTS.
COMPLETE AUTOMATIC RESTORATION with 5 increasing levels to get the job done, effectively, yet safely.
COMPLETE "ERROR PREVENTING" CIRCUIT TESTS including: Line Voltage, Focus and High Voltage.
COMPLETE WITH ALL SOCKETS AND ACCESSORIES – no hidden costs – you'll always be prepared.

CR31A SPECIFICATIONS

Shorts Test: H-K Shorts; G1 Shorts; **Emission:** Measures zero bias beam current for CRT under test. **Tracking:** Ratio of 1.55 to 1, or greater, will indicate BAD tracking. **Line Voltage.** 10KV and 50KV DC Voltage. **Restore:** Auto Cycle: 0 - 100mA current. Manual I: 0 - 100mA. Manual II: 0 - 150mA. Two rejuvenate positions. G1 shorts removal.
General: SIZE: 12¼"x11"x7". WEIGHT: 13¾ lb. POWER: 105 - 130VAC, 50/60Hz, 25 watts. 50KV High Voltage Probe and 18 sockets supplied.

CR31A SUPER MACK $495

PWR. SUPPLY

UPS164 39G42

UPS164 UNIVERSAL POWER SUPPLY

The most rugged, protected power supply on the market with both voltage and current regulation.

ONE UNIVERSAL POWER SUPPLY for all of your production, design, and service applications.
CURRENT LIMITING on all outputs protects supply and circuit under test, even with a dead short.

UPS164 SPECIFICATIONS

High Filtered Supply: VOLTAGE: .5 –15, .5 –30 volts DC. 0 – 2 Amps. Current Limiting Protection.
6 Volt Supply: CURRENT: 20 Amps continuous.
12 Volt Supply: CURRENT: 10 Amps continuous.
General: METERS: Voltage and Current. POWER: 105 - 130VAC, 60Hz, 350 watts. SIZE: 10"x13½"x9½". WEIGHT: 23 lbs.

UPS164 UNIVERSAL POWER SUPPLY $290

39G42 MODULE MASTER

The Module Master will convert the single output of the UPS164 to two adjustable positive and one adjustable negative current limited and regulated outputs, plus one positive output that is controlled by the power supply.

39G42 MODULE MASTER $35

SWEEP/MARKER EQUIPMENT

SM158

SM158 SPEED ALIGNER SWEEP AND MARKER GENERATOR

The industry's easiest - to - use sweep and marker.

SWEEP OUTPUT: Chroma, IF, or RF with front panel fine tuning.
CRYSTAL CONTROLLED MARKERS post injected for alignment accuracy.
UNLIMITED MARKER AMPLITUDE so you may place all markers at any height without affecting the curve.
15 MEGAHERTZ SWEEP WIDTH to cover the entire IF band.
GENERATES A ZERO REFERENCE BASELINE: All alignment instructions show a baseline, and the SM158 shows you exactly where zero is.
PUSHBUTTON MARKERS for the 8 most often used IF frequencies: 39.75, 41.25, 41.67, 42.17, 42.67, 44.25, 45.75, 47.25. Trap and carrier markers listed right on the front panel. 3.08, 3.58, and 4.08MHz for chroma.
SWITCHABLE HORIZONTAL OR VERTICAL MARKERS: Just pull the marker height control out and markers appear horizontally so you can view them easier in traps or for leveling.

SM158 SPEED ALIGNER $275

BE156

BE156 7 IN 1 DC BIAS SUPPLY

PROVIDES THE BIAS YOU NEED FOR ANY SET – IN ANY STAGE.
3 SEPARATE SUPPLIES for fast alignment work.
NEGATIVE AND POSITIVE SUPPLIES for both tube and solid state work.
NEGATIVE 75 VOLTS for sets requiring high negative bias in chroma amplifiers.

BE156 7 IN 1 BIAS SUPPLY $49.50

Prices and specifications subject to change without notice.

Form 1234P

DISTRIBUTED BY:

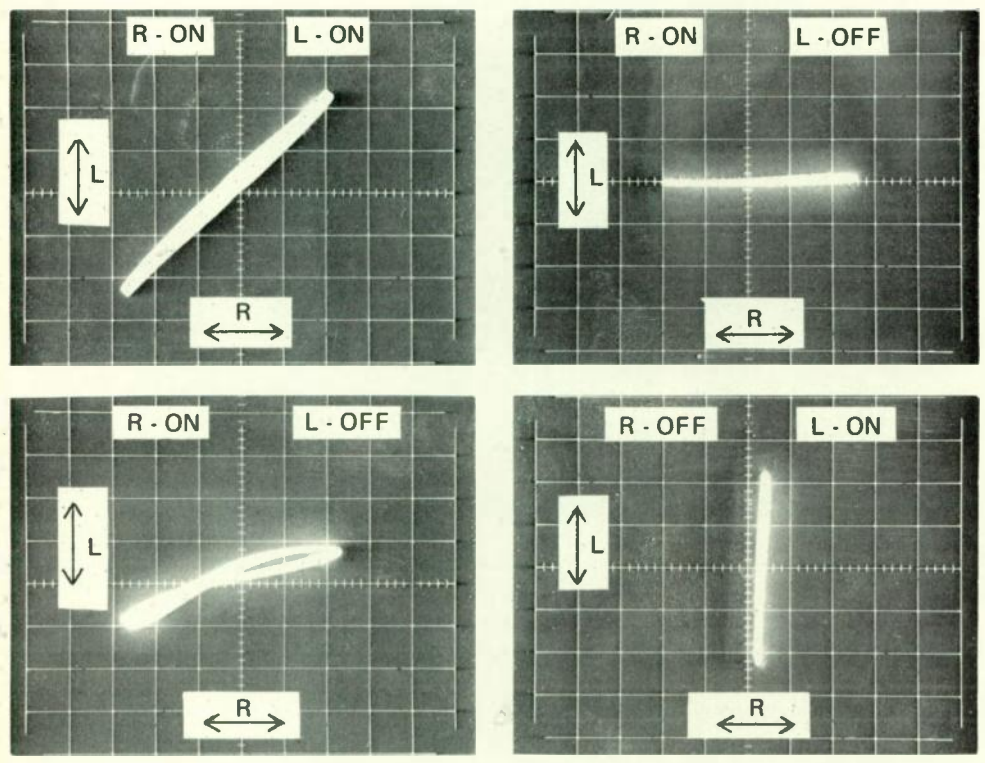
for maximum output as viewed with an oscilloscope. Next, adjust the 38KHz transformer for maximum. The next step is to adjust for maximum separation. This is done by switching off either the right or left channel modulation of the SG165 and adjusting the 19 and 38KHz transformers for maximum separation, as indicated on the built-in separation meters. In those receivers that incorporate an additional adjustment for phasing or separation, this should also be adjusted for maximum separation. Alternate the modulation between right and left channels as a final check for equal and maximum separation. The only thing remaining is the 67KHz SCA (Subsidiary Communication Authorization or "store cast") trap. The Motorola IC includes the trap within the IC and it is fixed. Receivers using discreet components will usually have the adjustable trap to remove any store cast interference. This is adjusted simply by connecting the SCA 67KHz output of the SG165 to the FM detector test point and adjusting the trap for minimum 67KHz as viewed on the oscilloscope. The 67KHz oscillator is precisely controlled and set to make the alignment of this trap accurate every time.

As far as alignment accuracy is concerned, the SG165 will never lead you astray. The multiplex signal is based on a 76KHz crystal oscillator, divided by 2 to provide the 38KHz modulation signal. The 19KHz pilot is obtained by again dividing by 2. The frequency of the 19KHz pilot is extremely accurate, plus or minus two Hz, matching the requirements of the FCC for FM stereo broadcast stations. The phase of the 19KHz can never change with respect to the 38KHz modulating signal, thanks to a Sencore circuit to control this phase. (Patent Number 3896268) There are no internal phase adjustments in the SG165 as you find with competitive units. The phase cannot drift in the SG165 because it is permanently locked to the master crystal oscillator. You will always align the multiplex section right on the nose with the SG165.

HOW ABOUT ONE SIMPLE TEST FOR COMPLETE FM CHECK OUT?

By now you probably understand how the SG165 is your Number One troubleshooting tool for walking the troubles out of each section of a stereo problem. Now, we'd like to show you something else that is the "Icing on the Cake." We use the complete front-to-back hook-up with the SG165 and the PS163 scope to really fine tune the separation and peak up the overall performance of the entire receiver. All we need to do is connect the SG165 to the antenna terminals with the modulated FM RF signal going in, and hook up the SG165 loads and PS163 to the speaker outputs. Now push the VECTOR button on the scope. With both channels modulated, we have a diagonal line which is the addition of equal stereo signals on both the vertical and horizontal amplifiers of the scope. Since both signals are equal and in phase, they line up in a 45° line, just like the Lissajous patterns in textbooks.

If we turn the left channel modulation off, which is the vertical channel in this case, we get a horizontal line. If you mis-adjust that 38KHz coil, the line curves to indicate loss of separation because of crosstalk between channels. If that coil isn't tweaked right up, you'll get left channel information in the right channel output. Now we adjust it for the best straight line and tweak the IF coils to see if that line can be straightened a little more. We can also watch the SG165 output meters to get the calibrated separation readings, too.



Now, with this same connection and the scope readout, modulate the other channel and tune the IF and multiplex sections to obtain the best horizontal line. You may never get them both perfectly straight, but the closer they are to straight vertical and horizontal, the better the separation. You may have to go between the IF and multiplex sections a couple of times to get the straightest line, but it doesn't take long.

This final adjustment of the IF coils makes separation even better, too, because we have aligned the whole system, and not just individual parts of it. It's a breeze to tweak up the entire system with two simple connections. Every unit should be checked out just like this before it goes out. You could improve the performance of every stereo job with the simple final test. It takes just a minute to do and is a real plus for your customers and for you, because you can charge an extra $15 to $25 for each job. And think of what your customer will say, too, when the stereo was brought in for "fixin'", and went back sounding "better than new."

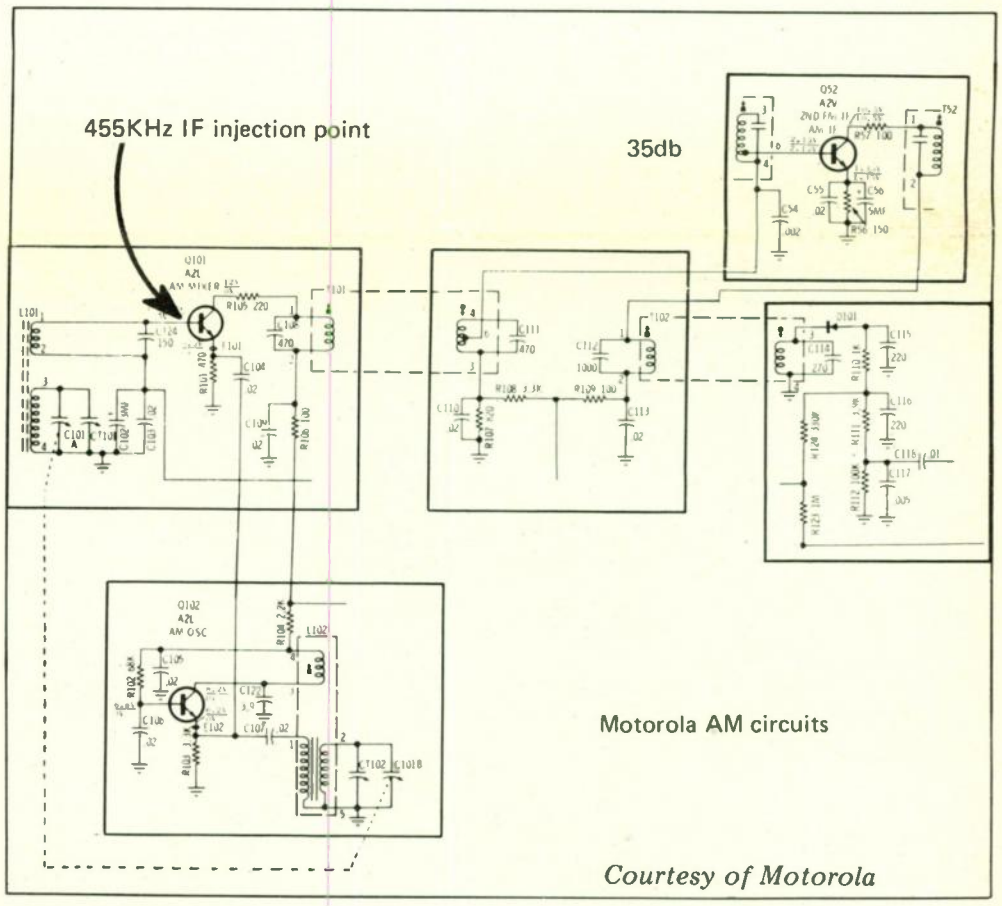
In fact, some of our long-time owners of the SG165 and the PS163 have told us this vector alignment method is the way to go when you don't have any service information handy for the unit you're working on. They say to just touch-up every IF and multiplex can. If the vector line gets flatter, then you're on the right track. If it doesn't, then go the other direction. And if the coil doesn't change at all, then you got one of the AM cans. Just mark it with a grease pencil and come back to it later to peak up the AM section. Now that's getting top notch performance and extra profits, even without schematic information!

This vector procedure practically eliminates the need for regular sweep and marker work, but there are times when you might want to use the sweep and marker procedure, especially when the customer tried to fix it himself and "tightened all the loose screws in there." The SG165 has included a 10.7MHz signal with sweep and markers, right in with all the other signals, so you're never cut short.

And here's the clincher. AM and FM monophonic radio are based on the same principles. In fact, they're easier to service since they don't have a multiplex section to worry you. The SG165 offers all the signals needed to service these, too, for a complete front-to-back check, just like we've talked about here.

WALKING THE TROUBLES OUT OF AM CIRCUITS

AM radio should be no stranger to most of you. These units have been around for over 2 decades and basically very little change has taken place. Sure, we use transistors and IC's rather than tubes but the overall operation still remains the same. The block diagram here shows the typical AM receiver.



The only major variation found in these units is that occassionally one will be encountered that has an RF amplifier for the AM rather than just a direct tuned input to the mixer. Other than that, you have the local oscillator, running 455KHz above the incoming signal, a mixer/converter stage, generally one or two IF stages and a detector. The general troubleshooting procedure is the same as for FM RF and IF stages. The alignment is a simple peaking of the IF transformers to 455KHz and adjusting the RF section for best sensitivity and band spread for the oscillator. The important thing to note is that many of the newer tuners have an increased range for the AM oscillator and the band adjustment points fall well outside the normal 535 to 1605KHz AM band. For this reason, the SG165 has an AM band extending from 525 to 1625KHz, making it easy for you to adjust any AM radio you might be working with.

The block diagram shows the normal signals and gain levels present in the Motorola tuner we have been using for an example. These values are valid for this unit but can also be used as relative gain figures for most AM units. The SG165 is an excellent analyzer for any AM problems that might come up. It provides both AM RF and AM IF, with two IF ranges; 455KHz for home receivers, and 262 for auto units. Both RF and IF signals can be used modulated or unmodulated at the flick of a switch. Let's see what it will do for us on an AM problem.

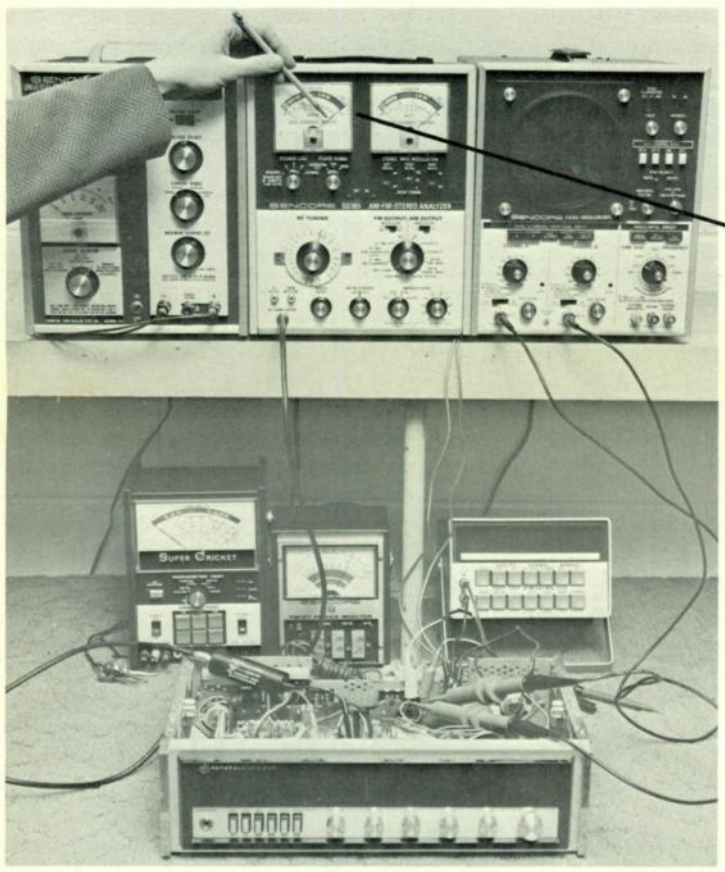
WHAT ABOUT AM TROUBLESHOOTING?

We will put in a very simple problem this time, an open detector diode. The symptoms are no AM, FM good. Since the FM is good, we know that the audio circuits plus the AM IF stage are good. These are common to both AM and FM.

Starting from scratch, almost any other stage could conceivably give us this type of problem. If we start at the back of the tuner, we will first inject an audio signal into the detector output to make sure the switching between AM, FM, tape and the like are ok. Good signal. Now we switch to modulated detector diode cathode. No signal - so we have isolated the problem to the bad diode. Replace the diode and we're back in business. Keep in mind, too, that the SG165 makes an excellent substitute for the local oscillator if it should be out. We haven't used that function but it is simply a matter of switching off the RF modulation and injecting the SG165 RF output into the normal oscillator injection point. This could come in handy in tieing down a dead oscillator. The SG165 is real handy to have on the bench because it simply does it all.

WHAT ABOUT AM ALIGNMENT?

AM alignment, as we have mentioned, is usually just a matter of using a modulated 455KHz IF input to the mixer and adjusting the IF transformers for maximum output. This procedure is extremely easy with the SG165 because you have the built-in meters to monitor output without listening to that



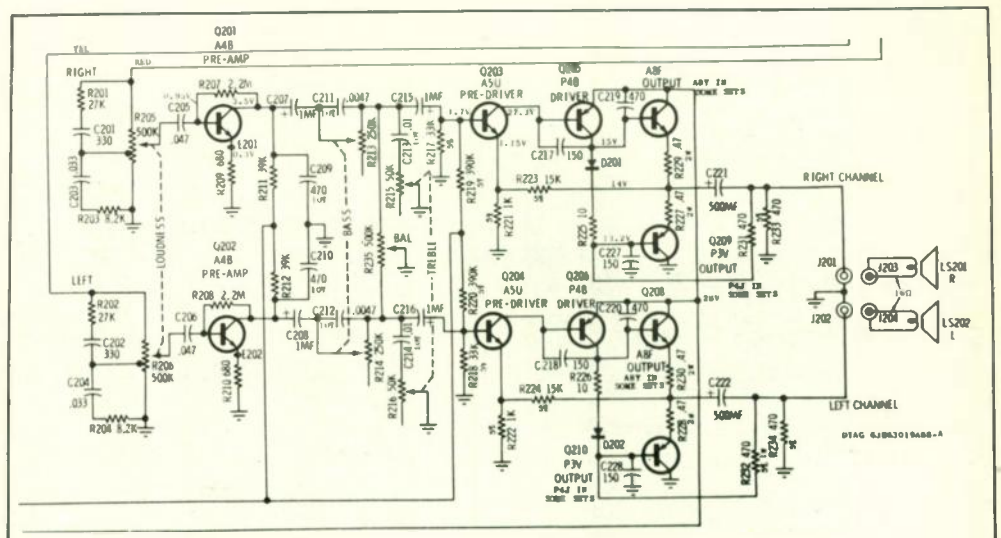
loud howl. Just inject the 455KHz IF signal, modulated, into the base of the mixer transistor and adjust the IF's for maximum indication on the meters. For the RF section, just follow the procedure listed by the manufacturer, using the RF output for the signal and the SG165 output meters for the level indication of the receiver. The IF Rocker also varies the frequency of the AM IF's, giving you full capability to handle the AM crystal filters when they come your way. The SG165 puts everything you need for total AM-FM Stereo servicing right on your bench in one simple to use package.

WALKING THE TROUBLES OUT OF AMPLIFIERS

Stereo amplifiers can often come up with some very elusive problems if you do not have full testing capabilities to locate the trouble. Distortion, unbalance between channels, poor frequency response and a host of other problems can really wear your patience thin. The customer is generally interested in two main properties of the stereo unit, the output power and the tonal quality. If anything happens to change either of these, he will be at your door looking for help. When you team up with the SG165 AM-FM Stereo analyzer and the PS163 Dual Trace Triggered Sweep Scope, you can really be sure you will be able to help him out. The SG165 provides both sine and square wave outputs at 400Hz for audio troubleshooting plus full output power monitoring capabilities. Put these together with dual trace comparison of signals in the amplifier with the PS163, and you have a real audio service center. It's time we look into the amplifier and see what we can do there.

WHAT ABOUT AMPLIFIER TROUBLESHOOTING?

We will use the Motorola tuner/amplifier for the amplifier section, as we have done for the tuner portions of this issue. The Motorola is a conventional

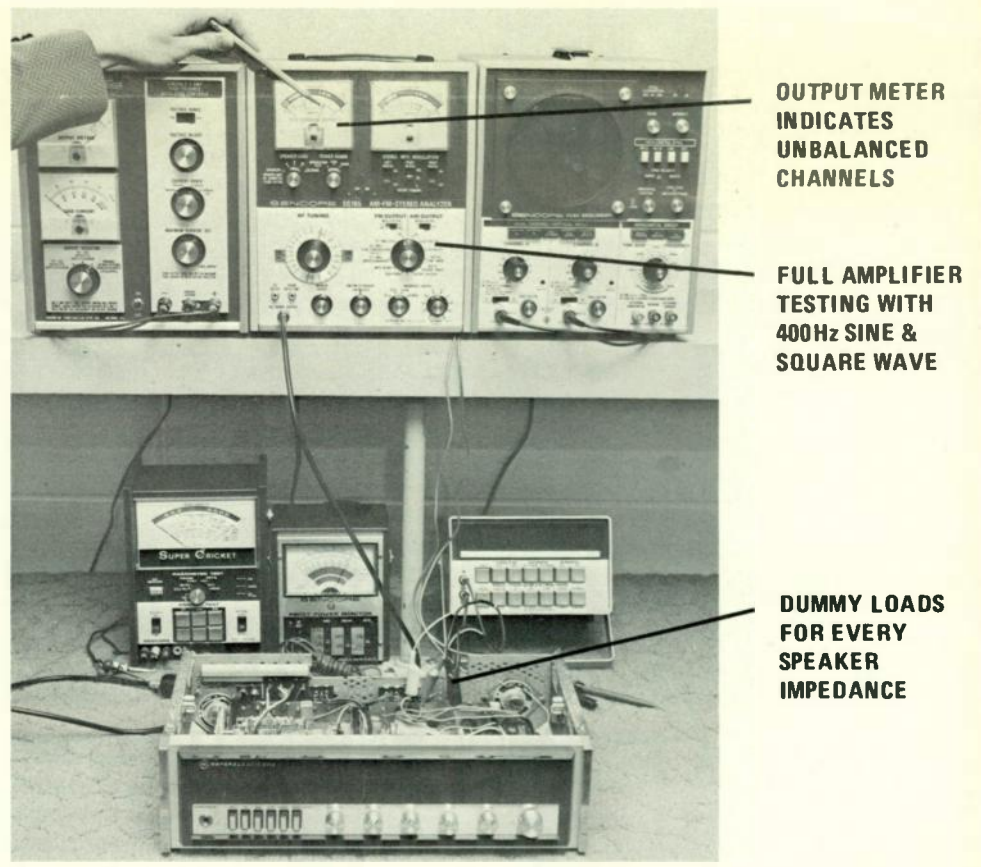


Schematic Diagram LHS62403

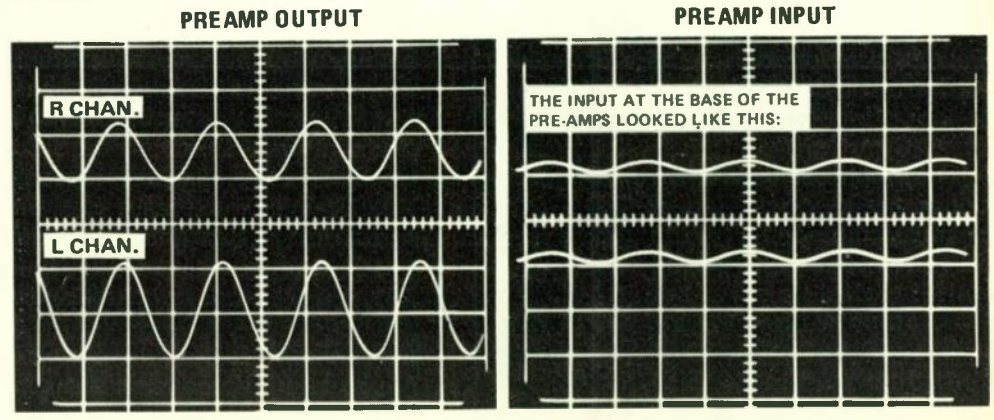
Courtesy of Motorola

amplifier employing 5 transistors per channel. Each channel has a preamplifier, predriver, driver and a pair of output transistors. The last four transistors are DC coupled, with the base, treble and balance controls between the pre-amp and pre-driver. Enough for now, how about locating a problem?

This one we will let you figure out on your own. The customer complaint is low volume from the right channel. The volume of the two channels can be matched, but the balance control must be turned far to the right to do it. First, we will inject the 400Hz audio signal into both channels. We also have the dummy speaker loads connected with the separation meters monitoring the output from each channel. The tone controls are set at the midpoint of their rotation, as is the balance control. A PS163 is connected to the speaker leads to observe output signal. Here are the results:



Right channel output shows minus 4db compared to 0 db for the left channel. Upper trace on PS163, right channel, shows definitely lower amplitude, but with no noticeable distortion. Any guesses? Let's see what we can find out. The PS163 probes were moved to the output of the pre-amp with these results:



The DC voltages are at or very close to the values shown on the schematic. If you guessed bad pre-amp transistor in the right channel, you're right. The transistor had high leakage between collector and base, which caused its output to be low. After replacing the transistor, the amplifier performance returned to normal. The audio signals of the SG165 make amplifier troubleshooting easier for you. The 400Hz sine wave serves as a general troubleshooting signal with the 400Hz square wave for performance testing such as distortion, frequency response and the like. Match this with the PS163 and you have a real combination.

The PS163 really helps, too, for stereo amplifier troubleshooting, especially the DC-coupled jobs. Servicing these goes a lot faster when you have the Dual Trace PS163 to check one channel against the other. The DC coupling of the scope input has also just about eliminated the need for a meter. It's much faster, too, because you don't have to find the leads for the meter. You already have the scope probe in your hand. Just set the input switch in the PS163 to ground position, set the reference, flip to DC, and you have the measurement. You can also work the same comparison on DC voltage levels that you can on AC. It really tells you quick what is going on in that amplifier. But, you can only do it if you have a sensitive, DC coupled, Dual Trace Oscilloscope like the Sencore PS163.

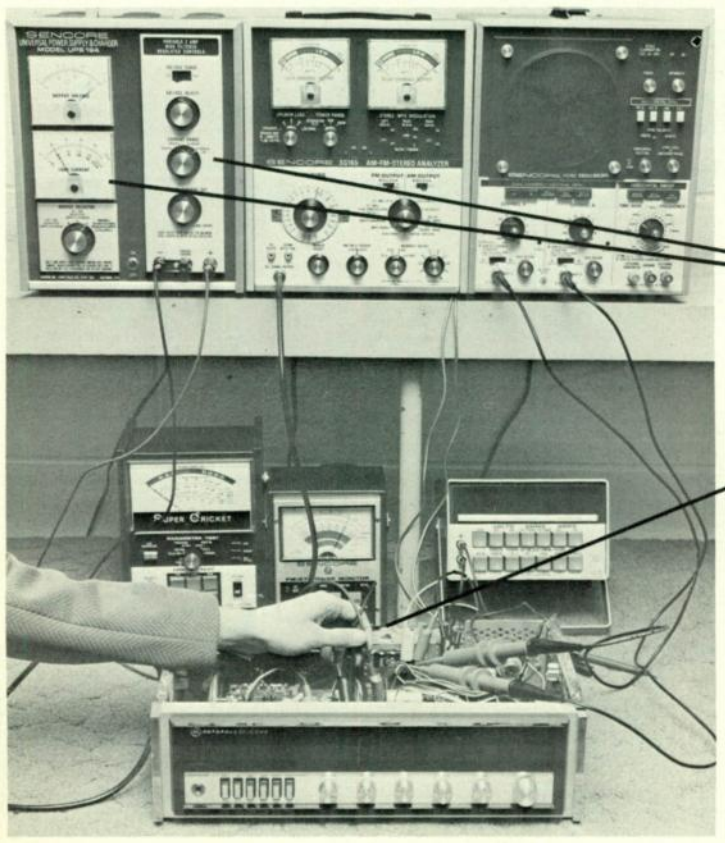
WHAT ABOUT THE OUTPUT STAGE?

By far the most common problem that occurs in the output stages is that the output transistors and drivers get blown. So you would order a complete new set of these, pop them in, and fire up the stereo to get on to the other problems, right? So what happens? You plug the set in and flick on the switch. Then you hear the worst sound in the world, that "Pffft" that means that new set of expensive, matched transistors went up in smoke. You're in that bind of not knowing whether the outputs went because the transistor itself blew, or if something else blew the transistor. And those first microseconds after you applied the power don't give you much chance of finding out, either.

This is where the SG165's bench-mate, the Sencore UPS164 Universal Power Supply, is your life-saver. The UPS164 is fully current limiting so you can set the maximum current level you need for the receiver's power supply, and not have to worry about an overload damaging those transistors. Let's take a closer look at this "Pffft-saver" to see what it can do for you.

The UPS164 provides an output of zero to thirty volts, up to 2 Amps. It's triple-regulated on current, voltage, and AC Line, so there is no ripple or hum to upset your testing — just straight, pure DC. Both the current and the voltage can be adjusted independently and monitored on the two big meters so you know exactly where you stand all the time. To set the maximum current level, just short the leads together and adjust the CURRENT RANGE and MAXIMUM CURRENT SET controls to whatever current level you want, up to 2 Amps. The magic in the UPS164 is the fact that it will still deliver the voltage you need, but the current will be limited to the safe level you want. It keeps the voltage on and holds it.

Other power supplies do one of two things. Some lab-type supplies will deliver the power up to the maximum you wanted, but then trip the circuit breaker or the overload reset. This doesn't do you much good. These supplies won't overload since the circuit is tripped off, but how are you ever going to find the problem if that little reset button keeps cutting off the power? On the other hand, you could use one of the "brute force" supplies that are really battery chargers more than power supplies. If you hook up one of these monsters to power a board that has a shorted output, then something's got to go — either the circuit or the supply itself. That's why the UPS164 is the only service power supply available that let's you power the chassis for troubleshooting without damage to the power supply or the receiver. Here's how to connect it to find your trouble.



With most receivers, you can just connect the UPS164 across the B+ supply. Set the Maximum Current level to the nominal supply current specified on most schematics (or one half this value if you're just powering one channel). Then set the UPS164 voltage to the B+ level and hook-up the connections to the board. With the power applied, you can make voltage checks to see which circuit is causing the loading. The resistors in the supply line to the defective circuit will generally have a proportionately larger than normal voltage drop across them because of the extra current being drawn through them. It's a simple matter, then, to make resistance and component tests to identify the defective part. The continuous, safe current level provided by the UPS164 makes puppies out of those troublesome driver and output dogs.

You get even more versatility from the UPS164 when you use the 39G42 Module Master accessory. Some output boards require more than one voltage source and the 39G42 provides a total of four independent, individually controlled and regulated sources for these applications. Team up the UPS164 with the SG165 and PS163 scope for a complete stereo servicing bench. That's why we call it the Stereo Trio — three matched instruments providing all the signals, power, and measuring requirements you need for walking the troubles out of stereo servicing.

WHAT ABOUT OTHER AMPLIFIER TESTS?

The amplifier tests such as those listed in the Sylvania manual shown in this section can be easily performed with the SG165. Input sensitivity for the various inputs to the amplifier were not listed, but many manufacturers are listing this information as an aid to the service technician. An example is the Sylvania information shown here for their R32 tuner amplifier series. This type of information allows you to make full performance checks on the system to make sure it is in top notch shape when you return it to your

PERFORMANCE ANALYSIS

Use a 20 watt, 8 ohm non-inductive load across each channel while checking R32 amplifier performance.

SENSITIVITY - PHONO

Connect a 600 ohm impedance audio generator to both PHONO inputs through 2200PF, 10% capacitors.

Adjust controls as follows:
Loudness — Maximum
Bass & Tredle — Mechanical Center.
Balance — Mechanical Center.
Select PHONO and STEREO functions.

This chassis requires 78mV ± 3db @ 1KHz for an output level of 1 watt (2.8V, RMS - measured across 8 ohm load resistor).

Channel output difference shall be no more than 5db.

SENSITIVITY - TAPE

Connect a 600 ohm impedance audio generator to both TAPE inputs through 10K, 10% resistors. Adjust controls as under phono sensitivity.

Select TAPE and STEREO functions.

This chassis requires 210mV ± 3db @ 1KHz for an output level of 1 watt (2.8V, RMS - measured across 8 ohm load resistor).

POWER OUTPUT

Connect a 600 ohm impedance audio generator to both PHONO inputs through 2000PF, 10% capacitors.

Adjust controls as follows:
Loudness — Maximum
Bass & Treble — Mechanical Center.
Balance — Equal left & right channel outputs.

Adjust generator input for amplifier output of 5 watts (6.3V, RMS - measured across 8 ohm load resistor) at 1KHz.

Each amplifier channel should reproduce the 1KHz frequency with a nominal 2% of Harmonic Distortion.

CHANNEL SEPARATION

Connect a 600 ohm impedance audio generator to ONE PHONO input through a 2200PF, 10% capacitor. TERMINATE second PHONO input with 2200PF, 10% capacitor.

Adjust controls as follows:
Loudness — Maximum.
Bass & Treble — Mechanical Center.
Balance — Mechanical Center.
Select PHONO and STEREO functions.

Adjust signal generator for amplifier output of 3 watts (5V, RMS - measured across 8 ohm load resistor) on programmed channel. Measure crosstalk on terminated channel.

Courtesy of Sylvania

customer. Let us make these same tests on the Motorola tuner to see what we mean. The Sylvania specs were all given at 1 watt RMS output, so all we need to do is inject the signals into the appropriate input and adjust for 1 watt on 10 watt power range of the meters. It is then a simple matter to convert the calibrated output control settings to input signal level, or make a direct measurement with the PS163.

Tape input: Both channels driven, volume control at maximum, tone and balance controls at center of rotation. Sensitivity 100mV.

Phono input: Same conditions as for tape input. Sensitivity 30mV.

Channel Balance: Both channels driven, balance control at center of rotation, tone controls maximum. Balance .5db Right Channel low.

Channel Separation: One channel driven, other input shorted to chassis ground, balance and tone controls at midrange, volume control at tap. Separation 40db.

How about output power? Have you ever wondered how much power output a unit had, especially after replacing transistors in just one channel. Are they matched? Is the amplifier delivering what it should? Well, now you can make

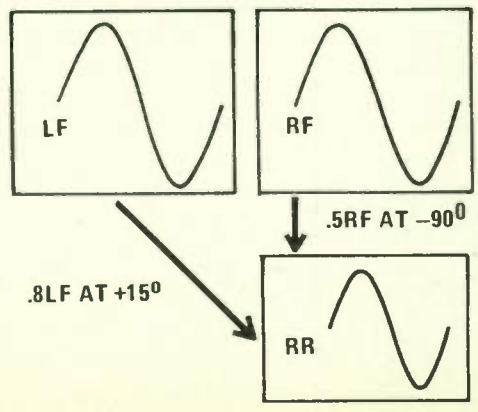
this all important test of an amplifier. . .and it is as easy as hooking up a couple of leads. All you need to do is connect the SG165 to the receiver, inject the 400Hz sine wave signal through any input (usually modulated RF for either AM or FM is the easiest) and then turn up the volume. Observe the shape of the output signal and adjust the volume control until distortion of the signal peaks begins. Back the volume control down until the 400Hz signal shows no distortion in the output and look at the meters on the SG165. The meter scales are calibrated directly in RMS watts from 0 to 10. Two power ranges are available to check amplifiers up to 100 watts RMS output. That's over 400 watts peak power!

WILL THE SG165 WORK WITH 4-CHANNEL?

At present, four channel systems are primarily either discrete four channel, with four separate signal paths for each of the four speaker channels, or some form of audio matrix or phase shift circuit which converts two channel inputs into four channel operation. Since discrete four channel systems are four single channel amplifiers in the same cabinet, they may be tested with the SG165 using the same square wave, sensitivity, and maximum power output tests as conventional audio amplifiers. Just remember to load all four channels with speakers or load resistors of the proper impedance.

Quad matrix systems must be compatible with conventional stereo systems. In other words, they faithfully reproduce a stereo broadcast, or record, in stereo, otherwise they would obsolete millions of stereo receivers. That is why the SG165 stays up-to-date for checking out these quad systems. There are many different types of quad matrix systems, but they basically use the same principles as the SQ system we show here.

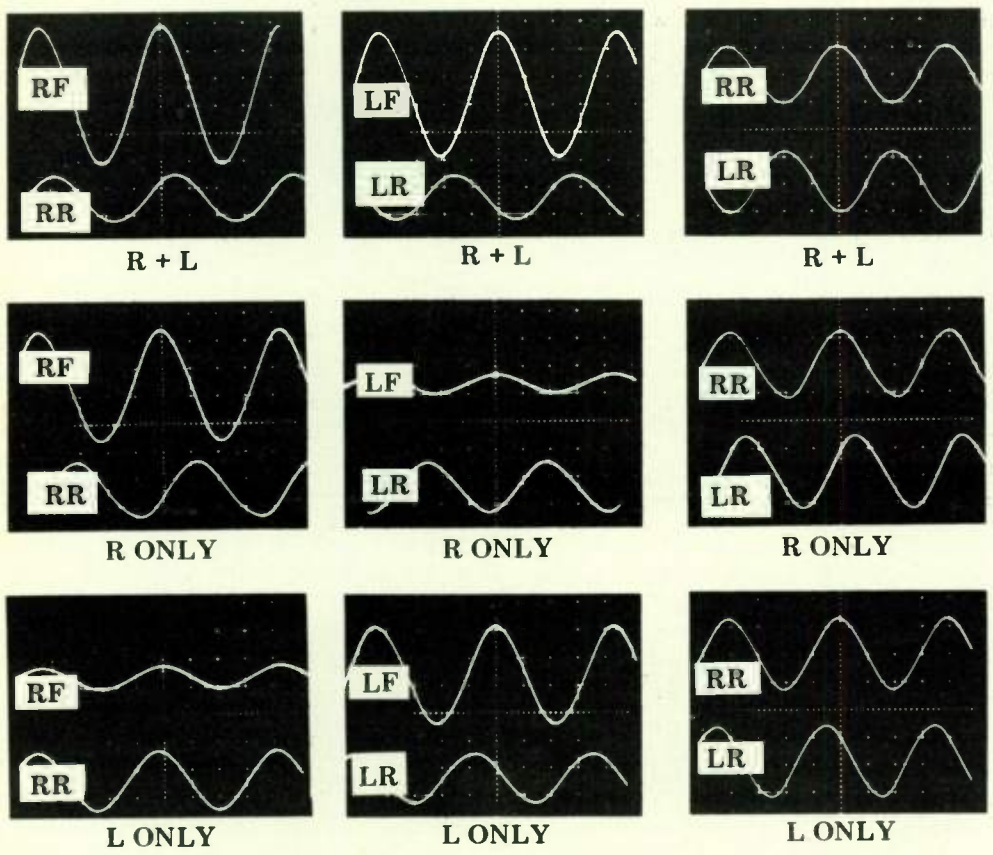
Two channels, Left Front (LF) and Right Front (RF), are encoded with the four channel information. When reproduced in regular stereo, these channels are the standard Left and Right outputs. To develop the rear channels for quad, though, a proportion of the LF signal at a specific phase shift is mixed with part of the RF signal that is also phase shifted. Here we show that .8 times the LF channel leading 15° is combined with .5 times the RF channel lagging 90° to produce the Right Rear (RR) channel. Likewise, the same two LF and RF inputs are combined in different proportions to generate the Left Rear (LR) signal.



SQ MATRIX COMBINES LF AND RF SIGNALS TO PRODUCE REAR CHANNEL

This clues us in on how to use the SG165 to troubleshoot quad matrix. We inject the FM RF signal into the antenna terminals, switch either the SG165 Right or Left channel modulation on, and compare the gain and phase between each of the channels on the scope. The photos below show all the comparisons for SQ. The manufacturer's literature will provide specific decoding information for the system you're working on.

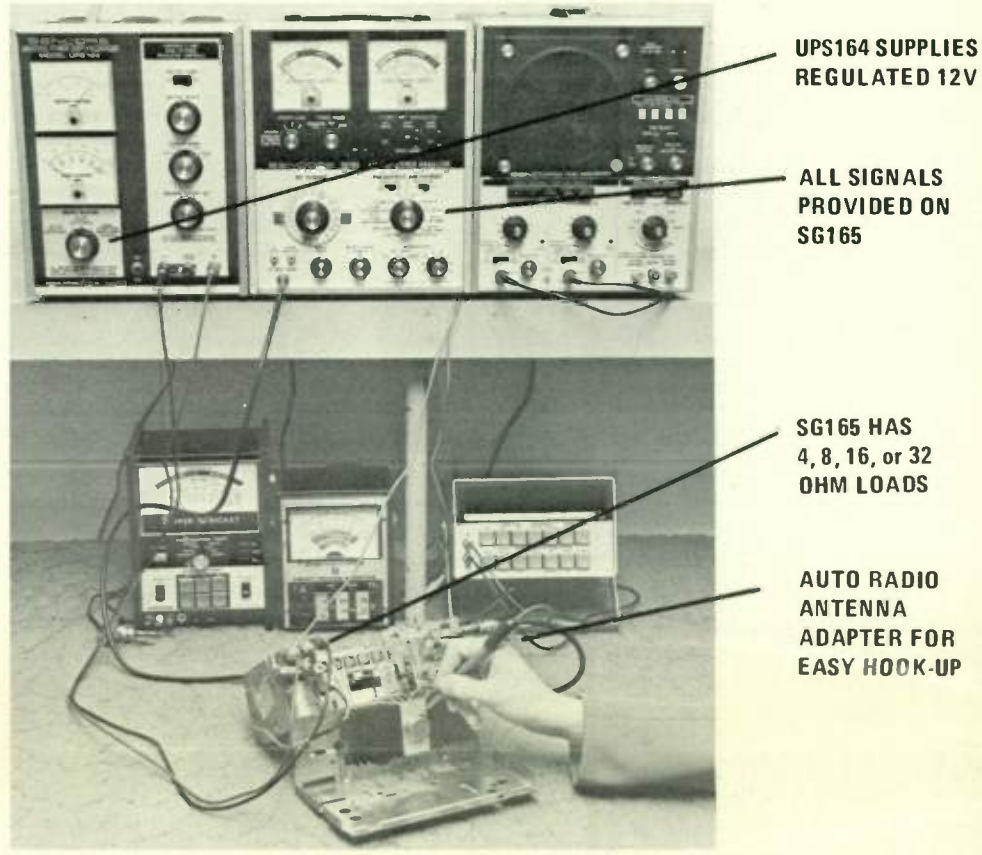
SQ QUAD SYSTEM OUTPUTS



You can see that just using a meter reading, or a single trace scope, to view these relationships would be meaningless, since the phase shift information contains the proper coding. Only a dual trace triggered scope with less than 1% phase shift between channels, like the PS163, will allow you to make these distortion-free waveform comparisons. With the SG165 and the PS163, you can be sure that you're prepared for any job your customer may bring in — monophonic, stereo, or quad.

WALKING THE TROUBLES OUT OF AUTO RADIO

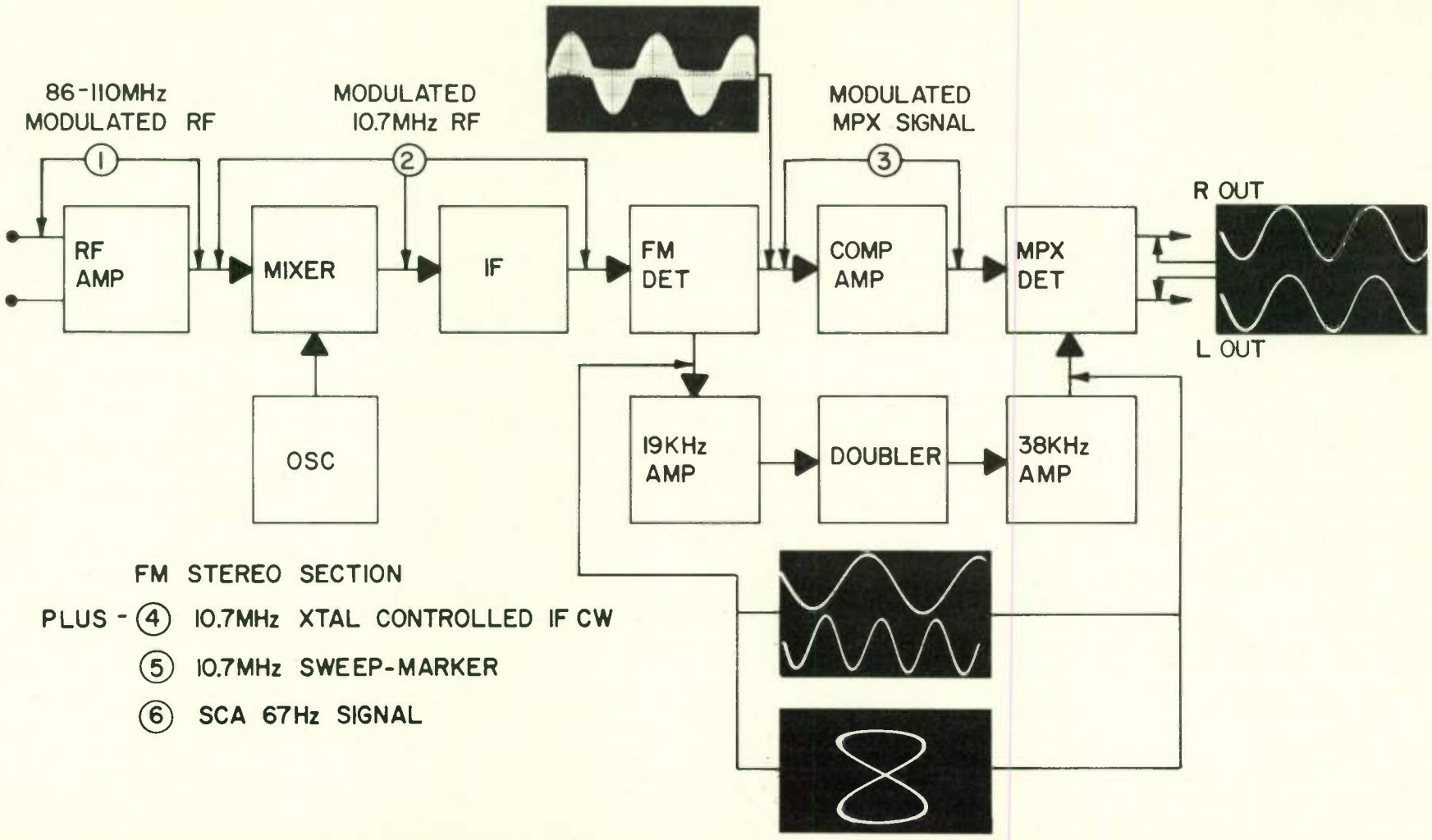
Many service technicians have made a very good business out of specializing in the service of auto radios and tape players. With the increased numbers of AM-FM Stereo and AM-FM Stereo Tape car units, greater demand will exist for service of these systems. The troubleshooting is no different from what we have mentioned for the "home" units. The SG165 will walk the trouble out of an auto unit in the same manner as it will a home unit. The same sensitivity tests will point out quickly whether the RF IF sections are performing up to specifications. This is very important in auto units since the input signal is constantly varying and, as a result, the sensitivity of the units must be high. The SG165 has been given an overwhelming approval by the Auto Radio Division of Motorola, who aided us in the final design of the SG165. When you buy the SG165, you are buying an instrument that was designed for COMPLETE AM FM-Stereo servicing, including the auto units. It even has an auto radio antenna adapter right in the lead storage compartment in the back of the unit.

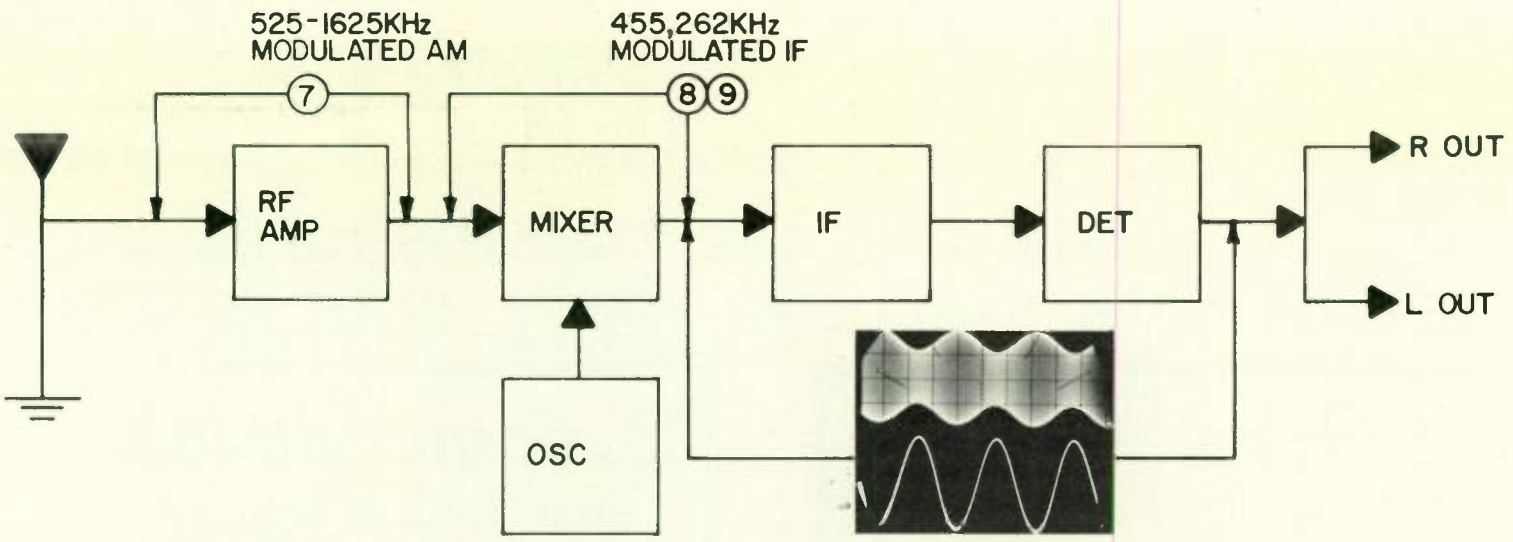


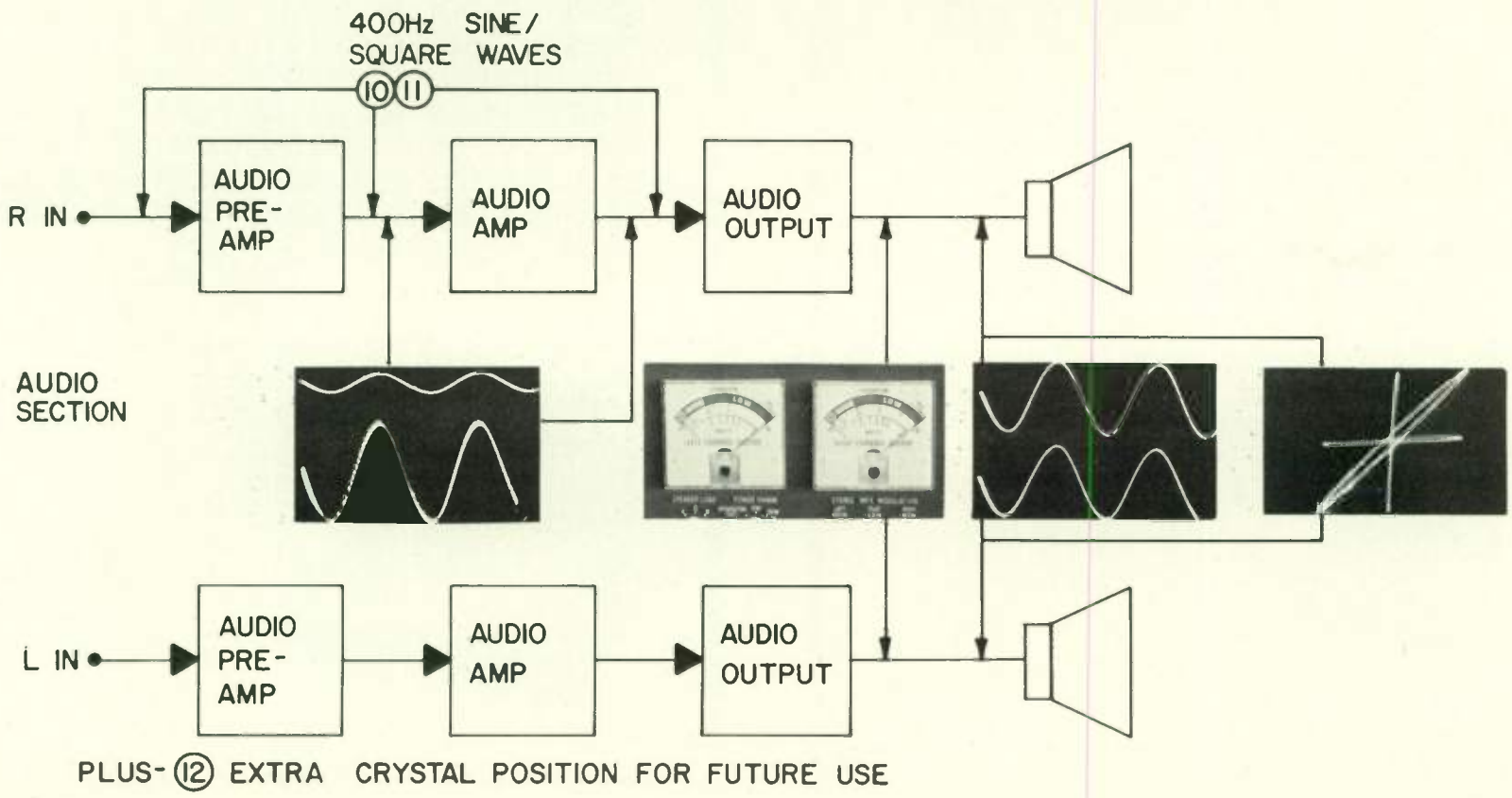
Again, you can team up the UPS164 Universal Power Supply with the SG165 for complete auto radio servicing. The UPS164 also has two regulated outputs for 12 Volts up to 10 Amps and 6 Volts up to 20 Amps for these jobs. You don't have to worry about keeping a messy auto battery with a trickle charger going to get enough power, or burning up the battery eliminator because of a shorted output transistor. The UPS164 handles it all. In fact, the UPS164 is the only service power supply around that will handle those auto radios with the automatic scanning systems. The UPS164 takes them like a breeze. Great for auto tape players, too.

That's our total story on the SG165, teamed up with the PS163 and UPS164 for fast, profitable AM, FM stereo servicing. See your local Sencore FLPD distributor about your SG165 Stereo Analyzer today.

THE SG165 PROVIDES ALL 12 SIGNALS NEEDED TO WALK THE TROUBLES OUT OF ANY SECTION OF AN AM-FM STEREO







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SG165


PS163

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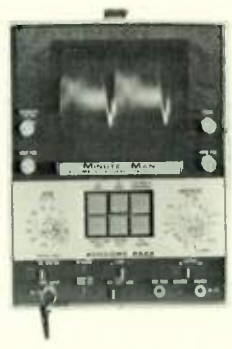
PS148

PS148 WIDEBAND OSCILLOSCOPE/VECTORSCOPE

"The workhorse" of the single trace service scopes.

WIDEBAND 10Hz to 6MHz ± 6db.
HIGH SENSITIVITY 17mV RMS per inch.
HIGH INPUT IMPEDANCE 27 megohms shunted by 11pf low cap.
SEVEN THOUSAND VOLT input rating with low cap probe.
DIRECT VERTICAL PEAK-TO-PEAK VOLTAGE READING.
CONVERTS TO PROFESSIONAL VECTORSCOPE with the flip of a switch.
FULL RANGE HORIZONTAL SWEEP frequencies from 5Hz to 500KHz.
POSITIVE SYNC with variable control locks onto complex waveforms.
EXTERNAL INPUTS for sync, sweep, Z axis and direct connections to deflection plates.

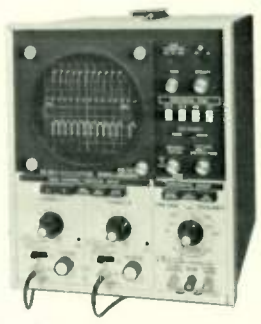


PS29

PS29 MINUTE MAN PUSHBUTTON OSCILLOSCOPE

The only completely automatic triggered, push-button oscilloscope on the market today for all video work.

PUSHBUTTON DISPLAY for every critical video and color signal.
AUTOMATIC TRIGGERING with guaranteed solid sync is backed by TV sync separators.
PLUS, IT'S A COMPLETE GENERAL PURPOSE BROADBAND SCOPE for any non-video signal from DC to 10MHz.
EXCLUSIVE 5000VAC INPUT PROTECTION backed by 10 milliVolt per division sensitivity lets you measure circuits with confidence.

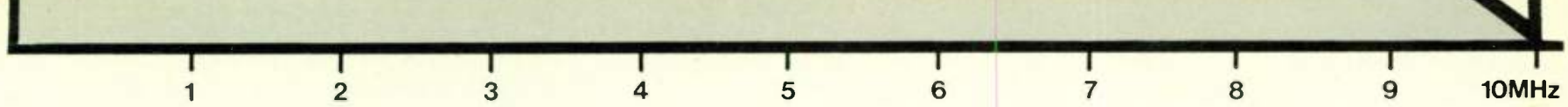


PS163

PS163 DUAL TRACE OSCILLOSCOPE

The easiest to use dual trace scope on the market — offering lab performance at 1/3 the cost.

PHASE LOCKED MATCHED CHANNELS allow comparison of any simultaneous waveforms within 1% lab accuracy.
HIGH SENSITIVITY of 5 milliVolts per centimeter, allows accurate display of low level signals.
TRUE BANDWIDTH using no peaking coils. Gives clean waveforms from DC to 8MHz.
TIME SAVING INSTANT MODE SELECTION for free running, manual and automatic triggered sweep, with selectable A or B channel triggering.
TV VERTICAL AND TV HORIZONTAL SWEEP settings with sync separator stability for viewing video signals.
IT'S ALSO A VECTORSCOPE with a simple front panel push-button control.



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FOR COMPLETE MEASURING CONFIDENCE

DVM38

AUTO-RANGING DIGITAL-MULTIMETER

3 ½ DIGIT, .1% ACCURACY

15 MEGOHM IMPEDANCE

$348.

"PROTECTED ACCURACY" FOR TODAY'S CIRCUITS

CONFIDENCE

The DVM38 is a meter of confidence. Confidence that the 10 milliVolt measurement you just took is right on the money. Confidence that the coil resistance you just measured is accurate to within one percent. Confidence that every in-circuit resistance measurement you take is accurately reading the in-circuit resistance without affecting circuit operation. Confidence that every measurement you take is made with extremely high input impedance, that will not alter circuit operation during measurement and offer up true measuring results. That's confidence that the DVM38 offers. Dependable measuring confidence that will pay for itself many times over. Backed by accuracy, versatility and true operating ease, for unmatched troubleshooting capabilities.

ACCURACY YOU NEED IN TODAYS CIRCUITS

Todays circuits require higher accuracy measurements. The DVM38 offers you unbelievably high .1% of reading DC voltage accuracy for measurements you can rely on in even the most critical circuits. Then we back this high accuracy with a 15 megohm input impedance, which guarantees 1/3 less circuit loading and 50% greater accuracy than conventional digital meters with 10 megohm input. When it comes to accuracy, the DVM38 is a prime measuring standard you can always rely on for today's solid state circuits.

VERSATILITY FOR ALL YOUR MEASURING NEEDS

Todays circuits present a wide range of measuring requirements from boosted boost voltage of 1500 volts in a TV receiver, or 1800 volts in x-ray equipment, down to 10 milliVolts and less on IC chips, and .47 ohms in output stages of stereo receivers. The DVM38 measures all of these, plus much, much, more. Special 20 ohm scale offers .01 ohm resolution, not available in conventional DVMs. Then step up to 2000 Volt DC measurement with the push of a button. You also have complete HI and LO power ohms functions. LO power ohms uses a maximum applied test voltage of 200mV, that will measure resistance in solid state circuits without triggering semiconductor junctions in IC's and transistors. HI power ohms uses a standard 2 volt applied test voltage that you need for measuring front to back ratios of diodes. The DVM38 supplies you with total measuring capabilities so you are always prepared . . . and that's what you want in a bench digital, isn't it?

OPERATING EASE FOR INCREASED EFFICIENCY

Some call this human engineering, . . . we call it common sense in design. The DVM38 was designed so you can make measurements fast and accurately, with the least amount of effort. That's efficiency that makes your day shorter . . . big pushbuttons, callouts, and displays are easier and faster to use than conventional DVMs. Auto Zero eliminates zero controls, and speeds your work on every measurement. The DVM38 is always zero'd out for your every measuring need. Auto-Decimal placement and Auto-Polarity indicators add to the operating ease. Finally, single step Auto-Ranging automatically ste[illegible]n to the next voltage range whenever the reading you are taking is [illegible]ne tenth full scale. This means you can take measurements on the 200 volt range down to 10 milliVolts, without changing ranges. Increases your efficiency and accuracy. If you're looking for one meter to use for fast, efficient troubleshooting, the DVM38 is it!

PROTECTION FOR MORE UPTIME

Now what good is all of that accuracy and measuring capability if the first time you overload the meter you blow the front end? That's a good question that Sencore has been asking about other meters for many years, and is the very reason that all Sencore digitals are protected for a long operating life. Complete diode protection to 2000V DC, 1000 volts on all other functions and ranges is backed by fuse protection to insure, at worst, a blown fuse, when those accidents happen. And they do happen. The DVM38 is protected so you can keep right on with your work, without that costly downtime.

AFFORDABLE

The DVM38 outperforms meters costing $500 and more, yet there are no meters as complete in this price range.

THINK ABOUT IT . . .

- ✔ Prime measuring accuracy
- ✔ Extremely versatile measuring capabilities
- ✔ Speed with ease of operation guaranteed on every measurement
- ✔ Protection that minimizes your downtime offering complete measuring confidence.

SPECIAL DIGITAL TRAINING TAPE "HOW TO USE YOUR DVM38"

Time is critical in electronic troubleshooting. This wasted time generally comes from not knowing what to do next. Sencore eliminates this wasted time by including a digital training tape on, "How to use your DVM38." Our training tape will familiarize you with the key operating points of the DVM38 so you can put this prime standard meter to it's full use minutes after it's on your bench.

IF YOU WANT TO . . .

✔ SAVE TIME ✔ REDUCE ERRORS ✔ INCREASE YOUR OUTPUT

THEN SEE YOUR LOCAL SENCORE FULL LINE DISTRIBUTOR ABOUT TRYING A DVM38 TODAY. A "PRIME" STANDARD AT YOUR FINGERTIPS FOR COMPLETE MEASURING CONFIDENCE.

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Form 1229SN

SENCORE NEWS

NEW CB41 AUTOMATIC CB PERFORMANCE TESTER

SEE IT AT A SPECIAL CB SEMINAR LISTED INSIDE

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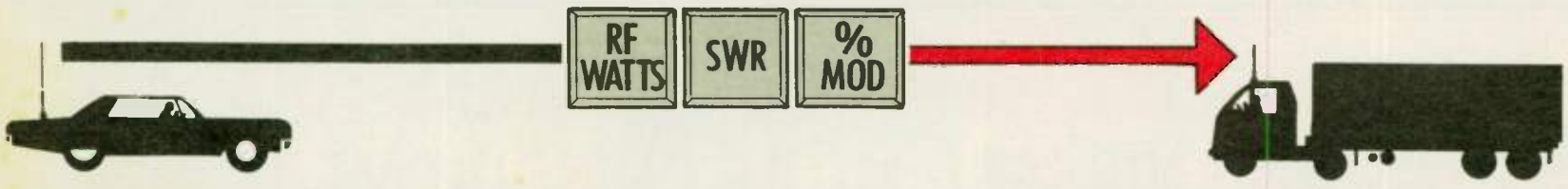

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SIMPLY PUNCH 3 POWER-PACKED PERFORMANCE PUSHBUTTONS . . . IN SECONDS WITH THE SENCORE CB41 AUTOMATIC CB PERFORMANCE TESTER

Only CB tester with built-in sensor so you can make error-free adjustments at your antenna with the car doors closed!

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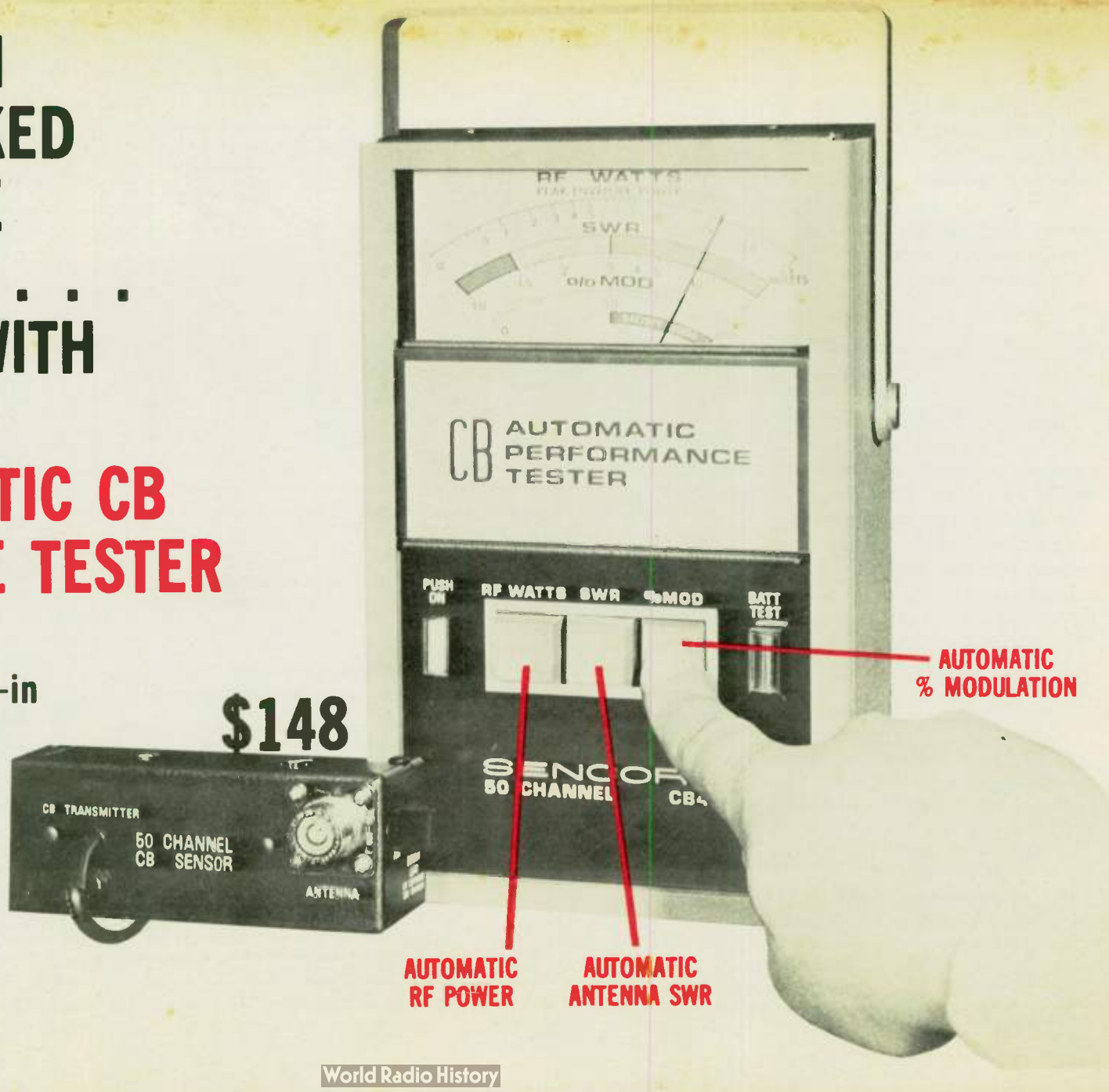
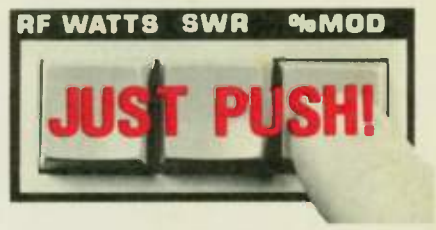


ARE YOU SURE YOUR CUSTOMERS ARE REALLY "PUNCHING THROUGH LOUD AND CLEAR"?

The typical CB'er can get an average of three miles further to "punch through loud and clear" with a check and adjustment of his CB and antenna system for peak performance. It's a fact, and we'll prove it to you in these pages. But here's what's new; you can now automatically check performance on all CB channels in one-third the time that it takes with old-fashioned SWR and RF power meters. You can do it only with the new Sencore CB41 Automatic CB Performance Tester.

HERE ARE TEN SURE-FIRE WAYS YOU CAN MAKE YOUR CB CUSTOMERS HAPPY AND SELL MORE CB EQUIPMENT AS YOU TURN CB POLLUTION INTO CB PROFITS IN YOUR AREA.

1 ARE YOU CAUSING CB POLLUTION BY NOT HAVING A COMPLETE PERFORMANCE TESTER?



If your CB customer isn't "punching through loud and clear," then he's broadcasting CB pollution. Read these excerpts about who really contributes to pollution, and you decide . . .

WASHINGTON, D.C.—The Federal Communications Commission reports that it has received voluminous complaints of late about interference by CB radios with other electronic devices including television receivers, church organs, phonographs and public address systems. The commission has described the problem as "CB horror stories" and reports that some automatic garage doors are responding to the spillover energy from citizens band transmissions, and that other electronic devices are suffering severe disturbances.

–Radio TV Weekly
Aug. 16, 1976

Since the CB radio must qualify before it can be sold, most work well—some better than others dependent on design and price. Thousands of good high quality radios in this country have been called some pretty unsavory names because the CB system installed doesn't work up to expectations.

–Radio TV Weekly
June 14, 1976

CB is being blamed for interference to television receivers and hi-fi systems, often unjustly. And CB users are polluting their own band. The interference problem won't lessen until something is done about it.

But, far more serious is pollution of the citizens band by over-modulated CB transmitters.

–Radio TV Weekly
Sept. 27, 1976

Don't be accused of contributing to CB pollution because of improper installation. Get pollution out before your customer sends it out. It takes only two minutes to check every channel on every installation with the new Sencore CB41 Automatic Performance Tester. This means that you can be sure that the CB installation is working right and not adding "CB pollution." Your customer will be happy, too, by knowing he is coming in "loud and clear."

What are we really saying when we talk about "performance testing"? We're talking about personal communications--talking and listening. It's as basic as two youngsters talking to each other

Fig. 1—Each link in this garden hose pipeline must be matched and working to communicate.

through four lengths of a garden hose. One talks and the other listens through their communications pipeline.

So here is our "communications pipeline" for CB. There are four links in it, too. Notice that each

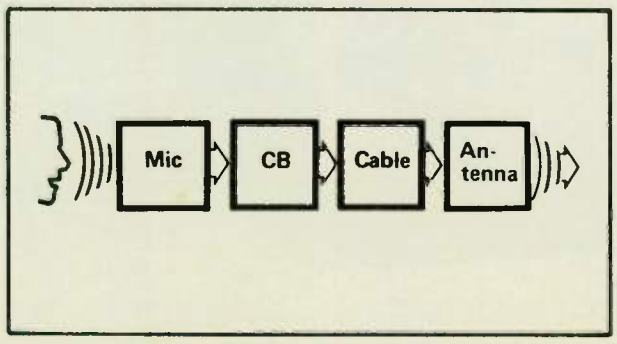


Fig. 2—CB is a personal communications pipeline in which each link must be matched, too.

link must be matched where it is coupled to the next link. Communications stops or becomes distorted when these links are not matched to each other. We can also see here that whatever is true for talking (transmitting) is also true for listening (receiving) when we reverse the links. It works both ways. So, we have performance tests to check that each link is working and properly matched to the next link. That is all we are trying to do.

You are breaking down communications and adding to CB pollution if you are not now testing all these links for proper match.

What if you are using a CB installation tester that limits your ability by not testing all these links? Again, you are not testing the entire system and adding to CB interference.

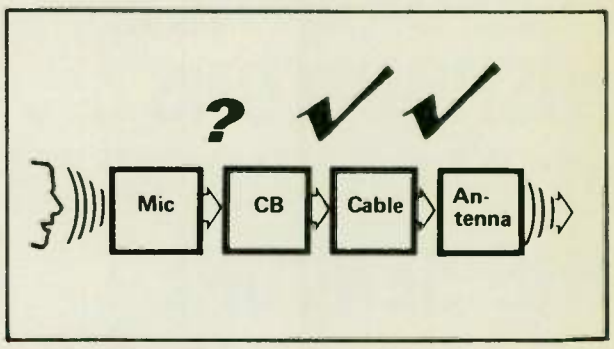


Fig. 3—Other CB testers do not check all the communications links.

For example, if a customer brings in a CB that has a power mike, how will you check to see if the power mike overmodulates? Your customer cannot hear himself overmodulate when he transmits. Only a modulation tester like the Sencore CB41 will show the modulation correct or incorrect.

Test an entire CB system in seconds with the CB41.

You can test the entire CB installation in seconds with the new CB41 Automatic CB Performance Tester. The CB41 is the first fully automatic tester with just three pushbuttons to check every link in the CB communications pipeline. All you need to do is to punch the buttons and read the meter.

Here's how simple the CB41 is to use. First, you'll want to check the RF output of the CB, and then check the modulation output. These two tests divide our pipeline neatly in half and will identify

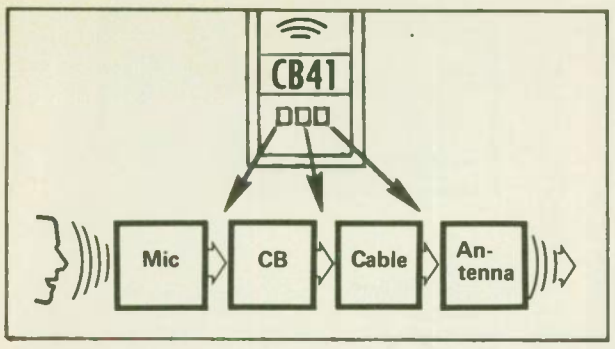


Fig. 4—Only with the CB41 can you check all the links automatically, in seconds.

whether any problem is before or after this point. We will know immediately whether any problem is in the CB or in the installation.

So first connect the Sensor to the CB. The Sensor has a built-in matched dummy load that prevents wrong readings. Now simply press the RF WATTS pushbutton and key the CB. A good AM transceiver will read between 3 and 4 Watts on the RF Watts scale. (An SSB CB will read zero Watts with no modulation.) The meter will read upscale to indicate the actual CB output power when you modulate with a tone or whistle. The CB41 indicates Peak Envelope Power, so you are fully

Fig. 5—Just push the button for calibration--free testing.

equipped with the CB41 for any CB, including SSB sets.

Secondly, press the PERCENT MODULATION button and whistle or talk into the mike. The meter will indicate 30-50% for normal speech, and 80-100% for a loud whistle in a good CB. So now we know that the first two links--the mike and the transmitter--work correctly.

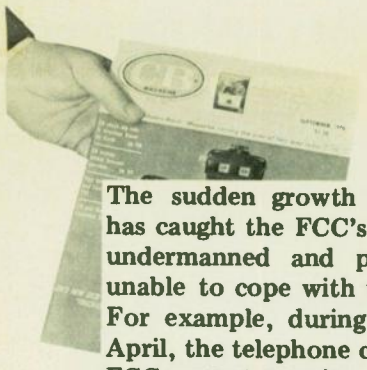
Thirdly, you can be sure that the CB's power is all

GET YOUR CB CUSTOMERS 3 MILES FURTHER IN 1/3 THE TIME WITH 3 SIMPLE CB41 PUSHBUTTONS

going "on the air" with good antenna and cable matching by pressing the automatic SWR button and reading the SWR "GOOD-BAD" scale on the meter. Only the CB41 performs these three tests automatically in seconds. You can be sure that the entire communications pipeline is really "punching through loud and clear."

2 ARE YOU PREPARED FOR A CRACKDOWN ON CB POLLUTION WITH POSITIVE PERFORMANCE PROOF TO BACK YOU?

Read these recent warnings--then you decide . . .



The sudden growth of Class D has caught the FCC's field office undermanned and procedurally unable to cope with the growth. For example, during a week in April, the telephone company, at FCC request, monitored the number of calls to the Dallas FCC office to determine how many were placed but did not get through. In five days time, some 2,200 callers never got through to the Dallas office. Field offices uniformly report their phones are tied up from daylight to dusk, with callers asking about CB, complaining about alleged CB interference to television and consumer products, and asking for assistance in interpreting FCC Class D rules. . . .

It is no wonder then, that local, county and state officials are "taking the law into their own hands" when their frustration with the FCC reaches the boiling point.

--CB Magazine
July, 1976

The CB TVI problem is approaching wild-fire dimensions. The FCC is unable to cope with the flood of complaints. The magnitude of the problem is simply too great for this relatively small agency.

The option open to CB users who do not get "this message" is not very pretty. If the FCC is unable to cope with the problem, sooner or later the neighbors of CB operators get incensed and take their problem to whatever local authority is willing to render assistance. And, local authorities are finding ways to crack down.

--CB Magazine
August, 1976

At the same time, reports of TV interference are sure to increase, as will additional Federal surveillance from the FCC's 24 district offices and four special enforcement facilities.

. . . In addition to techniques presently used, the study test will be enlarged to non-conventional techniques such as educational efforts, institution of several control cities to monitor enforcement results, and the application of "extreme sanctions" to hard-core violators by enlisting U.S. attorneys to criminally prosecute willful offenders under the Communications Act, which can result in a maximum fine of $10,000 and a year in jail.

--Electronic Engineering Times
Sept. 13, 1976

. . . Over-modulation can cause both adjacent channel bleedover and splatter across several channels, if not over the entire band.

All CB transceivers, type accepted at 2.5 watts or more output, are required to contain a modulation limiter. When a conventional microphone is used, the limiter usually prevents over-modulation. But, when a power mike is used, over-modulation can and does often result.

Because of the over-modulation problem, the FCC can be expected to tighten up its standards for modulation limiters.

--Radio TV Weekly
Sept. 27, 1976

And recent reports indicate that local authorities are cracking down. You may have heard of some in your area. Be prepared. Save yourself and your customers a fine. Use the CB41 on every installation or repair to minimize pollution. It takes only seconds to completely check CB performance on every CB channel to prevent you and your customer from getting into trouble with the FCC, and further, to back you up with reliable readings if anyone questions your work. Do you have that proof now?

WHAT OUR CUSTOMERS SAY

I just opened my shop August 1, and already I'm ahead of my competition. At least that's what my customers say, and there are a lot of them (we're right off the Interstate and get lots of truckers stopping in). We figure the CB41 paid for itself in just twelve days in time saved and it's made our customers super happy. They must be because they keep returning for more gear. They feel that the CB41 is not a toy like other guys use, but a real honest test instrument that they can understand. They can tell the difference between red-yellow-green and that's all they have to know. The CB41 has the most wanted functions they want to see and no fancy calibrations. I just go "bap-bap-bap" with the buttons and they believe it.

The automatic SWR test really helps with antenna problems. If the needle pegs, I know the cable or antenna is either shorted or open. If it reads really bad, then I have a bad coil or a corroded connection. And if the SWR is in the yellow scale, then I've got a bad match.

And talk about money-making! I sell a lot of mike cables real quick. I just punch up the Percent Modulation button and shake the mike cable. The cables intermittent if the needle bounces around.

Robert Rosedale
SWR Electronics
Jeffersonville, Indiana --a CB41 owner

3 ARE YOU DELIVERING THE CB PERFORMANCE YOUR CUSTOMER PAID YOU FOR?

Look at this conclusion of a Sencore Field Engineering survey of CB manufacturers and their warranty stations. They report that:(see page 7 for full report)

> "63% of CB installations in use need performance improvement."

Plus, an FCC report says:

> "2.7 Watts is the average output of actual CB installations tested."

Then read these test results of 198 CB rigs tested at a CB Jamboree attended by our Sencore Field Engineers:

SWR adjustment required	20%
No RF Power output	1.5%
Low RF Power output	4.5%
Low modulation	3.0%
Dead channels	1.0%

What does this mean? If the average CB installation is only putting out two-thirds of the maximum legal power, and this reduced power is further limited by improper installation matching, you can see that the typical CB driving past your door has less than half the talk power and range it could have. Now we are not saying that you as a salesman or installer are responsible for the customer actually getting half the power he wants, since the greatest percentage of CB's are installed by the owners themselves. But these results do indicate that, on the whole, the CB's are not installed correctly with complete checks of each link in the CB communications pipeline. You can start with a good radio, but it won't work right unless it is installed right.

CB41 identifies common installation problems

What are some causes of improper installation on these millions of CB's that need performance improvements? The CB41 Operational Manual lists many of these CB installation problems and shows how the CB41 will identify them for you, as shown here.

SYMPTOM	PROBLEM AREA
RF PWR ok % MOD low	-Defective mike -Not speaking close enough to mike -Low gain in audio circuits -XMIT/RCV relay not activating -Defective modulation coupling circuits
RF PWR ok % MOD ok SWR high	-Antenna or coax cable problem -Broken wire or shield (check full cable length with ohmmeter) -Shorted coax cable (check between conductor and shield with ohmmeter) -Pinched coax cable (inspect for kinks and sharp bends) -Open loading coil -Cold solder connection on jacks or antenna -Corrosion at antenna terminal connections -Corroded or aged coax cable -Improper antenna length -Improper antenna type -Moisture in loading coil
RF PWR low % MOD ok	-Low supply voltage to radio -Bad supply connection to radio -Defective RF output stage -Defective voltage regulator in auto
No RF PWR on one or a few channels	-Defective crystal or selector switch

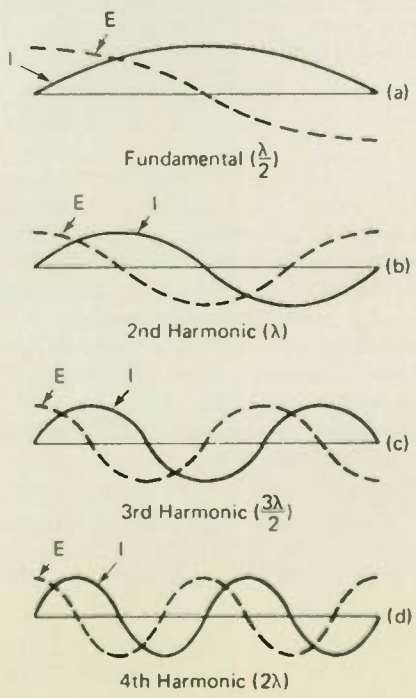
Fig. 6—The automatic CB41 will help you identify these common installation problems.

How should SWR be measured?

You may be asking how does the CB system work when it is properly operating? Let's backtrack a little bit and review some fundamentals of the CB antenna system to see how it should operate. We will refer to the Sencore Second-Class Radio-Telephone License Handbook, published by Howard W. Sams and Co., for a simplified explanation of antenna matching.

III-210. Why is the impedance of a transmission line an important factor with respect to matching "out of a transmitter" into an antenna?—When there is a match between the transmitter and the transmission line and between the transmission line and the antenna, there is a maximum transfer of power between the transmitter and the antenna. This efficient transfer of energy occurs when the transmitter output is matched to the *characteristic impedance* of the transmission line, and when the antenna system at the termination end of the line is matched to the characteristic impedance of the transmission line. When a transmission line is properly matched to an antenna system, there is a minimum radiation of radio-frequency energy from the line, eliminating a cause of energy loss or antenna-pattern distortion.

III-211. What is meant by standing waves, standing-wave ratio (swr), and characteristic impedance as referred to transmission lines? How can standing waves be minimized?—The definition for the characteristic impedance of a transmission line was given in Question III-209. When a transmission line is terminated in its characteristic impedance, all of the energy conveyed along the line is delivered to the termination. If the line is not terminated in its characteristic impedance, only a part of the energy moving along the transmission line is delivered to the termination. The remainder of the electrical energy is reflected at the termination and moves back along the transmission line in the opposite direction. There is now an interaction between the direct rf energy and the reflected rf energy. In this case, the rf voltages and the rf currents add algebraically to set up voltage and current standing waves on the transmission line. For example, at so-called voltage loops positioned along the line, the direct and reflected voltages are in phase and add to produce maxima. At other positions called voltage nodes, they are exactly out of phase and they subtract to produce minima.



These voltages and currents can be measured with a suitable rf meter arrangement. The ratio between maximum and minimum voltage readings or between maximum and minimum current readings is called the standing-wave ratio (swr). Stated as an equation, this is

$$\text{swr} = \frac{E_{max}}{E_{min}} = \frac{I_{max}}{I_{min}}$$

The standing-wave ratio on the line is a measure of the degree of mismatch between the transmission line and the termination, and it can also be expressed as follows:

$$\text{swr} = \frac{Z_R}{Z_O} \text{ or } \frac{Z_O}{Z_R}$$

The larger quantity, Z_R or Z_O, is substituted in the numerator.

It should be noted that the ideal situation exists when the standing-wave ratio is unity. This indicates that the maximum and minimum readings are the same, and thus there is no standing wave on the line. In this case, there is no reflected energy, and the rf energy coming down the line has been delivered in its entirety to the terminating load. Thus, the standing wave on the transmission line can be minimized by supplying a properly matched termination to the receiving end.

–Courtesy of Howard W. Sams and Co.

How do we measure SWR? We simply measure the forward energy going to the antenna and the reflected energy coming back from the antenna. We then compare them to determine the SWR.

Beware of competitive low cost SWR meters - they cost you over and over.

How is this done with the meter you may be using now? Let's look at this typical tester. Your first step here is to measure the forward power. Then

Fig. 7—Two time-consuming steps on each SWR check are needed with this meter on each channel checked.

you adjust the calibration control until the meter is set to a reference mark. Then a switch is depressed so the meter will indicate the reverse power directly on a scale calibrated for SWR. Each measurement on this meter takes two steps. Thus, you need to make 46 adjustments for reference calibration and measurement to check for maximum performance across all 23 channels. In comparison, the CB41 automatically measures the SWR when you punch the SWR button. It takes longer to read about the pushbutton automatic CB41 test than it does to do it.

CB41 - The only automatic, calibration-free tester made.

How can the CB41 automatically check for SWR when no other tester does? Because only the CB41 uses special IC circuits that automatically determine the forward and reverse levels and calculate the SWR instantaneously so you don't have to fiddle with controls and switches. It may cost more to do it the automatic way, but more than pays for itself in time saved.

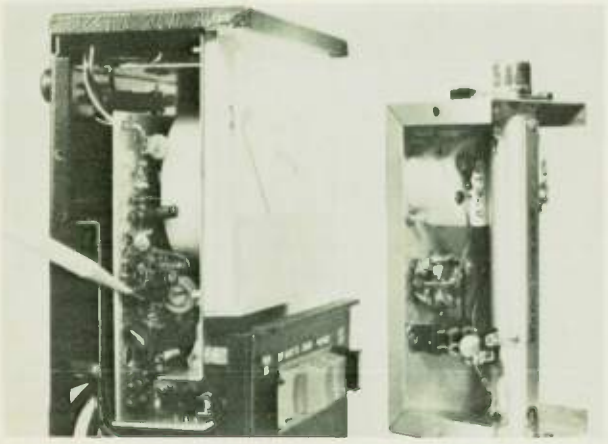


Fig. 8—Up-to-date integrated circuits in the CB41 free you from the manual calibrations other testers require.

Don't let yourself get cornered by a customer who finds out his CB wasn't totally fixed. Only with the CB41 can you check RF Power, Percent Modulation, and antenna SWR on all CB channels in seconds. This means you can be 100% assured of peak performance. The fiddle-free CB41 is so simple to use that your customer can even punch the buttons himself to be truly confident that he is getting full satisfaction in his CB installation.

Fig. 9—Your customers will believe the CB41, too.

WHAT OUR CUSTOMERS SAY

I have customers that install the CB themselves and then complain to me that they are not getting out. Well, you know the SWR is too high, so I use the CB41 to identify the problem for them. Like, somebody came in who cut off part of his antenna because he heard a friend got better performance by doing it.

So after I install a CB, too, I show the customer the scales and they are very pleased. They understand it easier than other meters. "When it's in the green, it's good." is all I have to say. I don't have to explain reflected power and all that.

I've used the Bird 43 and the CB41 measures up to it. But I bought the CB41 because it does not have to be calibrated every time it is used, like other meters in the market. It's an excellent instrument, and a good profit maker.

Richard Matassa
Addison, Illinois —a CB41 owner

GET YOUR CB CUSTOMERS 3 MILES FURTHER IN 1/3 THE TIME WITH 3 SIMPLE CB41 PUSHBUTTONS

WHAT OUR CUSTOMERS SAY

What interested me the most about the CB41 was that it provided such accuracy with so little attention. I had the CB41 compared against lab standards in New York, and it was right on the nose! Also, some testers say they need an SWR of 1:1.1 or better to read Power or Percent Modulation accurately. That's extra calibrations I don't need to make with the built-in matched load in my CB41s (I have two of them.) That's why I swear by it, not at it. My customers are happy with the results, too. So how can you measure their confidence against the price of a CB41?

Edward McClenahan
Arlington, Virginia —a CB41 owner

4 ARE YOU INVITING POOR CB PERFORMANCE BECAUSE YOU THINK YOUR TESTING TAKES TOO MUCH TIME?

Your present SWR meter may be costing you hours of unproductive, unprofitable time each day. Nobody can blame you for not wanting to stand on your head to hold up your SWR meter, or run back and forth between the antenna and the meter for each installation. But you're inviting poor CB performance and dissatisfied customers if you don't take the time to completely check the CB installation.

Fig. 10—No one likes back-breaking hook-up so performance testing is often avoided.

Testing does take a lot of time with any competitive meter. Let's see how much time it actually takes by adjusting an antenna the way you may be doing it now if you don't own a CB41. Many CB technicians use one of two methods to set SWR. Most installations will show a dip somewhere across the 23 or 40 channel band. This dip

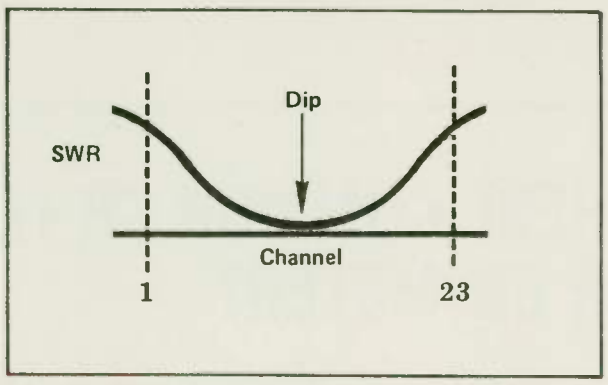


Fig. 11—Most properly adjusted antennas have dip in SWR.

should be in the middle of the 23 or 40 channel band for best overall use, usually channel 11 or 19. One way of testing for the dip is to check the SWR on channel one, and then check it on channel 23, as shown in this diagram. If the

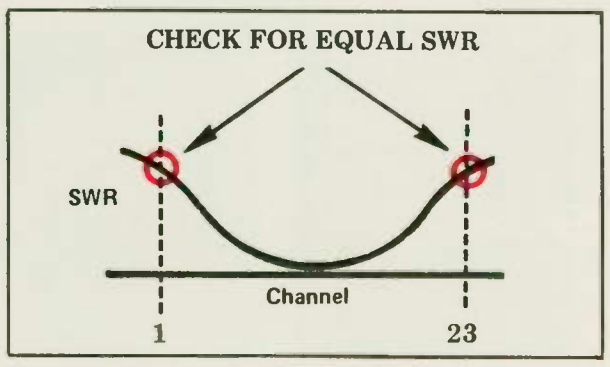


Fig. 12—You can adjust the antenna for equal SWR on channels 1 and 23.

SWR is lower on channel 1, then the antenna is too long. Likewise, if the SWR is lower on channel 23, then the antenna is too short. After you adjust the antenna you have to repeat both tests and compare again. These two checks are repeated until you find that both channel 1 and 23 read the same. For a typical installation, you may have to calibrate and measure as many as four or five times, with checks on both channels each time. This takes a great deal of time and bites into your installation profits.

Another method often used is to check channel 11, adjust the antenna for lower SWR, and continue to repeat the test until the SWR starts to rise again. Then you would back off slightly and think the system is tuned properly. You may have repeated this test over four or five times, but are you sure you are matched correctly?

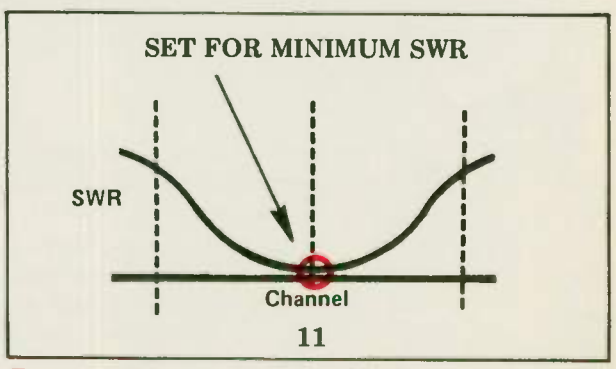


Fig. 13—You may also adjust the antenna for minimum SWR on channel 11.

How do you know that all 23 channels have a good range of SWR? The only way you can ever be sure is to check every single CB channel. With the competitive tester we have used here, you have to calibrate, measure the forward and reverse power 23 times over, and make 46 adjustments. What's more, you would need to make 80 such adjustments with the new 40 channel CBs if you wished to check all channels. It's no wonder that no one wants to check all channels with these meters! They take too much time, and the result is an open invitation to poor CB performance.

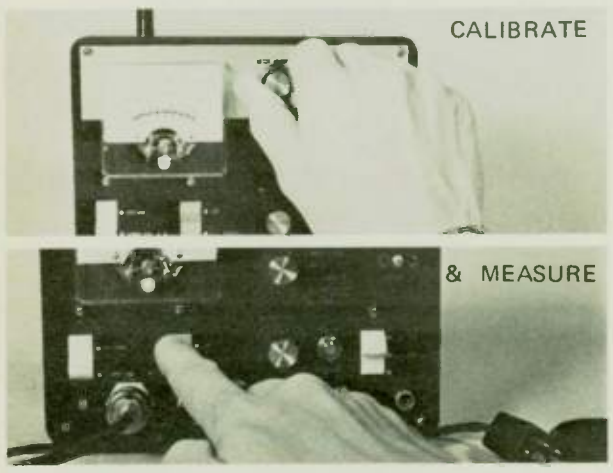


Fig. 14—Why calibrate and measure all 23 channels when you can own a CB41?

Only the automatic CB41 will enable you to check all channels on these CB antenna jobs in minutes for maximum performance and efficiency, too. Read what Radio-Electronics magazine says about the CB41's automatic tests:

. . . adjusting a short-whip antenna for minimum SWR can consume fifteen minutes to a half hour. And if the customer asks for proof the installation is *okay*, there goes another half hour as the technician connects test gear and then tries to explain what the readings indicate.

. . . time means more business to today's CB service center. Because of the CB41's forward power automatic nulling feature for the SWR and AM modulation readings, it is possible to test or checkout a new CB installation as fast as you can press three buttons; and you can adjust an antenna for minimum SWR in less time that it takes to calibrate the typical SWR meter for the first reading. Best of all, you can obtain your readings right at the antenna even though the sensing head is at the transmitter

--Radio Electronics --July, 1976

The real time saver exclusive with SENCORE.

Fig. 15—Save running back and forth to the antenna with the CB41.

Saving running back and forth for antenna checks by adjusting SWR right at the antenna. Simply connect the detachable Sensor to the CB under the dash and hook up the EX203 Extension Cable between the CB41 and the Sensor. The EX203 is 12 feet long so you can carry the CB41 back to the antenna on any vehicle including a station

Fig. 16—Carry the CB41 with you to the antenna for on-the-spot adjusting.

wagon or an 18 wheeler. The signal is detected in the Sensor head so there is no worry about RF upset in the 12 foot cable. Actually two cables can be used if you desire.

The CB41 makes your work unbelievably simple. Key the transmitter on channel 11. (You can keep the CB keyed by putting a rubber band around the mike switch.) Then carry the CB41 to the antenna, punch the SWR button, and tune the antenna for minimum SWR without moving from the spot. As a final check, go back to the CB and crank the channel selector through all the channels while watching the CB41 meter dip in the middle channels. You're all set in just a few minutes.

Fig. 17—Watch the adjustment results on the CB41.

Only the CB41 saves time and improves your installation performance because it is the only complete, automatic CB Performance Tester on the market and the only one with a detachable Sensor head.

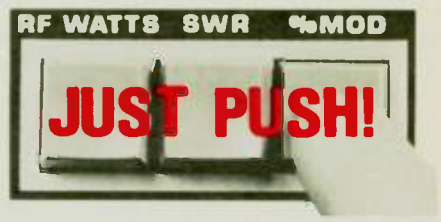
WHAT OUR CUSTOMERS SAY

We had one guy in the shop the other day. He was so impressed with the results he got from our CB41 that he got four other people in for checks. They'd never seen an SWR meter like this! It's one good looking piece of equipment. I like the IC operation and the pushbuttons. On others, I had to reverse the coaxes, set the calibrations, or throw a switch. This CB41 is direct reading and quick. It's accuracy is much better. With that big scale it has to be.

It gets used on every CB on the bench. We find intermittents by pushing on the boards and noisy mike cords show up when the meter jumps while we pull on the cord. This is one instrument that's working great!

Marvin Cook
Seatronics Electronics Repair Service
Seaton, Illinois --a CB41 owner

5 ARE YOU MAKING THESE COMMON CB TESTING ERRORS WITH YOUR CB METER?



You may know what can go wrong with the CB installation itself, but you may not realize that your testing may be causing additional errors. Many of the millions of installations needing performance improvement have been tested, but they weren't tested under actual operating conditions and additional errors were introduced. For example, here is an E. F. Johnson engineering report in Electronics Servicing Magazine saying that the car doors and trunk lids must be closed.

Incorrect results from tests can be more detrimental to CB repairs than if you made no tests at all.

More Wrong Readings

Another way of getting erroneous VSWR and power readings is to leave the car doors open and the trunk lid up. An open trunk lid affects the performance of antennas regardless of the location, although a roof-top mount is affected the least. You can appreciate the importance of the lid position after you watch an experienced two-way radio technician crawl inside the trunk and pull down the lid during a final tuneup.

--Electronics Servicing August, 1976

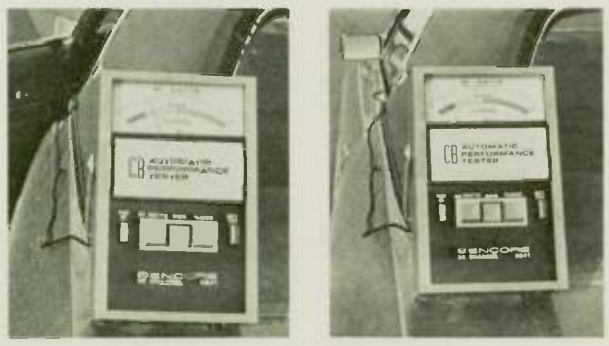


Fig. 18—Inaccurate readings result if car doors are open during the test.

The CB41 CB Performance Tester, with the exclusive Sensor head, is the only CB performance tester that allows you to close the doors and check SWR. It's the only one that's error-free.

A dummy load must be used to measure RF power accurately.

Many make the mistake of measuring RF Power with the antenna connected. A great measuring error will be introduced unless the antenna happens to be matched right on the nose at 50 Ohms. So, to make sure, you'll want to use a dummy load that has the same resistance as the characteristic impedance of the transmission line. But, most wattmeters do not include built-in matched dummy loads. You'll have to build your own load and take the time to connect the load to the CB to measure RF Power accurately. This is time consuming and requires the additional purchase or construction of the dummy load. Not with the

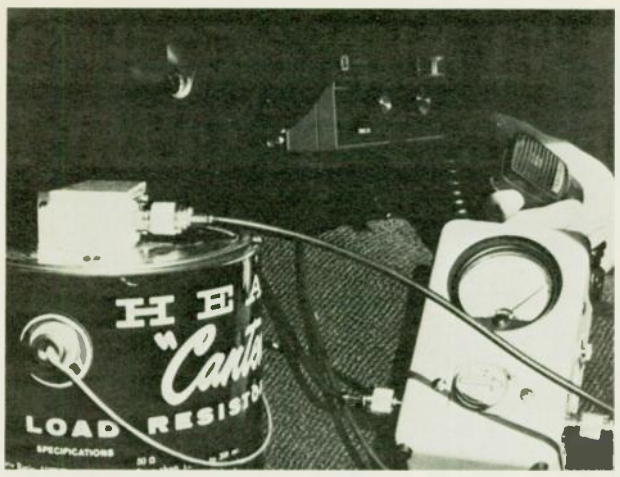


Fig. 19—Built-in CB41 dummy load eliminates external load for accurate RF power tests.

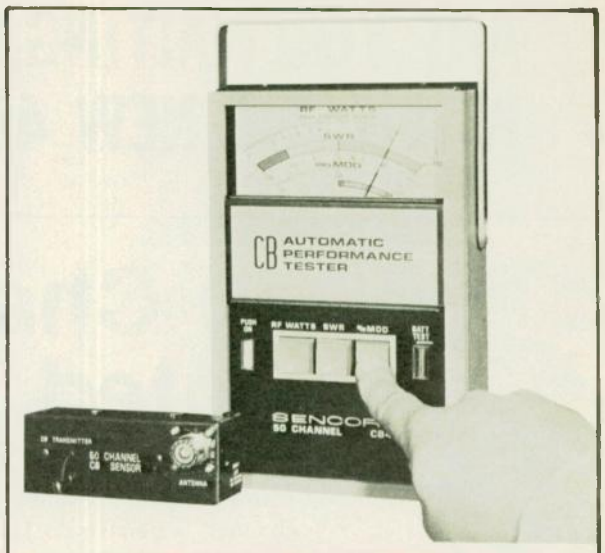
CB41. You simply set the switch on the Sensor to the "Dummy Load" position and then push the RF Watts button for automatic, self-calibrating operation.

WHAT OUR CUSTOMERS SAY

At least half our business is with business band and other communications transmitters. We use the CB41 for 20 Watt power and modulation percentage checks on high band, low power transmitters on the bench. We've checked it against the more expensive testers and found it's accuracy is closer than five percent. It is much easier to use, though.

For CB, the CB41 is a fantastic customer-pleaser. It makes them happier. We can practically diagnose the set in the vehicle before we even pull it to the shop. That makes us professionals in the customer's eyes, and the others look like "Mickey Mouse" organizations. We use those other testers that had to be calibrated, too,but the customer is never certain that it's done correct.

Charles Laye
Auburn Electronics
Auburn, Nebraska --a CB41 owner



GET YOUR CB CUSTOMERS 3 MILES FURTHER IN 1/3 THE TIME WITH 3 SIMPLE CB41 PUSHBUTTONS

6 ARE YOU COSTING YOURSELF MONEY BY PULLING "NO DEFECT" RADIOS FOR BENCH REPAIR WITHOUT TESTING THEM FIRST?

Read this report of a Sencore Field Engineering survey of ten top CB manufacturers and warranty stations--then check your own records.

CONCLUSIONS OF SENCORE FIELD ENGINEERING SURVEY OF CB MANUFACTURERS AND AUTHORIZED WARRANTY STATIONS*

1. 24.5% of radios returned to manufacturers for service had "no defect" or lack of testing by field people.
2. 58% of CBs needing repair had defective output stages, indicating that these service problems were caused by mismatched antennas, rather than defective components in the CB itself.
3. Thus, 68.8% of CB service problems reported are related to improper installation or checkout (including antenna mismatch and transceiver damage due to mismatch).
4. Most CBs are installed by the owners, or non-professional people, where performance tests are never performed or not done properly.
5. Even a properly installed system will be affected by corrosion, wear, and mechanical vibrations. As a result, performance will change with time and should be checked periodically.
6. All persons surveyed said that it is "absolutely essential" to check performance both before and after the CB is repaired.
7. Further, all surveyed reported that a total system check should include a percent modulation check to locate troubles other than antenna problems (especially in mike and power mike overmodulation). Common SWR or RF power meters were reported to lack this capability.

*including Pearce-Simpson, Pace, Craig, Delco, Fanon/Courier, HyGain, Kris, E. F. Johnson, Midland, Motorola. (Results are averaged from responses.)

Avoid pulling CB's for repair when the antenna system is at fault.

"It's the CB." That's the first thing a CBer says when he's not getting out, right? So you stand on your head, rip the car dash apart, and carry the CB to the bench only to discover it is "OK". Save yourself that back-breaking effort and lighten your load by checking the CB's performance before you pull the radio back to the shop with the CB41 CB Performance Tester.

Why you must check the antenna after each repair.

You may find the problem is in the CB and repair it. You may think everything is fine. But when the customer still gets poor performance, who is he going to blame? You told him the CB was fixed. Why did this happen? Because you tested only the first part of the CB communications pipeline on the bench. A CB isn't fixed until it is properly installed. You still need to check the whole system. So do as your CB manufacturers say--check and retune the entire installation after every service job.

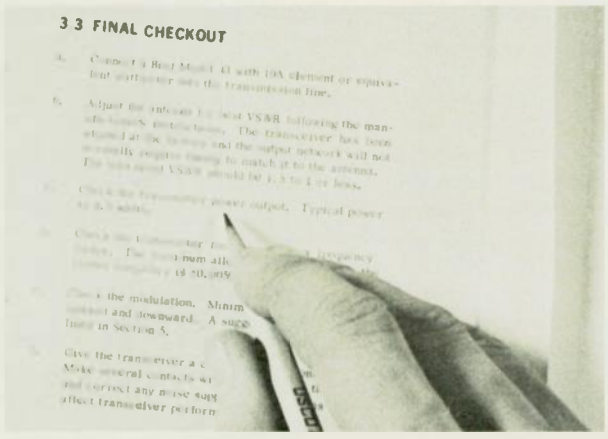


Fig. 20—CB manufacturers say the repair isn't complete until the CB is installed.

You can damage the CB if the antenna system isn't working.

If the final power amplifier was blown in your CB repair, a detuned antenna or cable, such as the 75 Ohm TV antenna cable found in this installation, could eventually cause the same damage again--

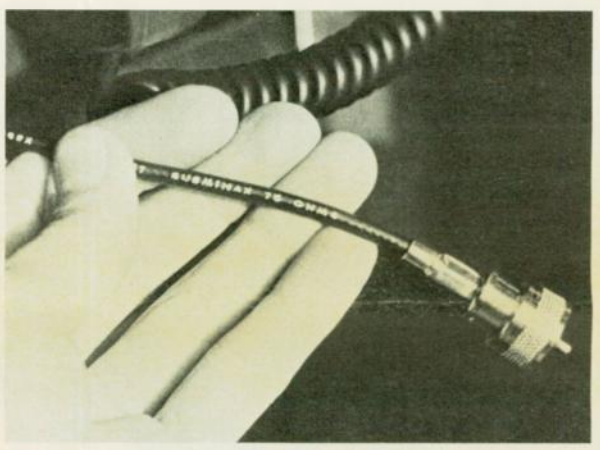


Fig. 21—A CB was damaged because a customer thought this TV cable "looked the same" as 50 ohm RG-58/U CB cable.

maybe under your warranty! This time you will have to repair it free, costing you both time and money. A two-minute check with the CB41 assures you and your customer that the entire installation is working right for continued trouble-free performance.

WHAT OUR CUSTOMERS SAY

We perform the auto radio and CB business for over 200 car dealers in our area, plus we do a big CB business in our own right. So to us simplicity is most desireable in getting the job done fast and accurately. When a customer brings a CB in the car or over the counter, we check it with the CB41. We can analyze the problem on the spot in a second and spin through all 23 channels on all modes almost instantaneously.

I've tested the CB41 against other testers two or three times and found it to be just as accurate or more. But we found that ninety-nine percent of the problems we had with the other ones was in the patch cables we had built to use them. And those patch cables had to be in nine foot quarter wavelength increments to avoid erroneous SWR readings. The CB41 has the attached short cable that simplifies set-up and eliminates cable problems.

Bill Allen
Auto Sound North
Stoneham, Massachusetts --a CB41 owner

7 ARE YOU WAITING FOR A CB TESTER THAT WON'T BE OBSOLETE WHEN THE NEW 40 CHANNEL CB's HIT THE MARKET?

40 Channel CB Voted by FCC

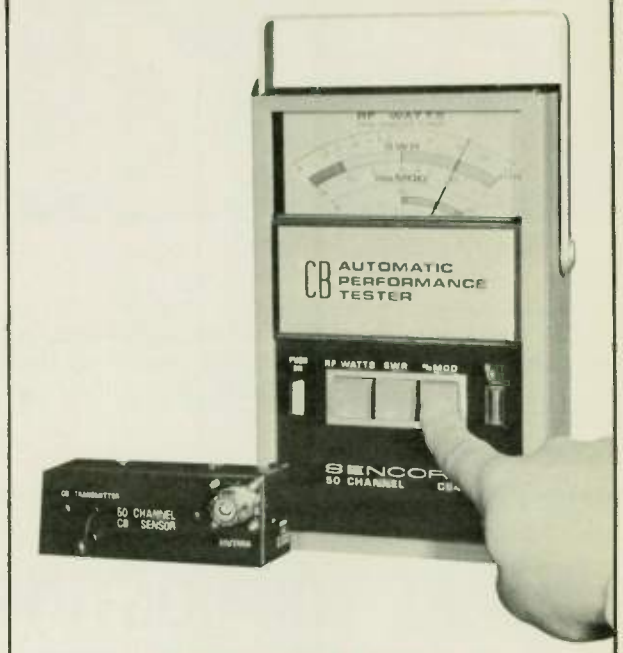
WASHINGTON, D.C.—The Federal Communications Commission has announced its long-awaited expansion of the citizens radio band from 23 to 40 channels, effective on January 1. CB channels are currently located in the band between 26.965 MHz and 27.255 MHz. After January 1, the band will expand to 27.405 MHz.

--Radio TV Weekly --August 16/23, 1976

Be 50 channel equipped

The new 40-channel CB receivers are here and you'll want to be sure that your tester goes all the way. The CB41 is the only CB Performance Tester that flatly states "50 Channels" right on the front panel. From the very beginning, it was designed with a flat frequency response using no sharply tuned circuits. Some owners are even using the CB41 in other two-way communications work up to 150 MHz and report that it works satisfactorily there, too.

It sure won't hurt to be ahead of your competition with a tester that gets you going on those 40-channel antennas and accessory sales. Of course, you'll want to sell those 40-channel CBs, too, because they will go for more money. Then you must be in a position to show your customers that the CB works on all 40 channels because it will be lonesome up there for a while, and they might not believe they are "getting out" without proof on the CB41. Only the CB41 says "50 Channel" right on the panel, and that is what your customer wants to see.



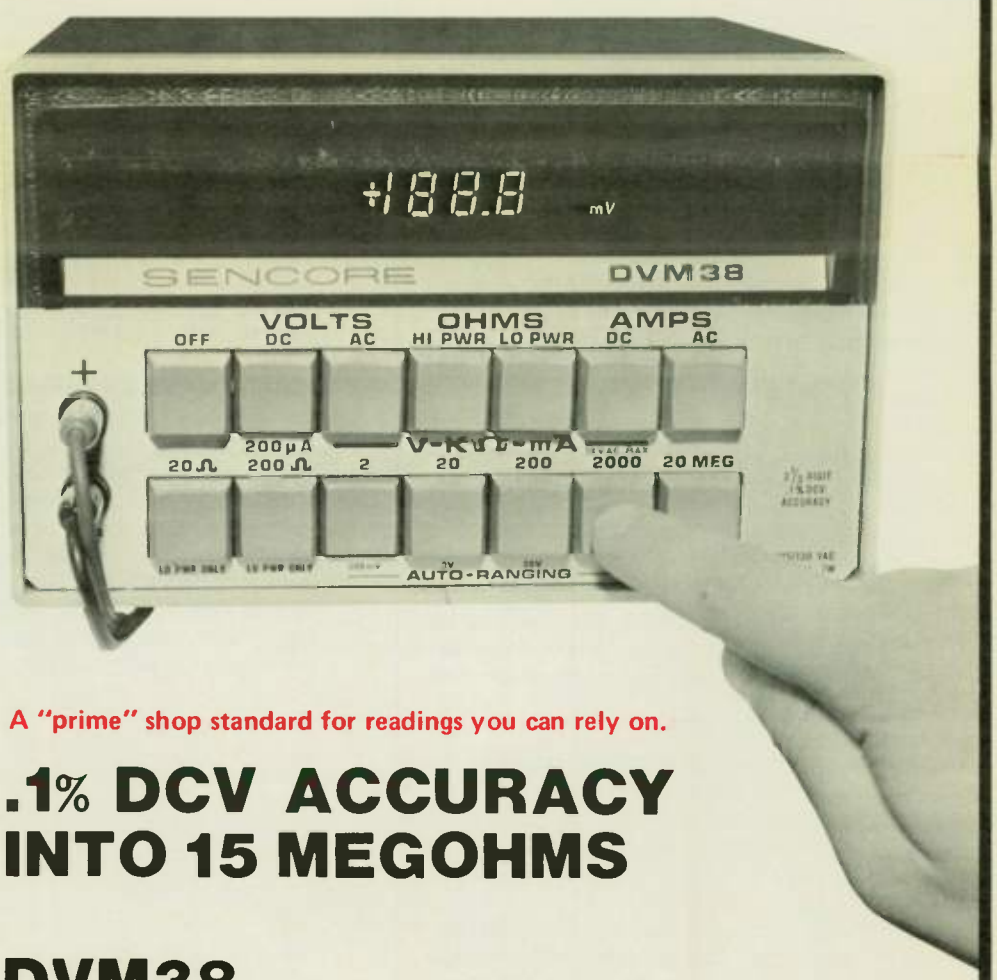
GET YOUR CB CUSTOMERS 3 MILES FURTHER IN 1/3 THE TIME WITH 3 SIMPLE CB41 PUSHBUTTONS

THIS IS THE BEST D.A.M.M.* ACCURATE METER YOU CAN BUY!

* DIGITAL, AUTOMATIC, MONEY-MAKING

Test in more circuits, more places, more adverse conditions, more accurately than with any other 3½ digit meter available.

- **TEST RESISTANCES IN AND OUT OF SOLID STATE CIRCUITS.**
  Push a button for Lo Power Ohms to measure .01 Ohm resolution without unsoldering and damaging components, or push Hi Power Ohms for standard out-of-circuit tests to 20 Megohms.
- **MEASURE IN "DIFFICULT TO TEST" CIRCUITS**
  Check in frustrating amplifiers, oscillators, RF and CB synthesizers accurately without loading with the 200K Ohm isolation resistor in the probe. 2KV range and optional 50KV probe prepare you for voltages others can't reach.
- **IGNORE RF AND MAGNETIC FIELDS**
  Now test in communications, RF, transmitter, television, and motor circuits without irritating "pick up" that makes other meters unusable.
- **KEEP ON WORKING AFTER ACCIDENTAL OVERLOAD**
  A measurement error could ruin your day--and your meter, so the DVM38 is protected four ways to 2000V on DC and 1000V on all other functions--including line voltage on Ohms!
- **WON'T "LIE" TO YOU**
  .1% accuracy backed with Sencore's 15 Megohm input impedance means every test you make is even more accurate with less circuit loading than 4½ digit multimeter!
- **ALMOST "THINKS" FOR YOU**
  The DVM38 automatically sets zero, polarity, and your voltage range for fast, fiddle-free testing without interpretation error on the easy direct reading digital readout.



A "prime" shop standard for readings you can rely on.

.1% DCV ACCURACY INTO 15 MEGOHMS

DVM38
AUTO-RANGING DIGITAL MULTIMETER
$348

HP200 50KV HIGH VOLTAGE PROBE $25.00

BACKED BY SENCORE'S 100% MADE RIGHT LIFETIME GUARANTEE

SENCORE buyer's guide

GET A SENCORE TESTER FOR CHRISTMAS. GIVE THIS CENTERFOLD TO YOUR WIFE OR BOSS AS A SUBTLE HINT. YOU DESERVE IT! AND HOW!

FORM 1338P

SENCORE DIGITAL MULTIMETERS

YOU CAN BE SURE MORE TIMES IN MORE CIRCUITS THAN ANY OTHER METERS

DVM35 3 Digit Pocket Portable Digital Multimeter

UPDATE YOUR "OLD FASHIONED" ANALOG METER . . . AT LESS THAN AN ANALOG PRICE

Want to minimize meter repair and replacement costs caused by accidental overloads and broken meters? Replace those delicate analog meters with the tough, protected DVM35 Pocket Portable -- at less than an analog price. The DVM35's 1% accuracy, backed by 15 Megohm input for minimal loading, is **ten times more accurate** than analogs. It **measures more** -- up to 2000 VDC -- with the exclusive "DCV X2" button in the probe.

The DVM35 is built to take the use and abuse a field meter gets. **Built-in overload protection** goes to 1000 Volts on all ranges including ohms, plus the probe tip contains back-up fuse protection. The **lightweight and breakproof** DVM35 case is less than half the size of standard VOMs, so it fits compactly in any tool case. **Long battery life** is assured with the exclusive "PUSH ON" switch in the probe that turns the unit on only when a measurement is made. DVM35 -- the right meter at the right price for updating yourself and your multimeter.

$124

PA202 Power Adapter **$9.95**

DVM36 3 1/2 Digit Pocket Portable Digital Multimeter

POCKET PORTABLE LAB ACCURATE PERFORMANCE THAT FITS EVERY BUDGET

More and more solid state equipment is appearing in field applications where you can't "take it to the shop", and these applications require a portable DVM with the same lab specs as the bench meters. That's where the DVM36 fits into your tool case -- and your budget. The DVM36 has the same **tough, pocket portable** features as the DVM35, plus **twice the accuracy** (.5%) and twice the range (2A, 20 Megohm) for sensitive solid state measurements in the field. It goes anywhere in the compact, drop-proof Cycolac® case, yet has **"big meter" features,** such as Hi-Lo Power Ohms, AC/DC current ranges, and **2000 VDC range** (and circuit isolation) when you push the built-in "DCV X2" switch in the probe. Ideal for field applications and production testing, the DVM36 is the lowest cost full capability 3 1/2 digit DVM anywhere, giving you the **highest performance-to-cost benefits** of any meter.

$148

PA202 Power Adapter **$9.95**

DVM32 3 1/2 Digit Portable Digital Multimeter

BENCH AND FIELD MASTER FOR HIGH ACCURACY MEASUREMENTS . . . ANYWHERE

Tomorrow's circuits are here today, and that "old reliable" VTVM or VOM just won't tell you what you need to know in solid state circuits. The DVM32 can . . . anywhere. It assures **30 times more accuracy** than analog meters because of .5% of reading DCV accuracy and direct 3 1/2 digit readout. This compact and lightweight portable is big enough for your bench, yet you can **take it anywhere** in the drop-proof Cycolac® case, with versatile 3-Way Power for battery, rechargeable, or AC line operation. The patented Auto-Off Display means your **batteries will last longer** than other portable meters. Now make all your tests with confidence -- from sensitive 1 mV resolution, all the way to 2000 VDC. The DVM32 keeps on working when others fail with full **overload protection to 2000 Volts** on DC and 1000 Volts on all other functions. Solid state measurements are fast and error-free with full range **Hi and Lo Power Ohms.** If you want to update with just one DVM for any bench or field job, then put the DVM32 to work for you.

$198

39G90 Power Adapter **$9.95**

DVM38 3 1/2 Digit Auto-Ranging Digital Multimeter

A "PRIME" STANDARD AT YOUR FINGERTIPS

If you're looking for that one meter to rely on when the going gets tough, then you want the DVM38 as your "prime" shop standard. Every measurement is more accurate with **.1% DCV accuracy** for 3 1/2 digit tests you can trust every time. **Measure in more circuits** than any other meter with 15 Megohm input impedance that guarantees 1/3 less circuit loading. **Measure interference-free in more places,** such as RF or magnetic fields, with sensitive 100 microVolt resolution. Yet you are fully protected to 2000 Volts on DC, and 1000 Volts on all other functions. Use the full range **Lo Power Ohms** function to test error-free down to .01 Ohms in solid state circuits. The easy-reading DVM38 has **Single-Step Auto-Ranging** to automatically change the voltage range sensitivity for faster testing than ever before. Plus **Auto-Zero** and big pushbuttons make measuring fast and trouble-free. Here is the most accurate 3 1/2 digit DVM you can buy -- your one meter for complete measuring confidence.

$348

Accessories for all Sencore DVMs:

HP200 50KV High Voltage Probe **$25.00**

39G3 RF Demodulator Probe ..... **$ 9.95**

SENCORE TRANSISTOR/FET TESTERS

PROVEN 99.9% RELIABLE IN-CIRCUIT TESTING

PATENTED

TF40 POCKET CRICKET Portable Transistor/FET Tester

THE FAMOUS CRICKET IS NOW PORTABLE TO USE ON ANY JOB SITE

Widespread use of solid state devices in consumer, industrial, business and communications products is placing an increasing load on you to service this equipment on location, rather than in the shop. The TF40 Pocket Cricket equips you for speedy field service with the reliable Cricket test in a tough, compact case to **use at any job site.** Built with rugged Cycolac® and a shock-proof meter movement, the lightweight TF40 rides along to go where the action is.

No schematic or set-up info is needed. Just connect the three test leads in any order and rotate the large Permutator switch through all basing combinations. The Pocket Cricket "chirps" if the device is good, and **identifies all three leads** with the exclusive Lead ID control. The TF40 won't fool you on leaky transistors or FETs like other portable testers without meters will. The **calibrated leakage scale** avoids callbacks by showing the leakage condition exactly.

The TF40 is the first and only patented, completely portable transistor/FET tester that you can now take to any job for **99.9% reliable troubleshooting** in or out-of-circuit.

$98

PA202 Power Adapter **$9.95**
39G85 Touch-Test PC Board Probe **$10.00**

PATENTED

TF26 CRICKET Transistor/FET Tester

HOP THROUGH SOLID STATE CIRCUITS IN SECONDS

Here's **the original miracle tester** that revolutionized the solid state servicing and maintenance fields. For the first time, even a **non-technical person can test** an entire transistorized board in seconds with 99.9% reliability, without unsoldering components or looking up set-up information.

Simply **connect the three E-Z Mini-Hook® leads in any order** and press each of the six pushbuttons on both polarities. The Cricket "chirps" and shows Good on the meter, if the device is good. You can't get it wrong because the TF26 **checks all possible basing diagrams** of any transistor or FET in seconds with the famous, patented Cricket test. Plus, the **calibrated leakage test** catches those leaky transistors that can cause headaches and callbacks later.

Thousands of satisfied Cricket owners acclaim its **proven 99.9% in and out of circuit reliability.** Why not join them with this speedy solid-state problem-solver.

$150

39G85 Touch-Test PC Board Probe **$10.00**

PATENTED

TF30 SUPER CRICKET Transistor/FET Analyzer

COMPLETELY ANALYZE ANY TRANSISTOR/FET IN SECONDS

Output stages of stereos, PA systems, communications transceivers, industrial controls, and balanced bridge circuits often require transistors that are matched for gain and leakage. The TF30 Super Cricket automatically performs these gain and leakage tests without zeroing, calibrating, or looking up set-up info. Simply test with the **patented Cricket test** then select the **Parameter test** for any transistor or FET and push the GAIN button. Read the beta or transconductance directly on the calibrated scale. It's that easy.

The TF30 is faster, safer, and more accurate than any other analyzer or curve tracer. **It tells you everything you want to know** -- (1) tells Good or Bad with the reliable Cricket test, (2) tells gain, leakage, Idss, (3) **identifies all three leads,** (4) tells if the device is a transistor or FET. Now you can stop installation errors by checking replacement transistors in seconds before you install them with the time-saving TF30 that **totally equips you for both in and out-of-circuit testing and full analyzing.** (39G85 Touch-Test Probe Included.)

$240

SENCORE

YOKE/FLYBACK TESTER

PATENTED

YF33 RINGER

SAVE HOURS OF FRUSTRATING GUESSWORK ON TV SWEEP CIRCUITS

Have you ever lost your customer, or your shirt, because you couldn't quickly and reliably check a yoke or flyback? Only the YF33 Ringer will save you those hours of frustrating guesswork and needless replacement in TV sweep circuits. The YF33 is so **reliable in and out of circuit for both tube and solid state** sets that it is approved by leading yoke and flyback manufacturers.

Now, you can check it before you replace it. Simply connect the Ringer across a winding and push the six Impedance Matching pushbuttons. If the **patent-pending Ringer test** says the coil is good, then it is good -- 100 times out of 100.

The YF33 also backs you for sweep circuit analyzing with **peak-to-peak drive scales** to 300 VP-P. The accessory probes for focus and high voltage tests to 50 KV help you find the problem fast. The portable YF33 even has **color-coded scales** to make the selling job to your customer easy, too. Get the YF33 Ringer and take the tough dogs out of sweep problems.

$195

YF33 10KV Focus and 50KV High Voltage Probe Set **$35.00**

SENCORE TUBE TESTERS

THE STANDARDS OF THE INDUSTRY FOR PROFITABLE SERVICING

PATENTED

TC28 HYBRIDER Tube/Transistor/FET Tester

THE ONLY AMPLIFIER TESTER FOR TUBE, SOLID STATE, AND HYBRID CIRCUITS

When you go on a call to the customer's home, business, or plant, you really don't know what type of circuit you'll encounter -- tube, transistor, or hybrid. Instead of breaking your back by carrying all the separate testers, carry along the new TC28 Hybrider -- the only amplifier tester on the market today to **fully equip you for any job.**

The TC28 is actually **two reliable testers in one.** It's a **Mighty Mite** with all the tests shown on big "Good-Bad" scales on the meter -- even the shorts test. It's also a **famous Cricket tester** in the same handy case for reliable in or out-of-circuit testing of all transistors and FETs. In the field or in the shop, be totally equipped, not half equipped, with the only amplifier checker for all circuits. It saves you money, too, at less cost than buying the two instruments separately.

$275

39G85 Touch-Test PC Board Probe **$10.00**

TC162 MIGHTY MITE VII Tube Tester

THE STANDARD IN TUBE TESTERS FINDS "TOUGH DOGS" OTHERS MISS

The Mighty Mite VII saves time on every service job because it finds those tough dog problems that other testers miss. Only the Mighty Mite **checks them all -- over 3000 tubes** total both foreign and domestic -- for all types of work: television, audio, industrial, ham radio, etc. Ten **Pin Elimination switches** cut out any internal connections within the tube for positive tests on all the latest types.

Every tube is tested under **full rated cathode current,** the same current it operates in the equipment. **The 100 Megohm grid leakage test** and stethoscopic shorts test are the most sensitive available to catch tough dog tubes other testers miss.

Speed through an entire chassis in minutes with the simplified four-step controls. **Color-coded "Good-Bad" scales** make it easy to back your claim that a new tube is needed. Don't accept a substitute -- ask for the famous Mighty Mite. 77,137 other owners have.

$175

MU150 CONTINENTAL II Mutual Conductance Tube Analyzer

THE ONLY COMPLETE TUBE ANALYZER ON THE MARKET

Sometimes an emission tester just doesn't go far enough to identify problems in push-pull amplifiers, control output circuits, and balanced input amplifiers. That's when you need the MU150 for complete amplifier testing. The MU150 is the only complete tube analyzer on the market because it uses a **special 5000 Hertz square wave test** that harnesses the tube into an amplifier circuit, just like the tube's actual operation. It checks for actual frequency conditions that may not show up on other testers using 60 Hz sine waves. **Exclusive Automatic Bias Control** reduces the number of controls you need to set up.

Use the first three controls and the MU150 becomes **a rapid Mighty Mite** for quick emission, 100 Megohm grid leakage, and Stethoscopic shorts tests, too. Complete tube analyzing ability and a handsome case make you **look like a pro wherever you go** with the MU150 in your hand.

$395

SENCORE STEREO ANALYZER

PATENTED

SG165 AM-FM Stereo Analyzer

THE ONLY COMPLETE STEREO ANALYZER — WITH SPECS BETTER THAN YOUR FM STATION

Why spend thousands of dollars to have expensive audio test instruments get tangled up on your bench? Get all twelve AM and FM stereo troubleshooting signals from the **single SG165 output cable.** It's the only instrument you need to service any component or console stereo, auto radio, or portable radio with better specs than FCC broadcast requirements. The SG165 **checks every stage** from the antenna to the speaker terminals. Just turn the dial to select full range FM or AM tuning, crystal-controlled FM or AM IF frequencies, selectable multiplex, SCA carrier, or sine/square audio signals. The SG165 is complete -- even the 10.7 MHz sweep/marker generator and speaker loads are built-in. Read the **dual output meters** for dB channel separation or up to 100 Watts RMS per channel power output. **Lab quality performance** is assured with standard IHF modulation and test signals, and exclusive **patented phase-locked multiplex subcarrier.** Complete and easy-to-use, the SG165 will equip you to quickly walk the troubles out of any stereo without making a mess of your bench or your budget.

$595

TV SERVICE INSTRUMENTS

TIME-SAVING, MONEY-MAKING TV SERVICE SIMPLIFIERS

COLOR GENERATORS

CG169 COLOR KING IV
Deluxe Digital Color Generator

THE ONLY ALL-CHANNEL, ALL-WEATHER COLOR GENERATOR

The CG169 is your MATV, CATV problem solver. Make more money on motel/hotel service contracts by getting to the trouble fast. Connect the **75 or 300 ohm cables** into your distribution system, dial any VHF channel, and adjust the RF microVolt output for a calibrated signal source you can check against.

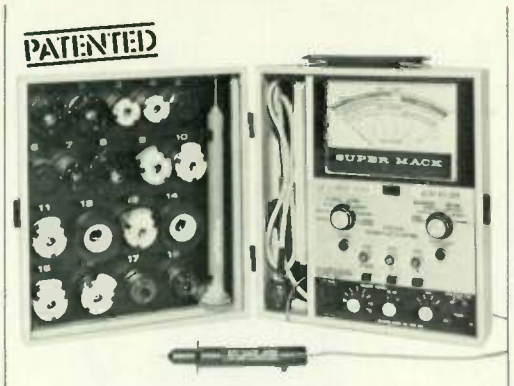
Color convergence is faster than ever before with the Color King. The CG169 is the original generator with **crystal-controlled IC digital logic circuits** and temperature control for jitter-free, **rock solid patterns** instantly -- in any weather condition. Select from all seven patterns recommended by manufacturers, including exclusive movable single cross and single dot patterns, for fast, precise convergence at the screen center or on the edge.

Use the CG169 as your interference-free standard signal source on the bench, too. Check **all VHF and UHF channels,** or use it as a signal generator to locate dead IF stages, color, video, AGC, or sweep troubles. The standard RCA vector pattern makes chroma alignment "eyeball easy." Get the picture with the all-channel, all-weather, all-pattern Color King.

$225

CRT TESTERS/RESTORERS

PATENTED



CR31A SUPER MACK Automatic
CRT Tester/Restorer

COMPLETELY EQUIPS YOU TO TEST AND RESTORE MORE CRTs THAN ANY OTHER TESTER.

You, too, can earn $475 in one week with the CR31A Super Mack -- the biggest "buckmaker" in the service industry -- by saving CRT testing bucks and making extra CRT restoring bucks. Sell picture tube restoration and earn big money. Just push a button on any of five restoring levels for **safe, automatic restoring** to extend CRT life. No timers, no gimmicks, no guesswork.

Only the complete, easy-to-use CR31A tests all CRTs under the actual operating conditions recommended by CRT manufacturers. The exclusive **patented Automatic Tracking** test catches troublesome tracking problems other testers miss. And the Super Mack is your silent CRT salesman with all the customer-convincing **"Good-Bad" tests on a single meter.** All 18 up-to-date sockets are included to **test more CRTs** and save those "optional socket" headaches. Exclusive built-in circuit tests check AC line, focus, and 50KV high voltage to be sure the circuit is not at fault. The CR31A is **guaranteed to outperform all others** for bigger CRT dollars.

$495

SWEEP/MARKER

SM158 SPEED ALIGNER
Sweep/Marker Generator

THE INDUSTRY'S EASIEST TO USE SWEEP/MARKER

Sweep alignment got you scared? Make sweep a snap for touch-up or troubleshooting of RF, IF, and chroma circuits in any set. It's easy with the Speed Aligner. Simply hook-up just **four cables** -- two to the set and two to the scope. Press the pushbuttons for preset **crystal-controlled markers** that won't distort your response curve. Then select IF, chroma, or any of **4 RF channels** for fast, interference-free alignment. The Speed Aligner also shows the **baseline reference** just like the set's service information. The SM158 peaks television response in minutes for happier customers and extra profits, yet costs less than any other sweep/marker generator.

$275

39G26 IF Link Detector Probe **$10.00**
39G47 Scope Connector Cable **$8.00**

SUBSTITUTORS

RC167 SUBSTITUTOR
RC Component Substitutor

IT'S A LEG SAVER

The Substitutor is the "handiest instrument" you could have on your service, school, or design bench. **Make quick substitution checks** in filter, power, or bias circuits before you waste time and tire your legs by installing replacement parts that may not be needed. The 46 most used resistors, power resistors, capacitors, electrolytics, and rectifiers are at your fingertips. Use the sections separately, or connect them together.

The safe, **automatic Surge Protector** prevents electrolytic healing that would otherwise cause callbacks. This Sencore innovation also protects you from dangerous discharge shock. The **Double Protection warning light** goes on if the low voltage solid state lytics are hooked up in a high voltage circuit.

The RC167 **mounts three ways** so it's always at hand, but never in the way. It even has a convenient drawer to store spare parts. Use the RC167 to speed service, design, or school experiments.

$99

CG25 LITTLE HUEY
Portable Digital
Color Generator

THE MOST DEPENDABLE DIGITAL IC GENERATOR ON THE MARKET FOR UNDER $100

Don't walk out the door with bad convergence on that repaired TV! Take Little Huey along on every color service call and really improve the picture in your customer's eyes. Little Huey is **the original caddy-size digital generator.** His 100% crystal-controlled digital logic circuits give **rock solid patterns** instantly with no warm-up. He'll work in high temperature or low because he's all-weather. The exclusive **Automatic Shut-Off** will turn off the battery power, too, even if you forget.

Even though Little Huey is compact and lightweight in the caddy, he'll take even the toughest treatment because he's ruggedized. He'll do the biggest convergence jobs with **fully adjustable RF channels** 2 through 6, a color level control for AFPC checks, and pushbutton selection of six convergence patterns, including blank raster and standard RCA keyed rainbow color bars. For home calls, or as your first generator, take along Little Huey - the most complete pocket generator on the market for under $100.

$99

PATENTED

CR168

BIG MACK Automatic CRT Tester

YOUR NUMBER ONE CRT CUSTOMER CONVINCER

Selling your customer a new CRT is a tough job. No customer likes to hear he needs a new picture tube. He wants to see real proof before he puts down his hard-earned cash. You can make that profitable CRT sale with this big customer-convincer -- the CR168 Big Mack.

You'll convince him because you're **prepared with the right socket** for his set included inside the cover. You'll convince him without making an expensive testing mistake because the CR168 tests all CRTs under **actual operating tests** using the filament, bias, and G2 cut-off levels recommended by the CRT's manufacturer. You'll convince him with confidence because he can follow each test on the simplified function control and read the **big "Good-Bad" scales** for interpretation-free proof. You'll convince him with the CR168's **patented Automatic Tracking** test to show him why the CRT has poor color tracking even though each CRT gun shows "Good." Only Sencore has it.

And you'll lock him in for a future sale with the **safe timed rejuvenation** that extends life of weak guns, too. That's why Big Mack will get your CRT customer off your back and why you should put this CRT salesman to work for you.

$275

FIELD STRENGTH METER

FS134

Portable Field Strength Meter

LOWEST COST FOR ALL VHF, UHF, FM BANDS

The FS134 is your signal strength simplifier. It's the only battery-operated portable field strength meter you can buy to check losses or gain on any **VHF, UHF, or FM channel** from rooftop to basement.

Here's how easy it is to use. Connect the standard 75 or 300 ohm fittings to the antenna, distribution line, or tap-off. Tune in the signal on the **fully variable dial** while listening to the speaker for the signal you want. Then read the **calibrated meter scale** for industry-standard microVolt or dB readings. The **high 30 uV sensitivity** and built-in attenuators equip you for the lowest antenna signal or the strongest amplifier output. The FS134 pays for itself many times over when installing antennas, trouble-shooting MATV and CATV networks, or checking systems in motels, hotels, apartments, hospitals, or schools.

$395

39G15 AC Power Supply for rechargeable batteries **$9.95**

RC24 PARTS PAK
Caddy RC
Component Substitutor

IT'S A TUBE CADDY JANITOR

More than any decade box, the compact Parts Pak puts the 36 most often-used EIA-value resistors, capacitors, and lytics right at hand for quick substitution. The safe, **automatic Surge Protector** prevents electrolytic healing that would otherwise cause call-backs. The **Double Protection warning light** goes on if the 1000 mF low voltage lytic for solid state circuits is accidentally hooked up to a high voltage. The leads tuck away completely for **dangle-free portability.** Carry the RC24 in the caddy to clean up messy parts, or use it for design or school experiments.

$45

Only Sencore instruments have this seal of quality.

BACKED BY SENCORE'S 100% MADE RIGHT LIFETIME GUARANTEE

Contact your distributor for additional information and specifications on any Sencore instrument.

SENCORE CB TEST INSTRUMENTS

THE FASTEST, EASIEST WAY TO MAKE EVERY CB SERVICE JOB PAY

Until now, you have only two choices to set up a shop for the booming CB service business. Either you put out thousands of dollars for lab equipment (and never used most of the capability), or you connected up to seven separate instruments together with a mess of cables. Now these two automatic Sencore CB test instruments will fully equip you to analyze and check all channel performance of any AM or SSB CB on the market. It's the fastest, easiest way to be competitive and turn around every CB service and installation job at better than FCC specs with automatic testing, digital speed, and simplified troubleshooting.

PATENT PENDING

CB42 Automatic CB Analyzer

WALK THE TROUBLES OUT OF ALL CB CHANNELS IN SECONDS . . . AT FCC SPECS

Now get a total CB service bench in **one easy-to-use instrument** with the CB42. It's the fastest, easiest way to turn around every CB service hob with automatic testing, digital speed and accuracy, and **better than FCC specs.** Walk through receiver troubles with all the RF, IF, audio, and alignment signals you need. The crystal controlled **45 channel PLL RF tuner** and full range IF generator equip you for any AM or SSB rig. Save service time with all audio signals, including EIA SSB two-tone, for audio injection. Built-in Speaker Sub eliminates speaker howl during the pushbutton-quick EIA receiver sensitivity test.

All the transmitter signals are at your fingertips to troubleshoot any transmitter stage from the mike (with Dynamic Mike Tester included) to the antenna jack. Check all oscillator and synthesizer frequencies with the **built-in 50 MHz frequency counter,** and use the exclusive Crystal Check, too. The CB42 has an easy hook-up antenna sub with **digital display** of the transmitter frequency, power, modulation, and distortion. No external load is needed. The **exclusive Percent Off-Channel** (Patent Pending) test checks all 40 channels for FCC .005% frequency limits in seconds. Use any 1 MHz scope with the built-in Scope Adapter. As recommended by major CB manufacturers, the CB42 is the one instrument you need to be competitive by getting out more CBs in less time than any other way.

$895

NL204 Noise Limiter Accessory **$25.00**

RFS205 RF Switch For Transmit/Receive Cable Change Over **$25.00**

CB41 Automatic CB Performance Tester

You can get your CB customers out three miles further on the average in 1/3 the time with 3 simple pushbuttons for complete performance testing of SWR, RF power, and percent modulation. The CB41 with accessory Extension Cable is the only performance tester that equips you to perform speedy installations by making antenna adjustments with the meter right at the antenna. It's then **pushbutton easy** to rotate the CB through all 40 CB channels and convince your customers of peak CB performance in seconds. The **self-calibrating automatic circuits** do all the work for you. You can stand on your head and run around the car for each antenna test with your present CB tester, or put the portable CB41 to work for **automatic CB performance testing in seconds** -- even at the antenna.

$148

PA202 Power Adapter **$9.95**

EX203 Extension Cable **$9.95**

SENCORE OSCILLOSCOPES

LAB QUALITY PERFORMANCE AT LESS THAN LAB PRICES

PS163 Sweep Oscilloscope Dual Trace Triggered

DUAL TRACE LAB PERFORMANCE AT 1/3 THE COST

The only way you can compare two waveforms is with a dual trace scope, and the PS163's **1% phase-locked matched channels** with flat 8 MHz bandwidth won't distort your comparisons as other scopes do. And the PS163 is the only dual-trace that is **protected from DC to 5000 VAC P-P** to cut repair and replacement costs.

Whether your work is digital and logic troubleshooting, calculators, televisions, VTRs, video games, or audio, the **Automatic Triggering** will lock on any signal of 1 cm deflection down to a low 5 mV/cm. **Automatic Video** presets both the sweep speed and the sync separators for stable video signals with the flick of a knob. The **Automatic Vector** mode, with matched front-panel inputs, speeds chroma and audio troubleshooting. Finally, you have **pushbutton quick selection** of Display, Sync, and Trigger modes for complete measurement versatility. For school, lab, and shop, the PS163 is the good scope that's still ahead of it's time. (Two Probes included).

$895

39G81 Demodulator Probe **$20.00**

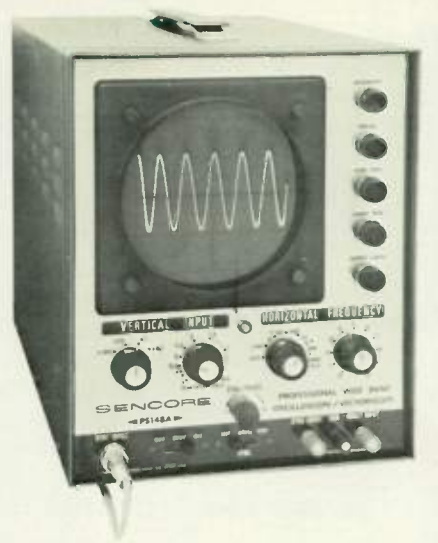
PS29 MINUTE MAN Automatic Pushbutton

THE ONLY COMPLETELY AUTOMATIC SCOPE FOR ANY COLOR TV & VIDEO SERVICE

Are you still fiddling and twisting knobs on your scope? Now enjoy the **pre-set, pre-"synced" video troubleshooter** that frees you from all that knob-twisting. The PS29 Minute Man is the only completely automatic pushbutton triggered scope on the market for all color TV and video servicing. **Just push a button** for every color and video signal -- TV Vertical, TV Horizontal, 3.58 MHz color, 5X Expand, Sweep Generator 60 Hz, and pushbutton Vector with front panel inputs. **Actual TV sync separators** and automatic triggering guarantee solid, stable sync even on hard-to-hold video waveforms. In addition, the exclusive **5000 VAC input protection** means you can measure any video, sync, or sweep signal without damage to the scope. Use the PS29 for fiddle-free video troubleshooting of TVs, video games, broadcast monitors, closed-circuit video, cameras, VTRs, etc. It's also a general purpose oscilloscope for any signal from DC to 10 MHz, including digital logic, CB, audio, and school use. (Probe included)

$595

39G81 Demodulator Probe **$20.00**



PS148A Wideband Oscilloscope/Vectorscope

THE LOW COST "WORKHORSE" OF PROFESSIONAL SERVICE SCOPES

Looking for a professional "workhorse" scope that gets the job done without all the expensive "extras"? The PS148 has **high 17 mV/inch sensitivity** and broad 6 MHz bandwidth for audio, television or CB troubleshooting. Adjust the four simplified gain and frequency controls for direct reading peak-to-peak voltages on the easy-viewing 5" screen. Even 3.58 MHz signals lock in easily with the PS148's **exclusive stable sync circuit.** The dual purpose probe (included) has a **7000 VAC rating** in the lo-cap section. The PS148 also **doubles as a vectorscope** with the flip of a switch to simplify television chroma troubleshooting and bandpass alignment. Whether you're a professional needing a second scope for your new man, or a hobbyist who wants professional performance at low cost, put the PS148 to work for you. (Probe included).

$395

39G3 Demodulator Probe **$9.95**

SENCORE POWER SUPPLIES

PS43 PORTA-PAK Universal Rechargeable Battery

THE ONLY SUPPLY ESPECIALLY DESIGNED FOR SOLID STATE CIRCUIT DESIGN AND SERVICING.

Here's a revolutionary approach to power supplies -- rechargeable batteries. The PS43 **powers up virtually all solid state equipment,** PC boards, ICs, and other circuits that require highly regulated and filtered voltages with virtually pure DC and no hum. It's a **direct battery replacement** for 6 and 12 Volt supplies to power up CBs, tape players, auto radios, etc. It's a **designer's and servicer's supply,** too, whenever you need hum-free power for PC boards, modules, production line testing, IC testing, TV biasing, and 101 other uses around your shop or lab.

Simply plug the PS43 into 115 VAC, or unplug it to use the rechargeable batteries for portable applications, or where you want **pure DC.** The Porta-Pak provides a 6 Volt supply, a 12 Volt supply, and two independent 15 Volt supplies with .6V taps all the way. All outputs have husky 200 mA continuous and **5 Amp peak current** output to handle the big jobs, too.

$98

UPS164 Universal Power Supply

THE MOST RUGGED AND PROTECTED SUPPLY YOU CAN BUY

The UPS164 is a dream supply for CB, mobile communications, auto radio, cassette, and 8-track servicing. It's **two supplies in one** -- a regulated 0 to 30V, 2 Amp high filtered section for normal power, plus regulated 6 and 12 Volt 10 Amp high current sections to operate channel selector solenoids, etc. It will power special aircraft, marine, and military systems and even recharge storage batteries.

Low 5 mV ripple output makes the UPS164 an **ideal solid state designer's and servicer's supply.** It has **triple regulation** of voltage, current, and the AC line to speed your work without output fluctuations. The **sensitive dual meters** monitor both voltage and current simultaneously.

It's student-proof, too, with **full current limiting.** Set the maximum current level and that's all the current the UPS164 will deliver -- even with a dead short!

$290

39G42 Module Master **$35.00**

BE156 ALIGN-O-PAK 7-in-1 DC Bias Supply

WORLD'S MOST POPULAR

The world's most popular DC bias box is seven supplies in one for fast alignment work in **any stage of any set** -- tube or solid state. This compact unit has three independently-controlled positive or negative outputs, plus -75V for chroma amplifiers.

$49.50

Prices and specifications subject to change without notice.

8 ARE YOU LOSING SALES BECAUSE YOU CAN'T PROVE CB PERFORMANCE TO YOUR CUSTOMERS?

A prospective buyer coming into your store undoubtedly has some idea of what he wants to buy in a CB and how much he wants to pay for it. He may have heard from a friend that the low-priced ABC model is good. But you ask about his needs and find that an XYZ model will be better suited, and you know he will be happier with it. If you are to make the sale, you will have to show him the proof he wants to see.

Use the CB41 as a customer convincer to close those bigger sales.

How will you show the customer who wants to know? Words alone won't always do it. He wants performance proof. A simple way to close this sale is with a comparison between the two systems. Take the system he wants and the system you know he should have out to his car. You can show him the results of the power, modulation, and SWR tests on the meter scale, and the extra value will be apparent to him.

But wait. Who will make all those connections, calibrations, references, and adjustments? It takes somebody who knows what he is doing to radiate confidence to the customer and make him a believer in the meter. You could tie up an expensive bench technician's time to demonstrate and explain each test. Or you can put the CB41 in your salesperson's hands, and let this super customer convincer be your salesman.

Operated by completely non-technical personnel.

Even a non-technical person can use the simplified, automatic CB41. No FCC license or technical training is required, either. Just connect the antenna cable to the tester and punch the three buttons, it's that simple and fast. Use the CB41 to

Fig. 22—Your customer will sell himself up to higher profit equipment when he sees the proof on the CB41.

sell and trade CBs and CB accessories by proving better performance and value. Your customer will understand the color-coded scales, and he can even push the buttons himself to be 100% sure he is getting the best value and performance every-time. As Radio-Electronics magazine says about the CB41 . . .

. . . A substantial number of today's CB equipment buyers have no technical knowledge or ability and depend almost entirely on the dealer to provide installation, adjustment, and service where necessary.

One of the ways to move CB installations along at a fast profit-making clip is to provide as much automation of the adjustments and checkouts as is possible.

GET YOUR CB CUSTOMERS 3 MILES FURTHER IN 1/3 THE TIME WITH 3 SIMPLE CB41 PUSHBUTTONS

. . . most CB'ers are primarily interested in RF power output, percent modulation and antenna system SWR—and it is these three performance characteristics that are most easily automated in an easy-to-understand manner for the non-technical CB'er.

. . . the customer can see it all taking place without asking why you keep fiddling with the calibration knob.

--Radio-Electronics
July, 1976

9 ARE YOU TECHNICALLY READY TO SELL UP TO THE NEW 40 CHANNEL CB's FOR EVEN BIGGER SALES?

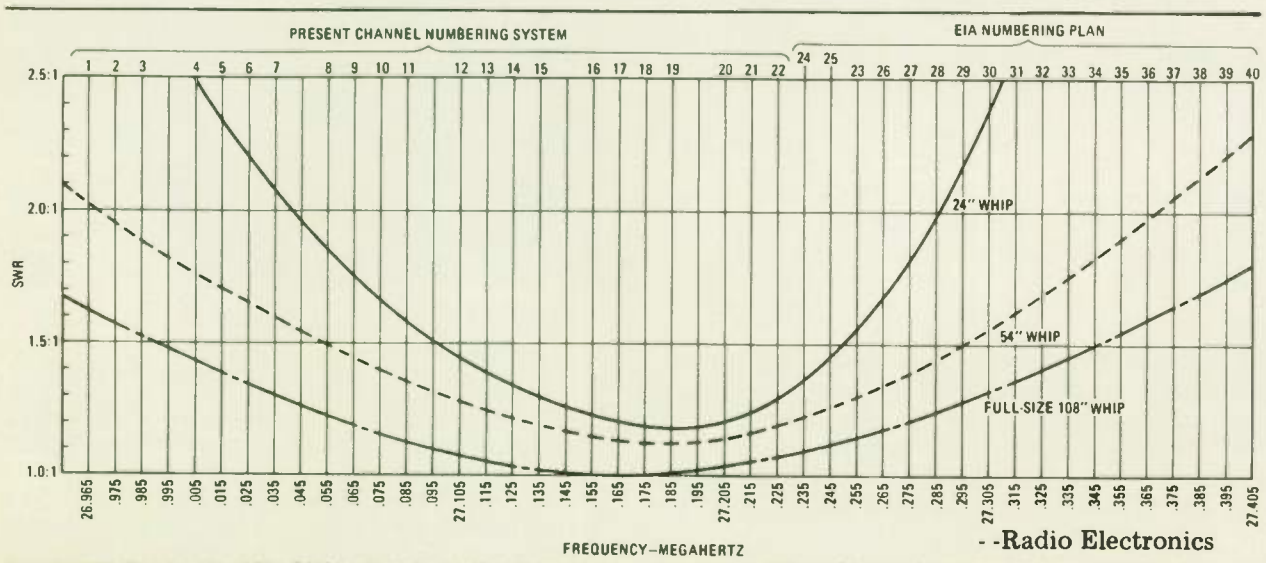
As we discussed, the new 40 channel CBs will cost more and it will be tougher for you to sell them unless you have the proof that they are better.

> It is believed by some members of the industry that the new 40-channel sets probably would sell at retail for 10 per cent to 15 per cent more than the current 23-channel models.
>
> –Radio TV Weekly
> Aug. 16, 1976

> And, new 40-channel sets will be more expensive than present 23-channel sets because they will have to meet stricter FCC technical standards.
>
> –CB Magazine Oct. 1976

FACT: *They will be more expensive* than current 23 channel sets.

CEDA gram Aug. 1976



--Radio Electronics

EXPANSION OF THE CITIZENS BAND will make greater demands on antenna design and performance. Some antennas, particularly the shorter mobile whips, perform best over just a few channels on each side of resonance. SWR and losses rise as you tune away from the channel to which the antenna is tuned. The curves compare the SWR's of a full-length quarter-wave whip and two shorter coil-loaded types.

But that's not all. Many present 23 channel antennas won't work well with the new 40 channel rigs. These antennas are especially built to cover the 23 channel bandwidth only. A 40 channel CB needs a 40 channel antenna with greater bandwidth. Look at the chart from Radio-Electronics magazine and see the difference.

How will you know with confidence that a customer's antenna will work with the new 40 channel CB you just sold him? He will be quite dissatisfied when he finds that he can talk on channel 19, but not on channel 1 or 40. We think you know the answer. You must test each and every channel with the automatic CB41 CB Performance Tester to be sure. Just press the SWR button and rotate the CB channel selector through all 40 channels on his 23 channel antenna. If the meter

Fig. 23—Will the customer's antenna work? Just crank through all 23 channels in seconds to know for sure.

reads in the red, you can show him he will lose talk power with his antenna on some channels. Then show him the good antenna match on a new 40 channel antenna. Move into selling 40 channel systems the easy way with your automatic CB41 to back you up.

10 ARE YOU INCREASING YOUR CB AND ACCESSORY SALES BY PROMOTING CLEAN CB PERFORMANCE?

Whether you are selling, installing, or servicing CBs, or just thinking about getting into CB, you have undoubtedly heard that the fantastic CB explosion in the last three years is only the beginning. So how can you increase your business in this hot, profitable market today? Do you know what is coming in the future?

CB41 builds your business today.

You will get out more sales, more installations, and more servicing in less time with the CB41 in your hands than with any other CB tester. Effective sales, better installations, and efficient servicing mean happier customers who will be back for additional equipment later. Your mobile CB customer today may be back tomorrow for a base station–if you satisfy him. And your happy customers will tell their friends about your shop, expanding your business more.

What about all the other CBers in your area? Just spend ten minutes in front of your store and count how many potential service and accessory customers are driving past. Wouldn't you like their business, too ?

Fig. 24—How many CB customers are passing by your store each day?

You have read in this Sencore News that over half of these CB installations need performance improvement. So build your business and bring them into your store for a free CB check-up by displaying this big banner in your window. Then use the CB41 to check the CB and antenna system in two minutes. You can step them up to improved CB performance and accessories when you show them the test results on the easy-to-understand CB41. Of course, if they just need to have their antenna system tuned, you can charge for your services.

WHAT OUR CUSTOMERS SAY

With the CB41, all you do is push three buttons and you're in business. We are a warranty station for Courier, RCA, Cobra, Johnson CB and FM. Most of the problems we see are due to mismatch. So we show the CBer the CB41 results before we adjust anything. Then we show him again when it's done. He always has an increase in power and modulation when the antenna is adjusted too. A radio is only as good as the antenna, we say. We have some good and some cheap antenna coils cut in half to show the winding construction. Some real cheap ones are wound on cardboard! Well, we show the difference on the CB41. It's a good hammer to get the point across to the customer to install a better system.

We also do FM, marine, and business communications work. For all these jobs, the CB41 is the standard on our bench.

Harold J. Brown
H & N Communications
Garden City, Missouri --a CB41 owner

Fig. 25—Draw extra business into your store with the CB41 "Free Performance Test" banner.

It is time to start promoting better trouble-free CB that truly punches through loud and clear. Your customers will believe you only when you show them percent modulation, standing wave ratio, and RF power. And you can do all these things in seconds only if you own a CB41 CB Performance Tester.

Get your free CB banner by attending a Sencore Seminar in your area!

Just ask your Sencore Tech-Rep for your free CB banner when you take home a CB41 on ten-day trial.

Get ahead of your competition. Get a CB41 today and start selling your CBs and service for tomorrow. Read what industry leaders say about the future of CB:

Remember to tell your dealers that there are 25 million 23 channel sets in use today--if 1½ million 40 channel sets are sold every year for the next 5 years there will still be twice as many 23 channel sets in use in 1982 as 40 channel sets in use.

CEDA-gram

The General Electric Co. estimated last week that the market for citizens band radios will reach $1 billion at wholesale in 1980.

The company projected wholesale sales this year of $550 million, up 44.7 per cent from the $380 million in 1975.

Compounded annual growth for CB radios during the last five years has been 42 per cent in wholesale dollars.

In its market survey of the CB industry, General Electric estimates that saturation at the present time is about 4 per cent of all families; 68 per cent of long haul truckers and 43 per cent of recreational vehicles.

--Radio TV Weekly
June 14, 1976

Market penetration, estimated at 5 percent this year, with 10 million units, is expected to grow to 24 percent by 1980, with about 50 million CB radios. Assuming an average unit price of $100, that projection means a $5 billion total market in the next five years, explained Willis Wolf, executive vp of Olson Electronics, Akron Ohio.

The projections show numbers of CB radios by 1980 at 28½ million for automobiles, 10 million for households, 9 million for farms, and substantial increases in all other market segments.

--Great Lakes Retailing Review

That is 50,000,000 times in the next few years that someone is going to sell a new CB, 50,000,000 times someone is going to install the CB, and possibly 50,000,000 times service will be needed for every single one of these systems. As any CBer would say, "This CB business is 'wall to wall,' good buddy!"

Get ahead with a CB41 today!

The one-man shop of today could be the big, ten-man CB center of tomorrow. And you can be right up on top with your own CB shop--if you

Fig. 26—Choose the business-building CB41 for increased CB profits.

are equipped. You can satisfy your customers with the accurate and efficient performance proof they demand, or one by one, you can turn your present customers away to your competitor. So it comes right down to one final question: "Are you putting your future on the line right now because you think you can 'get by' with a $50 power-SWR meter that customers cannot believe in?"

WHAT OUR CUSTOMERS SAY

Our biggest problem seems to be that over fifty percent of the installations we see are done by someone not experienced with CB, so we check them in the car the first thing with the CB41. We used to use a common SWR meter, but we had to go back and calibrate it each time. And another meter we had wasn't too accurate on Watts and Modulation. Now we get fewer callbacks using the CB41 on installations.

But it's quite a bit more than just an SWR checker. It helps with service too. I check out a radio on the counter when it comes in. The tips in the book tell what other things than SWR can go wrong and most of the time I know where to look before the CB goes on the bench.

I like it because it's automatic. It's paying for itself and I'm real glad I invested my money in it.

Forest Henry
CB Radio Equipment
Williamsburg, Virginia --a CB41 owner

If you believe, as we do, that the CB41 is the only CB Performance Tester on the market that helps your customers "punch through loud and clear" faster and more accurately than any other instrument, you will certainly agree that the CB41 is the greatest CB business expander you can invest in. All you have to do is rush to tell your Sencore distributor that you want one today. He'll even let you try one on a Sencore ten-day trial so you can prove to yourself that you can get out three miles further (average) and in one-third the time of other testers.

BACKED BY SENCORE'S 100% MADE RIGHT LIFETIME GUARANTEE

Only Sencore instruments have the 100% Made Right seal of quality.

SPECIFICATIONS

RF WATTS TEST: FREQUENCY RESPONSE: Flat for 20-30 MHz. RANGE: 0-25 watts PEP. ACCURACY: ± 3° arc.

SWR TEST: RANGE: 1 to infinity (∞). TEST METHOD: Self calibrating compares forward and reverse power ratio. ACCURACY: ± 5° arc from SWR — 1.0-3.0. INPUT: 1-15 watts PEP for rated accuracy.

PERCENT MODULATION TEST: RANGE: 0 to 100%. TEST METHOD: (AM only) Self calibrating. Refers P-P detected audio to average RF power. ACCURACY: ± 5% FS with input of 1-12 watts PEP. Calibrated for continuous tone modulation.

39G101 SENSOR HEAD: ANTENNA: Internal non-inductive dummy load or loop-through to external antenna. IMPEDANCE: 50 ohm, unbalanced. POWER CAPABILITY: 25 watts PEP intermittent duty, 6 watts average RF power continuous. CONNECTIONS: PS259 Female output. PS259 Male input on 16" coax stub, 4 conductor connector to unit.

GENERAL: POWER: 7.2-10 VDC, 8mA batteries: Two 9V radio batteries (Eveready No. 216 or equivalent). Rechargeable: PA202 Power Adapter used with two 9V rechargeable cells. AC line: 105-130 VAC, 50/60 Hz when used with PA202 Power Adapter and batteries installed for filtering. External: 9 VDC from Sencore PS43 Power Supply or external battery. METER: 4½" moving coil, 100uA, 1900 ohm, ± 2% FS. Spring protected jeweled pivots. SIZE: 10" x 5½" x 3½". WEIGHT: 4¼ lb. (with batteries).

ACCESSORIES:

EX203 12 ft. Extension Cable	$9.95
PA202 Power Adapter	$9.95

The Sencore News is written, edited, and published by the Field Engineering Department of Sencore, Inc., 3200 Sencore Drive, Sioux Falls, South Dakota, 57107. The Sencore News is distributed without charge to all individuals or companies who have registered the purchase of any Sencore instrument by means of the warranty card packed with that instrument. The information herein has been taken from one or more sources which we consider reliable. Although such information has been carefully prepared, we make no representations as to its accuracy or completeness. Prices and specifications are subject to change without notice.

"The Only Power Supply Especially Designed for Solid State Circuit Design & Service."

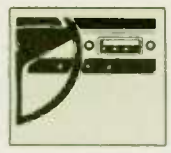
NEW

IT'S A DIRECT BATTERY REPLACEMENT
for 6 & 12 Volt Supplies to Power up . . .


CB RADIOS and other communications equipment


TAPE PLAYERS and portable recorders


PORTABLE RADIOS


AUTO RADIOS


CB TEST EQUIPMENT

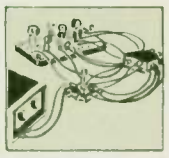

REMOTE CONTROL MODELS

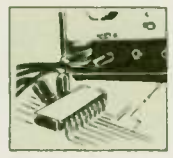
AND 101 OTHER APPLICATIONS DURING TESTING OR REPAIR

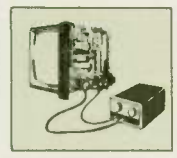
IT'S A DESIGNER'S & SERVICER'S SUPPLY
Whenever you Need Hum-free Power for:

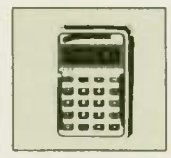

P. C. BOARDS AND MODULES


PRODUCTION LINE TESTING

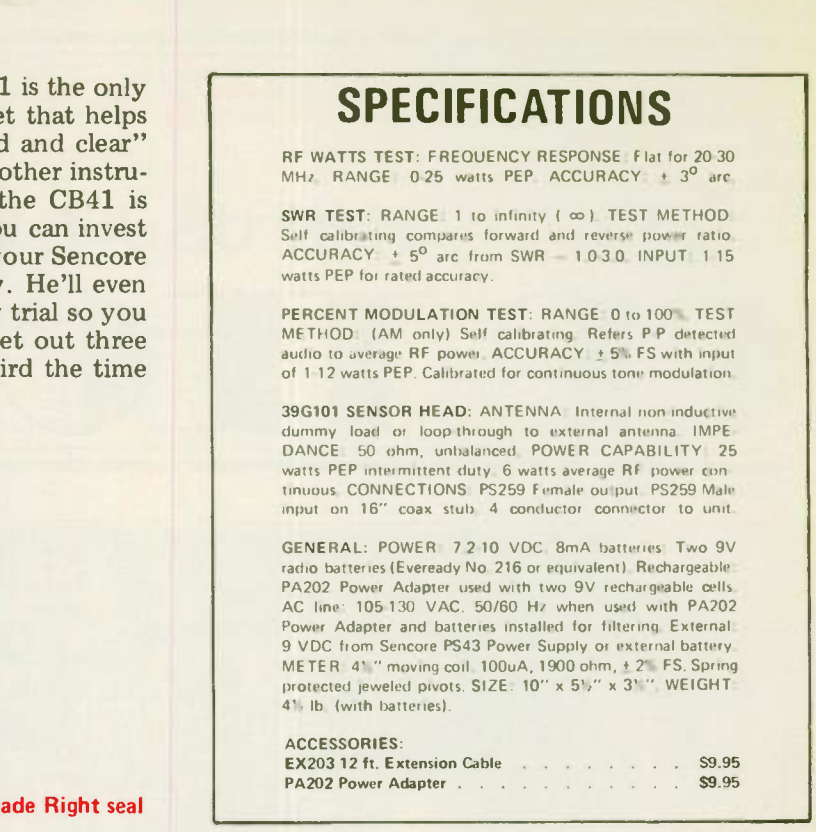

"BREADBOARD" CIRCUITS


IC TESTING AND "BURN IN"


TV SERVICE BIAS SUPPLY


CALCULATORS, BUSINESS MACHINE SERVICE

AND 101 OTHER USES AROUND YOUR SHOP OR LAB



ONLY $98 (Batteries not included.)

POWERS UP VIRTUALLY ALL SOLID STATE EQUIPMENT, PC BOARDS, ICs, AND OTHER CIRCUITS THAT REQUIRE:

- Highly regulated and filtered voltages.
- Virtually pure DC with no hum.
- Tapped outputs in .6V steps.
- Multiple outputs.

THE PS43 PORTA-PAK PORTABLE POWER SUPPLY PROVIDES:

- A 6 Volt supply
- A 12 Volt supply
- Two independent 15 Volt supplies with .6V taps all the way.
- All with husky 200 mA continuous and 5 Amp peak current output.

PLUG THE PS43 INTO 115 VAC OR UNPLUG IT TO USE THE RECHARGEABLE BATTERIES FOR A FEW HOURS WHERE YOU MUST, OR WHERE YOU WANT PURE DC.

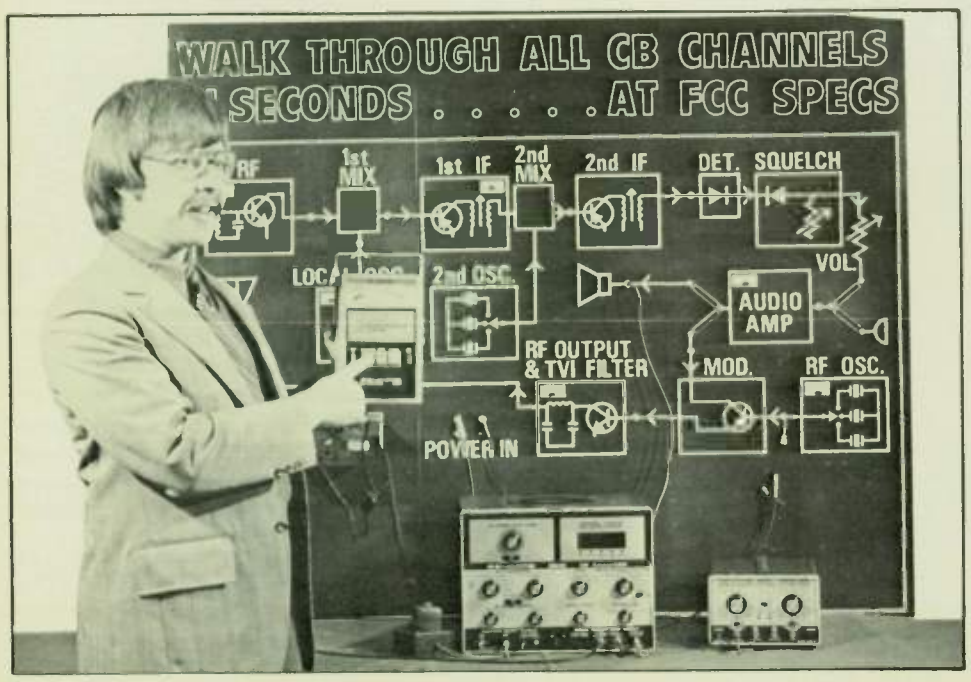
BACKED BY SENCORE'S 100% MADE RIGHT LIFETIME GUARANTEE

SEE YOUR
SENCORE
FULL-LINE PROMOTIONAL DISTRIBUTOR.

Want to Learn More About Faster, More Profitable Servicing?

JOIN US AT OUR ALL NEW SENCORE

CB TECH-A-RAMA



We'll demonstrate . . .

THE FASTEST, EASIEST WAY TO MAKE EVERY CB SERVICE JOB PAY

- **CB41 Automatic CB Performance Tester**
- **CB42 Automatic CB Analyzer**
- **PS43 Porta-Pak Portable Power Supply**

We'll show you all the basics of profitable CB troubleshooting with Sencore CB instruments.
Try these all-new automatic units yourself on our special CB demonstrator.

Come in and try . . .

SENCORE'S NEW DIGITAL MULTIMETERS

Bring along your meter and compare it with the four new Sencore DVMs on price, performance, portability, protection, and even a ten foot drop test!

We'll bet the Sencore DVMs equip you to:

- **Go more places**
- **Test in more circuits**
- **Measure more accurately**
- **Take more overloads**

Technicians, Engineers, Instructors!
Join us as you update for solid state!

CHECK THIS LIST OF SENCORE TECH-A-RAMAS FOR ONE IN YOUR AREA. THEN MARK YOUR CALENDAR AND COME ON IN! SEE YOU THERE!

ARIZONA

● Tucson — Nov. 17
at 3380 East Ajo Way — 7:00 P.M.
Inland Supply
715 East Broadway
Tucson, AZ 85719
(602) 624-4402

ARKANSAS

● Fort Smith — Nov. 11
at 4420 Whealer Avenue — 7:30 P.M.
Carlton-Bates
4420 Whealer Avenue
Fort Smith, AR 72901
(501) 646-8201

CALIFORNIA

● Bakersfield — Nov. 22
at Holiday Inn — 7:00 P.M.
2700 White Lane
RCA Distributing Corp.
233 East Harris Avenue
S. San Francisco, CA 94080
(415) 761-5343

● Fresno — Nov. 23
at Airport Holiday Inn — 7:00 P.M.
5090 East Clinton Avenue
RCA Distributing Corp.
233 East Harris Avenue
S. San Francisco, CA 94080
(415) 761-5343

● Hawaiian Gardens — Nov. 16
at 12016 East Carson — 7:00 P.M.
Carson Electronics
12016 East Carson
Hawaiian Gardens, CA 90716
(213) 425-8298

● Modesto — Dec. 7
at Holiday Inn — 7:00 P.M.
1612 Deale Road
RCA Distributing
233 East Harris Avenue
S. San Francisco, CA 94080
(415) 761-5343

● Oakland — Nov. 15
at Oakland Colliseum Holiday — 7:00 P.M.
Nimitz Frwy & Hegenserger Rd.
RCA Distributing Corp.
233 East Harris Avenue
S. San Francisco, CA 94080
(415) 761-5343

● Sacramento — Nov. 11
at South Holiday Inn — 7:00 P.M.
4390 47th Avenue
RCA Distributing Corp.
233 East Harris Avenue
S. San Francisco, CA 94080
(415) 761-5343

● Salinas — Nov. 10
at Town House Motel — 7:00 P.M.
808 North Main Street
RCA Distributing Corp.
233 East Harris Avenue
S. San Francisco, CA 94080
(415) 761-5343

COLORADO

● Denver — Dec. 2
at VFW — 7:00 P.M.
9th & Bannock
Fistell's Electronic Supply
1001 Bannock Avenue
Denver CO 80284
(303) 244-4691

ILLINOIS

● Belleville — Nov. 18
at Fisher's Restaurant — 7:30 P.M.
Cabanie Room
2100 W. Main Street
Lurtz Electronics
219-221 N. Illinois Street
Belleville, IL 62220
(618) 233-0942

● Springfield — Nov. 10
at 1023 Dorlan Avenue — 7:30 P.M.
Besco, Inc.
1023 Dorlan Avenue
Springfield, IL 62702
(217) 753-0111

IOWA

● Ames — Nov. 10
at 620 South Madison — 7:30 P.M.
Iowa City, IA
Mid-State Distributors
511 South 3rd
Ames, Iowa 50010
(515) 232-2104

● Des Moines — Nov. 11
at 2511 Bell Avenue — 7:30 P.M.
Mid-State Distributors
2511 Bell Avenue
Des Moines, IA 50321
(515) 288-7231

● Iowa City — Nov. 10
at 620 South Madison — 7:30 P.M.
Mid-State Distributors
620 South Madison
Iowa City, IA 52240
(319) 337-3726

● Marshalltown — Nov. 11
at 311½ South Center — 7:30 P.M.
Mid-State Distributors
311½ South Center
Marshalltown, IA 50158
(515) 752-0513

KANSAS

● Salina — Nov. 10
at 1809 South Broadway — 7:30 P.M.
Radio Supply
1809 South Broadway
Salina, KS 67401
(913) 823-6353

KENTUCKY

● Louisville — Dec. 7
at 829 S. Floyd Street — 7:00 P.M.
Collins Co.
829 S. Floyd Street
Louisville, KY 40203
(502) 583-1791

● Owensboro — Nov. 30
at 1421 Triplett Avenue — 7:00 P.M.
Hutch & Sons, Inc.
1421 Triplett Avenue
Owensboro, KY
(502) 684-6285

MASSACHUSETTS

● Northampton — Dec. 1
at Colonial Hilton Inn — 7:30 P.M.
Route 5 & 91
Signal Center
484 Worthington Street
Springfield, MA 01105
(413) 739-3893

MINNESOTA

● Duluth — Nov. 18
at Holiday Inn — 7:00 P.M.
250 N. Second Avenue
Stark Electronics
18 N. Second Avenue
Duluth, MN 55802
(218) 722-1766

● Minneapolis — Nov. 17
at 6413 Lyndale Ave. South — 7:00 P.M.
Team No. 5
6413 Lyndale Ave. South
Minneapolis, MN 55416
(612) 869-3288

MISSOURI

● Bridgeton — Nov. 11
at 4690 M. Lindberg Blvd. — 7:00 P.M.
Deltronics
864 Hodiamont Avenue
St. Louis, MO 63112
(314) 725-6060

● Joplin — Dec. 7
402 Wall Street — 7:30 P.M.
Norman Electronics
402 Wall Street
Joplin, MO 64801
(417) 869-7237

● Sedalia — Nov. 16
at State Fair Community — 1:00 P.M.
College
1900 S. Clarendon Road
Radio & TV Supply
321 E. Main Street
Sedalia, MO 65301

NEW YORK

● Glen Falls — Nov. 11
at Sheraton Inn — 7:30 P.M.
Ray Supply, Inc.
Upper Glen Street
Glen Falls, NY 12901
(518) 792-5848

● Syracuse — Nov. 23
at 839 Hiawatha Blvd. West — 7:30 P.M.
Standard Electronics
839 Hiawatha Blvd. West
Syracuse, NY 13201
(315) 422-0421

NEVADA

● Reno — Dec. 8
at Downtown Holiday Inn — 7:00 P.M.
1000 East 6th
RCA Distributing Corp.
233 East Harris Avenue
S. San Francisco, CA 94080
(415) 761-5343

TEXAS

● San Antonio — Nov. 17
at 3003 Anoil Street — 7:00 P.M.
Joe Thiele Co.
3003 Anoil Street
San Antonio, TX 78219
(512) 227-2491

● Waco — Nov. 16
at Holiday Inn — 7:00 P.M.
I-35 East
Hargis Co., Inc.
1205 Washington Avenue
Waco, TX 76703
(817) 754-5667

WISCONSIN

● Fon DuLac — Dec. 1
at Petries Bavarian Inn — 7:30 P.M.
84 N. Main Street
Fedco, Inc.
152 South Macy Street
Fon DuLac, WI 54935
(414) 922-6490

EARLY BIRD SPECIAL

BRING IN YOUR CRT DUDS

Come in a half hour before the regular meeting and dare the CR31A Super Mack CRT Tester and Restorer to restore those old, worn-out CRTs. If Super Mack can't restore them . . . nothing can!

You're Invited . . .

Come as you are right from work for some technical nuts and bolts, answers to your instrument questions, and good times you won't want to miss!

Meet your Sencore Field Engineer. He's a test equipment specialist who will show you how you can speed your servicing with Sencore instruments.

There's something here for everybody. Don't miss it.

We could talk to you all day about the performance of the new Sencore CR31A Super Mack CRT Tester and Restorer, but you won't buy it as quickly as you will by listening to your friends in the business.

Why should we tell you that the CR31A is the only tester that will test virtually all CRTs with three times the sockets of other testers, and restore nearly half those run down CRTs that others miss? We'll let your friends tell you.

Why should we tell you that the patented CR31A works faster and simplifies your sale because it is the only tester with Automatic Tracking and Automatic Timed Restoration? We'll let your friends tell you.

So here are 17 non-solicited comments, as your friends wrote them on recently received warranty cards.

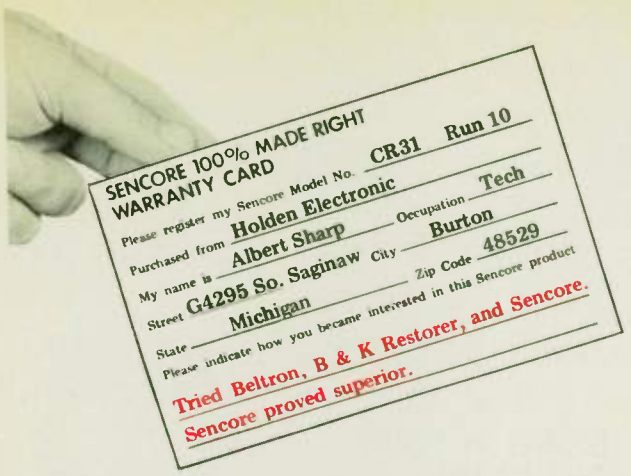
Then, tell yourself by attending the next Sencore seminar. Bring in a dud that no other CRT checker or restorer will do the job on, and prove it to yourself. Come in a half-hour before the meeting starts and your Sencore Tech-Rep will show you how to check and restore the dud, and let you prove to yourself what the CR31A can do. Then, make the best deal that you ever made right then and there.

Why wait? See your Sencore distributor for a 10 day free trial right now and prove it to yourself.

LET SENCORE CUSTOMERS TELL YOU!

RIGHT FROM THESE UNSOLICITED COMMENTS ON WARRANTY CARDS JUST RECEIVED:

It Works Best:



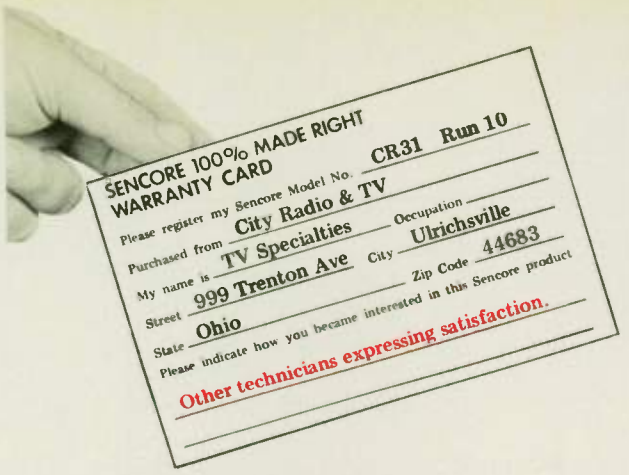
"The fact that it works."
Andre Pout
Andre's TV
New Orleans, Louisiana

"It's the only product that really works."
Ronald C. Taylor
San Francisco, California

"Sencore is up to date."
Jesse Lee Smith
Wilmington, Delaware

"Just like large face so you can read."
Eddie Johnson
Chicago, Illinois

Others Say it Works Best:



"Have had good reports on it."
Norman E. Baker
Coutesville, Pennsylvania

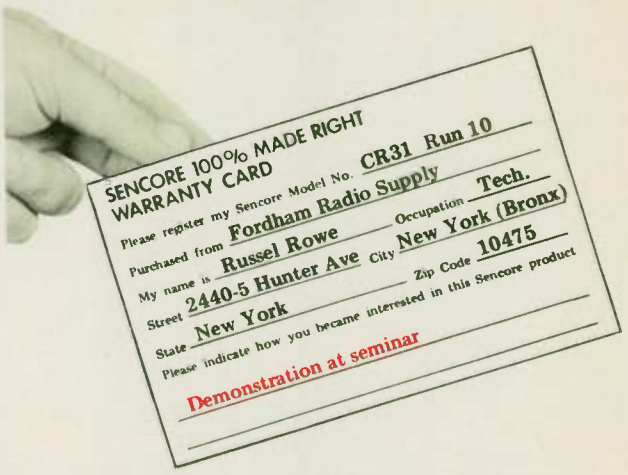
Trial Period Shows it Best:

"Ten day free trial."
Kerwith L. Dawson
Dawson TV
Vancouver, Washington

"Sencore News–Used for 10 days.
Karl Richter, Jr.
Windlake, Wisconsin

"A trial period"
A & R Electronics
Arthur L. Johnson

Demonstrations Show it Works With Best Features and Values:



"Attended meeting realized our tester was inferior and it had to be repaired and wasn't a year old. We were doing without."
Theo F. Richter
Richter Furniture and Appliances
Madison, Kansas

"Part time TV repair using B & K--was shown this unit better."
Walter P. Meisner
Ariel, Washington

"By comparison to other instruments more and better features per dollar."
Roy B. Coolbaugh
Urbana, Ohio

We could tell you all about the YF33 Ringer and the marvelous reports we have heard, as customer after customer tells us the Ringer checks all yokes and flybacks 100 times out of 100.

We could tell you just how simple it is to push the pushbuttons for maximum impedance match. We could prove to you that a ringing test on your scope just won't catch those tough ones. We could show you how important it is to check the peak-to-peak drive before you change a good yoke or flyback, or the importance of having high voltage measurements up to 50KV without fiddling with your multimeter.

We could even empathize with you when you run into those yokes that are cemented to the picture tube necks, and wonder what you do without a tester these times. We could show you why most of your tough dogs are in the TV sweep and high voltage sections, and prove in black and white why these repairs are usually the big loss-makers in your financial statement, because they consume too much servicing time. We could tell you because we cut our "eye teeth" in the TV service business.

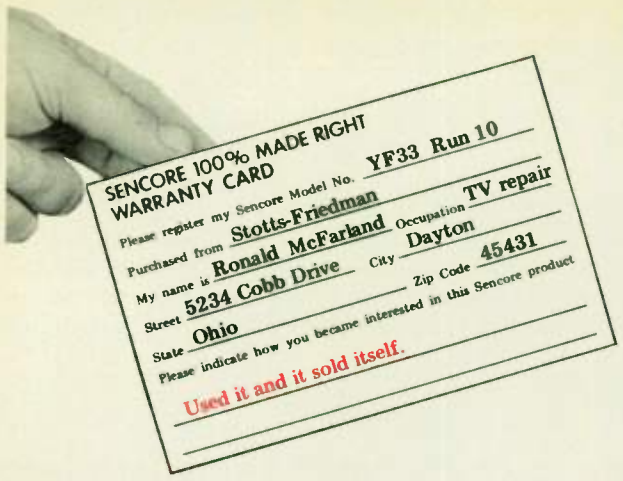
Instead, we'll have our Sencore customers who have used their own YF33s tell you, just as they told us on recent warranty cards received at the factory.

Then we hope that you, too, will march into your Sencore distributor as these friends of yours in the business have, and demand a YF33 Ringer for your own business. You'll be glad you did.

LET SENCORE CUSTOMERS TELL YOU!

RIGHT FROM THESE UNSOLICITED COMMENTS ON WARRANTY CARDS JUST RECEIVED:

They Tried it First:



"Ten day trial"

Dick's TV, Inc.
Albany, New York

"Have used it before. Great!!!"

Gary L. Keno
Moses Lake, Washington

"Ten day free trial"

Secrest Television
Paris, Texas

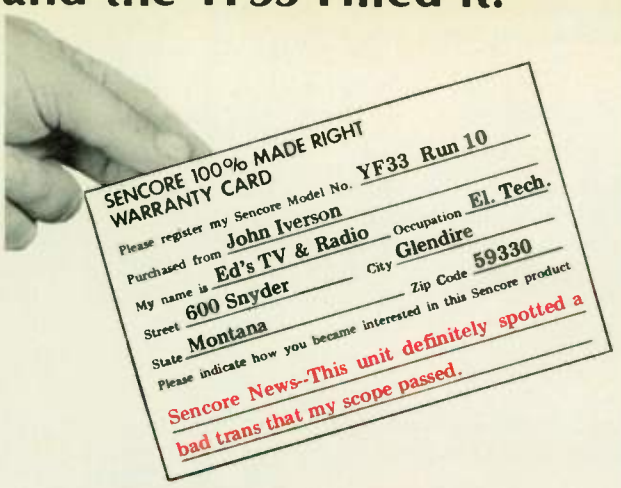
"Ten day trial offer"

Ashbrock Radio & TV
Reading, Ohio

"Ten day trial basis from Warren Radio"

Dennis Trayer
Battle Creek, Michigan

Had a Definite Need and the YF33 Filled it:



"needed flyback/yoke tester--saw this in store, used and liked it.

Stanley E. Corbett
Carter Lake, Iowa

"I'd been waiting for a good Yoke and Flyback Tester."

Reynaldo Rodriguez
Edinburg, Texas

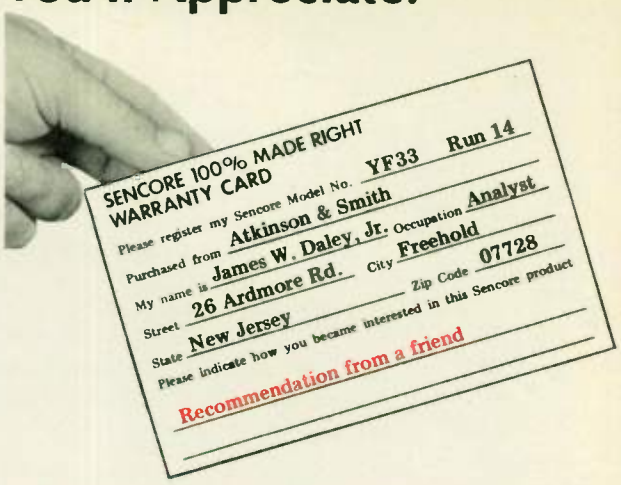
"I own a PS148A scope, but need the Ringer for the solid state advantages."

Morgan J. Thomas
Scranton, Pennsylvania

"Needed a Y & F Tester. This appeared to be the only one that could do the job RIGHT!"

Elmer D. Fink
Balto, Maryland

"Right Off the Shoulder" Comments That You'll Appreciate:



"Because Sencore instruments are made with reliable parts and come with service manuals."

Henry Hagihara
Honolulu, Hawaii

"No other company has an instrument like the YF33."

Ronald Kingham
Johnstown, Colorado

"Unique tester"

John T. Whipple John's TV Workshop
Silver Spring, Maryland

"It's a good product."

Vincent DiCenso
Derby, Connecticut

BE COMPETITIVE

45 CHANNEL CAPABILITY
Obsolete proof--Equipped for 40 Class D channels, plus five more for future expansion.

With Everything that you need for Fast CB Service in one Lower Priced, Compact Instrument.

AVOID TIME - WASTING MULTIPLE INSTRUMENTS AND CONFUSING CABLING SYSTEMS. GET AT THE PROBLEM IN A JIFFY WITH THE

CB42 AUTOMATIC CB ANALYZER

$895 $975 effective January 1, 1976

IT'S A CB PROFIT CENTER ALL IN ONE HANDSOME INSTRUMENT- YOU'LL NEED NOTHING ELSE

Let's face it. The CB service market is growing and more "on the ball" technicians are getting into the act every day. Competition for the CB business is getting tougher and you'll want to be sure you can compete. Knowledge alone won't be enough. You'll want to get ahead by simplifying your work to get the most jobs out with the least effort. You'll want to concentrate on your troubleshooting and not fiddle with 15 cables and 28 knobs on different instruments. So you'll want to get an instrument that takes you from antenna to speaker, and from mike to antenna load in one neat package. Only with the Sencore CB42 will you simplify every CB repair. Sencore has simplified CB servicing, just as we have been simplifying TV, radio, and stereo servicing for 25 years.

You might think you would have to pay a king's ransom for this one neat package, but the complete CB42 is actually hundreds of dollars below the nearest competition, and thousands below most. Only with the CB42 can you get the most simplified service bench for the least dollars in the business. We've got our competition beat, and you'll beat your competition, too, by saving these seven ways with the CB42 profit center.

SAVE ON REPAIR TIME:

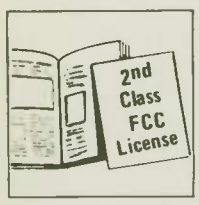
One simplified tester in a single case saves time on every test on any CB that comes in your door, including Single Sideband sets. Other testers waste your time with cables flying around your bench and knobs to twiddle for every test. Only the CB42 puts everything at your fingertips so you can concentrate on getting the repair done and not on setting up the equipment.

SAVE ON BENCH SPACE:

The CB42 takes less than one-third the bench space of other equipment. You can even take it to the field with you for on-the-spot mobile checks since it is also 12 Volt battery powered.

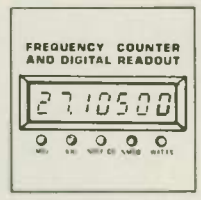
SAVE ON ANNOYING HOWL:

Why get a screwdriver in the back from the guy next to you, when you can substitute for that annoying speaker howl? Just plug the built-in speaker sub cable into the transceiver and monitor the audio output quietly on the meter.



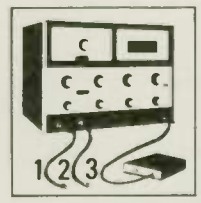
SAVE ON FCC HANDBOOK:

You'll want an FCC handbook for study and reference, even if you don't get an FCC license. Why pay extra when a specially-prepared book by Edward M. Noll, nationally-known technical writer, and published by Howard Sams & Co., is already packed with your CB42.



SAVE ON READOUT TIME:

One direct-reading digital readout saves interpretation time and reading errors. You'll know the CB's frequency, generator frequency, Percent Off-Channel, positive/negative modulation and distortion, RF output, and audio output with a simple flick of a switch. Only the CB42 is this simple.



SAVE ON TIME CONSUMING CONNECTIONS:

The handy CB42 cables save your time without having to connect cables into separate testers. Every cable you need is at hand on the CB42 front panel jacks for quick CB troubleshooting. Just three simple leads do the whole job to troubleshoot any transmitter or receiver stage--one cable for injecting into RF-IF stages and one cable for audio signals, and one cable that plugs directly into the CB jack for all transmitter tests.

SAVE ON CHANNEL CHECKING:

You and your customer want to know that every CB channel is within the FCC limit of .005% frequency deviation to avoid fines and assure maximum "talk power." You can throw away your chart of 80 frequency maximums and minimums (for 40 channel) with the CB42's exclusive Percent Off-Channel test (patent pending). Simply rotate the CB42 and CB selectors together through all 40 channels and read the percentage on the digital meter. It takes less than two minutes to prove it to yourself and your customer.

WE'RE SO SURE YOU'LL SAVE & BEAT YOUR COMPETITION, YOUR SENCORE DISTRIBUTOR WILL LET YOU TRY THE CB42 FOR 10 DAYS FREE OF CHARGE. IF YOU AREN'T ABSOLUTELY CONVINCED, BRING IT BACK. INCIDENTALLY, OUR COMPETITION DOESN'T DO THAT EITHER.

SENCORE NEWS

THE ALL NEW
YF33 RINGER
YOKE AND FLYBACK TESTER

BULK RATE
U S POSTAGE
PAID
SIOUX FALLS
SO DAK
PERMIT NO 731

ANNOUNCING

A YOKE AND FLYBACK TESTER THAT WORKS 100 TIMES OUT OF 100

THE YF33 RINGER

W Walker
509 Couse Rd
Neptune NJ 07753

SAVES HOURS OF FRUSTRATING GUESSWORK & NEEDLESS REPLACEMENT

1/21

introduction

Have you ever spent half a day diagnosing a sweep problem, hoping upon hope that the problem is somewhere other than in the yoke or flyback, only to end up replacing one or the other, and then find out it wasn't your problem?

If this has happened, then this News is for you.

We are introducing the all new YF33 Ringer, Yoke and Flyback Tester and Sweep Circuit Analyzer. Now for the first time you can actually test the yoke and flyback, in or out of circuit, in seconds, and with 100% reliability.

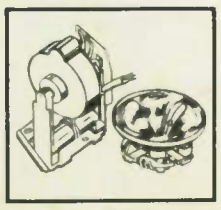
The "film" section of this News, starting on page 4, should be very interesting to any TV technician, as it covers the entire horizontal sweep circuit operation, and offers trouble-shooting techniques for this complex circuit.

You'll also find a list of Sencore Tech-A-Ramas, in the centerfold section, that are being held across the country for the next three months. Look for the next Tech-A-Rama in your area and plan on attending.

BOB BOWDEN
MARKETING DIRECTOR

6 REASONS WHY YOU NEED AN ACCURATE YOKE AND FLYBACK TESTER LIKE NEVER BEFORE:

1 ALMOST HALF OF ALL TV CIRCUIT PROBLEMS ARE IN THE HIGH VOLTAGE OR HORIZONTAL SECTION



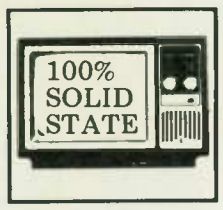
A recent NESDA survey showed that 45% of all TV circuit problems you encounter each day are in the high voltage and horizontal output sections, which means a fast, accurate yoke and flyback tester/sweep circuit analyzer would be in constant use, saving you hours every working day.

2 NEW SET WARRANTIES ARE REDUCING

Millions of these TV receivers are now becoming the responsibility of the independent service tech.

You can make big profits in this rapidly increasing, "Out of Warranty" market, if you can service yoke and flybacks fast and accurately. A 100% reliable yoke and flyback tester is your answer.

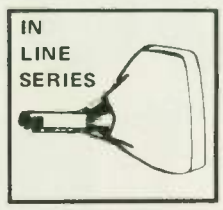
3 OVER HALF OF THE TV'S SOLD LAST YEAR WERE 100% SOLID STATE



While there are still millions of all tube and hybrid sets on the market, more and more solid state sets are coming in for service every day.

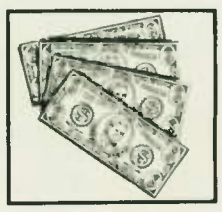
The YF33 is the only horizontal output tester that will test the yoke and flyback in all of these receivers, including solid state. It's "Fool-proof."

4 MANY NEW YOKES CAN'T BE SUBSTITUTED- THEY MUST BE TESTED



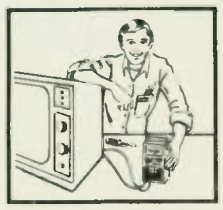
No more substituting the deflection yokes on the solid state in-line receivers — they are bonded on to the CRT. You must have a tester like the YF33 Ringer to avoid changing the entire CRT. The Ringer will pay for itself the first time you avoid this costly replacement error.

5 IT'S A GENUINE MONEY MAKER



Nothing can make more money for you in less time than a "Fool-proof" horizontal (and vertical) yoke and flyback checker, and this is what it's all about — profit! You can make a fast buck on these costly components if you can check them in minutes. Likewise, you can lose your shirt if you let these turn into costly "dogs," not to mention poor customer relations that can really cost you in the long run. $45.00 plus labor for some flybacks and $60.00 plus labor for some yokes, means the YF33 Ringer can pay for itself the first week.

6 SAVES TIME, INCREASES EFFICIENCIES & ELIMINATES THAT FRUSTRATING GUESSWORK



Now you can eliminate this yoke and flyback guesswork once and for all. The Ringer will tell you in seconds whether the yoke or flyback is your problem. The time saved alone will pay for the Ringer plus make your job that much easier.

10 REASONS WHY THE RINGER BELONGS ON YOUR BENCH TODAY:

1 100% RELIABLE

"Good-Bad" ringing test will check any yoke or flyback in seconds, in tube or solid state type sets, plus most other air core coils, with 100% accuracy.

2 SIMPLIFIED TEST

Takes only seconds to perform. Simply select the ringing test and push the six impedance matching buttons. If one button or more gives you a "Good" reading, you can be 100% sure you have a good component. If the yoke or flyback checks bad in circuit, disconnect it and test it out of circuit before ordering a replacement. It's that simple.

3 IN OR OUT OF CIRCUIT TESTING...

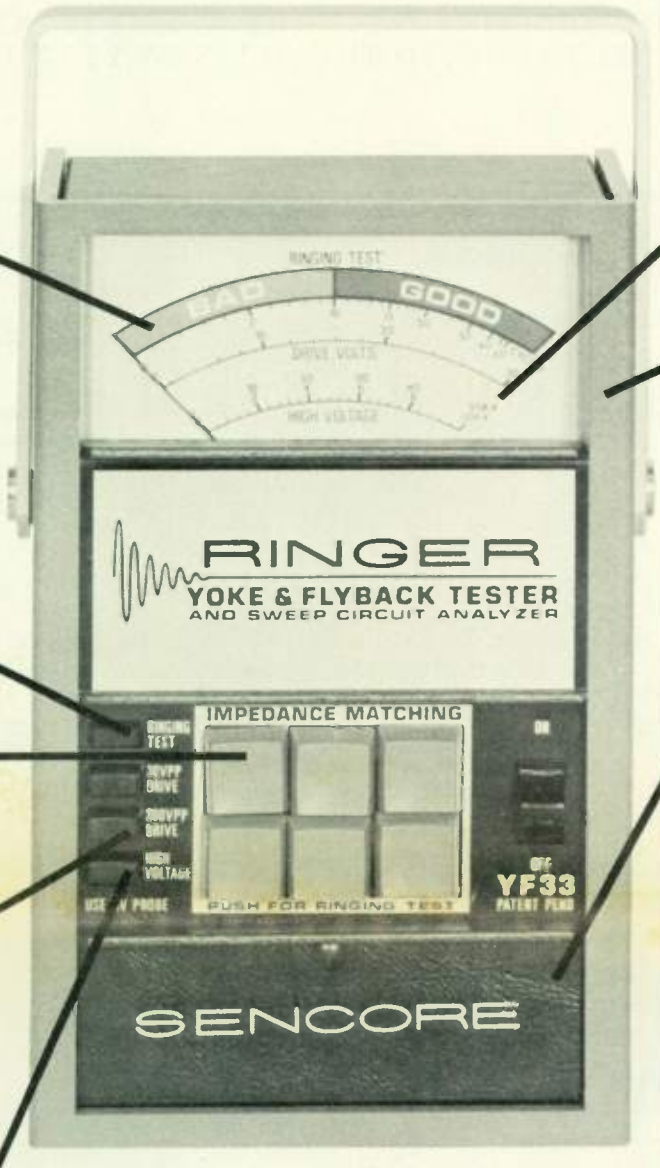
With 100% reliability using the six impedance matching buttons. All coils are designed to operate under a given impedance. The six impedance matching buttons match the Ringer test circuit impedance, for each coil under test. The button with the highest reading is the correct impedance match. This guarantees 100% reliability in or out of circuit.

4 IT'S A COMPLETE HORIZONTAL SWEEP CIRCUIT ANALYZER

Drive signals are crucial to proper horizontal sweep operation, so the Ringer has a 30V AC p-p range for measuring drive signals in solid state sets, and 300V AC p-p scale for tube-type sets, with a 3MHz frequency response so you can measure any signal, audio or video, past the detector.

5 COMPLETE HIGH VOLTAGE

Measure focus and boost voltage using 10Kv DC probe, with 50Kv DC capabilities using extender probe for 2nd anode measurements, making the Ringer a complete sweep circuit analyzer.



$195

6 EASY TO READ

"Drive Volts" and "High Voltage" scales, plus a calibrated Ringing scale for determining exact number of cycles a coil rings — allows you to compare matched left and right coils in a yoke.

7 TOUGH ACRYLIC CASE

makes the Ringer a true field instrument so you can check yokes and flybacks right in the home.

8 CONVENIENT LEAD STORAGE

lets you pack up your leads and be on to your next job fast.

9 SPECIAL RINGER TRAINING TAPE

If you get a new piece of test equipment, you want to get in operation as soon as you can. Right? Sencore makes this easy with a specially prepared 15 minute training tape supplied with every YF33 Ringer. You simply play the tape, follow along on the special instructions, and start increasing your efficiency and profits 15 minutes later.

APPROVED BY LEADING MANUFACTURERS

with 100% reliability. Now you can put the tried and proven Ringer to work for you.

10 DAY TRIAL OFFER

Try the Ringer on a no obligation, 10 day trial. If it doesn't do everything we say it will, return it within ten days to your local Sencore Distributor. No refurbishing charges, even if you damage the unit.

10 THE RINGER IS MADE RIGHT

BACKED BY SENCORE'S 100% MADE RIGHT LIFETIME GUARANTEE

The YF33 Ringer, as well as the entire Sencore Line, is covered by Sencore's 100% Made Right Lifetime guarantee, which warranties your unit against any factory workmanship errors for the life of the instrument. This iron-clad backing is available only on Sencore test equipment, the equipment line that is MADE RIGHT.

SPECIFICATIONS

DEVICES TESTED: Horizontal and vertical yokes, flyback transformers, horizontal linearity coils, horizontal efficiency coils and numerous general application mid-frequency coils.

RINGING TESTS: Test: Dynamic ringing test counting number of cycles coil rings before reaching a preset damping point after a given exciting pulse has been applied.
Exciting pulse amplitude: 0 to + 15V p-p
Exciting pulse repetition rate: 100 - 120 pulses/sec. Synced to AC line frequency.
"GOOD-BAD": Meter calibrated to give "GOOD" reading for 10 or more cycles.
Accuracy: ± 1 cycle at midscale.

SENSITIVITY CONTROL: Variable: Selects signal level at which counting circuit stops counting cycles.
Range: Typically 50% to 10% of exciting pulse amplitude.
Calibration: Normal cutoff = 25% of exciting pulse amplitude at mid-rotation of the control.

P–P DRIVE SCALE: Range: 0 - 30VAC P-P
0 - 300VAC P-P

FREQUENCY RESPONSE: 3db at 3MHz

HIGH VOLTAGE SCALE: Range: 0 - 10KV DC (with optional FP201 probe). 0 - 50KV DC (with optional 39G89 probe.)
Accuracy: ± 3% full scale.

POWER REQUIREMENTS: 105 - 130VAC, 50-60Hz, 10 watts.

MECHANICAL: Meter: 4½", moving coil movement, 100uA, 1900 ohm (illuminated). Accuracy: ± 2%. Meter Light: 1 - No. 47 pilot lamp in meter serves as "ON" indicator. Case: Molded acrylic and vinyl covered steel. Brushed aluminum handle also serves as tilt bail for bench use. Size: 10" (25.4cm) x5½" (13.8cm) x 3½" (8.9cm). Weight: 4¾ lbs. (2.2Kg.)

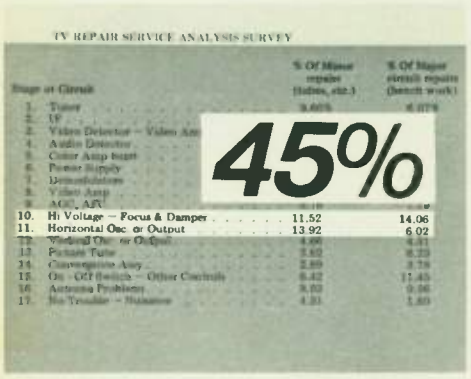
ACCESSORIES: Hook-up Leads: Two leads with alligator clips (attached to YF33.) Accessory High Voltage Probe set: FP201: 10KV Focus Voltage Probe. 39G89: 50KV High Voltage Probe slips onto FP201 for extended range . . $35.00

RINGER

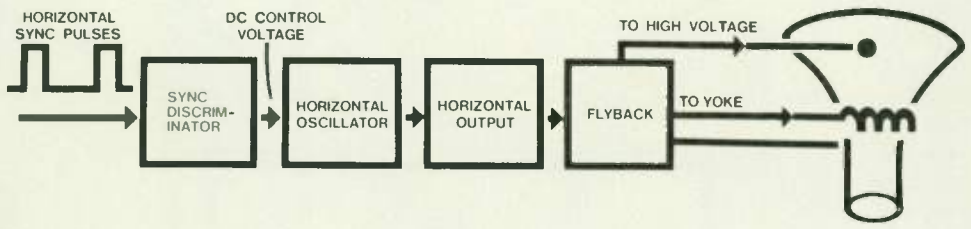
YOKE & FLYBACK TESTER

This is Charlie. He's a TV technician, with a real problem . . . The horizontal sweep section of this TV set. Ever been in a similar situation? We know you have, because the horizontal sweep section, including the yoke and flyback, is one of the most difficult circuits to trouble-shoot.

BUT NOW SENCORE HAS TAKEN THE "TOUGH DOG" OUT OF THIS HORIZONTAL SWEEP SECTION WITH THE ALL NEW YF33 RINGER / YOKE AND FLYBACK TESTER

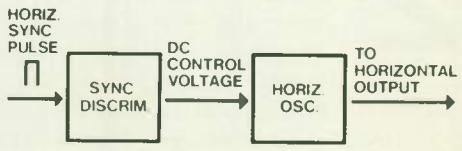


A recent survey by the National Electronic Service Dealers Association showed that 45% of the circuit problems you encounter each day are in the high voltage and horizontal output sections. That's almost half of the sets you service.

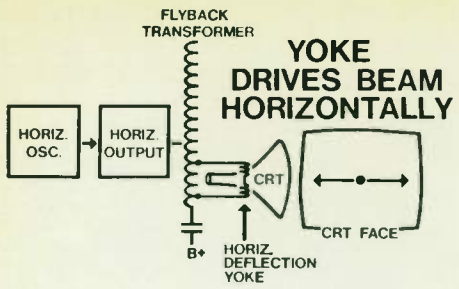


Let's take some time and look at this "high trouble rate" circuit. Here are the four basic stages of the horizontal sweep circuit.

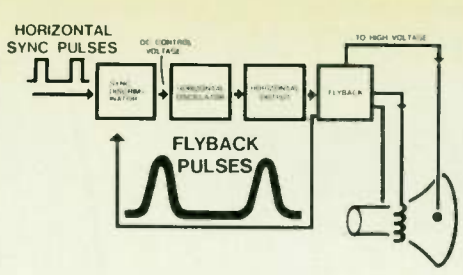
It's main purpose is to sweep the electron beam across the CRT, at one constant sweep rate, in synchronization with the horizontal sync pulse. Let's look at these stages one at a time.



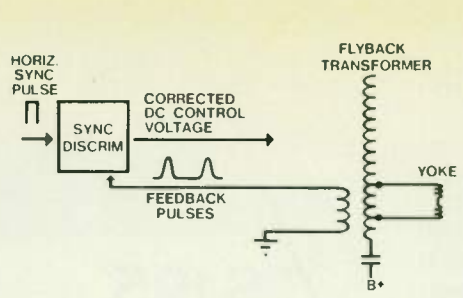
First, the horizontal oscillator is controlled by the sync discriminator. The sync discriminator locks the oscillator to the horizontal sync pulse from the station, using a DC control voltage.



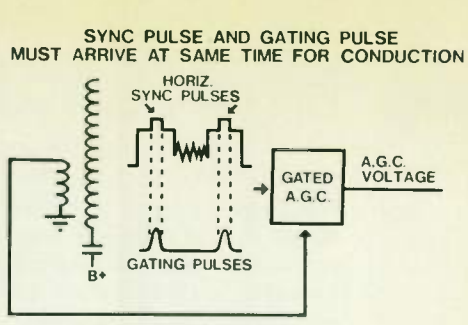
Then the horizontal oscillator feeds the horizontal output, which in turn drives the flyback transformer. The flyback generates the proper signal to drive the horizontal deflection yoke. The deflection yoke generates a magnetic field that moves the CRT beam horizontally on the CRT face.



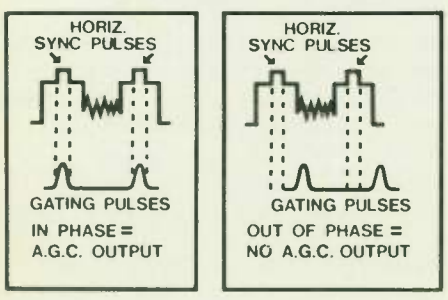
Now that in itself would not be difficult to troubleshoot, but there are feedback circuits to contend with, too. Here we've shown a flyback pulse that feeds the sync discriminator circuit. This circuit compares the timing of the flyback pulse to the incoming sync pulse.



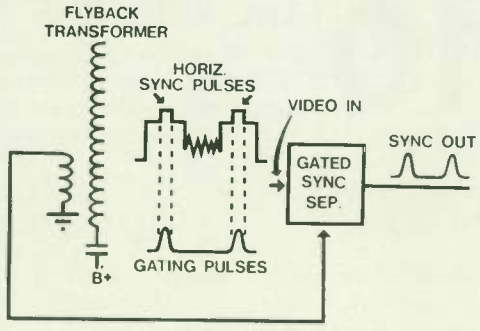
If there is a phase shift between the flyback pulse and horizontal sync pulse, the sync discriminator develops a correction voltage to put the horizontal oscillator back on frequency.



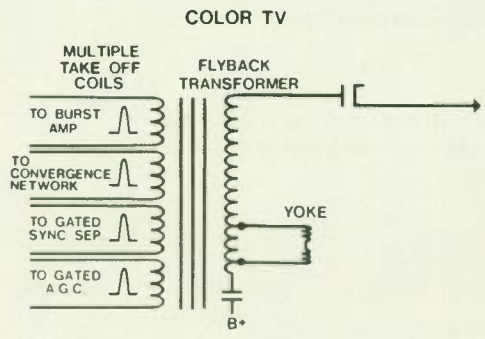
Another example of a feedback pulse is the gating pulse that feeds the gated AGC circuits. This pulse opens up the AGC circuit so it develops the AGC voltage only during the retrace time. This eliminates interference and ignition noise problems.



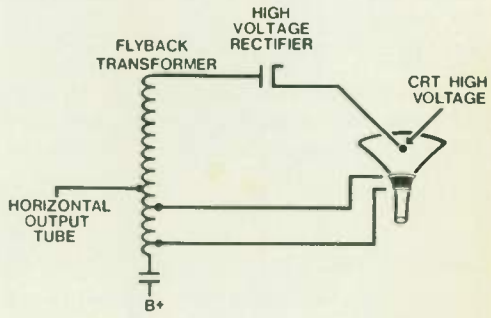
Here we see that if the flyback pulse does not arrive at the AGC gate at precisely the same time as the horizontal sync pulse, we will get no AGC output. OK — Another example is the gated Sync Separator.



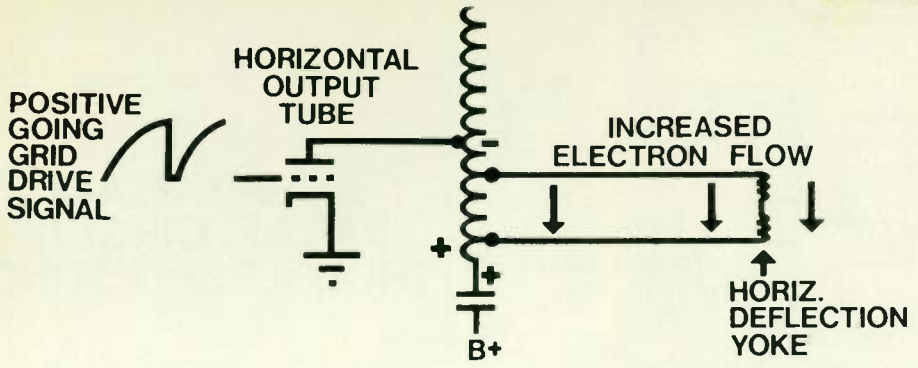
The flyback pulse is fed to the plate or collector of the stage, while the composite video is presented on the control element. Again, the timing and amplitude of the flyback pulses are important for the circuit to function.



So you see, all of these take-off coils from the flyback simply spread these pulses around to all the gated circuits to give us a more stable picture. The flyback does one more important thing, too.

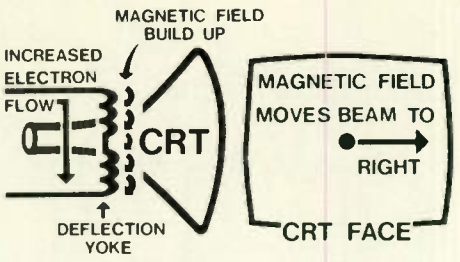


It develops the high accelerating voltage for our CRT beam. We simply rectify the stepped up flyback voltage through the high voltage rectifier and apply it to the CRT through the 2nd anode button. OK — Let's see how all these work together by following one horizontal sweep cycle.

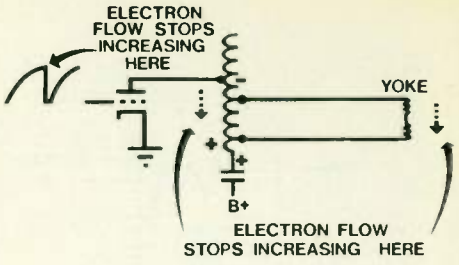


Since we have no deflection voltage yet, the CRT beam starts in the center of the screen. Now, let us increase the positive going grid drive signal.

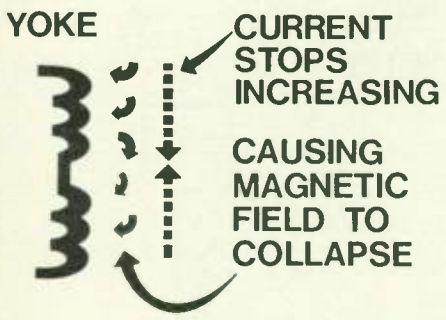
The electron flow through the horizontal output tube increases, which also increases the electron flow through the yoke.



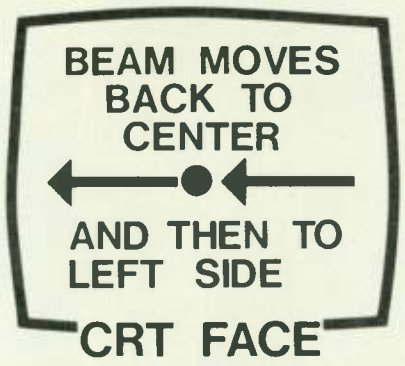
This increasing current through the yoke creates a magnetic field on the CRT neck. This magnetic field deflects the beam toward the right side of the screen. As the drive increases, the electron flow increases, and we get even greater deflection to the right.



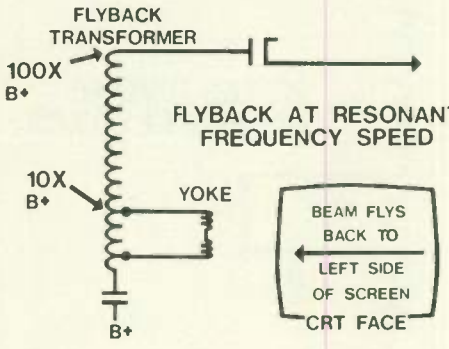
When the drive signal on the horizontal output tube reaches maximum, the flyback current stops increasing, as we see here. This means our yoke current also stops increasing. There is nothing to sustain the magnetic field at this point, so it collapses.



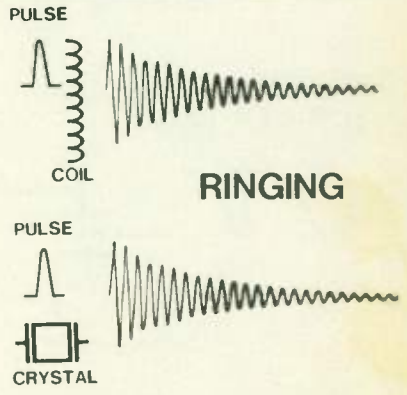
As it collapses, the potential of the field across the yoke reverses, which moves the beam back to the center of the screen. But will the magnetic field stop at zero, stopping the beam in the middle of the CRT?



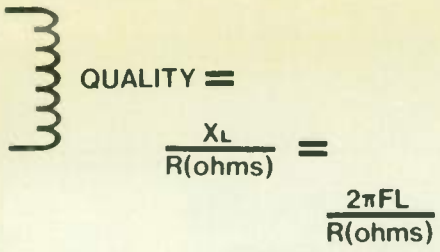
You know it won't as anything in physics will continue to oscillate or "ring" at its natural resonant frequency for a period of time. Therefore, the field goes through the other half cycle to drive the beam all the way to the left side of the tube.



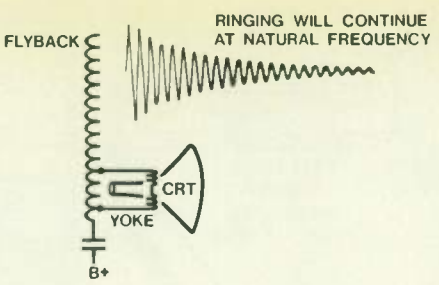
The beam literally "flys back" to the left side of the screen at the resonant frequency, which is at least 10 times as fast as the 15,750 Hertz drive frequency. Notice, we said "Ringing."



This is what "Ringing" looks like. If you hit a coil or transformer with a large pulse, and then let it continue to oscillate, it will continue to produce sine waves — just like a crystal. And the amount of ringing cycles before decay, is directly proportionate to the quality of the coil.



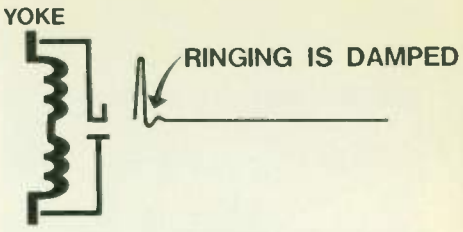
For a coil, this quality, or "Q" is measured by the ratio of the "magnetic resistance" (called inductive reactance) to the electrical resistance. This is 2 pi FL divided by R for resistance. Now let's see what this has to do with the electron beam.



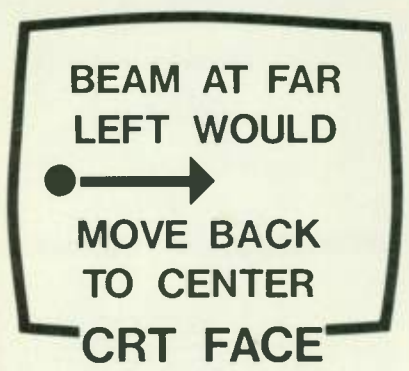
So far, we have the beam on the left side of the screen. However, since coils will ring, we need to stop the ringing effect that has started, or the yoke and flyback will continue to osillate.

BEAM WILL SWEEP AT FASTER RETRACE RATE

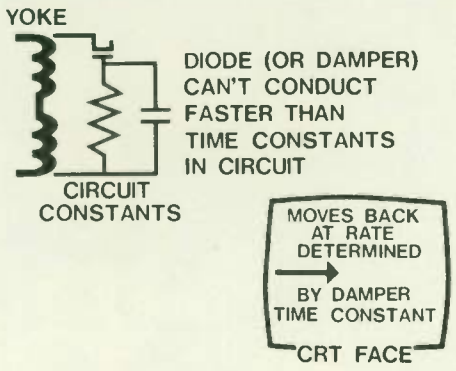
That poor electron beam will bounce back and forth across the CRT screen at this high retrace rate, until the ringing dampens out. How do we stop the beam on the left side then return it to the center of the CRT at the horizontal sweep rate? Simple.



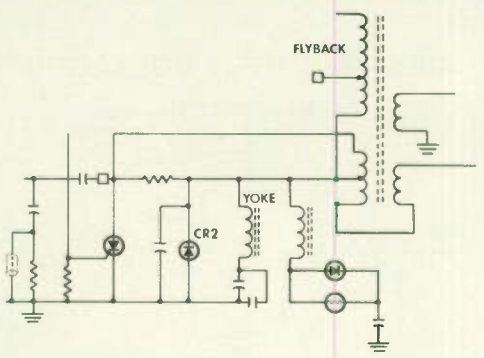
We short out the energy built up across the coil which kills the ringing effect. We can do this by connecting a diode, called the damper, across the coil. We use a diode so it will conduct or short the energy only after the first half cycle of the flyback pulse.



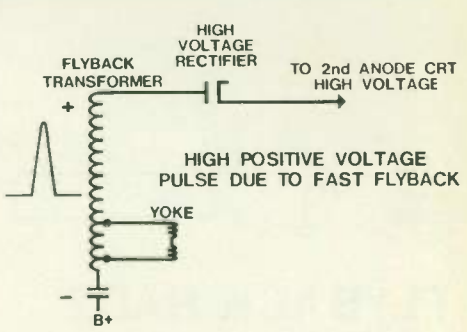
With the coil shorted, the energy dissipates, moving the trace back to the center of the CRT. But, how do we return the beam to the center of the CRT at the proper rate?



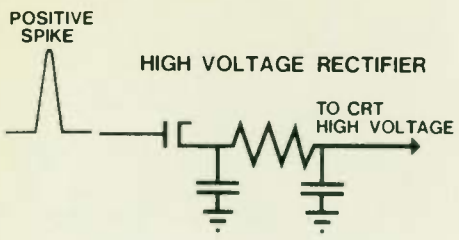
The rate that the beam returns to the center of the CRT is determined by the time constants in the damper circuit. We set the time constants so that the trace moves back to the center of the CRT at exactly the same rate as the horizontal output tube drove it to the right side before. And we're back in the center.



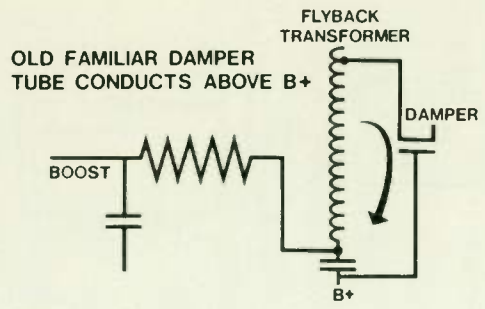
The latest solid state receivers use SCR's, triacs, and switching diodes to perform the trace and retrace sweep. Since the horizontal output and damper operation is essentially that of switching at the proper times, the principles we have explained here are still the same. Now let's see how the flyback pulse is generated.



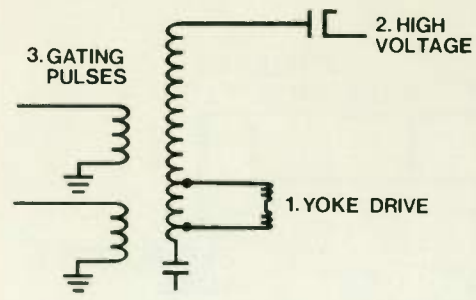
We said that the magnetic field in the yoke collapses at the faster retrace rate. This collapsing field develops an opposite polarity across the horizontal output transformer. As it does, the AC voltage on the top of the coil swings very positive.



The amount of voltage built up across a coil is dependent upon the speed of the change of the magnetic field, which is very fast in this case. This generates our flyback positive spike. We step it up, rectify it, and filter it, for our CRT high voltage.



We get additional DC voltage by connecting the damper return to B plus, rather than ground. In a tube type set, this boosts our voltage to power the horizontal output tube, as well as other stages that need more than B plus and is known as the boost voltage.

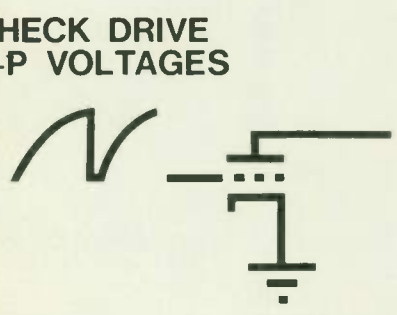


OK — Now we understand the three basic functions of the horizontal sweep section —

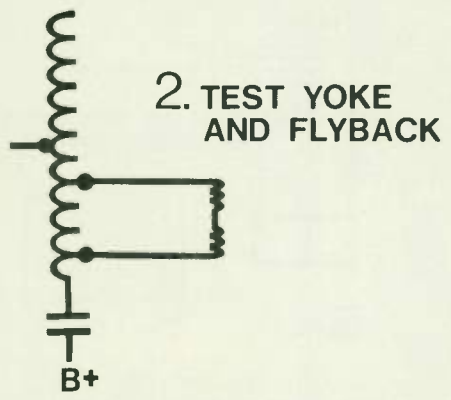
1. Provide yoke drive for beam trace and retrace.
2. Generate high DC voltage
3. Send pulses to gating circuits for better picture stability.

HORIZONTAL SWEEP CIRCUIT TROUBLESHOOTING

That pretty much sums up the overall operation of the horizontal section. Now let's see what we can do to simplify the troubleshooting of this section. It becomes apparent that one must approach horizontal troubleshooting in two steps.

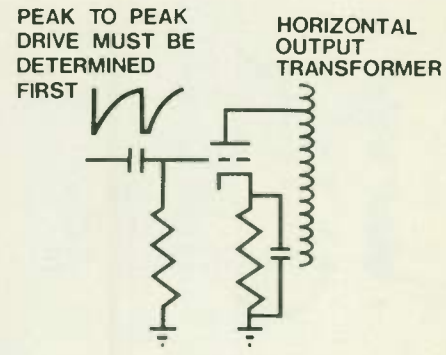


First, you need to determine that those drive pulses are present. Otherwise, it would be easy to start disconnecting yokes and flybacks only to find that the drive voltage was inadequate.

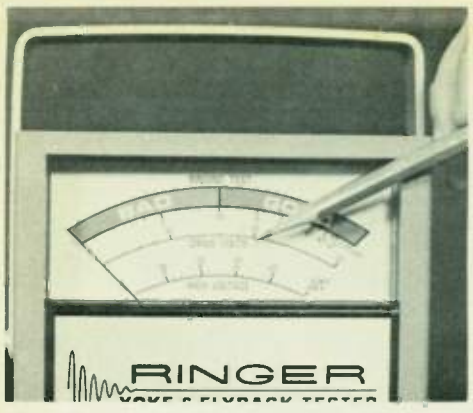


Secondly, you need to test the components themselves, including the yoke and flyback. Up until now this has been pretty difficult, but not anymore.

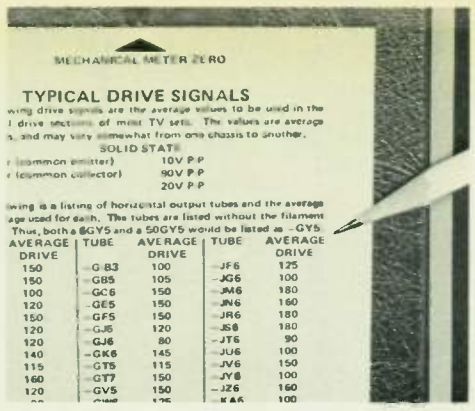
Meet the Ringer. The Ringer will put an end to your horizontal sweep problems, once and for all. It is the only in or out of circuit, yoke and flyback tester for all tube and solid state sets . . . plus it is a complete sweep circuit analyzer. Let's see how it works.



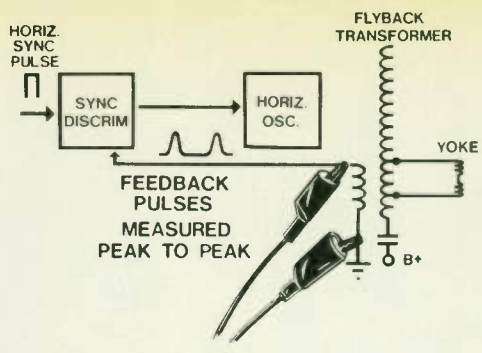
We want to measure the drive pulses first. With any horizontal sweep circuit problem, it is best to start at the grid or base of the horizontal output and measure the peak to peak drive signal at this point to see that it's adequate. If it is not, your output will be low.



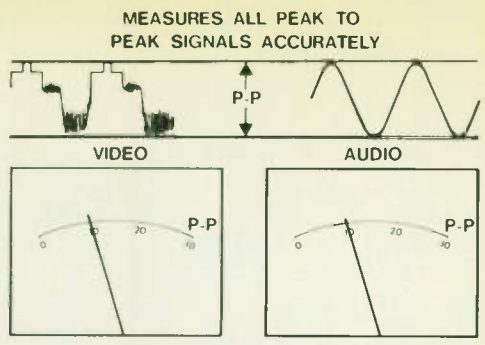
The Ringer is a peak to peak AC voltage meter for measuring these critical drive signals. We use the Ringer's 30 volt peak to peak scales for measuring the drive signals in solid state sets, and the 300 volt peak to peak scale for tube type sets.



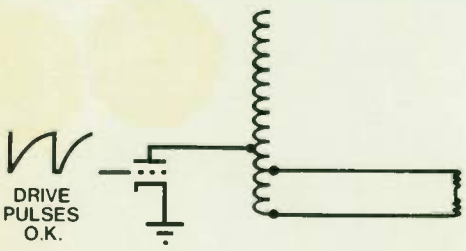
The Ringer even supplies you with a chart on the back side, that lists the typical drive values so you can make fast comparisons when in the field.



Next, be sure that the feedback pulses going to the sync discriminator and other gated circuits are of the correct amplitude. Again, a quick check with the Ringer will tell us where we stand.



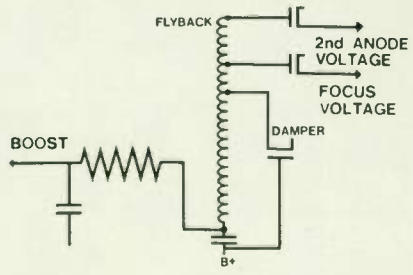
In fact, the frequency response of the Ringer is so good, that it can be used to measure any peak to peak signal after the detector, including video and audio signals. This will cover all of your drive signals.



FLYBACK BAD? OR YOKE BAD?

Once we know our input voltages are correct, we can suspect the yoke and flyback as our problem. But before we do, we should measure the high voltages. Here's why.

MEASURE HIGH VOLTAGES



Remember the boost voltage that operated above B plus? This can be off value due to a component failure, as well as a flyback failure. Same thing with the focus and 2nd anode high voltages that are generated off the flyback winding.

The Ringer will measure these values using the 10Kv probe for boost and focus voltage checks. Then slip the 50Kv adaptor on and you can measure the second anode voltage on any set you'll encounter. If any of these high voltages are off value, the yoke or flyback is probably your culprit.

And this is where the Ringer pays for itself. Now, for the first time, we can test the yoke or flyback, in or out of circuit, in seconds, with the patent pending "Good-Bad," Ringing test. Sencore designed the Ringer because, until now, nothing has been available to test yokes and flybacks with 100% accuracy.

SENCORE

THE ALL-AMERICAN MADE LINE OF INNOVATIVE TEST EQUIPMENT—BACKED BY SENCORE'S 100% MADE RIGHT LIFETIME GUARANTEE. SEE YOUR LOCAL SENCORE FULL LINE PROMOTIONAL DISTRIBUTOR TODAY.

DIGITAL MULTIMETERS

PATENT PENDING DVM32

DVM32 PORTABLE DIGITAL MULTIMETER

THE DVM32 IS THE ONLY TRULY PORTABLE DVM FOR ALL YOUR MEASURING NEEDS WITH COMPLETE FUNCTIONS, RANGES AND TRUE DIGITAL ACCURACY.

TRUE PORTABILITY using standard "C" cells, rechargeable Nicad "C" cells, or optional line cord adaptor for bench use.
BRIGHT L.E.D. DISPLAYS for easy reading, 3½ digit readout.
EXCLUSIVE "AUTO-OFF" position, automatically turns display off between measurements, for long battery life.
DROP PROOF with specially designed Cycolac® case.
BURN-UP PROOF with 2000V DC volts protection, 1000V protection on all other functions and ranges, including ohms.
DVM ACCURACY of .5% DC volts, backed by high 15 megohm input impedance for minimum circuit loading, plus Hi and Lo power ohms.

DVM32 SPECIFICATIONS

DC Volts: 4 RANGES: 0 to ± 1.999, ± 19.99, ± 199.9, ± 1999 volts. ACCURACY: .5%. AC REJECTION: 40db at 50-60Hz. INPUT IMPEDANCE: 15 megohms. RESPONSE TIME: Max. 1 sec. INPUT PROTECTION: 2000V (DC + peak) on all ranges.
AC Volts: 4 RANGES: 0 to 1.999, 19.99, 199.9, 1000 volts RMS. ACCURACY: 1.5% at 60Hz from ¼ scale to full scale. FREQUENCY RESPONSE: ± 1db from 40Hz to 3KHz. INPUT IMPEDANCE: 1.8 megohm shunted by 18pf. RESPONSE TIME: Max. 2 sec. INPUT PROTECTION: 1000V (AC RMS + DC) on all ranges.
Ohms: Low Power: 5 RANGES: 0 to 199.9 ohms, 1.999K, 19.99K, 199.9K, 1.999 megohms. ACCURACY: 1%. MAX. TEST VOLTAGE: 80mV. RESPONSE TIME: Max. 1 sec. INPUT PROTECTION: 1000V (DC + peak) on all ranges. Fuse protected.
Ohms: High Power: 5 RANGES: 0 to 1.999K, 19.99K, 199.9K, 1.999 megohm, 19.99 megohm. ACCURACY: 1% on all ranges except 5% on 19.99 megohms. MAX. TEST VOLTAGE: 800mV. RESPONSE TIME: Max. 1 sec. INPUT PROTECTION: 1000V (DC + peak) on all ranges. Fuse protected.
DC Current: 4 RANGES: 0 to ± 1.999, ± 19.99, ± 199.9, ± 1999 milliamps. ACCURACY: 1%. Internal voltage drop: 80mV full scale. INPUT PROTECTION: 2 Amp diode protection in series with 2 Amp fuse.
AC Current: 4 RANGES: 0 to 1.999, 19.99, 199.9, 1999 milliamps. ACCURACY: Same as AC volts. RESPONSE TIME: Max. 2 seconds. INTERNAL VOLTAGE DROP: 80mV RMS full scale. INPUT PROTECTION: 2 Amp diode protection with 2 Amp fuse.
READOUT: .3 inch L.E.D., seven segment. POWER REQUIREMENTS: Battery operation: Four standard "C" cells. Line Operation: Using optional 115/230VAC portable line cord power adaptor (Sencore part no. 39G90). Rechargeable Battery Operation: 39G90 recharger/adaptor and four rechargeable "C" cells.
Accessories: (39G90) 115/230VAC built-in line cord power adaptor/recharger (not supplied) . . . $9.95. Batteries (not supplied). (HP200) 50Kv Probe. . . . . $25.00.

DVM32 PORTABLE DIGITAL MULTIMETER. . $198.00

NEW!

DVM38

DVM38 THE COMPLETE DVM

HIGH .1% ACCURACY for standard measurements. Big, 3½ digit readout, you can rely on.
15 MEGOHM INPUT impedance that insures up to 1/3 less circuit loading than competitive 10 megohm DVM's, for 50% greater accuracy.
UNBELIEVABLE RANGE AND RESOLUTION for the most complete measuring capabilities available in this price range.
SPEED AND SUPERIOR EASE OF OPERATION with single step Auto-Ranging. Direct readout, Auto-Polarity, Auto-Zero, and human engineered panel and controls for faster, more accurate standard measurement.

DVM38 SPECIFICATIONS

NOTE: Accuracies expressed as percentage of reading ± resolution for the given range.
DC Voltage: 5 RANGES: 0 to ± 200mV, 2, 20, 200, 2000 volts. Each range except 200mV automatically increases sensitivity ten times for Lower Scale when reading is less than 1/10th of Full Scale. ACCURACY: 200mV scale ± .1% ± 3 digits. All ranges Full Scale ± .1% ± 1 digit. Auto-Range Lower Scale ± .1% ± 3 digits.
Input Impedance: 15 megohms with less than 10pf (in series with 200K ohm when probe isolation is used). POLARITY: Automatic. RESPONSE TIME: 1 sec. (max.) MAX. INPUT PROTECTION: 2000V (DC + peak). AC REJECTION: –60db at 50-60Hz on 2, 20, 200 ranges.
AC Voltage: 5 RANGES: 0 to 200mV, 2, 20, 200, 1000 volts. Each range except 200mV increases sensitivity ten times for Lower Scale when reading is less than 1/10th of Full Scale. ACCURACY: 200mV scale ± .5% ± 3 digits. All ranges – Full Scale ± .5% ± 2 digits. Auto Range Lower Scale ± .5% ± 3 digits.
Input Impedance: 1.5 megohms shunted by less than 40pf. AC CONVERTER: RMS reading, average detecting. RESPONSE TIME: 2 sec (max.) MAX. INPUT PROTECTION: 1000VAC (Peak + DC). FREQUENCY RESPONSE: 40Hz to 5KHz, +-5db.
DC Current: 5 RANGES: 0 to 200uA, 2, 20, 200, 2000mA. ACCURACY: ± .3% ± 2 digits. POLARITY: Automatic. RESPONSE TIME: 1 sec (max.) MAX. INPUT PROTECTION: 2A (fuse protected.)
AC Current: 5 RANGES: 0 to 200uA, 2, 20, 200, 2000mA. ACCURACY: ± 1% ± 2 digits. AC CONVERTER: RMS reading, average detecting. RESPONSE TIME: 2 sec (max.) MAX. INPUT PROTECTION: 2A RMS (fuse protected.)
Resistance: (Low Power): 6 RANGES: 0 to 20, 200, 2000, 20K, 200K, 2000K ohm. ACCURACY: 20, 200 ranges: ± .2% ± 3 digits plus lead resistance. All other ranges: ± .2% ± 3 digits. MAX. VOLTAGE AT LEADS: 200mV at Full Scale. RESPONSE TIME: 1 sec (max.) 20 - 200K ranges. 2 sec (max.) 2000K range. MAX. INPUT PROTECTION: 1000V (DC + peak). Fuse protected.
Resistance (High Power): 5 RANGES: 0 to 2K, 20K, 200K, 2000K ohm, 20 megohm. ACCURACY: All ranges (except 20M): ± .2% ± 2 digits. 20M range: ± .75% ± 2 digits. MAX. VOLTAGE AT LEADS: 2V at Full Scale. RESPONSE TIME: 1 sec (max.) 2K - 2000K ranges. 3 sec (max.) 20M range. MAX. INPUT PROTECTION: 1000V (DC + peak). Fuse protected.
General: DISPLAY: 3½ digit, 7 segment red L.E.D., 0.4" segment. INDICATORS: V, mV (volts, millivolts). Automatic polarity, decimal, zero, overrange (as blinking 1999 display.) SAMPLE RATE: 3.3 measurements per sec. ELECTRICAL: All solid state circuitry; including CMOS LSI. MECHANICAL: Vinyl covered steel case construction. Brushed aluminum handle also serves as tilt bail for bench use. SIZE: 5½"x8"x9". WEIGHT: 6½ lbs. POWER: 105 - 130VAC, 50-60Hz, 7 watts (220VAC conversion available.) SUPPLIED ACCESSORIES: 39G91 Input Probe (with 200K Isolation Position) and test lead. OPTIONAL ACCESSORIES: HP200 50Kv High Voltage Probe . . . . . $25.00.

DVM38 3½ DIGIT DVM $295.00
(Effective January 1, 1976 . . . . . $348.00)

TUBE TESTERS

TC162

TC162 MIGHTY MITE

THE STANDARD IN TUBE TESTERS, with over 70,000 Mighty Mites in use.
FULL LOAD CATHODE CURRENT check finds the weak tubes other testers might miss.
100 MEGOHM GRID LEAKAGE SENSITIVITY finds the "tough dog" tubes fast that can otherwise cause hours of wasted time.
STETHOSCOPIC SHORTS TEST with 300K sensitivity tests each element against all others to locate any shorts in the tube.
FET BALANCED BRIDGE CIRCUITRY for instant-on action, greater accuracy and dependability.
RUGGED STEEL AND ALUMINUM CASE for maximum protection and years of service.

TC162 SPECIFICATIONS

Cathode Emission Test: Full load current drawn through tube up to 120mA. Max. applied voltage, 40VAC RMS. Life test reduces fil. voltage by 15%.
Grid Leakage Test: GOOD AREA: Infinity to 200 megohms; ? AREA: 200 to 100 megohms; BAD AREA: 100 megohms or less.
Shorts Test: 300K ohms or less will cause shorts light to indicate. Max. applied voltage, 40VAC RMS.
General: POWER: 105 - 125VAC, 50-60Hz, 32 watts max. (220V conversion available.) SIZE: 10"x9"x4". WEIGHT: 9 lbs.

TC162 MIGHTY MITE VII. $150.00
(Effective January 1, 1976 . . . . . $175.00)

MU150

MU150 CONTINENTAL II

TRUE MUTUAL CONDUCTANCE TEST using a 5000 Hertz square wave for true tube test.
TWO TESTERS IN ONE. The MU150 can be used to make the Mighty Mite tests as well as mutual conductance.
FULL RATED CATHODE EMISSION TEST.
100 MEGOHM GRID LEAKAGE TEST.
SENSITIVE STETHOSCOPIC SHORTS TEST.

MU150 SPECIFICATIONS

Types of Devices Tested: Receiving and industrial tubes, including Miniature, Octal, Loctal, Nuvistor, Compactron, Magnoval, and Novar types.
Tests: SHORTS: Inter-element leakage test lights neon lamp at 300K ohms or less. Max. applied voltage: 40VAC RMS. GRID LEAKAGE: 100 megohm (.5uA) sensitivity for grid contamination or gassy condition. CATHODE EMISSION: Full rated cathode emission for tube under test. Max. current: 120mA. Max. applied voltage: 40VAC RMS. MUTUAL CONDUCTANCE: True mutual conductance (Gm) amplifier measurement using 5KHz square wave input, with Automatic Bias Control. LIFE TEST: Reduced filament voltage detects filament sensitive tubes.
General: MECHANICAL: Professional vinyl-covered steel attache case with chrome panel trim. POWER REQUIREMENTS: 105 - 130VAC, (220V AC conversion available), 50-60Hz, 50 watts max. SIZE: 18"x14"x4¾". WEIGHT: 18 lbs.

MU150 CONTINENTAL II Gm TUBE TESTER . . $350.00
(Effective January 1, 1976 . . . . . $395.00)

TC28

TC28 "THE HYBRIDER"

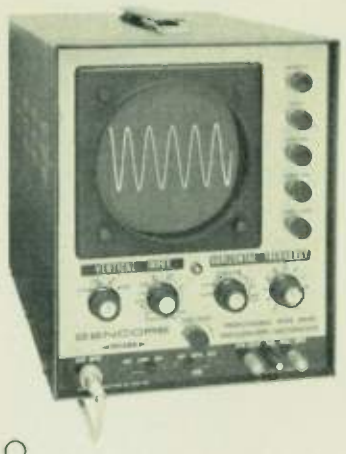
IT'S AN IMPROVED MIGHTY MITE TUBE TESTER that checks over 3000 tubes with one simplified test procedure, including the 100 megohm grid leakage sensitivity check.
IT'S A PATENTED CRICKET in and out of circuit transistor checker, for fast, reliable in-circuit troubleshooting without a reference book.
ALL TESTS READ ON ONE METER, including tube shorts, combining the two most popular Sencore testers for one total tester, and at less cost than buying them separately.

TC28 SPECIFICATIONS

Devices Tested: Tubes, transistors, diodes, single-gate FET's.
Tube Tests: EMISSION: Load currents to 120mA. Voltage applied. 40VAC RMS max. GRID LEAKAGE: 100 megohms or less reads BAD. 100 megohms to 200 megohms reads in questionable area. SHORTS: 300K ohms or less (40VAC RMS applied voltage) indicates short on meter.
Transistor Tests: GAIN: (In or out of circuit): V_{ce} = ± 5V; V_{be} = 3V p-p, zero reference, 2KHz frequency. LEAKAGE: (Out of circuit only): 5VDC applied voltage, meter indicates 0 - 3000 microamps leakage current.
General: METER: Large 6" D'Arsonval, 100 microamps. POWER REQUIREMENTS: 105 - 125VAC, 50-60Hz. (220V conversion available.) SIZE: 14¾"x12"x14½". WEIGHT: 13¾ lbs.

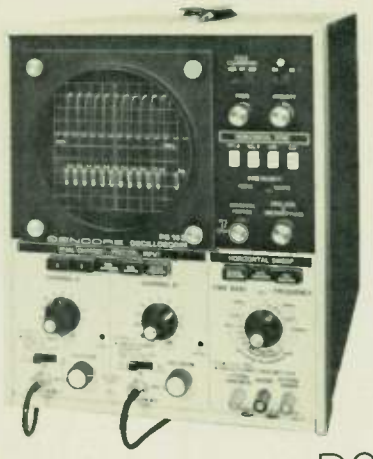
TC28 THE HYBRIDER. $260.00
(Effective January 1, 1976 . . . . . $275.00)

OSCILLOSCOPES



PS148

PATENT PENDING PS29



PS163

PS148 WIDEBAND OSCILLOSCOPE/VECTORSCOPE

"THE WORKHORSE" OF THE SINGLE TRACE SERVICE SCOPES.

WIDE BAND 10Hz to 6MHz ± 6db.
HIGH SENSITIVITY 17mV RMS per inch.
HIGH INPUT IMPEDANCE 27 megohms shunted by 11pf low cap.
SEVEN THOUSAND VOLT input rating with low cap probe, not 600 volts like other scopes.
DIRECT VERTICAL PEAK-TO-PEAK VOLTAGE READING with input controls calibrated directly in volts p-p.
CONVERTS TO PROFESSIONAL VECTORSCOPE with the flip of a switch.
FULL RANGE HORIZONTAL SWEEP frequencies from 5Hz to 500KHz in five overlapping ranges.
POSITIVE SYNC with variable control locks onto complex waveforms.
EXTERNAL INPUTS for sync, sweep, Z axis and direct connections to deflection plates.

PS148 SPECIFICATIONS

DEFLECTION SENSITIVITY: VERTICAL AMPLIFIER: Direct terminal .017 ± 5% volts RMS/inch. Low capacity terminal: .17 ± 5% volts RMS/inch.

HORIZONTAL AMPLIFIER: At horizontal input jack: .6 volts RMS/inch.

INPUT IMPEDANCE: At vertical input jack: 2.7 megohms shunted by 20pf. Through vertical input cable – direct input jack: 2.7 megohms shunted by 107uf. Through vertical input cable – low capacity jack: 27 megohms shunted by 11uf. At horizontal input jack: 3.2 megohms shunted by approximately 18uf. At sync input jack: 4.7 megohms shunted by approximately 18pf.

HORIZONTAL SWEEP: Frequency ranges continuously adjustable with approximately 10% overlap on all ranges. Range 1: 5Hz to 60Hz; Range 2: 50Hz to 500Hz; Range 3: 500Hz to 5KHz; Range 4: 5KHz to 50KHz; Range 5: 50KHz to 500KHz. TV Horizontal and Vertical are marked on Horizontal Range Control with an "H" and a "V" for fast selection.

SYNCHRONIZATION (Selectable and adjustable to over 4MHz): Internal, External, Line frequency; Plus and Minus Polarity (Semi-triggered) Sync.

MAXIMUM INPUT VOLTAGES: 1000V (DC + peak) with Direct Probe: 7000V (DC + peak) with Lo Cap Probe.

GENERAL: POWER REQUIREMENTS: 105 - 125VAC, 50-60Hz, 100 watts. (220 VAC conversion available). SIZE: 11"x9"x15½". WEIGHT: 22 lbs.

PS148 OSCILLOSCOPE/VECTORSCOPE . . . $395.00

PS29 MINUTE MAN PUSHBUTTON OSCILLOSCOPE

THE ONLY COMPLETELY AUTOMATIC TRIGGERED, PUSHBUTTON OSCILLOSCOPE ON THE MARKET TODAY FOR ALL VIDEO WORK.
PUSHBUTTON DISPLAY for every critical video and color signal. TV Vertical, TV Horizontal, 3.58MHz color, 5X Expand, 60Hz Line Sweep for sweep generator alignment, and Vector Mode with complete front panel hook-up.
AUTOMATIC TRIGGERING with guaranteed solid sync is backed by TV sync separators on TV Vertical and TV Horizontal. You simply connect to the test point and push a button.
PLUS, IT'S A COMPLETE GENERAL PURPOSE BROADBAND SCOPE for any non-video signal from DC to 10MHz.
EXCLUSIVE 5000VAC INPUT PROTECTION backed by 10 millivolt per division sensitivity lets you measure circuits with confidence.

PS29 SPECIFICATIONS

Vertical Amplifier: SENSITIVITY: .01V/cm to 50V/cm in 12 calibrated ranges. 1, 2, 5, sequence. Continuously variable between ranges. FREQUENCY RESPONSE: DC to 8MHz (–3db), 10MHz (–4db), usable to 15MHz. MAX. INPUT VOLTAGE: 5Kv AC or 1Kv DC with supplied Lo Cap probe. INPUT IMPEDANCE: 10 megohms shunted by 11pf using Low Capacity Probe. 1 megohm shunted by 35pf at input terminal.
Horizontal Sweep: RANGE: 0.2 microsec/cm to 0.1 sec/cm in 18 calibrated ranges: 1, 2, 5 sequence. ACCURACY: 3%. MODE: Automatic triggered baseline present in absence of input signal. SENSITIVITY: .5cm display needed for triggering. TRIGGER SOURCE: Internal, External, line; positive or negative slope polarity.
Exclusive Front Panel, Pushbutton Video Functions: TV Vertical and TV Horizontal with built-in TV sync separator.
3.58MHz Color: For fast, positive sync on color subcarrier frequency.
60Hz Line Sweep: Automatically locks in for response curve display in sweep alignment work. Front panel phase adjust control synchronizes scope to sweep generator.
Vector: Used with external input (B-Y), plus regular vertical input (R-Y). Full Front end amplification. RANGES: 2 or 20V/cm or .4 or 4V/cm using 5X Expand. EXTERNAL INPUT IMPEDANCE: 1 megohm shunted by 40pf. HORIZONTAL BANDWIDTH: –3db at 1MHz. Phase shift less than 1%.
Sweep Expand: 5 times. Accuracy: 5%.
Graticules: Lighted 10X10 cm grid. 30° vector grid with automatic lighting in vector mode.
General: Power: 105 - 130VAC, 50-60Hz, 60 watts (220VAC conversion available.) SIZE: 8"x10½"x16". WEIGHT: 25 lbs.
Accessories: Lo Cap Probe: 39G80, 10X probe with 5Kv rating (supplied with unit. Replacement price $20.00.) Demodulator Probe: 39G81 (not supplied. Price $20.00.) BNC to Phono Connector: 39G47 (not supplied. Price $8.00.)

PS29 AUTOMATIC PUSHBUTTON SCOPE . . . $595.00

PS163 DUAL TRACE OSCILLOSCOPE

PHASE LOCKED MATCHED CHANNELS allow comparison of any simultaneous waveforms within 1% lab accuracy.
HIGH SENSITIVITY of 5 millivolts per centimeter, allows accurate display of low level signals.
TRUE BANDWIDTH using no peaking coils or other gimmicks to cause ringing or signal distortions. Gives clean waveforms from DC to 8MHz.
PROTECTED TO 5000VAC. Most other scopes are rated to 600V. You're protected with Sencore.
TIME SAVING INSTANT MODE SELECTION for free running, manual and automatic triggered sweep, with selectable A or B channel triggering.
TV VERTICAL AND TV HORIZONTAL SWEEP settings with sync separator stability for viewing video signals.
IT'S ALSO A VECTORSCOPE with a simple front panel pushbutton control.

PS163 SPECIFICATIONS

Vertical (Channel A and B): SENSITIVITY: .005V/cm to 50V/cm in 13 ranges. Front panel calibrated from .05V/cm to 500V/cm for direct reading with low capacity probe. BANDWIDTH: DC to 8MHz –3db, –4db @ 10MHz. Usable to 15MHz. OVERSHOOT: Negligible. (Typically 1% or less.) ACCURACY: ± 2%. RISE TIME: 40 nanoseconds. INPUT VOLTAGE: 5Kv p-p AC or 1KvDC max. through low capacity probe. INPUT IMPEDANCE: 10 megohms shunted by 11pf using low capacity probe.
Horizontal: TIME BASE RANGE: .1 microsecond/cm to .1 second/cm in 19 calibrated ranges, continuously variable. TVV, TVH, 60Hz, External positions. FREE RUN: .1Hz to 1MHz in 19 ranges, continuously variable. ACCURACY: ± 2% (triggered mode only.) SWEEP MAGNIFICATION: 5X, 5% accuracy (not calibrated on .1, .2 and 5uSec/cm). HORIZONTAL INPUT: Variable uncalibrated: Sensitivity: Direct, less than 750mV required for one cm of deflection. With 5X Expand: Less than 150mV required for one cm of deflection. INPUT IMPEDANCE: 1 megohm shunted by 40pf.
Triggering: MANUAL: Sync level adjustable. AUTOMATIC: Baseline remains in absence of trigger source. FREE RUN: Conventional sync-sweep operation; SOURCE: Channel A, Channel B, Line or External. Positive or negative slope polarity. LEVEL REQUIREMENTS: Internal: 1cm of display, External: 15mV minimum. INPUT IMPEDANCE: 1 megohm shunted by 40pf.
Phase Shift: Less than 3° at 5MHz.
Vector or X-Y Mode: SENSITIVITY: .005V/cm to 50V/cm direct. FREQ. RESPONSE (–3db): DC to 8MHz vertical; DC to 7MHz horizontal; Channel A vertical, Channel B horizontal.
Power: 105 - 130VAC, 60Hz, 60 watts (220VAC conversion available). SIZE: 12"x10"x15½". WEIGHT: 30 lbs.
Accessories: 39G80 Lo Cap Probe: 10X with 5Kv rating (two supplied). 39G81 Demodulator Probe (not supplied. Price $20.00.) BNC to Phono Connector: 39G47 (not supplied. Price $8.00.)

PS163 DUAL TRACE SCOPE $795.00
(Effective January 1, 1976 . . . . . $895.00)

FIELD EFFECT MULTIMETERS

FE23

FE23 LITTLE HENRY
PORTABLE
FIELD EFFECT
MULTIMETER

TOUGHEST LITTLE MULTIMETER in the whole wide world eliminates downtime, repair, and replacement costs.

COMPACT AND HANDY TO GO ANYWHERE – even in the dark – with illuminated meter.

1.5% FET ACCURACY with high 15 megohm input impedance that minimizes circuit loading errors experienced with VOMs.

DROP - PROOF with tough acrylic case, shock-proof meter mounting, and exclusive sliding meter cover.

BURN - OUT PROOF protection to 1000V on all functions and ranges, including ohms, with back-up fuse protection.

NO MESSY, DANGLING LEADS with built-in lead storage compartment with auto-shutoff switch.

FE23 SPECIFICATIONS

DC VOLTS: RANGES: 0 to 3, 30, 300, 1000 and 6000 volts full scale. INPUT RESISTANCE: 15 megohms shunted by 27pf. ACCURACY: ± 1.5% full scale at 25°C (± 3% 6Kv range.) AC REJECTION: 30db minimum @ 60Hz. Protection: 1000 volts on any range.
AC VOLTS (RMS): RANGES: 0 to 3, 30, 300 and 1000 volts full scale. INPUT IMPEDANCE: 900K ohms shunted by 27pf. ACCURACY: ± 3% full scale at 25°C. FREQUENCY RESPONSE: ± 3db, 15Hz to 3KHz. Protection: 1000 volts on any range.
OHMMETER: RANGES: 0 to 1000, 100K, 10 meg, 1000 meg with 10 ohms center scale. ACCURACY: ± 2 degrees arc. APPLIED VOLTAGE: 1.5V. PROTECTION: Fuse and diode to 1000 volts, any range.
DC CURRENT: RANGE: 0 to 1 amp full scale. ACCURACY: ± 3% full scale. Internal voltage drop: 300 millivolts. Protection: 1½ amp fuse and meter diode protected.
GENERAL: METER: 3½ inch, 100 microamp, 2%. POWER SUPPLY: One 9 volt battery, Eveready 222 or equivalent. OHMS BATTERY: Two AA penlight, Eveready E91 or equivalent. METER LIGHT BATTERY: One AA penlight, Eveready E91 or equivalent (batteries not included.) SIZE: 7¾"x4¼"x2 3/8". WEIGHT: 2½ lbs.
HIGH VOLTAGE PROBE: For all Sencore Meters. HP200: 50Kv probe that extends all ranges by 100 times for fast, accurate high voltage measurements. SIZE: 5/8"x16". Price . . . $25.00.

FE23 "LITTLE HENRY" $99.00
(Effective January 1, 1976 . . . . . $124.00)

FE27

FE27 BIG HENRY
PORTABLE
FIELD EFFECT MULTIMETER

MOST DEPENDABLE MULTIMETER on the market today.

RUGGED AND PORTABLE to go anywhere.

1.5% FET ACCURACY on DC volts with high 15 megohm input impedance that minimizes circuit loading errors experienced with VOMs.

TOUGH ACRYLIC CASE, sliding meter cover, and shock-proof meter mounting means less costly downtime.

1000V PROTECTION on all functions and ranges – including ohms.

EXCLUSIVE P-P AND RMS reading scales for accurate AC measurements in any circuit.

AUTOMATIC SHUT - OFF for longer battery life when lead compartment cover is closed.

FE27 SPECIFICATIONS

DC VOLTS: RANGES: 0 to 0.3, 1, 3, 10, 30, 100, 300, 1000, 3000 volts full scale. ZERO CENTER RANGES: –0.15 to +0.15, –0.5 to +0.5, –1.5 to +1.5, –5 to +5, –15 to +15, –50 to +50, –150 to +150, –500 to +500 and –1500 to +1500. INPUT RESISTANCE: 15 megohms shunted by 58pf on all ranges except 47.5 megohms on 3Kv range. ACCURACY: ± 1.5% of full scale @25°C. AC REJECTION: 30db, minimum @ 60Hz. PROTECTION: Diode protected to 1000 volts any range.
AC VOLTS: RANGES: 0 to 0.3, 1, 3, 10, 30, 100, 300, 1000 RMS volts full scale. 0 to 0.3, 1, 3, 10, 30, 100, 300, 1000 p-p volts full scale. INPUT IMPEDANCE: 2.4 megohms shunted by 82pf. ACCURACY: ± 3% of full scale, true RMS for sine or square waves @ 60Hz. ± 3% of full scale p-p @ 60Hz. FREQUENCY RESPONSE: –1db @15 Hz –20KHz, –3db @ 10Hz –40KHz. PROTECTION: Diode protected to 1000 volts any range.
OHMMETER: RANGES: 0 to 1000 (RX1), 10,000 (RX10), 1M (RX1K), 100M (RX100K), 1000M (RX1M), with 10 ohms center scale. ACCURACY: ± 2 degrees of arc. APPLIED VOLTAGE: 1.5 volts. PROTECTION: Diode and fuse protected to 1000 volts on any range.
GENERAL: METER: 4½", 100uA, 2%. POWER SUPPLY: Two 9 volt batteries (Eveready No. 222 or equivalent). OHMS BATTERY: One "C" cell (Eveready No. 1035 or equivalent.) METER LIGHT BATTERY: One "C" cell (Eveready No. 1035 or equivalent.) MECHANICAL: Unbreakable acrylic and steel case. SIZE: 20"x5¼"x3½". WEIGHT: 4¼ lbs. ACCESSORIES: Test probe with 200K isolation position (supplied.)

FE27 "BIG HENRY" $175.00
(Effective January 1, 1976 . . . . . $195.00)

FOR YOUR BEST TEST EQUIPMENT BUY- SEE YOUR SENCORE FLPD DISTRIBUTOR

HERE IS YOUR COMPLETE LIST OF SENCORE FULL LINE PROMOTIONAL DISTRIBUTORS -PLUS- A LIST OF ALL TECH-A-RAMAS SCHEDULED ACROSS THE U.S.

● CIRCLE indicates FLPD Distributors sponsoring Tech-A-Rama's on the dates listed below their names.

***Listings preceded by a star have the most popular items on display and 24 hour delivery from the FLPD store.**

UNITED STATES

ALABAMA

DOTHAN
CARMICHAEL WHOLESALE
140 South Foster Street
(205) 792-0066

OPELIKA
SOUTHERN ELECTRONIC CORP.
309 South 10th Street
(205) 745-6478

MOBILE
ELECTRONIC SUPPLY
561 Holcombe Avenue
(205) 478-0455

ARIZONA

PHOENIX
CAPITOL ELECTRONICS
1311 North Central
(602) 252-5897
DALIS RADIO & TV SUPPLY
917 North 7th Street
(602) 258-8151
Star Store located in:
*Tucson
3380 Ajo Way
(602) 889-6391

TUCSON
INLAND ELECTRONIC SUPPLY
715 E. Broadway
(602) 624-4402

ARKANSAS

FT. SMITH
CARLTON-BATES
No. 1 Electronic Park
4420 Whealer Avenue
(501) 782-7258
WISE WHOLESALE
1001 Towson Avenue
(501) 783-8925
Star Store located in:
* SPRINGDALE
710 N. Thompson
(501) 751-4814

LITTLE ROCK
CARLTON-BATES
6821 Scott Hamilton Road
(501) 562-9100
DAVID WHITE RADIO
1222 Main Street
(501) 376-1391
Star Stores located in:
*FAYETTEVILLE
112 North Block
(501) 521-6611
*PINE BLUFF
615 Main Street
(501) 534-0612
*MONROE, LA.
309 Walnut
(318) 322-5136

PINE BLUFF
CARLTON-BATES
1510 State Street
(501) 535-1354

CALIFORNIA

BAKERSFIELD
KIESUB CORP.
218 21st Street
(805) 327-5535

BURBANK
ELECTRONIC CITY
4001 West Burbank Blvd.
(213) 842-5275

CANOGA PARK
SANDY'S ELECTRONIC SUPPLY
21305 Saticoy Street
(213) 346-8353
Star Stores located in:
*THOUSAND OAKS
369 Hampshire
(805) 497-7515
*NORTH HOLLYWOOD
6770 Coldwater Canyon
(213) 765-8585

EL MONTE
KIMBALL AND STARK, INC.
3053 N. Tyler Avenue
(213) 444-2594

FRESNO
DEVLIN-DREW CO.
165 Broadway
P.O. Box 1326
(209) 233-7171

GLENDALE
WESTERN ELECT. SUPPLY CORP.
229 South Orange Street
(213) 246-4861

HAWAIIAN GARDENS
CARSON ELECTRONICS
12016 East Carson
(213) 425-8298

HOLLYWOOD
●PACIFIC RADIO EXCHANGE
1351 Cahvenga Blvd.
(213) 462-1393
Meeting Date: December 3

HUNTINGTON PARK
MARTIN DISTRIBUTING
2509 East Florence Avenue
(213) 582-7111

LONG BEACH
●KIESUB CORP.
311 West Pacific Coast Hwy.
(213) 591-1335
Meeting Date: December 2
Star Store located in:
* SAN BERNADINO
910 11th Street
(714) 885-6807

LA PUENTE
KIESUB ELECTRONICS, INC.
15418 East Fairgrove Avenue
(213) 330-3444

LOS ANGELES
AMETRON SUPPLY
1200 North Vine
(213) 464-1144
RADIO PRODUCTS SALES, INC.
1501 South Hill Street
(213) 748-1271

MOUNTAIN VIEW
ASSOCIATED RADIO DISTRIBUTORS
2150 Old Middlefield Way
(415) 968-1689

OAKLAND
BRILL ELECTRONICS
610 East 10th Street
(415) 834-5888

SACRAMENTO
CALIFORNIA RADIO & TV
2537 Del Paso Blvd.
(916) 922-6531
NORCAL ELECTRONICS
1800 6th St.
(916) 442-9041
SACRAMENTO ELECTRONICS
1219 S Street
(916) 441-4821

SAN DIEGO
SHANKS & WRIGHT, INC.
2045 Ketner Blvd.
(714) 239-0176
●SOUTHLAND
3610 University Avenue
(714) 283-3941
Meeting Date: January 20
Star Store located in:
* SAN DIEGO
KERNEY MESA ELECT. SUPPLY
4917 Convey Street
(714) 279-6320

SAN FRANCISCO
ASSOCIATED RADIO DISTRIBUTORS
1583 Howard Street
(415) 431-0212

SAN JOSE
PENINSULA ELECTRONIC
980 South First Street
(408) 294-8781
QUEMENT
1000 South Bascom
(408) 998-5900
UNITED RADIO & TV SUPPLY
1425 West San Carlos Avenue
(408) 298-1212
●SENCORE TECH-A-RAMA
Meeting Date: January 15

SANTA ANA
●HURLEY ELECTRONICS
2101 North Fairview
(714) 638-7220
Meeting Date: December 4
Held: Inglewood, CA
Star Stores located in:
* SAN DIEGO
318 16th Street
(714) 235-6245

SUNNYVALE
●SUNNYVALE ELECTRONICS
534 South Murphy
(408) 736-1323
Meeting Date: December 3

VALLEJO
ASSOCIATED RADIO DISTRIBUTORS
1340 Tennessee
(707) 691-2363
ZACKITT CORPORATION
1815 Sonoma Blvd.
(707) 644-6676
Star Store located in:
* SACRAMENTO
1831 J Street
(916) 446-3131

COLORADO

DENVER
ELECTRONIC PARTS
1212 South Broadway
(303) 744-1992
FISTELL'S ELECTRONIC SUPPLY
1001 Bannock Avenue
(303) 244-4691
MADISON ELECTRONICS
2033 Lawrence Street
(303) 244-8140

GREELEY
WALKER ELECTRONICS
1525 8th Avenue
(303) 353-3241
Star Stores located in:
* DENVER
300 S. Bryant
(303) 935-2401
* PUEBLO
100 N. Victoria
(303) 542-1924

CONNECTICUT

HARTFORD
HATRY OF HARTFORD
500 Ledyard Street
(203) 527-1881

NEW HAVEN
HATRY OF NEW HAVEN
610 Boulevard
(203) 787-5921

NEW LONDON
AIKINS ELECTRONICS
531 Broad Street
(203) 442-4406
Star Store located in:
* WEST HAVEN
884 Orange Avenue
(203) 933-2581

NORWICH
AIKINS ELECTRONICS
499 North Main Street
(203) 889-8427

STRATFORD
HATRY OF BRIDGEPORT
1145 Honeyspot Road
(203) 375-5866

WATERBURY
HATRY OF WATERBURY
480 Watertown Avenue
(203) 755-1181

WEST HARTFORD
SIGNAL CENTER
589 New Park Avenue
(203) 233-8551
Star Store located in:
* SPRINGFIELD, MASS.
482 Worthington Street
(413) 739-3893

DELAWARE

WILMINGTON
WHOLESALE ELECTRONICS
1402 Walnut Street
(302) 656-9988

FLORIDA

FORT LAUDERDALE
VANCE BALDWIN, INC.
2207 South Andrews Avenue
(305) 523-3461
Star Stores located in:
*MIAMI
770 North 7th Ave.
(305) 693-2921
*WEST PALM BEACH
500 Clematis
(305) 832-5671

MIAMI
ELECTRONIC EQUIPMENT
2701 N.W. 42nd Avenue
(305) 871-3500

ORLANDO
HAMMOND ELECTRONICS
1230 West Central
(305) 241-6601
Star Stores located in:
* FORT MEYERS
2463 Frankland Street
(813) 334-2277
* TAMPA
1516 Cypress Street
(813) 253-0104
* LAKELAND
930 East Oak
P.O. Box 809
(813) 686-4145
* DAYTONA BEACH
719 North Ridgewood Avenue
(904) 253-0531
* JACKSONVILLE
250 E. First
(904) 356-4851

PENSACOLA
GRICE ELECTRONICS, INC.
320 East Gregory Street
(904) 434-2481
Star Stores located in:
* PANAMA CITY
2907 West Hwy. 98
(904) 769-2151
* MOBILE, ALABAMA
3698 Airport Blvd.
(205) 342-2062

SARASOTA
DOW ELECTRONICS
607 School Street
(813) 958-1551

GEORGIA

ATLANTA
GRAYBAR ELECTRIC
4825 Fulton Ind. Blvd.
(404) 892-6950
SPECIALTY DIST. CO.
763 Juniper Street
(404) 873-2521
Star Stores located in:
* AUGUSTA
1251 Gordon Parkway
P.O. Box 1728
(404) 722-1526
* BRUNSWICK
2812 Carrie Street
(912) 265-1927
* CHATTANOOGA, TENN.
1313 Central Avenue
(615) 267-9531
* ATHENS
230 Epps Bridge Road
(404) 548-1334
* ALBANY
428 Roosevelt Avenue
(912) 435-1711
*VALDOSTA
916 Marion Street
(912) 242-4910
* MACON
539 Arch Street
(912) 746-8564

COLUMBUS
RADIO SALES AND SERVICE
2000 12th Avenue
(404) 327-3296

SAVANNAH
KING'S APPLIANCE
1701 Louisville Rd.
(912) 234-1301

HAWAII

HONOLULU
ELECTRICAL EQUIPMENT CO. LTD.
832 South Queen Street
(808) 533-3884
PRECISION RADIO LTD., INC.
1160 South King Street
(808) 537-5291

IDAHO

CALDWELL
A-GEM SUPPLY CO.
715 Albany Street
(208) 459-0783

IDAHO FALLS
SCHWENDIMAN'S WHOLESALE DIST.
910 Lincoln Road
P.O. Box 2047
(208) 522-2492

POCATELLO
KIMBALL ELECTRONICS
504 E. Center
(208) 232-2201
Star Store located in:
*** BOISE, IDAHO**
418 N. Orchard
(208) 342-3559

ILLINOIS

ALTON
EBINGER RADIO, INC.
1155 East Broadway
(618) 462-9783
Star Store located in:
* ST. LOUIS, MISSOURI
4220 Gannett
(314) 353-8818

BELLEVILLE
DELTRONICS DISTRIBUTORS, CO.
3726 West Main
(618) 398-2188

BENTON
LAMPLEY ELECT. INC.
452 East Church Street
(618) 435-8194

Star Stores located in:
* SALEM
Laco Electronics
119 E. McMackin
(618) 548-3150
* PADUCAH, KENTUCKY
Paducah Electronics
2601 Broadway
(502) 443-1722

BERWYN
B-B&W, INC.
2137 South Euclid Avenue
(suburban) (312) 749-1710
(Chicago) (312) 242-1533

CHAMPAIGN
KLAUS RADIO
905 South Neil Street
(217) 356-1896

CHICAGO
HOWARD ELECTRONICS SALES, INC.
4573 South Archer Avenue
(312) 254-1777
NORTH CENTRAL ELEC. SUPPLY
3412 West Bryn Mawr
(312) 588-6012
U.S RADIO & TV SUPPLIES
6343 S. Western Ave.
(312) 925-4111

JACKSONVILLE
BESCO,INC.
419 South Mauvaisterre
(217) 243-6464
Star Store located in:
* SPRINGFIELD
801 Jefferson
(217) 528-1338

JOLIET
MAINLINE ELECTRONIC SUPPLY
804 Theodore Street
(815) 723-0658

LA SALLE
KLAUS RADIO, INC.
227 Bucklin Street
(815) 223-7400

MATTOON
MATTOON RADIO & TV SUPPLY
400 - 404 South 21st Street
(217) 235-5457
Star Store located in:
* BELLEVILE
Lurtz Electronics
219-221 N. Illinois St.
(618) 233-0942

MOLINE
LOFGREN DISTRIBUTING CO.
1202 Fourth Avenue
(309) 764-7436

PEORIA
KLAUS RADIO, INC.
8400 North Pioneer Pkway
(309) 691-4840
WARREN RADIO
800 S.W. Jefferson
(309) 674-5998
Star Store located in:
* LA SALLE
518 3rd Street
(815) 223-4028

QUINCY
KLAUS RADIO, INC.
1008 Jersey Street
(217) 223-7560

ROCKFORD
JAY-TRONICS
124 - 128 North Rockton
(815) 965-8786

SPRINGFIELD
BRUCE ELECTRONICS
1120 East Capitol Avenue
P.O. Box 115
(217) 528-7523

INDIANA

BEDFORD
ELECTRONIC SUPPLY
910 7th Street
(812) 275-5941

EAST CHICAGO
ACRO ELECTRONICS CORP.
1101 West Chicago Avenue
(219) 397-8681

ELKHART
WARREN RADIO
742 South Main
(219) 523-2398

EVANSVILLE
HUTCH & SONS, INC.
300 North Main Street
(812) 425-7201
Star Stores located in:
*MADISONVILLE, KY.
212 North Franklin
(502) 821-4334
*OWENSBORO, KY.
1421 Triplet
(502) 684-6285

INDIANAPOLIS
GRAHAM ELECT. SUPPLY INC.
133 South Pennsylvania Street
(317) 634-8486
Star Stores located in:
* MUNCIE
Muncie Electronic Supply
222 North Madison Street
(317) 288-8837
* FORT WAYNE
Fort Wayne Elect. Supply
3606 East Maumee Avenue
(219) 423-3422
WARREN RADIO
732 North Capitol Street
(317) 634-5566

IOWA

DAVENPORT
KLAUS RADIO
322 East Fourth Street
(319) 323-9761
WARREN RADIO
1205 East River Drive
(319) 323-8051

DES MOINES
● MID-STATE DISTRIBUTORS
2511 Bell Avenue
(515) 288-7231
Meeting Date: January 7
Held: Ottumwa, Iowa
Star Store located in:
● *APPLETON, WIS.
1037 West Wisconsin Ave.
(414) 731-4181
Meeting Date: December 17
Meeting Date: January 20
Held: Escanaba, Mich.
(Jan. 20 meeting)
● SIDLES
2205 Bell Avenue
(515) 280-1722
Meeting Date: December 10

SIOUX CITY
MOLSTAD ELECTRONICS
1110 Dace Street
(712) 255-8023

KANSAS

TOPEKA
ACME RADIO
135 Kansas Ave.
(913) 235-1363

WICHITA
RADIO SUPPLY CO., INC.
131 Laura Street
(316) 267-5216
Star Store located in:
*SALINA
809 South Broadway
(913) 823-6353

KENTUCKY

BOWLING GREEN
RANDOLPH, HALE & MEREDITH
319 State Street
(502) 781-1460
Star Store located in:
*HOPKINSVILLE
729 East 4th Street
(502) 885-5357

LEXINGTON
SERVICE ELECTRONIC SUPPLY
1046 "A" New Circle Road, N.E.
(606) 254-5786

LOUISVILLE
P.I. BURKS, INC.
842 South 7th Street
(502) 589-3960
THE COLLINS CO.
829 South Floyd Street
(502) 583-1791
PEERLESS ELECTRONICS EQUIP.
1815 South 7th Street
(502) 637-7677

PADUCAH
WARREN RADIO
455 South 31st
(502) 442-4367

LOUISIANA

LAFAYETTE
RALPH'S OF LAFAYETTE
3004 Cameron Street
(318) 234-4507
Star Stores located in:
* BATON ROUGE
1732 Plank Road
(504) 344-3761
* ALEXANDRIA
601 N. 3rd Street
(318) 443-4517
* BEAUMONT, TX.
1293 Broadway
(713) 833-9443
* MORGAN CITY
715 Brashear
(504) 384-9831
* PASCAGOULA, MS.
2102 Ingalls Avenue
(601) 769-1672

LAKE CHARLES
RALPH'S RADIO
911 4th Avenue
(318) 439-2493

NEW ORLEANS
WILLIAM B. ALLEN
1601 Orleans Avenue
(504) 525-8222
SHULER SUPPLY CO., INC.
2504 - 06 Tulane Avenue
(504) 822-2251
Star Stores located in:
* GRETNA
1728 Hancock
(504) 368-2455
* METAIRIE
112 Woodlawn
(504) 834-1174
SOUTHERN RADIO
1909 Tulane Avenue
(504) 524-2343
Star Store located in:
* BATON ROUGE
2610 Scenic Hwy.
(504) 355-0396

SHREVEPORT
AMERICAN ELECTRONICS
2618 Southern Avenue
(318) 424-6591

MARYLAND

BALTIMORE
A.R. SPARTANA CO., INC.
239 North Gay Street
(301) 727-5762

CUMBERLAND
ALLEGHENY ELECTRONICS
1100 E. Old Town Road
(301) 734-6460

HYATTSVILLE
MARK ELECTRONICS
3003 Hamilton Street
(301) 559-7700

KENSINGTON
FAIRWAY ELECTRONICS
4210 Howard
(301) 933-4420
Star Store located in:
* BALTIMORE
178 Alco Place
(301) 247-8383

SALISBURY
STANDARD ELECTRONICS
701 Snow Hill Road
(301) 749-7593

MASSACHUSETTS

BROCKTON
WARE RADIO SUPPLY CO.
913 Center Street
(617) 583-0810

NORTH WILBURHAM
INDUSTRIAL COMPONENTS CORP.
2551 Boston Road
(413) 596-3854

WORCESTER
R.M. ELECTRONICS
315 Grove Street
(617) 756-8311
Star Store located in:
* FITCHBURG
1334 Water Street
(617) 343-7473

MICHIGAN

BATTLE CREEK
WARREN RADIO CO.
93 Biddell W.
(616) 965-3338

DEARBORN
WEST SIDE RADIO & TV SUPPLY
7521 Wyoming Avenue
(313) 933-6972

DETROIT
R.S. ELECTRONICS CO., INC.
12775 Lyndon Street
(313) 491-1000
Star Store located in:
* GRAND RAPIDS
300 36th Street S.E.
(616) 241-3483
RADIO SUPPLY & ENGINEERING
85 Selden Avenue
(313) 831-3174
Star Stores located in:
* DETROIT
10001 Chalmers
(313) 371-9050
* CLAWSON
1203 West 14 Mile Road
(313) 435-5660

FLINT
HOLDENS DISTRIBUTORS, INC.
2427 South Vassar
(313) 742-1020

GRAND RAPIDS
T & W ELECTRONICS
1045 South Division Avenue
(616) 241-3645
Star Store located in:
* MUSKEGON
2100 Henry Street
(616) 759-7666
J.A. WHITE DISTRIBUTING
755 36th Street S.E.
(616) 241-6581

KALAMAZOO
WARREN RADIO CO.
1710 South Westnedge
(616) 381-4203
Star Store located in:
* GRAND RAPIDS
320 Michigan N.E.
(616) 456-5383

LIVONIA
● NORWEST ELECTRONICS
33611 Plymouth Road
(313) 261-4551
Meeting Date: December 3

MADISON HEIGHTS
WARREN RADIO CO.
32707 John Road
(313) 588-3327

MUSKEGON
FITZPATRICK ELECT. SUPPLY
444 Irwin Avenue
(616) 722-6621
WESTERN ELECTRONICS SUPPLY
1781 Fifth Street
(616) 722-7628

NILES
NILES RADIO
933 N. 5th
(616) 684-0550

OWOSSO
WARREN RADIO CO.
311 South Cedar
(517) 723-5239

ROYAL OAK
SATULLO CO.
4514 N. Woodward
(313) 549-3910

MINNESOTA

MINNEAPOLIS
NESS ELECTRONICS
3743 Nicollet
(612) 824-2646
STARK ELECTRONICS
112 3rd Avenue North
(612) 332-1325
Star Stores located in:
*LA CROSSE, WIS.
131 South 6th
(608) 782-3186
* ST. PAUL
154-160 University
(612) 222-4781
TEAM CENTRAL, INC.
720 29th Avenue S.E.
(612) 331-8511
Star Stores located in:
* NO. 1 MINNEAPOLIS
2460 Hennepin
(612) 377-9840
* NO. 2 ST. PAUL
455 Rice
(612) 227-7223
* NO. 4 ST. CLOUD
119 Fifth Avenue South
(612) 251-1335
* NO. 8 MADISON, WIS.
3365 East Washington
(608) 244-1339
* NO. 19 WATERTOWN, SD.
223 9th Avenue S.E.
(605) 886-4725
* NO. 22 ROCK ISLAND, ILL.
1714 5th Avenue
(309) 788-9595
* NO. 26 GRAND FORKS, ND.
1503 11th Avenue North
(701) 772-5575

ROCHESTER
SM SUPPLY CO.
902 7th Street N.W.
(507) 288-2037
Star Store located in:
* MANKATO
115 Byron
(507) 388-6245

MISSISSIPPI

BILOXI
ELECTRONIC PARTS
295 Iberville Drive
(601) 435-3221

HATTIESBURG
N & H ELECTRONIC SUPPLY
402 E. Pine Street
(601) 582-5571

JACKSON
RISHER RADIO
837 Bailey Avenue
P.O. Box 2810
(601) 355-6842
STUART C. IRBY
P.O. Box 1819
(601) 355-4532

MERIDIAN
HOOPER ELECTRONICS
1917 Sixth Street
(601) 693-2668
Star Store located in:
*** PASCAGOULA**
1406 E. Live Oak
(601) 762-9383

MISSOURI

CAPE GIRARDEAU
SUEDEKUM ELECT. SUPPLY
2215 Broadway
(314) 335-8202
Star Store located in:
* CARBONDALE, ILL.
Hwy 13 Reeds Station Road
(618) 549-7361

JOPLIN
FOUR STATE RADIO SUPPLY
402 Wall Street
(417) 624-0368

KANSAS CITY
BURSTEIN APPLEBEE
3199 Mercier
(816) 756-2525
ELECTRONIC SUPPLY CO., INC.
4100 Main Street
(816) 931-3383

ROLLA
SHOW ME ELECTRONICS
Hwy. 72 East
(314) 364-3896

ST. JOHN
TREPCO
3632 Woodson Road
(314) 426-3260

ST. JOSEPH
ST. JOSEPH RADIO & SUPPLY
720 South 9th Street
(816) 233-3118

ST. LOUIS
DELTRONICS DISTRIBUTING CO.
864 Hodiamont Avenue
(314) 725-6060
Star Store located in:
* ST. CHARLES
202 First Capitol Plaza
(314) 946-6766

SPRINGFIELD
REED RADIO SUPPLY CO.
805 - 09 Boonville Avenue
(417) 869-0752
UNIVERSITY CITY
OLIVE ELECTRONICS SUPPLY CO.
6662 Olive Blvd.
(314) 863-7800

MONTANA
BILLINGS
ELECTRONIC SUPPLY CO.
250 Eleventh Street West
(406) 252-2197

NEBRASKA
OMAHA
OMAHA ELECTRONICS
2222 Leavenworth
(402) 341-3440
● RADIO EQUIPMENT
625 North 18th Street
(402) 341-7700
Meeting Date: December 4
Held: Omaha
Meeting Date: December 1
Held: Norfolk
Meeting Date: December 2
Held: Grand Island
Star Store located in:
● * LINCOLN
2619 Holdrege Avenue
(402) 475-7668
Meeting Date: December 3
SCOTTS BLUFF
D & H ELECTRONICS
1913 Broadway
(308) 632-2181
Star Store located in:
* STERLING, COLORADO
117 Ash Street
(303) 522-3033

NEVADA
LAS VEGAS
KIESUB ELECTRONICS
3185 South Highland
(702) 732-2395

● SENCORE TECH-A-RAMA
Meeting Date: January 29
Held: Reno

NEW HAMPSHIRE
MANCHESTER
RSL DISTRIBUTORS, INC.
670 Chestnut Street
(603) 625-5444
Star Stores located in:
* BANGOR, MAINE
14 Perry Road
(207) 947-7396
* PORTLAND, MAINE
117 Anderson Street
(207) 773-0297

NEW JERSEY
CAMDEN
GENERAL RADIO SUPPLY CO.
600 Penn Street
At Bridge Plaza
(609) 964-8560
EATONTOWN
ATKINSON & SMITH
17 Lewis Street
(201) 542-2447
EDISON
WILLIAM ELECTRONIC SUPPLY
1863 Woodbridge Avenue
(201) 985-3700
HILLSIDE
LEADER ELECTRONICS
5 Evans Terminal Rd.
(201) 354-4200
NEW BRUNSWICK
BAY ELECTRONICS DISTRIBUTORS
226 Talamadge Street
(212) 295-8100
NEWARK
AARON LIPPMAN
99 Newark Street
(201) 621-9300
Star Store located in:
* PATERSON
170 21st Ave.
(201) 274-3277
SPRINGFIELD
ROUTE ELECTRONICS, INC.
Echo Plaza
40 US Route 22
(201) 467-0166
TRENTON
JACKSON DISTRIBUTORS
1900 Genesee Street
(609) 392-8008
NIDISCO, INC.
985 Princeton
(609) 396-3505
UNION CITY
NIDISCO, INC.
2812 Kennedy Blvd.
(201) 863-2111
Star Stores located in:
* HACKENSACK
55 State Street
(201) 343-8411
* JERSEY CITY
713 Newark Street
(201) 653-2360
* RIDGEFIELD
484 Bergen Blvd.
(201) 943-0510
* PASSAIC
294 Passaic Street
(201) 779-4962
* UNION
2401 Vauxhall Road
(201) 964-7070

NEW MEXICO

ALBURQUERQUE
ELECTRONIC PARTS CO.
2620 Rhode Island Street N.E.
(505) 293-6161
Star Store located in:
* PHOENIX, ARIZONA
1903 N. 22nd Avenue
(602) 257-1040
SANTE FE
A-1 COMMUNICATIONS SUPPLY CO.
441 Corrillas Road
(505) 982-4488

NEW YORK

BINGHAMTON
HARVEY ELECTRONICS
Vestal Parkway
(607) 748-8211
BRONX
FORDHAM ELECTRONIC SUPPLY
558 Morris Avenue
(212) 585-0330
RIM ELECTRONICS
2755 Webster Avenue
(212) 295-4300
BUFFALO
RADIO EQUIPMENT CORP.
196 Vulcan Street
(716) 874-2690
Star Store located in:
* NIAGARA FALLS
1720 Pierce Avenue
(716) 285-9366
STANDARD ELECTRONICS
3519 Union Road
(716) 685-4330
Star Stores located in:
* ENDICOTT
107 Duane Avenue
(607) 754-3102
* NIAGARA FALLS
2201 Pine Avenue
(716) 284-0437
* OLEAN
2828 West State Street
(716) 372-1800
* ROCHESTER
1800 Lyell Avenue
(716) 254-7950
* SYRACUSE
839 Hiawatha Blvd.
(315) 422-0421
FARMINGDALE
HARRISON RADIO CORP.
20 Smith Street
(516) 293-7990
GLEN FALLS
RAY SUPPLY, INC.
Upper Glen Street
(518) 792-5848
GREAT NECK
BROMPTON SERVICE CORP.
39 Allenwood Road
(516) 487-9591
KINGSTON
GREYLOCK ELECTRONICS
763 Albany Avenue
(914) 338-7900
LATHAM
SEIDEN SOUND
4 Northway Lane
(518) 462-9501
MIDDLETOWN
CERTIFIED ELECTRONICS
Wickham Avenue Ext.
Certified Drive Route 211
(914) 342-1054
NEW YORK
DALE ELECTRONICS
244 W. 14th Street
(212) 255-3660
ROCHESTER
GOLDCREST ELECTRONICS
482 St. Paul Street
(716) 546-8464
Star Stores located in:
* ALBANY
Everett Road
(518) 489-5406
* SYRACUSE
1920 Park Street
(315) 471-7115
SCHENECTADY
GRIMMERS ELECT. PARTS SUPPLY
41 North Brandywine Avenue
(518) 374-8480
SYRACUSE
SALINA ELECTRONICS, INC.
2100 Park Street
(315) 422-2336
Star Store located in:
* ROME
216 Erie Blvd. E.
(315) 337-5440
TROY
TROY TELEVISION, INC.
76 2nd Ave.
(518) 235-1521
VALLEY STREAM
HARRISON RADIO
10 E. Sunrise & Rockway
(516) 872-9565

NORTH CAROLINA

ASHVILLE
SOUTHEASTERN RADIO SUPPLY
1065 Patton Avenue
(704) 253-1446
CONCORD
MACVICTOR ELECT. SUPPLY
P.O. Box 3236
1094 Hwy. 29 North
(704) 786-4175
Star Stores located in:
* HIGH POINT
1506 South Main
(919) 883-7423
* STATEVILLE
1128 Shelton Avenue
(704) 872-8949
FAYETTEVILLE
SOUTHEASTERN RADIO SUPPLY
325 Rowan Street
(919) 483-0371
Star Store located in:
* WILMINGTON
1002 South College Road
(919) 791-7365
GREENSBORO
GUILFORD
315 Asheboro
(919) 275-1385
SOUTHEASTERN RADIO SUPPLY
445 English Street
(919) 273-8675
Star Stores located in:
* SALISBURY
316 North Depot Street
(704) 633-0741
* WINSTON-SALEM
200 South Marshall Street
(919) 724-0504
HICKORY
SOUTHEASTERN RADIO SUPPLY
907 Second Avenue N.W.
(704) 322-9493
KINSTON
SOUTHEASTERN RADIO SUPPLY
1005 East Highland Avenue
(919) 523-5113
Star Store located in:
* JACKSONVILLE
1009 LeJeune Blvd.
(919) 347-5137
RALEIGH
SOUTHEASTERN RADIO SUPPLY
414 Hillsborough Street
(919) 828-2311
Star Stores located in:
* DURHAM
401 Foster Street
(919) 688-8204
* WILSON
321 South Goldsboro Street
(919) 237-6375

NORTH DAKOTA
FARGO
RADIO & TV EQUIPMENT
2014 1st Avenue
(701) 232-8993
MINOT
JOHN IVERSON
330 North Broadway
(701) 838-5466

OHIO
AKRON
WARREN RADIO
71 South Broadway
(216) 434-6668
ASHTABULA
MORRISON RADIO SUPPLY
331 Center Street
(216) 997-6161
CLEVELAND
WINTERADIO ELECT. SUPPLY
1468 West 25th Street
(216) 621-9383
Star Stores located in:
* PARMA
5373 Ridge Road
(216) 884-9696
* SOUTH EUCLID
4432 Mayfield Road
(216) 382-7676
COLUMBUS
WHITEHEAD RADIO CO.
124 North Grant Avenue
(614) 224-1186
DAYTON
SREPCO ELECTRONICS
314 Leo Street
(513) 224-0871
Star Store located in:
* COLUMBUS
1045 Ridge Street
(614) 486-9483
V.J. MCGRANAHAN, INC.
1415 Stanley Avenue
(513) 224-9623
Star Store located in:
● * TOLEDO
McGranahan Dist. Co.
1717 Madison Avenue
(419) 241-8271
Meeting Date: January 14
● THE STOTTS-FRIEDMAN CO.
108-112 North Jefferson Street
(513) 224-1111
Meeting Date: January 12
DOVER
TV SPECIALTIES, INC.
320 West 3rd Street
(216) 364-6678
Star Store located in:
* STEUBENVILLE
Lou's Electronics
408 Washington
(614) 282-7535
ELYRIA
EL-A-CO ELECTRONICS
235 Lodi Street
(216) 322-2526 or
(216) 323-1805
LIMA
LIMA RADIO PARTS CO., INC.
150 West Grand Avenue
(419) 228-1220
TOLEDO
LIFETIME ELECTRONICS
1501-1505 Adams Street
(419) 241-5643
WARREN RADIO
1002 Adams Street
(419) 248-3364
YOUNGSTOWN
ROSS RADIO
325 West Federal Street
(216) 746-8881
WARREN
REM ELECTRONICS
515 South Park
(216) 399-2777

OKLAHOMA
LAWTON
MILLER JACKSON CO.
1701 "C" Avenue
(405) 355-5220
OKLAHOMA CITY
MILLER JACKSON CO.
121 East California
(405) 235-8426
THURMAN MAGBEE
530 S. Broadway
(405) 236-4351
TULSA
RADIO, INC.
1000 South Main
(918) 587-9123

OREGON
EUGENE
CENTRAL DISTRIBUTORS
1035 Conger
(503) 342-1101
MEDFORD
CENTRAL DISTRIBUTORS
605 North Fir Street
(503) 773-6677
PORTLAND
CENTRAL DISTRIBUTORS
955 N.E. Union Avenue
(503) 234-0711
AL SMITH COMPANY
3422 Halsey N.E.
(503) 234-7877

PENNSYLVANIA
ALLENTOWN
RESCO of Le HIGH VALLEY
425 Hanover Ave.
(215) 435-6743
ALTOONA
ALLEGHENY ELECTRONICS
800 Chestnut Avenue
(814) 946-0871
Star Stores located in:
* JOHNSTOWN
46 Valley Pike
(814) 536-3589
* STATE COLLEGE
University Electronics
258 East Beaver
(814) 238-3093
COATESVILLE
● COUNTY SUPPLY
301 Fleetwood Street
(215) 384-4585
Meeting Date: December 3
DREXEL HILL
KASS ELECTRONICS DIST.
2502 Township Line Road
(215) 449-2300
ERIE
J.V. DUNCOMBE ELECT. CORP.
721 Parade Street
(814) 455-4735
NORRISTOWN
PHILADELPHIA ELECTRONICS, INC.
624 West Airy Street
(215) 275-5550
Star Stores located in:
* EASTON
Radio Electronic Service Co.
1700 North Hampton
(215) 253-3569
* READING
Electronic TV
& Distributing
201 South 4th Street
(215) 376-4841
PARKSIDE
COUNTY SUPPLY
2903 Edgemont Ave.
(215) 872-2439

PHILADELPHIA
ALMO ELECT. CORP.
Roosevelt Blvd. & Blue Grass Rd.
(215) 676-6000
Star Stores located in:
* MOUNT EPHRIAM, NJ
301 North Black Horse Pike
(609) 933-3800
* SALISBURY, MD
317 Park Heights Avenue
(301) 742-1393
* WEST ATLANTIC CITY, NJ
1800 Verona Avenue
(609) 646-1300
* WILMINGTON, DE
1122 French Street
(302) 656-9467

PITTSBURGH
CRS ELECTRONICS CO.
818 Brownsville Road
(412) 431-7700
HAMBURG BROTHERS, INC.
24th Street & A.V.R.R.
(412) 471-0808

SCRANTON
CONSOLIDATED DISTRIBUTING
1148-1150 Capouse Avenue
(717) 346-3831
KEY RADIO & TV SUPPLY CO.
340 Phelp Street
(717) 342-0161

TREVOSE
TREVOSE ELECT. TV CO.
4033 Brownville Road
(215) 757-5300

RHODE ISLAND

CRANSTON
JABBOUR ELECTRONICS SUPPLY
1744 Cranston Street
(401) 944-2570
Star Store located in:
* NEW LONDON, CT
227 Jefferson Avenue
(203) 442-4386

PROVIDENCE
BALLOU-JOHNSON & NICHOLS
128-134 Dorrance Street
(401) 331-8320

SOUTH CAROLINA

CHARLESTON
WHOLESALE RADIO SUPPLY
515 East Bay Street
(803) 722-2634
Star Store located in:
* NORTH CHARLESTON
3847 Rivers Ave.
(803) 747-9672

COLUMBIA
DIXIE RADIO SUPPLY CO., INC.
1900 Barnwell Street
P.O. Box 408
(803) 253-5333
Star-Stores located in:
* ANDERSON, SC
1206 South Murray Avenue
P.O. Box 176
(803) 226-3421
* AUGUSTA, GA
1234 Gordon Park Road
P.O. Box 702
(404) 722-2055
* CHARLOTTE, NC
2220 South Tryon Street
P.O. Box 10563
(704) 377-5413
* FLORENCE, SC
531 East Palmetto Street
(803) 669-8201
* GASTONIA, NC
507 West Airline Avenue
(704) 864-3281
* GREENVILLE
500 Pendleton Street
P.O. Box 46
(803) 232-5357
* GREENWOOD, SC
116 Circular Street
(803) 229-4954
* SUMTER, SC
25 Guignard Drive
(803) 775-2306

SPARTENBURG
DIXIE RADIO SUPPLY CO., INC.
208 East St. John Street
P.O. Box 2746
(803) 583-3681

SOUTH DAKOTA

MITCHELL
ELECTRONIC SUPPLY
119 East 1st Street
(605) 996-4300

RAPID CITY
CHRIS SUPPLY CO.
403 West Blvd.
(605) 342-5900

SIOUX FALLS
GOURLEY DISTRIBUTING CO.
324 North Main
(605) 336-1466
WARREN RADIO SUPPLY
196 East 6th Street
(605) 336-1830

TENNESSEE

BRISTOL
BRISTOL ELECTRONICS
830 State Street
(615) 764-0157

KNOXVILLE
GRAYBAR ELECTRIC
1723 Grand Avenue
(615) 546-7550
BONDURANT BROS.
Box 2069 - 906 Sevier Avenue
(615) 577-0473
SHIELDS ELECTRONICS, INC.
704 North Central
(615) 524-7338
Star Store located in:
* CHATTANOOGA
1817 Dodds Avenue
(615) 624-0071

MEMPHIS
FRANK G. UFFER & CO.
1318 Madison Avenue
(901) 725-6743
WARREN RADIO CO.
190-192 South Cooper
(901) 274-2460
Star Store located in:
* DYERSBURG
Hwy. 51 North
(901) 285-3850
WOODSON-BOZMAN
3870 New Getwell
(901) 362-1500

NASHVILLE
KEITH-SIMMONS CO., INC.
621 Davison Street
(615) 259-3600

TEXAS

AMARILLO
AMARILLO HARDWARE
500-622 Grant Street
(806) 376-4726

AUSTIN
WHOLESALE ELECTRONIC SUPPLY
507 Pressler Street
(512) 478-9568

CORPUS CHRISTI
DOUGLAS ELECTRONICS
1118 South Staples
(512) 883-5103

DALLAS
THE STEWART CO.
11000 N. Central Expressway
(214) 691-5555
WHOLESALE ELECTRONICS
2809 Ross Avenue
(214) 824-3001
Star Store located in:
* SHREVEPORT, LA
2530 Linwood
(318) 422-2063

EL PASO
SUNLAND SUPPLY
2227 Texas Avenue
P.O. Box 1736
(915) 533-5901

FORT WORTH
ALLIED ELECTRONICS
401 East 8th
(817) 335-2551

HOUSTON
ANGIE ELECTRONICS
2300 Chenevert Street
(713) 222-6386
GILBERT'S ELECTRONICS
3303 North Main
(713) 225-0107
AUTOMATIC DISTRIBUTING
521 Harvey Wilson Drive
(713) 675-6521
ELECTROTEX
2300 Richmond
(713) 526-3456
Star Stores located in:
* HOUSTON
4435 Airline
(713) 695-6851
* LUFKIN
430 Atkinson
(713) 632-4409
* HOUSTON
8540 Winkler Drive
(713) 941-7016
* BEAUMONT
1275 South 11th
(713) 838-6421
Meeting Date: December 4

IRVING
ELECTROTEX
3417 East Carpenter Freeway
(214) 259-4510

McALLEN
McALLEN RADIO ELECT., INC.
401 South Broadway
(512) 682-2412
Star Store located in:
* BROWNSVILLE
Brownsville Radio
311 12th
(512) 546-4511

ODESSA
MIDLAND SPECIALTY CO.
2101 Andrews Hwy.
(915) 337-7365
Star Store located in:
* EL PASO
2235 Wyoming Avenue
(915) 533-9555

SAN ANGELO
GUNTER WHOLESALE CO.
606 S. Irving St.
(915) 655-9181

SAN ANTONIO
ELECTROTEX
1200 West Hildebrand
(512) 735-9271
Star Stores located in:
* CORPUS CHRISTI
4019 Brett
(512) 854-5306
* AUSTIN
914 West 12th
(512) 476-7644
JOE THIELE CO.
3003 Anoil
(512) 227-2491

TEXARKANA
McCULLOCH ELECTRONICS
1222 Main Street
(214) 792-6923

UTAH

PROVO
CENTRAL UTAH ELECT. SUPPLY
735 State Street
(801) 373-7522

VERMONT

BURLINGTON
VERMONT HARDWARE
180 Flynn Avenue
(802) 864-6835

VIRGINIA

ARLINGTON
ARLINGTON ELECTRONIC WHLSL.
3636 Lee Highway
(703) 524-2412

HAMPTON
CAIN ELECTRONICS
408 Aberdeen Road
(804) 826-5535

LYNCHBURG
WOMACK RADIO SUPPLY
1717 Park Avenue
(804) 845-5983

NORFOLK
CAIN ELECTRONICS
1530 Ingleside Road
(804) 855-3394

RICHMOND
AVEC ELECTRONICS CORP.
711 Granby Avenue
(703) 359-6071
MERIDIAN ELECTRONICS
1001 West Broad Street
(703) 353-0040

ROANOKE
PEOPLE'S RADIO & TV
1015 Moorman Road N.W.
P.O. Box 6067
(703) 342-8933
SOUTHEASTERN RADIO SUPPLY
1330 Courtland Road, N.E.
(703) 344-6611
Star Store located in:
* DANVILLE
215 Craghead Street
(804) 792-0811

WASHINGTON

SEATTLE
WESTERN ELECTRONICS SUPPLY
717 Dexter North
(206) 284-0200

SPOKANE
AMFAC ELECTRIC SUPPLY
E. 3420 Ferry Avenue
(509) 435-0611

TACOMA
A.T. STEWART
711 Broadway
(206)272-1112
C & G ELECTRONICS
2502 Jefferson Avenue
(206) 272-3185
Meeting Date: December 10

TUKWILA
CENTRAL DISTRIBUTORS
1179 Andover Park West
(206) 243-9611

WENATCHEE
MIDSTATE ELECTRONICS
611 A Wenatchee Avenue
(509) 662-8103

YAKIMA
LAY & NORD
511 South 3rd Avenue
(509) 453-5596

WEST VIRGINIA

FAIRMONT
STATE ELECTRONICS CO.
503 Virginia Ave.
(304) 366-4520
Star Stores located in:
* MORGANTOWN
505 Beechurst
(304) 292-1641
* UNIONTOWN, PA
104 West Peter Street
(412) 437-6110

WISCONSIN

EAU CLAIRE
BUSHLAND RADIO SPECIALTIES
1728 Loring Street
(715) 832-0425

GREEN BAY
NESLO, INC.
715 14th Avenue
(414) 437-5496

MILWAUKEE
ACME RADIO SUPPLY CORP.
511 North Broadway
(414) 271-0641
MARSH ELECTRONICS
6047 West Beloit Road
(414) 545-6500
Meeting Date: February 10
PARTS MART
1314 North 7th Street
(414) 276-4160

OSHKOSH
ELECTRONIC INDUSTRIES, INC.
19 East Irving Street
(414) 235-8930

SHEBOYGAN
J.J. KOEPSELL COMPANY
1010 South 9th Street
(414) 457-3646

WYOMING

CASPER
FLEMING SUPPLY
332 East "A" Street
(307) 234-7144

PUERTO RICO

ARECIBO
ARECIBO ELECTRONICS
P.O. Box 1787 - Gonzalo Marin #59
(809) 878-4350

BAYAMON
REFEBRACON ELECTRONICS
D43 Marginal Street
Extension Forest Hill
(809) 785-6153

CAPARRA TERRACE
TELE IMPORT, INC.
1413 Avenida Central
(809) 783-6735 or
(809) 783-6814

HATO REY
ALL TV PARTS
81 Munoz Rivera Ave.
(809) 765-4508

MAYAGUEZ
CARRION RADIO SHOP
150 Calle 11 de Agosto, Este.
(809) 832-1274

PONCE
TELE RADIO PARTS SUPPLIERS
Box 5540 (Atocha 122 Esq. Tricoche)
(809) 842-0198

SANTURCE
IMPORTADORA TELE PARTS, INC.
#605 Pedro de Castro St.
(809) 724-4450 or
(809) 725-7010

SANTURRE
ELECTRONICS CENTER CORP.
P.O. Box 8413
(809) 724-3823 or
(809) 724-0175

Action Request Card

IF YOU ARE INTERESTED IN A SENCORE PRODUCT AND WOULD LIKE FURTHER ACTION TAKEN, SIMPLY COMPLETE THIS COUPON AND MAIL TO: SENCORE CUSTOMER SERVICE DEPARTMENT, 3200 SENCORE DRIVE, SIOUX FALLS, SOUTH DAKOTA 57107

10 DAY TRIAL: I AM INTERESTED IN TRYING THE SENCORE UNIT, MODEL NUMBER _____

ON A NO OBLIGATION, 10 DAY TRIAL. I UNDERSTAND THAT SENCORE HAS NO REFURBISHING CHARGES SHOULD I DAMAGE THE UNIT IN ANY WAY.

I WOULD LIKE FURTHER INFORMATION ON SENCORE MODEL NUMBER _____

PLEASE FORWARD AS SOON AS POSSIBLE.

I AM READY TO PURCHASE THE FOLLOWING SENCORE UNIT(S), MODEL NUMBER _____

I WOULD LIKE A DEMONSTRATION ON THE FOLLOWING SENCORE UNIT(S), MODEL NUMBER _____

ALL ACTION REQUESTS WILL BE FORWARDED TO YOUR NEAREST SENCORE FLPD DISTRIBUTOR, UNLESS YOU SPECIFY YOUR PARTICULAR FLPD DISTRIBUTOR HERE:

_____
DISTRIBUTOR CITY STATE

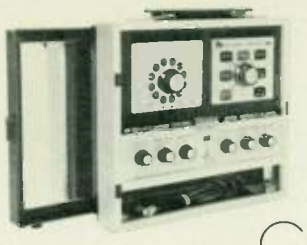
MY NAME IS: _____

ADDRESS: _____

_____
CITY STATE ZIP

TELEPHONE _____

COLOR GENERATORS



CG169

CG169 DELUXE COLOR KING DIGITAL COLOR BAR GENERATOR
EXCLUSIVE ALL-CHANNEL TUNING for operation in any part of the U.S.
EXCLUSIVE TEMPERATURE CONTROL to warm power supply up on cold days or dry out moisture in humid areas.
EXCLUSIVE CONVERGENCE PATTERNS. Moveable single dot and single cross makes convergence a snap.
75 OHM OUTPUT for MATV, CATV systems, with 300 ohm balun for conventional antenna systems.
100% DIGITAL for Rock Solid patterns.
THE ONLY ALL-CHANNEL, ALL-WEATHER DIGITAL COLOR BAR GENERATOR.

CG169 SPECIFICATIONS

Temperature Limits: Useful range of operation: 20° to +120°F (-30°C to 50°C). Operation within specified tolerances: 50° to 100°F (10° to 40°C).
TV Channels: VHF: LO BAND: Channel 2, 3, 4, 5, 6. HI BAND: Channel 7, 8, 9, 10, 11, 12, 13. UHF: Channel 23, 26, 29, 32, 35, 38, 41.
Output Levels: VHF: Maximum Output: 1000uV ± 5db into 300 ohm. UHF: Maximum Output: 1000uV ± 8db into 300 ohm Adjustable.
Patterns: Color bars, Horizontal lines, Vertical lines, Crosshatch, Dots, Single lines, Single dot. Signal to Sync ratio: 40:60 to 60:40 maximum. Single Horizontal Line Position: Adjustable off screen top and bottom. Single Vertical Line Position: Adjustable off screen left or right. Color Oscillator Frequency: 3563816 ± 10Hz at 72°F. Color Signal Amplitude: At 200% setting, color burst amplitude equals sync pulse amplitude, ± 15%.
Sound Carrier Amplitude: 30 ± 10% of the P-P video and sync amplitude as measured on the composite signal line just after the sync clipper.
Video and Sync Frequencies: Vertical lines and master oscillator: 188.8KHz ± 0.1, ± .02%. Horizontal Sync: 15733Hz ± 0.1, ± .02%. Vertical Sync: 60.04Hz ± 0.1, ± .02%.
General: POWER REQUIREMENTS: 70 - 135VAC, 50-60Hz, 25 watts. (220VAC conversion available). SIZE: 10½"x10½"x4 1/8". WEIGHT: 8 lbs.

CG169 DELUXE COLOR KING. $225.00

CG25

CG25 "LITTLE HUEY" DIGITAL COLOR BAR GENERATOR

ALL THE PATTERNS you'll need. Standard color bar, Vert. lines, Horiz. lines, Crosshatch, Dots and Blank raster.
DIGITAL TIMING for locked in patterns that just can't bounce.
BIG GENERATOR FEATURES with color adjust and channel tuning.
LOW POWER DRAIN for long battery life. Automatic shutoff after 15 minutes to back you up.
CABLE STORAGE COMPARTMENT. No messy cords to untangle.
PUSHBUTTON OPERATION for fast and easy pattern selection.

CG25 SPECIFICATIONS

TV Channel Frequency: Factory set to Channel 4 (67.25MHz) ± 500KHz. Adjustable to 2, 3, 5, or 6 (55.25 - 83.25MHz). **PATTERNS:** Color bars, Horizontal lines, Vertical lines, Crosshatch, Dots and Blank raster.
Video and Sync Frequencies: (–20°F to +120°F); Vertical lines, and Master oscillator—188.8KHz, –.1% to +.02%. Horizontal Sync: 15,733Hz –.1% to +.02%. Horizontal Lines: 960.64Hz –.1% to +.02%. Vertical Sync: 60.04Hz –.1% to +.02%. Color Signal: 3.563812MHz ± 10Hz @ 70°F.
Battery Type: One 5.6 volt mercury, Eveready E164, NEDA 1404, or equivalent (minimum operating voltage 4.2V).
General: POWER CONSUMPTION: Color Bars: 6.6mA at 5.6V. All other outputs: 6.2mA at 5.6V. AUTOMATIC TURN OFF TIME: 20 minutes typical. SIZE: 2"x4"x6". WEIGHT: 2 lbs.

CG25 "LITTLE HUEY" $99.00

TRANSISTOR TESTERS

PATENTED

TF26

TF26 TOUCH TONE CRICKET

LETS ANYONE TROUBLESHOOT ENTIRE SOLID STATE BOARDS IN SECONDS – WITHOUT SET-UP INFORMATION.
ONE SIMPLIFIED PATENTED IN OR OUT OF CIRCUIT TEST for all NPN, PNP transistors and N-Channel or P-Channel FET's.
NO SET-UP DATA OR TECHNICAL KNOWLEDGE REQUIRED. Just hook the three "E-Z" Hooks up to the transistor leads in any order, and push the 6 buttons for a 99.9% reliable "GOOD-BAD" readout.
SENSITIVE OUT-OF-CIRCUIT LEAKAGE CHECK lets you measure all inter-element leakage values to catch marginal transistors.
RUGGED PORTABILITY with tough acrylic and vinyl clad steel case, sliding meter cover and lead storage compartment.
AUDIBLE TONE plus meter indication tells if a transistor is good. (The tone was added because the test can be made so fast, the meter may not have time to deflect.)

TF26 SPECIFICATIONS

Type Devices Tested: Diodes, transistors, Darlingtons and single gate FET's.
Test Voltages: GAIN TEST: V_{ce} = ± 5V. V_{be} = ± 3V p-p, 2000Hz centered on zero reference.
Test Currents for Gain Test: I_C = 10mA max. I_B = 7mA max.
Leakage Test (Out of Circuit Only): Range: 0 - 3000 microamps.
Illuminated Meter: 4½", 100 microamp, D'Arsonval meter movement with specially designed jewel pivot meter movements for shock protection.
General: SIZE: 10"x5½"x3½". WEIGHT: 4 lbs. POWER: 105 - 130 volts, 50-60Hz AC, 5 watts (220VAC conversion available.)

TF26 TOUCH TONE CRICKET $150.00

PATENTED

TF30

TF30 SUPER CRICKET

NOW COMPLETELY ANALYZE ANY TRANSISTOR OR FET IN SECONDS – WITHOUT ANY KNOWLEDGE ABOUT THE TRANSISTOR WHEN YOU START.
IT'S A PATENTED CRICKET for fast, 99.9% reliable, in circuit trouble-shooting without a reference book.
IT'S AN AUTOMATIC TRANSISTOR ANALYZER. Simply rotate the function control and push for complete parameter tests, including Beta, Icbo, Gm, Igss and Idss, without zeroing or calibrating.
IT AUTOMATICALLY IDENTIFIES ALL THREE LEADS in seconds with front panel roll chart.
IT WILL IDENTIFY A TRANSISTOR FROM AN FET without a reference book.

TF30 SPECIFICATIONS

Devices Tested: Diodes, transistors, Darlingtons, single and dual gate FET's.
Regular (Bi-Polar) and FET Transistors. In-Circuit Test: TEST METHOD: Dynamic gain indication with patented phase inversion circuit. TEST FREQUENCY: 2KHz. TEST VOLTAGE: V_{ce} = ± 5.6VDC. V_{ce} = 7mA max. (3mA average continuous.)
Regular Bi-Polar Transistor: Out-Of-Circuit Gain Test: TEST METHOD: Self zeroing dynamic AC Beta. TEST FREQUENCY: 2KHz. TEST VOLTAGE: V_{ce} = ± 5.6VDC. V_{be} = 7V p-p. TEST CURRENTS: I_C. Low Power: 15mA. Med. Power: 150mA. I_B: Low Power: 30uA. Med. Power: 100uA. High Power: 300uA. BETA RANGE: 0 - 500. **Leakage Test (Icbo):** TEST LEVELS: V_{cb} = 4VDC (emitter open.) LEAKAGE RANGE: 0 - 2500 microamps.
Field Effect Transistor: Out-Of-Circuit Gain Test: TEST METHOD: Dynamic mutual conductance. TEST FREQUENCY: 2KHz. TEST VOLTAGE: V_{ds} = ± 5.6VDC, V_{gs} @ 0VDC, Signal Level: .4 volts p-p. Gm RANGE: 0 - 15,000 micromhos. **Leakage Test (Igss):** VOLTAGE LEVEL: V_{gs} = ± 4VDC (source open.) LEAKAGE RANGE: 0 - 25,000 microamps.
General: METER: 6", 100uA, 2%, POWER: 105 - 130VAC, 50-60Hz, 8.5 watts (220VAC conversion available.) SIZE: 9¾"x7½"x7¼". WEIGHT: 6 lbs.

TF30 SUPER CRICKET. $240.00

TIME SAVERS

FS134

FS134 PORTABLE FIELD STRENGTH METER
EQUIP YOURSELF FOR CATV, MATV AND ADDITIONAL ANTENNA WORK
HIGHLY SENSITIVE all the way down to 30 microvolts.
STANDARD REFERENCE of zero DB = 1000 microvolts for direct signal strength reading.
COMPLETELY PORTABLE with battery operation.
BOTH 75 AND 300 ohm inputs.

FS134 SPECIFICATIONS

Tuning Range: 53MHz to 109MHz – TV Channels 2 to 6; FM: 173MHz to 218MHz – TV Channels 7 to 13. 465MHz to 895MHz – TV Channels 14 to 83. **SENSITIVITY:** 53MHz to 109MHz – 30 microvolts ± 3db. 173MHz to 218MHz – 30 microvolts ± 3db. 465MHz to 895MHz – 30 microvolts ± 3db.
Selectivity (Bandwidth): 500KHz @ 3db points. **IF FREQUENCY:** 42.8MHz. **INPUT IMPEDANCE:** 75 ohms or 300 ohms with built-in Matching Transformer. **IMAGE REJECTION:** 53MHz to 109MHz – 40db. 173MHz to 218MHz – 40db. 465MHz to 895MHz – 30db. **IF REJECTION:** 40db. **AUDIO POWER OUTPUT:** 150 milliwatts. **POWER REQUIREMENT:** Nine "C" cell batteries. 39G15 Accessory battery charger, used with a rechargeable battery available. **METER RANGE:** 30 - 30,000 microvolts (60db) on logarithmic scale.
General: SIZE: 9½"x10"x5". WEIGHT: 9 lbs. TEMPERATURE RANGE: –5 to +140°F storage range.

FS134 PORTABLE FIELD STRENGTH METER . . $275.00
(Effective January 1, 1976 . . . . . $395.00)

NEW!

YF33

PATENT PENDING

YF33 "RINGER" YOKE & FLYBACK TESTER

PATENT PENDING RINGING TEST checks yokes, flybacks and most other air core coils in seconds with one simplified pushbutton test.
100% RELIABLE – If the Ringer says a coil is GOOD, you're 100% sure.
IN OR OUT OF CIRCUIT testing on both tube and solid state sets – It's the only universal yoke and flyback tester available today.
COMPLETE SWEEP CIRCUIT ANALYZER including 30V p-p and 300V p-p scales for drive signals, plus 10Kv and 50Kv scales, for focus and high voltage.

YF33 SPECIFICATIONS

Ringing Tests: TEST: Dynamic Ringing test counting number of cycles coil rings before reaching a pre-set damping point after a given exciting pulse has been applied. EXCITING PULSE AMPLITUDE: 0 to + 15V p-p. EXCITING PULSE REPETITION RATE: 100 - 120 pulses/sec. "GOOD-BAD": Meter calibrated to give "GOOD" reading for 10 or more cycles. Accuracy: ± 1 cycle at midscale.
P-P Drive Scale: RANGE: 0 - 30VAC p-p; 0 - 300V AC p-p.
High Voltage Scale: RANGE: 0 - 10Kv DC (with optional FP201 probe). 0 - 50Kv DC (with optional 39G89 probe used with FP201 probe.) Accuracy: ± 3% Full Scale.
General: POWER REQUIREMENTS: 105 - 130VAC, 50-60Hz, 10 watts. (220VAC conversion available). CASE: Molded acrylic and vinyl covered steel. SIZE: 10"x5½"x3⅜". WEIGHT: 4¼ lbs.
Accessories: High Voltage Probe Set: FP201 and 39G89 . . . . . $35.00.

YF33 RINGER $195.00

SUBSTITUTORS

RC24 RC167

RC24 "PARTS PAK"
COMPACT AND TRULY PORTABLE to fit in any tool box or parts caddy, neatly and conveniently, to clean up messy loose resistors and capacitors.
FULL SURGE PROTECTION just like the RC167, for increased uptime – less downtime.

RC24 SPECIFICATIONS

Resistors: 24 values from 10 ohms to 5.6 megohms. 1 watt to 5.6K, ½ watt over 5.6K.
Capacitors: 9 values from 100pf to .5mfd at 600 volts.
Electrolytics: 100mfd at 450 volts, 1000mfd at 75 volts.

RC24 "PARTS PAK" $45.00

RC167 THE SUBSTITUTOR
IT'S A REAL TIME SAVER WITH A FULL RANGE OF RESISTORS, CAPACITORS, ELECTROLYTICS AND RECTIFIERS.
SURGE PROTECTION switch eliminates surge current so the electrolytic cannot be healed, plus eliminates arcing. Warning light next to switch indicates if more than 75 volts is applied to any 75 volt position or if polarity on any electrolytic is reversed for double protection.
EXCLUSIVE PARTS IN A DRAWER for easy access to common substitute parts, plus doubles as a mount for bench installation.
UPDATED FOR SOLID STATE WORK with 2000mfd electrolytic.

RC167 SPECIFICATIONS

Resistors: 24 values from 10 ohms to 5.6 megohms. 1 watt up to 5.6K, ½ watt over 5.6K. 20 values @ 10 watt from 2.5 – 15K ohms.
Capacitors: 10 values from 100pf to .5mfd, at 600 volts.
Electrolytics: 2, 5, 10, 20, 50, 100, 200mfd at 450 volts. 500, 1000, 2000mfd at 75 V.
Rectifiers: Universal selenium and silicon rectifier substitutes, ½ amp forward; 800PIV.
Protection: Surge protector switch plus warning light next to the switch.

RC167 THE SUBSTITUTOR $99.00

STEREO ANALYZER

SG165 AM - FM STEREO ANALYZER

ONLY COMPLETE STEREO ANALYZER WITH SPECS BETTER THAN YOUR FM STATION.

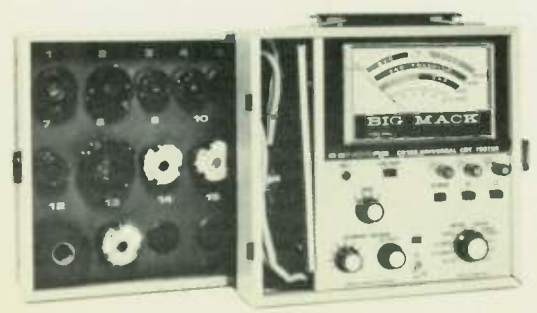
THE ONLY INSTRUMENT YOU NEED to service any brand of stereo equipment.
CHECKS EVERY STAGE of a receiver from antenna to speaker, with all 12 signals for complete testing.
SINGLE OUTPUT CABLE for all functions eliminates confusing bench tangle.
EXCLUSIVE FULL RANGE AM - FM tuning with broadcast quality signals.
10.7MHZ CRYSTAL CONTROLLED or adjustable for the latest receivers.
DIRECT - READING OUTPUT meters to 100 watts RMS for power testing or – 40db for separation.
BUILT - IN SPEAKER LOADS save the output stages and your ears.
PATENTED 19KHz PILOT is phase-locked to guarantee you are aligning to a signal identical to your station.

SG165 SPECIFICATIONS

FM RF: 86 to 110MHz, modulated or unmodulated CW.
FM IF: 10.7MHz, modulated or unmodulated crystal controlled CW (FM Modulation: FCC or IHF level, 400Hz sine wave).
FM IF Sweep: 10.7MHz with post injected markers at 10.7, 10.6, and 10.8MHz. Two lead hook-up from receiver to scope.
Multiplex: FCC or IHF level stereo.
SCA: 67KHz for setting subscription signal traps.
AM RF: 525 to 1625KHz, 400Hz sine modulated or unmodulated.
AM IF: 262 or 455KHz, 400Hz sine modulated or unmodulated.
Audio: 400Hz sine or square wave for amplifier power and frequency tests.
Dual Monitoring Meters for constant check of each stereo channel.
Meters: 3½", D'Arsonval, calibrated from 0 to –40db, 0 to 10 watts, and 0 to 100 watts RMS.
Speaker Dummy Loads: Up to 100 watts RMS for full power test. Speaker direct, 4, 8, 16, or 32 ohms to match receiver being tested.
Output: Single cable for RF, IF, Sweep, Audio – all one common cable. All cables, auto radio adaptor included.

SG165 AM-FM STEREO ANALYZER $595.00

CRT TESTERS



CR168 BIG MACK
IT'S YOUR NUMBER ONE CUSTOMER CONVINCER

TESTS THEM ALL including new RCA 110° color tube, the thin neck in-line tubes and the 17" Japanese Trinitron.
PATENTED AUTOMATIC TRACKING: You simply read tracking on the big meter after making emission tests.
COMPUTER MEMORY CIRCUITS store CRT information for the tracking test.
LARGE 7 INCH METER with easy to read "GOOD-BAD" test that convinces your customer "she" needs a new CRT.
SAFE REJUVENATION with RC timed voltages. Takes all the guesswork and hazard out of rejuvenation.

CR168 AUTOMATIC CRT TESTER $275.00

CR31 SUPER MACK

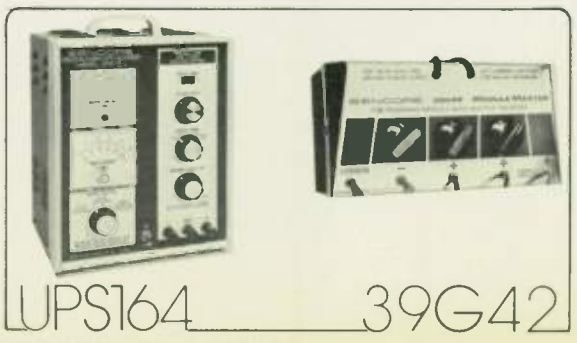
GUARANTEED TO OUT PERFORM ANY OTHER CRT TESTER AND RESTORER OR YOUR MONEY BACK.
COMPLETE, PATENTED, AUTOMATIC CRT TESTS.
COMPLETE AUTOMATIC RESTORATION with 5 increasing levels to get the job done, effectively, yet safely.
COMPLETE "ERROR PREVENTING" CIRCUIT TESTS including: Line Voltage, Focus and High Voltage.
COMPLETE WITH ALL SOCKETS AND ACCESSORIES – no hidden costs – you'll always be prepared.

CR31 SPECIFICATIONS

Filament Voltage: Continuously variable from 1 - 14 volts. **Shorts Test:** H-K Shorts: 2 Meg sensitivity. G1 Shorts: 20 Meg sensitivity. **Emission Scale:** Measures zero bias beam current for CRT under test. **Meter Sensitivity:** Low end of GOOD: 300uA. High end of BAD: 200uA. **Tracking Scale:** Ratio of 1.55 to 1, or greater will indicate BAD tracking. **Line Voltage Scale:** ± 2% of meter reading. **10Kv and 50Kv DC Voltage Scale:** ± 3% of full scale. **Restore:** Auto Cycle: 0 - 100mA current. Nominal 4 seconds ON and 2 seconds OFF for 3 cycles. ON time adjustable from front panel. Restore Manual I: 0 - 100mA restore current. Restore Manual II: 0 - 150mA restore current. Two rejuvenate positions. G1 shorts removal.
General: METER: 6", 100uA, 2%, 1900 ohms. SIZE: 12¼"x11"x7". WEIGHT: 13¼ lbs. POWER REQUIREMENTS: 105 - 130VAC, 50-60Hz, 25 watts. (220VAC conversion available).

CR31 SUPER MACK $395.00
(Effective January 1, 1976 . . . . . $495.00)

PWR. SUPPLY



UPS164 UNIVERSAL POWER SUPPLY
COMPLETE CB OR AUDIO SERVICING supply, especially for mobile units.
REGULATED low ripple supply for a constant, reliable power source for variable .5 to 30 volts DC, 0 - 2 amps.
MONITORS VOLTAGE AND CURRENT to speed work with continuous readout of supply parameters.

UPS164 SPECIFICATIONS

.5 - 30 Volt Variable, Regulated, High Filtered Supply: VOLTAGE OUTPUT: .5 - 15, .5 - 30 volts DC, regulated and continuously variable (35 volts available at less than 1 amp load). 0 - 2 amps continuous current limiting protection. RIPPLE: 5.4mV p-p **Current Limiting Protection:** Adjustable with no overshoot above set limit, 2 amp max. **Standard 6 Volt Fixed Supply:** VOLTAGE OUTPUT: 7.5 volts (no load). 4.5 volts (full load). CURRENT OUTPUT: 20 amps continuous at 4.5 volts. 28 amp maximum surge. RIPPLE: No Load: .10 volts p-p or less. 10 amp load: 2.5 volts p-p or less. Full Load: 4.0 volts p-p or less.
General: METERS: (Voltage and Current) Switched for either 0 - 30 volt regulated supply, 6 or 12 volt supply. Accuracy: ± 3%. POWER REQUIREMENTS: 105 - 130VAC, 60Hz, 30 watts (max. load). (220VAC conversion available). SIZE: 10"x13½"x9½". WEIGHT: 23 lbs.

UPS164 UNIVERSAL POWER SUPPLY . . . $260.00
(Effective January 1, 1976 . . . . . $290.00)

39G42 MODULE MASTER
The Module Master will convert the single output of the UPS164 to two adjustable positive current limited and regulated outputs, and one adjustable negative supply with zener regulated maximum output voltage, plus one positive output that is controlled by the power supply.

39G42 MODULE MASTER $35.00

SWEEP/MARKER EQUIPMENT

SM158 SPEED ALIGNER SWEEP AND MARKER GENERATOR

SWEEP OUTPUT: Chroma, IF, or RF with front panel fine tuning.

CRYSTAL CONTROLLED MARKERS post injected for alignment accuracy.

UNLIMITED MARKER AMPLITUDE so you may place all markers at any height without affecting the curve.

15 MEGAHERTZ SWEEP WIDTH to cover the entire IF band.

GENERATES A ZERO REFERENCE BASELINE: All alignment instructions show a baseline, and the SM158 shows you exactly where zero is.

PUSHBUTTON MARKERS for the 8 most often used IF frequencies: 39.75, 41.25, 41.67, 42.17, 42.67, 44.25, 45.75, 47.25. Trap and carrier markers listed right on the front panel. 3.08, 3.58, 4.08, and 4.5MHz for chroma.

SWITCHABLE HORIZONTAL OR VERTICAL MARKERS: Just pull the marker height control out and markers appear horizontally so you can view them easier in traps or for leveling.

SM158 SPEED ALIGNER $275.00

BE156 7 - IN 1 D.C. BIAS SUPPLY

PROVIDES THE BIAS YOU NEED FOR ANY SET – IN ANY STAGE.

3 SEPARATE SUPPLIES for fast alignment work.
NEGATIVE AND POSITIVE SUPPLIES for both tube and solid state work.
NEGATIVE 75 VOLTS for sets requiring high negative bias in chroma amplifiers.

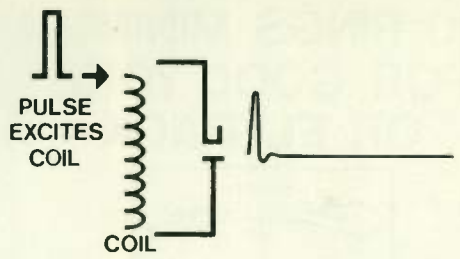
BE156 7 in 1 BIAS SUPPLY $39.00
(Effective January 1, 1976. . . . . $49.50)

Prices and specifications subject to change without notice.

Form 1121P

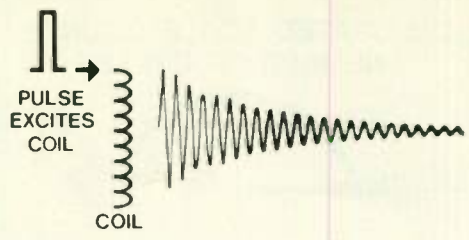
DISTRIBUTED BY:

Some technicians have used ohmmeters to test coils. However, this is not very reliable, because a meter shows virtually no difference between a shorted coil and a good coil. So you're stumped. Other technicians have gone to using the scope Ringing test. Here's how this test works.



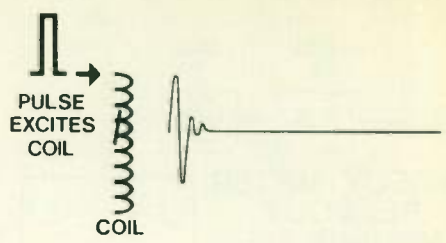
DAMPED COIL RINGS LIKE THIS

If you recall, coils will ring when hit with an input pulse. This ringing effect is used to generate the flyback pulse in a TV set. However, only the first half cycle of the flyback is needed in a TV, so the damper diode is used to short out the rest of the ringing cycles.



COIL RINGS WITH DECAYING AMPLITUDE

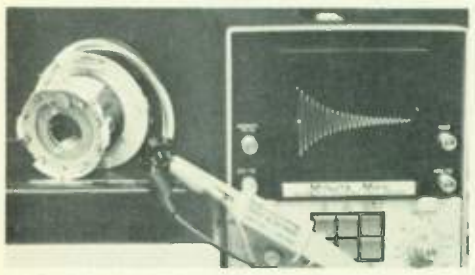
If we disconnect this damping diode, however, and hit this good coil with a pulse, we will get continuous ringing as shown here. This is a test of the coil under actual operating conditions.



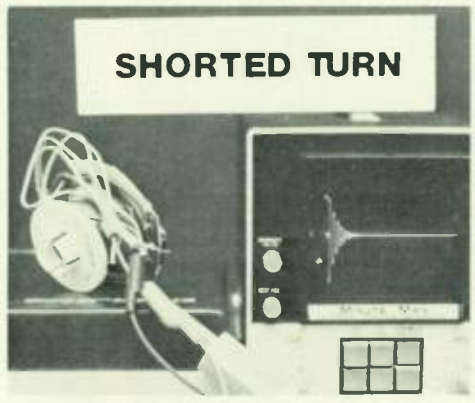
SHORTED COIL DECAYS RAPIDLY

A coil with a shorted turn will ring like this, with only a few oscillations, in most cases. An open winding will not ring at all.

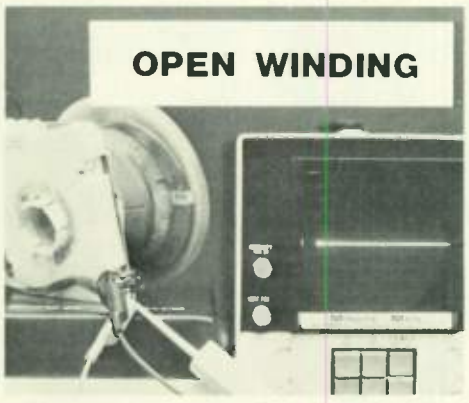
NORMAL RINGING ACTION



So, if you are using a Sencore scope, you can take a pulse off of the sweep output on the back of the scope, connect that to the coil under test, and analyze the ringing waveform that is produced on the scope. If the coil is good, the Ringing test looks like this.

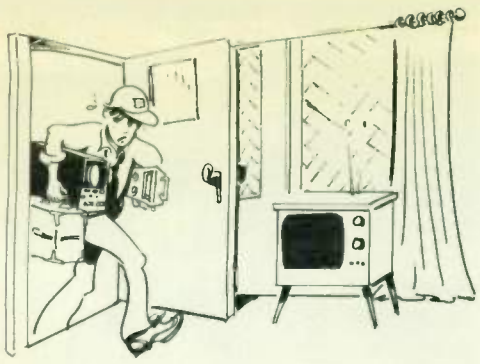


If the coil is shorted, the Ringing test looks something like this.

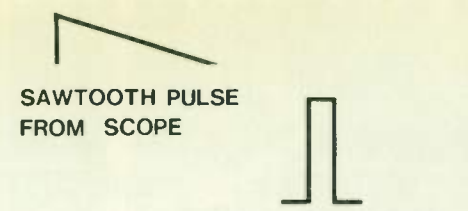


If the coil is open, the test looks like this. Now this may sound pretty good, but there are several problems.

First, many scopes do not have an external sweep pulse that you can use. This would limit you right here.

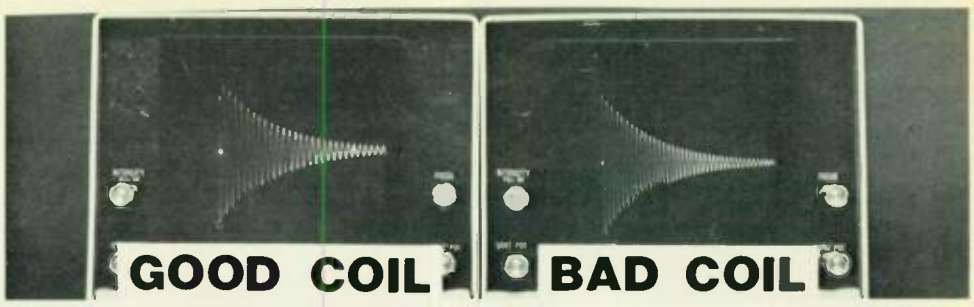


Then there's the fact that most scopes are not meant for field work. This test doesn't become very practical, unless you want to take in a scope on every call.



Add to this, the fact that a coil requires a sharp pulse with a steep wavefront. A scope generates a sawtooth that must be converted into a pulse before it can be used.

DECAY IN EXACT AMPLITUDE IS HARD TO DETERMINE FROM SCOPE



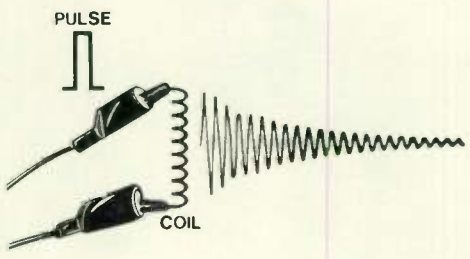
The biggest problem, however, is the fact that the scope test requires interpretation.

How about these two tests? They look the same, yet the left coil is "Good" and the right coil "Bad."

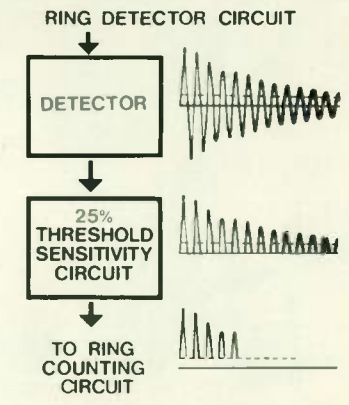
THE RINGER IN ACTION

But the Ringer eliminates all of this guesswork, in one portable unit, so you can test any yoke or flyback, in or out of circuit, in seconds, with a simple "Good-Bad" test, and do it right in the home. Here's how you use it.

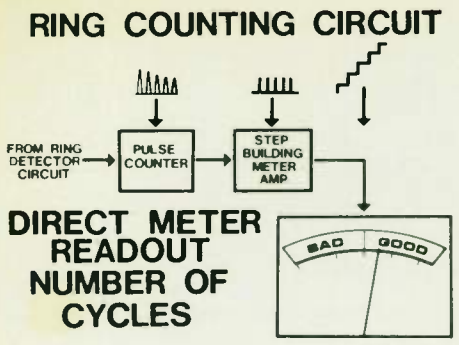
Connect the Ringer across the coil you want to test. Select the Ringing test. Then push all six impedance matching buttons, one at a time. If one or more of the buttons shows a good indication, you know the coil is good, 100 times out of 100. Now that is speed and reliability. Here's how the Ringer works.



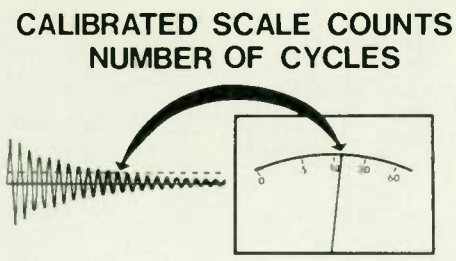
The Ringer test circuit works much the same way as the scope Ringing test, but with several major improvements for 100% reliability. When you push the six impedance matching buttons, the Ringer hits the coil with a safe 15 volt peak to peak pulse, that causes the coil to ring.



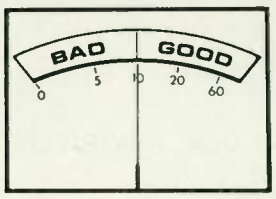
Knowing that the coil quality is directly related to the number of ringing cycles, we want to count the number of cycles. So the Ringer has a counting circuit that counts these pulses above the 25% level of the original wavefront.



These pulses are then fed to a step building meter amplifier. The steps build higher as the rings are counted. The DC meter reads higher with each ring.



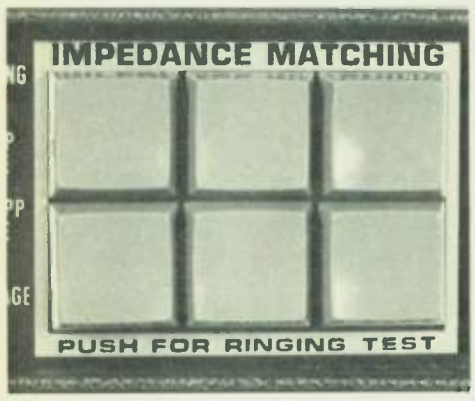
This means that we can calibrate the scale in the number of ring cycles. Now if we could set a minimum level for the number of cycles a good coil should ring before decay, we would have an effective "Q" meter that would detect any fault in the coil. And this is the real beauty of the Ringer.



After extensive testing, the Sencore Engineers determined that a good coil will ring at least 10 times before it damps down to the 25% level. Shorted or open coils ring less than 10 times. This was the big breakthrough. Now, yoke and flyback coils can be tested with a simple "Good-Bad" test, with 100% accuracy.

THE SIX IMPEDANCE MATCHING BUTTONS

Now you may be asking an obvious question, "Why not just count the number of Ringing cycles on a scope?" The big difference is the six impedance matching pushbuttons. All coils are designed to operate under a given impedance.



These six buttons change the impedance of the Ringer test circuit to match the coil impedance for actual operating conditions. The scope Ringing test can't do this since the scope has only one fixed impedance.

Each impedance matching button on the Ringer will give you a different reading. Here's the highest reading button for this coil.

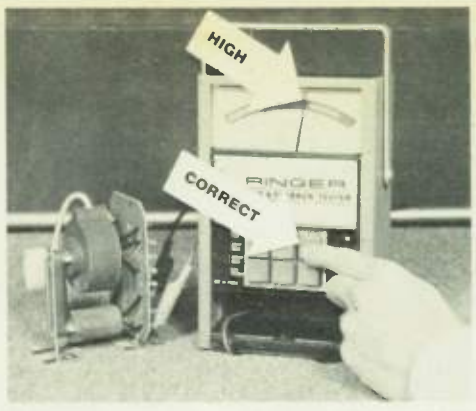
Notice the reading on another impedance matching button, for the same coil. This is the variation that you might get if you use the old fashioned scope procedure and would not even be aware of it.

This scope is ringing a good coil in a solid state set, which has a low impedance.

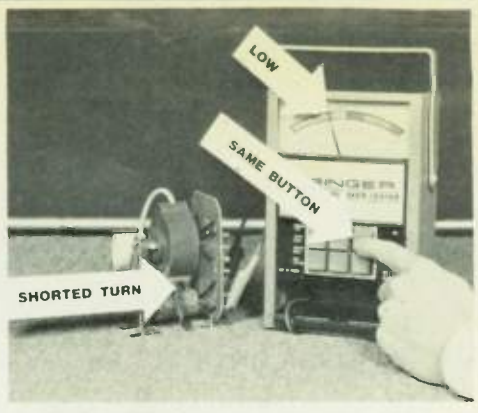
This scope is ringing a bad coil in a tube type set, which has a much higher impedance.

IMPEDANCE MATCHING OFFERS 100% ACCURACY

The scopes show both coils as the same, while the Ringer detects the good coil from the bad one. You need to match the impedance for 100% accuracy, and here's the hard proof.



Here's a typical flyback. We test it with the Ringer and it tests good. Now we'll hold down the button that gave us the highest reading, and simply short a loop of wire around the core. This wire is cutting the magnetic field the coil has developed.



And the Ringer now shows the coil as bad. This proves that the Ringer is a true, dynamic test, that tests with 100% reliability. Here's what the Ringer designers say about it's reliability.

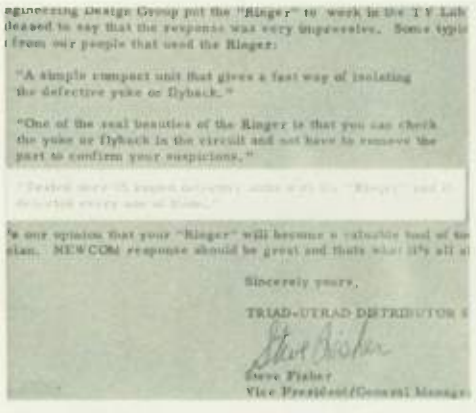
First, Bob Baum, Vice President of Engineering at Sencore.

"I personally tested over 20 known defective yokes and flybacks and the Ringer caught every one of them."

Bob Winter, the Ringer designer told us,

"I have used the Ringer on over 50 different yokes and flybacks with 100 percent accuracy."

Then we put the Ringer to the acid test, by sending one to Triad-Utrad, a leading manufacturer of yokes and flybacks. Here is what Steve Fisher,



"A simple compact unit that gives a fast way of isolating the defective yoke or flyback."

"One of the real beauties of the Ringer is that you can check the yoke or flyback in the circuit and not have to remove the part to confirm your suspicions."

Steve Fisher

Vice President and General Manager of Triad Utrad said about the Ringer.

"We tested over 45 known defective yokes and flybacks with the Ringer and it detected every one of them. It's our opinion that your "Ringer" will become a valuable tool of today's technician."

And the Ringer checks more than just horizontal yokes and flybacks. The Ringer will check the vertical yoke as well, but you might have to remove the damping resistors for accurate measurements.

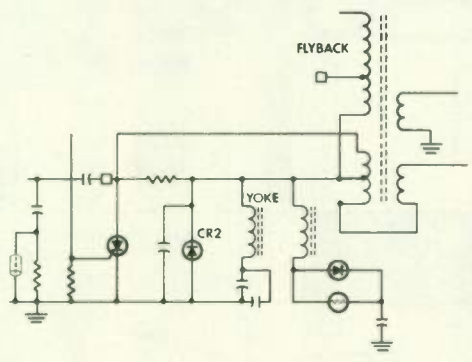
The Ringer will check small take-off coils of a flyback too. If any small take-off coil is shorted, the Ringer will show the flyback as bad.

What about the efficiency coils or pincushion transformers? Test any of the air core coils or higher frequency transformers, such as efficiency coils and pincushion transformers the same way you check the yoke and flyback, and use a comparison test on a known good coil to back you up.

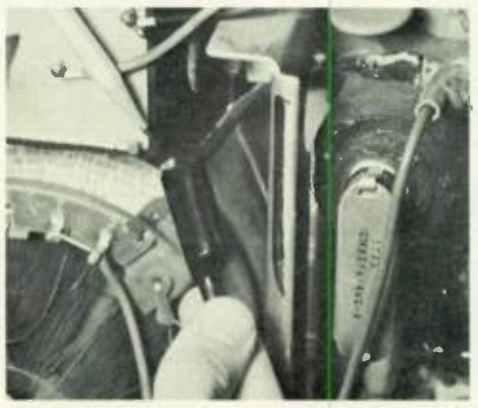
But it won't check the sluggish iron core transformer since these transformers are designed to operate at an extremely low "Q" and frequency.

Out of circuit, the Ringer is 100% reliable, on any yoke or flyback. In circuit you perform the same test. If you get a good indication, you can be 100% sure that the coil under test is good. This means, for the first time, you can eliminate the yoke and flyback as being your problem.

If you get a bad test in circuit, the first thing you want to do is disconnect the yoke from the flyback. This can be done in seconds as most of these connections are made with a plug, as shown here. Then you can proceed with the Ringing test as usual.

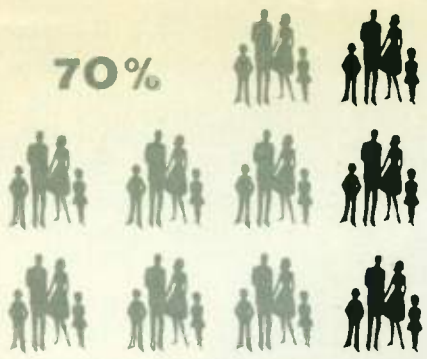


In some solid state sets, the YF33 test signal may cause conduction across the damping diodes, such as in this RCA XL100. In other chassis, components like certain voltage triplers, or damping resistors, may load the Ringing test down.

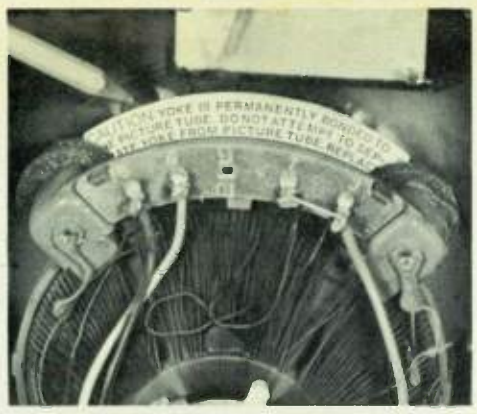


If these components can be removed, just remove them and make all tests in circuit. If you can't remove them, you can disconnect one end of the coil you are testing and proceed with 100% accuracy. And that sums it up — other than this one important point.

The Ringer is backed by Sencore's 100% Made Right Lifetime Guarantee. This is the iron-clad backing that only Sencore offers, which is indicative of the high quality designed into every Sencore product.



You know with more than 70% of all families in America now owning color TV receivers, and many of these all 100% solid state, you have more need than ever before for a complete sweep circuit analyzer.



And some of these new sets have the yokes bonded right to the picture tubes. The old substitution method won't work at all with these. A reliable yoke and flyback tester is the only answer.

Survey Reveals Four of Eight TV Manufacturers Offering 90-day Warranty

Zenith To Announce New Warranty Plan

Plus many manufacturers have cut back on their warranties, so you can earn extra profits on these jobs if you are properly equipped.

With the Ringer you can save servicing time, increase your business, and really ring up profits.

Your Full Line Distributor has this professional Sencore Yoke and Flyback demonstrator, so you can see for yourself just how the Ringer works in or out of circuit on solid state and tube driven yokes and flybacks.

And as a special offer, a 15 minute Ringer training tape will be included with your Ringer. It covers all the basic Ringer applications, for fast in and out of circuit testing, plus general operating instructions. You simply plug the tape in, and you'll be testing yokes and flybacks, with confidence, 15 minutes later.

Why not try the Ringer in your own shop for ten days with the Sencore no obligation 10 day trial. You'll find that it will begin paying for itself the very first day. Just Ring it.

The Sencore News is written, edited, and published by the Field Engineering Department of Sencore, Inc., 3200 Sencore Drive, Sioux Falls, South Dakota, 57107. The Sencore News is distributed without charge to all individuals or companies who have registered the purchase of any Sencore instrument by means of the warranty card packed with that instrument. The information herein has been taken from one or more sources which we consider reliable. Although such information has been carefully prepared, we make no representations as to its accuracy or completeness. Prices and specifications are subject to change without notice.

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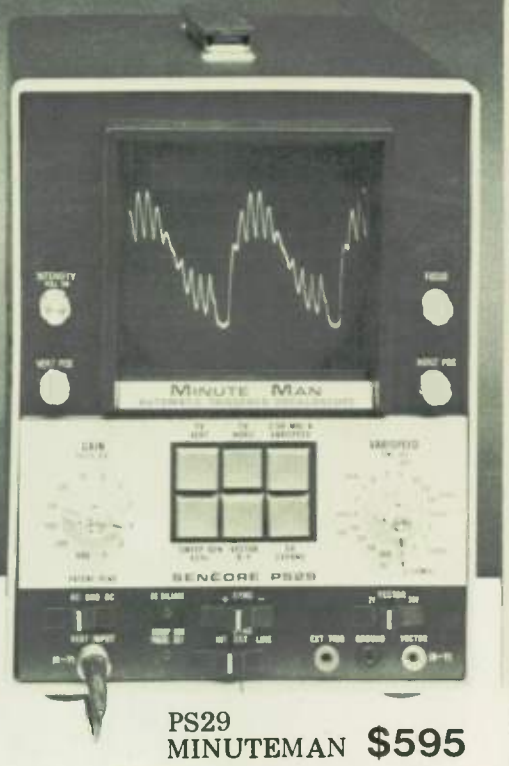

PS29
MINUTEMAN **$595**

PS163 **$795** Effective Jan. 1, $895

An oscilloscope can be the most useful tool on a technician's bench, if he knows how to put it to full use. Well, the Sencore Field Engineering Department has an answer for all the technicians that want to be able to use a scope as their "right-hand." We call it the Sencore Scope School Manual. The Scope School Manual covers the "A to Z" of oscilloscopes, from basic AC theory to scope control familiarization to measuring waveform frequency, amplitude and time delays, all the way to complete analysis of the composite video waveform in a TV receiver, plus much more.

Over 60 pages, with 99 detailed waveforms that show you the meat of Sencore Scope applications.

A Scope School manual is packed with every Sencore Scope . . . or available from your local Sencore Full Line Promotional Distributor for $10.00.

The Scope School manual is the format for the Sencore Scope Schools that are being held across the country at sponsoring Sencore Full Line Distributors. If you are interested in attending a Sencore Scope School, contact your local Sencore Distributor about setting one up with a Sencore Technical Representative.

So now you have a choice of the three popular Sencore Scopes, which are all backed by Sencore's 100% Made Right Guarantee, and now available with the new "Sencore Scope School" Manual.

ALL THREE SENCORE SCOPES ARE COVERED INCLUDING THE:

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Here is what Ken Jacobs, a Columbus, Ohio, service dealer had to say about his CR31 Super Mack . . .

"I made $475 in one week by selling the restoring service to my customers, at $25 a crack. Now that was over four months ago and not one CRT has bounced yet. That's performance. I have used the other restorers on the market and Super Mack restores CRT's that those others wouldn't touch. It has done the job every time, without one mishap. It's the biggest profit maker in my shop."

KEN JACOBS

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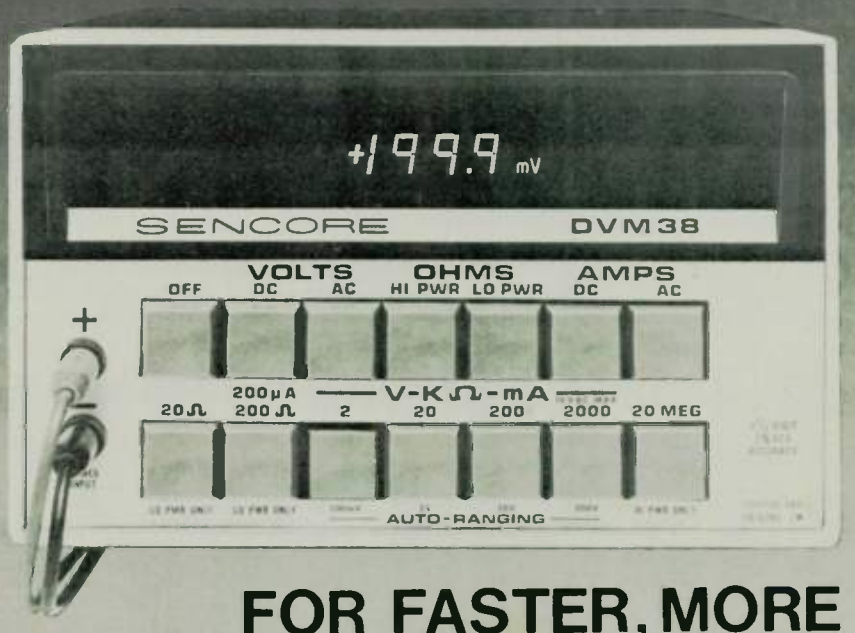

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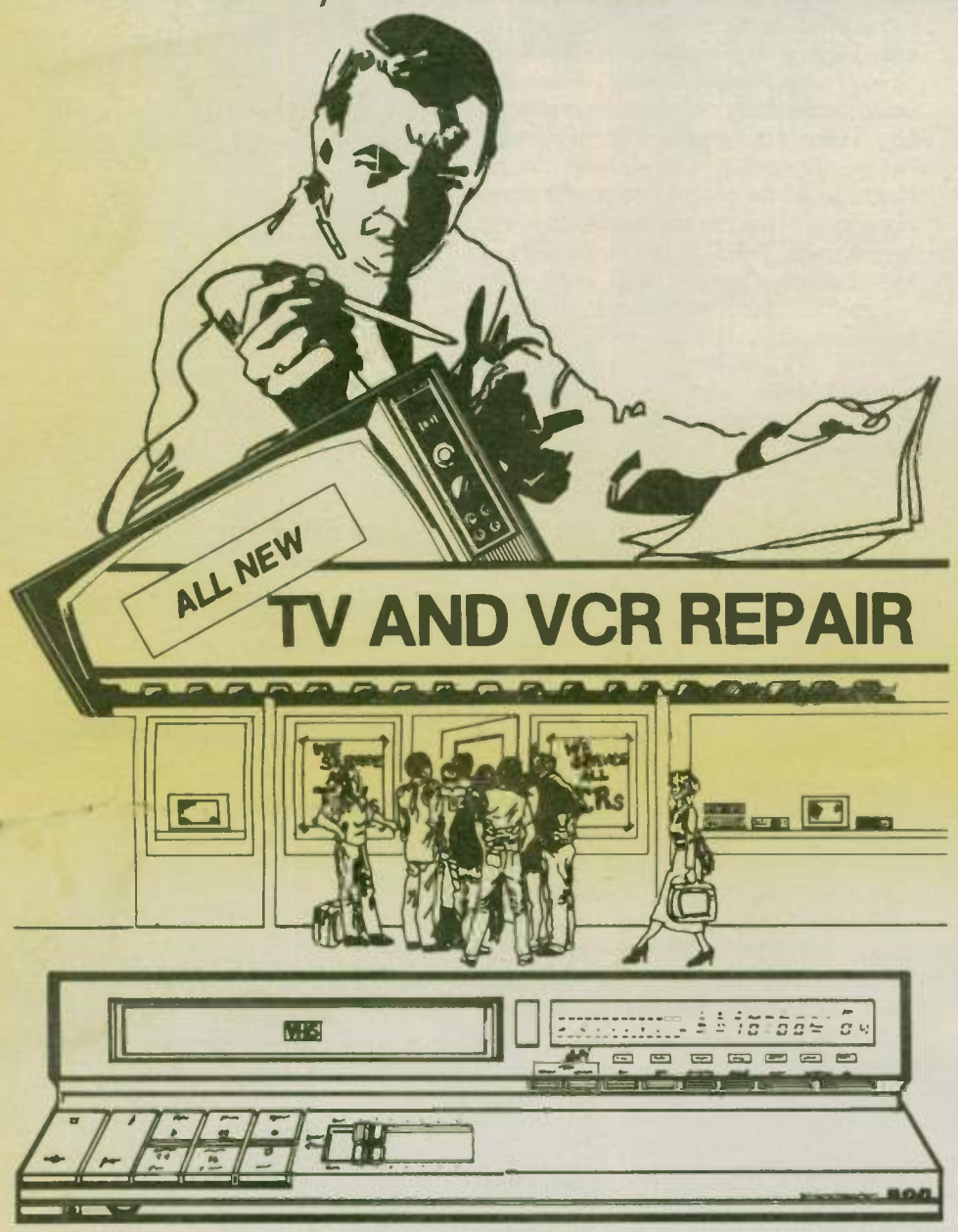
SENCORE NEWS

Issue #127

100,000 square feet and 300 people dedicated to saving your precious analyzing time.

Move From TV To Video Service

A full Sencore News issue dedicated to servicing modern video circuits more profitably . . .



Learn how to counteract the higher reliability of TV receivers by expanding your market as you step up from a "TV Repair Shop" to a "Video Service Center."

Video servicing is more profitable than ever before — if you're ready to service all the newest video circuits, including:

- VCRs
- Video Monitors
- Video/Chroma IC Chips
- Integrated Flybacks
- SAW Filter IF Stages
- Projection TVs
- Cable-ready Tuners
- Comb Filters
- Scan-Derived Supplies
- VIR-Controlled Color

Learn how to service all video circuits with a single, universal system.

This issue takes you from beginning to end — from the antenna right up to the CRT — in understanding shortcuts of how to effectively service all video circuits, at a profit. Read this issue to see how.

Learn how easy signal substitution is to use.

Don't let the fear of learning a different method hold you back. Signal substitution is easy to use, once you understand it. Full block diagrams and plenty of examples take you through the most often asked questions. Read this issue to see how.

Learn how to isolate any problem without disconnecting components.

Only Sencore lets you take full advantage of signal substitution because only Sencore lets you inject known-good signals without disconnecting components — even lets you test integrated circuits dynamically, in the circuit. Read this issue to see how.

And you cannot make a purchasing mistake.

After you see how to update your servicing, after you learn all the shortcuts this issue gives you, you may feel it's time to update your equipment. Since all Sencore units are sold with a solid 30-day Money-Back Guarantee, you have plenty of time to prove to yourself that you've made a wise decision. Read this issue to learn the details on this guarantee (and some other special prices) too.

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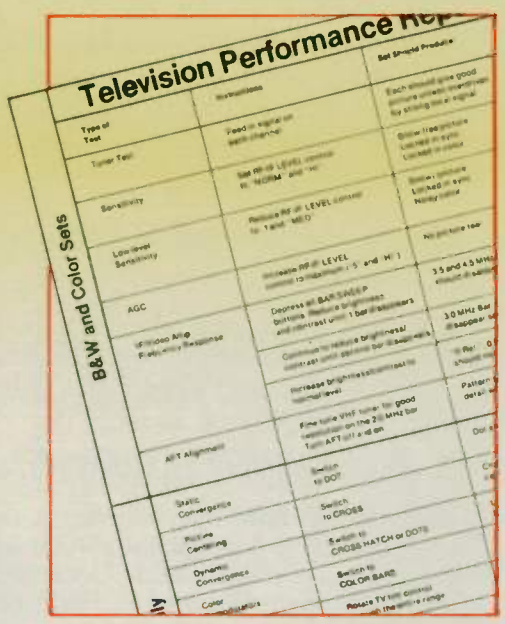
Why Do You Need A Video Analyzer?

From TV To Video . . . The New Direction For TV Repairmen

The consumer electronics industry is in a continuous state of change, always moving new products into the marketplace. You too are moving (in your service work) from TV to Video. Service technicians and business managers see new video products every day. Gone is the TV shop we have grown accustomed to. No longer can a tube tester, scope and multimeter serve as our sole equipment. To achieve results, we must move with the industry and shift our emphasis from just television repair to the more appropriate and encompassing field of Video. We need equipment that will allow us to not just keep up, but *stay ahead* of the competition. Speed and efficiency become more important. Customers want fast reliable repairs on their equipment. They must have confidence in our abilities as repairmen, and we must earn that confidence. We must gain the confidence ourselves to jump right into the most modern video equipment and quickly analyze and repair it. Then, we must be ready to show the customer that the job was done right. Tell the customer what we will, but the performance of a completed repair is the only proof that the customer wants.

How do we succeed in this changing market? By studying the new video products, and by choosing the best tools for the job. Technicians must master "Video" to achieve success in consumer electronics. Every technician needs signals (tools) for injection, comparison, and substitution during video troubleshooting. Signals like: all standard and cable channels, precision trap frequencies, staircase, multiburst, audio, RF, IF, Interlace, Chroma, 3.58 MHz, Vertical Interval Reference (VIR), Vertical Drive, and Horizontal Drive. These signals (and more) must be available and compatible with transistor, IC, tube, and SCR circuits. Special signals for Video Cassette Recorder troubleshooting are also needed. There's more! A digital voltmeter, frequency counter, transistor tester, flyback and yoke tester, oscilloscope, isolation transformer, power supply, audio generator, capacitor and inductance tester, and still more, must be by his side. Then, just maybe, he'll be ready to meet the challenge of video.

Can't we combine most of these requirements into one simple "analyzer"? This is what we need to meet the challenge of video; a "video analyzer"! We need one piece of equipment that lets you find troubles quickly in modern video equipment, that cuts service time in half, that doubles TV and VCR troubleshooting productivity, and at the same time helps prevent unnecessary parts replacement. Equipment is needed that checks flybacks, yokes, integrated circuits, amplifiers, filters, and all the other circuits from the tuner to the CRT in modern video equipment. We need performance in one instrument designed to meet our needs. Only a "video analyzer" fills this exhaustive requirement.



Proof of performance is what the customer wants.

What about estimates? There may be a time when you will almost completely repair video equipment (TV, VCR, Monitor, etc.), to give the customer an ACCURATE estimate! What happens when you miss an expensive part, a flyback or yoke, for example, in your estimate? It surely doesn't make the customer happy. Do you simply increase all your estimates to cover the unexpected? Needlessly high estimates turn business away, while quick, accurate estimates with the problem isolated down to the defective circuit increase business and profits. An analyzer is needed here.

Do tough dogs make your day? Preventing the piling up of *tough dogs* is essential to success. An analyzer is needed here.

Profit isn't profit unless you KEEP it. "Keeping profit" could boil down to saving time in troubleshooting and buying the right part the first time. I don't suppose that I am the only technician who ever replaced the same Integrated Circuit twice before replacing the entire circuit board as a last resort. No profit here, only losses and extra parts that are never used. Positive identification of the defective circuit will help save on parts purchases and produce positive results in video repair efforts. Elimination of repeat service calls also contributes to "real" profit. An analyzer is needed here.

Can You Really Do Without A Video Analyzer?

Are you impressed by the new video technology? Do you want to be more confident? Have you wondered what is the best troubleshooting method to use on new equipment? Using signal tracing and voltage measurements is slow and often ineffective. Signal substitution, with known good signals, is a better way to troubleshoot. An analyzer, equipped for signal substitution, will help divide any video equipment into known good circuits and conquer any problems in the rest! Signal substitution makes sense and is more efficient than any other method.

Why You Need The New Sencore VA62 Video Analyzer

The new VA62 Video Analyzer solves video problems and quickly isolates problems down to the circuit. As you use the VA62, you will build confidence that new circuits and technological advancements can't shake.

The Detectors Are Your Halfway Points

The VA62 methodically walks troubles out of any circuit by proving which circuits function properly. Once you know what works, it's easy to find the defect. The detectors are your halfway points. Detectors split the TV into major blocks which "receive and display" the television signal. Problems are found quickly with the VA62's unique signal substitution method. Video cassette recorders are tamed with the same signal substitution technique. Even the video heads are substituted to ensure none are replaced, unless they are bad.

Signal Substitution Spells Profit For Video Business

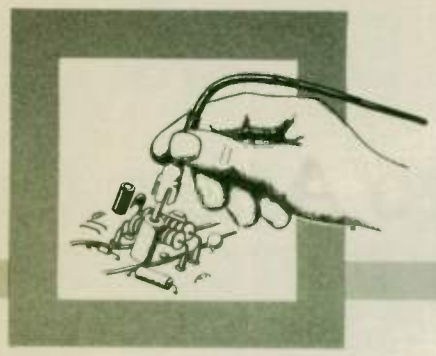
Signal substitution is the key to success in modern video service and the only sure way to beat the competition. The VA62 is a color generator, a "tough dog" tamer, an alignment tool, and more importantly, the VA62 is the very foundation you need to stay profitable.

Capable, Easy To Use, And Essential

- Service the latest video circuits with updated tests.
- Isolate tuner problems with all-channel, cable-ready RF generator.
- Test high performance video circuits with improved test patterns.
- Expand to new challenges as the video circuits improve.
- Depend on signal substitution for fast results on any TV or VCR.
- Use industry-accepted signals for warranty servicing.
- Avoid parts over-stocking by knowing which parts to order.
- Increase productivity and decrease returns.
- Improve VCR efficiency by 2 to 3 times.
- Increase productivity so much that you won't need to hire an extra tech, even when business booms!
- Updated easily so it's never obsolete.

The VA62 includes every signal video service shops will need. Accessories handle specialized functions like VCR repair and special video patterns. This expandability through accessories ensures obsolete proof performance.

The center pages of this issue include a full size photo of the VA62 front panel together with TV and VCR block diagrams. Use this pull out now as we discuss the VA62's capabilities.



RF/IF Troubleshooting

Most video servicers agree that the tuners and intermediate frequency (IF) amplifiers present some of the biggest challenges to troubleshooting. We cannot measure the tiny, high frequency signals with an oscilloscope, and DC voltage measurements don't help isolate problems related to the tuned circuits. In addition, the components in these high frequency circuits have undergone major transitions as we moved from discreet inductive/capacitive tank circuits, to electrically tuned varicap diodes, to the latest digital circuits. The RF section of the VA62 Universal Video Analyzer helps isolate any problem related to RF and IF stages.

Why RF Circuits Need Testing

The RF circuits relate to all video troubleshooting because the antenna terminals are the main receiver input. The RF signals are important for three main reasons. First, effective troubleshooting requires that we start with a performance test to determine the problems we need to solve in the chassis. Second, we need to feed a signal into the antenna terminals when using signal substitution (see "Tech Talk" box to the left) to hold all the good circuits in sync while we substitute into one circuit at a time. Finally, when we suspect tuner or tuner-control circuit problems, we need a way to confirm whether the tuner works correctly. Of these three uses for RF signals, tuner servicing is probably the least understood, so let's look at how some of the major advances in tuner design have affected symptoms and circuit failures.

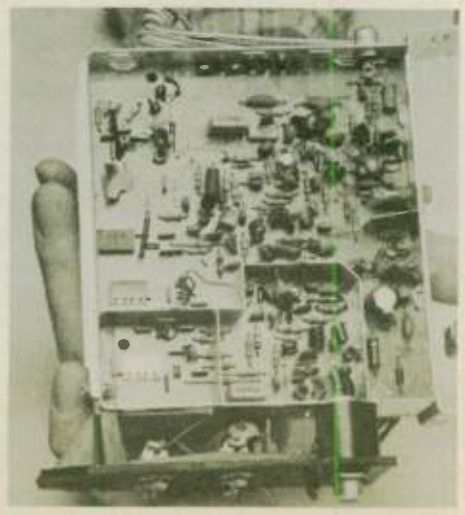


Fig. 1: Even if you send tuners to a tuner repair company, you need to know if the tuner is good or bad before pulling it.

Tuners have always been tough to service, which is the reason most people send tuners to tuner-service companies. Even if we send the tuner away for service, the question of whether a problem is in the tuner, or whether it's in some circuit associated with the tuner, must be answered before we pull the tuner. Tuners may have poor sensitivity, poor tuning range or may be missing channels. All of these failures apply to old mechanical tuners, as well as the latest models. But, the new solid-state tuners bring even more complications and questions.

The first solid-state "varactor" tuners brought increased reliability by eliminating the problems associated with switching high frequency signals with mechanical switch contacts. But, they added some offsetting problems. First, their varicap tuning diodes were more sensitive to changes in power supply voltages than the passive capacitors and coils which tuned the circuits in mechanical tuners. Second, they needed much better operation of the automatic fine tuning (AFT) circuits because the varicap diodes were more likely to drift over short periods of time.

Then, digital, direct-access tuners replaced the varactor models and brought even more complexity. The digital tuner used the same varicap diodes as the varactor tuner, with the addition of digitally-controlled phase-locked-loops (PLLs) and their microprocessors, digital counters, and crystal reference oscillators.

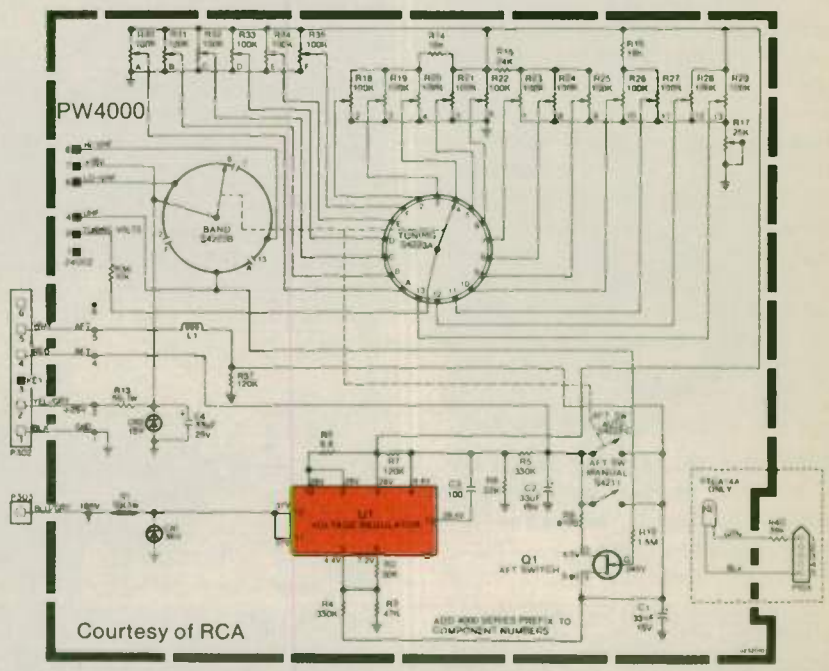
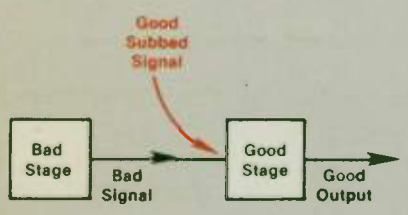


Fig. 2: The "varactor" tuners were more reliable than mechanical models but required tight regulation of DC supplies and control voltages.

Tech Talk

How Signal Substitution Saves Time

Most technicians use a meter or scope to measure signals at various test points and then use the results of these measurements to deduce which circuits might have a problem. The biggest problem with signal tracing is that a problem in one circuit often affects signals several stages before or several stages after the defect. We must carefully analyze each circuit to know what measurements to expect or to explain incorrect readings. Most technicians still labor under this time consuming method, resulting in fewer than 4 TV receivers repaired per day by the average TV servicing technician (according to NESDA).



Signal substitution helps isolate defective circuits faster. We isolate the problem to a single functional stage and then use conventional troubleshooting procedures to find the problem in the small group of components within the identified stage. On the average, users of this method experience a 54% increase in efficiency (according to a survey of Sencore video analyzer users) compared to using signal tracing alone.

How does signal substitution work? We start by injecting a reference signal at the antenna to test the performance of the receiver and to identify all the symptoms associated with the problem. We leave the antenna cable connected for later substitution to hold all good circuits in sync, while we inject known-good signals into the stages we think are related to the trouble. This calls for several different signals over which we have full control of amplitude and polarity. We inject the signal while watching the CRT (or listening to the speaker) to see if we get an improvement in our original symptom. If we see no change, we know the substituted signal is being affected by the defective circuit, proving that we are injecting before the defective stage. If we see an improvement, we know we are injecting after the problem. The defective stage is the circuit which shows an improvement when we inject at its output and the original symptom when we inject at its input.

We become even more effective when we use the "divide and conquer" method of selecting test points. We start by dividing the circuits into major groups according to function: tuner, IF, video, color, sound, sync, and sweep. We then inject a signal at a test point about half way through the circuits associated with the symptom. We then move to the center of the another signal. We continue to divide the remaining circuits in half with each injection until we've identified the one bad stage. By using this dividing approach, we reduce the number of troubleshooting steps by the square-root compared to starting at the input and working through to the output, stage by stage. Four steps with the divide and conquer approach replace up to 16 steps with conventional methods.

(See page 5 for details about injecting in the circuit)

Many digital tuners also select cable channels, calling for five or more tuning bands, compared to the three bands found in VHF/UHF tuners.

Cable TV brings even more complication to tuners than added channels. First, cable system operators can pick and choose whichever channels they will use on a system, meaning our customer may be having troubles receiving a channel we do not have on our local cable system. Second, some cable systems shift the frequencies of the RF carriers away from the frequencies used for over-the-air transmissions, causing tuning trouble for some receivers. If we cannot duplicate the cable channels or the frequency shifts, we may have trouble confirming whether the customer has a legitimate complaint.

Channel	HRC Frequency Shift	ICC Frequency Shift
	(MHz)	(MHz)
2	−1.25	0
3	−1.25	0
4	−1.25	0
4+	4 (+4.75) or 5 (−5.25)	4 (+6.00) or 5 (−4.00)
5	+0.75	+2.00
6	+0.75	+2.00
7	−1.25	0

Fig. 3: Cable systems often shift the frequencies of some or all of the channels, requiring a wide lock-in range for the tuner and AFT circuits.

Imagine how much easier our job of isolating tuner problems would be if we had access to every TV channel—whether it was from a distant TV station or from every cable system in a 100 mile radius. That's really what the VA62 Universal Video Analyzer's RF section lets us do. To understand how to use it, we must first see what features it has.

The All-Band VA62 RF Generator

The VA62's all-band RF generator duplicates any over-the-air or cable channel. Each channel is referenced to a high-accuracy crystal and is fully modulated. We choose the channels through a keyboard. If we prefer, we can step the channels up or down, one channel at a time, with the special CHANNEL STEP buttons.

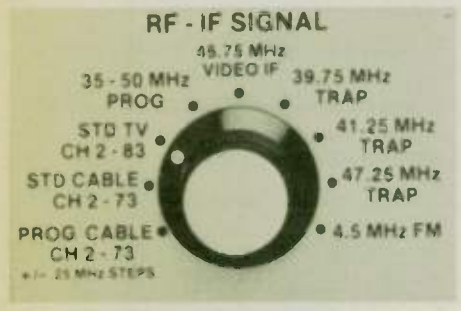


Fig. 4: The first three positions of the RF-IF SIGNAL switch selects any VHF, UHF or cable channel for complete tuner testing.

The VA62 has three RF functions to duplicate any signal condition: Standard TV, Standard Cable and Programmable Cable. Here is how each of these functions works.

Standard TV Channels: The "STD TV" position of the RF-IF SIGNAL switch produces all VHF and UHF channels to duplicate any over-the-air signal. The VA62 produces all the channels, so that we can duplicate any of the standard channels, whether we are testing mechanical or electronic tuners.

Standard Cable Channels: The "STD CABLE" position of the RF-IF SIGNAL switch replaces the UHF channels with the special mid band, super band, and hyper-band cable channels. The VA62 uses the same cable numbering sequence used by most digital tuners. Channels 2 through 13 are identical to the VHF carriers produced by the Standard TV function. Channels 14 through 73 produce the special cable channels. All carrier frequencies are at the FCC (non-shifted) carrier frequencies to duplicate the frequencies used by the many cable systems that do not use shifted channels.

Programmable Cable: The "PROG CABLE" position of the RF-IF SIGNAL switch produces the same cable channels as the "STD CABLE" function. The programmable function, however,

Fig. 5: The programmable function lets you program any shift, up to 9.75 MHz (plus or minus) by entering the shift into the keyboard.

lets us change the carrier frequency of any channel to duplicate shifted cable channels. We can program each channel with the same or a different amount of shift, depending on the tests we need to do.

The shifts are stored in a special type of memory (EEPROM) until we decide to program a new shift. The use of this special memory means we don't have to reprogram the cable shifts every time we turn on the power. EEPROM neither calls for 24-hour power nor a backup battery to maintain the memory for maximum convenience.

We enter the shift with the keyboard. We can program shifts to 9.75 MHz in the positive direction (a frequency higher than the FCC-assigned frequency) or in the negative direction by simply choosing the polarity with the "±" key. We can also temporarily change the direction of the shift, without affecting the shift stored in memory, for special tests of the tuner locking range.

Accurate RF Attenuator

An important part of using the RF generator is controlling its output level to duplicate fringe levels or strong signal conditions. This is the function of the RF attenuator.

The RF signals are controlled by the RF-IF LEVEL switch and the RF-IF LEVEL VERNIER control. The RF-IF SIGNAL switch has three ranges: "LO," "MED," and "HI." The RF-IF LEVEL VERNIER control is calibrated with markings from "0.5" to "5" with the word "NORM" marked at "1."

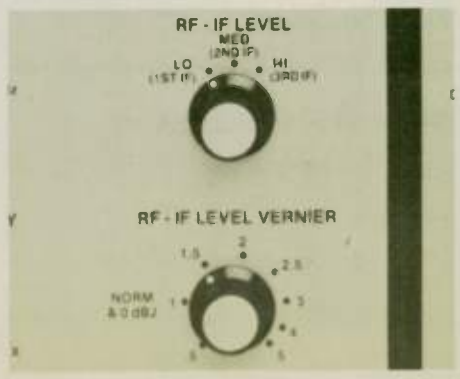


Fig. 6: The microprocessor-controlled output attenuator provides accurate signal levels for all RF and IF signals.

The VA62 produces 1000 microvolts when the RF-IF LEVEL VERNIER is set to "NORM" and the RF-IF SIGNAL switch is set to "HI." This is considered normal because all TVs and VCRs should produce an acceptable color picture with a 1000 microvolt signal. The output with the RF-IF LEVEL VERNIER control set to "5" is five-times the "NORM" setting (5000 microvolts) while the output with the control at "0.5" is one-half the "NORM" level (500 microvolts).

The "MED" setting of the RF-IF SIGNAL switch divides the output by ten, giving a range of signal levels from 50 to 500 microvolts for testing "fringe-area" reception sensitivity. The "LO" setting again divides the output by ten (a total division of 100 from the "HI" setting) for testing even the most sensitive receivers.

The VA62 attenuator is microprocessor-controlled to insure accurate attenuation on all channels. Each VA62 microprocessor memory contains a channel-by-channel correction table, unique to that one unit, which compensates for all circuits which affect output level. This (patent-pending) feature gives dependable test results.

Video And Audio Modulation

Video and audio modulation lets us simply inject the RF signal into the antenna terminals and watch the CRT (or listen to the audio speaker) to tell if the circuits work correctly. The modulation serves as a reference for testing, trouble-shooting, and alignment.

The VIDEO PATTERN switch (in the upper right-hand corner) selects the signal that modulates the video carrier. The video patterns let us do all conventional tests plus many new, time-saving tests. Details on the video patterns is covered in a later section of this Sencore News, starting on page 8.

In addition, we can add a frequency-modulated 4.5 MHz audio carrier to dynamically test the audio circuits. We simply move the AUDIO switch to the modulation frequency we want. The VA62 adds the sound carrier plus modulation. (NOTE: There is no sound carrier in the "OFF" position to prevent interference between the sound carrier and the video patterns.)

Now we have an overview of the VA62 RF generator. It produces any RF channel, has accurately adjustable output levels, and has video and audio modulation. Now, let's see how we use these features to isolate different problems.

Putting The RF Generator To Use

The best way to begin any troubleshooting is with a full performance test. This exercises every circuit in the receiver, so that we can tell exactly which circuits work and which ones don't. We don't even need to take the back off the set because we connect the VA62 RF output to the antenna terminals and watch for the test results on the CRT. After correcting any problems in the receiver, we repeat the test to confirm that all circuits work correctly and that we have not missed a secondary problem.

We start by choosing a low band channel to check overall performance. We use the various video patterns to check for different symptoms within all the circuits. Even if the symptom is not related to the tuner or IF stages (such as poor color or poor sync), we leave the RF signal connected as a reference.

Channel Selection Tests: Tuner problems may affect certain channels, bands of channels, or all channels. Our first tuner check tells us which of these conditions exists in the receiver or VCR we're testing. It helps to know how the bands are related to the channels, so that we can base our tests on the tuner design.

Cable-ready tuners often have as many as 5 tuning bands. This is the case in the RCA chassis we are using

Band	Channels Covered
1. LOW VHF	2 THRU 6
2. MID	(A-5) THRU C
3. MID & HIGH VHF	D THRU 13
4. SUPERBAND (SB)	J THRU (W + 17)
5. UHF	14 THRU 83

Fig. 7: The digital tuner in the RCA CTC108 chassis uses 5 different local oscillator and RF amplifier bands in order to receive all the cable channels.

as our example. The RCA service literature tells us that the tuner divides the bands as follows: I. Low band VHF (channels 2 through 6); II. Mid band special cable (cable channels 14 through 17 and 69 through 73); III. High band VHF (channels 7 through 13) and mid band cable (cable channels 17 through 22); IV. Super band cable (cable channels 23 through 53); and V. UHF (channels 14 through 83). We use these channel numbers to guide our testing, picking channels from the low and high end of each band to tell whether the symptoms are band related.

If the customer's original complaint involved problems picking up certain channels, we check all the channels within the band associated with those channels. Sometimes, digital tuners can have problems on a single channel. In other cases, the customer's problem picking up one channel may turn out to be problems on every fourth or every eighth channel.

If our tests show that only one channel is affected, we suspect a problem in the digital control circuits. If the bad channels fall into regularly spaced groups, the defect is probably caused by the programmable digital divider in the phase-locked-loop circuit. If an entire band is affected, the problem could be in the tuner control circuits or in the tuner itself. We further isolate band-related problems by confirming that the DC band-switching voltages are properly applied to the tuner connectors. If they are, we know the tuner is to blame.

Sensitivity Tests: We use different signal levels as we test the tuner to isolate sensitivity problems. The receiver should produce a solid color picture, with no "snow," with a signal level of 1000 microvolts (RF-IF SIGNAL switch set to "HI" and RF-IF LEVEL VERNIER control set to "NORM"). Most digital systems have much better low-end sensitivity than conventional tuners. Our RCA chassis, for example, produces a slightly snowy, locked-in color picture at 100 microvolts (RF-IF SIGNAL switch set to "MED") and still gives a locked in (although very snowy) picture at 20 to 30 microvolts (RF-IF SIGNAL switch set to "LO" and RF-IF LEVEL VERNIER control set between 2 and 3).

Sensitivity problems could be caused by a bad tuner or by problems in the IF amplifiers or video detector. We use the VA62 to substitute for the tuner to confirm whether the IF amplifiers are the actual cause of the poor sensitivity. We simply unplug the tuner "link" cable, which feeds to our first IF amplifier, and replace it with the VA62 substitute signal. (Details on testing and servicing IF problems are covered later in this article.)

If the IF stages show normal sensitivity, we know we either have tuner or AGC problems. We isolate one problem from the other by injecting a DC bias voltage from the VA62's DC POWER SUPPLY control (in the lower, left-hand corner) into the tuner AGC test point, while injecting the 1000 microvolt VA62 signal. We adjust the DC voltage through the normal range of AGC operating voltages. If we see poor sensitivity at all settings of the DC supply, we know the tuner is to blame. If, on the other hand, some bias levels produce a clear picture, we know the tuner operates normally and the problem is in the AGC detector circuits.

Since some AGC problems affect only strong signals, we need to check a few channels with the VA62 set to produce its maximum (5000 microvolt) signal level. If we see signs of signal overload (tearing, loss of contrast, etc.) we know the tuner cannot respond to large signals correctly. As with poor sensitivity, we confirm whether the defect is in the tuner or the AGC detector by injecting a bias voltage from the troubleshooting power supply.

Lock-in Tests: The final tuner tests confirm the automatic fine tuning (AFT) circuits and tuner have enough lock-in range. This confirms the AFT can compensate for drift in component values with changes in temperature, line voltage, etc. It is especially important when the tuner receives shifted cable signals.

We use the VA62 programmable cable function to test lock-in capability. We must first decide how much lock-in range is needed. If the customer only uses the receiver to pick up over-the-air telecasts, a lock-in range of half a megahertz should be enough. This range insures that the AFT circuits will be able to compensate for component aging. If, on the other hand, the receiver will be connected to cable, we may need a 2 MHz locking range to insure that it will be able to pull in shifted cable channels.

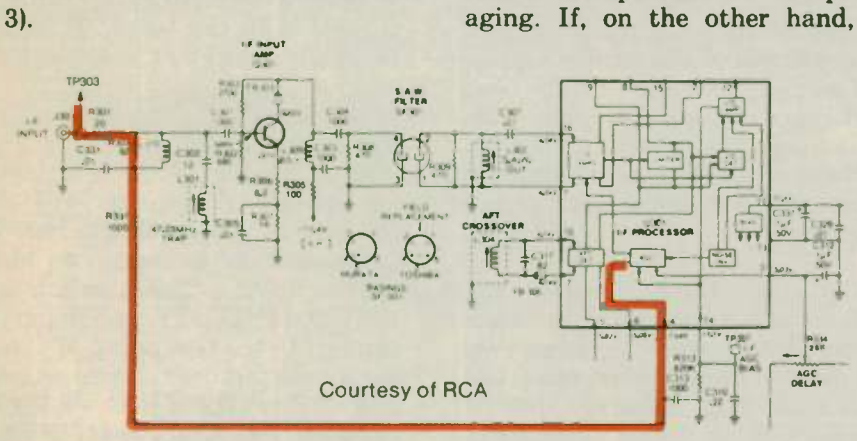


Fig. 8: Injecting DC from the VA62 DC POWER SUPPLY lets us control the gain of the tuner to tell whether AGC problems are in the tuner or the AGC detector circuits.

Once we know how much range we need, we shift to the "PROG CABLE" function to add a shift to the carrier frequency. This function lets us shift the carrier in 0.25 MHz (250 KHz) steps, above and below the normal FCC-assigned carrier frequency. We can use this feature in either of two ways; we can duplicate the most common cable shifts in the area, or we can program in a pattern of shifts that starts with small shifts on lower channels and adds progressively larger shifts on higher channels. If we choose the second option, for example, we could use the shifting arrangement shown in Figure 9.

Now, we can step through the low band VHF channels 2 through 6 to see if each channel can lock in the positive and negative direction. Each channel alternates in direction, so that we do not need to shift directions manually. If we find that channels 2 through 5 lock normally, for example, but channel 6 fails to lock, we know the circuits can follow shifts as high as 1 MHz, but cannot follow a positive shift of 1.5 MHz.

Channel	Shift
(Low Band VHF)	
2	+ 0.50
3	– 0.50
4	+ 1.00
5	– 1.00
6	+ 1.50
(High Band VHF)	
7	+ 0.50
8	+ 0.75
9	+ 1.00
10	+ 1.25
11	+ 1.50
12	+ 1.75
13	+ 2.00

Fig. 9: We can shift each channel by a different amount in order to test the lock-in range of the tuner, channel-by-channel.

Tech Talk

How Signal Injection Works — And Why

Video analyzers using signal substitution have been available for over twenty years. The earlier units, however, did not save much time because any signals already present at a test point had to be disabled, by disconnecting components, before the substitute signal from the analyzer could be injected. If the old signal is not disabled, the substitute signal mixes with the signal already in the circuit, causing a confusing combination of good and bad signals.

Sencore's engineers developed a better way to use signal substitution — which disables the circuit signal without disconnecting components. The VA62 output circuits provide a low impedance path to ground for signals that are in the suspect circuit, and then, *with the same probe*, injects the fresh, substitute signal. The low driving impedance *swamps out* the questionable signals.

The swamping impedance is different for vacuum tubes and solid-state components. Swamping in solid-state circuits is more difficult because they call for a much lower impedance than for high impedance vacuum tubes. Whether using discrete components or ICs, solid-state circuits fall into three general types. The common base circuit is often used as an RF amplifier in TV tuners. Common collector (emitter follower) circuits match impedances and drive output lines. Common emitter circuits are used where voltage and power gain is important. The table below shows typical values for these three circuit types.

The VA62 DRIVE SIGNAL OUTPUT has three voltage ranges, each having an impedance which properly swamps circuit signals. The ranges and impedances are:

3V range: 3 VPP into 100 ohms impedance
30V range: 30 VPP into 100 ohms impedance
300V range: 300 VPP into 10,000 ohms impedance

The 3 VPP position provides the signal level and impedance needed to substitute into integrated circuits. The 30 VPP position matches the voltages and impedance for transistor circuits, while the 300 VPP position is tailored for vacuum tube circuits. Still lower impedances could have been chosen to swamp out the circuit signals, but a new problem developed. Lower impedance means the circuit provides more power, and too much power applied to the circuit can damage good components. The VA62 circuits give the best balance between clear indications and safe operation.

Transistor Circuit Impedances

Specification	Common Emitter	Common Base	Common Collector
Input impedance	1,200 ohm	100 ohm	25,000 ohm
Output impedance	25,000 ohm	500 ohm	1,200 ohm
Voltage gain	100	5	0.95
Current gain	40	0.95	80
Power gain	1,000	150	50
Phase shift	180	0	0

The high-band VHF channels are all shifted in the positive direction. We take advantage of a special VA62 feature to test lock-in range. This feature lets us shift the direction of the programmed shift without affecting the value stored in the microprocessor memory.

To use this feature, we press the "±" key, which causes the digital readout to show the shift programmed into the chosen channel. Pressing the "±" key a second time, reverses the direction of shift without affecting the shift direction in the memory. Here's how we use this feature to test both directions of lock-in, using the shifts we've added to the high-band VHF channels.

First, we will select channel 7, which contains a half-megahertz shift. A good picture on the receiver confirms the tuner followed the shift. Then we press the "±" key two times. The second press shifts the direction of shift, so that the carrier moves from a positive half-megahertz shift to a negative half-megahertz shift. If channel 7 remains locked in both directions, we press the CHANNEL UP button to move to channel 8 and repeat the process. If we still have a locked picture on channel 13, we know the tuner and AFT can follow a full 2 MHz shift in either direction.

If we find the lock-in range is too narrow, we use the VA62 to troubleshoot or align the AFT circuits. We can use the VA62 RF generator to adjust the AFT centering and AFT range controls to be sure that we can lock to a wide enough range of frequencies.

IF Troubleshooting

We face some of the same problems in troubleshooting IF circuits that we faced in the tuners. The biggest similarity is that we cannot measure the signals with a scope or meter because of the high frequencies involved. Schematics do not even show scope waveforms in the IF stages because circuit loading by the test probes causes the waveforms to be meaningless.

The frequency response of the IF circuits may cause problems, even if the circuits work electrically. Frequently, a symptom that points to a bad component turns out to be a misadjusted trap or coil. Although most people are doing fewer alignments, alignment is sometimes necessary because it's the only thing that's wrong with the receiver. Even if we don't do a full alignment, the traps must be set correctly whenever the receiver is connected to a cable system.

The VA62 IF Section

The VA62 has four IF functions: 1. A programmable generator, 2. A crystal-controlled troubleshooting generator, 3. A special trap-setting generator, and 4. An audio sub-carrier generator. The signals produced by these four generators are fully adjustable in amplitude to match the signal level in each IF stage. The functions have different types of modulation to best meet the needs of the stages in which they will be used.

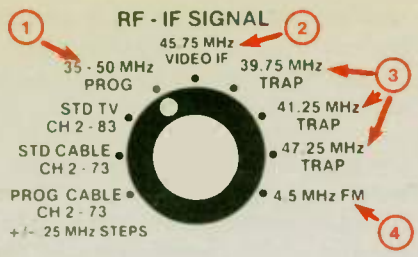


Fig. 10: The VA62 has four functions for troubleshooting or alignment of any IF circuit.

Programmable Generator: The first IF function is the programmable IF generator, which lets us select any frequency, between 35 and 50 MHz, in 10 KHz steps. The two main uses for this function are adjusting stages which are severely out of alignment (spot alignment) and setting traps which use frequencies other than the three standard trap frequencies.

We choose the desired frequency by entering four numbers into the VA62 keyboard. We simply choose the "35-50 MHz PROG" position of the RF-IF SIGNAL switch. The signal is unmodulated when the AUDIO switch is in the "OFF" position. If desired, we can add modulation by switching the AUDIO switch to one of the four audio frequencies.

IF Troubleshooter: The second IF function produces a crystal controlled 45.75MHz carrier which helps isolate IF problems. The carrier is modulated with the information chosen by the VIDEO PATTERN switch. A 4.5 MHz sound carrier, modulated with one of four audio frequencies, is added when the AUDIO switch is in any position except "OFF."

We can inject this signal into any IF stage. We choose this function by moving the RF-IF SIGNAL switch to the "45.75 MHz VIDEO IF" position. Since the signal is fully modulated, we simply look at the CRT to see whether the signal finds its way from the injection point to the output. If it does, we know that every stage from our injection point to the output works correctly.

Fig. 11: The RF-IF LEVEL switch shows the normal signal level to inject at the input of each stage of a three-stage IF system.

The three positions of the RF-IF LEVEL switch correspond to the normal signal level found at the input of each stage of a conventional three-stage IF system. This gives a range of signals from 500 microvolts to 500 millivolts (500,000 microvolts). The RF-IF LEVEL VERNIER control lets us adjust the exact signal level for each step to provide an acceptable picture.

Trap Setter: The third IF function lets us quickly adjust standard IF traps by simply looking at the CRT. The VA62 produces a crystal-controlled IF carrier that is modulated with the signal selected by the VIDEO PATTERN switch. This signal has a fixed amplitude (1000 microvolts) and serves as a reference for our AGC circuits, so that they do not respond to the interfering carrier the trap should remove. It eliminates the need to use a bias supply to clamp the AGC circuits or an attenuator to keep the signal below the AGC threshold.

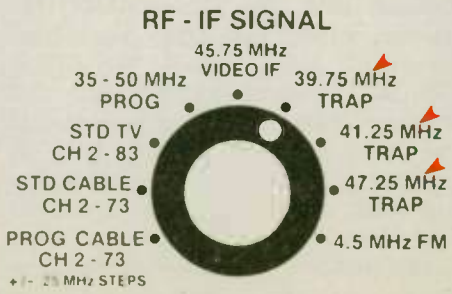


Fig. 12: The special trap setting signals simplify adjustment of standard IF traps.

The VA62 then adds a second signal with a frequency determined by the setting of the RF-IF SIGNAL switch. This signal duplicates the interfering carrier the trap should eliminate. The 39.75 MHz signal represents the video carrier of the next higher channel, the 41.25 MHz signal represents the sound carrier of the on-channel signal, and the 47.25 MHz signal represents the sound carrier of the next lower channel. If we want, we can add amplitude modulation to the interfering signal by moving the AUDIO switch to one of the four positions marked with an audio frequency.

We have full control over the amplitude of the interfering carrier, so that we can balance the level of it with the reference signal. We adjust the amplitude of the second carrier until we can just barely see the beat interference in the picture, and then we adjust the trap until the interference has the least effect on the picture. This is the best setting of the trap.

Setting the traps insures the receiver will work correctly when connected to a cable system. We may decide to only adjust the traps instead of fully aligning the IF amplifiers. If we decide to do a full alignment, we always start by setting the traps with the special signals.

Audio IF Generator: The fourth, and final, IF function helps isolate audio problems by listening to the speaker. The VA62 produces an unmodulated carrier when the AUDIO switch is in its "OFF" position, or a frequency modulated carrier when we choose any of the four audio frequencies.

Now that we know about the four IF functions, let's see how we use them. We will start with the main function: the IF troubleshooter.

Zeroing In On IF Defects

Most people find IF troubles tough to find. They also find that the VA62 greatly simplifies trouble-shooting. We use the same basic troubleshooting technique, whether we're working in discrete circuits or in stages using integrated circuits. We inject a normal IF signal and watch to see if the original symptom improves.

The first use of the VA62, in most cases, is substitution of the tuner. This confirms whether the problem is in the tuner or in one of the later stages. To substitute for the tuner, we disconnect its cable from the IF input, (11) and connect the IF adapter supplied with the VA62. We set the RF-IF SIGNAL switch to

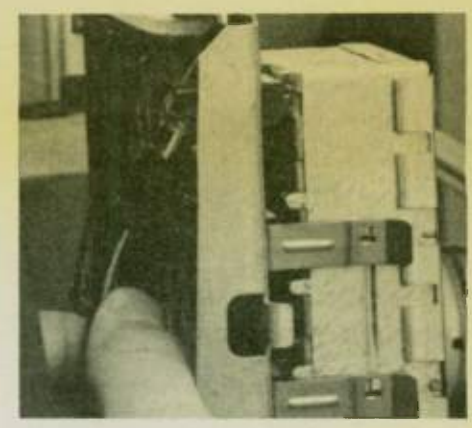


Fig. 13: Simply unplug the tuner link cable and replace it with the VA62 IF adapter to confirm whether all stages after the tuner work correctly.

the "45.75 MHz VIDEO IF" position and set the RF-IF LEVEL switch to the "LO (1ST IF)" position. The receiver should produce a good picture with a setting near the "NORM" position of the RF-IF LEVEL VERNIER control. If it does, we know the IF stages work correctly, and the trouble is in the tuner. If not, the trouble is in a circuit after the tuner.

If we suspect IF problems, we move our injection signal to one of the later IF stages. When injecting into the second IF amplifier, (12) (either the grid of a tube or the base of a transistor) for example, we simply set the RF-IF LEVEL switch to the "MED (2ND IF)" position and connect to the test point. We should see a clear picture at some setting of the RF-IF LEVEL VERNIER control. The exact setting of the control does not matter, since the gain will normally vary from one IF strip to the next.

If we find we must use the "HI" setting of the RF-IF LEVEL switch to get a clear picture when feeding into the 2nd IF stage, we know that circuits after the injection point lack sensitivity. We move closer to the video detector to confirm that the third IF amplifier works correctly, and quickly identify the bad stage.

Test Point	Link In	SAW Input	SAW Output
VA62 Output	Lo 1.2	Lo 5	Lo 1

Fig. 14: These are the normal signal levels for each IF test point in the RCA CTC108 chassis.

Newer receivers use SAW filters and synchronous video detectors instead of the discrete, tuned amplifiers of a few years ago. We use the same approach to substitute for the tuner as we did with discrete circuits. The only real difference is that most of the gain takes place inside the IF IC. As the chart in Figure 14 shows, the RCA CTC108 chassis calls for the "LO" setting of the RF—IF LEVEL switch for injection into each IF test point, right to the IC itself. If we have to use the 2nd or 3rd IF signal level to get a picture, we know we are forcing signals through a defective stage.

We use the 4.5 MHz FM signal in a similar manner to isolate problems in the audio circuits. We inject the signal and listen to the loudspeaker to confirm whether the signal passes through to the output. We can inject at any point between the sound takeoff in the video IF circuits and the audio FM detector.

Trap Setting Without A Scope

The special trap setting signals let us set all standard IF traps by simply watching the CRT screen. We use identical procedures for every single chassis. We only need the VA62 to set traps; we don't need a scope or other instruments.

We don't inject the trap-setting signal at the antenna terminals because fine tuning would affect our results. The best injection points for most receivers is at the UHF input

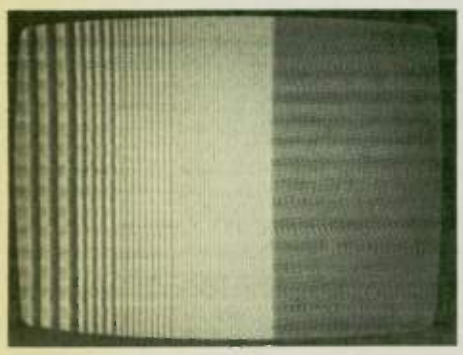


Fig. 15: Reduce the amount of interference in the picture to the least amount possible when using the new VA62 IF trap setting signals.

of the VHF tuner, which routes the signal through the mixer in the VHF tuner but eliminates the variations of fine tuning. If the tuners don't have this connection because both are in one box, we can unplug the tuner and connect the VA62 to the input of the first IF stage.

We use whichever video pattern we feel gives the best contrast. The 10 Bar Staircase provides the best results for many people, while the Multiburst Bar Sweep provides good results for others. The final choice is really a matter of personal preference.

We set the RF-IF SIGNAL switch to the correct trap-setter position and then adjust the RF-IF LEVEL switch and the RF-IF LEVEL VERNIER control until we can see a small amount of interference in the picture. If we want, we can add audio modulation to the trap signal by moving the AUDIO switch to one of the positions marked with an audio frequency. Any frequency works as well as the others so, similar to the video pattern, we use whichever one gives the best contrast.

The final step is to adjust the trap for the least amount of interference. If the interference drops out altogether, we simply increase the setting of the RF-IF LEVEL VERNIER control until we again see the trap signal and finish nulling the adjustment.

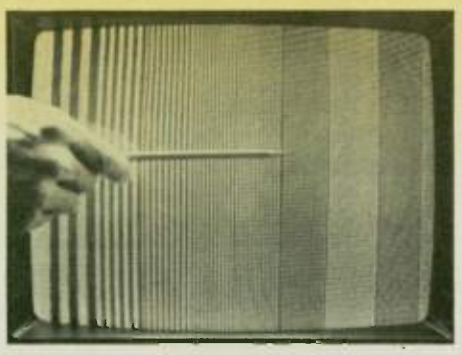


Fig. 16: We determine the frequency response of the IF and video amplifiers by observing which bar of the Multiburst Bar Sweep pattern contains vertical stripes of information.

Alignment Isn't A 4-Letter Word

Many people are dead set against doing IF alignment under any circumstance. If you are one of these people, we won't try to change your mind. But, we do need to mention alignment because some people touch up the alignment of nearly every chassis, while others do an alignment from time to time when they see IF troubles that may be alignment induced.

The VA62 lets us check the alignment without taking the back off the receiver. We simply watch the CRT while we inject the special Multiburst Bar Sweep video pattern at the antenna terminals. This special pattern tests for the two main symptoms of alignment errors: restricted frequency response and ringing. If the receiver uses a synchronous video detector, we also check for proper contrast using the 10 Bar Staircase video pattern.

To test frequency response, we simply look at the bars produced on the screen by the Multiburst Bar Sweep. We know that the frequencies produced by the bars are making their way to the CRT if we see little vertical stripes, as shown

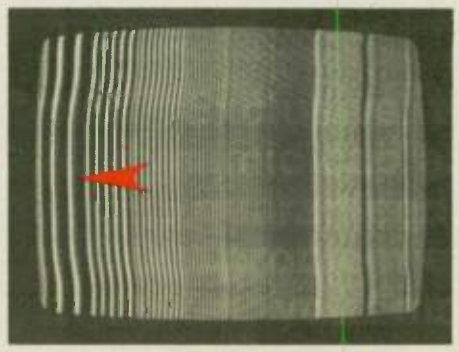


Fig. 17: Ringing in the low frequency Multiburst Bar Sweep bars. This type of ringing causes white lines to form to the right of dark objects in the picture.

in Figure 16. If a bar is a uniform shade of grey, we know that the frequency has been restricted in some circuit before the output. A color TV receiver should show detail out to the 3.0 MHz Multiburst Bar Sweep bar. The 3.5, 4.0, and 4.5 MHz bars should be grey, indicating the IF stages and video amplifiers are properly limiting the higher video frequencies.

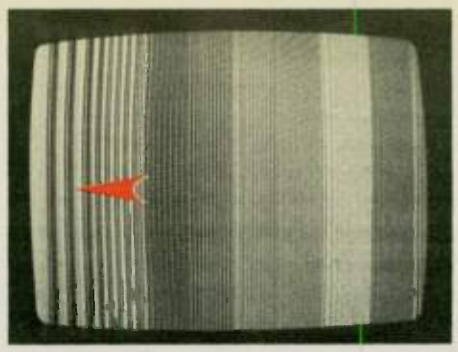


Fig. 18: This type of ringing causes a dark line to appear next to bright objects in the picture.

Ringing appears as harsh edges on the lower frequency bars, as shown in Figures 17 and 18. Ringing causes an annoying harshness in the picture and should be eliminated if we want our customers to see a good picture.

The 10 Bar Staircase test of contrast range is important for all receivers, but is especially important for the new receivers which use a synchronous video detector. We simply feed in the 10 Bar Staircase video pattern and then adjust the brightness and contrast controls on the front of the receiver until we can see as many shades of grey as possible. The receiver should show 10 distinct levels. If some of the bars have nearly identical brightness levels, we know there are circuit problems.

While poor alignment might be the cause of any of these problems, it is not the only cause. We must isolate the problem before we go any farther. The next step involves injecting the VIDEO PATTERN signal from the VA62 DRIVE SIGNAL output at the video detector to see if the symptom improves. If it does, we know it is caused by the tuner or IF circuits. If it does not improve, we know the problem is in the circuits after the video detector.

Dynamically Align The IF Stages: The VA62 signals let us align IF stages with dynamic results. Since we don't clamp the AGC circuits with a bias voltage, we are doing the alignment with the circuits operating normally. This produces better results than a static sweep-and-marker system because we are setting the circuits for the best detected video, instead of setting the circuits for a theoretical response curve which may not produce a good picture.

Probably the single biggest advantage of using the VA62, however, is that we use the same procedure for alignment of any chassis—whether it uses tubes, transistors, or ICs in the IF circuits. The main difference from one chassis to the next is the location of the test points and the number of coils we need to adjust.

The details of using the VA62 for alignment are covered in the VA62 Operation and Application Manual. In brief, we simply connect a scope to the video detector (or the first video amplifier follower stage), adjust the traps using the VA62 trap setter, and then adjust the bandpass coils for best overall response of the special Multiburst Bar Sweep video pattern. We always follow the same sequence as we adjust the bandpass coils, starting with the stage closest to the detector, jumping back to the first IF stage (along with the mixer coil

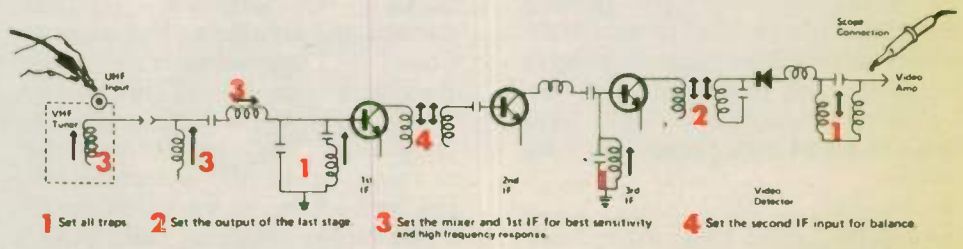


Fig. 19: We follow the same sequence for alignment, no matter which type of circuit is used in the IF amplifiers.

in the tuner), and finally adjusting the inter-stage coupling adjustments between the first and last IF stages to get a balanced response.

Dynamically Align Synchronous Detectors: The VA62 lets us adjust the synchronous video detector, used in almost all color TV receivers and VCRs, for the best detected picture. The synchronous video detector provides many technical advantages over the old diode video detector, but even slight alignment errors cause problems in the detected signal, ranging from loss of sync, to restricted picture contrast, to no output.

Detector tuning needs only a few minutes when using the VA62. And, since most IF stages that use a synchronous video detector also use a SAW filter for tuning, a full alignment may only call for the adjustment of three or four coils—including traps.

We start the way we start any alignment: by connecting the VA62 to the IF input and by connecting our scope to the detector output. We first use the trap-setter function to set all traps and then move the RF-IF SIGNAL switch to the "45.75 MHz VIDEO IF" position and choose the 10 Bar Staircase with the VIDEO PATTERN switch. We set our scope to show the waveform at the horizontal line rate and simply watch the steps on the waveform as we adjust the detector tuning coil. We want all ten steps to be as close as possible to equal amplitude.

What happens if the coil is not adjusted correctly? Figure 20 shows the answer. The top waveform shows the normal scope waveform for the 10 Bar Staircase. Notice the ten individual steps. Now, look at the bottom waveform. Notice how the top three bars have compressed to a single amplitude. This means that our receiver has lost 30% of its brightness/contrast range.

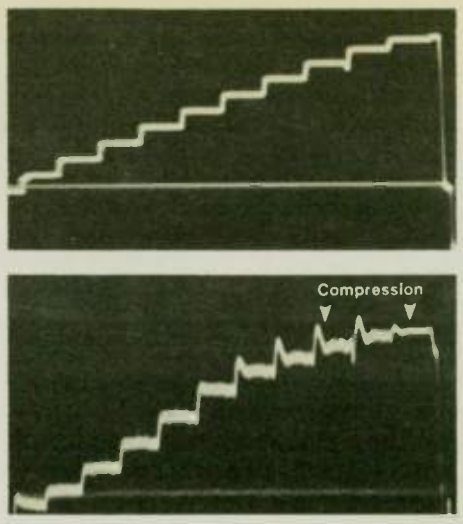
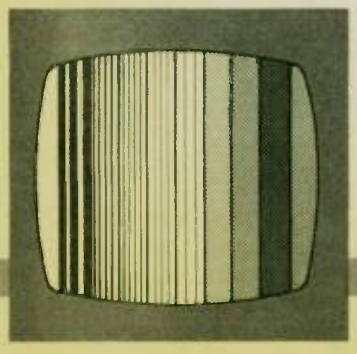


Fig. 20: (a) The normal response to the 10-bar staircase shows individual steps. (b) Slight misalignment of the synchronous video detector causes a loss of 20 to 30 percent of the brightness content.

You may wonder how far the detector was misadjusted to cause a 30% reduction in performance. It may surprise you to know that the detector tuning coil is less than one-half a turn from its ideal setting. From this, you can begin to understand why alignment is still important — even in the latest chassis. With the VA62, however, alignment takes only a few minutes, so there is really little reason to skip it.



Video Patterns

The VA62 contains complete color circuit testing and convergence patterns in a totally new, one of a kind, phase-locked troubleshooting system. All the test patterns meet the NTSC (FCC) tolerances for timing and amplitude ratios. The patterns may be interlaced or non-interlaced to allow them to be used in various applications. Industrial and broadcast equipment (tape recorders, editing equipment, etc.) may need fully interlaced signals. Some cameras, video games, and home computers produce non-interlaced sync. In troubleshooting, the ability to choose interlaced or non-interlaced vertical sync enhances repair of countdown and Vertical Interval Reference (VIR) circuits.

All standard signals are available, including the Multiburst Bar Sweep, for solving difficult response problems in any video equipment or system. Performance tests are done without removing the back from the set. Nothing else lets you test so thoroughly.

With all the patterns you will ever need present, the VA62 is truly a "universal" video analyzer usable in any video system. Each pattern provides important clues to circuit performance. Test patterns have been used and improved since the beginning of Color TV and have been shown on schematics since the 1950's.

The digitally generated pattern may be used to modulate the RF and IF generators, the video pattern position of the DRIVE SIGNAL switch, and the VCR STANDARD output of the VA62.

A Pattern That Matches The Circuit

The key to signal substitution is having the necessary signal to inject into any stage. Any television or video equipment, whether black and white, or color, can be broken down into a basic, universal, block diagram. The block diagram for a color TV is supplied as part of the center sheet of this issue. The input signal to each block is universal, no matter who manufactured the set or when it was built. The VA62 provides all the necessary signals to inject into any block. Notice how the VA62 separates the luminance (black and white) signals from the chroma (color) signals to allow substitution in any part of the video system from the detector to the CRT.

The IF Amplifier Frequency Response, Trap Performance, Video Amplifier, Automatic Fine Tuning, Static Convergence, Picture Centering, Dynamic convergence, Color Demodulators, Color Bandpass Amplifier, Tint Range, Black and White Tracking (CRT Drive and Bias), and Color Killer, can even be checked without taking the back off the set when you use the VA62 video patterns. Lets take a look to see what video patterns are supplied and where they are used in our universal block diagram.

The VIDEO PATTERN switch begins with the single dot pattern. The single cross, crosshatch, and dot patterns form the standard convergence patterns.

DOT: This pattern produces a single dot centered between the horizontal and vertical blanking intervals. This places the dot in the exact center of the screen. Static convergence is correct if this dot is white. If not, the Yoke magnets need adjusting.

CROSS: This pattern is used for picture centering and yoke alignment. It should appear like cross hairs aimed at the center of the screen.

CROSSHATCH and DOTS: Dynamic convergence and screen size are checked using these two full screen patterns. There are 21 Vertical lines and 15 Horizontal lines which produce perfect squares on the screen. Dots may be chosen

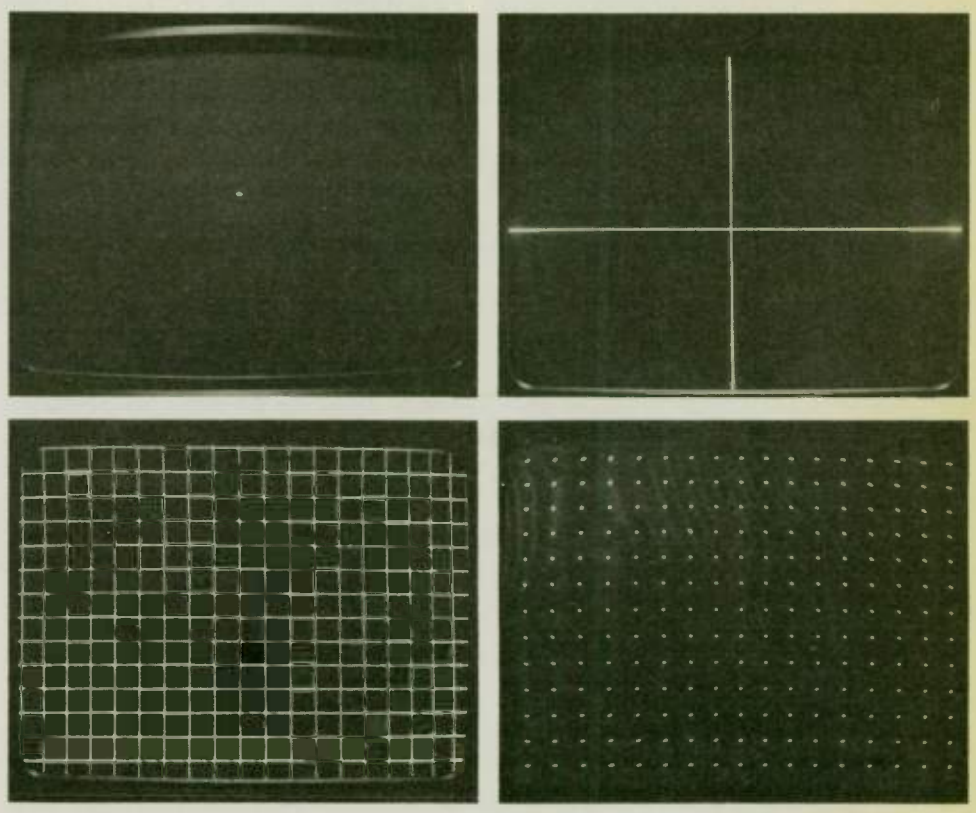


Fig. 1: Familiar patterns are used for convergence.

instead of the perfect squares. Both crosshatch and dots provide excellent indications of convergence and pincushion problems. A dot-size control adjusts the dot and cross pattern lines to allow more accurate convergence adjustments on different sizes and types of color CRT s. Set the dot size for your application, whether it is TV, video games, or video monitors.

Black and white (luminance), and color (chrominance) patterns supplied by the VA62 allow you to accurately analyze problems in video amplifiers and color circuits.

Luminance Patterns

The 10 Bar Staircase and Multiburst Bar Sweep patterns provide complete information about the frequency response and dynamic range of any video system, TV, or VCR. No other video generator provides these complete trouble-shooting patterns.

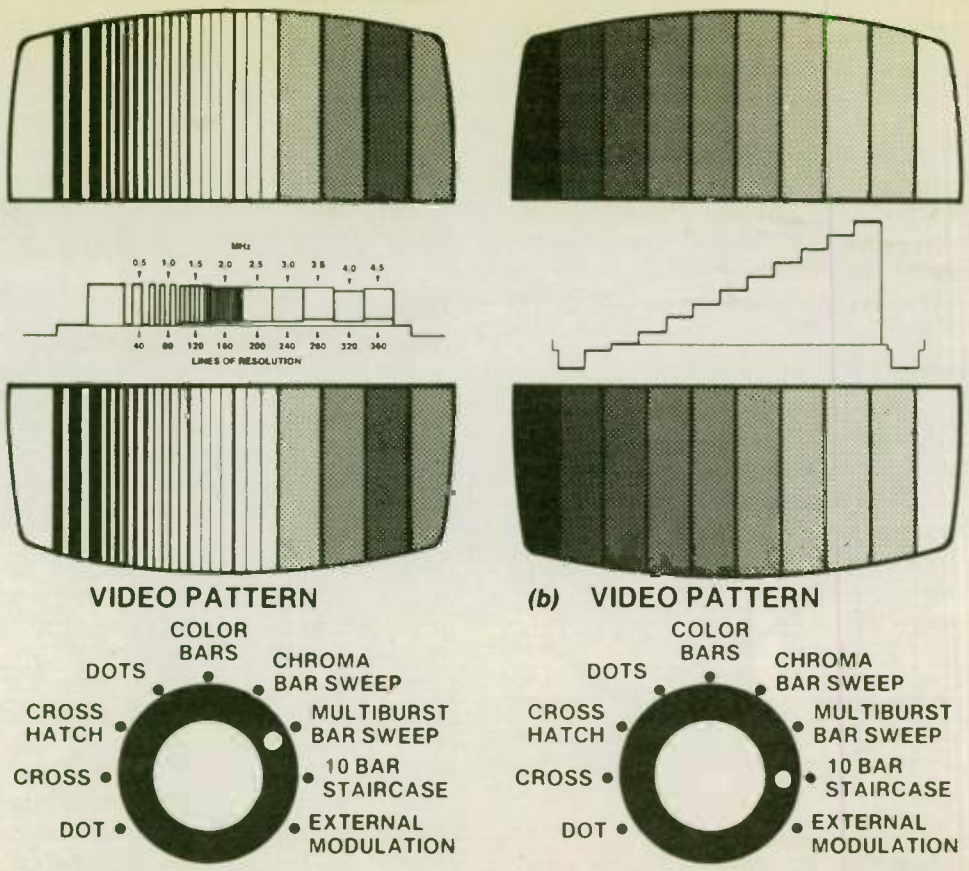


Fig. 3: Select the Multiburst Bar Sweep (a) and EIA Staircase (b) patterns to see frequency response and dynamic range.

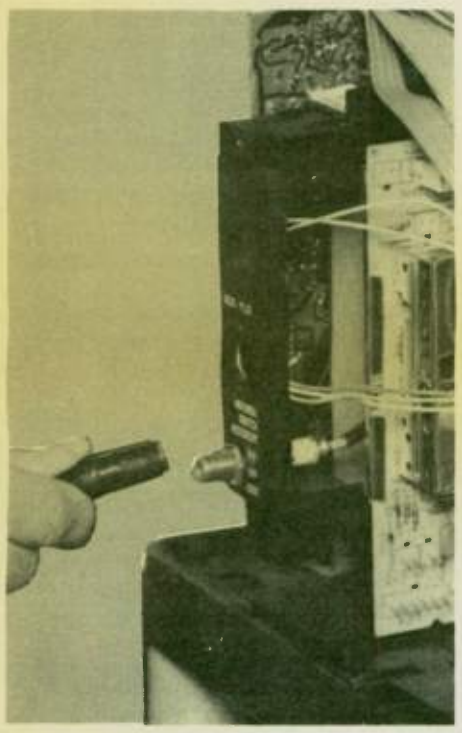


Fig. 2: "Signals are fed into the antenna terminals."

Looking at the Universal TV Block Diagram, blocks (1) and (2) are antenna terminals. *"Throughout our discussion, points on the block diagram are referenced by circled numbers in the text, which correspond with specific points on the block diagram. Inputs and outputs of the various circuits are numbered and arrows show signal direction. The Universal TV Block Diagram is located on page 17 of this issue."*

Feed the "RF-IF out" signal into the antenna terminals (1) or (2), set the RF-IF LEVEL VERNIER, choose the channel with the RF-IF SIGNAL SWITCH, pick a VIDEO PATTERN, and you are ready for a complete performance check. Just select the Multiburst Bar Sweep (Figure 3a) or the EIA Staircase (Figure 3b) pattern to see frequency response or dynamic video range right on the front of the screen.

(We'll see how this is possible a little bit later.) Use the MULTIBURST BAR SWEEP INTERRUPT buttons to select any increment of the entire video carrier.

Inject at the IF input (11) and connect your scope to the video detector output (15) so you can see what both Multiburst and EIA staircase patterns do. Note the picture detail in the frequency bars of the Multiburst Bar Sweep pattern and see the distinct stair step of the EIA test pattern (Figure 3b). When aligning the sychronous detector, you simply adjust for best linearity of the pattern.

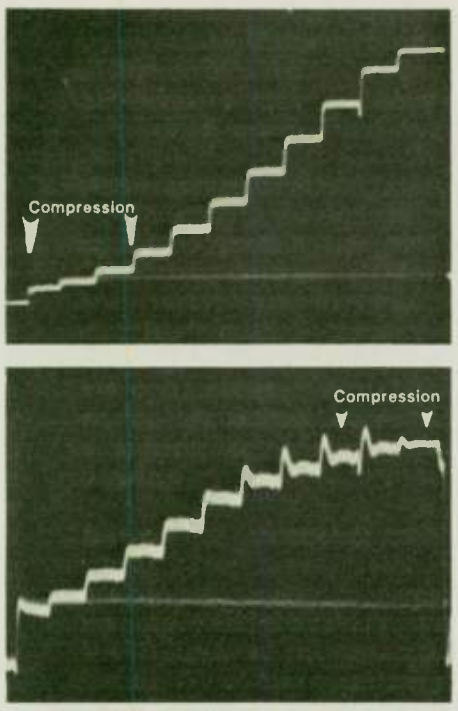


Fig. 4: Linear stair steps of the VA62 pattern check linearity of the IF and video amplifiers and check alignment of the synchronous detector.

10 Bar Staircase Solves Brightness And Contrast Problems

A closer look at the 10 Bar Staircase Pattern shows its usefulness in solving brightness and contrast problems and in adjusting the synchronous detectors. Use this staircase pattern when working in the luminance stages (16), (17), and (18). It provides exactly the same information as the stair-step part of the industry NTSC pattern. The linear stair steps are used to check linearity of the IF and video amplifiers and for alignment of the reference coil in synchronous detectors.

Synchronous video detectors need a linear pattern for testing and alignment. Mis-alignment (Figure 4) causes poor contrast or brightness, which is especially noticeable on large-screen units. Other video circuits may cause compression at any point of the operating curve (white, gray, or black), which is only found with a test of the full operating range of the system. The staircase test pattern, with its equally spaced steps, aids you in accurately testing or aligning synchronous video detectors or testing the dymanic range of any video amplifier, video tape system, or other luminance circuit. This pattern was not previously available outside the broadcast studio.

While we have the staircase pattern chosen and injected at the IF input (11), let's adjust the tuning coil of the synchronous video detector (15) to see just how critical it is. Good reproduction of the station signal is our goal. Synchronous detector output is picture quality, it doesn't get any better (it only gets larger) after it leaves the detector. This is one reason the detectors are adjusted first in most alignment procedures. Some manufacturers recommend that you don't touch the synchronous detector alignment, however, even minor mis-alignment produces adverse effects in the picture. Many TV sets have been adjusted by other technicians and some have simply drifted out of alignment through ageing and vibration. With the VA62 staircase pattern, you are assured of getting the best output from the detector.

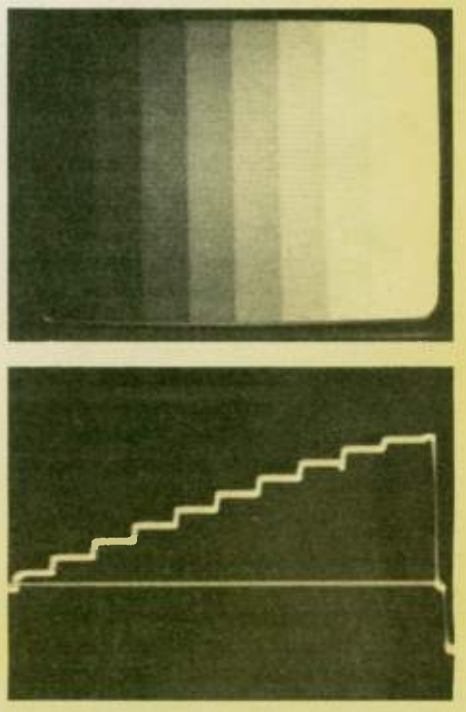


Fig. 5: The response curve of the synchronous detector showing correct alignment with the staircase pattern.

Multiburst Bar Sweep

The Multiburst Bar Sweep pattern may be compared to the sweep curve shown in service literature. The multiburst bars occur every 0.5 MHz all the way to 4.5 MHz, providing a complete dynamic check of the resolution of video systems. The high frequency bars (near the color carrier) roll off at the same rate at the video detector as a sweep generator, allowing you to compare directly to any service literature, even if there are no Bar Sweep waveforms shown. There are no jumps in the frequencies that may cause you to miss important information between bars. But, more important, the multiburst bar sweep pattern allows the circuits to work *normally* without artificial AGC bias. The Bar Sweep Pattern duplicates exactly the signal found in the stages during normal operation.

How does the VA62 Bar Sweep pattern compare to a sweep and marker generator for RF and IF alignment? Each point on the video IF response curve represents a different part of the video frequency response. The traps determine the upper and lower frequency limits.

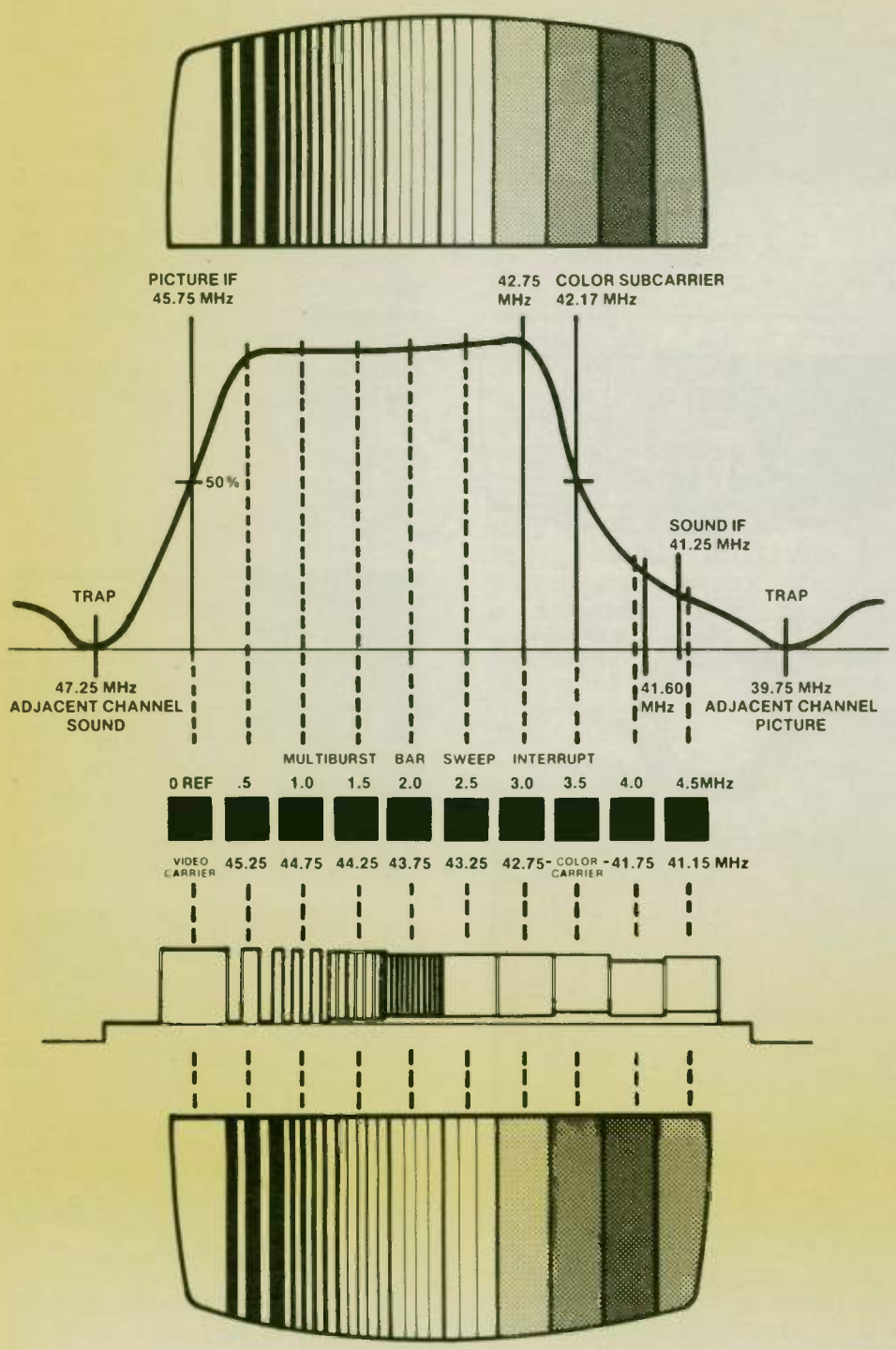


Fig. 6: The traps determine the upper and lower frequency limits of the video IF response curve. Each point on the curve represents a different part of the frequency response.

Each Bar Sweep bar corresponds to a Video frequency shown above the selector pushbutton for reference, and an IF frequency shown below each pushbutton.

The bar frequencies of the Multiburst Bar Sweep video pattern are related directly to the critical frequencies of the IF response curve. These ten bars provide a *complete* frequency response test of the IF system from zero to 4.5 MHz in half-megahertz steps. Many comb filter receivers have video frequency responses out to 4.2 MHz. Most video test equipment stops at 3 MHz and does not test the full response.

Bar Sweep alignment prevents tuning problems at the color end of the IF curve because all key frequencies are present and adjustments may be made to achieve best overall IF response.

The VA62 multiburst bars are actually square waves. Square waves are better for testing because they will help in detecting IF circuit ringing.

The multiburst bar sweep pattern is the only signal on the market that dynamically tests every video stage (from the antenna to the CRT) for signal amplification, linearity, frequency response, and circuit ringing.

Color Patterns (Chrominance)

The VA62 produces all the standard color-bar generator patterns that you are already familiar with. One common set of video patterns support all TV receiver and VCR service requirements. These patterns have the same peak-to-peak amplitudes as produced by the "NTSC" color bar generator. Use the manufacturers' service literature without calculation or compensation.

A white level is provided in the Chroma Bar Sweep pattern to cause the non-keyed AGC circuits found in VCRs to operate properly. Chroma Bar Sweep bars at 3.0, 3.5, and 4.0 MHz allow fast, accurate, color bandpass checks and adjustments. When the three Chroma Bar Sweep bars are turned off with the 3.0, 3.5, and 4.0 MHz interrupt buttons, the VA62 produces a pure-white, snow-free pattern for purity tests, brightness limiter adjustments, and high voltage regulation tests.

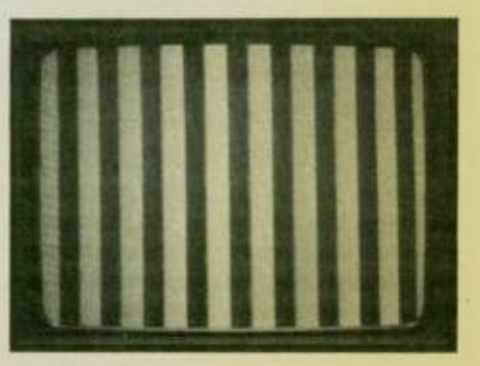
Improved Gated Color Bars

All signals in the color processing circuits (25) through (39) and (45) through (53) must be properly phase-locked to produce the correct colors.

Switch to the color bar pattern to see the fully saturated standard phase-locked color bars on the CRT. The color modulation levels of this pattern are higher than on most other color generators which causes richer colors in the color bars. The levels in the color circuits agree directly with the amplitudes of the color signals on a schematic referenced to the 75% Saturated EIA Color Bar pattern.

Make color tests and adjustments faster and more accurately with the VA62. The demodulators (29), (30), and (31) are a good point to begin analyzing because they call for *two* phase-locked reference signals. The color signals from the TV station or color generator need the TV's 3.58 MHz oscillator locked to the color burst signal, and the same 3.58 MHz signal shifted 90 degrees, for proper demodulation. Defects in the color oscillator (53), frequency and phase correction circuits (52), tint circuits (53), demodulators (23) and (24), matrix (35) and (36), and CRT drivers (37), (38), and (39) are isolated, with absolute assurance, using phase-locked substitute signals.

The phase-locked, gated rainbow color pattern will remain the industry standard for trouble-shooting and aligning TV receivers and VCRs. It is the pattern that all service technicians are familiar with. The gated rainbow pattern serves you well for troubleshooting and allows tests on any video system. It has been the only color pattern in video service for over 25 years.



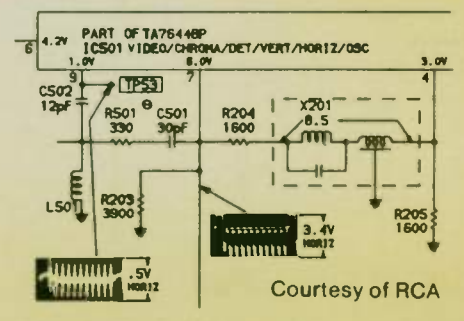


Fig. 8: The VA62 supplies standard color-bar patterns that agree directly with service literature for TV receivers or VCRs.

Chroma Bar Sweep

Accurately align the chroma bandpass amplifiers with the patented Chroma Bar Sweep.

The Chroma Bar Sweep pattern tests the full frequency response of the color circuits. The signal is phase-locked for operation of any color video circuit. White reference levels appear on either side of the chroma frequency bars. The chroma amplitudes agree directly with the amplitude of the "NTSC" cyan bar.

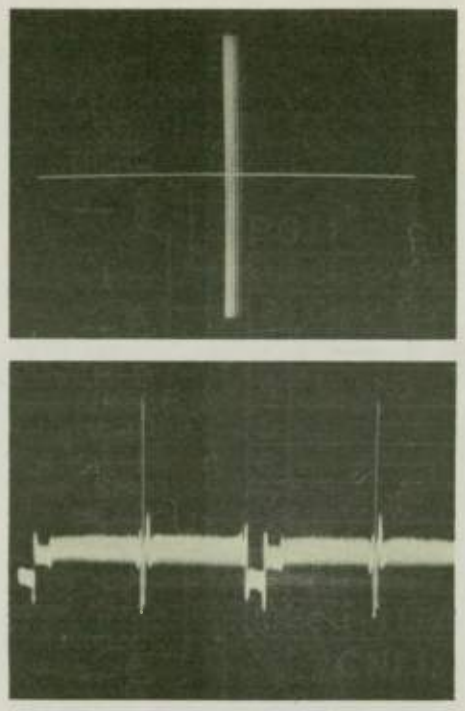
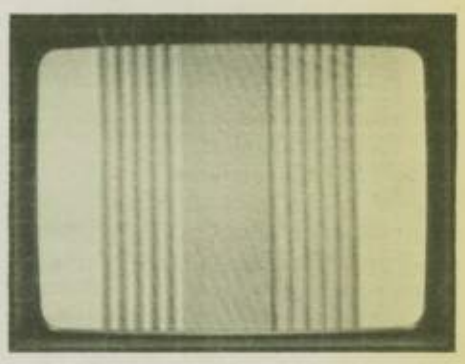
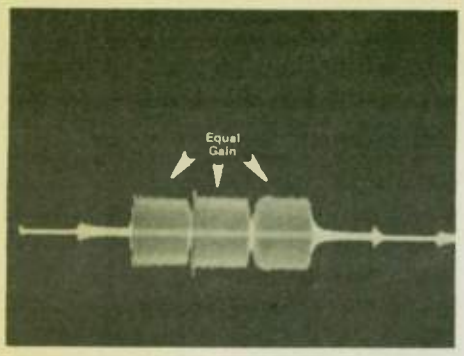


Fig. 7: Ringing in the IF amplifiers will appear as harsh white edges on the lower frequency bars. The distortion may show on the white or the black area, depending on the direction of the overshoot in the circuits.



Manufacturers use cyan for reference because it has the highest amplitude of all the colors. Color circuits must be able to pass this amplitude correctly, to prevent clipping or limiting on highly saturated color signals. VCR schematics directly reference these color signals. The pure white reference levels lock the VCR AGC circuits.



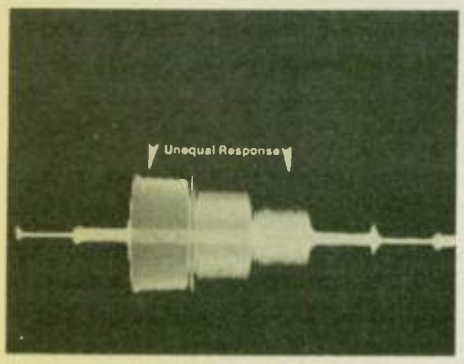


Fig. 9: In a chroma bandpass amplifier system (25), the three Chroma Bar Sweep bars should have the same amplitude when injected at the input to the first video IF stage (15) and monitored at the input to the color demodulators (30). (A) Properly aligned chroma amplifier. (B) Unequal response caused by mis-alignment.

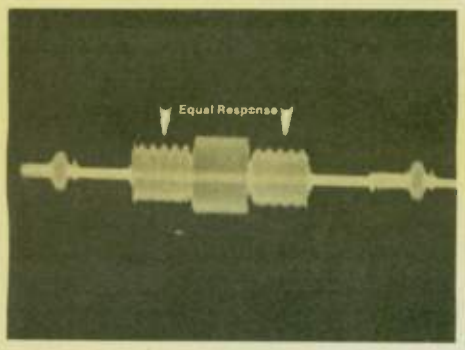


Fig. 10: The output of an IC bandpass system may have the center (3.58 MHz) bar larger than the other two. If so, make certain the two outside bars have the same amplitude.

NTSC Color Bars

The NT64, an accessory to the VA62, will produce phase-locked and sync locked NTSC patterns, including both full field and split field. These patterns are used for VCR service, video production, and television broadcast. The output of the NT64 is connected to the external modulation jack on the VA62, giving you the NTSC patterns in the EXTERNAL MODULATION position of the Video Pattern switch.

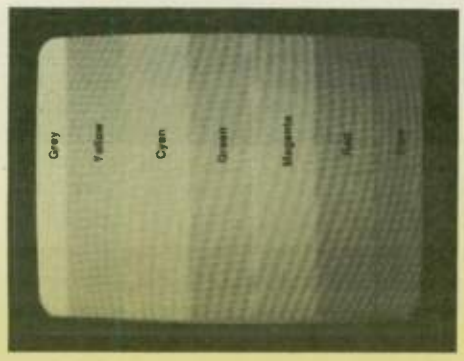
Signal Adders

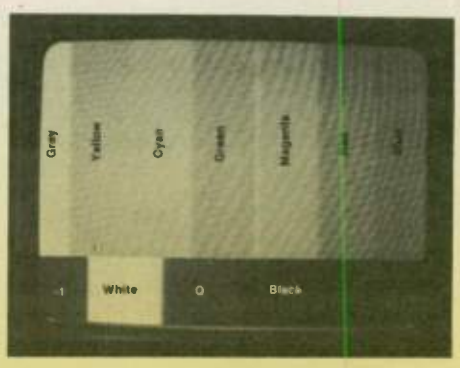
Interlace

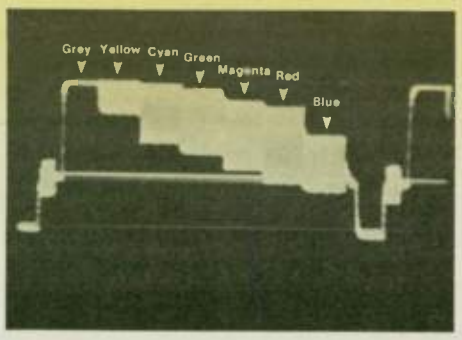
The Interlace Adder switch performs a deceptively simple function, switching between interlaced and non-interlaced vertical sync. The ability to switch between these two sync modes enables technicians to test special circuitry in TV, broadcast, and video editing applications. Here's how:

New vertical digital countdown circuits must be checked with interlaced vertical sync to duplicate off-the-air signals. Non-interlaced sync duplicates sync from some cameras, video games, and home computers. Vertical count down circuits must be dynamically tested to insure they work on both types of vertical sync. Otherwise, you'll be getting a callback when the customer hooks his computer or video game to his newly repaired TV set. Check the vertical countdown digital sync circuits by simply selecting any video pattern and then confirming that the receiver holds sync as the INTERLACE ADDER switch is turned on and off.

You'll want to use non-interlaced sync for convergence adjustments. Interlaced signals cause the horizontal lines to dance and jitter. Non-interlaced sync gives rock-solid convergence patterns without interlace beat.







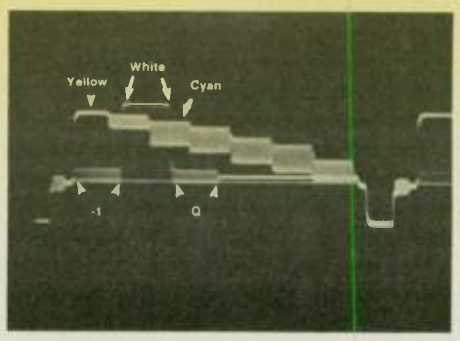


Fig. 11: Both full field and split field NTSC patterns are available from the NT64.

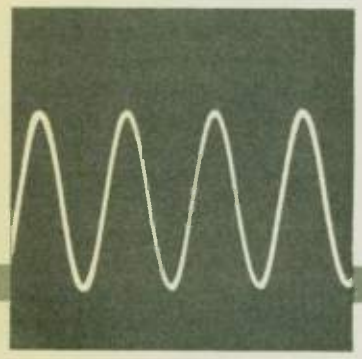
Vertical Interval Reference (VIR)

Vertical Interval Reference (VIR) is a standard FCC signal that all networks and most local stations use on every program. There are many TV's that use VIR and you need a good way to test today's VIR circuits. Automatic chroma circuits use the VIR signal to compensate for changes which affect tint. The VA62 adds an FCC accurate VIR signal when you press the VIR ADDER button to dynamically test VIR circuits for proper tint and color level.

Any of the VA62 patterns may have a standard VIR signal added. This allows dynamic testing of circuitry which makes use of VIR. But, why not use "off the air" signals to test VIR circuits? Off the air signals just may not include the VIR signal when you need it. Furthermore, how can you be sure that you really are receiving the desired signal? The capability of VIR and INTERLACE signals adds another dimension to your troubleshooting ability.

External Modulation

Any one volt peak-to-peak composite video with negative sync may be applied to the external modulation jack. Use this input for Camera, VCR, Game, Computer, or Pattern signals that you wish to translate to an RF channel for observation and tests.



Drive Signals

Properly chosen, drive signals form a warehouse of known good signals to substitute into suspect circuits. Signal substitution finds difficult troubles faster than any other method. Increased use of integrated circuits created the need for the VA62's wide range of substitute signals. These drive signals will solve circuit problems and improve your troubleshooting effectiveness in all of the latest circuits.

Audio Troubleshooting

Full Performance Check

As with the video circuits, you can do a full performance check on TV audio without taking the back off the set. A level controlled, frequency modulated, audio carrier, when injected at the antenna, thoroughly checks the audio performance. Sets are checked for frequency response as well to ensure that amplifiers and speakers are working properly.

Manufacturers recommend four different audio frequencies for testing and aligning audio stages. Audio frequencies supplied by the VA62 are appropriate for troubleshooting audio circuits in any video system. An audio generator modulates the RF, IF or 4.5 MHz sound IF signals with 333 Hz, 1 KHz, 5 KHz or 7 KHz audio. The generator also supplies a signal to the DRIVE SIGNAL switch for use in troubleshooting the circuits after the detector (15).

Signal levels for injection up to the detector (14) are provided by the RF-IF generator. Signals to inject into stages after the detector are provided by the DRIVE output.

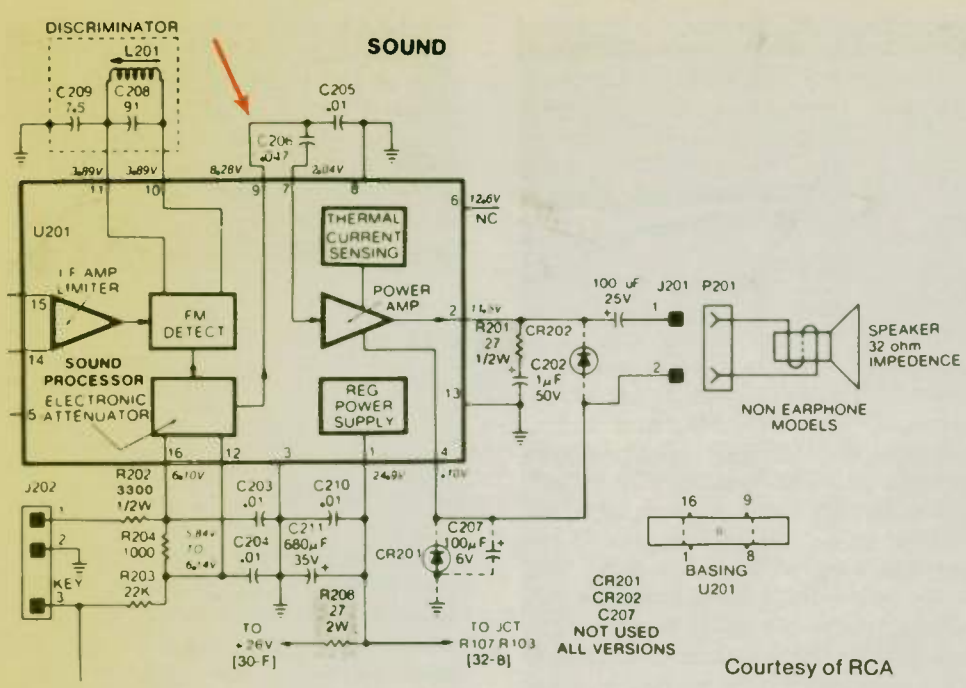


Fig. 1: Inject a test signal at the input of the audio amplifier.

Divide And Conquer Difficult Audio Troubles

The "Divide and Conquer" troubleshooting concept keeps you from having to step through each stage in search of problems because you jump over several stages when you inject a good signal. Step back to the input of the audio amplifier (7) and inject a test signal. The volume control quickly identifies this stage. Connect the audio signal to the center conductor on the volume control, proper pin on the integrated circuit, or base of the audio transistor. Sound at the speaker tells you that all audio stages past this point are good. No sound means you should divide the audio stages and inject a signal again. When you have found the defective stage, sound will be restored. Using signal substitution, you can normally test the audio stages faster than you can find them on the schematic.

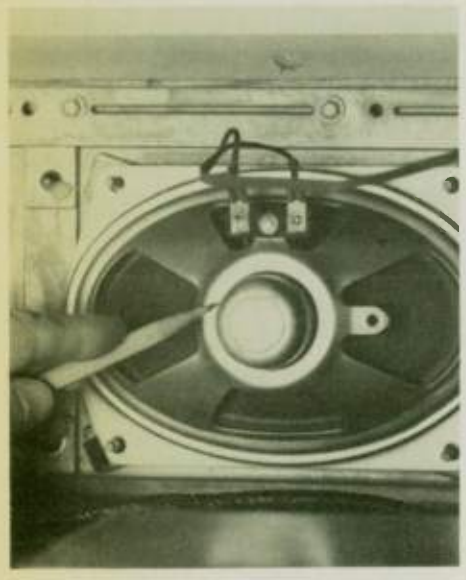


Fig. 2: Signal substitution tests audio stages faster than you can find them on the schematic.

Antenna: Here, signals are injected for quick performance checks. Choose the proper RF CHANNEL and AUDIO modulation. Inject at the antenna and check for sound output from the TV. This test provides fast proof of audio performance without removing the back from the set. Easily tie audio problems down to the defective stage with signal substitution.

Fig. 3: Run through all four audio frequencies for a final test of repaired audio circuits.

Audio Detector: Substitute an audio signal at the output of the audio detector (7) to prove that circuits from there to the speaker work.

Video IF: Move to the 3rd video IF (13) and substitute a modulated 45.75 MHz VIDEO IF signal to see if the problem is after the sound take off.

FM IF: Substitute the 4.5 MHz FM signal at the FM IF output (6) to prove the trouble is in the FM IF stage.

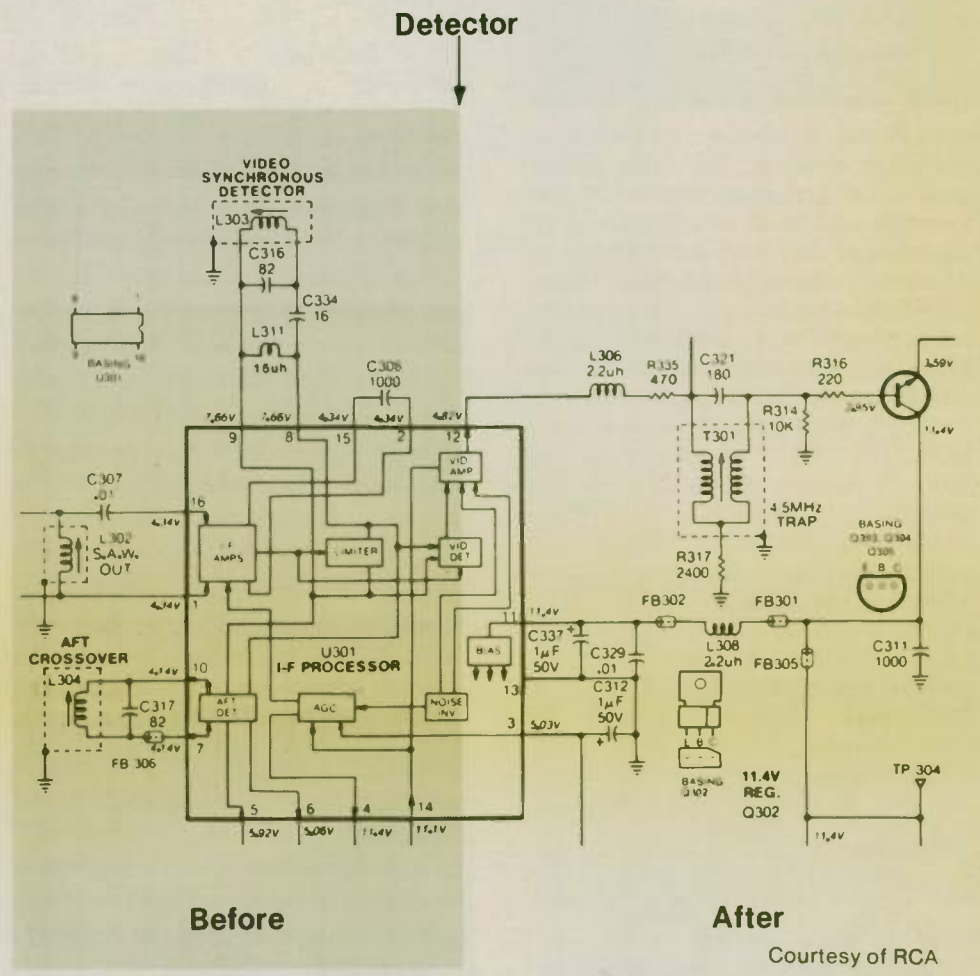
Once you have isolated and corrected the trouble in an audio stage, run through all four audio frequencies to show that you have done a quality job.

All Signals After Detection

Drive Signals

Years of experience, together with customer feedback and knowledge gained through testing, enabled Sencore engineers to choose and incorporate drive signals which make the VA62 the most capable video analyzer available. These signals were developed to fill the practical needs of video service technicians. The DRIVE RANGE provides attenuator controlled levels in a range of amplitudes which cover every application from low level integrated circuit inputs to the CRT itself. The 3 VPP drive range is used for integrated circuits, the 30 VPP range for transistors, and 300 VPP for tube circuits. A phase-locked 30 Hz SERVO DRIVE signal allows the servo circuits of VCR or video disc players to be phase-locked to the other VA62 signals.

oscillator (56) directly. Integrator filter circuits (55) are checked quickly and positively. The integrated vertical drive signal helps isolate problems to any stage up to the output stage (61). For troubleshooting, vertical output stages are treated like any power amplifier; the vertical deflection coils are the load, and the frequency is fixed at 59.94 Hz. Use the VERT DRIVE sawtooth waveform to substitute in these stages. Observe the results of signal substitution on the CRT and work from the vertical oscillator to the output stage.



Courtesy of RCA

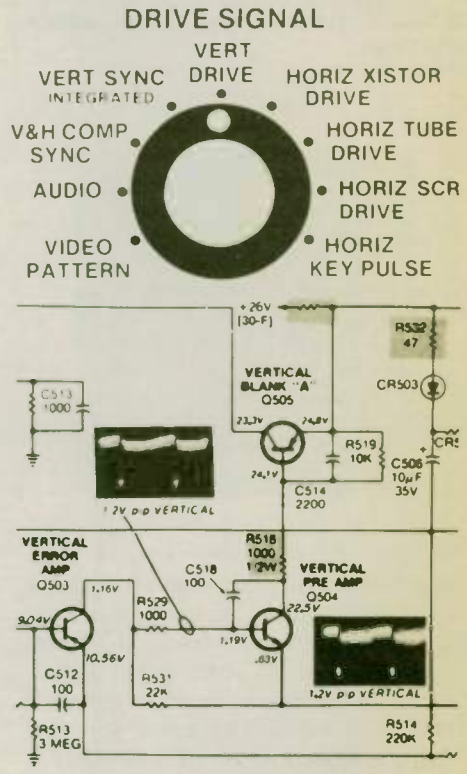
Fig. 4: Drive any circuit in the TV after the detector with phase-locked drive signals.

Phase-locked drive signals drive any circuit in the TV after the detector. Drive signal capability makes the video analyzer act like a large stack of good TV chassis to borrow signals from. This is a positive approach to troubleshooting. Speed and accuracy in troubleshooting come not only from experience, but also from having test equipment with known good signals to substitute into suspect circuits. Every drive function, both internal and external, is monitored by the digital meter.

Drive circuits are isolated from ground and all other circuits to allow substitution into any stage. Problems with ground returns, loops, or differing potentials are eliminated. Troubleshooting errors are minimized and greater protection is given for both the VA62, and the circuit under test.

Vertical

A phase-locked integrated vertical sync pulse drives the vertical



Courtesy of RCA

Fig. 5: Drive Vertical Stages with the integrated VERT SYNC and VERT DRIVE signals.

Horizontal

Separate horizontal drive signals are provided for substitution in transistor, tube and SCR type circuits. The horizontal keying signal is made available for troubleshooting various circuits, such as AGC or color burst gates, high voltage multipliers, and integrated high voltage transformers. It is not practical to directly drive the flyback transformer and deflection yoke with a substitute signal. The wide range of voltages and currents needed to drive the flyback and yoke, together with the different impedances needed for servicing chassis of every manufacturer, would make direct driving of flybacks and yokes too costly.

With drive power *and* impedance matching, you may even drive defective ones and make them look good. A better method is to provide a foolproof test of the flybacks and yokes and forget about trying to drive them directly. The RINGING TEST is the answer. It produces results with 100% accuracy without generating unsafe voltages. Drive all stages to the flyback and yoke with substitute signals and use the RINGING TEST if you suspect the yoke or flyback is the trouble. Use positive polarity horizontal drive signals for transistor, tube, or SCR output circuits. Inject the drive signal at the base of the horizontal output transistor, at the control grid of the horizontal output tube, or gate of the retrace SCR in an SCR horizontal circuit. Look for improvement as you inject into these stages.

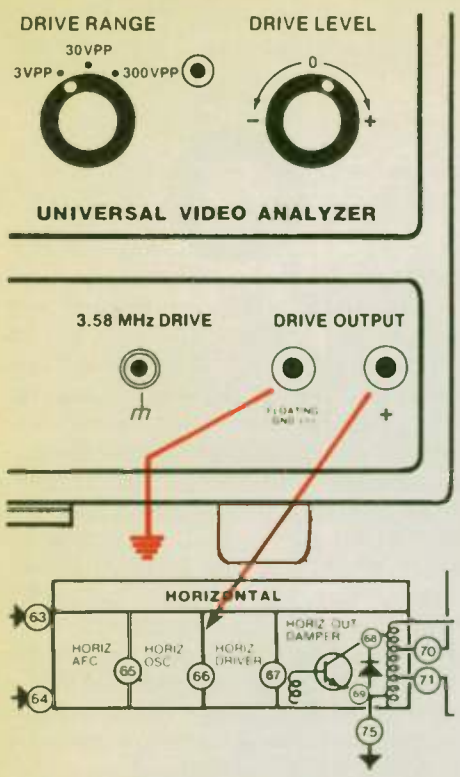


Fig. 6: Use positive polarity horizontal drive signals for transistor, tube or SCR output circuits.

Servo Drive

Signal substitution into electro-mechanical playback systems, such as VCR or video disc players, is made practical through phase locking the video pattern to the playback servo reference signal. This is done in the VA62 by supplying a separate phase-locked 30 Hz servo drive signal. The servo drive signal is adjustable in amplitude and when reversed in phase, allows substitution at different points in the servo control loop. The servo drive signal seizes control of the servo loop by "swamping out" the unit's own servo signal and replacing it with the VA62's signal. When the VA62's servo drive signal controls the servo loop, video patterns and color stay locked in sync. VCR tests are discussed in another section of this issue.

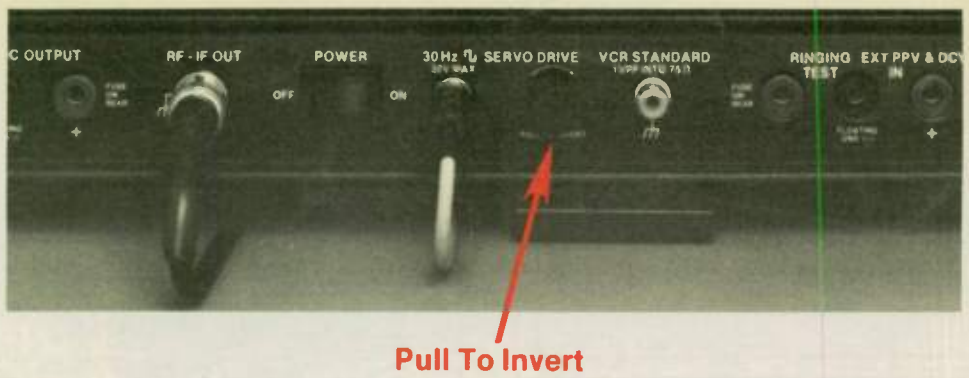
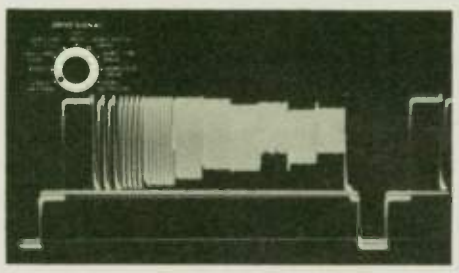


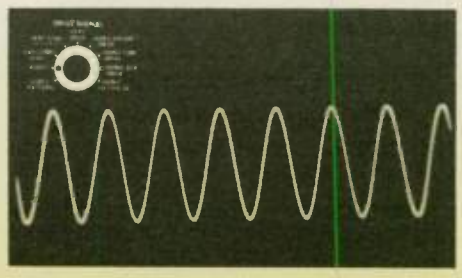
Fig. 7: Reversible in phase, the 30 Hz servo drive signal allows substitution at different points in the servo control loop.

Drive Signal Selection Switch Revisited

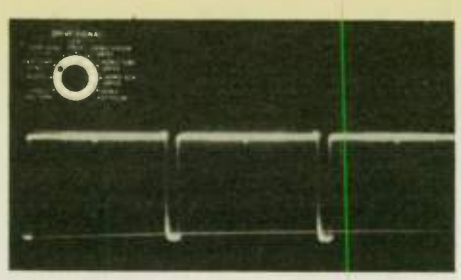
Look again at the drive signal selection switch and let's review these important substitute signals.



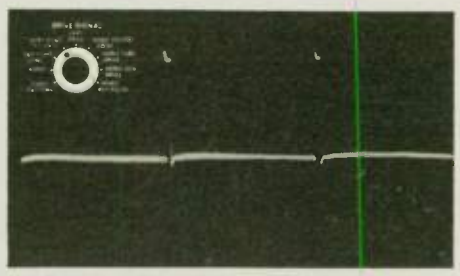
Video Pattern: The pattern selected by the VIDEO PATTERN SWITCH is available at this DRIVE SIGNAL position. Video pattern signals are injected into individual video stages, while the RF-IF signal is fed to the antenna or IF input to hold all good circuits in sync. The video system returns to normal when the substitute signal is injected at the correct point because the phase-locked substitute signal duplicates the signal normally found in the circuit. Defective stages are quickly isolated using this phase-locked signal substitution method.



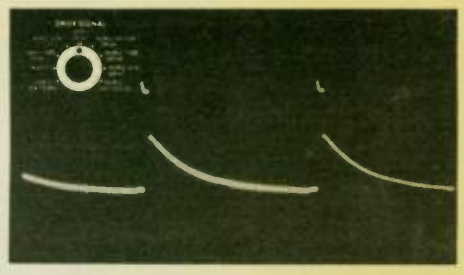
Audio: In this DRIVE SIGNAL application, the audio frequency selected by the AUDIO switch is available for substitution into any audio stage.



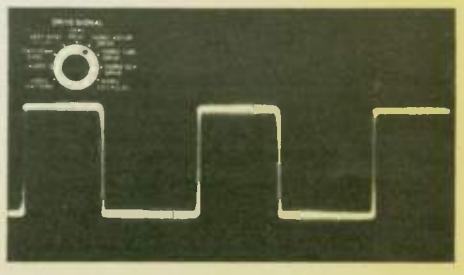
V&H Comp Sync: Composite sync at this DRIVE SIGNAL switch position is used in troubleshooting to isolate problems in the sync separator, vertical integrator filter, or horizontal automatic frequency control (AFC) circuits. Both horizontal and vertical sync pulses duplicate the signal found at the output of the sync separator.



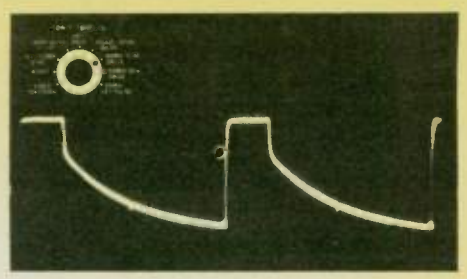
Vertical Sync Integrated: Vertical pulses needed to keep the vertical oscillator in step with the incoming video are provided at this DRIVE SIGNAL switch position. This signal is shaped like the integrated sync in the receiver and will help isolate problems in the integrator filter or vertical oscillator.



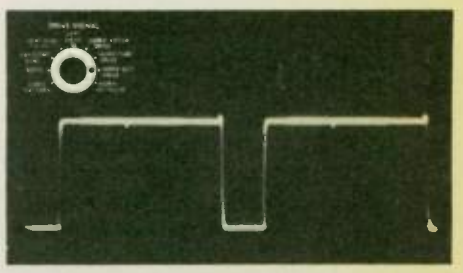
Vertical Drive: This DRIVE SIGNAL is the sawtooth waveform needed to produce vertical sweep. Substitute this signal at the grid of the vertical output tube or the base of the vertical output transistor. Restoration of full height and linearity are not expected with this substitute signal because vertical waveforms differ from one receiver to another. Instead, look for major improvement in circuit performance which serves to quickly isolate the defective circuit.



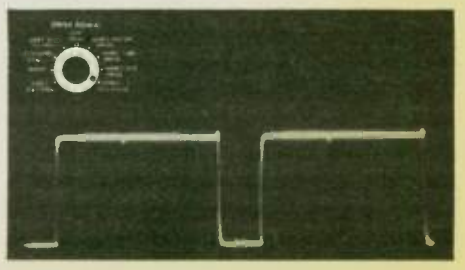
Horiz Xistor Drive: This square wave DRIVE SIGNAL duplicates the signal found between the base and emitter of the horizontal output transistor. Substitute this signal in horizontal drive and output stages. Defective horizontal stages and start-up problems are identified quickly with this signal.

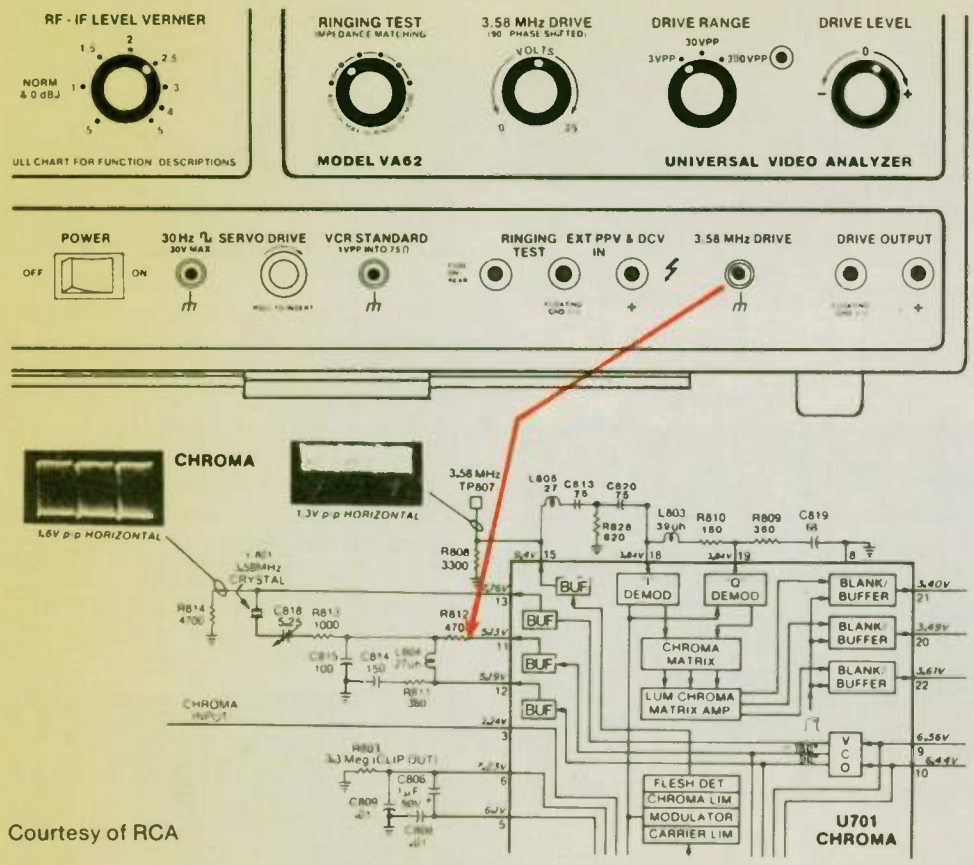


Horiz Tube Drive: Drive the grid of the horizontal output tube with this DRIVE SIGNAL. The 300 VPP range of the DRIVE RANGE switch provides proper impedance matching and amplitude for tube type circuits.



Horiz SCR Drive: This drive position provides narrow pulses used to drive TRIAC or SCR outputs. The retrace device is normally driven with a narrow positive pulse at sync time. Substitution, in SCR and TRIAC outputs, aids in isolating circuit defects.





Courtesy of RCA

Fig. 8: The separate 3.58 MHz color drive signal quickly identifies color oscillator problems. Color is restored when this phase-locked signal is injected.

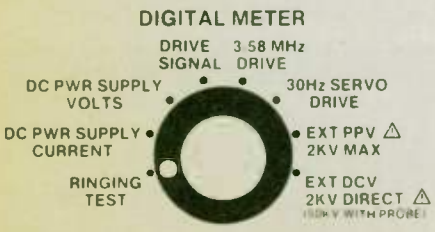
Horiz Key Pulse: This DRIVE SIGNAL matches the timing and pulse width of the horizontal flyback keying pulse that AGC or color burst gate circuits use. Integrated flyback transformers, triplers and other high voltage multipliers are also tested with the horizontal keying pulse.

Separate Color Drive Signals

The separately controlled 3.58 MHz color signal, phase-locked 90 degrees from the color pattern, is used together with the pattern to inject two color signals simultaneously into the color demodulator. This simulates the color mixing action in a TV or VCR and provides a positive test of the color circuits.

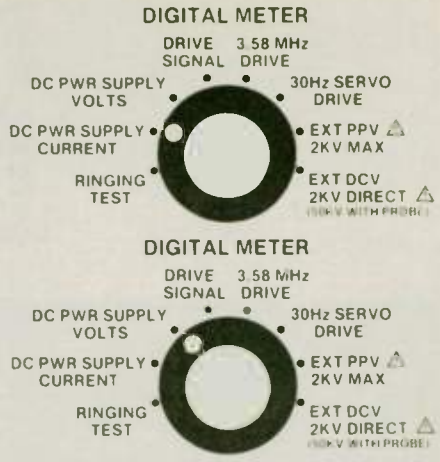
Metering For Reference

In addition to proper waveshape, the drive signals must be delivered to the circuit with the proper polarity and level. Drive signals are monitored to prevent damage to the circuit and to see the effects of loading on the signal. The 3.58 MHz and 30 Hz servo drive signals must also be monitored. The DIGITAL METER switch makes the fully autoranged digital meter available to monitor signals both internal and external to the VA62.

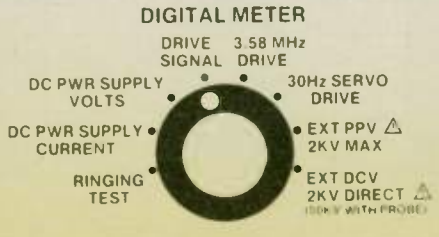


Ringing Test: This first position on the DIGITAL METER switch is the ringing test. When yokes or flybacks are suspected, do the ringing test before going any further. This patented test is the most accurate method for testing coils in a deflection yoke or flyback transformer. Shorted or open windings (even one shorted turn), are detected with this totally reliable test.

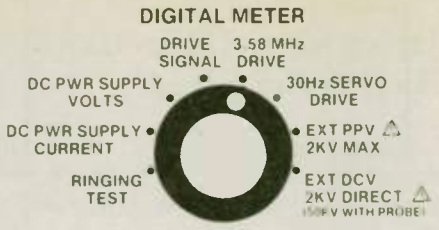
To use the Ringing Test, simply connect the suspect coil to the RINGING TEST terminal, choose RINGING TEST with the DIGITAL METER switch, and rotate the RINGING TEST impedance matching control through its six positions. A reading of 10 or more in any position indicates a good coil. A bad coil will read less than 10 in all of the six positions. Use this test and in less than a minute, any yoke or flyback is proven good or bad with 100% accuracy.

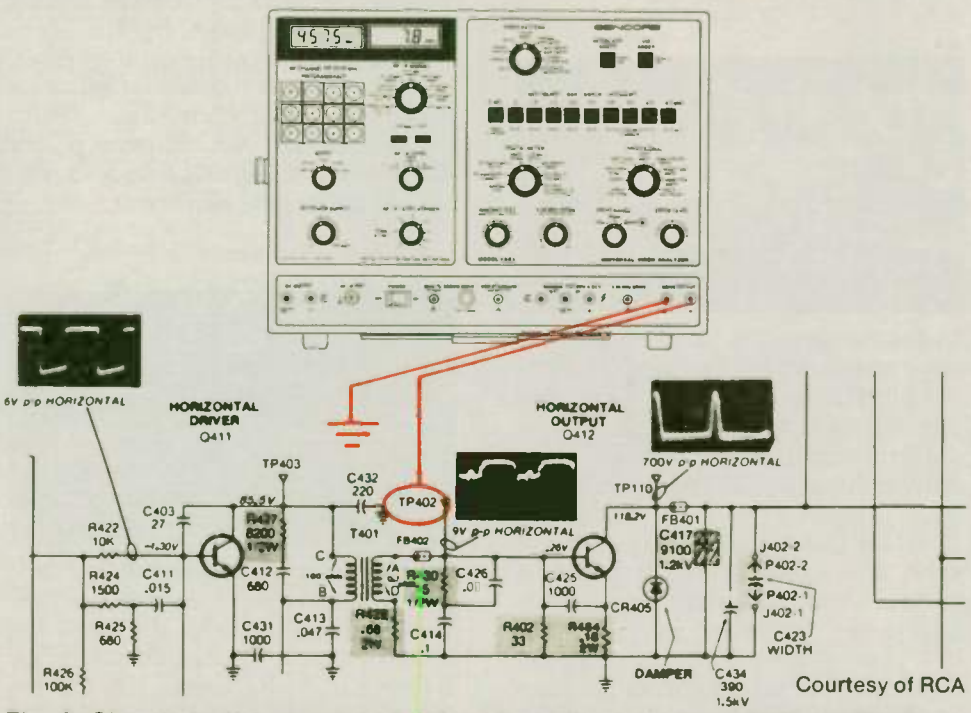


DC Power Supply: The power supply becomes an analyzing tool when the output current and voltage are monitored with an internal meter. Set voltages accurately and monitor current drain and circuit loading. The DC PWR SUPPLY CURRENT position of the DIGITAL METER switch monitors power supply current, and the DC PWR SUPPLY VOLTS position monitors DC OUTPUT voltage.



Drive Signal: The peak-to-peak amplitude of the signal appearing at the DRIVE OUTPUT jacks, whether internal or external, is displayed on the digital meter when this position of the DIGITAL METER switch is selected.

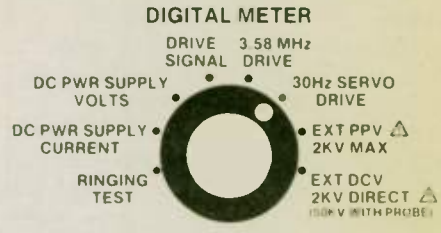




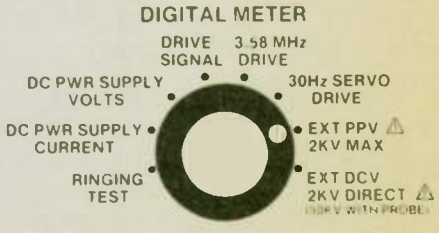
Courtesy of RCA

Fig. 9: Signals in the circuit and drive signal levels at the DRIVE OUTPUT are monitored in the DRIVE SIGNAL position of the DIGITAL METER switch; you see the effects of circuit loading on the signal and adjust drive levels under dynamic conditions.

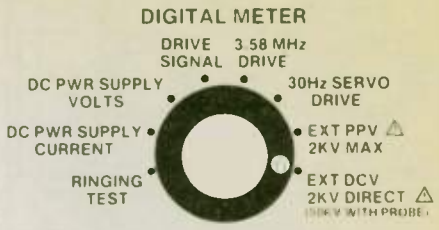
3.58 MHz DRIVE: This position of the DIGITAL METER switch monitors the 3.58 MHz (90 degree phase shifted) drive level set by the 3.58 MHz DRIVE control.



30 Hz SERVO DRIVE: This DIGITAL METER switch position monitors the level of the SERVO DRIVE signal.



EXT PPV: The highest troubleshooting efficiency comes when you combine signal injection with signal tracing using the VA62's peak-to-peak meter. The peak-to-peak circuitry has a frequency response of 5 MHz to measure any signal with better accuracy than an oscilloscope. Autoranging and digital peak-to-peak accuracy are the secrets which allow this meter to substitute for a scope on most tests. Connect your scope in parallel with the VA62 meter for tests that call for both peak-to-peak voltage and waveform interpretation. Usually, the amplitude is all that you need to determine if the circuit operates correctly.

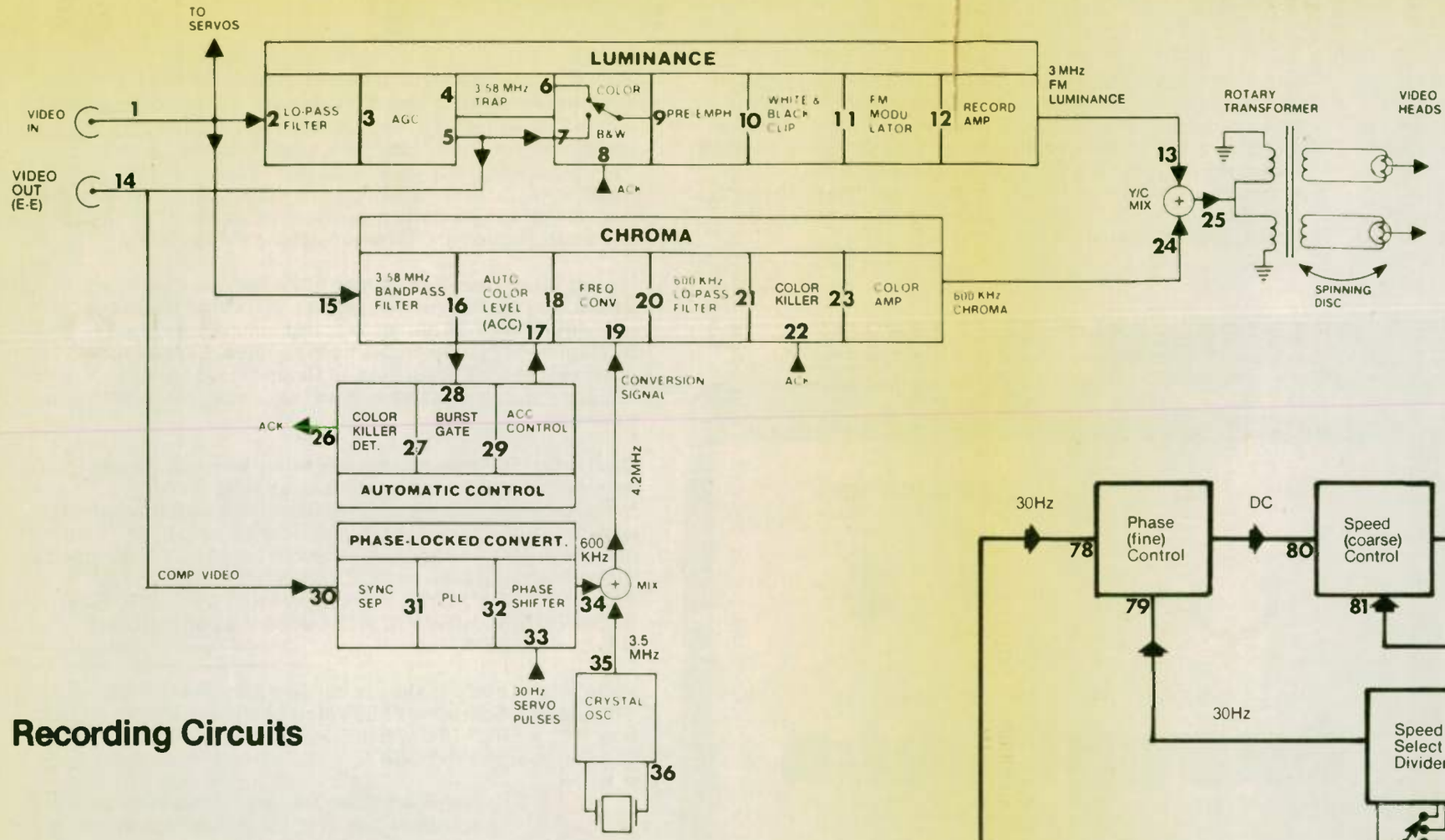


EXT DCV: DC voltages are analyzed with the VA62 autoranging digital meter to confirm that circuits are good or bad. Measurement of focus and second anode voltage (high voltage) is necessary to completely isolate high voltage problems. Trouble-shooting speed and accuracy is increased through autoranging and protecting the meter to 2000 volts. Readings in sensitive circuits are measured more accurately with the high input impedance and measurement range is extended with add-on probes to allow tests to either 10,000 or 50,000 volts.

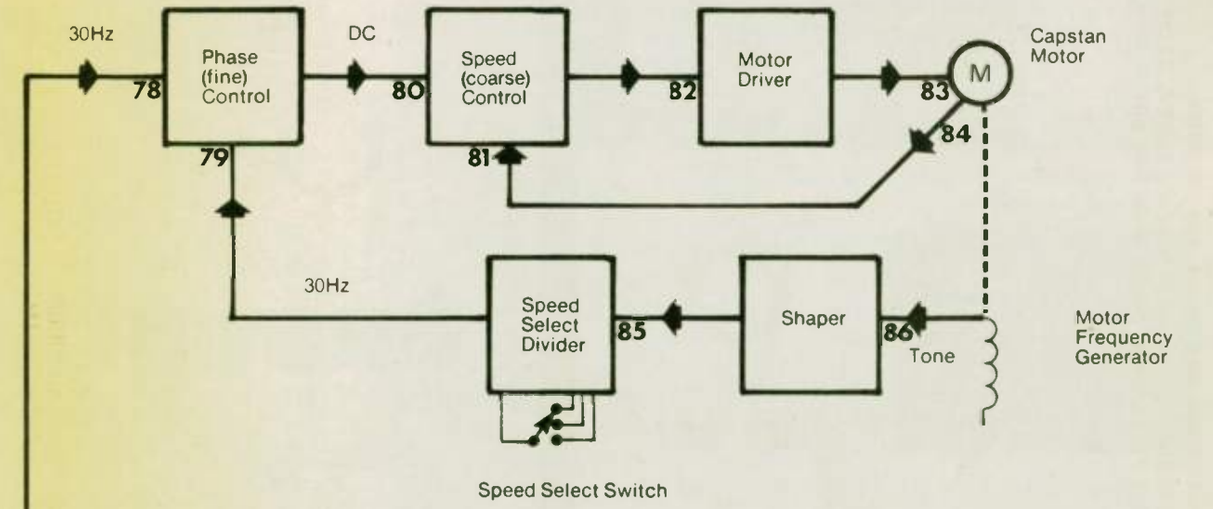
Best Combination Ever Developed

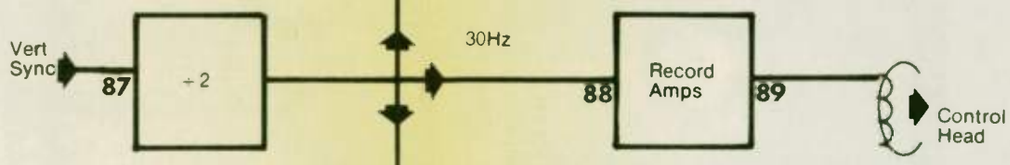
Whether troubleshooting audio, video, sync, scan, color, servo, or high voltage, the VA62 drive signals and autoranged meter provide the very best combination of video tests ever developed.

Universal VCR Block Diagram

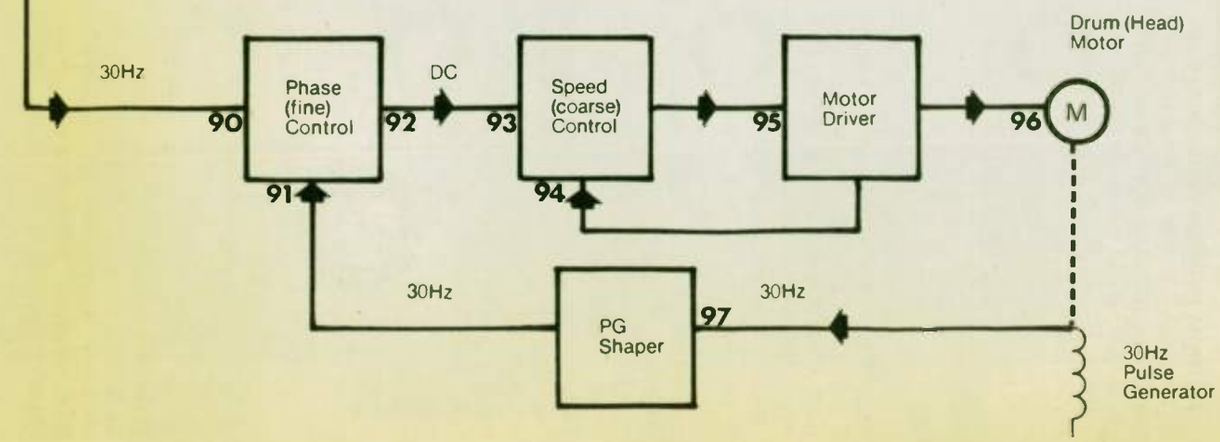


Recording Circuits





Recording Servos



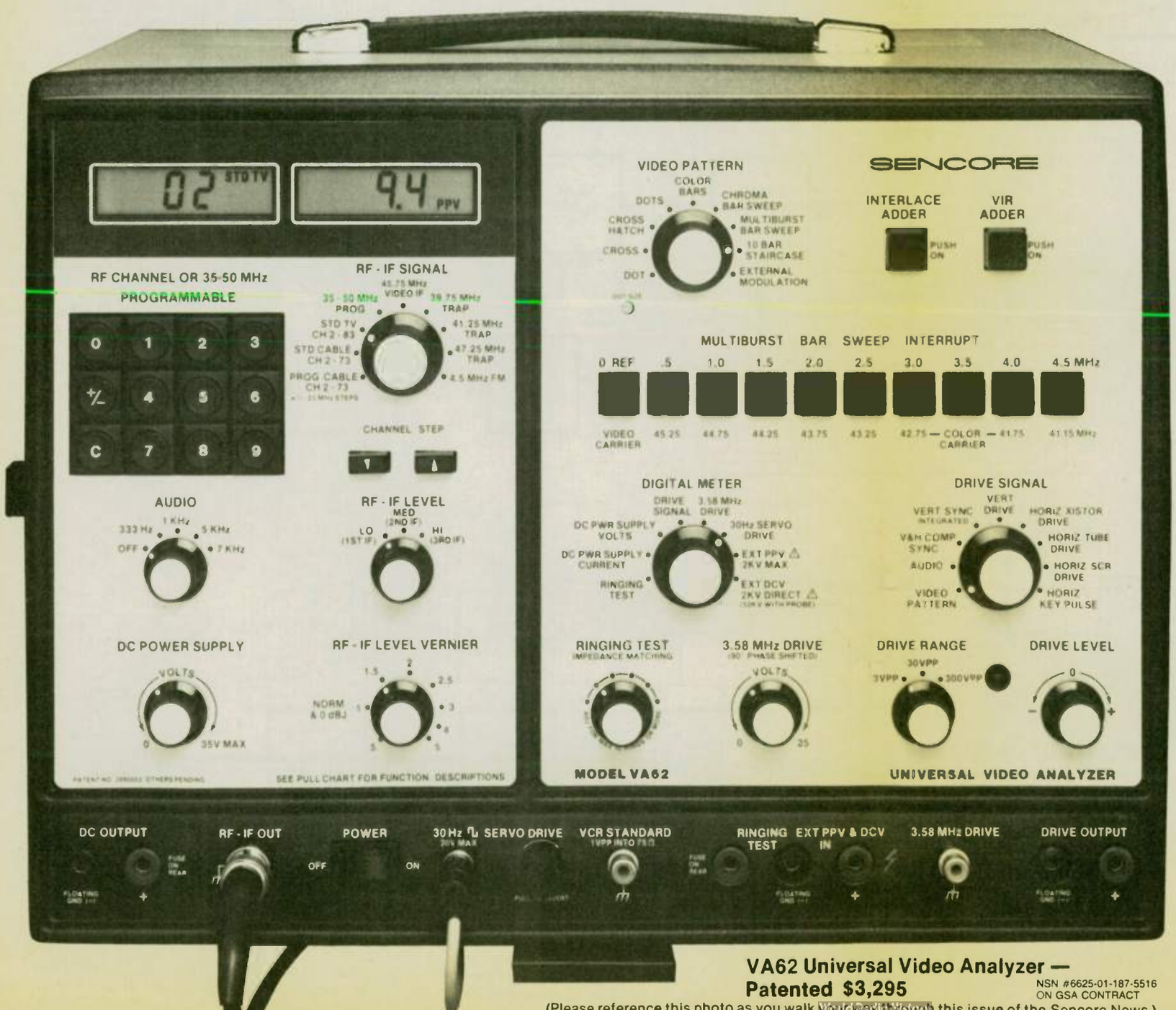
Special Pullout Section

Please pull out and reference this section, as this issue of the Sencore News walks you through TV and VCR troubleshooting.

You'll Walk "Tough Dog" Troubles Out Of Any TV & VCR In Half The Time . . . Or Your Money Back!

Cut Your "Tough Dog" Analyzing Time In Half. Isolate any problem to one stage in any TV or VCR in minutes, without breaking a circuit connection, or removing any components using Sencore's exclusive tried and proven signal substitution method of troubleshooting.

Cut Costly Callbacks And Increase Customer Referrals. At last you can completely performance test every TV and VCR quickly before they leave your shop. The VA62 Video Analyzer equips you to check all standard and cable channels with digital accuracy. Check complete, RF, IF, video and chroma response of any chassis in minutes without taking the back off the receiver or removing the chassis, plus set traps dynamically right on CRT too. . . catch those little things before your customer does. You'll turn unprofitable callbacks into profitable cash referrals.



Take The Guesswork Out Of Stocking Costly Service Parts With The Patented Ringing Test. Why own any more yokes, flybacks, and IHVTs than you have to, because you weren't sure the one under test was good or bad? With the VA62 you can run dynamic tests on any yoke, flyback, or integrated high voltage transformer . . . in-, or out-of-circuit — for 100% proof positive results that can save you a bundle on stocking inventory for parts substitution and time-consuming shotgunning.

Protect Your Future By Servicing VCRs For Your Customers Before They Go To Your Competition. Walk out "tough dog" troubles in any VCR chrominance or luminance circuit — stage by stage — to isolate problems in minutes. Have a proof positive test of all VHS, Beta, or Umatic video heads before you replace the entire mechanism and save a bundle on your stock inventory.

Cash In On Profitable Authorized Factory Warranty Service. Increase your business by meeting all TV and VCR manufacturers' requirements for profitable warranty service work with one up-to-date system. Here's a partial list of the manufacturers who approve or recommend the VA62 Universal Video Analyzing system: CURTIS MATHES, GENERAL ELECTRIC, GOLDSTAR, MONTGOMERY WARD, PROTON, RADIO SHACK, HOWARD W. SAMS, J.V.C., MITSUBISHI, N.E.C., RCA, ZENITH.

Write for more information or call us today, **WATS Free, 1-800-843-3338,** to put a VA62 Video Analyzing System on your bench for a FREE 15 Day Self Demo and start getting those dogs off your bench TODAY.

Simplified Video Training Course included if you act before July 31st, 1986. (See Page 31 For Details)

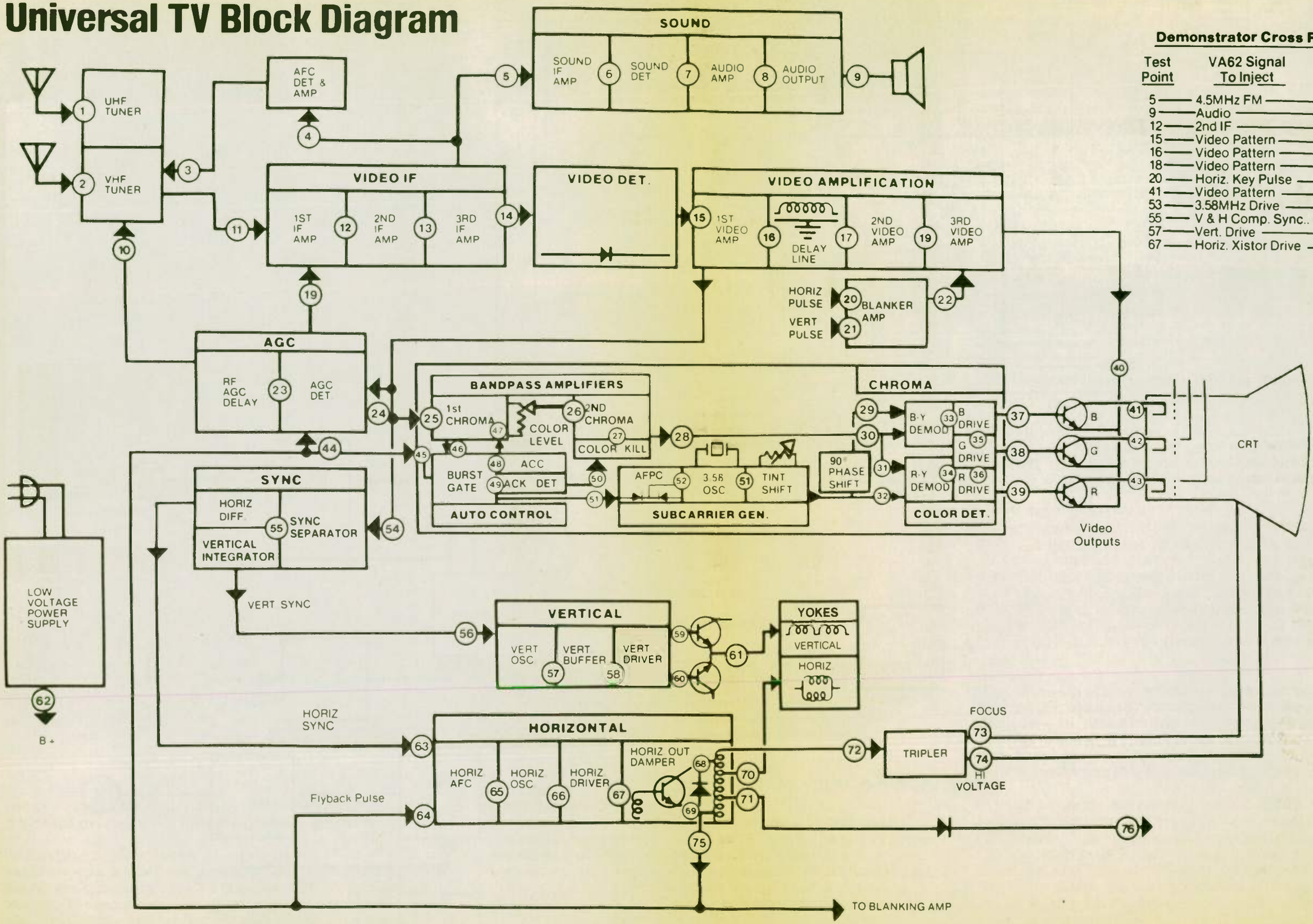
VA62 Universal Video Analyzer — Patented $3,295

NSN #6625-01-187-5516
ON GSA CONTRACT

(Please reference this photo as you walk your way through this issue of the Sencore News.)

VC63 VCR Test Accessory — $495
NT64 NTSC Pattern Generator Accessory — $395

Universal TV Block Diagram

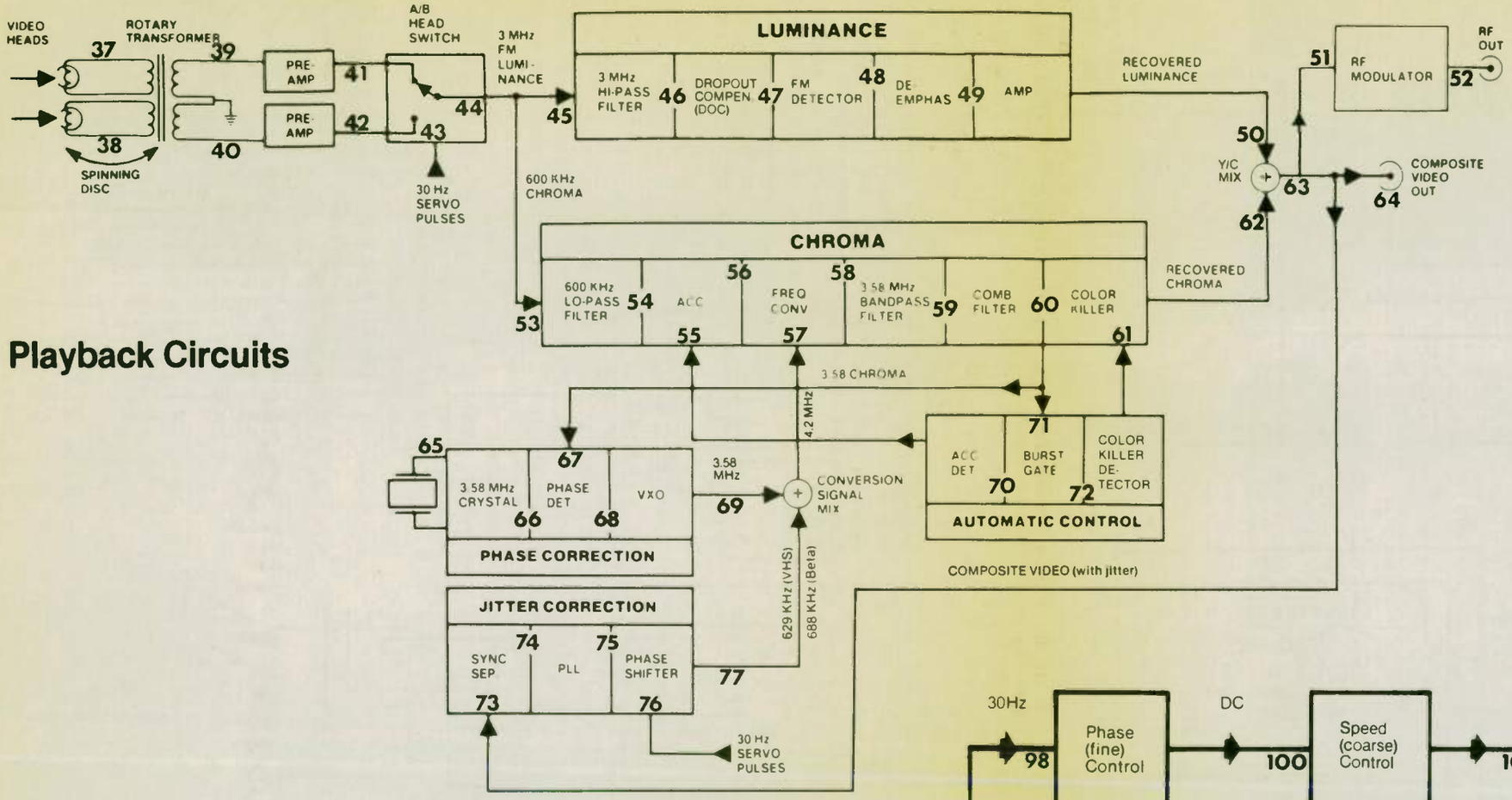


Demonstrator Cross Reference

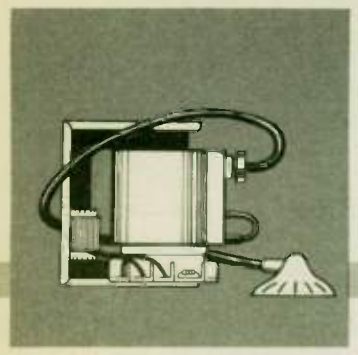
Test Point	VA62 Signal To Inject	VPP
5	4.5MHz FM	Hi / 3
9	Audio	3V
12	2nd IF	Med. / 1
15	Video Pattern	– 2V
16	Video Pattern	– 2.5V
18	Video Pattern	– 0.5V
20	Horiz. Key Pulse	+ 5V
41	Video Pattern	+ 140V
53	3.58MHz Drive	6.5V
55	V & H Comp. Sync..	+ 20V
57	Vert. Drive	– 3 up; + 11dN
67	Horiz. Xistor Drive	+ 1.5V

This Universal TV Block Diagram has been supplied to be used as your reference for simplified understanding of the VA62 and its exclusive troubleshooting capabilities. Please use it as a reference while reading through this issue. For your convenience, the circled numbers correspond with specific test points referenced throughout this issue.

Playback Circuits



Playback Servos



Special Tests

High voltage, automatic feedback, scan derived power sources, automatic fine tuning, automatic gain control, and similar circuits are analyzed faster using the VA62. Special test features save you time, increase your confidence, and enhance your success in troubleshooting.

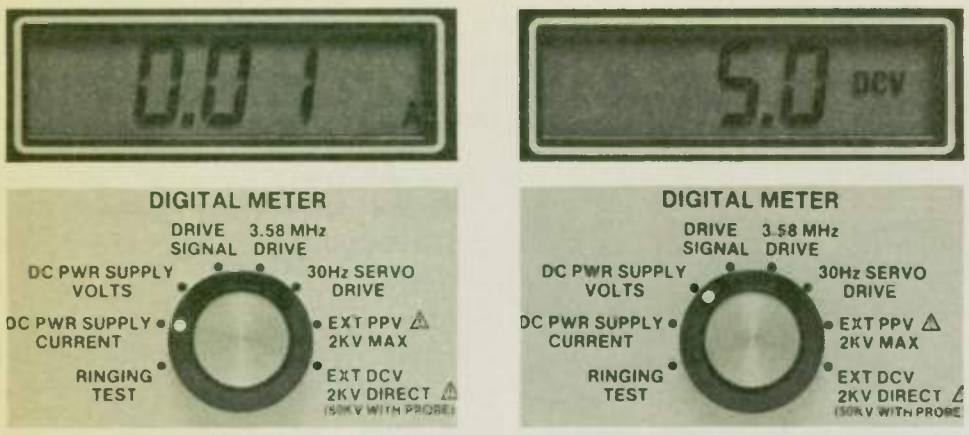
The power supply, for example, is metered for both current and voltage. This allows you to analyze defects in AGC, AFT, and start-up circuits. The ringing test is essential to video service and provides 100% accuracy in yoke and flyback tests. Autoranged metering of DC and PPV to 2000 volts adds measurement ability for any circuit (including the collector of the horizontal output).

The Power Supply Becomes An Analyzer

When both voltage and current are monitored, the power supply becomes an analyzer. Open or shorted circuits are easy to spot, and the effect of circuit loading is readily apparent. Use this supply to substitute in bias, AGC, control and start-up circuits. The output terminals are isolated, allowing the power supply to be substituted into any circuit at either positive or negative polarity. Both voltage and current are monitored to help analyze circuit defects. You will know when the right voltage is present and how much current is being drawn.

Ringing Test

The ringing test measures the "quality" of a flyback or yoke. Even one shorted turn will easily be detected by this patented test. When you connect the yoke or flyback coil to the RINGING TEST terminals, the coil is included in a circuit which will "oscillate" when a pulse is applied. The number of times the oscillating voltage cycles represents the quality of the coil. The impedance of the circuit is adjusted by the RINGING TEST control. A good yoke or flyback will show ten or more on the DIGITAL METER in at least one position of the RINGING TEST.



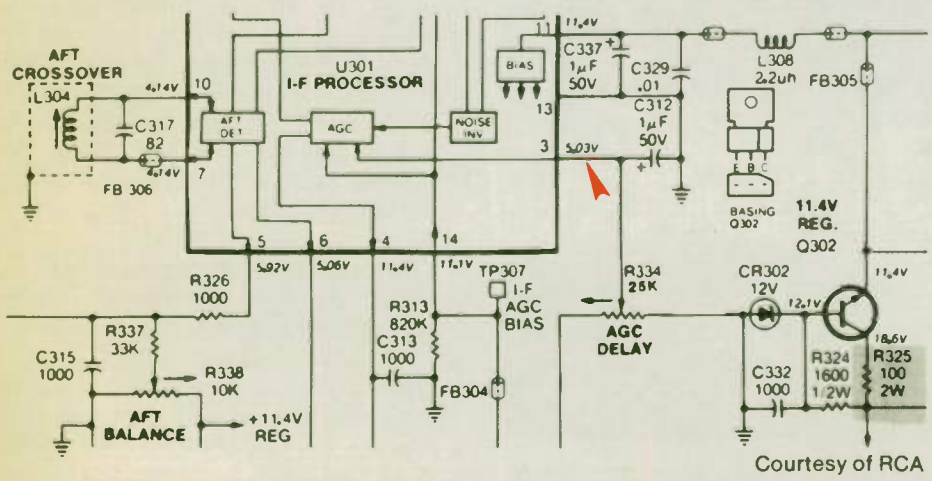


Fig. 1: Voltage and Current monitoring makes the DC power supply an analyzing supply.

Fig. 2: Even one shorted turn will easily be detected by the patented ringing test.

One Shorted Turn Adds Confidence

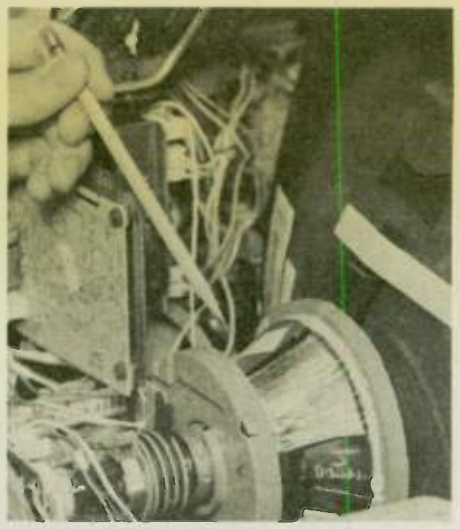


Fig. 3: Add a shorted turn to create a method of comparison. Make your "shorted turn test loop" out of small insulated wire and wrap it closely around the suspected yoke or flyback coil.

100% Accurate

The ringing test provides a simple 100% accurate good/bad test for yokes and flybacks. Trouble-shooting of high voltage and sweep problems is simplified when you know the yoke and flyback are good.

What About Next Year?

When new chassis are produced that have different flyback and yoke designs, it is conceivable that manufacturers may make a model that just doesn't ring at least "ten" on at least one position of the impedance matching RINGING TEST control. Is a new and entirely different type yoke or flyback "good" or "bad" for example, if it "nearly" rings ten times? Gain confidence in the 100% accuracy of the ringing test. Simply wrap a single loop of wire closely around the suspected flyback, twist it together to make one shorted turn, and check for the number of rings. The shorted turn will make the flyback read bad in all six positions of the RINGING TEST control. Restore the flyback to normal and check the number of rings. Now you have a method of comparison. Ring the suspected yoke or flyback, add a known shorted turn, and compare the readings. A good yoke or flyback will exhibit a large change in the number of rings (10 or more for present designs) when the shorted turn is added. One that already has a shorted turn will simply not change when another shorted turn is added. On yoke coils, lay the "shorted test loop" along the path of the coil for close coupling. Be sure to remove the shorted test loop before restoring the set!

Locating Yoke Windings

Both horizontal and vertical deflection windings are made up of two identical coils mounted opposite one another. The electron beam moves at right angles to the magnetic field, so you will find the horizontal coils mounted at the top and bottom of the yoke assembly and the vertical coils on each side. The horizontal coils are the ones closer to the CRT.

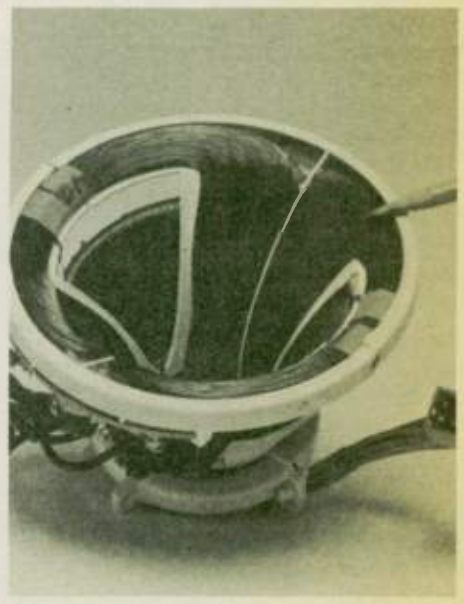


Fig. 4: Horizontal and Vertical deflection windings are actually made up of two identical coils mounted opposite one another. The horizontal coils are the ones closer to the CRT.

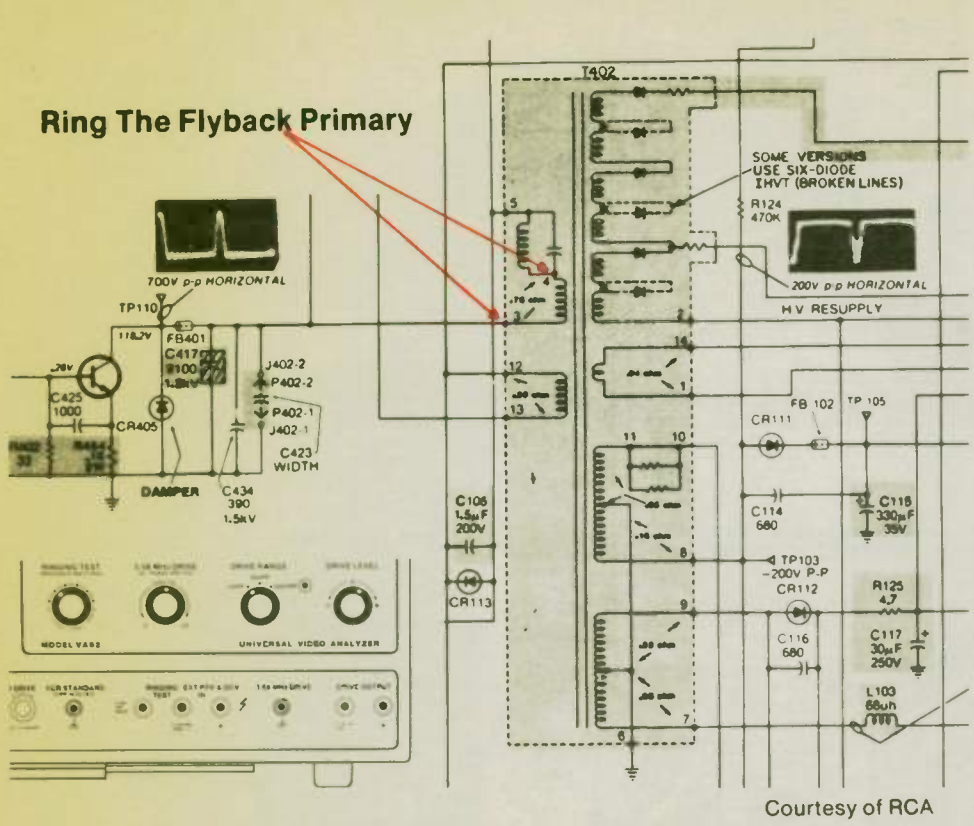


Fig. 5: Ring the flyback first to check the entire horizontal output section, including the horizontal yoke and output transistor windings.

Ring The Flyback Primary First

Ring the flyback primary to check the entire horizontal output section, including the horizontal yoke windings and the horizontal output transformer windings, without disconnecting individual components. Successful "in-circuit" ringing tests on the primary of the flyback (ten or more rings) show that there are no shorted turns in the yoke's horizontal windings or in the flyback. Check each winding for "opens" to complete the test. Flyback and yoke assemblies that ring less than ten rings in the circuit, may prove good when external circuits are disconnected.

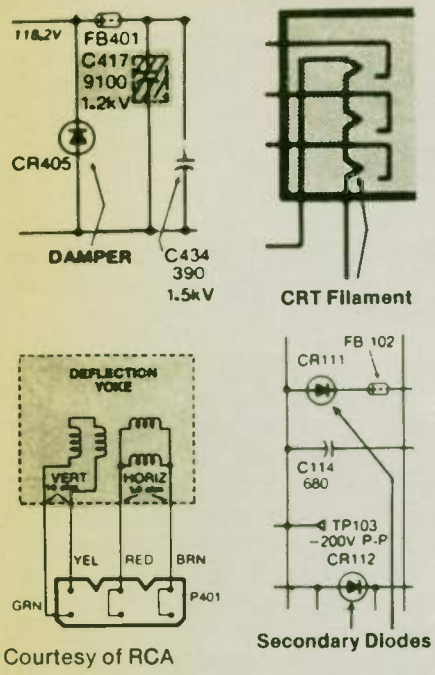


Fig. 6: Eliminate the damper diode, CRT filaments, yoke and secondary diodes when flybacks don't ring properly.

High voltage rectifier filaments, damper diodes, CRT filaments, scan derived power sources and similar circuits may foil "in-circuit" flyback ringing tests. When this happens, you must isolate the problem by monitoring the ringing test at the flyback primary, as you disconnect each winding. The damper diode and CRT filaments should be disconnected first because it is normal in some chassis for them to load the circuit. Next, isolate the yoke from the flyback.

Trace the wires from the deflection yoke to the chassis and unplug the connector to simplify flyback tests. On a chassis with a wired-in yoke, disconnect the leads. Remove the external circuit from each winding of the flyback, one circuit at a time. If the ringing test improves to ten or more when a winding is disconnected, then the flyback is good and the problem is probably in the circuit attached to that winding.

The important thing to remember, is that once the flyback rings good (10 or more rings), either there never was a problem in the flyback circuits, or you disconnected the problem! Interpret the symptoms carefully; newer flyback and yoke assemblies may ring good on only the primary winding and then only when all circuit loads are disconnected. Check external circuits for shorted components while they are disconnected from the flyback.

Ringing Horizontal And Vertical Yoke Windings

Usually, vertical deflection windings are in series and horizontal windings are in parallel in solid state sets. Damping resistors are sometimes placed across the vertical windings and will cause a bad indication on the ringing test if not disconnected. Always break parallel connections and ring yoke windings individually to find open or mis-matched windings. When tested separately, both coils should ring the same number of times. A reading of ten or more in any RINGING TEST position indicates a good winding.

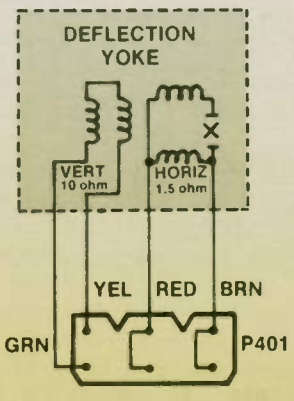


Fig. 8: Always break parallel connections and ring yoke windings individually. Damping resistors must be disconnected when ringing yokes.

Yoke Reading Good After Being Removed From The CRT Neck

On some yokes, a "Bad" condition may apparently correct itself when the yoke is pulled off the tube. This is caused by some of the yoke wires being shorted by the pressure of the yoke mounting assembly. Test the yoke before removing it from the CRT to find this problem.

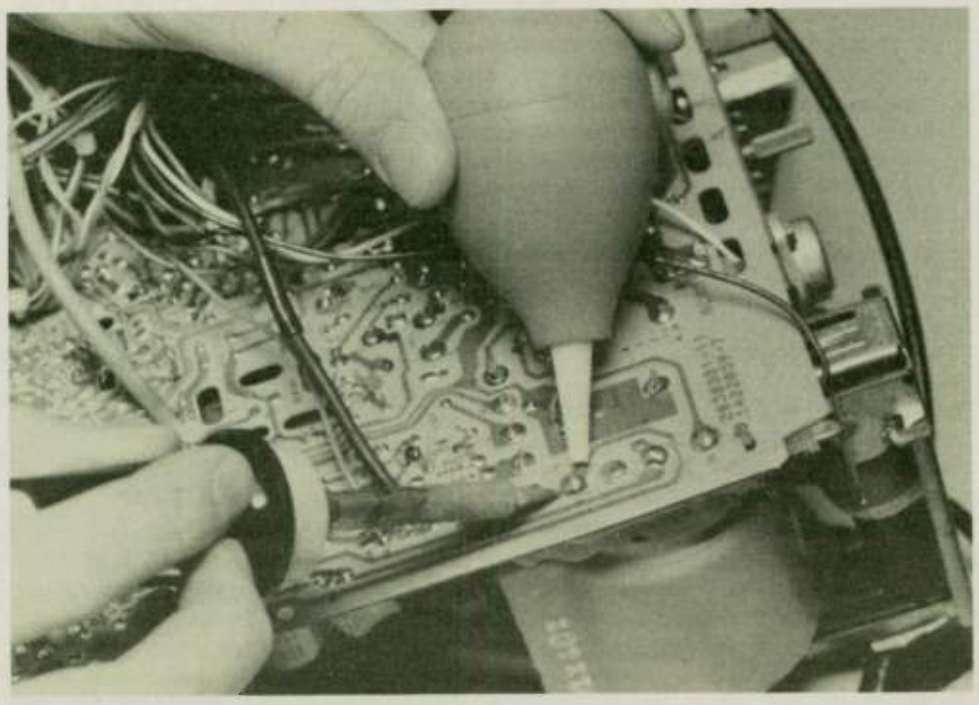


Fig. 7: External circuits affect ringing. Removing them one at a time, while monitoring the RINGING TEST, lets you identify the circuit that is loading the flyback.

External PPV Meter

Looking at the waveforms on the schematic of the set you are servicing now, the peak-to-peak voltages are given for all important test points. Compare the peak-to-peak readings on the VA62 with the schematic as you trace through a suspected circuit, and you will quickly locate the troublesome stage without having to interpret oscilloscope waveforms. Connect an oscilloscope in parallel with the meter for tests that call for both PPV and waveform interpretation.

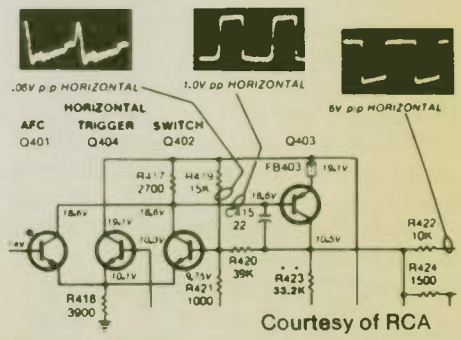


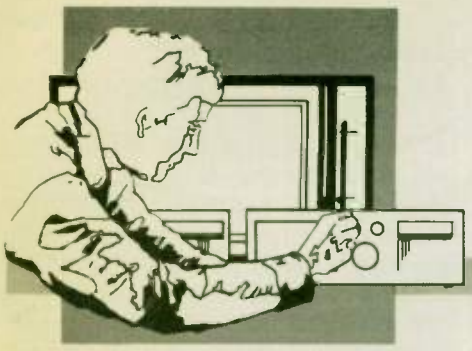
Fig. 9: Schematics show peak-to-peak voltages on oscilloscope waveforms.

External DC Meter Isolates Problems Fast

Isolate problems in circuits quickly with this 2000 VDC, 3½ digit, highly accurate (0.2%), autoranged meter. Fifteen megohm input impedance keeps circuit loading to a minimum. The voltage on the collector of the horizontal output transistor, or any other DC voltage, may be read with speed and accuracy. Extend the EXT DC range to 10,000 Volts, and the impedance to 150 Megohms with the TP212 TRANSIENT PROTECTOR PROBE. Use the HP200 HIGH VOLTAGE PROBE to extend the DC meter to 50,000 Volts for measuring the CRT second anode voltage.

Fig. 10: TP212 Transient Protector Probe and HP200 High Voltage Probe extends input impedance and range of the VA62 EXT DC meter.

The special test features of the VA62 are now considered routine and standard tests of the industry. Use these features every day to speed your troubleshooting and you too will come to find them not only *special, routine,* and *standard* tests of the industry, but *essential* to your video repair efforts. The VA62 is just plain "good business."



VCR Servicing

VCR servicing does not need to be more difficult than any other type of service if we approach it from a logical point of view. We start with a performance test to identify the symptoms associated with the defect. Then, we use a combination of signal tracing and signal substitution to zero in on the defect. We will learn more about this as we look at how to isolate typical problems a little later. First, however, let's see some of the things that seem to complicate VCR servicing.

Everything Starts With A Standard

We need a dependable signal source for our performance testing, troubleshooting and aligning. The industry adopted a standard video signal level of one volt peak-to-peak for a peak-white picture delivered into a load impedance of 75 ohms for tests of the recording circuits. *During playback, our reference comes from a test tape.*

There are two types of test tapes: an expensive manufacturer's tape for compatibility testing and a low cost "working" standard which we use for troubleshooting. We record the working standard tape ourselves using the signals from the VA62 and a known-good recorder. Using this tape insures that we don't risk damaging our expensive manufacturer's tape in a defective VCR.

Length	Video Pattern	Audio
10 sec.	Multiburst Bar Sweep (Fast Speed)	1 KHz
10 sec.	Multiburst Bar Sweep (Med Speed)	1 KHz
10 sec.	Multiburst Bar Sweep (Slow Speed)	1 KHz
20 sec.	Color Bars	333 Hz
20 sec.	Chroma Bar Sweep	1 KHz
20 sec.	Multiburst Bar Sweep	5 KHz
20 sec.	10 Bar Staircase	7 KHz
2 min.	Color Bars	333 Hz
2 min.	Chroma Bar Sweep	1 KHz
2 min.	Multiburst Bar Sweep	5 KHz
2 min.	10 Bar Staircase	7 KHz

Fig. 1: Follow this plan to make a troubleshooting tape with the VA62 patterns on a known-good VCR.

Tricky FM Circuits

The luminance circuits use a frequency modulated carrier. We can use a scope to measure the peak-to-peak amplitude of the signal, but we cannot tell whether the signal is the FM signal or a noise signal of the same amplitude.

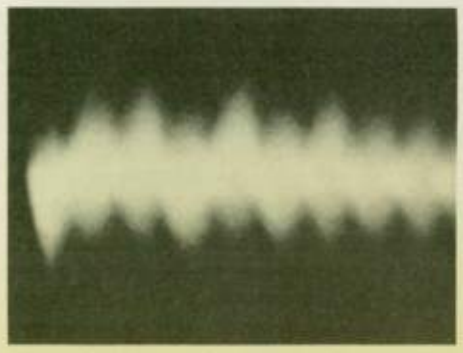


Fig. 2: Using a scope in the FM luminance circuits leads to confusion because the CRT cannot lock onto the changing carrier frequency.

In addition, the video head signals are typically less than half a millivolt, which is too small to measure with a scope. Because of this, people often substitute the head disk when they see a symptom which looks like a bad head. This is chancy because *there are about a dozen circuits* which, when defective, cause the same symptoms as bad heads.

To complicate matters, VCR circuits have gone through major changes. The three most common formats today are the VHS and Beta 1/2" tape formats and the U-Matic 3/4" format used by industry. New format improvements include hi-fi stereo sound and the "Super" Beta and 8 millimeter formats. *These constant improvements call for the ability to update our test signals* to keep up with new developments. This is why the VA62 video analyzing system includes accessories to produce the special signals needed by some, but not all, servicers.

Closed Loop Servo Circuits

The servo circuits form closed loops to control the speed of motors. Each of the two sets of servo circuits produces nearly the same symptom when defective. To make matters worse, each set of servos usually contains two loops—one inside the other. The inside loop, the "speed" loop, causes the motor to turn at nearly the correct speed. The outside loop, the "phase" loop, provides additional control over the first one. *A problem in either loop causes all the signals in both loops to shift away from the normal values as the automatic circuits try to correct for the defective stage.*

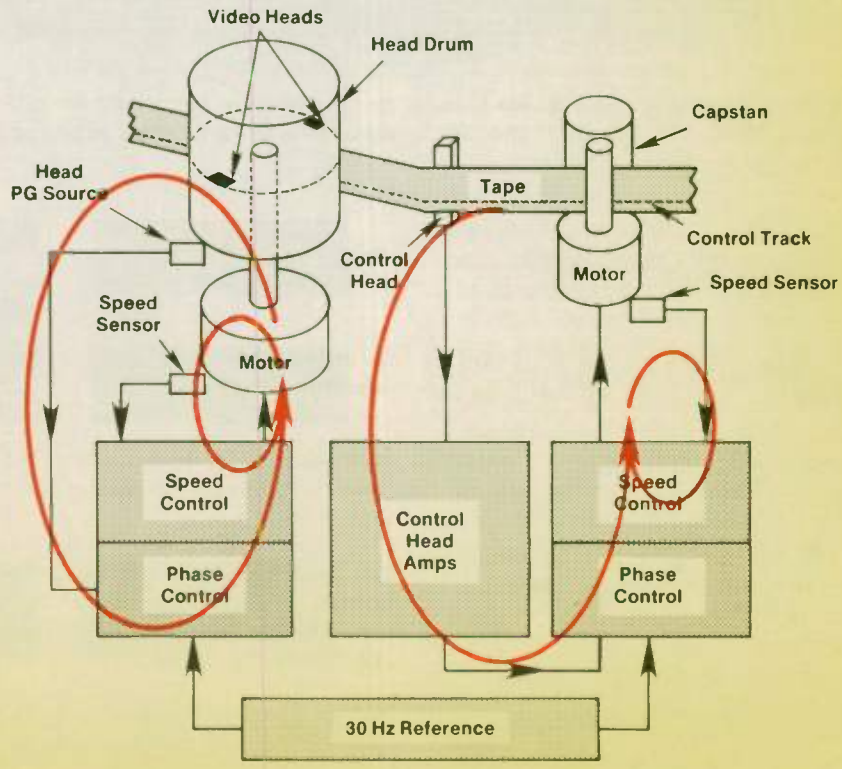


Fig. 3: The servos are tough to troubleshoot because they form two closed loops, one inside the other. A defect in any part of either loop causes all voltage measurements to be wrong.

Additionally, the servos have both electrical and mechanical components. Mechanical defects produce identical symptoms and measurements as electrical defects. The VA62 helps break the loops to separate these confusing conditions.

Understanding The VA62 VCR Features

The VA62 VCR service features fall into two groups. Features which are *universal to all VCRs* are built into the *main analyzer.* Features which *only apply to certain formats* are supplied by *VA62 accessories* to allow updating when desired.

The "VCR STANDARD" jack supplies the main reference signal. This jack provides a standard one volt peak-to-peak composite video signal into a 75 ohm load, just as needed by standard video inputs. This allows the signal, chosen by the VIDEO PATTERN switch, to be fed directly to the video input, bypassing the tuner and IF stages. The signal is sync- and phase-locked to all the other VA62 signals to allow the use of signal substitution.

The 30 Hz SERVO DRIVE signal is built into the VA62 because all VCRs use the same 30 Hz servo signal. The signal can be adjusted in amplitude with the 30 Hz SERVO DRIVE control, and the phase can be reversed by pulling the SERVO DRIVE control to its "out" position to match the phase of servo signals in the circuits.

The VA62 ACCESSORIES JACK is in the lead storage compartment in the rear of the unit and carries 13 different signals (such as power, separated vertical and horizontal sync, audio, keying pulses, 3.58 MHz color, etc.) to accessories connected to it. The accessories combine these signals as needed for special tests. Since all the signals come from the VA62, the accessory signals are phase-locked to the internal VA62 signals. The result is an integrated testing system.

The VC63 VCR Test Accessory provides signals for the three most common VCR formats: Beta, VHS, and U-Matic. The VC63 produces FM luminance and down-converted chroma signals, so that we can inject into the circuits unique to each

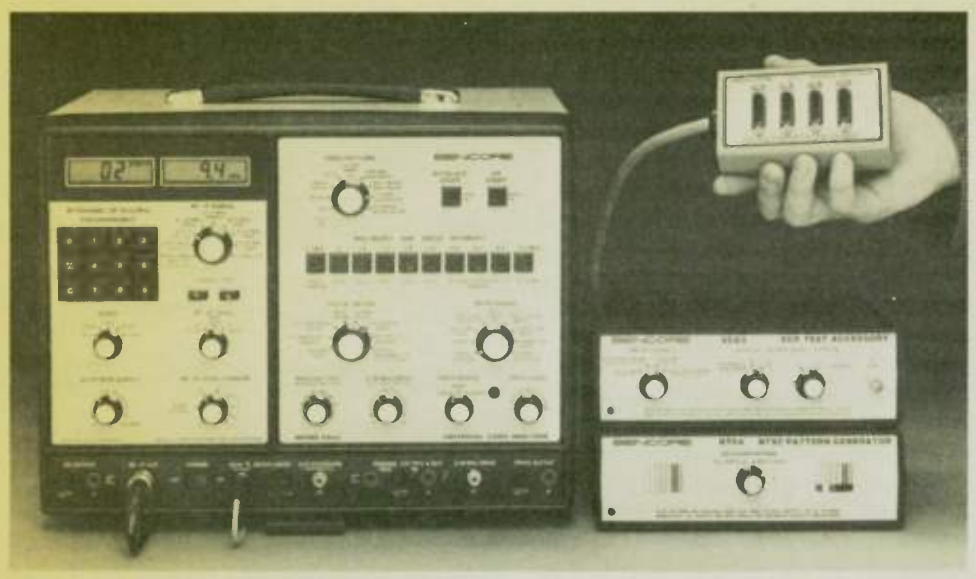


Fig. 4: Accessories allow special signals to be added to the VA62 for different troubleshooting. The EX231 in the background allows up to 4 accessories to be connected at the same time.

format. The luminance signal modulates a 3.4 MHz carrier for VHS or a 3.6 MHz carrier for Beta and U-Matic. The color signals convert to the 629 KHz signal needed for VHS decks and the 688 KHz signal needed for Beta or U-Matic, including the special phase shifting used to reduce color crosstalk. The VA62 output signal is fully adjustable from less than a millivolt to 5 volts peak-to-peak to allow injection into any stage from the video heads, right up to the FM detector.

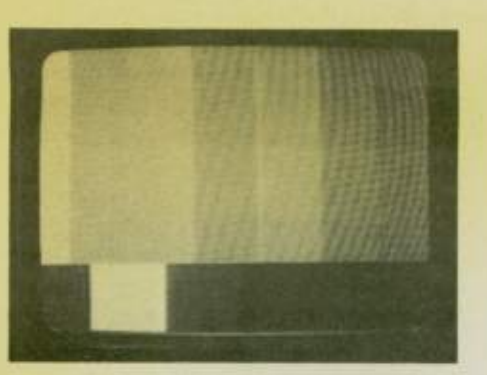
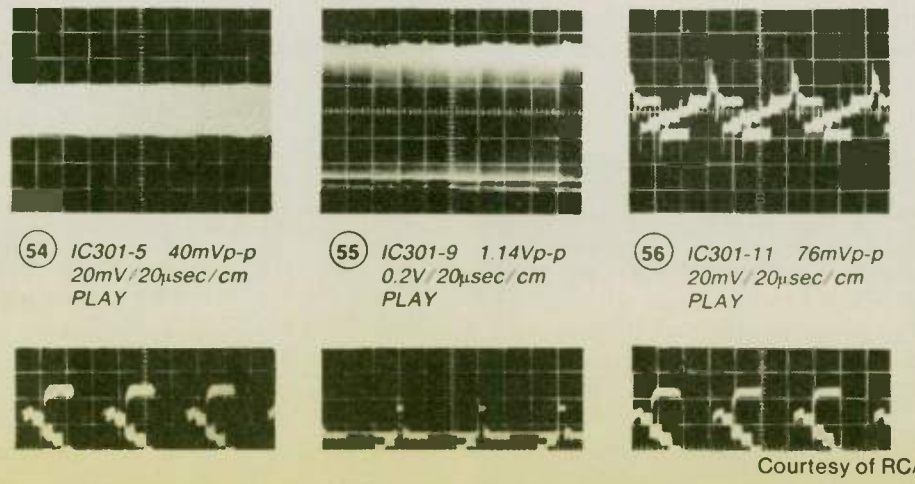


Fig. 5: The optional NT64 NTSC Pattern Generator supplies the Full Field or the Split Field NTSC patterns if needed for servicing at about one-fifth the cost of stand-alone generators.

The final accessory is the NT64 NTSC Pattern Generator. This accessory produces the two standard EIA RS189 color bar patterns called for by some manufacturers: "Full-Field" (the bars extend from the top to the bottom of the CRT) and "Split-Field" (the bottom fourth of the screen contains additional reference bars). These patterns *meet all manufacturer's requirements* for an NTSC color bar generator.

The NT64 signals offer two advantages over a separate, stand-alone "NTSC" generator. First, the NT64 costs only about 20% as much as a stand-alone generator because it gets its sync, timing, and power supply signals from the VA62. Second, its patterns are locked to all the other signals supplied by the VA62. This lets us use the video pattern exactly the same as though the patterns were coming from inside the VA62.



Courtesy of RCA

Fig. 6: The waveform on the VCR schematic gives the details on the test point locations and peak-to-peak amplitude for each test point referenced on the Sencore block diagram.

Now that we know the various features that help troubleshoot VCR problems, let's see how they are used. We will begin by looking at problems in the recording circuits.

Isolating Recording Problems

We use signal tracing to troubleshoot recording problems. We inject the VCR STANDARD signal at the video input, while we trace the signals through the circuit using the SC61 Waveform Analyzer.

We use the universal block diagram (see page 17 of this issue) as our guide. *All brands and all models of VCRs follow this same block diagram,* meaning we can use the same troubleshooting procedures each time. We use the Sencore block diagram to find corresponding test points on the manufacturer's block diagram for the VCR we're servicing. If the block diagram does not give enough information to isolate the trouble, we use it to find specific test points on the schematic.

The scope waveforms accompanying the Sencore block diagram show typical waveforms for Beta and VHS tape decks. Each picture shows two different VA62 video patterns for comparison. These waveforms have been taken at the test points representing the *major transitions* in the circuits. All the waveforms between these key test points will have the same general waveshape as the examples shown.

Although the waveshape is the same from one deck to the next, the signal levels vary. Refer to the manufacturer's service literature to determine the peak-to-peak level of the scope waveforms.

Isolating Playback Luminance Problems

Signal substitution simplifies playback troubleshooting. We use signals from the VC63 VCR Test Accessory when injecting into circuits *ahead of the FM video detector* and signals from the VA62 drive output to inject into stages *after the detector.*

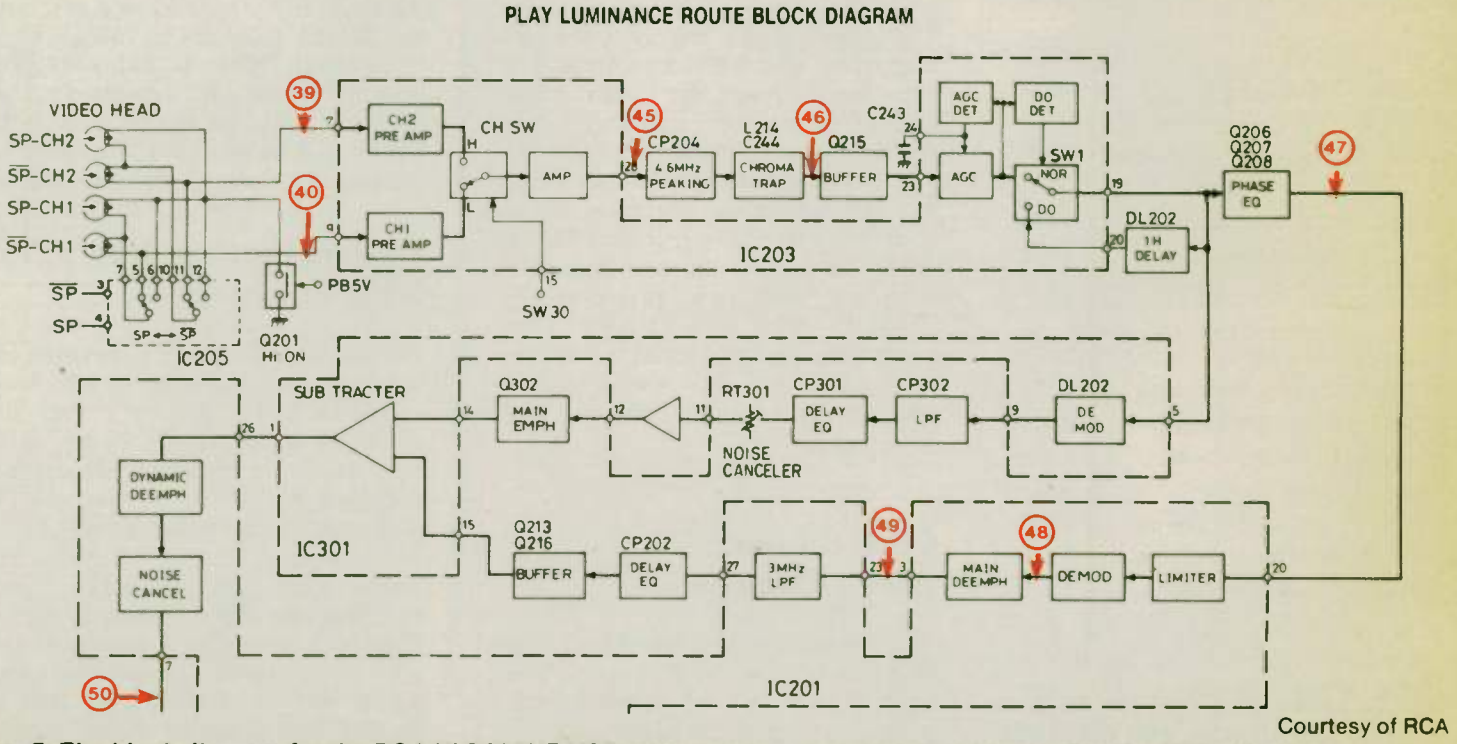
The calibration of the VC63 output circuit lets us match the level of the test signal with the peak-to-peak amplitude shown on the schematic for each test point. For example, if we need a 0.3 volt signal, we set the switch to the "X.1" position and the control to "3." If we need 2 volts, we set the switch to the "X1" position and the control to "2."

We must remember to *use the test leads supplied with the VC63* when injecting signals. These leads have a special matching network which swamps out the signals already in the circuit. If we use a plain coaxial cable, the capacitance of the cable often causes a circuit to go into oscillation, making interpretation difficult.

Examples In An RCA VCR

Let's see how we would use signal substitution in a typical VCR. We will be injecting signals into an RCA model VLT625HF. *All the circuits work normally,* so that we can see the results of signal substitution when we've injected the signal into normally operating circuits.

Fig. 8(A) shows the TV screen when we're playing back the Multiburst Bar Sweep video pattern from a reference tape. Now, we will replace the tape signal by injecting the VC63 signal at the output of the video head switcher—test point (45)



Courtesy of RCA

Fig. 7: The block diagram for the RCA VLP625HF VCR serves as an example for understanding the VC63 signals.

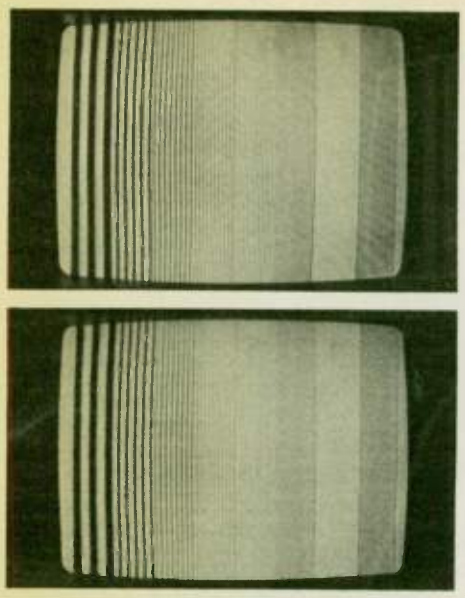


Fig. 8: (A) The picture when playing back the Multiburst Bar Sweep video pattern from a test tape. (B) The results when injecting at test point 45. Notice that the injected signal looks nearly the same when injecting as when playing back the reference tape.

on the Sencore block diagram or pin 28 of IC 203 on the RCA schematic. Notice that the signal still produces *close to normal results*. We can easily tell that the signal is passing from our injection point to the output, which is what we need to know when troubleshooting.

Now, look at the difference when we add a problem into IC 301, which contains the FM detector. When injecting at test point (45), we see that the picture has nearly all noise and no contrast. We know the problem is in a later circuit, so we move closer to the output. Injecting at test point (47) produces nearly similar results, showing the problem

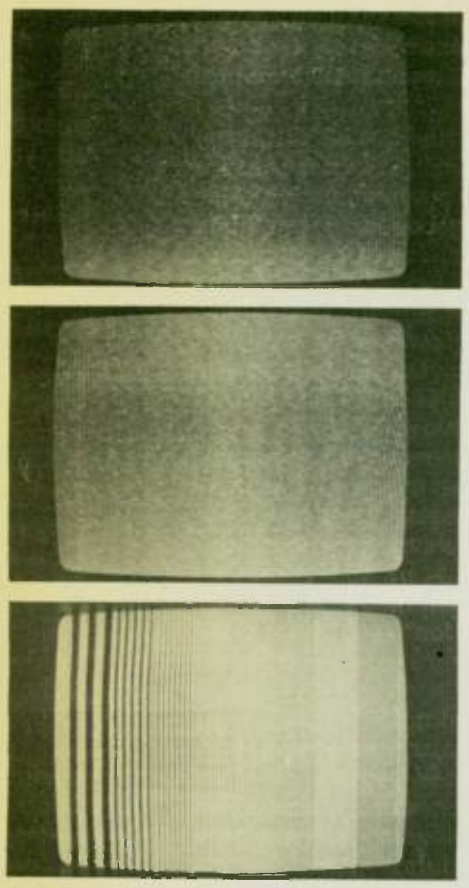


Fig. 9: With a defect in the FM detector, the screen produces these patterns when injected at: (A) Test point 45, (B) Test point 47, and (C) Test point 49.

is still later in the circuits. To confirm that the problem is not in one of the circuits after the detector, we inject the VIDEO PATTERN signal at test point (49), the output of the video detector. As we see in Fig. 9C, this improves the symptom, which pinpoints the trouble. Since we get a *bad* signal when injecting at the input of the FM detector, and a *good* signal when injecting at its output, we have confirmed that the defect is *between* these two points, or in the detector.

Now, compare signal substitution to trying to isolate the same problem with a scope. First, if we connect our scope to the detector output, we see that the signal is noisy, just as we see on the CRT of the monitor connected to the VCR output. Moving to test point (47) (the detector input), takes us to that unknown land of FM signals. We confirm there's a signal present. The scope's peak-to-peak amplitude shows that the signal has about the right amplitude, which doesn't tell us much because it could be mostly noise. Signal substitution, on the other hand, eliminated these questions because we replaced the circuit's signal with a known-good signal and then watched to see if the stage processes the signal normally.

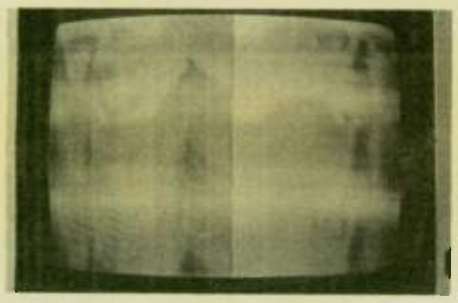


Fig. 10: One defective head or head channel produces the distinctive symptom of a picture overlayed with noise.

Head Related Problem

Symptoms related to the video head circuits are different from the ones in the later FM circuits. When one head (or related circuit) fails, we see some signal come through from the tape which is overlayed with a high level of noise, as shown in Fig. 10. The reason for this symptom is that each video head picks up one of the two video fields of the interlaced picture. The path from the good head supplies a full vertical field of video, and the bad head path produces random noise during the second field.

We use the VC63's "Playback Head Sub" function to isolate problems related to the head's circuits. This function duplicates the tiny signals normally found in the high-gain head amplifiers. We need to know how much signal to inject, since the schematic rarely shows the head signal level. Sencore has taken care of this question with a special procedure.

When we use the VC63 "Playback Head Sub" function in the head amplifiers, we try all settings of the OUTPUT LEVEL control to see if any produce a picture on the monitor. The VC63 prevents overdriving by limiting the PLAYBACK HEAD SUB signal to 5 millivolts. *If we don't see an output* at any setting of the control, we know that the circuit has low sensitivity and is the cause of the problem.

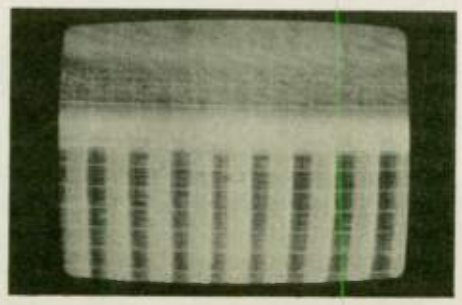


Fig. 11: We use the crosshatch pattern to inject so it contrasts with the signal coming from the test tape. The two signals normally mix, although they will not be in sync with each other.

If we do get a signal, we use the VC63's calibrated output to compare the sensitivity of each test point to its companion test point in the second head path. If one side needs *significantly more signal* than the second one, we know that the two amplifiers do not match each other as they should.

When testing head circuits, we play back our troubleshooting reference tape to provide a signal for the circuit path which is not being substituted. The tape should contain a different video pattern than the one we use for injection, so that we can tell whether the signal is coming from the tape or from the VC63. The plans for making a test tape, covered in the VA62 manual, do not include a crosshatch pattern, allowing us to use the crosshatch for all video head injection.

When injecting signals before the head switcher, we *should see the picture from the VC63 flicker* at a 30 Hz rate, either mixed with noise or with the video tape signal. If, on the other hand, we see no signal when injecting into one of the head amplifiers, and a signal without flicker when injecting into the second amplifier, we know that the head switcher is *stuck in one position*. The problem could be a defective head switching IC or that the switching IC is not receiving the square wave it needs at test point (43).

As Fig. 11 shows, injection will usually produce a combination of the tape signal and the injected video pattern. The two patterns *will not be in sync* with each other, but that is not a problem. If we see *both* patterns on the screen, we know both head circuits work. If we see the VC63 signal (the crosshatch pattern) *alone*, we know that the VC63 is replacing the tape signal, and we need to move the injection point to the second head circuit. If we again see the crosshatch pattern come through (either with or without the tape signal in the background) we know the second set of circuits also works correctly, showing *the problem is ahead of the injection points*. We use the following procedure to determine the exact cause of the problem.

1. **Stop the VCR** and unplug the head connector on the main PC board.
2. **Connect an oscilloscope** or SC61 Waveform Analyzer across the conductors for one of the video heads on the unplugged connector.
3. **Set the VC63** for an output of 2 VPP (OUTPUT LEVEL switch to "X1" and control to "2").

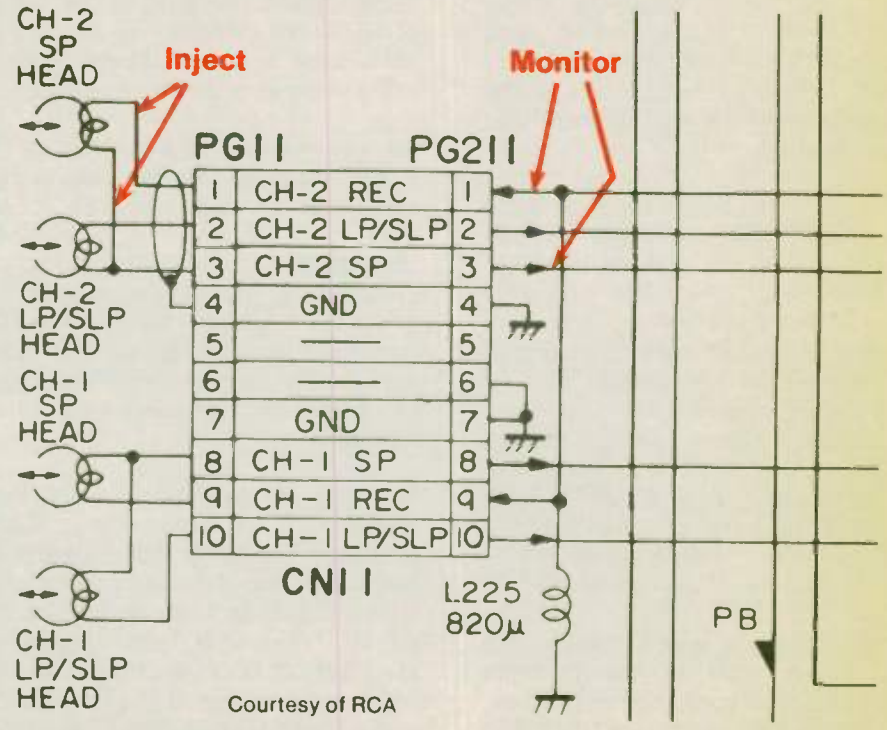


Fig. 12: Confirm whether the problem is in the video heads or part of the interconnecting path by injecting the VC63 signal across a head while monitoring the peak-to-peak level at the PC board connector.

4. **Inject the VC63 signal** into the video head that corresponds to the connection made in step 2.
5. **Measure the peak-to-peak level** of the output signal.

a. If the signal is 3 VPP or higher, the path is normal.

b. If the signal is less than 3 VPP, we either have a shorted head (loading the signal) or a connection problem. To determine which, we unsolder one of the wires for the associated head. If the signal now is larger than 3 volts, we know the head was shorted. If the amplitude remains low, we know the problem is *not* the head, so it must be in a connecting component.

6. **Repeat the test** for each of the other video heads.

Isolating Servo Problems

Now, let's look at servo troubleshooting. A servo problem *always* produces a *randomly tearing* picture or an *out-of-sync* picture. If we see see a tear which stands still in the picture, we know that the servos are working, but they may be out of adjustment.

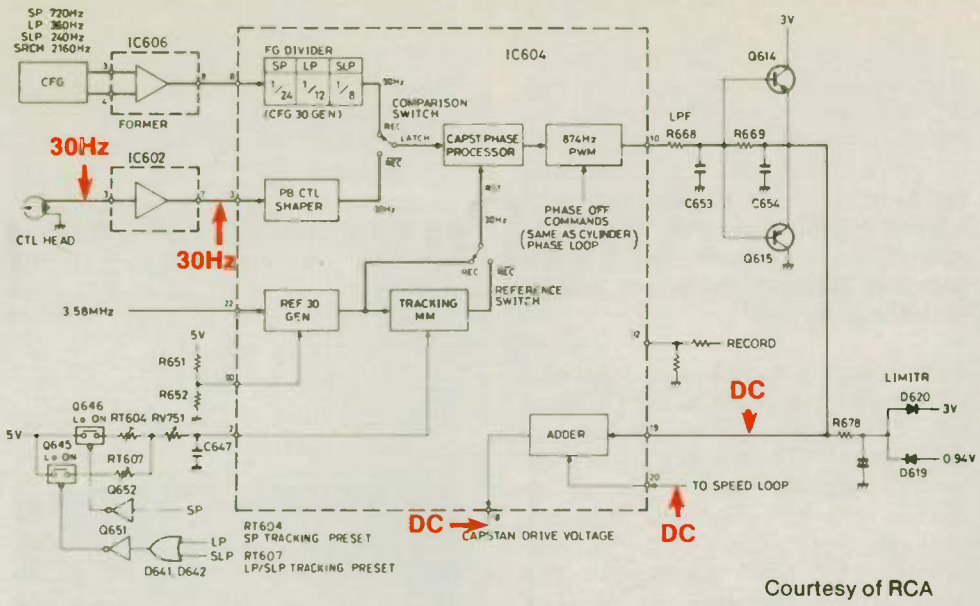
Fig. 13: Servo problems cause the picture to randomly tear. Use the audio to determine whether the problem is in the capstan or drum servo section.

If we're sure we have a servo problem, we must decide whether the problem is in the circuits which control the video heads or those which control tape speed and motion. *This divides the number of servo circuits in half.* We use the test tape's audio signal to make this determination.

We listen to the audio while the tape plays back. *If the audio plays at the correct speed,* without fluctuation, we know that the tape speed is correct, that the capstan servos are working, and that our problem is in the head servos. If the audio *plays at the wrong speed,* or the tone fluctuates, we know the tape motion is affected and that the problem is in the capstan servos. *(NOTE: Turn the Hi-Fi circuits off when making this test on the models which record audio using the spinning heads.)*

If we note a tape speed problem, we then check whether the problem affects all tape speeds or only some. We use the first section of the VA62 test tape, which includes video signals recorded at each tape speed, to check the speed selection circuits.

CAPSTAN PHASE LOOP BLOCK DIAGRAM



Courtesy of RCA

Fig. 14: Using the VA62 to inject substitute signals at the 30 Hz or the DC test points breaks the closed loop to isolate servo problems.

If only one or two speeds are affected, the problem is in the automatic speed selection circuits and not in the servos themselves. If *all three speeds* have speed errors, the trouble is in the servos.

Breaking the Servo Loops

We use the same test methods to isolate the bad circuits, whether the problem is in the head servos or in the capstan servos. Therefore, we must find a way to *break into the feedback loop* to tell which parts of the loop work and which parts do not work.

To break a loop, we inject a signal in place of the feedback signal. If all later circuits *work correctly,* we will see the symptom *change.* If, on the other hand, the *circuits did not respond* to the substituted signal, the problem is *between our injection point and the output.*

We have two VA62 signals to inject into the loops. The first signal lets us substitute for any of the 30 Hz servo signals. Because of the design of the servo circuits, we use the 30 Hz signal a little differently than other drive signals. Here's why.

As we explained earlier, most of the VA62 signals swamp the circuit signal to ground (see the "Tech Talk" box on page 5). The VA62 then inserts a new signal for the circuit's signal. Swamping isn't a good idea in the servo circuits, however, because servo ICs have such a low output impedance that swamping to ground can cause damage.

Instead of swamping the servo signal, we use the VA62 peak-to-peak meter to measure its amplitude and then add just enough VA62 signal to take control of the circuit. *We do this by turning the 30 Hz SERVO DRIVE control to zero before connecting to the circuit.* We move the DIGITAL METER switch to the "30 Hz SERVO DRIVE" position and then connect to the circuit.

When the SERVO DRIVE control is at zero, the digital meter shows the peak-to-peak level of any signal in the circuit. If the meter reads close to zero, we can safely increase the setting of the SERVO DRIVE control until the digital meter reads a level close to the normal signal level at the test point. If, on the other hand, the meter shows a signal is already in the circuit, we *slowly increase* the SERVO DRIVE control until the meter shows a peak-to-peak value that is *between 1 and 2 volts higher* than the original signal. This overpowers the circuit signal without the danger of damaging good components. A change confirms the VA62 signal took control of the circuit.

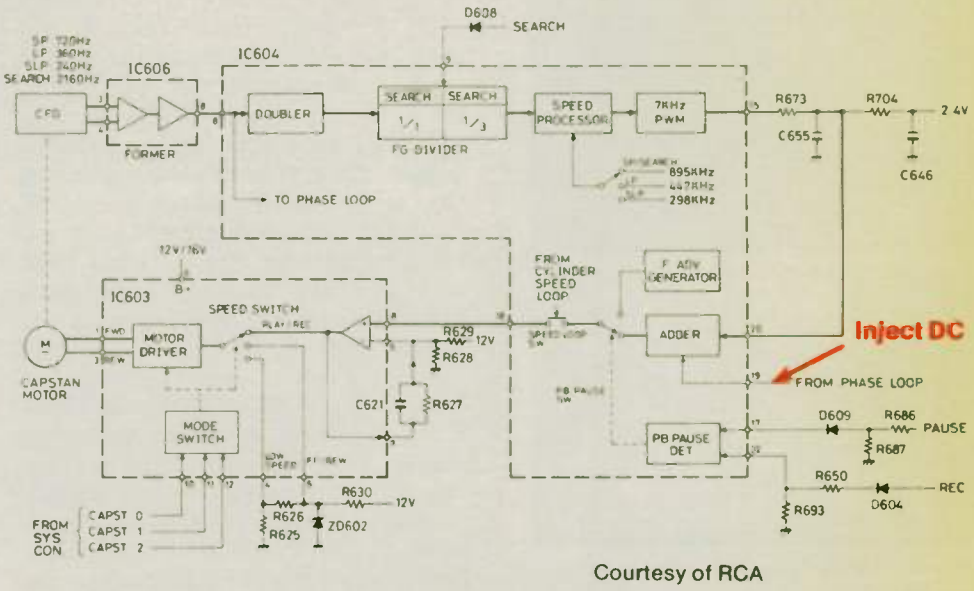
The VA62 DC POWER SUPPLY output is the second servo troubleshooting signal. We use this signal in the same way we used it to troubleshoot other automatic feedback circuits. We inject a DC level that is close to the normal DC level at the test point and then adjust the DC voltage up and down slightly from the normal level. The motor for the servo should increase or decrease in speed to show it responded to the changing voltage.

Notice that we've used the word "change" instead of "improve" when talking about servo circuits. This is a little different from substituting into other circuits and happens for a very good reason. The substitute signal is being fed into a circuit which normally depends on an error signal for correction. Since the substituted signal contains no error (it's a perfect signal), the feedback loop doesn't know whether to speed up or slow down. Therefore, the substituted signal may cause either condition. But the important thing is to look for a *change* in the old symptom. If this change is an *improvement or worsening* of the old symptom, we know the circuits responded to our injection signal.

Finally, it helps to know where to start troubleshooting. *One of the best places to start is at the junction between the inside and the outside feedback loops.* In the RCA deck, for example, it would be at pin 19 of IC604 (See Fig. 15). We choose this point because it about divides the circuits in half.

Some servos use a phase detector (similar to the phase detector in the horizontal oscillator of a TV receiver) to compare the feedback signal with the reference signal. Others use a sample-and-hold (often marked "S/H" on the schematic) to compare two frequencies. In either case, the output is a DC signal or DC riding on an AC signal. Injecting the substitute DC signal will override the signal. If we see the symptom change, we know the inside loop is responding correctly and need to work in the outside loop. If not, we need to work from the injection point towards the motor.

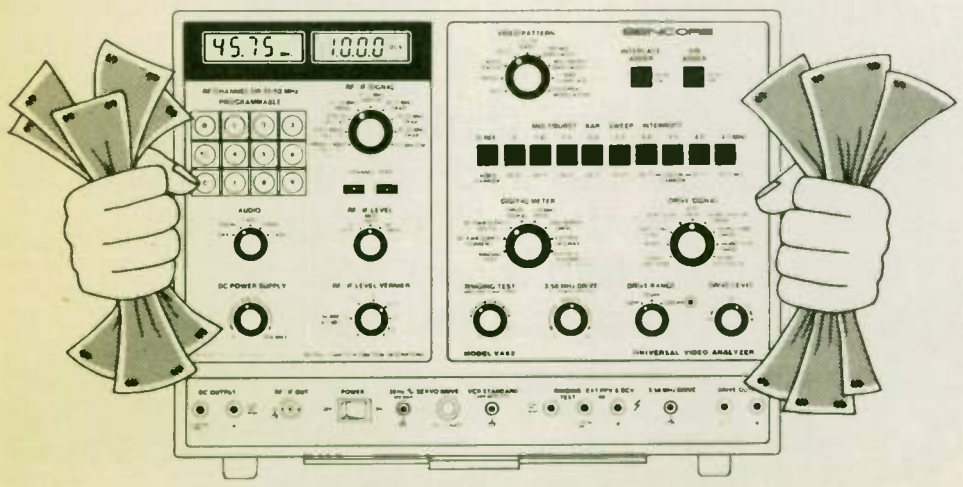
CAPSTAN SPEED LOOP BLOCK DIAGRAM



Courtesy of RCA

Fig. 15: A good spot to start servo troubleshooting is where the inside and the outside loops join together. Inject DC at the output side of the filter network and watch for a change in the symptom while playing back the VA62 test tape.

The VA62 Pays You Big Dividends



One often thinks of test equipment as an outlay of money and an expenditure. But actually one should think of the purchase of test equipment as an investment in greater profits and greater capability for the future. A man is only as good as his tools and tools only as good as the knowledge and know how of the man. Test equipment is that tool that enables the knowledgeable to do things that he couldn't before and thus expand his capability. It is this expanded capability that insures a bright future and that's exactly what the VA62 Video Analyzing System will do for you. Let us explain what we mean.

If You're A Service Manager, The VA62 Is Your Key To Faster Repairs And More Satisfied Customers. Just what would it be worth to you to be able to turn tough dog warranty jobs 54% faster for higher profits? How about enhancing your shop's quality image and insure those important customer referrals? And maybe most of all, what's it worth to have the correct tools that will help your technicians increase bottom line profits and make your department look better on the quarterly financial statement? Just what's that worth to you?

If You're A Salaried Or Commission Technician, The VA62 Means More Finished Repairs, Less Re-Work — You Can Bank On It. We don't have to tell you that time is money. You know that the more chassis you can turn around — The more money you'll take to the bank at the end of each week. What's it worth for you to be able to cut your turnaround time and eliminate those costly re-works that take money right out of your pocket and rob your precious time? Just what would it be worth to you to be able to turn "tough dogs" in half the time with half the hassle? What's that worth to you?

If You're An Independent Shop Owner, The VA62 Is Your Answer To Increasing Your Business' Bottom Line Profits. What's it worth to you to be able to cut out those long evening hours you spend shotgunning that dog to get that anxious customer off your back? Just what's it worth to you to be able to give accurate estimates that don't end up "skinning" you of your profit or upsetting your customer because of unexpected parts costs, etc.? Just what's it worth to you to be able to stay competitive with those large "multi bench" service centers and still make a good profit? Just what's that worth to you?

Is It Worth $3.60 A Day For All This And More? Believe it or not, you can own a VA62 Video Analyzing System for only $3.60 a working day. You see our extended term financing option lets you own a VA62 for as little as $75.00 a month (on our low interest 48 month extended terms plan). Now let's say there are 250 working days a year (we're not including any Saturdays and are allowing for a two week vacation — Both well deserved relaxation breaks you probably haven't been able to take in a while). If you divide your yearly payment of $900 ($75 a month x 12 months = $900 a year) by 250 working days you see that you're getting everything we talked about (and more as you use the VA62) for only $3.60 a day — Aren't you worth $3.60 a day?

But The VA62 Really Pays Big Dividends When You Own It. That $3.60 figure above can really be deceiving — Yes, we said deceiving. You see that $3.60 figure doesn't take into account the added productivity that the VA62 will give you and/or your technicians. How much you ask? Well, if the VA62 does not increase your video troubleshooting productivity by at least 54% (the very 1st month you own it) you may return it for a full refund. Impossible you say? Well, we didn't pick that figure at random — That figure was empirically derived from a survey of over 3,000 technicians using the VA62's "Divide And Conquer" method of troubleshooting.

But let's take that 54% and divide it in half for a 25% increase — Or about one extra chassis a day for the average shop (according to NESDA figures). That's conservative in most cases, but let's use it for our example. Just how much will the VA62 return you the first year when you own it. Just what type of return on your $3.60 a day investment can you expect? Well, sharpen your pencil and see for yourself as you complete the cost analysis worksheet below — The results will probably astound you.

Now, you'll notice we haven't even begun to talk about depreciation and investment tax credits — They help make the equipment you've chosen pay for themselves even quicker — Just ask your accountant. If you're a technician at a shop, why not cut out this worksheet today and show your boss or supervisor just how much an investment in the VA62 will pay them?

Say Yes For A Risk Free Trial And Prove The Profits To Yourself. Your results from the cost analysis worksheet below will probably amaze you. In fact, if you're like most servicing pros you're probably seeing that it's actually costing you by not owning the VA62 Video Analyzer — It's a fact. But the real proof comes when you put the VA62 to the acid test right on your own bench. So here's what we want you to do . . . write or call us WATS Free, 1-800-843-3338, today and say yes to a Risk FREE 15 day Self Demo on the VA62 (or the Video Update Package you prefer) and let us show you greater profits and guaranteed increased capability for the future.

VA62 Cost Analysis Worksheet

	Example	Your Actual Figures
1. Equipment Cost.	$3,295 Cost of Pkg.	
2. Average Profit Per Chassis Serviced (For the extra chassis per day).	$35 Avg. Profit Per Service	
3. # Of Days Before Your Investment Is Paid For (Divide Line 1 by Line 2).	94 Days ($3,295 ÷ 35 = 94)	
4. Subtract Line 3 From 250 Number Of Working Days Left In The Year After The VA62 Has Paid For Itself.	156 Days (250 - 94 = 156)	
5. Return On Your Initial Investment 1st Year. (Multiply Line 4 by Line 2).	$5,460 (156 x 35 = $5,460)	

Return On Your Investment $ _____

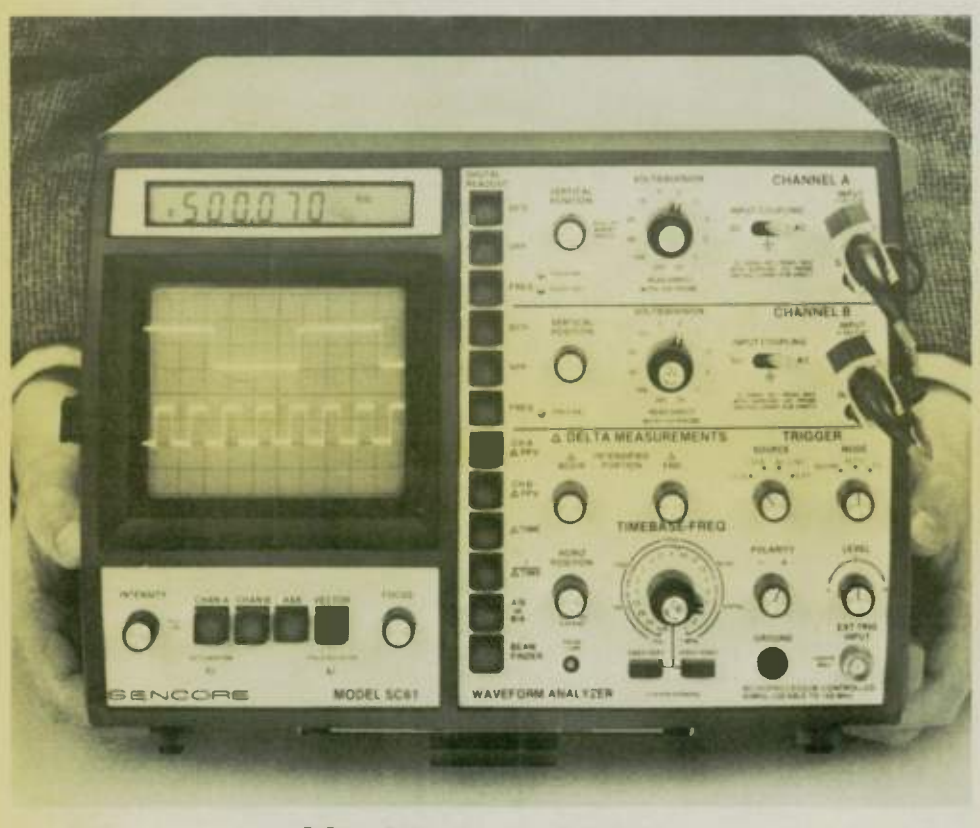
* Remember to act before July 31st, 1986 to take advantage of your Video Shop Update Specials we discussed on the back page for even bigger savings. Your actual figures may include an entire package — for even added productivity.

Thought you would want to look at our new 1986 Shopping Guide
Happy Shopping
J. La Perry

Here is a brief look at the 1986 Sencore product line. You'll want to take a minute to browse through this all new 1986 Shoppers Guide for highlights on the Sencore instruments you've been wanting to add to your bench, plus highlights of some new exciting products. But, before you do, pull out your Factory Direct Communication Form (inserted inside the envelope on this page) so you can request more information on applications and specifications on specific instruments, or to order the instruments you want most factory direct. For quicker action, call us **WATS Free, 1-800-843-3338,** and we'll handle your requests or order TODAY. Whether you call or write though, you'll want to enter the SC61 Sweepstakes (see your Factory Direct Communication Form for details). You just may win a $3,500 SC61 Waveform Analyzer Package absolutely FREE. And for big savings don't miss our Video Shop Update Packages on the back cover — they could save you up to $1,785. Happy Shopping!

SENCORE

Analyze defective waveforms faster, more accurately, and more confidently — every time . . . or your money back



SC61 Waveform Analyzer
Patented $2,995 NSN #6625-01-169-2318 ON GSA CONTRACT

End frustrating fiddling with confusing controls. Exclusive ultra solid ECL balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT helps you measure signals to 100 MHz easier than ever.

Accurately and confidently measure waveforms. The SC61's exclusive front end gives you four times the measuring range of a regular scope: From a tiny 5 mV (tuner output) all the way to a whopping 3,000 V (horizontal output collector) without hesitation; patented 3,000 VPP input protection eliminates expensive "front end" repairs and costly equipment downtime.

Exclusive one probe hook-up lets you quickly and accurately analyze any test point. You can instantly read out DC volts, peak-to-peak volts and frequency with digital speed and accuracy 100% automatically, simply by pushing a button. There are no eyestraining graticules to count, no confusing controls to interpret and no frustrating calculations to make. It's a real troubleshooting confidence builder.

Confidently analyze complex waveforms fast and easy. Exclusive Delta measurements let you intensify any waveform portion by simply "Lighting Up" that portion with the Delta Positioning control and pushing a button for Δ P-P, Δ time and Δ frequency time. You'll analyze glitches, interference signals, rise or fall times or voltage equivalents between levels — instantly at the push of a button.

Speed your digital logic circuit testing. Analyzing troublesome divide and multiply stages is quicker and error free — no time-consuming graticule counting or calculations. Simply push a button for ERROR FREE results.

To see what the SC61 can do for your personal troubleshooting productivity and analyzing confidence write for more information or CALL TODAY, **WATS Free, 1-800-843-3338,** for a NO OBLIGATION 15 Day Self Demo absolutely FREE.

Exclusive, triple patented dynamic cap and coil analyzing . . . guaranteed to pinpoint your ALL NEW problem every time or your money back

with the all new LC75 "Z METER 2"
Capacitor Inductor Analyzer
Patented $995

Eliminate expensive part substitution and time-consuming shotgunning with patented tests that give you results you can trust every time. Test all four capacitor parameters: Value, Leakage, Dielectric Absorption, and ESR; dynamically with up to 600 volts applied for guaranteed 100% reliable results — it's patented.

Save time and money with the only patented 100% reliable, in- or out-of-circuit inductor test available. Dynamically test inductors, yokes, flybacks, and even IHVTs for: Value, Shorts, and Opens; automatically under "dynamic" circuit conditions. You will have 100% proof positive tests.

Reduce costly parts inventory with patented tests you can trust. No more need to stock a large inventory of caps, coils, flybacks, and IHVTs for costly substitution. The "Z METER 2" eliminates time-consuming and expensive parts substituting and "shotgunning" with 100% reliable LC analyzing you can trust. At last you can troubleshoot cap and coil problems to component level with 100% confidence and reliability.

Test troublesome SCRs and TRIACs easily and automatically without investing in an expensive second tester. The patented "Z METER 2" even tests SCRs, TRIACs, and High-Voltage Diodes dynamically with up to 600 volts applied. You'll even be able to turn chaos into cash by quickly locating transmission line distance to opens and shorts to within feet, in any transmission line.

Write for more information or call **WATS Free, 1-800-843-3338,** to put the world's only triple patented Dynamic LC Tester on your bench for a NO OBLIGATION 15 Day Self Demo absolutely FREE. See for yourself the peace of mind 100% reliable cap and coil analyzing will give you today!

SHOPPERS GUIDE

You can thoroughly analyze and pinpoint any RF video trouble, in any video distribution system, automatically to FCC specifications

ALL NEW

FS74 CHANNELIZER, SR.
Patents Applied For $2,995

Tune in all of today's standard and cable TV channels. Exclusive all channel, microprocessor-controlled tuner checks every standard and cable channel with FCC accuracy.

Super sensitivity to bring in weak signals and for orienting antennas. Five microvolt super sensitivity gives you four times the measuring power on all VHF, UHF and FM channels.

Automatic channel shift for HRC and ICC systems. Exclusive "frequency offset" feature automatically retunes for cable HRC and ICC frequency offsets; 100% error proof so you don't have to remember all those offset channels and frequencies.

Automatic hassle-free S/N ratio, A/V ratio, and hum level tests. Exclusive on-channel automatic signal-to-noise ratio test. Eliminates time-consuming signal comparison and chart reading. Exclusive audio-to-video ratio test measures directly in dB for easy comparison to FCC specifications.

Exclusive checks for ghosts, co-channel interference, line reflections and other signal quality checks. Built-in 4 MHz wide bandwidth monitor lets you finally check the quality of your cable or MATV system to stop annoying callbacks.

Built-in autoranging AC/DC volt and ohmmeter makes troubleshooting a snap. Exclusive all-weather design holds tighter than FCC specifications from −13°F to +122°F. Truly portable, field tested tough for dependable ease of use.

For more information write or call **WATS Free, 1-800-843-3338** and put the all new FS74 to the test yourself with a Risk FREE 15 day Self Demo.

You can thoroughly performance test every single TV Channel, in any TV system, to full FCC specifications 100% automatically.

ALL NEW

FS73 CHANNELIZER, JR.
Patents Applied For $1,995

The perfect FCC accurate performance tester. The FS73 CHANNELIZER, JR. incorporates the same exclusive automatic "signal quality" checks as the FS74 CHANNELIZER, SR. It's perfect for quick FCC accurate signal checks. Write for more details or call **WATS Free, 1-800-843-3338,** today for a no obligation 15 Day FREE Self Demo.

You'll catch defective caps and coils bridge testers miss with the original "Z METER"

LC53 "Z METER"
Patented $895 NSN #6625-01-118-8016 ON GSA CONTRACT

Find defective capacitors bridge testers miss. The original LC53 "Z METER" dynamically tests for value, leakage, and dielectric absorption with up to 600 V applied.

Catch faulty coils that will trick bridge testers: The patented ringing test will catch bad inductors with just one shorted turn. Value test gives you accurate reading of true inductance.

Special tests round out the LC53's versatility. It's an SCR, TRIAC, and High Voltage Diode tester too. Plus, it's a transmitter line tester that helps you locate the distance within feet of an open or short in any transmission line.

Write for a full color brochure or call **WATS Free, 1-800-843-3338** . . . and put an LC53 to the test on your bench.

SENCORE

Walk the troubles out of any stereo system in half the time . . .

SG165 AM-FM Stereo Analyzer
Patented $1,295 ON GSA CONTRACT

Saves you time on every job. Finally you'll have everything in one instrument for complete stereo servicing: It has every signal and test you'll need for troubleshooting from the antenna terminals to the speakers. Having only one output cable for every AM or FM signal saves you time like never before and keeps your bench tangle-free. Plus all signals and tests are within FCC broadcast specs and tolerances are tighter than the transmitter itself.

Reduces callbacks and increases your service reputation in your community. Complete AM check: Separate microvolt controlled RF and 455 KHz and 262 KHz IF, plus a 400 Hz square wave gives you a signal for substitution in every AM radio stage. Complete FM stereo check: 88 to 108 MHz RF, 10.7 MHz IF (crystal-controlled or adjustable), and 5% and 10% signals make FM servicing a snap.

Dynamically speeds your RF & IF alignment. It's an FM sweep and marker generator, plus offers you an even more innovative and exclusive vector alignment procedure for faster, more accurate alignment and alignment checks.

Special meters guide you all the way. Dual dB and watt meters backed with 100 W speaker loads. You monitor every action on color-coded and good-bad meters as you work on the different stages or align the MPX decoder.

If you want to cut your stereo troubleshooting in half write us for more information or call **WATS Free, 1-800-843-3338,** and put the SG165 Stereo Analyzer on your bench absolutely Risk FREE.

Now test every CRT on the market . . . without ever buying another adaptor socket or coming up embarrassingly short in front of your customer . . .

CR70 "BEAM BUILDER"™
Universal CRT Tester and Restorer
Patented $995 NSN #6625-01-187-4395 ON GSA CONTRACT

A real customer's satisfaction builder. Imagine the customer base you can build by being able to restore 9 out of 10 of the weak or shorted CRTs that you come across. Plus you'll be able to restore that older TV, Data Display Terminal or even an industrial scope CRT that your competition advised "just had to be replaced." That's why the CR70 is a real reputation builder.

Cash in on the profitable restoration business. You can earn an extra $35 or more for every CRT restoration or rejuvenation — it makes every service call or carry-in more profitable. Plus when you back it with the "BEAM BUILDER" exclusive "television picture tube guarantee" you're assured extra income and repeat business.

Profitably handle trade-ins and rental sets. Because you can restore 9 out of 10 of these expensive picture tubes rather than replacing them you can add a new profit generating service to your existing business.

You'll never be caught embarrassingly short in front of a customer because you'll always have the right adaptor socket and setup information in your setup book (or as close as a WATS Free call) right at your fingertips.

If you want to increase your service profits you'll want to try the CR70 Universal CRT Tester for a NO OBLIGATION 15 day Self Demo absolutely FREE. Call **WATS Free, 1-800-843-3338** TODAY.

Order before July 31st and we'll include a specially designed $50 CRT Testing/ Restoration Promotion Package, valued at $50, absolutely FREE.

"BEAM BUILDER" is a trademark of Sencore, Inc.

SHOPPERS GUIDE

Earn big profits while you protect your instruments and build your reputation

PR57 POWERITE®
Patented $395 NSN #6625-01-124-6269 ON GSA CONTRACT

Protects you and your expensive test instruments. Supplies supreme isolation from the AC line that saves you damaging downtime and costly repairs by isolating you and your instruments from the chassis under test.

Tame tough startup and shutdown problems fast. The continuously variable 0-150 VAC supply with 4 Amp circuit breaker will save you hundreds of dollars each year troubleshooting those time-consuming "tough dog" startup and shutdown problems.

Keeps you from chasing phantom circuit problems. The PR57 keeps you from spending time and dollars tracking down problems that do not exist because your AC line voltage is fluctuating too low or too high.

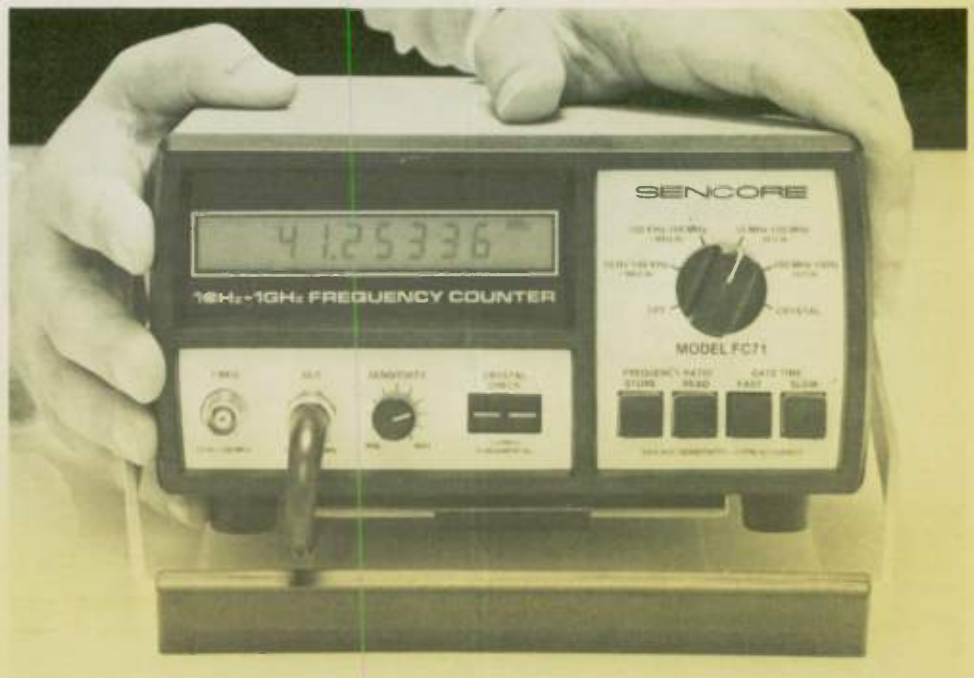
Helps you avoid expensive part damage. Large, easy to read, calibrated meter lets you know if your circuits are pulling the right power, so you avoid expensive part damage.

Patented safety leakage tester gives you peace of mind on every repair. Helps your customers avoid accidental shock and builds your reputation by testing for excess AC leakage with the simple touch of a probe. No expensive jigs or confusing "Jerry Rigged" circuits. Plus safety testing and charging a modest $5.00 charge turns your PR57 into a profit builder that will earn you an extra $5,000 a year in profits.

If you're interested in discovering just how the PR57 POWERITE® can earn you over $5,000 in additional service income in just 12 months, give us a call, **WATS Free, 1-800-843-3338,** and let us put this positive profit generator to the test on your bench for 30 days absolutely Risk FREE.

POWERITE is a registered trademark of Sencore, Inc.

Your best FCC accurate 1GHz truly portable counter buy



FC71 Portable 1 GHz Frequency Counter
Patent Pending $995 ON GSA CONTRACT

FCC accurate, 1 GHz band, 9½ hour battery operation for today's versatile testing needs. Patent pending microprocessor-controlled time base provides .5 PPM accuracy from 10 Hz to 1 GHz anywhere, anytime. A single battery charge is all you need for a full day's FCC accurate portable operation.

Triple shielded for guaranteed interference free readings. It's RF immune so you can finally reliably count even right at a transmitter site. No more dancing digits when you need an accurate count.

Count signals other counters can't. The FC71's 5 mV super sensitivity will even let you measure the output of RF generators and communication monitors. Super stability lets you count AM, FM signals and even audio signals with noise that drives other counters crazy. .01 Hz resolution in 1 second is ideal for setting PL tones, 30 Hz VCR servo controls and even critical audio adjustments.

Special tests for added versatility and convenience. Special frequency ratio test compares two frequencies and displays ratio directly. Exclusive crystal check tests the operating frequency of any crystal quick and easy. You can even add an external IEEE 488 Bus controller (Model IB72-$625) for automated testing applications.

All this for 1/3 the cost. Yes, believe it. You can own the highest quality 1 GHz FCC accurate portable counter for 1/3 less than the nearest competition, or as little as $75.00 a month (great if you have an operating budget). But prove it to yourself — put the FC71 to the test on your bench or test site. CALL TODAY, **Wats Free, 1-800-843-3338,** for a NO OBLIGATION 15 day Self Demo absolutely FREE.

Why every Sencore instrument has 100% made right quality — exclusively guaranteed

Sencore uses the latest quality control techniques every step of the way from the time raw components land on our dock until your unit is shipped out the door. We dynamically test integrated circuits, transistors, and other components. Sophisticated, computerized testers confirm every printed circuit board has been properly assembled. The PC board is then connected to a special jig that simulates all of the other circuits in the final instrument in order to dynamically test all functions under actual operating conditions. Only after passing all of these tests is the PC board installed into your unit.

Experienced technicians carefully calibrate the assembled unit to factory specifications before it goes through three exhaustive tests. First, a skilled production tester verifies that every function operates within all published specifications. Each unit that passes this test moves on to a Quality Assurance (QA) tester who retests all functions using different equipment and different procedures than used by the Production tester.

Units that pass the first QA test are placed on special, heated, vibrating racks and moved to our "shake and bake" room. Here, the units operate, under power, for at least 24 hours with voltages raised, lowered and cycled. Finally, your unit is retested (using the same QA tests made before aging) to be sure nothing changed during the aging test.

In the meantime, members of the Quality Department serve on quality circles with members of other departments to find ways to increase quality every day. This complete quality program gives us the confidence to be able to guarantee that every piece of Sencore equipment will remain free from manufacturing defects for as long as you own the instrument.

SHOPPERS GUIDE

When the going gets tough, you need a tough DVM that keeps going

The DVM37 3½ digit . . . 1% bench portable DVM
Double Patented $395 ON GSA CONTRACT

It's one tough meter. An indestructible DVM that can handle tough use on both the bench and in the field.

It's a prime standard. .1% lab standard accuracy in a portable meter for field measurements you can count on every time. Exclusive 15 megohm input impedance for less loading error, especially in high impedance circuits.

It's virtually burn-out proof. Protection to 2 KV DC with 5 KV transient protection means you can confidently measure in more circuits without hesitation.

Write for more information or CALL TODAY, **WATS Free, 1-800-843-3338,** to put the toughest bench portable, lab accurate meter on your bench Risk Free TODAY!

100% automatic microprocessor-controlled DVM will save you at least an hour a day

DVM56A MICRORANGER®
Patent Pending $995 ON GSA CONTRACT

It's fast. The MICRORANGER® is totally autoranging. You simply select the function you want and touch the probe for instant measurements. The MICRORANGER® does everything else.

It's accurate. 4½ digit readout with a .975% DCV accuracy means reliable readings every time. A high 15 megohm input impedance minimizes circuit loading for readings you can trust in any circuit.

It's versatile. The MICRORANGER® has more functions and ranges than any other meter on the market, including dB, ACV peak-to-peak, true RMS, peak and null, and more.

It's RF interference free. The DVM56A holds rock solid under the largest broadcast transmitting tower.

The DVM56A is a one of a kind meter. If you use a meter for most or all of your troubleshooting, you should be using the DVM56A MICRORANGER®. For more information write or call us **WATS Free, 1-800-843-3338,** to put the DVM56A on your bench absolutely Risk FREE.

MICRORANGER is a registered trademark of Sencore, Inc.

Test any transistor or FET with 99% reliability in less than 15 seconds in- or out-of-circuit with the . . .

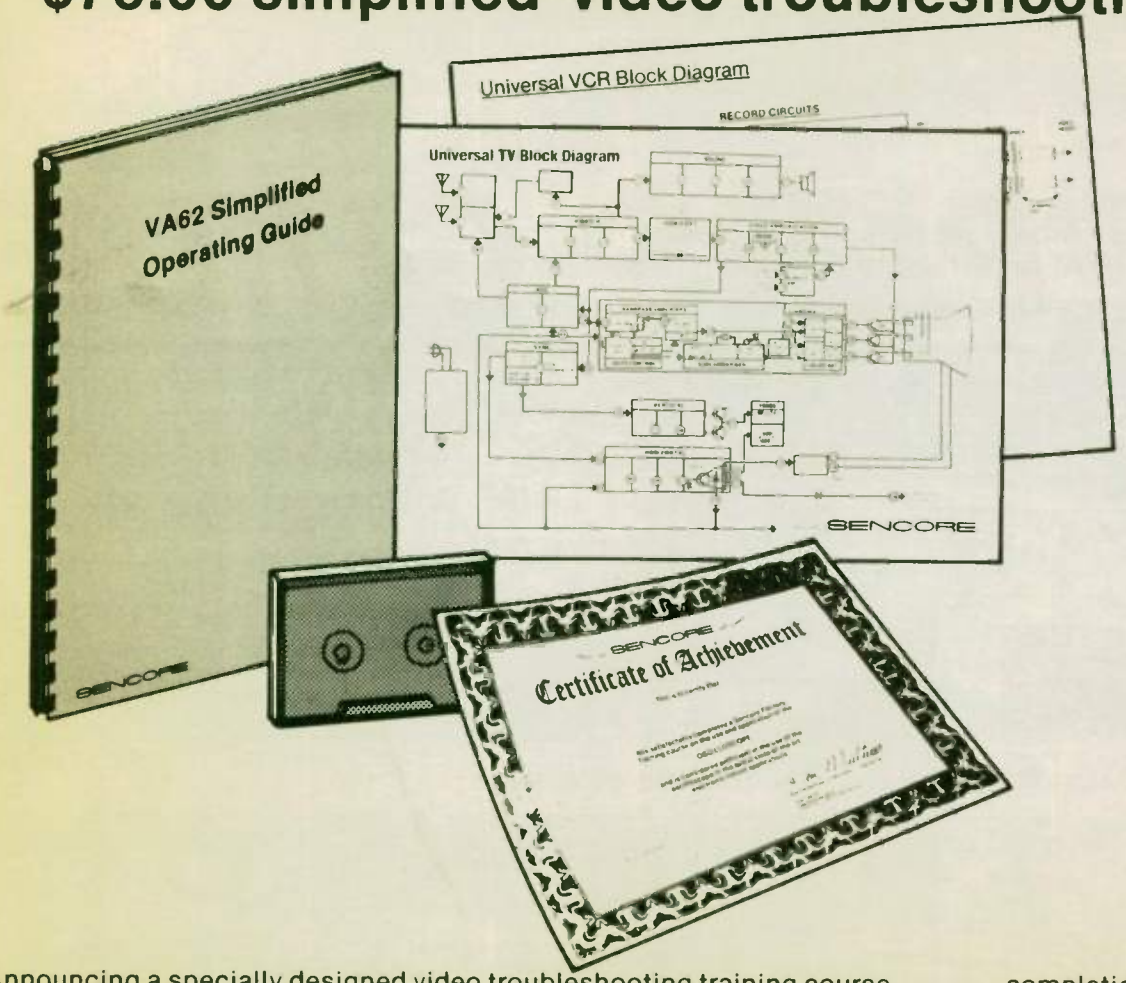
TF46 Portable
Super Cricket
Transistor/FET Tester
Patented $395 NSN #6625-01-058-9564 ON GSA CONTRACT

Fast accurate test you can rely on. Patented go/no-go in-circuit Cricket test is proven 99% reliable. Pushbutton Beta test for quick matching and comparing of semi-conductor parameters. Backup out-of-circuit Leakage test gives you reliable tests every time.

Easy to use — automatic lead identification. You need no setup book or instructions. The TF46 automatically identifies transistor of FET configuration without interpretation. Plus a handy automatic power shut-off after 20 minutes so you're never caught with dead batteries.

If you're interested in faster, more reliable transistor FET testing write for more information or CALL TODAY, **WATS Free, 1-800-843-3338,** to put a TF46 on your bench absolutely Risk FREE.

Try or buy a VA62 Video Analyzer before July 31st and receive a $75.00 simplified video troubleshooting training course—FREE!



Your Sencore Video Training Course comes complete with:

1. Simplified Operating Guide.
2. Step-By-Step Audio Tape.
3. Detailed TV And VCR Block Diagrams.
4. "Tough Dog" Analyzing Diploma*.

*Upon Successful Completion Of Course.

Announcing a specially designed video troubleshooting training course that's your guide to quicker, easier, and more profitable video servicing with your VA62 Video Analyzing System. This simplified step-by-step course will walk you right through troubleshooting and analyzing applications in TVs and VCRs. The training package consists of a simplified step-by-step operating guide, an accompanying audio tape for clear, concise explanations, and a complete set of universal simplified TV and VCR block diagrams. All this, plus a self test that upon successful completion qualifies you for a factory authorized VA62 "tough dog" analyzing certificate.

This $75 value training course is yours when you invest in a VA62 Video Analyzer or by saying yes to a 15 day Self Demo before July 31st, 1986. (You can even take advantage of all our special promotions too!) It's your key to quicker, more confident operation and troubleshooting, so don't delay, Act TODAY.

Why Chance Missing An Issue Of The All New Sencore News?

How To Subscribe To The All New Sencore News

If you presently own Sencore instruments, or plan to invest in New Sencore instruments within the next 12 months, we want you to have a one year subscription to this all new Sencore News ($20.00 Value) FREE.

If you do not own or plan on investing in Sencore instruments, you can save 50% off the normal subscription price if you act before July 31st — That's right, an all new 1 year subscription for only $10.00.

To subscribe, take 60 seconds right now, to fill in and mail the subscription application below. Place in envelope and mail to: Sencore, Inc., 3200 Sencore Drive, Sioux Falls, S.D. 57107.

PLEASE NOTE: This is an extra renewal form for your convenience, to be used if your postage paid Factory Direct Communication Form (located on Page 26) is misplaced or if you want to pass a subscription on to a friend.

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1. NAME _____
   ADDRESS _____
   CITY _____
   STATE_____ZIP _____
   PHONE( ) _____

2. COMPANY _____
   TITLE _____
   ADDRESS _____
   CITY _____
   STATE_____ZIP _____
   PHONE( ) _____

Send my subscription to address: ☐ #1 ☐ #2

Best time to contact me: ☐ AM ☐ PM ☐ Evening

1. ☐ Please enter my name for a paid subscription, as I do not own or plan to purchase Sencore instruments. I am enclosing $10.00 for the next 12 month mailings (normally $20.00).

2. ☐ Please enter my name for a FREE subscription for the next 12 months as:

   A. I own the following Sencore instruments, or am entering the order with this application: (Please write in blank space below.)

   B. I, and/or my company, plan on investing in the following Sencore products: (Please write in blank space below.)

   C. I perform the following type of work where I would use Sencore test equipment: (Please write in blank space below.)

Signature and Title: _____

You Can Save Up To $1,785 With These Video Shop Update Packages

Invest Today For Greater Profits And Capability For The Future

On this page you'll find the best deals we've ever offered on complete video servicing shop packages. We've specially designed these packages to help you to bigger profits — today and tomorrow. We'll only be offering these specials until the end of our corporate fiscal year — July 31st, 1986. So if you've been dreaming of updating your bench.— you'll want to ACT NOW and SAVE.

Our Best Deal Ever Offered — Our Three Best Selling Troubleshooters, Each With Patented Productivity Built-In At An Effective Whopping 30% Discount

You Buy the SC61 Waveform Analyzer for $2,995 or — the VA62 Universal NTSC Video Analyzer for $3,295

You Get FREE
LC53 "Z METER" Cap/Coil Tester ($895 Value)

You Save $895

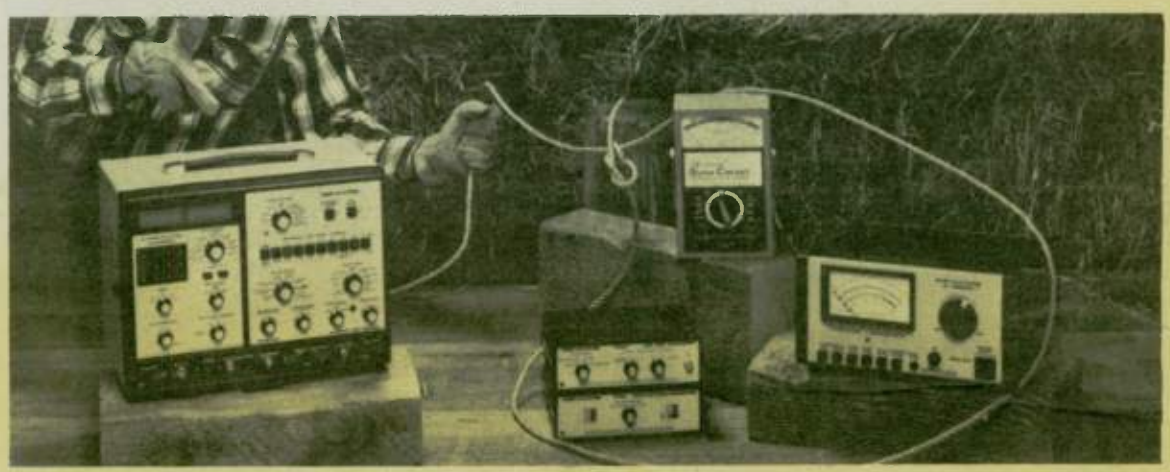
Own This Package For As Little As $82 A Month

Time	Monthly Investment*
12 Months	$247.76**
24 Months	$134.46**
36 Months	$98.84**
48 Months	$82.22**

SAVE Up To 27% With Our Most Popular Video Bench Update Package

You Buy the VA62 Universal NTSC Video Analyzer for $3,295

You Get (Choose Any 2) FREE
VC63 VCR Test Accessory ($495 Value)
NT64 "NTSC" Pattern Generator ($395 Value)
PR57 POWERITE® Variable Isolation Transformer ($395 Value)
TF46 Super Cricket Transistor FET Tester ($395 Value)



You Save Up To $890

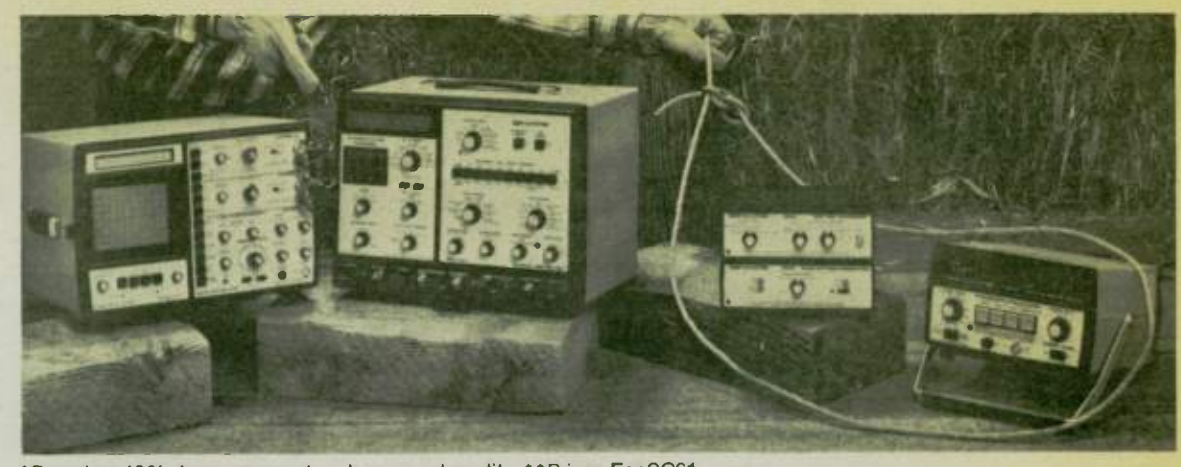
Own This Package For As Little As $90 A Month

Time	Monthly Investment*
12 Months	$272.32
24 Months	$147.78
36 Months	$108.64
48 Months	$90.38

SAVE 28% With This Super Video Shop Setup Deal — Everything You'll Need To Service The Latest TV And VCR Circuits Effectively

You Buy the SC61 Waveform Analyzer & the VA62 Video Analyzer for $6,290

You Get FREE
VC63 VCR Test Accessory ($495 Value)
NT64 "NTSC" Pattern Generator ($395 Value)
LC53 "Z METER" Cap/Coil Analyzer ($895 Value)



You Save $1,785

Own This Package For As Little As $173 A Month

Time	Monthly Investment*
12 Months	$520.08
24 Months	$282.24
36 Months	$207.47
48 Months	$172.60

*Based on 10% down payment and approved credit. **Prices For SC61

Last Chance To Trade Your Old Oscilloscope For A New Patented SC61 Waveform Analyzer

If you've been dreaming of the SC61 or promising yourself you'll update your older scope "some day," then I think I hear opportunity knocking at your door. Why?

Well, if you're ready to say YES today to updating to the fully integrated SC61 Waveform Analyzer, we'll help you make room on your bench for it. We will take that old scope (or equivalent test equipment) off your bench and give you a full $500 towards the purchase of your new SC61 Waveform Analyzer you've been dreaming of having on your bench. You heard us right; we will flat out give you $500 for your old scope (or equivalent test equipment) whether it works or not.

Act before July 31st and you may save an additional $250. Say YES before July 31st and we'll let you keep your scope trade-in (or equivalent), so you can take advantage of the tax savings. You could save up to an additional $250, since we've established the $500 fair market value for you (see your tax advisor for details). But don't wait, ACT TODAY!

Think of it: A chance to make room on your bench for your new SC61, plus $500 right off the $2,995 Factory Direct price — just $2,495 for saying YES to this limited offer TODAY. This special $500 once-in-a-lifetime offer is good only until July 31st, 1986 (sorry no other promotions apply on the trade-in deal). So be sure to call me TODAY to assure prompt delivery.

1-800-843-3338

Just Ask for Me,

Al Baarson

Your Phone Sales Engineer About Factory Direct Savings

Pricing Note: All prices shown are U.S. dollars. Canada must add applicable duty, freight and F.S.T. Prices and specifications subject to change without notice.

These specials supersede all others and no other promotions apply.

Form 3485
Printed In U.S.A.

3456

SENCORE NEWS

Issue #126

100,000 square feet and 300 people dedicated to saving your precious analyzing time.

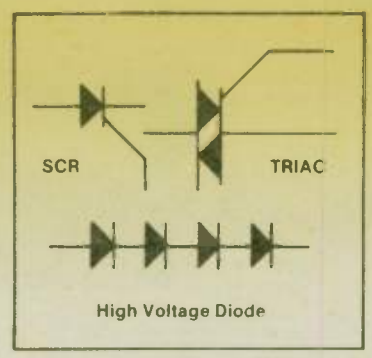
Read all about it!

THE ALL NEW "Z METER 2" AND WHAT IT WILL DO FOR YOU. A TECHNOLOGICAL BREAKTHROUGH IN LC TESTING; FASTER, MORE ACCURATE, AND MORE RELIABLE

Are you still missing over half of the defective capacitors when you troubleshoot because you check for value only? Are you still not able to check capacitor leakage because your tester doesn't have a voltage supply? Are you unknowingly installing defective electrolytic capacitors that went bad on the shelf or should have been reformed before installation?

Are you still struggling with and trying to justify an old-fashioned, time-consuming bridge?

Are you still wasting valuable time substituting inductors because you don't have a way to check for value or shorted turns quickly, in the circuit?



Are you frustrated with your inability to check SCRs, TRIACs, or high voltage diodes?

Are you tying up valuable dollars in deflection yoke and flyback transformer inventory for substitution only and still don't always have an exact replacement?

Are you looking for an easier way to find the distance to an open or short in a transmission line? Are you looking for a way to check insulation leakage in printed circuit boards, connector terminals, etc. without investing in a high-pot tester?

If these personal productivity killers are slowing your analyzing time or costing you valuable dollars in mis-diagnosis, you'll want to read all about the All New LC75 "Z METER 2" Capacitor-Inductor Analyzer.

SENCORE
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Permit No. 731
Sioux Falls, SD

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IMPORTANT!

If the last two digits in the upper right hand corner of your mailing label do not end in 86 or 87, this will be your last issue of the original Sencore News. Why? Because we're introducing a new format for the Sencore News. The All New Sencore News will be bigger and better than ever before, with more articles on applications and more information on troubleshooting tips. (Please see the Factory Direct Communication Form on page 24 for details.)

MAIL ROOM:
If the person on the label is no longer with your organization, this should be routed to his replacement or superior.

Route to:

1._____

2._____

3._____

INTRODUCING THE ALL NEW "Z METER 2" CAPACITOR-INDUCTOR ANALYZER, THE WORLD'S ONLY DYNAMIC LC TESTER, AND WHAT IT WAS DESIGNED TO DO FOR YOU

LC75 "Z METER 2" — $995

Triple Patented: No. 3,990,002 No. 4,258,315 No. 4,267,503

The Amazing, All New "Z2" Triple-Patented Capacitor — Inductor And Special Component Analyzer — $995

Now Even Faster, More Accurate And More Complete

I'll bet you thought that Sencore could not build a better "Z METER" than the model LC53. So did we. We knew, like the 15,000 owners of the famous Sencore LC53 "Z METER," that this calibrated, exclusive tester was the ultimate in capacitor-inductor analyzing. We knew that this triple-patented "Z METER" was the only tester on the market that automatically measured capacitor value, dynamically tested capacitor leakage with up to 600 volts DC applied, and effectively checked for dielectric absorption too. We also knew that the "Z METER" was the only tester that automatically measured inductor value and then backed the value test with a dynamic ringing test. We also knew that most people had no other way to test SCRs, TRIACs, high voltage diodes, transmission line shorts and opens, or insulation leakage. Yet, our customers told us that things were happening in the market that we should study for possible improvement.

We looked into our customers' considerations and learned several things. First, we found that capacitor values have grown so large, particularly in computers, that it takes longer to test them for both value and leakage. Secondly, we found that coil manufacturers are packing such high inductance values into such small sizes that resistance in the windings could cause some error in the inductance value readings. Lastly, we found that electrolytic capacitors, placed in low voltage, high-current, or critical-filtering circuits (such as AGC), can become ineffective if internal resistance builds up inside the capacitor.

Fig. 1: Subbing a capacitor into a circuit, for test purposes, is inefficient and troublesome.

It took a little work to convince our engineers that they could do better than our triple-patented LC53, but they finally went to work and designed the all new, improved "Z METER 2." Compared to the LC53, the "Z2" is faster and more accurate. It is also now more complete, as it checks equivalent series resistance (ESR) directly in ohms with a new patent applied-for circuit. For a better understanding of what the new, improved "Z METER" does, here is a complete explanation of the different tests the "Z2" makes, and why and how it makes them, so you can determine how each test will serve you in your work.

Here Is What The New "Z METER 2" Will Do For You

Checks Capacitor Value At The Push Of A Button

Are you still guessing at capacitor value; using time-consuming, limited-value, substitution-box testing; trying to keep costly replacement values in stock for substitution only; struggling with an old fashioned bridge or a value-only meter; or guessing at replacement values? Maybe it is time to consider the LC75 "Z METER 2" with 100 percent automatic value readings from a tiny 1 picofarad to 199,900 microfarads with the push of a button. The "Z2" reads value directly, with no confusing millifarad or nanofarad readings, such as on most competitive meters. All readings have an accuracy of 1 percent or better.

All you do is connect the capacitor, push the VALUE button and read the LED readout. But, what's important is that the readings take only half the time of the original LC53 "Z METER." For example, a very large 100,000 microfarad electrolytic, that could take 8 seconds for a value test on the LC53, would read out in only 4 seconds on the LC75. Why did we make it faster? Because time is money, and we don't want to rob you of either.

Fig. 2: Simply press the Value button on the "Z2" for fully automatic value readouts.

Checks Capacitors For Leakage, Under Full Load, With Up To 600 Volts Applied

Most of us who have analyzed defective circuits for many years have learned the hard way that most capacitor defects are not from value variation, but rather from old-fashioned dielectric leakage. But, we have often had to find this leakage by very tedious and inaccurate circuit analysis; discovering other damaged components which had excessive AC current drawn through them, reaching over and finding an electrolytic that was too hot to handle, or simply substituting until we cured the problem. There is probably nothing more time-consuming and frustrating than tracking down a leaky coupling filter, or bypass capacitor.

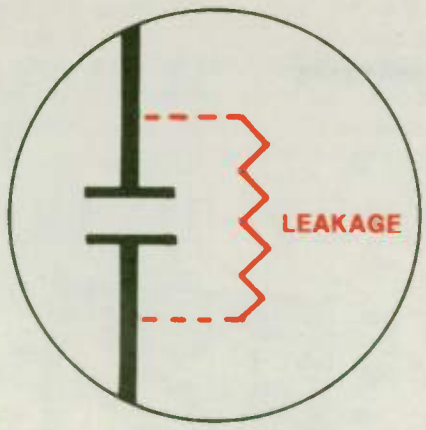


Fig. 3: Troublesome capacitor leakage is more common than incorrect value, but cannot be tested directly with other capacitor testers.

The "Z METERS" are the only capacitor testers on the market that supply B + voltage, up to 600 volts, to simulate the circuit potentials to detect capacitor dielectric leakage. The "Z METERS" catch defective capacitors that are just beginning to leak too, by measuring leakage current as low as one tenth of a microamp.

To measure leakage, usually after measuring capacitor value, all you do is set the LEAKAGE VOLTAGE switch to the DC voltage just under the capacitor's maximum voltage rating. Then, simply push the LEAKAGE button and read leakage current directly on the LED readout. If you wonder how much leakage current is excessive, refer to the handy pull chart at the bottom of the "Z METER 2."

What's different between the LC53 "Z METER" and the LC75 "Z2"? Studies showed that very large electrolytics, generally found in computers, were taking more time than we thought practical to fully charge during the leakage test. The "Z2" provides more than twice the charging current to enable you to check leakage in about half the time. Why did we make it faster? Because we know that each minute saved in testing is another minute you could put into analyzing.

Checks Capacitor Dielectric Absorption With Unique, Patented Test

How often have you, as an electronic analyzer, checked a circuit and convinced yourself that the capacitor value and leakage were okay, but the circuit just didn't function as it should and you still suspected a capacitor? How many times have you replaced an electrolytic with an "exact replacement" to find that the ripple level or bias on the next stage was still higher than shown on the schematic and you still suspected the capacitor? These are just two indications of excessive dielectric absorption. Dielectric absorption is the inability of the capacitor to fully discharge between pulses or cycles.

Fig. 4: Simply look at the pull chart to find how much leakage to allow for any capacitor value and voltage rating.

Dielectric absorption acts like a small DC battery inside an electrolytic. This "effective battery" leaves a residual DC level across the electrolytic, which upsets the DC bias on the stage, or next stage, or simply reduces the filtering ability of the electrolytic. This happens because electrolytics are constructed much like a battery, and conversely, a battery works well as a filter. All capacitors have a small amount of dielectric absorption, but it often becomes excessive in electrolytics. How do you find excessive dielectric absorption with the "Z METER"? Simply use the patented test procedure as follows.

First, check both value and leakage as you normally would. Then, retest the value. If the value changes appreciably, the "Z METER" has told you that dielectric absorption is causing the capacitor to hold an extra charge, which effectively changes the capacitor's value when charged. If the capacitor reading is within 5% of the original value, the capacitor is good. If the reading is between 5 and 15%, the capacitor may need reforming. If the difference is greater than 15%, the capacitor should be replaced.

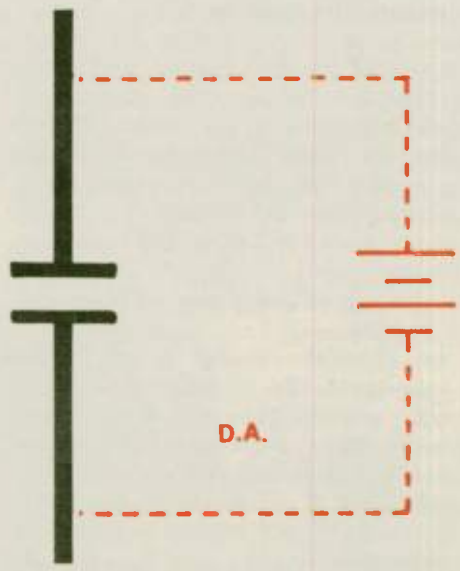
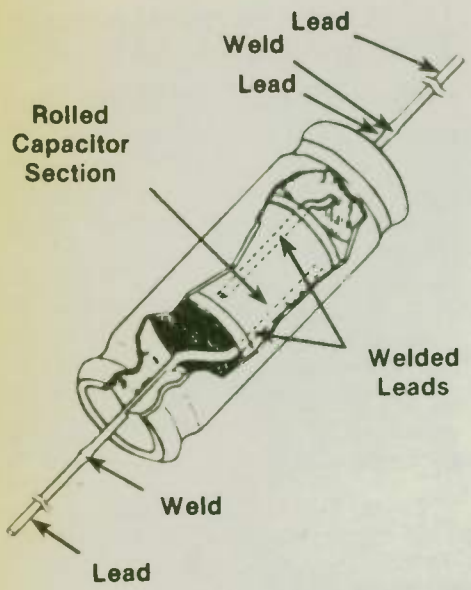


Fig. 5: Dielectric absorption prevents a capacitor from fully discharging because it acts like a small battery is inside.

What is different between the LC53 "Z METER" and LC75 "Z2"? As we said, the "Z2"'s value test is twice as fast, as well as its leakage test. Therefore, the dielectric absorption test takes only half the time it does on the LC53 "Z METER." Why did we make it faster? Because we want to help you use your time analyzing circuits, not waiting for the tester to react.

Checks Equivalent Series Resistance (ESR) With The Push Of A Button

Most "old timers" will tell you that the number one problem in capacitors is leakage when voltage near the maximum rating is applied. The second most common problem is generally value change. The third most likely failure is dielectric absorption buildup in electrolytics. The fourth most common fault, mostly in electrolytics used in high filtering, high current circuits, is high equivalent series resistance (ESR). These circuits are critical because the high current, going in and out of the electrolytic, will cause an excessive IR (voltage) drop across just a few ohms of contact resistance (for example). Excessive ESR causes inadequate filtering in AGC and other DC correction or "sample and hold" circuits, switching power supplies, flyback derived voltage supplies in TV receivers, etc. It takes only a few ohms of ESR to cause trouble in critically filtered circuits.



Courtesy of Sprague Products Co.

Fig. 6: Most ESR problems result from high contact resistance at a weld or joint in the capacitor's construction.

Here's an example of how high ESR can cause real confusion. You recognize the symptom of inadequate filtering. You test the capacitor and notice low value. You install a new capacitor (which may even read the correct value) and still see poor filtering. How is this possible? High ESR is often built into a capacitor at the factory. ESR is most often caused by a poor mechanical connection, corrosion buildup, poor welding, contact resistance, and the like. It isn't supposed to happen, but it does, and we have to be able to read this internal resistance if we are going to catch all defective capacitors.

Upon investigation of this problem, it first appeared that ESR was impossible to test because no one could derive a way to measure resistance inside the capacitor. One would need to make connection to the other end of the resistance with an ohmmeter. But one day, one of our bright young engineers really applied himself and came up with an answer.

I'd like nothing more than to give details on just how our designer discovered a way to measure this internal resistance to 1000 ohms, but we've just applied for a patent on the circuit and I dare not give you this information yet. I promise, however, to explain the test in detail in the next issue of the Sencore News, after the papers are all filed. Perhaps you would like to try guessing at how we accomplished this feat in the "Z2." I will give you a hint. It has something to do with wave shaping.

Fig. 7: Simply press the ESR button on the "Z2" and read the resistance directly in ohms to isolate ESR problems.

How do you find ESR with the new "Z2"? After measuring value, testing for leakage and checking for dielectric absorption, you simply push the ESR button and read the ESR level directly in ohms with 5% accuracy (which is adequate for this kind of test). Naturally, you can check ESR without going through the other tests if it is important to you, such as in a high frequency, low impedance circuit like a switching power supply where you suspect ESR as the problem, or when you simply wish to eliminate it as the problem first.

Reforms Electrolytic Capacitors With The Built-In Power Supply

How often have you picked up an electrolytic from the shelf and connected it into the circuit in place of a defective electrolytic, only to find that the circuit's function was not corrected? Most of us are aware that electrolytics will deform or "dry out" while not in use. And, most of us are aware that these capacitors often restore themselves when placed into the circuit, if given enough time. But, we find that placing the deformed electrolytic directly into the circuit often causes it to "blow up" because of excessive, uncontrolled, internal current; especially oil filled electrolytics.

Fig. 8: Simply use the supplied push button holder to latch the Leakage button to attempt to reform leaky electrolytic capacitors.

To prevent damage to deformed capacitors, and to be sure that you are installing a known-good replacement capacitor, it is a good idea to check each electrolytic before installing it. If it shows excessive leakage, simply leave the capacitor connected to the "Z METER" and place the specially supplied push button holder between the handle and the LEAKAGE button so that the selected voltage (with limited current to protect the electrolytic) is applied continuously to the capacitor until the leakage reading drops to normal. An external holding device of this type prevents shock hazards that would be possible if the LEAKAGE switch were defeated and latched.

Fig. 9: Check complete range of inductors automatically and directly by simply pushing the Value button.

Checks Inductor Value Automatically From A Tiny 1 Microhenry To A Whopping 10 Henries

How often have you suspected a coil, but you had no substitute to prove your point? How many times have you gone through the laborious job of checking or replacing everything else in the circuit, other than the coil, in an attempt to prove that the coil was bad, only because you had no way to measure inductance value? How many times have you cracked a powdered-iron slug and wished you had a sure-fire way of finding out whether the inductance value had changed?

Inductors are generally designed for a specific circuit and application, and exact replacements are next to impossible to find. How do you measure coil value in a jiffy and move along to other components when troubleshooting? Simply connect the "Z2" to any inductor within its measuring range, push the VALUE button and read the value directly on the LED display. It's 100 percent autoranged. And, it measures to a solid two percent accuracy on all ranges and tests the coils, which use the extremely fine wire, without additional error too.

Exclusive Dynamic Inductor Test Finds Even One Shorted Turn

How many times have you checked a coil's value or tried to measure it with a DC ohmmeter to find that the reading was the same as indicated on the schematic, but the circuit still malfunctioned? That's because neither value nor DC resistance changes much with a shorted turn, the most common problem in inductors. A shorted turn simply absorbs the energy and drops the Q to a very low level. Basically, only a dynamic Q test will determine whether all turns are effectively insulated from each other. How do the "Z METERS" detect one or more shorted turns? They use the patented "RINGER" test.

The "Z METER" applies a sharp wave front pulse which rings the inductor to see if it will maintain the ringing for a reasonable period. If it does not continue to ring in the same manner as a high quality tuning fork would, the Q has been reduced and the coil is bad. All you have to do to make this dynamic test is to push the RINGER button and rotate the IMPEDANCE MATCH switch for the highest reading on the digital display. The "Z METER"'s impedance matching circuits are set so that 10 rings or more indicate a good inductor. And, it works 100 times out of 100 without having to do any time-consuming, error-producing calculating at all.

Checks SCRs And TRIACs With Added Low Cost Accessory

The "Z METER" was not designed to test SCRs and TRIACs, but most electronic technicians and engineers don't have a piece of equipment to test these popular devices. The "Z METER"'s current-limited power supply was harnessed up to test SCRs and TRIACs because it is just what you need to check the turn-on

Fig. 10: The "Z2"'s Ringer test finds even a single shorted turn in an inductor by simply watching for a reading of 10 or larger on the display.

and the turn-off capabilities of these power devices. A convenient accessory, the SCR224, was built to take advantage of the power supply to check the turn-on and turn-off capability of SCRs and TRIACs.

Simply hook up the "Z METER"'s test leads to the SCR224 accessory, connect the three test leads of the accessory to the SCR or TRIAC, and set the "Z2"'s LEAKAGE VOLTAGE switch to the device's rated voltage. Press the LEAKAGE button and move the switch on the SCR224 to its "On" and "Off" position. If the SCR or TRIAC is good, the "Z METER" will show flashing 8s when the switch is set to "On" and zero when set to "Off." Any reading other than zero, when set to "Off," indicates leakage.

Fig. 11: The low-cost SCR224 adapts the "Z2" to test SCRs and TRIACs, accurately and easily.

Checks Distance To Opens Or Shorts In Transmission Lines To Within Feet

If you ever need to repair a damaged transmission line, you will soon learn to appreciate clues to the location of the defect. Imagine, for example, what a help it would be to know exactly where to dig to find a problem in a buried cable. Or, think how much easier it would be to know the location of a problem in a line running behind a wall or through a tunnel. The "Z2" helps here, too.

Most of us are aware that all transmission lines are made up of uniformly-spaced conductors. This causes capacitance to be distributed between the conductors and inductance to be distributed along its length. Surprisingly not, the capacity per foot is a constant value to the point of a break and can be used to clearly determine the distance to the break. Likewise, a shorted transmission line has a short across the effective capacitance, but the series inductance remains.

To determine the distance to a short, we simply measure the total inductance of the transmission line, ascertain the inductance per foot established for the transmission line being measured, and divide the measured inductance by the inductance per foot. To determine the distance to an open, capacity per foot is divided into the total measured capacity. Some people buy "Z METERS" for this purpose only, because they are just as accurate as expensive TDR meters.

Checks High Impedance Leakage In Insulation Materials As A Bonus

Many electronic technicians and engineers have a rather expensive high-pot tester to detect bothersome leakage in PC boards, switch wafers, connectors, or other insulating materials. Owners of "Z METERS" have learned that they work just as well to detect leakage current by simply cranking up the leakage test voltage to 600 volts, connecting the leads across the insulated material, pushing the Leakage button, and reading leakage current directly on the LED readout. This gives reasonable results, especially if you only need to measure breakdown conditions occasionally.

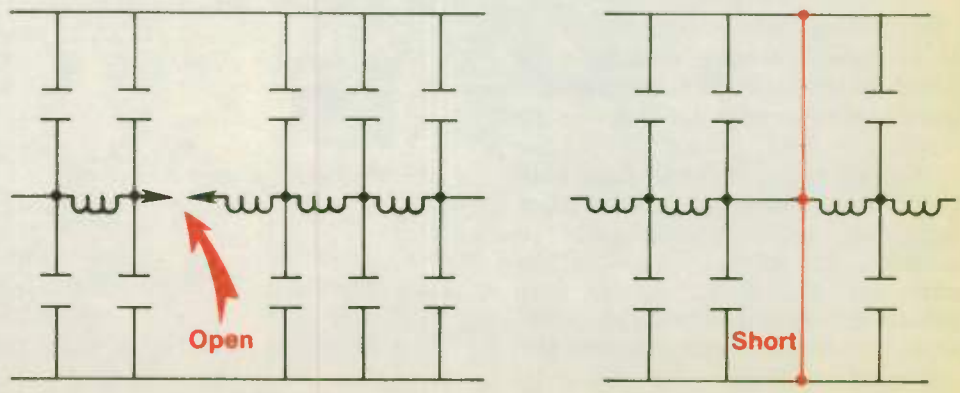


Fig. 12: Since transmission line has both distributed capacitance and inductance, the "Z2" isolates the distance to a break by measuring capacity value or the distance to a short by measuring inductance.

What Does The "Z2" Cost And How Can I Get One?

Your investment is less than $1,000 to own the exciting, exclusive, triple-patented LC75 "Z METER 2" capacitor and coil analyzer, just $100 more than the LC53. We will have both models available because many people own an LC53 "Z METER" and simply want another.

But, that's not all. For a limited time, we will offer three FREE accessories to encourage you to learn about the added features the "Z2" offers. If you decide to make your investment before April 30th, you will receive the SCR224 SCR and TRIAC Test Accessory, the FC221 Field Calibration Tester, and the CC237 "Kangaroo" Lead Carrying Pouch absolutely FREE of charge as an introductory offer. That's a savings of $138.95 (a 14 percent discount) if you decide to act now. For more details, or to place an order, simply call your Telemarketing Sales Engineer by dialing Sencore's **WATS Free number, 1-800-843-3338.**

And remember, the "Z2" is sold with Sencore's exclusive 30-day Proof of Performance Guarantee. If you are not completely satisfied, simply return it for a full refund — including your shipping costs both directions. It won't cost a single penny to learn how the new, improved, faster, more accurate, "Z METER 2," with newly developed, patent applied-for ESR measurements, can rapidly move you through capacitor, inductor, and special component testing with the utmost of confidence.

And, best of all, the "Z2" is in stock right now. Just call for details on how you can be one of the first to try the all-new "Z2."

SPECIFICATIONS

DIGITAL READOUT

TYPE: .5", 7 segment LED.
ACCURACY: Function accuracy ± resolution error.
RESOLUTION: 3 significant digits ± 2 counts on 3rd digit (3½ digits on capacitors of 100,000 uF to 200,000 uF).
AUTORANGING: Fully automatic decimal placement. One or two place holding zeros added as needed (does not affect accuracy) to provide standard value readouts of uF, pF, uH, or mH.
RANGE INDICATORS: Type: LED Operation: Controlled by the autoranging circuits.

CAPACITORS (Out-of-Circuit)

Dynamic test of capacity value determined by measuring one RC time constant when capacitor is charged to + 5V through:
10 Megohms for 0-9000pF.
10 Kilohms for 9000pF-90uF.
Values greater than 90 uF are charged with a constant current of 60 mA.

ACCURACY: ± 1% of reading + resolution error, ± 1pF. ± 5% of reading + resolution error for caps over 1000uF.
RANGE: 1.0 pF to 199,900 uF in 10 automatically selected ranges.

CAPACITOR LEAKAGE

ACCURACY: ± 5% + resolution error.
RANGES: 0 to 99.9 uA and 0 to 9,990 uA in two switch selectable ranges.
VOLTAGES: 12 selectable DC voltages from 3 VDC to 10 VDC filtered, and from 15 VDC to 600 VDC, non-filtered. Available at test leads only when LEAKAGE pushbutton is depressed. Capacitor is automatically discharged when button is released.

CAPACITOR ESR (Patent Pending)

ACCURACY: ± 5% + resolution error.
RANGE: 0.10 Ohm to 999 Ohms in 3 automatically selected ranges.
CAPACITOR RANGE: 1uF minimum value for specified accuracy.

CAPACITOR D/A

Dynamic test of capacitor dielectric absorption determined by the difference in capacity value measured before and after applying rated voltage to the capacitor. (US patent 4,267,503)

APPLIED VOLTAGE: Same as capacitor leakage.
ACCURACY: Same as capacitor value accuracy.

INDUCTANCE (In- or Out-of-Circuit)

Dynamic test of inductance value determined by measuring the EMF caused by a constantly varying current through the coil under test (US patent 4,258,315). Current rates are: 10 mA/usec - 0 to 90 uH. 1 mA/usec - 90 to 900 uH. .1mA/usec - 900 uH to 9 mH. .01 mA/usec - 9 to 90 mH. 1 uA/usec - 90 to 900 mH. .1 uA/usec - 900 to 9,990 mH.

ACCURACY: ± 2% of reading + resolution error.
RANGES: 1.0 uH to 9,990 mH in 6 automatically selected ranges.

RINGING TEST

Dynamic test of inductor quality determined by counting the number of cycles the inductor rings before reaching a preset damping point after a given exciting pulse has been applied. (US patent 3,990,002)

EXCITING PULSE AMPLITUDE: Approximately 7 Volts peak.
ACCURACY: ± 1 count from readings of 8 to 13

GENERAL

TEMPERATURE RANGES (Typical): Calibrated at 70 degrees F. Rated accuracy range: 50-90 degrees F. Operating range: 32-130 degrees F.
POWER: 105-130 VAC, 60 Hz, 50 Watts.
TEST LEAD INPUT: Fuse protected with in-line 1 Amp 3AG Slo-Blo fuse.
SIZE: 6" x 9" x 11.5" (15.24cm x 22.86 x 29.1 cm)
WEIGHT: 7.75 lbs. (3.56 Kg).

Specifications subject to change without notice.

Capacitor Testing Needs In Modern Circuits

by Rick Meyer, Application Engineer

One method used in the past to locate defective capacitors was the substitution method. Before the development of practical capacitor test equipment, it was the only method available to troubleshoot capacitor related problems. In addition, the circuits used in the past were not as critical on part values and performance characteristics as some present day circuits. As circuit designs increase in complexity and sophistication, the need for a reliable way to test capacitors is becoming more important. For example, critical timing circuits sometimes use capacitors with non-standard values, and high voltage circuits need capacitors capable of withstanding the frequencies and voltages encountered.

To better understand the problems encountered in servicing electronic equipment (and in particular) capacitor problems, let's look at a schematic and parts list of a typical modern day television.

Figure 1 shows a portion of the parts list for a typical television receiver.

SYMBOL NO.	STOCK NO.	DRAWING NO.	DESCRIPTION
			CHASSIS ASSEMBLY
			CTC131A/M
C100	157345	1491976-001	• CAP POLY .22UF M 600V
C101	149771	1491927-015	• CAPCD 680PF M Z5P 1KV
C102	149771	1491927-015	• CAPCD 680PF M Z5P 1KV
C103	149771	1491927-015	• CAPCD 680PF M Z5P 1KV
C104	149771	1491927-015	• CAPCD 680PF M Z5P 1KV
C105	160548	2841263-003	• CAP LYTC 820UF P 250V
C106	150733	2841260-12M	CAPCD 1000PF K Z5P 250V
C107	161374	2870697-021	• CAPCD 5000PF M Z5V 1.4KV
C108	147971	2841255-32M	CAPCD .01UF K Z5P 50V
C109	109956	973973-004	• CIRCUIT ENCAPSULATED
C110	120832	1490360-018	CAPCD 1000PF M Z5P 500V
C112	136675	973999-271	CAP POLY .047UF K 600V
C113	161373	1490360-031	CAPCD 4300PF K Z5P 1KV
C114	161208	2841275-312	CAP LYTC 220UF N 6V
C117	151831	1442616-074	CAPCFT 470PF P Z5P 50V
C118	151831	1442616-074	CAPCFT 470PF P Z5P 50V
C119	147971	1491415-32M	CAPCD .01UF K Z5P 50V
C120	160131	1491927-011	CAPCD 680PF M Z5P 1KV
C301	143879	2841253-90M	CAPCD 1000PF Z Z5P 50V
C302	103245	1490132-53A	CAPCD 12PF J NPO 250V
C303	150733	2841260-12M	CAPCD 1000PF K Z5P 250V
C304	150733	2841260-12M	CAPCD 1000PF K Z5P 250V
C305	147971	2841255-32M	CAPCD .01UF K Z5P 50V
C306	139445	1472442-080	CAP POLY .27UF K 75V
C307	143879	2841253-92M	CAPCD 1000PF K Z5P 50V
C308	142768	2841261-40R	CAPCD .01UF Z Z5V 250V
C309	153970	2841259-22M	CAPCD 220PF K Z5P 250V
C310	161213	2841258-13A	CAPCD 33PF J NPO 250V
C311	145316	2841252-33A	CAPCD 56PF J NPO 50V
C312	150733	2841260-12M	CAPCD 1000PF K Z5P 250V
C313	153970	2841259-22M	CAPCD 220PF K Z5P 250V
C314	147958	1490305-342	CAP LYTC 22UF N 25V
C316	145376	1490133-63A	CAPCD 82PF J NPO 250V
C317	145376	1490133-63A	CAPCD 82PF J NPO 250V
C318	147628	1490862-253	CAPCD 16PF J NPO 250V
C319	153970	2841259-22M	CAPCD 220PF K Z5P 250V
C321	153970	2841259-22M	CAPCD 220PF K Z5P 250V
C322	147958	2841274-342	CAP LYTC 22UF N 25V
C323	146256	2841274-143	CAP LYTC 10UF M 25V
C324	143871	2840392-63J	CAPCT 100PF J NPO 50V
C325	139445	1472442-080	CAP POLY .27UF K 75V
C326	142751	2841255-12M	CAPCD 6800PF K Z5P 50V
C327	149200	2841273-161	CAP LYTC 1UF R 50V
C329	150733	2841260-12M	CAPCD 1000PF K Z5P 250V
C330	120832	1490141-12M	CAPCD 1000PF K Z5P 250V
C331	150737	2841253-23J	CAPCD 270PF J NPO 50V
C332	149200	2841273-161	CAP LYTC 1UF R 50V
C333	157199	2841251-73A	CAPCD 22PF J NPO 50V
C334	145676	2841252-43A	CAPCD 68PF J NPO 50V
C401	143867	2841252-21A	CAPCD 47PF Z NPO 50V
C402	134778	1472442-069	CAP POLY .033UF K 100V

Fig. 1: Typical television parts list.

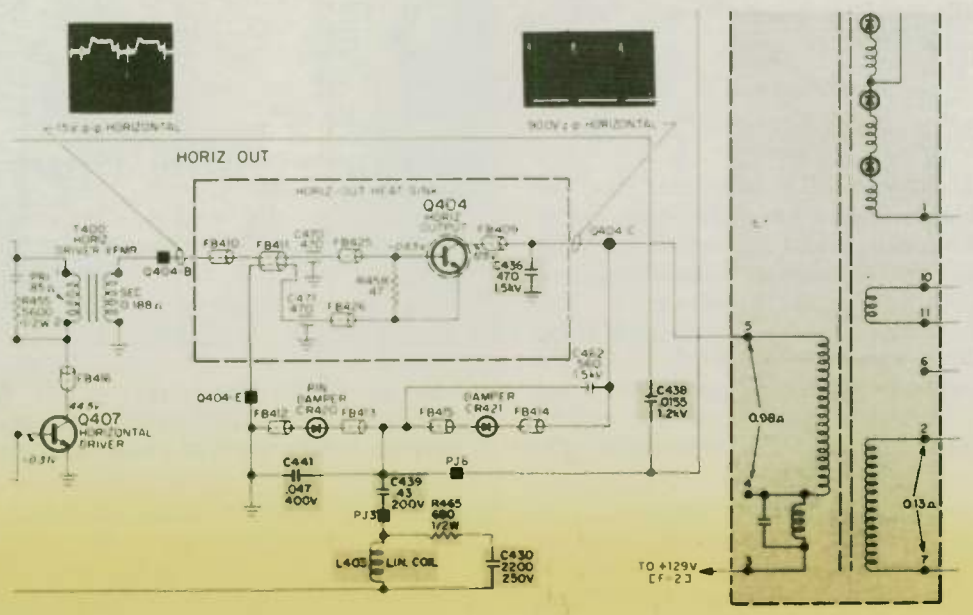


Fig. 2: Typical high voltage section in a television. Courtesy RCA

Notice that several types of capacitors are used: ceramic discs (CD), polystyrenes (POLY), electrolytics (LYTIC), and others. Note the different capacitor values and voltages specified. An examination of the entire parts list for the television shows that it uses capacitors with values varying from less than one picofarad to several thousand microfarads with many different values in between.

Figure 2 shows the schematic for the high voltage section of the same television.

Note that the capacitors in the shaded area are critical safety components and must be replaced with capacitors having the same characteristics as the original parts. Any attempt to substitute a capacitor with a slightly different capacitance value, working voltage, or other characteristic, even for test purposes only, can cause damage to the television and leave the television in a potentially hazardous condition.

The television used as an example is typical of modern day televisions. This television was found to contain a total of 695 capacitors. Other models and brands of televisions have similar quantities of capacitors. Think of the stock of substitute capacitors needed to troubleshoot this television, or any other television, VCR, or other electronic device, using the substitution method. Stocking substitute capacitors for all potential substituting situations becomes expensive, time-consuming, and impractical.

Another problem with the substitution method of trouble-shooting capacitor problems is the fact that capacitors can go bad just sitting on the shelf. Even if you have the capacitor in your parts stock, you can't be sure the substitute capacitor is still good. This is especially true of electrolytic capacitors. Aluminum electrolytics can become leaky just sitting on the shelf. This type of capacitor should be checked for leakage before being installed in a circuit. Installation of an aluminum electrolytic capacitor without first checking it for excessive leakage can have potentially disastrous affects on the circuit it is used in.

The only practical way of troubleshooting capacitor problems is to test them with the new Sencore "Z METER 2." Why the "Z METER 2"? Because capacitors can can fail for any of four different reasons: They can change value, become leaky, develop excessive dielectric absorption, or they can have excessive internal resistance. Now for the first time, the "Z METER 2" allows you to check a capacitor for all four potential capacitor defects. In order to understand why these four tests are important, let's look at a capacitor and see how it works and why it fails.

Capacitor Failure Modes

Each capacitor type, whether it be ceramic, film, electrolytic, or others, tends to fail due to a particular defect common to that type of capacitor. Some capacitors tend to short when they fail, others will open up, while others may have an increase in dielectric absorption or their internal resistance may change. The mode of failure is determined, to a great extent, by the type of materials used and the construction of the capacitor. Table 1 shows some common types of capacitors and the most common failure modes of each type.

Let's look at these different failure modes and see why it is important to be able to check capacitors for each type of failure.

Table 1: Common Failure Modes Of Capacitors

	Failure Modes			
Capacitor Type	Value Change	Excessive Leakage	High D.A.	High ESR
Paper	×	×		
Film	×	×		
Ceramic	×	×		
Electrolytic	×	×	×	×

Value Change

Capacitors can change in value while in a circuit or while sitting on the shelf. Ceramic capacitors, for instance, can change value if the plates of the capacitor break. This can happen due to mechanical stress or by a sudden temperature change. Multilayer capacitors, like the type shown in Figure 3, can change value if the connection of a plate to the termination fails.

In the example shown in Figure 3, the capacitor will not open up entirely, but will rather show a change in capacitance value.

Electrolytic capacitors are another example of capacitors that can change value in circuit or on the shelf. As these capacitors dry out, they eventually lose their capacitance due to the failure of the aluminum oxide film making up the dielectric. A change in value in an aluminum electrolytic will often also be preceded by other defects, such as high leakage, high dielectric absorption and/or high internal resistances. Let's take a look at these other capacitor defects.

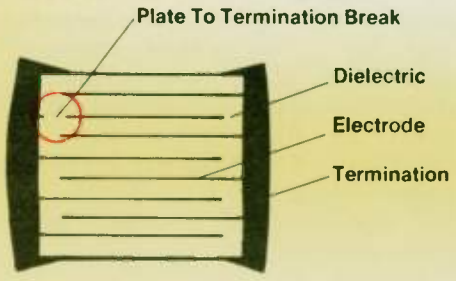


Fig. 3: A change in value in a multilayer capacitor can be due to a break in the plate-to-end termination bond.

Leakage

One of the most common capacitor failures is caused by current leaking through the capacitor. Some capacitors will show a gradual increase in leakage, while others will change rapidly and even short out entirely. In order to effectively test a capacitor for leakage, it is necessary to test the capacitor at its rated voltage. An ohmmeter can be used to locate a completely shorted capacitor, but many capacitors show no leakage at the low voltages present in an ohmmeter. The Sencore "Z METERS" are the only capacitor testers available that dynamically test capacitors for leakage and they do it at the rated voltage of the capacitor. Value-only meters cannot test for leakage and thus cannot locate these defective capacitors.

Dielectric Absorption

One of the most common types of failures of electrolytic capacitors is dielectric absorption. Dielectric absorption is the result of a capacitor remembering a charge that is placed on it. In a capacitor that has dielectric absorption, the capacitor cannot be completely discharged and a voltage will reappear after the capacitor has been discharged. Another name for dielectric absorption is battery effect. As this name implies, a capacitor with excessive dielectric absorption will act like a battery in the circuit. This will upset the circuit by changing bias levels. A capacitor with excessive dielectric absorption will also have a different effective capacitance when it is operating in a circuit.

Effective Series Resistance

All capacitors have some internal series resistance due to the leads, lead connections and other causes. We will talk about "Effective Series Resistance" later on in this article, but for now, we'll simply say that it is a defect that can cause problems and needs to be checked.

To understand more about what goes wrong with capacitors and why they need to be tested, let's look at the capacitor and what it is.

A Capacitor Is More Than A Capacitor

An ideal capacitor is defined as "a device consisting of two electrodes, separated by a dielectric, for introducing capacitance into an electric circuit." Unfortunately, we don't work with ideal components. The capacitors we encounter every day in our service work are much more complex than this simple definition. In an actual capacitor, a certain amount of current leaks through the dielectric or the insulation. Capacitors have internal series resistances, can exhibit an effect called dielectric absorption, and the capacitance can change in value. If we were to draw a circuit to represent an actual capacitor, it might look like the circuit in Figure 4.

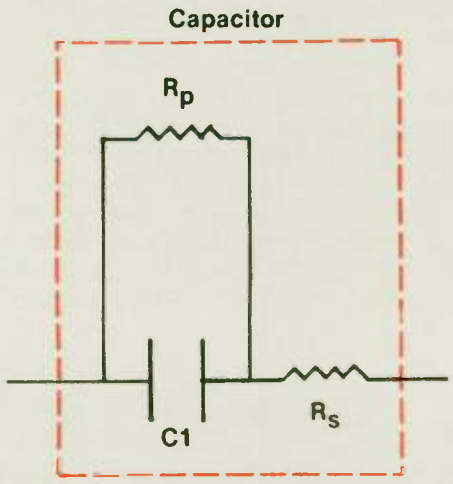


Fig. 4: Equivalent circuit of a practical capacitor.

The capacitor C1 represents the true capacitance, the resistance Rp represents the leakage path through the capacitor, and the resistance Rs, called the Effective Series Resistance (ESR) represents all of the combined internal series resistances in the capacitor.

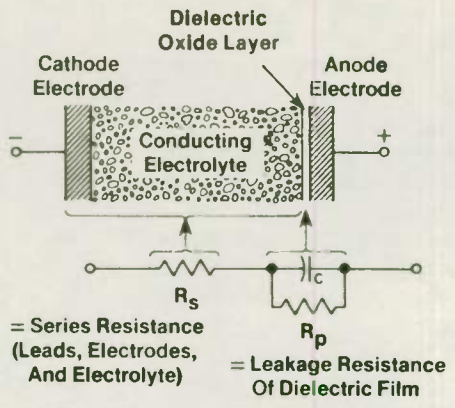


Fig. 5: Construction of an electrolytic capacitor and its equivalent circuit.

The Aluminum Electrolytic Capacitor — A Chemical Factory

Many of the capacitor defects listed earlier are common in aluminum electrolytic capacitors. Many of these defects can be attributed to a loss of the electrolyte inside the capacitor. To understand how and why this is true, let's look at how an aluminum electrolytic capacitor works.

An aluminum electrolytic capacitor is composed of aluminum plates separated by a spacer which is soaked with an electrolytic solution. See Figure 5.

The dielectric inside the capacitor is created when the water in the electrolyte reacts with the aluminum in the plates to form a thin layer of aluminum oxide and hydrated aluminum oxide. Remember the formula for capacitance:

$$C = kA/D$$

where C is the capacitance, K is the dielectric constant, A is the area of the plates, and D is the distance between the plates. In an aluminum electrolytic capacitor, the aluminum oxide layer is extremely thin. If the distance between the plates is made very small, then a large capacitance is possible for a given size of plate. Since the dielectric layer in an electrolytic capacitor is very small, large capacitance values are possible in relatively small packages. This is one of the reasons electrolytic capacitors are used so often in electronic circuits.

Another advantage of an aluminum electrolytic capacitor is its ability to heal itself. If an electric current, such as a voltage spike, passes through the aluminum oxide layer, the water in the electrolyte will react with the aluminum in the plates and form a new dielectric layer. This effectively heals the dielectric allowing the capacitor to continue to operate in the circuit.

All aluminum electrolytic capacitors have some leakage current flowing through them. Thus, the healing process occurs continually. As long as there is sufficient water in the electrolyte to react with the aluminum in the plates, everything is fine. When the water is used up, however, the capacitor can no longer heal itself and the capacitor will fail.

Heat can affect the chemical reaction that occurs within an electrolytic capacitor. Capacitor manufacturers have long known that heat is an enemy to electrolytic capacitors. The chemical processes are accelerated in a "hot" capacitor, and the life of the capacitor is reduced. A general rule of thumb states that the life of an aluminum electrolytic capacitor will be cut in half for every 10 degrees Centigrade temperature rise in the capacitor. Thus, any defect that causes the temperature of the capacitor to rise will also cause that capacitor to fail sooner than it normally would.

There are several things that can cause a capacitor to get hot. Looking back at the capacitor model in Figure 4, we can see that heat can be generated if a current flows through either of the two resistances, Rp and Rs. Let's look at each of these resistances and see what affect they have.

Leakage Current

When a DC voltage is applied to a capacitor, a certain amount of current will flow through the capacitor. This current is called the leakage current and is the result of imperfections in the dielectric. Whenever this leakage current flows through an electrolytic capacitor, normal chemical processes take place to repair the damage done by the current flow. Heat will be generated from the leakage current flowing through the capacitor and will speed up the chemical repair processes.

As the capacitor ages, the amount of water remaining in the electrolyte will decrease, and the capacitor will be less capable of healing the damage done by the various leakage paths through the dielectric. Thus, as the amount of water in the electrolyte decreases, the capacitor will be less capable of healing the leakage paths and the overall leakage current in the capacitor will ultimately increase. The increase in leakage current will generate additional heat, which will speed up the chemical processes in the capacitor. This process, of course, will use up more water and the capacitor will eventually go into a run-away mode. At some point, the leakage current will finally get large enough to adversely affect the circuit the capacitor is used in. At that time, the service technician will be called to find the problem.

Effective Series Resistance

All of the internal series resistances in a capacitor can be lumped together into a single term called the Effective Series Resistance or ESR for short. Figure 6 shows the various internal resistances that make up the ESR.

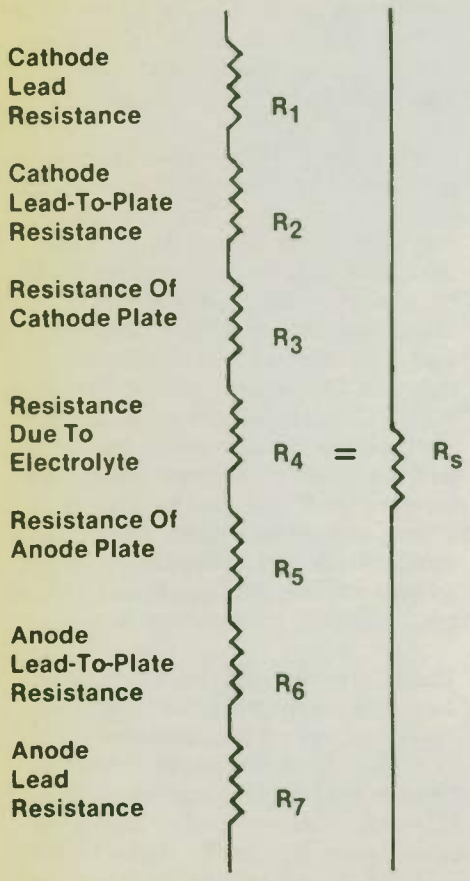


Fig. 6: The Effective Series Resistance (ESR) is composed of all the combined internal resistances in the capacitor.

As Figure 6 shows, the ESR is the combined resistances of the connecting leads, the electrode plates, the resistance of the lead to plate connections, and the losses associated with the dielectric. All capacitors have some ESR. Normal amounts of ESR are tolerated by the capacitor and the circuit it is used in. Defects can occur, however, in the capacitor which will increase the ESR in the capacitor. Any increase in ESR can affect the circuit in which the capacitor is used, as well as the capacitor itself.

To understand what affect excessive ESR has, let's look at what goes on inside a capacitor in a circuit. First, let's consider a DC voltage applied to a capacitor, as shown in Figure 7.

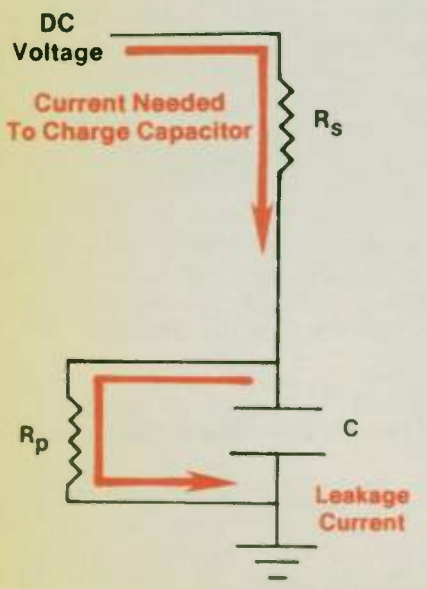


Fig. 7: Effect of a DC voltage being applied to a capacitor.

When a DC voltage is first applied to a capacitor, a current will flow through the series resistance (Rs) and will charge the capacitor. Once, the capacitor is charged, however, the only current that will flow through the series resistance (Rs) is the leakage current. Under normal conditions, this current is relatively low, and thus the series resistance will have little effect on the capacitor or on the circuit.

If an AC voltage is applied to this capacitor, the series resistance becomes more important. Let's consider the simple example of a power supply as shown in Figure 8.

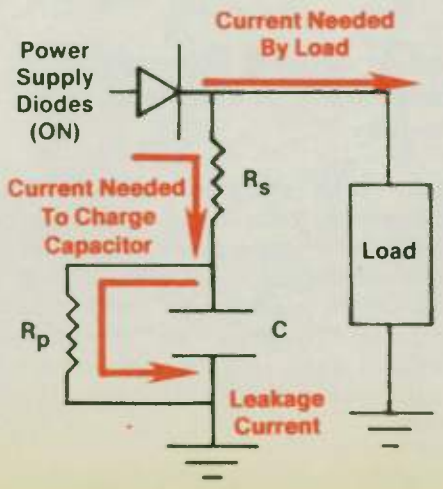


Fig. 8: Current flow in a filter circuit while power supply diodes are conducting.

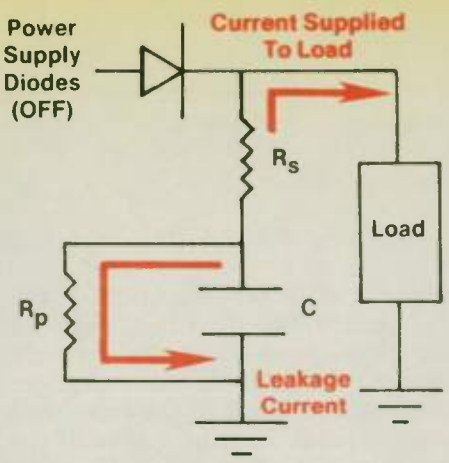


Fig. 9: Current flow in filter circuit when power supply diodes are not conducting.

When the power supply diodes conduct, some current will flow to the load and the rest of the current will flow into the capacitor. The current which flows into the capacitor will charge the capacitor. Of importance here, is the fact that all of the current that goes into charging the capacitor will flow through the series resistance and generate heat.

When the AC voltage applied to the power supply diodes swings towards zero volts, the current supplied to the load by the diodes will decrease and the energy stored in the capacitor must be used to supply the current needed by the load. See Figure 9.

The current needed by the load will flow out of the capacitor and through the internal series resistances (ESR). This current flow will again produce heat inside the capacitor. Thus, as the capacitor alternately stores and supplies energy, current will flow through the ESR and heat up the capacitor. In the case of an aluminum electrolytic capacitor, this heat will speed up the chemical processes inside the capacitor and cause it to fail.

In the past, most power supplies operated at the AC power line frequency. In these power supplies, the current flow into and out of the capacitor occured at a rate of 60 to 120 cycles per second. At these frequencies, capacitors would tolerate a fair amount of ESR without generating an excessive amount of heat. Today, however, we are seeing the rapid increase in the use of switching power supplies which operate at significantly higher frequencies. These power supplies may be scan derived power supplies running off of the horizontal flyback pulses in a television set, or they may be chopping power supplies running at frequencies substantially higher than 60 cycles per second. Switching power supplies are becoming more popular because they eliminate the low voltage ripple associated with the traditional line operated power supplies, plus they can eliminate the need for heavy and costly power transformers. Capacitors used in switching power supplies have currents flowing in and out at very high rates, and any increase in the capacitor's ESR will result in a rapid increase in temperature.

There is another reason that ESR is important. Excessive ESR can affect the circuit the capacitor is used in, and let's face it, that is the reason you are called in to fix the circuit. To understand what affect a capacitor with high ESR has on circuit operation, let's look at the capacitor model in Figure 10.

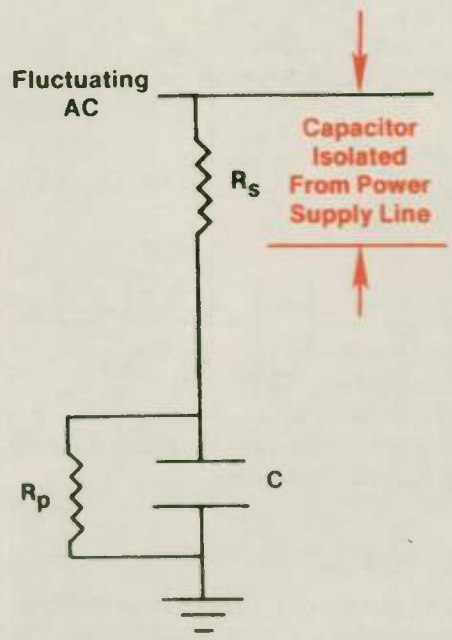


Fig. 10: The Effective Series Resistance has the result of isolating the capacitor from the power supply line, reducing its filtering capabilities.

As can be seen in this example, the series resistance (Rs) will isolate the capacitor from the fluctuating AC it is meant to filter. As the series resistance increases, the capacitor will become isolated even farther from the rest of the circuit. The end result is that the capacitor's ability to smooth out the voltage fluctuations is reduced and the ripple on the power supply line will increase.

The "Z METER 2" — The Only Tester To Test For All Four Common Capacitor Failures

Now, for the first time, there is a tester that will test capacitors for the four important capacitor failures: change in value, excessive leakage, high dielectic absorption, and high ESR.

The "Z METER 2" measures the true capacitance value. Like the original "Z METER," the "Z METER 2" measures the true capacitance of any capacitor using the patented "Z METER" test. Why is this important? Because other testers using the bridge method are frequency selective. They measure the capacitive reactance of the capacitor rather than its capacitance. Since reactance is frequency dependent, bridge measurements are frequency dependent also. With the "Z METER" method, the capacitance is measured directly, giving you a true indication of what the capacitance really is.

Like the original "Z METER," the "Z METER 2" measures the leakage of a capacitor dynamically. The only way to correctly measure the leakage current of a capacitor is to test it at the voltage rating of the capacitor. An ohmmeter will not give you a true leakage reading since it applies only a small voltage to the capacitor. A value only tester won't measure leakage either. Only the patented Sencore "Z METERS" give you a true indication of the leakage of a capacitor.

Like the original "Z METER," the "Z METER 2" measures dielectric absorption. The Sencore "Z METERS" are the only capacitor testers on the market that measure dielectric absorption. And what's more, they do it quickly and easily.

And now, for the first time, you can get the new Sencore "Z METER 2." The "Z METER 2" is the only capacitor tester to combine the proven capacitor tests of the original "Z METER" with the ability to test capacitors for excessive Effective Series Resistance (ESR). With the increasing use of capacitors in high frequency switching applications, this feature now gives you the ability to find those defective capacitors which have high ESR.

So what are you waiting for? Check it out. The "Z METER 2" is here now!!!!!

YOU 'LL CATCH DEFECTIVE CAPS & COILS ALL OTHER TESTERS & BRIDGES MISS.

THE ORIGINAL

Are you impeding your productivity with these common time & money wasters?

- *Are you missing over half of all capacitor defects because you are checking for value only?*
- *Are you unknowingly installing defective electrolytics that went bad sitting in stock?*
- *Are you substituting inductors as a last resort because you can't check for value or shorted turns quickly?*
- *Are you wasting your money purchasing expensive deflection yokes and flyback transformers for substitution only?*
- *Are [you] struggling with a time consuming bridge?*
- *[Are you] frustrated by your inability to check SCRs, TRIACs, or High [Voltage] diodes?*
- *[Are you] unable to tell the distance to an open or short in a [transmis]sion line?*
- *[Are you] hard pressed to clearly detect insulation leakage in printed [circuit] boards, connector terminals, etc.?*

If these productivity cripplers sound familiar to you, it's time you discovered the answer; the triple patented "Z METER".

In A Nutshell!
Here Is What The "Z METER" Is:

- It's the only capacitor tester on the market that dynamically analyzes a capacitor with up to 600 volts applied. It's patented.
- It's a double patented inductor analyzer, with tests not found on any other instrument at any price. In fact, it catches one shorted turn, even though the inductance value hasn't changed. No other bridge or coil tester can make that claim.
- It's an SCR, TRIAC, and High Voltage diode tester.
- It's a transmission line tester that tells you the distance within feet to an open or short in any transmission line.
- It's a hi pot dielectric leakage tester, too!

Do you know why only the "Z METER" does all these things? Because it is the only dynamic LC tester on the market. All others don't apply operating voltage and therefore make static tests.

LC53 "Z METER" — $895

Triple Patented:
No. 3,990,002
No. 4,258,315
No. 4,267,503

"Z METER" Challenge Guarantee

Try an LC53 for 30 days. If you aren't completely satisfied for any reason, return the LC53 for a full refund, including freight both ways. No questions asked.

Write or call today **WATS Free 1-800-843-3338**. Experienced Phone Sales Engineers are ready to answer your questions and help you take the "Z METER" Challenge.

If you're ready to order, call today and take advantage of a 10% Factory Direct "Finder's Fee" Discount (See Back Cover). You'll save $89.50 just by calling us direct, **SO ACT TODAY!**

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What It Does For You . . .

the only way to truly determine test equipment value

by Herb Bowden, President

Sencore has just finished an extensive marketing survey to ascertain what you, our customers, think about our products and services. While we were generally very pleased at the answers, we were somewhat confused by the ratings given to the value of our equipment. Some surprised us by indicating that they thought that our test equipment was too costly. On the other hand, many indicated that they thought that we offered the best value on the market. Why this vast difference?

We soon discovered that there was a common denominator to those who thought our test equipment was too high in price; these people generally owned none, or very little Sencore.

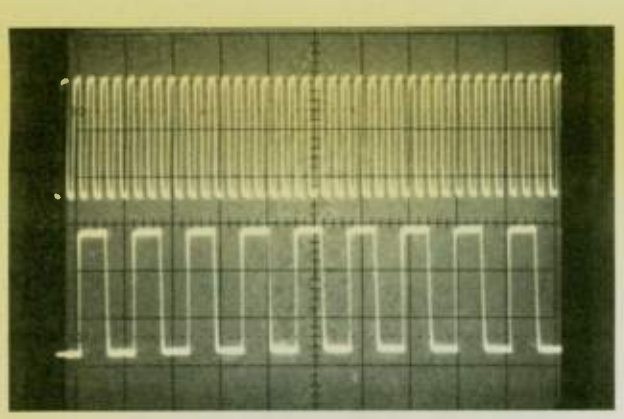


Fig. 1: The SC61 has a clear, bright, sharply focused trace.

Conversely, those who owned many pieces of Sencore boastfully gave Sencore instruments a 10 rating and in most cases made unsolicited comments about what the product had done for them. Further investigation clearly indicated that those who were evaluating Sencore instruments and analyzers on specifications only, were giving us a low rating. Those who were looking at a piece of equipment for what it was truly intended to do, help them do things better, faster, or with less error, evaluated Sencore far ahead of competition. This revelation caused me to stop and think for a moment and realize how easily one could mis-evaluate test equipment by looking at meaningless specifications, dimensions, aesthetics, or things that may not help us do our work.

If what an instrument does for us is the only thing that really counts, logic will tell us that a design engineer should never determine design requirements from electrical specifications, but rather from a complete study of the customer needs and wants. Making a job easier, faster, fiddle-free, with readouts in understandable common direct reading terms, and error-free use, are the real design criteria that the designer must start with. This is just what we believe we do at Sencore and we believe that most Sencore owners are aware of it.

The SC61 Waveform Analyzer is referred to in our survey more than any other instrument, so let me use the SC61 features to show you what I mean. We believe the SC61 satisfies these needs and wants 100 percent, as they told us that these features were of great value. Let's see if you agree.

Our customers said, "Here's what we need to view when locked onto the waveform": Firstly, we need a clear, bright, sharply focused trace. Secondly, we need easy to set timebase frequencies and preset rates for horizontal and vertical when we are working on video. Thirdly, we need very aggressive and positive sync that practically grabs the signal and locks it in so we don't have to fiddle with the sync at all.

What Sencore engineers gave you to fill your needs and wants. The SC61 uses a clear, bright post deflection tube, with sharp focus, that enables you to see the waveforms all the way to 60 MHz, with a slow roll-off to the 100 MHz at the 12 dB point (so you don't get ringing or overshoots). The timebase has preset vertical and horizontal positions for fast video measurements and is calibrated in both microseconds and frequency for fast selection. The sync circuits are specially designed ECL circuits with noise cancelling differential amplifiers to assure positive sync. Sync separators are switched in, on video, to prevent interlace jitter, often found on other scopes. The sync is so solid, it is harder to keep the scope out of sync than to synchronize it.

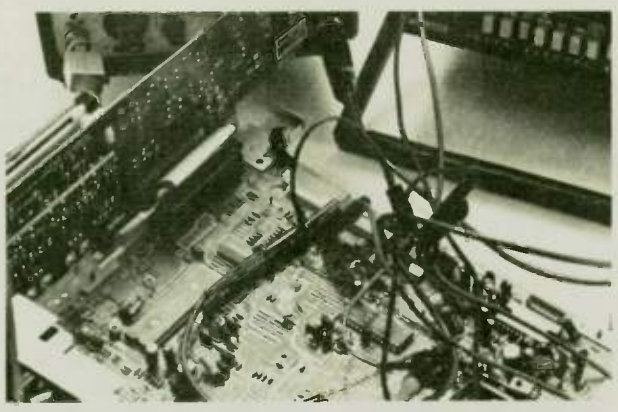


Fig. 2: Using additional leads often doubles the loading.

The real question when evaluating a scope is . . . What is this kind of scope worth to you? A scope of this caliber will cost you from $1,600 to $2,000, depending on other features.

What did our customers say they needed to determine the circuit's DC level if they own a conventional scope? They generally like to know the DC B + level and/or bias voltage. This means setting up a DC voltmeter, hooking it onto the scope lead and perhaps doubling the amount of loading on that stage, or disconnecting the scope for each measurement. "We are often just a little clumsy with these fragile connections and knock off both leads, which consumes time hunting up the test point again and reconnecting. Our other option is to go through the seven time-consuming steps, explained in the scope operating instructions, to get a rough estimate of the DC."

What Sencore engineers gave you to make your DC measurements easier and more reliable. The SC61 is the only scope, or combination of instruments, where you can leave the input coupling switched to AC or DC and get the same DC measurements to 2000 volts, automatically by simply pushing a button.

Fig. 3: Measure DC volts to 2,000 volts on either channel automatically at the push of a button.

What did our customers say they needed to determine peak-to-peak amplitude of the waveform on a conventional scope? We must go through the seven laborious, time-consuming graticule counting steps as outlined in the operating manual. Parallax, operating, and calculating errors are difficult enough to deal with, but when all done, we still wind up with only an estimate. The error of a peak-to-peak reading on a conventional scope is often up to 10 percent, even if calculated correctly.

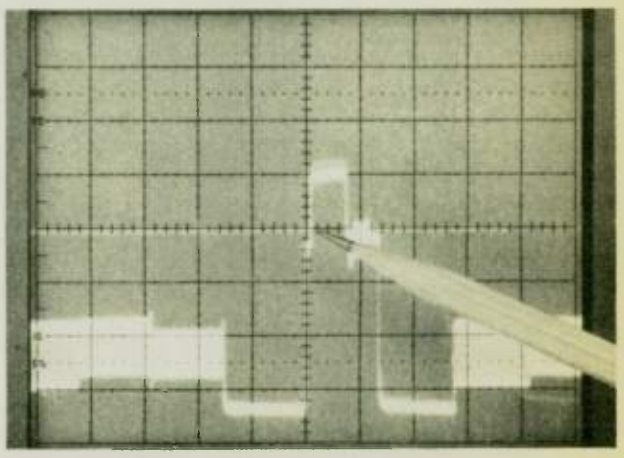


Fig. 4: The error of graticule counting on a conventional scope is often up to 10%.

What did the Sencore engineers give you to make your job easier and faster? Simply push the button labeled VPP, on either channel, and read peak-to-peak volts automatically, all the way to 100 MHz, with approximately 10 times greater accuracy than on a conventional scope.

Fig. 5: Measure AC volts up to 100 MHz on either channel automatically at the push of a button.

What would that be worth to you? This may be a little difficult to determine as there are no other peak-to-peak meters on the market that reach anywhere near these frequencies. If there were, they would certainly cost over $1,000, but we'll just use $500 to figure. However, your true value comes in determining how many hours a month this feature will save you and how many costly errors it will prevent.

What did our customers indicate they needed to do to measure the frequency of the waveform on a conventional scope? "If you have a conventional scope, you probably will elect to struggle through without measuring frequency because, here too, are the seven laborious time-consuming steps to go through. The answer then comes out in microseconds, which have to be converted to frequency. This reciprocal calculation often generates an error in decimal counting even if an error hasn't been made before."

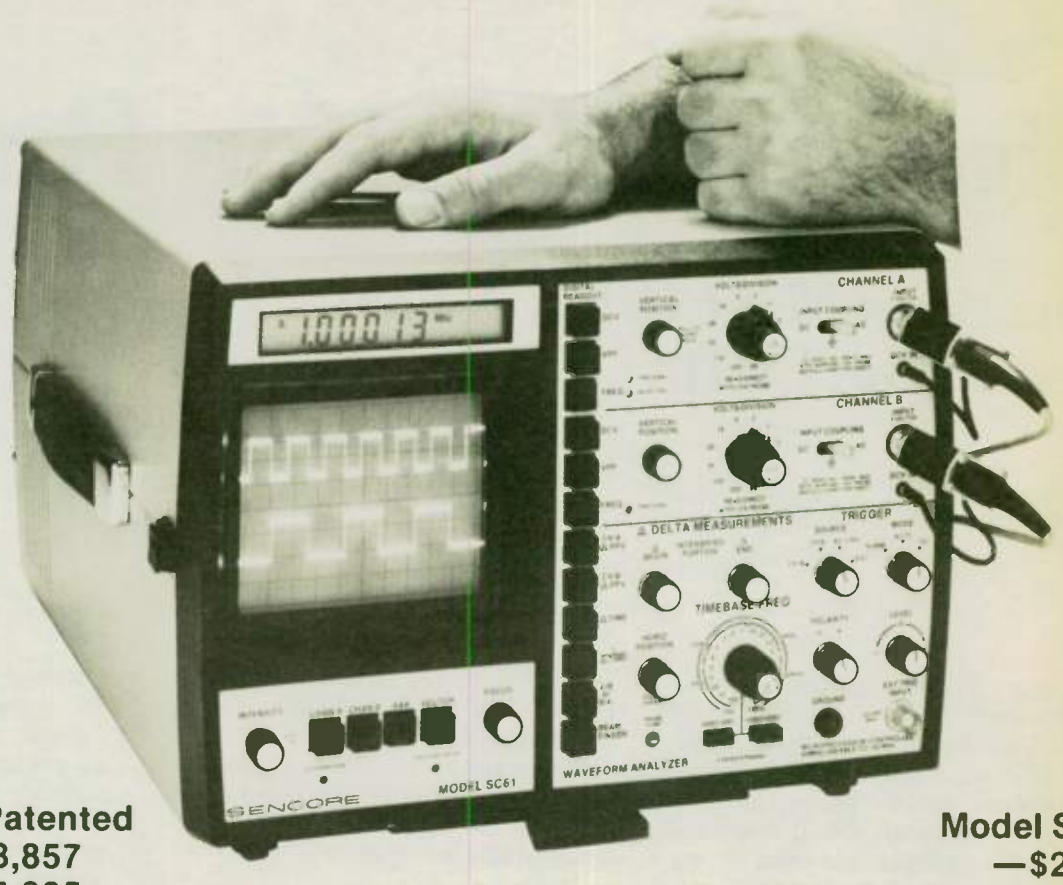
What did the Sencore engineers give you to make your job more profitable? Want to know the frequency of any waveform to 100 MHz? Simply push the button labeled FREQ, on either channel, and read the digital readout automatically.

Fig. 6: Measure frequency to 100 MHz on either channel automatically at the push of a button.

What is this worth to you in time saved by being able to measure frequency when you should or preventing calculating errors? Even compared to an ordinary, non-automatic, non-integrated frequency counter, you can easily estimate a $500 price, don't you think?

What did our customers say they needed to measure a portion of the waveform, such as when identifying interference or glitches with a conventional scope? "If you own a conventional scope, you'll need to go through the same seven 'graticule counting' steps that you used to determine peak-to-peak volts, frequency or time in microseconds for the full waveform to measure any portion of the waveform." Graticule counting results in the same errors, the same misinterpretations, and the same time consumption as earlier measurements.

What did the Sencore engineers give you so you would have confidence in every partial waveform analyzed? Want to measure the peak-to-peak voltage level, frequency or time in microseconds of any portion of a waveform? Simply select the PPV, delta time or one over delta time (frequency) push button in the "delta measurements" portion of the SC61, adjust the lighted portion (cursor) of the waveform to the area you want to measure, and read the digital meter directly. Everything is 100 percent automatic.



Double Patented
No. 4,473,857
No. 4,564,805

Model SC61
—$2,995

What is this feature worth to you? Probably as much as the frequency counter and peak-to-peak meter measurements combined, but let's just toss in another $500 to stay on the very conservative side, as you won't use these features as often as the full waveform measurements.

What do you need to measure divide or multiply stages with a conventional scope? You'll need to connect the scope to the input, go through all seven time-consuming graticule counting steps on the divider input, and connect to the output and go through the same steps. If you are connected to an adjustable divider, you'll have to repeat these steps every time that you wish to check to see if you have set the divider accurately.

What did the Sencore engineers give you to simplify this work? If you want to check a divide or multiply stage, or wish to set an adjustable type, simply connect channel A input lead to the input and channel B input to the output. Then push the A/B or B/A push button and read the digital readout directly. What's more, the LCD readout will tell you if the chip is multiplying or dividing the way you have it connected. You won't ever need to reverse the leads to check the dividing or multiplying number.

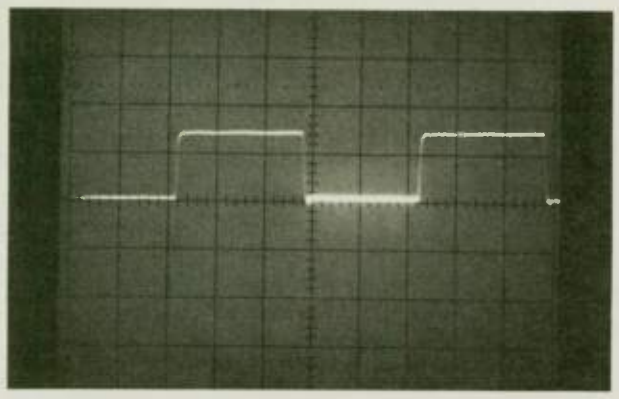


Fig. 7: Measure any portion of a waveform on either channel automatically at the push of a button.

What's this feature worth to you? This could easily be worth $500 to you, but let's toss it in as an extra and not figure it in at all. We think that we can cost justify the SC61 without it.

One could easily determine that you would receive a $4,100 value for $2,995 if you purchased an SC61 Waveform Analyzer. Yet, the value received is even greater because you are really cost justifying only the automatic features if you have decided that you are going to buy a new broad band scope anyway. For example, if you agree that the scope feature is worth the same as a new conventional scope ($1,600), you have to cost justify only the extra $1,395 for the automatic features. The automatic features' value add up to $2,500 for a $1,395 expenditure. That's a 179 percent value in relation to the value you believe that you can get from this 100 percent automatic, fully integrated system in relation to purchasing individual pieces of test equipment and, don't forget, we were very conservative all the way in our estimating.

Can you see why Sencore SC61 Waveform Analyzer owners give Sencore a 10 rating on "value to them" when calculated on the basis of what the instrument or analyzer does for them in their daily work?

Fig. 8: Check divide and multiply stages automatically at the push of a button.

How do you determine the value of the SC61 Waveform Analyzer yourself? Very simply, if any company wishes to prove real value to you in your work, they should do two things: (1) Offer a 30 day money back guarantee without obligation and mean it. (2) Offer a 15 day FREE trial to test and prove that these claims are 100 percent true. Sencore does both of these things so you can prove to yourself that "What it does for you, is the only way to truly determine test equipment value." You may be paying for this fine piece of test equipment every day that you don't have it. You owe it to yourself to find out. Simply place an order on the enclosed order form and postage paid envelope, and you'll automatically be backed by a 30 day, no questions asked, money back guarantee. Or, use the order form and envelope to request a 15 day FREE evaluation. To speed things up, call us, **WATS Free, 1-800-843-3338,** give the phone operator your zip code number, and your area sales engineer will see that an SC61 Waveform Analyzer is delivered to you fresh from Sencore factory stock.

Field Application Bulletin

Questions Most Often Asked About The CR70

by Cherlan Coffman, Application Engineer

Test every CRT on the market . . . plus restore 90% of all weak or shorted CRTs . . . You've all read that bold claim before. But, some customers have been asking questions about the CR70 and how we are able to make that bold claim. We would like to share some of these questions with you.

What Is The Difference Between Cathode Current And True Beam Current? Which Does The CR70 Measure?

Cathode current is the total current developed by the cathode. True beam current, however, is only the amount of current that passes through the opening in the control grid (G1 in figure 1). The CR70 measures true beam current. Why is this important? Consider water in a tank . . . It's not the water in the tank that matters . . . it's how much can flow through the shutoff valve! When the FUNCTION switch is in the EMISSION position, the CR70 removes the negative bias from the first grid (G1), (opens the valve), to simulate the beam current produced by the CRT with maximum drive. This is the white level or true beam current.

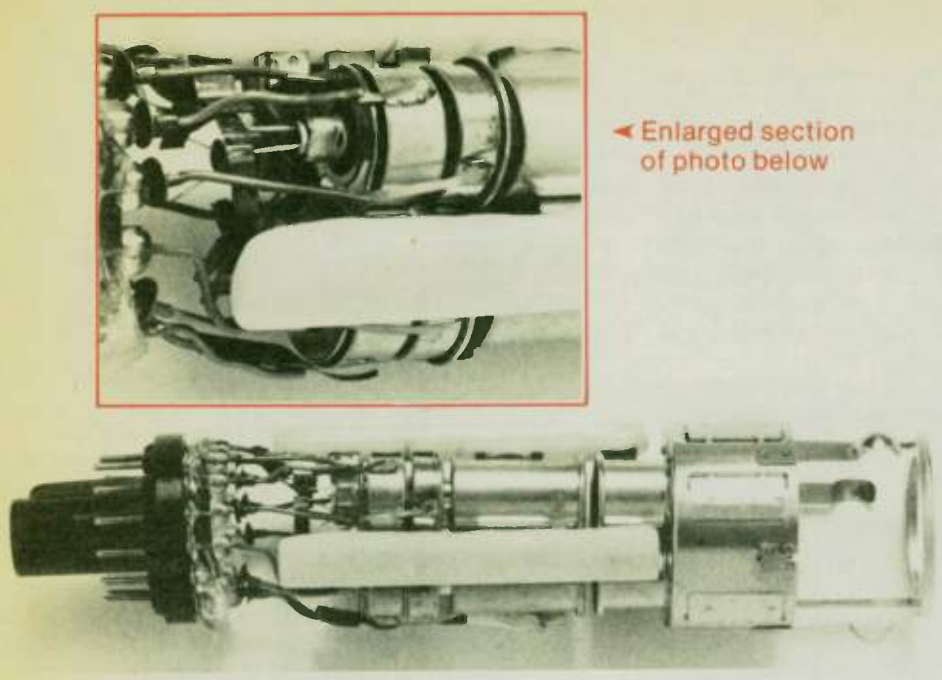


Fig. 1: Cutaway view of cathode and control grid. "Only the electrons which pass through the hole in the control grid form the true beam current."

In addition to shorts tests and restoration, other CR70 tests measure cutoff, (ability of the control grid to control the electron beam), true beam current, and color tracking (comparison of the white levels of all three guns).

Why Isn't The CR70 "Shorts" Reading More Consistent? When First Testing A Shorted Picture Tube, The Meter Reading Was Easily In The "bad" Area Of The Meter, And After Pressing "Remove G1 Shorts", It Tested Almost "good".

The calibrated meter scale on the CR70 shows the severity of the short (more positive than an indicator light), allowing better results on short removal. Your "almost good" tube still has some leakage which may come back to haunt you.

Should you still use the tube? The CRT just cannot be used with a G1 short. An effort to remove G1 shorts should be repeated up to three times and if not successful, the extended G1 shorts removal procedure outlined in the CR70 manual should be used. The dividing line between "good" and "bad" on leakage is 2 megohms resistance on heater to cathode shorts function and 20 megohms on grid one to cathode or grid one to screen grid shorts. These values have proven effective indicators for continued CRT performance.

What Is Wrong When A CRT Gun Will Not Reach Cutoff? Is The Bias Control Really Important? All Of My Tubes Seem To Test OK In The – 36V Position Regardless Of What Is Shown In The Setup Book.

If the filaments are good and there are no shorts, the CRT must still pass three tests (emission, cutoff, and tracking) to determine if it is good or bad. The emission test is the most common test made. It tests the condition of the cathode, and in the case of the CR70, measures true beam current. The color tracking test automatically compares the emission level of each gun to confirm that the three guns can be balanced to produce a good color picture. The cutoff test (when conducted with proper bias) checks for proper operation of the control grid. Many CR70 users fail to realize the importance of this test, and in fact, other CRT testers treat this important test as a mere setup step, placing very little importance on it. Why then does the CR70 place so much importance on it?

Figure 2 shows the relationship between cathode to control grid voltage, control grid to grid two voltage, and the effect these voltages have on cutoff. What is cutoff? Cutoff occurs when the negative bias on the control grid (with respect to the cathode) is sufficient to blank (cutoff) the electron beam and produce a black level. Locating the cutoff point provides an accurate method of measuring the grid's ability to control the electron beam. The CR70 cutoff control adjusts grid two to cathode voltages over a range extending to 400 volts. For a CRT with a bias setting of -68V, it can be seen (see figure 2) that cutoff must occur between about 165 and 335 volts, for the tube in this example, to be good.

How would this tube react if it were bad? Why is G1 control important? If the conduction will not come up to "CUTOFF SET", the CRT has poor or no contrast. If the conduction can't be adjusted down to "CUTOFF SET", the CRT has an open grid. A bad CRT showing up on the tester as good (because of the wrong bias setting) would surely lead most technicians right back into the chassis. The bias settings on the CR70 enable measurement of cutoff for present and future CRT types including Black and White and tubes with other design parameters.

The correct bias setting is determined by simply subtracting the control grid (G1) voltage from the cathode voltage. You can use this formula if you need to determine a setup from a schematic. If the difference is greater than -68V, use the -68V bias setting (otherwise use the bias setting nearest the value obtained by subtracting the control grid (G1) voltage from the cathode voltage).

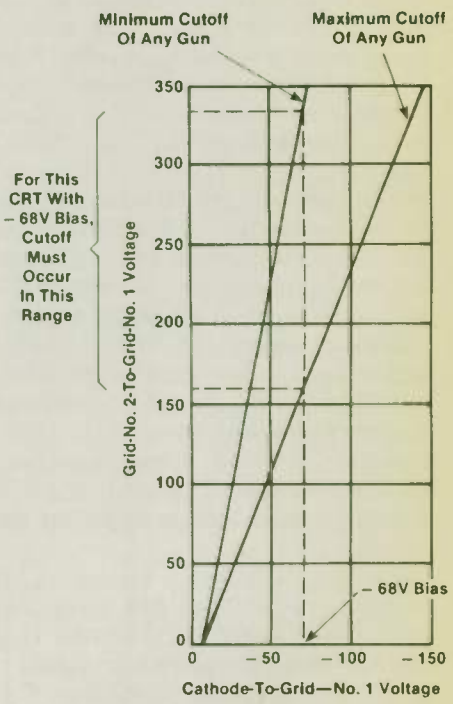
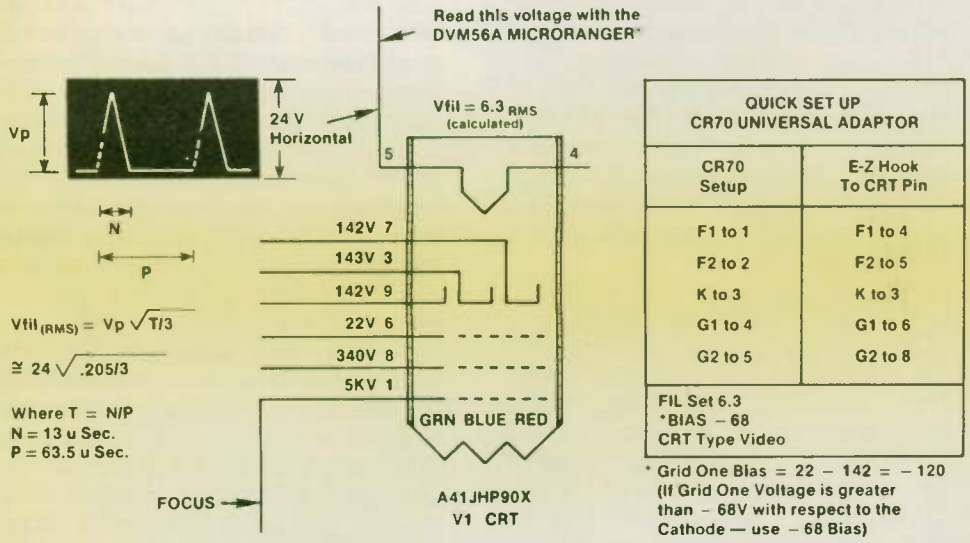


Fig. 2: "Cutoff occurs when the negative bias on the control grid is sufficient to blank the electron beam and produce black level."

See figure 3. Example: Cathode voltage = 142V. Grid One voltage = 22V. 142 minus 22 equals 120. The grid is 120 volts negative with respect to the cathode. This is more negative than -68, so use the -68V bias setting to test this CRT for cutoff. When testing scope CRTs, always use the −68V bias setting because when the CRT TYPE switch is in the SCOPE position, the CR70 is automatically scaled for the lower bias and current of the scope type tubes.

When Do I Stop Restoration? Which Of The Five Restoration Levels Should I Use?

Restoration of a CRT consists of the proper application of "Beam Building" techniques designed to improve, salvage, or restore to use a weak or shorted CRT. In most cases, restoration produces noticeable improvement in the image quality of the CRT, and often restoration returns a CRT image close to that provided by a new CRT.



QUICK SET UP CR70 UNIVERSAL ADAPTOR	
CR70 Setup	E-Z Hook To CRT Pin
F1 to 1	F1 to 4
F2 to 2	F2 to 5
K to 3	K to 3
G1 to 4	G1 to 6
G2 to 5	G2 to 8
FIL Set 6.3 *BIAS − 68 CRT Type Video	

* Grid One Bias = 22 − 142 = −120 (If Grid One Voltage is greater than − 68V with respect to the Cathode — use − 68 Bias)

Fig. 3: "Obtaining filament voltage and setup from the schematic may require technical skills."

The five levels of restoration provided by the CR70 are designed to prevent damage to the tube elements, to match the cathode recovery to the type of failure, and to ensure that only as much restoration as needed is used. When restoration is needed, always use just enough current to improve the CRT. The "Auto Restore" function offers the safest form of restoration and should be applied first. Test the CRT gun again. The CR70 cutoff and emission tests provide positive indication of improvement. When the CRT is improved, then stop! Further restoration will not help, and could decrease the service life of the old CRT. The life test will assist in estimating the usefulness of the restored CRT.

My Other Tester, (Brand B), Calls Tubes Bad That The CR70 Calls Good . . . Why?

Some CRT testers test tubes good at about 500 microamps, and bad if the tube's emission falls below this value. The CR70 not only tests for emission and emission life (different for each type of CRT), but also tests cutoff and tracking for proof of the CRT condition. So is "Brand B" better? It has fewer tests and the CRT has to be in better condition to pass. The difference between a "good" CRT and a "bad" CRT is performance. Will the CRT produce an acceptable picture? The ability to measure this CRT performance with confidence, to judge restoration efforts with confidence, and to get the equipment back to the customer with confidence makes the difference. You be the judge, which is better? Your CR70, or your "Brand B"?

My CR70 Doesn't Work . . .!

Of the few problems experienced in "getting to know" the CR70, the most frequent questions concern color tracking and set up. These are comments like: "My color tracking shows good, but I know the CRT isn't because one gun doesn't even conduct!" or, "I always get good color tracking even when the CRT is unplugged!".

To understand these questions, let's look first at the CRT test. To test a color CRT, one gun at a time is selected and tested for shorts, cutoff, and emission. The color tracking test is then selected to compare "stored" emission readings from the three guns. As mentioned earlier, color tracking compares the emission level of each gun against the other guns to confirm that the guns can be balanced to produce a good color picture. This is simple enough, but problems occur during testing when the gun select switch is rotated to gun positions which are not under test. See figure 4.

Special storage circuits continuously monitor the emission of the gun selected for use in the color track test. Rotating the GUN SELECT switch while the FUNCTION switch is in the EMISSION position simply puts the same reading in each storage location and causes the color track test results to show good! Once the CRT tests are completed, power off, test socket removed, and FUNCTION switch left in "COLOR TRACKING", the gun tracking

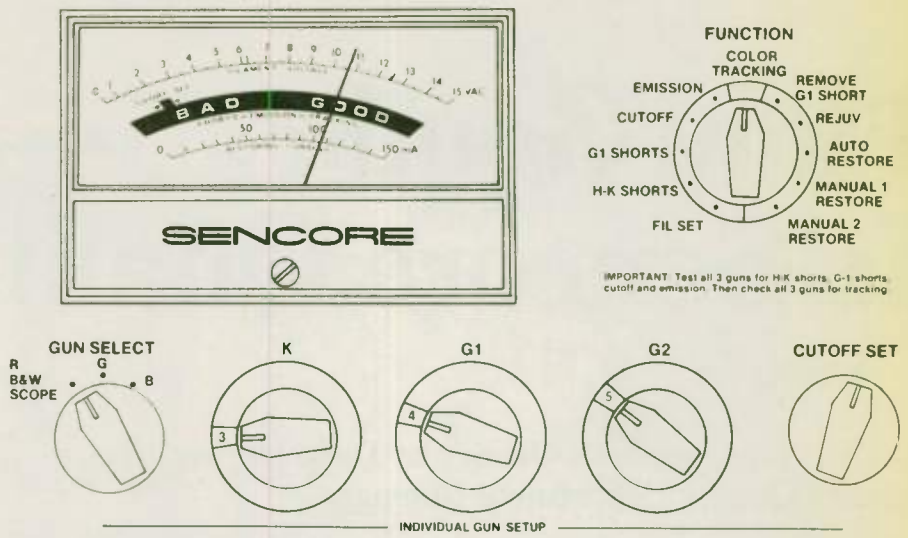


Fig. 4: (a) Test all three color guns for Shorts, Cutoff, and Emission (You must switch the GUN SELECT switch BEFORE testing each gun for Emission), (b) Set to COLOR TRACKING FUNCTION, (c) Set GUN SELECT to "R," (d) Read GOOD/BAD meter scale, (e) Repeat for G and B guns.

results are still retained for a short time and may be re-examined if needed upon restoration of power to the CR70. Tracking will read good even if a CRT is not tested, because storage capacitors will have the same charge.

The Universal Adapter (Needed For Odd Bases . . . Schematic May Be Used With Regular Bases That Fit)

Setup information books are always outdated as "odd bases" and (more importantly) new CRT's come on the scene daily. These problems are eased for CR70 owners with the use of the universal test adapter. From a schematic, enough information can usually be obtained to enable complete tests of any CRT. The pin numbers for the cathode, grid one, grid two, and filament, together with the filament voltage and grid one bias, are required. (These pin numbers are listed in the setup book under the specific element headings for those tubes listed). If a regular socket base fits the CRT you need to test, you may use the regular socket base together with the pin numbers for the individual CRT guns. (The CRT PRESET CONTROLS and INDIVIDUAL GUN SETUP CONTROLS switch position numbers to match the socket base pin numbers).

When there is a socket base that doesn't fit, use the universal adapter. The CR70 CRT PRESET CONTROLS and INDIVIDUAL GUN SETUP CONTROLS are set to the universal quick test position (F1 to 1, F2 to 2, K to 3, G1 to 4, and G2 to 5). These positions connect to the five leads with *E-Z Hooks on the Universal Adapter.

To test the CRT: Filament voltage, bias, and CRT type are selected. The universal test adapter *E-Z Clips are connected to the base pins of one CRT gun, (F1 and F2 to the CRT's filament pins, K to the cathode pin, G1 to grid one pin, and G2 to grid two pin). The gun select switch is set to the gun that the universal adapter *E-Z Hooks are connected to, power is applied, FIL SET adjusted, and then shorts, cutoff, and emission tests are performed. See figure 4. The function switch is then returned to the H-K shorts position, the GUN SELECT set for the next gun to be tested, and the universal test adapter leads connected to the cathode, grid one, and grid two pins of that gun. Shorts, cutoff, and emission tests are repeated. The function switch is then returned to the H-K position. After all guns have been tested, the color track test is selected.

As we've just seen, in order to test a CRT, you must either have the setup information and the correct socket, or you must glean the setup information from the schematic and use the universal adapter.

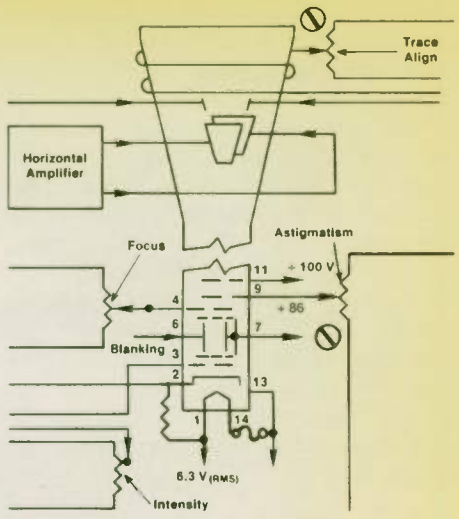


Fig. 5: A type of oscilloscope CRT. "Schematic information allows us to test this CRT using the universal adapter."

Scope tubes sometimes present a unique problem when it comes to determining the setup information from a schematic. Figure 5 is a representation of one type of oscilloscope CRT. An interesting feature of this tube design is the placement of "deflection blanking plates" in the focus electrode area. These plates effectively blank the screen by turning off the beam between sweeps. The cathode (pin 2) emits the electrons which are controlled by grids one, two, and the blanking deflection plates (pins 3, 6, and 7), focused (pin four), shaped (astigmatism pin 9), accelerated (pin 11), deflected by horizontal and vertical deflection plates, and finally strike the phosphor coating of the screen.

*Registered Trademarks

How Good Is Sencore Quality?

Insights into Sencore's Quality by Dave Drewes, Sencore Quality Department Manager.

Have you ever asked two people for the time of day and received two different answers? If you have, you've discovered the importance of a standard. A standard is any definite rule, principal, or measure established by authority and agreed upon by general consent as being correct. Measurement standards may be set on measures of quantity, weight, length, voltage, or any other definable, physical parameter, including time. Some of you may recall a recent article in a previous Sencore News that described the primary calibration standards we use at Sencore. Now, we'd like to show you how the very accurate primary calibration standards we have enable us to be certain of the accuracy of the Sencore products you buy.

Prime Standards

Prime standards are highly accurate devices used as references for all other calibration and electronic test equipment. At regular intervals, the accuracies of all of our prime standards are certified by the National Bureau of Standards (NBS) as compared against the national standards, which are very accurate indeed. The accuracy of our prime standard for DC voltage is depicted in the following flow chart (Figure 1).

This flow chart also shows the hierarchy of calibration standards from NBS to the unit under test (UUT) in the areas listed above. As you can see, the accuracy of the standard cell is +/− 1.5 ppm. As a rule of thumb, each level of the hierarchy chain needs to be between 4 and 10 times more accurate (depending on how critical the need) than the level directly below it in the chain to guarantee accurate traceability through the chain back to NBS.

To calibrate the products we manufacture for you, we use standards that are practical, durable, reliable, fast, and easy to use. And, just like the NBS does between the national standards and our prime standards, we transfer the accuracy of our prime standards to the secondary standards we use in manufacturing.

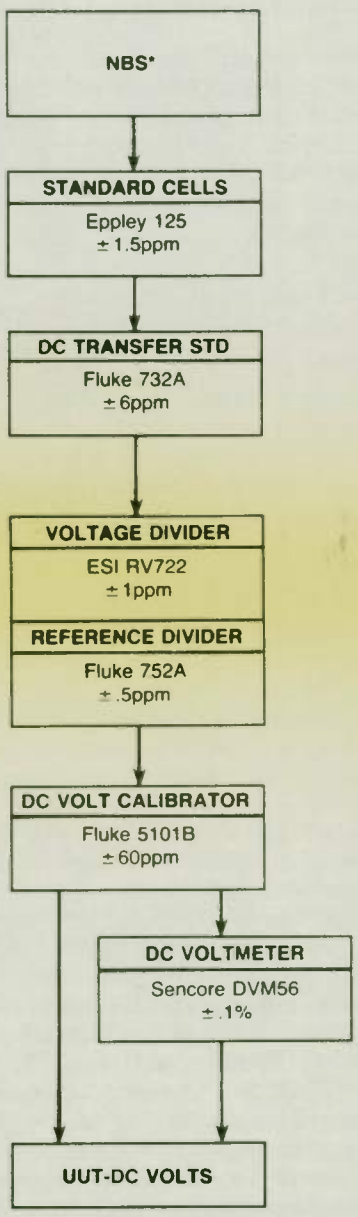


Fig. 1: Diagram of the setup for transferring DC accuracy.

Transfer Standards

How do we "transfer" the accuracy of the prime standards to the secondary or working standards?

The following diagram (Figures 2 & 3) shows the setup, equipment, and interconnections necessary to transfer the accuracy of the standard cell to the DC voltage calibrator.

To transfer DC voltage accuracy, we first transfer the accuracy of the NBS certified standard cells to a 10 volt transfer standard. We want to use 10 volts when we calibrate instead of the approximate 1.018 volts of the standard cells in order to minimize the effects of noise.

Figure 2 shows how we compare a DC voltage calibrator (Unit Under Test, or UUT) to the transfer standard for voltages less than 10 volts. Without using the divider, the null meter would show any differences at 10 volts. We then adjust the calibrator to null the null meter, and therefore "transfer" the accuracy of the transfer standard to the UUT. For voltages less than 10 volts, we use a highly accurate 7-decade Kelvin-Varley voltage divider to divide down the transfer standard to the voltage that we are calibrating.

For voltages between 10 and 100 volts (Figure 3), we put in a special 10:1 reference divider between the UUT and the null meter. This simply allows us to continue the accuracy of the transfer standard and the Kelvin-Varley divider as we did before by first dividing down the output of the UUT. Likewise, we use a 100:1 divider for voltages up to 1000 volts DC.

Transfer standards in the other areas (resistance, capacitance, etc.) are basically used in the same way, with some variations on the theme. Even though the products we manufacture are a few steps down the hierarchy from the prime standards, the transfer standards enable us to give you NBS traceable accuracy.

Calibration Guaranteed

We have developed an internal calibration program (based on and complies with the requirements of MIL-STD-45662) that basically insures that each piece of equipment used in the direct calibration of our products or in the hierarchy of transfer standards and the prime standards are certified at regularly scheduled intervals. Through our Service Dept., actual test results at the time of calibration can be obtained on the equipment you own so that you can be more assured of the performance of your instrument. We don't do all this only because we have to. We do this because we want to; to provide you with NBS traceable calibration to make every measurement you make with a Sencore instrument as reliable as we possibly can.

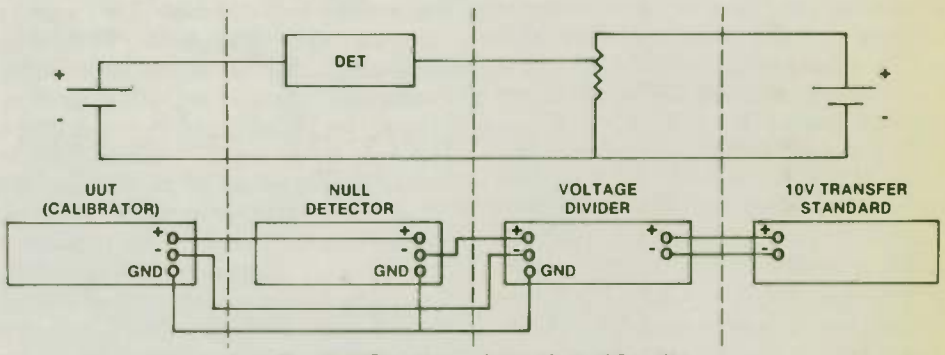


Fig. 2: DC voltage less than 10 volts.

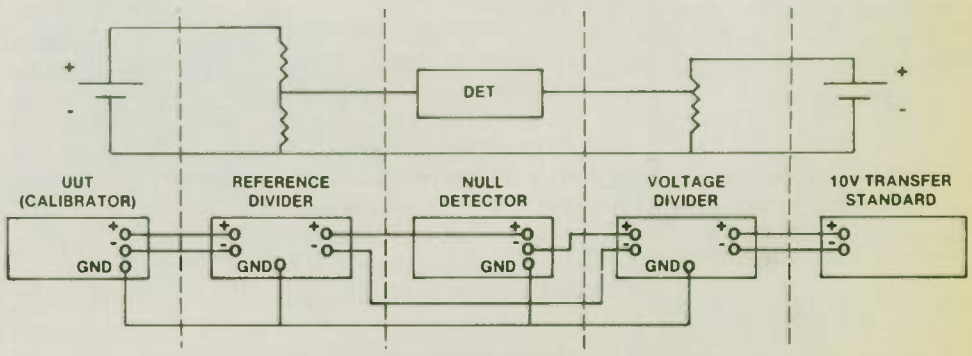


Fig. 3: DC voltage greater than 10 volts.

How can you earn an extra $15,000 a year while building more satisfied customers?

Patented No. 4,563,649

Model CR70 — $995

It's no secret that today's CRT sales explosion means a big opportunity for video servicing pros who are equipped to take advantage of the profitable CRT testing and restoring business. Think about it. Home TVs, projection TVs, video display monitors, computer display terminals, and video arcade games all have CRTs that are getting weaker by the day. It's easy to see why the CRT testing and restoring business will be the most profitable part of any service business for years to come.

Wouldn't you just love to be able to test every CRT ever manufactured (and the new ones just being introduced) and never be caught without the socket or having to buy a new socket just for that basing arrangement. Imagine having the confidence to take on every restoration job – and not have to worry about blowing the CRT or worse yet, having to replace it for free. Picture the profits rolling in as you're able to restore that factory fresh picture back into your customer's old chassis. Sound impossible? Just too good to be true – well that's just what Sencore's patented CR70 "Beam Builder" can do for you. In fact we guarantee it. Here's why.

HERE'S THE CR70 IN A NUTSHELL

* **THE CR70 IS GUARANTEED TO TEST EVERY CRT YOU'LL EVER WANT TO TEST.** You'll never get caught short without having the socket you need for any new or "odd ball" CRT. Our latest research shows it would take at least 75 sockets at a cost of over $1,875 to be able to test today's tubes with any other testers. With the CR70 you'll be able to test every CRT – now and in the future – and never have to buy another socket again.

* **30 YEARS EXPERIENCE IN THE CRT TESTING MARKET MEANS YOU'RE ASSURED THE MOST RELIABLE CRT TESTER/RESTORER ON THE MARKET.** The CR70 will locate heater-cathode shorts, control grid shorts, check the cut off capability and emission of each gun – it even finds open control grids and troublesome "gassy" CRTs. The exclusive built-in automatic circuits enable you to make all readings as good or bad right on the meter with no interpretation at all, it's a real customer convincer.

* **THE CR70 IS GUARANTEED TO RESTORE AT LEAST 9 OUT OF 10 OF YOUR WEAK OR SHORTED CRTS.** How many customer sets have you bought because you could not safely restore the picture and the customer would not pay the cost of the new tube? Well fear no more, because of our exclusive 5-step "Beam Building" process, we can guarantee the CR70 to safely restore 9 out of 10 weak or shorted CRTs or your money back.

* **NEW ENGINEERING UPDATES MAKE THE CR70 BETTER AND TOUGHER THAN EVER BEFORE.** The CR70's exclusive protection circuits are like an insurance policy against accidental overload (from charged CRTs for example). You'll save hundreds of dollars in service bills, from those inevitable discharge shorts that normally damage other CRT testers.

YOU CAN CASH IN BIG ON CRT TESTING/RESTORING PROFITS

Our latest survey shows that most service shops charge an average of $35 for a CRT restoration and guarantee it for 6 to 12 months. Not only is restoration a real profit generator, it's also a customer relations builder too. After you "shoot" a tube, you send it back with a "television picture tube guarantee". If the tube should fail in warranty, you'll credit the restoration towards the purchase of a new tube or set. You and your customer are both winners and you're assured the extra income and their repeated business with their guaranteed satisfaction. Just imagine, restoring only two CRTs a week. This adds up to an extra $3,500 profit by year's end. Restoring two CRTs a day adds up to $15,000 the first year. Think of it, an extra $15,000 a year – that's better than a 1500% return on your investment the first year!

But the profits don't stop there. Think about the money you'll save by being able to restore the CRT on that old trade-in you took in last week. Best of all, you'll never again come up a socket short on a job only to realize it will cost you $20 for that socket and a 3 week wait for delivery while your customer climbs the walls or goes to your competitor. Does all this sound too good to be true? Well don't just take our word for it, see for yourself.

A MONEY MAKING OFFER YOU CAN'T REFUSE

We're so convinced that today's video professional servicers need an up-to-date profit generating CRT Tester/Restorer that we're willing to offer you this special CR70 "Beam Builder" free trial. Here's our offer.

Say yes by either clipping out and returning your CR70 Reservation Certificate below, or by calling us WATS Free 1-800-843-3338 and we'll send you a CR70 "Beam Builder" to put to the test on your bench for 30 days. Use it on every tube you have, big or small, and see for yourself how the CR70's unique design lets you test every one of them. Why not "shoot" the tubes of the sets you've repaired and see how much more receptive your customers are to the service repair charge. If by chance at the end of 30 days you're not absolutely convinced that the CR70 "Beam Builder" is a real profit center – you may return it with no future obligation and keep the profits you've made. Or, if you want even bigger savings, say "Yes" by ordering today and take advantage of a 10% Factory Direct "Finder's Fee" Discount (that's a $99.50 savings) just by calling us — so call today.

EARLY BIRD OFFER

Try your CR70 before May 31st and we'll include a specially designed $50 CRT Testing/Restoration Promotion Package. This specially designed promotion package will help you more effectively promote your restoration service and cash in on the profits the patented CR70 "Beam Builder" can earn you.

Clip or Call 800-843-3338 TODAY to take us up on our Free Trial Offer

Simply clip out this reservation coupon and return it in your factory direct communication envelope – or for faster action call WATS-Free 1-800-843-3338

☐ Yes, I want to try a CR70 "Beam Builder" on my bench for 30 days. Have my phone sales representative call me to set up the details.

☐ Yes, I think I want to try a CR70 "Beam Builder", but call me first as I have a few questions.

☐ Yes, I'm interested, but want to preview a full color application video tape (FREE!) before I say yes.

Please send me a

☐ Beta Format ☐ VHS Format

Company _____

Name _____

Title _____

Address _____

City _____

State _____ Zip Code _____

Telephone ( ) _____

Best time to contact me:

☐ AM ☐ PM ☐ EVENING

"Sencore As It Affects You"

Hello, I'm John Cope, the Advertising Manager here at Sencore. As most of you know, we recently mailed our survey to our customers to see how Sencore affects them. We wanted to let you know that we really do read the surveys, value your input and appreciate your helping us. We've taken these candid comments right from the surveys, just as our Sencore equipment owners expressed them. We've even included their names, addresses, and telephone numbers, so if you see an application you have a question on, a time-saving tip, or you're thinking of investing in Sencore instruments and want an unbiased opinion, give them a call. Once again, thanks for helping us out by supplying this valuable marketing information.

KDLR
Gary Christianson/Engineer
Devils Lake, North Dakota
(701) 662-2161

"We have saved approximately $800 per year using the FC71 Counter when performing our scheduled, semi-annual calibration and frequency checks, usually done by a hired company."

Virginia Power Company
L.B. Gregory III
Spring Grove, Virginia
(804) 357-3184

"I'm currently using the Super Cricket and "Z METER" on industrial I & C equipment. We're quite pleased with the ease of operation they have given us, as well as the diverse testing ability, and faster troubleshooting they've made possible. These instruments convinced me to submit a purchase order for the SC61 Waveform Analyzer, which is working very well for us, too."

Stuk-Up Electric Bed Service
Verne Lager/Owner
Baldwin Park, California
(818) 442-4440

"Without my growing inventory of Sencore test equipment, I would still have disgruntled customers waiting longer for their sets to be completed, along with a mountain of sets in the back of the shop that I had previously given up on."

Anthony Electronics
Don Anthony/Owner
Southern Texas
(512) 289-2008

"Sencore is impressive test equipment with good/bad test readings for building customers' confidence. Also, I've obtained two commercial accounts recently by showing your equipment and using the safety stickers for the PR57."

John's Color TV Service
John Huckaby/Owner
Eunice, Louisiana
(318) 457-3319

"Just a line to let you know some of the ways we are using our new Sencore equipment and at the same time our customers are aware of and are helping pay for this new equipment.

We had our printers make up some ads and hand bills which we attach to each piece of equipment we service (sample enclosed). We also added our own 'lines' to the 'safety certified' stickers we attach to each repaired unit as well as putting the same info on each repair bill (sample enclosed). In this way our customers can see what they are getting for the extra service labor we charge them with and also they are getting a much more reliable service on their equipment. I also might add that the PR57 and CR70 have paid for themselves in less than 6 months total, and the SC61 and VA62 are well on their way of 'Paying their own way.' I don't know how I ever repaired TVs and video without these fine pieces of equipment for the past 28 years.

Hope you have a good week and to all of Sencore, keep up the good work."

Audio-Video Workshop II
William Musante/Owner
Oxford, Massachusetts
(617) 987-2415

"My two SC61s, VA62, VC63, PR57, and SG165 were all purchased to speed repair time on the bench and to remedy the cluttered test lead problem with most equipment. They all lived up to your advertising and have performed trouble-free."

Glenn Poor's Audio & Video
James Fellman/CET
Champaign, Illinois
(217) 356-6618

"The Sencore products that I use daily are always functional. That affects me by knowing that when I need a certain measurement, my Sencore equipment will work reliably. They help improve shop productivity."

Duke Power Company
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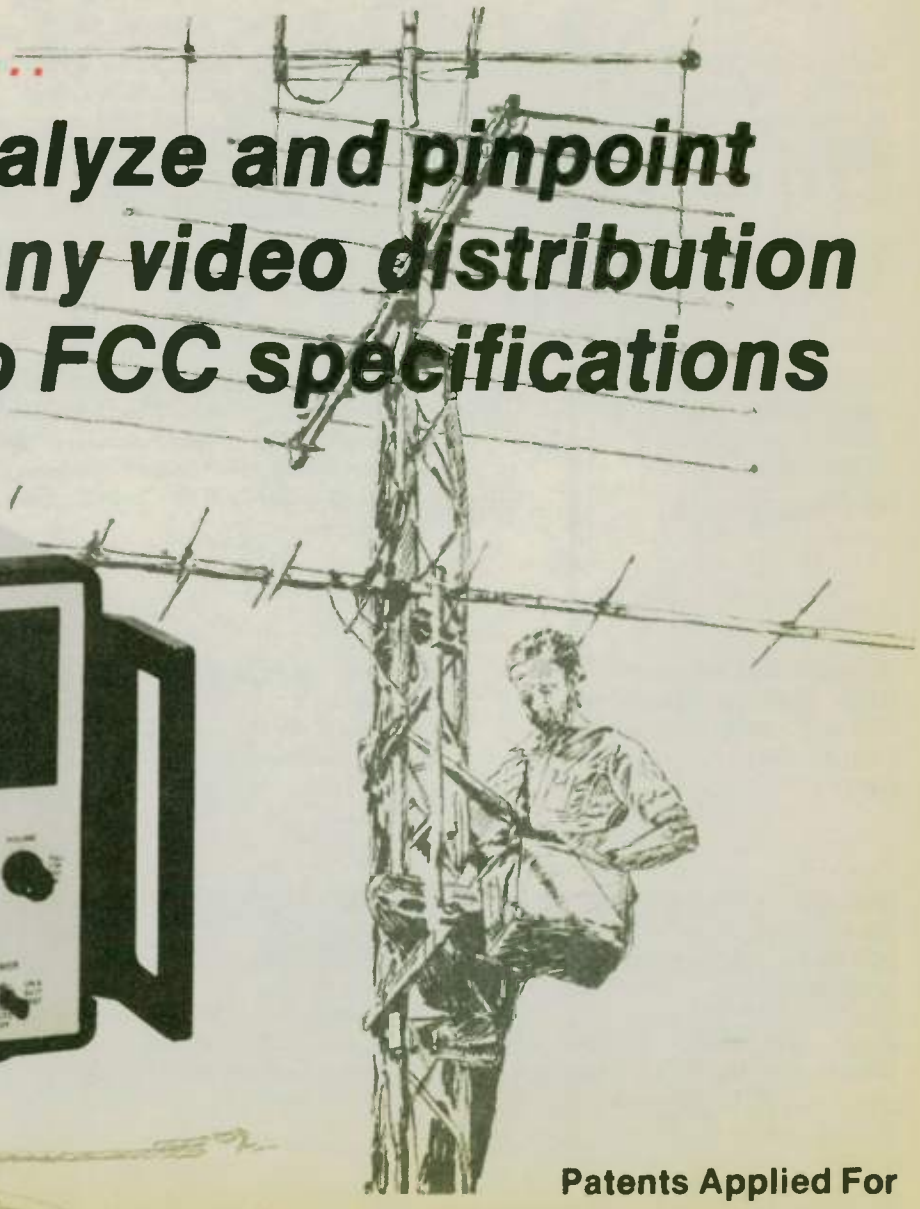

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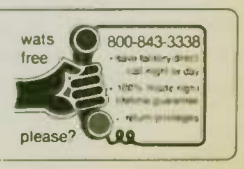


How The SC61 Simplifies VCR Alignment

by Greg Carey, CET, Application Engineer

A technician at a recent Sencore VCR Service Clinic commented, "Oh, I never touch the internal adjustments on VCRs because they never go out of alignment."

A second technician commented, "Sure, the new decks drift a lot less than the old ones. But, you should at least double-check the main test points or you'll have trouble with some decks."

Why are many VCR servicers ignoring alignment checks? It seems there are two reasons. First, many do not understand the purpose of each adjustment because the brief instructions in the service literature do not explain how each affects the VCR's performance. Second, many find the procedures too time-consuming because several pieces of test equipment must be used with an assortment of leads, operating instructions, and tolerances.

We will help you understand VCR alignment better by looking at five of the VCR adjustments that cause the biggest questions for VCR servicers. We will explain what each adjustment does in the circuit and then show how the fully integrated tests of the Sencore SC61 Waveform Analyzer let you quickly make every measurement or adjustment.

Setting Head-Switch Timing

All VCR alignment instructions require adjustment of the head-switching signal. Let's be sure we understand the purpose of the head-switch signal. The VCR circuits produce a visible horizontal noise bar when they switch from one video head to the other. If the circuits switched between heads half way between vertical sync pulses, the picture would have a noise bar right in the middle of the screen. Or, if the circuits switched during vertical sync, the TV receiver would show rolling or vertical jitter.

To prevent these problems, the circuits switch the heads during the last few lines of each vertical field. This places the noise at the very bottom of the screen, often below the viewable picture. The switching happens three or four horizontal

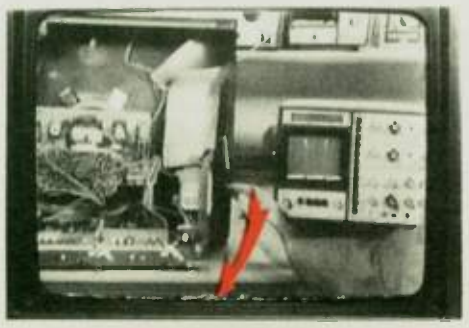
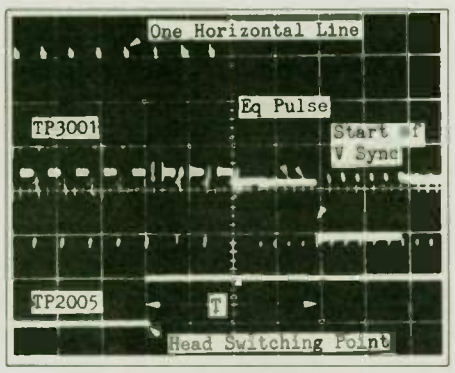


Fig. 1: A tear appears on the picture if the VCR switches between heads at the wrong time.

lines before vertical blanking to prevent sync problems.

The "Head Switch" adjustment changes the timing of the head-switch square wave relative to vertical sync. Some VCRs have only one control, which affects the timing during playback. Others have two controls; one for recording and one for playback. Still others have three controls; one affecting the position of the positive recording transition, the second affecting the position of the negative transition, and the third affecting playback timing. All three types use identical alignment procedures.

TP	ADJ.	MODE	INPUT
TP2005 TP3001	R2023	SP PLAY	
TAPE	M. EQ.	SPEC.	
ALIGNMENT TAPE (VFM30001H6) Color Bars	OSCILLO-SCOPE	T = 6 ± 1 H	



Courtesy of Panasonic

Fig. 2: The alignment instructions call for head switching to take place 6.5 to 7 lines before the vertical sync pulse.

Many people fear that they must use a delayed-sweep oscilloscope to set the "Head Switching" control (sometimes called the "Head PG" or the "Head Shifter"). Some early VCR service manuals referenced a delayed-sweep scope, but today's service literature rarely (if ever) calls for delayed sweep. Still, the rumor persists that this adjustment needs delayed sweep.

Here's how to use the SC61 to adjust the head-switch timing to manufacturer's specifications:

1. Connect the probes to the test points specified in the VCR alignment instructions.
2. Set the TRIGGER MODE switch to "Auto" and the TRIGGER SOURCE switch to the channel ("CHA" or "CHB") with the head-switching signal. (Set the TRIGGER LEVEL control to zero.)
3. Set the TIMEBASE-FREQ switch to the "1 m sec" position. (Be sure the sweep is not expanded by pressing the HORIZ POSITION knob.)
4. Press the "A&B" (dual trace) button under the CRT and adjust the VOLTS/DIVISION switches and VERTICAL POSITION controls for each vertical input until both waveforms appear on the CRT.
5. Adjust the HORIZ POSITION control to view the right-hand edge of the CRT trace, and then adjust the horizontal vernier (the small knob in the center of the TIMEBASE-FREQ switch) until a square wave transition and vertical sync pulse appear at the right edge of the waveforms.
6. Adjust the HORIZ POSITION control until the square wave transition lies on the CRT's center, calibrated, graticule line.
7. Pull the HORIZ POSITION control to expand the waveform ten times.

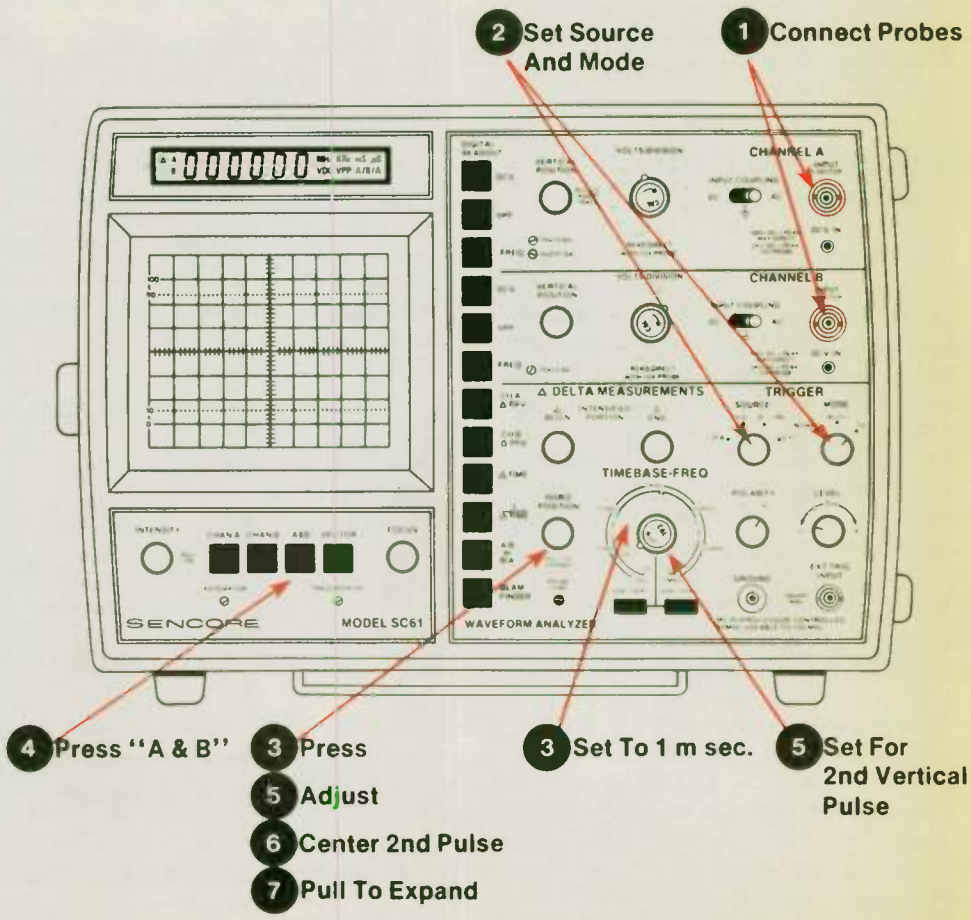


Fig. 3: Simply follow these steps to set the SC61 to view the head-switch signal.

The waveform will look like the one in Fig. 4. Notice that we can easily see the horizontal sync pulses ahead of the vertical sync interval. Simply adjust the VCR control for the correct timing between signals.

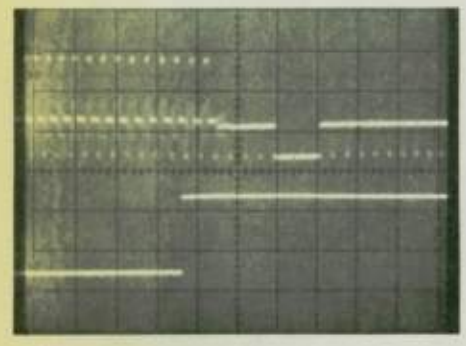


Fig. 4: The SC61 expands the waveform with plenty of detail to follow the alignment instructions directly.

The SC61's "ADD" function makes it even easier to compare the timing of the two signals. To add the two input signals together, press the CHAN A and the CHAN B CRT selector buttons simultaneously. Now, the head-switching square wave causes a "jog" to appear in the composite video signal, as shown in Fig. 5. Most people find this makes comparison easier than placing one waveform next to the other.

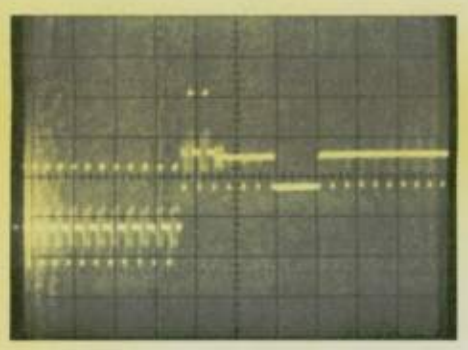


Fig. 5: The head-switch signal causes a jog in the composite video signal when viewed with the SC61's ADD function. Simply adjust the timing until the jog takes place 3.5 lines ahead of vertical blanking.

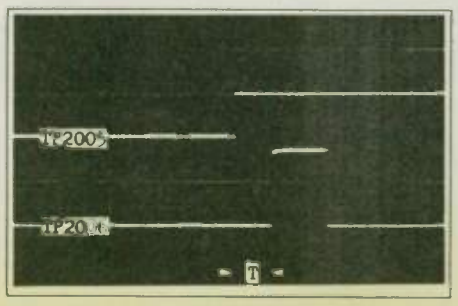
Setting "Tracking Fix" Adjustments'

The "Tracking Fix" or "Tracking Centering" adjustment insures that the front-panel "Tracking" control produces the best picture when set to its center position. Adjustment procedures vary, according to the specific VCR. Most call for the correct delay between a square wave at one test point and a pulse at a second test point. Some Panasonic VCRs, for example, need a delay of 0.4 milliseconds for machines with two video heads but need a delay of 7.3 milliseconds for four-head machines.

Making these measurements with a conventional scope calls for very attentive graticule counting. We must measure the time of one signal relative to the second signal. To complicate matters, the second waveform contains "jitter" (it moves back and forth as the tape plays) caused by the tape motion and the constant correction for the servo circuits. We must remember how many little squares one signal should be displaced from the second signal on the CRT, while we try to interpolate the average position of the moving signal.

The SC61's "Delta Time" function eliminates these problems. We read the time delay between signals directly on the SC61's digital readout. The Delta Time test provides accurate time measurements directly on the waveform. We don't multiply switch settings or count CRT graticule markings. The results are accurate,

TP	ADJ.	MODE	INPUT
TP2005 TP2006	R2024	SP SELF RECORD-ING	VIDEO SIGNAL
TAPE	M. EQ.	SPEC.	
BLANK TAPE	OSCILLO-SCOPE	(a) T=0.4 ± 0.4msec. (b) T=7.3 ± 0.5msec.	



Courtesy of Panasonic

Fig. 6: The instructions call for careful CRT graticule counting to set the Tracking Fix adjustment.

whether the horizontal sweep speed is in the "Cal" or the uncalibrated mode. Parallax errors or interpretation errors between the two signals don't cause problems either because the Delta Time test marks the waveform itself, instead of requiring us to align waveform segments with the CRT graticule.

To measure time, we press the DELTA TIME button. This activates two controls called DELTA BEGIN and DELTA END, as shown in Fig. 7. These two controls position an intensified zone, called the "Delta Bar", anywhere we want it on the waveform. The SC61 measures the time duration of the Delta Bar and displays the time on the digital readout.

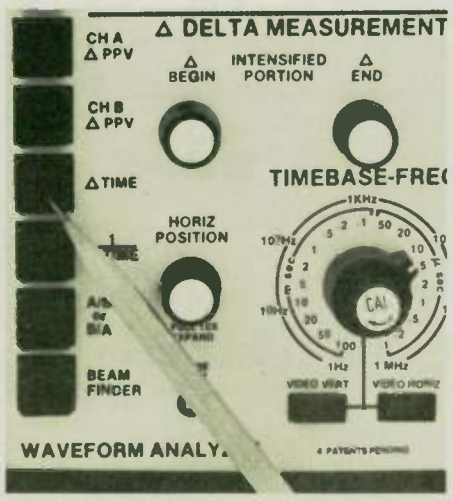


Fig. 7: Pressing the Delta Time button activates the Delta Begin and Delta End controls which position an intensified bar on the CRT waveform.

To measure the delay between two signals, we simply adjust the beginning of the Delta Bar until it just touches the transition in the first waveform. Then, we adjust its end until it just touches the transition in the second trace and read the digital readout to see the time delay between the signals.

The reason this works is that the Delta Bar has exactly the same starting point and exactly the same time duration in both traces. By simply adjusting the Delta Bar, we are measuring the time between the signals, even though they come from separate test points.

When we need to set the circuits for a certain delay, we use the Delta Bar "backwards." We adjust the beginning of the Delta Bar until it just touches the reference square wave. Then, we adjust the end of the Delta Bar until the digital readout shows the delay called for in the alignment instructions. Finally, we adjust the circuit until the pulse in the second trace just touches the bright zone on the CRT.

We don't even worry about the effects of playback jitter, since the Delta Bar remains referenced to the stable square wave. We simply watch the intensified area and center the moving signal over the intensified area.

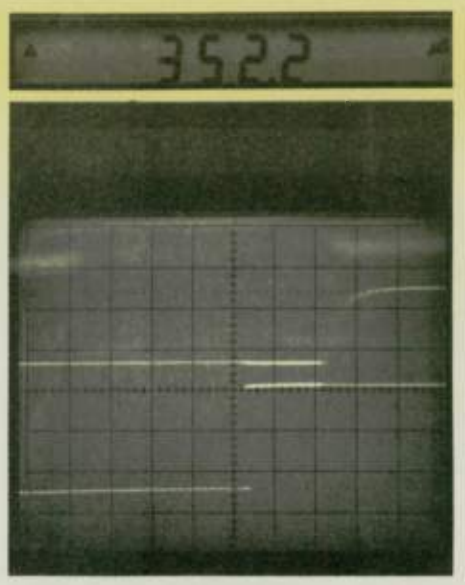


Fig. 8: Adjust the Delta Bar until the digital readout shows the specified amount of delay. Then adjust the circuit until the pulse touches the highlighted bar.

Two things complicate the adjustment of these controls when using a conventional scope. First, the trigger circuits of most competitive scopes have a difficult time locking onto the composite video signal. Second, we must measure the peak-to-peak voltage level of a small part of the complete signal, meaning we must carefully count graticule divisions.

We will rely on the special SC61 sync separators to grab onto the video sync pulses and hold the waveforms in perfect synchronization. We will use the special "Video Preset" position of the TIMEBASE-FREQ switch to instantly switch from the horizontal to the vertical sweep rates at the push of a button.

We use the "Delta PPV" mode of the digital readout for these adjustments. This function displays the amplitude of any part of a waveform on the digital readout. We measure the cyan bar of a color pattern for the Chroma Record Current adjustment and the vertical sync pulse for the Luminance Record Current adjustment, as specified by the alignment instructions.

To use Delta PPV, we simply press the CHA DELTA PPV or the CHB

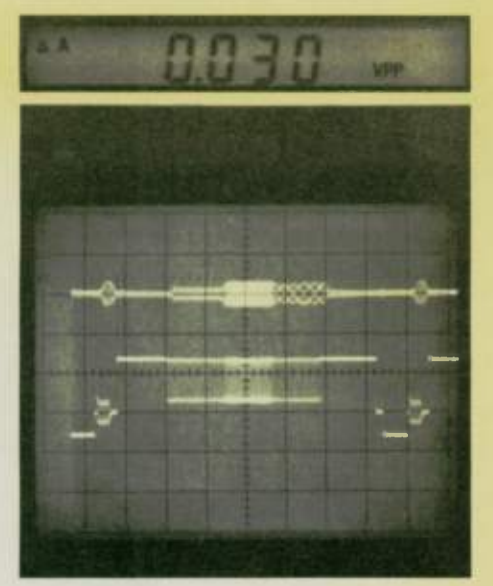


Fig. 9: Use the Delta PPV function to highlight the cyan bar. Then adjust the circuit until the digital display shows the correct level.

Setting Record Current Adjustments

A few millivolts of measuring error become critical when adjusting the Chroma and the Luminance Record Current controls. The typical signal level for Chroma Recording Current is only 30 millivolts. The Luminance Record Current has a level around 100 millivolts.

These two adjustments determine whether the VCR will record a clean signal. If the signals are too large, the video heads will saturate the tape, causing a noisy picture or incorrect colors during playback. If the signals are too small, the tape will have a poor signal-to-noise ratio.

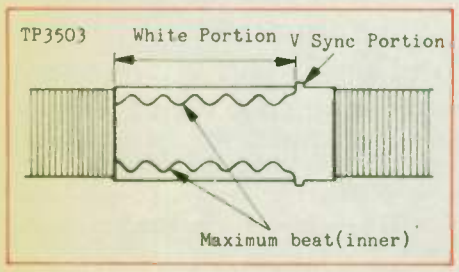
DELTA PPV button. Just as with the Delta Time measurements (covered earlier), these buttons activate the intensified Delta Bar controlled by the DELTA BEGIN and DELTA END controls. We adjust the controls until the Delta Bar just covers the part of the waveform the alignment instructions tell us to measure.

To adjust the Chroma Record Current control, we display the signal at the horizontal sync rate and highlight the cyan bar of the NTSC split-field video pattern or of the VA62's Chroma Bar Sweep pattern (both video patterns produce the same results). For the Luminance Record Current, we

display the signal at the vertical sync rate and highlight the vertical sync interval. Then, we simply adjust the VCR circuits until the digital readout shows the correct peak-to-peak amplitude.

Understanding the FM Deviation Controls

Few people understand the zero-beat procedures used to set the FM modulator in VHS recorders. Even if we understand the procedures, the manufacturer's procedures produce confusing results because of the overlap of several signals. Let's take a minute to understand how the settings of the Sync Tip Frequency and the Deviation Frequency controls affect the VCR's performance and then see how to adjust them.



Courtesy of Panasonic

Fig. 10: The instructions for setting the FM deviation adjustment.

The frequency-modulated carrier used to record the luminance signal must have the correct amount of swing from the lowest to the highest modulation frequency. If the frequencies are different from the VCR standards, the playback circuits cannot properly detect the video signal. Most VCRs contain an adjustment for the lowest modulation frequency (the modulation during sync pulses) and a second adjustment for the highest modulation frequency (the modulation for pure white pictures) in the recording circuits.

A few alignment instructions call for a frequency counter to measure the unmodulated sync-tip frequency. But, we cannot use a frequency counter to measure the frequency during modulation because the frequency is constantly changing. Most alignment instructions call for beating an external generator with the modulated carrier to determine frequency indirectly.

We use the SC61's auto-ranging frequency function when the instructions call for a frequency reading. We simply connect the SC61 probe to the test point, press the FREQ button, read the frequency on the digital readout, and adjust the VCR control for the specified value.

Few people understand the heterodyning method used to determine the peak-white modulation frequency. The service manual says to observe a scope waveform from one test point, while injecting a signal from an external signal generator into a second test point, and watching for a beat pattern on the waveform. The instructions warn that the beat may appear at a "correct" and at an "incorrect" point of the control adjustment. What does all that mean? Let's be sure we understand the procedure.

We set the generator until it produces the 4.45 MHz VHS peak-white frequency and then mix its output with the FM modulator output. The signals beat together to produce the sum and difference frequencies. If the two signals are very close in frequency, the beat becomes visible on the scope as amplitude modulation. We adjust the circuit until only one cycle of amplitude modulation shows, indicating the frequencies are the same.

But, why do the instructions warn of a "correct" and an "incorrect" beat? Because of the video pattern specified. The procedures always tell us to use the split-field NTSC color bar pattern and to set our scope to display waveforms at the vertical rate. We then observe the area just to the left of vertical sync, which contains the peak-white bar, as shown in Fig. 11.

The problem, however, is that the same part of the waveform also contains the black bar and the two samples of the color subcarriers, "-I" and "Q". These extra bars cause the "right" and the "wrong" places to set the modulation control. The zero-beat might represent the white bar or one of the other bars.

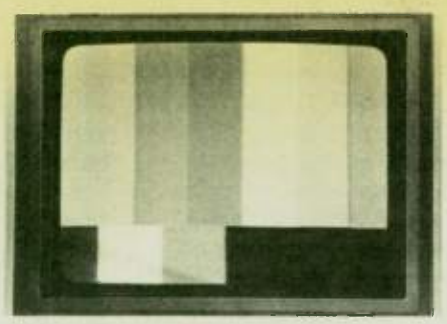


Fig. 11: The white bar of the split field pattern is on the same line as the "–I" and "Q" bars, causing an overlap when viewed on an oscilloscope.

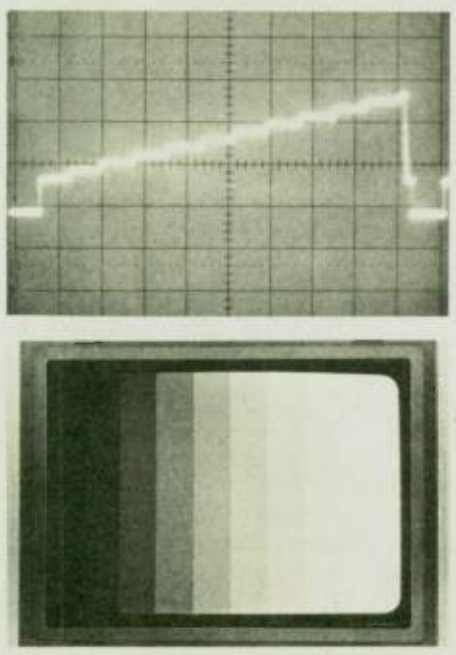


Fig. 12: The VA62 10-Bar Staircase video pattern (top) provides samples of ten different video levels (bottom), producing different VCR modulation frequencies.

There is little that can be done to improve the manufacturer's procedures when using the NTSC split-field video pattern because of the way the white window overlaps with the "-I" and "Q" bars when viewed at the vertical rate. Viewing at the horizontal rate causes even more overlap, as the white bar blends with the color bars. There is, however, a way to simplify the heterodyning methods if we use a different video pattern.

Simplifying Deviation Adjustments

The first step to simplifying the deviation frequency adjustment is to use the VA62's 10 BAR STAIRCASE pattern instead of the NTSC color bar pattern. As we will see shortly, this pattern eliminates the overlapping signals during the zero-beating procedure. This pattern offers an added advantage because it does not contain color information. This feature eliminates the need to turn the Chroma Record Current adjustment to zero while adjusting the deviation frequency.

Each of the ten staircase steps causes the FM modulator to produce a different frequency. When we observe the waveform at the TV horizontal rate, the externally applied signal zero-beats with only one frequency at a time, as we see in Fig. 13. We adjust the Deviation control until the zero-beat lines up with the top (pure white) bar.

Fig. 13 shows why we want to use the dual-trace display mode. The first trace shows the combination of the FM and the generator signals. The second trace displays the composite video signal, from the VCR's "Video Out" jack, which provides sync and a convenient way to tell which part of the FM signal contains each video modulation level.

Using the staircase, viewed at the horizontal rate, eliminates the overlap of modulation levels caused by the NTSC split-field pattern. But, be careful if you have a scope other than the SC61. When we set other scopes to display the FM signal at the horizontal line rate, the CRT nearly always displays a little of the FM present during vertical sync and blanking. This brings us back to the overlapping modulation levels we saw with the split-field pattern.

The SC61 video triggering circuits remove the vertical blanking and sync signals when observing signals at the TV horizontal sweep rate. The circuits detect vertical sync and then hold off the CRT trigger circuits during each vertical sync interval so that we don't become confused by the vertical sync or blanking. Other scopes (including the Sencore SC60 or SC60A "WIDEBANDER") do not have these special circuits.

Alignment Gets Easier with Practice

You can probably see why it's important to check the alignment of the internal VCR controls. If you check alignment, you will probably find most controls will be right on the nose. Some will need a minor touch-up, while others will be further out of adjustment. But, it's hard to get into the habit of checking the test points.

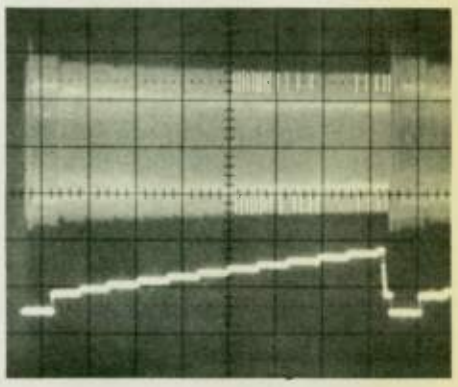


Fig. 13: Using the staircase pattern, adjust the modulation control until the area of minimum beat lines up with the top (10th) bar. Here, the zero-beat agrees with the 9th bar.

Alignment gets easier the more you practice it. You know it's a good idea to check alignment. You simply need to force yourself to do it on every VCR you service. At first, you might find some of the procedures a struggle. But, you will soon learn how to do the adjustments correctly. Soon, you will be able to perform each step by simply checking the instructions to find the test points.

Then, you will start to notice how many of the adjustments were set incorrectly. Each time you correct one, you will know you are returning a VCR to your customer that produces every bit of performance of which it's capable. You know your VCR service work has high quality. Isn't quality work what keeps your customer coming back to you instead of finding someone that does the job better?

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How can such portability and performance be packed into one counter? Not so easily - our engineers have developed a patent pending, micro-processor time base - this is the key. In all other counters, you must trade off accuracy for portability or frequency range, and visa versa. But the FC71 gives you the best of both worlds possible only with the exclusive patent pending micro-processor time base.

The low current draw of the micro-processor controlled time base means you can count anytime, all day long, on 1 battery charge with rock solid FCC accuracy guaranteed to 1 GHz, something counters with crystal ovens & TCXOs just can't do. Maybe best of all, this patent pending time base is nearly immune to temperature changes that make other counters inaccurate.

Why is it so important for you to have a sensitive counter these days? Well obviously all broadcasters & 2-way techs encounter very low signals day in and day out. But think about just plain troubleshooting a circuit that is not functioning properly too. Many times the signals are much lower than normal because the gain of a stage is out, the circuit is being loaded down, etc.. So only a very sensitive counter will let you do it. Not to mention many times you cannot connect directly to the circuit because the low impedance of the counter will stop the circuit from functioning. But the FC71 has such a sensitive front end you can use the snoop-loop, supplied, which inductively couples the circuit (or crystal for example) under test. So you can quickly and accurately measure the frequency of the signal. Just think how quickly you can walk through 2-way RF transmit drive stages. But sensitivity goes hand in hand with stability, because if you have a sensitive front end that's not stable (or selective of the frequency you'll need) you measure noise, other signals, and everything else but the signal you want - a real frustrating experience.

What's so special about the FC71's stability? Our specially designed front end doesn't get fooled by complex signals like the others do - this, combined with the sensitivity control, let's you count signals that fool other counters like the complex composite video signal thats made up of multiple signals...all changing or picking out the critical 19 KHz FM pilot pulse signal from the FM carrier. When measuring with the FC71, the LCD display locks right on signals that would cause other counters displays to shake, rattle, and roll.

Why do you need to have a shielded counter?

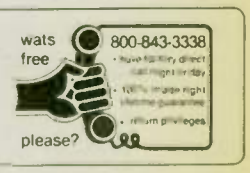
Is there anything worse than trying to accurately count a frequency or troubleshoot in a high RF area? Well probably not especially if you're in the broadcast or communications field. That's why we took special precautions and double shielded our FC71 - it's RF immune, but you really have to see it to believe it.

Exclusive special tests are an added bonus if you're a 2-way tech or video servicer. You probably have drawers full of questionable crystals that you're not sure whether are good or bad. The FC71's exclusive crystal check test will tell you in seconds which ones are good and which ones to toss - it's a super troubleshooting aid. The FC71 also has an automatic ratio test. You'll find this feature super convenient in today's digital circuits. It makes troubleshooting multiply and divide stages, PLL's etc., a breeze!

Call today and take a free FC71 15 day self demo - and you may win one free. Lot's of pro's compare spec for spec before they buy a counter only to discover that when they take delivery the spec's are fine but the units operation - well that's another story. What better way for you to prove to yourself that the FC71 is your best frequency counter value than to put one through the paces right there on your bench or field site. But rather than send in a salesman with a 30 minute demo - we want you to put the FC71 thru a full 15 day self demo. Here's how.

Call us today at 1-800-843-3338. Tell us you want to put the FC71 through its paces for 15 days (or ask for a 4 page brochure and spec sheet or applications video tape). Prove to yourself that the FC71 is the best price performance counter on the market and you'll find it tough to believe it's priced ⅓ less than the nearest competitive unit. Everyone who says "Yes" to our offer and tries (or buys) an FC71 before May 31st will automatically qualify for our "Win an FC71" Sweepstakes - or better yet, order your FC71 today and take advantage of our 10% Factory Direct "Finder's Fee" Discount (that's a $99.50 savings) just by calling us. But either way ACT TODAY.

SENCORE
ELECTRONIC TEST EQUIPMENT
Innovatively Designed With Your Time In Mind
3200 Sencore Drive
Sioux Falls, South Dakota 57107
(605) 339-0100



Attention VA48 Owners:

VA62 Video Analyzer — $3,295.00
NT64 NTSC Pattern Generator — $395.00
VC63 VCR Test Accessory — $495.00

Is now the time to update for more profitable servicing? You be the final judge.

Since you already own a VA48 Video Analyzer, we know that you appreciate Sencore's quality, service backup, understand functional analyzing, and believe in investing in the tools you need to make your job easier, faster, and more profitable. But, we also know that you may be letting today's changing video servicing opportunities pass you by. Why? Well, because you may not be updating with the tools necessary to profitably and reliably service today's (and tommorow's) video technologies. Specifically the VA62 Universal Video Analyzing System. What type of changing technologies are we talking about? Just what will the VA62 let you do that your VA48 won't? Why is now the very best time for you to update?

These are questions many other VA48 owners asked before they decided whether to update to the VA62 Video Analyzing System. So let's quickly review 10 important things you can do with the VA62 that you just can't do with the VA48.

1. ***Digital Tuners*** require FCC accurate signals to check for tuner accuracy, drifting, and channel drop outs. Only the VA62 provides you with a shop standard FCC digitally accurate RF generator from channel 2 to 83.

2. ***Cable compatible receivers*** can be tough enough to service, let alone not having the same cable channels in your shop as in the customer's home. The VA62 is your FCC shop standard, providing you all the mid band, super band, and hyperband cable channels.

3. ***Shifted cable channel frequencies*** can drive any TV or VCR nuts, including the technician. Is it the set or the signal? How can you tell? Just enter in the frequency shift and the VA62's exclusive programmable cable channel automatically shifts, just like the shifted cable signal.

4. ***All cable channel transmission*** may now add customer annoying beat frequencies, noise, or co-channel interference that is not completely trapped out. The VA62 can check and set all traps without pulling one chassis using the picture tube, an exclusive technique.

5. ***Performance check.*** The toughest customer complaint has to be, "The picture doesn't look as good as it used to." The VA62's exclusive, expanded multiburst pattern lets you check the RF, IF, CHROMA, and video response of the latest high resolution comb filter sets in less than 60 seconds without taking the back off the set.

6. ***Only the VA62 gives you just one TV or VCR synchronous detector test point hookup*** to check or adjust for the best luminance response. The VA62 special crystal-controlled IF signal lets you check and set any synchronous detector correctly without all the sweep and marker setup and time-consuming alignment procedures.

7. ***Close the color loop on frustrating chroma problems.*** The VA62 exclusive sync-locked, phase-locked chroma drive signals let you dynamically inject 3.58 MHz phase signals or chromanance signals to walk any chroma problem out in minutes.

8. ***Stubborn audio problems will be heard no more.*** The VA62's exclusive audio performance test lets you walk every problem out stage-by-stage, from the tuner to speakers.

9. ***Service VCRs just like TVs:*** The VA62 new standard 30 Hz servo sync-lock-signal lets you troubleshoot all VCRs all the way through. Plus the all new VA62 exclusive video head sub-signal tells you, proof-positive, whether it's the head or the circuit.

10. ***New circuits and new challenges-obsolete all other generators.*** These are just 10 reasons why you should say "Yes" to updating your VA48 to the all new VA62 Video Analyzing System. However, there are many more reasons ... and as each week, each month passes, new video technology makes your VA62 investment decision even more sound, because you'll be able to add the new accessories as your service needs demand.

If you haven't updated your VA48 by now, it most likely boils down to two reasons: Either you've grown so fond of your VA48, you find it tough to really part with it, or you're still not sure just how much more capability the VA62 will give you over your VA48. (If you have other reasons, please call us. We would really like to know). The only way you can prove to yourself the VA62 really gives you more performance over your VA48 is to put a VA62 through it's paces in your business, on your bench.

Free 15 day test drive Just call our **WATS**

Free number, 1-800-843-3338 and you will have your own $4,185 VA62 Video Analyzing System to test drive for *15 days. Use it on everything: TVs (Old & New), VCRs, Tough Dogs, and Tough Circuits. Really work it over. If your new VA62 doesn't measure up to what you feel you really need, just return it . . . But we feel you will find the VA62 is your next natural step to updating your video servicing requirements. If you agree, we've got a super opportunity for you.

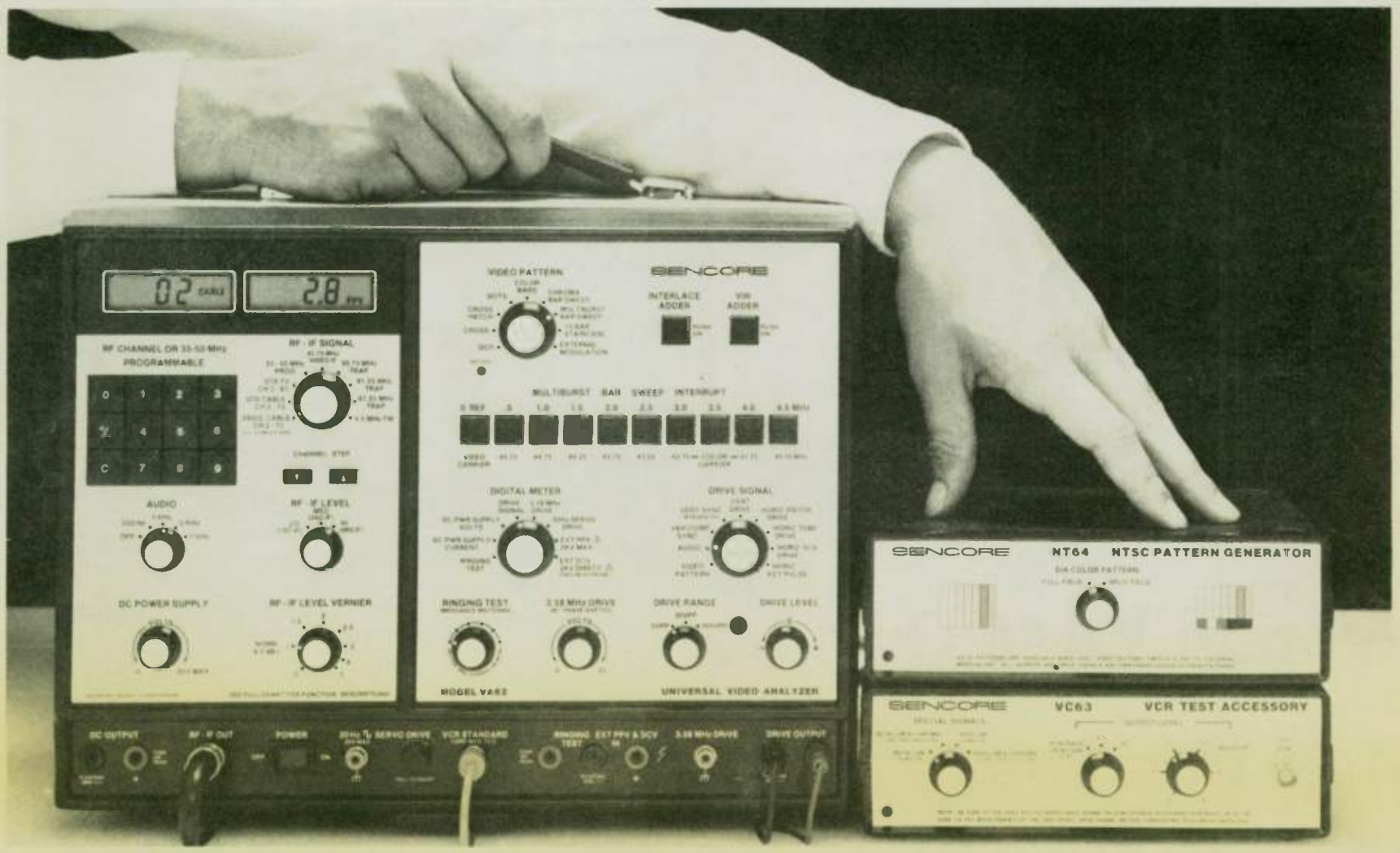
Last chance super VA48 trade-in offer

Now you can get your full VA48 purchase price as your "Last Chance" Trade-In Offer when you invest in a new VA62 Video Analyzing Package consisting of the VA62 Video Analyzer, NT64 NTSC Pattern Generator, and VC63 VCR Test Accessory.

Regardless of how long you've owned your VA48, you'll get FULL PURCHASE TRADE-IN VALUE for a new VA62 (As long as your VA48 is in reasonable working condition). But you had better hurry if you want to take advantage of our final VA48 Trade-In Offer. So, call us **WATS Free, 1-800-843-3338** to try a VA62 Analyzing System or work up your own Last Chance Trade-In.

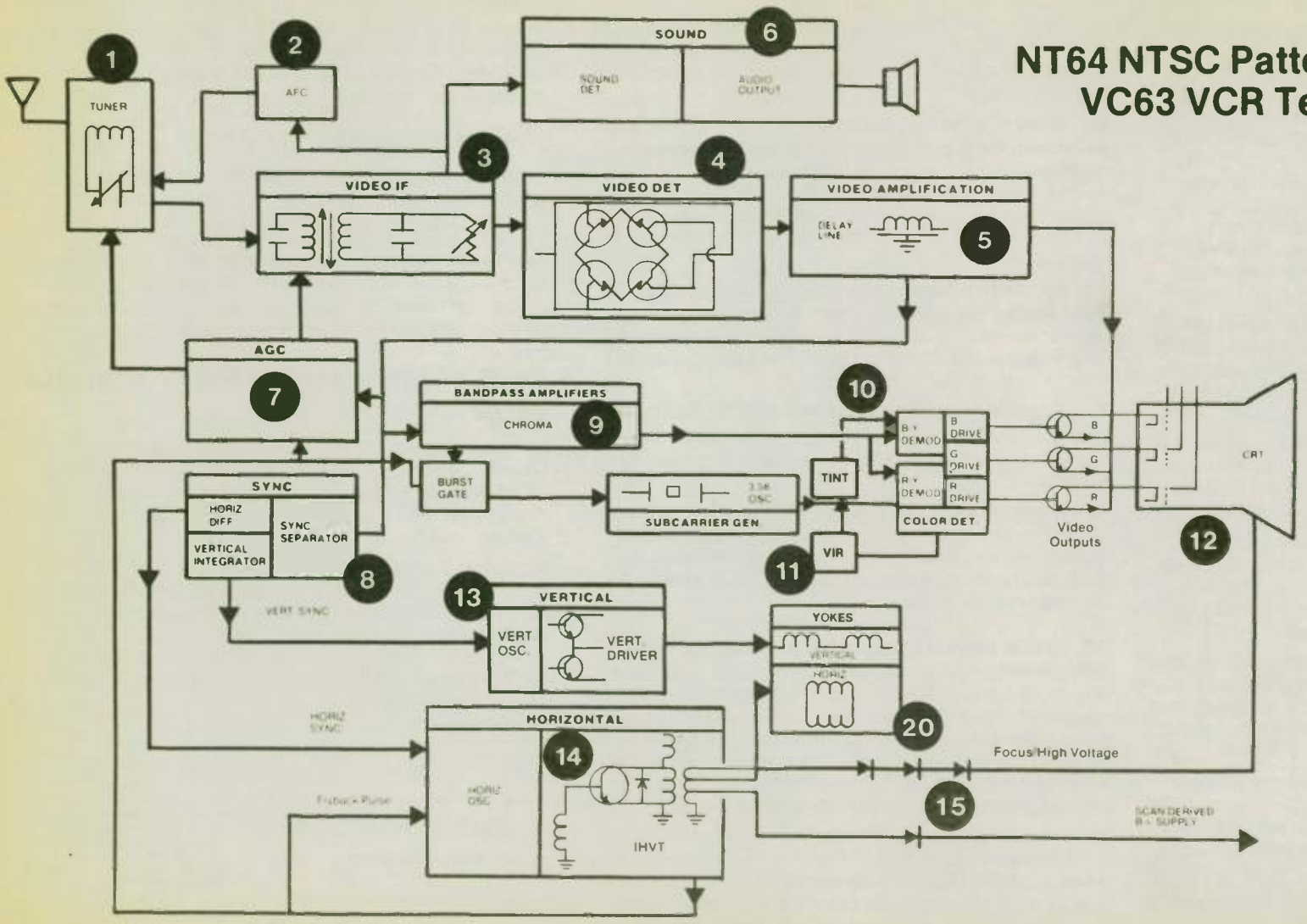
* with approved credit

20 Reasons Why Updating To The VA62 Will Help You Cash In On Today's Profitable



VA62 Video Analyzer — $3,295

Double Patented: No. 3,990,002
No. 4,562,469
NT64 NTSC Pattern Generator — $395
VC63 VCR Test Accessory — $495



Video Analyzing System

New Video Market Opportunities

Reason 1: The VA62 is the only all channel, cable-ready RF generator on the market. It provides every VHF, UHF, and cable channel at FCC specs to use as a shop standard. Within the next five years, 53% of all American households will subscribe to cable, and only the VA62 allows you to generate any cable channel right in your shop.

Reason 2: The VA62 provides cable channels at any standard or non-standard offset. You simply program in the offset you need to match the cable system. Now you can win those arguments with the cable company.

Reason 3: Exclusive Trap Setting Signals reproduce the interferences the traps are designed to eliminate. You just adjust them for the least interference on the CRT. With all adjacent channels provided on today's cable systems, trap settings have never been more critical. The programmable IF generator allows you to set non-standard traps too. Only with these exclusive signals can you performance test for cable operation, check alignment and set traps, if necessary, without pulling the chassis.

Reason 4: An exclusive 10 bar staircase pattern with steps from 100% black to 100% white allows you to dynamically check and align today's synchronous detectors. Conventional sweep and marker alignment won't even turn these detectors on because they don't simulate the normal signal found at the input. In fact, one manufacturer, NAP, makers of Magnavox, Philco, and Sylvania, states in its service literature, "Due to the nature of the synchronous detector (internal to the video IF/Detector IC) a standard sweep generator set up does not produce a true IF bandpass response curve. The curve illustrated is valid for adjustment purposes only."

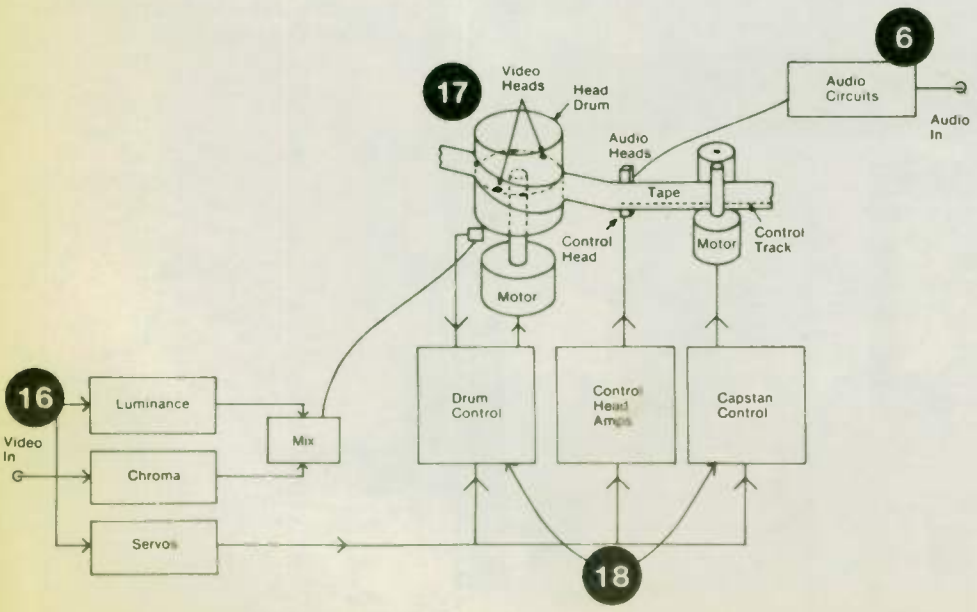
Reason 5: The expanded VA62 Multiburst Pattern provides video signals to 4.5 MHz. This enables you to thoroughly check the video response of all the circuits from the antenna to the CRT. Only this pattern allows you to check today's high resolution monitors and comb filter televisions, which have video bandwidths to 4 MHz and beyond.

Reason 6: The VA62 supplies audio signals to performance test and troubleshoot any television or VCR audio circuit. Only the VA62 provides a 4.5 MHz sound IF signal to inject before the sound detector in a TV, plus four audio frequencies to modulate with or inject after the detector in a TV or VCR.

Reason 7: A wide range of RF and IF signal levels from 5 uV to 500 mV means you can duplicate any signal condition from the deepest fringe to the strongest overload. You'll never make another repeat service call because the set couldn't handle the signal level.

Reason 8: An exclusive Interlace Adder checks the vertical countdown chip used in many of today's sets. Unless you check that the set works with both types of signals, you don't know if it will work when your customer connects it to his computer or video camera.

Reason 9: An improved Chroma Bar Sweep allows you to check color saturation, tint, and color frequency response right on the CRT. No other signal provides EIA levels and checks the full 1 MHz Chroma Bandwidth.



Reason 10: Only the VA62 provides a separate 3.58 MHz drive in addition to the Chroma Drive Signals. For the first time you can troubleshoot all the color circuits. You can even troubleshoot the demodulators by injecting both chroma and 3.58 MHz, 90-degrees-phase-shifted color oscillator.

Reason 11: Only the VA62 provides signals to check the operation of the VIR circuits used by such manufacturers as Zenith, Sylvania, and GE to automatically control color saturation and tint.

Reason 12: Only the VA62 provides all the signals and levels to inject into any video circuit, including the CRT. All video signals are fully adjustable from 0 to 300 VPP.

Reason 13: Complete vertical drive signals allow you to substitute in the vertical oscillator, vertical output stage, or any intermediate stage. Simply feed a DC voltage from the VA62 current limiting DC power supply, along with the drive signal, to troubleshoot any DC coupled vertical stage.

Reason 14: The VA62 provides signals to drive any transistor, tube, or SCR chassis, including chassis with split flybacks. For the first time, one analyzer allows you to inject directly into any horizontal stage, from the oscillator to the flyback.

Reason 15: An autoranged DVM digitally reads both Peak-to-Peak and DCV. For the first time a single unit not only allows you to measure power supplies, but using the DVM along with the drive signals, you can even analyze triplers and integrated high voltage transformers. Now you can be sure the components are bad before you spend the time and money replacing them.

Reason 16: Together, the VA62 and NT64 produce all the color patterns required to meet manufacturers' warranty service requirements. Only the VA62 provides patterns to match the waveforms shown on manufacturers' schematics, as well as special patterns for troubleshooting.

Reason 17: Together with the VC63, the VA62 allows you to substitute directly for the VCR heads. You are proof-positive if the heads, or other chroma or luminance stages are defective.

Reason 18: The VA62 provides an exclusive 30 Hz servo reference to aid in pinpointing difficult servo problems.

Reason 19: The VA62 is completely obsolescence proof. An external modulation jack and external accessory jack allow you to update whenever a new accessory is introduced.

Reason 20: An exclusive, patented Ringing test dynamically checks yokes and flybacks for shorted or open turns. The VA62 is the only analyzer on the market today that allows you to check these components, saving you valuable troubleshooting time.

MONEY BACK GUARANTEE

Put the VA62 to work for you on your bench for 30 days — if you don't find that the VA62 helps you cut your video service time by at least 54% you can return it for a full refund including freight both ways — no strings attached. You be the judge.

Refer to the last two pages of this issue for details on the VA62 Specials and a special 10% "Finder's Fee" Discount.

Career Opportunities At Sencore

A Growing Company Looking For Growth Oriented People

Sencore is growing in all areas of the company. Our projections show a 50% increase in people needs for this next fiscal year and we will be adding people in Production, Engineering and Sales along with Service and other business support areas. Listed below please read about a couple of key technical positions we are presently recruiting for.

Sales Representatives

Technical Sales Engineering has been a dynamic growth area for Sencore in the past several years, and due to growth, we are seeking qualified individuals for this area.

Technical Sales Engineers are the liaison between the customer and Engineering. Technical Sales Engineers handle all incoming and make outgoing calls concerning Sencore test equipment, with the sale of Sencore test equipment being the final result.

Electronic Technicians

The Electronic technician's responsibilities include analyzing and troubleshooting all defective PC boards and assigned instruments down to the component level. Electronic technicians will work as part of either the Production, Quality or National Service teams that are responsible for the manufacture or repair of all Sencore test equipment designed and manufactured in our facility.

Requirements for Sales & Techs:

* 2 year degree or certificate in analog/digital electronics
* 2 years bench experience troubleshooting/analyzing consumer electronic products
* Excellent written and oral communication skills
* Desire to relocate

The above listed positions are career opportunities existing in the following areas:

* Engineering
* Technical Management
* Application Engineering
* Production Engineering
* Technical Writing
* Quality Control

Why Should I Join The Sencore Team?

At Sencore, we feel we have many attractive tributes typical of a quality organization. We offer the type of team atmosphere that will provide the challenge you need to grow and develop, along with personal satisfaction of knowing you're an important part of our team.

Listed below are 6 reasons why we feel you should work for Sencore:

1. STATE-OF-THE-ART TECHNOLOGY IN ALL OF OUR DESIGNS: Sencore has always used state-of-the-art technology in design as well as manufacturing.

2. SENCORE IS A MEDIUM-SIZED COMPANY: We employ approximately 200 people. Sencore offers the benefits of a medium-sized company to the aggressive, interested person who wants to become involved.

3. SENCORE CONTROLS ALL OF ITS MANUFACTURING . . . WE'RE ALL-AMERICAN MADE: All Sencore products are completely designed and manufactured in our corporate headquarters in Sioux Falls, South Dakota.

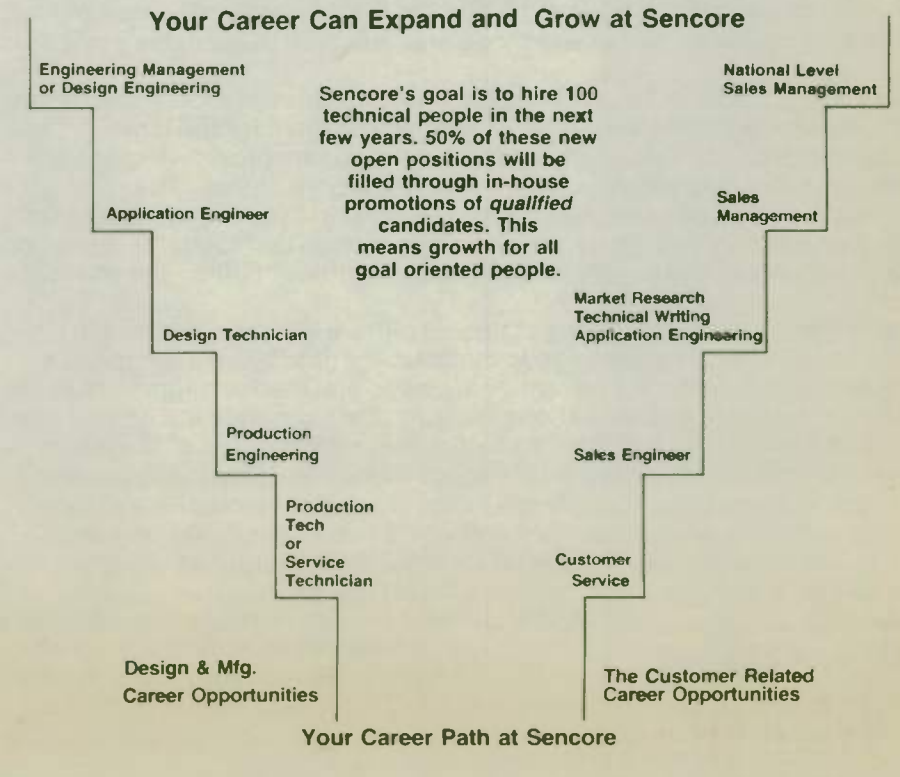
4. 35 YEARS EXPERIENCE AS A LEADER IN THE CONSUMER ELECTRONICS SERVICE INDUSTRY.

5. EXCLUSIVE PRODUCT LINE: These 35 years of experience have generated one of the most exclusive lines of test instruments in the market today. Over one-third of our product line is protected by patents.

6. LOCATED IN A CITY THAT IS SECOND TO NONE IN QUALITY OF LIFE.

EEO/AA EMPLOYER

Your Career Can Expand and Grow at Sencore



Your Career Path at Sencore

The SENCORE PR57 POWERITE® . . . Your Midas-Meter Turns Every TV, VCR, And Audio Chassis You Touch And Test Into A Little Bit Of Gold

The SENCORE PR57 POWERITE® can be your very own Midas-Meter. Here are five ways the POWERITE® can turn every TV, VCR, and audio chassis you touch into a little bit of gold for you and your business.

1. **The POWERITE® Is An Isolation Transformer** that saves you that downtime damage and dollars by isolating you and your instruments from the chassis under test.
2. **The POWERITE® Is A Variac** that will save you hundreds of dollars each year troubleshooting those time consuming tough-dog shutdown problems.
3. **The POWERITE® Is An AC Line Voltage Monitor** that keeps you from spending time and dollars tracking down problems that do not exist because your AC line voltage is too low or too high.
4. **The POWERITE® Is An AMP/WATT Power Monitor** that lets you know if your circuits are pulling the right power, avoiding expensive part damage.
5. **The POWERITE® Is A Patented Safety Leakage Tester** protecting you, your instruments, and your customers from accidental shock.

The POWERITE® . . .Your Midas-Meter: Just touching and safety testing, and charging a modest $5.00 for every TV, VCR, and audio chassis that leaves your shop, turns your PR57 into a profit building Midas-Meter that will guarantee you over $5,000 in additional service income just 12 months from now. Plus, you will have peace of mind knowing every chassis that leaves your shop is customer safe.

24 Karat Gold Offer

Use a POWERITE® for 30 days. If it does not earn at least 1/3 its purchase price ($131.66) by using just the customer safety leakage test, return it to Sencore — freight collect. Plus you will receive FREE a $24.00 value POWERITE® Business Builder Kit that includes: sample safety stickers, a special customer building banner, and a neat customer ad slick to build customer traffic. All yours to keep, even if you return your POWERITE®. But you had better hurry, the 24 Karat Gold Offer is good only till May 31st. Call your phone Sales Engineer today, **WATS Free, 1-800-843-3338,** for your POWERITE®.

POWERITE is the registered trademark of Sencore, Inc.

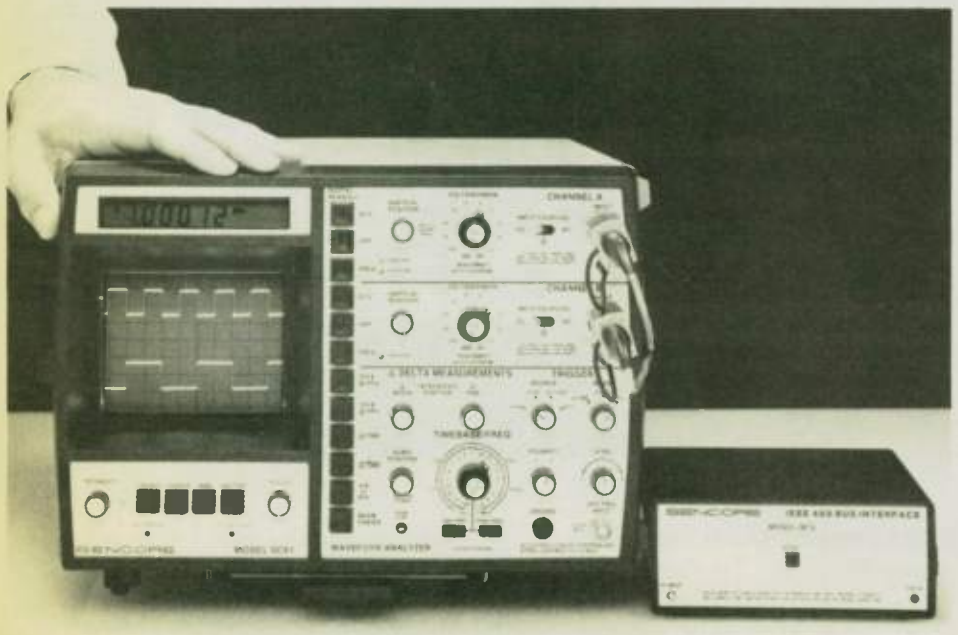
Please refer to the back cover for details on our special 10% "Finder's Fee" Discount.

PR57 POWERITE® — $395

Patent No. 4,352,058

SENCORE SHOPPING GUIDE

Discover How You Can Analyze Any Waveform 10 Times Faster, 10 Times More Accurately With 0 Percent Chance Of Error — Guaranteed Or Your Money Back!



SC61 60 MHz Waveform Analyzer

$2,995 Double Patented

NSN #6625-01-169-2318
GSA CONTRACT #GS-OOF-78407

THE ONLY SCOPE WITH AN INTEGRATED COMPUTER DIGITAL READOUT. The SC61 is the first instrument to truly integrate a high performance 60 MHz scope with a patented autoranging digital display. View any waveform to 100 MHz on the CRT, then simply push a button to read the DCV, PPV, and frequency instantaneously on the digital display; all with only one probe and no additional fiddling or set-up.

IT'S TEN TIMES FASTER - TEN TIMES MORE ACCURATE. There are no graticules to count or calculations to make. So you end up with measurements ten times more accurate than conventional scopes in one tenth the time.

EASY TO USE. The operation is simplicity itself. Make one probe connection, push and read. That's it. Makes for fewer operator errors and saves you time.

MEASURE PART OF A WAVEFORM, TOO. Use the exclusive Delta functions to intensify any portion of the waveform you wish. The digital display will read out PPV, time, or frequency for just the intensified section.

60 MHz BANDWIDTH. 60 MHz (-3 dB) bandwidth lets you see glitches that you'll miss with 10-, 20-, and 30-MHz scopes.

SUPER SYNC. Special sync circuits lock any waveform to 100 MHz. Our secret is an exclusive ECL (Emitter Coupled Logic) front end with noise cancelling differential amplifiers used throughout the sync circuits to provide better sync than any other scope on the market.

EXCLUSIVE 3 KV PROTECTION ELIMINATES COSTLY DOWN TIME. Most general purpose scopes are limited to a 600 V input. The SC61 lets you measure from 5 mV all the way to 2000 V (patented) for more versatility and protection.

PLUS THESE PERFORMANCE EXTRAS:

- Dual delayed signal trace so you see the leading edge of the waveform on both channels.
- Add, subtract, or view both channels separately.
- Post deflection, high intensity blue phosphor 8 x 10 cm CRT provides easy-to-view trace, even under high ambient lighting conditions.
- Push button X-Y vector display with 4 MHz response for accurate phase comparisons.
- Z-Axis input.
- Beam Finder.
- TVV, and TVH video preset positions with sync separators.

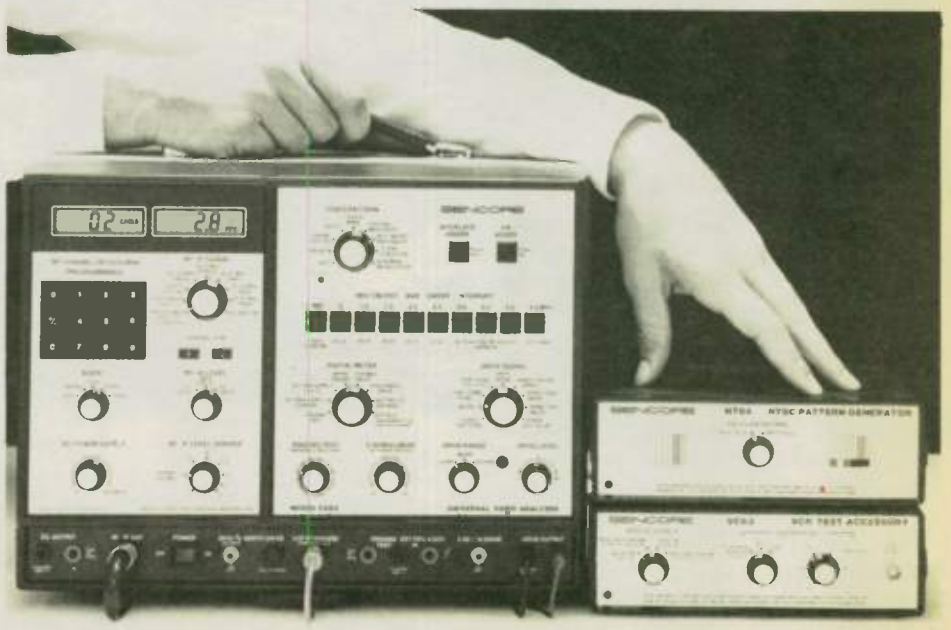
THE ONE AND ONLY. There are other scopes with digital readout, but none completely eliminate graticule counting like the SC61. That's because only the SC61 incorporates a microprocessor to automate every scope function at just the push of a button.

UPDATE TODAY. Just as DVMs have replaced analog meters, the SC61 is replacing conventional scopes (under 100 MHz), and for the same reasons: increased speed, accuracy, and reliability. Update today with this new automated scope technology, and begin increasing your productivity. Begin by calling or writing for our FREE 8 page color SC61 brochure.

OPTIONAL ACCESSORIES

HP200 50 KV High Voltage Probe	$59.95
DP226 1:1 Direct Probe	$60.00
PC227 Protective Cover	$29.00
TP212 10 KV Probe	$24.95
39G81 250 MHz Demodulator Probe	$29.95
IB72 IEEE Computer Interface Bus	$625.00
IE 233 1 Meter (39.4 inches) IEEE Bus Cable	$79.95

The Only All-Channel, NTSC Video Service System . . . Guaranteed To Cut Your Service Time By At Least 54%* Or Your Money Back



VA62 Universal NTSC Video Analyzing System

$3,295 Double Patented

NSN #6625-01-187-5516
GSA CONTRACT #GS-OOF-79334

SIGNAL SUBSTITUTION IS THE KEY. There are two basic methods of troubleshooting a circuit: signal tracing and signal substitution. Signal tracing means you take a scope (or meter) and measure the signal at various points.

Signal substitution, on the other hand, lets you inject known good signals from a video analyzer into any stage of a TV. If you get a good picture on the screen, you know everything is working from that injection point forward. You then back up stage by stage until the defect appears on the screen. You then know you are injecting into the defective stage. It's just that simple. A recent nationwide survey showed an average time savings of 54%* when technicians used signal substitution in place of signal tracing.

IT'S A SIGNAL SUBSTITUTER. The VA62 is a totally updated design in video analyzers that now lets you use the tried and proven method of signal substitution in all the latest TV and VCR formats.

COMPLETELY UPDATES YOU FOR ALL NEW TVs. The VA62 drive circuits have been specially designed so you can signal inject into any stage of even the newest TV chassis, including comb filters, SAW filters, synchronous detectors and more.

EXCLUSIVE "ALL CHANNEL CABLE-READY" TUNING. Now, for the first time, check absolutely every channel in use today, including all VHF, UHF and cable channels. There's no other generator on the market like it.

NEW IMPROVED TEST PATTERNS. Speed your video troubleshooting with all new, improved test patterns including our all new 10 step Multiburst Bar Sweep, an improved Chroma Bar Sweep, a special 10 bar staircase, plus the industry standard NTSC (EIA) color bars for VCR service. These new patterns will tell you things about VCR and TV operation that you just can't determine any other way, speeding your troubleshooting tremendously.

IT'S A COMPLETE VCR ANALYZER, TOO! Until now, you've serviced VCRs using a scope and a pattern generator. The most popular pattern generator on the market costs $2,000, and all you get is a basic pattern generator. You still have to scope test points and interpret waveforms. But not any longer.

For the first time, the VA62 brings tried and proven signal substitution to VCRs. Isolate tricky servo problems by signal substituting the VA62 30 Hz Servo Drive. Then, simply plug in the VC63 VCR Test Accessory for the special signals needed to signal substitute into every VHS, Beta, or U-Matic circuit.

SUBSTITUTE FOR HEADS DIRECTLY. The VA62/VC63 system even lets you use signal substitution to substitute directly for the video playback heads! Why guess when it comes to these expensive parts? Now you have a proof-positive test before you replace.

OBSOLESCENCE PROOF. All this, and the VA62 is obsolescence proof. That's right. We'll provide new accessories as the manufacturers announce new formats, test patterns, etc. This makes your VA62 a protected investment.

Write or call for the VA62 brochure for complete details.

ACCESSORIES

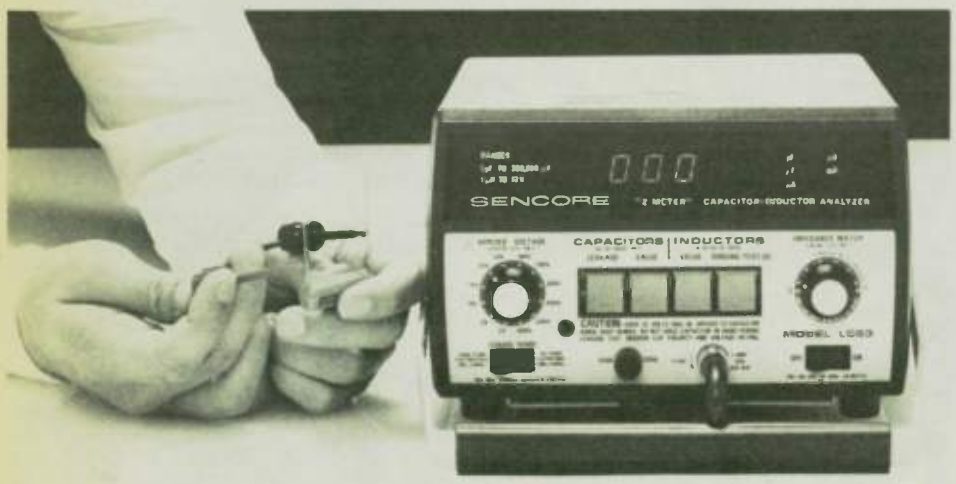
VC63 VCR Test Accessory $495.00
Supplies video-modulated, FM luminance signals, plus phase-corrected, down-converted chroma signals for VHS, Beta, or U-Matic VCRs. Special "head-sub" signal and signals to inject in any stage up to detectors.

NT64 "NTSC" Pattern Generator ... $395.00
Supplies the two EIA color-bar patterns required by some VCR manufacturers: the full-field and the split-field pattern. The NT64 patterns are phase-locked and sync-locked to all other VA62 drive signals so they can be used for signal substitution.

*Results empirically derived from actual survey of Sencore customers using functional analyzing.

SENCORE SHOPPING GUIDE

Catch Defective Caps And Coils That All Other Testers And Bridges Miss With The Triple Patented "Z METER"



LC53 "Z METER" Cap/Coil Analyzer

$895 Triple Patented — Others Pending

NSN #6625-01-118-8016
GSA CONTRACT #GS-OOF-78407

The "Z METER" is the most reliable capacitor tester on the market at any price. That's because it is the only tester that dynamically tests capacitors for capacity value, leakage (at full rated voltage up to 600V), and dielectric absorption (a patented test). According to thousands of tests made by Sencore Field Engineers, less than 25% of all capacitor defects cause a value change. Only the "Z METER" steps in to find the remaining 75% of the caps that give so much trouble loading circuits, causing excess hum, upsetting biases, or who knows what. Value-only testers and bridges will mislead you. You need all three "Z METER" tests to be sure.

The "Z METER" is the most reliable coil tester on the market, as well. That's because the "Z METER" measures inductance, not inductive reactance as bridge type testers read. Test results often vary from one bridge to another because different test frequencies or amplitudes are used. The "Z METER" uses a patented true inductance test, not related to frequency, to provide consistent, accurate results every time.

Second, only the "Z METER" provides you with a patented Ringing Test that is sensitive enough to detect one shorted turn in air or powdered iron coils. One shorted turn will seldom change the inductance value of these high-Q-coils, yet the coil won't work in circuit. This is why value-only testers will mislead you. The patented Ringing Test tells you positively, at the push of a button, whether a coil is good or bad.

PLUS YOU GET THESE SPECIAL TESTS

- Test SCRs, TRIACs, high voltage rectifiers and diodes with up to 600V applied.
- Pinpoint distance to a short or open in a transmission line or coaxial cable. (Great for broadcast and avionics work.)
- Test for dielectric leakage (hi pot) to 600 volts.

It's like getting a special tester free.

Measure Frequencies To 1 GHz With FCC Accuracy. Anyplace, Anywhere, Anytime At 1/3 Less The Cost

FC71 Portable 1 GHz Frequency Counter

$995 Patent Pending

GSA CONTRACT #GS-OOF-70434

Yesterday's counters, with their 80-, 100-, or 520-MHz top ends, just won't meet today's 1 GHz demands in avionics, broadcast, two-way communications, or video disk service; not to mention future applications. 1 GHz counters have always meant trade-offs of some sort — until now. Thanks to several innovations, the FC71 is the first 1 GHz counter that provides totally uncompromising, portable performance.

The FC71 uses a unique, new, microprocessor-controlled timebase. This patent pending circuit provides .5 ppm accuracy (0.5 ppm/y aging) from 10 Hz to 1 GHz. The 8½ digit LCD display provides superior accuracy on the high end while allowing .01 Hz resolution for low end audio work. Since there is no power robbing oven, the FC71 is the first battery operated 1 GHz counter to give you nine hours of continuous operation.

The FC71's front end sounds almost like magic: an average sensitivity of 5 mV from 10 Hz to 1 GHz — a typical 1 GHz sensitivity of 14 mV. Counts signals in more circuits than any other counter — without external amplifiers. Add to this the super stability and double RF Shielding — you can count signals other counters just can't.

EXTRA TESTS FOR ADDED VERSATILITY

- Frequency-ratio function walks right through the ever-present multiply and divide stages in today's digital and 2-way circuits.
- Crystal Check tests the fundamental operating frequency of any crystal.
- IEEE 488 Bus Option lets you add the IEEE 488 bus controller IB72 at any time (without modifying the unit) for automatic readings.

OPTIONAL ACCESSORIES

BY234 Lead Acid Battery Pack	$59.95
CC238 Carrying Case	$49.95
PA239 220 AC Power Adapter	$60.00
AN210 Telescoping Antenna	$25.00
IB72 IEEE Computer Interface Bus	$625.00

Test Any Transistor Or FET With 99%* Reliability In Less Than 15 Seconds — In- Or Out-Of-Circuit

TF46 Portable Super Cricket Transistor/FET Tester

$395 Patented

NSN #6625-01-058-9564
GSA CONTRACT #GS-OOF-70434

The "Cricket" has a patented "go/no-go" in- or out-of-circuit test for all transistors and FETs. It's proven 99% reliable in- or out-of-circuit. Simply connect the leads in any order and rotate the test switch. There's no setup needed. If the device is good, you'll hear a chirp. That's the total test.

Out-of-circuit leakage check finds those transistors that show good gain but are still leaky.

Push a button for gain. Helpful in troubleshooting as well as matching transistors and FETs.

*As documented by actual tests in Sencore's Application Engineering Department.

Troubleshoot Startup And Shutdown Problems Fast

PR57 POWERITE® Variable Isolation Transformer And Safety Tester

$395 Patented

NSN #6625-01-6269
GSA CONTRACT #GS-OOF-70434

The POWERITE® 400 Watt AC variable output transformer provides a continuously variable output voltage from 0 to 140 volts; a necessity for troubleshooting the new shutdown circuits. The PR57 POWERITE® protects you and your test equipment from those shocking overloads by isolating you (and your equipment) from the AC line. Safety leakage checks are now a snap with the patented POWERITE® test. Simply push a button and touch all the exposed metal parts with the PR57 probe. Any leakage reads on the meter.

POWERITE is a registered trademark of Sencore, Inc.

SENCORE SHOPPING GUIDE

Now, For The Very First Time In TV History, You Can Thoroughly Performance Test Every Single TV Channel, In Any TV System, To Full FCC Requirements And Specifications, 100 Percent Automatically . . . Or Your Money Back

FS73 CHANNELIZER JR. $1,995 Patents Applied For

Now, for the very first time in TV history, you can thoroughly performance test every TV channel, in any TV system, to full FCC specifications, 100 percent automatically . . . or your money back. This hard-nosed claim is backed by the following industry first and exclusive features.

All channel, super sensitive, digitally accurate tuner. Checks them all: standard VHF-UHF, cable mid-band-superband-hyperband, special 5 to 50 MHz band and FM. Tuning accuracy of .1 MHz, new low sensitivity of 5 microvolts (−46 dB) on VHF and 15 microvolts on the highest UHF channel, means FCC specified accuracy and reliability. Exclusive cable system frequency shift detector tells you exactly in microvolts how far any cable channel is off standard FCC, or switch to HRC or ICC and read frequency off these standard cable shifting systems on LCD readout. To make other specified FCC cable tests, switch function switch from RF video to A/V to read the video to audio carrier ratio which must be between 13 and 17 dB. Next, switch to noise reference to register noise level and then to S/N to read the signal-to-noise ratio. The only meter that tests noise on channels in use with new patent applied for circuit. Last, switch to HUM to be sure that the hum level is below the specified 5 percent. Operates from −25C (−13F) to 50C (122F). All parts cushioned to take 10 foot drop on cement. 7" x 9½" x 10", 9 lbs. Powered by 120V AC, cigar lighter or two rechargeable batteries. Auto-off turns off power after 15 minutes should you forget.

OPTIONAL ACCESSORIES

PA241 FS73 & 74 AC Power Adapter & Charger $48.00
BY242 FS73 & 74 6 Volt Lead Acid & Rechargeable Batteries (2 Required) (Each) $44.00
CC243 FS73 Carrying Case & Pouch $148.00
SS245 200 MHz Standard Signal Reference. $68.00
PL246 Panel Light to Light Up Entire Panel $9.95
HF247 Headphone to Defeat Speaker. $9.95
IB72 IEEE Computer Interface Bus $625.00

And For The First Time In TV History, You Can Thoroughly Analyze And Pinpoint Any RF Video Trouble, In Any Video Distribution System, Automatically To FCC Specifications, In Less Than Half The Time Than You Now Take . . . Or Your Money Cheerfully Refunded

FS74 CHANNELIZER SR. $2,995 Patents Applied For

Now for the very first time in TV history, you can thoroughly analyze and pinpoint any RF video trouble, in any video distribution system, automatically to FCC specifications, in less than half the time you now take, or your money back.

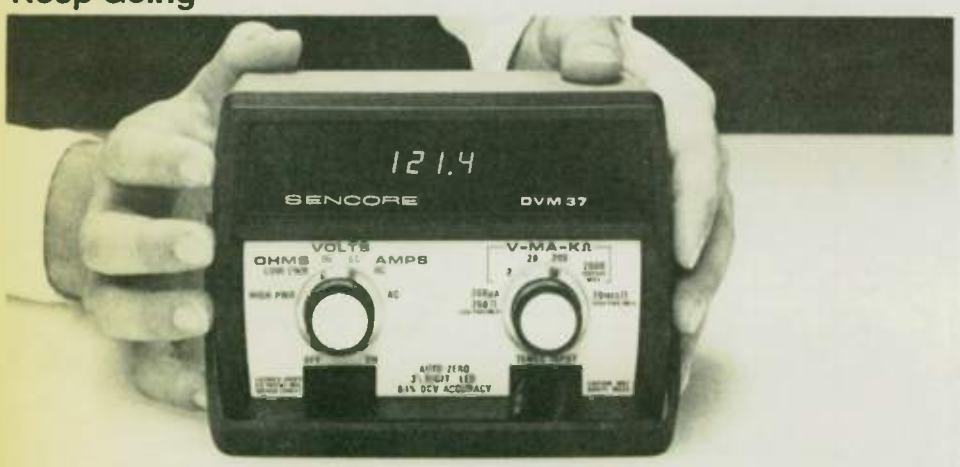
The CHANNELIZER SR. performance tests video systems just like, and to the exact same specifications as, the CHANNELIZER JR. But, sometimes knowing signal quality is not enough to solve a distribution problem or to assure that you have done a thorough job. If you need to know signal quality as well, detect ghosts and line reflections, ignition and other noise, adjacent or co-channel interference, or sync compression in amplifiers, simply pull the on-off control to ON and a wide band video picture will pop on the 3 inch screen to show you every flaw. A special 4 MHz IF bandwidth gives true representation of all that is transmitted and shows up high frequency ringing that portable TVs won't. B/W picture is used because good black and white means good color but not visa versa. Special sync circuits will cause roll if sync is compressed.

View for a good solid B/W picture to assure quality. Built-in 200V AC meter for measuring line or supply Voltage, 200V DC meter to check on MATV, and special low range ohmmeter for checking continuity and line resistance, making the FS74 a complete troubleshooter. 7" x 12" x 10½", 15 lbs. All other specifications are the same as FS73 CHANNELIZER JR.

OPTIONAL ACCESSORIES

PA241 FS73 & 74 AC Power Adapter & Charger $48.00
BY242 FS73 &74 6 Volt Lead Acid & Rechargeable Batteries (2 Required). (Each) $44.00
CC243 FS73 Carrying Case & Pouch $148.00
CC244 FS74 Carrying Case & Pouch $148.00
SS245 200 MHz Standard Signal Reference. $68.00
PL246 Panel Light to Light Up Entire Panel $9.95
HF247 Headphone to Defeat Speaker. $9.95
IB72 IEEE Computer Interface Bus $625.00

When The Going Gets Tough, You Need A Tough DVM To Keep Going



DVM37 3½ Digit
0.1% Bench/Portable DVM

$395 Double Patented

GSA CONTRACT #GS-OOF-70435

If you are the kind of person who likes to get used to one meter and use it everywhere and anywhere, you'll want the super reliable DVM37. You can drop it, kick it, carry it by the test leads, and it will keep right on operating at lab accuracy.

Unheard of 8 KV transient protection with 2 KV DC protection on every function and range, including ohms, spells unmatched internal protection.

15 megohm input impedance means 50% less loading and thus 50% greater accuracy than other 0.1% DVMs.

Auto Zero, Auto Polarity, Auto Decimal, and Auto Overrange, plus Hi-Lo Ohms.

100% Automatic Microprocessor-Controlled DVM Will Save You An Hour A Day

DVM56A MICRORANGER®

$995 Patented

GSA CONTRACT #GS-OOF-70434

Of all the instruments a tech uses on the job, his meter has got to be the one he uses most often. Yet, many meters just don't meet the needs of today's techs. That's why we designed the DVM56A MICRORANGER®. We surveyed thousands of techs and engineers to see what they liked and didn't like about their present meters. We then put the microprocessor to work to make one meter with everything in it that you would ever want for your testing and troubleshooting.

The MICRORANGER® is totally autoranging. You simply select the function you want. The MICRORANGER® does everything else. 4½ digit readout with a .075% DCV accuracy means reliable readings every time. The DVM56A holds rock solid under the largest broadcast transmitting tower.

MICRORANGER® is a registered trademark of Sencore, Inc.

SENCORE SHOPPING GUIDE

For The First Time Ever . . . Test Every CRT On The Market — Now And In The Future — Plus Restore 90%* Of All Weak Or Shorted CRTs . . . Or Your Money Back

CR70 "BEAM BUILDER"™ Universal CRT Analyzer And Restorer

$995 Patented

NSN #6625-01-187-4395
GSA CONTRACT #GS-OOF-70434

"BEAM BUILDER" is a trademark of Sencore, Inc.

The CR70 is the only CRT tester that lets you test every type of CRT in use today by solving an age-old CRT Tester problem: the adaptor sockets. It takes 64 different adaptors (at a cost of over $700) for a conventional CRT tester to test all the CRTs tested with the 5 adaptors supplied with the CR70. Plus the optional 39G170 Universal Adaptor connects to any "non-standard" CRT that might be announced in the future. So you'll never need to buy another socket.

Only the CR70 tests the CRT over its entire operating range, from black (cutoff) to white. The CR70 tests emission as true beam current and identifies CRT problems related to bad contrast that other testers miss. The CR70 also tests for shorted elements. Plus, a patented color-tracking test gives a direct good/bad comparison of all three guns of a color CRT or all three CRTs of a projection system to confirm they will balance properly for any color or B&W picture.

The CR70 is guaranteed to extend the life of 9 out of 10 weak or shorted CRTs. In industry, this saves thousands of dollars per year as you stretch the life of computer display tubes or high-priced scope tubes. In TV service, this is a real profit generator as you charge $25 to $35 for restoration.

The CR70 is more effective than any other CRT restoring instrument because it's the only one with five different restoration levels for each CRT type. We call it "progressive restoration." This means you start with the lowest (safest) level of restoring current. If the CRT responds to the lower level, you stop. If it doesn't, you step up the energy level until you improve the tube. There is nothing on the market that is safer or more effective.

*As verified by actual use testing by Sencore's Application Engineering Department.

You Can Walk The Troubles Out Of Any Stereo System In Half The Time — Or Your Money Back

SG165 AM/FM Stereo Analyzer

$1,295 Patented

GSA CONTRACT #GS-OOF-70434

The SG165 Stereo Analyzer is the only instrument designed for complete troubleshooting of any AM/FM stereo system. The key to the SG165 troubleshooting capability is signal injection. You inject known good signals from the SG165 into each stage starting from the output and moving towards the input. As soon as the problem appears, you know you are injecting into the defective stage.

The SG165 gives you every signal you need, at better than FCC tolerance, to inject into any of the basic blocks.

A sweep and marker generator, plus an innovative vector alignment procedure, lets you peak stereo separation in just minutes.

Two built-in meters, with dummy loads up to 100 watts, monitor your every action as you walk through the circuits.

INTRODUCING THE ALL NEW "Z METER 2" CAP/COIL ANALYZER

Dynamically Pinpoints Defective Caps And Coils Faster And More Reliably Than Ever Before . . . Because It Is The Only Dynamic LC Meter On The Market

LC75 "Z METER 2" Cap/Coil Analyzer

$995 Triple Patented — Others Pending

The all new LC75 "Z METER 2" tests large-value capacitors twice as fast as the famous LC53 "Z METER," plus tests electrolytics for Equivalent Series Resistance (ESR) too. Faster, more accurate and now an even more thorough checker, as it's hard to find electrolytic ESR.

The all new "Z METER 2" provides the same time-proven tests of the early model "Z METER"; it tests capacitors for capacity value, dynamically tests capacitor leakage at full rated voltage to 600 volts, and makes an exclusive, patented test for dielectric absorption too. But now, all three of these tests are twice as fast on the "Z2" compared to the original "Z METER" to save you valuable testing time. But then, with the push of a button, the new "Z2" adds a brand new patent-pending test for equivalent series resistance (ESR). ESR becomes critical in high-frequency, high current circuits like switching power supplies, flyback-powered TV receivers, and keyed AGC circuits. Only the all new "Z2" makes these four important tests to truly locate faulty capacitors that all others miss.

The "Z METER 2" still gives you the reliable "Z METER" coil tests too. The "Z2" measures inductance, not inductive reactance as bridges measure, for more reliable results. This patented test eliminates frequency-dependent variations often seen with bridges. The new "Z2" circuits also provide improved accuracy when testing the newer coils with high DC resistance.

The "Z METER 2" still provides you with Sencore's dynamic, patented, Ringer Test for fast, reliable good/bad results on air or powdered-iron coils. Guaranteed to detect even a single shorted-turn, every single time, which seldom changes the inductance value enough to detect with other testers. Yet, a shorted turn means the coil won't work in the circuit. At the push of a button, the Ringer Test boldly tells you whether a coil is good or bad.

PLUS YOU GET THESE SPECIAL TESTS

- Test SCRs, TRIACs, and high-voltage diodes with up to 600 volts applied with the easy to operate SCR224 accessory.
- Pinpoint distance to a short or open, to within feet, in any transmission line. Great for broadcast and avionics work.
- "Hi-Pot" dielectric leakage test to 600 volts. It's like getting a special tester FREE.

SENCORE

ELECTRONIC TEST EQUIPMENT
Innovatively Designed With Your Time In Mind
3200 Sencore Drive
Sioux Falls, South Dakota 57107
(605) 339-0100

wats free please?
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SPRING ROUNDUP SPECIALS

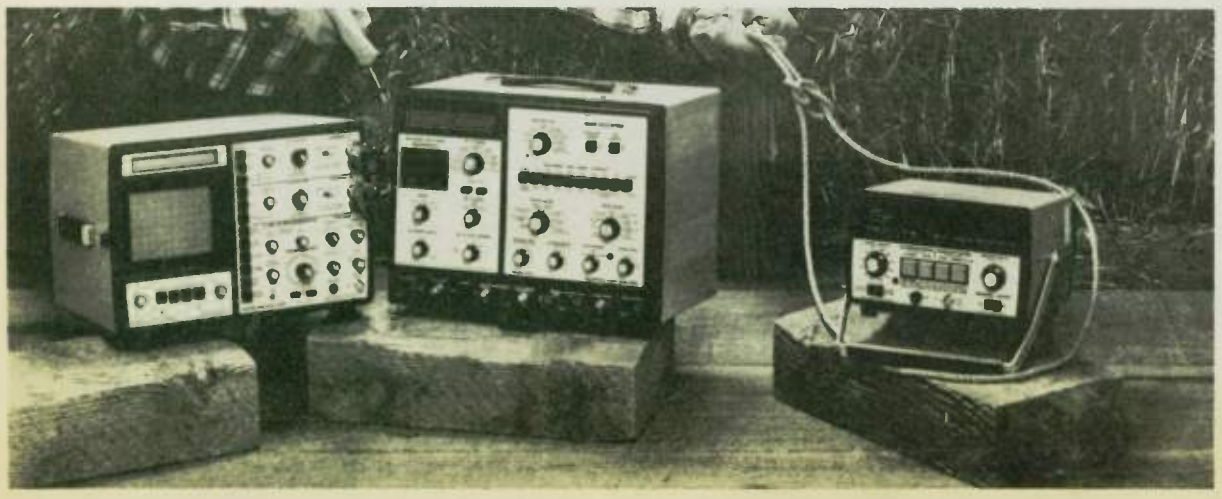
Save 30% With Sencore's Spring Roundup Specials

Now through May 31st, you can save up to 30% on the Sencore equipment packages we've put together below. These Spring Roundup Specials will update your service shop for more profitable servicing.

So, take a couple of minutes, evaluate your service bench, look over these specials and give us a call WATS Free, 1-800-843-3338 to discuss some applications, ask any questions you might have, or "roundup" the package that best suits your needs. If by chance you do not see that special package you want here, why not create your own package. Then remember to call us so you can take advantage of your own Factory Direct "Finder's Fee" savings.

Package Special #1

Our Best Deal Ever Offered — Our Three Best Selling Troubleshooters, Each With Patented Productivity Built-In At An Effective Whopping 30% Discount



You Buy Our SC61 Waveform Analyzer for $2,995 Or — Our VA62 Video Analyzer for $3,295

You Round Up
LC53 "Z METER" Cap/Coil Tester ($895 Value)

$895 Value FREE!

Own For As Little As $82.22 A Month

Time	Monthly Investment*
12 Months	$247.76**
24 Months	$134.46**
36 Months	$98.84**
48 Months	$82.22**

Package Special #2

SAVE Up To 27% With Our Most Popular Video Bench Update Package

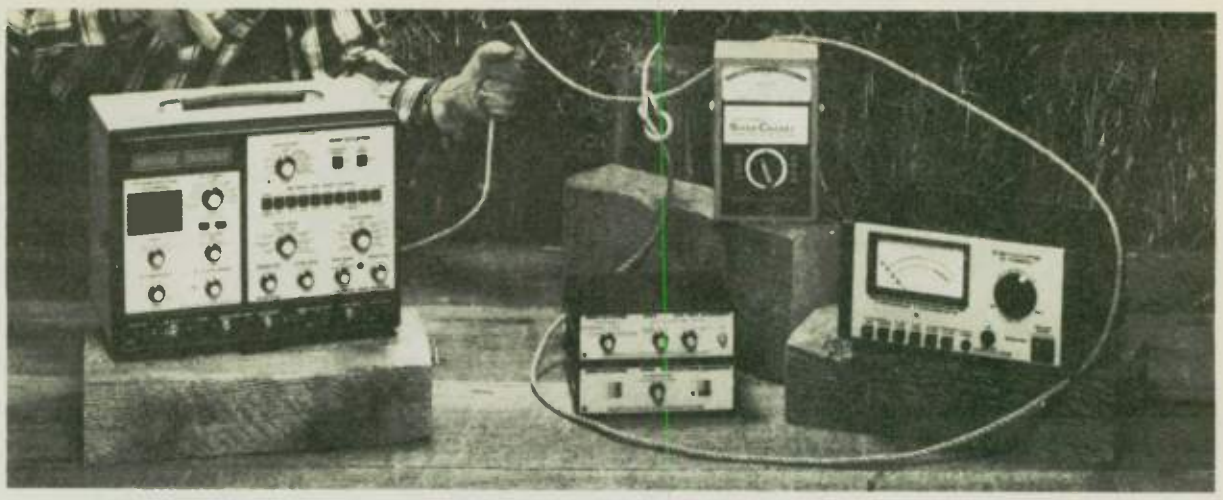
You Buy Our VA62 Universal NTSC Video Analyzer for $3,295

You Round Up (Choose Any 2)
VC63 VCR Test Accessory ($495 Value)
NT64 "NTSC" Pattern Generator ($395 Value)
PR57 POWERITE® Variable Isolation Transformer ($395 Value)
TF46 Super Cricket Transistor FET Tester ($395 Value)

Up To $890 Value FREE!

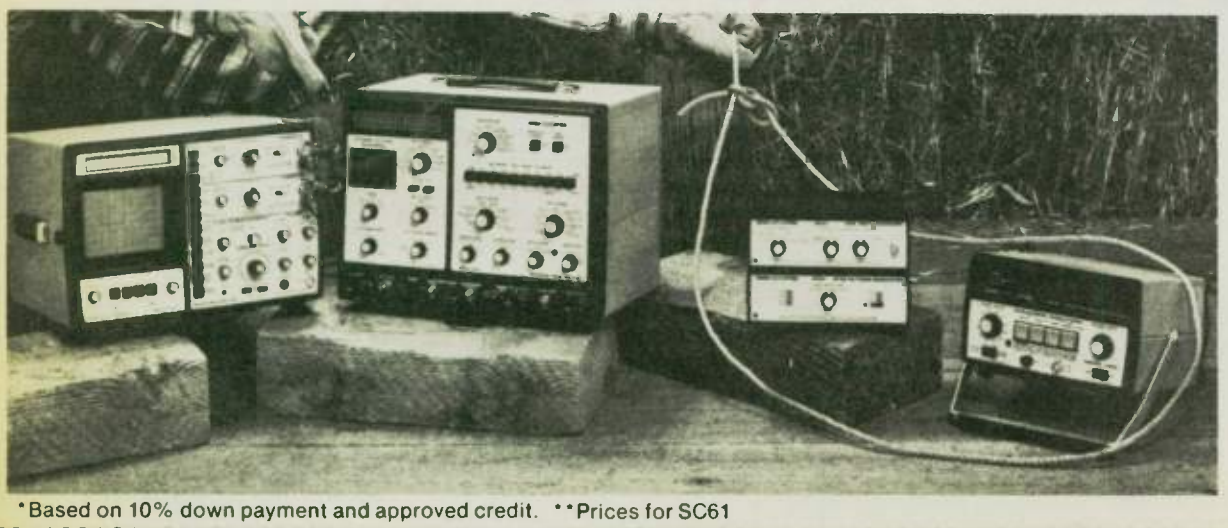
Own For As Little As $90 A Month

Time	Monthly Investment*
12 Months	$272.32
24 Months	$147.78
36 Months	$108.64
48 Months	$90.38



Package Special #3

SAVE 28% With This Super Video Shop Setup Deal — Everything You'll Need To Service The Latest TV And VCR Circuits Effectively



You Buy Our SC61 Waveform Analyzer & VA62 Video Analyzer for $6,290

You Round Up
VC63 VCR Test Accessory ($495 Value)
NT64 "NTSC" Pattern Generator ($395 Value)
LC53 "Z METER" Cap/Coil Analyzer ($895 Value)

$1,785 Value FREE!

Own For As Little As $173 A Month

Time	Monthly Investment*
12 Months	$520.08
24 Months	$282.24
36 Months	$207.47
48 Months	$172.60

*Based on 10% down payment and approved credit. **Prices for SC61

SPECIAL 10% "FINDER'S FEE" DISCOUNT

FACTORY DIRECT "FINDER'S FEE" DISCOUNT — SAVES YOU 10%

Our recent survey showed us that spring is the time most shop owners, technicians and department heads make the move to update their service bench by investing in new test instruments. With this in mind, we feel it's our responsibility to call you so we can discuss your present and future test equipment needs, new business opportunities, and help you invest in the test instruments that will benefit you most. But let's face it, we just can't get in touch with everyone during this time, especially when you consider the more than 225,000 servicing pros we would have to contact. That's why we have developed this very special 10% Factory Direct "Finder's Fee" Discount, so you can help yourself to Big Savings — Here's how it works.

YOU SAVE 10% WHEN YOU CALL US BEFORE MAY 31st: That's right, our closest calculations tell us that it costs us about 10% more per sale when we call you. But, it costs only a fraction of that if you call us. So we've decided to pass on a big 10% savings right off the top of your purchase if you call us to place your order. It's our way of saying "THANKS" for helping us find you. So choose the instruments you've been wanting most, grab your phone and dial **WATS Free, 1-800-843-3338.** You'll be saving the 10% that it would normally cost us to find you. Think of it as your own Factory Direct "Finder's Fee" — but remember you must call us.

SAVE 30% WITH OUR SPRING ROUNDUP SPECIALS: If you've been doing some spring cleaning around your shop and notice your bench needs some updating, you won't want to miss these three very special "Spring Roundup Specials" we've put together inside this cover. These Spring Roundup Specials can save you up to 30% (no "Finder's Fee" savings on these). Plus, update your service shop for more profitable servicing.

10% "Finder's Fee" Discount

CALL WATS FREE, 1-800-843-3338, TODAY AND SAVE

Whether you're calling us to take advantage of your 10% "Finder's Fee" or to "Round Up" the package that best fits your needs, the time will not be better than now — so pick up your phone, give us a call Factory Direct, **WATS Free, 1-800-843-3338,** today!

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SENCORE NEWS

New **VA48** TV-VTR
MATV video analyzer

walk tough dog troubles out

of any colorTV, video system or video tape recorder... in minutes ...step by step with the all new

PATENTED **VA48 FUNCTIONALIZED TV-VIDEO ANALYZER**

With only 3 leads to lead you all the way

Here is what you can do if you own a Sencore TV-video analyzer

Double your color TV output: Jump your color TV bench service from a national average of 4 sets a day to 6 in one month. Double your output to 8 sets within the first year; as you learn to use the VA48 that makes all TV sets look alike by breaking the circuits down to their basic functions . . . and testing them that way. Your servicing output will be superior, too, without those costly call backs.

Boost your shop income: Increased service with fixed overhead means increased profits as you learn to trust the VA48 to help you pinpoint service problems, particularly in those new, hard to tie down, integrated circuits that often have more than one function.

Whip those profitable "money losing" tough dogs: Turn those tough dog TV sets into "gentle puppies" as you learn to pinpoint troubles to the exact faulty stage in minutes with this new streamlined universal functionalized analyzing troubleshooting

Increase your income by expanding to new video tape recorder service: You'll need only the VA48 to walk the troubles out of new video tape recorders, too. The VA48 provides standard testing signals plus 0 to 30 Volt variable video tape signals for troubleshooting each stage.

Expand to closed circuit TV service: Expand your servicing business further by contracting for closed circuit video system maintenance and repair in schools, hospitals, airports, security systems in retail stores and banking, etc. All signals available to walk troubles out of entire system right up to the input of the CRT.

Get into the profitable MATV & CATV service business, too: Expand into MATV and CATV servicing and maintenance with microVolt controlled special "multi-burst" type standard CATV system checking bar patterns.

W Walker
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Neptune NJ 07753

Bulk Rate
U.S. Postage
PAID
Permit No. 207
St. Cloud, MN

An instrument that will pay for itself the very first month & at 1/3 the cost of equivalent instruments on your bench

up to the video and sound IF detectors for all TV receivers. The output of these signals is controlled by the RF-IF LEVEL attenuator and de-

The DRIVE SIGNAL control (right of meter) selects all substitute injection signals after the

connections. The DRIVE LEVEL attenuator is very unique, because it acts as a double attenua-

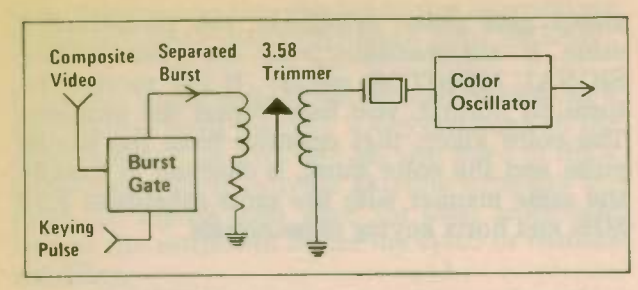

Fig. 35—The 3.58 MHz oscillator trimmer must be properly set for proper APC operation.

set as near the 3.58 MHz signal from the station as possible, so that the APC circuit can operate above and below mid-frequency for maximum control by the color sync. This has normally been done by shorting out the APC circuit and setting the trimmer for minimum "barber polling" on the screen. This can be done quicker and more accurately by switching to BAR SWEEP and switch on the 3.56 MHz color bar only. Turn up the color killer until you see the 3.56 MHz bar in color. Now, adjust the 3.58 MHz trimmer until barber polling stops and the bar becomes solid. You have then "zero beated" the 3.58 MHz oscillator in the TV set against the 3.56 MHz oscillator from the VA48 to give you a difference frequency of 15,734 Hertz. This difference gives you exactly one 360 degree phase shift each time that you move across the screen. That is exactly what you want to produce color bars in absolute sync. Perhaps you have been wondering why we use 3.56 MHz in the VA48 and 3.58 MHz in the TV set. The difference between these two frequencies is what produces your color bars in the first place. All you have to worry about is setting the color bar for a solid color.

Note: Be sure you turn the color killer back down and readjust it when you are finished.

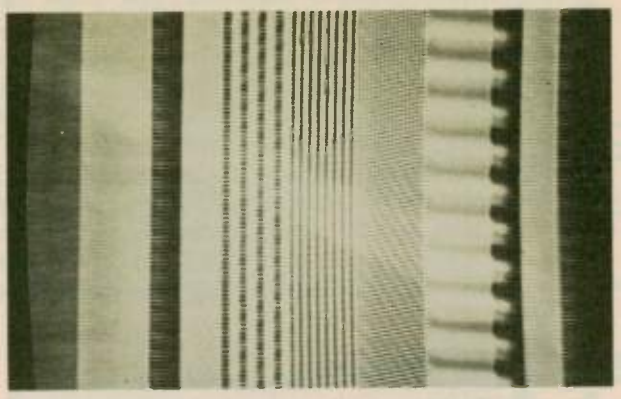

Fig. 36—Adjust color trimmer until barber polling stops.

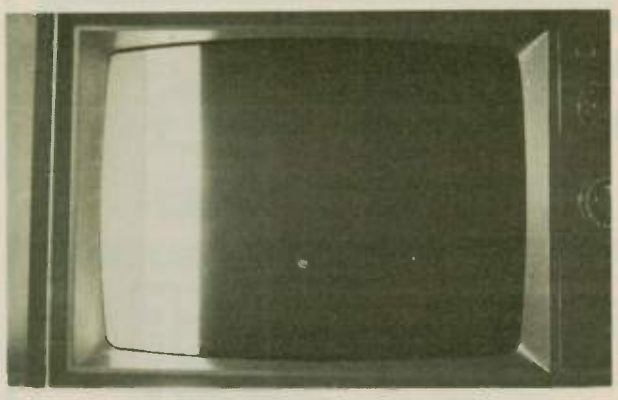

Fig. 37—The VA48 simplifies color tracking adjustments with a pure grey and white bar in addition to the pure black background.

Let us talk about B & W tracking. This, too, can be very time-consuming and one doesn't always know whether he has done it exactly right. The VA48 offers you a streamlined way to set these tracking adjustments, without even flipping the service switch, once again offering a more dynamic setting. Select the BAR SWEEP pattern again and turn off all five Bar Sweep control switches. You will now see only two bars on the left of the CRT. The bar on the left is generated to produce your grey level (that we so often talk about) and the bar second from the left generates your pure white level.

The CRT tracking is done by first setting your brightness and contrast control to normal viewer's setting. Next, turn down all the CRT drive and screen controls. Then turn up the red screen until you just see the color red in the large black area to the right of these two bars (across the remainder of the screen). Then, turn the red screen down slightly until this same area returns to black again. Do the same thing with the green and blue screen controls. Next, look at the white bar (second from left) and see if the bar is truly white. If it has a color in it, simply turn down the screen on that color until the bar is pure white.

Now look at the grey bar. The bar will normally be pink at this point because most sets don't have a red drive control. All we need to do now is turn up the blue and green drive controls until that bar is pure grey. If for some reason, you cannot get a good grey and a good pure white bar, you should suspect your CRT itself.

Can you begin to see why we say that you will cut your service time in half and produce superior service, too?

Question No. 7: Just how thorough is the VA48 in sync circuit testing?

Adjustable positive and negative sync levels, with standard rise time sync pulses, make sync servicing a snap.

Double your output with superior service

Sync circuits do not seem complicated on the surface but can become a real dog if not understood and checked thoroughly. More so, the sync stage in a TV receiver seems to be designed last and any left over IC sections (or whatever) go into this section of the receiver. We are now confronted with tube operated receivers, transistor operated receivers, and integrated circuits, too. Then too, one never knows when he is going to run into a tricky gated sync separator that adds complexity beyond belief because of the wind-up feedback circuits. The VA48 must be able to service all of these receivers, simulate the TV station, and once again, make all circuits look alike for standardized testing.

The sync stages actually begin in the video amplifier, on most receivers (except some Zenith's), because video amplifier limiting is used to clean up the signal for improved operation. This is all well and good if the AGC system is operating properly. If it is not, excessive IF gain will drive the video output stages to cut-off and a compressed (but very clean) sync pulse is produced. The sync separator does not "know" the sync is compressed and the result is that lower frequency black portions of the picture pass through the sync separator producing the "horizontal bends" or wiggles. Once we have eliminated the video amplifier, most of us attack a sync problem from the sync take-off point and our VA48 must have adequate amplitude and correct polarity to feed that point with a composite video signal to check the entire sync system. We have talked about most of the composite video signal, except the sync pulse itself. We think that you would readily agree that the sync pulse should be as good as the pulse at the TV station, if you are to truly rely on it for correct troubleshooting analysis. We, in Sencore field engineering, have been very disappointed in sync pulses generated by other analyzers on the market that remind us more of a "banana" than a true sync pulse square wave. The sync pulse from the VA48 is a genuine FCC, rise time standard horizontal sync pulse; exactly the same as the TV station delivers.

Let us talk about amplitude and polarity for a moment. It is very obvious that you need an adjustable sync output drive signal, with both positive and negative polarity, if you are going to substitute for both inputs and outputs. Amplitude can indeed be a different question, as we must cover all TV sets on the market today and in the foreseeable future, and we must not damage any of them with the VA48. Our field engineering survey on this question told us that a 300 Volt peak-to-peak signal was more than adequate for any sync stages in any tube operated receiver. It was a temptation to simply provide a 300 Volt peak-to-peak drive signal but further testing showed that this potential could easily damage a solid state sync stage. Therefore, the V & H SOLID STATE COMPOSITE SYNC position on the DRIVE SIGNALS switch was restricted to 30 Volts peak-to-peak maximum.

One of the most often asked questions at Sencore Seminars is "What happens if I connect the VA48 to the input of a sync separator, for example, and the normal TV sync pulse is already present?" This is a good question and we will answer it again so that you might be sure. We must agree first that we do not want the TV signal to be present at the substitute signal test point while we're testing. We do want to use the VA48 to tie the input circuits down with known good signals. We do this by using a much lower impedance, in the VA48 DRIVE LEVEL output than the circuits that we are testing so the VA48 substitute signal "swamps" out any other signals present. The impedance used in tube operated sets is always much higher than solid state receivers. This means that the output impedance of the VA48 must be lower on the solid state receiver setting than the tube operated setting. Secondly, these impedances must be chosen so that they swamp the TV signal but do not load the TV circuits. This is how the impedances are chosen in the VA48 DRIVE SIGNALS V & H COMP SYNC positions.

TV sync circuit troubleshooting would often be thought of as one of the simpler circuits to troubleshoot if it were not for the gated sync separators. These rascals complicate sync circuit troubleshooting as the feedback gating pulses from the horizontal output transformer develop a closed loop. One must find a way to tie down troubles in this system where any trouble in one section of the loop reflects to the same trouble throughout the loop. The VA48 comes to your aid on these more complex circuits, too.

(Continued after Buyer's Guide)

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SENCORE NEWS

New **VA48** TV-VTR
MATV video analyzer

walk tough dog troubles out

of any colorTV, video system or video tape recorder... in minutes ...step by step with the all new

PATENTED **VA48 FUNCTIONALIZED TV-VIDEO ANALYZER**

With only 3 leads to lead you all the way

Here is what you can do if you own a Sencore TV-video analyzer

Double your color TV output: Jump your color TV bench service from a national average of 4 sets a day to 6 in one month. Double your output to 8 sets within the first year; as you learn to use the VA48 that makes all TV sets look alike by breaking the circuits down to their basic functions . . . and testing them that way. Your servicing output will be superior, too, without those costly call backs.

Boost your shop income: Increased service with fixed overhead means increased profits as you learn to trust the VA48 to help you pinpoint service problems, particularly in those new, hard to tie down, integrated circuits that often have more than one function.

Whip those profitable "money losing" tough dogs: Turn those tough dog TV sets into "gentle puppies" as you learn to pinpoint troubles to the exact faulty stage in minutes with this new streamlined universal functionalized analyzing troubleshooting

Increase your income by expanding to new video tape recorder service: You'll need only the VA48 to walk the troubles out of new video tape recorders, too. The VA48 provides standard testing signals plus 0 to 30 Volt variable video tape signals for troubleshooting each stage.

Expand to closed circuit TV service: Expand your servicing business further by contracting for closed circuit video system maintenance and repair in schools, hospitals, airports, security systems in retail stores and banking, etc. All signals available to walk troubles out of entire system right up to the input of the CRT.

Get into the profitable MATV & CATV service business, too: Expand into MATV and CATV servicing and maintenance with microVolt controlled special "multi-burst" type standard CATV system checking bar patterns.

An instrument that will pay for itself the very first month & at 1/3 the cost of equivalent instruments on your bench

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Bulk Rate
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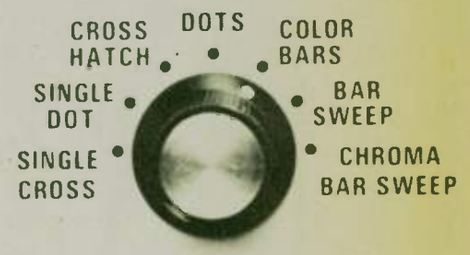
$975 including all cables

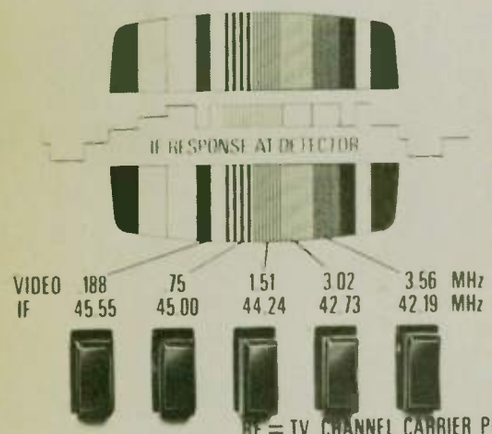
CHANNEL

VIDEO PATTERN

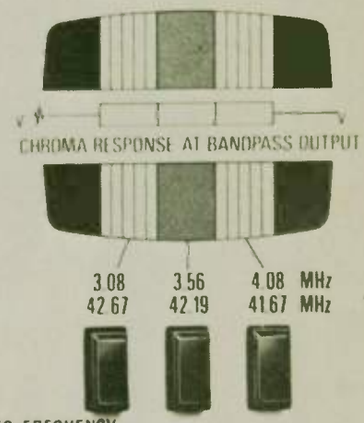


SENCORE
MODEL VA48

BAR SWEEP

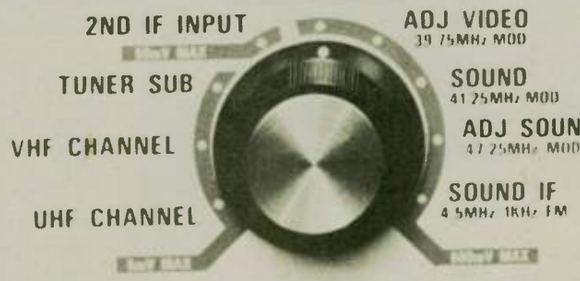


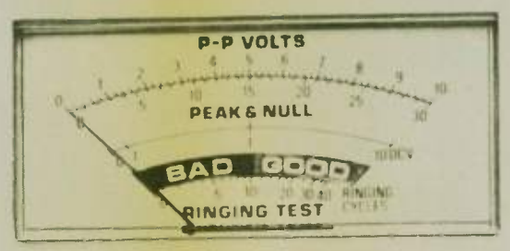
CHROMA BAR SWEEP



RF = TV CHANNEL CARRIER PLUS VIDEO FREQUENCY

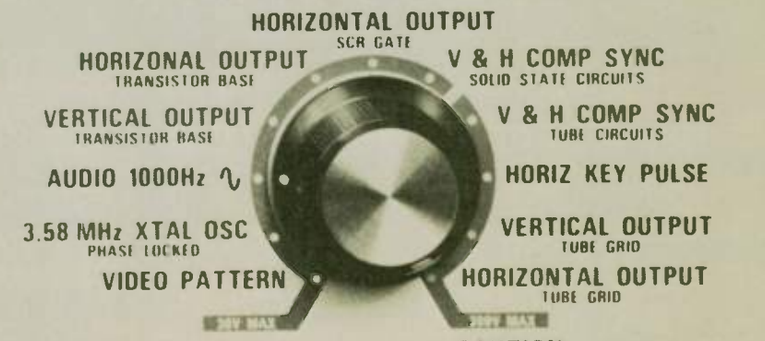
RF-IF SIGNALS





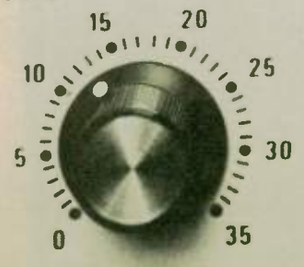
TV-VTR-MATV & VIDEO ANALYZER

DRIVE SIGNALS

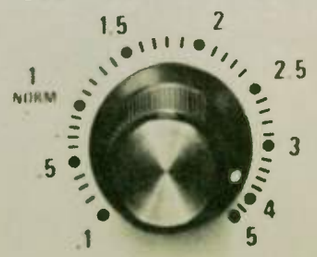


CAUTION: TUBE DRIVE SIGNALS MAY DAMAGE TRANSISTOR CIRCUITS

BIAS & B+ SUB



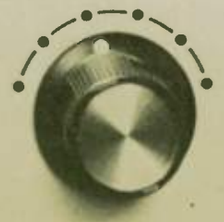
RF-IF LEVEL



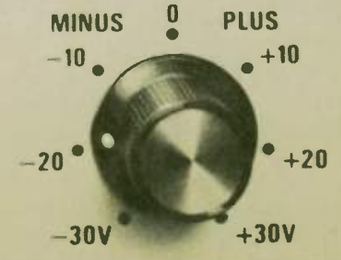
METER

RINGING TEST

IMPEDANCE MATCHING



DRIVE LEVEL



DCV OUTPUT
− +
1 AMP MAX

RF IF OUTPUT

OFF ON

METER INPUT
1000VPP MAX

COMMON

RINGING TEST

VTR STANDARD
1VPP VIDEO INTO 75Ω

DRIVE OUTPUT
DANGER: 300VPP MAX

SENCORE INC SIOUX FALLS, S.D. 57107

105/130VAC 50/60Hz 150W

PATENT NO. 3879491

Covered by U.S. Patent No. 3879491 and No. 3980002

Life size VA48 photo is shown on opposite page for you to refer to as you read through the questions and answers in this Sencore News.

Actual size is shown so you can imagine this instrument on your bench working for you. We suggest you remove this Sencore News front cover and lay it in front of you as you follow the copy. You may want to cut out the photo, mount it on a cardboard, and actually place it on your bench for comparison to your present equipment.

17 Most often asked questions and answers from the Sencore VA48 TV-Video Analyzer seminars

... by Your Sencore Field Engineering Department

Fig. 1—Questions from the audience are answered by Sencore *field engineers* at a video servicing seminar.

Sencore tech reps and field engineers are holding over 1,000 video seminars this year in nearly every city in the USA. We in field engineering prepared the materials for these seminars and attended the first presentations to be sure that we were doing the job with our new video-taped programs. We found that the video tape in full color, does a fantastic job of showing you just how troubles can be walked out of even the toughest TV dog. We found more technicians asking more pertinent questions about TV and video servicing with the VA48. These questions were logged and answers given back to our field people so they might relay the correct answers back to you. These same questions are answered by our field engineering staff in this Sencore News.

In short, the VA48 Analyzer approaches TV service in the most logical and positive way possible, to make each TV receiver look just like the last one. It breaks the composite video pattern into it's basic functions. Then, it provides each of those basic waveforms, or signals, in a variable controlled output, for injection into the stage of the receiver with the same function, for trouble-shooting that stage. We are simply substituting a known good signal for a questionable signal into each function of the receiver. If the receiver returns to normal, we know that the good signal did the job and we located our defective stage. This new functional type analyzing is even more important in today's electronics with integrated circuits and schematics that often don't show voltages, waveforms, or a darned thing to tell you what to expect. The thing that is common to all receivers, even when these integrated circuits perform more than one function, is the function itself. Every TV receiver has to respond to the station signal and the VA48 takes full advantage of this to make every TV test alike.

You will begin to think of the VA48 as a miniature TV station, after you have used it for a short time, because it is just that. Further, each part of the composite signal is phase-locked together, including the 3.58 MHz color signal, so that the

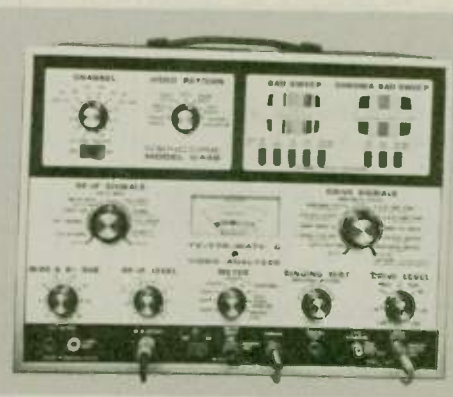
Fig. 2—The advantages of the VA48 single output cable are explained by Sencore Chief Field Engineer Greg Carey.

TV stays in sync for you during your signal injection into subsequent suspected faulty stages.

The new patented bar sweeps simplify servicing even further, as you understand their simplicity in troubleshooting and aligning, or just checking alignment, up to the video and chroma detectors. You will be surprised to find that you can improve the performance of at least 25 percent of all new sets, right out of the factory, with these new patented patterns. What's more, you can check and align, and charge for alignment on every TV in the shop or home, without removing the TV chassis with these new miracle service patterns.

Question No. 1: Does this one instrument, with only three test leads, contain everything that I need to pinpoint troubles in every stage of a color TV?

The VA48 has a signal for every single stage, color or B & W, tube or solid state; it's the only analyzer that does.



Double your output with superior service

The answer is "yes" and with great simplicity. Let us take a look at the front panel to see just how simply this is done. All substitute injection signals are selected by two controls; one on your left and one on your right. The RF-IF SIGNAL (left of meter) control selects all injection signals up to the video and sound IF detectors for all TV receivers. The output of these signals is controlled by the RF-IF LEVEL attenuator and delivered into one single RF-IF OUTPUT test lead. How handy can you get with all RF and IF signals on one control, controlled by one attenuator and delivered out one matched RF-IF output cable? This alone is a tremendous time saver, as you will find out as we move along.

The DRIVE SIGNAL control (right of meter) selects all substitute injection signals after the video and sound detectors. These signals are controlled by the DRIVE LEVEL attenuator and delivered into a common DRIVE OUTPUT jack for injection into all "after detection" stages. Once again, we see the ultimate in simplicity with one control for signal selection, one output control to set the signal level and one output jack for all connections. The DRIVE LEVEL attenuator is very unique, because it acts as a double attenua-

Fig. 3—Duane Shultz, Director of Technical Training begins the explanation of the VA48 by showing the location of the two main function controls.

tor, producing either positive or negative polarity for signal injection into inputs or outputs of any stage in the TV receiver.

So that we might understand the RF and IF signals and where we can use them, let us go through each setting of the RF-IF SIGNAL control switch

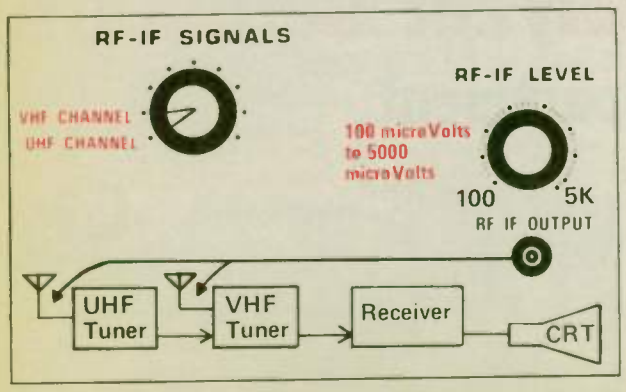


Fig. 4—Injecting the VA48 signals into either the VHF or UHF antenna inputs tests the entire receiver in a jiffy.

and discuss these signals one at a time. The first two settings of the RF-IF SIGNALS switch are used for selecting the VHF or UHF front end channel frequencies (channel set from CHANNEL tuner switch above). We will use one of these settings anytime that we want to inject signals into the tuner input for individual channel checks, overall channel check, sensitivity or gain test of the entire TV system, or just to keep all of the TV stages in sync while we are injecting a detected signal at any stage past detection. The RF signals are modulated with any pattern on the VIDEO PATTERN switch above.

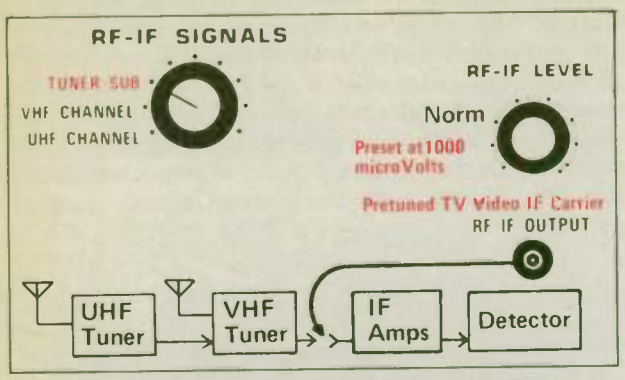


Fig. 5—The microVolt controlled tuner sub signal of the VA48 lets you quickly isolate defective tuners.

Let us turn the RF-IF SIGNALS control to the next position. This position pretty well explains itself as it is labeled "TUNER SUB". This means exactly what it says and is intended for signal injection into the 1st IF stage to substitute for the VHF-UHF tuner. This substitute signal is RF controlled, Xtal controlled at the video IF carrier (so you know that you are always tuned correctly), modulated with one of the patterns selected by the VIDEO PATTERN switch, and preset at 1000 microVolts when in NORM position (for an IF gain check at the same time). The RF-IF level control can be advanced from the NORM position, to 5000 microVolts, for feeding signals through a defective stage. It is easy to see that the VA48 tuner sub is far superior to any off the air tuner sub that relies on TV station signal strength, the antenna, or a distribution system for signal input.

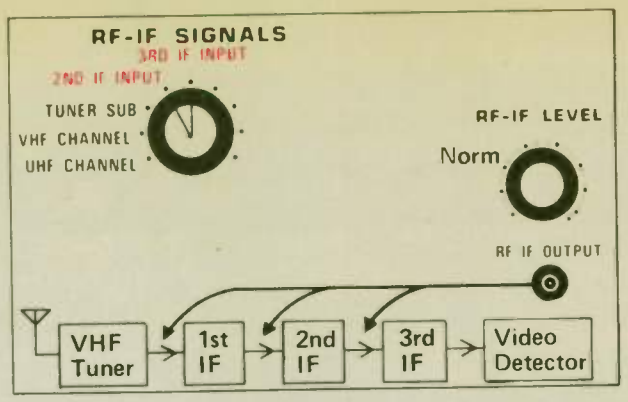


Fig. 6—RF-IF LEVEL automatically presets IF output level to detect low gain in any IF stage.

The next two positions on the RF-IF SIGNALS switch are IF signals for injection into the 3rd IF and 2nd IF which have preset microVolt outputs to determine a 10 times signal gain in each IF stage for a snow-free pattern on the CRT. This 10 time gain check works the same on tube or solid state, because both have the same number of stages and each stage must produce a good picture from the 1000 microVolt output of the tuner. We should already begin to see just how the VA48 starts to make all TV sets look alike to simplify your TV service; in this case tube and solid state IFs.

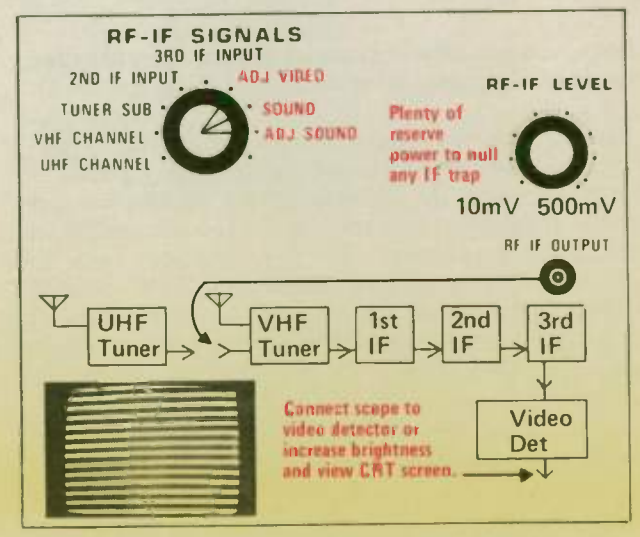


Fig. 7—All crystal-controlled, AM-modulated trap signals produce a pattern right on the CRT to allow rapid testing of trap settings.

Don't gloss over the next three positions on the RF-IF SIGNAL switch until you understand that you have just flipped this control to three of the most often used signals on the VA48. For the first time, in TV servicing history, the VA48 places crystal controlled 1000 Hz modulated trap frequencies at your fingertips for speed setting of the adjacent video, sound, and adjacent sound traps on any modern TV receiver. This feature alone will darned near pay for your VA48 because most IF alignment troubles are misaligned traps because no one had a crystal to set them right "on the nose" before. The modulated bars appear on the TV screen (because of the 1000 Hz detection at the video detector) so you can make all trap adjustments for minimum modulation bars right on the CRT; once again providing a universal test to make all TVs look alike, without removing the chassis.

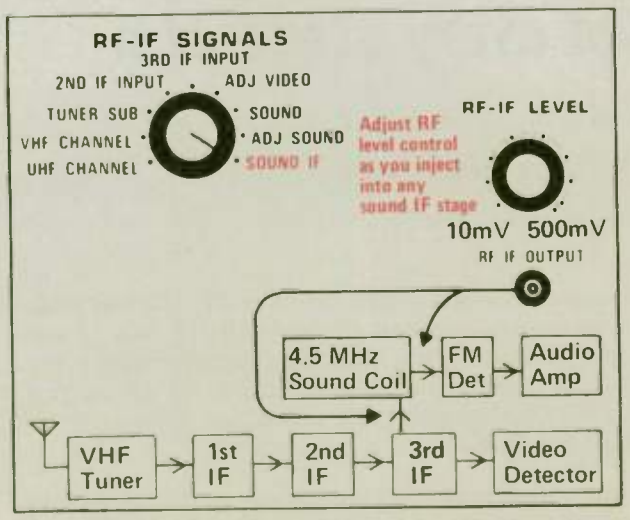


Fig. 8—The 4.5 MHz FM-modulated sound IF signal allows rapid testing or alignment of the sound IF and FM detector.

The last position on the RF-IF SIGNAL control switch does just what it says; it provides a 4.5 MHz, 1000 Hertz tone FM modulated signal for sound IF troubleshooting from the sound IF take-off point through the FM detector. One simply injects signals into any of the sound IF inputs or outputs and adjusts the IF amplifiers for maximum signal. Then, the detector transformer is adjusted for clearest sound. Once again, every sound IF and the FM detector is made to look alike to speed up your servicing and produce superior service.

This completes our discussion of the RF and IF signals on the RF-IF signal switch. It is a good idea to stop and review these signals to see that the VA48 provides you with a controlled substitute signal to pinpoint troubles in every stage up to the detectors.

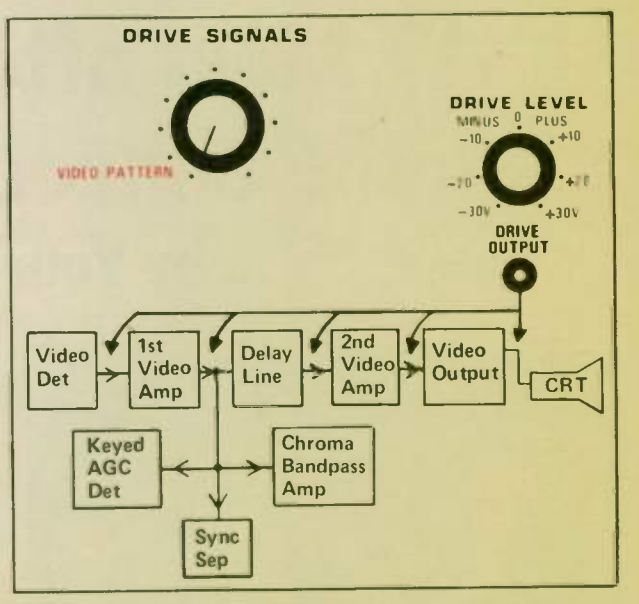


Fig. 9—The universal composite video drive signal is fully adjustable—both in amplitude and polarity—for injection into any stage using composite video.

If you have done this, let us move over to the DRIVE SIGNALS and see how they serve you to speed up your work in any stage after the detectors. The first position delivers composite video signal for injection into the video detector, the video amplifier, directly into the CRT, or into any other video system such as tape recorders and closed circuit TV. The DRIVE LEVEL control delivers 0 to 30 Volts peak-to-peak, positive or negative, composite video into the DRIVE OUTPUT jack for direct substitution into any input or output video stage.

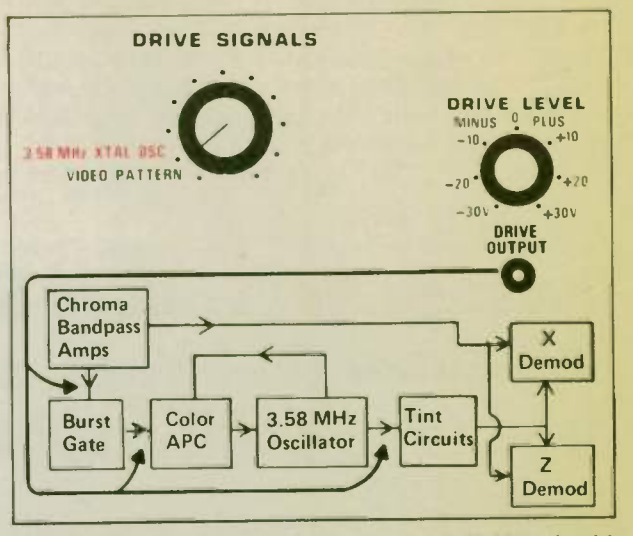


Fig. 10—The phase-locked crystal-controlled 3.58 MHz signal is used to substitute for any color subcarrier signal to simplify color servicing.

The next position of the DRIVE SIGNAL switch moves you from the video amplifiers into the chroma section with a "3.58 MHz XTAL OSCILLATOR" that is phase-locked to the other signals in the VA48. Once again, we can produce either positive or negative phased signals for injection directly in place of the 3.58 MHz stages. This handy tool enhances your technical capability beyond belief as you substitute in the chroma stages and see if the 10 color bars pop back on the screen when you have located the defective color stage.

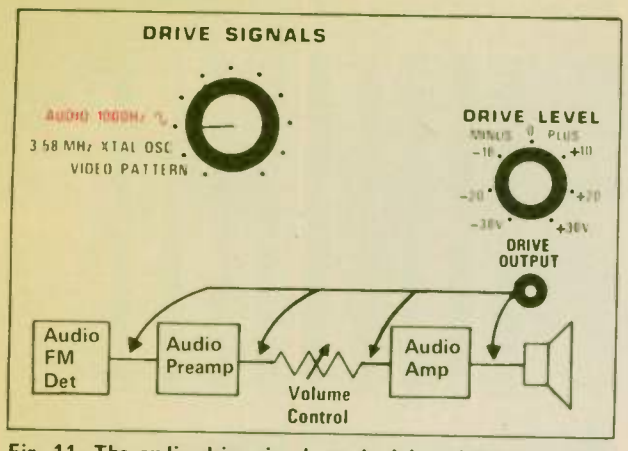


Fig. 11—The audio drive signal can be injected into any stage, including the speaker for complete audio troubleshooting.

No analyzer would be complete without audio analyzing capabilities. That is just what the 1000 Hz audio sine wave signal in the next position of the DRIVE SIGNAL switch is used for. Adequate power is available to drive any audio stage, including the speaker itself. You simply substitute audio signals stage by stage, from input to output, and listen for a clear tone, all the way to the speaker.

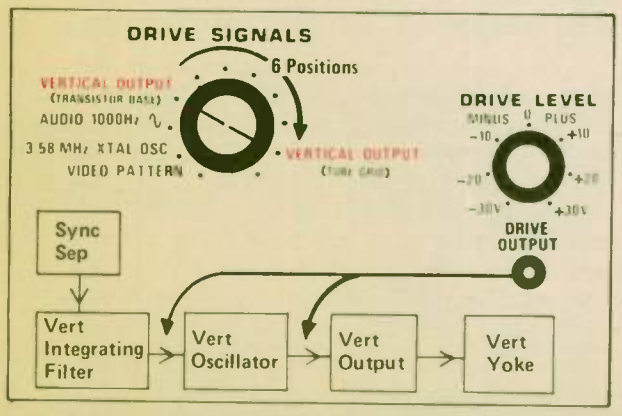


Fig. 12—Two drive signals are available for pinpointing vertical problems. The signal level is automatically switched from 30 to 300 V P-P (max) by the Drive Signal switch.

The next position on the DRIVE SIGNAL switch is the VERTICAL OUTPUT signal that is used to inject a synchronized vertical pulse into the transistor base to see if you achieve full height on the TV screen. "Now wait a minute," you say, "this says transistor base and there just isn't any transistor base on a tube-operated set, is there?" Well, stay with us a minute and move your eyes over to 6 snap positions of the switch to your right. You come upon another VERTICAL OUTPUT position that is designed to drive tube grids. Both VERTICAL OUTPUT signals are fully adjustable, in both polarity and amplitude for injection into any vertical output stage. The VA48 provides drive signals for both tube and solid state receivers and is the only analyzer on the market that does.

Okay, will you "snap back" with us to the next position on the DRIVE SIGNAL switch labeled HORIZONTAL OUTPUT and subtitled "transistor base?" This position is used to drive the horizontal output transistor base directly on solid state sets that use a transistor output. The next position of the switch is used to drive horizontal outputs on TV sets that use SCR (Silicon Con-

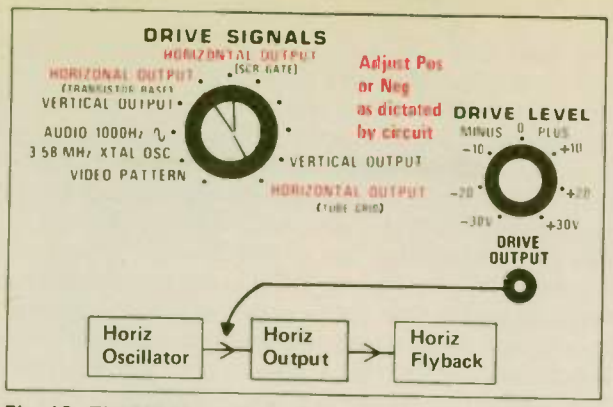


Fig. 13—The VA48 produces three special horizontal drive signals to match the three types of horizontal output amplifiers.

trolled Rectifiers). Here is where you might have a little difficulty because Sencore does not control the TV industry. These transistors and SCR's look alike but act differently. You must identify these horizontal outputs before you select the drive signal. The schematic will tell you the difference in a hurry, but that is the only way we know to tell for sure. Sencore is the only manufacturer that provides you with the correct drive signal for tubes, transistors, and SCR's. All you have to do is increase the drive signal level after selecting tube, transistor, or SCR, and see if you finally get a full raster. If not, the problem is not the drive signal in the TV but rather the TV output stage. You may be concerned about selecting a positive or negative signal for horizontal output drive if you don't have a schematic or another form of identification. Don't worry about that. Use the full range of the control, if you want, as you will do no harm in the opposite polarity if you simply move through the control without letting it sit in one position on the opposite polarity.

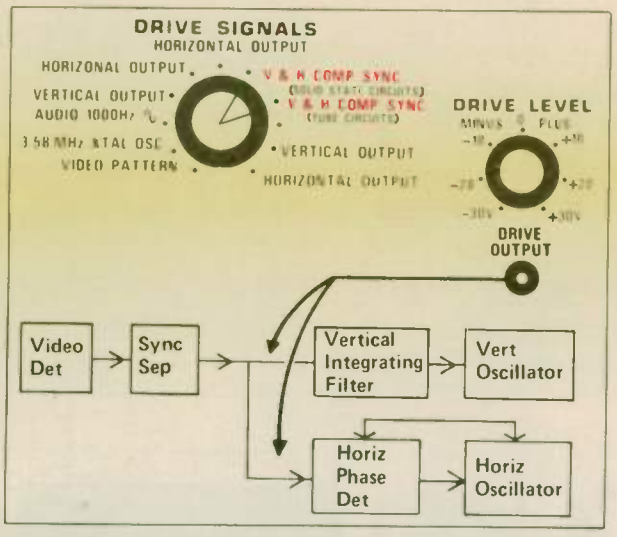


Fig. 14—Two composite sync signals allow direct substitution in tube or solid state circuits. Both positive and negative polarities allow injection into inputs or outputs.

The next position on the DRIVE SIGNAL control is V & H COMPOSITE SYNC. The subtitle is "solid state circuits". This position is used for exactly what it says and you are not restricted to any stage, input or output, from the sync take off point to the vertical or horizontal oscillators. The next position is V & H COMPOSITE SYNC and the subtitle is "tube circuits". We certainly don't feel that you will have any difficulty identifying tube or solid state receivers. Once again, Sencore is the only company that provides the correct universal sync signals with proper matching impedances, for both tube and solid state. Put another way, the Sencore VA48 Analyzer is the only up-to-date TV analyzer on the market today.

We have moved you back and forth across the DRIVE SIGNAL control, from tube drive signals to solid state drive signals. It might seem that the control does not have continuity because you are moving back and forth as you study the control. Quite the opposite is true as all solid state signals are together and all tube signals are together. You simply select the set of signals you need for the receiver you are working on. At the same time, you can jump back and forth if you are servicing a hybrid receiver. Note that all tube drive signals are tied to a red band. This is simply a warning that you are delivering higher voltages in these positions so you don't accidentally use them when servicing solid state. Lower voltage positions are all identified with a blue band.

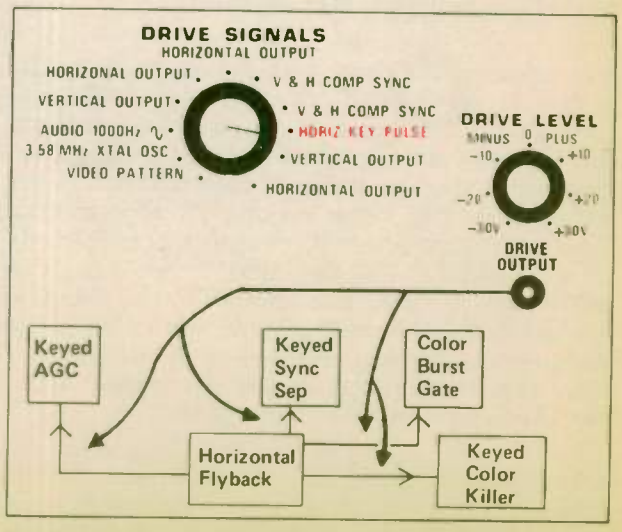


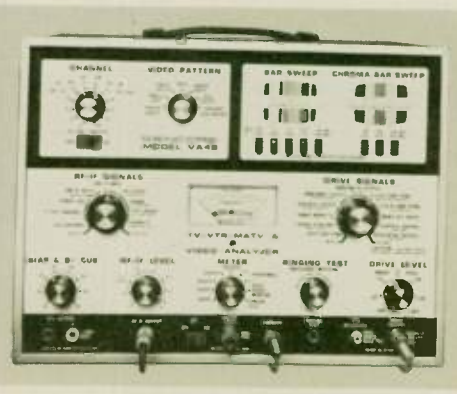
Fig. 15—The horizontal keying pulse rounds out the VA48 drive signals and substitutes for the different keying signals supplied by the flyback transformer.

Let us move to the last signal we will discuss on the DRIVE SIGNAL control switch. We see a HORIZONTAL KEYING pulse, that can be adjusted positively or negatively for tube or solid state, from zero to 300 Volts PP. This pulse is phase-locked to all other signals, for direct substitution in any circuit that uses a flyback gating pulse. What a handy signal to have to open up gated or keyed stages throughout the color TV receiver, and it is right in step with the other signals (because it is phase-locked), so you know that you are opening up the stages at exactly the right time.

We hope that we have shown you that we do provide a signal for each and every function in the TV receiver, tube or solid state, and so far have only needed two output cables. The third is explained later when we come to checking the yoke and flyback, using the peak-to-peak meter for signal tracing, etc.

Question No. 2: I understand the RF, IF, and Drive Signals, but what do I see on the TV screen? What modulation patterns do you use?

The VA48 uses all standard color patterns found in all popular service instructions and schematics. There's nothing new to learn.



Double your output with superior service

The VA48 uses five standard electronically generated test patterns. We, in field engineering, had a great deal to do with that decision because our engineers only knew what the test pattern used on the B & K TV Analyzer didn't do. They knew that it was fun to be able to insert different slides and look at yourself, but that became rather old after awhile. They also told us that a flying spot scanner is not the best thing in the world for res-

olution and that the old Indian head test pattern didn't always come out with frequency wedges that were usable for a good TV performance check. They also pointed out that the photo pick-up tube will drop in efficiency after six hours of use and contrast and brightness start to fade. The small advantages were simply outweighed by the disadvantages and we all agreed that an all electronic pattern had to be the answer.

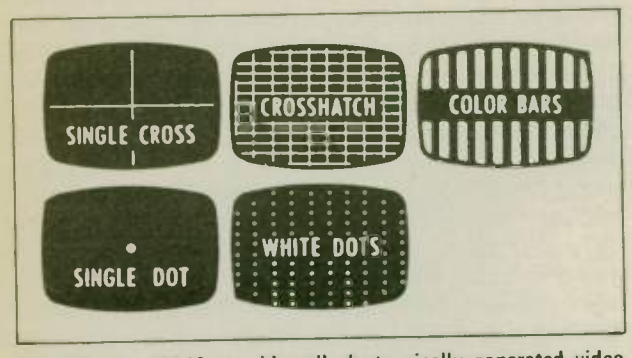


Fig. 16—The VA48 provides all electronically generated video patterns. Standard color bar generator patterns are used to allow standard servicing literature to be used directly.

Not knowing the exact patterns required, we did a market survey and our customers told us as they said "Sure, give us an electronic pattern, but be sure that it is something that we can identify with. Give us standard patterns that we are all familiar with when making TV adjustments. Give us patterns where the waveforms are already on all schematics, be they from Howard Sams or otherwise." Our customers won and all standard electronically generated patterns were used in the design of the VA48.

The first pattern we needed was a single cross to center the picture and to check the static convergence. But, there are those who just don't like to check static convergence with a cross, even though it works pretty well, and insist on a fixed dot in the center of the screen. So, the next pattern produced was a single fixed dot, dead in the center, to satisfy our "dot-oriented" friends. Flipping the switch one position to the right produces a crosshatch pattern with true square segments for better tests on picture linearity and pincushioning as well as full screen convergence. One more flip of the VIDEO PATTERN switch and the screen lights up with 315 bright, sharp dots.

The fifth position of the VIDEO PATTERN switch, just above the meter, is our standard RCA licensed 10 color bars. We have proven to ourselves that these 10 color bars are generated to NTSC phases, are better understood than any NTSC signal, and will work in any place that calls for an NTSC generator. The only argument with this is that the RCA system uses the 12th color bar instead of a "zero reference" color burst to synchronize the color oscillators in the color TV receiver. This does not prove adequate for synchronization checks on video tape recorders. Therefore, our engineers modified the standard RCA licensed 12 bar system by removing the 12th bar and replacing it with a true, "zero reference", color burst signal of proportionate amplitude to simulate the NTSC system. It is important that you understand that the color bars on the VA48 are not the same as on a standard 10 color bar generator, but are especially made to equip you for video tape recorder service. Phase-locked signals produce a superior color bar, too, with rock solid sync and no "running" color bar edges.

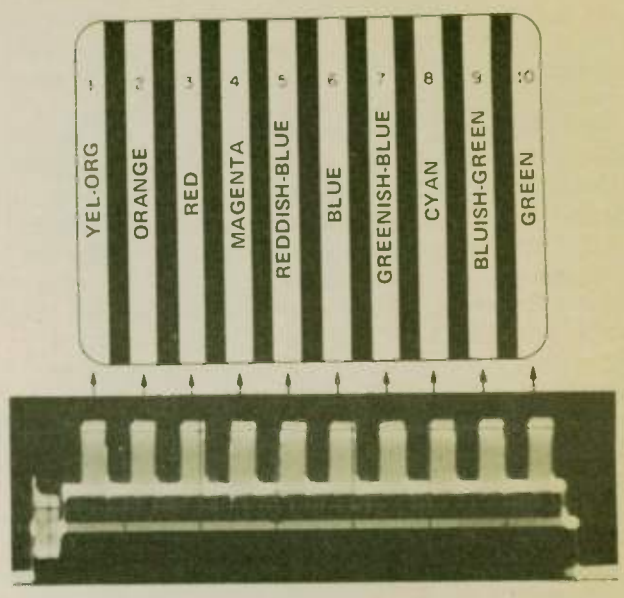
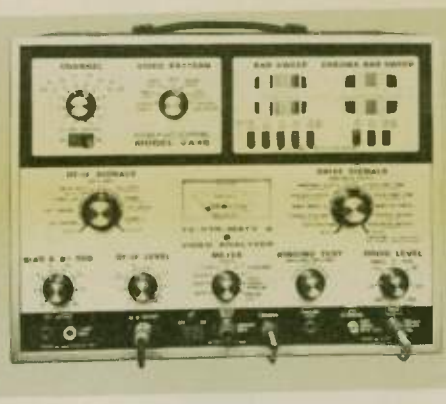


Fig. 17—VA48 rainbow color bars signal provides 10 standard bars plus color burst signal on back porch. NOTE: The first and tenth bars may not be visible on some TV screens due to overscanning.

Standard patterns mean faster, superior service because you are working on patterns that you are familiar with. You have nothing new to learn, and you can find the waveforms on any standard schematic. Further, service literature from TV manufacturers does not have to be altered, and perhaps more importantly you need no other deluxe color bar generator on your service bench.

Question No. 3: What about that Bar Sweep pattern? What is it and where do I use it?

The Bar Sweep provides a fast, accurate alignment check from the antenna terminals through the CRT, with no need to pull the chassis.



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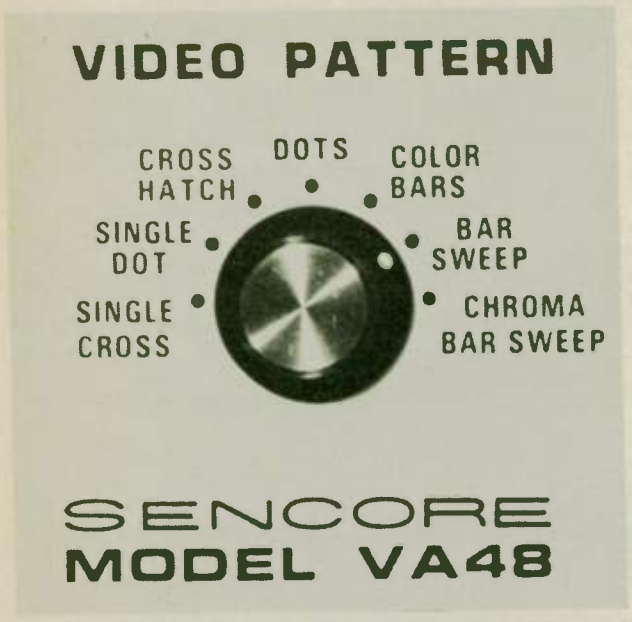


Fig. 18—The Video Pattern switch selects the standard color bar generator patterns or the two special Bar Sweep patterns. The same pattern modulates the RF or IF generator and is also available as a composite video drive signal and as a 1 Volt P-P signal at the "VTR Standard" output jack.

We didn't cover the Bar Sweep pattern when we talked about the standard patterns, because it is in no way standard. This unique new development will simplify your RF and IF troubleshooting beyond your fondest dreams. More so, the patterns will enable you to check alignment and frequency response from the tuner through to the CRT. Not only can you check alignment, but you can realign in just fractions of the time that it takes with a sweep and marker. The Bar Sweep system differs greatly from a sweep and marker because it checks the system with a dynamic signal across the TV bandwidth. The bar sweep actually harnesses up the circuit, just like the TV station does, to see if the TV receiver will respond to all the video signals generated by the TV station. We think that we can help you understand and appreciate this new patented dynamic test method if you will review the video system with us from the camera to the CRT.

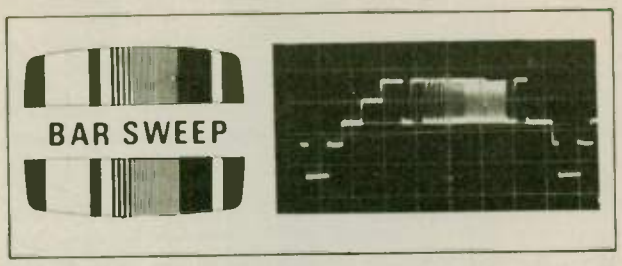


Fig. 19—The Bar Sweep is similar to the "multiburst" signal used by TV stations to test the frequency response of their transmitters. The frequencies and amplitudes of the Bar Sweep have been selected to produce equal amplitude bars at the video detector of a TV receiver when the IF stages are properly set.

THE CAMERA:

Let us look at a monochrome camera for simplification (because color cameras are simply three monochrome cameras combined with color filters) and see just how our camera looks at the video spectrum.

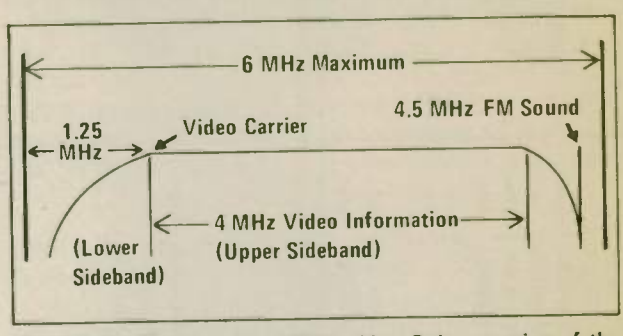


Fig. 20—A TV channel is 6 MHz wide. Only a portion of the lower sideband is transmitted in vestigal type transmissions to prevent the total signal from causing adjacent channel interference.

The FCC restricts every station from using more than six megaHertz in a given channel. The TV video carrier is located 1.25 MHz up from the beginning of the allocated channel. The video information, that modulates this carrier is limited to four megaHertz before it must be attenuated to leave enough room, at the high end, for the sound. The important point here is that we are always limited to video information from 0 to 4 MHz, because the FCC says so.

Just what does this four megaHertz video information give us in real practical terms? What can we see? What can we sell the customer? Note that we didn't say that a four megaHertz signal was any real criteria. We said that all video modulating frequencies from zero to four megaHertz were important. Let us have a good look at what these frequencies represent in real video inform-

ation as we move from zero to four megaHertz. We have drawn a set of modulation bars that move from zero to four megaHertz so that you might reason this out with us. Beginning at zero change in video signal, we find that our beam doesn't change in intensity (as it moves across the screen) at all, and we are talking about solid black backgrounds. There really is nothing to learn here unless we make the mistake of having AC coupling in our video amplifier and lose the DC level. But, let us move up from zero modulation to some video modulation that we are familiar with. One of the standard low frequency bars that you will encounter is the color bar generator that has 10 bars exhibited (and two during retrace). These bars interrupt the beam 12 different times as they move from left to right and back through retrace and represent a modulation frequency of 188 KHz (the 15,750 Hz horizontal sweep x 12). 2 bars appear during the 13 percent of the time that the beam is retracing; 10 bars appear during the 87 percent of the time that the beam is tracing the pattern on the CRT. We have drawn these ten bar interruptions (during trace time) on a graph in Figure 21 for you to study and compare to other modulation frequencies on the TV screen. This simply represents any object in the picture that fills about one-tenth of the screen, such as ten soldiers that we have drawn in here for comparison.

Let us move to a higher frequency of 40 interruptions as the beam moves across the screen. This represents a frequency of .75 MHz away from the video carrier, and interrupts the screen once every 1/40th of the time across, duplicating scenes like the neckties on each of the soldiers. Note: The video modulation frequency is always calculated by multiplying the horizontal sweep frequency (15,750) times the number of times the horizontal sweep is interrupted (40) by the video beam, and adding 13 to 14 percent for retrace time, to determine the total number of video interruptions per second. This gives us the modulating video signal frequency. These calculations will not come out exactly on the cycle because different TV receivers have different retrace times and retrace time must be estimated. The main issue is that you do get forty interruptions on each TV, but some may overscan a bit.

If we understand our beam interruptions and relationships to modulating frequencies at this point, let us double our interruptions from 40 to 80 beam interruptions across the screen. These interruptions will be caused by a modulating frequency of 1.5 MHz, and represent a smaller object, such as the bayonet on the end of the soldier's rifle or some such object of that relative size to the overall picture width.

We are now getting down to pretty small details as we pass the 1.5 megaHertz (bayonet) reproductions but we are sure that you wouldn't be satisfied to stop there because many smaller objects, such as the hair on the soldier's head, the edge of his coat, or even the press in his pants, must paint a sharp, clear picture. Let us double the interruptions from 80 to 160 during trace time, for this fine detail, and multiply this times the sweep frequency of 15,750 Hz (and add 13 to 14 percent for retrace time) and we arrive at a modulation frequency of 3 MHz. We can now reproduce the hair on the soldier's head, as shown in the graph, and we have pretty well painted our picture from the largest video interruptions to the smallest detail that modulates the CRT beam. It becomes apparent that we must pass from near zero to 3 MHz video with equal amplitude to paint a clear black and white picture on the CRT.

3 MHz will normally result in a satisfactory B & W picture and almost no B & W receivers attempt to reproduce beyond that because the 3.58 MHz color signal begins to interfere and tuning becomes critical. Color receivers are different and must add color with the 3.58 MHz color subcarrier. The 3.58 MHz subcarrier will interrupt the CRT beam at even greater detail; actually

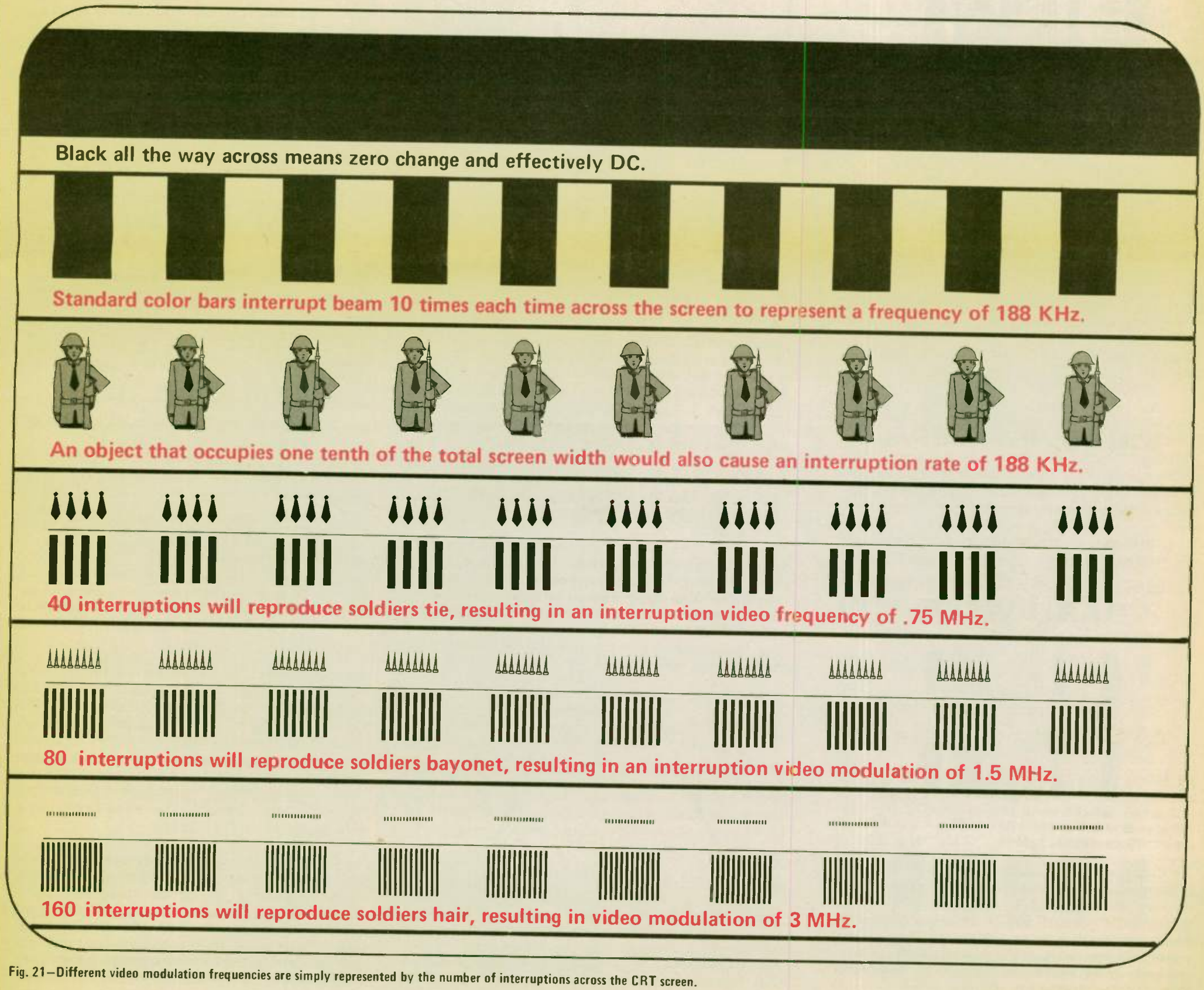


Fig. 21—Different video modulation frequencies are simply represented by the number of interruptions across the CRT screen.

197 times. The 3.58 MHz color carrier is of little significance to the monochrome check and, therefore, we do not show this modulation on this monochrome diagram. The 3.58 MHz signal is designed to "spin the color wheel" and paint color into the black and white detail. Very little 3.58 MHz signal actually gets to the CRT because the video amplifier has a trap to eliminate picture interference. A small amount feeds through the video amplifier because the 3.58 MHz trap is not 100 percent effective.

One does not have to interrupt all the way across the screen to prove that the video system will respond to one of these modulation frequencies. As a matter of fact, the video picture is randomly made up of all of these modulation bars from zero to over three megaHertz as it moves across the screen each time. So, why not simply modulate the beam with 10 interruptions for awhile (to represent 188 KHz), then another period of interruption of 40 times for a period of time (to represent .75 MHz), then an 80 time interruption for the 1.5 MHz check, then 160 time interruption for the 3 MHz check, and finally 197 for the 3.58 MHz color check.

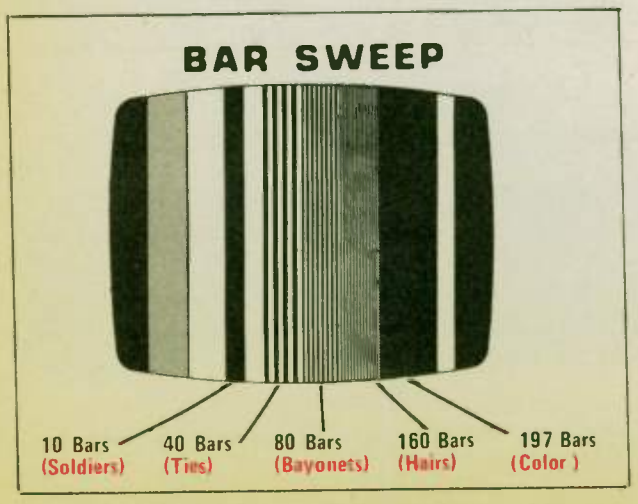


Fig. 22—The Video Bar Sweep provides samples of each interruption frequency from 10 to 197 bars to produce a dynamic check of the video frequency response.

Now, look at the Video Bar Sweep from the VA48 and note that each bar does exactly this as it precisely modulates the video carrier to sweep across the entire video system to ascertain whether that system will reproduce from zero through the 3.58 MHz color subcarrier. Does this take the mystery out of the Sencore patented bar sweep for you? It actually isn't a sweep and marker, but rather a dynamic simultaneous presentation for checking frequency response of the entire system. Yet, it performs the same function in a truly dynamic way, without connecting bias boxes or upsetting the circuits.

Now that you understand just what these bars are, we want to be sure that you can identify

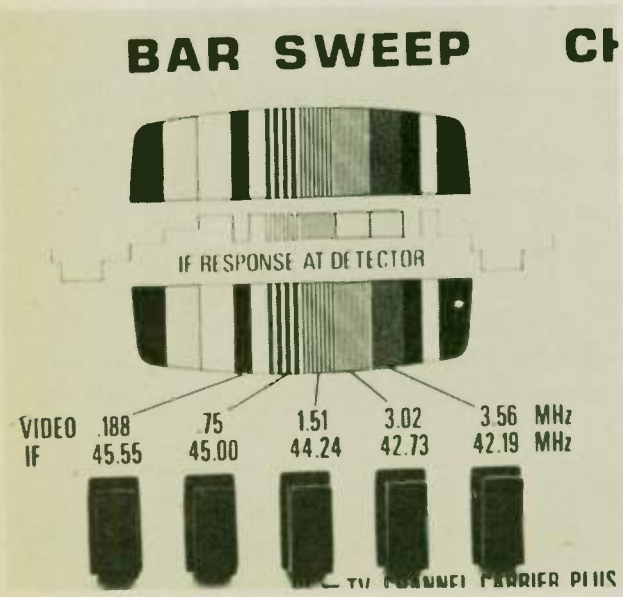


Fig. 23—Bar Sweep buttons select desired frequency bars when pressed in. Buttons will lock in place. Both the video interruption frequency and the corresponding IF frequency are shown above the buttons for reference.

them easily by doing two things: (1) Showing the pattern on the front panel of the VA48 and identifying the frequency of each bar. (2) By giving you an interruption switch, identified with the interruption frequency for each bar, so you can turn each bar off and on for further positive identification on the TV screen. Incidentally, the interruption switches serve another purpose too, as you can turn all bars off and leave only one bar (if you want) for stagger tuned stage setting or individual stage troubleshooting. You will find that each bar is tuned close enough to each of the stagger tuned stages for setting them, high, low, and "rocker stage" without referring to a schematic.

Before we leave the makeup of the bars in the bar sweep, take note of the shape of each of the bars. These could easily have been sine waves for every application to this point in our discussion. As a matter of fact, a sweep and marker generator generates only sine waves and here is where the small square bars in these interrupting signals are far superior. You can often align a TV receiver with a sweep and marker generator, flip on a TV picture and our soldier and all his detail are showing but the edges of his coat, his bayonet, or rims of his glasses are reproduced twice, three times, or even more as the IF circuits

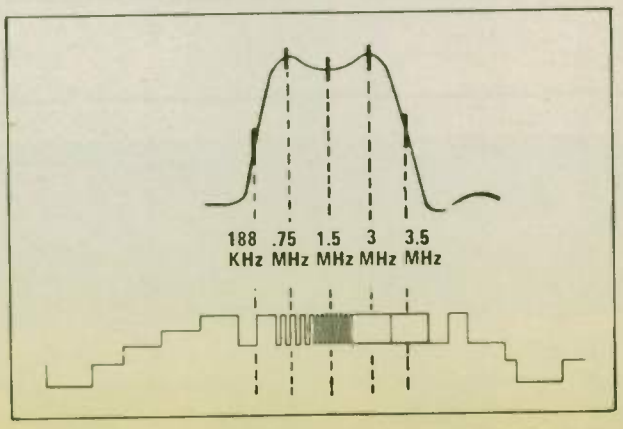


Fig. 24—The Sencore Bar Sweep uses sharp square waves to test the entire system for ringing. Sweep and marker checks video IFs with sine waves only that do not check ringing.

ring with these sharp wave fronts. So, why not present the video system with sharp front square wave bars, the same as it will have to contend with from the TV station, to simultaneously check circuit ringing when you are aligning? That's exactly what we do on the VA48 and there never is a doubt about the picture not looking as clean as the pattern when you get it back to the customer's home. You will do much superior service, and the picture will often look better than when it came from the TV factory.

Okay, so you know what the bars are all about, you know why they are square, you know that the modulation patterns move away from the carrier in an exponential manner, and you know that you have yourself a truly dynamic check from the antenna terminal to the video detector. We should be asking ourselves just one more question: Can these bars all be the same amplitude if we feed them into the antenna terminals of a TV receiver? Let us reason this together to see the amplitudes each bar should be in relation to the other bars.

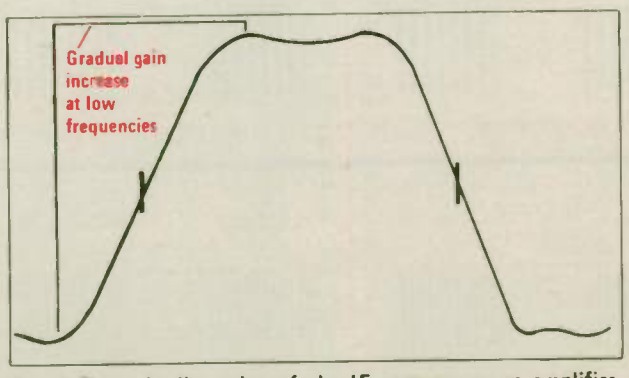


Fig. 25—The leading edge of the IF response curve amplifies lower frequencies less than upper frequencies.

The overall response curve of a TV receiver is not flat from the video carrier to the 4 MHz point. As a matter of fact, the video carrier is down at the 50 percent point on the leading edge of the response curve. The IF response curve has the same overall characteristics and should look just like the overall. Let us use the IF response for simplification purposes (you can do this in actual practice, too). Let us apply the 188 KHz signal. Note that the 188 KHz signal falls on the IF response curve just above the video carrier. One would begin to think that you should deliver a bar with additional amplitude for the CRT to see a bar that is the same height. This is not true for one simple reason. Vestigal side band transmission (not transmitting the lower sideband under 1.25 MHz) causes all TV manufacturers to detune the IF response below the 1.25 MHz area because both upper and lower sidebands are present to beat against the carrier in the detector at the lower video frequencies only. This produces double power, at these lower frequencies, and this

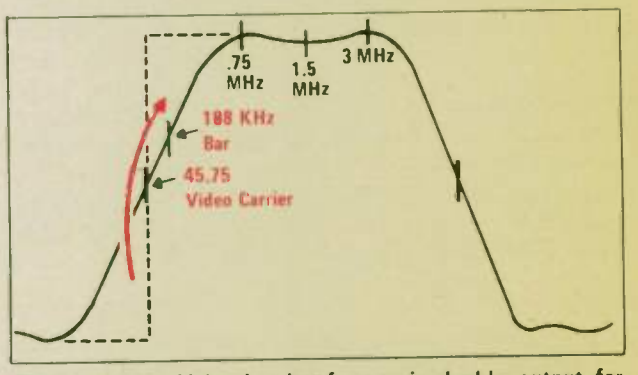


Fig. 26—Double sideband on low frequencies doubles output, for those frequencies only, resulting in even output at video detector.

doubles the output at the detector. Therefore, our 188 KHz signal produces double power and the portion below the carrier adds to the portion above the carrier to give a resultant flat output. The next modulating bar of .75 MHz just reaches the top of the response curve and has virtually no lower sideband to add to the total detector output. The transmitter may actually transmit below the .75 MHz lower sideband level but TV receivers are tuned to pass only .75 MHz of this video information. Let us see what happens if we use a sweep and marker to check these frequencies under .75 MHz. We have to visualize this lower sideband power, superimposed on top of the de-

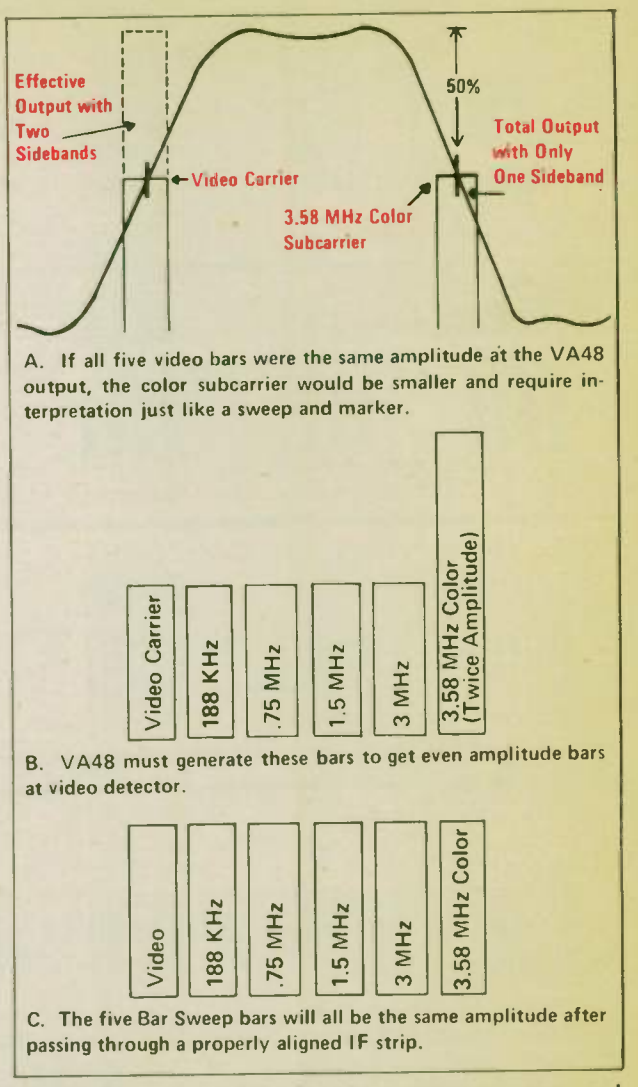


Fig. 27—Comparison of the Bar Sweep pattern to a sweep and marker curve.

tuned portion of the IF response curve. We really have no positive check on this very important lower frequency portion of the video IF system with a sweep and marker. The check is made very simply with the VA48 by adjusting for equal bar amplitude at the video detector to see that upper and lower sidebands, added together, result in the same amplitude as it did at the TV station.

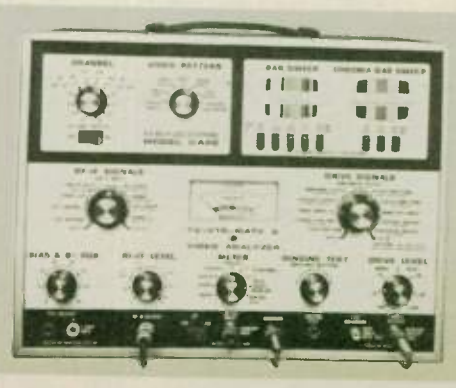
There should be no mystery about the next modulating bar of 1.5 MHz because it falls outside the double sideband area, as does the 3 MHz bar. Therefore, the 1.5 MHz and 3 MHz bars fed into the IF should be equal amplitude for proper circuit check. The 3.58 color bar is a "horse of another color" because it is detuned, just like the video carrier, on all modern TV receivers, about 50 percent of the way down the response curve. An equal amplitude bar here will produce only a half amplitude bar at the video detector (if that is where we wish to view it). The 3.58 MHz bar amplitude is doubled in amplitude from the VA48, to make it possible to simply adjust all bars to the same amplitude, at the video detector for a fast positive alignment check from the antenna terminals to the detection point. This is one more way that the VA48 makes all sets look alike; it simply disregards all the circuit differences and standardizes on the station signals for flat detection. This means that you can align any kind of TV receiver without ever having to look up a response curve again, connect a battery or bias pack to the AGC buss, touch up the TV set on a picture off the air for ringing, or remove a chassis for alignment only. That's one reason why we claim that you can double your service output with superior service quality.

Let us go one step further: How many times have you aligned a TV set video IF response curve, with a sweep and marker, picture perfect but snapped on the picture and it wasn't perfect? How many times have you wished that you could check that darned video amplifier to see if it was reproducing what you had at the detector or was causing the ringing? Here is where the VA48 is really handy as all you have to do is remove your scope from the video detector (after you have equal bar amplitude at the video detector) and view these bars right on the CRT. A bad peaking coil will be detected in seconds because you have effectively purchased yourself a video sweep generator as well. As a matter of fact, you will find yourself seldom connecting to the video detector for alignment checks or touch up and doing everything right on the TV screen. If the TV video IFs can't be aligned for good equal bars on the CRT, you will suspect the video amplifier and then connect a scope to the video detector to isolate your problem. If you wish to check the video amplifier only, these same bars are available from the DRIVE SIGNAL OUTPUT for injection directly into the video detector.

Couple this knowledge with what you learned in the previous section (about signal injection into the tuner and IF stages) and you will have the greatest troubleshooting tool that you have ever put on your bench. This is particularly true when you come to realize that stagger tuned stages just happen to be tuned very near the .75 MHz, 1.5 MHz, and 3 MHz bars in the first place. You can use these new patented bars to set the stagger tuned stages or check them out for gain and reproduction capabilities as you interrupt the bars with the individual bar switches.

Question No. 4: What about the Chroma Bar Sweep? How do I use that and where?

The Chroma Bar Sweep checks or aligns the chroma bandpass amplifier in seconds.



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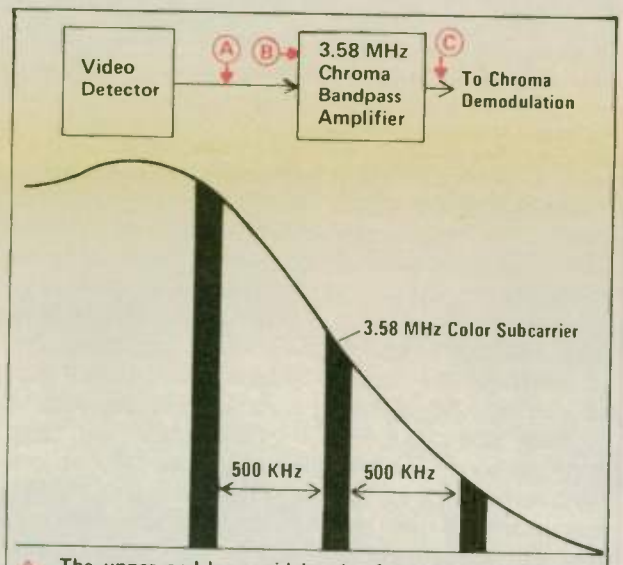
I hope that we have shown you that you aren't really aligning when you use the Bar Sweep, you are resetting the amplifiers where they should be to respond to the station TV signals and using this principle to troubleshoot, too. Yet, you can charge for an alignment because you have done the same things without going through all those time-consuming steps. The Chroma Bar Sweep works in the same way and is used for troubleshooting, checking out the response of the chroma amplifiers and simply seeing whether or not the modulation in that section of the signal reproduces color to your satisfaction. Let us look at a Chroma amplifier to see just what it is supposed to do.

The chroma bandpass amplifier is tuned to 3.58 MHz to extract the color information from the video signal. All chroma amplifiers have a frequency response of 1 MHz; 500 KHz above the 3.58 color signal and 500 KHz below. The chroma bandpass should be checked with a three bar system; one at 3.58 MHz, one bar 500 KHz below (3.08 MHz), and one bar 500 KHz above (4.08 MHz). The output of all chroma amplifiers should produce equal amplification of both the upper and lower color sidebands. But, we learned in the previous section that, since the 3.58 color signal was detuned to the 50 percent point in the IF response curve, the 3.58 MHz bar will have half amplification. This is compensated for in the chroma bandpass amplifiers by creating a frequency response curve that is exactly opposite to the "roll off" in the video IF response. Feeding our equal amplitude bars into the chroma bandpass amplifiers directly results in uneven bars at the chroma bandpass output. We can feed these even chroma bars into the chroma circuits directly to isolate troubles to the chroma bandpass amplifiers but this is not very handy when you want to check or align the bandpass amplifiers because of the uneven output.

Chroma amplification actually takes place (at the higher end of the video response) from the tuner, through the video IFs and then through the chroma bandpass amplifiers. If we are going to check the entire system, to see just how the color signal is amplified in relation to the other video



A. The upper and lower sidebands of the chroma subcarrier receive different amounts of amplification in the video IF stages because of the roll-off of the frequency response.

B. The frequency response of the bandpass amplifier is just the opposite of the IF curve. If equal amplitude bars were fed into the bandpass input, the result would be uneven bars at the output.

C. When the bandpass amplifier curve is added to the chroma section of the IF curve, the result is equal amplification.

Fig. 28—The chroma bandpass amplifiers compensate for the uneven amplification the color signals receive in the IF stages.

information, we need to check from the tuner or input to the video IF amplifiers. But, if we use our BAR SWEEP pattern (not the Chroma Bar Sweep) to inject into the antenna terminals, we

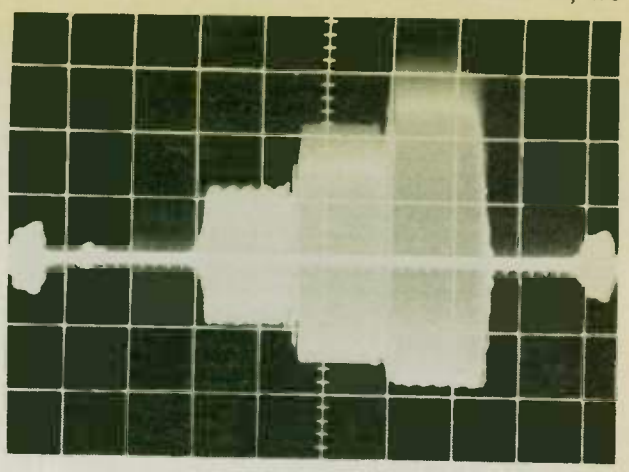


Fig. 29—The Video Bar Sweep cannot be used for chroma bandpass amplifier checking because the color subcarrier bar (which is double amplitude) will receive additional amplification in the bandpass amplifier.

just learned that the 3.58 color bar is twice the amplitude of the other bars and our same unbalance occurs because this bar receives twice the amplification in the chroma bandpass amplifiers, too. Therefore, we need another set of bars that are even in amplitude with our 3.58 MHz color carrier in the middle and two bars one half mega-Hertz to each side. These bars can then be fed into the antenna terminals, or the video IF input, and the entire system checked at the chroma bandpass output for even amplitude bar levels.

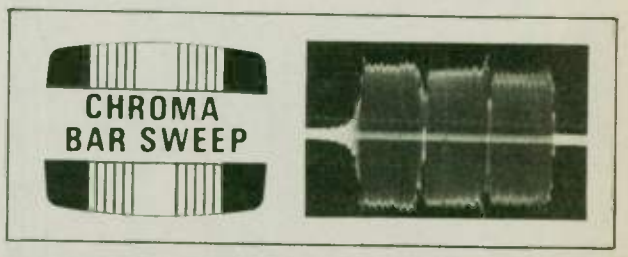


Fig. 30—The Chroma Bar Sweep should produce 3 equal amplitude bars at the output of a properly adjusted chroma bandpass amplifier. If your scope is not flat beyond 4 MHz, use a detector probe.

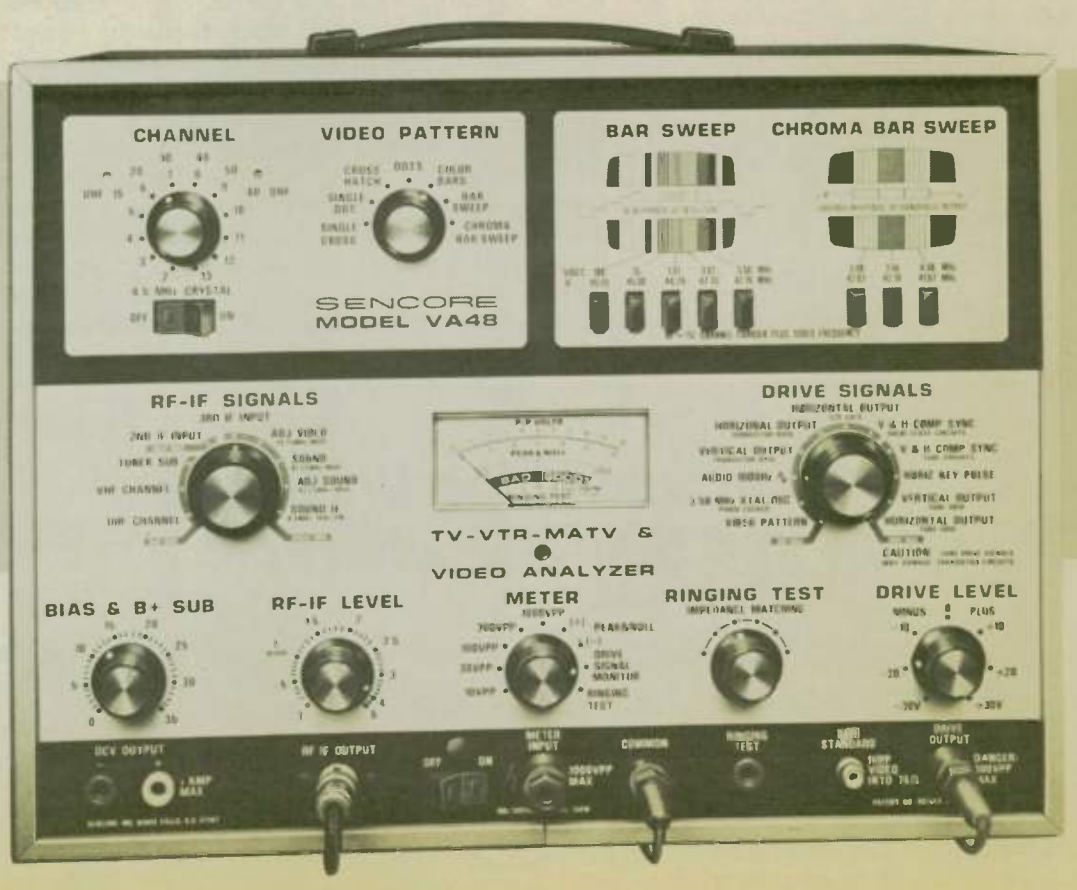
This is the reason that the VA48 has a second set of bar patterns called "CHROMA BAR SWEEP".

If all this seems rather complicated, it must be a real relief to learn that the VA48 has done all the compensating for you and all you have to do is to feed the VA48 into the antenna terminals (or video IF input), and look for even amplitude bars at the output of either the video or chroma amplifier.

You may be thinking that we are making too big an issue of the RF, IF, and Chroma alignment, particularly if you are from the old school and have convinced yourself that alignment is just too time-consuming and doesn't always do what it is supposed to. We had field engineers that thought the same way, but have changed their minds as they have been using the VA48 in the field to whip those tough dogs that others set back on the bench. Their field reports tell another story as well as over 50 percent of these so-called "tough dogs" were simple alignment problems. Our TV friends didn't realize that they may have been aligning with a sweep and marker that did not have a dynamic check on the AGC (such as we do with the VA48 that doesn't use a bias box) with resultant sync pulse clipping in the video amplifiers or ringing sync pulses that caused instability. The most common tough dog is the complaint of poor color or poor color sync caused by poor overall alignment from the tuner to the chroma bandpass output. Mis-set traps, (causing adjacent channel interference on cable), poor operation on rabbit ears or in fringe areas, poor contrast ratio due to compressed video and naturally poor picture quality, have been some of the other tough dog problems that we have taken out of these TV sets by simply touching up the alignment with the VA48. That's how the VA48 Bar Sweep system will help you cut your servicing time in half with far superior service output.

Question No.5: Just how far can I go with servicing in the chroma circuits? Can I check every stage?

The VA48 provides a phase-locked signal for signal substitutor into every color stage to the CRT.



Double your output with superior service

We have explained that chroma amplification starts from the front end of the TV set, not just

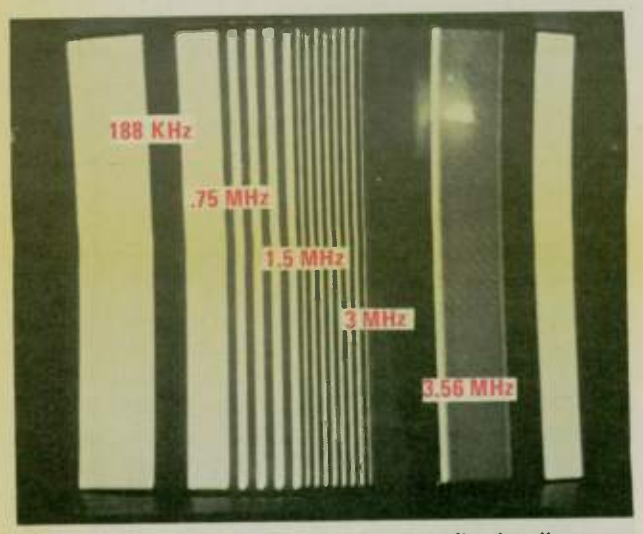


Fig. 31—Lower the brightness control until the first bar disappears to determine the relative brightness of each bar. Notice that the 3 MHz bar has disappeared before the 1.5 or 3.56 MHz bar indicating an improperly aligned IF.

the chroma circuits. There is one problem when you feed into the tuner input; you may not be absolutely sure of the fine tuning setting. For this reason, we suggest that you inject into the input of the video IF amplifiers when checking the overall chroma response. First, check the video IF amplifiers by using the BAR SWEEP and

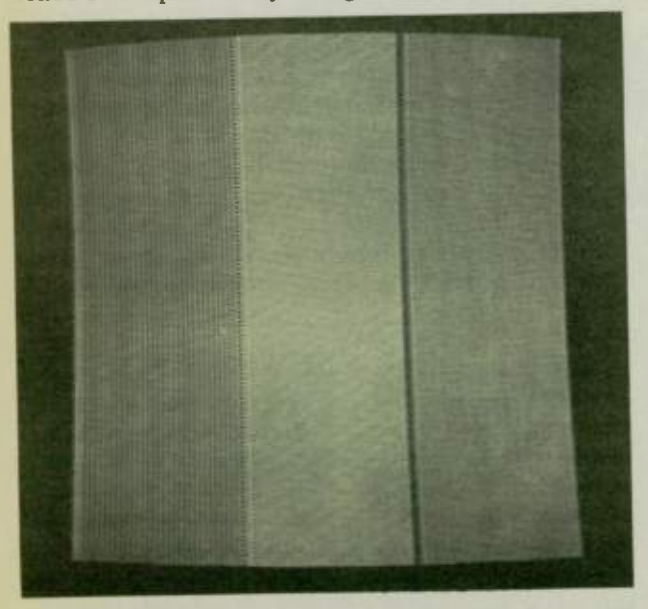


Fig. 32—Chroma Bar Sweep should produce three bars on the CRT screen—the center bar should be bright blue.

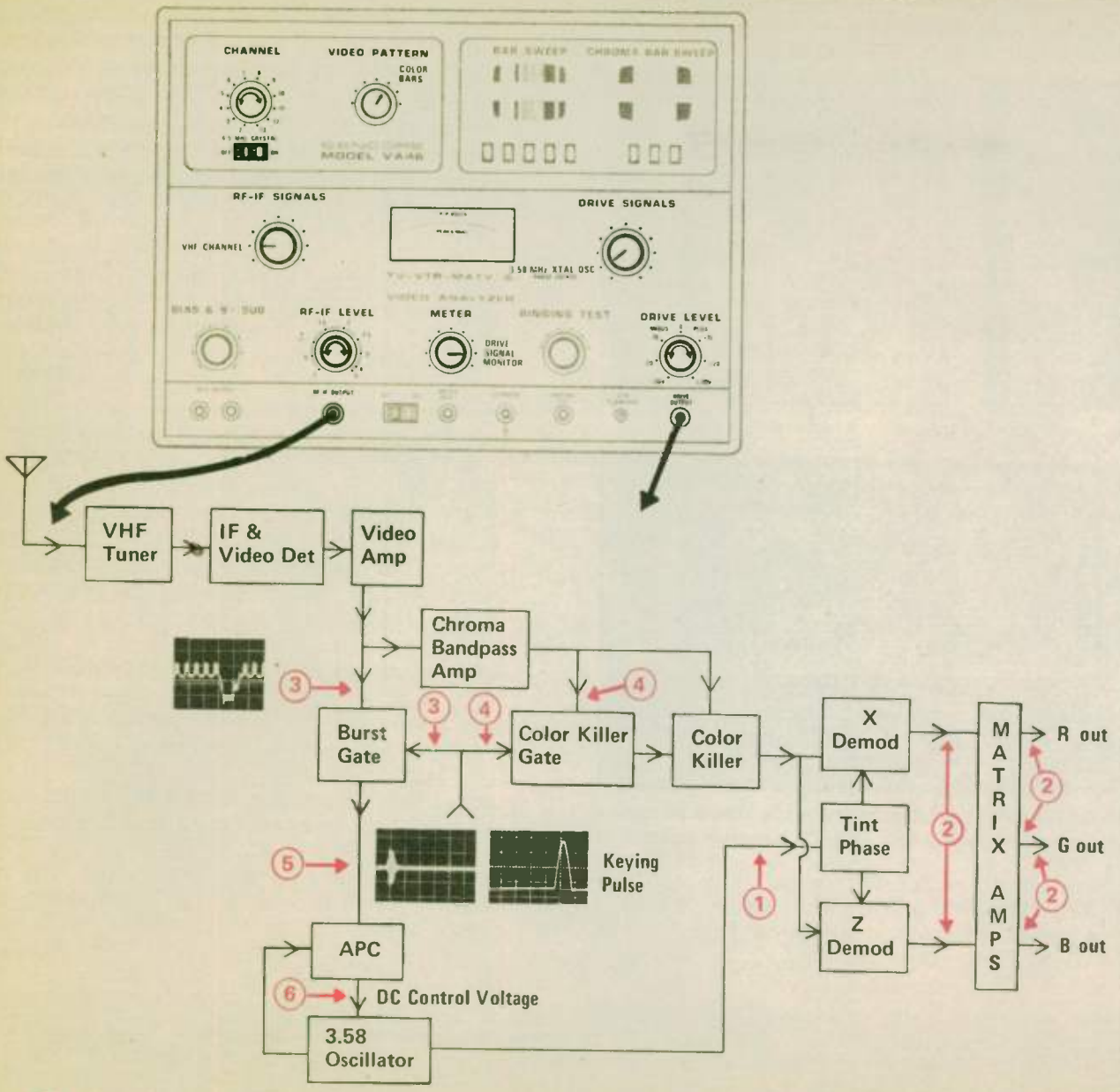
noting whether you have even bars at the video detector (or on the CRT screen). Even bar amplitude, on the CRT, is easily determined by reducing the brightness control slowly and noting which bar disappears first, second, etc. Now you know that chroma signal is being delivered to the color circuits. Next, switch to the CHROMA BAR SWEEP to check the chroma amplifiers for even bars at the chroma bandpass amplifiers output. The 3.58 MHz color subcarrier bar should be blue and the 500 KHz bars should be "random rainbow".Now you are sure that the chroma signal is arriving at the color demodulator. If the remainder of the chroma circuits are working, you will see the three equal bars in color on the CRT. If you do not see these three chroma bars, and you cannot get all three bars of equal amplitude at the chroma bandpass amplifier output, align the chroma amplifiers until you do.

There are many times that the remainder of the color circuit is defective and we must isolate those troubles, too. This is done by a process of elimination. We simply substitute the signals that are fed into the color section, one at a time.

Your first thought may be that this will not work because we are not substituting signals that are derived from the TV set but rather from the VA48. Here is where our phase-locked signals really become a big benefit as we keep all of these signals locked together so that you can substitute without fear of losing color sync. (Be sure that you understand that this is only true if you feed the VA48 color bars into the antenna terminals of the TV.)The next thing that you may want to do is substitute for the 3.58 MHz oscillator. To substitute, you simply connect the VA48 in place of the 3.58 MHz color oscillator and crank up the Drive Level output to see if the color bars appear on the CRT. Naturally you will have to connect the VA48 to the antenna terminals and set it to COLOR BARS. If the color bars are locked in but the yellow bar starts to the right of center instead of the far left, the 3.58 MHz substitute signal is 180 degrees out of phase and you will want to rotate the DRIVE LEVEL control to the opposite polarity to see if the bars appear in the normal color sequence. If the color bars appear on the CRT in the proper sequence, you have isolated your problem to the 3.58 MHz oscillator section.

If you aren't getting color at all at this point, you may want to check the chroma signal past the color demodulator to be sure that the matrix and CRT are in working order. The VA48 will enable you to do this by flipping the DRIVE SIGNALS switch to VIDEO PATTERN and leaving the VIDEO PATTERN switch set on Color Bars. Injecting the bars into the R-Y amplifier will give you all red bars on the CRT, etc., giving you a positive check on your R, G, & B matrix amplifiers. You can even inject right up to the CRT grids if you wish. This happens to be a good check of your grid input circuit, also, to assure you that you aren't about to change a color picture tube when the CRT input is not functioning properly.We, in field engineering, almost changed a color tube recently but made this last minute check to find a wire going from the R-Y amplifier to the CRT was broken. If we can make that mistake, you can too, but the VA48 saved us from a costly CRT plus the time of removal and replacement.

Okay, so our problem is not the chroma bandpass amplifier, the color oscillator, the matrix system or CRT input; where do we go from here? Suppose our problem is a running color bar pattern or poor color sync. We might suspect that the 3.58 MHz color burst is not being separated in the burst gate amplifier. There are two signals that feed this amplifier and you can substitute for both and they will be right in sync from our VA48. Substitute the 3.58 MHz xtal oscillator, from our VA48, directly into the burst gate amplifier to see if the color bars return to normal.



1. 3.58 MHz may be used to substitute for 3.58 MHz oscillator.
2. VIDEO PATTERN may be used to substitute for input to matrix Amp or CRT drive.
3. Inject 3.58 MHz signal or keying pulse to check burst gate.
4. Inject 3.58 MHz signal or keying pulse to check color killer.
5. Inject 3.58 MHz to APC detector to check APC operation.
6. Substitute DC correction voltage at output of APC to check reactance circuits of 3.58 MHz oscillator.

Fig. 33—The phase-locked signals of the VA48 allows testing of any chroma stage to pinpoint any color problem.

You may wonder about the continuous color signal from the VA48 substituting for a 9-cycle burst signal. This presents no problem because the stage is gated and the gate will allow the 3.58 MHz signal to pass only during the time that the gate pulse is present. You may also wonder about connecting the VA48 to this circuit on top of the 3.58 MHz signal that might be present. The output impedance of the VA48 is low enough to "swamp out the TV signal" and take over the circuit operation. You don't have to disconnect anything for any of these substitutions here or in any other circuit. Further, the VA48 is carefully protected against the TV signals from developing excess power that could burn up the VA48 output circuit.

Perhaps you think that the burst gate amplifier gating pulse, from the flyback transformer, is missing, or is not of adequate amplitude to "gate" the amplifier. All you have to do is set the DRIVE SIGNALS control to HORIZ KEYING PULSE and connect the VA48 in place of the keying pulse in the TV. If you are concerned about gate pulse amplitude, the peak-to-peak value is automatically read on your DRIVE SIGNAL MONITOR meter. If the receiver returns to normal, you have found the problem. The color killer, that operates from the keying pulse and the color burst, is checked in exactly the same manner with the same substitute 3.58 MHz and horiz keying pulse signals.

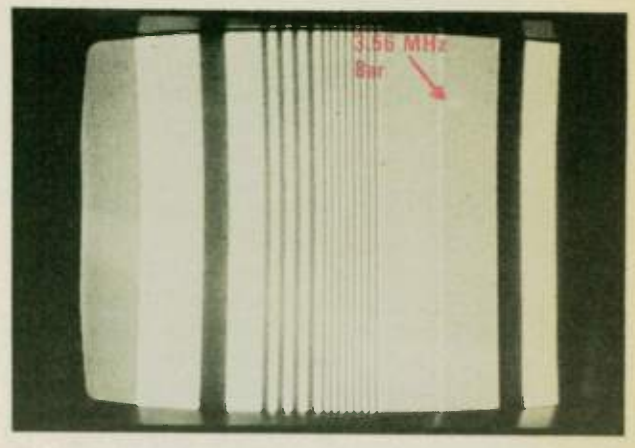


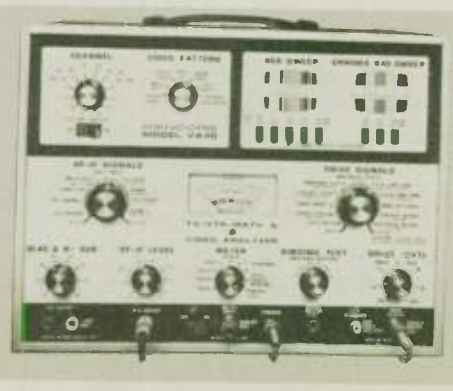
Fig. 34—The color killer is properly set when the 3.56 MHz color bar of the Bar Sweep has just turned from colored to grey.

The VA48 also provides a very positive, yet very simple, way to check and set your color killer threshold control. The BAR SWEEP PATTERN (not Chroma Bar Sweep) is flipped on and the CRT viewed. The 3.56 color bar should be black and white, with just a slight amount of color coming through, when the color killer is set properly. Turn up the color killer setting until the 3.56 MHz bar shows in color on the screen and then reduce the setting until the color just starts to disappear. This is proof positive that your color killer is working as it should because it does not show color during black and white transmissions, but is just ready to turn on when color is present. If you wish to double check the color killer action and be sure that color is present even in a fringe area switch to color bars and reduce the RF-IF LEVEL control to the 100 microVolt setting.

We have now checked through all circuits in the color stage except the chroma demodulator itself and the automatic phase comparison circuit (APC). The burst amplifier feeds the APC circuit directly and one might think that you had to stop here. The VA48 enables you to go even one step further by feeding the input to the APC with the continuous phase-locked 3.58 MHz signal and seeing whether the circuit returns to normal. If it does not, we know that our problem is in the APC or the demodulator. The APC too can be checked (just like you check an ordinary AGC circuit), by substituting a DC voltage from the VA48 BIAS & B PLUS SUB supply for the APC DC correction voltage. Simply vary the supply around the voltage expected and note whether colors on the CRT can be locked in. If they can be locked, the problem is in the APC and you have now found a method of isolating problems to every single section of the color processing circuits.

Question No. 6: Is there any way to reduce the time I spend setting the color oscillator and the black and white tracking controls?

The VA48 makes grey scale setting and color oscillator adjustments faster and more accurately.



Double your output with superior service

These type adjustments do take considerable time but are very important to both color and monochrome reception. These settings should be right on the nose if you want to do superior service, as we promised you would. We discussed how you can adjust the color killer in less time and more accurately in the previous section, but let's move to the color oscillator. Most TV sets have a 3.58 MHz crystal trimmer, that must be

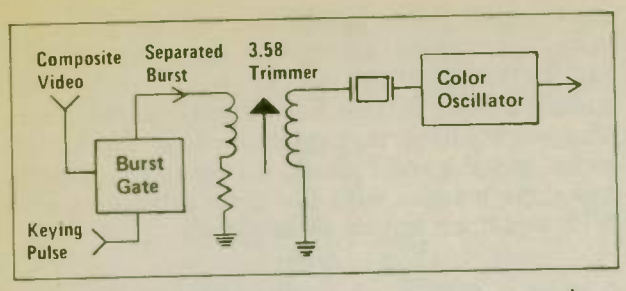


Fig. 35—The 3.58 MHz oscillator trimmer must be properly set for proper APC operation.

set as near the 3.58 MHz signal from the station as possible, so that the APC circuit can operate above and below mid-frequency for maximum control by the color sync. This has normally been done by shorting out the APC circuit and setting the trimmer for minimum "barber polling" on the screen. This can be done quicker and more accurately by switching to BAR SWEEP and switch on the 3.56 MHz color bar only. Turn up the color killer until you see the 3.56 MHz bar in color. Now, adjust the 3.58 MHz trimmer until barber polling stops and the bar becomes solid. You have then "zero beated" the 3.58 MHz oscillator in the TV set against the 3.56 MHz oscillator from the VA48 to give you a difference frequency of 15,734 Hertz. This difference gives you exactly one 360 degree phase shift each time that you move across the screen. That is exactly what you want to produce color bars in absolute sync. Perhaps you have been wondering why we use 3.56 MHz in the VA48 and 3.58 MHz in the TV set. The difference between these two frequencies is what produces your color bars in the first place. All you have to worry about is setting the color bar for a solid color.

Note: Be sure you turn the color killer back down and readjust it when you are finished.

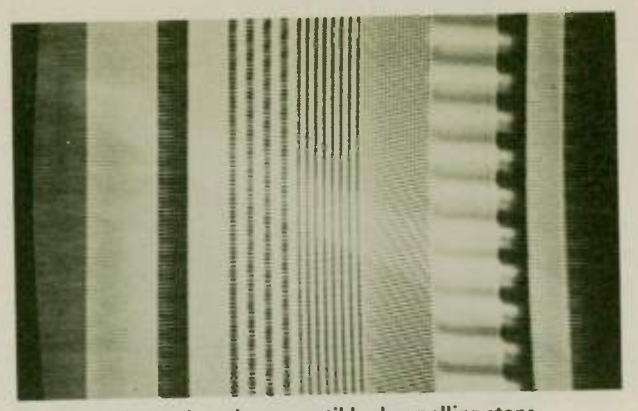


Fig. 36—Adjust color trimmer until barber polling stops.

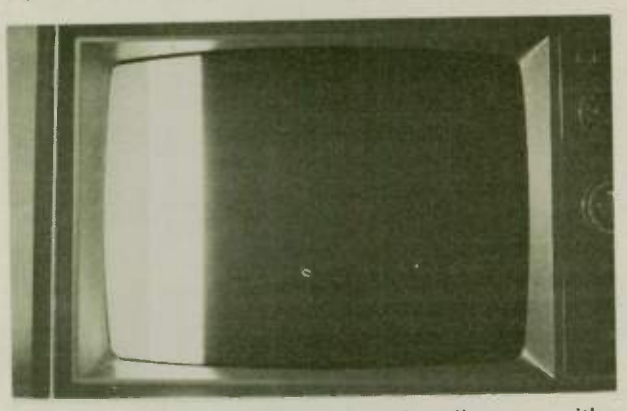


Fig. 37—The VA48 simplifies color tracking adjustments with a pure grey and white bar in addition to the pure black background.

Let us talk about B & W tracking. This, too, can be very time-consuming and one doesn't always know whether he has done it exactly right. The VA48 offers you a streamlined way to set these tracking adjustments, without even flipping the service switch, once again offering a more dynamic setting. Select the BAR SWEEP pattern again and turn off all five Bar Sweep control switches. You will now see only two bars on the left of the CRT. The bar on the left is generated to produce your grey level (that we so often talk about) and the bar second from the left generates your pure white level.

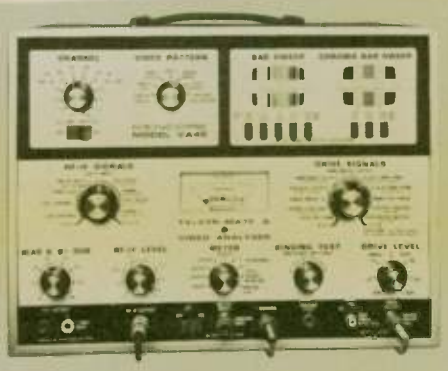
The CRT tracking is done by first setting your brightness and contrast control to normal viewer's setting. Next, turn down all the CRT drive and screen controls. Then turn up the red screen until you just see the color red in the large black area to the right of these two bars (across the remainder of the screen). Then, turn the red screen down slightly until this same area returns to black again. Do the same thing with the green and blue screen controls. Next, look at the white bar (second from left) and see if the bar is truly white. If it has a color in it, simply turn down the screen on that color until the bar is pure white.

Now look at the grey bar. The bar will normally be pink at this point because most sets don't have a red drive control. All we need to do now is turn up the blue and green drive controls until that bar is pure grey. If for some reason, you cannot get a good grey and a good pure white bar, you should suspect your CRT itself.

Can you begin to see why we say that you will cut your service time in half and produce superior service, too?

Question No. 7: Just how thorough is the VA48 in sync circuit testing?

Adjustable positive and negative sync levels, with standard rise time sync pulses, make sync servicing a snap.



Double your output with superior service

Sync circuits do not seem complicated on the surface but can become a real dog if not understood and checked thoroughly. More so, the sync stage in a TV receiver seems to be designed last and any left over IC sections (or whatever) go into this section of the receiver. We are now confronted with tube operated receivers, transistor operated receivers, and integrated circuits, too. Then too, one never knows when he is going to run into a tricky gated sync separator that adds complexity beyond belief because of the wind-up feedback circuits. The VA48 must be able to service all of these receivers, simulate the TV station, and once again, make all circuits look alike for standardized testing.

The sync stages actually begin in the video amplifier, on most receivers (except some Zenith's), because video amplifier limiting is used to clean up the signal for improved operation. This is all well and good if the AGC system is operating properly. If it is not, excessive IF gain will drive the video output stages to cut-off and a compressed (but very clean) sync pulse is produced. The sync separator does not "know" the sync is compressed and the result is that lower frequency black portions of the picture pass through the sync separator producing the "horizontal bends" or wiggles. Once we have eliminated the video amplifier, most of us attack a sync problem from the sync take-off point and our VA48 must have adequate amplitude and correct polarity to feed that point with a composite video signal to check the entire sync system. We have talked about most of the composite video signal, except the sync pulse itself. We think that you would readily agree that the sync pulse should be as good as the pulse at the TV station, if you are to truly rely on it for correct troubleshooting analysis. We, in Sencore field engineering, have been very disappointed in sync pulses generated by other analyzers on the market that remind us more of a "banana" than a true sync pulse square wave. The sync pulse from the VA48 is a genuine FCC, rise time standard horizontal sync pulse; exactly the same as the TV station delivers.

Let us talk about amplitude and polarity for a moment. It is very obvious that you need an adjustable sync output drive signal, with both positive and negative polarity, if you are going to substitute for both inputs and outputs. Amplitude can indeed be a different question, as we must cover all TV sets on the market today and in the foreseeable future, and we must not damage any of them with the VA48. Our field engineering survey on this question told us that a 300 Volt peak-to-peak signal was more than adequate for any sync stages in any tube operated receiver. It was a temptation to simply provide a 300 Volt peak-to-peak drive signal but further testing showed that this potential could easily damage a solid state sync stage. Therefore, the V & H SOLID STATE COMPOSITE SYNC position on the DRIVE SIGNALS switch was restricted to 30 Volts peak-to-peak maximum.

One of the most often asked questions at Sencore Seminars is "What happens if I connect the VA48 to the input of a sync separator, for example, and the normal TV sync pulse is already present?" This is a good question and we will answer it again so that you might be sure. We must agree first that we do not want the TV signal to be present at the substitute signal test point while we're testing. We do want to use the VA48 to tie the input circuits down with known good signals. We do this by using a much lower impedance, in the VA48 DRIVE LEVEL output than the circuits that we are testing so the VA48 substitute signal "swamps" out any other signals present. The impedance used in tube operated sets is always much higher than solid state receivers. This means that the output impedance of the VA48 must be lower on the solid state receiver setting than the tube operated setting. Secondly, these impedances must be chosen so that they swamp the TV signal but do not load the TV circuits. This is how the impedances are chosen in the VA48 DRIVE SIGNALS V & H COMP SYNC positions.

TV sync circuit troubleshooting would often be thought of as one of the simpler circuits to troubleshoot if it were not for the gated sync separators. These rascals complicate sync circuit troubleshooting as the feedback gating pulses from the horizontal output transformer develop a closed loop. One must find a way to tie down troubles in this system where any trouble in one section of the loop reflects to the same trouble throughout the loop. The VA48 comes to your aid on these more complex circuits, too.

(Continued after Buyer's Guide)

(Question 7 continued)

The input of the gated sync separator is checked just like a conventional separator by feeding the composite signal into the input. If the input is malfunctioning, the TV will return to normal.

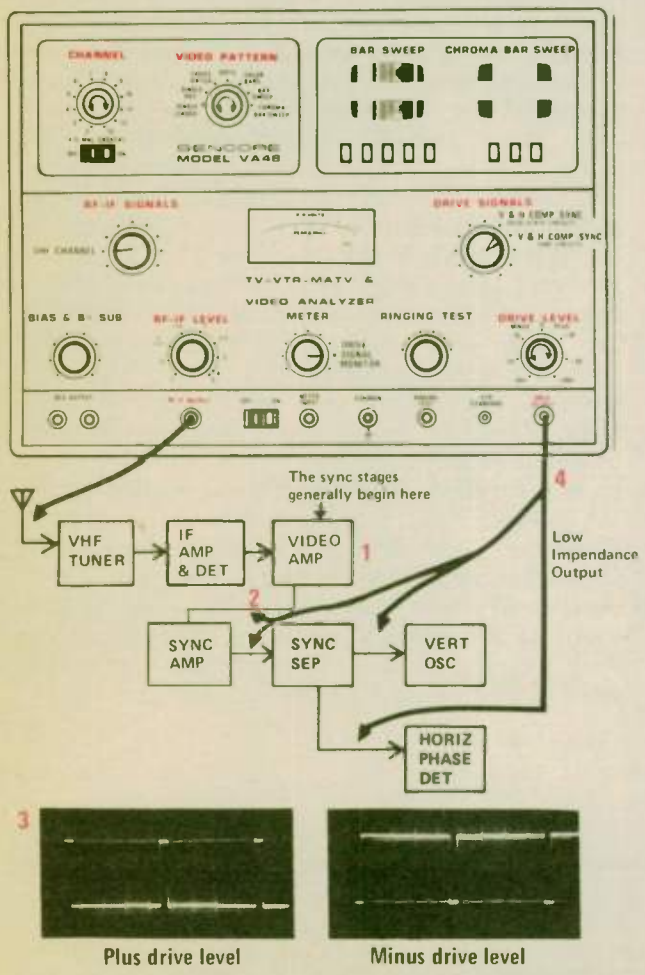


Fig. 38—(1) The VA48 provides composite video signals to substitute for the output of the video amplifiers. (2) Inserting signal from VA48 here eliminates the effect of earlier circuits. (3) All substitute sync pulses have standard FCC rise-times, 30 V P-P max for solid state, 300 V P-P for tube types. (4) Low impedance output swamps out circuit signal.

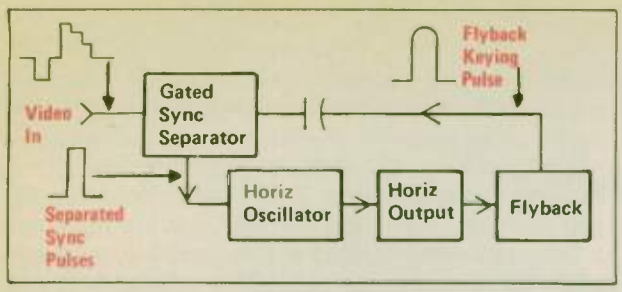


Fig. 39—Gated sync separators complicate sync troubleshooting because of closed loop wind-up circuits. The VA48 provides both phase-locked sync and gating pulses to troubleshoot these circuits.

The sync separator output is substituted just as easily by reversing the phase, increasing the drive level amplitude and substituting for the sync pulses in the output stage. If the receiver returns to normal, the problem is often the gating pulse. This can be substituted for very easily by switching to the HORIZ KEY PULSE and connecting directly to the sync separator output. All of these signals are phase-locked together, in the VA48, and there is no concern about the signals not arriving at the same time. The same pulse can be used to drive your horizontal sync discriminator by simply lowering the amplitude and

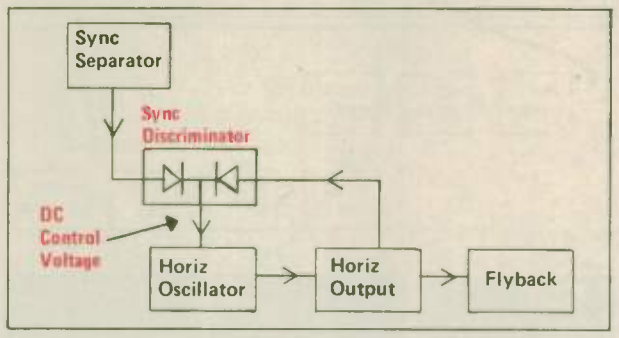


Fig. 40—Sync discriminator is easily checked by substituting equivalent control voltage from VA48 bias supply.

feeding it in before any waveshaping takes place, directly in place of the feedback pulse from the flyback transformer. The sync discriminator itself can be checked, the same way we check other automatic circuits, by connecting the BIAS supply and feeding the control voltage directly to the horizontal oscillator. A small variation in control voltage should vary the horizontal oscillator frequency until the picture falls into sync.

It should become apparent that the amplitude of all pulses in this section are very important to proper operation. One could connect a scope directly to the specially provided scope connection jacks on the output leads but that would be time-consuming. Special jacks are provided on the VA48 DRIVE OUTPUT so you can connect a scope (or multimeter) for monitoring if desired. It is much easier to follow every single step with a built-in peak-to-peak meter that automatically switches as you make your signal selections. This is what we do on the VA48 as the DRIVE SIGNAL MONITOR meter monitors your action to tell you just how much peak-to-peak signal you are driving each stage with. This monitor becomes very important when troubleshooting stages where you suspicion that you are overdriving to make up for low gain (or some such thing). It is possible to force signal through a defective stage by simply overpowering it. This will not happen if you use the drive signal monitor because it will tell you that you are somewhere in the ball park, or out of the ball park and that the stage has low gain. There are those times that you locate your problems, repair the stage, and just want to know the pulse level that you are driving the good stage with to compare to the recommended peak-to-peak amplitude on the schematic. The drive signal monitor does this for you automatically.

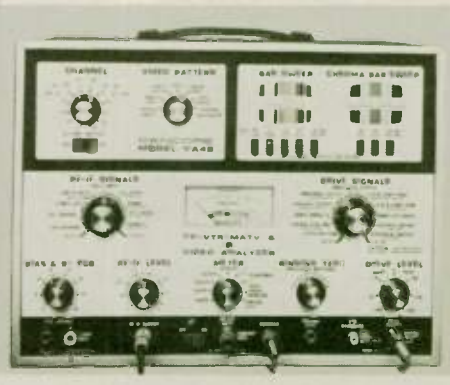
Fig. 41—Built-in peak-to-peak meter automatically monitors drive signal levels and can be used for signal tracing using external METER INPUT lead.

There are many times when you would like to check the sync section (for example) by feeding the input of the sync separator, and checking signal amplitudes at subsequent stages to speed up your analyzing time (especially when you have no sync at all). This is particularly true in these kinds of circuits where amplitude is very important because we are basically separating the signal amplitudes. The VA48 enables you to signal trace as well with this same peak-to-peak signal monitor by switching to the appropriate range (from 10 to 1000 Volts peak-to-peak) and using external test leads to walk through the circuits. This peak-to-peak signal tracing method can be used in any other stage after signal detection because of the unusually high input bandwidth on our peak-to-peak meter.

We hope that we have shown you how you can walk through these sync circuits in half the time and provide that superior service, too . . . as you pinpoint troubles in the sync stages.

Question No. 8: How effective is the VA48 in troubleshooting the horizontal oscillators?

The VA48 is the only analyzer that has a horizontal oscillator substitute signal for all transistor, SCR, and tube horizontal outputs.



Double your output with superior service

Our field engineering group discussed this section of the TV receiver before answering this question and unanimously agreed that the horizontal section can easily be called a "dog section", because we find more TV sets sitting on the back shelf with horizontal troubles than nearly any other problem in TV. We find these TV receivers sitting there for three good reasons: (1) Some TV techs don't understand the horizontal output stages in the first place; (2) He is "working in the dark" because the high voltage is generated in this section and he can't identify symptoms on a "blacked out" CRT; (3) He has no good way to eliminate suspected sections in these big "wind up" circuits.

The VA48 is designed to help you tie down these complex circuits and eliminate the suspected component or stage one at a time. We hope that we can help you understand the circuits better, too, but we have no way of helping you not work in the dark, even though we can shed some light on the subject.

The first section that most of us want to tie down is the horizontal oscillator itself. The horizontal oscillator has just one purpose; to drive the horizontal output stage. Therefore, it seems logical that the oscillator is best checked by connecting our universal horizontal oscillator drive signal to

the input element of the horizontal output stage. There is nothing to stop you from substituting back to the oscillator; many do if there is a suspected coupling capacitor in between, etc. We claimed that we were going to make all TV receivers look alike for simplified speeded-up service. To do this, we have to provide three different HORIZONTAL OUTPUT drive signals because there are three different kinds of horizontal output stages on the market; a tube operated receiver, a transistor operated receiver, and an SCR operated receiver. You do have to make a determination of the kind of horizontal output stage that you have. The only problem is identifying the SCR from the transistor. This is the only determination that we ask you to make for yourself (when using the VA48) because you generally can't tell the difference if you don't know the TV set or look at a schematic (sorry about that). The horizontal oscillator is substituted by connecting to the input of the horizontal output stage and increasing the drive signal from the VA48 until the raster returns to normal. When this happens the first time, you will be very pleased to see the picture pop into sync and know what we mean by phase-locked signals.

You will want to monitor your peak-to-peak drive signal, with the DRIVE SIGNAL MONITOR, but may be more concerned about the driving waveform polarity. No horizontal output stage should operate very long without a drive signal because lack of bias may cause excessive output current and the output device itself can burn up. One should really look up the polarity and amplitude and set the VA48 drive signal to about that level.

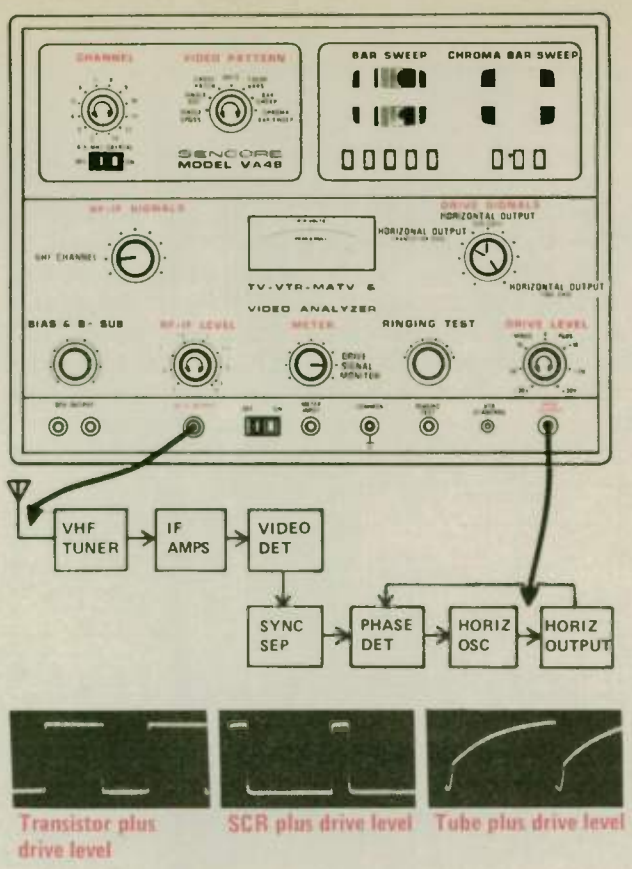


Fig. 42—The VA48 provides universal horizontal output drives to substitute for tube, transistor, and SCR outputs. It's the only one on the market that does.

From a practical standpoint, almost no circuit element, even the horizontal output itself, is designed to burn up instantaneously when no drive is present. More than this, one knows that all tube operated sets have a positive drive and that most transistor and SCR sets have a positive drive as well. Also, one learns that underdriving can be harmful, too, but you can never do any harm by overdriving. Therefore, from a practical standpoint, when you can't find a schematic (or just feel a little too lazy to look it up) start with the DRIVE LEVEL cranked up to the most positive setting and note whether or not the picture comes in. If it doesn't, crank the control back through zero and all the way to the most negative setting to see if the picture is now restored. Do not leave the VA48 connected to the horizontal output with the wrong polarity as you may do some harm to the TV set (but not to your VA48). Very often, the problem is a short at the point of signal substitution and you wouldn't want to go any further. This is quickly identified by the VA48 drive signal monitor meter as the short reduces the VA48 drive signal output, making the monitor show a lesser reading as soon as it is connected. We have just found a very good troubleshooting tool, and it works in other circuits as well, where there are shorts or high load conditions caused by malfunctioning circuits.

Question No. 9: How does the VA48 help me isolate troubles in the horizontal output circuit? Does it have universal tests here, too?

The VA48 checks all tube and solid state yokes and flybacks with the famous "Ringer" test.

Double your output with superior service

We are now assuming that you have driven the horizontal output stage and you still have horizontal problems. The next component to test is the horizontal amplifier itself. Sencore engineers deliberated on the possibility of providing a universal amplifier to drive the horizontal output load directly. We decided not to include a horizontal output amplifier for several reasons: (1) Impedance matching became a real problem with the many yokes and flybacks on the market today, to say nothing of the many tubes, transistors, and SCR's. Every attempt became misleading and was left with constant interpretations of the results. (2) A 5KV test lead would have been exposed on the front of the VA48, endangering the operator or anyone else who happened to be near the work bench. We felt that this was a real OSHA problem. (3) We would have had to incorporate all three types of amplifiers: Tube, transistor, and SCR. Mistakenly using the wrong amplifier would have resulted in damaged components, such as expensive flybacks. It was decided that the very best way to check these three type amplifiers was by using a tube tester to test the tube operated models, a transistor tester to test the transistor operated models, and to substitute for the SCR (just like you have always had to do on gas operated tubes that operate with the same characteristics).

A much easier, and universal way of troubleshooting the horizontal output circuit is to eliminate the loading components. The first component that all of us would like to eliminate is the horizontal flyback transformer. This is done on the VA48 by simply making the RINGING TEST to see that the transformer Q is good. This critical, but very easy to make test, has been used by Sencore in the YF33 Ringer Yoke and

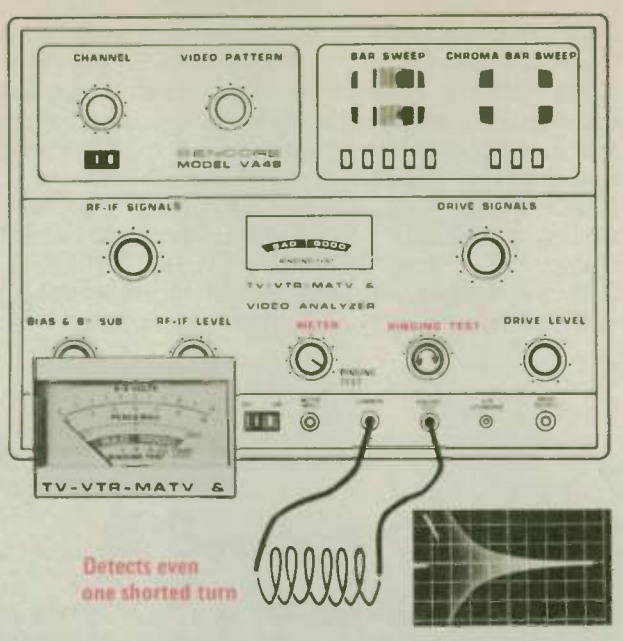


Fig. 43—The VA48 Ringing Test checks the entire yoke or flyback or individual sections with a 100% reliable dynamic test. Meter shows number of rings before decay to the 25% level. Ten or more rings indicate a good coil.

Flyback Checker and has proven to be universal and correct 100 times out of 100 in thousands of YF33's in use today. This same test is incorporated in the VA48 and the DRIVE SIGNAL MONITOR meter is switched over to serve as the ringing test meter. All one has to do is to connect the "ringing test" leads to the flyback transformer, switch the METER switch to RINGING TEST, and rotate the RINGING TEST IMPEDANCE MATCHING switch through its six impedance matching positions. Like all impedance matching devices, the output, and thus the meter reading, will increase when you have matched the flyback the closest. The meter is calibrated in the number of rings before the exciting pulse decays to 25 percent. Flyback transformers must exhibit at least 10 rings before they decay to this level, or they are defective. You simply read the meter as good or bad, as it is calibrated in the number of ringing cycles, and any number below 10 is shown as bad. The ringing test will work in-circuit if not shunted directly by a shorted circuit or a damper diode. In those few cases, you will have to disconnect at least one lead, but you can be sure that the ringer test will never lie to you or call a flyback good in-circuit when it is not. It may cause you to disconnect a lead once in awhile, but a 100 percent accurate out-of-circuit check is there to back you up to assure you that you never have to make wasted trips to your distributor to pick up a flyback because the ringer test gave you a bum story.

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The beauty of the ringing test is that it will detect even one shorted turn, while opens are simply detected with no reading at all. You can check small sections of the flyback transformer, too, giving you a positive check on those numerous small winding take-off coils, that you probably have had no way to check before.

If the flyback and take-off windings have been passed as okay by the Ringer test, you will want to make the same check on the yoke. The procedure is exactly the same and the results just as conclusive. The Ringer can also be used to check pincushion and horizontal efficiency coils.

If you have eliminated all the components with these simple, easily made checks, and you still have trouble, you are down to straight forward DC paths and it is time to get out your favorite Sencore multimeter (and your 50KV high voltage probe) to check some DC voltages. The boost voltage is an important check at this point because proper drive, a good output amplifier stage, and a good yoke and flyback should produce boost voltage. If it doesn't, the damper is probably bad or the boost voltage circuit is loaded by a shorted component. If the boost is okay, you know that the problem is in the high voltage section of the receiver.

You should note that all of these tests are made without interpretation or reference to a single chart and that all TV receivers are made to look alike for faster, easier troubleshooting.

MEASURE HIGH VOLTAGES

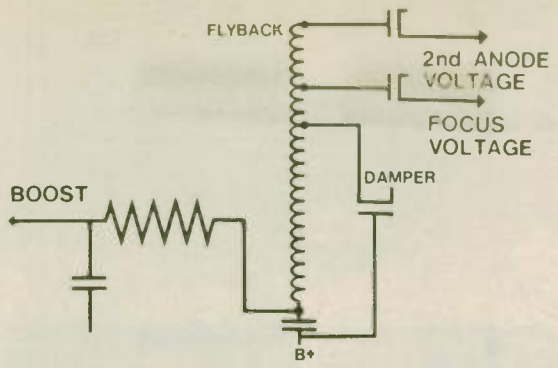
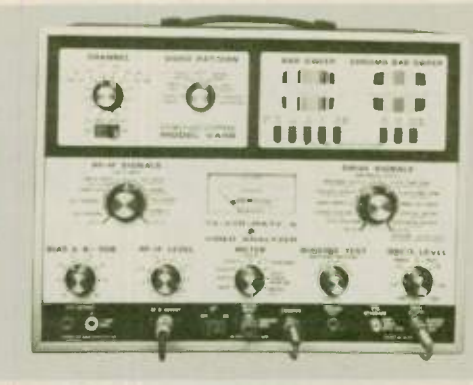


Fig. 44—Use a high voltage probe to check the high DC voltages developed from the flyback pulse and provide additional information about the horizontal stages.

Question No. 10: Can the VA48 walk the troubles out of the vertical section as well?

Special tube and solid state drive signals let you walk vertical troubles from the sync separator to the vertical output stage.



Double your output with superior service

The VA48 can walk the troubles out of the vertical section, but can do it in much less time than in the horizontal section because of the less circuit complexity. Let us start at the output of the sync circuits that feed the vertical oscillator. The composite sync is fed through a vertical integrator filter to the vertical oscillator. There has never been a good way to check the integrator filter before, even with a good oscilloscope. It was generally assumed that good horizontal sync and poor vertical sync meant a defective integrator filter. We wished that this were always true, and in most cases it is, but we all know that we would like to be sure that the problem is the integrator filter before disconnecting all those little leads. The VA48 really comes to the rescue here as we feed into the integrator filter, as we have just been doing in our past tests, or jump the filter and connect directly to the input of the vertical oscillator. The VA48 forms its own integration ramp to trigger the oscillator directly. If vertical sync is possible after the integrator, you know that you have a defective integrator filter.

The vertical oscillator itself is checked by driving the input of the vertical output stage. Once again, two pulses are available and are labeled VERT-

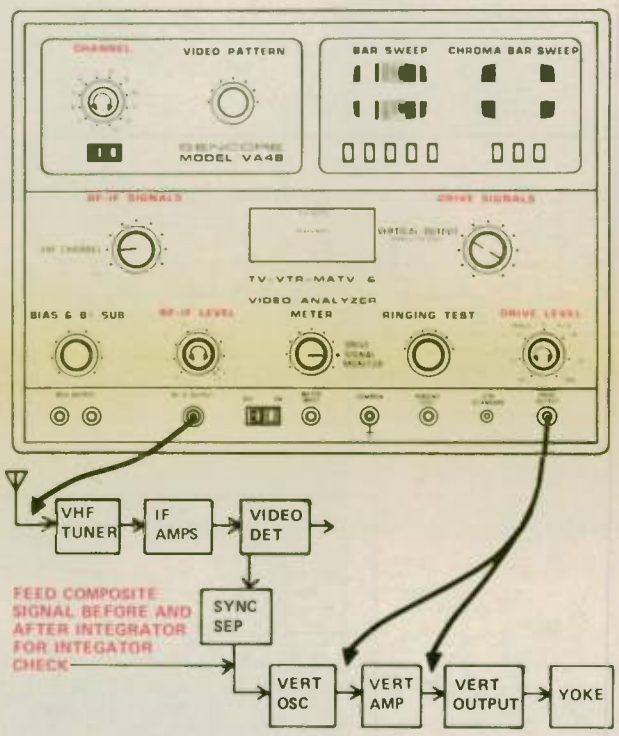
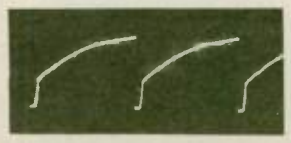
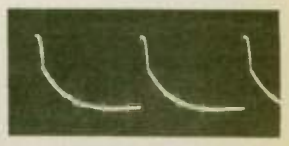


Fig. 45—The VA48 provides a positive check on every stage in the vertical circuits, including the integrator filter.



Plus drive level



Minus drive level

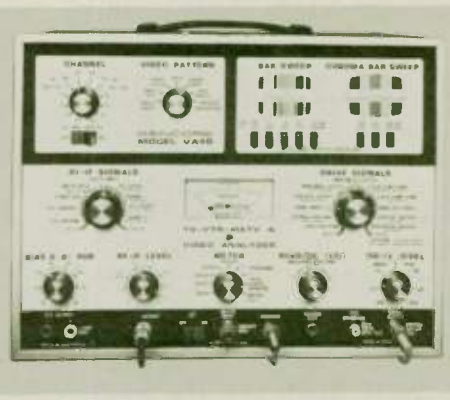
Fig. 46—The vertical drive signal provides a signal with an integrated sync pulse and a linear drive ramp. The polarity of the signal can be changed with the drive level control to allow injection into the input or output of any vertical stage.

ICAL OUTPUT TRANSISTOR BASE and TUBE GRID to provide universal driving signals. Every attempt is made to generate a waveform that will deliver nearly full height with good linearity. Linearity is close enough to detect faults in the waveform shaping circuits at that point, serving one other troubleshooting function.

If we haven't located our problem by now, we will suspect the vertical deflection yoke. This yoke is checked in exactly the same manner as the horizontal deflection yoke with the ringing test. We have then isolated our problem to the vertical output and transformer. A quick check of the amplifier itself (with a Sencore tube or transistor tester) will pinpoint the trouble to a defective output transformer.

Question No. 11: Why does the VA48 have a B Plus power supply? Aren't most TV sets AC operated?

This special supply helps locate troubles in AGC, ACC, APC, etc., plus powers up sets that use the "flyback power" to power up stages in the TV, and many more uses.



Double your output with superior service

The purpose of the BIAS & B PLUS SUB is not to power up the entire TV or other portable equipment. It can certainly be used on your bench for this purpose for anything up to one ampere of current and under 35 Volts. This covers most everything that uses up to, and including C cells. That's just an added bonus.

There are five main uses of this supply for TV servicing, and any TV or video analyzer without such a supply will not service all TV circuits:

(1) To replace the DC voltage on automatic feedback circuits, such as the AFC, AGC, ACC, APC, Sync Discriminators, etc. If you have never used this form of troubleshooting in these automatic circuits, you must try it. Each of these circuits produce a DC correction voltage to control some amplifier or oscillator stage(s). All you have to do is connect this bias supply to that DC feedback point and override the correction voltage with this low impedance supply. You don't need to disconnect anything. If the circuit, being controlled, returns to normal as you vary the bias, you know that you have substituted the correct amount of DC voltage to do the job, and you know that the automatic circuit is not doing this. Therefore, you know that the automatic circuit is defective. (2) The second big reason for this supply is to bias stages that have heat "run-away" when not properly biased. A good example of this is some horizontal outputs that must be biased if the horizontal oscillator is not driving the horizontal output. You may be able

to think of other such stages that make it handy to have this DC voltage at your fingertips. (3) The third big reason for this well filtered supply is to power up module boards for servicing. There are more people doing their own module work because they simply find it profitable and expedient. The VA48 B PLUS SUB supply will let you do this work, too. If you require more than one voltage to power up these modules, you can use the Sencore 39G42 Module Master which provides four independently adjustable supplies from the single DC output of the VA48. (4) The fourth big reason for this one Ampere, 35 Volt supply (either positive or negative) is to power up stages that derive their power from the flyback circuits. There are more and more of these circuits in today's TV receivers and they become inoperative as soon as the horizontal section shuts down. At this point, you can't check anything unless you restore the B Plus voltage on these solid state receivers. This supply puts you back in business

Fig. 47—Well-filtered supply provides positive or negative voltage (by just reversing leads) for four big circuit checks and uses.

and once again enables you to reduce your servicing time with superior work. (5) The fifth big reason for this DC supply is for troubleshooting direct-coupled (DC) solid state circuits. These circuits include video amplifiers, vertical oscillator and output stages and audio amplifiers. A direct-coupled stage depends on the DC voltage from the preceding or following stage for proper bias. Simple signal substitution may not return the operation of a direct-coupled stage to normal, even though the actual defect is not in that stage. This is true with all signal substitution analyzers because they must be AC coupled for protection to the analyzer and so that erroneous DC voltages are not coupled into the stage being tested. The BIAS and B PLUS SUB supply of the VA48 (used with a series current limiting resistor) returns proper bias to the stage so the substitute signal supplied by the VA48 drive output returns the stage to normal operation.

Question No. 12: I am running into more integrated circuits every day and have no positive way to troubleshoot them. Will the VA48 help me?

The VA48 is the best TV Integrated Circuit Analyzer that you can lay your hands on, as it checks each IC for it's function.

Double your output with superior service

We in field engineering are very aware of your problems in IC testing and can state flatly that there will never be an integrated circuit tester for the special ICs found in TV receivers. An integrated circuit is a "circuit" and not a component. Therefore, it can never be tested as a component because there is no commonality. An integrated circuit generally performs one function in a TV receiver, for example, but it may be only part of a function or may perform two or more functions. The easiest way to understand a TV IC is to consider the functional stages in a TV receiver, or any other video system. This takes us back to our old familiar block diagram that is often called a "functional block diagram". Each function often has more than one stage in it but for simplicity purposes, and better understanding of troubleshooting methods, we can simply substitute the word "stage" for function and all TV sets begin to look alike.

The VA48 provides a signal for every stage in a TV receiver. This signal is the closest thing that you will ever have to an IC checker and simplifies TV IC testing tremendously. We at Sencore doubt that we would have introduced the VA48 on the market at this time, if it were not for the complexity of testing presented by these new IC circuits. One simply feeds these substitute signals into the input of any stage, be it IC or anything else, and notes whether or not the receiver returns to normal. If it does, the IC is not at fault. If it does not, one should go directly to the input of the following stage and inject the signal from the VA48. If the receiver then returns to normal, the IC *stage* is at fault.

There are three things that can cause an IC stage to fail, in addition to the IC itself. (1) The input stage can be open or shorted. This is easily checked by connecting to the IC input directly. (2) The output can be shorted by the load or coupling to the next stage. This is easily checked by injecting the VA48 past the suspected point and seeing if the TV returns to normal. (3) The B Plus power supply itself can cause a dead stage. This can be checked by a DC check but can be further tied down by substituting the VA48 power supply if desired. Once these three things are checked, you know the trouble is the integrated circuit itself.

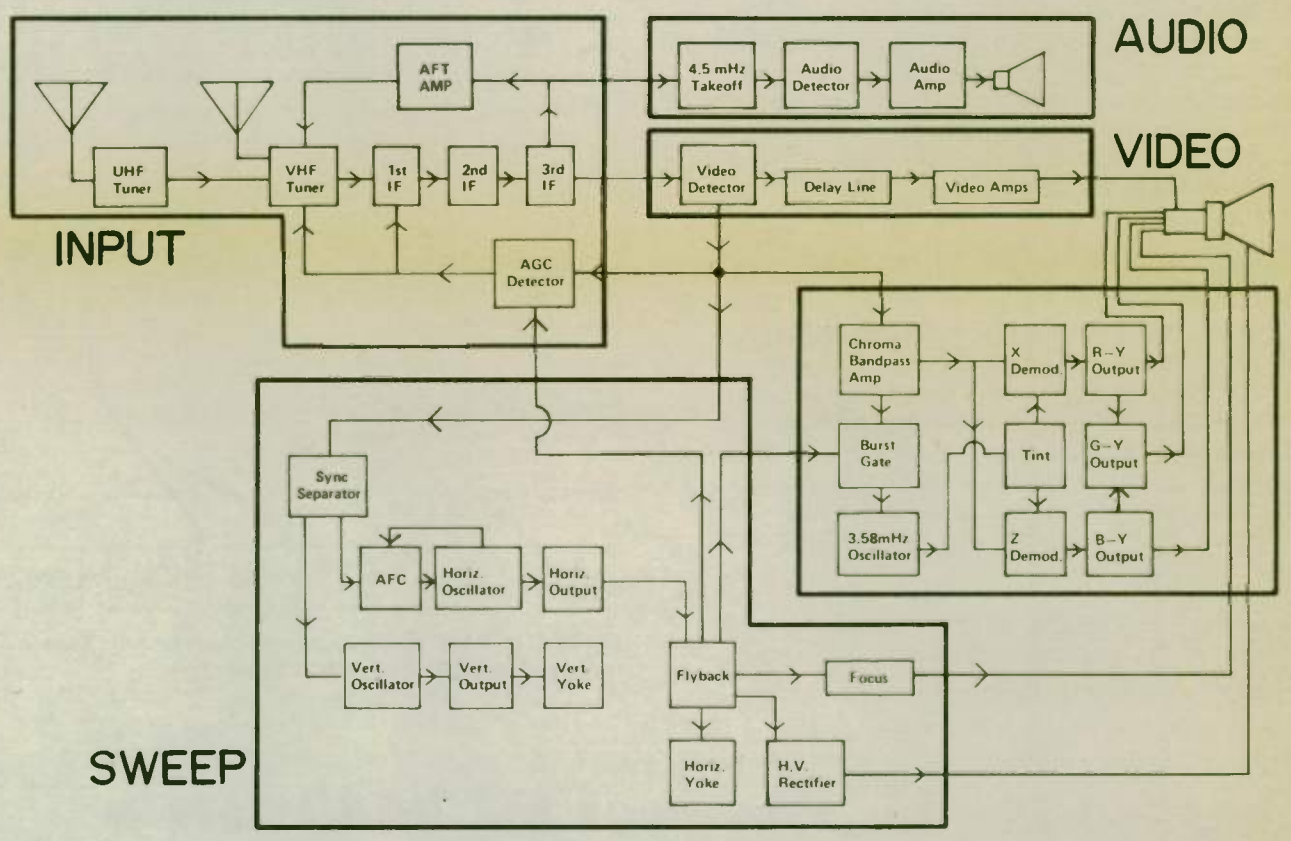


Fig. 48—Servicing circuits with IC stages merely involves treating each IC as a section of a block diagram. The VA48 provides all signals needed for injecting at the input or output of any stage.

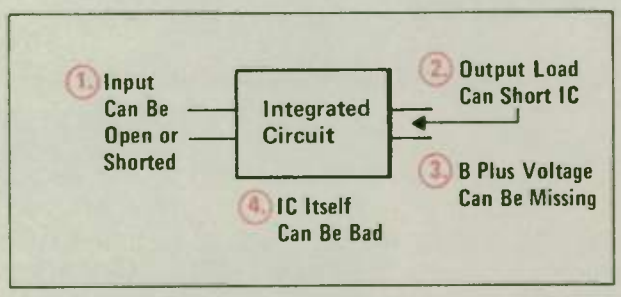


Fig. 49—An IC stage will not function if any of these four defects are present.

Let us see how we might check these same IC malfunctions with an oscilloscope. The input to the IC is easily checked with a scope and one can quickly determine whether the input waveform is present. Here is where the comparison stops, however, because lack of waveform on the IC output could mean a defective IC, a defective load, defective coupling, or no B plus. As we just discussed, the VA48 quickly checks all of these because the circuit is returned to normal with a new driving signal that the scope does not have. The scope must work from the energy in the TV set and becomes useless. Further, your scope may not have adequate frequency response in such circuits as the video IFs, and once again does not help you locate a defective IC in these circuits.

We hope that we have shown you that the VA48 is far superior to an oscilloscope in these new integrated circuits and lets you walk the troubles out of them step by step, regardless of the circuit that the IC is malfunctioning in.

Question No. 13:

Are you sure the VA48 can be used to service tape recorders? Most equipment now recommended for tape recorder service costs four times the price of the VA48 and really doesn't apply to my color TV service.

The VA48 provides special patterns and signals for this fast-growing, highly profitable video market.

Double your output with superior service

The video tape recorder market is a fast growing market and prices are coming in line so that many can now afford them. Video tape recorders are rapidly becoming a way of life in schools, sales departments, technical training departments, and other such places that find that they can do better training at much less cost with these systems. This alone is a huge market, but the consumer himself is now becoming interested and beginning to purchase video tape equipment. A great deal of consideration was given to video tape recorders during the design of the VA48. Many tape recorders were purchased and gone through in detail to be sure that the sync pulses, blanking pulses, color burst signal, modulation levels and types of modulation were available from the VA48 for direct substitution. These signals must be delivered to the video tape recorder, at one Volt peak-to-peak into 75 Ohms, for standard checks of the video tape recorder input capability (or to replace the camera). This has been provided on the VA48 for direct injection to check out the entire system. No adjustments are necessary because this is a fixed level.

Fig. 50—Video tape recorders represent a fast-growing service market and the VA48 equips you for this profitable business.

Many tape recorder manufacturers specify NTSC signals for checking out their tape recorders. The Sencore field engineering department has done a great deal of research and checking into these specifications and can find no reason that the more familiar standard RCA licensed 10 color bar system will not do the job. It was necessary to modify the 10 bar system to generate a color burst reference in place of the usual 12th bar, as used on color bar generators, however. The automatic color circuits in the VTR depend on a fixed amplitude burst signal to maintain a constant chroma level. A standard color bar generator does not provide this reference, but the 10 bars on the VA48 do and thus we, in effect, have an NTSC color generator with all colors generated at NTSC phases and compared to a zero reference color burst.

The one Volt peak-to-peak serves as a video tape recorder reference signal but this alone is not adequate for video tape recorder circuit troubleshooting. All of these troubleshooting signals,

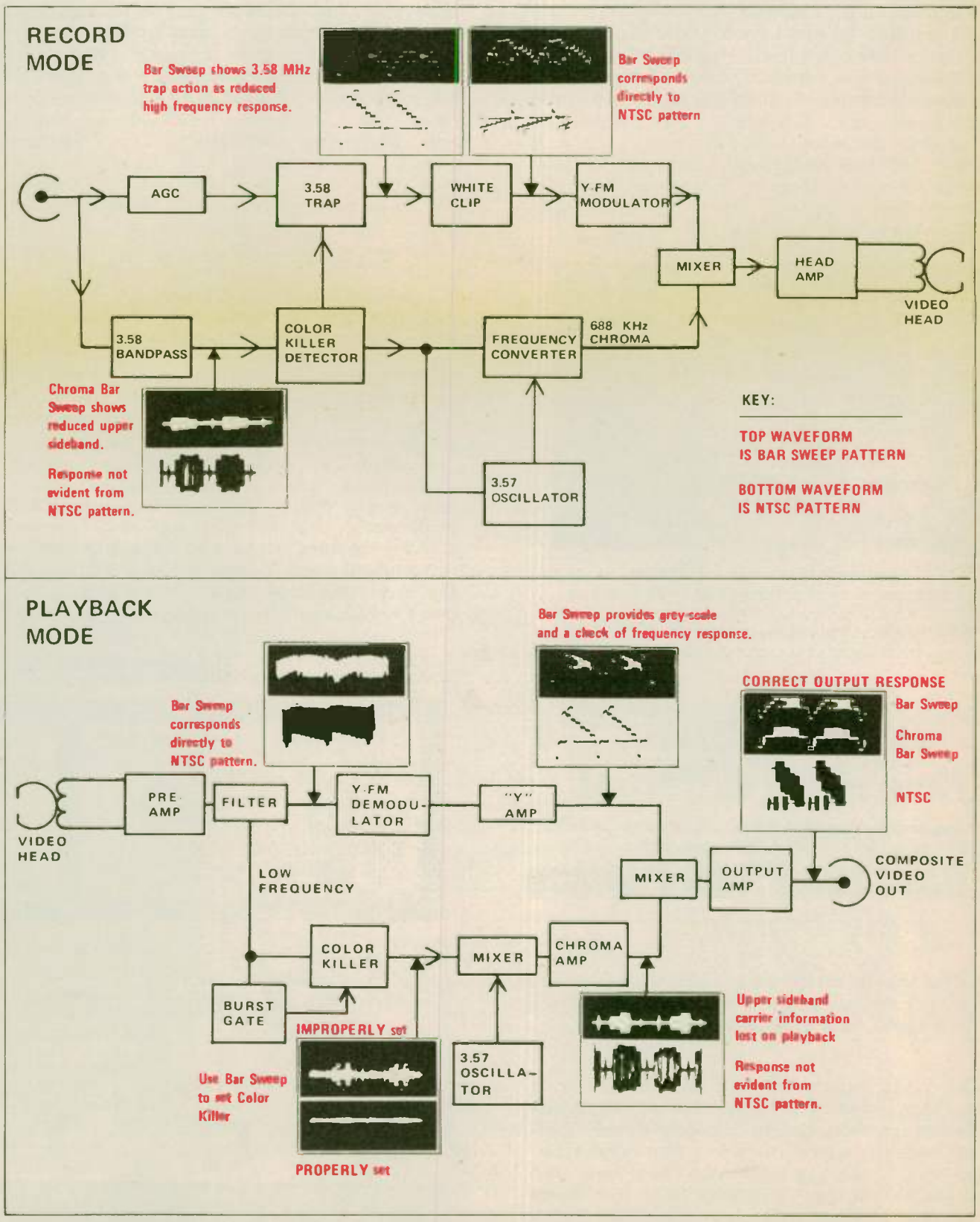


Fig. 51—Comparison of NTSC and Sencore VA48 system shows the VA48 will do the complete job in VTR servicing.

including all signals in the composite video signal and the modified color bars are available at the DRIVE SIGNAL OUTPUT, from zero to 30 Volts, positive or negative, for injection into any stage in the tape recorder system. The VA48 even offers a frequency response check not found in the NTSC color bar system. Bar Sweep patterns provide a check of the frequency response of the video amplifiers over their entire operating range.

In addition, the black, grey, and white bars, at the left of the bar sweep pattern, provide a direct check of the black and white limiting circuits found in the record amplifiers of these tape decks.

Finally, the Chroma Bar Sweep provides an overall check of the chroma processing circuits, just as they do in the color circuits of the TV receiver. We do not have time to go through the entire troubleshooting procedures for a tape recorder here and this subject will be discussed in detail in a subsequent *Sencore News*. In the meantime, many of the video tape recorder companies are rewriting their service instructions to include the modified color bars, as we have on the VA48. This means that you can use one system for color TV and video tape servicing at a much reduced cost.

Question No. 14: Now that I am understanding the capabilities of the VA48, I am wondering just how much I could do if I took the VA48 with me into the home. What do you think of that idea?

The VA48 lets you pinpoint troubles in the home and eliminates need to pull chassis in most cases. You decide.

Double your output with superior service

This question is coming up more and more at our video seminars as TV techs begin to think of just how quickly they might pinpoint their problems in the home and never have to remove the chassis. We really can't answer your question because that decision is yours and you know your trade and just how far you have to travel to your customers or how much traffic you fight to get back. We don't know whether you are set up with a real good universal color TV test jig, or how much you like to work in the home. We can tell you that there are many things that you can do with the VA48 that could help you speed up your home service, do more while you are there, and do superior service and estimating at the same time. Let us reason some of this together.

Fig. 52—Carrying the VA48 on a service call allows you to perform many tests in the home that you cannot do now.

The VA48 equips you with a high caliber color bar generator. This means that you don't have to tote along a color bar generator. The VA48 provides you with a grey scale check to make your tracking and color adjustments right on the nose to save time and make your customer happy. The VA48 provides you with a piece of equipment to align or check alignment right in the home. This should be particularly helpful if you are working on cable or MATV systems where these traps must be set on the nose to prevent adjacent channel interference. The VA48 provides you with a complete check of the tuner so that you can accurately diagnose tuner problems and know that your estimate on a tuner replacement is going to be a profitable transaction. The VA48 checks yokes and flybacks, without removing the chassis, for better diagnosis and more accurate service estimates. The VA48 provides you with a sensitivity and circuit ringing check to prove to your customer that the TV is working to standard and that the antenna, MATV or CATV system is at fault or off channel frequency. This alone could be worth the cost of the VA48 to win this argument and improve your service reputation. Who is going to argue with a "miniature TV station?" The VA48 can be used to check out home distribution systems for additional service income all in one trip. The VA48 peak-to-peak troubleshooter section can be used to trace troubles in case you want to go further or to take it along for emergencies. You can use the drive signals to check out modules if you don't have a substitute module with you, or just to be sure before you order a new module to find that this wasn't the problem. There are many other things that you can do with the VA48 in the home, such as power up boards and troubleshoot automatic circuits or just tie them down for estimates. We are not recommending that you go that far, but it is nice to have that capability. We think that we, in field engineering, might carry a VA48 just to show our customers that we are equipped to take care of their service better than anyone else in this area, which of course, is a license to add a little to the bill.

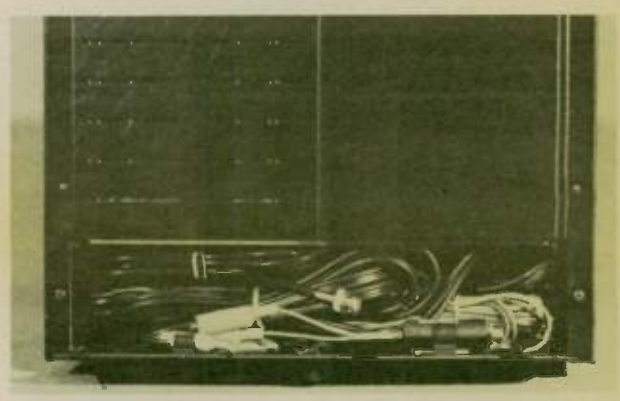
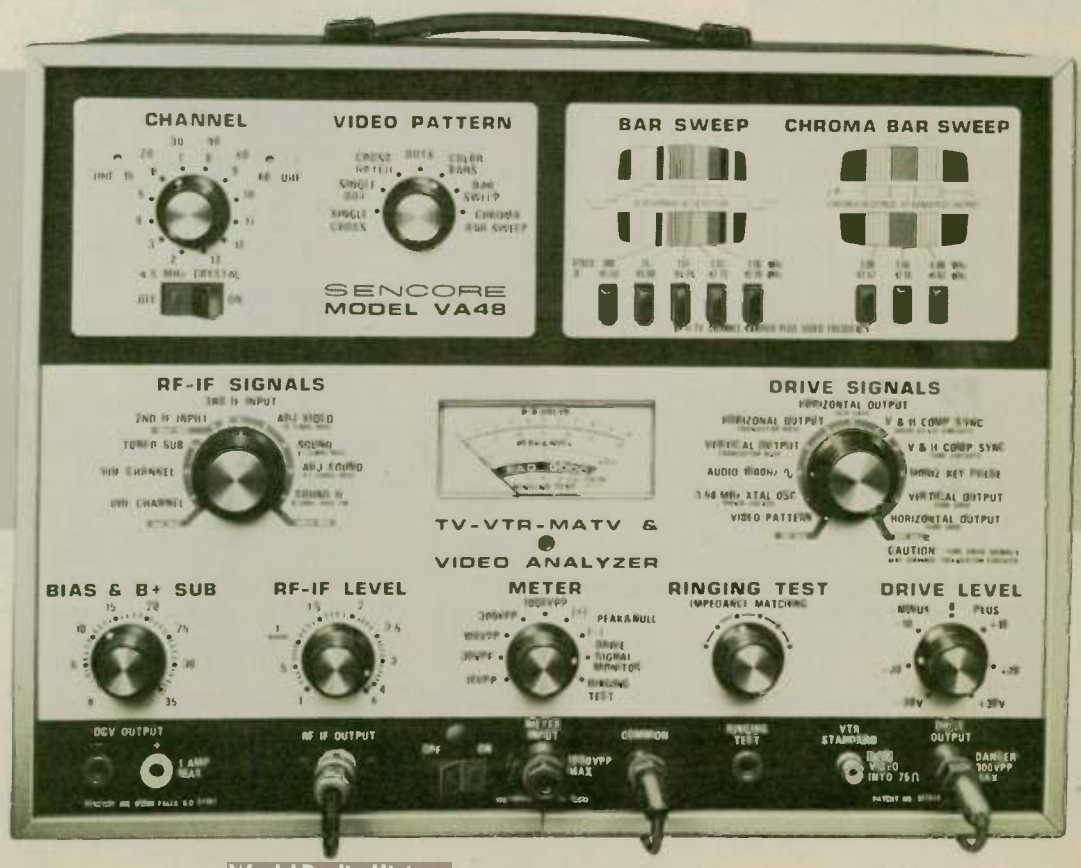


Fig. 53—The handy lead storage compartment on the back of the VA48 allows all leads and accessories to be carried with the VA48 when it is used in the field.

The VA48 has a large storage compartment, in the rear, to tuck in all the leads, and other servicing tools, so that you can carry it with you into the home if that is your decision.

Question No. 15: How many different instruments does the VA48 replace on my bench?

The VA48 replaces at least 10 separate instruments that normally cost well over $3,000 and has up to 60 individual test leads.



Double your output with superior service

$975 including all cables

The VA48 replaces most of the instruments on any service bench and leaves the service technician with a clean, orderly bench, with only three test leads to do most every job. More importantly, each of the test signals are phase-locked together so that there will never be an instrument coupling problem. A clean, organized bench means increased efficiency. Fewer test leads mean that you are going to get right at the prob-

lem without wasting valuable time hunting up leads or setting up instruments. Time is money in service and a customer will generally pay about the same service charge whether you spend two hours or four to make the repair. These two hours simply go into the profit till.

One would rather assume that any piece of equipment that would save time would be more costly. Yet, our customers find that their total investment is greatly reduced because the VA48 replaces equipment that costs them a minimum of three times as much. Here are some of the pieces of equipment that the VA48 replaces and updates your shop for the latest technology at the same time.

1. An old style TV Analyst that is not updated for solid state or new integrated circuits.

2. An old-fashioned Sweep and Marker Generator that you probably never wanted on your bench in the first place and owned it only because there was never a better way before the VA48.

3. A Video Generator that you have never had to have in color TV work, but will need for video tape recorder service. This alone is the same price as the VA48.

WHICH DO YOU WANT?

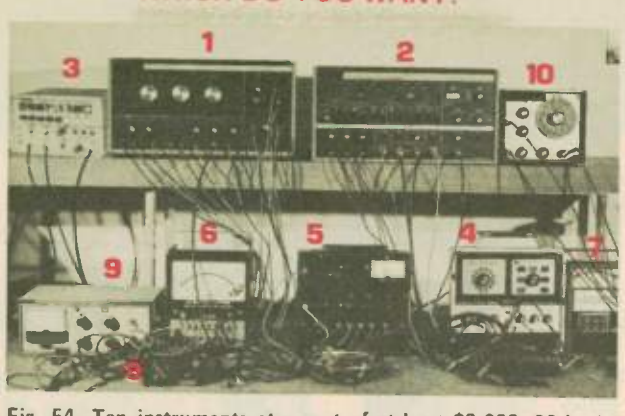


Fig. 54—Ten instruments at a cost of at least $3,000, 60 leads not phase-locked to each other, or . . .

. . .one instrument at a cost of only $975, only three leads to connect, with all signals phase-locked to each other.

4. A Deluxe Color Generator that does not equip you for video tape recorder service and does not check all TV channels.

5. A Sweep Circuit Analyzer. None of these are up to date for the latest low impedance solid state outputs.

6. A wide band peak-to-peak Signal Tracing Meter. Digital meters do not have peak-to-peak measurements and you won't want to restrict yourself.

7. A Yoke and Flyback Checker. The Sencore YF33 is the only up-to-date tester, but you may not have purchased yours yet.

8. A Tuner Sub that depends on the TV station and the antenna system as a "standard signal source".

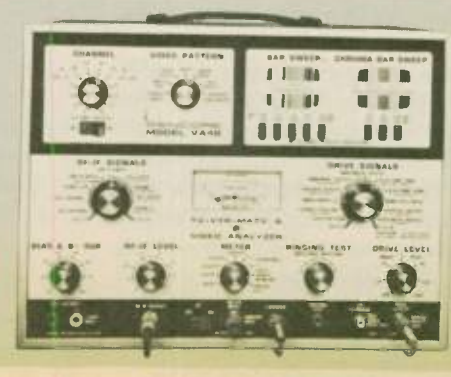
9. A one Amp variable regulated Power Supply. Doubles for your bias box, too.

10. A separate RF and Audio Generator that leaves you to interpretation and time-consuming set up.

The VA48 updates every single one of these pieces of equipment that are priced at well over $3,000. The VA48 costs you only $975.

Question No. 16: If the VA48 replaces all of these instruments, what happens if it needs service? I then can't afford to be without it.

The VA48 gets special handling in the Sencore Service Department, because they know that you just can't get along without it, once you are used to it.



Double your output with superior service

We in field engineering considered this question and first discussed it with the Sencore production department. Jim Stalzer, our production manager, immediately took us back to the area where every VA48 is placed on special racks that age the VA48 with both heat and vibration. Jim told us, "We age each VA48 for 100 hours on these racks before they are given their final test. We want to be sure that every unit works properly when it is taken from the box ."

Jim went on to say that if any defect should develop that proves to be a manufacturing error the unit is covered by the famous Sencore 100% Made Right Lifetime Guarantee which simply states that Sencore will correct any manufacturing error at Sencore's cost for parts and labor to assure each customer that "Sencore has made the VA48 right ."

We then talked with Roger Swier, our National Service Manager. Roger understands the problem, too, and surprisingly told us "Didn't you know that I was servicing all Sencore analyzers with three day turn around service?" Roger explained that he had been running into this problem with the CB42 CB Analyzer and the SG165 Stereo Analyzer as customers called to insist that they couldn't be without their analyzer for even one day, let alone weeks.

Fig. 55—Roger Swier in Service Department with Mary Lund, service secretary, showing a VA48 being unpacked to go directly to a Sencore service specialist.

We can't come to your shop and service the VA48 for you but we can see that our National Service Division repairs any VA48 the day after it arrives at the Sencore factory. If a day or two means that much, send the VA48 air freight, and request that Sencore return it to you air freight. The difference in freight cost is very little compared to the value of the VA48, and our service department will comply with your wishes. Sencore is located right next to the Sioux Falls airport that is served by three airlines; Ozark, Western, and North Central, and has 36 jet flights a day. United Parcel will take only a day or two longer, from any point in the United States, and the United Parcel Service is located right behind the Sencore factory on Sencore Drive.

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Sencore has done a great deal to help you understand the Sencore VA48. We have just written this *Sencore News* so that you won't be buying a pig in a poke. You know what you are buying and you know just what to expect. Naturally, a well prepared operating and service manual is sent with each VA48. Addendums are being added to the manual as we, in field engineering, learn more and better ways, to use the VA48. A 30-minute familiarization tape is included in each VA48 package for you to sit back and listen as it familiarizes you with each control on the front panel and the VA48 patterns. A special *VA48 Speed Test Set-up* book clearly depicts each and every application and setting of each control. A coupon is included with each VA48 for you to return to receive a book now being prepared on video tape recorders. Each Sencore

like to sort them out in the copy. [illegible] about CATV, MATV, Closed Circuit TV, or the very profitable Video Tape Service that the VA48 equips you for. Our competition won't service them effectively. What is important, and

If you want less and want to spend more, purchase from our competitor. If you want all these tests at your fingertips, for less money, buy the VA48.

your shop net profits even further. Consider the superior service, with less call backs, that are generally "freebees" and your total sales and profit picture takes another jump. Consider the free advertising that you get from a better repu-

New Standard of the CB Service Industry

Rarely does a new product receive immediate acceptance and use by the leaders in the big CB market, the fellows who know more about building and servicing CBs than anyone else. But these 16 CB manufacturers must have thought the Sencore CB42 CB Analyzer would do the job faster, more reliably, and more profitably for you, or they wouldn't have put their stamp of approval on it so quickly after it was introduced. Some wanted it for their own use, too, and have actually purchased units for their own factory design, service, and quality assurance departments.

As John Magnusson, HyGain's Field Engineering Manager told us, "It is imperative that the service organization become equipped with self-contained test instruments. The CB42 is an excellent integrated test instrument that speeds up troubleshooting and servicing". Why not try the CB42 on your bench to see how much more quickly and profitably you can turn out those CB service dollars.

hy-gain

E. F. JOHNSON COMPANY

MIDLAND

Aircommand by SUPERSCOPE

ROBYN

GENERAL ELECTRIC

Delco Electronics

AUTOMATIC RADIO®

CRAIG

Teaberry Electronics Corporation

AUDIOVOX

Fanon/Courier Corporation

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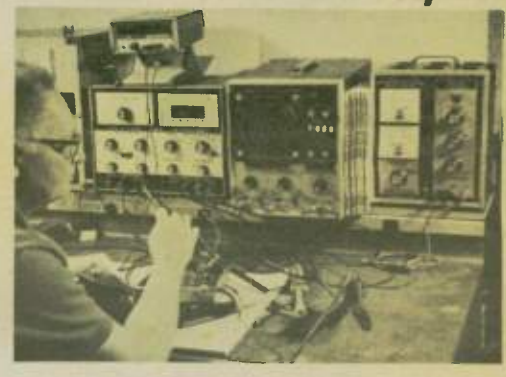
RAY JEFFERSON

Manufacturer Communications Equipment

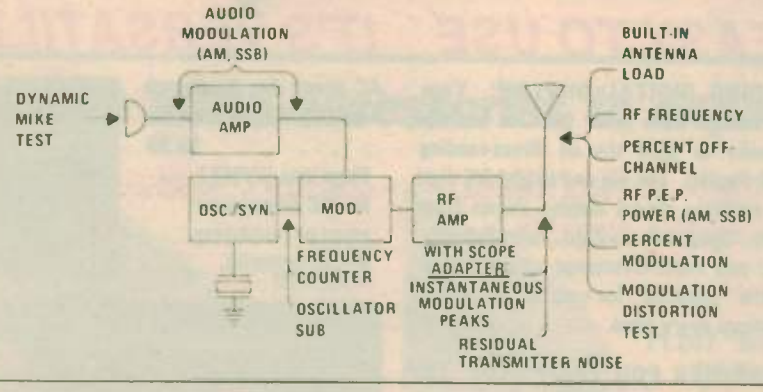
Howard W. Sams & Co., Inc.

Only $1095
Hundreds of dollars less
than buying separate instruments

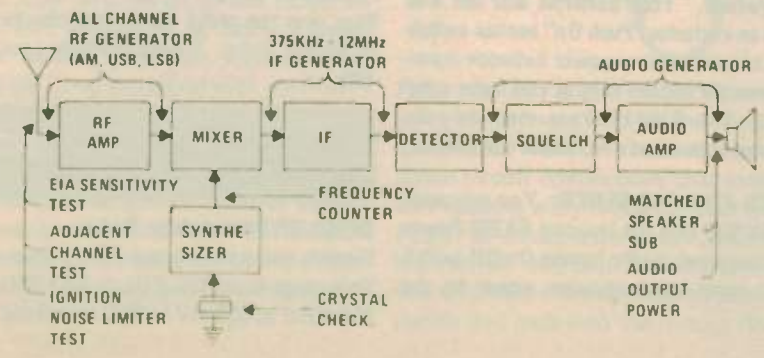


— Courtesy Howard W. Sams

WALK THE TROUBLES OUT OF TRANSMITTER STAGES IN MINUTES



ALL THE SIGNALS YOU NEED FOR INJECTING INTO EVERY RECEIVER STAGE, TOO



BACK UP YOUR SERVICE JOB WITH

Your Automatic CB Talk Power Tester

CB41 Automatic
CB Performance Tester
$148

For the first time, you can make all three tests for maximum CB Talk Power – RF Watts, antenna SWR, and Percent Modulation – on all the 23 or 40 CB channels in only three minutes from hook-up to "radio check"! Just push the button you want, and you and your customer can read the color-coded meter scale to know if he's "getting out" as he should.

The CB41 checks both AM and SSB CBs for Peak Envelope Power, checks the mike itself, and helps locate intermittent mike cable problems the simple, automatic way without adjustments or calibrations. It's the only 100% automatic Talk Power tester you can buy to keep your customers talking strong.

FORM 1742SN

lem without wasting valuable time hunting up leads or setting up instruments. Time is money in service and a customer will generally pay about the same service charge whether you spend two hours or four to make the repair. These two hours simply go into the profit till.

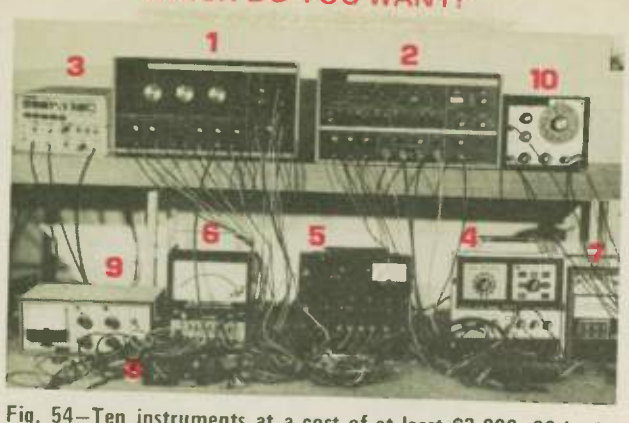
One would rather assume that any piece of equipment that would save time would be more costly. Yet, our customers find that their total investment is greatly reduced because the VA48 replaces equipment that costs them a minimum of three times as much. Here are some of the pieces of equipment that the VA48 replaces and updates your shop for the latest technology at the same time.

1. An old style TV Analyst that is not updated for solid state or new integrated circuits.

2. An old-fashioned Sweep and Marker Generator that you probably never wanted on your bench in the first place and owned it only because there was never a better way before the VA48.

3. A Video Generator that you have never had to have in color TV work, but will need for video tape recorder service. This alone is the same price as the VA48.

WHICH DO YOU WANT?



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4. Check RF and IF alignment from top of chassis if desired. No need for bias connection. *	No alignment check at all. Need separate sweep and marker and bias supply, plus you'll have to remove the chassis.
5. Align in minutes right from top of chassis and check the AGC action, too. View right on CRT.*	No other analyzer or tester can completely align a TV receiver because they do not have, nor will ever have, the patented Bar Sweep.
6. Align or check the alignment of chroma amplifiers from top of chassis.	Sweep and marker required on any other analyzer ever made. Cost of competitive analyzer, plus sweep and marker, far exceeds cost of VA48.
7. Check the video amplifier for frequency response, ringing, plus action of peaking coils and 3.58 traps from top of chassis. *	You can align with a sweep and marker, use our competitor's analyzer, and you still may have troubles in the video amplifier. You are on your own.
8. Set all traps right on the nose with crystal accuracy right from top of chassis.	No other analyzer or alignment equipment gives you any method of setting the traps with crystal accuracy, let alone from the top of the chassis.
9. Drive the CRT directly to check the CRT input circuits with up to 30 Volt drive signal.	The main competitive analyzer is limited to 2.5 Volts peak-to-peak drive and it takes 30 Volts to do the job.
10. Substitute the 3.58 MHz oscillator directly while the TV stays in color sync.	The VA48 is the only analyzer on the market with a phase-locked 3.58 MHz signal for substitution. Our competition uses a 3.56 MHz signal and it just doesn't work.
11. Substitute for any color signal in any of the color circuits with full synchronization, right up to the CRT.	Nothing else on the market even comes close. We just won't compare,
12. Drive any audio stage, even the speaker itself, for audio trouble isolation.	Main competitive analyzer uses only 1 Volt peak-to-peak audio. The VA48 has 0 to 30 Volts variable for every stage.
13. Drive sync stages with FCC standard rise-time sync pulses so waveforms look just like TV schematic.	Competitive analyzers use self-improvised sync pulses that leave you guessing whether the trouble is the set or the sync pulse. Nothing is standard.
17. Substitute for flyback keying pulses in any stage with variable polarity and amplitude up to 30 Volts for transistors and 300 for tubes.	Competitive model has only 400 Volts fixed positive polarity. Could be quite dangerous on low level keying pulses or solid state circuits.
18. Check all deflection yokes on the market, both tube and solid state, with tried and proven Ringer method. In-circuit, too.*	Main competitive analyzer doesn't check solid state deflection yokes with low impedance.
19. Check flyback transformers, in or out-of-circuit with tried and proven Ringer test.*	No competitive analyzer (except the Sencore YF33 Ringer) uses a calibrated test signal with correct impedance.
20. Substitute well-filtered DC supply for circuits that must be powered to test them; AGC, ACC, APC, AFT, flyback derived B+, direct-coupled solid state circuits, etc.	Competitive analyzer provides 25 Volts at only 250 milliAmps. The VA48 has 1 Amp of power to 35 Volts to do the entire job.
21. Monitor drive signals at all times with built-in peak-to-peak monitoring meter.	You will have to use a separate meter with competitive equipment. They have no such monitor.
22. Use built-in meter to signal trace from any detector to output for fast troubleshooting when stages are dead.	No competitive analyzer has a built-in signal tracer to simplify your service.
23. Check color tracking on specially prepared "black and grey" scale. Speeds up alignment and results are more accurate.	No such tests on any other analyzer, even those Sencore has made.
24. Set the color oscillator in a truly dynamic way right on color bar pattern.	You'll have to do it the old-fashioned way if you own a competitive analyzer.
25. Set color killer in a truly dynamic way right on color bar pattern.	Sorry, you'll still have to do it the old way if you own a competitive analyzer.

Only **$975 including all cables**

*Covered by U.S. Patent No. 387949 and No. 3990002

Conclusion:

These are 25 checks that you can make if you own a VA48 Video Analyzer. We have many more, but we think you would like to sort them out in the copy. We haven't said anything about CATV, MATV, Closed Circuit TV, or the very profitable Video Tape Service that the VA48 equips you for. Our competition won't service them effectively. What is important, and what must be said again, is that the cost of the VA48, with all these tests for troubleshooting and alignment, is far less money than our competitor's analyzer and sweep and marker generator. If you want less and want to spend more, purchase from our competitor. If you want all these tests at your fingertips, for less money, buy the VA48.

Fig. 56—Sencore provides all of these aids to help you learn to use your VA48 quickly and increase your servicing effectiveness.

Tech Rep has, or will have, a two-hour video tape presentation on "Video Servicing in the 70's and Beyond". Sencore will hold over 1000 video seminars this next year to educate you to these new methods of servicing. Video tape servicing seminars will follow the conventional VA48 video servicing meetings in your area. We suspect that many manufacturers of video systems will be using the VA48 in their training sessions, too. There will be many magazine articles on the use of the VA48, starting in March of 1978. As if that were not enough, there will be two more *Sencore News*, discussing specific applications of the VA48 in tape recorder, color TV, MATV and CATV, and closed circuit servicing. We want every single service tech to know the VA48 and what it does.

Just how long does it take to pay for your VA48? We are proud to say that we believe that the VA48 will pay for itself quicker than any other piece of equipment produced by Sencore. Our experience has shown that the average tech will increase his service bench output from four color TV receivers a day to six color TV receivers a day within a month. We find that this output doesn't stop here and continues to climb to eight color TV sets a day as he begins to trust and believe in this kind of servicing.

We are sure that it won't take you very long to sit down with a pencil and paper and see what would happen in your business if each tech knocks out 50 percent more TV repairs each

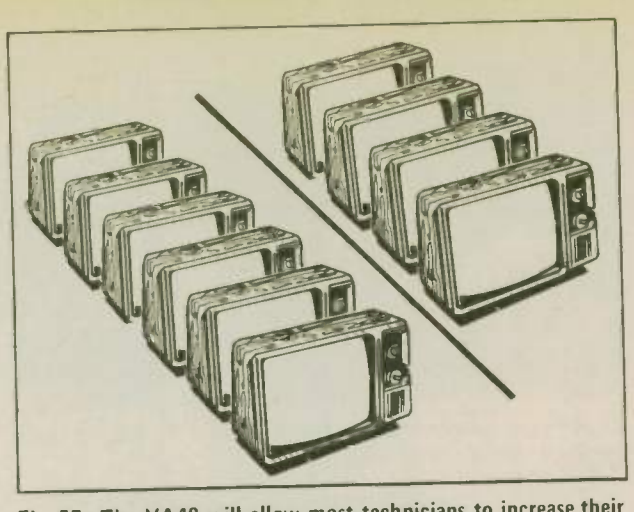


Fig. 57—The VA48 will allow most technicians to increase their average shop output from 4 to 6 sets a day within the first 30 days.

day. Your servicing income is increased by 50 percent, but your profits could easily quadruple because your overhead is already paid for on these last two repairs. This means that gross profit, profit after the cost of parts only, becomes net profit on any increase in service that you do.

Consider further the tough dogs that collect on the service racks and begin to project what would happen if you didn't take a loss on these. This, too, goes into the gross profit column to boost your shop net profits even further. Consider the superior service, with less call backs, that are generally "freebees" and your total sales and profit picture takes another jump. Consider the free advertising that you get from a better reputation because you fixed the TV correctly in the first place and the new customers that this can bring you without added costs. Consider the business that you may be passing up in video tape recorder service, MATV, CATV, and booming closed circuit TV, and the VA48 becomes a real business expander for you.

Now, being the good business man that we know you are, you must realize that the VA48 is not written off the first year. Equipment of this type is normally written off in four years, meaning that your true cost is only $243.33 a year. Getting right down to brass tacks, this means that the cost of the VA48 in your place of business is just one dollar a working day. This is not much more than a pack of cigarettes a day or the cost of the gasoline that it took to get you to work in the first place. Can you afford not to have it?

Lastly, consider what will happen in your shop if your competition has a VA48 and is using these streamlined servicing techniques and you are not.

Fig. 58—The superior service produced by the VA48 means more satisfied customers which generates good will and customer referrals.

Renew your Sencore News now

Third Request

Sencore News is sent free of charge to owners of Sencore instruments. All others, except field engineers and instructors pay $5.00 to cover the cost of postage and handling. Please fill in the questions below if you wish to continue being on the Sencore News mailing list.

☐ I am a Sencore customer. I own the following Sencore instruments:

_____

and I plan on purchasing the following Sencore instruments soon:

_____

☐ I am not a Sencore customer yet, but am interested in purchasing the following Sencore instruments soon:

_____

TV Seminar Notice

You can really count on these FC45 buyer's benefits

1. Covers Audio through 230MHz VHF continuously

The FC45 has an extremely wide frequency range coverage for every use from 30 Hz audio through 230 MHz VHF. It will even go to 600 MHz UHF with the PR47 Prescaler, equipping you for virtually any frequency test you may encounter.

2. Better measurement accuracy than FCC specs

You can be sure that the FC45 has the accuracy you need for critical design checks or for documenting your FCC frequencies with every reading at least five times better than FCC standards. A high accuracy reference crystal enclosed in a temperature-controlled oven insures one part per million (.0001%) guaranteed accuracy (0-40° C.) throughout the 230 MHz frequency range.

3. High sensitivity for circuit testing

High 25 milliVolt average sensitivity all the way through 230 MHz means that you can now use a pick-up loop in low level circuits without circuit loading sometimes caused by direct connections. You can now trace frequencies all the way through oscillators, amplifiers, and high power stages with full confidence that your reading is 100% accurate.

4. Easy to use with all pushbutton operation & all direct reading display

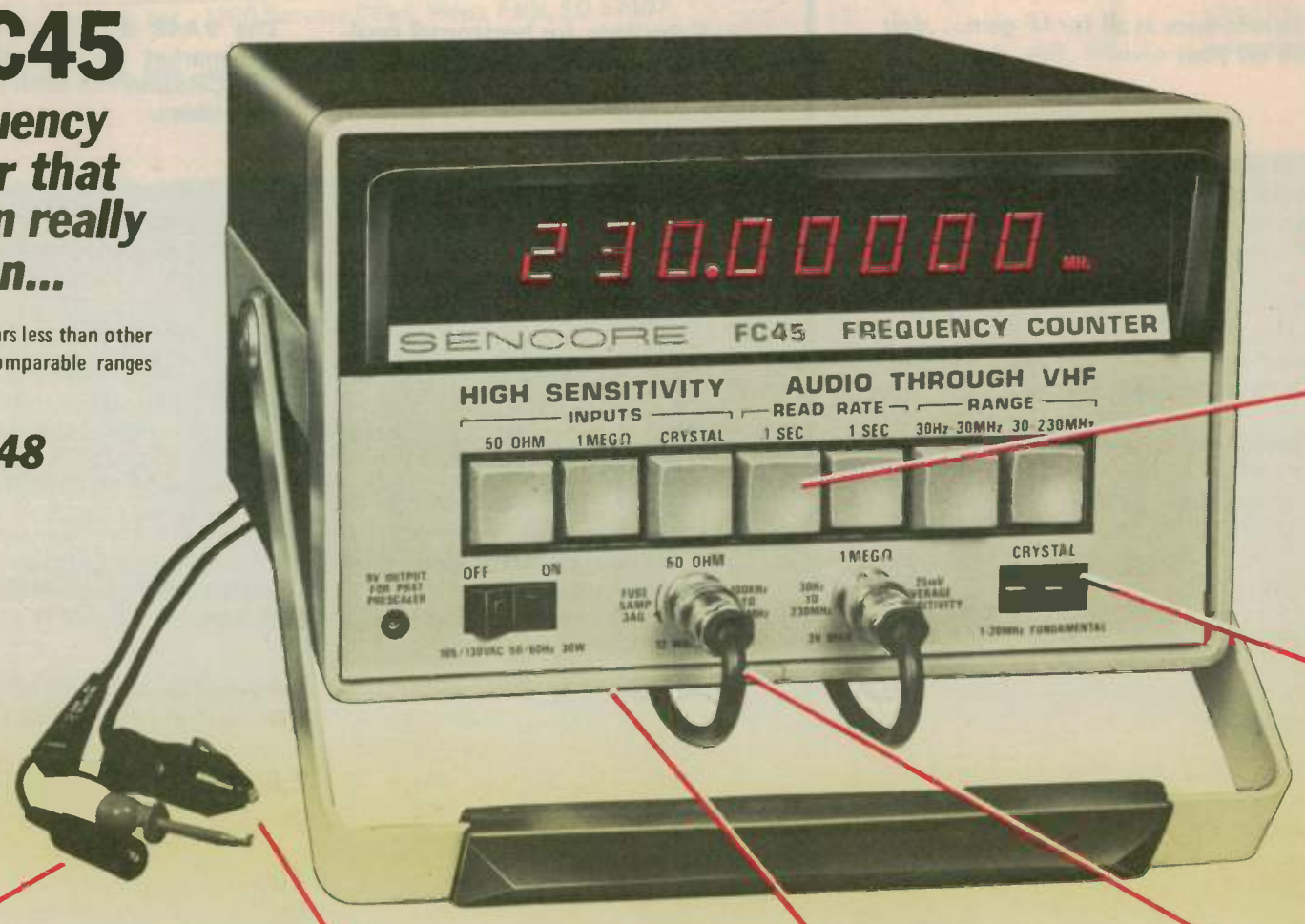
Just push the button you want and read the direct reading display. The FC45 is that simple to use. You won't have to interpret your scales or shift decimal places mentally with the FC45. Automatic ranging, decimal positioning, and special Hz and MHz indicators show you the exact frequency you are checking every time. The big, bright eight digit readout provides ten Hertz resolution at the higher frequencies and 1 Hz resolution below 30 MHz, too, so you won't be mislead with overrange indicators and range switching.

New **FC45**

A Frequency Counter that you can really count on...

Hundreds of dollars less than other counters with comparable ranges and accuracies.

Only $448



BACKED BY SENCORE'S 100% MADE RIGHT LIFETIME GUARANTEE

All Probes and Cables Included

Now here's a plus—you're equipped for the job the moment you take your FC45 out of the box with all test probes and cables included. You won't spend a dime extra to order special cables, because you get both the Counter Probe (with switched Direct and Isolated inputs), and the 12 Volt Auto Lighter Plug with the FC45.

12 Volt DC Operation

Use the FC45 in the field with a special Auto Lighter Adapter Plug included for making mobile transmitter and other frequency checks right on location.

Double Shielding Eliminates RF Interference

At last you can own an FCC accurate counter that is double-shielded from high power RF itnerference. Use the FC45 at your broadcast transmitter or with high power communications transceivers for super-accurate, super-stable readings that don't bounce around as plastic-cased frequency counters do. As far as we know, the FC45 is the only frequency counter that you can use right at a high-powered transmitter site.

5. Provides special time-saving user's features, too

Selectable .1 Sec and 1 Sec Read Rates

You can set the FC45 counter to update the readings at the rate you want. Punch up the .1 Sec time base rate for monitoring rapid frequency changes, or select the 1 Sec Read Rate for maximum resolution when the frequency does not change so often. Either way, the FC45 gives you the choice.

Exclusive Crystal Check

Here's the fastest, easiest way to check crystals today—an exclusive plug-in Crystal Check. Plug in the crystal to the front panel universal socket, and read the frequency. It's that simple to find out the fundamental frequency of any unknown crystal or if a crystal is working or not. Many FC45 owners say this exclusive check alone is worth the total price in time saved from substituting crystals.

12 Watt 50 Ohm Matched Dummy Load

Now you can connect CBs and other low power transmitters directly into the FC45 without adding a dummy load and transmitter line tap-offs to clutter your bench. Simply plug the transmitter into the FC45 50 Ohm load and you're all set. It's fast-blow fuse protected, too, so the FC45 won't be damaged if an improperly operating transmitter accidentally goes above the 12 Watt limit.

Use these FC45 accessories to expand your frequency measuring capabilities for...

UHF Testing

PR47
600 MHz
UHF
Prescaler
$125

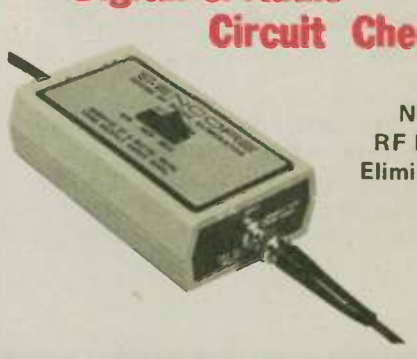
Extend the 230 MHz range of the FC45 all the way to 600 MHz UHF at 300 mV sensitivity. It quickly connects between the PL207 Pick-Up Loop (supplied with the PR47) and the FC45 1 Megohm input jack. Now you can be fully equipped for UHF band testing on land mobile transmitters, scanners, aircraft radio and navigation, amateur equipment, and many other uses. The PR47 divides the frequency by ten, so you simply multiply the FC45 reading by ten for your input frequency.

In Circuit & High Power Output Stage Checks

PL207 "Snoop Loop"
RF Pick-Up Loop
$9.95

Now you can troubleshoot through the circuits all the way back to the oscillator coils! The PL207 "sniffs" the frequencies without direct circuit connections that may cause circuit loading and frequency change. Use the PL207 to measure the output frequency from high power 100 Watt transmitters in seconds too, without wasting time to connect attenuators and pads into the output line.

Digital & Audio Circuit Checks



NE206
RF Noise
Eliminator
$25

Digital signals could present problems with any frequency counter because fast rise times may cause ringing "noise" pulses on the cable line that may be inadvertantly counted. The NE206 is especially designed for digital work with (1) a built-in low pass filter so the counter will ignore the pulses, and (2) a switchable attenuator to reduce high level digital signals.

.1 Hz & .01 Hz Resolution for Audio Tests

PR50
Audio
Prescaler
$125

You may need to measure frequencies to within .1 Hz or .01 Hz for electronic organs and instrument tuning, tone-controlled squelch oscillator checks, and other audio testing to 30 KHz. The PR50 Audio Prescaler equips you for these critical checks by multiplying the input frequency by ten or 100, whichever you select, for direct display on the FC45.

The beauty of the ringing test is that it will detect even one shorted turn, while opens are simply detected with no reading at all. You can check small sections of the flyback transformer, too, giving you a positive check on those numerous small winding take-off coils, that you probably have had no way to check before.

If the flyback and take-off windings have been passed as okay by the Ringer test, you will want to make the same check on the yoke. The procedure is exactly the same and the results just as conclusive. The Ringer can also be used to check pincushion and horizontal efficiency coils.

If you have eliminated all the components with these simple, easily made checks, and you still have trouble, you are down to straight forward DC paths and it is time to get out your favorite Sencore multimeter (and your 50KV high voltage probe) to check some DC voltages. The boost voltage is an important check at this point because proper drive, a good output amplifier stage, and a good yoke and flyback should produce boost voltage. If it doesn't, the damper is probably bad or the boost voltage circuit is loaded by a shorted component. If the boost is okay, you know that the problem is in the high voltage section of the receiver.

You should note that all of these tests are made without interpretation or reference to a single chart and that all TV receivers are made to look alike for faster, easier troubleshooting.

MEASURE HIGH VOLTAGES

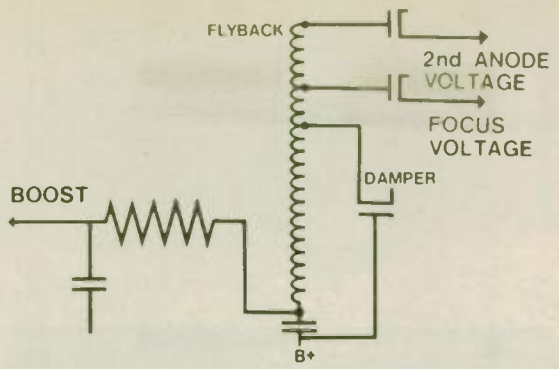
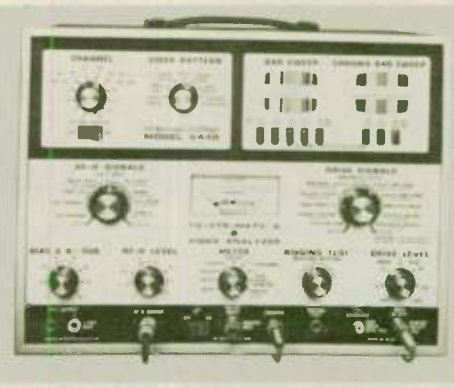


Fig. 44—Use a high voltage probe to check the high DC voltages developed from the flyback pulse and provide additional information about the horizontal stages.

Question No. 10: Can the VA48 walk the troubles out of the vertical section as well?

Special tube and solid state drive signals let you walk vertical troubles from the sync separator to the vertical output stage.



Double your output with superior service

The VA48 can walk the troubles out of the vertical section, but can do it in much less time than in the horizontal section because of the less circuit complexity. Let us start at the output of the sync circuits that feed the vertical oscillator. The composite sync is fed through a vertical integrator filter to the vertical oscillator. There has never been a good way to check the integrator filter before, even with a good oscilloscope. It was generally assumed that good horizontal sync and poor vertical sync meant a defective integrator filter. We wished that this were always true, and in most cases it is, but we all know that we would like to be sure that the problem is the integrator filter before disconnecting all those little leads. The VA48 really comes to the rescue here as we feed into the integrator filter, as we have just been doing in our past tests, or jump the filter and connect directly to the input of the vertical oscillator. The VA48 forms its own integration ramp to trigger the oscillator directly. If vertical sync is possible after the integrator, you know that you have a defective integrator filter.

The vertical oscillator itself is checked by driving the input of the vertical output stage. Once again, two pulses are available and are labeled VERTICAL OUTPUT TRANSISTOR BASE and TUBE GRID to provide universal driving signals. Every attempt is made to generate a waveform that will deliver nearly full height with good linearity. Linearity is close enough to detect faults in the waveform shaping circuits at that point, serving one other troubleshooting function.

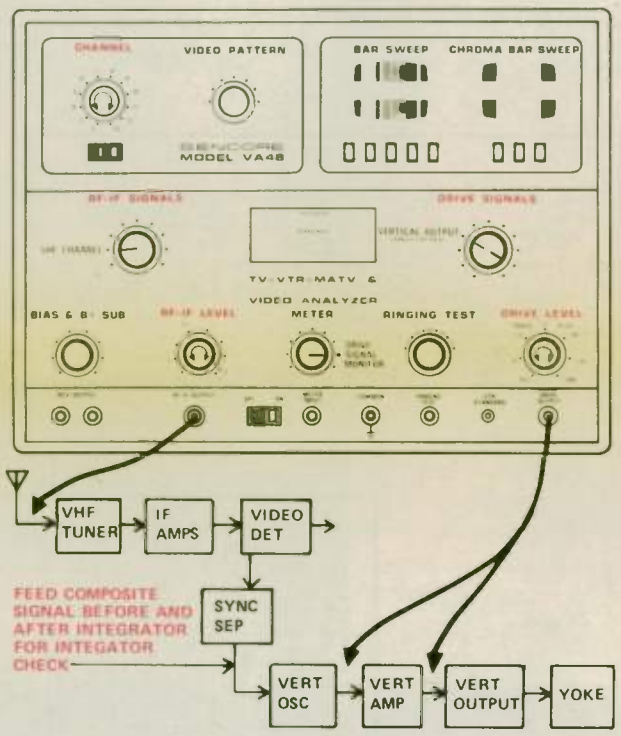
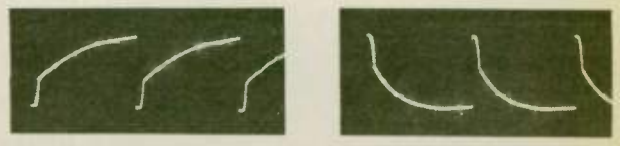


Fig. 45—The VA48 provides a positive check on every stage in the vertical circuits, including the integrator filter.



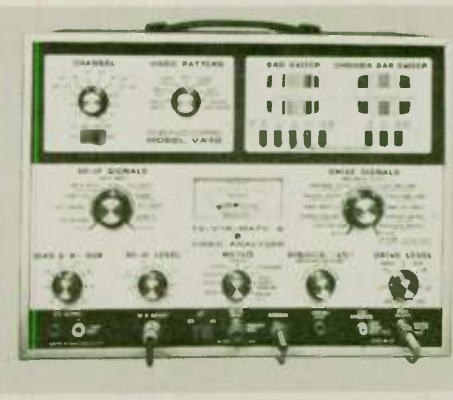
Plus drive level | Minus drive level

Fig. 46—The vertical drive signal provides a signal with an integrated sync pulse and a linear drive ramp. The polarity of the signal can be changed with the drive level control to allow injection into the input or output of any vertical stage.

If we haven't located our problem by now, we will suspect the vertical deflection yoke. This yoke is checked in exactly the same manner as the horizontal deflection yoke with the ringing test. We have then isolated our problem to the vertical output and transformer. A quick check of the amplifier itself (with a Sencore tube or transistor tester) will pinpoint the trouble to a defective output transformer.

Question No. 11: Why does the VA48 have a B Plus power supply? Aren't most TV sets AC operated?

This special supply helps locate troubles in AGC, ACC, APC, etc., plus powers up sets that use the "flyback power" to power up stages in the TV, and many more uses.



Double your output with superior service

The purpose of the BIAS & B PLUS SUB is not to power up the entire TV or other portable equipment. It can certainly be used on your bench for this purpose for anything up to one ampere of current and under 35 Volts. This covers most everything that uses up to, and including C cells. That's just an added bonus.

There are five main uses of this supply for TV servicing, and any TV or video analyzer without such a supply will not service all TV circuits: (1) To replace the DC voltage on automatic feedback circuits, such as the AFC, AGC, ACC, APC, Sync Discriminators, etc. If you have never used this form of troubleshooting in these automatic circuits, you must try it. Each of these circuits produce a DC correction voltage to control some amplifier or oscillator stage(s). All you have to do is connect this bias supply to that DC feedback point and override the correction voltage with this low impedance supply. You don't need to disconnect anything. If the circuit, being controlled, returns to normal as you vary the bias, you know that you have substituted the correct amount of DC voltage to do the job, and you know that the automatic circuit is not doing this. Therefore, you know that the automatic circuit is defective. (2) The second big reason for this supply is to bias stages that have heat "run-away" when not properly biased. A good example of this is some horizontal outputs that must be biased if the horizontal oscillator is not driving the horizontal output. You may be able

to think of other such stages that make it handy to have this DC voltage at your fingertips. (3) The third big reason for this well filtered supply is to power up module boards for servicing. There are more people doing their own module work because they simply find it profitable and expedient. The VA48 B PLUS SUB supply will let you do this work, too. If you require more than one voltage to power up these modules, you can use the Sencore 39G42 Module Master which provides four independently adjustable supplies from the single DC output of the VA48. (4) The fourth big reason for this one Ampere, 35 Volt supply (either positive or negative) is to power up stages that derive their power from the flyback circuits. There are more and more of these circuits in today's TV receivers and they become inoperative as soon as the horizontal section shuts down. At this point, you can't check anything unless you restore the B Plus voltage on these solid state receivers. This supply puts you back in business

Fig. 47—Well-filtered supply provides positive or negative voltage (by just reversing leads) for four big circuit checks and uses.

and once again enables you to reduce your servicing time with superior work. (5) The fifth big reason for this DC supply is for trouble-shooting direct-coupled (DC) solid state circuits. These circuits include video amplifiers, vertical oscillator and output stages and audio amplifiers. A direct-coupled stage depends on the DC voltage from the preceding or following stage for proper bias. Simple signal substitution may not return the operation of a direct-coupled stage to normal, even though the actual defect is not in that stage. This is true with all signal substitution analyzers because they must be AC coupled for protection to the analyzer and so that erroneous DC voltages are not coupled into the stage being tested. The BIAS and B PLUS SUB supply of the VA48 (used with a series current limiting resistor) returns proper bias to the stage so the substitute signal supplied by the VA48 drive output returns the stage to normal operation.

Question No. 12: I am running into more integrated circuits every day and have no positive way to troubleshoot them. Will the VA48 help me?

The VA48 is the best TV Integrated Circuit Analyzer that you can lay your hands on, as it checks each IC for it's function.

Double your output with superior service

We in field engineering are very aware of your problems in IC testing and can state flatly that there will never be an integrated circuit tester for the special ICs found in TV receivers. An integrated circuit is a "circuit" and not a component. Therefore, it can never be tested as a component because there is no commonality. An integrated circuit generally performs one function in a TV receiver, for example, but it may be only part of a function or may perform two or more functions. The easiest way to understand a TV IC is to consider the functional stages in a TV receiver, or any other video system. This takes us back to our old familiar block diagram that is often called a "functional block diagram". Each function often has more than one stage in it but for simplicity purposes, and better understanding of troubleshooting methods, we can simply substitute the word "stage" for function and all TV sets begin to look alike.

The VA48 provides a signal for every stage in a TV receiver. This signal is the closest thing that you will ever have to an IC checker and simplifies TV IC testing tremendously. We at Sencore doubt that we would have introduced the VA48 on the market at this time, if it were not for the complexity of testing presented by these new IC circuits. One simply feeds these substitute signals into the input of any stage, be it IC or anything else, and notes whether or not the receiver returns to normal. If it does, the IC is not at fault. If it does not, one should go directly to the input of the following stage and inject the signal from the VA48. If the receiver then returns to normal, the IC *stage* is at fault.

There are three things that can cause an IC stage to fail, in addition to the IC itself. (1) The input stage can be open or shorted. This is easily checked by connecting to the IC input directly. (2) The output can be shorted by the load or coupling to the next stage. This is easily checked by injecting the VA48 past the suspected point and seeing if the TV returns to normal. (3) The B Plus power supply itself can cause a dead stage. This can be checked by a DC check but can be further tied down by substituting the VA48 power supply if desired. Once these three things are checked, you know the trouble is the integrated circuit itself.

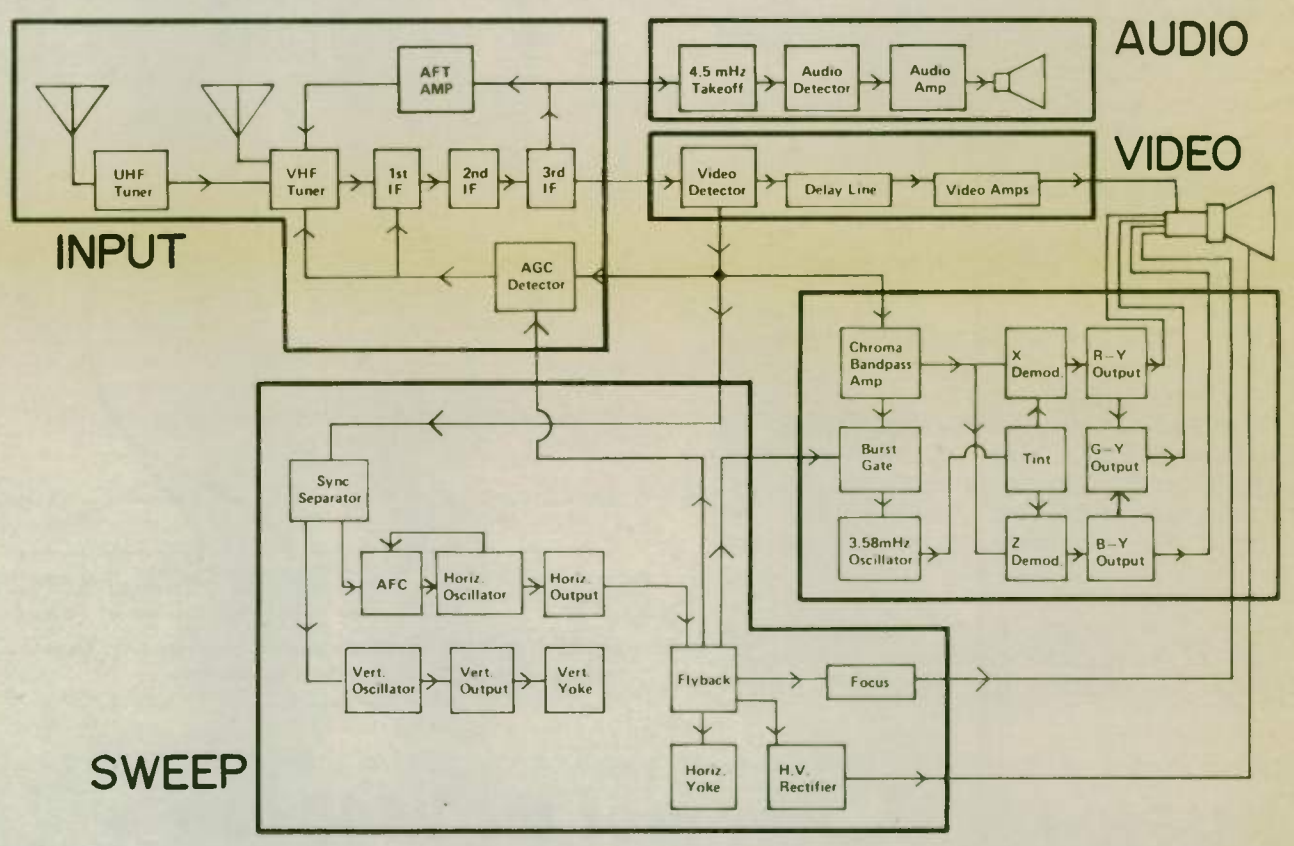


Fig. 48—Servicing circuits with IC stages merely involves treating each IC as a section of a block diagram. The VA48 provides all signals needed for injecting at the input or output of any stage.

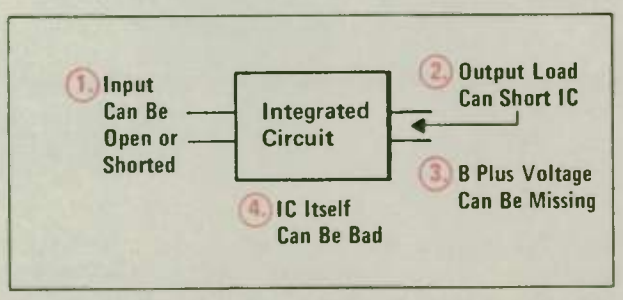


Fig. 49—An IC stage will not function if any of these four defects are present.

Let us see how we might check these same IC malfunctions with an oscilloscope. The input to the IC is easily checked with a scope and one can quickly determine whether the input waveform is present. Here is where the comparison stops, however, because lack of waveform on the IC output could mean a defective IC, a defective load, defective coupling, or no B plus. As we just discussed, the VA48 quickly checks all of these because the circuit is returned to normal with a new driving signal that the scope does not have. The scope must work from the energy in the TV set and becomes useless. Further, your scope may not have adequate frequency response in such circuits as the video IFs, and once again does not help you locate a defective IC in these circuits.

We hope that we have shown you that the VA48 is far superior to an oscilloscope in these new integrated circuits and lets you walk the troubles out of them step by step, regardless of the circuit that the IC is malfunctioning in.

Question No. 13:

Are you sure the VA48 can be used to service tape recorders? Most equipment now recommended for tape recorder service costs four times the price of the VA48 and really doesn't apply to my color TV service.

The VA48 provides special patterns and signals for this fast-growing, highly profitable video market.

Double your output with superior service

The video tape recorder market is a fast growing market and prices are coming in line so that many can now afford them. Video tape recorders are rapidly becoming a way of life in schools, sales departments, technical training departments, and other such places that find that they can do better training at much less cost with these systems. This alone is a huge market, but the consumer himself is now becoming interested and beginning to purchase video tape equipment. A great deal of consideration was given to video tape recorders during the design of the VA48. Many tape recorders were purchased and gone through in detail to be sure that the sync pulses, blanking pulses, color burst signal, modulation levels and types of modulation were available from the VA48 for direct substitution. These signals must be delivered to the video tape recorder, at one Volt peak-to-peak into 75 Ohms, for standard checks of the video tape recorder input capability (or to replace the camera). This has been provided on the VA48 for direct injection to check out the entire system. No adjustments are necessary because this is a fixed level.

Fig. 50—Video tape recorders represent a fast-growing service market and the VA48 equips you for this profitable business.

Many tape recorder manufacturers specify NTSC signals for checking out their tape recorders. The Sencore field engineering department has done a great deal of research and checking into these specifications and can find no reason that the more familiar standard RCA licensed 10 color bar system will not do the job. It was necessary to modify the 10 bar system to generate a color burst reference in place of the usual 12th bar, as used on color bar generators, however. The automatic color circuits in the VTR depend on a fixed amplitude burst signal to maintain a constant chroma level. A standard color bar generator does not provide this reference, but the 10 bars on the VA48 do and thus we, in effect, have an NTSC color generator with all colors generated at NTSC phases and compared to a zero reference color burst.

The one Volt peak-to-peak serves as a video tape recorder reference signal but this alone is not adequate for video tape recorder circuit troubleshooting. All of these troubleshooting signals,

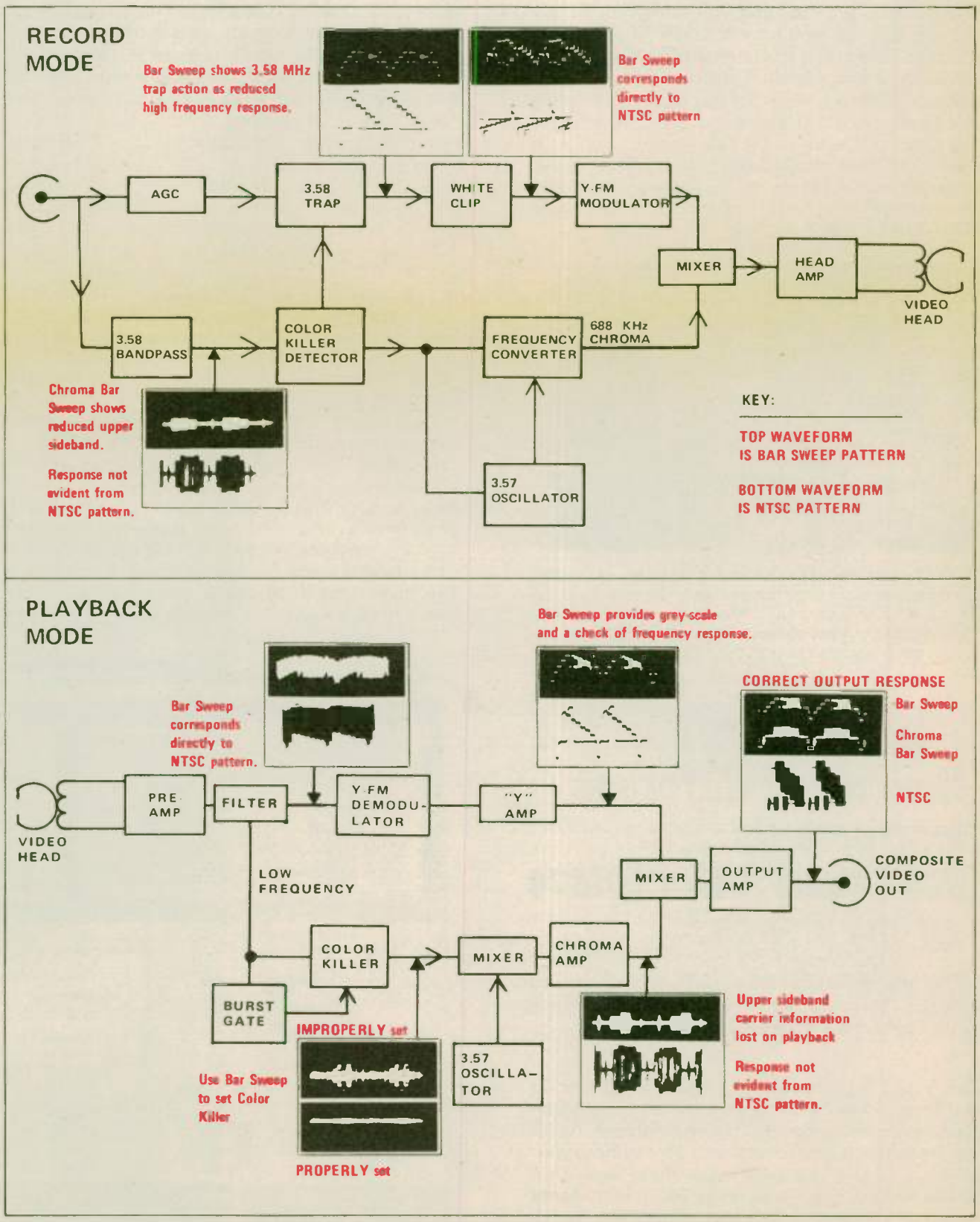


Fig. 51—Comparison of NTSC and Sencore VA48 system shows the VA48 will do the complete job in VTR servicing.

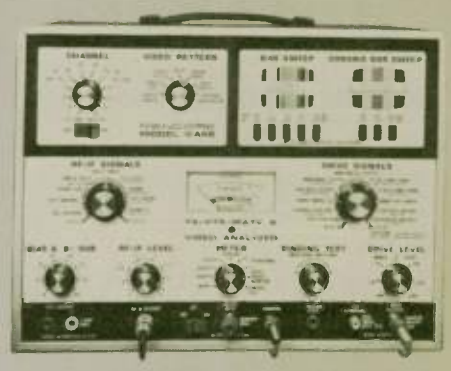
including all signals in the composite video signal and the modified color bars are available at the DRIVE SIGNAL OUTPUT, from zero to 30 Volts, positive or negative, for injection into any stage in the tape recorder system. The VA48 even offers a frequency response check not found in the NTSC color bar system. Bar Sweep patterns provide a check of the frequency response of the video amplifiers over their entire operating range.

In addition, the black, grey, and white bars, at the left of the bar sweep pattern, provide a direct check of the black and white limiting circuits found in the record amplifiers of these tape decks.

Finally, the Chroma Bar Sweep provides an overall check of the chroma processing circuits, just as they do in the color circuits of the TV receiver. We do not have time to go through the entire troubleshooting procedures for a tape recorder here and this subject will be discussed in detail in a subsequent *Sencore News*. In the meantime, many of the video tape recorder companies are rewriting their service instructions to include the modified color bars, as we have on the VA48. This means that you can use one system for color TV and video tape servicing at a much reduced cost.

Question No. 14: Now that I am understanding the capabilities of the VA48, I am wondering just how much I could do if I took the VA48 with me into the home. What do you think of that idea?

The VA48 lets you pinpoint troubles in the home and eliminates need to pull chassis in most cases. You decide.



Double your output with superior service

This question is coming up more and more at our video seminars as TV techs begin to think of just how quickly they might pinpoint their problems in the home and never have to remove the chassis. We really can't answer your question because that decision is yours and you know your trade and just how far you have to travel to your customers or how much traffic you fight to get back. We don't know whether you are set up with a real good universal color TV test jig, or how much you like to work in the home. We can tell you that there are many things that you can do with the VA48 that could help you speed up your home service, do more while you are there, and do superior service and estimating at the same time. Let us reason some of this together.

Fig. 52—Carrying the VA48 on a service call allows you to perform many tests in the home that you cannot do now.

The VA48 equips you with a high caliber color bar generator. This means that you don't have to tote along a color bar generator. The VA48 provides you with a grey scale check to make your tracking and color adjustments right on the nose to save time and make your customer happy. The VA48 provides you with a piece of equipment to align or check alignment right in the home. This should be particularly helpful if you are working on cable or MATV systems where these traps must be set on the nose to prevent adjacent channel interference. The VA48 provides you with a complete check of the tuner so that you can accurately diagnose tuner problems and know that your estimate on a tuner replacement is going to be a profitable transaction. The VA48 checks yokes and flybacks, without removing the chassis, for better diagnosis and more accurate service estimates. The VA48 provides you with a sensitivity and circuit ringing check to prove to your customer that the TV is working to standard and that the antenna, MATV or CATV system is at fault or off channel frequency. This alone could be worth the cost of the VA48 to win this argument and improve your service reputation. Who is going to argue with a "miniature TV station?" The VA48 can be used to check out home distribution systems for additional service income all in one trip. The VA48 peak-to-peak troubleshooter section can be used to trace troubles in case you want to go further or to take it along for emergencies. You can use the drive signals to check out modules if you don't have a substitute module with you, or just to be sure before you order a new module to find that this wasn't the problem. There are many other things that you can do with the VA48 in the home, such as power up boards and troubleshoot automatic circuits or just tie them down for estimates. We are not recommending that you go that far, but it is nice to have that capability. We think that we, in field engineering, might carry a VA48 just to show our customers that we are equipped to take care of their service better than anyone else in this area, which of course, is a license to add a little to the bill.

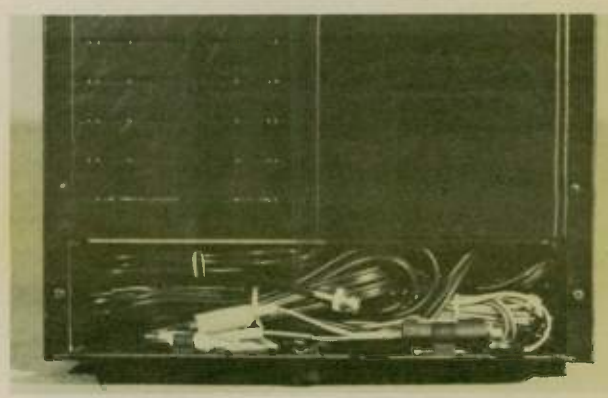
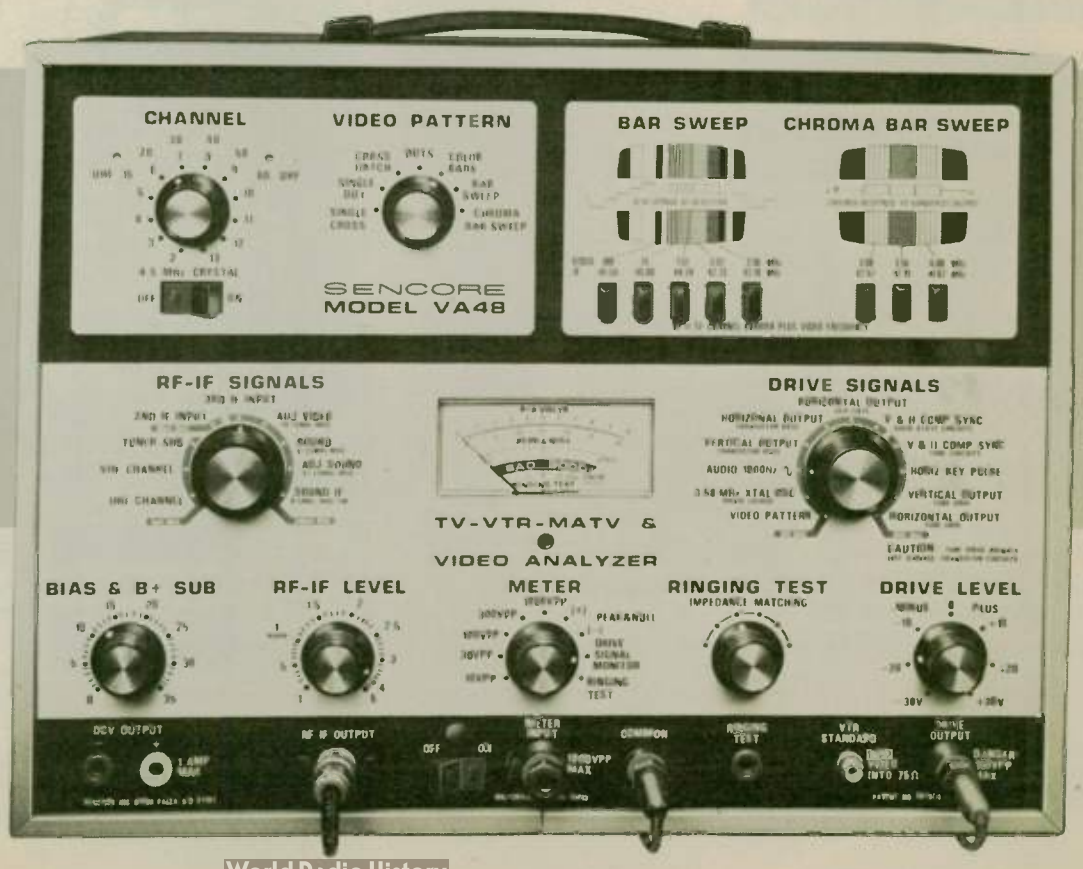


Fig. 53—The handy lead storage compartment on the back of the VA48 allows all leads and accessories to be carried with the VA48 when it is used in the field.

The VA48 has a large storage compartment, in the rear, to tuck in all the leads, and other servicing tools, so that you can carry it with you into the home if that is your decision.

Question No. 15: How many different instruments does the VA48 replace on my bench?

The VA48 replaces at least 10 separate instruments that normally cost well over $3,000 and has up to 60 individual test leads.



Double your output with superior service

$975 including all cables

The VA48 replaces most of the instruments on any service bench and leaves the service technician with a clean, orderly bench, with only three test leads to do most every job. More importantly, each of the test signals are phase-locked together so that there will never be an instrument coupling problem. A clean, organized bench means increased efficiency. Fewer test leads mean that you are going to get right at the prob-

lem without wasting valuable time hunting up leads or setting up instruments. Time is money in service and a customer will generally pay about the same service charge whether you spend two hours or four to make the repair. These two hours simply go into the profit till.

One would rather assume that any piece of equipment that would save time would be more costly. Yet, our customers find that their total investment is greatly reduced because the VA48 replaces equipment that costs them a minimum of three times as much. Here are some of the pieces of equipment that the VA48 replaces and updates your shop for the latest technology at the same time.

1. An old style TV Analyst that is not updated for solid state or new integrated circuits.

2. An old-fashioned Sweep and Marker Generator that you probably never wanted on your bench in the first place and owned it only because there was never a better way before the VA48.

3. A Video Generator that you have never had to have in color TV work, but will need for video tape recorder service. This alone is the same price as the VA48.

WHICH DO YOU WANT?

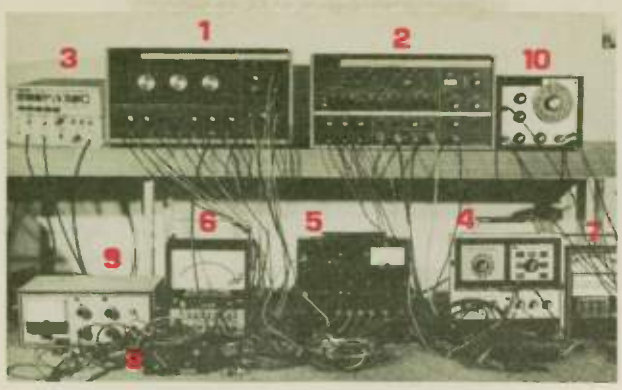


Fig. 54—Ten instruments at a cost of at least $3,000, 60 leads not phase-locked to each other, or . . .

. . .one instrument at a cost of only $975, only three leads to connect, with all signals phase-locked to each other.

4. A Deluxe Color Generator that does not equip you for video tape recorder service and does not check all TV channels.

5. A Sweep Circuit Analyzer. None of these are up to date for the latest low impedance solid state outputs.

6. A wide band peak-to-peak Signal Tracing Meter. Digital meters do not have peak-to-peak measurements and you won't want to restrict yourself.

7. A Yoke and Flyback Checker. The Sencore YF33 is the only up-to-date tester, but you may not have purchased yours yet.

8. A Tuner Sub that depends on the TV station and the antenna system as a "standard signal source".

9. A one Amp variable regulated Power Supply. Doubles for your bias box, too.

10. A separate RF and Audio Generator that leaves you to interpretation and time-consuming set up.

The VA48 updates every single one of these pieces of equipment that are priced at well over $3,000. The VA48 costs you only $975.

Question No. 16: If the VA48 replaces all of these instruments, what happens if it needs service? I then can't afford to be without it.

The VA48 gets special handling in the Sencore Service Department, because they know that you just can't get along without it, once you are used to it.

Double your output with superior service

We in field engineering considered this question and first discussed it with the Sencore production department. Jim Stalzer, our production manager, immediately took us back to the area where every VA48 is placed on special racks that age the VA48 with both heat and vibration. Jim told us, "We age each VA48 for 100 hours on these racks before they are given their final test. We want to be sure that every unit works properly when it is taken from the box ."

Jim went on to say that if any defect should develop that proves to be a manufacturing error the unit is covered by the famous Sencore 100% Made Right Lifetime Guarantee which simply states that Sencore will correct any manufacturing error at Sencore's cost for parts and labor to assure each customer that "Sencore has made the VA48 right ."

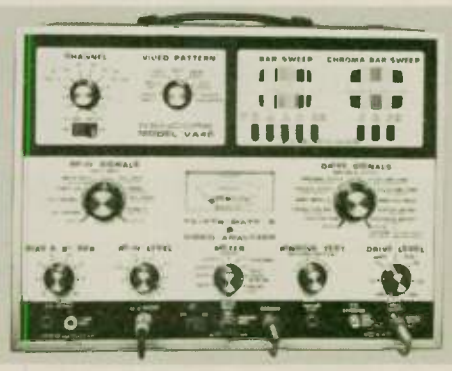
We then talked with Roger Swier, our National Service Manager. Roger understands the problem, too, and surprisingly told us "Didn't you know that I was servicing all Sencore analyzers with three day turn around service?" Roger explained that he had been running into this problem with the CB42 CB Analyzer and the SG165 Stereo Analyzer as customers called to insist that they couldn't be without their analyzer for even one day, let alone weeks.

Fig. 55—Roger Swier in Service Department with Mary Lund, service secretary, showing a VA48 being unpacked to go directly to a Sencore service specialist.

We can't come to your shop and service the VA48 for you but we can see that our National Service Division repairs any VA48 the day after it arrives at the Sencore factory. If a day or two means that much, send the VA48 air freight, and request that Sencore return it to you air freight. The difference in freight cost is very little compared to the value of the VA48, and our service department will comply with your wishes. Sencore is located right next to the Sioux Falls airport that is served by three airlines; Ozark, Western, and North Central, and has 36 jet flights a day. United Parcel will take only a day or two longer, from any point in the United States, and the United Parcel Service is located right behind the Sencore factory on Sencore Drive.

Question No. 17: How quickly will the VA48 pay for itself? How long will it take me to learn how to use it?

The VA48 will pay for itself in less time than any instrument Sencore has ever manufactured.



Double your output with superior service

Sencore has done a great deal to help you understand the Sencore VA48. We have just written this *Sencore News* so that you won't be buying a pig in a poke. You know what you are buying and you know just what to expect. Naturally, a well prepared operating and service manual is sent with each VA48. Addendums are being added to the manual as we, in field engineering, learn more and better ways, to use the VA48. A 30-minute familiarization tape is included in each VA48 package for you to sit back and listen as it familiarizes you with each control on the front panel and the VA48 patterns. A special *VA48 Speed Test Set-up* book clearly depicts each and every application and setting of each control. A coupon is included with each VA48 for you to return to receive a book now being prepared on video tape recorders. Each Sencore

Fig. 56—Sencore provides all of these aids to help you learn to use your VA48 quickly and increase your servicing effectiveness.

Tech Rep has, or will have, a two-hour video tape presentation on "Video Servicing in the 70's and Beyond". Sencore will hold over 1000 video seminars this next year to educate you to these new methods of servicing. Video tape servicing seminars will follow the conventional VA48 video servicing meetings in your area. We suspect that many manufacturers of video systems will be using the VA48 in their training sessions, too. There will be many magazine articles on the use of the VA48, starting in March of 1978. As if that were not enough, there will be two more *Sencore News*, discussing specific applications of the VA48 in tape recorder, color TV, MATV and CATV, and closed circuit servicing. We want every single service tech to know the VA48 and what it does.

Just how long does it take to pay for your VA48? We are proud to say that we believe that the VA48 will pay for itself quicker than any other piece of equipment produced by Sencore. Our experience has shown that the average tech will increase his service bench output from four color TV receivers a day to six color TV receivers a day within a month. We find that this output doesn't stop here and continues to climb to eight color TV sets a day as he begins to trust and believe in this kind of servicing.

We are sure that it won't take you very long to sit down with a pencil and paper and see what would happen in your business if each tech knocks out 50 percent more TV repairs each

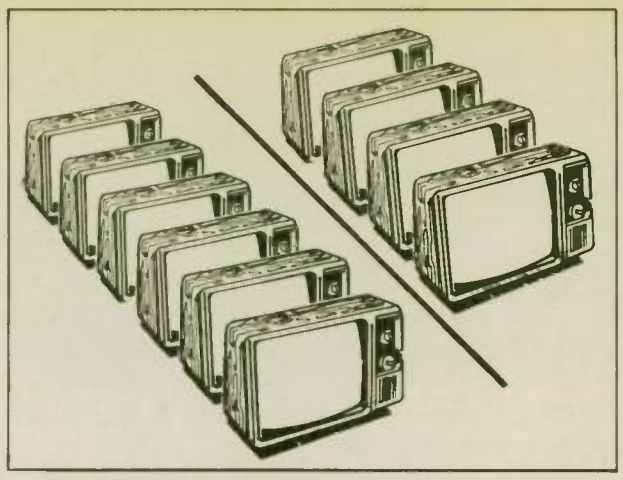


Fig. 57—The VA48 will allow most technicians to increase their average shop output from 4 to 6 sets a day within the first 30 days.

day. Your servicing income is increased by 50 percent, but your profits could easily quadruple because your overhead is already paid for on these last two repairs. This means that gross profit, profit after the cost of parts only, becomes net profit on any increase in service that you do.

Consider further the tough dogs that collect on the service racks and begin to project what would happen if you didn't take a loss on these. This, too, goes into the gross profit column to boost

Fig. 58—The superior service produced by the VA48 means more satisfied customers which generates good will and customer referrals.

your shop net profits even further. Consider the superior service, with less call backs, that are generally "freebees" and your total sales and profit picture takes another jump. Consider the free advertising that you get from a better reputation because you fixed the TV correctly in the first place and the new customers that this can bring you without added costs. Consider the business that you may be passing up in video tape recorder service, MATV, CATV, and booming closed circuit TV, and the VA48 becomes a real business expander for you.

Now, being the good business man that we know you are, you must realize that the VA48 is not written off the first year. Equipment of this type is normally written off in four years, meaning that your true cost is only $243.33 a year. Getting right down to brass tacks, this means that the cost of the VA48 in your place of business is just one dollar a working day. This is not much more than a pack of cigarettes a day or the cost of the gasoline that it took to get you to work in the first place. Can you afford not to have it?

Lastly, consider what will happen in your shop if your competition has a VA48 and is using these streamlined servicing techniques and you are not.

Renew your Sencore News now

Third Request

Sencore News is sent free of charge to owners of Sencore instruments. All others, except field engineers and instructors pay $5.00 to cover the cost of postage and handling. Please fill in the questions below if you wish to continue being on the Sencore News mailing list.

☐ I am a Sencore customer. I own the following Sencore instruments:

_____

and I plan on purchasing the following Sencore instruments soon:

_____

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Return to: Sencore, Inc., 3200 Sencore Drive, Sioux Falls, SD 57107

TV Seminar Notice

All seventeen of these questions and answers are brought to life in a truly dynamic way at each VA48 Video Seminar in your area. Each of these points, graphs, and photos are explained and demonstrated on full color video tape. We suggest that you read this Sencore News thoroughly and note any questions that you have alongside the copy. Then, attend a Sencore Video Seminar, watch these same issues explained in a dynamic way, and then ask your technical instructor any question that the video tape does not clear up. For much better results, purchase your VA48 now, try these things, and make additional notes of things that may not work for you the first time. A demonstrator will be available for you to simulate your condition so our Sencore technical specialist can help you.

25 TV tests that the VA48 will make that no other analyzer or tester will make.

Test	Comment
1. Test or align every UHF, VHF, Tuner Channel in use in your area.	Competitive analyzer has no output on channels 5, 9, 10, and 11.
2. Test RF sensitivity with preset microVolt control . Simulate fringe condition and know the level of operation in microVolts.	Competitive analyzer does not have a calibrated RF output control. You may be able to simulate a fringe condition, but you have lost your reference for the next TV.
3. Check overall gain of IF amplifiers or each IF stage with preset microVolt reference for good or bad reference.	No reference at all for IF gain. . .you are on your own.
4. Check RF and IF alignment from top of chassis if desired. No need for bias connection. *	No alignment check at all. Need separate sweep and marker and bias supply, plus you'll have to remove the chassis.
5. Align in minutes right from top of chassis and check the AGC action, too. View right on CRT.*	No other analyzer or tester can completely align a TV receiver because they do not have, nor will ever have, the patented Bar Sweep.
6. Align or check the alignment of chroma amplifiers from top of chassis.	Sweep and marker required on any other analyzer ever made. Cost of competitive analyzer, plus sweep and marker, far exceeds cost of VA48.
7. Check the video amplifier for frequency response, ringing, plus action of peaking coils and 3.58 traps from top of chassis. *	You can align with a sweep and marker, use our competitor's analyzer, and you still may have troubles in the video amplifier. You are on your own.
8. Set all traps right on the nose with crystal accuracy right from top of chassis.	No other analyzer or alignment equipment gives you any method of setting the traps with crystal accuracy, let alone from the top of the chassis.
9. Drive the CRT directly to check the CRT input circuits with up to 30 Volt drive signal.	The main competitive analyzer is limited to 2.5 Volts peak-to-peak drive and it takes 30 Volts to do the job.
10. Substitute the 3.58 MHz oscillator directly while the TV stays in color sync.	The VA48 is the only analyzer on the market with a phase-locked 3.58 MHz signal for substitution. Our competition uses a 3.56 MHz signal and it just doesn't work.
11. Substitute for any color signal in any of the color circuits with full synchronization, right up to the CRT.	Nothing else on the market even comes close. We just won't compare,
12. Drive any audio stage, even the speaker itself, for audio trouble isolation.	Main competitive analyzer uses only 1 Volt peak-to-peak audio. The VA48 has 0 to 30 Volts variable for every stage.
13. Drive sync stages with FCC standard rise-time sync pulses so waveforms look just like TV schematic.	Competitive analyzers use self-improvised sync pulses that leave you guessing whether the trouble is the set or the sync pulse. Nothing is standard.
14. Check integrator filter in vertical input with preintegrated waveform and ramp for substitution after integration.	Competitive analyzer has no such check and even uses a sine wave right off the AC line. You know "what good that isn't" when you are running 59.94 Hertz on color TV.
15. Drive the vertical output and check for linearity.	Competitive analyzer(s) uses 60 Hz sine wave and makes no attempt to check for linearity.
16. Substitute for horizontal oscillator in tube, transistor or SCR TV.	The VA48 is the only analyzer on the market that has a drive signal for SCRs plus has both polarities for transistors.
17. Substitute for flyback keying pulses in any stage with variable polarity and amplitude up to 30 Volts for transistors and 300 for tubes.	Competitive model has only 400 Volts fixed positive polarity. Could be quite dangerous on low level keying pulses or solid state circuits.
18. Check all deflection yokes on the market, both tube and solid state, with tried and proven Ringer method. In-circuit, too.*	Main competitive analyzer doesn't check solid state deflection yokes with low impedance.
19. Check flyback transformers, in or out-of-circuit with tried and proven Ringer test.*	No competitive analyzer (except the Sencore YF33 Ringer) uses a calibrated test signal with correct impedance.
20. Substitute well-filtered DC supply for circuits that must be powered to test them; AGC, ACC, APC, AFT, flyback derived B+, direct-coupled solid state circuits, etc.	Competitive analyzer provides 25 Volts at only 250 milliAmps. The VA48 has 1 Amp of power to 35 Volts to do the entire job.
21. Monitor drive signals at all times with built-in peak-to-peak monitoring meter.	You will have to use a separate meter with competitive equipment. They have no such monitor.
22. Use built-in meter to signal trace from any detector to output for fast troubleshooting when stages are dead.	No competitive analyzer has a built-in signal tracer to simplify your service.
23. Check color tracking on specially prepared "black and grey" scale. Speeds up alignment and results are more accurate.	No such tests on any other analyzer, even those Sencore has made.
24. Set the color oscillator in a truly dynamic way right on color bar pattern.	You'll have to do it the old-fashioned way if you own a competitive analyzer.
25. Set color killer in a truly dynamic way right on color bar pattern.	Sorry, you'll still have to do it the old way if you own a competitive analyzer.

Only **$975 including all cables**

*Covered by U.S. Patent No. 387949 and No. 3990002

Conclusion:

These are 25 checks that you can make if you own a VA48 Video Analyzer. We have many more, but we think you would like to sort them out in the copy. We haven't said anything about CATV, MATV, Closed Circuit TV, or the very profitable Video Tape Service that the VA48 equips you for. Our competition won't service them effectively. What is important, and what must be said again, is that the cost of the VA48, with all these tests for troubleshooting and alignment, is far less money than our competitor's analyzer and sweep and marker generator. If you want less and want to spend more, purchase from our competitor. If you want all these tests at your fingertips, for less money, buy the VA48.

You can really count on these FC45 buyer's benefits

1. Covers Audio through 230 MHz VHF continuously

The FC45 has an extremely wide frequency range coverage for every use from 30 Hz audio through 230 MHz VHF. It will even go to 600 MHz UHF with the PR47 Prescaler, equipping you for virtually any frequency test you may encounter.

2. Better measurement accuracy than FCC specs

You can be sure that the FC45 has the accuracy you need for critical design checks or for documenting your FCC frequencies with every reading at least five times better than FCC standards. A high accuracy reference crystal enclosed in a temperature-controlled oven insures one part per million (.0001%) guaranteed accuracy (0-40° C.) throughout the 230 MHz frequency range.

3. High sensitivity for circuit testing

High 25 milliVolt average sensitivity all the way through 230 MHz means that you can now use a pick-up loop in low level circuits without circuit loading sometimes caused by direct connections. You can now trace frequencies all the way through oscillators, amplifiers, and high power stages with full confidence that your reading is 100% accurate.

4. Easy to use with all pushbutton operation & all direct reading display

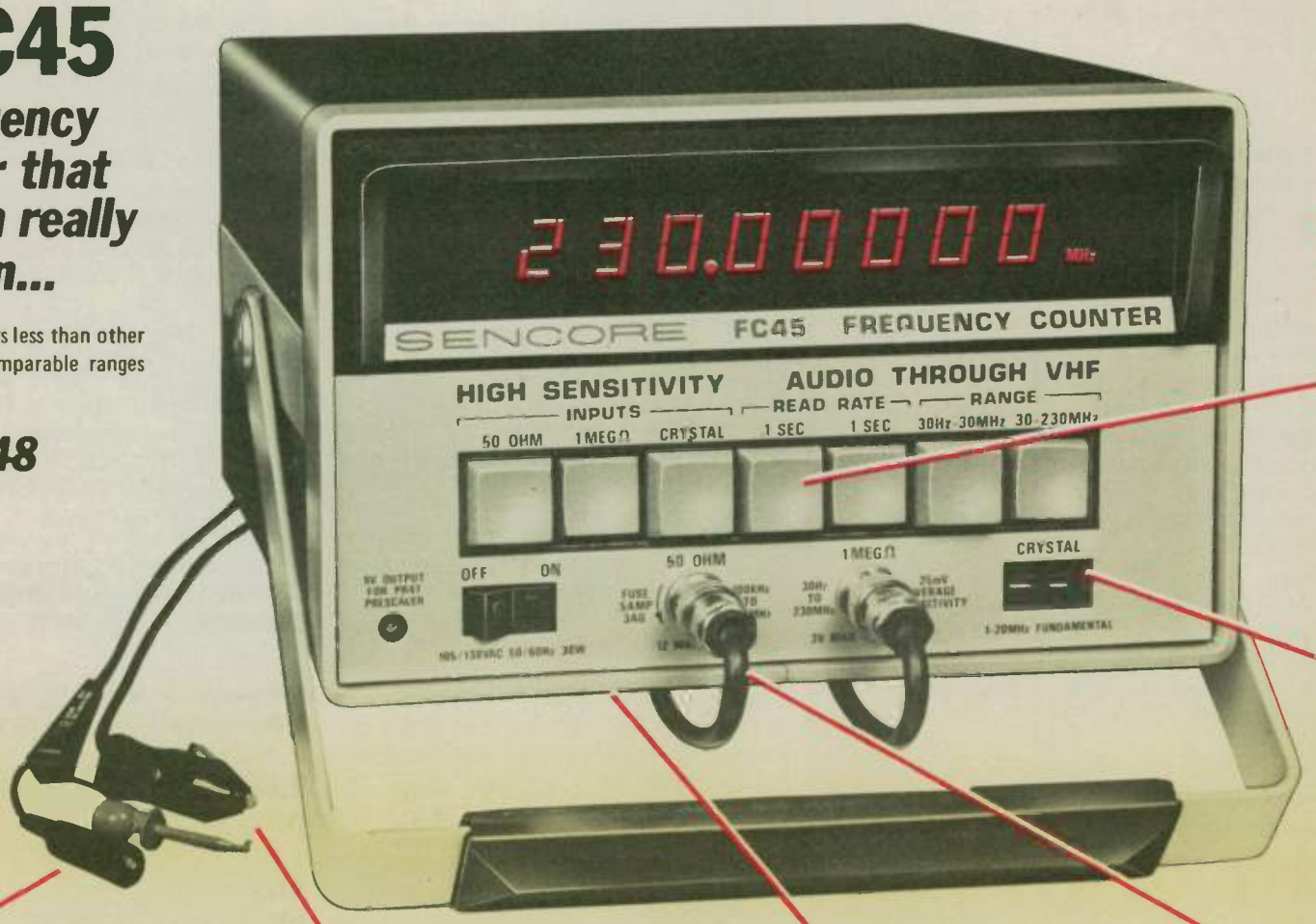
Just push the button you want and read the direct reading display. The FC45 is that simple to use. You won't have to interpret your scales or shift decimal places mentally with the FC45. Automatic ranging, decimal positioning, and special Hz and MHz indicators show you the exact frequency you are checking every timé. The big, bright eight digit readout provides ten Hertz resolution at the higher frequencies and 1 Hz resolution below 30 MHz, too, so you won't be mislead with overrange indicators and range switching.

New FC45

A Frequency Counter that you can really count on...

Hundreds of dollars less than other counters with comparable ranges and accuracies.

Only $448



BACKED BY SENCORE'S 100% MADE RIGHT LIFETIME GUARANTEE

5. Provides special time-saving user's features, too

Selectable .1 Sec and 1 Sec Read Rates

You can set the FC45 counter to update the readings at the rate you want. Punch up the .1 Sec time base rate for monitoring rapid frequency changes, or select the 1 Sec Read Rate for maximum resolution when the frequency does not change so often. Either way, the FC45 gives you the choice.

Exclusive Crystal Check

Here's the fastest, easiest way to check crystals today—an exclusive plug-in Crystal Check. Plug in the crystal to the front panel universal socket, and read the frequency. It's that simple to find out the fundamental frequency of any unknown crystal or if a crystal is working or not. Many FC45 owners say this exclusive check alone is worth the total price in time saved from substituting crystals.

All Probes and Cables Included

Now here's a plus—you're equipped for the job the moment you take your FC45 out of the box with all test probes and cables included. You won't spend a dime extra to order special cables, because you get both the Counter Probe (with switched Direct and Isolated inputs), and the 12 Volt Auto Lighter Plug with the FC45.

12 Volt DC Operation

Use the FC45 in the field with a special Auto Lighter Adapter Plug included for making mobile transmitter and other frequency checks right on location.

Double Shielding Eliminates RF Interference

At last you can own an FCC accurate counter that is double-shielded from high power RF itnerference. Use the FC45 at your broadcast transmitter or with high power communications transceivers for super-accurate, super-stable readings that don't bounce around as plastic-cased frequency counters do. As far as we know, the FC45 is the only frequency counter that you can use right at a high-powered transmitter site.

12 Watt 50 Ohm Matched Dummy Load

Now you can connect CBs and other low power transmitters directly into the FC45 without adding a dummy load and transmitter line tap-offs to clutter your bench. Simply plug the transmitter into the FC45 50 Ohm load and you're all set. It's fast-blow fuse protected, too, so the FC45 won't be damaged if an improperly operating transmitter accidentally goes above the 12 Watt limit.

Use these FC45 accessories to expand your frequency measuring capabilities for...

UHF Testing

PR47
600 MHz
UHF
Prescaler
$125

Extend the 230 MHz range of the FC45 all the way to 600 MHz UHF at 300 mV sensitivity. It quickly connects between the PL207 Pick-Up Loop (supplied with the PR47) and the FC45 1 Megohm input jack. Now you can be fully equipped for UHF band testing on land mobile transmitters, scanners, aircraft radio and navigation, amateur equipment, and many other uses. The PR47 divides the frequency by ten, so you simply multiply the FC45 reading by ten for your input frequency.

In Circuit & High Power Output Stage Checks

PL207 "Snoop Loop"
RF Pick-Up Loop
$9.95

Now you can troubleshoot through the circuits all the way back to the oscillator coils! The PL207 "sniffs" the frequencies without direct circuit connections that may cause circuit loading and frequency change. Use the PL207 to measure the output frequency from high power 100 Watt transmitters in seconds too, without wasting time to connect attenuators and pads into the output line.

Digital & Audio Circuit Checks

NE206
RF Noise
Eliminator
$25

Digital signals could present problems with any frequency counter because fast rise times may cause ringing "noise" pulses on the cable line that may be inadvertantly counted. The NE206 is especially designed for digital work with (1) a built-in low pass filter so the counter will ignore the pulses, and (2) a switchable attenuator to reduce high level digital signals.

.1 Hz & .01 Hz Resolution for Audio Tests

PR50
Audio
Prescaler
$125

You may need to measure frequencies to within .1 Hz or .01 Hz for electronic organs and instrument tuning, tone-controlled squelch oscillator checks, and other audio testing to 30 KHz. The PR50 Audio Prescaler equips you for these critical checks by multiplying the input frequency by ten or 100, whichever you select, for direct display on the FC45.

Ruggedized Accuracy

New **DVM37** .1% Accuracy Portable Digital Multimeter

Handy carrying handle & tilt stand

Convenient back-up fuse protection

Circuit isolation

Battery-saving On-Off button

Direct reading big 3½ digit LED display

Automatic zero, polarity, decimal and overrange

Super-sensitive tests to .1 Ohm and .1 microAmps resolution

28 Full ranges to 2,000 Volts, 2,000 milliAmps and 20 Megohms

Break-proof Cycolac® case construction

Exclusive 8,000 Volt transient protection

2,000 Volt continuous protection on all ranges

Tug-proof test leads attached for safety

Compact palm-size for field or bench

Hi-Lo Power Ohms for in-circuit resistance checks

Standard "C" cell battery operation with battery self-check

Only $268

IT'S ACCURATE

"PRIME STANDARD" ACCURACY: The new DVM37 provides the .1% "prime standard" DCV accuracy you'll want for tests you can trust every time in the field or on the bench. This state-of-the-art accuracy is backed with exclusive 15 Megohm input impedance for 50% greater accuracy and 1/3 less circuit loading than the 10 Megohm input other .1% DVMs use. You'll find the DVM37 is a virtual necessity if you are operating or troubleshooting voltage-controlled, IC, digital, or varactor-tuned circuits.

SUPER SENSITIVITY FOR CRITICAL TESTS: 0.1 Ohm resolution on the 200 Ohm range equips you for super-low tests of low value resistors in solid state bias circuits. Super critical AC leakage current checks for medical and OSHA requirements are easy with .1 microAmp current resolution.

FULL RANGES FOR UNIVERSAL TESTING: Here are 28 full ranges to cover your measurement needs all the way up to 2000 Volts DC, 1000 Volts AC, 2000 milliAmps on current, and 20 Megohms of resistance. The Hi-Lo Ohms function checks resistances in solid state circuits, without disconnecting components.

IT'S RUGGED

RUGGED OUTSIDE FOR THE FIELD: The compact and comfort-designed case looks stylish, yet it is built tough and rugged to take the use and abuse a field meter gets. It's built in an unbreakable Cycolac® case, the same material automobile bumpers and football helmets use, to withstand ten-foot drops that would shatter other meters. All mechanical components are thoroughly ruggedized, including the high-quality computer-type circuit boards and switches.

TOUGH AND PROTECTED INSIDE: You really don't know what the voltages are when you start to troubleshoot defective circuits. That is why triple-protection was built into the DVM37 to keep it working day after day. Exclusive 8000 Volt transient spark gap protection saves damage from the 5000 Volt spikes at a horizontal output tube plate and other transients, such as back EMF motor surges and line transients. Continuous 2000 Volt diode protection, with back-up fuses, further prevents damage to all the DVM37 ranges, including the lowest Ohms range. It's virtually burnout proof, and is the only .1% portable DVM to offer such protection at no extra cost.

IT'S EASY TO USE

DIRECT-READING DIGITAL DISPLAY: Your circuit measurements have never been so fast nor so easy to make as with the all direct-reading DVM37 digital display. The big and bright 3½ digit L.E.D. (light emitting diode) display shines from across the room. Special Auto-Zero, Auto-Polarity, Auto-Decimal, and Auto-Overrange circuits practically do all the "thinking" for you for fast, error-free interpretations every time.

BATTERY POWERED FOR THE FIELD: The DVM37 is completely battery powered from standard "C" cells for unlimited "prime standard" measurements anywhere. Your batteries will last and last, too, with an exclusive "Push On" button switch in the probe to save battery power between measurements. Press the button only as you make your measurement. The DVM37 draws absolutely no current between tests when you release the button.

AC-POWERED FOR THE BENCH: You may wish to plug the DVM37 into the low-cost PA208 Power Adapter accessory and use the bypass On-Off switch on the front panel for continuous power on the bench.

IT'S VERSATILE

AC power for the bench
–PA208 Power Adapter $9.95
Plugs into DVM37 for AC power operation or recharging NiCad batteries.

High voltages to 50,000 Volts
HP200 50KV High Voltage Probe . . . $25.00
Slips over the probe for voltage checks all the way to 50,000 Volts. Simply multiply your reading by 100.

DP209 RF Demodulator Probe . . . $14.95
Directly measures average RF voltages on any DC Volt range from 400 KHz to 150 MHz (usable to 250 MHz) at 500 mV to 50V sensitivity.

New Standard of the CB Service Industry

Rarely does a new product receive immediate acceptance and use by the leaders in the big CB market, the fellows who know more about building and servicing CBs than anyone else. But these 16 CB manufacturers must have thought the Sencore CB42 CB Analyzer would do the job faster, more reliably, and more profitably for you, or they wouldn't have put their stamp of approval on it so quickly after it was introduced. Some wanted it for their own use, too, and have actually purchased units for their own factory design, service, and quality assurance departments.

As John Magnusson, HyGain's Field Engineering Manager told us, "It is imperative that the service organization become equipped with self-contained test instruments. The CB42 is an excellent integrated test instrument that speeds up troubleshooting and servicing". Why not try the CB42 on your bench to see how much more quickly and profitably you can turn out those CB service dollars.

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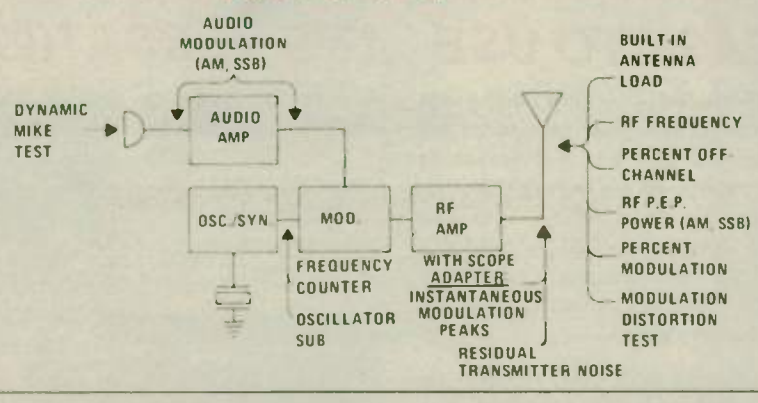
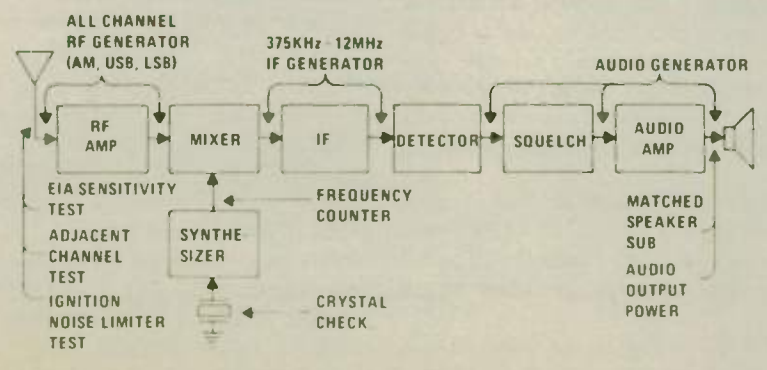
WALK THE TROUBLES OUT OF TRANSMITTER STAGES IN MINUTES



ALL THE SIGNALS YOU NEED FOR INJECTING INTO EVERY RECEIVER STAGE, TOO



BACK UP YOUR SERVICE JOB WITH

Your Automatic CB Talk Power Tester

CB41 Automatic CB Performance Tester $148

For the first time, you can make all three tests for maximum CB Talk Power – RF Watts, antenna SWR, and Percent Modulation – on all the 23 or 40 CB channels in only three minutes from hook-up to "radio check"! Just push the button you want, and you and your customer can read the color-coded meter scale to know if he's "getting out" as he should.

The CB41 checks both AM and SSB CBs for Peak Envelope Power, checks the mike itself, and helps locate intermittent mike cable problems the simple, automatic way without adjustments or calibrations. It's the only 100% automatic Talk Power tester you can buy to keep your customers talking strong.

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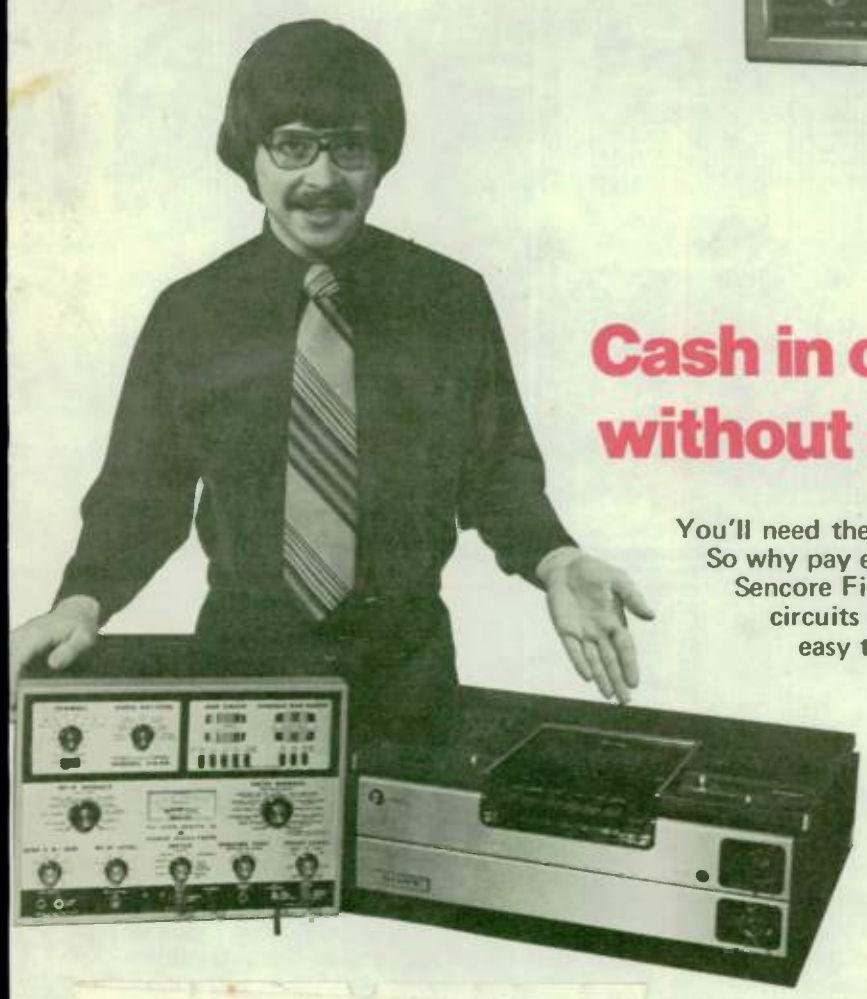
SENCORE NEWS

SPECIAL FEATURE
Speed Test Charts
for VHS and Betamax servicing with your VA48.
See centerfold.

Walk troubles out of any Video Tape Recorder

step by step & stage by stage... with your functionalized VA48 TV-Video Analyzer.

The most complete, fastest, and most accurate means of troubleshooting VTRs today... and at a fraction of the cost of other systems.



Cash in on the exploding VTR service market without spending an extra dollar in your shop

You'll need the VA48 TV-Video Analyzer to keep up with new integrated circuits in the latest TV sets anyway. So why pay extra for VTR test equipment when one instrument will do the entire job and do it better? Follow Sencore Field Engineers through the understanding of the Sony Betamax VTR, see how to analyze the VTR circuits as they are reduced to their basic functions for simplified testing, and understand how simple and easy the repair can be. See how the VA48 compares to costly, engineer-recommended instruments, and how the VA48 will make tests this equipment won't do. Then, get a good operating video tape recorder and put troubles in various stages to see how your VA48 will walk these troubles out for you. No need to pay more when you already own the best.

IMPORTANT: If you have questions or want to see the VA48 demonstrated, fill in the "Sencore Instrument Interest Form" and mail it to the Sencore factory today. Also, be sure to renew your Sencore News. See coupon on back cover of centerfold.

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The Sencore Field Engineering Department covers

Questions & Answers about Video Tape Servicing

by Greg Carey, Chief Field Engineer

Introduction

Two new buzz words are circulating in the TV/Video servicing market: VTR (Video Tape Recorders) and VCR (Video Cassette Recorders). Many service shops are looking at this new, but rapidly expanding, market as a good way to supplement the service business of a shop that is presently servicing only TV receivers. We have had the opportunity to discuss the future of the VTR service market with both service technicians and VTR manufacturers and find that many people are concerned with just what test instruments are needed for complete VTR servicing. At least one manufacturer is suggesting (but not requiring) a list of equipment with a price tag of almost $15,000 for use by their service centers. Such suggestions are making many shops a little "gun shy", and understandably so.

The VTR market will most likely follow similar new-technology markets (such as color TV and solid-state TV) and require 2 to 2½ years to become a mature service market. A shop that has a $15,000 investment in equipment (that may not be fully used for two years) has every right to ask just how such an investment can possibly pay for itself in a reasonable period of time.

Sencore has been observing the VTR service market since Sony first introduced their Betamax tape decks to the American public. This new service market led to some very important considerations in the design of the VA48 TV-VTR-MATV & Video Analyzer to make sure that the signals and patterns produced by this new analyzer would fill the needs of the VTR service technician as well as the technicians in other phases of video service. The results of this early planning are that we now have a single instrument that will service both TV receivers and the new video tape systems. This simply means that a shop that is only starting to see requests for video tape service is fully equipped to meet this need with the VA48. But, since the VA48 also provides complete TV service capability, a separate investment in a VTR service bench is not needed until the amount of service picks up. When this does happen, (as it most likely will) a second VA48 purchase will equip the dedicated VTR service bench leaving the first VA48 for the technician that is doing the TV servicing, and, of course, double as a second TV service bench if the backlog of TV sets waiting to be serviced suddenly begins to build.

A key consideration in equipping a shop for VTR service is the total cost of the equipment needed to do the job. The price of the VA48, with its full TV and VTR analyzing capabilities, is actually less than an "NTSC" generator alone. As you will see in the following article, the VA48 provides full analyzing capabilities that an "NTSC" generator does not provide and still provides all signals needed for complete VTR service.

What Equipment Do I Need in Addition to the VA48?

Video tape servicing requires a minimum of equipment when you are using the VA48 as your signal source. Basically, you need a good dual-trace oscilloscope and a frequency counter, in addition to your other test equipment, such as a digital voltmeter and transistor tester. We will discuss why each of these items is necessary by considering what tests need to be made.

Dual Trace Scope

Some shops are now using a dual trace scope for their present service applications. Other people want to know what a dual trace scope can do for them. The greatest advantage of a dual trace scope, compared to a single trace scope, is that it allows comparison of two waveforms at the same time. This is convenient in tracing signals through inputs and outputs of various stages, but is essential in troubleshooting such critically timed circuits as the servo stages, where two signals must be properly timed. A few manufacturers are suggesting the use of a 20 MHz scope for VTR servicing. When we asked why they were recommending such a high frequency response (when the highest frequency used in the VTR is 4.3 MHz) the usual answer was that such higher-priced scopes usually have a brighter trace.

We found that the Sencore PS163 Dual Trace Oscilloscope provided good brightness in all of our work with the tape decks. As a matter of fact, every scope waveform shown in this article was shot using a PS163 even though our design labs have 50, 100, and 200 MHz scopes available for use. The reason that we used the PS163 is simply because it provided a more stable trace than the other scopes. The PS163 is one of the few (if not the only) dual trace scopes available with true TV sync separators built into the triggering circuits for both vertical and horizontal sweep rates. Many scopes have a "TV" position, but do not use actual integrator filters to allow triggering on vertical sync pulses. We found that the PS163 saved time on every waveform, as all we needed to do was set the timebase switch to "TVV" or "TVH" for every signal we measured.

Frequency Counter

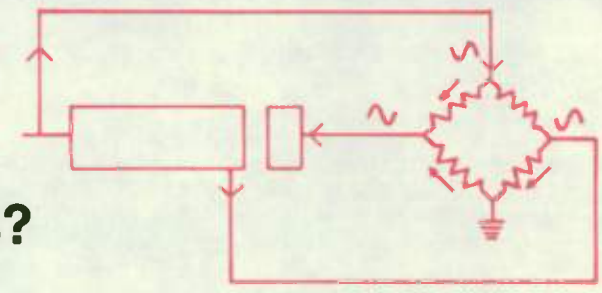
A stable frequency counter is required for setting the reference oscillators found in the color circuits of the VTR and for adjusting the servo circuits. The Sencore FC45 offers high 25 mV sensitivity for measuring low-level signals with a full 8-digit readout for direct readings of the oscillator frequencies down to 1 Hz resolution. The versatility of the FC45 is expanded even more with the use of the PR50 Audio Prescaler, which allows the adjustment of the 30 Hz control track signals to an accuracy of .01 Hz. Many competitive frequency counters use a "period measurement" mode for measuring these low frequencies. This proves to be time-consuming, because the frequency is shown (on the competitive counters) as a time interval instead of a frequency. You must then use a calculator to figure the actual frequency by dividing the time measurement into one (Frequency= 1/time). The PR50 provides a direct readout of frequency, which is updated every second or 10 times a second with .1 Hz resolution, to eliminate the time-consuming calculations necessary with a period counter. The PR50 also has filtering built in to prevent false double-counting due to signal noise that is often present in these low-frequency signals.

Digital Voltmeter

The use of a DVM is important for VTR servicing because most of the circuitry is contained in ICs. The DVM is used for adjusting the regulated power supplies to the correct output voltages and for measuring the low-level signals found in some of the ICs. The Sencore DVM38 provides an ideal DVM for VTR service, because it has extra ranges usually not found on other meters in the same price range. These ranges include one that reads to 200 mV full scale for measuring low-level signals. Most other meters have 2 Volts as the lowest range. The DVM38 also includes a 20 Ohm resistance range which measures down to .01 Ohms for measuring the resistance of video heads and rotary transformers. The single-step auto-ranging and auto-zero features of the DVM38 are extra features designed to save time on every measurement.

Transistor Tester

Many of the circuits in the VTR are controlled by discrete transistors. A VHS tape deck, for example, has 180 transistors used for various control functions. The use of an in-circuit transistor tester, such as the TF46 Portable Super Cricket, greatly simplifies the troubleshooting of a transistor circuit since the suspected transistors can be checked in-circuit to confirm whether or not they are the cause of the defect. The TF46 claims the highest in-circuit testing accuracy, for both transistors and FETs, of any transistor tester available from any manufacturer. And, the TF46 includes an automatic gain test to allow grading or matching of transistors used in critical circuits.



Question 1: I need to understand the special types of circuits used in a video recorder. Could you cover the details of these special circuits?

Magnetic Recording Principals

Any tape recorder, whether an audio or video recorder, must be able to convert an electronic signal to a magnetic signal that is used to magnetize a layer of oxide that coats the magnetic tape. The magnetic tape is pulled past a recording head which is nothing more than an electromagnet. The recording head consists of a u-shaped piece of metal that has a coil wrapped around it. The coil (which receives a signal from some type of amplifier system) causes a magnetic field to build and collapse within the metal in step with the signal applied at its coil. The open end of the u-shaped metal head is a very narrow slit called the "head-gap". This head-gap is the portion of the head that makes contact with the tape. The magnetic flux lines passing between the two parts of the head-gap also pass through the tape that is in direct contact with this area of the head, causing the magnetic

particles on the tape to be magnetized. The amount of magnetization is directly related to the amount of current passing through the head coil at the instant it is in contact with the tape.

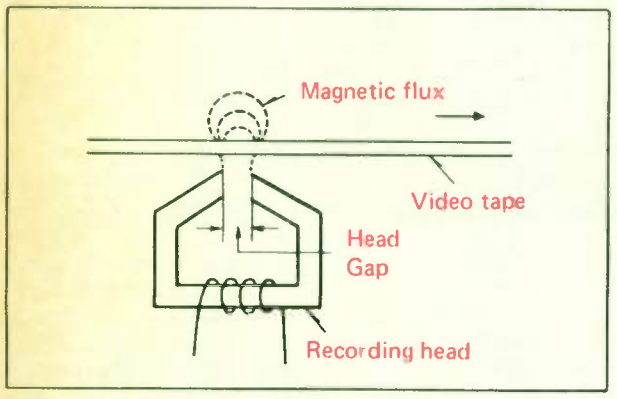


Fig. 1—The record/playback head is simply an electromagnet. The small slit is called the head-gap and is the portion of the head that actually contacts the tape.

This process is reversed during playback. The tape (with the varying magnetized sections created during recording) is pulled past the head. The changing magnetic levels on the tape cause a current to be induced in the head coil which is passed to very sensitive amplifiers. These amplifiers then increase the signal level sufficiently to produce an audio or video output.

Frequency Limits of the Direct Recording System

A direct recording system is one that feeds the output of the recording amplifiers directly to the head without any other signal processing other than equalization. A direct recording system has both high and low frequency limits that are determined by the width of the head gap and the relative speed between the tape and the recording head. The output voltage of the playback head is determined by the rate of change of the magnetic field produced by the moving tape. The faster the magnetic field changes, the higher will be the output voltage. If, for example, the frequency is doubled, the rate of change is also doubled, and the output voltage is doubled. The maximum output voltage occurs when the wavelength of the signal on the tape is twice as long as the width of the head-gap. As the frequency decreases (and the tape wavelength increases) from this optimum point, the output voltage decreases at a 6 dB per octave rate. An octave is simply a doubling (or halving) of the frequency. The output versus frequency is shown in Fig. 2.

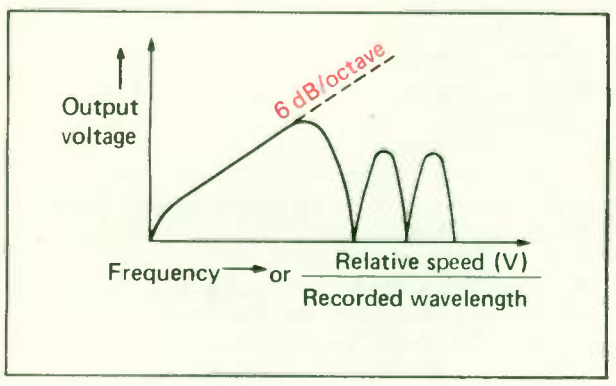


Fig. 2—A recording head has a 6 dB per octave rolloff below its optimum frequency point.

There is also a loss of output voltage at higher frequencies. The combination of the head-gap width and the head-to-tape speed determine the highest frequencies that can be recorded. The recording head can only record a signal when the wavelength of the recorded material on the tape is longer than the width of the head-gap. The reason for the high-frequency loss is shown graphically in Fig. 3.

The top drawing (in Fig. 3) shows the tape being pulled across the recording head at a fixed rate. This example shows a signal whose wavelength is longer than the width of the head-gap. As the tape moves past the head, the changing magnetic field causes the induced electric current in the head coil that we need for an output from the playback head. As the frequency of the recorded signal increases, the wavelength of the signal becomes shorter. If the wavelength of the signal is shorter than twice the head-gap, cancellation begins to occur. This cancellation will produce total cancellation, and a zero output, when the wavelength of the recorded signal is the same as the gap-width because the signal will show both a positive and negative amount of change at the same time. Therefore, the output voltage drops rapidly as soon as the recorded signal wavelength becomes less than twice the gap-width.

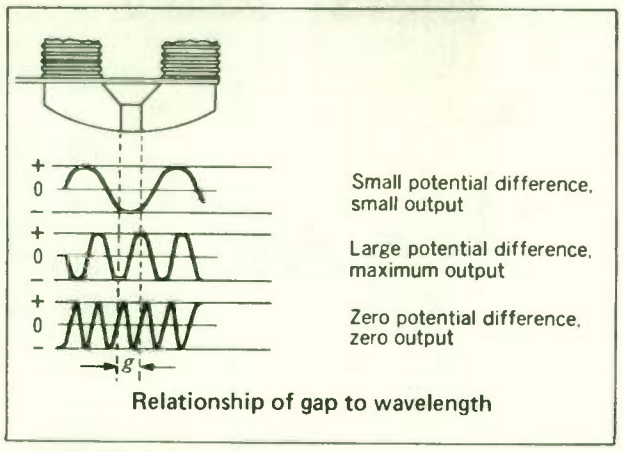


Fig. 3—Cancellation reduces the output of the head if the wavelength of the signal on the tape is shorter than twice the gap width.

We can increase the upper cutoff frequency by either reducing the gap-width, or by increasing the tape-to-head speed. If we halve the gap-width, we double the upper cutoff frequency because smaller wavelengths may be recorded before cancellation takes place. If, on the other hand, we double the tape speed (holding the gap-width constant) we again double the upper frequency limit because the wavelength of a given frequency signal is now twice as long on the tape. But, in either case, the total bandwidth that can be recorded is not increased because of the 6 dB per octave rolloff that takes place at the lower frequencies.

In practical terms, a direct recording system allows 9 octaves of range before the low frequency noise or high frequency cancellation renders the output of the playback head unusable. If, for example, the lowest frequency we want to record is 30 Hz, the highest frequency a direct recording system will record is 15,000 Hz. If we raise the lower limit to 60 Hz, our upper limit is 30,000 Hz, etc.

Recording Bias Signal

The total frequency range of our recording system may be increased with the use of a high-frequency bias signal. This signal is used in most audio recorders to produce a more even output over the desired ranges of input signals. The bias signal (which is typically 100 KHz in an audio deck) in effect becomes a carrier signal to increase the low-frequency response of our system. The drawing in Fig. 4 shows how a low-frequency signal AM modulates the bias frequency. Since the carrier produced by the bias frequency is a fixed frequency, the voltage output of the playback head remains the same while the modulation envelop carries the information we wish to record. A bias system improves the recording bandwidth. It will not, however, produce a wide enough bandwidth for direct video recording.

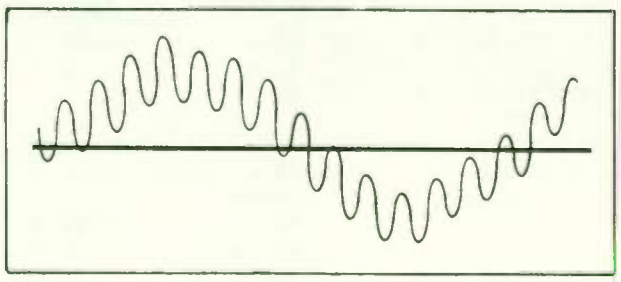


Fig. 4—The use of a bias signal increases the low-frequency output because it acts like a carrier signal.

Video recording requires an extremely wide frequency bandwidth. The frequencies contained in a video waveform extend from essentially DC to 4 MHz. This represents 18 octaves of frequency response, which is greater than either a direct or a bias frequency recording system can handle. In addition to the wide frequency response required for the B & W portion of the video waveform, we must also make sure that the phase relationships of the chroma subcarrier accurately duplicate the original composite color signal during playback. Video tape decks use two different systems for recording the wide bandwidth required for the B & W information and the accurate phase information needed for color. We will discuss each in later sections.

The Spinning Video Head

The first thing we need to record video information is the ability to record frequencies up to 4 MHz. We have already discussed the fact that the high frequency limits of a magnetic tape recording system are determined by both the size of the head-gap and the relative head-to-tape speed. There are physical limitations that come into effect if we only control the head-gap width. Let's say, for example, that we wish to design a system that will have a tape speed of only 3¾ inches per second to keep the cost of our tape as low as possible. The wavelength of the signal on the tape at this speed in only 0.0000009" (9/10,000,000) for a frequency of 4 MHz. This means that the gap should be half this width or 0.00000045". Even if it were practical to produce a gap this small, any wear on our head would soon widen the gap and result in a loss of high-frequency response.

We mentioned that we can increase the upper frequency cutoff point by increasing our head-to-tape speed. An early attempt to produce a low-cost video recording system used a fixed-head format with a tape speed of 100 inches per second. This system proved to be impractical. A single hour of recording required 30,000 feet of tape! And, any mechanical malfunction in the tape transport mechanism resulted in tape literally spilled all over the room.

Up to this point we have been thinking of tape decks with fixed heads. The tape is pulled past the head-gap at a fixed rate and the signals are recorded in a path that runs parallel to the edges of the tape. This method of recording is known as a "longitudinal" recording system. Almost all audio tape decks use a longitudinal recording format. The audio signals of a video tape system are recorded with a fixed head just like a standard audio tape deck and are therefore longitudinal. The electronic circuits of the audio section of a video tape deck are very similar to an audio deck.

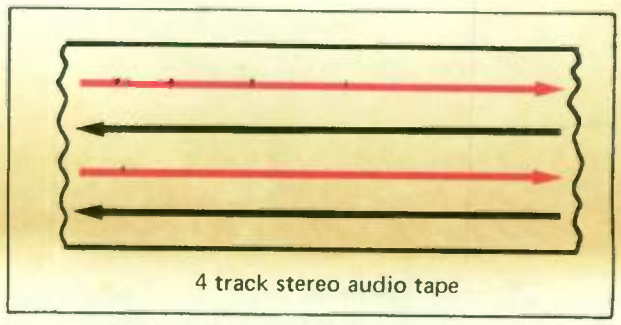


Fig. 5—Audio tape decks record the signal in paths running parallel to the tape edge. Such tape formats are called "longitudinal".

You should notice that we have been saying that the "relative" tape-to-head speed is important, not necessarily the actual speed of the tape moving from the supply to the takeup reel. A more practical method of increasing the head/tape speed involves moving the tape at a relatively slow speed while a special spinning head is used to record the information. Commercial broadcast video tape decks, for example, use 4 heads mounted on a disk that spins at 240 revolutions per second. The head disk is mounted perpendicular to the direction of tape travel and the tape is moved past the spinning disk. The video information is recorded in stripes that run perpendicular to the edges of the tape. The spinning disk moves the heads past the tape at a relative head-to-tape speed of 1500 inches per second. This system is known as the "quadraplex" system. The cost of both the equipment and the tape make these systems impractical for home use.

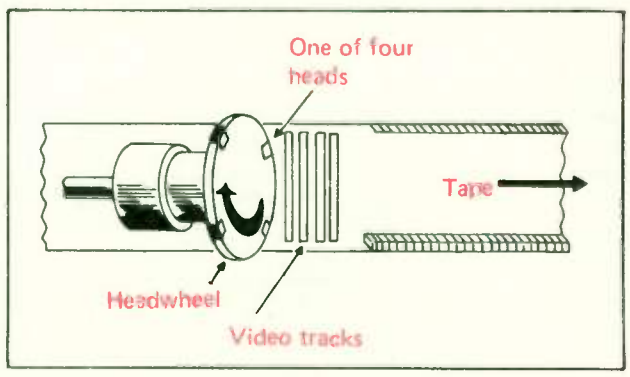


Fig. 6—The quadraplex format uses 4 heads to record stripes that are perpendicular to the edge of the tape.

The introduction of the "helical scan" or "slant track" recording system reduced the cost of video tape recorders and at the same time, greatly reduced the amount of tape necessary for one hour of recording time. The helical scan formats use one or two spinning video heads contained in a cylinder that has a slanted (helical) tape path wrapped around it. The tape is passed across the head(s) at an angle which results in a recording path that falls in

parallel, diagonal lines as shown in Fig. 7. The tape widths used by various helical scan recorders run from ¼" to 2 inches. The most common tape widths for video cassette recorders (VCR) are ½" for the Beta and VHS formats, and ¾" for U-Matic recorders.

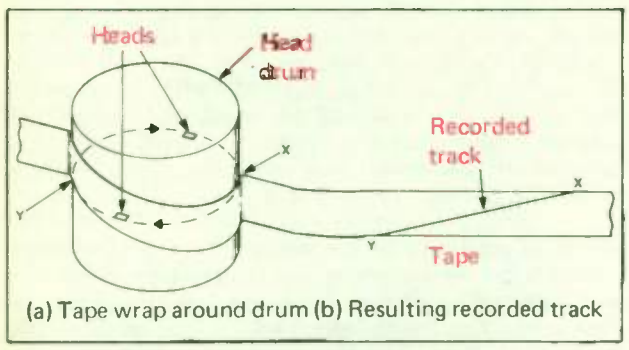


Fig. 7—A helical scan tape deck pulls the tape past the spinning heads at an angle resulting in a slanted video track on the head.

The heads of a two-head system are spinning at 30 revolutions per second. This means that one complete field (262½ lines) of video information is recorded in one tape stripe. Two stripes produce one complete interlaced frame (525 lines) of video information. NOTE: Some video recording systems (such as the Sanyo "V-Corder") do not record every field of video information. The basic theory of operation remains the same in this "skip-field" recording system except that the same information is repeated two or three times during playback. Table I shows the different tape speeds and head-to-tape speeds for different video tape formats.

TABLE I

TAPE SPEED vs. HEAD SPEED

FORMAT	TAPE SPEED	HEAD SPEED
Quad	15 ips	1500 ips
U-Matic	3.75 ips	400 ips
Beta 1-Hour 2-Hour	 1.57 ips .78 ips	 272 ips 272 ips
VHS 2-Hour 4-Hour	 1.34 ips .65 ips	 228 ips 228 ips

Preventing Signal Crosstalk

Proper playback is possible only when a single recorded track is played back at one time. Provisions must be made in the design of a video tape format to prevent the video heads from playing more than one signal track at a time. If part of a second signal path is picked up during the tape playback, a condition known as "crosstalk" is present. Crosstalk is present in an audio tape deck that has an improperly adjusted head which plays back the desired signal and part of another signal on the tape. Video crosstalk will cause a noisy picture.

Two systems are used to prevent video crosstalk. The first system uses "guard bands", which are simply blank areas between each stripe of video information. This system is used in the U-Matic and most reel-to-reel formats. The greatest disadvantage to the use of guard bands is that no information is recorded on the guard bands which means that more tape per minute must be used. Eliminating these guard bands increases tape efficiency by "squeezing" the individual stripes of video information closer together.

Eliminating Guard Bands

If you have worked with audio tape decks, you have most likely encountered a loss of high frequency response due to improperly aligned playback heads. A tape head will provide its highest signal output if the angle of the gap of the playback head is exactly the same as the recording head. An audio head is aligned by adjusting the position of the head with the head "azimuth" adjustment which simply tilts the head slightly. Both the Beta and VHS VTR formats use two video heads located 180° apart on the video head disk assembly. Two heads are used to allow one head to be in contact with the tape while the other one is located on the back side of the video drum as shown in Fig. 8. The first head records one field of information, and the second head records the next field of information as the heads spin. Thus, the individual stripes of information are recorded alternately by the two video heads.

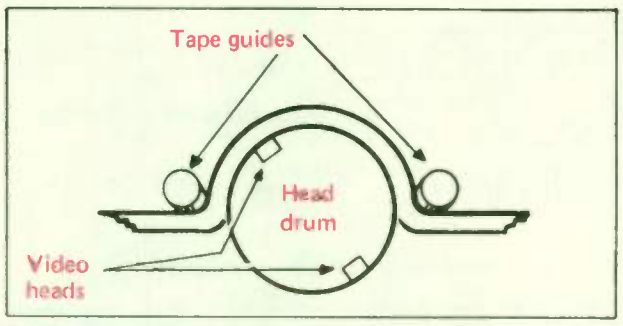


Fig. 8—Two video heads are used so one is always in contact with the tape.

The gap in each head is set at a 7° (6° for VHS) slant. The slant of one head is exactly opposite the other. This means that the azimuth angle of each stripe of information differs by 14° from the next adjacent stripe. The result of this 14° azimuth shift is that each head will pick up the signal that was recorded at the correct angle but reject the crosstalk information recorded at the other angle. Thus, the need for the wasted tape required for guard bands is eliminated.

NOTE: Azimuth cancellation is maximum at the higher frequencies used for recording the B & W portion of the signal. Additional crosstalk rejection is required for the color signals. We will cover this when we discuss the color processing circuits.

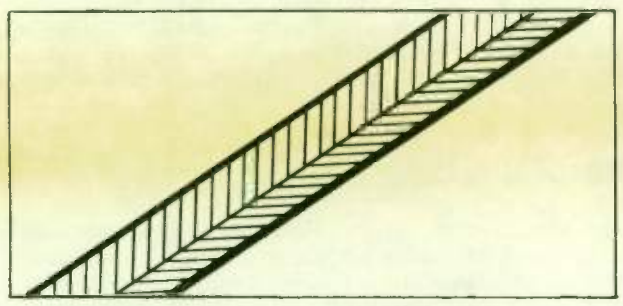


Fig. 9—Alternate video stripes are recorded at different angles to minimize crosstalk.

Video Head Alignment

There are several reasons that the playback head must exactly follow the same path on the tape as was followed during recording. The main reason is that the best signal pickup (resulting in a better signal-to-noise ratio) depends on the playback head following the center of the recorded path. Another important reason is that many VTR owners want to be able to play back a tape on one machine that was recorded on another machine. We will discuss some of the features of modern VTR systems to achieve these two important points.

First, the head must trace the recorded tracks at exactly the same angle during playback and recording. If the head takes a slightly different angle, the result is an increase in playback noise in either the top or bottom of the picture as the head begins to lose contact with the recorded signal path. The angle of the recording and playback path is determined by the diameter of the video drum, the path around the drum, the angle that the tape approaches the drum, and the speed of the tape as it passes the spinning video heads. Each of these variables is related to the tape transport mechanism. Proper tape angles require very accurate tape guides. Proper tape speed requires synchronous motors and precise tension adjustments on both the supply reel and the takeup reel to prevent the tape from stretching a different amount during recording and playback.

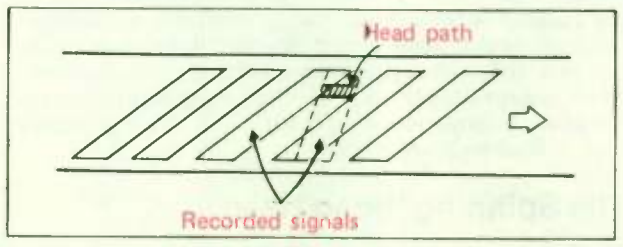


Fig. 10—The head must follow the same playback path the recording head traced for a sharp, snow-free picture.

In addition to the mechanical alignment of the tape path, the machine must "know" exactly where each recorded path begins and position the spinning heads (during playback) to follow these paths. Modern tape decks using "zero guard band" formats must also "know" which of the two video heads was used to record each of the tracks so that the same head is used during playback. If the machine could not determine this, the wrong head (with the improper head azimuth angle) could be used during playback with a resulting loss in output level due to the azimuth cancellation we discussed earlier.

The Video Head Servo

All video tape systems that use spinning video heads use a signal known as a "control track" as a reference to position the heads properly during playback. This track is a series of pulses recorded on the edge of the tape by a head that is fixed along the tape path a precise distance from the video recording drum. All VTR formats discussed in this article use a control track signal made up of a 30 Hz signal that is formed by recording every other vertical sync pulse. We do not use every sync pulse because two heads are used to record one complete frame (two fields) of the video waveform. Let's see why this is important by calling one of the video heads "A" and the other head "B".

Each video head records every other field (262.5 lines) of the video signal. In our example, let's say that the "A" head records the odd numbered fields, 1, 3, 5, etc., and the "B" head records the even numbered fields, 2, 4, 6, etc. We need each recorded path to be played by the same head on playback as was used during recording, so let's record a pulse on the tape each time the "A" head just begins to record its path, and repeat this procedure each time the "A" head is in this position. We then use an electro-mechanical servo system to adjust the position of the spinning head during playback. The "A" playback head should be in the same position every time our control track head picks up one of the pulses that was recorded at the beginning of the "A" head path. If the head is not in the proper position, our servo circuit simply makes speed adjustments until the head is properly positioned. The control track then acts like the sprocket holes found in a movie film. The function of both the control track and the sprocket holes is to reference the tape (or film) during playback. In either case, we are simply supplying a reference that can be used for proper synchronization.

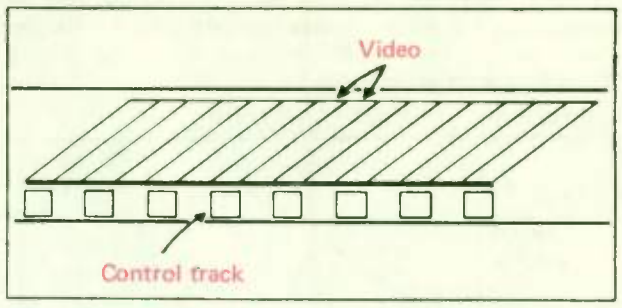


Fig. 11—One control track pulse is recorded for every two video stripes as a playback reference.

This is exactly how the control track is used. It provides a reference that is used to position the spinning video head during playback. The vertical sync pulses are used to generate the control track pulse because they are already used for other control functions inside the machine during recording and are properly timed to function as the control track signal.

Recording the Composite Video Signal

Now that we have an understanding of the spinning video head, let's see how we use it to record the luminance (B & W) and chroma (color) signals. We have explained how the spinning head allows signals with frequencies up to 4 MHz to be recorded. *But, we still have a 6 dB per octave rolloff for lower frequencies.* This means that we are still limited to 9 octaves of frequencies that can be recorded. The lowest frequency that can then be recorded with the spinning head is 8 KHz. Complete video information can only be recorded if we include the 60 Hz sync pulses and the DC levels represented by a totally black picture. We need another system to get the full 18 octaves of frequencies needed for video recording.

All VCRs use an FM signal to record the luminance information and a separate recording system to record the color information. The first advantage of the FM system is a high immunity to noise. The signal level can fluctuate greatly (in amplitude) due to head wear, dirty playback heads, worn tapes, etc. These variables are elimin-

ated because an *FM system does not depend on signal amplitude* above a certain minimum detectable level.

A second advantage to the use of the FM system is that a DC signal level simply represents a constant frequency. If you will recall our discussion of the output voltage of a video head, you will remember that the output voltage from the head is dependent on a *change* in the magnetic level. A fixed magnetic level (as recorded by a DC signal) will provide no output. The FM carrier, on the other hand, will provide an accurate output for any DC level.

The main reason that the FM system is used, however, is that it allows the 18 octaves of video information to be recorded. Let's take the Beta format as an example.

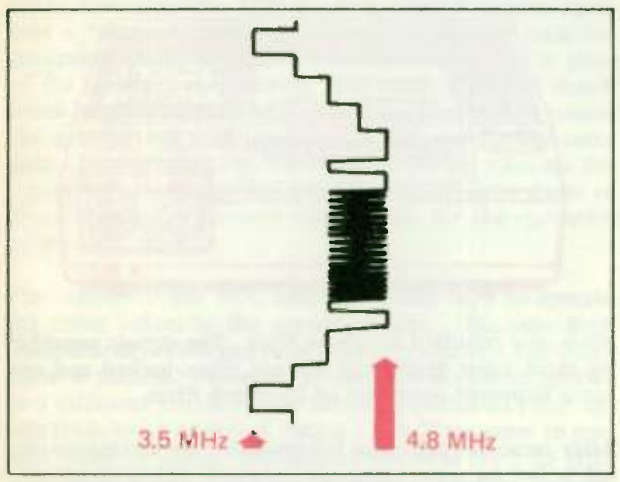


Fig. 12—An FM carrier allows the entire video spectrum to be recorded with less than 1 octave of bandwidth.

The FM modulation system uses the tips of the sync pulses as a reference. This reference produces the lowest modulation frequency of 3.5 MHz. The video information is used to modulate the FM carrier to a higher frequency. The upper limit for the Beta format is 4.8 MHz for the 100% white recording level. We now have defined the frequency response limits that we need. The FM carrier will only change 1.3 MHz to record the entire video signal. *This represents a frequency change of less than 1 octave* which is well within the limits of a spinning recording head. We do provide pre-emphasis to the higher frequency video information because an FM modulator has an increased noise factor with higher modulation frequencies. A simple FM demodulator is used to recover the luminance information during playback.

We find the need to add one more stage for a reliable playback signal to compensate for the small periods of time that the spinning video head loses contact with the tape oxide. These carrier "dropouts" would produce annoying flashes on the TV CRT because the FM carrier is missing for a short period of time. These dropouts are caused by small particles of dirt on the tape surface or damaged segments of tape. The dropouts are replaced with a circuit known as a "dropout compensator" (called the DOC) which simply inserts a small segment of the previous horizontal line during the time that the carrier is missing.

The Color Under System

We could record the color information at the same time as the luminance information, but find that the phase relationships of the chroma signal are what determine what color is reproduced by the TV and are, therefore, very important.

Phase errors are caused by several mechanical factors. First, the speed of the video head is not absolutely constant. The head is controlled by a servo system which adjusts the speed slightly to make sure the head traces the same path on playback as when the tape was recorded. These slight variations would cause the colors to shift if the chroma was recorded directly with the video. This type of phase distortion is called "phase jitter" or "servo error".

Tape tension becomes a second cause of phase error. The tension of the tape is constantly changing as the amount of tape on the take-up and supply reels change. Tension differences are also present when a tape is played back in a different machine than was used for recording. As the tension changes, the tape stretches different amounts. If the tape stretches, for example, the horizontal sync pulses are slightly farther apart and the color subcarrier frequency is slightly lower than desired. If the tension is decreased, the opposite happens. This type of color subcarrier frequency error is known as "timebase" error and can also cause changes in the color.

The effects of both phase-jitter and timebase error are minimized with the "color-under" recording system. This recording system converts the color signal to a frequency of about 700 KHz by simply mixing the 3.58 MHz chroma signal with an oscillator during recording. The chroma is then recorded directly (but at the lower frequency) along with the FM luminance signal we have already discussed. Now, you may think that this frequency is too low to record with the same head used for the FM signal. This is not true, however, because the FM signal acts as a bias signal to increase the efficiency of the recording head at this lower frequency.

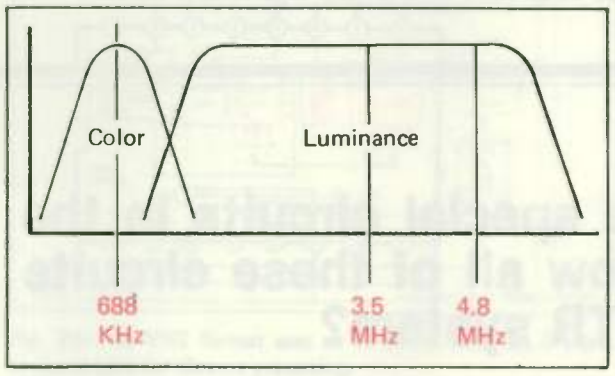


Fig. 13—The frequency of the chroma information is converted to a lower frequency by hetrodyning.

During playback, the low-frequency color information is converted back to the NTSC color frequency (3.58 MHz) by again mixing it with an oscillator. During playback, however, this oscillator does not operate at a fixed frequency. Phase correction circuits are used to compensate for the slight frequency changes that may affect the color playback. The horizontal sync pulses (recovered from the FM signal) are used to indicate the amount of phase jitter or timebase error and are used to correct the chroma frequency. The result is a close duplicate of the original chroma information.

Eliminating Color Crosstalk

We discussed crosstalk in our explanation of the luminance recording system. The FM signal used to record our B & W detail is recorded at two different azimuth angles to allow "zero guard band" recording. *Azimuth recording only attenuates the crosstalk of the higher recorded frequencies.* Since the chroma information occupies a frequency range of 188 KHz through 1.19 MHz (500 KHz above and below 688 KHz), we do not get enough cancellation of adjacent tracks on playback. We need additional crosstalk rejection to provide a noise-free color picture.

Both the Beta and the VHS formats use a system of phase shifts to prevent color crosstalk. The phase of each line of color information is changed compared to the previous line. The Beta format simply inverts the phase of every other horizontal line when one (of the two) video heads is recording a field of information. The other head records the chroma information without this line-by-line inversion.

During playback, the phase correction circuits re-invert the line-by-line chroma information for every other field to restore the original phase relationships. A "comb filter" is used to cancel out any crosstalk. We will discuss this filter in the next section.

The VHS system uses a similar system with one modification. Rather than inverting the phase of every other line, the phase of each line is advanced by 90° in one field and delayed by 90° in the other. This means that we have a total of 4 different phase angles (as compared to 2 for the Beta format) to make phase cancellation possible. Again, the proper phase angles are restored during playback and a comb filter is used for cancellation of the crosstalk signal.

The Comb Filter

The comb filter is a device that can separate two signals that have a fixed phase relationship. The comb filter will provide two outputs, one that passes only those signals that are *in phase* with each other, and the other that passes only those signals that are *out of phase* with each other. This fact leads to two important applications in a video tape system. The first application allows the rejection of color crosstalk using the phase processing techniques we just described. The second allows the separation of chroma from the luminance information as it comes from the TV station with better effectiveness than the bandpass amplifier found in a color TV receiver. Both applications depend on the fact that the phase of the chroma information changes each horizontal line. Let's see how this works.

The chroma subcarrier of the NTSC signal is inverted every horizontal line. This means that the phase of one line is shifted 180° from the phase of the previous (and following) line. This line-by-line phase inversion results in "frequency interleaving". Frequency interleaving simply means that the frequency of the color subcarrier (and all of its harmonics) falls between the harmonics of the luminance information. This frequency interleaving is determined by the color subcarrier frequency (3.579545 MHz) and the horizontal sweep frequency (15,734.26 Hz). Really, all this means is that the two frequency are related to each other in such a way that the required phase-inversion takes place when the two signals are phase-locked together as they are at the TV station. With this phase inversion in mind, let's first look at how the comb filter is used to eliminate color crosstalk.

The phase shifting that is produced by the VCR during recording and playback in both the Beta and VHS format results in *crosstalk information that is a continuous phase for every line.* The two formats produce this continuous phase crosstalk information with slightly different signal processing as explained previously, but the results are basically the same. Since the unwanted crosstalk information has a continuous phase, and the desired chroma signal is phase-inverted line-by-line, the comb filter will separate the signal from the crosstalk.

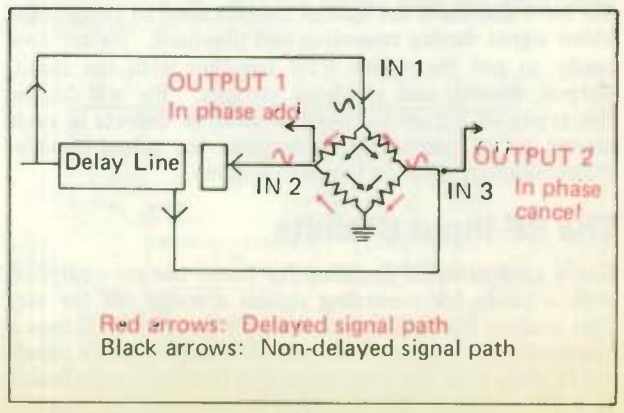


Fig. 14—The comb filter separates phase-related signals by means of phase addition and cancellation. Output 1 passes only signals that are in phase in 2 adjacent lines and output 2 passes those that have a 180° phase shift.

The comb filter simply consists of a delay line (designed to delay the signal by one horizontal line) and a resistor bridge. The bridge has three input points and two output points. The first input is for the non-delayed signal, and the other two for the delayed signal. One of the output terminals will provide a signal only if the delayed and non-delayed signal are both the same phase, and the other will provide an output if the two signals are 180° out of phase. This second output provides the desired chroma signal without the crosstalk. The reason that the two signals are separated is that *the delayed signal is taking a different path* around the resistive bridge than the non-delayed signal as shown in Fig. 14. The left-hand side of the resistor bridge adds the two signals if they are the same phase. The signals are canceled if they are out-of-phase. The right-hand side of the bridge has the delayed signal flowing the opposite direction through the resistors and is therefore inverted 180°. Now, the signals will add only when they are of opposite polarities.

The second application of the comb filter is used by Sony in their two-speed machines to separate the luminance from the chroma information during recording. Previous video tape recorders used a low-pass filter to separate the luminance signal which was then used to produce the FM signal that is recorded. The chroma signal was separated with a bandpass filter similar to that used in a

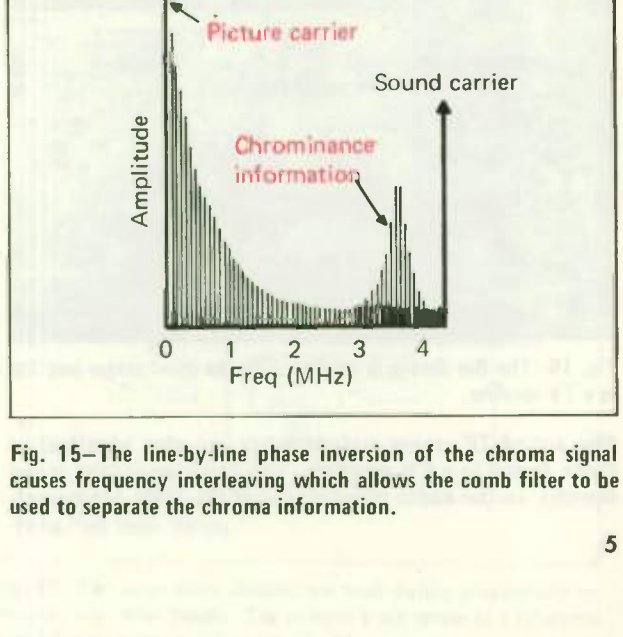
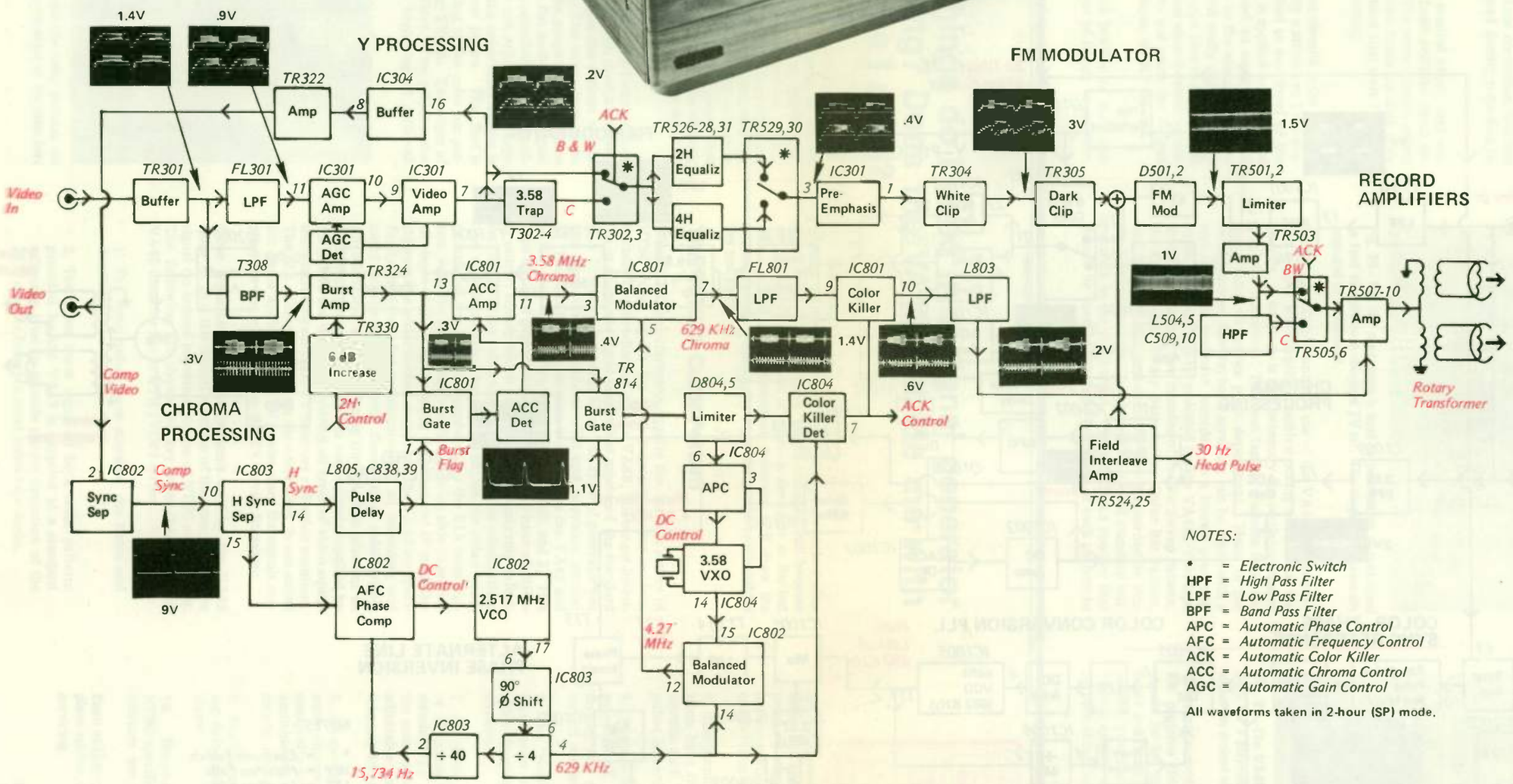


Fig. 15—The line-by-line phase inversion of the chroma signal causes frequency interleaving which allows the comb filter to be used to separate the chroma information.

VHS RECORD CIRCUITS

SENCORE
VA48 SPEED-TEST CHART



NOTES:

* = *Electronic Switch*
HPF = *High Pass Filter*
LPF = *Low Pass Filter*
BPF = *Band Pass Filter*
APC = *Automatic Phase Control*
AFC = *Automatic Frequency Control*
ACK = *Automatic Color Killer*
ACC = *Automatic Chroma Control*
AGC = *Automatic Gain Control*

All waveforms taken in 2-hour (SP) mode.

TV receiver. This system produced satisfactory results in the Beta format decks that only had the standard play

This application takes advantage of the interleaving that is part of the MPEG color signal to allow signal separation that is used for crosstalk rejection during playback.

ated because an *FM system does not depend on signal amplitude* above a certain minimum detectable level.

A second advantage to the use of the FM system is that a DC signal level simply represents a constant frequency. If you will recall our discussion of the output voltage of a video head, you will remember that the output voltage from the head is dependent on a *change* in the magnetic level. A fixed magnetic level (as recorded by a DC signal) will provide no output. The FM carrier, on the other hand, will provide an accurate output for any DC level.

The main reason that the FM system is used, however, is that it allows the 18 octaves of video information to be recorded. Let's take the Beta format as an example.

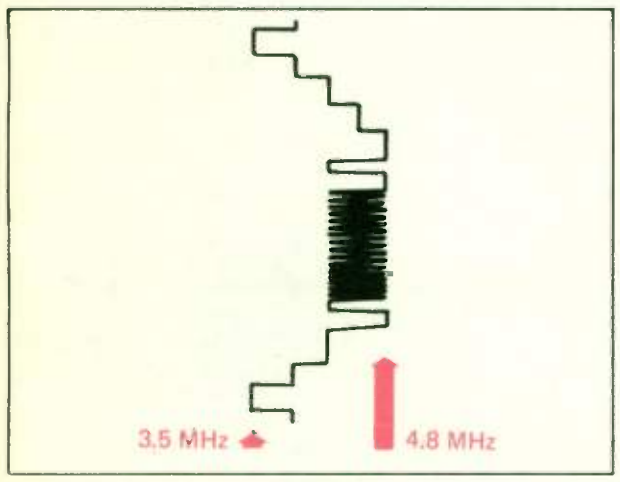


Fig. 12—An FM carrier allows the entire video spectrum to be recorded with less than 1 octave of bandwidth.

The FM modulation system uses the tips of the sync pulses as a reference. This reference produces the lowest modulation frequency of 3.5 MHz. The video information is used to modulate the FM carrier to a higher frequency. The upper limit for the Beta format is 4.8 MHz for the 100% white recording level. We now have defined the frequency response limits that we need. The FM carrier will only change 1.3 MHz to record the entire video signal. *This represents a frequency change of less than 1 octave* which is well within the limits of a spinning recording head. We do provide pre-emphasis to the higher frequency video information because an FM modulator has an increased noise factor with higher modulation frequencies. A simple FM demodulator is used to recover the luminance information during playback.

We find the need to add one more stage for a reliable playback signal to compensate for the small periods of time that the spinning video head loses contact with the tape oxide. These carrier "dropouts" would produce annoying flashes on the TV CRT because the FM carrier is missing for a short period of time. These dropouts are caused by small particles of dirt on the tape surface or damaged segments of tape. The dropouts are replaced with a circuit known as a "dropout compensator" (called the DOC) which simply inserts a small segment of the previous horizontal line during the time that the carrier is missing.

The Color Under System

We could record the color information at the same time as the luminance information, but find that the phase relationships of the chroma signal are what determine what color is reproduced by the TV and are, therefore, very important.

Phase errors are caused by several mechanical factors. First, the speed of the video head is not absolutely constant. The head is controlled by a servo system which adjusts the speed slightly to make sure the head traces the same path on playback as when the tape was recorded. These slight variations would cause the colors to shift if the chroma was recorded directly with the video. This type of phase distortion is called "phase jitter" or "servo error".

Tape tension becomes a second cause of phase error. The tension of the tape is constantly changing as the amount of tape on the take-up and supply reels change. Tension differences are also present when a tape is played back in a different machine than was used for recording. As the tension changes, the tape stretches different amounts. If the tape stretches, for example, the horizontal sync pulses are slightly farther apart and the color subcarrier frequency is slightly lower than desired. If the tension is decreased, the opposite happens. This type of color subcarrier frequency error is known as "timebase" error and can also cause changes in the color.

The effects of both phase-jitter and timebase error are minimized with the "color-under" recording system. This recording system converts the color signal to a frequency of about 700 KHz by simply mixing the 3.58 MHz chroma signal with an oscillator during recording. The chroma is then recorded directly (but at the lower frequency) along with the FM luminance signal we have already discussed. Now, you may think that this frequency is too low to record with the same head used for the FM signal. This is not true, however, because the FM signal acts as a bias signal to increase the efficiency of the recording head at this lower frequency.

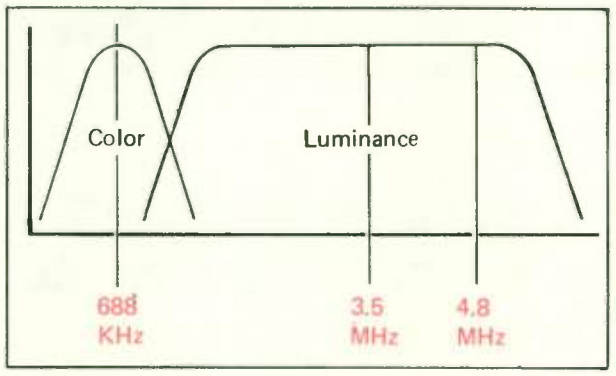


Fig. 13—The frequency of the chroma information is converted to a lower frequency by hetrodyning.

During playback, the low-frequency color information is converted back to the NTSC color frequency (3.58 MHz) by again mixing it with an oscillator. During playback, however, this oscillator does not operate at a fixed frequency. Phase correction circuits are used to compensate for the slight frequency changes that may affect the color playback. The horizontal sync pulses (recovered from the FM signal) are used to indicate the amount of phase jitter or timebase error and are used to correct the chroma frequency. The result is a close duplicate of the original chroma information.

Eliminating Color Crosstalk

We discussed crosstalk in our explanation of the luminance recording system. The FM signal used to record our B & W detail is recorded at two different azimuth angles to allow "zero guard band" recording. *Azimuth recording only attenuates the crosstalk of the higher recorded frequencies.* Since the chroma information occupies a frequency range of 188 KHz through 1.19 MHz (500 KHz above and below 688 KHz), we do not get enough cancellation of adjacent tracks on playback. We need additional crosstalk rejection to provide a noise-free color picture.

Both the Beta and the VHS formats use a system of phase shifts to prevent color crosstalk. The phase of each line of color information is changed compared to the previous line. The Beta format simply inverts the phase of every other horizontal line when one (of the two) video heads is recording a field of information. The other head records the chroma information without this line-by-line inversion.

During playback, the phase correction circuits re-invert the line-by-line chroma information for every other field to restore the original phase relationships. A "comb filter" is used to cancel out any crosstalk. We will discuss this filter in the next section.

The VHS system uses a similar system with one modification. Rather than inverting the phase of every other line, the phase of each line is advanced by 90° in one field and delayed by 90° in the other. This means that we have a total of 4 different phase angles (as compared to 2 for the Beta format) to make phase cancellation possible. Again, the proper phase angles are restored during playback and a comb filter is used for cancellation of the crosstalk signal.

The Comb Filter

The comb filter is a device that can separate two signals that have a fixed phase relationship. The comb filter will provide two outputs, one that passes only those signals that are *in phase* with each other, and the other that passes only those signals that are *out of phase* with each other. This fact leads to two important applications in a video tape system. The first application allows the rejection of color crosstalk using the phase processing techniques we just described. The second allows the separation of chroma from the luminance information as it comes from the TV station with better effectiveness than the bandpass amplifier found in a color TV receiver. Both applications depend on the fact that the phase of the chroma information changes each horizontal line. Let's see how this works.

The chroma subcarrier of the NTSC signal is inverted every horizontal line. This means that the phase of one line is shifted 180° from the phase of the previous (and following) line. This line-by-line phase inversion results in "frequency interleaving". Frequency interleaving simply means that the frequency of the color subcarrier (and all of its harmonics) falls between the harmonics of the luminance information. This frequency interleaving is determined by the color subcarrier frequency (3.579545 MHz) and the horizontal sweep frequency (15,734.26 Hz). Really, all this means is that the two frequency are related to each other in such a way that the required phase-inversion takes place when the two signals are phase-locked together as they are at the TV station. With this phase inversion in mind, let's first look at how the comb filter is used to eliminate color crosstalk.

The phase shifting that is produced by the VCR during recording and playback in both the Beta and VHS format results in *crosstalk information that is a continuous phase for every line.* The two formats produce this continuous phase crosstalk information with slightly different signal processing as explained previously, but the results are basically the same. Since the unwanted crosstalk information has a continuous phase, and the desired chroma signal is phase-inverted line-by-line, the comb filter will separate the signal from the crosstalk.

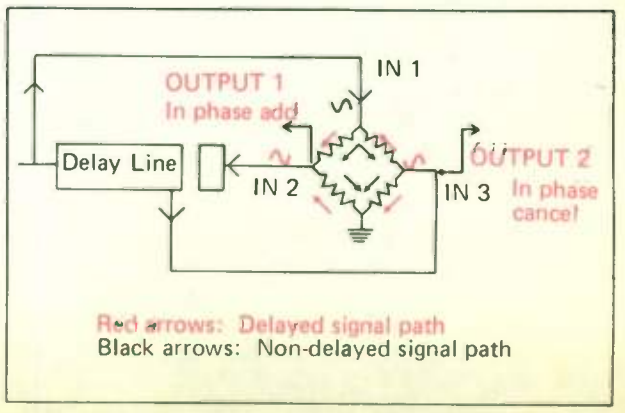


Fig. 14—The comb filter separates phase-related signals by means of phase addition and cancellation. Output 1 passes only signals that are in phase in 2 adjacent lines and output 2 passes those that have a 180° phase shift.

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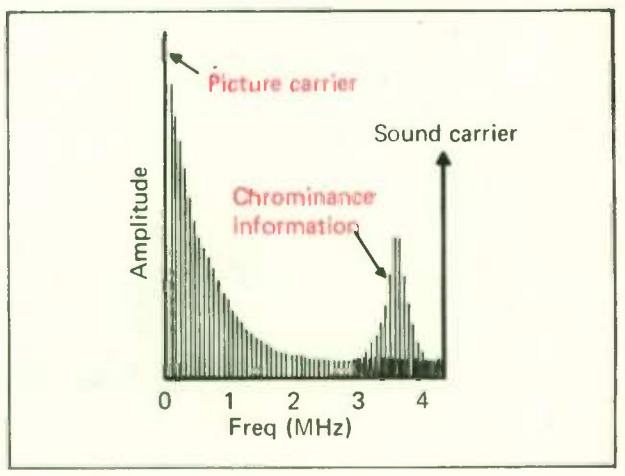


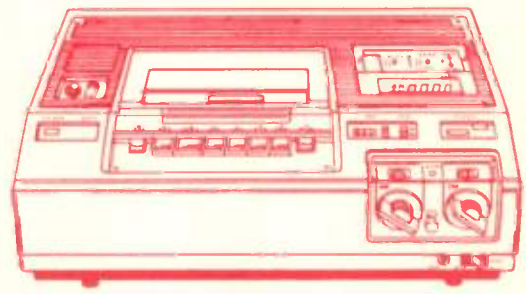
Fig. 15—The line-by-line phase inversion of the chroma signal causes frequency interleaving which allows the comb filter to be used to separate the chroma information.

TV receiver. This system produced satisfactory results in the Beta format decks that only had the standard play recording speed, but the low-pass filter restricted the high-frequency portion of the video signal. When the two-speed machine was introduced, Sony added a separate video equalization circuit for the 1-hour and 2-hour recording speeds. Since the high video frequencies suffer more from a poor signal-to-noise ratio than the lower frequencies, it is desirable to have more high frequency information at the output of the stages that separate the luminance and chroma information. The comb filter is once again used to obtain the higher video frequencies that were lost in the low-pass filter.

This application takes advantage of the interleaving that is part of the NTSC color signal to allow signal separation by phase detection. The low-pass filter used in earlier 1-hour machines restrict the video frequency response in the areas where the luminance and chroma information share the same frequency band, and thus restrict the highest video frequencies to about 3 MHz. The luminance information of a composite color signal is not phase-inverted every other line, but the chroma information is. This means that the comb filter's in-phase output node provides the high-frequency luminance information, and the out-of-phase output provides the chroma information. The comb filter used for this separating is the same one that is used for crosstalk rejection during playback. Switching of the input and output connections results in the dual usage of the same filter.

The use of comb filters for both crosstalk rejection and signal separation brings up a very important need in the signals used for VCR service. *The color signals produced by most color-bar generators do not phase-lock the color information to the horizontal sync pulses like a TV station does.* This means that the phase relationships from one line to the next do not necessarily contain a line-by-line phase inversion. Keep this in mind when we discuss what is needed in a signal source for VTR servicing.

Question 2: We have covered the special circuits in the VTR. Could you show me how all of these circuits work together in the total VTR system?



We have discussed the special circuits used to process the video signal during recording and playback. We are now ready to put the entire VTR together with the input, output, record, and playback circuits. We will discuss the types of signals we need to analyze defects in each circuit so we can better understand the actual troubleshooting procedures in the next section.

The RF Input Circuits

Video tape systems designed for home use are equipped with a tuner for recording signals directly off the air. This section is no different than a TV receiver. It uses a standard tuner for the VHF and UHF inputs and a standard IF strip with the same traps and bandpass coils found in a TV receiver. *The VA48 provides complete trouble-shooting and alignment signals for servicing the RF, IF, and video detector sections of the video tape recorder.* We will not go into details on these stages since they have been covered in previous *Sencore News* articles. We should, however, review the key benefits of using the VA48 Bar Sweep signals compared to the conventional sweep and marker generator in case you missed the previous articles. Reprints of these articles are available by simply writing to Sencore Promotion Department, 3200 Sencore Drive, Sioux Falls, SD 57107.

The individual frequency bars of the Bar Sweep pattern have been chosen to represent the key areas called out in sweep and marker instructions to allow these instructions to be used directly. The key difference, however, is that the *Bar Sweep provides a truly dynamic check of the operation of the IF amplifiers* because of the use of actual modulation signals with sharp square waves instead of the gentle sine waves produced by the sweep generator. This provides a check of ringing and overshoot that the sweep and marker simply cannot duplicate. The use of standard sync pulses in the Bar Sweep pattern totally eliminates the need to tie down the AGC bus for alignment so that we get a dynamic check of the AGC as well. And, the levels of the individual frequency bars are compensated so that all that is necessary is to adjust the individual IF bandpass coils until the bars are as close as possible to equal amplitude. All of these factors mean that you produce superior results in less time than with any other IF alignment system.

Fig. 16—The Bar Sweep is used to align the input stages just like in a TV receiver.

The sound IF stages and detector are also identical to those found in a TV receiver. The detector output is fed directly to the audio input stages of the VTR for recording onto the tape. Again, the VA48 provides an FM-modulated 4.5 MHz signal for injection into the FM-IF stages, and a direct audio signal for injection after the audio detector.

The Luminance Recording Circuits

NOTE: Complete block diagrams for the Beta and VHS tape decks are included as an insert in the center of this issue. Please pull these pages out to follow along with our description of the operations of the record and playback circuits.

The video detector output is fed to the composite video input of the tape deck. The signal is fed to two filters to separate the color from the luminance information. The inputs to these filters require a standard one Volt peak-to-peak signal like that supplied by the VTR standard output jack on the VA48.

The first stage we see in the luminance signal path is an AGC circuit. This circuit maintains a fixed level of video information and uses the horizontal sync pulse as a reference. Many color bar generators do not hold a fixed ratio between the sync pulse and video information. Others do not use standard pulse widths to duplicate the sync pulse itself. Either of these shortcomings in the signals produced by most color generators can lead to improper operation of the AGC circuits. *The signals provided by the VA48 maintain the proper sync to video ratio and provide standard sync pulse width and rise-times to provide a reference for these circuits.* We will see later how the substitute sync pulses and the bias voltage available from the Bias and B+ Sub supply are used to troubleshoot defects in this stage.

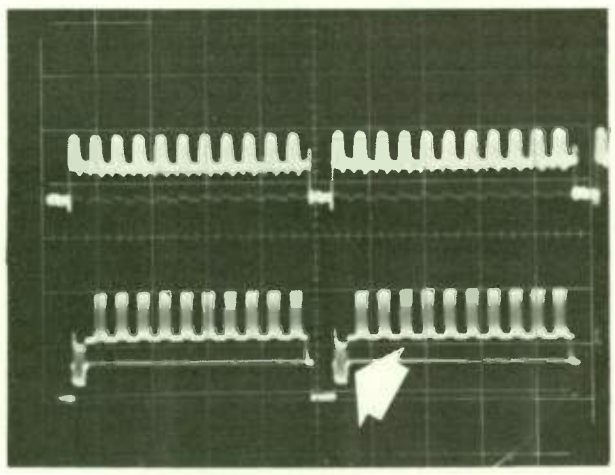


Fig. 17—The VA48 signals (bottom) differ from a color generator to assure proper operation of critical circuits.

After the signal level is controlled by the AGC circuits, it is fed to a trap to filter out any chroma information. This is necessary to prevent interference in the luminance channel caused by the chroma subcarrier. As we mentioned earlier, some newer VTR designs use a comb filter to separate the luminance from the chroma signal. *The phase-locked color subcarrier provided by the VA48 allows the same signal to be fed to a deck that uses a comb filter or a standard bandpass filter.* The signals provided by most color generators are not phase-locked and can cause improper operation of the comb filter.

After removing the color information, the luminance signal is fed to a pre-emphasis network which boosts the levels of higher frequency video information. This pre-emphasis is necessary because the higher frequencies are more susceptible to interference and tape noise. Machines that have both a long play and standard play tape speed use two different pre-emphasis circuits to add additional high-frequency pre-emphasis in the long-play mode which uses a slower tape speed and requires additional high-frequency compensation for a good picture on playback. *The "multi-burst" type signal provided by the VA48 Bar Sweep allows the frequency response of the pre-emphasis network to be easily checked or adjusted.*

After the signal is processed by the pre-emphasis network, it is necessary to limit both the white and dark portions of the signal to prevent over-modulation of the FM carrier. Proper adjustment of the dark and white clipping circuit is accomplished with the grey-scale portion of the VA48 Bar Sweep. This special signal is produced at the left of the five frequency bars provided by the Bar Sweep.

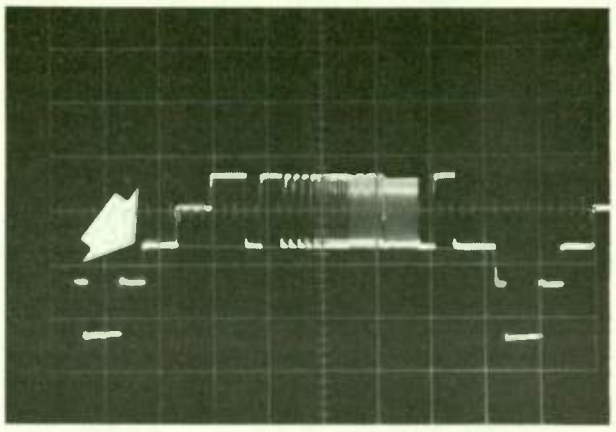


Fig. 18—The grey-scale is part of the VA48 Bar Sweep pattern to allow testing of the clipping circuits and the pre-emphasis circuits simultaneously.

The clipped signal is then fed to an FM modulator and then to amplifier stages to increase the level to drive the recording heads. A resistive mixing stage is used at this point to mix the FM-modulated signal with the chroma signal which is processed separately. Let's go back to the input circuits to see exactly how the chroma signals are processed.

The Color Recording Circuits

The chroma subcarrier is separated from the composite signal with a comb filter or a bandpass amplifier tuned to 3.58 MHz. The signal is then fed to an automatic chroma control (ACC) which holds the chroma signal at a fixed level with changing input signals. The gain of the ACC circuit is controlled by the amplitude of the color burst in a circuit that separates the chroma-burst signal in a keyed burst gate. This burst gate operates just like the burst gate in a TV receiver. A capacitive, inductive, or resistive delay circuit is used to delay the horizontal sync pulse sufficiently to position it over the blanking area occupied by the chroma-burst. This same delay is produced by the horizontal flyback transformer in a tele-

vision receiver. This delayed signal is called a "burst flag". The burst flag is used to turn the burst gate on only while the burst signal is present. The separated burst is fed to a 3.58 MHz oscillator which produces a continuous wave 3.58 MHz signal whose amplitude is the same as the burst. The level of this continuous wave signal is then used to control the gain of the ACC circuit.

Proper operation of the ACC circuit depends on having the burst signal of our incoming signal at the proper amplitude. A standard color generator will not prove effective in operating this ACC circuit because it does not provide a "zero-reference" color burst. A standard color bar generator simply injects an additional color bar in place of the standard color burst. The result is a signal that is much larger in amplitude than a color burst which causes the gain of the ACC stage to be reduced for the color bars. *Both of the color bar patterns and the Chroma Bar Sweep of the VA48 use a zero-reference color burst to provide proper reference signal levels for the operation of the ACC circuit.*

The output of the ACC detector is also used to operate the color killers in the record circuits. The tape deck automatically switches into the color mode if the burst signal is present. The color killer signal is used to control two different circuits. The first circuit kills all color signals from being recorded during a B & W program to prevent noisy playback. The second circuit is the 3.58 MHz trap found in the input circuits of the luminance circuits. Higher frequency luminance signals are recorded (resulting in better horizontal resolution for a black and white program) when this trap is switched out of circuit.

After the chroma signal has been adjusted in amplitude with the ACC circuit, it is fed to a frequency converter stage. This stage mixes the 3.58 MHz chroma signal and its sidebands with the output of an oscillator to convert the color frequency down to 688 KHz for the Beta format or 630 KHz for the VHS format. This oscillator also injects the phase shift used to prevent color crosstalk as we explained in an earlier section.

The signal used to down-convert the color signal is produced by use of a phase-locked-loop that is referenced to the horizontal sync pulses. By referencing the signal to the horizontal sync pulses, we maintain the phase relationships of our chroma signal in the conversion process. The Beta format, for example, starts with a PLL output of 692 KHz. This frequency is exactly 44 times that of the horizontal sync pulses. This signal is then mixed with a crystal oscillator that is operating at 3.57 MHz. The resulting mixer output frequency is simply the 692 KHz frequency plus the 3.57 MHz crystal oscillator frequency, or 4.27 MHz. We will see the importance of this frequency in just a minute.

A stable frequency counter (such as the Sencore FC45) is necessary to adjust the oscillators in this conversion process. A frequency counter is also helpful in analyzing troubles in the PLL used to generate the conversion signal.

The only step necessary to complete our color-under conversion is to inject the phase adjustments necessary to eliminate color crosstalk during playback. The Beta format simply uses a center-tapped transformer to produce the needed phase inversion. An electronic switch picks the signal from first one and then the other end of the transformer secondary. Since the center-tap is grounded, the result is a phase-inverted signal from each of the two ends. Digital logic circuits are used to control the actions of the electronic switch so the switching is synchronized to both the horizontal sync pulses and the spinning recording heads.

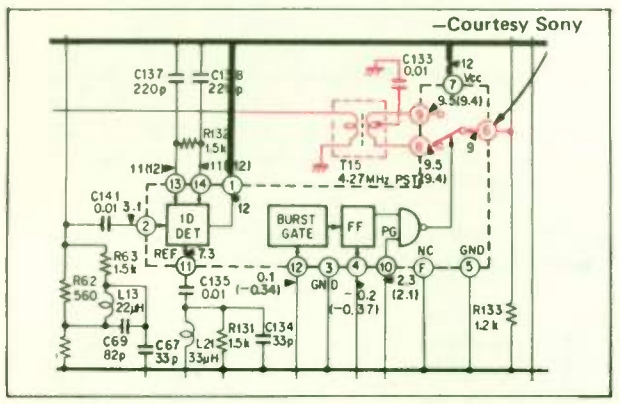


Fig. 19—The Beta format uses a center-taped transformer fed to an electronic switch to produce the phase shift needed for chroma crosstalk control.

The VHS system uses an I.C. to change the phase of the chroma signal each line. During one field of the signal, the phase is advanced by 90° each line, and during the second field the phase is delayed 90° each line. A dual-trace scope, such as the Sencore PS163, is very helpful in troubleshooting the phasing circuits.

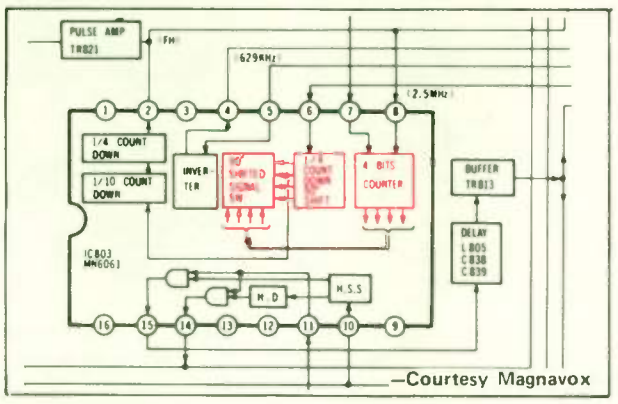


Fig. 20—The VHS format uses an IC to produce the 4 phase angles needed for chroma processing.

After we have adjusted the phase of our conversion signal, it is applied to the mixer stage that has the 3.58 MHz color signal at its second input. The 4.27 MHz signal used in the Beta format is 688 KHz above the 3.58 MHz chroma signal. A filter at the output of the mixer is tuned to 688 KHz to eliminate both the 3.58 MHz and the 4.27 MHz signals. The output of this filter is then amplified and mixed with the FM luminance signal and the two signals are sent to the video heads to record the tape.

The Servo Circuits

The head servo circuits are operating while all of this signal processing is taking place. The composite video input signal is fed to a sync separator which has the vertical sync pulses at its output. A second signal is fed to the servo circuits from the spinning disk containing the video heads. This signal (called the "PG" or "pulse generator" pulse) is generated by a permanent magnet located on the video head disc assembly which passes over a pickup coil as the heads rotate. The phase between the PG pulse and the vertical sync pulse is compared and the speed of the head disk is varied until the two signals are in phase with each other.

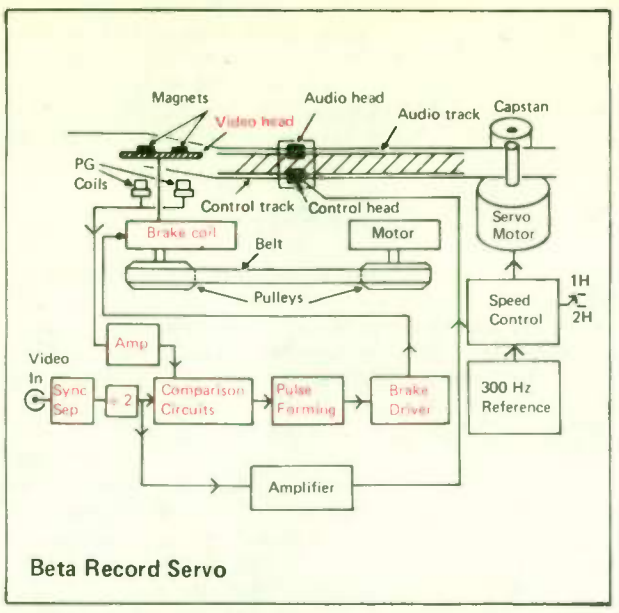


Fig. 21—The servo circuits control the position of the video heads so they are always properly positioned during recording.

The vertical sync signal is also fed to a stage that simply divides the frequency in half. This 30 Hz signal is fed to a recording head which is fixed along the tape path. This fixed head records the 30 Hz "control track" which will be used as a reference to control the servo circuits during playback.

Analyzing troubles in the servo circuits are simplified with the phase-locked signals of the VA48. The vertical sync pulses may be substituted with the Drive Signals Output of the VA48, and the control voltages may be substituted with the Bias and B+ sub output. *The VA48 is the only video analyzer that supplies all needed signals to substitute for any recording stage from the antenna to the recording heads and servo circuits.* We will discuss the uses of signal substitution in more detail in the next section.

The Playback Circuits

During playback, the recording signal processing procedures are just reversed from those we just described. We will begin with the pickup heads and follow the signal through our block diagram.

The outputs of the two video heads are fed to preamplifiers which have frequency compensation circuits to adjust for the frequency characteristics of the heads. The amplified signals are then fed to an electronic switch which selects only the head that is in contact with the tape at any given moment. This switch is controlled by a signal that comes from the servo circuits. The color and luminance signals are separated and processed separately, just like in the record circuits.

The Luminance Playback Circuits

The first circuit that the luminance signal is fed to is the "Dropout Compensator" (DOC). As we mentioned, this circuit eliminates loss of video information if the video head signal is interrupted. The DOC simply consists of a delay line that delays the signal one horizontal line. A detector circuit senses the loss of the FM carrier during a dropout and controls an electronic switch which simply picks the signal up from the output of the delay line during the carrier loss. Since the delay line output is actually the signal from the preceding line, a small portion of the signal is played twice. The duration of the dropout is normally so short that the viewer does not notice the difference on the TV screen.

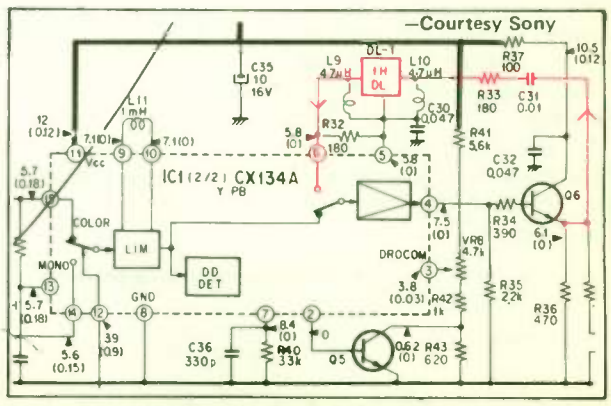


Fig. 22—Carrier dropouts are replaced by the dropout compensator which picks up signals from the previous line which have been delayed in the delay line.

After the dropout compensation, the signal passes to an FM demodulator which produces composite video at its output. The output of the demodulator is then amplified and fed to a mixer where the color information is added. The output of the mixer is then fed to the tape deck output.

The Color Playback Circuits

The chroma signal is taken from the head switch and fed to an ACC circuit which functions the same as the ACC circuit used in the recording process. Again, the burst signal is separated in a keyed burst gate and used to adjust the level of the chroma signals. The signal is reconverted to 3.58 MHz by mixing. The mixing signal reverses the phase shifting process used during recording. The result is that the chroma signal has a 180° phase shift each line just like it was originally transmitted, and the undesirable crosstalk signal has a continuous phase in each line. These phase differences are separated in the comb filter where the crosstalk signal cancels out and the desired chroma signal phase-adds. The processed chroma signal is then mixed with the demodulated luminance signal and fed to the output of the deck.

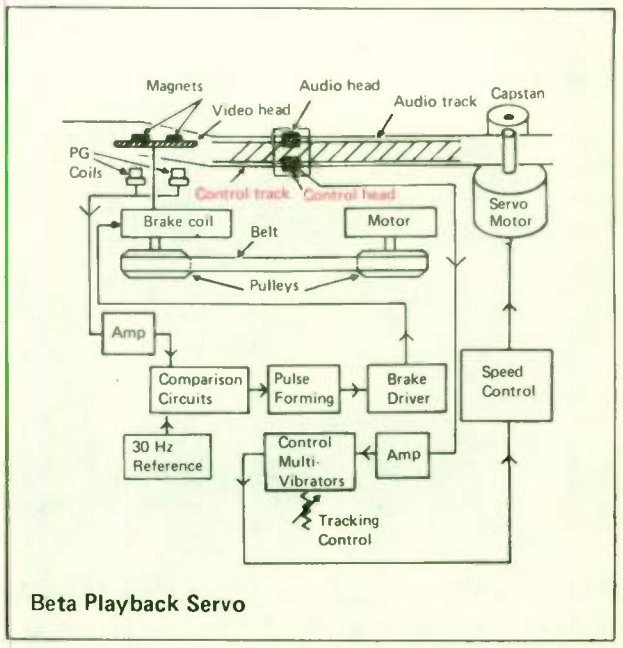


Fig. 23—The same servo circuits are used during playback to reposition the video heads. The control track serves as a reference signal like sprocket holes in a movie film.

The signal that is used to convert the signal back up to 3.58 MHz contains several stages of phase correction to maintain the proper phases in the playback chroma output. One circuit is locked to the horizontal sync pulses as a reference. Additional phase correction is provided by comparing the 3.58 MHz chroma output signal with a crystal controlled reference oscillator. These stages of phase correction compensate for timebase errors and phase-jitter. The last stage of phase correction reverses the phase adjustments that are used during recording to cancel playback crosstalk.

The servo circuits compare the control track, that was recorded on the tape, with the head position signal developed by the PG pickup coil. The servo circuits adjust the position of the spinning video heads so that they trace the same paths during playback that were followed by the spinning heads during recording.

The only stage left in the playback circuits is the RF output modulator. This stage is really a miniature TV transmitter. The video signal is applied to one input of the modulator, and the audio signal is applied to the second input. These two signals are used to modulate an RF carrier which may be fed directly to the antenna input of any TV receiver. This stage is not really designed to be serviced. *Most manufacturers prefer that the unit be replaced if defective* to make sure that unauthorized adjustments made to the modulator do not cause the output signals to differ from FCC regulations for RF devices.

Methods of servicing the playback portion of the video tape deck will vary from one type of failure to another.

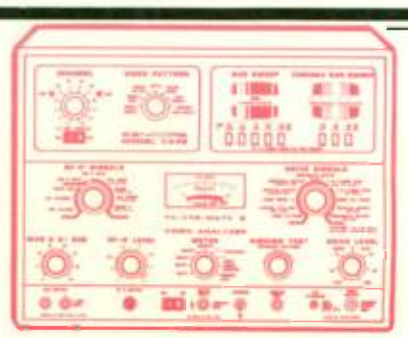
Fig. 24—The RF modulator is used to produce an output signal to feed directly to a standard TV set. This stage is not generally intended to be repaired.

Signal substitution and the use of the VA48 Bias and B+ sub supply will simplify troubleshooting of most of the circuits. A test tape is also necessary for verifying proper playback operation. This test tape is available from the manufacturer's service parts department. Many of the tests required for playback servicing can be made with a test tape that you have recorded on a known good machine, using the signals provided by the VA48. This tape should have about five minutes of the Bar Sweep pattern, the Chroma Bar Sweep pattern, the Color Bar pattern, and the crosshatch pattern. The tape is recorded by simply feeding the signal from the VA48 VTR standard output jack to the video input. The VTR has a counter that should be used to mark the beginning of each pattern to aid in locating a pattern when desired. For example, the first pattern can be recorded from 000 to 050, the second from 050 to 100, etc. The audio signal from the VA48 should also be used to record an audio tone on your reference tape.

Fig. 25—The VA48 patterns may be recorded on a known good deck for a playback reference. Use the deck's digital counter to allow the desired section of the tape to be located.

When you record your own test tape, you should not feed the patterns into the antenna input jack. The signal should be fed directly to the "camera" input so that the tuner and IF stages are bypassed by the direct input. This assures you that your reference test tape will have the highest quality recording because it will not be affected by such things as tuner fine tuning or IF alignment.

Question 3: What things do I need in a signal generator for VTR servicing? Does the VA48 provide me with all of the signals I need?



We discovered several needs for test signals as we explained how the VTR processes the various signals during recording and playback. We found that we needed signals that are more precise than produced by a standard color bar generator. We found, for example, that we need the proper sync-to-video ratio for the recording AGC circuits to operate properly. Then, we found that we need a check of both the black and the white clipping to properly set the limiting circuits found at the input to the luminance FM modulator.

We found similar signal requirements in the color sections of our recording circuits. We, first of all, need a zero reference color burst to effectively test the actions of our automatic chroma level circuits. The newer tape decks that use a comb filter require the proper chroma phase relations between adjacent lines for both chroma signal separation and playback crosstalk cancellation. The standard 10-bar color pattern is again not suited for this type of circuit because the phase of the color information is not locked to the horizontal sync pulses. This fact is easily confirmed by simply looking at the color bar pattern on the front of an operating TV set. The edges of the color bars show a cog-like effect. This effect is due to the phase difference at the beginning of different circuits. A color bar pattern that is phase-locked (like the VA48) will have these "cogs" standing still because the phase of each frame of video is the same as the last one. A non-locked generator, however, will show the edges running. This is because the phase relationships are not fixed.

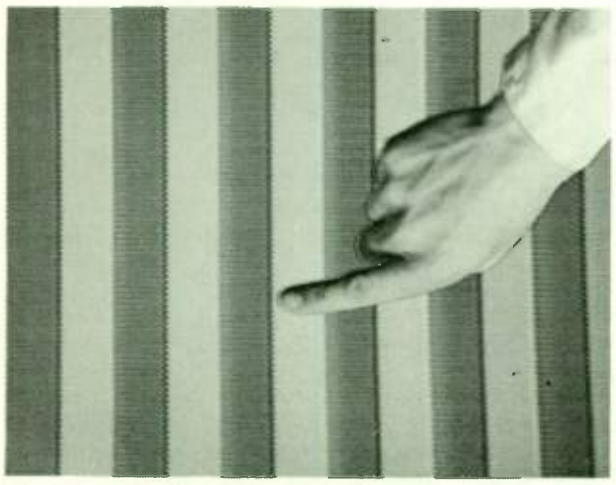


Fig. 26—It is easy to see the fact that the color patterns are properly phase-locked by noting that the edges of the color bars do not "run".

The "NTSC" Color Pattern

Many VTR manufacturers require the use of a source of NTSC color signals for their warranty service centers. Before the introduction of the VA48, this meant investing in a separate signal source that produced the standard EIA 75% saturated color bars. This type of generator has two limitations in general VTR and television service: 1) The cost of this generator is as great as the VA48 and is only used for servicing the video tape deck, and 2) This type of signal generator generally does not have additional output signals which can be used for analyzing defective circuits of the video tape deck with signal substitution. The signals provided by the VA48, on the other hand, provide all the key tests produced by the EIA color pattern with the additional benefits of being able to service all stages of the VTR including the tuner and IF amplifier stages. The phase-locked outputs of the VA48 are specifically designed for troubleshooting all recording and many playback stages with direct signal substitution. An additional benefit of using the VA48 in place of an EIA color generator is that the same signals supplied by the VA48 are used for servicing all types of video equipment including standard TV receivers and video monitors. The EIA color generator, on the other hand, is not suited for direct application to TV service since the signals supplied are not referenced on the TV service literature.

Close examination of the patterns used by the VA48 show us that the critical portions of the composite video signal do indeed provide a source of NTSC color signals. The following list shows the key areas that make the VA48 ideal for use in VTR (VCR) service:

1. The sync pulses have standard rise times and durations.

2. The color burst signal of both color patterns provided by the VA48 is supplied at a standard reference level to provide proper operation of the ACC circuits found in most video tape decks.

3. The chroma information supplied by both the color bar and the Chroma Bar Sweep pattern are properly phase-locked and interleaved with the luminance portion of the signal so those decks using comb filters will operate properly.

4. The amplitudes of the video and sync information have the proper ratios for operation of the circuits such as the AGC circuits that use the sync pulses as a reference.

5. The reference black, grey, and white signal levels provided by the Bar Sweep pattern are ideal for testing and adjusting the clipping circuits in the record section.

6. The "multi-burst" type signal provided by the Bar Sweep provides a dynamic check of the true video frequency response of all video processing circuits.

7. All of the video patterns are available as an RF or IF signal for checking the input circuits, as a standard 1V P-P output for feeding directly into the composite video input of most decks, or as an adjustable amplitude signal for direct substitution into any internal stage.

8. All special signals, such as 3.58 MHz continuous wave chroma subcarrier, horizontal, vertical and composite sync information, audio signal, etc., are available for direct substitution into any stage for step-by-step analyzing.

9. The Bias and B+ sub signal is available for analyzing defects in automatic control stages and servo stages.

10. The phases of all color signals are held within NTSC specifications because all of the internal oscillators are locked to a single master oscillator.

Each of these points make the VA48 the most complete source of video signals for VTR as well as TV servicing.

(Continued after inserts)

Betamax

RECORD CIRCUITS

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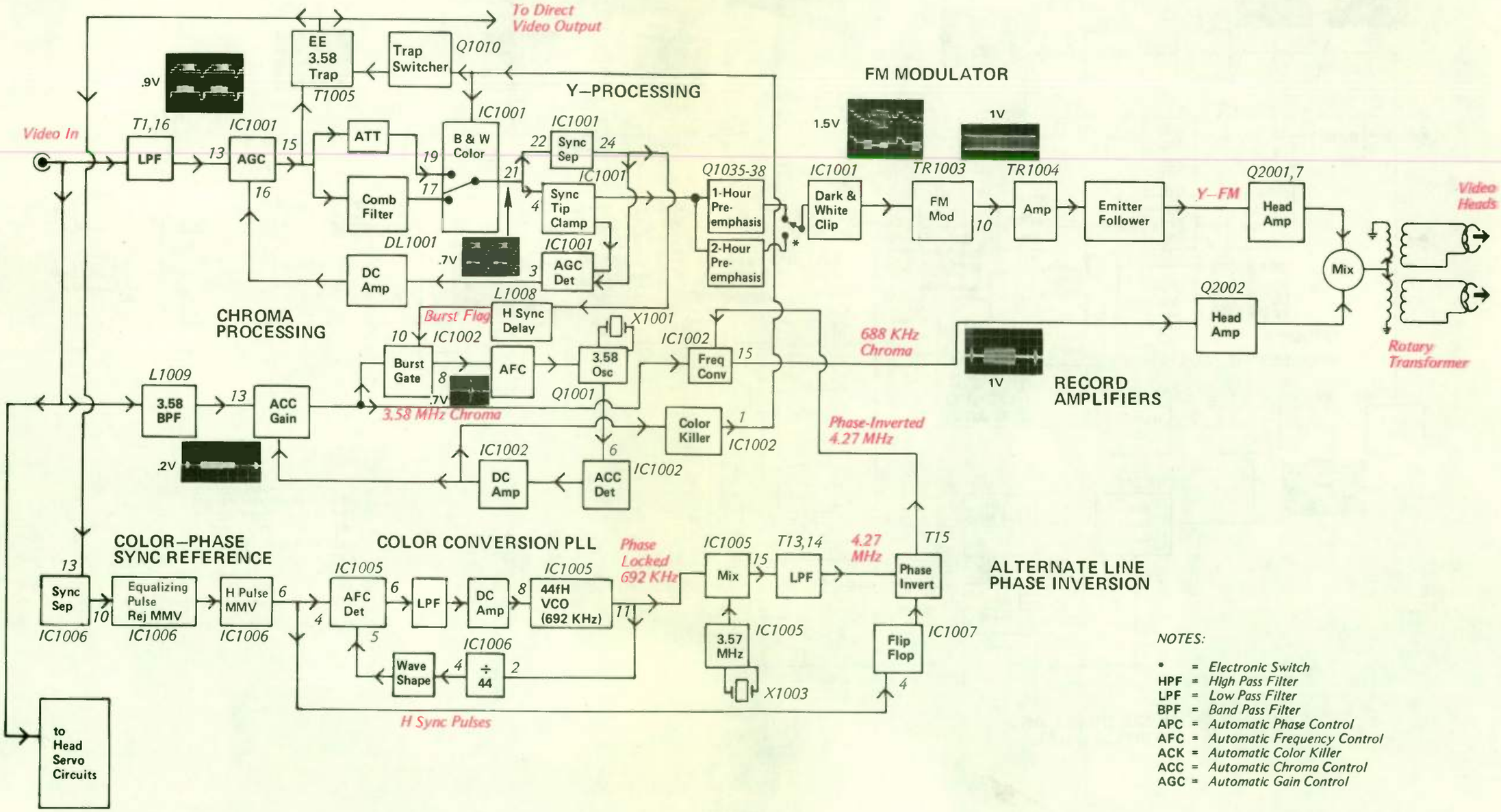
SENCORE VA48
SPEED TEST CHART

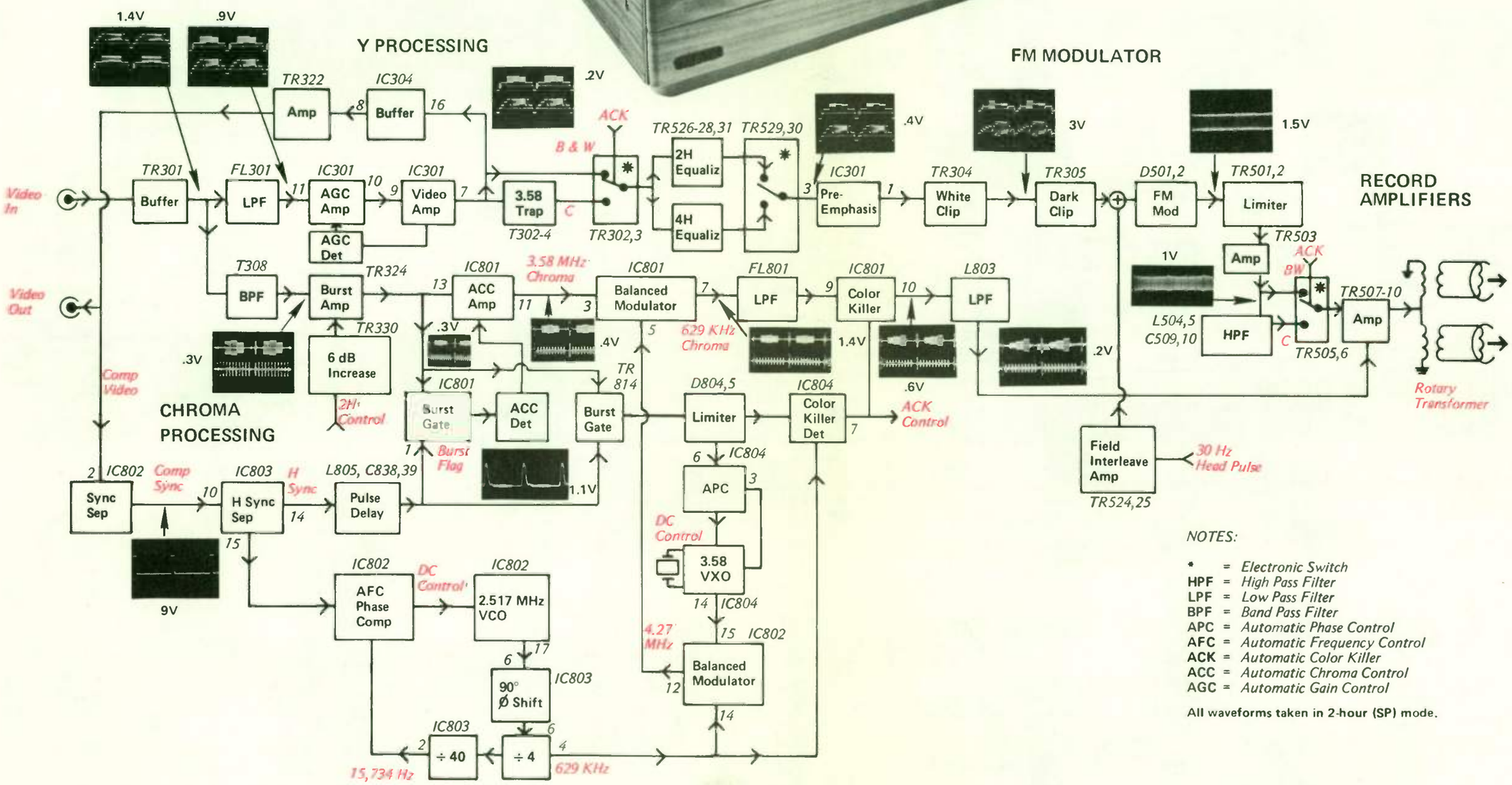


NOTES:

- • = *Electronic Switch*
- **HPF** = *High Pass Filter*
- **LPF** = *Low Pass Filter*
- **BPF** = *Band Pass Filter*
- **APC** = *Automatic Phase Control*
- **AFC** = *Automatic Frequency Control*
- **ACK** = *Automatic Color Killer*
- **ACC** = *Automatic Chroma Control*
- **AGC** = *Automatic Gain Control*

VHS RECORD CIRCUITS

SENCORE
VA48 SPEED-TEST CHART



COLOR PLL AND PHASE SHIFT

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All waveforms taken in 2-hour (SP) mode.

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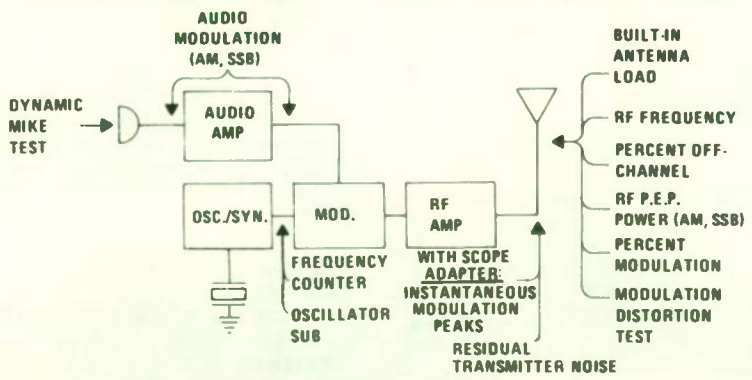

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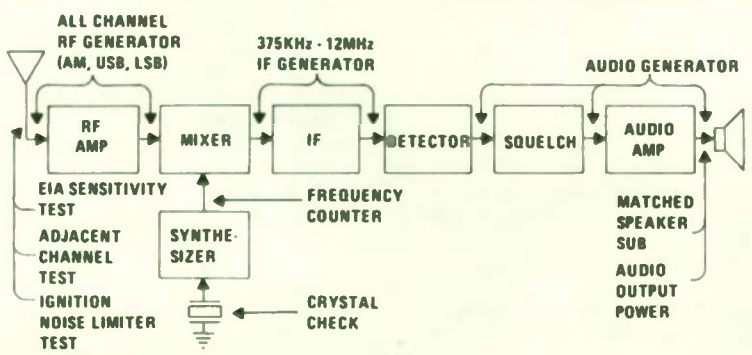

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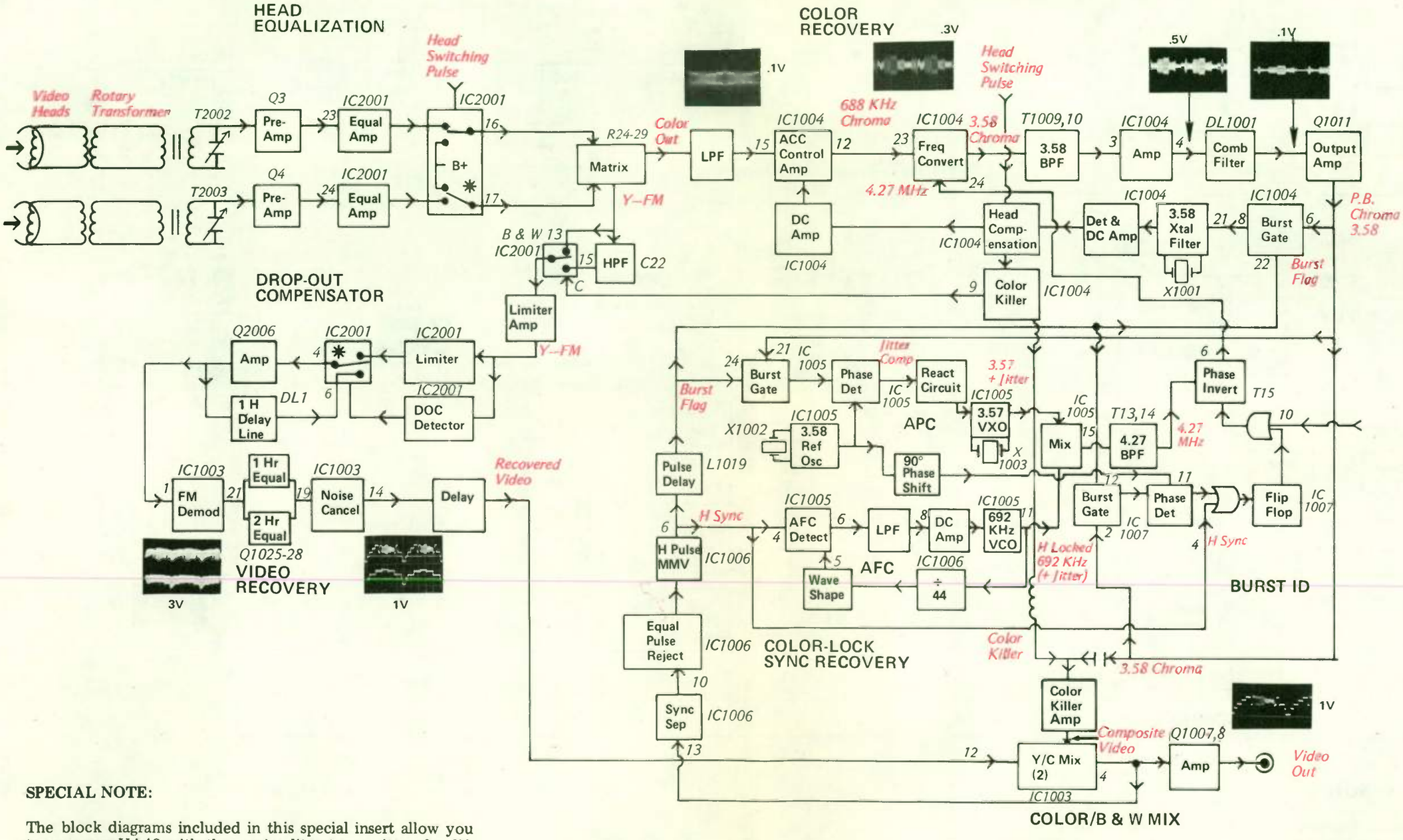


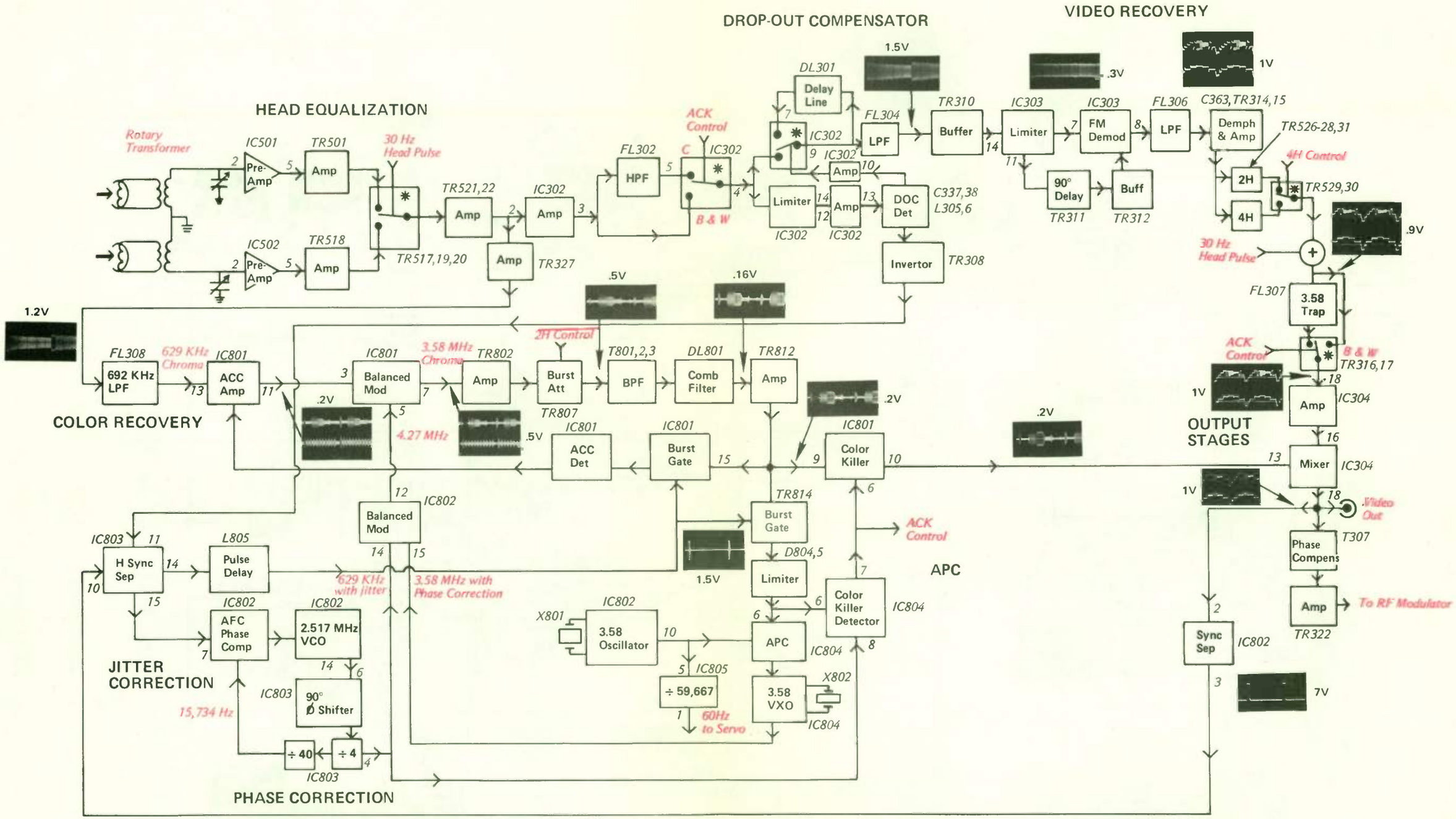
SPECIAL NOTE:

The block diagrams included in this special insert allow you to use your VA48 with the service literature written for different brands of tape decks. Diagrams are included for the record and playback functions of the Beta and VHS decks available at the time of the printing of this Sencore News. IC and transistor numbers are given so that you can quickly locate the input and output components on the full schematic for the tape deck you are servicing. You may wish to attach the diagrams to a piece of cardboard as you are using them to keep them in good shape. Simply use paper clips or pins so you can change from one format to another easily.

VHS PLAYBACK CIRCUITS

SENCORE

SENCORE VA48 SPEED-TEST CHART



SPECIAL NOTE:

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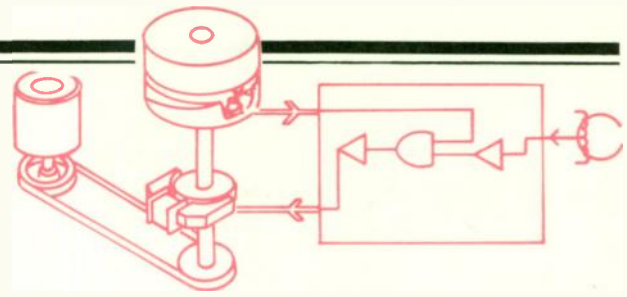

Question 4: How do I service the mechanical and servo sections of a VTR?

As we reviewed the section about how a VTR works, we saw a rather complex instrument. The tape deck is made up of both mechanical and electrical components. These two systems join forces in the servo circuits since the mechanical video head is controlled by electronic signals to keep it properly positioned at all times. Technicians that are presently servicing video tape systems tell us that tape deck defects fall into each of these three (mechanical, electrical, and servo) sections, and each must be serviced with different techniques. We will cover each of these types of failures separately.

Mechanical Defects

The mechanical sections of the VTR control the handling of the tape. The first section is responsible for pulling a length of tape from the tape cassette and threading it around the drum that contains the video heads. This is generally controlled by a DC motor and mechanical switches that "tell" the threading mechanism when the threading or unthreading is complete. Servicing this section of the tape deck simply involves straight DC paths and a voltmeter or ohmmeter provides the best servicing tool. Proper understanding of the operations of this section requires the use of the manufacturer's service literature so the technician has information about the operation of the loading system and instructions about the adjustments that can be made to correct defects in this area.

A second important part of the mechanical sections involves the supply and take-up sections that move the tape past the recording and playback heads. One important factor in this mechanical section is that the tape tension must be correct for proper operation. The tape tension adjustments must be properly set to prevent the possibility of damaging the tape or the video heads if the tension is too high and to insure compatibility between machines. Each manufacturer has special test gauges available to set the tape tension properly. These special tools are essential for adjustment of the tape transport mechanism. Other test jigs are available for such critical adjustments as the ones that affect the position of the tape cassette in the cassette holder, and the position of the capstan which pulls the tape from the supply spool of the cassette at a constant rate.

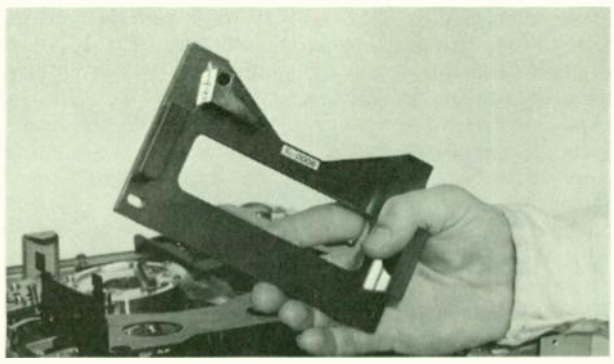

Fig. 27—Proper mechanical alignment requires the use of the special gauges and test jigs available from the deck manufacturer.

Finally, the tape guides inside the machine are very critical for proper position of the tape as it passes across the video recording drum and the audio and control track recording heads. *These tape guides are factory set and should never be adjusted without following the factory alignment procedures.* These procedures usually call for the replacement (rather than the adjustment) of the tape guides with factory adjusted replacement parts. The reason that these guides are so critical is that they determine whether the tapes recorded on another machine can be properly played on the machine being serviced. Any slight differences in the adjustment or position of these guides will make tape interchange from one machine to another impossible.

We have emphasized the need for using manufacturer's literature for servicing the mechanical sections of the tape deck, but how do you know that a particular defect is mechanical or electrical in nature? The video patterns provided by the VA48 will allow you to provide reference signals that you can use to check the general performance of the tape deck. The use of these patterns is not so important in the case of a complete failure (such as a broken drive belt) because the machine will just fail to operate. But, the patterns will provide a reference for the more subtle types of mechanical defects.

Locating Tension Error

Proper tape tension is one of the factors that determines if we have compatibility between two machines. Let's say, for example, that the tension of our machine under test is too high. A tape that has been recorded on another machine will be stretched more when it is played back on the defective machine. This causes the video stripes recorded on the tape to be slightly longer than if the machine was properly set. The result will be a bending at the top or bottom of the picture. This type of playback error is known as a "skew" error. Such an error has two common causes. The first of these errors is improper tension, and the second is improperly adjusted video heads. The use of the VA48 crosshatch pattern, recorded on a known good machine, allows this bending to be quickly observed. If the skew error is present when this reference tape is played back on a suspected bad machine, you know that the second machine has one of the two mechanical errors we mentioned.

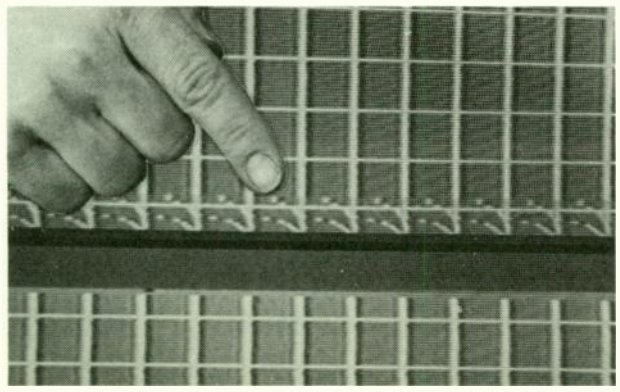

Fig. 28—Tape tension errors show on the TV screen as bending of vertical lines.

The use of the tape tension gauges will quickly determine if the defect is in the tape transport mechanism. If the tension is properly set, you should then adjust the video heads following the instructions in the service literature that explains how to adjust the "dihedral error" of the video heads. This adjustment is usually made by inserting tapered screws into the head assembly and using them to move the video heads a slight amount until they are exactly 180° apart on the video head disk.

Other types of mechanical defects are covered in the troubleshooting sections of the manufacturer's service literature. Most manufacturers provide manufacturer's service "flowcharts" to help locate additional mechanical defects.

Servicing Servo Defects

The servo control circuits of a video tape deck simply compare two signals to tell if the video heads are in the correct position during both recording and playback. During recording, the two signals are the vertical sync pulses and the head position signal (PG pulse). *The two signals should arrive at the servo comparison circuits at the same time.* If they are not properly timed, the servo circuits adjust the rotational speed of the video heads until the two signals correspond.

During playback, the same head reference pulse (PG pulse) is compared with the output of the control track head. Again, the two signals are compared and the speed of the rotating head disk is adjusted until the two pulses are properly timed. Signal substitution may be used to analyze many sections of the servo circuits that are difficult to analyze using a scope or other servicing technique. Let's look at an example.

The Betamax tape decks use the servo circuits as a protection circuit as well as a control circuit. The servo logic circuits "look for" a servo pulse coming from the spinning heads. If this pulse is missing, it may indicate that the video head is not spinning due to a jammed tape or defect in the motor or drive belt that runs the head. Anytime the PG pulses are missing, the tape deck automatically actuates the "stop" mode to prevent the possibility of further damage.

The tape deck symptom in our example is that the deck will not stay in the "play" mode. As soon as we press the play button, the deck will run for about one second and then automatically shut down. Now, we cannot use an oscilloscope to analyze this defect because the signal produced by the PG head is only present when the video head is spinning. The head, of course, will only spin when the deck is in the play mode, so there is no signal to trace.

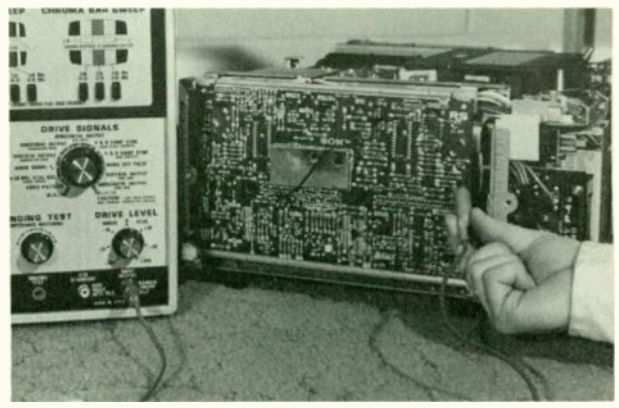

Fig. 29—The servo signals are substituted with the vertical Drive Signal available from the VA48.

We need to substitute for the PG signal coming from the pickup heads. This signal is normally a 30 Hz pulse. We find, however, that the circuits will also accept a 60 Hz signal because the PG input circuits are multi-vibrators. We simply adjust the vertical drive signal from the Drive Signals Output of the VA48 for 1V P-P (The normal signal level at the input to the PG amplifiers) and feed it to the input of the servo board in place of the PG head output. Let's say that the tape deck will now stay in the "play" mode. This tells us that the defect is a missing PG pulse caused by a bad PG pickup head, or the wiring running from the head to the servo board. If the signal does not, on the other hand, correct our defect, we simply leave the substitute signal connected and proceed to trace the signals with our scope. *The beauty of this technique is that we do not need to have the deck running to signal trace through the remainder of the servo circuits.* We are simulating the PG pulse that would normally be generated by the spinning head location magnet passing over the PG head. The only thing to remember is that the waveforms are going to be slightly different from those shown on the schematic because we are injecting a 60 Hz signal in place of the normal 30 Hz signal. Fig. 30 shows the typical waveforms to expect with the substitute signal.

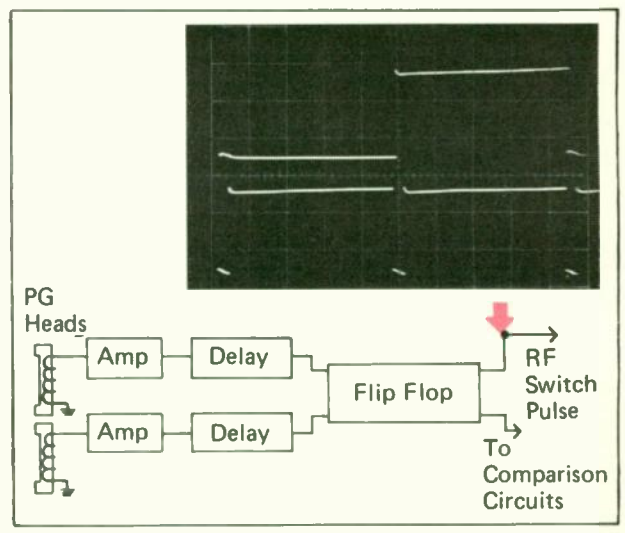

Fig. 30—Substituting for the "PG" pulse with the vertical drive signal allows a scope to be used to trace the signals. The top waveform is the one found when the deck is operating normally and the bottom one is the "subbed" signal. See text for details.

The other signal that operates the servo circuits during playback in the newer 2-speed models is generated by an internal 30 Hz generator. This circuit is simply a 300 Hz oscillator that is phase-locked to the AC line. The 300 Hz signal is then divided by 10 (resulting in a 30 Hz output frequency) and used as a reference to compare with the 30 Hz control track signal. This section of the servo circuits is analyzed by signal tracing with the VA48's built-in peak-to-peak meter, a frequency counter such as the Sencore FC45, or with an oscilloscope. The use of the PR50 Audio Prescaler used with the FC45 gives us 2 more digits of resolution (to .01 Hz) for accurately troubleshooting this section.

Question 5: Just how do I use the VA48 signals to analyze defects in the recording circuits of a VTR?

The sections of the video tape deck that we have dealt with up to this point have been mechanical or electro-mechanical. Any type of mechanical adjustments must be done with the tools available through the tape deck manufacturer to obtain the proper results. The electronic circuits of the deck, on the other hand, require reference signals and proper troubleshooting techniques. We will see how the various output signals and video patterns provided by the VA48 allow great simplification of video tape deck service compared to any other type of service techniques. Basically, there is only one adaptation that is necessary in interpreting the results covered here compared to a so-called "NTSC" signal generator, and that is the waveforms of the signals in various stages will vary from those shown on the schematic. We will cover these differences so you can use your present service literature directly. We will deal mainly with block diagrams of a tape deck, because the same block diagram applies to virtually all brands of decks.

The Record Circuit

Let's start with the recording circuits of the tape deck. At this point, you should have the full recording block diagram (located in the center of this *Sencore News*) in front of you so you can follow along with each of our examples on the overall block diagram while we cover smaller block diagrams in this section. This will allow you to see how each of the individual circuits fit into the total recording system.

The first recording stage is the AGC amplifier. This stage must be first tested with a reference input level of 1V P-P to make sure that the output is the proper amplitude. Simply inject the output of the VTR Standard jack directly to the camera input of the tape deck and adjust the AGC control for the proper output level using the Bar Sweep video pattern. The circuit is further tested by using the adjustable output supplied from the Drive Signals Output jack instead of the VTR Standard jack. This adjustable output should be varied form .5-2V (negative polarity) while the output of the AGC is viewed with an oscilloscope. The waveforms shown in Fig. 31 should result if the AGC circuit is operating properly. This figure also shows the waveforms produced by a faulty AGC circuit.

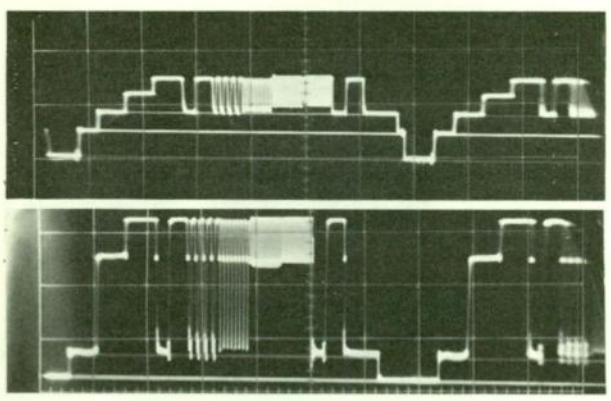

Fig. 31—The top waveform shows the normal AGC output and the bottom one shows an improperly operating output.

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What should we do if the AGC is not functioning? Well, the first step is to determine if the AGC stage, the DC amplifier, or the AGC detector is the cause of malfunction. We can simply connect our Bias and B+ sub supply to the AGC line and vary the voltage with the signal supplied by the VA48 VTR standard output fed to the camera input. The signal level at the output of the AGC stage should change as we vary this voltage. If it does not, we know that the trouble is in the gain controlled stage. If the voltage does produce a change, we know that we need to go back to the AGC detector and inject the DC voltage at its output.

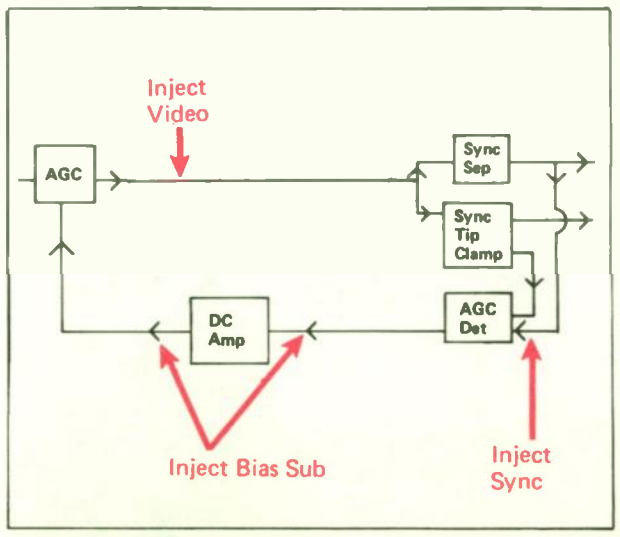


Fig. 32—The Drive Signals output from the VA48 allows each stage of this AGC circuit to be tested.

Finally, we can substitute for both of the signals feeding the AGC detector itself by simply injecting the composite video signal at the camera input (using the VTR Standard jack) and then feeding the composite sync pulses supplied by the Drive Signal Output in place of the deck's sync separator output. This example allows us to locate an AGC defect to a single stage which is especially important when we are troubleshooting defects caused by defective integrated circuits or poor solder connections in our signal path.

The use of the VA48 Bias and B+ sub supply also allows us to tell if the color killer signal is properly switching the color/B & W filters. The bias voltage is simply set to 4 Volts and injected into the IC that controls these filters. The scope waveforms shown in Fig. 33 shows the difference in the Bar Sweep pattern with the color killer activated. Normal operation of this circuit should allow more high-frequency response during a black and white presentation compared to a color presentation. We once again get proof positive that the circuits are working properly.

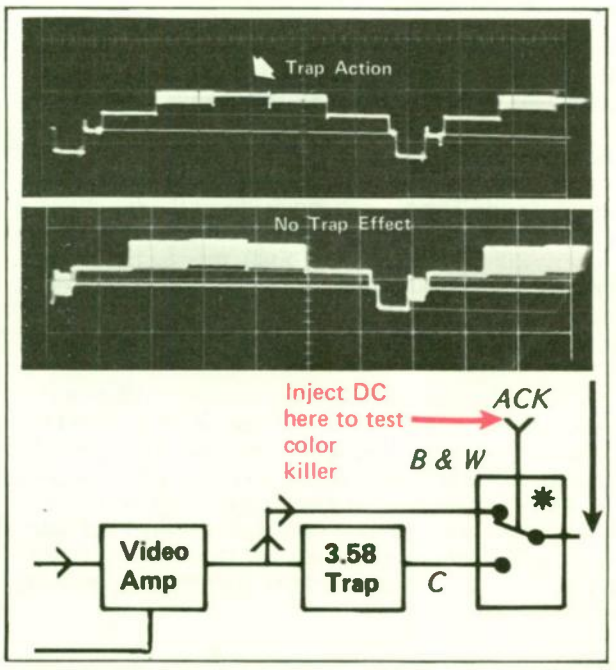


Fig. 33—The operation of the color killer is quickly confirmed using the Bar Sweep pattern and the Bias and B+ sub voltage.

Are you beginning to see the advantage of using the Bar Sweep pattern as a reference for checking the video frequency response of the different circuits that are processing the video signals? *This single pattern gives a total frequency response check of our video circuits.* This function is not provided by a standard "NTSC" signal generator or other color generators. We will continue to use the Bar Sweep pattern as a reference for signal tracing in both recording and playback circuits.

Pre-Emphasis Circuits

The Bar Sweep allows the recording pre-emphasis circuits to be checked for proper operation. The newer two-speed decks require different amounts of pre-emphasis for each speed. The scope waveforms shown in Fig. 34 show what the Bar Sweep looks like in properly adjusted pre-emphasis circuits.

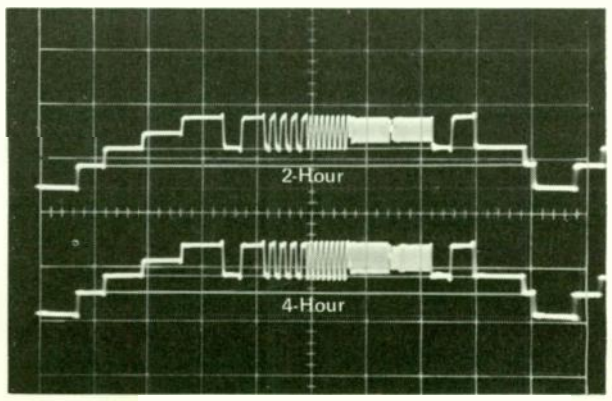


Fig. 34—The recording pre-emphasis circuits boost the high frequency content to reduce video noise.

White and Dark Clipping

The clipping circuits located between the pre-emphasis network and the FM modulator must be properly set to prevent over-modulation which causes the picture to tear during playback. The adjustment of these circuits require both a reference white level and a reference black level to make sure that the limiters are not favoring one portion of the signal over another. Again, the Bar Sweep speeds these adjustments. Not only do we have a 3-step grey scale to check for proper video linearity, but the different frequency bars give us a dynamic check of the clipping circuits at different video frequencies. *This is super-important when the signal is pre-emphasized because the higher frequency content is boosted in amplitude.* It is possible for the clipping circuits to be operating properly at the low-frequency range of the signal (like that produced by a 10-step grey-scale) but provide too much limiting to the compensated high frequency information.

The Bar Sweep pattern allows all frequencies of the signal to be checked at the same time. Since the Bar Sweep is the only pattern available with both the frequency bars and a grey scale in a single pattern, it is the only one that allows all critical portions of the clipping circuits to be checked at one time.

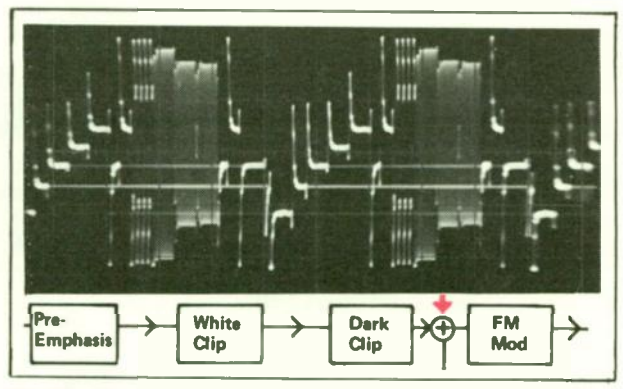


Fig. 35—The fact that the Bar Sweep pattern provides both a grey-scale and a "multi-burst" type signal allows testing of the clipping circuits at all operating frequencies.

The circuits from the FM modulator to the video heads are best analyzed by tracing the signals with the VA48 Signal Tracing Meter, or with a scope. For general signal tracing, the high frequency response of the meter is usually faster since the shape of the waveforms is not as important as the peak-to-peak amplitude.

Color Circuit Analyzing

The phase-locked signals provided by the VA48 allow much faster analyzing of the chroma processing circuits than with any other analyzing technique. Direct signal substitution is used to substitute for any signal up to the stage that converts the frequency of the chroma signal down from 3.58 MHz. Let's look at a few examples of how we would service a defect in the color processing stages.

The Automatic Chroma Control (ACC) requires two input signals for proper operation. The first is the composite chroma signal. The important part of this signal that we need for ACC operation is the color burst. The amplitude of this burst signal is used to control the gain of the chroma circuits to maintain a constant color level with changing input signals. The second signal required is the "burst flag". As we mentioned earlier, this signal is simply the horizontal sync pulse that is delayed a small amount to place its timing exactly in line with the burst signal riding on the back porch of the horizontal blanking interval. *The timing of this signal is very important because it determines what portion of the color signal is used to control the gain of the color circuits.* If the burst flag arrives too late, for example, the burst gate will separate the first part of the picture (just after the blanking interval) instead of the color burst. The result is that the color levels will be constantly changing because the amount of chroma information will be different in each color scene.

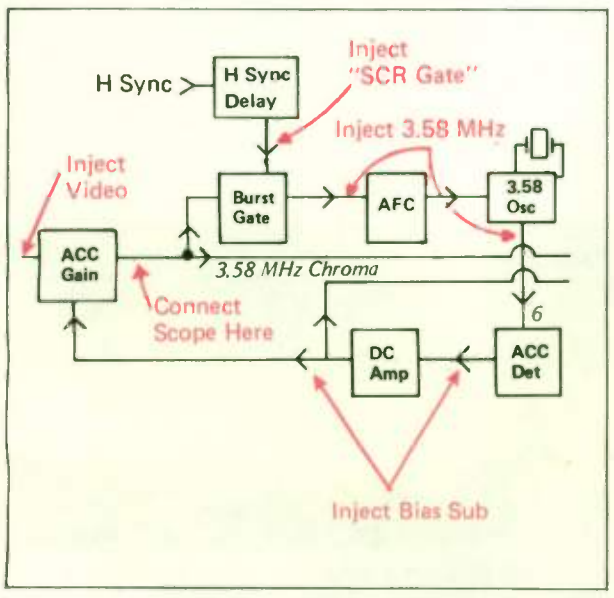


Fig. 36—Each stage of the ACC circuit is substituted with the VA48 Drive Signals.

Let's look at how the Drive Signals provided by the VA48 will allow us to analyze these circuits with stage-by-stage signal substitution. We will start with a symptom of changing color levels when a tape is being played. We, first of all, need to know if the levels are changing during the recording or playback of the color program. This is easily confirmed by simply playing back a tape that has been recorded on our suspected bad machine on a machine that we know is working properly. If the color levels remain the same, we know that the defect is in the playback circuits. In this case, however, we find that the levels are changing when the signal has been recorded on our suspected machine and played back on our reference machine. We then know that the trouble is in the recording circuits of the machine in question.

Changing color levels could be caused by a defect in any of the seven circuits shown in Fig. 36. These seven circuits make up the ACC circuit. A defect (such as a bad IC or a poor solder connection) anywhere in the stages would produce almost the same symptom, changing color levels with different input signals. A scope will allow us to look for missing signals, but the substitute signals produced by the VA48 will allow a more positive check because we can duplicate the signals that should be produced at the output of each and every stage.

The first thing that we need to do is provide a reference signal at the input to the ACC stages. This is done by simply connecting the VTR Standard output of our VA48 to the camera input of the tape deck. Now, all we need to do is select the Chroma Bar Sweep pattern to provide a reference color pattern for the rest of our analyzing.

Let's first check the circuits that produce our burst flag signal. The input to this stage is the composite sync pulses that have been separated from our luminance signal. A substitute signal is produced by the VA48 V & H Comp Sync position of our Drive Signals switch. The solid-state position of the switch should be used to prevent the possibility of supplying too much signal which could damage one of the solid-state devices in our circuit. The impedance of this position is also matched to drive the low-impedance solid state circuits that we find in these stages. The built-in Drive Signals monitor position of the VA48 meter system should be used so we know just how much signal we are using to inject into the suspected bad stage.

We can start by injecting the composite sync signal into the Horizontal Sync Delay circuit to see if proper operation returns. The best place to monitor the operation of our circuit is at the output of the ACC controlled stage. The scope waveforms shown in Fig. 37 show the proper amplitudes for both the Beta and the VHS formats. The bottom photos show what these signals look like when the ACC circuits are not operating properly.

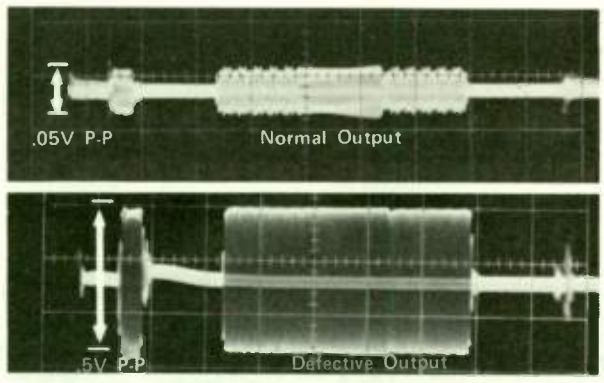


Fig. 37—The ACC circuit is designed to hold the chroma signal at a constant level with changing input signals.

If the substitute signal does not return the proper amplitude at the output of the ACC circuit, we can move one stage and substitute for the burst flag. In this case, we will change the Drive Signals switch from the composite sync position to the SCR Gate Drive Signal. This signal provides a proper substitute for the burst flag because the pulse produced by the SCR Gate signal is "stretched" the same amount as the burst flag. The pulse is present during the color burst and will therefore operate the burst gate just the same as the signal produced by the circuits inside the tape deck's chroma processing stages. If the operation of the ACC circuits returns to normal, we know that the trouble in the horizontal sync delay stage.

If this signal does not return proper operation, we can continue our stage-by-stage injection at the output of the burst gate. This time, we will use the 3.58 MHz (phase-locked) signal. Now, you may think that this signal will not work because the normal output of the burst gate is a 9 cycle color burst and the output of the VA48 substitute signal is a continuous wave 3.58 MHz signal. The AFC circuit (at the output of the burst gate) cannot tell the difference between the color burst and a continuous wave signal, however, and will operate equally as well with a continuous wave signal. We can also check the dynamic operation of the ACC circuit with this substitute signal by simply varying the amplitude of the substitute 3.58 MHz signal. If, for example, we increase the amplitude slightly, the ACC output signal should reduce in amplitude. If we see this dynamic change, we know the ACC circuit is working and our trouble is in the burst gate. If, on the other hand, we see that changing the amplitude of our substitute signal does not change our ACC output, we know that the trouble is in a later stage.

The same 3.58 MHz signal can then be used at the output of the 3.58 MHz oscillator. Varying the amplitude of the substitute signal should again produce a change in the ACC output level. If not, we need to step forward one more stage.

The output of the ACC detector is a DC voltage whose amplitude is related to the amplitude of the burst signal. The use of Bias and B+ Sub output of the VA48 allows us to check the operation of both the DC amplifier and the ACC controlled stage. We should start by setting the output of the Bias and B+ Sub to the level shown on the schematic. We should then raise and lower this voltage about 10 percent. The results should be a change in the ACC output signal level. If we still do not have proper operation, we simply inject our DC voltage at the output of the DC amplifier (input to the ACC controlled stage) and again vary the voltage. If we still do not get a changing output level, we know that our trouble is in the ACC controlled stage itself. We have now been able to tie down all 7 of the circuits in this rather complicated feedback system to locate our defect to a single stage.

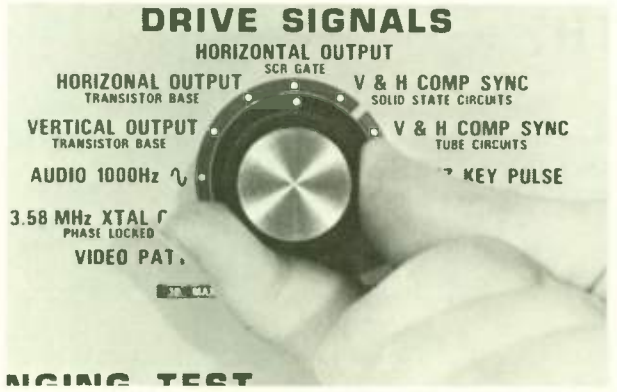


Fig. 38—The phase-locked signals provided by the Drive Signals output allow direct substitution to simplify analyzing of feedback circuits.

Now, all of this may seem to be the "long way around" this signal path. In real life, we would not have to substitute for each and every signal. We could, for example, start at the output of the ACC detector and supply our substitute DC voltage. This divides our circuits in half. If we get proper operation, we know that the defect is somewhere in front of this stage. If we do not get proper operation, we know that the trouble is either the DC amplifier or the ACC controlled stage. We now know which direction to go to further analyze the stages. *The key point to remember is that you have a signal to substitute for each and every input and output stage so that you are never left guessing as to the cause of the circuit malfunction.* This direct substitution method will become a real time saver once you get used to applying it to the various types of circuit defects you will run into.

Signal substitution is especially handy when combined with a method of signal tracing. You simply inject the substitute signal at the input to a stage and monitor the resulting signal at the output of the same stage or one that is supposed to be controlled by the substitute signal. Any time that you are only concerned with the amplitude of the output signal, the use of the signal tracing meter built into the VA48 allows a fast, convenient check that reads directly in peak-to-peak volts to allow comparison with scope waveforms shown on the schematic. Other circuits require that both the amplitude and the waveshape of the signals be correct. In these cases, the use of an oscilloscope is important. The combination of signal tracing and signal substitution provides your best answer for speed and accuracy in your analyzing.

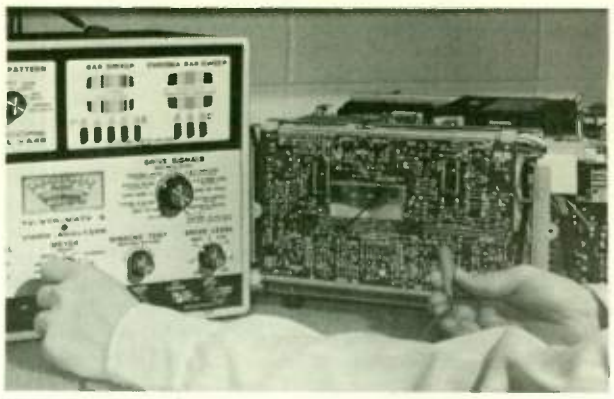


Fig. 39—The peak-to-peak reading signal tracing meter is especially handy when the signal amplitude is more important than the waveshape.

Before we leave the makeup of the chroma processing stages, let's talk about one more example where signal substitution may be used to locate a defective stage. In this case, we will also use a frequency counter (in addition to our scope and signal tracing meter) to confirm that the stages are working properly. You should recall that the frequency conversion stages simply mix the incoming 3.58 MHz chroma signal with a second signal that is referenced back to the horizontal sync pulses through a phase locked loop arrangement. We will follow the signals through a Beta format deck although the operations of the VHS conversion is similar.

(See block diagram on next page.)

The first step of our frequency conversion is to separate the horizontal sync pulses from the incoming composite video signal. These pulses are then formed into a series of pulses with a fixed amplitude (and pulse width) in two multi-vibrator stages. These clean pulses are then fed to the phase-locked-loop to maintain the proper conversion frequency at the output.

The composite sync signals provided by the V & H Comp Sync output can be fed directly to the input or output of the sync separator stage. These pulses (being phase-locked to the composite video) will then replace the signals that should be at these two points. We could take the composite signals past the "Equalization Pulse Rejection Multi-vibrator", but doing so would result in the wrong frequency at the output of the PLL. The reason is that the PLL would try to lock up to the vertical sync

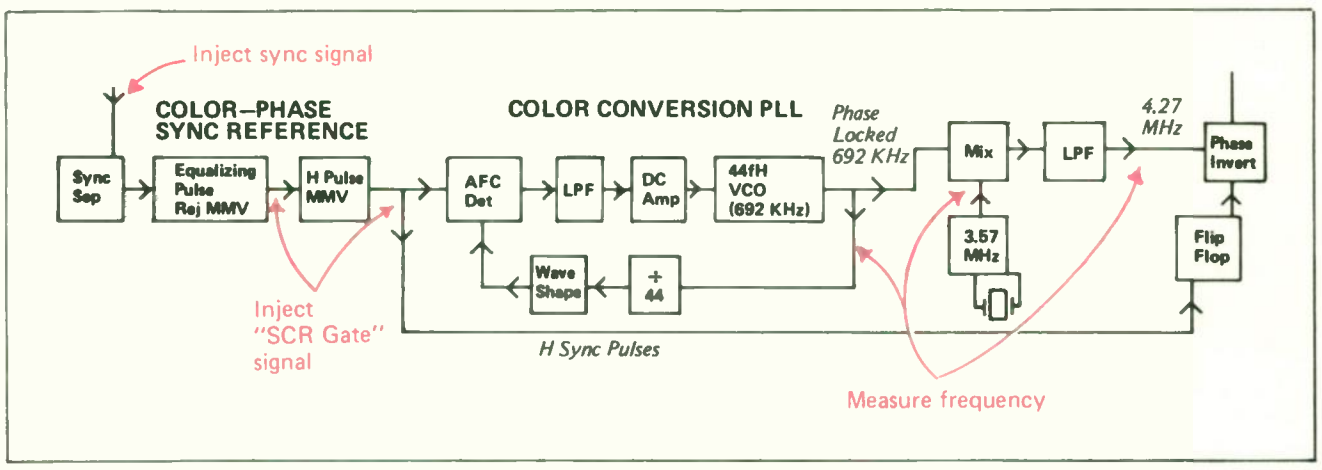


Fig. 40—The signals from the VA48 substitute for those normally found in the frequency conversion stages. A frequency counter is used to measure the resulting output frequencies.

pulse (as well as the horizontal sync pulses) and change frequency during every vertical sync pulse. We need to remember that the function of the "Equalizing Pulse Rejection Multi-vibrator" is to provide a constant pulse rate during the vertical blanking and vertical sync pulse intervals.

We get around this error by using the Horizontal Output (SCR gate) signal for injection after the multi-vibrator stages. This signal works well because it does not contain the vertical sync pulses. It is just a series of pulses that are phase-locked to the horizontal sync pulses. Therefore, it is an exact duplicate of the output of the "Horizontal Pulse MMV" and can be injected directly into the AFC Detector, which is used to keep the PLL output frequency an exact multiple of the horizontal frequency.

The only thing we need to remember when using the drive signals supplied by the VA48 is to supply signals of the same polarity and amplitude as the signals normally found in the circuit. This information, of course, is given on the schematic for the tape deck you are servicing.

The total operation of the PLL is determined by checking the output frequency with a frequency counter such as the Sencore FC45. The PLL output frequency should be exactly 44 times the horizontal sync pulse frequency of 15,734 Hz or 692,307 Hz. If this frequency is not correct, we will find that the tape deck will record and reproduce color but that a color tape that has been recorded on another machine will not play back in color.

If we do not obtain the proper frequency at the output of the PLL, we simply move our frequency counter to the output of the ÷ 44 stage. At this point, we should have the horizontal sync frequency (15,734 Hz). If this stage is dividing properly, the trouble could be in the low-pass filter, or the DC amplifier. The Bias and B+ Sub supply can be connected to the output of these stages to see if the adjustment of the bias voltage changes the frequency of the PLL output. If there is no change in output frequency when the bias voltage is changed, we know the defect is in the Voltage Controlled Oscillator (VCO) and that we have a defective IC. Once again, the use of signal substitution allows us to locate a defect with stage-by-stage analyzing. *As soon as we get the proper output frequency (with a substitute signal injected) we know that our injection point is after the defective stage.* We simply check inputs and outputs until we find the stage that provides no improvement, and that is the one that is defective.

The operation of the remainder of the frequency conversion stages is simply analyzed with our frequency counter or scope. The second conversion frequency oscillator (in the Beta format, that is the 3.57 MHz crystal controlled oscillator) is simply adjusted until we have the proper conversion frequency. The output of the mixer stage is simply measured with our frequency counter, and should provide 4.267918 MHz in the Beta format.

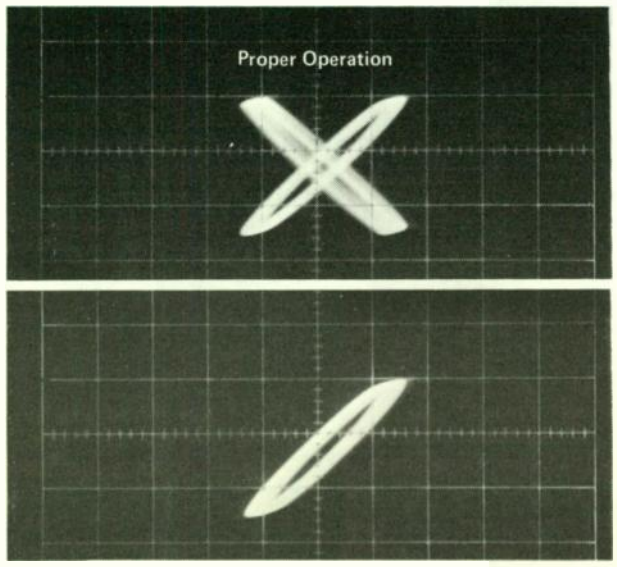


Fig. 41—The vector mode of the PS163 is used to test for proper phase shifting of the chroma conversion frequency.

The use of the vector mode on the PS163 scope allows us to check for proper phase shifts in the frequency conversion stages. All we need to do is connect the "A" channel to the 4.27 MHz signal before it is phase inverted and the "B" channel to the output of the phase inversion stage. The scope waveforms shown in Fig. 41 show what the patterns should look like if the stages are processing the phase properly. If they are not, we will find that we have noisy color, or no color at all on playback.

Converted Color

We have discussed each of the stages up to the color frequency converter, but have not discussed the converted output. The fact that each of the two popular formats uses a different converted chroma frequency means that direct substitution is not practical. The use of the Chroma Bar Sweep pattern, however, allows us to check the resulting frequency response at the output of the color conversion stages to be sure that we are not losing color detail in the converting processes.

An important point is that the patterns produced by an "NTSC" generator do not check the total color bandwidth of the color sub-carrier information. *The actual frequencies occupied by the color subcarrier sidebands are determined by the size of the color information being represented.* Several small colored objects in the picture, for example, will represent a higher color sideband frequency than a large object. The color bars produced by an "NTSC" generator (or by a standard color bar generator) represent only 10 interruptions across the TV screen. This means that the color sideband information is only 188 KHz above and below the color subcarrier. We are, therefore, only certain that the color stages are able to reproduce a color bandwidth of 3.39 to 3.77 MHz or 376 KHz. Remember that the chroma bandpass amplifier of a TV receiver is set to accept all color information from 3.08 to 4.08 MHz or 500 KHz either side of the color subcarrier. *This frequency range determines the amount of color detail that can be reproduced properly on the final TV picture.* The output of the video tape deck should be able to record and play back the same amount of color detail for good color reproduction.

The signals produced by the VA48 Chroma Bar Sweep form a truly dynamic check of the entire color frequency response necessary for a good color picture with color detail in even the smallest objects on the TV screen. The three bars of the Chroma Bar Sweep represent the color subcarrier, and the points 500 KHz above and below the subcarrier frequency. Each of the bars is generated at the same amplitude so they can be used as a reference of the total system's frequency response. We simply use a scope to trace the converted Chroma Bar Sweep through the amplifier stages to make sure that we are not losing some of our color detail during the recording process.

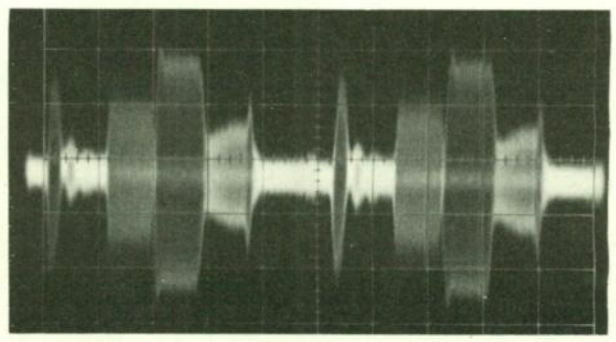
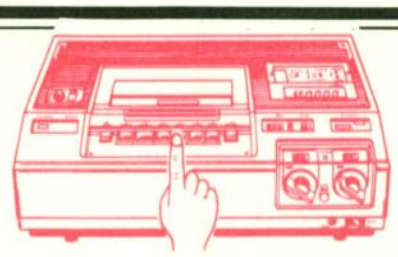


Fig. 42—The Chroma Bar Sweep tests the full chroma bandwidth of the color circuits. An "NTSC" generator only checks a narrow portion of the entire frequency response.

The waveform shown in Fig. 42 shows how these patterns are processed in a properly operating tape deck. Notice that there is a loss of the high frequenoy color detail. The VA48 Chroma Bar Sweep is the only color pattern that actually allows you to see how much high frequency loss is present. The Speed Test Charts in the center of this issue show typical waveforms found in properly operating decks for comparison.

We will see even more important uses of the Chroma Bar Sweep in troubleshooting the playback sections of the tape deck. The key thing we will see is the need to have these signals phase-locked to the horizontal sync pulses for troubleshooting or alignment of the playback comb filters used to eliminate color crosstalk.

Question 6: How are the VA48 signals used for analyzing the playback circuits of a VTR?



The patterns and signals produced by the VA48 provide important checks of the playback portions of the tape deck. We will discuss the most common defect areas (according to the deck manufacturers) and suggested methods of troubleshooting. Before you begin troubleshooting the playback sections, you will need a reference tape. The tape supplied by the deck manufacturer should be used for most of the checks. You will find additional help in recording your own reference tape (using the VA48 patterns) on a deck that is working properly as we discussed in an earlier section. Let's see how we can use our reference tape to supplement the tape that you have purchased from the tape deck manufacturer.

The main advantage of using this tape is the cost is lower than a pre-recorded alignment tape. This means that you can easily record another if the tape is accidentally damaged during the servicing of a unit. And, the Chroma Bar Sweep pattern provides an additional check of the color processing circuits that is not found on the commercially produced tape. Finally, the use of the same patterns for testing the playback circuits, as used for the record circuits, is a benefit for many technicians as they learn to interpret the different patterns. Really, the choice of whether to use the manufacturer's or your own tape is entirely up to you.

Let's say that you decide to use your own reference tape. What tests can we make with it?

Video Frequency Response

The most important test of the playback system is to make sure that the entire system is providing the best possible frequency response. The use of the Bar Sweep pattern will produce a truly dynamic test of the entire system's video response. The only thing we need to do is connect a scope to the output of the tape deck. Remember to terminate this output with a 75 Ohm resistor

to make sure that the signal levels at the output are at the proper amplitude.

The scope waveform shown in Fig. 43a shows the output of a properly operating deck. Notice that the output is flat to the 3 MHz bar, and then drops off at frequencies above this level. If the bars dropped off more quickly (as shown in Fig. 43b) we know that we are losing frequency response somewhere along the line. The first place to suspect is the adjustment of our head equalization circuits that are used to compensate for the nonlinear output of the video heads. The best method of checking this equalization is to use the manufacturer's alignment tape and follow the procedures recommended in the service literature.

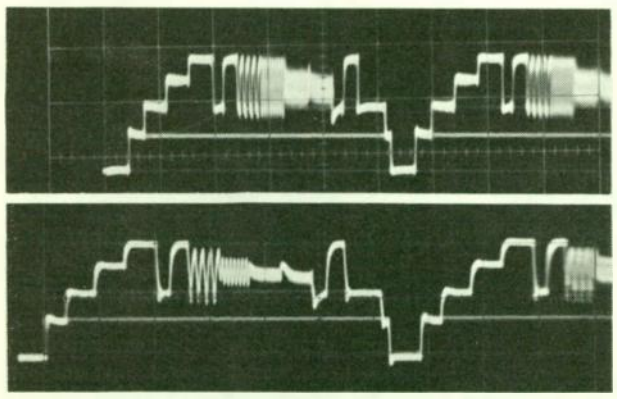


Fig. 43—Playing back the Bar Sweep pattern tests the total frequency response of the playback circuits. a) Properly operating deck; b) Defective head alignment causes a loss of high frequency detail.

The Chroma Bar Sweep provides a check of the chroma frequency response. This test is probably the most important advantage of using the VA48 patterns to record a test tape because there is no other test that is as complete for testing all of the circuits that are used to process the color signals. The Chroma Bar Sweep checks the color circuits at both the upper and lower frequency limits that are necessary for good color detail. The center (3.56 MHz) bar provides a reference level for a comparison of the frequency detail 500 KHz above and below the subcarrier. A key point about all three of the bars produced by the Chroma Bar Sweep is that they are phase-locked back to the horizontal sync pulse and have a 180° phase shift every horizontal line. This means that they will be properly separated by the comb filters used to cancel color crosstalk during the playback mode of operation. This is a test that is not found in the "NTSC" color pattern as we mentioned earlier, but is very important for good color detail.

Setting the comb filter used in the playback portion of the color circuits is easy to do as long as you are using a scope with good vertical sensitivity such as the Sencore PS163 Dual Trace Oscilloscope. The PS163 has 5 mV sensitivity when used with a direct probe. Most competitive scopes have half this sensitivity (10 mV). Start by using a direct probe to connect the scope to the output of the comb filter bridge that *is not* connected to the chroma amplifiers. This output point will show the crosstalk rather than the chroma output. The signal at this point does not have sync pulses, so the external trigger input should be connected to the video output jack for triggering. Simply set the scope to trigger at the horizontal rate. The PS163's built-in sync separators will provide a stable trace with the composite video signal used as a reference.

Now, simply play back the portion of your alignment tape that has the Chroma Bar Sweep pattern. Adjust the comb filter's mixer control until the amplitude of the signal has the least amount of the second (3.56 MHz) bar as shown in Fig. 44. Be sure to use a direct scope probe and have the scope set for maximum sensitivity as the signal level is very low at this point. The two phasing coils used in the comb filter of the VHS tape decks should be left in the factory-aligned positions as they require at least $6,000 worth of additional equipment to set. The RCA service literature, for example, does give a procedure for setting these coils, but calls for the use of a broadcast vectorscope. You should note that *this is not a standard service scope with vector inputs*, but rather a unit that has special demodulator circuits which detect the two chroma subcarriers (I & Q), the luminance (Y), and three color signals (R, B, and G) to produce the vector pattern. The cost of this instrument is so high (and only used for this one adjustment in a VHS deck) that it is advisable to not attempt to make adjustments to these coils. Most manufacturer's service literature give this same warning.

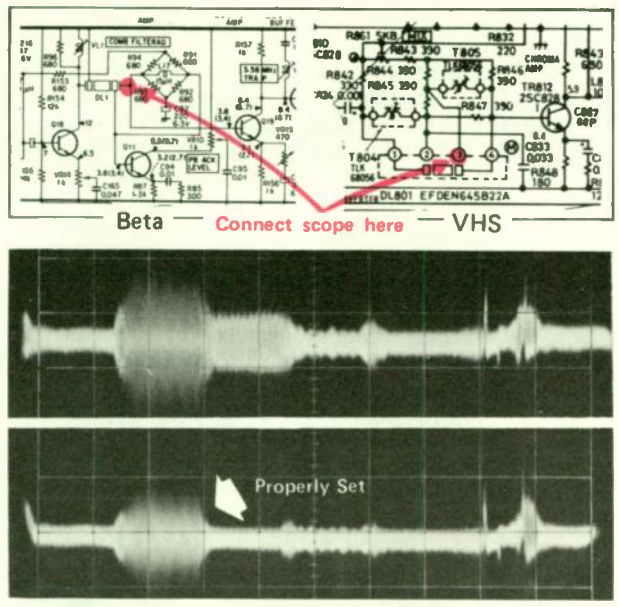


Fig. 44—The Chroma Bar Sweep allows the comb filter found in the playback circuits to be adjusted for best crosstalk rejection faster than with the "NTSC" signal which requires a special scope for adjustment.

Locating Video Head Problems

Video tape technicians report that one of the most difficult stages to analyze is the low-level input circuits associated with the video playback heads. The reason for this difficulty is that the signal levels produced by the spinning playback heads are so low that an oscilloscope will not prove effective in tracing a signal. The symptom for a defective head is the same as a dirty switch contact, a bad rotary transformer, or a defective head pre-amp. We really need a method of determining which of these components in our low-level head signal circuit is the actual cause of the defect.

The symptom for a defective head circuit is easy to recognize. The picture (on playback) has a severe flicker and is very noisy. The cause of this symptom is that only every other video field is reaching our TV set. The two-head system, as you will recall, uses one of the heads to pick up every odd field and the other head to pick up every even field. When one of the signal paths is defective, we have one complete field followed by a period of noise information. The result, in our interlaced picture, is the symptom we described.

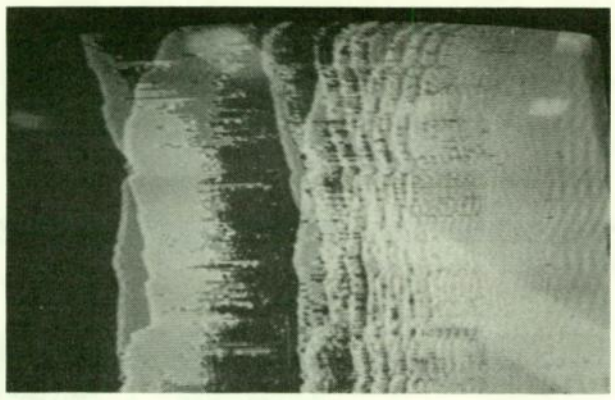


Fig. 45—A defective video head or preamp causes severe video noise because every other video field is missing.

Each of the two video heads has its own rotary transformer which transfers the signal from the head output to the preamplifier. This rotary transformer is simply made up of two coils, one that is part of the moving head disk, and the other that is part of the stationary portion of the video head assembly. As the video head picks up the signal from the tape, it is inductively coupled to the stationary coil by the moving coil. This eliminates the need for slip rings or brushes that could cause intermittent operation as they wear.

The signal that is picked up by the stationary portion of the rotary transformer is passed to the head preamplifiers. There are two of these preamplifiers, one for each head. Each preamplifier has a set of adjustments which allows any differences in the frequency response of the two heads to be compensated. The signal level at the input to these preamplifiers is in the neighborhood of 1 mV. This low signal level means that there are several points in the video head system that can cause trouble.

The first possible cause of a defect is the video head itself. If the head wears too much, its output level will drop. The second possible defect is the rotary transformer. A broken wire leading to the moving coil of the rotary transformer, for example, would mean that one of the two head signals would never reach the proper preamp. The next circuit component is a switch that is used to switch the heads between the record and playback circuits. A dirty contact here will result in the loss of the signal from one of the heads. Finally, we have the possibility of a defect in the preamps themselves.

What we really need is a signal that can be injected at any point in this low level signal path. This signal should be the proper frequency to pass through the tuned head preamp circuits just as though it was being picked up by the spinning head. The amplitude of our substitute signal must be low enough to duplicate the signals normally found in these stages. If we supply too much signal, we will find that there is so much cross-coupling from one head channel to the other that we cannot really tell if we have found the defective stage.

The VA48 provides a signal that is just suited for this type of signal substitution. The signal is the one that is normally used for troubleshooting the audio IF stages of a TV or VTR receiver section. This signal is adjustable in amplitude and uses a 4.5 MHz carrier frequency. The use of a simple 100:1 (40 dB) attenuator drops the level of this signal to the 1 mV level needed to troubleshoot the first stages of the playback circuits. The best place to look for the signal output is at the output of the resistive matrix that is used to mix the output of the two video heads.

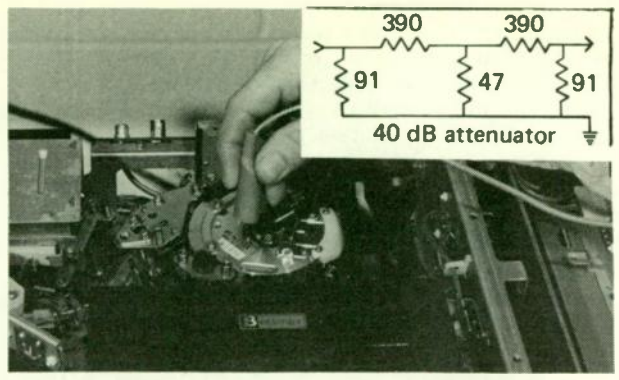


Fig. 46—The 4.5 MHz sound signal provides a signal for direct substitution of the video head output. Notice the use of an attenuator to reduce the signal level.

It should be noted that an electronic switch is used to switch between the "A" head output and the "B" head output during playback. This switch is normally switched by a pulse that comes from the servo circuits. When you are using the substitute signal to analyze the video head input circuits, simply connect your Bias and B+ sub supply in place of the head switching pulse. When you supply the bias signal, the electronic switch will switch over to one of the head amps, and when the bias is removed it will switch to the other preamp.

The reason that the ability to analyze the head input circuits is so important is that the video head disk (which

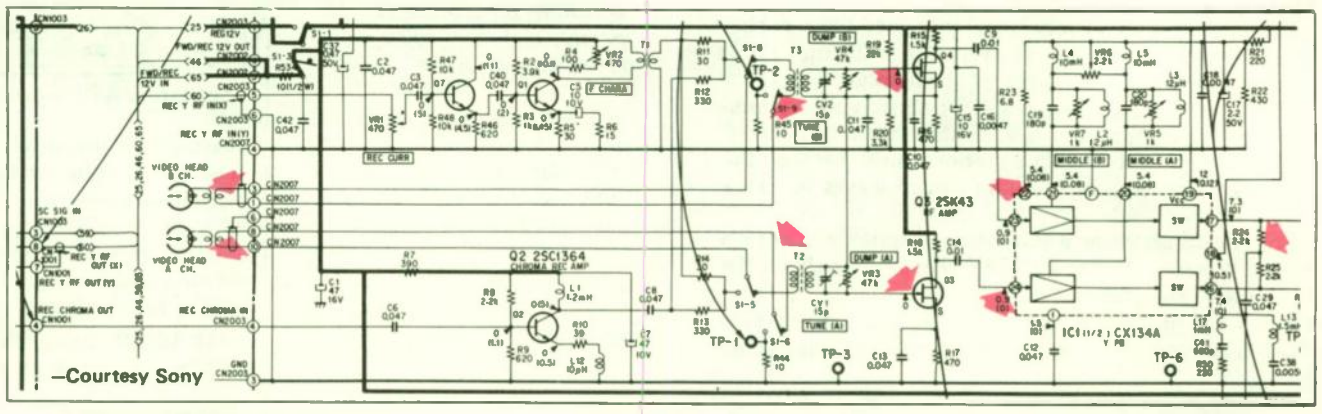


Fig. 47—The 4.5 MHz signal may be injected at any of these points for analyzing the video input circuits and dropout compensator.

contains both of the video heads) is one of the single most costly parts to replace in the tape deck. We learned this lesson in our Field Engineering Lab when we were servicing one of the 35 video tape decks used by our technical sales people across the country. The symptom was that one of the video head outputs would stop from time to time. The symptom, as we mentioned, was a severe flickering and increase in the noise content of our picture. We finally concluded that we had a defective head and were about to change it when we tried the signal substitution method we just discussed. We quickly located a dirty switch contact as the actual cause of the defect. Changing the switch corrected our problem, and saved us from replacing an expensive head disk that was really not defective.

The same output signal used to troubleshoot the head preamps is also used (without the attenuator) to troubleshoot the drop-out compensator circuit. All we need to do here is supply a signal at the input to the DOC detector and look at the output of the DOC circuit with our scope. This circuit is designed to switch to the delay line output (see the first section of this article for details about the operation of the DOC) any time our signal level coming from the video heads drops to a certain level.

When we inject our 4.5 MHz signal, the DOC detector should switch the signal around the delay line. When the signal level drops below the detector trigger level, the circuit should switch back to the delay line. Since we are no longer feeding a signal into the delay line, the output quickly drops to zero.

The DOC trigger circuit is tested by increasing the RF-IF control to full output and then reducing the signal level. When the level control is at about .1 (10 mV) the output signal should suddenly disappear. Increasing the signal level should then return our output. If our DOC circuit is not operating properly, we should use a DC voltmeter to check the output of the DOC detector. The detector should provide a DC voltage to control the switching circuits inside the IC. If we see this voltage change as we change our signal level at the input, we know that the detector is working properly and the defect is in the switching circuits. If the voltage does not change, we know that the defect is in the detector itself.

The delay line is also checked by simply feeding our 4.5 MHz signal to its input and checking for an output.

One other playback circuit that is tested with the adjustable 4.5 MHz signal is the limiter circuit. The function of the limiter is to compensate for changing levels in our playback signal so our FM demodulator always has enough signal to operate properly. All we do to test the limiters action is to feed our 4.5 MHz signal into the limiter input and look at the output level. The output level should remain almost the same over the full range of the input signal. If we have a defective limiter, we will have a playback signal that varies in detail and noise content.

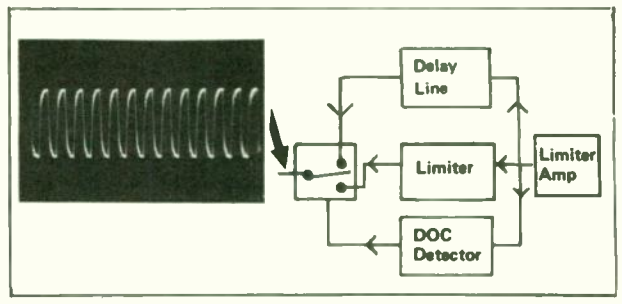


Fig. 48—The limiter output should remain about the same with different input signal levels.

The color processing circuits in the playback stages are treated the same as those found in the recording circuits. In fact, the same circuits are often used for both record and playback. The use of the Bias and B+ sub output is the best way to check any of our automatic circuits as we substitute for the feedback voltage and see if we get a change in the condition we are trying to correct. One thing to remember as we substitute for signals in the playback circuits is that the signals supplied by the VA48 are no longer phase-locked to the signals on the tape. This does not prevent our using the substitute signals; however, because we can simply inject at the input to a circuit, such as the playback frequency conversion phase-locked-loop, and then look at the resulting output to see if the signals are being processed properly.

Question 7: Just how long will it take for the VA48 to pay for itself in VTR servicing?

The actual amount of time necessary to repay an investment in new equipment for VTR service will, of course, be different for different shops. The variables involved include how much equipment you will need, what your profits per repair actually are, and how many units per day you are servicing. We will use some general figures to show how quickly the investment can be paid back. Then, you can place your own figures in the enclosed table to find out your actual amount of time before the investment is repaid.

Let's start by listing 4 new pieces of equipment you may need for your VTR service bench. These are the VA48, the PS163 Dual Trace Scope, the FC45 Frequency Counter, and the PR50 Audio Prescaler. The total list price for these 4 pieces of equipment is $2,443.00. Now, let's estimate the amount of profit per VTR repair at $35.00. Simply dividing the price of the equipment by the income per repair tells us that it will take only 70 VTR repairs to totally pay for your investment in equipment. If we further estimate that we service only 3 machines per day we see that the total investment is paid back in only 23 working days. From that time on, each additional VTR serviced becomes pure profit because the test equipment is now paid for. The equipment should also be written off your taxes over a 4-year period to reduce your actual investment even more.

Are you beginning to see how quickly the VA48 will pay for itself by simplifying your VTR servicing? But, what if your VTR customer base is just starting to grow? What if you are not getting those 3 units a day we estimated for service yet? The VA48 is the only analyzer designed for VTR service that is also a complete TV analyzer. The VA48 makes all tape decks *and* TV sets look alike for streamlined servicing. You can use your VA48 for both TV and VTR service now, and, as your VTR business increases, all you need to do is purchase a second VA48 for your VTR bench. That makes the VA48 a "double-protected" investment as it serves double duty in your shop whether your main market is TV service or VTR service. Let's review the key advantages of the VA48 for TV service.

1. The VA48 supplies every signal you need for servicing tube, transistor, or IC TV receivers. It is the only completely up-to-date TV analyzer on the market.
2. The patented Bar Sweep signals allow you to completely check or align any TV IF stage without a sweep and marker generator with superior results because the Bar Sweep uses true modulation square waves to check for ringing.
3. The VA48 serves as a tuner sub to quickly tie down tuner problems. It has all VHF channels to check the operation of the tuner, too.
4. The VA48 provides all crystal-controlled trap frequencies that let you check or align traps without pulling the chassis.
5. All signals are phase-locked to a master oscillator so you know immediately that you have located a defective stage.
6. The patented Ringer test provides the most accurate "good/bad" test of yokes and flybacks available.
7. All color setups, including the color oscillator adjustment, the drive and screen controls, and the color killer are set by simply watching the screen of the CRT with truly dynamic signals.
8. All signals are available through only 2 output leads (compared to 60 for competitive units) to save servicing time on every service job.
9. The built-in peak-to-peak reading meter monitors your output level of your substitute drive signals to prevent damaging expensive solid-state devices. And, this same meter lets you signal trace through stages faster than with an oscilloscope.
10. The VA48 includes a Bias and B+ Sub adjustable, 1 Amp, highly-regulated power supply to help you tie down those tricky automatic feedback circuits in seconds. And, this supply is essential for working on the new TV receivers that use the horizontal output transformer to power the entire set.

We hope you see why we say, "The VA48 is the most complete, up-to-date analyzer for both VTR and TV servicing". If you agree, just contact your closest Sencore distributor (listed in the centerfold of this issue).

VA48 COST ANALYSIS

	Example	Your Figures
1. Equipment Cost	$2443	
2. Estimated Labor/Repairs	$35	
Divide Line 1 by Line 2 3. No. of Repairs to Pay for Equipment	70	
4. Ave. No. of Repairs per Day	3	
Divide Line 3 by Line 4 5. No. of Working Days to Pay for equipment	23	

Business Promotion Layout and "Ad Mat"

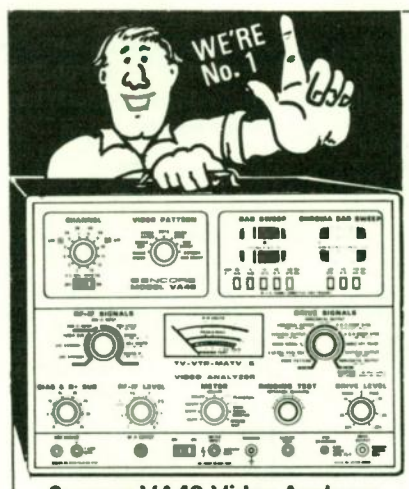
Here is a layout that you can use to promote your business with your VA48. Customers want to be sure they are taking their TV or video tape recorder to a shop that has the latest, most modern equipment. Why not sell your services by:

a. Cutting out the layout and having it run off on low-cost offset colored paper stock.

b. Adding an additional message and running this advertisement on an 8½" x 11" low-cost offset handout or mailing piece.

c. Having your printer blow this artwork up and putting it in your window.

d. Cutting out this piece and pasting up your own low-cost ad.



Sencore VA48 Video Analyzer

We are excited as we can be because we can now serve you better.

We are now equipped to service your B & W TV, color TV, closed circuit system, and even new video tape recorder, faster and more accurately than ever before.

We have recently purchased the Sencore VA48 Video Analyzer. This revolutionary new test instrument enables us to walk troubles out of any circuit, including the very latest integrated circuits, step by step. What's more, we can now check your alignment, touch it up if necessary, or completely align any and all sections of a color TV in a fraction of the time it took us with old-fashioned sweep and marker generators. The VA48 uses a newly-created and patented Bar Sweep system that simulates the TV station signal, but places all the segments of the signal at our fingertips for maximum troubleshooting capability.

Much more goes into a service job than just labor. There are years of training, constant updating at service seminars, the cost of modern, streamlined instruments, such as the VA48 analyzer, travel costs, phone, rent, clerical help, etc. We bought the VA48 so we would be the most updated shop in your area. Why not give us a try if your TV or video system isn't working just right?

FREE TOUCH-UP ALIGNMENT: To show you just how little time it takes to touch up TV alignment, we will touch up alignment on your TV, free of charge, for the next 30 days.

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You can be sure more times in more circuits in more places

than with any other multimeters on the market today

Each Sencore DVM is backed with 15 Megohm input impedance for one third less circuit loading on every measurement. That means 50% higher accuracy than other DVMs. Every one is built tough inside and out with burnout-proof and break-proof protection. Make your choice from these pocket portables to the "prime" .1% standards.

DVM37 — $268

3½ DIGIT .1% DCV ACCURACY PORTABLE DVM

Prime standard .1% accuracy on the bench or in the field for less than $270. The DVM37 is the most accurate portable DVM you can buy, with 15 Megohm input impedance for 50% more accuracy. Includes automatic features—Auto Zero, Polarity, Decimal, Overrange. Exclusive spark-gap protected to 8000 Volt transient overload on every range, including Ohms. It's virtually burnout-proof! Full ranges for every test. Fingertip "Push-On" switch in probe saves batteries as power is applied only when needed.

Ranges: 0-2000 VDC in 4 ranges. 0-1000 VAC in 4 ranges. 0-2000 mA AC and DC in 5 ranges. 0-20 Megohm resistance in 6 Hi and Lo ranges. Accuracy: .1% DCV, .5% ACV, .3% DCC, 1% ACC, .2% Ohms. Protection: 2000V on all functions and ranges. Drop-proof Cycolac case. Probe attached. Power: 4 "C" cells. Size: 7" x 5" x 4". Weight: 2¼ lb.

DVM32 — $225

3½ DIGIT .5% DCV ACCURACY PORTABLE DIGITAL MULTIMETER

Bench and field master for digital accuracy measurements anywhere. 0.5% DCV accuracy, backed with 15 Megohm input impedance. Exclusive battery-saving Auto-Display turns the display on automatically when you make a measurement. 2000V input protection on all functions and ranges—including Ohms.

Ranges: 0 to 2000 VDC in 4 ranges. 0-1000 VAC in 4 ranges. 0 to 20 Megohms in 6 ranges with both Hi and Lo Power. 0 to 2000 mA DC and AC current in 4 ranges. Accuracy: 0.5% DCV; 1.5% ACV; 1% resistance; 1% DC current; 1.5% ACC. Power: 4 1½ V "C" cells. Size: 7" x 5" x 4". Weight: 2¾ lbs. Test leads included.

Optional accessories available for all Sencore Digital Multimeters: HP200 50KV High Voltage Probe—$25.00, PA208 AC Power Adapter (replaces PA202 previously used with DVM35, DVM36, and 39G90 Adapter used with DVM37, DVM32)—$9.95.

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3½ DIGIT .1% DCV ACCURACY AUTO-RANGING DVM

A "prime" standard at your fingertips for measurements you can trust. Auto-ranging for extended low-level range and ease of operation. 15 Megohm input impedance assures .1% reading accuracy is maintained in solid state circuits. Highly sensitive, yet fully protected to 2000 VDC overloads. Hi-Lo Power Ohms circuit simplifies in-circuit resistance measurements.

Ranges: 0 to 2000 VDC in 4 ranges. 0 to 1000 VAC in 4 ranges. 0 to 20 Megohms in 7 ranges with both Hi and Lo Power. 0 to 2000 mA DC or AC current in 5 ranges. Accuracy: 0.1% DCV, 0.5% ACV, .3% DCC, 1% ACC. Power: 105-130 VAC, 50/60 Hz, 7W. Size: 5½" x 7¼" x 9". Weight: 6½ lbs. Test leads included.

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3 DIGIT 1% DCV ACCURACY POCKET PORTABLE DVM

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Ranges: 0-1000 V DC or AC in 4 ranges. 2000 VDC using "DCV x 2" button in probe. 0-1000 mA AC/DC in 4 ranges. 0-10 Megohm in 6 ranges (Hi and Lo Power). Accuracy: 1% DCV, 1.5% ACV, 2% ACC/DCC. Protection: 1000 V on all functions and ranges. Drop-proof Cycolac case. Probe included. Uses 6 1½ Volt AA cells. Size: 4" x 6" x 1¼". Weight: 1.1 lb.

DVM36 — $158

3½ DIGIT .5% DCV ACCURACY POCKET PORTABLE DVM

Pocket portable lab accurate performance that fits every budget with highest performance-to-price benefits of any meter..5% DCV accuracy, backed with 15 Megohm input impedance for lowest circuit loading. Full protection to 1000 V on all functions and ranges—including ohms. Drop-proof case. Battery-saving "Push On" button in probe.

Ranges: 0-1000 VDC or AC in 4 ranges. 2000 mA AC/DC in 4 ranges. 0-20 Megohm in 6 ranges. (Hi and Lo Power Ranges). Accuracy: .5% DCV, 1% ACV, 1.5% ACC/DCC. Protection: 1000 V on all functions and ranges. Drop-proof Cycolac case. Probe included. Uses 6 1½ Volt AA cells for power. Size: 4" x 6" x 1¼". Weight: 1.1 lb.

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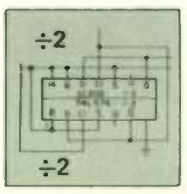
(and 600 MHz, too, with PR47 Prescaler)
- 1 Part per million accuracy
- At high 25 milliVolt sensitivity

New FC45 230 MHz Frequency Counter

The Frequency Counter is being used in nearly every phase of electronics today and a shop or lab will become old-fashioned pretty fast without one. You'll want two things when you buy your frequency counter though, accuracy within a reasonable time after you turn the counter on and freedom from interference. The FC45 is one of the only counters on the market that uses a temperature compensated crystal controlled oven to stabilize accuracy within a short time after turning it on and to maintain that accuracy during use. The FC45 is the only frequency counter that we know of that is interference free and will operate right next to a high wattage transmitter or next to a TV high voltage cage without the jump of a number. That's because it is one of the only frequency counters on the market with an all-metal case to act as a second shield.

$448

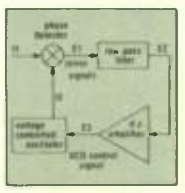
...to meet FCC standards in communication equipment repair.



...to quickly locate improper counting in new digital circuits.

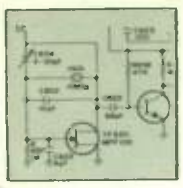
...to repair audio equipment such as electronic organs and musical instruments.

...to document radio and TV broadcast frequencies.

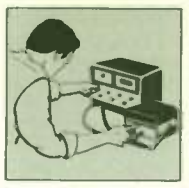


...to tie down defects in PLL feedback circuits.

...to check digital horizontal & vertical oscillators & varactor frequency control circuits on new TV sets.



...to speed up clock & electronic timer analyzing



...to calibrate generators and check oscillators.

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... and hundreds of new technology circuits coming your way

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FACTS

You've Always Wanted to Know About

COLOR TV ALIGNMENT

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FEATURING THE

SM158 Speed Aligner

FAST!

SM152 Sweep and Marker Generator

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See back cover for FREE offer

12 Most Frequently Asked questions about Sweep Alignment.

Jim Smith

Norm Pedersen

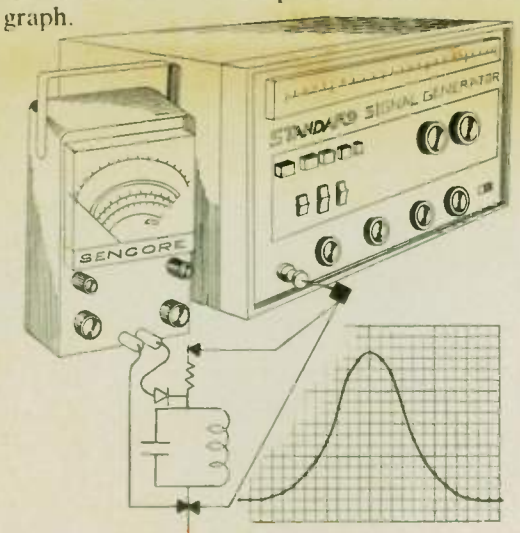
The SENCORE Field Engineering department has been conducting sweep alignment workshops for over two and one-half years. A considerable background has been gained from these seminars and from the work with TV manufacturers in preparation for the meetings.

This issue of the SENCORE NEWS deals with the most frequently asked questions about alignment and alignment equipment at our seminars. We feel that we may be able to answer some of the questions you may have and help you to better understand receiver alignment. We would also encourage you to try your choice of SENCORE Sweep/Marker generators and make your purchase during our Special Offer.

1 WHAT IS A SWEEP GENERATOR AND WHERE DO YOU USE IT?

You have heard many times that the sweep generator is a necessary tool in television servicing but may not know exactly what a sweep generator is and how it is used in your daily work. Let's cover the fundamentals of the sweep generator so that we can better understand how it is used to make your servicing easier and faster.

Let's use a simple tuned circuit. We can connect an RF generator with a constant output to the circuit, a volt meter with a detector probe across the coil and measure the frequency that the coil will respond to or its frequency response. By starting at a low RF frequency and slowly turning the frequency dial of the RF generator in small steps and recording the resultant DC voltage on a graph as shown, we can plot out a response curve of the tuned circuit. We can determine the exact frequency of resonance and the bandpass of the curve from this graph.

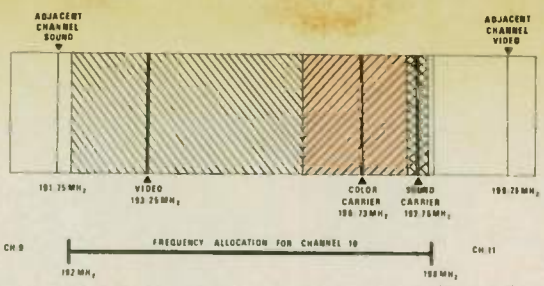


Response check of simple tuned circuit and response curve obtained.

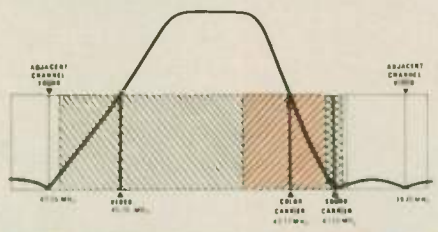
If each tuned circuit that we encountered during TV alignment had to be plotted in similar fashion, it would be a very time consuming task. The graph would have to be replotted each and every time that a simple coil tuning adjustment was made. Were this procedure used to attempt alignment of the many coils in a television IF strip, the job would take at least several hours and possibly days.

A simpler means of obtaining the response graph must be used to make alignment practical. The oscilloscope can be used to exhibit the graphic response curve if the frequency of the generator is varied at a rapid rate. This rate however is faster than can be done manually and therefore some electronic method must be used to change the RF generator frequency over the desired frequency band. This is the basic concept of modern sweep generators. The common rate of change is 60 times a second. This is readily available from the AC line and has been accepted as the standard sweep rate. 60 Hertz is also the frequency used in both Sencore sweep generators.

We have talked about the method of viewing the response of one tuned circuit but more than one tuned circuit is used in television receivers to obtain the necessary bandwidth to pass all the video and color information that is transmitted. Here is a graph of frequencies that are transmitted from the television station that we must amplify.



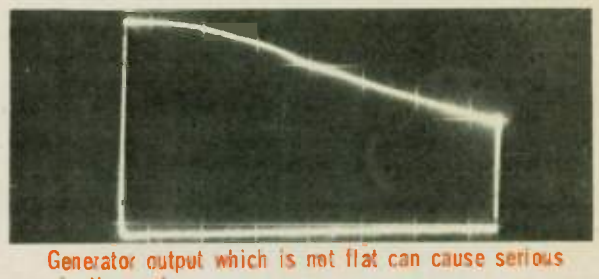
If we take three of the single tuned coils and gang them together so that the resultant addition of curves gives us the desired bandwidth then add amplification, we have an IF strip of today's color receiver. Here is an ideal IF sweep curve as it is found in today's television receiver. Note the signals and their relations to the curve.



Comparison of ideal response curve and I.F. frequency spectrum.

Only with a sweep generator can the shape and bandwidth of the curve be seen and conveniently adjusted to conform to this shape.

As we mentioned earlier when plotting the curve of the single tuned circuit, we had an RF generator with a constant output level. This must also be true of the sweep generator if it is to give a true representation of the curve that is formed by the three tuned circuits. The output level of the sweep signal must be flat. If it has peaks or valleys, then you will align the coils to compensate for the peak or valleys of the generator, making the alignment incorrect.



Generator output which is not flat can cause serious misalignment.

You can check a generator output for flatness by simply feeding the output of the RF cable into a demodulator probe and then into a scope. A flat output will look like two parallel lines in the scope screen. Any peaks or valleys indicate an output that is not flat, and this condition will give you incorrect alignment.

Careful design of Sencore generators assures flat sweep output.

Many hours were spent in the Sencore engineering department to make certain the output of the SM152 and SM158 sweep/marker generators is flat. Only with generators employing this careful design can you obtain consistent and accurate alignment results.

The sweep generator is used in television alignment of the tuner, IF and chroma stages. It is used to check and align both RF and IF stages in FM. The sweep generator is also often used to check antenna distribution systems for flat response across the RF band.

Troubleshooting is also a very important role played by the sweep generator in the service shop. The sweep generator is really the only practical way to isolate problems in any tuned circuit as it shows both gain and bandwidth of each amplifier. The IF amplifiers of a receiver are one of the more difficult sections to troubleshoot simply because gain alone is no criteria. Injecting a sweep signal into these stages and observing the output at the video detector will prove to be an effective shortcut for finding IF troubles. The same procedure can be used to quickly find problems in the RF and chroma circuits.

2 WHAT FREQUENCIES SHOULD BE COVERED BY THE SWEEP GENERATOR?

The right frequency coverage of the sweep generator is very important if it is to do the job for you. The following are the most commonly used frequencies that should be available on a sweep generator.

STANDARD 40 MHz IF: The generator should be able to cover the standard 40 MHz IF frequencies from 36 to 51 MHz with a very flat output. This is the band of frequencies needed for alignment of television receivers. Both Sencore Generators provide this coverage.

SPOT ALIGNMENT: This becomes a very important feature when you encounter a set which has been severely misaligned. Actually, it is simply an RF generator without any sweep covering the IF band of frequencies. It is used to preset or "peak" the IF transformers as a preliminary step in overall alignment on some receivers. This takes much of the guesswork out of aligning the difficult sets.

Preliminary adjustments are simplified with SM152 spot align band.

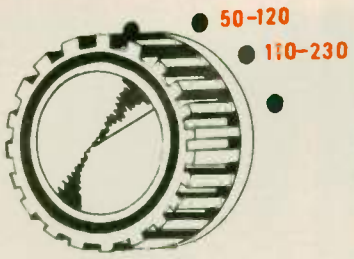
The Spot Align band eliminates the need for a separate RF generator to peak the IF transformers. This is an exclusive feature found only on the Sencore SM152 deluxe sweep and marker generator.

CHROMA THROUGH THE IF: (VSM) This is a must for alignment of the chroma bandpass amplifiers as recommended by major set manufacturers today. This signal is a 45.75 MHz crystal controlled Video carrier with a 42.17 MHz swept signal added. When the signal is passed through the IF stages, it mixes at the video detector and produces a 3.58 MHz swept chroma signal. This assures accurate chroma alignment on a color receiver as the entire IF chroma response is observed. This important feature is available on both Sencore generators.

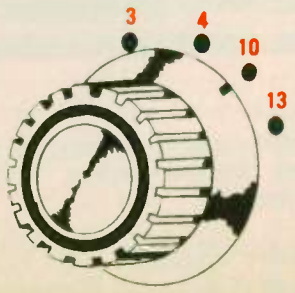
CHROMA SWEEP: This is a 3.58 MHz swept signal that is used to troubleshoot and align the chroma bandpass amplifiers as recommended by some of the set manufacturers. It can also be used to check the video amplifiers of the receiver as a troubleshooting aid to determine poor high frequency performance.

This is one more feature of the SM152 that makes it the most complete generator on the market today.

VHF - RF SWEEP: These are the standard TV channel frequencies used to make an overall alignment check and are also used in tuner repair and alignment. Only the Sencore SM152 and the RCA equipment covers all VHF channels, channel 2 all the way to channel 13 for a complete check of the tuner.

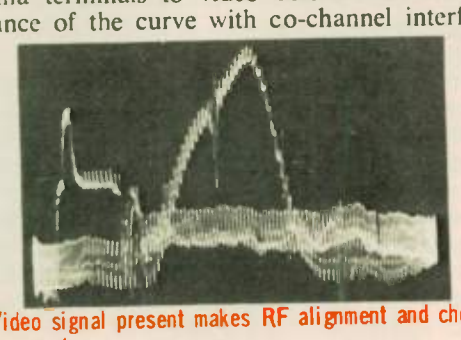


The Sencore SM158 Speed Aligner provides four VHF channels, two high and two low, for RF/IF overall checks.



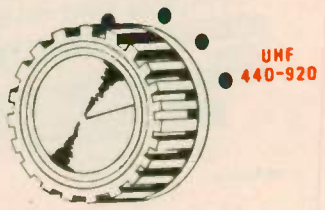
Other generators available today either have no RF sweep provisions or supply only 2 channels of sweep signal. The lower cost mixing system used on these generators does not allow all channel coverage like the SM152. Extra beats and spurious signals appear on some channels making the output signal useless. This is why these generators are limited in their RF coverage. The Sencore sweep/marker generators on the SM152 uses fundamental frequencies for all channels, providing an answer for complete tuner alignment.

We call the SM158 a speed aligner because it does the job fast but not as complete as the SM152. Two extra RF channels are provided over other "speed aligner types" because TV reception on a channel being aligned can cause some alarming things; especially when taking a quick overall check from antenna terminals to video detector. Note the appearance of the curve with co-channel interference.



Video signal present makes RF alignment and checking rough.

UHF-RF SWEEP: This is a must for a complete check on today's receivers. A sweep generator without this feature is not complete as the UHF tuner should be checked to see that it operates properly before the receiver is returned to the customer. This is a general check to see if the tuner functions correctly and that there is no great suck out or loss of signal on the channels present in your area.



Only the Sencore SM152 has this feature.

FM - RF SWEEP: For complete FM alignment and checking, coverage of the FM RF frequencies is necessary. A sweep signal should be available so that the signal can be injected into the antenna terminals and the response curve viewed for an overall performance check. The Sencore SM152 gives you complete coverage of this important band of frequencies for FM.

FM - IF SWEEP: A crystal controlled signal as well as a sweep signal should be available for a complete alignment of the FM receiver. Some manufacturers suggest the use of a 10.7 MHz crystal controlled CW signal while others recommend that a sweep signal be used in the alignment of the FM IF. For proper FM coverage, the generator should have both signals. The Sencore SM152 does.

21 MHz IF SWEEP: Older receivers and several Japanese imports use this IF frequency.

IMPORT SETS USING 21MHZ I.F. FREQUENCIES		
Delmonico/Nivico	Model	PTV-19T 4T-20V 5T-30V 4T-40 VPF-96 VPF-105 9T-14AEM
Sanyo	Model	16-PS2
Sony	Model	TVS-303W TV8-301W TV9-304W TV-304W

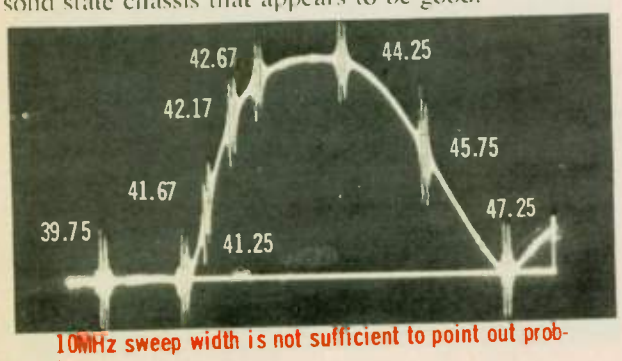
The chart above shows some of the Import sets that use the 21 MHzIF system. If you are going to service any import TV receiver, you will have to use the SM152 as it is the only generator with these IF frequencies (including the latest sweep and marker coming in from Japan).

Complete coverage of SM152 includes 21MHz IF frequencies.

3 WHAT SWEEP WIDTH IS NEEDED AND HOW DO WE DETERMINE ZERO REFERENCE?

f ? ? ? ? f

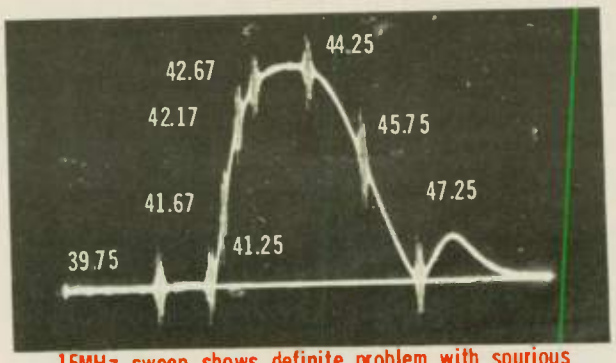
An important specification of any sweep generator is the sweep width. This determines the range of frequencies covered above and below the center frequency. If you refer back to the typical response curve and the associated signals, you will see that the generator must have at least 7.5 MHz sweep width to observe all of the response. The sweep width must be greater than 7.5 MHz if we wish to see beyond the adjacent signal traps to be sure that they are aligned correctly. Many coils can be mis-tuned and produce spurious response outside of the normal IF bandpass. This will lead to problems. Therefore, you should have capabilities of sufficient sweep width to see well beyond the normal IF response. Here is a curve of a late model Zenith solid state chassis that appears to be good.



10MHz sweep width is not sufficient to point out problems.

The sweep width used to exhibit this curve is 10 MHz so that we can see beyond the traps to be sure they are in proper adjustment. If you only used 10 MHz sweep width to view this curve you would probably expect the set to operate properly. But let us look further.

If we look at the same Zenith chassis and increase the sweep width to 15 MHz, we now see a new hump on the response curve past the 47.25 MHz trap where there theoretically should be no gain. If it is placed on a cable system or in a noisy area, you will have all kinds of difficulty with the picture.

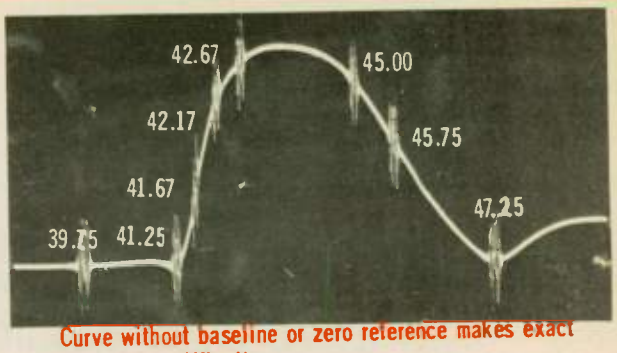


15MHz sweep shows definite problem with spurious response outside normal curve limits.

This is an indication of a misaligned IF and would be by-passed if the sweep generator did not have sufficient sweep width to allow you to see past the skirts and traps on the response curve. In this case, the mixer coil had been misadjusted, increasing the bandwidth of the link circuit beyond that needed for proper TV reception. The Sencore generators have been designed to provide a full 15 MHz sweep width. This allows you to achieve more accurate alignment results and more satisfied customers.

This same problem can also go unnoticed if there is no baseline to tell you that you have gain at a point where you should have none. Here, we have removed the baseline on the same receiver so you can see the difference.

This has been done to emphasize how difficult it is to check trap positions and maintain zero gain beyond the skirts of the curve without some form of reference. The zero baseline provided by Sencore generators give you a constant zero reference for easier, more accurate alignment.



Curve without baseline or zero reference makes exact trap setting difficult.

Here is an alignment curve taken from the Zenith Service manual. Note that the position of markers are referenced to the baseline in percentage. Positioning of the markers becomes easy with a reference. Judging where the markers should fall becomes a guess and a misalignment can occur if you remove the reference. Essentially every TV manufacturer uses the baseline as a reference to position the markers on their response curve. This is why both Sencore generators use a baseline. The sawtooth sweep used on most other generators does not produce a baseline, nor can it be added to the system.

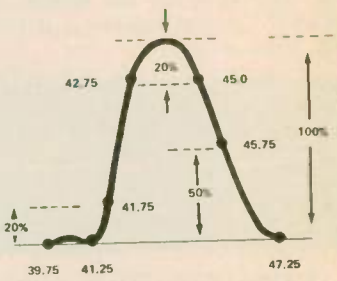


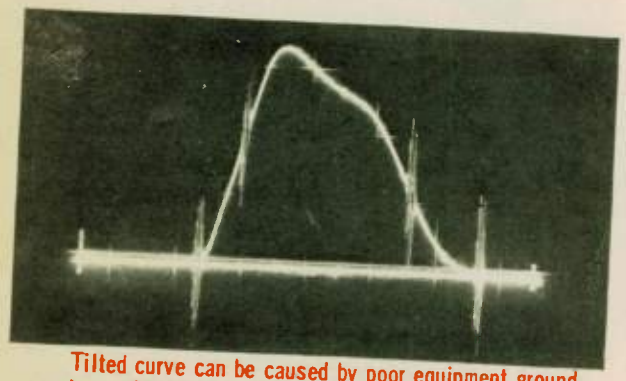
Figure 10—Overall Response Curve, Taken at Test Point C1.

Another important point, which often goes unmentioned by many test equipment manufacturers is the linearity of the sweep signal (moves from left to right at a constant speed). If the sweep is non-linear, the curve will be compressed and distorted on one side. This can be confused with an improper alignment curve. Sencore sweep generators have an ultra-linear sweep to eliminate this type of problem as a sinewave is used on both scope and sweep thus moving both at the same exact speed at all times; the result is a 100 percent linear action.

8 TYING DOWN THE AGC

In all alignment procedures, the AGC line is always tied down. There are two very important reasons that this is done. First, it is necessary to establish a constant gain in the IF stages during alignment. Placing a constant bias on the AGC line keeps the gain from changing.

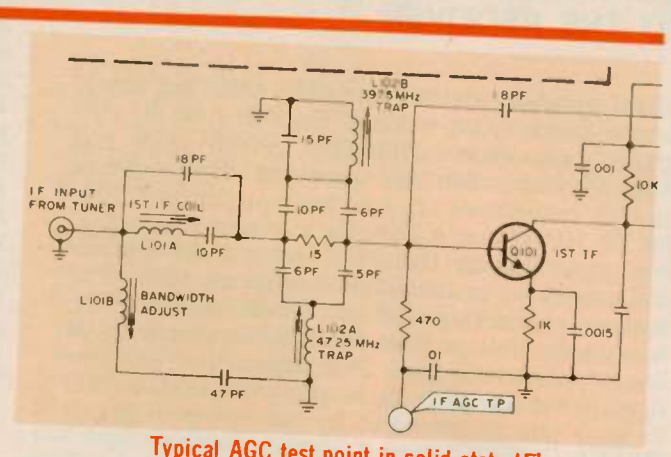
You will also find that if you do not tie down the AGC, the 60 Hertz sweep signal picked up at the video detector will be fed into the AGC system. This changes the gain of the IF's 60 times a second in step with sweep signal. The results are that the gain of the IF stages will change the shape of the curve causing a slight decrease in amplitude at one end and a corresponding increase at the other. If the receiver is aligned to a flat response under this condition, the receiver will not perform properly.



Tilted curve can be caused by poor equipment grounding or AGC line not tied down.

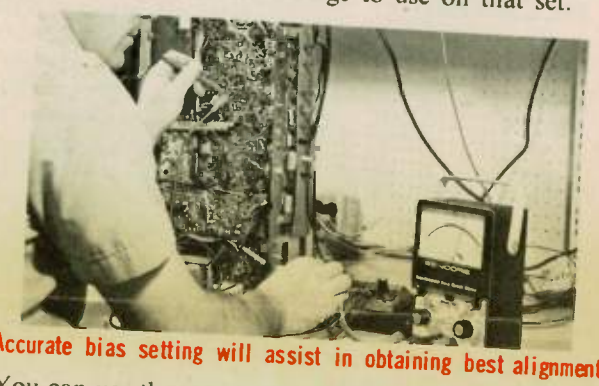
The biggest problem with AGC is locating the test points on the various chassis. Many manufacturers are starting to mark these points on their chassis for easier servicing. Regardless of the make of TV, tube or solid state, it is quite easy to find the IF AGC test point. The AGC is almost always used to control the gain of the first IF stage, so the AGC line will be connected to the controlling element of the first IF stage. In tube receivers, find the grid pin to locate the grid resistor. The bottom end of the resistor of end opposite the grid connection is the AGC test point. In solid state sets, it is generally a similar point. Just follow the base resistor from the first IF down and the end of the resistor opposite the base is generally the IF AGC test point. You will find either no base resistor, or the resistor goes to ground in some receivers. In this case, the AGC is tied to the second IF base through a resistor.

"I can find the test point, but how much voltage should I use?" This is a very common question as AGC bias voltages in the various receivers are not



Typical AGC test point in solid state IF's. Courtesy of Zenith Corp.

identical. In tube type receivers, you can usually apply a negative two volts to the AGC test point and be in good shape. Just use the calibrated output of the Sencore BE156 7 in 1 bias supply. In solid state, when no information is available, you can determine the voltage in several ways. Connect the bias supply and set the output to positive voltage. Slowly advance the control in the positive direction while watching the amplitude of the response curve. The curve will reach a peak or maximum amplitude at some point. If you increase the voltage, the curve will begin to decrease in amplitude. Continue advancing the control slowly until the curve drops about 25% in amplitude. This is the voltage to use on that set.



Accurate bias setting will assist in obtaining best alignment.

You can use the measured AGC voltage under strong signal conditions also. Connect a high impedance FE meter such as the Sencore FE16 to the AGC test point and tune in a strong station. Note the voltage and turn the tuner off that channel to an unused high channel for the alignment procedure. Without removing the FE from the test point, connect the output of the BE156 to the test point and slowly adjust the bias control until the meter reads the same voltage. Even though the BE156 is calibrated, the residual voltage on the solid state AGC line must be considered. Measuring the voltage present at the test point will prevent errors in biasing.

When aligning the chroma circuits, bias is generally required to assure that the chroma bandpass amplifier is operating and the color killer is disabled. Because each manufacturer differs in the connections and voltages required, it is impossible here to list each one. Generally, the chroma amplifier is turned on by a bias in the order of 2 volts positive, applied to the bottom end of the grid resistor. The blanker stage is cut off with a high negative voltage applied to the grid.

For overall RF IF alignment checks, an additional bias source must be connected to the tuner AGC test point. This will assure constant RF gain and prevent overloading. The RF AGC test point is easy to locate on most tuners. It will be a brown or white wire (in most cases) and has a large capacitor from that point on the tuner to ground.

RF AGC is usually white wire to tuner.

Sencore considered adding a bias supply to the sweep generators when they were being developed. Careful testing pointed out a major problem which could occur if this were done.

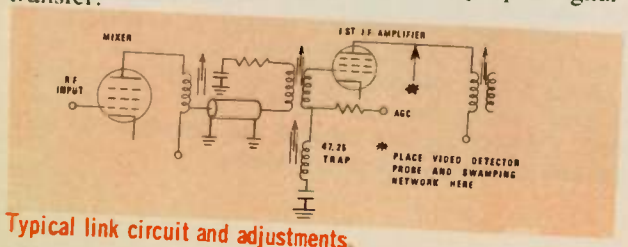
There could be interaction between the bias supply and the power supply of the sweep generator if the two were contained in the same unit. This is avoided, along with common grounds which can cause all sorts of problems, by making a separate bias supply like the BE156. The bias supply can also be used for general troubleshooting, if it is separate and convenient, like the BE156. See back cover.

Other questions regarding a built-in bias supply were raised. "What voltage levels do we provide to be certain any future sets will be covered." This is impossible to determine without a crystal ball. For example, a major set manufacturer has recently introduced a receiver requiring 67 volts negative bias for alignment. This development made all bias supplies, separate or included in the sweep generator, obsolete. We are sure you will agree that it is easier and less costly to replace a separate bias supply than to replace or make extensive modifications on a sweep generator.

9 LINK ALIGNMENT

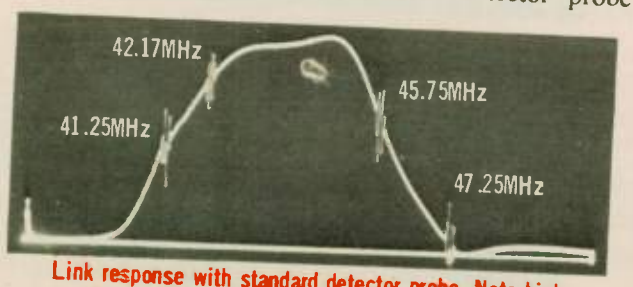
During the meetings which we present and the conversations with many technicians, we get the impression that there is some mystery surrounding link alignment. Link alignment is not new for it has been a part of color receiver alignment since the early color sets were produced.

The link alignment procedure is one of the first steps in the alignment of a large majority of color receivers in use today. The adjustment is made to assure proper coupling and bandpass between the tuner and the IF strip. The output of the tuner and the input of the IF's have to be complementary so the full range of frequencies present in the mixer output will also appear at the input to the first IF. The output characteristics of the tuner, the link cable (the coaxial cable between the tuner and IF), and the IF input characteristics will not always provide the perfect match and coupling that is necessary. The adjustments made during the link procedure will establish the tuned coupling circuit needed for proper signal transfer.



Typical link circuit and adjustments.

The adjustments usually associated with the link alignment are the mixer output coil, the first IF input coil, and a trap in the first IF to remove any adjacent channel sound interference. Perhaps some of the mystery of link alignment can be attributed to the fact that a special detector probe is needed to observe the response of the link. A conventional detector probe can sometimes cause the link alignment to be made incorrectly. The detector probe



Link response with standard detector probe. Note high positions of 41.25 and 42.17 MHz markers.

used to observe the link alignment must have two basic functions. The first to provide demodulation of the RF signal present at the output of the 1st IF, which is the test point used for this adjustment.

The second function of the link detector probe is to swamp out the output transformer of the first IF stage. What is meant by "swamp out" is to eliminate the normal resonant characteristics of this transformer. If this is not done, the output transformer can cause the link response to shift or exhibit tilt.

Another troublesome part of link adjustment is the low level of signal present at the first IF output. In many cases, the output is so low that a usable response is difficult or impossible to obtain with normal service instruments. Sencore studied the problem of link alignment in depth during the development of the sweep marker generators we now manufacture to serve you. The link detector probe available for use with either Sencore generators has been designed to eliminate the "mystery" or difficulty of link alignment. The 39G26 Link Detector probe provides the necessary RF detector network as well as the all-important swamping circuit needed to remove the effects of the first IF output transformer. The big plus which has been designed into the Link Detector probe is the voltage quadrupler circuitry used. This now provides, for the first time, a signal output at the link test point which is of sufficient amplitude to allow you *accurate adjustment of the link response.*

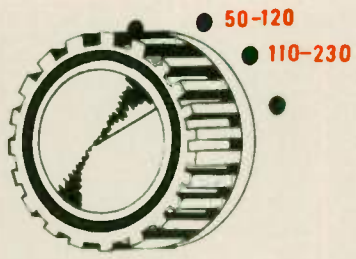
Link detector probe connected for link alignment of Admiral K-10 chassis.

Whenever sets using the link alignment procedure are to be adjusted, the 39G26 Link Detector probe is a must.

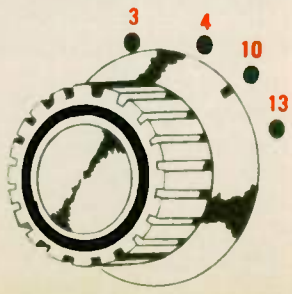
CHROMA SWEEP: This is a 3.58 MHz swept signal that is used to troubleshoot and align the chroma bandpass amplifiers as recommended by some of the set manufacturers. It can also be used to check the video amplifiers of the receiver as a troubleshooting aid to determine poor high frequency performance.

This is one more feature of the SM152 that makes it the most complete generator on the market today.

VHF - RF SWEEP: These are the standard TV channel frequencies used to make an overall alignment check and are also used in tuner repair and alignment. Only the Sencore SM152 and the RCA equipment covers all VHF channels, channel 2 all the way to channel 13 for a complete check of the tuner.

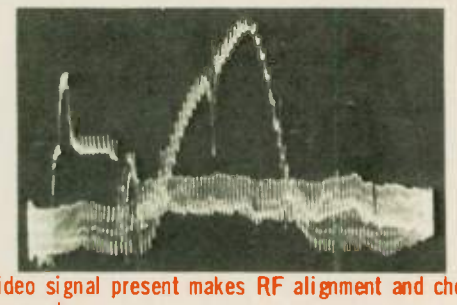


The Sencore SM158 Speed Aligner provides four VHF channels, two high and two low, for RF/IF overall checks.



Other generators available today either have no RF sweep provisions or supply only 2 channels of sweep signal. The lower cost mixing system used on these generators does not allow all channel coverage like the SM152. Extra beats and spurious signals appear on some channels making the output signal useless. This is why these generators are limited in their RF coverage. The Sencore sweep marker generators on the SM152 uses fundamental frequencies for all channels, providing an answer for complete tuner alignment.

We call the SM158 a speed aligner because it does the job fast but not as complete as the SM152. Two extra RF channels are provided over other "speed aligner types" because TV reception on a channel being aligned can cause some alarming things; especially when taking a quick overall check from antenna terminals to video detector. Note the appearance of the curve with co-channel interference.



Video signal present makes RF alignment and checking rough.

UHF-RF SWEEP: This is a must for a complete check on today's receivers. A sweep generator without this feature is not complete as the UHF tuner should be checked to see that it operates properly before the receiver is returned to the customer. This is a general check to see if the tuner functions correctly and that there is no great suck out or loss of signal on the channels present in your area.

Only the Sencore SM152 has this feature.

FM - RF SWEEP: For complete FM alignment and checking, coverage of the FM RF frequencies is necessary. A sweep signal should be available so that the signal can be injected into the antenna terminals and the response curve viewed for an overall performance check. The Sencore SM152 gives you complete coverage of this important band of frequencies for FM.

FM - IF SWEEP: A crystal controlled signal as well as a sweep signal should be available for a complete alignment of the FM receiver. Some manufacturers suggest the use of a 10.7 MHz crystal controlled CW signal while others recommend that a sweep signal be used in the alignment of the FM IF. For proper FM coverage, the generator should have both signals. The Sencore SM152 does.

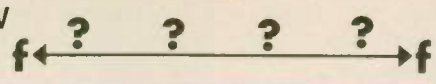
21 MHz IF SWEEP: Older receivers and several Japanese imports use this IF frequency.

IMPORT SETS USING 21MHZ I.F. FREQUENCIES		
Delmonico/Nivico	Model	PTV-19T 4T-20V 5T-30V 4T-40 VPF-96 VPF-105 9T-14AEM
Sanyo	Model	16-PS2
Sony	Model	TVS-303W TV8-301W TV9-304W TV-304W

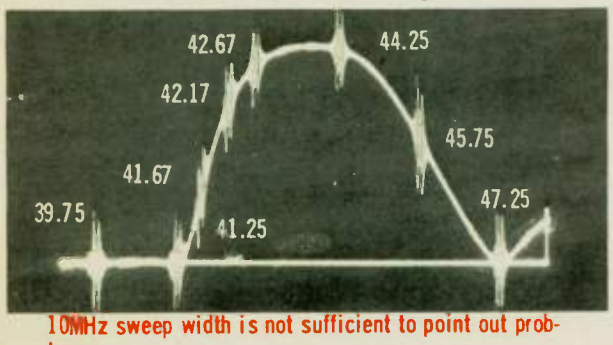
The chart above shows some of the Import sets that use the 21 MHzIF system. If you are going to service any import TV receiver, you will have to use the SM152 as it is the only generator with these IF frequencies (including the latest sweep and marker coming in from Japan).

Complete coverage of SM152 includes 21MHz IF frequencies.

3 WHAT SWEEP WIDTH IS NEEDED AND HOW DO WE DETERMINE ZERO REFERENCE?



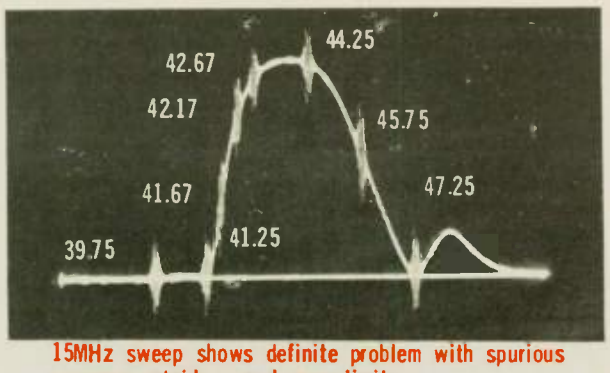
An important specification of any sweep generator is the sweep width. This determines the range of frequencies covered above and below the center frequency. If you refer back to the typical response curve and the associated signals, you will see that the generator must have at least 7.5 MHz sweep width to observe all of the response. The sweep width must be greater than 7.5 MHz if we wish to see beyond the adjacent signal traps to be sure that they are aligned correctly. Many coils can be mis-tuned and produce spurious response outside of the normal IF bandpass. This will lead to problems. Therefore, you should have capabilities of sufficient sweep width to see well beyond the normal IF response. Here is a curve of a late model Zenith solid state chassis that appears to be good.



10MHz sweep width is not sufficient to point out problems.

The sweep width used to exhibit this curve is 10 MHz so that we can see beyond the traps to be sure they are in proper adjustment. If you only used 10 MHz sweep width to view this curve you would probably expect the set to operate properly. But let us look further.

If we look at the same Zenith chassis and increase the sweep width to 15 MHz, we now see a new hump on the response curve past the 47.25 MHz trap where there theoretically should be no gain. If it is placed on a cable system or in a noisy area, you will have all kinds of difficulty with the picture.

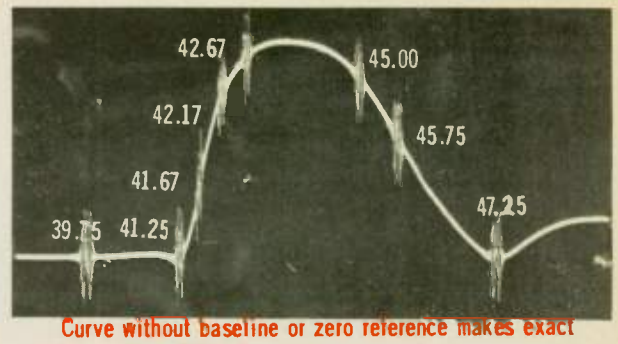


15MHz sweep shows definite problem with spurious response outside normal curve limits.

This is an indication of a misaligned IF and would be by-passed if the sweep generator did not have sufficient sweep width to allow you to see past the skirts and traps on the response curve. In this case, the mixer coil had been misadjusted, increasing the bandwidth of the link circuit beyond that needed for proper TV reception. The Sencore generators have been designed to provide a full 15 MHz sweep width. This allows you to achieve more accurate alignment results and more satisfied customers.

This same problem can also go unnoticed if there is no baseline to tell you that you have gain at a point where you should have none. Here, we have removed the baseline on the same receiver so you can see the difference.

This has been done to emphasize how difficult it is to check trap positions and maintain zero gain beyond the skirts of the curve without some form of reference. The zero baseline provided by Sencore generators give you a constant zero reference for easier, more accurate alignment.



Curve without baseline or zero reference makes exact trap setting difficult.

Here is an alignment curve taken from the Zenith Service manual. Note that the position of markers are referenced to the baseline in percentage. Positioning of the markers becomes easy with a reference. Judging where the markers should fall becomes a guess and a misalignment can occur if you remove the reference. Essentially every TV manufacturer uses the baseline as a reference to position the markers on their response curve. This is why both Sencore generators use a baseline. The sawtooth sweep used on most other generators does not produce a baseline, nor can it be added to the system.

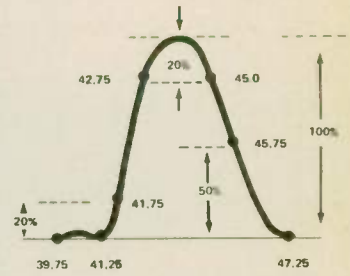


Figure 10—Overall Response Curve, Taken at Test Point C1.

Another important point, which often goes unmentioned by many test equipment manufacturers is the linearity of the sweep signal (moves from left to right at a constant speed). If the sweep is non-linear, the curve will be compressed and distorted on one side. This can be confused with an improper alignment curve. Sencore sweep generators have an ultra-linear sweep to eliminate this type of problem as a sinewave is used on both scope and sweep thus moving both at the same exact speed at all times; the result is a 100 percent linear action.

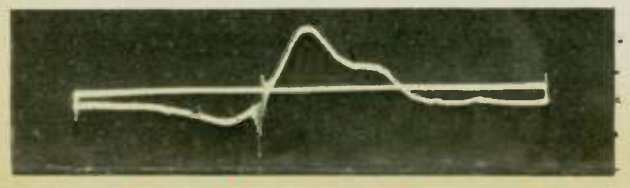
4 A BIT ON MARKERS

The response curve itself has little meaning unless you are able to mark critical frequency check points on the curve.

You must be able to determine accurately where the traps are to be positioned. Also, the position of the video and color carriers on the curve are important if the proper picture information is to be displayed. Let's look at a few of the common marker systems currently in use.

PREINJECTION MARKERS AND THEIR PROBLEMS

This is one of the earliest marker systems used. It simultaneously injects the RF generator signal and sweep signal into the IF amplifiers. When the signals arrive at the video detector, they mix and form a beat note that appears on the response curve as a birdie or marker. Many problems are encountered with this type of system. First, you are limited in the number of markers, generally only one at a time. This means that when you make an adjustment, you have to stop, set your marker generator to the different frequencies and observe their location on the curve. If more adjustments are required, you have to repeat the procedure. This is a very time consuming method. There is also another disadvantage to the preinjection marker system. It will overload the IF amplifiers if you inject too much RF signal from the marker generator and distort the response curve so that the curve is meaningless.

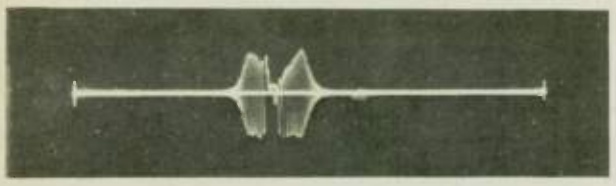


Pre-injection markers can cause severe overloading and curve distortion.

Trap action on the RF marker generator, with this system, is also a problem because the marker must actually pass through the trap and thus it may be "sucked out" and hard to see. If you increase the output of the generator to compensate for this action, you again overload the IF amplifiers and distort the curve shape.

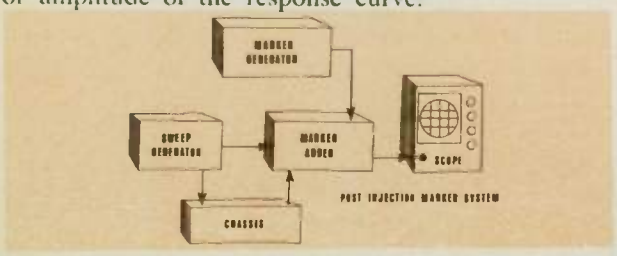
POST-INJECTION MARKERS

To overcome the problems of preinjection markers, a method was devised to add the markers to the response curve after it had been taken from the receiver. Adding the markers at this point is called post-injection. The markers are generated by applying a sample of the sweep signal and the desired marker frequencies to a detector. This then creates the marker pips.



Expanded "birdie" marker used in modern post-injection systems. Marker frequency shown accurately by zero beat point in center of birdie.

The resultant beat or birdie is amplified, then added to the curve after it comes from the television receiver. The total signal is then applied to the vertical input of the scope. The result is markers at the desired frequency that will not interfere with the shape or amplitude of the response curve.



The post-injection marker system allows you to use more markers than with the preinjection system, have more marker amplitude without interfering with the response curve, and eliminates the problem of interference.

Both Sencore generators, the SM152 and SM158, use the post-injection marker system to eliminate the preinjection marker problems. Twelve crystal controlled chroma and IF markers are available on both Sencore generators to insure you of the greatest accuracy for alignment. Eight push buttons give you fast selection of the markers you need; just push the button to turn the marker on, push the button again and turn the marker off; it's that simple.

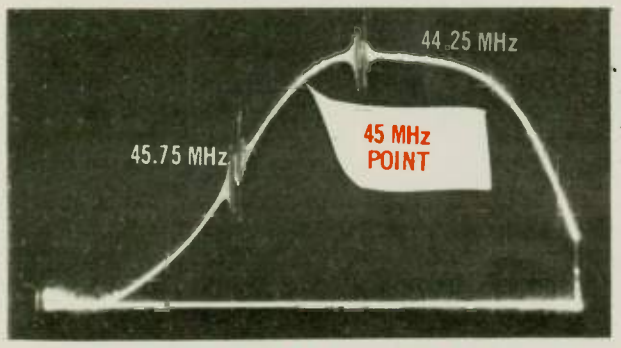
Sencore generators feature easy-to-use pushbutton markers with marker frequency listed on front panel.

The twelve marker frequencies on the Sencore sweep/marker generators are as follows: 39.75 MHz adjacent video trap, 41.25 MHz sound trap, 41.67 MHz lower color sideband, 42.17 MHz color carrier, 42.67 MHz upper color sideband, 44.25 MHz curve slope, 45.75 MHz video carrier, 47.25 MHz adjacent sound trap, 4.5 MHz sound trap, 4.08 and 3.08 MHz color sideband and 3.58 MHz color carrier markers are all available with the eight push buttons. These frequencies are marked for your convenience on each Sencore generator. Just push the button for the desired marker, whether it is for chroma or IF alignment. Any one or all of the markers may be placed on the response curve without causing interference or distorting the curve shape.

The SM158 is a speed aligner and we would not want you to take the time to look up marker frequencies. They are all called out by name on a simplified correlation chart above the push button. You simply select the marker you want, be it video, sound, etc.

Lights on a response curve to indicate marker position is a good idea but a quick look at the shape of the different manufacturers' curves makes you realize that the lights really can't be followed and that you must look at the manufacturers' literature for best results.

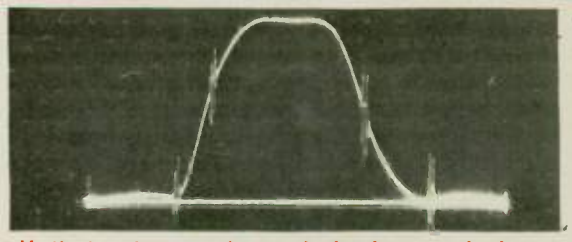
If an odd marker frequency is called out, as is the 45 MHz marker by one manufacturer, it can be



Ultra-linear sweep of Sencore generators allows unusual marker frequencies to be located accurately.

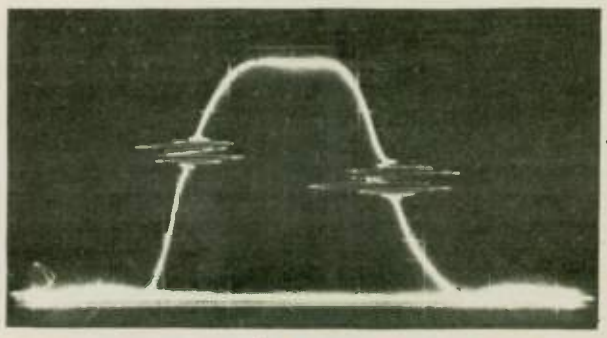
easily found due to the ultra linear sweep of these generators. The 45 MHz marker point will fall exactly half way between the 44.25 and 45.75 MHz markers.

The post-injection marker system offers one more advantage that you could not get with a preinjection marker system. That is the tiltable marker or the horizontal marker as some call it. By adding the markers after the response curve comes from the television receiver, they can be added to the vertical input of the scope for vertical markers or to the horizontal input for horizontal markers.



Vertical markers are sharp and crisp for easy viewing.

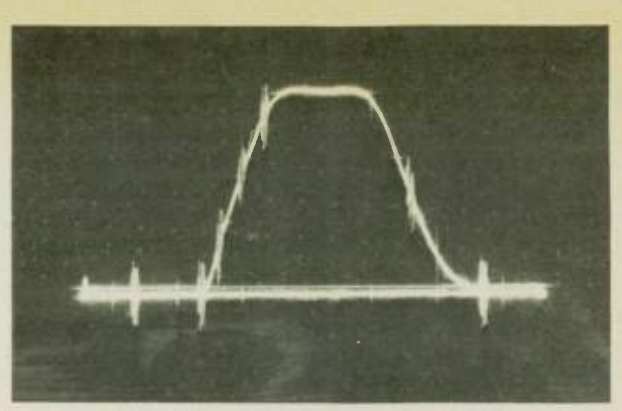
Here is a response curve showing the vertical markers as most often used. Here is a curve showing the horizontal markers as available on the Sencore SM158 with the flip of a switch.



Horizontal markers aid in accurate positioning of carrier markers.

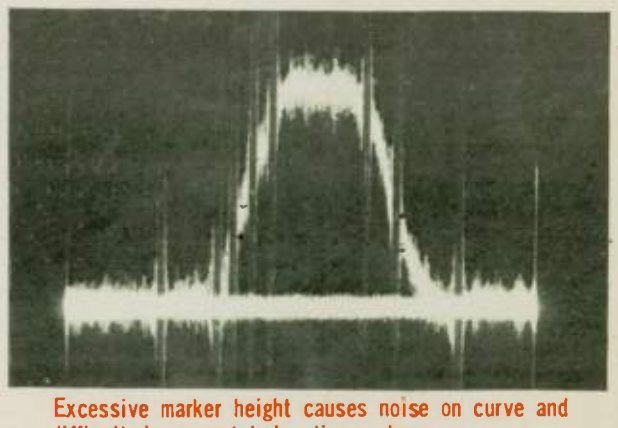
The horizontal markers are most often used to balance the two sections of the curve at the 6 DB points.

Marker amplitude is an important consideration on a sweep generator. Some generators make claims for a tremendous amount of marker amplitude which in reality is useless. You simply will want a visible indication on the curve as to where the desired frequency is located and no more for most of your alignment and troubleshooting.



Small, clean markers make alignment easy and accurate.

The photo here shows the marker level that is recommended for normal use. The second photo shows excessive marker amplitude. Note the noise on the curve making it harder to distinguish the dips of the traps.



Excessive marker height causes noise on curve and difficulty in accurately locating markers.

Excessive marker amplitude can also overdrive the vertical amplifier in the oscilloscope causing the curve to appear distorted, giving you false indications. Be sure to use only the marker amplitude that is required to give you a visible indication on the curve.

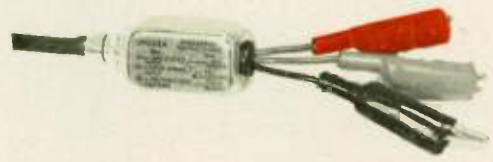
5 MATCHING THE GENERATOR TO THE RECEIVER

A very important part of sweep alignment is matching the output of the sweep generator to the receiver. A mismatch between the RF output of the generator and the input of receiver can cause standing waves on the cable. This can cause the response to shift or change shape as you move near the cable. The cable should be terminated in its characteristic impedance at the end connecting to the receiver and, if possible, at the sending end as well.

Generator output and receiver must be properly matched for accurate alignment.

A good test of the impedance match of a sweep generator is to connect it to the receiver and then "milk" or "wipe" the cable from the generator to the receiver with your hand. Any body capacity effects that alter the shape of the curve, indicate standing waves on the line. Put the Sencore sweep generators to this test and they will stand out from all others on the market as the quietest. The use of shielded and low impedance cables on sweep generators is also part of the matching systems to reduce noise and assure proper match to the receiver. Each lead has its own ground connection, eliminating ground loops and other problems that are associated with common ground connections. If you have proper matching, but the RF leakage is high, the matching is meaningless as the leakage signal will get into the receiver and act similar to standing waves on the cable. The Sencore engineering staff put extensive effort into making the leakage from the Sencore generators as low as laboratory gear. This means that only the signal from the cable is reaching the receiver and its level can be controlled by the sweep height or SWEEP OUTPUT control on the generator.

Both Sencore generators come complete with a special designed pad to match the receiver antenna terminals, the mixer or any test point in the IF.



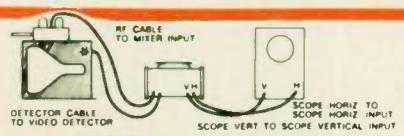
Carefully designed matching pad means proper match to receiver.

Here is the 39G22 matching pad supplied with both Sencore sweep/marker generators. It will match into the 300 ohm antenna terminals of any receiver using the red and green leads. When injecting into the mixer test point, or IF test points, use the black lead to ground and the red lead to the test point. This assures proper impedance match to any test point. Of equal importance is matching the generator to the receiver in the detector probe. If the improper probe is used, it can load or distort the response curve. The Sencore 39G23 standard detector probe (supplied with both Sencore Sweep generators) uses a series 27,000 ohm resistor to isolate the video detector test point from the input of the sweep generator. This eliminates the loading of the video detector caused by the capacity of a direct probe without isolation.

Special probe furnished with all Sencore generators provides detector probe and isolation probe in one.

The 39G23 is a special probe because it has a built-in demodulator that is used during chroma alignment and in troubleshooting procedures. The demodulator is a standard video detector that matches the detector circuits recommended by set manufacturers.

6 CONNECTING THE SWEEP GENERATOR TO THE RECEIVER



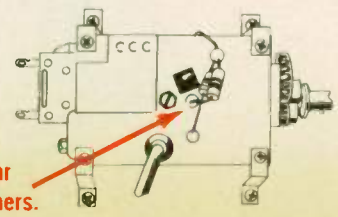
Connection of the sweep generator to the receiver obviously is an essential part of the alignment job. This can be difficult if you do not know the test points in the receiver. In most cases, the test points in one receiver are basically the same as in another. With a little knowledge of these points, you can quickly hook up to any receiver for a quick check or for full alignment.

The simplicity designed into the Sencore sweep/marker generators eliminate the long tedious task of equipment connection which has been prevalent in the past. Only 4 cables are required for the complete connection of both generator and oscilloscope.

The overall RF/IF check: The RF output cable from the sweep generator is connected to the antenna terminals. Here you use the red and green leads of the 39G22 matching pad so you match the 300 ohm input of the receiver. One word of caution here: *Do not align the receiver IF stages, except for a slight tilt adjustment, through the antenna terminals.* The reason being that you are not sure where the local oscillator in the tuner is set and you can misalign the receiver, especially the traps. We call your attention to this point because it is recommended by one test equipment manufacturer. Overall check should be just that — a check on alignment. Try it — you will see we are right.

The connection of the RF cable to the mixer test point for IF alignment is a little harder to find. In most cases, especially in tube type tuners, the mixer test point is right next to a square hole in the top of the tuner chassis.

Look for the feed through capacitor near the square hole. The red lead of the matching pad is connected to this point and the black lead to ground to provide the necessary low impedance match into the mixer. This information is screened on the matching pad cover for easy reference. Refer to the manufacturer's service information if you are in doubt as to the exact location of this test point.



Mixer test point located near square opening on most tuners.

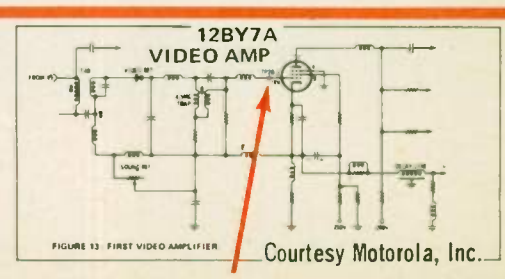
The 39G22 matching pad provides an excellent impedance match directly into a single IF amplifier such as recommended on the Zenith 4B25C19 chassis. The first step requires the signal injection directly into the 3rd IF stage. You simply connect the black lead of the pad to ground and the red lead to the test point called out in the manufacturer's procedure.

CONNECTING THE DETECTOR PROBE

The receiver response curve is picked up at the video detector (or other test point as noted) and coupled into the sweep generator marker adder sections. You will use the 39G23 standard detector probe supplied with the generators for this.

Do not connect to the video detector diode itself as it may change the curve shape. Most alignment instructions specify that a resistor ranging between 10K and 47K be placed in series with the scope (or detector lead) and the test point.

This is not needed when using Sencore equipment as the resistor is built into the 39G23 detector probe supplied with the SM152 or SM158.



Courtesy Motorola, Inc.

Typical test point for video detector is grid of first video.

A demodulator probe is required for the chroma alignment as the signal take-off point is ahead of the chroma demodulators. The blue lead on the 39G23 standard detector probe connects to a demodulator for use in chroma alignment. This is clearly indicated on the probe cover.

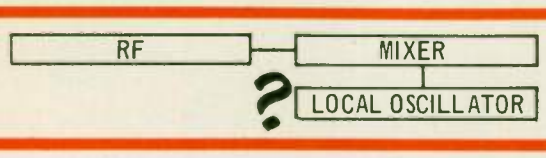
39623 probe provides chroma demodulator needed for chroma alignment.

This probe was designed to work with all manufacturers' receivers to give the proper alignment curve. If the chroma test point cannot be found or is not known, you can use the centertap of the chroma level control on most receivers, or the input to the chroma demodulator circuit.

The input leads to the oscilloscope are self explanatory. The vertical lead goes to the vertical input and the horizontal lead goes to the horizontal input.

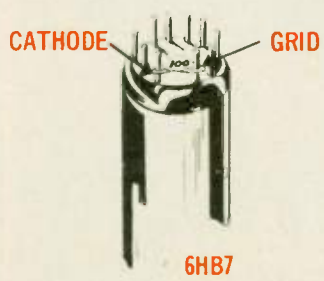
If you do not wish to use the horizontal marker feature of the Sencore generators, the horizontal drive lead need not be used. The sinewave sweep of the Sencore SM152 and SM158 allows you to use the line sweep function of your scope, further simplifying the connections.

7 WHAT TO DO WITH THE LOCAL OSCILLATOR?



There are times when a strong local oscillator in a TV tuner may feed enough signal into the IF's to cause extra beats and other problems when attempting alignment. If these symptoms occur, the local oscillator can be disabled quite easily.

A small .001 MFD disc capacitor from the grid of oscillator to the cathode will stop the oscillator. Simply wrap the leads of a small .001 MFD around the grid and cathode pins of the oscillator tube as shown here. Reinsert the tube into its socket and proceed with the alignment. Be sure to remove the capacitor after you have completed the alignment. The capacitor "kills" the local oscillator and no transmitted information will reach the video detector if it is not removed.



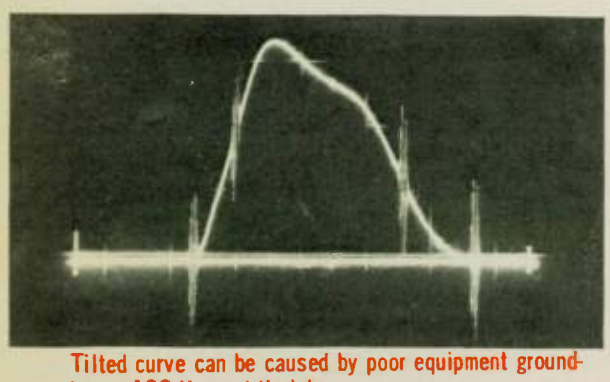
An often used procedure to disable the oscillator is to set the TV tuner between channels on the high end (10-13). This procedure should be used with caution. It interrupts the B plus voltage and opens the coils to the oscillator in the tuner. This procedure can sometimes cause a tilted curve due to the effect of the oscillator coils when they are switched back into the circuit.

An alternate injection method which can be used if a mixer test point is not readily accessible is to use a foil wrap on the mixer tube. Remove the tube from its socket, wrap with a layer of foil, wrap tape or other insulation over the foil and re-insert the tube. Connect the hot lead of the generator to the foil and black lead to tuner chassis.

8 TYING DOWN THE AGC

In all alignment procedures, the AGC line is always tied down. There are two very important reasons that this is done. First, it is necessary to establish a constant gain in the IF stages during alignment. Placing a constant bias on the AGC line keeps the gain from changing.

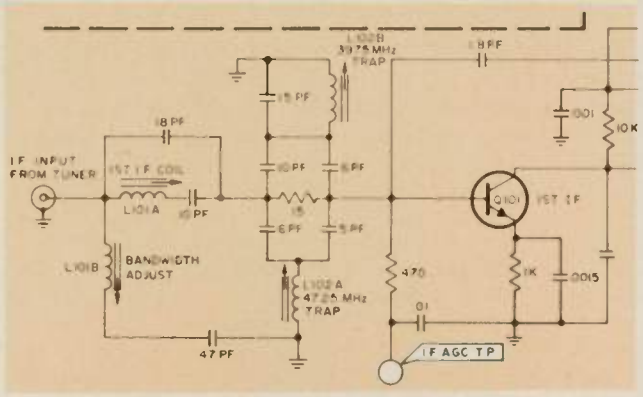
You will also find that if you do not tie down the AGC, the 60 Hertz sweep signal picked up at the video detector will be fed into the AGC system. This changes the gain of the IF's 60 times a second in step with sweep signal. The results are that the gain of the IF stages will change the shape of the curve causing a slight decrease in amplitude at one end and a corresponding increase at the other. If the receiver is aligned to a flat response under this condition, the receiver will not perform properly.



Tilted curve can be caused by poor equipment grounding or AGC line not tied down.

The biggest problem with AGC is locating the test points on the various chassis. Many manufacturers are starting to mark these points on their chassis for easier servicing. Regardless of the make of TV, tube or solid state, it is quite easy to find the IF AGC test point. The AGC is almost always used to control the gain of the first IF stage, so the AGC line will be connected to the controlling element of the first IF stage. In tube receivers, find the grid pin to locate the grid resistor. The bottom end of the resistor of end opposite the grid connection is the AGC test point. In solid state sets, it is generally a similar point. Just follow the base resistor from the first IF down and the end of the resistor opposite the base is generally the IF AGC test point. You will find either no base resistor, or the resistor goes to ground in some receivers. In this case, the AGC is tied to the second IF base through a resistor.

"I can find the test point, but how much voltage should I use?" This is a very common question as AGC bias voltages in the various receivers are not



Typical AGC test point in solid state IF's. Courtesy of Zenith Corp.

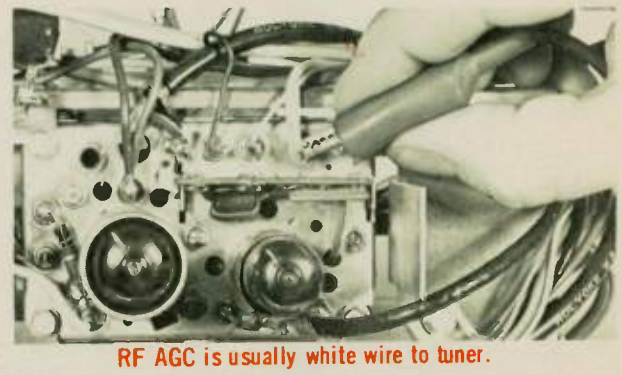
identical. In tube type receivers, you can usually apply a negative two volts to the AGC test point and be in good shape. Just use the calibrated output of the Sencore BE156 7 in 1 bias supply. In solid state, when no information is available, you can determine the voltage in several ways. Connect the bias supply and set the output to positive voltage. Slowly advance the control in the positive direction while watching the amplitude of the response curve. The curve will reach a peak or maximum amplitude at some point. If you increase the voltage, the curve will begin to decrease in amplitude. Continue advancing the control slowly until the curve drops about 25% in amplitude. This is the voltage to use on that set.

Accurate bias setting will assist in obtaining best alignment.

You can use the measured AGC voltage under strong signal conditions also. Connect a high impedance FE meter such as the Sencore FE16 to the AGC test point and tune in a strong station. Note the voltage and turn the tuner off that channel to an unused high channel for the alignment procedure. Without removing the FE from the test point, connect the output of the BE156 to the test point and slowly adjust the bias control until the meter reads the same voltage. Even though the BE156 is calibrated, the residual voltage on the solid state AGC line must be considered. Measuring the voltage present at the test point will prevent errors in biasing.

When aligning the chroma circuits, bias is generally required to assure that the chroma bandpass amplifier is operating and the color killer is disabled. Because each manufacturer differs in the connections and voltages required, it is impossible here to list each one. Generally, the chroma amplifier is turned on by a bias in the order of 2 volts positive, applied to the bottom end of the grid resistor. The blanker stage is cut off with a high negative voltage applied to the grid.

For overall RF/IF alignment checks, an additional bias source must be connected to the tuner AGC test point. This will assure constant RF gain and prevent overloading. The RF AGC test point is easy to locate on most tuners. It will be a brown or white wire (in most cases) and has a large capacitor from that point on the tuner to ground.



RF AGC is usually white wire to tuner.

Sencore considered adding a bias supply to the sweep generators when they were being developed. Careful testing pointed out a major problem which could occur if this were done.

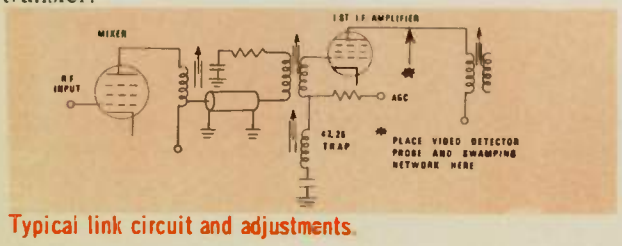
There could be interaction between the bias supply and the power supply of the sweep generator if the two were contained in the same unit. This is avoided, along with common grounds which can cause all sorts of problems, by making a separate bias supply like the BE156. The bias supply can also be used for general troubleshooting, if it is separate and convenient, like the BE156. See back cover.

Other questions regarding a built-in bias supply were raised. "What voltage levels do we provide to be certain any future sets will be covered." This is impossible to determine without a crystal ball. For example, a major set manufacturer has recently introduced a receiver requiring 67 volts negative bias for alignment. This development made all bias supplies, separate or included in the sweep generator, obsolete. We are sure you will agree that it is easier and less costly to replace a separate bias supply than to replace or make extensive modifications on a sweep generator.

9 LINK ALIGNMENT

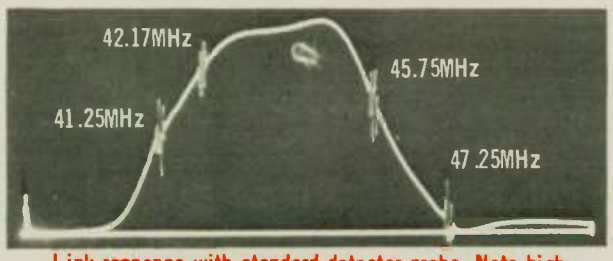
During the meetings which we present and the conversations with many technicians, we get the impression that there is some mystery surrounding link alignment. Link alignment is not new for it has been a part of color receiver alignment since the early color sets were produced.

The link alignment procedure is one of the first steps in the alignment of a large majority of color receivers in use today. The adjustment is made to assure proper coupling and bandpass between the tuner and the IF strip. The output of the tuner and the input of the IF's have to be complementary so the full range of frequencies present in the mixer output will also appear at the input to the first IF. The output characteristics of the tuner, the link cable (the coaxial cable between the tuner and IF), and the IF input characteristics will not always provide the perfect match and coupling that is necessary. The adjustments made during the link procedure will establish the tuned coupling circuit needed for proper signal transfer.



Typical link circuit and adjustments.

The adjustments usually associated with the link alignment are the mixer output coil, the first IF input coil, and a trap in the first IF to remove any adjacent channel sound interference. Perhaps some of the mystery of link alignment can be attributed to the fact that a special detector probe is needed to observe the response of the link. A conventional detector probe can sometimes cause the link alignment to be made incorrectly. The detector probe



Link response with standard detector probe. Note high positions of 41.25 and 42.17 MHz markers.

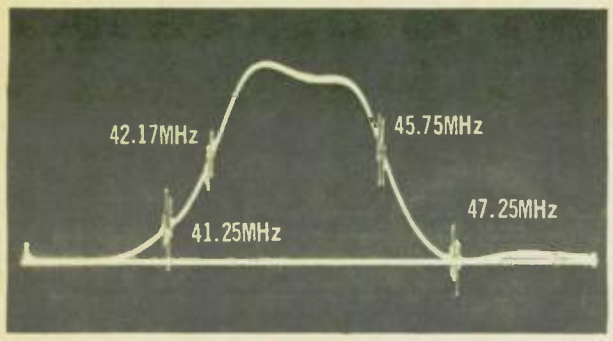
used to observe the link alignment must have two basic functions. The first to provide demodulation of the RF signal present at the output of the 1st IF, which is the test point used for this adjustment.

The second function of the link detector probe is to swamp out the output transformer of the first IF stage. What is meant by "swamp out" is to eliminate the normal resonant characteristics of this transformer. If this is not done, the output transformer can cause the link response to shift or exhibit tilt.

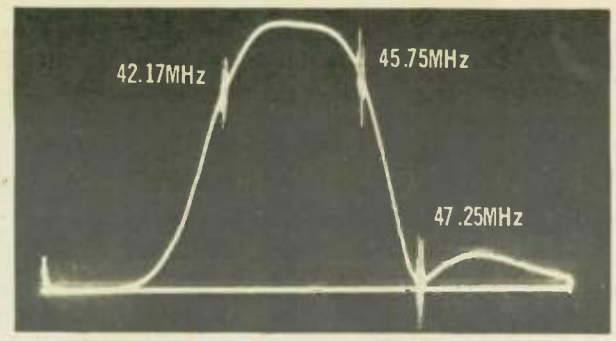
Another troublesome part of link adjustment is the low level of signal present at the first IF output. In many cases, the output is so low that a usable response is difficult or impossible to obtain with normal service instruments. Sencore studied the problem of link alignment in depth during the development of the sweep marker generators we now manufacture to serve you. The link detector probe available for use with either Sencore generators has been designed to eliminate the "mystery" or difficulty of link alignment. The 39G26 Link Detector probe provides the necessary RF detector network as well as the all-important swamping circuit needed to remove the effects of the first IF output transformer. The big plus which has been designed into the Link Detector probe is the voltage quadrupler circuitry used. This now provides, for the first time, a signal output at the link test point which is of sufficient amplitude to allow you *accurate adjustment of the link response.*

Link detector probe connected for link alignment of Admiral K-10 chassis.

Whenever sets using the link alignment procedure are to be adjusted, the 39G26 Link Detector probe is a must.



Link detector probe shows correct response.

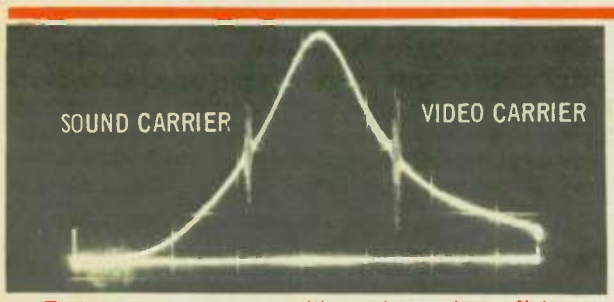


Typical link response curve after link adjustment.

The link adjustment is a relatively simple procedure. The IF sweep output of either the SM152 or SM 158 Sweep/Marker generator is applied to the mixer test point. The 39G26 Link Detector probe is connected to the output of the first IF stage. Proper AGC bias potentials are applied and the receiver is ready for link alignment.

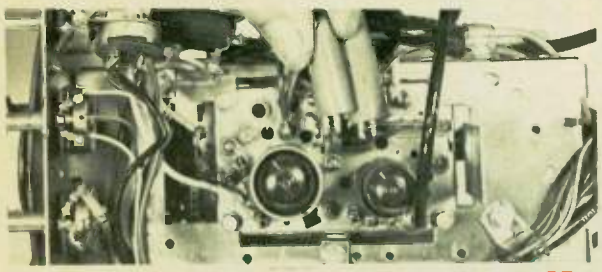
The mixer coil and the first IF input coil are adjusted to obtain a curve such as that shown here. The adjacent sound trap and its rejection control are adjusted for minimum response at 47.25 MHz. This is normally all the adjustments connected with the link alignment. A few receivers will also have a 39.75 MHz trap in the first IF input and this then would be adjusted as part of the procedure. The high level of RF output available on the Sencore sweep/marker generators and the 39G26 Link Detector Probe will provide more than adequate response to make the adjustment easy. The sharp markers which are selected by the simple push of a button will also speed your receiver alignment.

10 HOW IMPORTANT IS TUNER ALIGNMENT?



Typical tuner response with carrier markers. Note wide, peaked response indicating maximum gain at center channel.

The correct alignment and operation of the tuner should obviously be very important. Any information presented on the screen of the receiver must first pass through the tuner. UHF signals must pass through the tuner. UHF signals must pass through both tuners in order to supply the IF's and subsequently the picture tube with intelligent information. Any lack of gain or bandpass will be seen as a defect in the picture. The bandpass of the tuner must be wide to assure selection and amplification of all information transmitted for the station desired. The bandpass, however, cannot be excessively wide or problems of adjacent channel interference will develop. The gain of the tuner must be sufficient to supply a signal to the IF amplifiers. The IF amplifiers are

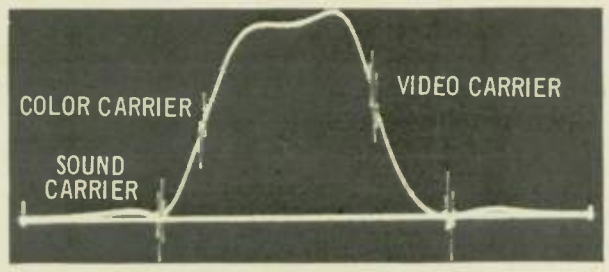


Antenna terminals make fast, easy connection for RF response checks.

responsible for the majority of the gain selectivity of the receiver. The tuner serves as a pre-selector to amplify the desired channel considerably more than adjacent channels. A set rule for checking the tuner may not be established, but many manufacturers recommend checking the RF-IF overall response after IF alignment has been completed. This means the signal is injected into the antenna terminals and the video detector test point is used as the signal take-off. The RF AGC bias must also be set to provide proper RF amplifier action. Normally, the 300 ohm output of the matching pad will be connected to the antenna terminals for the RF-IF overall response check. In most cases, a quick check of the response on one low VHF channel (2-6) and one High VHF channel (7-13) will be sufficient to determine proper tuner operation. This should be done on an unused channel in each band to prevent the video signal from a local station from distorting the response curve. The RF video signal present will make the results of the check difficult or impossible to interpret. Some sweep/marker generators available provide output for RF checks on only channels 4 and 10. This does satisfy the requirements of checking both high and low VHF bands but does not allow for the possibility of a local station operating on channel 4 and 10 or both in some cases.

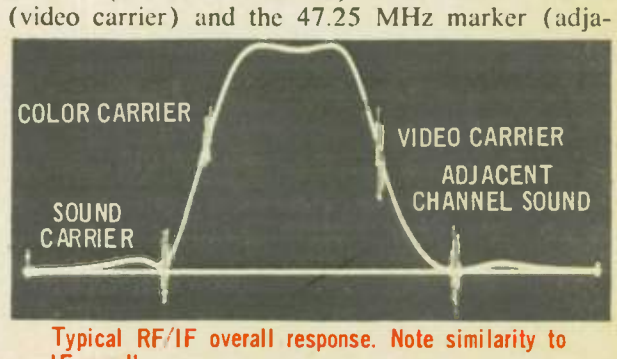
OVERALL RF-IF CHECK

Next, what are you to look for when you have the RF-IF overall response curve? The RF-IF overall response should have the same shape and symmetry as the IF overall response displayed. Any tilt or difference in shape of the RF-IF curve when compared to the IF curve indicates a fault in the tuner. If the tilt is the same on all channel checks, a minor touch-up of the mixer or 3rd IF transformer will sometimes correct the situation. If the tilt or error varies from one channel to another, the problem definitely exists in the tuner. This points to an alignment job



Minor tilt in RF/IF response may be corrected by slight IF touchup.

on the tuner. The position of the markers should be essentially the same as the IF response curve. Using the SM158 Speed Aligner, the marker position can be checked by depressing the pushbuttons for the 41.25 MHz marker (sound carrier) 42.17 MHz marker (chroma subcarrier) 45.75 MHz marker (video carrier) and the 47.25 MHz marker (adjacent channel sound carrier). Adjust the receiver fine tuning until the 41.25 and 47.25 MHz markers appear at the baseline on either side of the response curve. The carrier markers should be near 50% amplitude and opposite each other on the curve. When the SM152 is employed, the RF check is made by selecting one of the RF carrier markers available. Each VHF and each UHF channel can be checked for response amplitude and shape with the SM152. Making this check gives you added assurance that the receiver will provide top performance when it is returned to the customer.



Typical RF/IF overall response. Note similarity to IF overall.

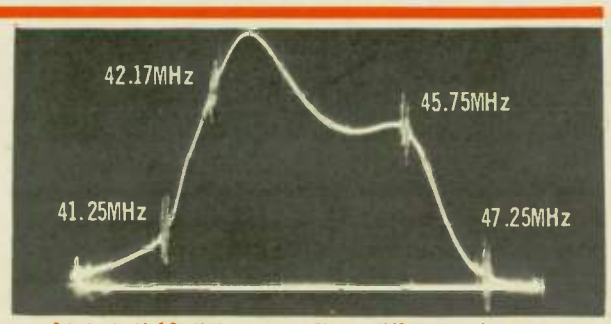
If it is suspected that one or two used channels have poor response, it is recommended that these are checked to determine whether a problem is actually present.

The SM152 with its 82 channel coverage is the ideal generator for this troubleshooting procedure. The calibrated RF output allows you to make meaningful checks of the RF gain, on each and every channel!

Every major set manufacturer supplies tuner alignment information and response curves should RF trouble develop. The test points vary somewhat depending on the tuner used and it is suggested that the manufacturer's instructions be followed. The set manufacturers supply you the information and the Sencore SM152 is the ONLY sweep/marker generator to provide all channel RF sweep to make this alignment. Be sure to consider this point before you make a large investment in sweep equipment.

11 IDIO SYNC RA SEES

As technicians we may be unable to correctly spell words such as this but working closely with the set manufacturers does allow us to keep up-to-date on all types of receivers. Regardless of the manufacturer, all sets must supply the CRT with the same information if the total picture is to be displayed. Therefore, every set will have essentially the same IF response curve. The RF-IF response will also be similar for all receivers. Each set will have some circuit difference but the overall result of the circuitry will be the same.

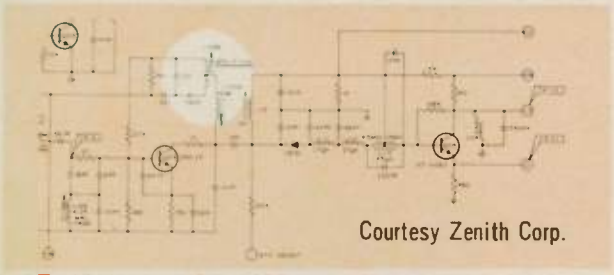


Admiral K-10 link curve. Note difference in curve shape compared to tube-type receivers.

There are distinct differences we have noted in some receivers and feel these should be brought to your attention. The Admiral K-10 hybrid color set for example, has two 41.25 MHz traps in the IF's. One is located in the 3rd IF in a conventional configuration. The other is located in the first IF input and is a part of the link alignment procedure. Therefore, it is important that both 41.25 MHz traps be set accurately for best performance. The K-10 solid state IF system has a somewhat different link response when compared to other receivers.

As shown, the 45.75 MHz video carrier marker is considerably lower on the curve than that shown in the curve in the Link Alignment section of this article. The tuner-IF link has a much higher gain or response at the color carrier frequency than most sets. The lack of gain at the video frequency is compensated for by having the 3rd IF tuned for a higher response at 45 MHz.

The Zenith 4B25C19 color chassis also has some minor differences when compared to most receivers. Zenith engineers have added a 40.0 MHz trap in the 3rd IF stage to add in rejection and the shaping of the overall response curve. Zenith also begins the



Zenith incorporates additional adjustment at 40MHz.

alignment with the 3rd IF stage and then goes to IF overall response. Zenith recommends that the sweep generator used to align this chassis has the capability of delivering approximately 350 millivolts IF sweep signal to the input of the 3rd IF. This signal requirement is greater than most sweep generators can provide. In tests made in the Sencore Field Engineering lab on over 50 Zenith chassis, the alignment was successfully accomplished with the normal output of the generator but the response amplitude was understandably lower than specified. Sencore worked with Zenith and has available a simple modification kit for the SM158 Speed Aligner which will provide approximately 400 millivolts of signal for Zenith 3rd IF alignment. Anyone owning or intending to purchase the Sencore SM158 may order the 39G31 RF Modification Kit directly from the Sencore Service Department for only $10.00. This simple change will permit you to follow all Zenith alignment specifications.

The Motorola Quasar II color receiver also uses an alignment procedure which adjusts the 3rd IF stage as the first step of the alignment procedure. The Quasar II incorporates a 39.75 MHz trap in the first IF stage. This information was brought out as we worked with Motorola Field Service department to develop the alignment procedure for the Quasar II receiver. The full alignment procedure is now available for the Quasar II in workshop manual form. This workshop manual was prepared and published by Sencore in conjunction with Motorola Inc.

Sencore works with television manufacturers to prepare training manuals on sweep alignment.

WHY SENCORE SWEEP AND MARKER GENERATORS?

We have tried to bring some of the key alignment points to your attention in this issue of Sencore News. We have also pointed to some pitfalls and problems which you may encounter due to differences in color receivers. The Sencore sweep and marker generators have been designed by service oriented engineers for service technicians. We feel that this approach to the development and manufacture of quality test equipment will provide the equipment you need to serve your customers better. Also by working closely with the set manufacturers, you can be sure the equipment has been engineered in such a manner that it will satisfy their equipment specifications. The SM158 Speed Aligner has been developed for the man who wants the ultimate in speed and simplicity. The preset outputs, simple controls and fast hook-up make it a valuable addition to any service organization. The true post-injection marker system and individual crystal marker oscillators means distortion-free response curves with bright, sharp markers. The horizontal marker feature makes accurate marker positioning a breeze. The SM158 provides all basic sweep frequencies and markers for the complete IF and chroma alignment of any set. The 4 RF channel sweep outputs permits interference free checking of RF-IF overall response. The SM158 is truly a feature-packed sweep/marker generator and it is priced as much as $120 less than comparable units!

The SM152 Deluxe Sweep/Marker generator is the most complete sweep/marker generator available today. The full selection of RF sweep frequencies from 10 MHz to 900 MHz gives complete RF coverage of television and FM frequencies. Calibrated RF output and Automatic Level Control means pinpoint accuracy in adjusting RF levels for alignment, testing and troubleshooting. The spot-align band serves as an RF generator without sweep for peaking transformers and setting traps in preparation for full sweep alignment. Chroma IF and Chroma Video signals are both available for any color alignment or troubleshooting need. Calibrated sweep width gives you complete control over the signal applied to the receiver. You are completely in command with marker size control, full marker amplitude control, sweep and pattern polarity reversal controls. The SM152 provides all necessary crystal markers for Chroma alignment and IF alignment plus markers for RF carriers on channels 4, 5, 10 and 13. The 10.7 FM marker is included as well as the 10.6 and 10.8 FM sideband markers. An external marker input has also been provided to make the SM152 the most complete generator you can buy. Consider all these features and pick one up the next time you are at your distributor and take advantage of our special offer shown below.

Sencore Alignment Special

FREE OFFER COUPON

(OFFER VOID WITHOUT COUPON)

Fill out this coupon and present to your SENCORE Distributor when you purchase your SM152 Deluxe Sweep/Marker Generator or SM158 Speed Aligner. You will receive a BE156 free with the SM158 and the FE16 free with the SM152.

Name_____

Address_____

City, State, Zip_____

Unit Purchased_____

Unit Free_____

SHOW THIS TO YOUR DISTRIBUTOR

Mr. Distributor: Sencore will replace to you on a no-charge basis the FE16 or BE156 used from your stock for this special program or an equivalent in other Sencore merchandise. Be sure to send this coupon with a copy of your sales invoice for the instruments listed to: Sencore, Inc., Promotion Dept., 3200 Sencore Drive, Sioux Falls, South Dakota 57107.

(Offer expires March 1, 1972)

FREE FE16

with the purchase of SM152 DELUXE SWEEP/MARKER GENERATOR

(until March 1, 1972)

FE16 $84.50

High Accuracy Field Effect Multimeter.

(SEE CENTER SECTION FOR FEATURES)

FREE BE156

with the purchase of SM158 SPEED ALIGNER

(until March 1, 1972)

A must for television alignment and servicing.

- Provides bias needed for any set; tube or solid state.
- 0-25 volts either positive or negative from each of three supplies.
- 0-75 volts negative to cover RCA.
- Separate, independent calibrated supplies.
- Extremely well filtered to prevent distortion of alignment curve.

BE156 $24.95

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SPECIAL INTRODUCTION
VA48 Video Analyzer . . . Page 12

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Ruggedized Accuracy

for your bench or in the field

New **DVM37** .1% Accuracy Portable Digital Multimeter

for the first time...

you can make those demanding tests on integrated & digital circuits

- **with lab accuracy**
- **anywhere**
- **anytime**

.1% DCV Accuracy	**"Prime" standard .1% DCV portable or AC-operated DVM**
15 Megohm input	**The most accurate .1% DCV portable DVM you can buy** because 15 Megohm input impedance has one-third less circuit loading
	**Fully protected inside with 8KV transient protection and outside with an unbreakable case**
	**Auto-Zero, Auto-Polarity, Auto-Decimal and Auto-Overrange**
	**28 full ranges of voltage, current, and resistance** to 2000 Volts, 2000 milliAmps, and 20 Megohms
	**Exclusive battery-saving feature** turns on power only when in use, making the batteries last and last
	**Hi-Lo Power Ohms** for checking diodes, but lowering battery voltage below conductance level of solid state devices for in-circuit resistance checks

... and all for the lowest-priced portable .1% DVM on the market

Ruggedized Accuracy

New **DVM37** .1% Accuracy Portable Digital Multimeter

Handy carrying handle & tilt stand

Convenient back-up fuse protection

Circuit isolation

Battery-saving On-Off button

Direct reading big 3½ digit LED display

Automatic zero, polarity, decimal and overrange

Super-sensitive tests to .1 Ohm and .1 microAmps resolution

28 Full ranges to 2,000 Volts, 2,000 milliAmps and 20 Megohms

Break-proof Cycolac® case construction

Exclusive 8,000 Volt transient protection

2,000 Volt continuous protection on all ranges

Tug-proof test leads attached for safety

Compact palm-size for field or bench

Hi-Lo Power Ohms for in-circuit resistance checks

Standard "C" cell battery operation with battery self-check

BACKED BY SENCORE'S 100% MADE RIGHT LIFETIME GUARANTEE

Only $248 ($268 Effective Jan. 1, 1978)

IT'S ACCURATE

"PRIME STANDARD" ACCURACY: The new DVM37 provides the .1% "prime standard" DCV accuracy you'll want for tests you can trust every time in the field or on the bench. This state-of-the-art accuracy is backed with exclusive 15 Megohm input impedance for 50% greater accuracy and 1/3 less circuit loading than the 10 Megohm input other .1% DVMs use. You'll find the DVM37 is a virtual necessity if you are operating or troubleshooting voltage-controlled, IC, digital, or varactor-tuned circuits.

SUPER SENSITIVITY FOR CRITICAL TESTS: 0.1 Ohm resolution on the 200 Ohm range equips you for super-low tests of low value resistors in solid state bias circuits. Super critical AC leakage current checks for medical and OSHA requirements are easy with .1 microAmp current resolution.

FULL RANGES FOR UNIVERSAL TESTING: Here are 28 full ranges to cover your measurement needs all the way up to 2000 Volts DC, 1000 Volts AC, 2000 milliAmps on current, and 20 Megohms of resistance. The Hi-Lo Ohms function checks resistances in solid state circuits, without disconnecting components.

IT'S RUGGED

RUGGED OUTSIDE FOR THE FIELD: The compact and comfort-designed case looks stylish, yet it is built tough and rugged to take the use and abuse a field meter gets. It's built in an unbreakable Cycolac® case, the same material automobile bumpers and football helmets use, to withstand ten-foot drops that would shatter other meters. All mechanical components are thoroughly ruggedized, including the high-quality computer-type circuit boards and switches.

TOUGH AND PROTECTED INSIDE: You really don't know what the voltages are when you start to troubleshoot defective circuits. That is why triple-protection was built into the DVM37 to keep it working day after day. Exclusive 8000 Volt transient spark gap protection saves damage from the 5000 Volt spikes at a horizontal output tube plate and other transients, such as back EMF motor surges and line transients. Continuous 2000 Volt diode protection, with back-up fuses, further prevents damage to all the DVM37 ranges, including the lowest Ohms range. It's virtually burnout proof, and is the only .1% portable DVM to offer such protection at no extra cost.

IT'S EASY TO USE

DIRECT-READING DIGITAL DISPLAY: Your circuit measurements have never been so fast nor so easy to make as with the all direct-reading DVM37 digital display. The big and bright 3½ digit L.E.D. (light emitting diode) display shines from across the room. Special Auto-Zero, Auto-Polarity, Auto-Decimal, and Auto-Overrange circuits practically do all the "thinking" for you for fast, error-free interpretations every time.

BATTERY POWERED FOR THE FIELD: The DVM37 is completely battery powered from standard "C" cells for unlimited "prime standard" measurements anywhere. Your batteries will last and last, too, with an exclusive "Push On" button switch in the probe to save battery power between measurements. Press the button only as you make your measurement. The DVM37 draws absolutely no current between tests when you release the button.

AC-POWERED FOR THE BENCH: You may wish to plug the DVM37 into the low-cost PA208 Power Adapter accessory and use the bypass On-Off switch on the front panel for continuous power on the bench.

IT'S VERSATILE

AC power for the bench
–PA208 Power Adapter $9.95
Plugs into DVM37 for AC power operation or recharging NiCad batteries.

High voltages to 50,000 Volts
HP200 50KV High Voltage Probe . . . $25.00
Slips over the probe for voltage checks all the way to 50,000 Volts. Simply multiply your reading by 100.

DP209 RF Demodulator Probe . . . $14.95
Directly measures average RF voltages on any DC Volt range from 400 KHz to 150 MHz (usable to 250 MHz) at 500 mV to 50V sensitivity.

10 most often asked questions about the new Sencore DVM37 Digital Multimeter

...and answers from the design engineer

by Marlin Westra, Sencore Digital Design Engineer

I am Marlin Westra, the chief design engineer on the DVM37 Digital Multimeter. My background is teaching and answering questions, as I came from the teaching profession and directed the Physics Department of a local college for seven years before coming to Sencore. I was working on my doctorate at Texas A & M, and working on new technology when I became interested in instruments. This brought me to Sencore in charge of the new technology lab. My job includes travels out to government offices, other manufacturers, some Tech-A-Ramas, and I run the Educational Division at Sencore, where we bring other engineers up to date.

Here are 10 of the most often asked questions that I run into concerning the new and unique DVM37 .1% DCV accuracy digital multimeter, and the answers that I give. I hope that these questions are the same that you generally have about a digital multimeter and I hope that the answers convince you that Sencore stands head and shoulders above anyone else in this field in building the digital meters that you need in your business.

1. Before you get into the new DVM37, would you mind jogging my memory on the advantages of a DVM over the analog meter?

Ruggedized Accuracy

Fast, easy-reading direct digital readout without interpretation errors.

I had thought that most technicians and engineers knew the advantages of a digital multimeter over an analog by now, but this question continues to come up as thousands of people continue to ask this question as they are making the big switch to digital. They want to be sure that they are making the right decision, and I certainly understand why this question must be answered again and again. I personally never use an analog anymore because it seems old-fashioned to me, and there are four big reasons why I feel this way. I would like to share these thoughts with you.

A digital meter is direct-reading and error-proof

There is absolutely no reading interpretation when you read a digital multimeter. The numbers that light up in the display are exactly the voltage, current, or resistance value that you have. Even the decimal point moves automatically for you so you never have to guess at that either. For example, a measurement of 95.4 Volts reads 95.4 Volts and what you read in the window is exactly what you have. This is not true on an analog meter, as you have to determine the scale to read, the multiplier range to multiply by, and of course, the old problem of parallax error, as we have shown you here on one of the older Sencore analog meters.

A digital meter is easier and faster to read

Touch the DVM37 test probe on a given test point and a readout number pops into the display window in a fraction of a second. There is no time required for the old-fashioned needle to settle down. There are no ranges to interpret, or misinterpret. There is no time spent on multiplying the range times the scale reading. The DVM37 digital L.E.D. numbers are big and bright and can be seen without eyeglasses by nearly anyone, even at a distance should you decide to put your digital multimeter high on the bench. It is what you don't have to do to make measurements with a digital multimeter that really counts. There are even less ranges to switch than there are on an analog. In some cases, you don't switch ranges at all for normal service because increased accuracy and less circuit loading gives you a reasonable reading for all tests. For example, you can set a Sencore DVM38 on the 200 Volt range and service a Zenith solid state TV receiver all day long without ever switching a range. That's speed to move you along in lab, field, or on your bench.

A digital meter is not affected by magnetic and RF fields, so you can measure accurately anywhere

I want to make it clear that we are not speaking for other digital multimeter companies when we say that all digital meters can be operated in these magnetic fields. As a matter of fact, we are told by many radio and TV stations that only Sencor

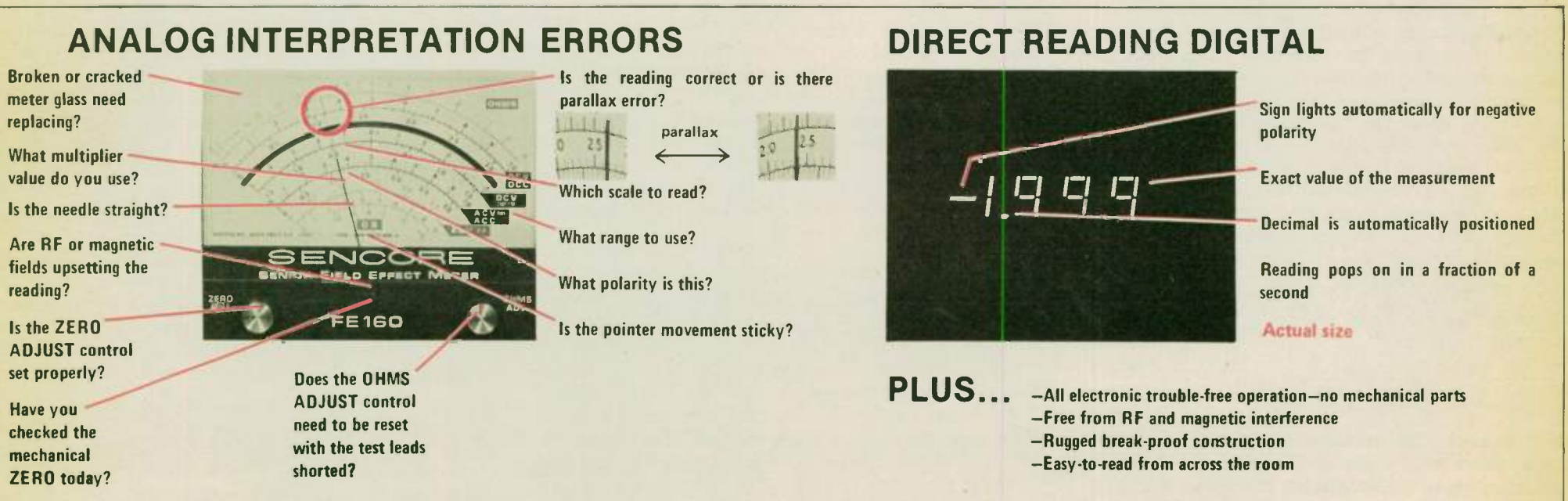


Fig. 1–Comparison of analog and DVM readings. Which do you think is easier to use?

will operate right in their transmitter rooms. We have found that other digital multimeters may not have adequate shielding or rejection at this frequency level to operate with stability. We use the Sencore digital multimeters in places in our Sencore factory where we cannot use analogs.

For example, here is our DVM37 used right next to our big automatic Diacro punch press that has large servo motors and huge magnetic fields. The DVM37 operates like a champion without a single number jump as we approach the machine. Our communication department uses the DVM38 right in the middle of the two-way communication lab, where every imaginable frequency is being generated and transmitted around the room. The Sencore FE160 analog multimeter is obviously affected by magnetic fields, because the meter itself operates by magnetic action, so it just won't sit still in that room. I know this to be a big disadvantage and well worth mentioning to you when you are considering your next multimeter.

Fig. 2—The DVM37 can be used in high power motor and RF fields that would render analogs and other DVMs useless.

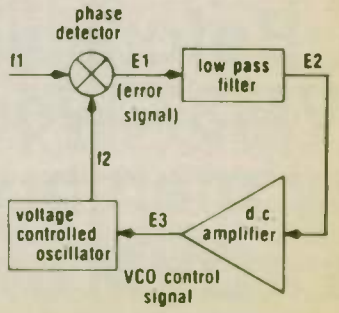
A digital meter is more rugged and less troublesome because it has no mechanical or moving parts

How many times have you had an analog meter jump off pivot or have a sticky pivot? The Sencore DVM37 has no pivot, because it has no meter. This is an age-old problem that can quickly be avoided with an all-electronic system, as you have on Sencore DVMs. Likewise, there is no meter to break, no repair bills to pay, or down time on your multimeter because the meter is in the shop being repaired. Analog meter prices have more than doubled this past three years, and you may be in for a great surprise if you have one replaced these days. Light Emitting Diodes (LEDs) used in the DVM37 are known for their long life and continue to work and work without interruption. We are moving into the computer technology in electronics and everyone is learning to do things by the number. The advantages are great and that's why Sencore no longer manufactures a single analog meter, but makes five digital models to fill nearly every need. We, too, want to do things by the number and stay up with today's technology, because it has so many advantages.

2. The Sencore DVM37 has .1% DCV accuracy; where would I need such accuracy in practical applications?

Ruggedized Accuracy

PLL, VCO, digital and IC circuits operate with critical voltage changes.



This is a very good question and one that I could speak on all day. There are just too many circuits that require correct measurement to a fraction of a volt today for me to possibly cover all of them in this Sencore News. I will give you a few examples to show you the trend in this direction and explain why we are moving toward more critical measurements every day.

Circuit operation has changed drastically with all solid state operation. It used to be that B plus voltage was commonly measured at 200 or 300 Volts. Biasing voltages were often 3, 4, or even 15 or 20 Volts. A half Volt biasing difference usually indicated trouble in the circuit and it did not take a critical instrument to measure a half Volt to a reasonable accuracy. Solid state circuits changed this thinking quickly as B plus voltages dropped to a few Volts and biasing voltages, feedback control voltages, etc. dropped to a few tenths of a Volt and less. It became necessary to measure to a tenth of a Volt and even a hundredth to be sure that we were correct. Our old-fashioned 20,000 Ohm per Volt meter suddenly became totally inadequate, because it operated at its greatest error level in the lower voltage ranges used in solid state circuits.

Manufacturers spec IC voltages to hundredths of a Volt.

New, integrated circuits (ICs) have placed new accuracy demands on our multimeters, as we see here in a typical video — IF — AGC color chip that we have extracted from a Howard Sams schematic. Voltages are no longer shown in Volts and half Volts, but rather in hundredths of a Volt, as 6.78 Volts is shown here. To quote a well known TV service ace in our community "That voltage indicated on those IC chips may not be super important, but it is the greatest lead to trouble in an IC that I have ever seen and a digital multimeter is my greatest weapon to locating a defective chip". He went on to explain that one must be absolutely sure that the chip is faulty before disconnecting up to 28 leads, making a trip to the parts distributor and waiting for a part, only to find that the trouble was elsewhere.

These voltages are shown in fractions of a Volt because the TV manufacturer wants you to measure them in a fraction of a Volt. They are very aware of the demand that this puts on your equipment, but the manufacturers specify these voltages to a hundredth of a Volt because that measurement is important.

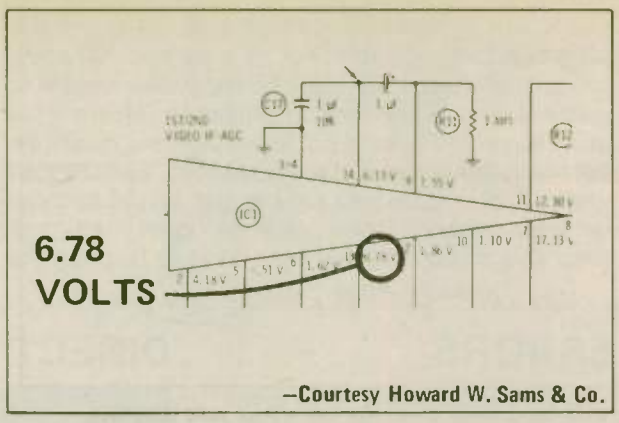


Fig. 3—A DVM can be your greatest weapon for troubleshooting IC voltages that are listed to a hundredth of a volt.

.1% accuracy needed for PLL, VCO, automatic circuit tests.

Many new circuits are popping up on the scene where small voltage changes make big things happen. Here, for example, is a new Phase Locked Loop Circuit in an Admiral Digital "Touch Type" tuner. The tuner is operated at 24 volts, but a small voltage change of only .34 Volts changes the tuner to the next channel. One must be able to monitor these voltage changes as channels are changed, to determine correct operation of the tuner feedback system. The same measurement requirements are necessary in varactor tuners,

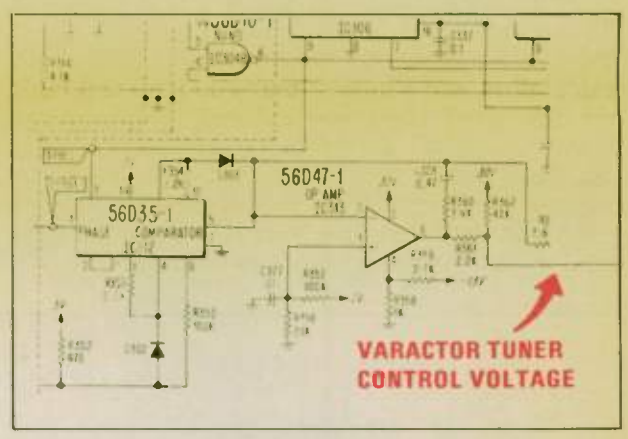


Fig. 4—A digital's accuracy and resolution are needed in this Admiral varactor-controlled tuner in which a .34 Volt change moves the tuner to the next channel. —Courtesy Admiral

digital clock oscillators, and other state of the art circuits.

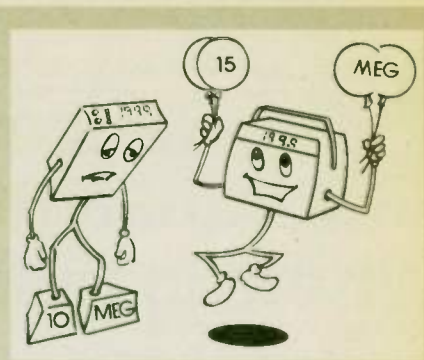
New automated factories, printing plants, automated mining, and automation in nearly every phase of our daily work, has created voltage controlled circuits that perform tasks as small voltage changes direct servo mechanisms to do their job.

Is .1 percent accuracy needed for correct measurements in these critical circuits? We could go through the math with you to show you just how much each measurement error would produce and let you ascertain this answer for yourself. But let's do the flip side of that and simply say "the more accurate the better" and you just can't get more accurate than .1 percent from a practical performance/cost ratio. Why not have the most accurate .1% DCV multimeter—the DVM37?

3. Why does Sencore think 15 Megohms input impedance is so important, when all others have 10 Megs?

Ruggedized Accuracy

15 Megohm input has 1/3 less circuit loading.



For the life of me, I don't see why technical people don't want to talk about circuit loading. I suppose it is because they seldom have a separate meter with less loading to compare readings to. Circuit loading is a real factor on virtually all voltage measurements and is most pronounced in low voltage—high impedance circuits. Let us take a look at what drastic loading really looks like, if you are still trying to use a 20,000 Ohm per Volt meter in some of these circuits.

An example shows how loading affects each measurement.

Here we have two one Megohm resistors connected to a six volt supply as a voltage divider, such as you might find in solid state bias circuits. If we connect a 20,000 Ohm per Volt meter across one of the one Megohm resistors to measure voltage, and put the meter on the 10 Volt range, we have placed 200,000 Ohms directly across the 1 Meg resistor. If we multiply 200K times 1 Meg and divide by 200K plus 1 Meg, we have an effective resistor of 166K. The voltage is now divided between 166K and the 1 Meg resistor on top. The measured voltage is calculated by dividing 166K by 166K plus 1 Megohm, and multiplying it by the 6 Volts applied. In this case, we measure only .85 Volts, generating a whopping 72 percent error into the measurement! Now, there is a possibility that you won't believe my calculation and I suggest that you stop and build up this circuit right now and make this measurement to see that your 3 Volts truly measures only .85 Volts and becomes meaningless. Perhaps you can see why technicians and engineers no longer trust a 20,000 Ohm per Volt meter and are stepping up to something they can trust.

Sencore DVMs have an input impedance of 15 Megohms while all others on the market have a 10 Megohm input. This doesn't seem to be a great factor until you begin to establish accuracies like .5 percent or .1 percent as we have on the DVM37. Let us take a good look at the additional error introduced by a 10 Meg DVM by building up lower impedance voltage dividers that are super practical in today's electronics.

Proof that the 15 Megohm DVM37 is more accurate than others.

Let's use the same six Volts again and reduce the voltage divider resistance down to 5,000 Ohms in practical steps to see the additional error that is introduced. Two 100K dividers, measured with a 10 Megohm input DVM will have an additional 1.7 percent error introduced over the same measurement with a 15 Megohm input meter. Studying the table of measurements further, you will note that the 10 Megohm DVM introduces one third more error at 20,000 Ohms and you have to reduce the divider all the way down to 5,000 Ohms before the two meters read approximately the same. Putting this altogether, we can simply say that all digital multimeters look pretty much alike up to a 10K circuit resistance, but then the one third less loading error on the Sencore digital multimeters becomes a real factor as the stated accuracies on other meters are outweighed by their circuit loading.

Let's verify the results of these computations with an actual circuit test in the two unretouched photos shown. We are measuring right at the gate of the FET oscillator and the 10 MHz crystal used in a 10 MHz clock oscillator of a digital countdown circuit. It won't take you too long to note that the DVM using a 10 Megohm input loads the circuit by 0.35 Volts more than the 15 Megohm input DVM37.

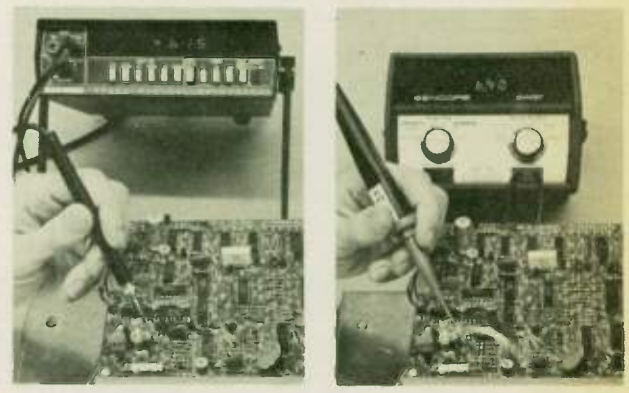


Fig. 7—Standard .1% DVM with 10 Megohm input adds .35 V loading error over the .1% DVM37 with 15 Megohm input.

I should mention also, that if you wish even less circuit loading than the standard 15 Megohm input, you may press the button on the probe marked "ISO DCV X2" to increase the total input impedance to an unbelievable 30 Megohms. This "double duty" feature of the Isolation resistor (which we'll discuss in more detail later) is especially useful when you need to measure critical voltages in high impedance circuits over 1 Megohm impedance. Only the DVM37 lets you go this far to minimize your circuit loading errors for accuracy you can count on in virtually all uses.

These are the reasons why, in practical circuits around our lab, I have found that I am even better off with a .5 percent 15 Megohm digital multimeter than I am with a .1 percent 10 Megohm digital multimeter, simply because I am actually more accurate more times. I consider 15 Megohm input impedance necessary for a .1% digital multimeter to be meaningful. You should be able to see why we say that the DVM37 is the most accurate .1% portable DVM you can buy, without any exceptions, because of one-third less circuit loading 15 Megohm input impedance.

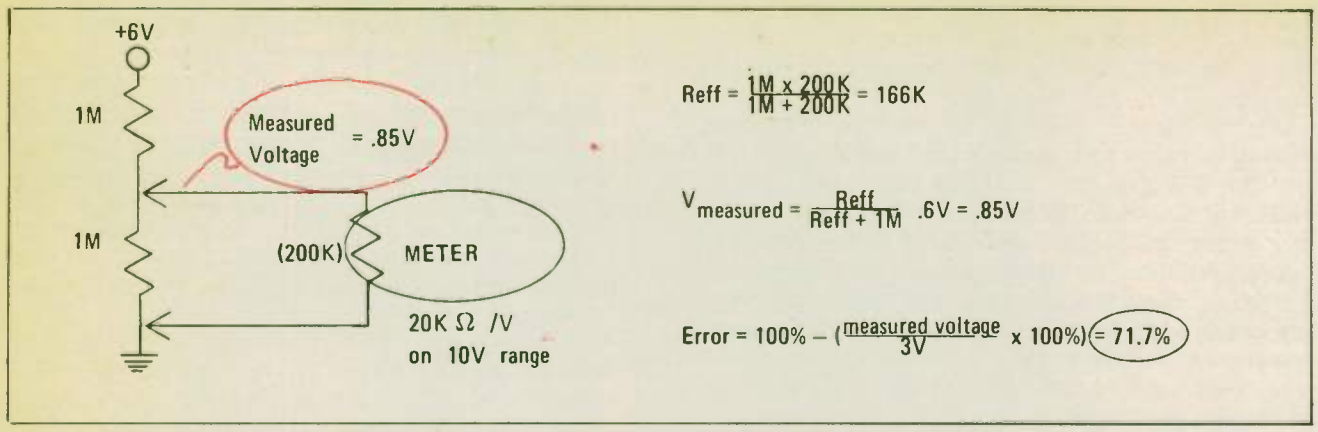
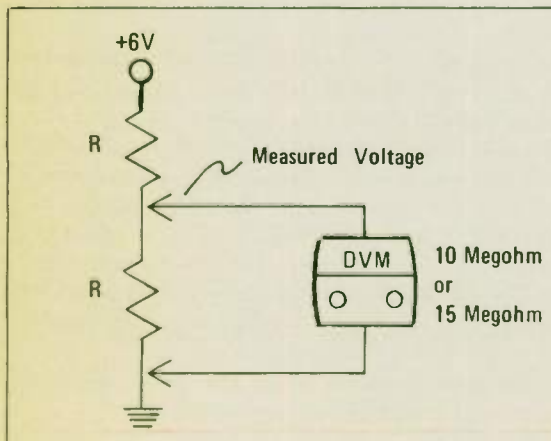


Fig. 5—A whopping 72% loading error calculated here shows why standard VOMs are virtually useless for low voltage solid state tests.



ACTUAL R	10 MEGOHM INPUT — EFFECTIVE R	VOLTAGE MEASURED	LOADING ERROR	15 MEGOHM INPUT — EFFECTIVE R	VOLTAGE MEASURED	LOADING ERROR
100K	90.9K	2.85V	5.0%	93.7K	2.90V	3.3%
50K	47.6K	2.93V	2.3%	48.4K	2.95V	1.7%
20K	19.6K	2.97V	1.0%	19.7K	2.98V	.7%
10K	9.9K	2.98V	.7%	9.9K	2.98V	.7%
5K	4.97K	2.99V	.3%	4.97K	2.99V	.3%

EFFECTIVE ACCURACY

Fig. 6—Sencore's exclusive 15 Megohm input impedance delivers 50% greater effective accuracy than standard 10 Megohm input DVMs.

4. The Sencore DVM37 has an 8KV transient input protection. Where in the world do I need that?

Ruggedized Accuracy

Triple-protection prevents damage from unexpected overloads

The Sencore DVM37 internal circuits are critical in that they must measure to a tenth of a volt accuracy and normally operate on approximately five volts. This presents no problem if everyone used their digital meters as they should and set them on the right range, because the voltages are simply divided down to proper measuring levels. Human nature being what it is, Sencore has to protect against simple operator error by believing that sooner or later you will use the DVM37 on the wrong range or have the meter on Ohms when it should be on a high voltage range. For this reason, we have found it necessary to triple-protect the DVM37 against accidental application of the wrong potentials, so you never need to worry about meter downtime and damage.

Diode protected voltage and ohms ranges

The easiest way to take care of excess voltage is simply to limit the amount of voltage that is allowed to pass into these highly accurate circuits. A conventional diode serves us well, as the threshold level can be used to pass small voltages under .6 Volts to the measuring circuits and limit

Fig. 8—The DVM37 simply winks at 120 Volts AC line voltage applied on the 200 Ohm range because of built-in diode protection.

other voltages above .6 Volts. A number of special diodes are used on the voltage and resistance ranges, both positive and negative, to protect these ranges to a whopping 2000 Volts. This means that you can place any Sencore digital meter on Ohms and apply it directly to the AC outlet (as an example) and you will not damage your meter. Try that with your analog meter and see what you get . . . Crispy Critters and a repair bill.

Current ranges protected with a fuse and as a backup to the diodes

It is pretty obvious that diodes cannot be used to protect against current that must pass through the meter for measurement. A 2 Amp fast blow fuse is placed in series with the current path in the test lead to protect against any sudden rush of excessive current of more than 2 Amperes. A second fuse, conveniently located in the battery compartment, backs up the diodes on the voltage and resistance ranges to prevent the diodes from dissipating excessive power (when overload is applied for a long period of time) and blowing the diodes themselves. This means that the diodes do the main protecting on voltage and ohms,

Fig. 9—Current ranges are fully protected against overloads above two Amps with a handy fuse in the probe.

and the fuse is there to back up the diodes so they don't blow. (It is simpler to change a fuse at the end of the test probe than a diode.) Spare fuses are located in the battery compartment so you are always back to work in a jiffy.

8 KV spark gap used to protect against transient overload

Two thousand Volt protection sounds like a lot of protection and one would think that this would be adequate for all practical applications. Yet, our initial field testing on the DVM37 showed that one service technician, one medical technician, and one electrician each managed to find transient spikes that damaged our prototype DVM37. Investigation showed that none of these techs thought they were measuring above 2000 Volts, but a check of the instrument showed that they did. They didn't know that they were measuring above 2000 Volts because there was no way to easily measure a transient. A field check showed that the electrician was getting a line kick from the back EMF on a large motor when he turned it off. The medical tech was getting next to high voltage on X-ray equipment and the TV tech was getting a large spike in his boost voltage when his bleeder network was open in a defective TV. We went back to the drawing board and soon we developed the installation of a device called a spark gap, connected directly across the input leads, that will directly shunt any transient spike to ground. The improved DVM37s were sent back to the same test shops and none of them could blow the DVM37 under these adverse conditions, even when they tried to. They also found the spark gap presented little danger to the equipment under test because the transients were of such short duration.

Just how good is the spark gap for protection? A color TV set with high voltage spikes to spare certainly represented a challenge to our DVM37. Could we accidentally touch 6 KV plate cap of a horizontal output tube and survive? Our field engineers tried it and wound up blowing out a 6CD6 horizontal output tube after about 20 tries, but the meter kept on working. Our field engineers quickly put this "acid test" into Quality Assurance line testing. Electric fencers with the same 6 KV to 8 KV spikes were purchased to test every single DVM37 manufactured on the production line before they were shipped to our distributors. The DVM37 is the only .1 percent digital meter with continuous protection from

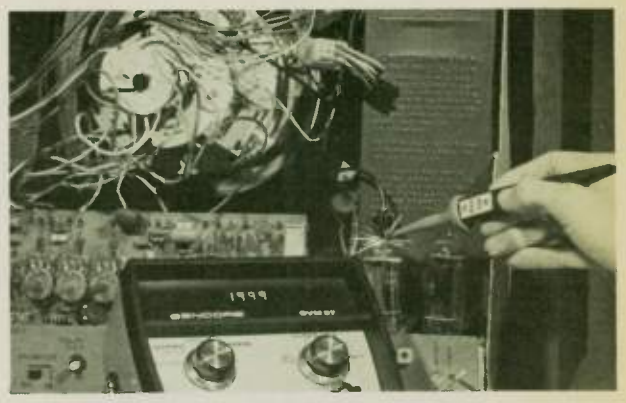


Fig. 10—Would you dare to measure the 5000 Volt spike from a horizontal output tube with any meter other than the DVM37?

one volt to eight thousand Volts on every function on every range on the market today. I'm sure you'll appreciate what this one-of-a-kind protection means to you in added confidence.

Test leads hard wired into the circuit for added protection and accuracy assurance

The first DVM37 prototypes had detachable leads, but our field testing revealed some amazing findings. The jacks themselves would usually break down before the 2,000 Volt protection level was reached. What good is all this protection if every commercially available jack won't stand up to the overload protection of the input circuit of the DVM37? Additional testing in a salt spray bath showed resistance buildup in the contact, causing minor errors in the low Ohms range and in the current measurements, as well. The decision was made to hard wire the test leads directly to the spark gap for continuous protection that could be relied upon and accuracies that could be counted on. This in no way was an omission, but our opportunity to serve you with an instrument that will give you that ruggedized accuracy for years to come. The leads can be quickly wrapped around the carrying handle, and you are on your way to the next job without fear of leaving them behind.

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5. Just how ruggedized is the DVM37? Can I be absolutely sure I can drop it and not have to replace something?

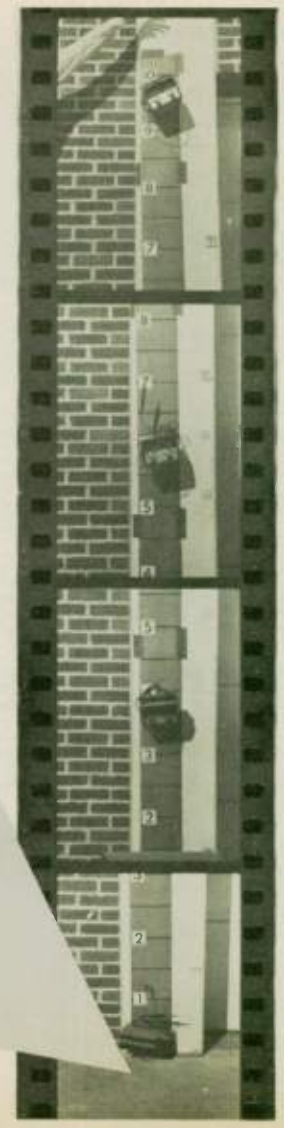
The DVM37 is made for the bench or field. Knowing that it will be transported, we set out to ruggedize the circuit board, the inter-connections, and the case itself as well as all integral parts that fit onto it. We know what a job it is to keep running in and replacing that old-styled plastic case, and certainly wanted to prevent that on the DVM37. We tried a competitive lower-priced DVM on the market and found that it was in seventeen pieces after a ten-foot drop test on a steel plate.

We certainly wanted to prevent that should you accidentally drop your DVM. The DVM37 was mechanically designed to withstand this same 10-foot drop test without breaking a single thing inside or out. The case is made of tough Cycolac® material by the same company that makes football helmets and car bumpers. Heavy duty flexible circuit boards were used to prevent damage inside the instrument. Let us photograph a ten-foot drop for you in slow motion and then show you that the DVM37 will still be working just as accurately as it was before the drop.

Tug-proof test leads, too.

Ever dropped a DVM? What do you do? You grab for the test leads and they pop off in your hand. Not the DVM37, as the test leads are tested by dropping the DVM37 and grabbing the leads to be sure they don't pull off. They are hard wired in, too, and won't pop off in your hand. We know that you don't intentionally drop your DVM, but it does happen and Sencore wants to be sure that you can pick it up again, brush it off, and put it back to work. That's what we called ruggedized accuracy.

Fig. 11—Here's the proof that the DVM37 keeps on working after a ten-foot drop when other DVMs are shattered.



Ruggedized Accuracy

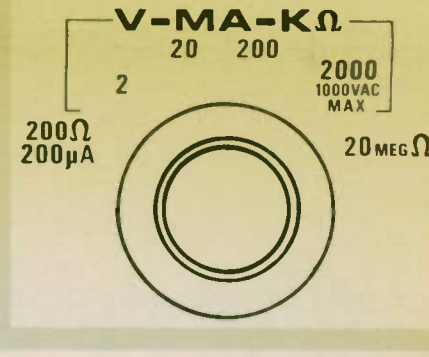
It's super-rugged with unbreakable Cycolac® case.

Other DVMs don't survive

6. Does the DVM37 have the voltage, current and resistance ranges I need? How about isolation from the circuit I am testing?

Ruggedized Accuracy

Greater ranges for less money than other DVMs available.



This is the first question I always ask myself when starting design on a multimeter. I believe that we have given our customer practical ranges with practical limits. Let me cover them with you to show you what I mean.

Four DC and AC voltage ranges

Ranges were kept to a minimum to avoid range switching and still maintain a DC accuracy .1 percent of reading and .5% AC accuracy. Note that I said "percent of reading", not full-scale, as is often done on many other digital multimeters, even the high-priced spreads on the market. Full scale accuracy does not mean that you will get .1% accuracy at the point you are reading throughout the range from top to bottom, and is actually an additional error not expressed.

There are four voltage ranges in all: A 2 Volt range, a 20 Volt range, a 200 Volt range, and a 2000 Volt range. These are all directly applicable on DC but we have to limit the AC voltage usage to 1000 Volts RMS (as do all others), because we are really measuring 2800 Volts peak-to-peak and additional AC voltage input would far exceed the 2000 Volt protection. If you should accidentally apply more than 1000 Volts AC, the spark gap is set to shunt the difference to ground and thus avoid circuit or switch damage.

That pretty well covers the high end voltage measurements. What about the low end measurements where you may want to measure a bias by placing the probes between emitter and base? Here is where the DVM37 performs like a champion with capability of measuring all the way down to .001 Volts (one milliVolt) to detect any minor change. The DC voltage range can be extended to 50 KV, too, with the addition of the HP200 50 KV High Voltage Probe for checking anode voltages in CRT high voltage supplies.

Five AC and DC current ranges from 200 microamps to 2 amps

A VTVM and a Digital Multimeter both have constant input impedances on all ranges and are superior to a volt ohmmeter in this respect. The

Fig. 12—Low, low 200 microAmp range measures medical and OSHA leakage currents with ease and accuracy.

big advantage of a digital multimeter over a VTVM is it's current measuring capability as we most often measure in today's solid state circuits that employ current amplifiers. The DVM37 measures from a low, low 200 microAmp range for OSHA and medical leakage tests and the like. Likewise, one owner reported he found this current sensitivity to be important for measuring the 6—8 microAmp flame current in gas heating and air conditioning systems. You might imagine that something this delicate would be limited to low level measurements, as leakage tests often are, but the DVM37 jumps right back and measures up to 2 Amperes and even to 20 Amperes with a specially constructed current shunt shown in the service manual. This is a good example of the ruggedized accuracy that we designed into your DVM37. Accuracy is .3% on DC current and 1% on AC.

Six resistance ranges from 200 ohms to 20 megohms with .2 percent accuracy

A good accurate digital multimeter most certainly would not be complete if it didn't have good accurate full Ohms range reading capability. The DVM37 has six resistance ranges from 200 Ohms to 20 Megohms at an unbelievable .2 percent accuracy. Resistors can be measured as low as .1 Ohms in those critical transistor output stages, such as in audio circuits that use .47 Ohms in the emitter of the output transistor. These

resistors must be measured accurately because they set the bias for the stage, thus determining the amount of distortion introduced into the system. We would have liked to have put in fewer ranges to reduce range changing, but needed the full six ranges to maintain vast coverage all the way to 20 Megohms to check those focus resistors and such; many digital multimeters stop at 10 Megs and just won't reach.

Circuit isolation built into test probe

There is nothing more frustrating than placing the test probe on the element of an oscillator

Fig. 13—Isolation switch in the probe isolates the test lead capacity to prevent upsetting critical oscillator circuits during tests.

stage to find that the input capacity of the DVM changes the oscillator frequency or shunts the feedback signal to ground, thus reducing the output or killing the stage. This is taken care of very easily in the DVM37 by a large 15 Megohm isolation resistor placed in series with the test lead at the end of the probe before the capacity is introduced, and switched in as you need it. 15 Megohms was chosen so that you could automatically multiply any voltage reading by 2, still get a direct reading, and maintain your meter accuracy. It is worth mentioning that the 15 Meg resistor can be used to double your voltage reading capability without the need to switch up a range.

7. Tell me more about those battery-saving features. I'm tired of replacing batteries in that cheap import model.

Ruggedized Accuracy

Exclusive battery-saving "Push On" button in the probe.

We get this question all the time. "Tell me more" they say. Do you really turn off all the current when you release that button on the test probe after the measurement? The answer is very simple; yes, we do. We turn off the entire current drawn from the battery when that button on the end of the probe is released. Simply click the button marked "Push On" to get your reading and let it go when you're done. As a matter of fact, this is one more reason that the leads are hard wired in, as they serve as a part of the on-off switch.

Just how long will the batteries last? This depends strictly on how much you use your DVM37. The DVM37 draws current only when you use it and draws nothing in-between, which is even less than your digital watch. What's more, it is the only digital multimeter on the market that completely turns the power supply off when tests are not being made, and battery life is extended to many times any other.

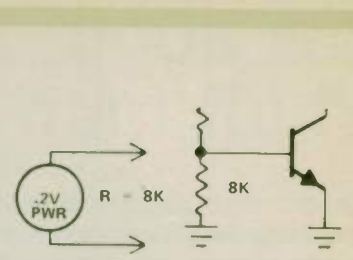
There are times, too, when you want to monitor a circuit and want to leave the DVM on. This is taken care of with a by-pass on-off switch on the front panel. Even then, battery drainage is lower than most DVMs at only 100 milliAmps for the entire meter, including the display. Batteries are easily checked by using the DVM37 to check itself by simply inserting the test probe in a special opening in the rear panel, making contact, and reading the meter for a minimum of 4.8 Volts. How's that for simple operation.

Finally, easily-purchaseable standard "C" cells are quickly replaced by loosening a screw in the rear and flipping the door open. In short, the DVM37 lets you leave battery drain worries at home as you take it's ruggedized accuracy with you for virtually unlimited use anywhere, anytime.

8. What does Hi-Lo Ohms do? How do I use this feature in my work and today's circuits?

Ruggedized Accuracy

Lo Power Ohms measures resistances in solid state circuits without turning on semiconductors



Hi and Lo Power Ohms functions have been used on meters for some time, but many techs and engineers still don't seem to understand what this important feature can do for them, and how they often unnecessarily waste precious time in servicing solid state circuits. I'd like to explain why Hi-Lo Power Ohms is so handy for solid state.

You know that if you place more than .6 Volt or so across a semiconductor junction that the junction (whether it be in a diode, rectifier, transistor, or FET) will turn on and conduct. Thus, when you measure a resistor in a solid state circuit using a typical ohmmeter with more than .6 Volt potential across the leads, you just might turn on one or many junctions as you make the test. The result is an ohmmeter reading that is much lower than the actual resistance because of the current shunt paths through the junctions. One solution, of course, is to drag out your soldering pencil and disconnect at least one end of the resistor.

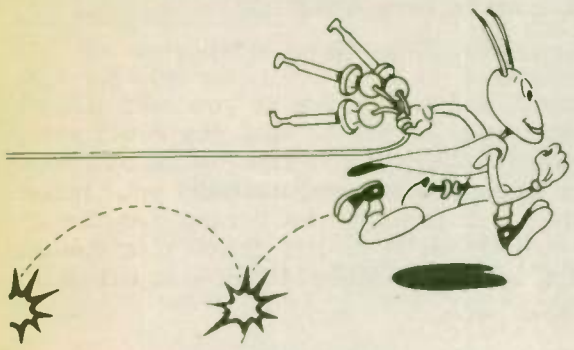
In-circuit resistance checks with Lo Power Ohms

How does Lo Power Ohms prevent these in-circuit resistance test errors without disconnecting components? We are simply lowering the battery voltage across the test leads to below the conduction level of diodes and transistors so they won't conduct and read too low when we measure circuit resistance.

There are times when you want the higher voltage of 1 Volt for checking the forward to reverse ratio of diodes, rectifiers, transistor junctions, and the like. Simply switch to the Hi Ohms position and one full Volt is supplied at the probe tip to turn these semi-conductor devices on. Either Hi or Lo Ohms can be used for normal resistance measurements with the same accuracy. The choice is yours, as only Sencore provides it on all ranges.

Fig. 14—Lo Power Ohms equips you to measure resistances in-circuit without unsoldering components or switching leads.

Now hop through your solid state jobs



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KLAUS RADIO, 905 West Neil Street, (217)356-1896
CHICAGO
B–B&W, INC., 2137 South Euclid Avenue
(Suburban) (312)749-1710
(Chicago) (312)242-1533
HOWARD ELECTRONICS SALES, 4573 South Archer Avenue (312)254-1777
NORTH CENTRAL ELEC. SUPPLY, 3412 West Bryn Mawr (312)588-6012
U. S. RADIO & TV SUPPLIES, 6343 South Western Avenue (312)925-4111
ELGIN
ALLIED, 1355 McLean Blvd.,(312)697-8200
ELK GROVE VILLAGE
RETCO ALLOY CO., 880 Estes Avenue, (312)593-7770
JACKSONVILLE
BESCO, INC., 419 South Mauvaisterre, (217)243-6464
*SPRINGFIELD, 1023 Dorlan, (217)753-0111
LA SALLE
KLAUS RADIO, INC., 227 Bucklin Street, (815)223-7400
MATTOON
MATTOON RADIO & TV SUPPLY, 400-404 South 21st Street (217)235-5457
PEORIA
KLAUS RADIO, INC., 8400 North Pioneer Parkway (309)691-4840
WARREN RADIO, 800 S. W. Jefferson, (309)674-5998
*LA SALLE, 518 3rd Street, (815)223-4028
* STERLING, 110 2nd Avenue, (815)625-6253
QUINCY
KLAUS RADIO, INC., 1008 Jersey Street, (217)223-7560
ROCKFORD
JAY-TRONICS, 124-128 North Rockton,(815)965-8786
ROCK ISLAND
* TEAM NO. 22, 1714 5th Avenue,(309)788-9595
SPRINGFIELD
BRUCE ELECTRONICS, 1120 East Capitol Avenue, P.O.Box 115 (217)528-7523
STERLING
* WARREN RADIO CO.,110 2nd Ave.,(815)625-6253

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ELECTRONICS SUPPLY, 910 7th Street, (812)275-5941
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ACRO ELECTRONICS CORP., 1101 West Chicago Avenue, (219)397-8681
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WARREN RADIO, 742 South Main, (219)295-4205
EVANSVILLE
HUTCH & SONS, INC., 300 North Main Street, (812)425-7201
FT. WAYNE
FORT WAYNE ELECT.SUPPLY, 3606 East Maumee Ave.,(219)423-3422
PEMBLETON ELECTRONICS, INC., 513 East Wayne Street, (219)743-1812
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GRAHAM ELECT. SUPPLY,INC., 133 South Pennsylvania Street (317)634-8486
* MUNCIE, Muncie Electronic Supply, 222 North Madison Street. (317)634-8202
3606 East Maumee Avenue (219)423-3422
WARREN RADIO, 732 North Capitol Street, (317)634-5566
RICHMOND
RODEFELD CO.,INC., 96 West Main St., P.O.Box 1424 (317)966-3505
* INDIANAPOLIS, 8641 East 30th, (317)898-0670

IOWA

DAVENPORT
KLAUS RADIO, 322 East Fourth Street, (319)323-9761
WARREN RADIO, 1205 East River Drive,(319)322-5301
* BURLINGTON, 2500 Mt. Pleasant, (319)752-1842
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* MARSHALLTOWN, 311 South Center, (515)752-0518
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*SALINA, 809 South Broadway, (913)823-6353

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BOWLING GREEN
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* HOPKINSVILLE, 729 East 4th Street, (502)885-5357
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* HUTCH & SONS, INC., 212 North Franklin, (502)821-4334
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HUTCH & SON, 1421 Triplet, (502)684-6285
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* PADUCAH ELECTRONICS, 2601 Broadway,(502)443-1722
WARREN RADIO, 455 S. 31st.,P.O.Box 1250,(502)442-4367

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RALPH'S RADIO, 3004 Cameron Street, (318)233-0105
* MORGAN CITY, 715 Brashear, (504)384-9831
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RALPH'S RADIO, 911 4th Avenue, (318)439-2493
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*DAVID WHITE ELECTRONICS, 309 Walnut, (318)322-5136
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SHULER SUPPLY CO., INC., 2504-06 Tulane Avenue (504)822-2251
*GRETNA, 1728 Hancock, (504)368-2455
* METAIRIE, 112 Woodlawn, (504)834-1174
SOUTHERN RADIO, 1909 Tulane Avenue, (504)524-2343
* BATON ROUGE, 2610 Scenic Hwy., (504)355-0396

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* RSL DISTRIBUTORS' INC., 117 Anderson Street, (207)773-0297

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TRI-TRONICS, INC., 8843 Belaire Road, (301)256-4400
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HYATTSVILLE
MARK ELECTRONICS, 3003 Hamilton Street, (301)559-7700
KENSINGTON
FAIRWAY ELECTRONICS, 4210 Howard Avenue, (301)933-4420
*BALTIMORE, 178 Alco Place, (301)247-8383
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ALLIED ELECTRONICS, 3705 West Street, (301)773-6556
SALISBURY
STANDARD ELECTRONICS , 701 Snow Hill Road, (301)749-7593
* ALMO ELECTRONICS, 317 Park Heights Avenue, (301)742-1393

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WARE RADIO SUPPLY CO., 913 Centre Street, (617)583-0810
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A & W ELECTRONICS, 491 Riverside Avenue, (617)396-5550
* LAWRENCE, Two Franklin Street, (617)685-3377
* NORWOOD, 810 Providence Hwy., (617)769-4850
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CRAMER ELECTRONICS, 85 Wells Ave., (617)969-7700
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GRAHAM RADIO, INC., 505 Main Street, (617)944-4000
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* SIGNAL CENTER, 484 Worthington Street, (413)739-3893
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MIL ELECTRONICS, 27-33 Jones Road, (617)891-6730
WILMINGTON
ALLIED ELECTRONICS, 845 Woburn Street, (617)942-0150
WORCESTER
R. M. ELECTRONICS, 315 Grove Street, (617)756-8311

MICHIGAN

BATTLE CREEK
WARREN RADIO, 93 Bidwell W., (616)965-3338
*DETROIT, 10001 Chalmers, (313)371-9050

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It means that the 1977 prices are held over at your participating Sencore FLPD distributor.

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YOUR SENCORE FULL LINE PROMOTIONAL DISTRIBUTOR

A "prime" standard at your fingertips for measurements you can trust

DVM38
3 1/2 Digit .1% DCV Accuracy
Auto-Ranging DVM $348
($395–Eff.Jan.1,1978)

- **A "prime" standard at your fingertips**

If you're looking for that one meter you can really rely on when the going gets tough, then you want the DVM38 as your "prime" shop standard.

- **Super-accurate .1% into 15 Megohm input**

Measurement instruments just don't come more accurate than the DVM38 with every voltage test super-accurate within .1% of the reading. Plus, the 15 Megohm input impedance guarantees up to 50% greater measurement accuracy when compared to meters with 10 Megohm inputs (even 4½ digit DVMs).

- **Hi-Lo Power Ohms measures from .01 Ohm to 20 Megohms**

Here's the range you need when you need it from .01 ohms resolution all the way to 20 Megohms. Use Lo Power Ohms for resistance checks in solid state circuits and Hi Power Ohms for standard diode tests.

- **Simple to use pushbuttons with automatic operation**

Just push the button and read. Auto Ranging, Auto Zero, Auto-Polarity, and the large finger-sized pushbuttons make the DVM38 so easy to use and easy to read.

- **Highly protected inside and shielded from RF interference**

Go first class at an economy price

New

DVM37 3 1/2 Digit
.1% DCV Accuracy Portable DVM $248
($268–Eff.Jan.1,1978)

- **"Prime" standard portable accuracy for less than $250**

The new DVM37 provides the .1% "prime" standard accuracy you need for tests you can really trust in the field or on the bench. It's a virtual necessity for reliable checks in IC voltage-controlled, or varactor tuned circuits.

- **Most accurate portable DVM with .1% DCV accuracy into 15 Megohm input**

It's 50% more accurate than other .1% meters because of the 15 Megohm input impedance, rather than the 10 Megohm input other meters use. You get one-third less circuit loading on every test.

- **Automatic features at a low, low price**

Includes effort-saving automatic features usually costing a hundred dollars more, such as Automatic Zero, and Automatic Polarity, Decimal, and Overrange. It practically "thinks" for you so you can get on to the next job faster.

- **Fully protected outside and inside**

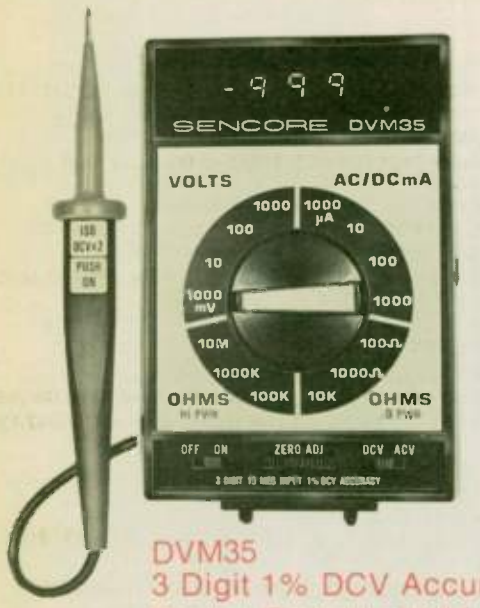
Here's unheard-of protection to 2000 Volts on every function and range down to the lowest ohms range. Extra fuse and high voltage protection equip the DVM37 to withstand 440 VAC motor start-up surges and 5000 VAC horizontal tube spikes, too. It's super-rugged on the outside, too, with a case that is as tough as a football helmet.

- **Full ranges for every test**

PA208 Power Adapter ..... $ 9.95
(Replaces 39G90 previously used)

DIGITAL MULTIMETERS

Fast, direct reading digital accuracy for the man on the go



DVM35
3 Digit 1% DCV Accuracy
Pocket Portable DVM $134

- **1%, 3 digit accuracy**

Put portable 1% digital accuracy in the palm of your hand for up to ten times more accurate measurements than you're getting now with analog meters—at less cost than many high accuracy analogs, too.

- **Tough protection inside and outside**

You won't need to handle the DVM35 with "kid gloves" because it has a rugged Cycolac ® case that takes abuse in stride and tough 1000 Volt protection against measurement errors to save on your instrument repairs.

- **Battery-saving, Push-On Probe**

The batteries won't let you down in the middle of a job since you draw current only when you make a reading by using the exclusive "Push On" switch in the probe. Press the button and the display lights up. Release the button and the power is shut off.

- **Tests resistances in-circuit**

PA208 Power Adapter ..... $ 9.95
(Replaces PA202 previously used)

Pocket portable lab-accurate performance that fits every budget

DVM36
3 1/2 Digit .5% DCV Accuracy
Pocket Portable DVM $158

- **Lab accuracy in a portable meter**

Take the same .5% accuracy that is normally found in the large, expensive shop meters with you to the field in the DVM36. It's pocket-sized lab performance you'll want for today's solid state measurements.

- **Tough protection inside and outside**

You can drop it, overload it with 2000 Volts DC, apply AC voltage to the Ohms scale, and it keeps on working. Internal diode and fuse protection with an unbreakable Cycolac ® case outside keeps the DVM36 on the job rather than in the repair shop.

- **Battery-saving Push-On probe**
- **Tests resistances in-circuit**

PA208 Power Adapter ..... $ 9.95
(Replaces PA202 previously used)

Accessories for all Sencore DVMs:

HP200 50KV High Voltage Probe $25.00
DP209 RF Demodulator Probe $14.95
(Replaces 39G3 previously used)

Bench and field master for digital accuracy measurements . . . anywhere

DVM32 3 1/2 Digit .5% DCV Accuracy
Portable DVM $198
($225–Eff.Jan.1,1978)

- **Tough, portable DVM for today's circuits**

Tomorrow's circuits are here today, and the DVM32 tells you what you need to know in solid state and IC circuits anywhere in the shop or on the job.

- **.5% lab accuracy anywhere**

You get reliable readings every time with .5% DCV accuracy and 3½ digit resolution. Your measurement confidence is backed with 15 Megohm input impedance for one-third less circuit loading than other DVMs.

- **Protected inside and outside**

Forget about burned out range resistors and broken meters with the DVM32's diode and fuse protection up to 2000 Volts DC. Forget about broken cases, too, with the DVM32's rugged case that withstands even a ten-foot drop.

- **Battery-saving automatic display**
- **Hi-Lo Ohms checks resistances in-circuit**

PA208 Power Adapter ..... $ 9.95
(Replaces 39G90 previously used)

COMMUNICATIONS & CB

A frequency counter you can really count on from audio through 230 MHz VHF

New

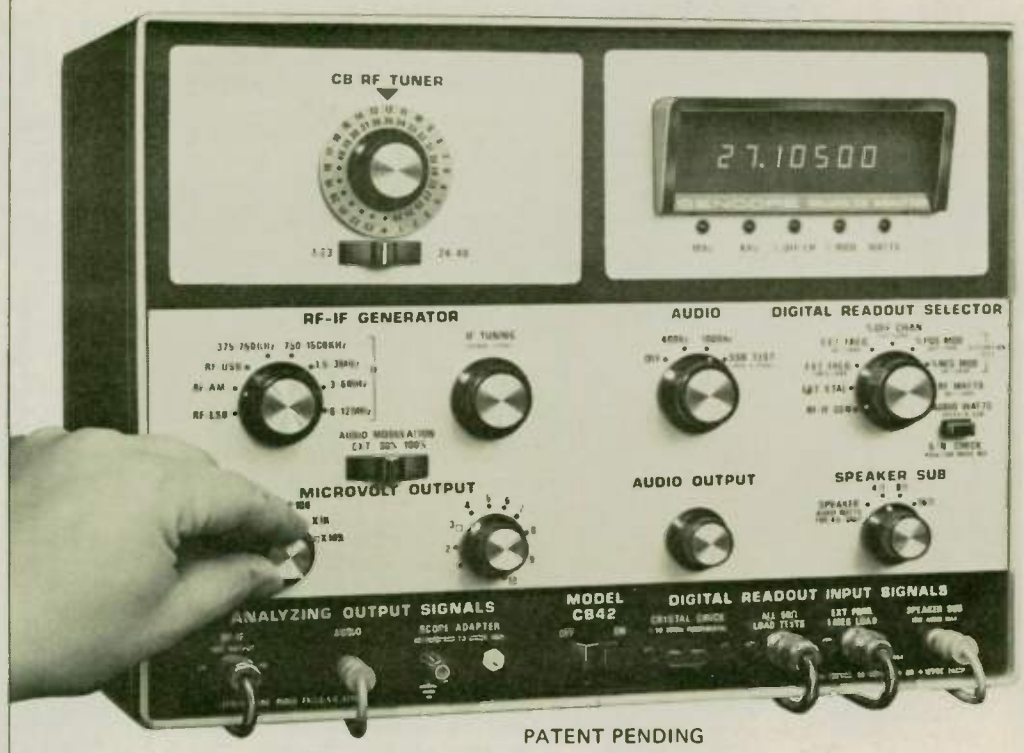
FC45 230MHz Frequency Counter

$395
$448
(Eff.Jan.1,1978)

- **Covers audio through VHF (and UHF, with PR47 Prescaler)**
  Extremely wide frequency range for every use from audio through 230 MHz VHF. Goes to 600 MHz UHF with PR47 Prescaler, too.
- **Better than FCC accuracy**
  Five times better than FCC requirements with .0001% accuracy (one part per million).
- **High sensitivity for circuit testing**
  High 25 milliVolt sensitivity throughout the range allows checking coils in oscillator circuits with PL207 "Snoop Loop."
- **Easy-to-use pushbuttons & direct readout**
- **Provides special user features**
  Exclusive automatic Crystal Check. Built-in 12 Watt Dummy Load. Either AC or 12 Volt mobile operation.

PL207 "SNOOP LOOP" for probing in low-level or high-power circuits without loading or connections $9.95
NE206 RF Noise Eliminator (for removal of RF riding on lower frequency waveforms) $25.00
PR50 Audio Prescaler for increased resolution to .01 Hz in audio tests $125.00

Walk the troubles out of all 40 CB channels in seconds — at FCC specs

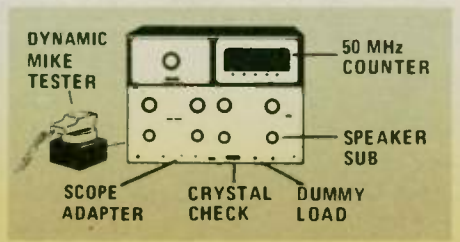


PATENT PENDING

CB42 Automatic CB Analyzer

$975
($1095—Eff.Jan.1,1978)

- **Troubleshoots every receiver stage**
  Every 40-channel RF,IF,audio, and alignment signal is at your fingertips to step through the stages in minutes.
- **Direct digital readout of all transmitter tests**
  Fast digital meter reads out RF power, channel frequency, percent modulation, and modulation distortion for error-free FCC performance tests.
- **Simplifies channel checking for .005% FCC frequency limits**
  Exclusive Percent Off Channel reads actual percentage off the FCC frequency on all 40 channels in less than one minute.
- **Makes receiver sensitivity test a snap**
  Fast, pushbutton easy test with direct-reading microVolt sensitivity control insures your customer can hear as far as he can talk.
- **Checks all single sideband CB's, too**
  Checks all SSB transceivers as easily as standard AM to bring in the profits on these higher-margin units.
- **It's a complete service center with extra features**
  Includes built-in 50 MHz Frequency Counter, 12 Watt Dummy Load, Speaker Substitute Load, Crystal Checker, and Dynamic Mike Tester to keep your bench clean from additional cables.



Complete CB service center

- **Everything you need to service CB in one instrument**
  Everything you need for testing and trouble shooting any AM or SSB rig from the antenna through the speaker, and from the mike back to the antenna.
- **Uses only three connecting cables to CB**
  Only three connecting cables does the whole job without time-wasting multiple connections between separate instruments.

NL204 EIA Noise Pulse Simulator $35.00
($45.00—Eff.Jan.1,1978)
RFS205 RF Switch For Transmit/Receive Cable Change Over $25.00
($35.00—Eff.Jan.1,1978)

Take your frequency counter all the way into 600 MHz UHF, too

New

PR47
600 MHz UHF Prescaler $125

- **Extend any 60 MHz Frequency counter range to 600 MHz**
  Extends range of FC45, or any 60 MHz counter, to 600 MHz for UHF band tests.
- **FCC accurate with FC45**
  Equips you for FCC tests in UHF with no change in the one part per million FC45 accuracy.
- **High sensitivity for circuit tests**
  Lets you troubleshoot through stages with supplied PL207 "Snoop Loop."

PA208 Power Adapter ..... $ 9.95

Convert any 1MHz scope to a 40 channel CB scope

New

CB44
27MHz CB Scope
Frequency Converter $75

- **No conversions necessary**
  Saves hundreds of dollars for a special 30 MHz scope to view the 27 MHz CB modulation envelope for distortion, clipping tests, or SSB.
- **Much-needed built-in 12 Watt Dummy Load**
  Connects directly to CB for safe operation.

Get your CB customers out 3 miles further in 1/3 the time with 3 simple pushbuttons

CB41 Automatic CB
Performance Tester $148

- **Automatically tests CB Power, SWR, and Percent Modulation**
  Provides 100% automatic "talk power" tests of RF Watts, SWR, and Percent Modulation in seconds with the push of a button.
- **Self-calibrating pushbutton operation**
  Automatic, self-calibrating circuits do all the "thinking" for you without messy calibrations and time-consuming adjustments.
- **Adjusts SWR with meter at antenna**
  You can take your meter right to the antenna as you make SWR adjustments. The exclusive EX203 Extension Cable makes it easy.
- **Customer-convincing Good/Bad scale**
  Show your customer the easy-to-understand Good/Bad scale to show peak CB performance and keep him happy.

PA208 Power Adapter ..... $ 9.95
(Replaces PA202 previously used)
EX203 Extension Cable ..... $ 9.95

Everything you need to completely service an AM-FM stereo receiver

SG165
AM-FM-Stereo Analyzer $695

- **Everything in one instrument for complete stereo servicing**
  Every signal and test you'll need is at your fingertips for troubleshooting from the antenna terminals to the speaker.
- **Uses only one output cable**
  Only one output cable for every signal saves your time like never before and keeps your bench tangle-free.
- **Dual dB & Watt meters backed with 100W speaker loads**
  Even the speaker loads are built-in with full monitoring of each channel output on the color-coded meters.
- **It's an FM sweep & marker generator**

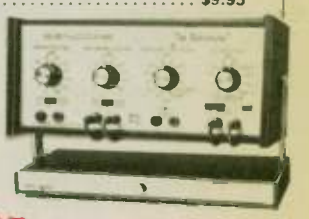
Only continuous- tuning VHF,UHF,FM field strength meter on the market

FS134 $395
Portable Field Strength Meter

- **Ideal for MATV & CATV with all connections & matching impedances**
- **Uses standard microVolt & dB scales for easy reference**
- **High 30uV sensitivity for both VHF and UHF fringe tests**

39G15 AC Power Supply for rechargeable batteries $9.95

It's a real leg and time saver



RC167
SUBSTITUTOR $140
R-C Component Substitutor

- **46 most-used substitution components**
- **Electrolytic surge protection**
- **Convenient 3-way mounting**

BACKED BY SENCORE'S 100% MADE RIGHT LIFETIME GUARANTEE

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100% MADE RIGHT LIFETIME GUARANTEE

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