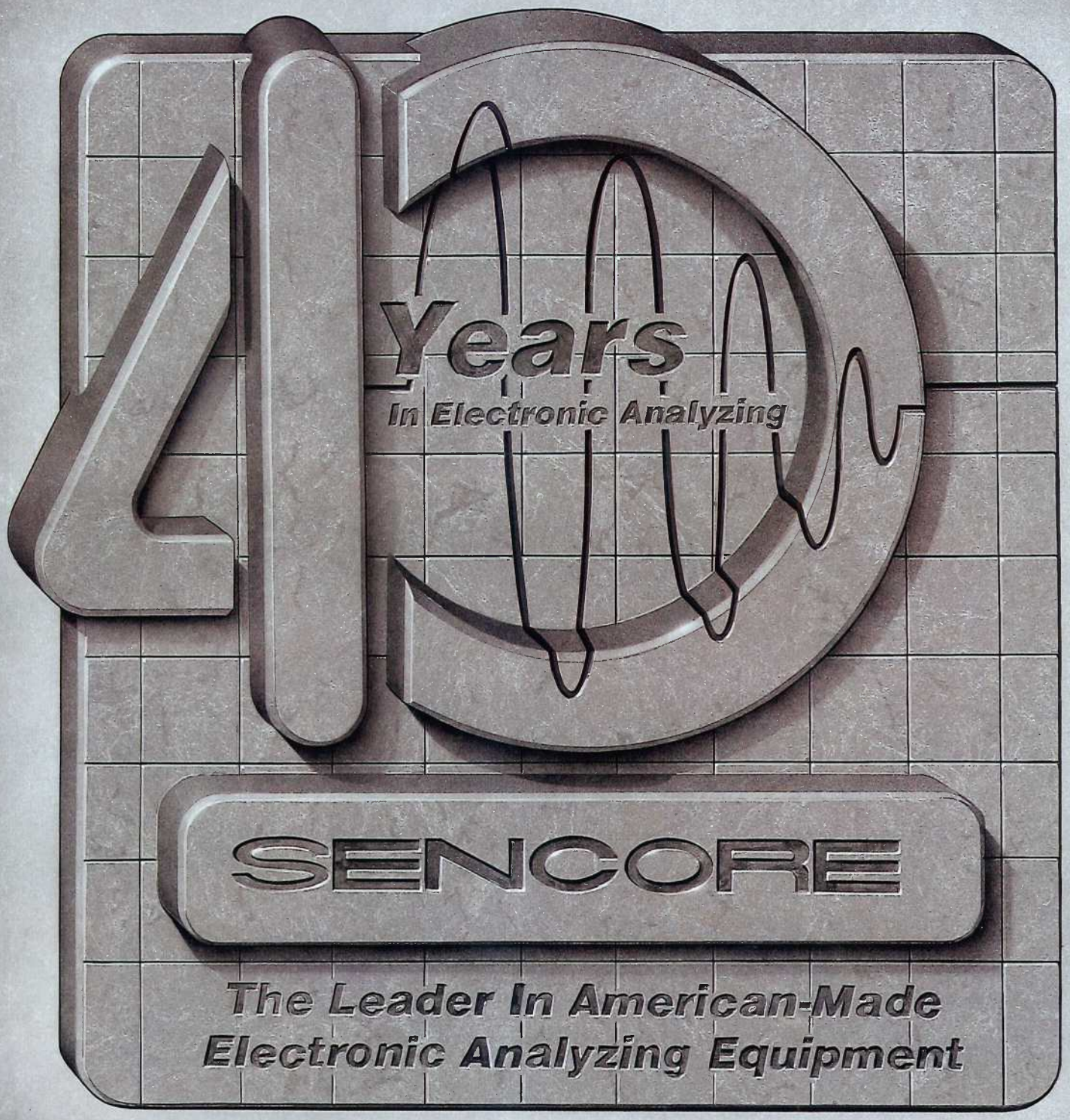
SENCORE NEWS

Issue #154 July/Aug. 1991



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How Accurately Can You Determine -

Is It The Servos Or Isn't It?

Are Servo Defects Costing You:

- **Profits –** by spending too much time on the VCR you're presently servicing, and not getting to the VCRs with the easy defects?
- **Time –** by mistakenly troubleshooting in the video stages when the defect is actually in the servo circuits?
- **Confidence –** both yours and your customer's confidence in your service center?

New!

VC93 All Format VCR Analyzer
Exclusively from Sencore!

Companion to the
VA62A Universal Video Analyzer
Patented

Introducing The Service Industry's Only Dedicated VCR Analyzer!

Now, you'll be able to pinpoint all servo defects and answer the question "Is it the servos or isn't it?" Two connections and read the VC93's digital display. It truly is that easy.

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- Pinpointing capstan and cylinder servo defects!
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Is It The Heads Or The Servos?

By Rick Meyer, Application Engineer

- **Servos are prone to failure because they are a combination of electrical and mechanical circuits**
- **Analyze VCR servos with five simple, automatic tests**
- **Observe how the VC93 pinpoints servo problems with two case histories**

On The Cover

1991 marks Sencore's 40th year of dedicated support to electronic servicers. Sencore customers are among the best in the business and we will continue to support you in every way we can.

In This Issue

Is it the heads? Is it the video playback circuits? Is it the servos or a tape path problem? How many times do you ask yourself these questions while you watch a VCR play back a work tape? Problems in any one of these areas produce symptoms that can look almost identical.

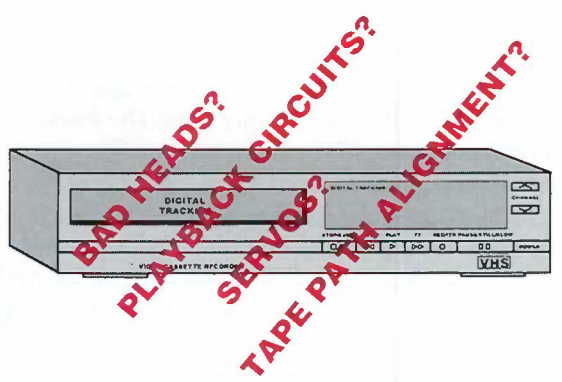


Fig. 1: Several VCR defects can cause the same symptoms. Our challenge is to quickly and accurately determine which defect is causing the symptom.

How can so many different problems produce the same symptom? The process of playing back a video tape is complex and requires proper operation of all the following.

1. Tape movement: The video tape must be pulled through the VCR at the right speed and be in the correct position at all times.

2. Tape path alignment: The video tape must be mechanically aligned so that the video (and Hi-Fi audio) heads follow the tracks of information on the video tape.

3. Head positioning: The drum containing the video (and sometimes Hi-Fi audio) heads must be rotating at the right speed and be correctly positioned so that it can follow the tracks of information on the video tape.

4. Head condition: The video (and Hi-Fi audio) heads must be clean and capable of picking up the recorded information contained on the tape.

5. Signal processing circuits: The electrical circuits that process the information from the heads must be capable of correctly processing the luminance, color, and audio information.

A problem in any one of these five areas produces bad video and/or audio from the VCR. Servicing VCRs efficiently and profitably requires fast and efficient methods of isolating the real cause of the problem as fast as possible. Time and money are needlessly wasted when we troubleshoot the wrong section because we aren't sure of the exact cause of the problem.

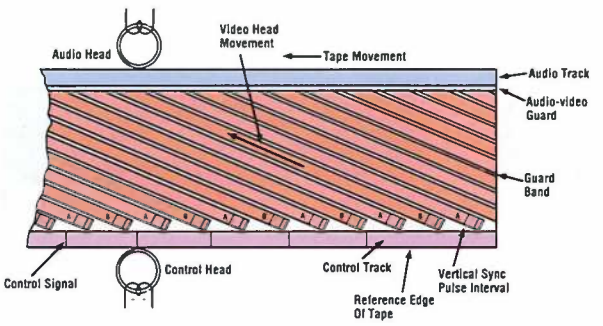


Fig 2: The video heads traveling at approximately 1800 RPM must follow a track on the video tape that is only a few thousandths of an inch wide.

Correct Servo Operation Is A Must

The servo section is especially prone to failure. A problem in the servos can cause symptoms such as complete loss of video, video with snow, pulsating video, as well as other related symptoms.

The servo section commonly fails because it is a combination of mechanical and electrical components. The servos must line up a video head that is spinning at about 1800 RPM with a moving recorded track that is only a few thousandths of an inch wide (Fig. 2). Even a

"minor" servo problem can cause partial or complete loss of video and/or audio.

Servos fail because the mechanical components such as motors, belts, and idlers wear out and fail. Servos fail when the needed signals are lost or are too weak to be used. They also fail when the electronic control circuits malfunction. (For a review of how servo circuits work, see the Tech Talk box on page 6.)

The New VC93 All Format VCR Analyzer contains an innovative servo analyzer function that takes the guesswork out of servo analyzing. First, it positively proves if the servos are working correctly. If the servos are working, there is no need to try to repair them. If the servos are bad, however, the VC93 servo analyzer tests quickly identify which servo is at fault and even gives information that helps you know where to look for the problem.

In order to understand how the VC93 servo analyzer tests can do all of this, let's first take a look at these new innovative servo tests. Then we'll use these tests to analyze some typical VCR problems.

A Simple Five Step Servo Test Positively Analyzes VCR Servos

The VC93 uses five fast, easy-to-use, servo analyzer tests to make servo troubleshooting a snap. These tests include:

1. Servos Locked
2. Capstan Speed Error
3. Capstan Jitter
4. Drum Speed Error
5. Drum Jitter

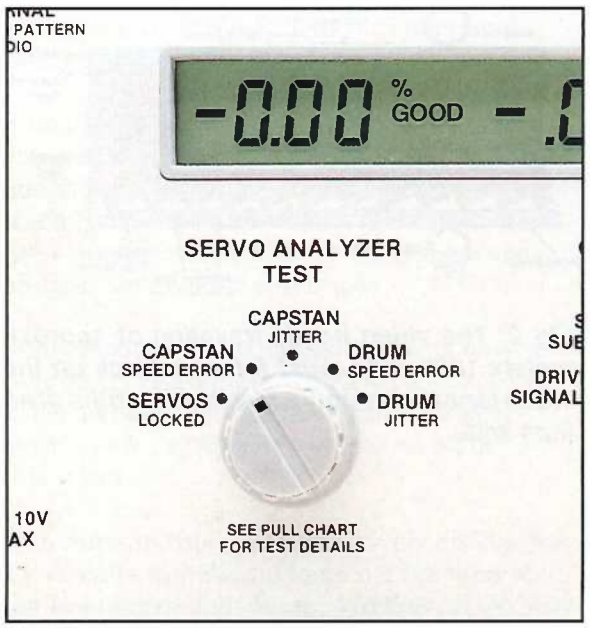


Fig 3: The VC93 contains five servo analyzer tests that identify servo problems.

These five tests are performed using either of two test leads. One test lead is called the Servo Performance Test Lead. Simply connect it to the audio and video output jacks on the VCR. The Servo Performance Test Lead works with the special Servo Performance Test Tape that has special signals recorded on it. A VHS Servo Performance Test Tape is supplied with the VC93. Beta and U-Matic tapes are also available.

The Servo Performance Test Lead simplifies servo analyzing since you don't even need to take the cover off the VCR. Each servo test analyzes the signals on the Servo Performance Test Tape to determine the condition of different portions of the drum and capstan servos (see Fig. 4).

But what if the VCR's condition is so bad that it does not put out a video and/or an audio signal? That's where the second servo test lead is used. This lead is called the Servo Troubleshooting Test Lead. It connects to the two key servo reference signals and analyzes the servos even if the video and/or audio signals are missing. Simply hook the Servo Troubleshooting Test Lead to the CTL and SW30 test points in the VCR. These test points are usually very easy to find since they are the key signals needed to align the VCR. In most cases, these test points can be located without even opening up a schematic. All five servo tests work identically no matter which Servo Test Lead you use. The VC93 even knows what test lead is connected to it, automatically.

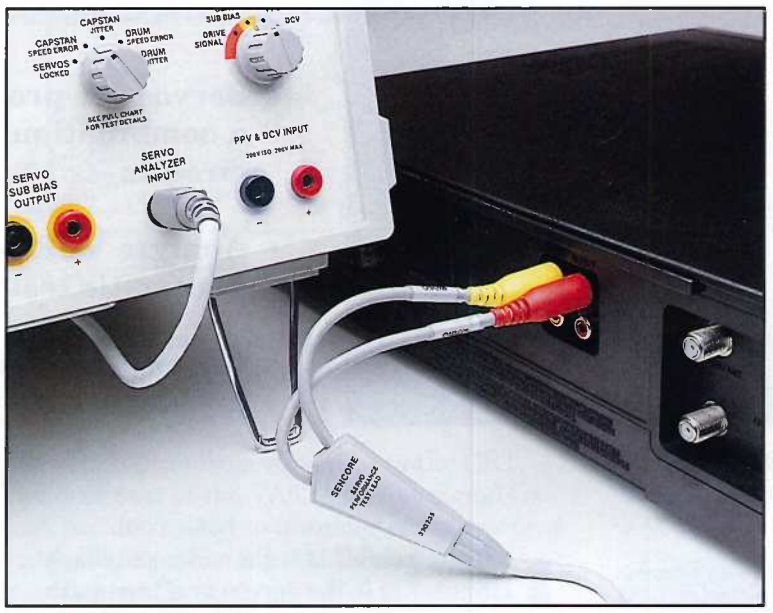


Fig. 4: The Servo Performance Test Lead lets you check out the VCR servos without even taking the cover off the VCR.

Before we see how these five servo analyzer tests find actual VCR servo problems, let's briefly look at what each test is designed to tell us so we can better understand how to interpret the results.

Servos Locked Test: In a normally operating VCR, the drum and capstan servos use the same reference signal. (See the Tech Talk box on page 6.) If both servos are working properly, the capstan and drum reference signals will be locked together. The VC93 compares the capstan and drum reference signals to each other to determine if the servos are locked. If the signals are locked to each other, then they must be locked to the internal reference signal. If the signals are not locked together, then either the capstan or the drum phase loop is bad. The remaining four servo tests help determine which servo is the actual source of the problem.

Capstan Speed Error Test: This test analyzes the capstan reference signal to determine if the capstan is running at the correct speed. The VC93 analyzes the frequency of the capstan reference signal to determine the true speed of the video tape. A capstan that is running at the wrong speed is most often the result of a missing CTL or FG pulse, a bad motor or motor driver, or a bad capstan servo control circuit.

Capstan Jitter Test: This test analyzes the capstan reference signals to determine how constant the capstan speed is. It analyzes the capstan reference signals to find short term variations in the speed of the video tape. These short term speed variations are called jitter. Excessive capstan jitter is often caused by a missing CTL pulse, excessive oxide buildup on the capstan or pinch roller, or a bad capstan servo control circuit.

Drum Speed Error Test: This test analyzes the drum servo reference signals to determine the speed of the video drum. Incorrect drum speed is most often caused by a missing drum FG or PG pulse, a bad drum motor winding, or a defective drum servo control circuit.

Drum Jitter Test: This test also analyzes the drum servo reference signals and looks for short term variations in the speed of the drum. Excessive drum jitter is most often caused by problems such as bad drum motor bearings, excessive oxide buildup on the drum, a missing drum PG signal, or a defective drum servo control loop.

Now that we know what each servo analyzer test does, let's see how the VC93 can save VCR troubleshooting time by tracking down a couple of real life problems.

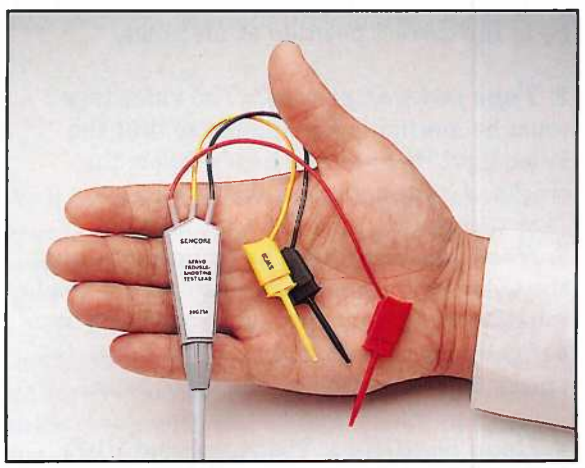


Fig. 5: The Servo Troubleshooting Test Lead is used whenever the video or audio signal is missing or of very poor quality.

Is It A Bad Head Or Isn't It?

A customer brought in a VCR with a snowy picture. Our first reaction was that the VCR probably had a dirty head. The customer told us that he used the VCR for watching rental tapes only. The last time he attempted to use the VCR, the picture suddenly became snowy.

We hooked the VCR up to our monitor and inserted our work tape recorded at the SP speed. This speed was selected since it is the speed of most rental tapes. When the play button was pressed, the VCR came to life and a picture appeared on the screen. The picture was not as sharp and clear as it should have

been and was filled with speckles of snow from the top to the bottom (see Fig. 6). A classic symptom of a dirty head!

We stopped the VCR and ejected our work tape. This would be a fast job if the only problem was a dirty video head. After removing the cover, the video heads and the complete tape path were carefully cleaned. We again inserted our work tape in the VCR and pressed the play button. But, the picture was no better than it was before. The video heads were cleaned again — still no improvement! This job was more serious than we originally thought. Our thoughts immediately suggested a bad video head.

Before contacting the owner with any bad news, we decided to confirm the problem before jumping to conclusions. Using the head substitution signal from the VC93 seemed like the logical first step, but we decided to do a check of the servos since it is so fast and easy with the VC93.

We grabbed the Servo Performance Test Lead and quickly plugged it into the VC93 — the red plug into the audio output jack and the yellow plug into the video output jack. We pulled our Sencore Servo Performance Test Tape off the shelf and inserted it into the

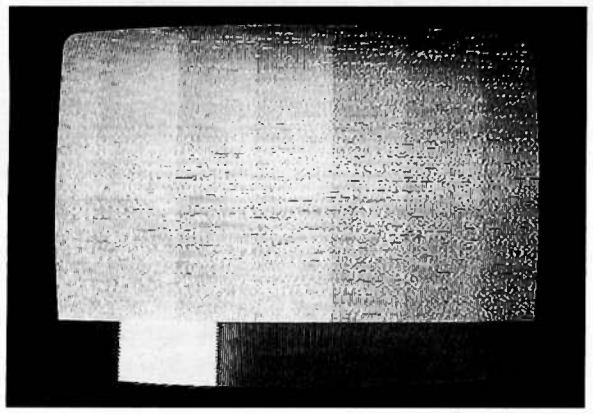


Fig. 6: The VCR had a typical symptom of a dirty or bad video head.

VCR. As the VCR went into the play mode, we turned the VC93 SERVO ANALYZER TEST switch to the SERVOS LOCKED position. The test tape began to play and the VC93 SERVO ANALYZER display began giving us test results — all the percentage numbers were high and the BAD indicator came on. This wasn't a head problem — it was a servo problem!

Our first test indicated that there was a problem in the servos. Since the video was pretty snowy, we suspected that the VCR output signals might not be sufficient for a reliable test. Switching to the Servo Troubleshooting Test Lead would eliminate any concern over the signal quality. We connected the red connector on the Servo Troubleshooting Test Lead to the CTL test point inside the VCR and the yellow connector to the SW30 test point.

Playing the test tape again showed nothing but dashes on the VC93 SERVO ANALYZER display (Fig. 7). This immediately told us that either the CTL pulse or the SW30 signal was missing. We could have stopped at this point and used our SC61 Waveform Analyzer to check for these signals, but the remaining VC93 Servo Analyzer Tests gave us the additional information we needed.

We turned the SERVO ANALYZER TEST switch to the CAPSTAN SPEED ERROR test position. The VC93 display continued to show dashes. Since this test only looks at the CTL pulse using this test lead, we immediately knew the VC93 was not seeing signal. A quick check of our connection to the CTL test point verified that the connection was good. The VC93 had zeroed in on the problem in only a few minutes.

We grabbed our SC61 probe and connected it to the CTL test point. Sure enough, the CTL pulse was missing. We ejected the test tape and closely examined the CTL head. Everything looked in order. We carefully unsoldered the leads to the CTL head and made a conti-

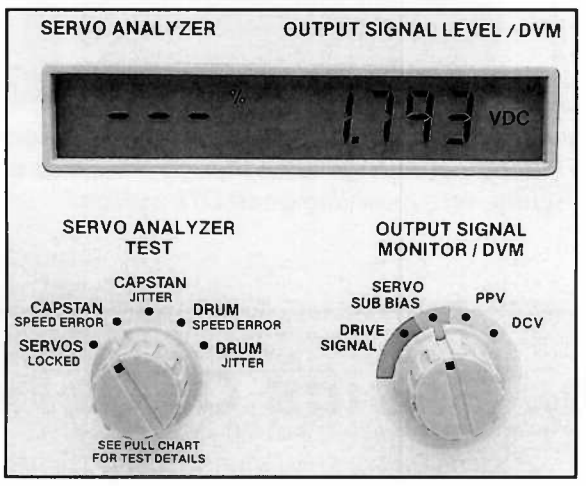


Fig. 7: The dashes on the VC93 servo analyzer display confirmed that the CTL pulse was missing.

nuity test. The head was open. When the CTL head was replaced, the picture returned clear and sharp. Our VC93 servo analyzer had prevented us from incorrectly replacing the video heads and narrowed the problem down to the real defect. In a matter of minutes, the problem was solved.

The Case Of Intermittent Video

Several weeks later, a customer brought in a VCR and complained that the picture was noisy every now and then. We connected his VCR to our monitor and inserted our work tape. The picture looked good on the monitor, but, after about 20 seconds, it started to jitter and became very noisy. After a few seconds, the picture cleared up. As we continued to watch, the same symptoms occurred over and over again.

The presence of a clear picture for a short period of time confirmed that the problem was not in the video heads or the luminance circuits. The audio also sounded good. This looked like a classic servo problem. It was time to use the VC93 Servo Analyzer tests to prove our suspicions.

We fired up our VC93 and connected the Servo Performance Test Lead to the audio output and video output jacks . We played back the Performance Test Tape and monitored the results on the SERVOS LOCKED test. As soon as the tape began to play, the VC93 SERVO ANALYZER display began to tell us the story. The numbers on the display varied between 3 and 6%. As we continued to watch the display, the "BAD" indicator lit up as shown in Fig. 9. The VC93 had immediately confirmed our suspicion. There was a servo problem — but where?

We switched to the CAPSTAN SPEED ERROR test. The numbers rapidly settled down around 0.4% and a "GOOD" indicator popped into view. The VC93 verified that the capstan was running at the correct speed.

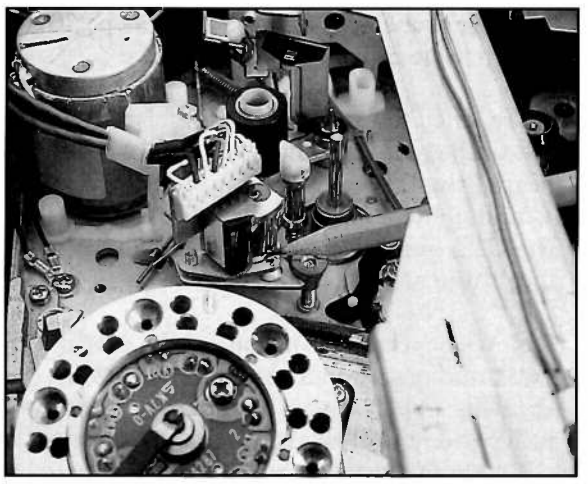


Fig. 8: A bad CTL head turned out to be the cause of a snowy picture.

So we moved to the CAPSTAN JITTER test. The numbers quickly stabilized, but they never dropped below 2%. Soon the "BAD" indicator appeared on the VC93 display. The VC93 had just identified a capstan problem that was causing excessive jitter. Could this be the cause of our video problem? One cause of excessive capstan jitter is a missing CTL pulse. Since the VC93 was currently analyzing the audio and video information from the Servo Performance Test Tape, we did not know if the CTL pulse was present or not.

So we changed servo test leads, removed the cover from the VCR, and connected the Servo Troubleshooting Test Leads to the CTL and SW30 test points. When the SERVOS LOCKED test was selected, the VC93 display sprang to life giving us numbers similar to what we had seen before, along with a "BAD" indication. This wasn't what had been expected. Because the SERVOS LOCKED was displaying a reading, the CTL and SW30

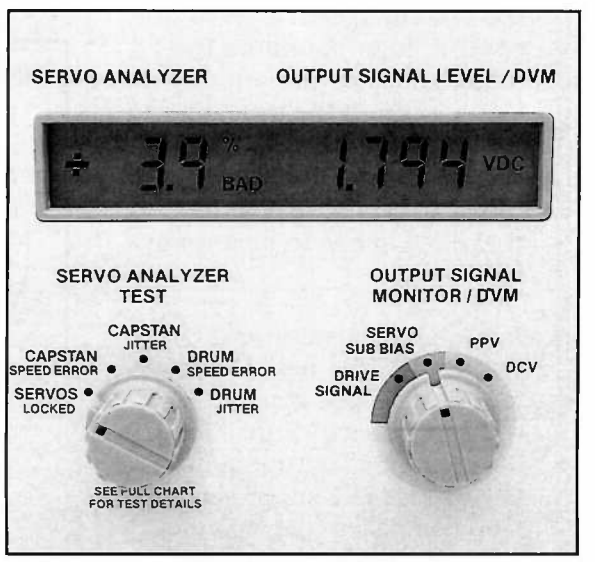


Fig 9: The Servos Locked test confirmed that one of the servo phase loops was not locked to its internal reference signal.

signals had to be present. Where could the problem be?

The CAPSTAN SPEED ERROR test confirmed that the capstan was running at the correct speed. The CAPSTAN JITTER test, however, again came up "BAD".

We finished the tests by checking the drum servos. Both the DRUM SPEED ERROR test and DRUM JITTER test produced low numbers and a "GOOD" indicator. The VC93 Servo Analyzer tests indicated the drum servos were working properly. Our problem was positively proven to be in the capstan circuits.

We reached for our SC61 Waveform Analyzer test probe and the schematic for the VCR. We located the CTL pulse input pin on the servo IC and made a quick check with the SC61. The CTL pulse was present and of sufficient amplitude at the servo IC.

Next we checked the output of the phase PWM and observed a constant waveform. Applying physical pressure to the capstan pulley did not affect the duty cycle of the PWM signal (see Fig. 10). For some reason, the servo chip was receiving a CTL pulse but was not responding to it. After further diagnosis, we concluded that the problem was a bad capstan phase servo circuit in the servo IC. We confidently ordered a new servo IC and placed the VCR on the shelf until the chip came in.

A few days later the servo IC came in. After a quick replacement and check, the problem was gone. The VC93 Servo Analyzer tests had again done their job. In only a few minutes we had analyzed a servo problem, narrowed the problem down to the defective section, and solved the problem.

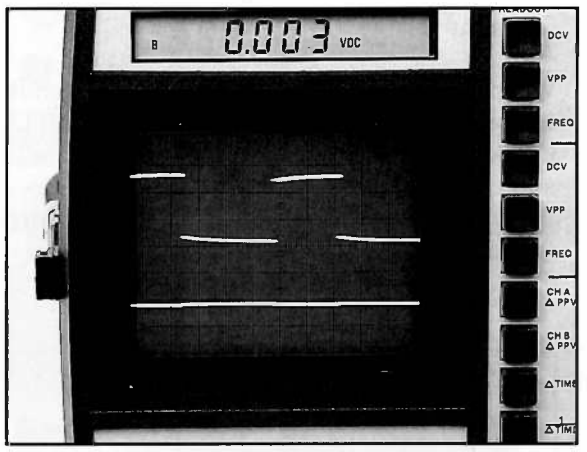


Fig 10. The capstan phase loop PWM signal would not change even though the servo circuits were receiving good CTL pulses.

The VC93 Puts Simplified Servo Troubleshooting At Your Fingertips

Did you see yourself in either of these two examples? They describe just a few of the many examples of how the VC93 Servo Analyzer simplifies servo troubleshooting. The five simple servo tests take less than two minutes and give you a proof positive checkout of the VCR servos.

Servo analyzing is only one of the many features of the all new VC93 All Format VCR Analyzer. Ask your Area Sales Engineer for a free video tape demonstration showing all of the VC93's VCR analyzing capabilities. To reserve your VC93, just call **1-800-SENCORE**. But act fast, the VC93 is already on backorder. ■

Circle Fast Fact #240 for more information on the VC93 All Format VCR Analyzer.

Sencore Tech Talk

The Basics Of Servos

VCR servos control the movement of both the video tape and the video heads. Servos are a combination of mechanical devices and electronic circuits. The capstan servo controls the movement of the video tape through the VCR, while the drum servo controls the movement of the video heads. Together they ensure that the correct video head is positioned exactly over the corresponding video track on the magnetic tape. Since the video heads spin close to 1800 RPM, and the recorded track is only a few thousandths of an inch wide, servo operation must be exact.

The capstan servo uses a motor and pinch roller to pull the video tape through the VCR. An electronic motor driver supplies the current to run the motor. In order for the motor to run at the correct speed, a servo control "loop" monitors the motor rotation and another loop monitors the tape position. They supply correction signals to the motor driver to correctly position the video heads to pick up a signal.

A frequency generator (FG) sensor, located next to the motor, develops a signal for the servo speed control loop to tell it how fast the motor is turning. The speed servo loop compares this signal to a reference signal and sends a correction voltage to the motor driver to correct for any motor speed variations.

A second signal, called the control track logic (CTL) signal, is obtained from the video tape using a CTL head. It tells the capstan phase loop where the tape is at any instant in time. The CTL signal is compared to the reference signal and a correction signal is sent to the motor driver to speed up or slow down the motor to get the tape in the correct position at the correct time.

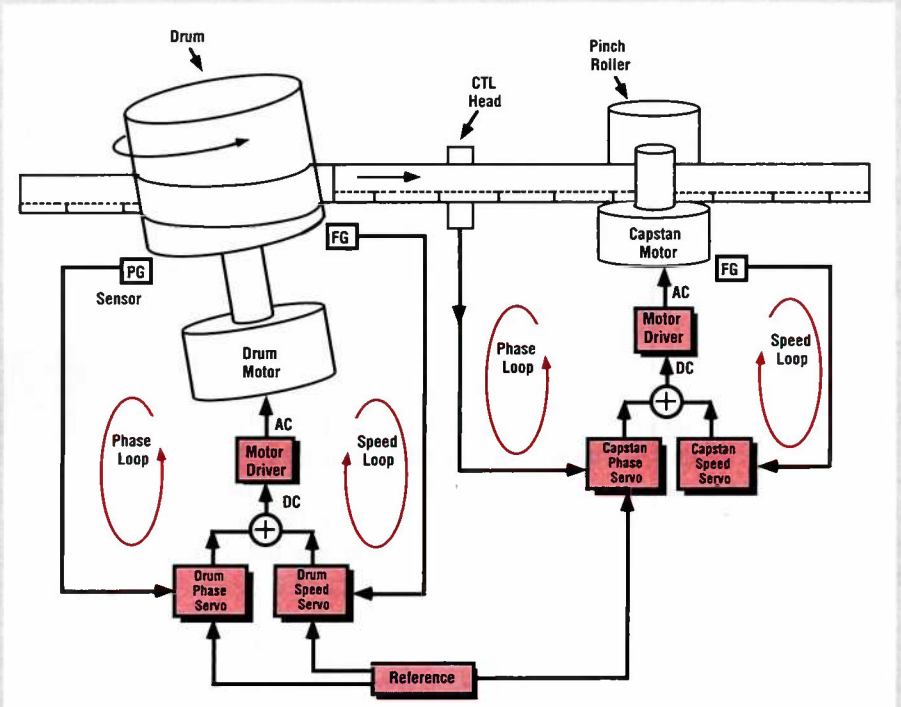


Fig. 1: The basic servo block diagram.

The drum servo controls the speed of the drum motor which rotates the video heads at a rate of approximately 1800 RPM. A similar electronic motor driver supplies the current to run the drum motor. In order for the drum motor to run at the correct speed, two control "loops" are again used to monitor the speed of the spinning heads and their position.

Like the capstan servo, the drum servo uses an FG sensor to create a signal that indicates how fast the drum is turning. This signal is monitored by the drum speed loop and a correction voltage is created to speed up or slow down the motor.

The drum servo uses a pulse generator (PG) signal to tell the drum servo phase loop where the video heads are in their rotation. The PG signal is compared to the same reference signal used by the capstan circuit to create a correction voltage that places the video heads at the correct position at any instant of time.

Since both the drum and capstan servo use the same reference signal to lock in their signals, they are also locked to each other. The VC93 All Format VCR Analyzer uses this fact to check for proper servo locking with its exclusive servo analyzing tests.

LETTERS To The Editor

Editor's Note: Thank you for your generous response to our request for letters and feedback. We received many letters worthy of publishing, and we'll print as many as space allows.

We will try to print viewpoints that represent the Sencore News' entire readership, not just one market or part of the country. So read on to see what's affecting your business and the electronics industry.

Oscillators And Capacitors

There is a condition that sometimes pops up in broadcast transmitters that can be very misleading: OSCILLATOR FAILURE! It's a dirty word. About a year ago, the Harris SX-1, 1 kilowatt AM transmitter at radio station KGOL suffered an oscillator failure. This causes the transmitter to do nothing at all. When the oscillator fails, it looks very much like a failure on one of the Intermediate Power Amplifier boards. You can spend a lot of time looking for a problem that does not exist, as I did. Eventually (hours later) I found the real problem. Now when I have a failure, I hook up the snoop loop to my FC71 counter. In seconds, I can eliminate or confirm a problem in the oscillator. I also use my counter to make certain that the 19 kHz pilot frequency, as well as the microwave systems and transmitter frequencies, are all OK. . . . .

Editor's Note: Steve also commented on the LC101 Z Meter.

. . . . . I can't understand why, in this day of great technical advancement, professional engineers will still place the test probes of a $30.00 analog meter across a .005 microfarad vacuum capacitor that is worth $1500.00, seeking wisdom. If you look real hard and don't blink, you might catch a glimpse of something that almost resembles meter movement. There have been many instances where the average analog meter showed a capacitor to be good that was actually leaky and the value changed. Every broadcast engineer should have a Z Meter. End of discussion!

Steve Halatyn
Spring, TX

Efficient Troubleshooting

I enjoyed your article entitled "Is Your Oscilloscope Helping You Troubleshoot Efficiently?" from *Sencore News* #153. The article (and advertisement) opened my eyes to see how much time I'm wasting using multiple instruments.

Most of the articles in the *Sencore News* focus on using your equipment for servicing. I work in a manufacturing environment as a Sr. Test Technician and I can see how Sencore equipment (the SC61, LC102) could be very efficient in production-type testing. We currently use separate oscilloscopes, frequency counters, and DMMs to test over 40,000 pieces of data communication equipment per year. Please do an article on "Using Sencore Test Equipment For Production Testing."

David Garrett
Hagerstown, MD

Editor's Note: Thanks for the letter, David. We have many customers using Sencore equipment in production-type settings and have had several requests for this type of information. Watch the upcoming issues for articles relating to this type of analyzing.

Advice For New Technicians

I would like to share some advice I have given new technicians for many years. It is a simple principle which can save much grief and frustration, to say nothing of lost income and reputation.

This type of work attracts people who have special talents. They are smart, resourceful, and they actually enjoy the challenge of problem-solving. Often they go on to develop a "sixth sense", an ability to get quickly to the cause of the technical troubles, which can sometimes baffle the outside observer. These talents and abilities lead to confidence, but sometimes confidence, especially in the early days on the job, can be pushed too far.

Simply put, new technicians often get into trouble by beginning jobs they can't finish. Their training and skills, especially troubleshooting skills, are not yet good enough. The object, in business, is to make money, and not every job which presents itself is going to be a profitable one. Usually, an experienced technician can quickly determine which ones will be a waste of time. This is something managers and supervisors need to recognize as well.

Gradually, with experience, you will learn. Watch and listen to experienced people. Study the doers, not the talkers. Learn the theory. Practice the basic skills. Become expert at soldering. Don't be afraid to explore new territory - when you have proper supervision and instruction. Then you will succeed.

But remember, it's no sin to refuse to go beyond the limits of your abilities. In fact, it's smart. And you had to be smart to get involved in all this in the first place, didn't you?

Frank Burke
St. John's, Newfoundland

Thanks For The Loaner

I would like to thank you for the loan of the SC61 as I have become so attached to the one probe measurements that I would have been in deep trouble trying to use one of my other scopes. Again thank you.

Tell Troy {Hoteling} that the SC61 is working properly on all functions and I will let him know if I have any other problems.

Sidney J. Stewart
Niagara Falls, NY

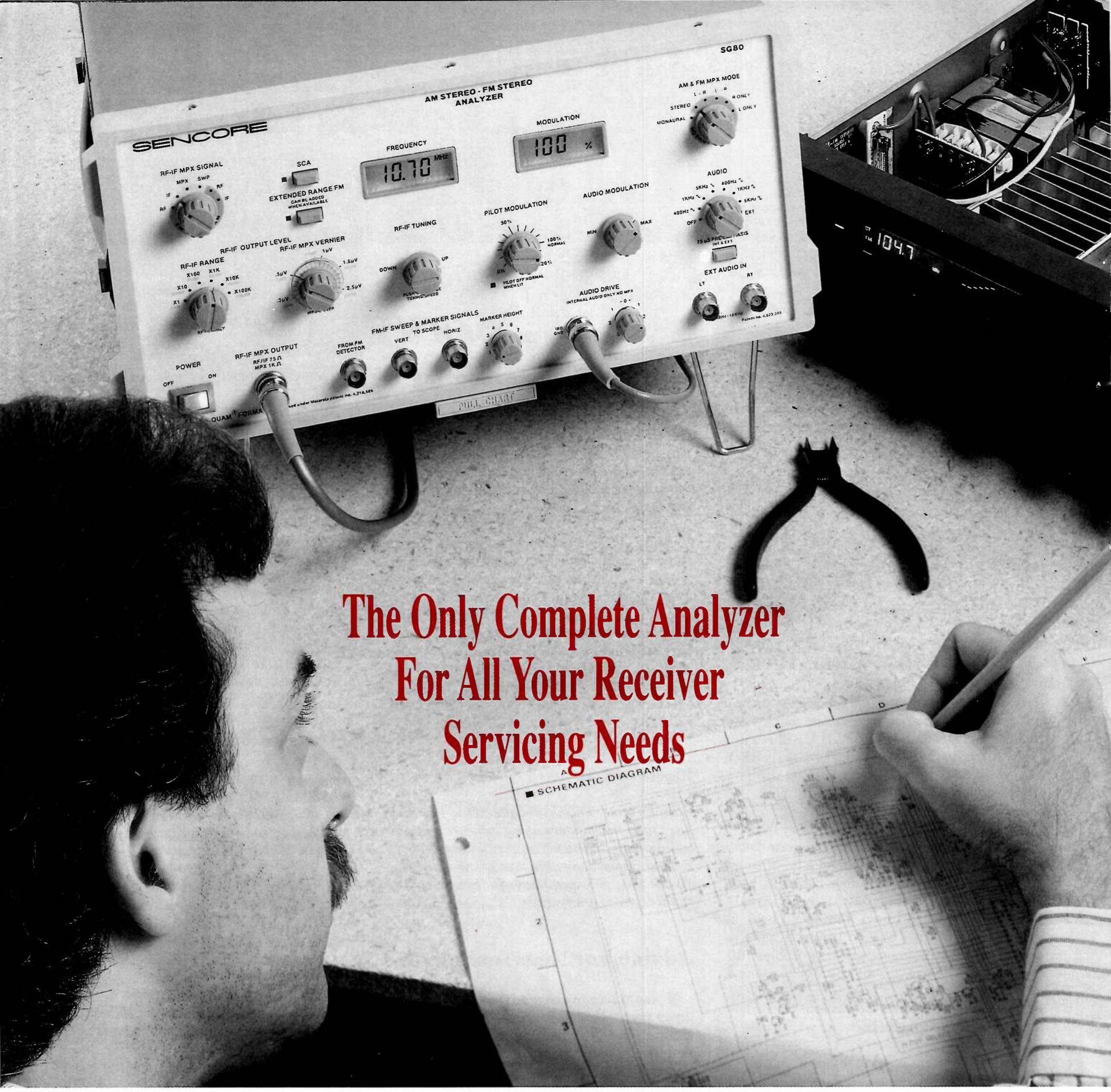
Editor's Note: Loaners are available on most Sencore instruments for a nominal fee. If you can't be without your Sencore instrument, for whatever reason (service, time-share, etc.), call the Sencore Factory Service Department for details on obtaining a loaner.

We Invite Your Letters

The *Sencore News* welcomes letters from its readers. We encourage mail on subjects ranging from troubleshooting tips to feedback on *Sencore News* articles. Address the letters to:

Letters To The Editor
Sencore
3200 Sencore Dr.
Sioux Falls, SD 57107

We reserve the right to edit letters for space and clarity. All submitted material becomes property of Sencore.



The Only Complete Analyzer For All Your Receiver Servicing Needs

SG80 AM Stereo–FM Stereo Analyzer

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How many AM-only or FM-only receivers have you seen lately? You won't find many. So, if you service one receiver format, you'll need equipment to service both.

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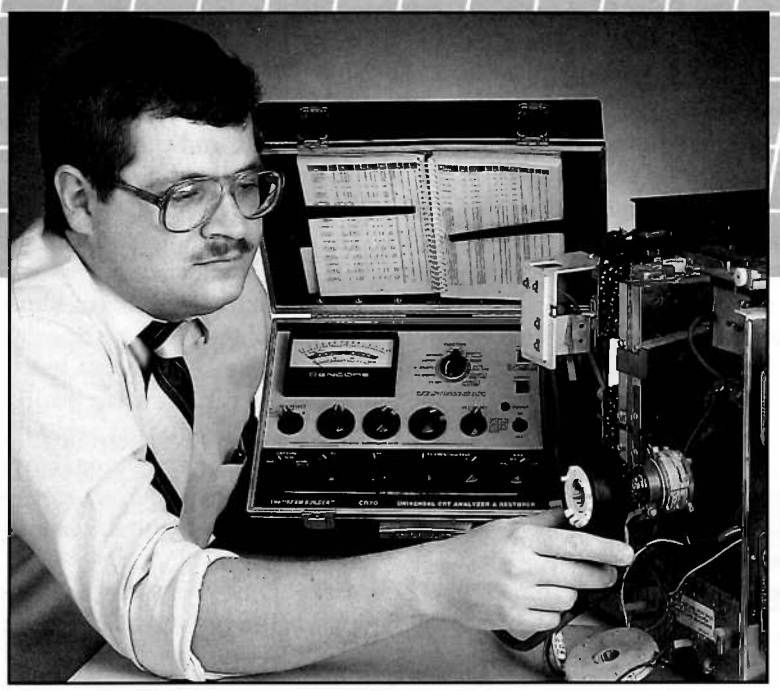


Understanding And Restoring CRTs

By Paul Nies, Application Engineer

- **Learn how CRTs work**
- **Find out how CRTs fail**
- **Use the CR70 and "Progressive Restoration" to safely restore 9 out of 10 CRTs**

The CRT is one of the oldest pieces of technology still in use. Its beginnings can be traced to 1879 when William Crookes deflected cathode rays inside a vacuum tube with a magnet. Today's CRT has changed considerably from the Crookes Tube, but its basic operation remains unchanged: a hot cathode emits electrons that form a beam which strikes a phosphor screen to produce light. Because the ability of the cathode to emit electrons decreases with age, all CRTs will eventually wear out.

Every service technician who services video equipment today must be prepared to answer two very important questions concerning CRTs: "How do I know if this CRT is good or bad?" and, "Is there a proven reliable alternative to replacing a worn out CRT?" This article addresses the technical aspects of CRTs - how they work, how they fail, and how restoration can give them new life.

How CRTs Work

A CRT has three major sections: 1) the electron gun; 2) the accelerator grids; and 3) the phosphor screen. The electron gun forms and controls an electron beam which is accelerated by grids. The amount of light produced by the screen depends upon the intensity (current) of the electron beam striking it - more current produces more light. Deflection plates or deflection yokes move the beam to produce a scanned raster.

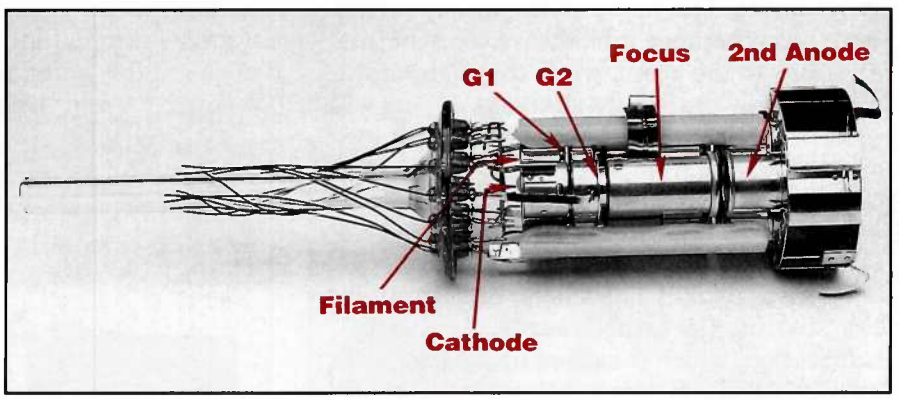


Fig. 2: The electron gun consists of a filament, cathode (K), control grid (G1), and screen grid (G2).

A cathode in the electron gun emits electrons when it is heated. The electrons are formed into a beam by other grids in the electron gun, as shown in Fig. 2. These grids, G1 and G2, are cylinders with tiny holes. The G1 "control grid" determines the intensity of the electron beam by changing the amount of its negative voltage (bias) compared to the cathode - more negative bias equals less beam current; less bias equals more beam current. (Remember that electrons are negatively charged). Applying a video signal to either the cathode or control grid changes the beam current in accordance to the picture information.

Positive voltage on the G2 "screen grid" pulls the electrons through G1 to form a thin, thread-like electron beam. The beam is accelerated by the high voltage on the accelerator grids and reaches a velocity great enough to cause light when it strikes the phosphor screen.

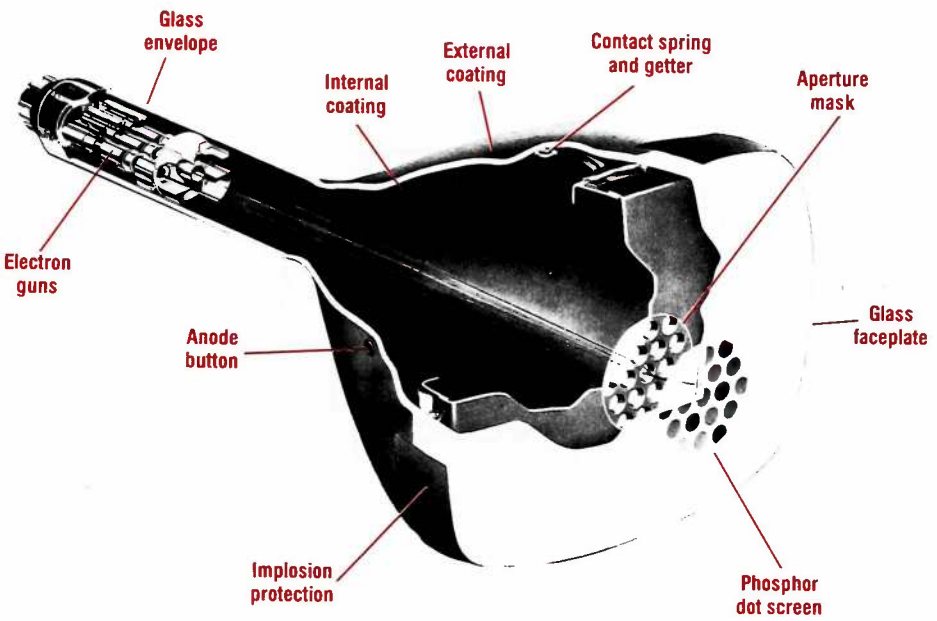


Fig. 1: In a CRT, an electron gun produces an electron beam which is hurled at a phosphor screen to produce light.

How CRTs Fail

Most technicians think of CRT failures in terms of only two failures, shorts and low emission, because many CRT testers lump all tests into a "Shorts" test and an "Emission" test. But each of these broad categories includes several distinct failure modes that need to be identified for reliable diagnosis and restoration.

Open Filament - An open filament cannot heat the cathode. The filaments, however, are pretty durable, so open filaments are not common. Open filaments can't be repaired.

H-K Short - A heater-to-cathode short (H-K) occurs when the two elements physically touch or if a flake of conductive material from inside the tube shorts them. The symptoms of an H-K short depend on how the filaments are powered. Filaments powered directly from a 60 Hz power line cause "hum bars", poor contrast, and possible retrace lines if an H-K short exists. If the filament voltage is scan derived, an H-K short will cause no visible problem if the flyback winding is floating. If the flyback winding is tied to ground, the CRT bias may be affected.

G1 Shorts - Most G1 shorts occur when a conductive flake of material lodges between the cathode and control grid (see Fig. 3). Shorts between G1 and G2 are possible, but less common. A G1 short usually causes loss of

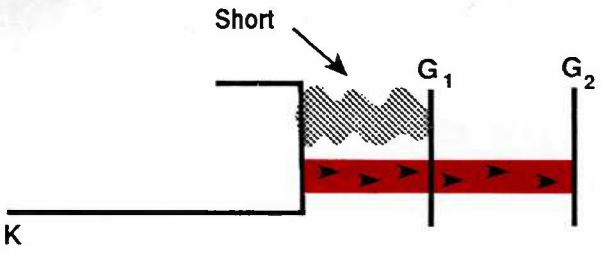


Fig. 3: A G1 short causes loss of beam control which results in a bright white, red, green, or blue raster.

beam control allowing the beam to run wide open. The result is a bright white, red, green, or blue raster. The excessive beam current may even be enough to cause the chassis to shut down.

Poor Gamma - A tube with a gamma problem produces over-driven whites and deep blacks, but few shades of gray inbetween. Although some technicians call these tubes "gassy", the problem is caused by a defective cathode. Poor gamma occurs when the center of the cathode wears to the point it can no longer produce sufficient beam current for the gray shades. The center of the cathode often wears first because it is always contributing electrons to the beam, while the edges of the cathode only contribute electrons during white picture portions. Fig. 4 shows how poor gamma results from a non-linear change in beam current versus bias.

Weak Emission - A CRT with reduced brightness usually has a layer of "contamination" coating the cathode surface. The contamination, which is caused by minute amounts of air reacting with the hot cathode material, acts like a blanket to prevent the electrons from leaving the cathode's surface. If the contamination covers the entire cathode surface, the CRT will have reduced brightness over its entire range. Sometimes the contamination will develop only around the edges of the cathode because the center portion is always heavily conducting. This results in normal blacks and grays, but reduced whites (the opposite of poor gamma) which causes the CRT to have poor contrast.

Stripped Cathode - A stripped cathode has lost most or all of its emitting material and produces little or no beam current. The cause of stripped cathodes is not normal wear. (A cathode will fail from contamination long before the emitting material wears out.) A stripped cathode is caused by excessive restoration which removes good emitting material along with the contamination.

Temperature Sensitive Cathode - Some CRTs show good emission under normal operation but lose emission quickly with small reductions in filament voltage. All cathodes have lower emission at reduced filament voltage, but a normal cathode produces more electrons than are needed for the electron beam. So a small drop in filament voltage produces no change in beam current as electrons are borrowed from the "reserve" (Fig. 5). Less emitting material and a thin layer of contamination buildup cause the dropoff to be more severe than normal. Either condition reduces the amount of reserve electrons and will eventually hinder the electron beam at normal filament voltage. Therefore, a temperature sensitive cathode is a sure sign that the cathode is failing.

Color Tracking - A color tracking problem occurs when the three guns of a color CRT (or the separate CRTs in a projection system) do not balance with each other to produce white or pure shades of gray. Instead, B&W picture portions show a hint of color and color portions are the wrong tint and cannot be set correctly. A color tracking problem can occur even though each gun has "good" emission. CRT manufacturers specify that no gun in a color CRT or projection system should produce more or less than 55% of the current of any other gun. Any gun beyond this limit can fall outside of the adjustment range of the screen and drive controls and cannot be properly balanced.

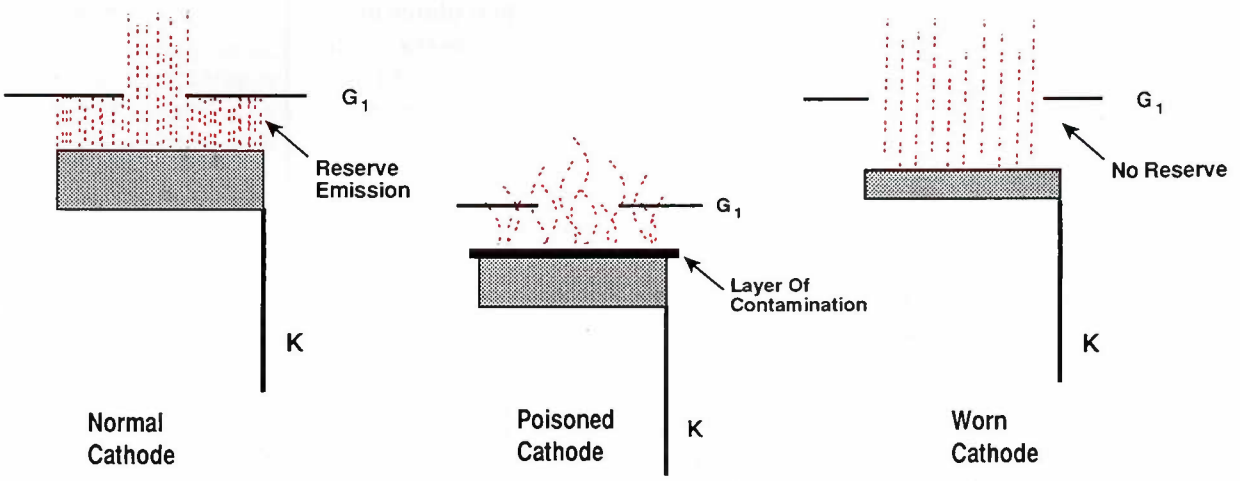


Fig. 5: A good cathode produces more electrons than are needed to form the electron beam. Reduced emitting material, or a thin layer of contamination will produce a temperature sensitive cathode.

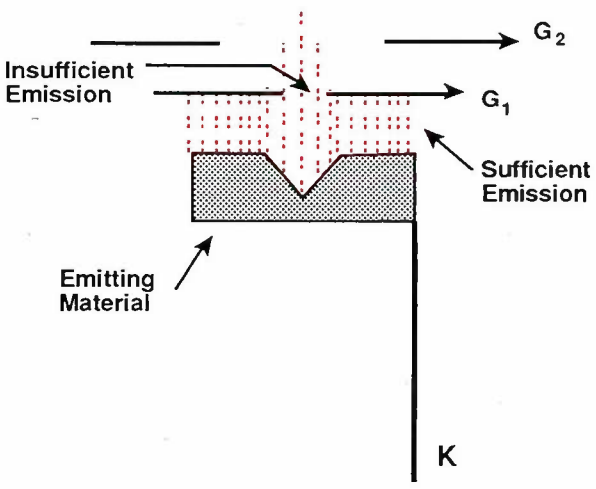


Fig. 4: Poor gamma is caused by a cathode that is severely worn in the center portion. The tube is able to produce blacks and whites, but unable to produce proper gray shades.

As you can see, there are two types of shorts, and several different types of emission problems. Can these problems be fixed without replacing the CRT? The answer is "Yes, 9 out of 10 times using the CR70 BEAM BUILDER"®. But, before you restore a tube, you need to test it so you can use restoration to its maximum effectiveness.

Reliably Test For All CRT Defects With The "BEAM BUILDER" ®

A CRT tester must provide reliable tests. Without a reliable test, you might restore a CRT that doesn't need restoration and end up with a damaged tube. The CR70 BEAM BUILDER® Universal CRT Analyzer & Restorer is designed to show you exactly what's wrong with a CRT so you know what restoration steps to take. Here's a closer look at each CR70 test.

H-K Shorts - The CR70 has two different shorts tests, H-K and G1 (Fig. 6), so you can determine which type of short the CRT has (other CRT testers show all shorts on one test). We don't recommend attempting to remove H-K shorts because you could easily open the filaments. (Most H-K shorts can be successfully isolated using a special filament transformer.) The H-K Shorts test reads out on the same Good/Bad meter scale that is used for all of the CR70's quality tests. We use a meter instead of the indicator lights found on other testers because the meter provides an accurate indication of the severity of the short.

G1 Shorts - The G1 Shorts test reads directly on the Good/Bad meter scale. In the G1 shorts test, the CR70 connects the cathode to G2 and looks for leakage between this connection and G1. Thus, shorts or leakage between K and G1 and between G1 and G2 are detected. A meter reading far down in the "Bad" area indicates a direct, metal-to-metal short which can be difficult to remove. Readings farther up in the "Bad" area indicate resistive shorts which are much easier to remove.

Dynamic Emission Test - The CR70's test of CRT emission is done in two parts. First, the cutoff is tested. During the Cutoff test, the CRT is biased at the black (beam cutoff) point which is the lowest current output of the tube. This tests for the gamma problem explained earlier. If the CRT passes the cutoff test, you

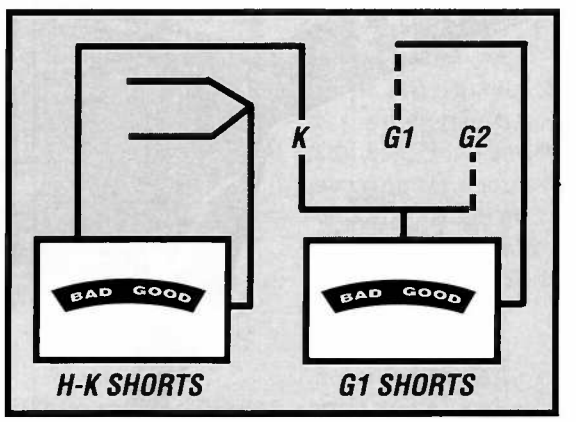


Fig. 6: The CR70 tests H-K shorts separately from G1 shorts. The test results are displayed on a "Good/Bad" meter that indicates the severity of the short.

perform the emission test. The emission test checks the tube's current output at the white level. The current is measured at G2, rather than at G1 as other testers do. Measuring the "true beam current" at G2 ensures that the opening in G1 is not clogged by a flake of contamination. By checking both the black and the white current levels, the CR70 dynamically tests the tube over its entire operating range (see Fig. 7).

Emission Life Test - Temperature sensitive cathodes are identified with the CR70 Emission Life test. During this test the filament voltage is lowered by 25%. A normal cathode will not show a drop-off in emission current, but a tube that has insufficient emitting material, or one in which contamination is beginning to form, will show a decrease in emission. Other testers remove the filament voltage completely. This leads to much interpretation as you must estimate how fast the drop-off occurs, and take into account that smaller cathodes normally drop off faster than the cathodes in larger tubes.

Color Tracking - Many CRT testers have three meters for comparing the emission of all three guns. The CR70 "Beam Builder" compares all guns automatically and gives you a simple "Good/Bad" determination. As you perform the emission test for each gun, the CR70 remembers the gun's emission level. Then, when you switch to the "Color Tracking" function, the emission level of each gun is compared to the other two guns as you switch the "Gun Select" control. If the gun's emission current is less than 55% of either of the other two guns, the meter reads "Bad."

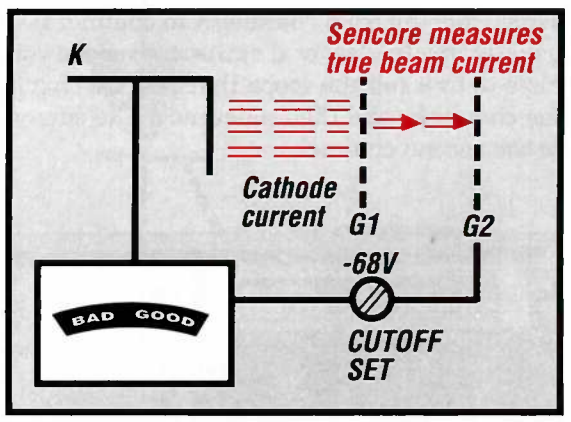


Fig. 7: The CR70 measures the current at the black level and the "true beam current" at the white level to provide a truly dynamic test.

Safely Restore 9 Out Of 10 Bad Tubes

CRT rejuvenators and restorers have been around for decades. All restorers use the principle of increasing the cathode temperature in order to clean off the contamination. Increasing the cathode temperature involves increased filament voltage and increased cathode current. Older types of rejuvenators do not work very reliably on today's CRTs because they often apply too much current and damage more tubes than they successfully improve. If you've given up on restoration because you've tried a competitive restorer and had bad luck — try again. The CR70 is different.

The CR70 provides five levels of restoration and shorts removal which are guaranteed to reliably improve 9 out of 10 weak or shorted CRTs. We call the five levels "Progressive Restoration" because you start with the lowest (and safest) level and progress to higher levels only as needed. The restoration procedure you use for each CRT failure is listed in Fig. 8. Let's take a look at the CR70's method of shorts removal first.

Test Results				CR70 Restoration Procedure
Cutoff	Emission	Life	Tracking	
good	bad			Auto Cycle, then MAN1 if still weak.
bad	good			Auto Cycle once.
bad	bad			Auto Cycle. REJUV if less than 20 mA restore current.
good	good	bad		Auto Cycle once.
good	good	good	bad	Auto Cycle lowest gun(s).

Fig. 8: Use the CR70's five levels of Progressive Restoration to match the type of restoration to the CRT failure for maximum effectiveness and minimum risk of damage.

Shorts Removal - A G1 short can almost always be vaporized by passing a high current through it. The CR70 quickly discharges a 450 volt capacitor through the shorting material (Fig. 9). During the discharge the filament voltage is removed to prevent possible damage to it or the cathode. Tougher shorts, which need more current to vaporize, draw more current from the capacitor than resistive shorts. When the short is gone, the current stops. Thus, the CR70 is safe and effective.

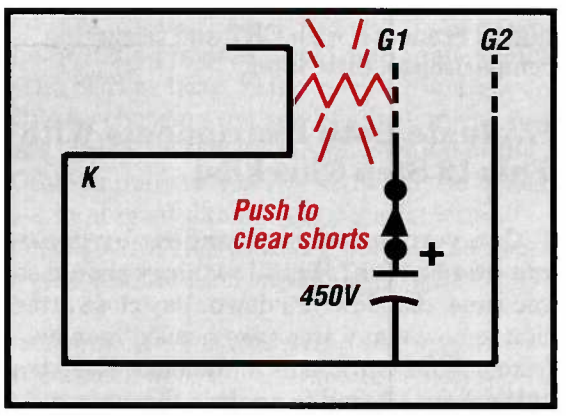


Fig. 9: In the "Remove G1 Shorts" function a 450 volt capacitor is discharged through the short.

Cathode Restoration - Contamination can be removed from the cathode by heating it to a much higher than normal temperature. But, restoration is a subtractive process - it doesn't deposit new material back on to the cathode, it merely cleans off the contamination to expose new emitting material. The trick is to remove the contamination without removing any of the good emitting material. Here's how the CR70 progressive restoration system works:

The CR70 provides three levels of restoration: Auto Restore, Manual 1, and Manual 2. Each is similar in operation and effect on the cathode. Restoration "boils off" the contamination and exposes fresh emitting material on the cathode's surface (Fig. 10). The levels differ in the intensity of the restoring current. Auto restoration is the least intense and should always be used first. The restore current is limited to 100 mA and is cycled on and off three times to prevent the cathode from overheating. Auto restore is sufficient to restore most cathode-related problems.

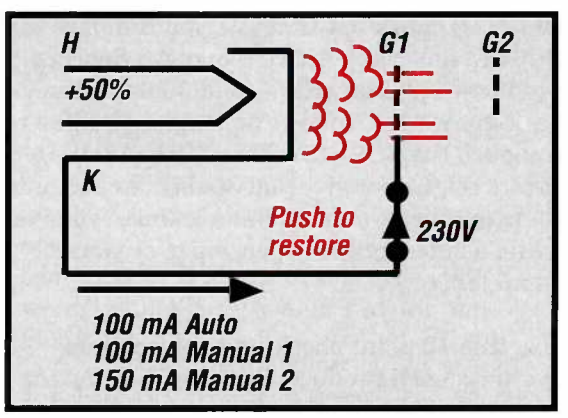


Fig. 10: The CR70 "Restore" functions superheat the cathode to remove the layer of contamination.

Manual 1 is used on tubes which are not adequately restored by Auto Restore. The restore current is again limited to 100 mA, but the current is allowed to flow for as long as you press the "Restore" button.

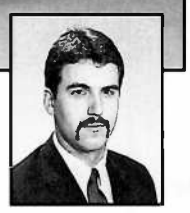
Manual 2 is the highest level of cathode restoration. This is a "last resort" level and is used when repeated attempts at restoration at the lower levels proves unsuccessful. The current is limited to 150 mA and flows for as long as you press the "Restore" button.

The Rejuvenate function is used when the CRT cathode is so totally encrusted that no restore current can be drawn by the other Restore functions. In "REJUV", a capacitor is discharged between the cathode and control grid with the filament voltage applied. The sudden positive voltage from the capacitor discharge causes the electrons to break through the contamination. Once the layer of contamination has been cracked, Auto Restore usually brings the tube back to proper operation.

Do you see how the CR70 can help you know for sure if a CRT is good or bad before you replace it? Do you see how restoring a CRT with the CR70 is a reliable alternative to replacing a worn out CRT? If so, give your Area Sales Engineer a call today at **1-800-SENCORE**. He'll show you how the "Beam Builder" can answer all of your CRT analyzing questions. ■

Circle Fast Facts #242 for more information on restoring CRTs.

The SC61 Waveform Analyzer™ Out Performs Digital Readout Scopes—Prove It To Yourself On Your Own Bench Risk Free . . .



By Brian Phelps, Technical Writer

- **Make DCV, PPV, and frequency readings by pushing one button**
- **Measure waveform parameters independent of the CRT**
- **Safely measure signals to 3000 VPP**

Many companies manufacture oscilloscopes with digital readouts. On paper, some appear to have the same capabilities as the Sencore SC61 Waveform Analyzer. But, side-by-side comparisons show there are major differences which can affect your service profits.

Here is a check list that lets you compare the SC61 to any competitive scope. All Sencore products are sold with a solid 30-day money-back guarantee, so take as long as you like to compare the SC61 to others. (Other manufacturers might not give you 30 days to evaluate their product; you may have to make your test while a salesperson is peering over your shoulder.)

Use this 12 point checklist to objectively evaluate each product. Perform your testing with your time in mind. But remember, the decision you make will affect you every time you make a measurement for years to come. Isn't it worth taking the time now?

First, Set Up The SC61 And The Competitive Scope

Most of the tests can be done with the signal supplied by the front-panel probe compensation jack. This provides a square wave for the two channels. Sync the SC61 and the other unit(s) on the waveform. Set the CRT to the dual-trace mode, and adjust the vertical size and position controls until both traces show on the CRT. If you have any questions about setting up the SC61, dial Sencore's toll-free number, **1-800-SENCORE**, and we'll help.

NOTE: We will refer to the two vertical input channels as "channel A" and "channel B" throughout this article. Some oscilloscopes call these "channel 1" and "channel 2," so use whichever reference you need with competitive units.

Now, look for answers for the following 12 questions. As you answer each question, think about the different needs you have in signal testing, then decide whether the SC61 or the competitive unit will give you better results. The first questions involve the functions of the digital readouts, with CRT and triggering comparisons a little later.

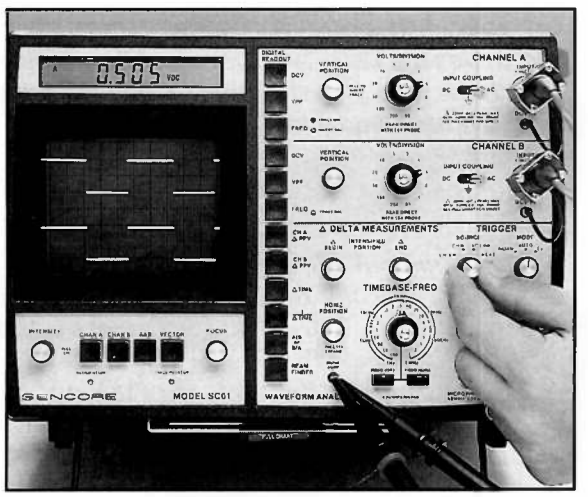


Fig. 1: Most of the tests can be made by analyzing the signal supplied by the probe compensation jack on the front panel.

Evaluate Both Instruments With This 12 Step Checklist

1. Can you choose any reading by pressing one button? Digital readings should save you time, not slow you down. Pay close attention to how many steps are needed to move from one measurement to the next. Keep track of the steps needed to analyze the square waves on the CRT. Count the switches, knobs, and buttons you have to operate to measure the DC voltage, the peak-to-peak voltage, and the frequency of the signal in channel A.

With the SC61, you press one button to measure DC voltage. You press a second button to read peak-to-peak volts. You press a third button to read frequency. Only three steps are needed to analyze the channel A signal with the SC61.

One popular competitive unit requires 9 operations for these same readings. Another needs 10, including several time consuming adjustments of cursor position. How much extra time and effort will these extra steps cost day after day?

2. Can you make a peak-to-peak reading without error? Most scopes use cursors (dotted lines) on the CRT's screen for voltage measurements. Cursors add several problems to testing. First, the signal you want to measure must be displayed on the CRT just as when making CRT-based readings.

Second, manual cursor settings are subject to the same interpretation errors you had when trying to match a waveform to the graticule lines etched in front of the CRT.

Third, moving from channel A to channel B usually involves several extra steps since you have to first tell the scope that you are changing channels, and then must move the cursors to the second channel.

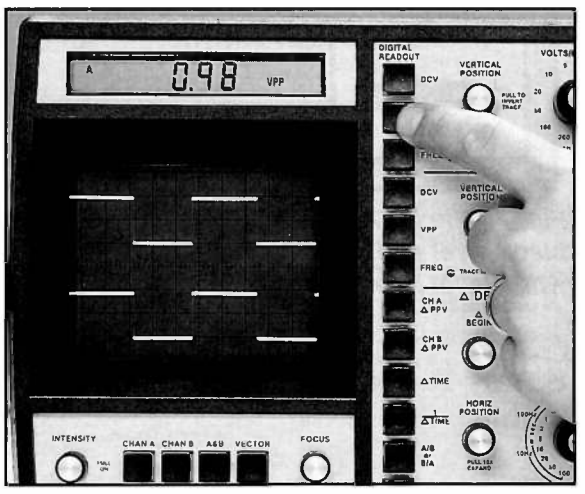


Fig. 2: Only the SC61 lets you push one button to measure DC volts, a second button to measure peak-to-peak volts, and a third button to measure frequency for each of the vertical inputs.

The SC61 doesn't use cursors. You just press the button for the digital reading you want, and the SC61's microprocessor does the rest. The SC61 doesn't even require a displayed CRT signal when testing DC volts, peak-to-peak voltage, or frequency, because the microprocessor gets its signals through a different circuit path than the CRT display. Just apply the signal, press the button, and read the display.

Fully Analyze Any Waveform At The Push Of A Button

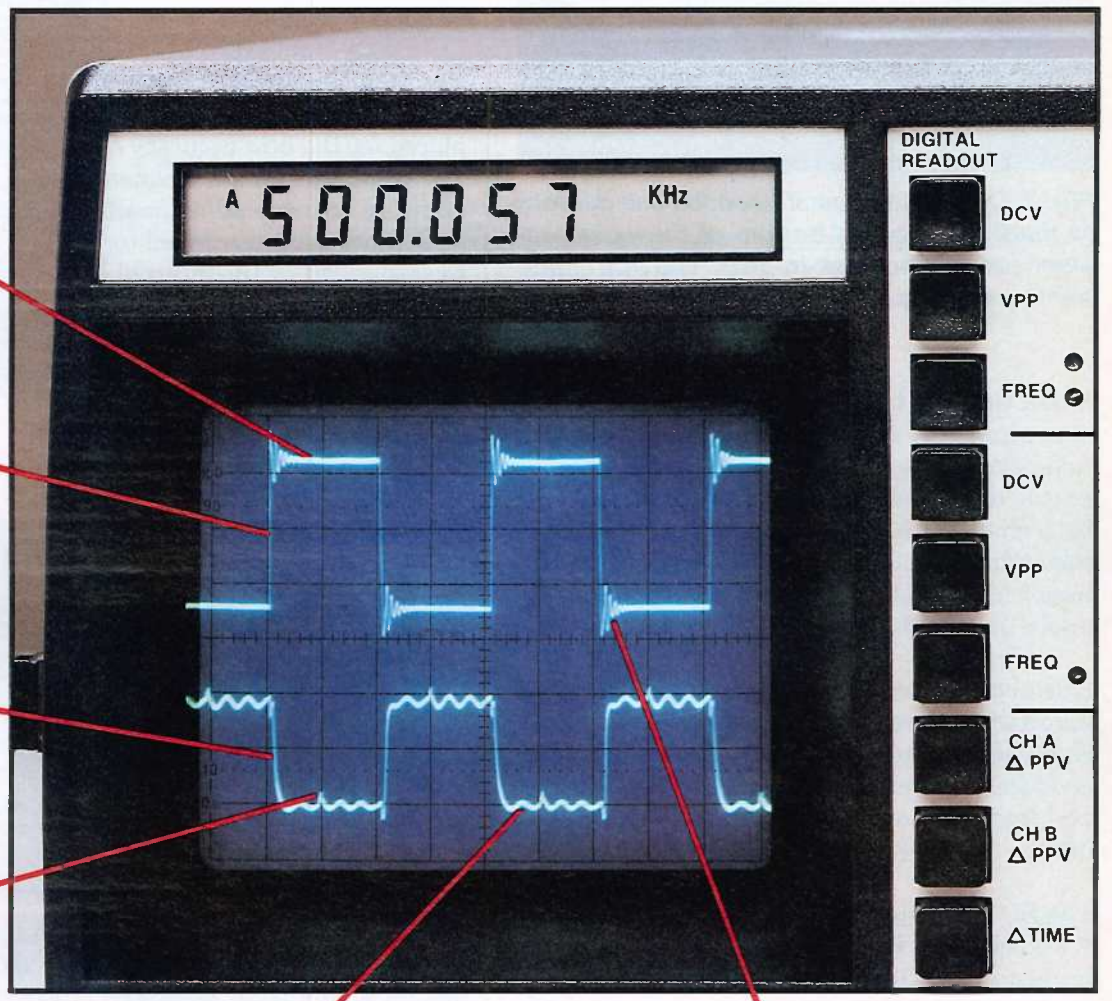
Push A Button To:

Analyze the true peak-to-peak level of any waveform.

Analyze DC through the same probe as all other tests.

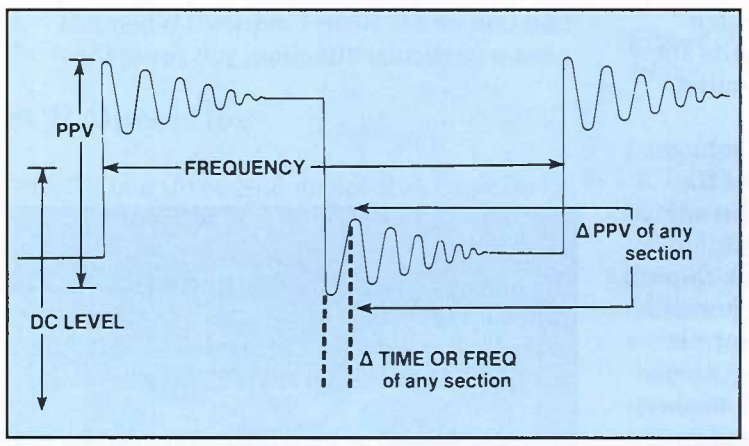
Analyze the frequency to a full 100 MHz, fully autoranged.

Analyze the true peak-to-peak level of any part of the waveform.



Analyze the time relationship of any waveform segment.

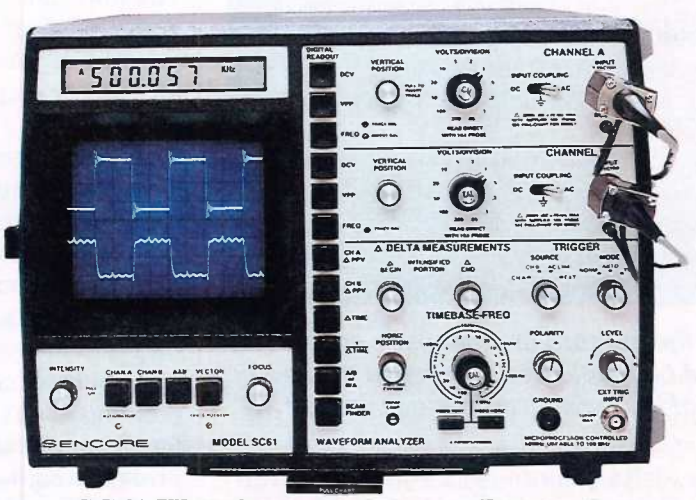
Analyze the frequency of interfering signals.



Only the SC61 measures all six parameters needed to fully analyze any waveform.

IEEE 488 BUS COMPATIBLE

RS232 COMPATIBLE



SC61 Waveform Analyzer — Patented

Now, digitally analyze any waveform — 10 times faster — 10 times more accurately — and without the measuring errors associated with counting graticules on a conventional scope. How? By simply connecting either SC61 probe to your circuit test point and pushing a button. The SC61 is the only instrument that gives digital readouts of every waveform parameter to 60 MHz (useable to 100 MHz) at the push of a button. This added speed, accuracy, and reliability is guaranteed to double your trouble-shooting and testing productivity – or your money back.

Take The SC61 Challenge:

Try the SC61 for 30 days. If you don't agree it has doubled your productivity, return it for a full refund, including freight both ways.

For More Details Call 1-800-SENCORE

Circle #203 for FREE information. **(736-2673)**

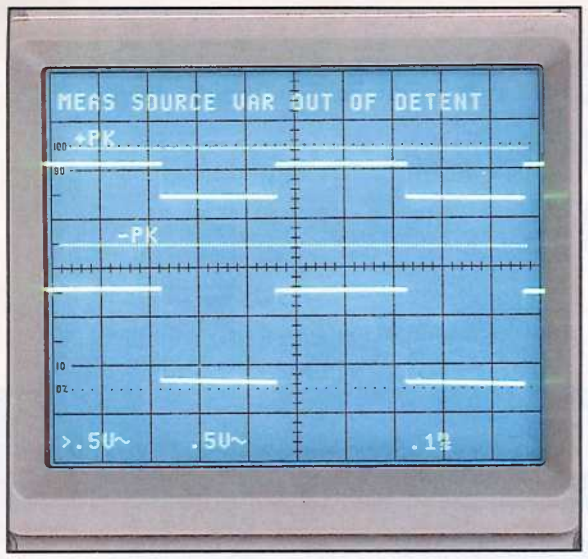


Fig. 3: Competitive oscilloscopes use cursors to mark the top and bottom of the waveform when measuring peak-to-peak. The SC61 measures peak-to-peak automatically.

3. Do the digital readings only work with one channel? Answering this question might take some close examination, because some scopes make some measurements through both channels and other measurements through only one channel. Look closely, or you might incorrectly assume all the readings apply to both channels.

One popular model, for example, lets you use manually controlled cursors on either input channel when testing peak-to-peak volts, time, or 1/time. However, DC voltage, RMS voltage, and frequency only work with the channel A input.

The SC61 provides every test for both channel A and channel B. Each channel uses a single probe to read DC volts, peak-to-peak volts,

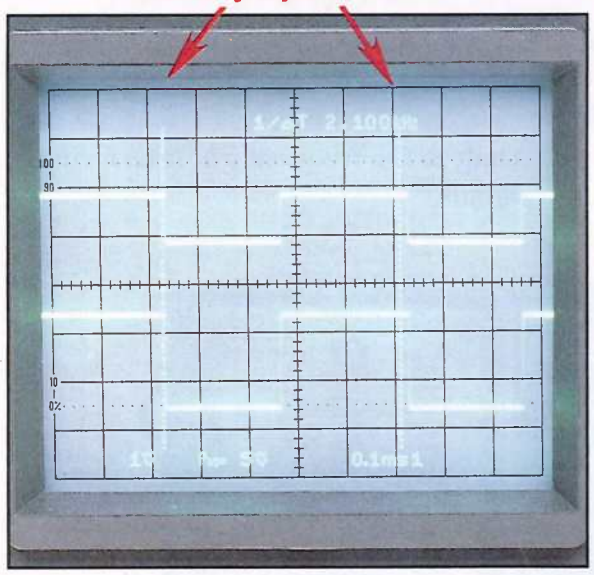


Fig. 4: If the cursors are manually controlled, they must be readjusted every time the size or position of the waveform changes on the CRT.

frequency, delta peak-to-peak volts, delta time, or 1 /delta time. All you do is press the button for the test you want, and read the display.

4. Can you press a button and automatically get a frequency reading? You often need to test the frequency of an oscillator, servo pulse, or digital clock, yet competitive models are severely limited in their ability to measure frequency. Most don't measure frequency directly — you have to intensify one cycle of the waveform and use the "1/Time" function to calculate the equivalent frequency. Time-related readings are never as accurate as a frequency counter since the reading depends on how closely you've adjusted the cursors to the exact beginning and end of the waveform.

The units that do have a frequency function usually limit the resolution to 3 or 4 digits. The best accuracy you can get with a 3-digit reading is 0.1% (1 count out of 999), which is not close enough for most tests needing a frequency reading.

The SC61 frequency counter is autoranging from 10 Hz to 100 MHz to keep the decimal placed for the best accuracy on all readings. The resolution on low frequencies is 0.01 Hz, allowing accurate adjustment of servo circuits or communications control tones. The accuracy supplied by the internal crystal is 0.001% (10 parts per million), so you can depend on every reading. The SC61 eliminates the need for a separate frequency counter in nearly all troubleshooting applications.

Fig. 5: The SC61's exclusive DC signal path lets you instantly switch from AC to DC digital readings, no matter where you have the input coupling switch set. This lets you move through power supply testing quickly.

5. Can you turn any of the "Cal" controls without affecting the digital readings? CRT-based digital readings, such as cursors, depend on the accuracy of the CRT circuits. You must leave the vertical and horizontal verniers ("Cal" controls) in the calibrated position. If you don't, cursor-based units show an error or simply won't display a reading.

The SC61, by comparison, takes the voltage, time, and frequency readings ahead of the controls which affect the CRT. You can adjust the vertical position or the vertical "Cal" controls without upsetting DC or peak-to-peak voltage readings. You can adjust the horizontal position or the horizontal "Cal" controls without causing errors in time or frequency readings. You simply set up the CRT display for the most convenient waveform display, press the digital readout button for the reading you need, and read the digital readout. No other instrument lets you do this.

6. Are measurements correct when testing composite video signals? Composite video waveforms present extra problems for testing. First, it's difficult to sync onto a video waveform. Unless your scope has sync separators, you may have trouble locking to the complex video signal — especially when trying to view signals at the 60 Hz vertical sync rate.

But, video can cause problems even if you have sync separators. The biggest problem comes when you try to measure a peak-to-peak voltage with automatically controlled cursors. The cursors don't know which part of the signal you want to measure, and often bounce back and forth from one level to another. For example, one cursor may jump between the levels representing sync, then blanking, then black. The digital reading changes with each cursor position.

The SC61 prevents these problems when you switch the trigger circuits to the "TV" mode. This function provides stable triggering, plus special logic circuits which prevent signals such as vertical sync and vertical equalizing pulses from causing misleading readings.

7. Does the digital readout cause "black holes" in the waveform? It might seem like on-screen digital readings are a good idea, but they cause some unexpected problems. Since a single electron beam creates both waveforms and the digital readings, the beam must alternate between its two duties. This causes part of the waveform to have black gaps. The gaps become more noticeable at some sweep speeds than others and may cause you to think you have a glitch (or cause you to miss a glitch when you do have one). Switch the timebase through all the sweep rates, using different signal sources, to see if the scope you're testing has this problem.

The SC61 doesn't have this problem. The digital readings are on a separate liquid crystal display and are about 4 times larger than on-screen displays. You get error-free, easy-to-see readings every time.

8. Do any of the controls have more than one function? Buttons with 2 or 3 different functions save space on the front panel, but they can cause real confusion when you operate the unit. Do any of the digital readout buttons have multiple functions? Are some functions buried 3 or 4 layers deep in menus? Do some controls apply to the digital display at times, and to other, unrelated functions (such as delayed sweep) at others?

Look at the SC61's controls. Each is a single function and is clearly marked. When you need a particular function, you press the

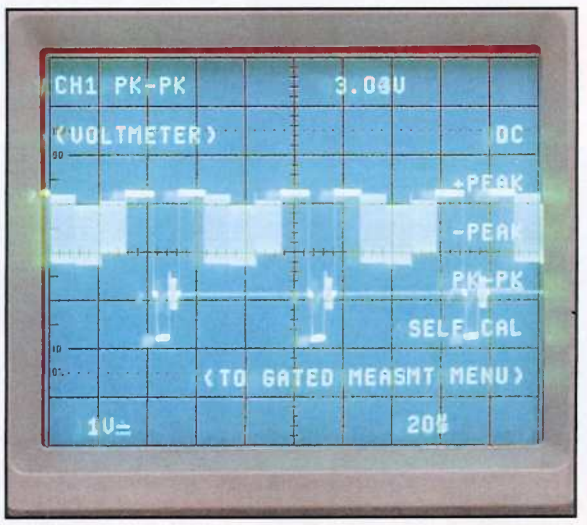


Fig. 6: Multiple readings can be complicated and some readings disappear for certain set-ups, causing even more confusion — taking your mind off the circuit.

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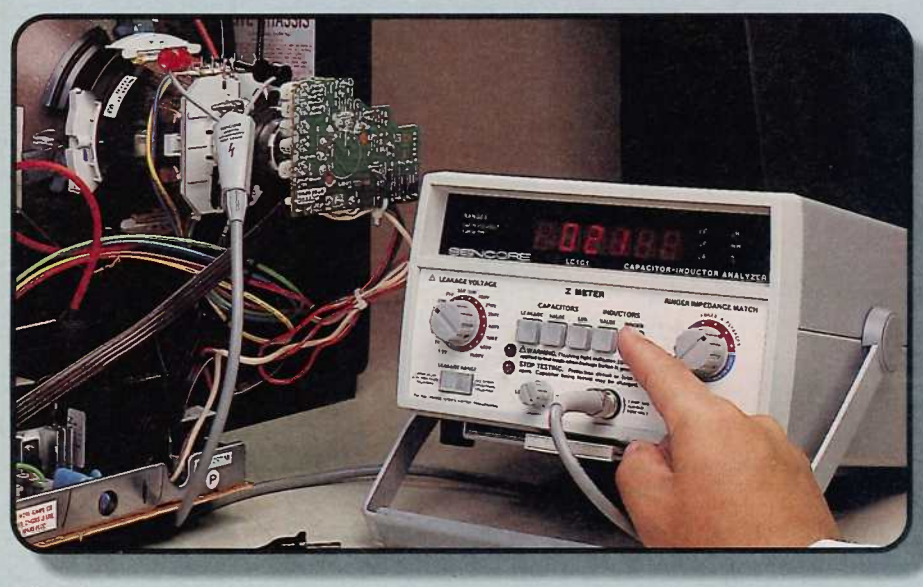

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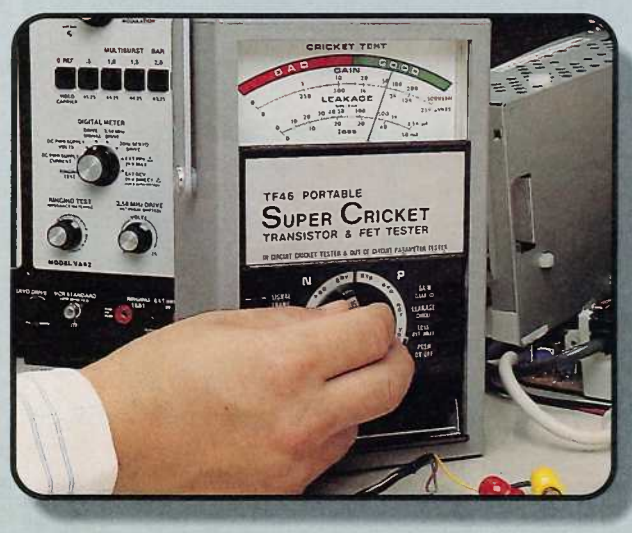

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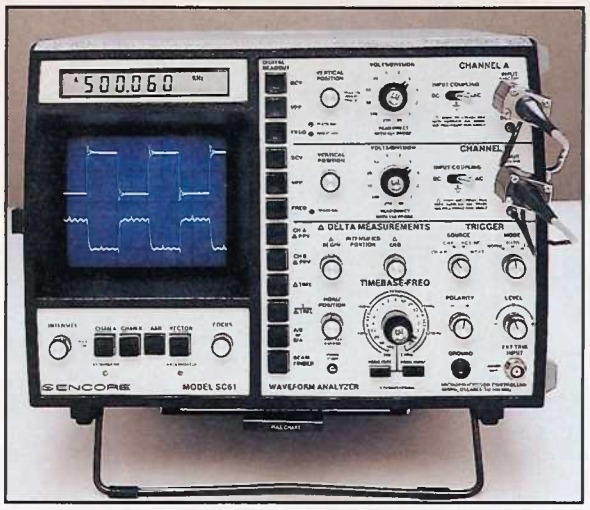

Fig. 7: Each function on the SC61 is clearly marked and conveniently spaced to save time.

button or turn the control with the associated name. There is nothing more to remember.

9. Does the trace stay locked without fiddling with the trigger circuits? So far, we've concentrated on the digital readout. But the CRT display also has much to do with the usability of the unit. While you're comparing units, be sure to include tests of the triggering circuits. Lock in the waveform, and then try these tests.

Switch the input between AC and DC coupling. Does this affect the triggering? Set the trigger level control to its center position and adjust the "VOLTS/DIVISION" switch through its full range. Can you change from less than one CRT division to more than full scale without readjusting the triggering circuits?

Feed a source of composite video into the unit and adjust the circuits to view signals at both the vertical and horizontal sweep rates. Run the vertical attenuator through its full range to see how much the signal can change in amplitude before affecting triggering. Adjust the sweep rate to see if the trace remains stable.

The SC61 triggering circuits give better stability than any other scope. Its special video sync separators provide wide, dynamic range on any video signal for maximum stability.

10. Can you safely measure to 3000 volts? Measuring range varies widely. Most oscilloscopes are protected to only 500 volts peak-to-peak, even when using a 10:1, low-capacity probe. The SC61 is the only unit that lets you measure to 3000 volts peak-to-peak (2000 DCV) with full 3000 volt protection to prevent damage from accidental overloads. It provides maximum uptime, even when you work around the horizontal stages of a TV receiver or video monitor.

11. Does the front panel have room for your hand? The controls on some competitive scopes are so tiny and close together that they are hard to use.

Do you need a pencil eraser to push the tiny buttons? Or, are the knobs so close together that you cannot turn one knob without scraping against another?

The SC61's panel was designed to prevent these "knuckle busters." The controls are finger-sized, and room is left around all controls. This makes the panel a little larger than competitive units, but the time savings and ease-of-use is money in your pocket.

12. Can you dial a toll-free number to get any question answered? Do you have a way to find answers for your technical application questions? With Sencore, all answers are a toll-free call away. Try the customer service of each company to see how it compares. Think of a good question about operating each unit, and see how long it takes to get that question answered.

If you'd like to try an SC61 Waveform Analyzer, give your Area Sales Engineer a call at **1-800-SENCORE.** He'll help work out the details so you can start efficient waveform analyzing today! ■

Circle Fast Facts #244 for more information on the SC61 Waveform Analyzer.

Compare For Yourself

The only way to compare the SC61 Waveform Analyzer with digital readout oscilloscopes is in a side-by-side comparison. The SC61 is designed to let you make every waveform paramater measurement at the push of a single button, based on the signal being measured. Others base all readings on the CRT display, just like a conventional scope.

Here are comparisons of the SC61 to two competitors. We've left room for you to write in your own results when you compare the SC61 in your own tests. Remember to record each step as you go.

After running through these general comparisons, put the SC61 Waveform Analyzer and the competitive scope to work, measuring some of your actual signals. See which one really saves you time. Then, keep the one that gives you better productivity, and return the other for a full refund (at least you can do that for the first 30 days if it's from Sencore).

	Test Results			
Function	**Sencore SC61**	**Tektronix 2247A**	**Hitachi V-1100A**	**Your Test**
Channel A Only				
DCV (steps needed)	1	3*	4*	
PPV (steps needed)	1	2	6	
Frequency (steps needed)	1	2	2	
Alternate A&B (steps needed)	6	13	N/A**	
P-P Cursors	N/A	Auto	Manual	
P-P Follows Signal				
Change Automatically	Yes	Yes	No	
DC While AC Coupled	Yes	No	No	
Readings On Both Ch.	Yes	Yes	Some	
Read Without Display	Yes	Some	No	
Frequency Reading	6 Dig.	8 Dig.	3 Dig.	
Freq. Accuracy	0.001%	0.001%	0.1%	
Freq. Ratio	Yes	Yes	No	
Accurate Readings If				
Verniers Uncal'ed				
DCV	Yes	No	Yes	
PPV	Yes	No	No	
Freq.	Yes	No	Yes	
Delta PPV	Yes	No	No	
Delta Time	Yes	No	No	
1/Delta Time	Yes	No	No	
Auto. PP OK On Video	Yes	No	N/A	
TV Triggering Mode	Yes	Yes	Yes	
Digital Makes Black				
Holes In Waveform	N/A	Yes	Some	
Multi-Function Controls	No	Yes	Yes	
Stable Triggering	Yes	Yes	Some	
Measuring Range	2,000	400	400	
Protection	3,000	400	400	
Hand-sized Controls	Yes	No	No	
Toll-Free Answers	Yes	?	?	

*Includes moving input coupling switch to "DC" ** Does not have all functions on channel 2

(NOTE: All results taken from actual lab tests of competitive instruments, or from the specifications provided by the individual manufacturer.)

SCRs And Triacs - Special Tests For Special Components

By Larry Schnabel, Editor

- **Used as regulators and controllers**
- **Common failures: leakage and inability to turn on**
- **Two types of SCRs: sensitive gate and normal gate**

A variety of consumer and industrial applications use SCRs and triacs. In consumer electronics, SCRs are found in television shutdown and regulator circuits. Triacs are often used in consumer products to turn AC line voltages on and off. In industry, SCRs and triacs are used as voltage regulators, controlled duty cycle rectifiers, and motor speed controls, as well as other voltage control applications.

SCRs and triacs belong to a family of components called thyristors. A thyristor is a solid state device that is used as a switch. These solid state switching devices have become increasingly popular due to their long life and fast switching action.

Servicers need a quick, simple method to test SCRs and triacs. The LC102 Auto-Z combined with the SCR250 SCR & Triac Test Accessory, provide the signals and methods you need for dynamic and accurate testing. In order to better understand SCR and triac testing, let's first look at how these components work and how they fail. Then we'll show you how to test them.

SCR Operation

An SCR is a three lead device that functions like a DC switch when given the proper control signal. An SCR has a cathode lead and an anode lead just like a standard rectifier. A third lead, called the gate, controls the operation of the SCR. Figure 1 shows the symbol used on schematics for an SCR.

An SCR functions like an open circuit when it is "turned off" and like a diode when the SCR is "turned on". This SCR action is controlled by the signal applied to the gate lead. Notice that the symbol looks similar to a diode with the exception of the gate lead.

With no gate current applied to the gate lead, the SCR acts like a switch that is in the "off" position. When a sufficient gate current (trigger current) is applied, the anode-cathode junction is turned on and conducts current. Once the SCR is turned on, it continues to conduct current (latch), even if the trigger

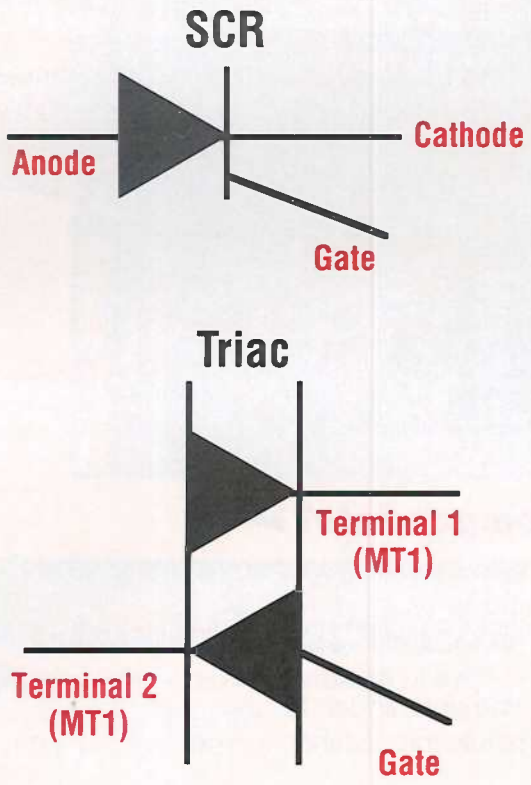

Figure 1: Schematic symbols for SCRs and triacs.

current is removed. The only way to turn an SCR off is to reduce the current flowing between anode and cathode below the holding current level.

SCRs are current-operated devices, so sufficient trigger and holding currents are much more important for SCRs to operate than are the voltage potentials applied to the terminals. Trigger currents vary from only 200 microamps in small SCRs to as high as 150 milliamps in some industrial SCRs. These larger SCRs may also require 200 milliamps of holding current.

Triac Operation

A triac is a bi-directional device similar in operation to an SCR except that it passes current in both directions when turned on. Figure 1 also shows the schematic symbol for a triac. Note that the symbol resembles two diodes facing opposite directions.

A triac has three leads: gate, MT1 (Main Terminal 1), and MT2 (Main Terminal 2). The gate lead performs the same function as the gate lead on an SCR: it turns the device on. The other two leads are labeled differently from an SCR because the function of these leads changes with the polarity of the voltage applied to the leads. The two-way conductivity makes the triac resemble back-to-back SCRs.

How SCRs And Triacs Fail

An SCR or triac operates in one of two states: it is either on or off. In the "off" state, a properly operating SCR or triac blocks the flow of current through it. In the "on" state, a good SCR allows current to flow in one direction only. A good triac allows current to flow in both directions.

The most common failures in SCRs and triacs are:

1. No turn-on
2. Leakage or direct short
3. Leakage at higher working voltages
4. Triac only: Short in one direction; normal operation in the other direction.

SCRs and triacs fail to turn on when either the gate junction is damaged or when the lead from the external connection to the gate junction is damaged. In either case, an external control current applied to the gate lead will not turn the device on.

Another common failure is leakage. The leakage through the SCR or triac may be small, or it may be large enough to simulate a direct short. A leaky or shorted SCR/triac causes loss of control of the device to which it is connected. Some typical symptoms of a shorted SCR/triac are incorrect voltages in a regulator circuit or a motor controller that allows the motor to run at full speed with little or no control.

The third failure occurs when a relatively small amount of current flows through the SCR or triac when a high voltage is applied between the main leads and the device should be "off." This leakage current may be small or

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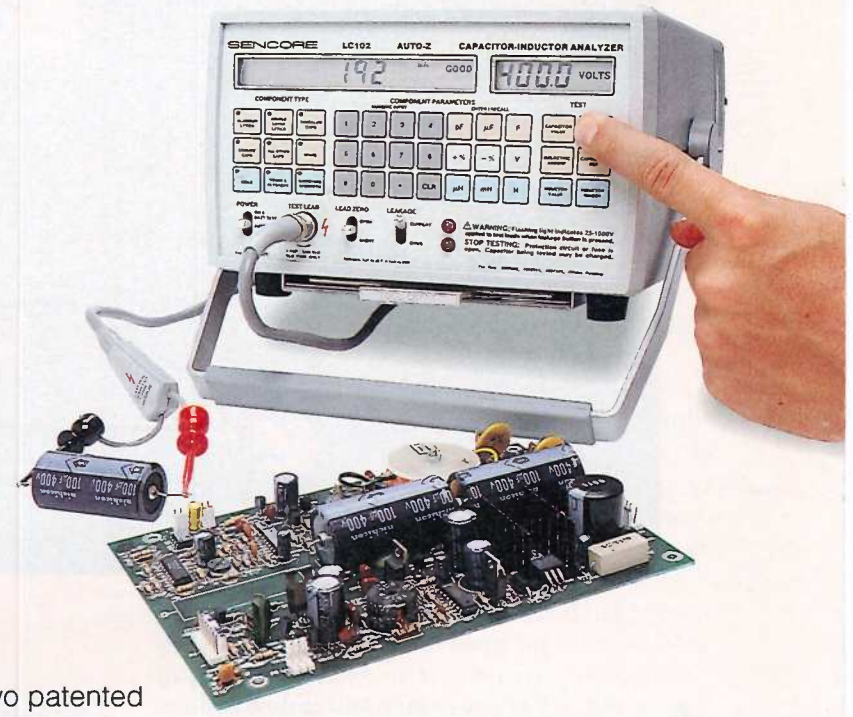

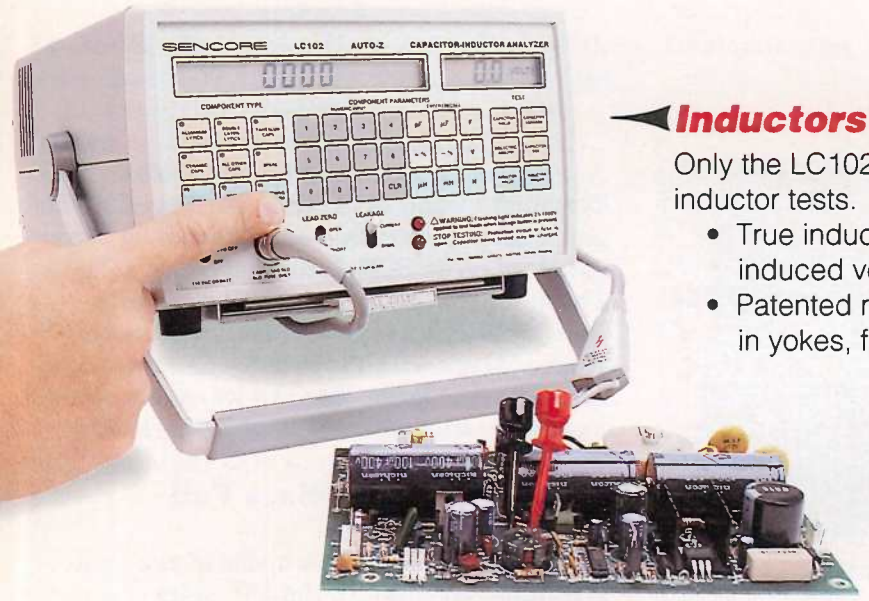

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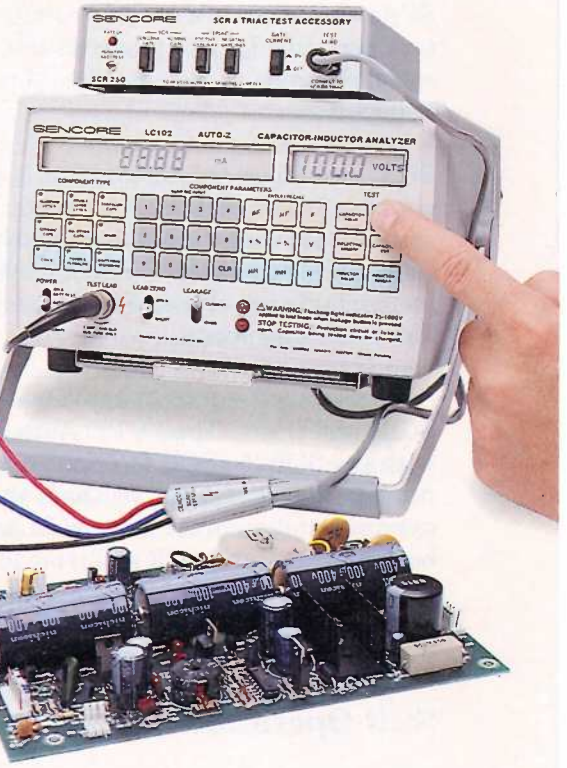

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it may be so large as to act like a direct short. Low voltage tests of such an SCR or triac will indicate that the device is good. The device fails only when a high voltage is applied.

Triacs also exhibit a fourth type of failure. This failure results when the triac becomes shorted in one direction only. This allows current to flow in one direction, even when the triac is turned off. In the "off" mode, the defective triac acts like a diode.

SCR Types

SCRs come in a variety of sizes, shapes, current ratings, and voltage ratings. They can, however, all be classified into one of two types: sensitive gate and normal gate SCRs.

Sensitive gate SCRs get their name from the fact that they are very sensitive to the current applied to the gate lead. They are typically used in low current applications where only a small gate control current is available. Sensitive gate SCRs come in a variety of physical shapes and sizes and cannot be distinguished by simply looking at them.

For many applications, sensitive gate SCRs, are too sensitive for reliable use. Internal currents in the SCR, or small currents in the triggering circuits, may accidentally cause these SCRs to turn on. Heat can also cause internal leakage currents to rise to the point of turning on the SCR.

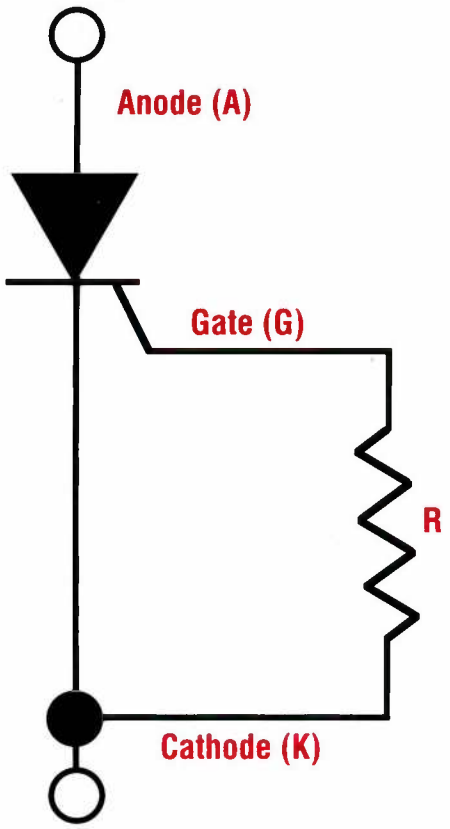


Figure 2: SCRs with an internal bleeder resistor require a larger external gate current to turn them on.

To prevent SCRs from accidentally turning on, many of them have an internal bleeder resistance built into them. This bleeder resistance is placed between the gate and cathode lead as shown in Fig. 2. The resistance bleeds off any internal currents that might build up and prevent the SCR from accidentally turning on by itself. Due to the internal resistance, these SCRs require a higher external gate current to turn them on. In most applications, this additional gate current is easily obtainable making these SCRs more popular than the sensitive gate type. These higher gate current devices are called normal or standard gate SCRs.

How To Test SCRs And Triacs With The LC102 Auto-Z And SCR250 Test Accessory

The LC102 Auto-Z, along with the SCR250 SCR & Triac Test Accessory, analyzes SCRs and triacs with reliable and dynamic tests. The Auto-Z supplies the normal working voltage across the cathode and anode lead for an SCR, or across the MT1 and MT2 lead for a triac. The LC102's high voltage checks for failures caused by leakage or a partial short.

The Auto-Z supplies voltages high enough to locate SCRs and triacs that leak or short only at their working voltage. In addition, the Auto-Z's digital meter monitors the amount of current flow through the SCR or triac. This measures the leakage current and also tells you when the SCR or triac is conducting.

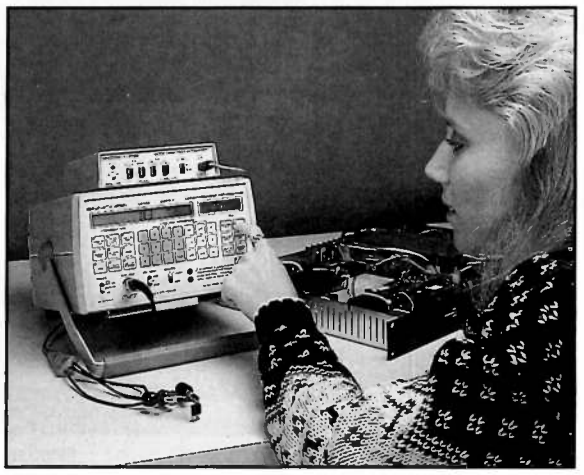


Figure 3: The Auto-Z and SCR250 test SCRs and triacs with dynamic tests you can trust.

The SCR250 provides a controlled gate signal to the SCR or triac. You can safely analyze SCRs by choosing the size of gate current you need. The SENSITIVE GATE position of the SCR250 applies a smaller signal to the SCR's gate to prevent damage on more sensitive SCRs. The NORMAL GATE position applies a larger signal to turn on the larger gate SCRs.

A convenient color-coded test lead speeds up the connection of the SCR250 to the component in question. The simplified operating instructions on the top of the SCR250 guides you through the tests. Following the simple procedure, you can also quickly identify the SCR as a sensitive gate type or a normal gate type.

Want to know more about SCR and triac testing with the Auto-Z? Call your Area Sales Engineer today at **1-800-SENCORE** and ask him for the Tech Tips on testing SCRs and triacs. You'll find helpful information that you can put to good use every day in all of your SCR and triac troubleshooting. ■

Circle Fast Facts #255 for more information on the LC102 Auto-Z and testing SCRs/triacs.

Sencore Tech Talk

How Do I Test "Hockey Puck" SCRs?

One of the most common industrial SCRs is commonly called the "hockey-puck" SCR. The hockey-puck SCR gets its name because of its shape as shown in Fig. 1. Hockey-puck SCRs test similarly to regular industrial SCRs except for a few differences.

Figure 1: The hockey puck SCR gets its name because of its shape and size.

Many hockey-puck SCRs have a pressure-sensitive gate switch which will not allow the SCR to turn on until the SCR plates are compressed. Until the plates are compressed, the gate will remain open at all times. All you need to do is compress both plates of this type of SCR when testing it with your Z Meter and SCR250.

Typically, hockey-puck SCRs are very high-powered devices. If testing the SCR with the SCR250 and the Z Meter doesn't prove the SCR good, you'll want to keep a couple of things in mind.

Some high-powered SCRs require a very large gate current for turn-on. The leakage test will find the majority of problems in this type of SCR. When in doubt, test a known good SCR, and compare the results.

What's Needed For Computer Monitor Service?

By Stan Warner, Market Research Engineer

- **Computer monitors use various scanning rates**
- **Video patterns reveal many monitor problems**
- **Signal substitution effectively narrows problems to single stages**

In the past couple issues of the *Sencore News*, we've presented business and technical information on computer monitors and the computer monitor industry. Here is a review of some of the highlights:

- According to the Electronics Industry Association (EIA) the computer and computer peripheral market in 1989 was $62.5 billion.
- The EIA projected the home computer market to be over $7.0 billion in 1990.
- Every computer must have one or more computer monitor or terminal to display input and output information.
- An article in *Service News* reported, "Larger users are reporting more than a 50% fatality rate of their VGA monitors." The major source of the problem has been the flyback transformer.
- A computer monitor is very similar to a television except that it doesn't have a tuner or an IF section. Computer monitors fail much the same way TVs do.
- The horizontal scanning frequencies and the number of displayed pixels has been increased to improve the resolution and clarity of the picture. Because of this, NTSC video generators will not work for computer monitor servicing.
- Because of the similarities to television, the computer monitor repair market presents a tremendous opportunity to the video servicer.

This issue presents some of the tools and the tests you need for efficient and profitable computer monitor troubleshooting. With the right equipment, you can jump into this service market.

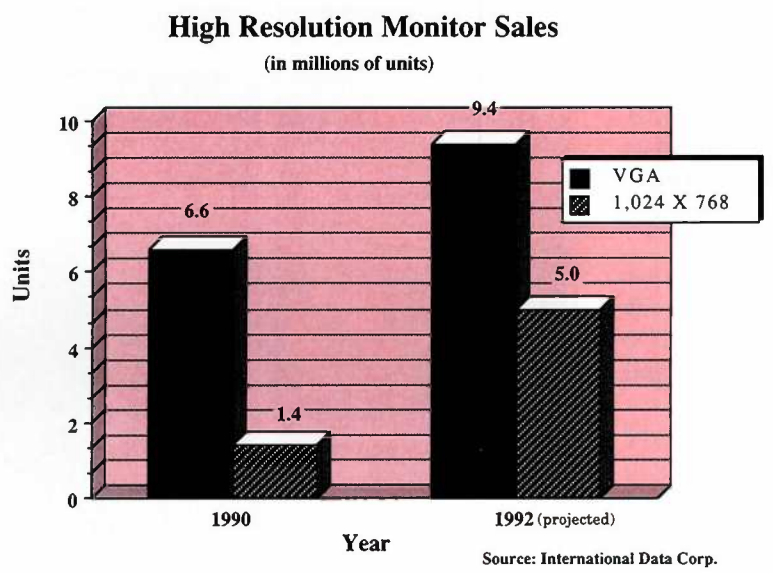


Figure 1: Computer monitor sales continue to increase creating a growing service market.

Complete, Easy-To-Use Signals

You need an instrument that generates the same input signals provided by the computer. This includes horizontal and vertical sync or composite sync; and red, green, and blue video signals. With these signals fed to the computer monitor, you can re-create the symptom reported by the user. But you also need these signals in an easy-to-use format that compliments your troubleshooting skills.

Variable Scanning Rates

Most computer monitors don't operate on the NTSC horizontal frequency of 15.734 kHz and vertical frequency of 59.94 Hz. You need an instrument that generates the horizontal and vertical scanning frequencies and the horizontal and vertical pixel rates the computer monitor requires. Since there has been a tremendous evolution in the computer monitor market with ever-increasing scanning frequencies, you need an instrument that generates the signals needed by today's computer monitors as well as those that are introduced on the market in the future.

Higher scanning frequencies and more displayed pixels improve the monitor's ability to show fine detail. While NTSC televisions have a maximum video bandwidth of 4.2 MHz, the video graphics array (VGA) computer monitors have a bandwidth of over 25 MHz (see Fig. 2). Monitors with even higher bandwidths are starting to appear in the mainstream computer monitor market and will probably replace the VGA standard in the next several years.

An instrument that generates the signals to test the computer monitor to its full bandwidth capabilities for today's technology as well as the technology of the future will make your servicing successful. You'll have the assurance the computer monitor you've repaired is capable of producing clear, crisp images for all of the user's word processing and graphics applications.

Analog vs. Digital

There are two types of computer monitors: digital and analog. Monochrome digital computer monitors display one or two shades of green, amber, or B&W. Color digital computer monitors have red, green, blue, and intensity input lines and can display eight, 16, or 64 colors through various combinations of logic "1"s and "0"s.

Analog computer monitors can display an infinite number of colors and shades of gray. The video signal fed to an analog computer monitor is 0.7 - 1 volts. Typically the horizontal and vertical sync pulses are at digital levels. Most analog monitors require a non-interlaced signal, but a few new models require an interlaced signal.

As a computer monitor servicer, you need to be able to test each type of display that comes into your service center. You need to test monochrome and color, digital and analog, and non-interlaced and interlaced monitors. If you don't have an instrument that generates this variety of signals, you may be forced to turn away profitable business.

Good Video Patterns Reveal Monitor Defects

A wealth of information about a monitor can be gained by looking at the pattern or image it displays on the CRT. You can determine if the monitor can produce even color across the entire display and if the guns are properly converged. You can also test if a computer monitor has correct brightness linearity, maximum bandwidth resolution, and high voltage regulation.

For effective computer monitor troubleshooting, you need an instrument that generates video patterns that help you isolate faulty circuits. Comprehensive, dynamic video patterns let you do a final performance test on the computer monitor before it goes back to the end user.

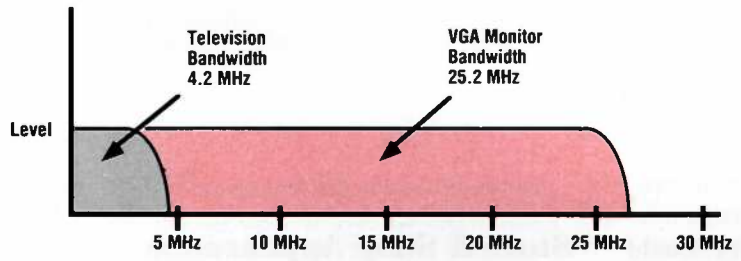


Figure 2: Computer monitor bandwidths have increased significantly over television.

Signal Substitution - The Answer To Isolating Defective Stages

Computer monitors will come into your service center with the same problems as TV receivers: poor video response, collapsed vertical raster, failed power supplies, blown outputs, loss of vertical or horizontal sync, and no high voltage. Quickly isolating the faulty circuit stage and then the faulty component is the key to efficient computer monitor servicing — just like TV servicing.

The fastest and most effective way to isolate a faulty circuit stage in a computer monitor is to use functional analyzing (see Fig. 3). Functional analyzing involves signal injection and signal tracing. First use signal substitution to help narrow the problem down to a single stage by injecting a known good signal into the input of a functional block and monitoring the output. If the output is OK (a clear, locked-in display), you can be confident all the circuits between the injection point and the output are good. If the symptom persists after your injection, move to a later stage until the symptom disappears.

Once the problem is narrowed down to a single stage, use signal tracing to find the faulty component. As you signal trace, compare voltage levels, frequencies, and waveshapes to those in the service literature.

Isolating Defective Major Components

As in television, the computer monitor's flyback transformer is a major source of failure. Problems also are very common in the high voltage diodes in the flyback or the multiplier. Horizontal and vertical yokes and the switching transformers in switched mode power supplies are also frequent failures.

High voltage, horizontal output, and power supply problems are probably the most time consuming and difficult to troubleshoot because the computer monitor is usually in shutdown. You need an instrument that provides an accurate and efficient means for isolating these types of problems and determining which component is defective — without expensive substitution.

Sorting Through The Maze Of Hookups

There are a number of different monitor input connectors and wiring configurations (Fig. 4). Some take a 9 pin D-sub; others a 15 pin D-Sub; others a 15 pin high-density D-Sub, and still others use BNC connectors. The CGA, EGA, MDA, and PGC computer monitor formats all use the 9 pin D-Sub, but their wiring configurations are different.

Building connectors for each of the common computer monitor types can be a time consuming task. You need an instrument that provides the connectors for the most common computer monitor formats so you can hook up to the computer monitor and start your troubleshooting.

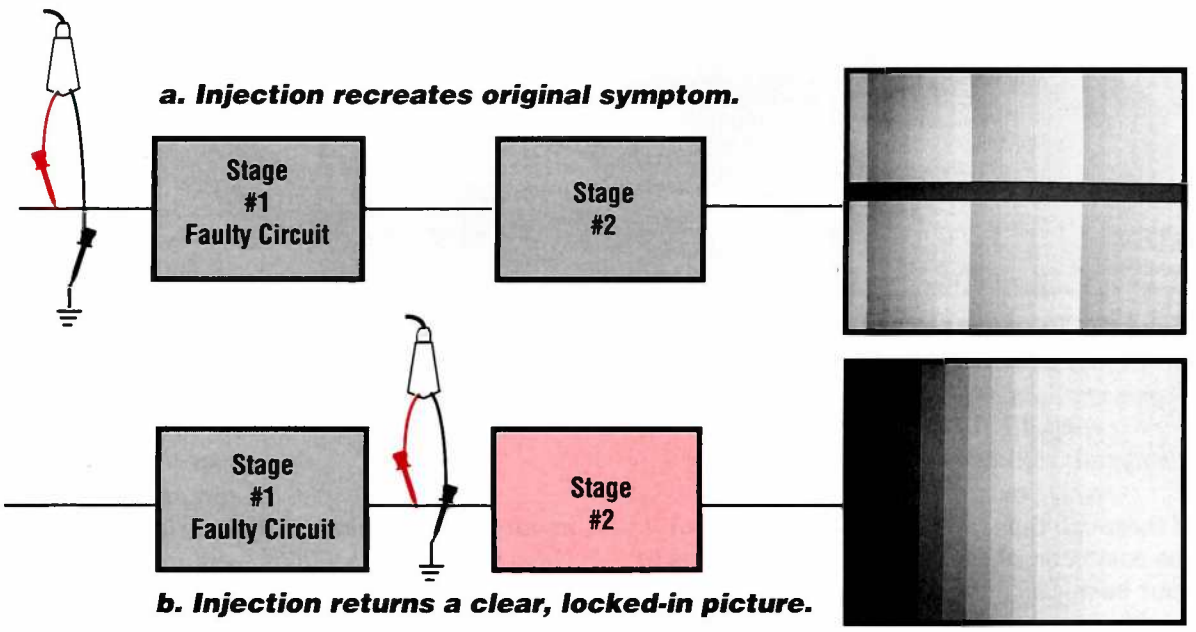


Figure 3: Use signal substitution to narrow a problem down to a single stage.

Testing On The Go

Computer monitor servicing isn't confined to the service bench. Often you need to go on location to determine if the user's complaint is caused by the computer or the computer monitor. You may need to do "on site" alignments and performance tests. Some minor repairs can also be done without taking the unit back to the shop.

In short, you need an instrument that goes wherever your computer monitor analyzing takes you. It must be small, lightweight, and rugged enough to take the bumps of being transported to and from the service van.

Remember The Tremendous Opportunities

There are tremendous opportunities for the video servicer in the computer monitor repair market. Computer monitor repair may be the vehicle for expanding your service business into the profitable fields of business, industry, medical, and schools. As in other service markets, you'll need equipment with the capability of providing quick, thorough service that will get you through any job.

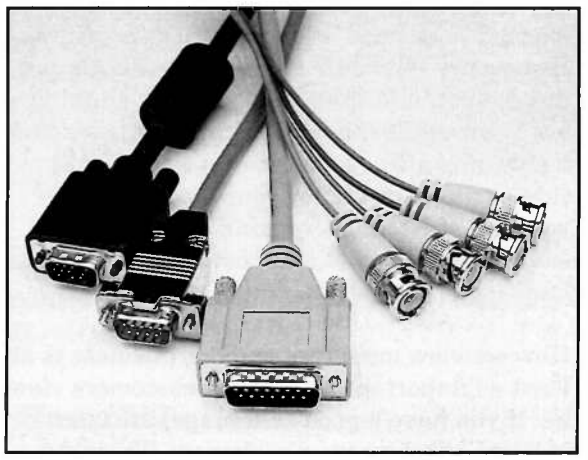


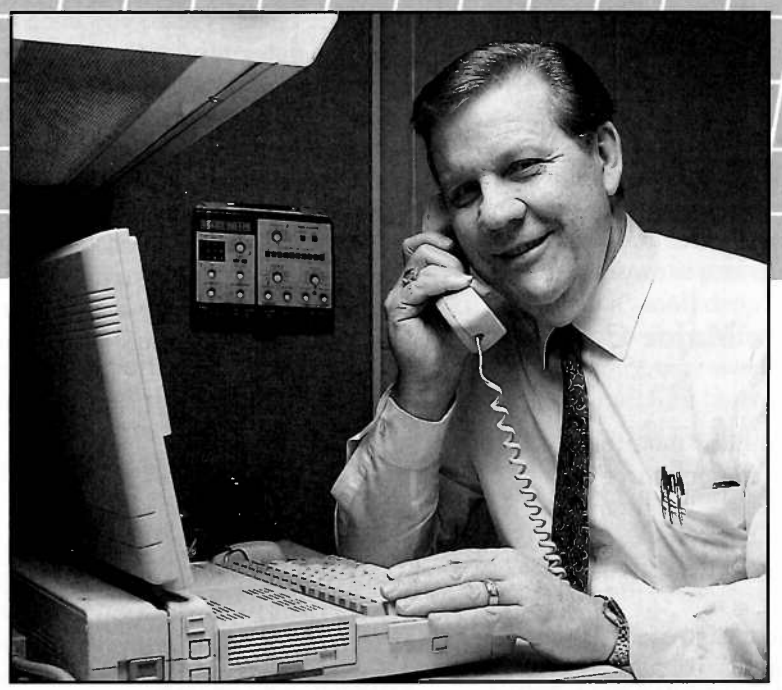
Figure 4: Computer monitors use a variety of different hook-up adapters.

You need an instrument with the following:

- Ease-of-use without cumbersome menus or instructions
- Input signals to match any monitor
- Video patterns that quickly show the problem
- Drive signals for efficient troubleshooting of defective stages
- Accurate, dynamic tests for flybacks, yokes, and switching transformers
- Connectors and adapters to match any computer monitor input
- A compact, rugged design that you can take along on field service calls

Watch for upcoming issues of the Sencore News to find out about the instrument that will help you capitalize on the opportunities in the computer monitor repair market. It's an opportunity for you to expand your servicing business with very little change in procedures or equipment, but with a large increase in profits. ■

Circle Fast Facts #256 for information on a New computer monitor analyzing instrument.



Improving Your Business Image

By Norm Tipton, Application Engineer

- **A good first impression is a lasting impression**
- **Advertising is an extension of your image**
- **Show your customer that you care**

In the excitement of today's business world, we sometimes forget our fundamentals and stray from what we have learned to be good, sound business practices. Every once in awhile we need to sit back, put up our feet, and think back to the beginning of our business to recapture that original excitement and enthusiasm. After all, look what that excitement did for your business when you first started. Now, think of what that same enthusiasm can do combined with the knowledge you have accumulated today.

How we view ourselves and our business is at least as important as how our customers view us. If you have a good self image, it has a positive effect on your customers. Their confidence in you is created by your positive attitude and professional image. In short, customer behavior mirrors your business image. With this in mind, let's see if your image measures up to what the customer expects.

Making A Good First Impression

Your customer's first impression of your business is a lasting impression. If you make a positive first impression, chances are you have gained a customer.

Professionalism is the operative word here. If your business doesn't have a professional appearance inside and out, the customer may not even enter the front door of your business. You won't even have a chance of repeat business if the customer doesn't walk in the front door.

When your customer asks for your services, he also expects to deal with a professional. He likes that confidence of knowing his property is in the hands of a competent, caring business person who will solve his problems in a fast and courteous manner.

Professionalism is not a simple goal to achieve, however. These are several key points you may want to consider to help your overall professionalism:

Conduct: Your language and integrity should be at their best at all times. Even when dealing with difficult customers, your professional attitude must prevail.

Goals: Everything you do in a business should be customer oriented. Your customer is your business. He should be the focal point of every business goal you set.

Quality: Quality is the character of your business. The quality of your work and your attention to detail is what makes you stand out from all the rest.

Figure 1: The professional appearance of you and your business is the first thing your customer sees.

If these are the traits of a professional, can the customer, at first glance, identify these in your business? If he can, you should be on the road to a successful business. But there's still more to it.

Store & Shop Appearance

In a business, you must erect a sign that will most correctly communicate your business goals, product, and services. That sign should convey your statement to the customer. The words should be inviting. . . the color warm and appealing. . . and tell the customer exactly what you can do for him. The interior of your store should be an extension of the words on your sign. . . leading your customer to the conclusion that he has come to the right place, and is put at ease.

Appearance is one of the main attributes of a successful business. When you walk into other businesses, notice the cleanliness and professionalism; then notice the number of people there or the amount of business presently going on. Look around and borrow ideas if you like the feeling of being there.

Learn and implement. That's the key to success. Fear of failure will always tell you that your ideas are no good or it's not worth the trouble. However, striving for success will encourage and promote ideas and exalt learning. You have to find out which you are listening to (failure or success) and take the appropriate action. Have you ever had a good feeling about being in a place of business? Do people feel that way about your business? A satisfied, comfortable customer will come back.

Figure 2: A newspaper or yellow pages ad should be brief but informative.

Advertising. . . Is It Necessary?

A very successful businessman once said, "Advertising is just an extension of the sign on my store. I would not consider stopping my advertising any more than I would consider taking my sign down. In comparison to this city's population, only a drop in the bucket comes past my store. Why, if I didn't advertise I would have to close my doors." So, is advertising necessary?

Remember that advertising is an extension of your image. Of course, the purpose of advertising is to let your prospects (future customers) know what it is you do and how well you do it. However, your image in your advertising makes the difference — whether they take you up on your offer...or not.

Since most of your service business probably comes from the telephone, yellow page advertising is an appropriate place to promote your professional image. The size of your yellow page advertisement depends on what your business can afford. A quarter page is usually best for a servicing business. An eighth of a page is the least you would want to consider or your advertisement may be overlooked.

In the advertisement, plan what you want to tell the customer, but remember, there should be at least one reason why they should call you over everyone else. Don't try to write a book. Keep your ad simple so the customer can read it in a quick glance (Fig. 2).

Other forms of advertising depends on your business' size and diversity. Sales and grand openings, of course, should be advertised in the newspaper, local shopping news, etc. Television advertisement is more expensive, so you'll need to judge what your return will be on such an investment.

There are always alternatives. If you are just starting from the ground up, hand-delivered flyers work out well for many newcomers. Or, look into placing your flyer inside the local shopping news (you might be surprised how accommodating some shopping news agencies can be).

Are You Ready For Business?

A customer brings a TV or VCR for you to service and you accept it with a half smile. If you forgot to attend the manufacturer's service school on that model, you've got a right to that sinking feeling.

Just check it off as a future goal. Always take advantage of service schools, no matter how inconvenient they might seem at the moment. The knowledge you obtain allows you to be more productive.

Some who are just starting out and have not yet aligned themselves with any one brand of consumer product might find it a little difficult to get into service schools since most are closed to the manufacturer warranty servicers. Well, don't let that stop you. The majority of the training manuals and workbooks that the schools use are all available from that manufacturer's publication department for a nominal fee. And the books' instructions are usually so detailed that you can go through them without the aid of an instructor.

Other schools are available from the Electronic Industry Association (EIA), Sencore Inc., and the National Electronic Sales & Service Dealers Association (NESDA).

Honest, Courteous, And Dependable Service

A business is not just a building or a telephone, whereby, someone comes in or calls you for a service. A business is a relationship between you and the public that needs your constant attention. One of the most important business goals you should set for yourself is to be an honest, courteous, dependable servicer. If you can fulfill these goals and combine them with your business expertise, your business will grow and prosper.

Caring For The Customer

Does the customer feel that you care? How does he or she know this? Let's look at a typical service call.

As the lady of the house opens the door for you, she notices your well groomed appearance and sharp looking uniform...at the same time peers over your shoulder at your shiny clean truck. She feels good about this service call already. And you break the ice with a nice compliment on her home.

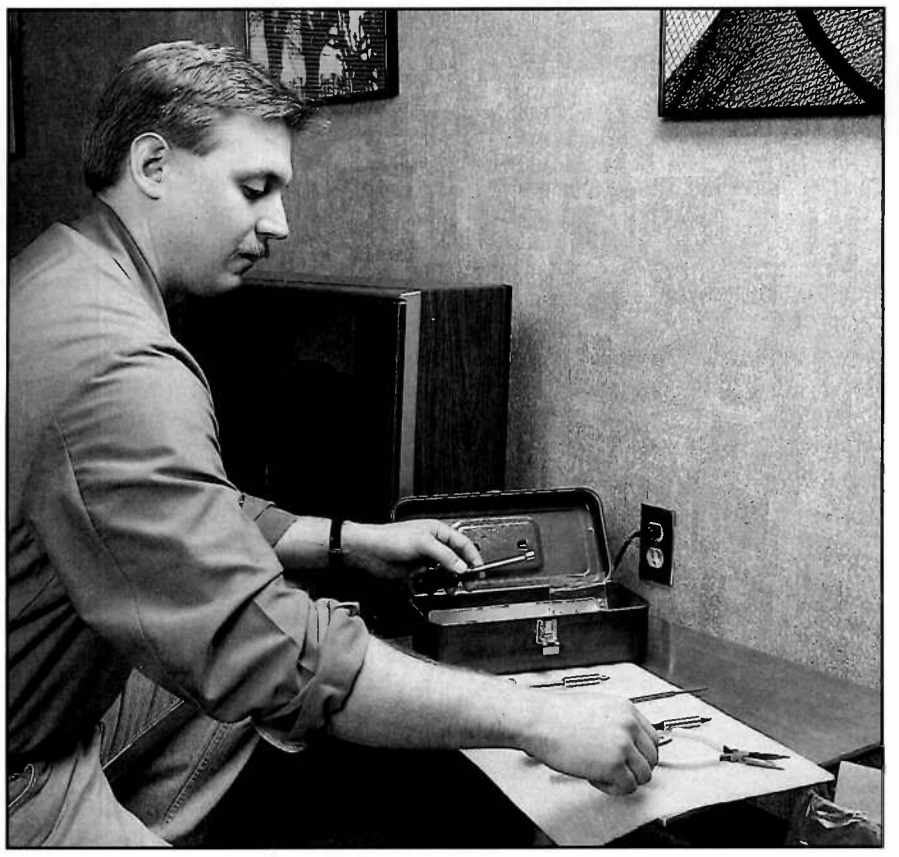
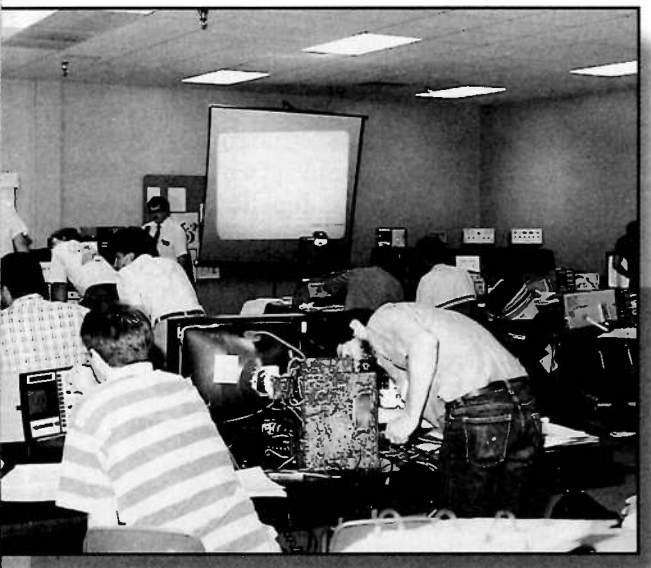


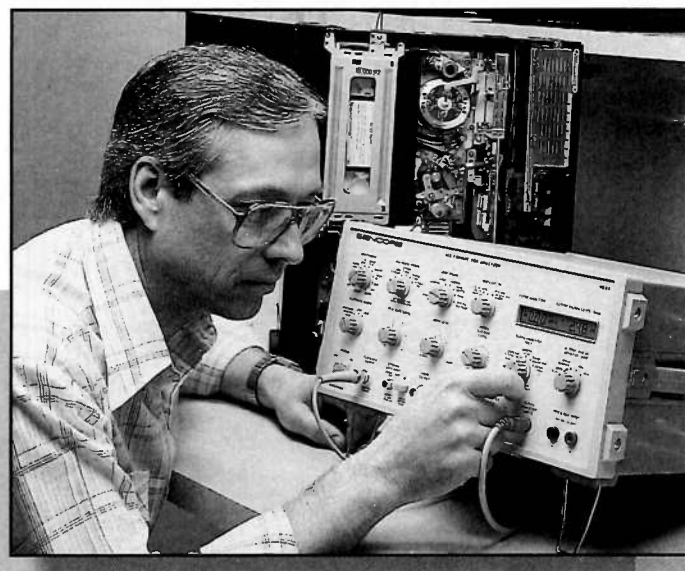
Figure 3: Caring about the customer and his possessions leaves a positive feeling about you and your business.

You've put your customer right at ease. Notice how she opens up to you about her television and how she needs it to watch her favorite shows. Now, really wow her and lay out that nice clean mat to lay your tools on instead of on top of her "pride and joy" furniture.

Everything's going great. The repair was a routine 15 minute repair. It works like a champ again. Notice that she's writing the check with a smile. She's happy, you're happy, and the TV's working. Caring is your business. Don't you just love this business? ■

1 Day Tech Schools





What: One day workshop on switch mode power supply or VCR "Tough Dog" troubleshooting. (Check your city and state for the Tech School in your area)

When: Each one day Tech School runs from 9:00 AM - 4:00 PM.

Who: Sponsored by Sencore.

Hands-On Switch Mode Power Supply Troubleshooting

July

State	City	Date
Georgia	Atlanta	July 9-11
North Carolina	Charlotte	July 16-17
Virginia	Norfolk	July 23-24
Dist. Of Colum.	Washington	July 30-31

August

State	City	Date
Pennsylvania	Philadelphia	Aug. 13-15
New Jersey	Newark	Aug. 20-22
New York	Long Island	Aug. 27-29

September

State	City	Date
New York	Elmsford	Sept. 10-12
Connecticut	Hartford	Sept. 17-18
Massachusetts	Boston	Sept. 24-26

(call for last minute changes)

What You Will Learn:

- The different types of SMPS, where they are used, why they are used, how they fail, and how to troubleshoot them.
- "Safe Troubleshooting Techniques" for any chassis.
- How to test switched mode supply components.
- TV kick and trickle start circuit operation and troubleshooting.
- Simplified shutdown circuit servicing.

(Your workstation will be equipped with Sencore's SC61 Waveform Analyzer, LC102 Auto-Z, PR57 Powerite, and special demonstrators).

What It Costs:

$50.00 registration fee payable in advance. VISA, MasterCard, check, or purchase orders are accepted. **Maximum attendance: 30 by pre-registration only.** *(Cancellation policy: must call 48 hours in advance or fee is non-refundable)*

How To Register:

Call **1-800-SENCORE** and ask for Natalie. Registration is based on first-come, first-serve. Please use the 6 digit number above your name on the mailing label to speed your registration.

What You Need To Bring:

A fresh mind with room for a lot of useful information. Nothing else is required.

What You Will Get:

- Valuable information and troubleshooting tips that you can apply daily.
- Technical workbook (yours to keep).
- Certificate of Achievement.

(All Tech-Schools are smoke-free)

tech school

For More Details Call 1-800-SENCORE

(736-2673)

VCR "Tough Dog" Troubleshooting Techniques

with the VC93 All Format VCR Analyzer

July

State	City	Date
Wisconsin	Wausau	July 15-16 (Video)
Wisconsin	Milwaukee	July 18-19
Illinois	Chicago	July 24-26
Indiana	Indianapolis	July 30-31

August

State	City	Date
Indiana	Indianapolis	Aug. 1
Tennessee	Memphis	Aug. 13-14
Missouri	St. Louis	Aug. 12-14
Missouri	Kansas City	Aug. 20-22
Colorado	Denver	Aug. 27-29

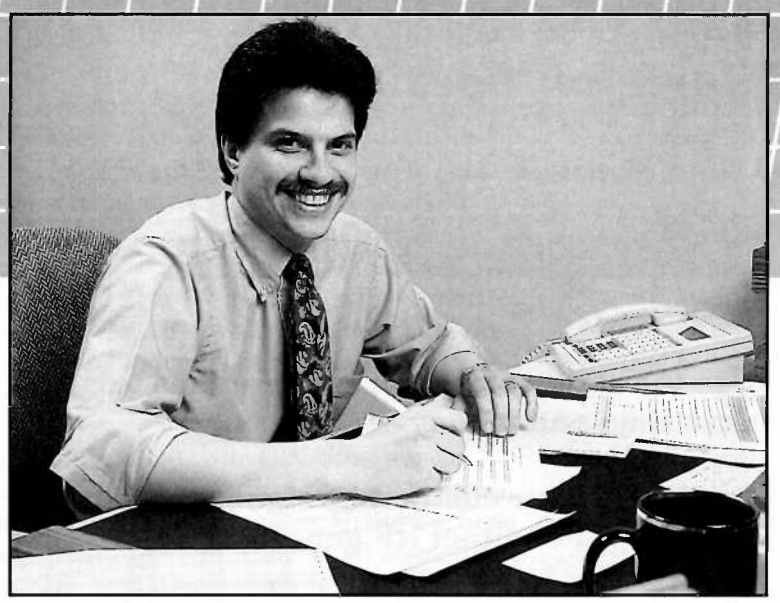
September

State	City	Date
Iowa	Des Moines	Sept. 5-6
New Mexico	Albuquerque	Sept. 9-10
Texas	El Paso	Sept. 12-13
Arizona	Phoenix	Sept. 18-20
California	San Diego	Sept. 24-26

(call for last minute changes)

What You Will Learn:

- How to dynamically substitute for any format VCR head: VHS, Beta, U-Matic, VHS-C, S-VHS, Super Beta, U-Matic SP, 8 MM, Hi 8
- How to dynamically substitute any VCR Stereo Hi-Fi head for all formats.
- How to isolate any VCR luminance/chroma problem with exclusive sync-lock trouble-shooting signals
- How to isolate any VCR Servo problem in less than 30 seconds without taking the VCR cover off



Value Added Services Help Pay For Your Test Equipment

By Garrett Carter, Service Manager

CRT Restoration Means Increased Earning Power

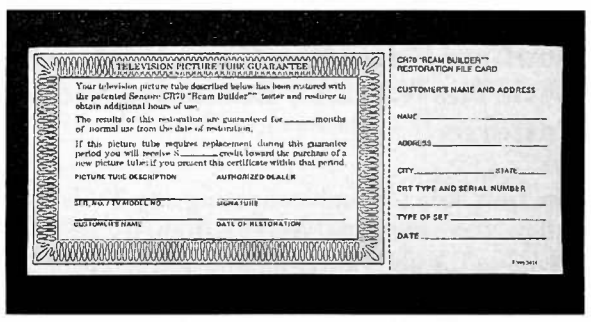
Many servicers are already taking advantage of the extra income earned through the use of the CR70 CRT Restoration Certificate (Fig. 1). By using these certificates in their business, CR70 Beam Builder ® owners have found a way to pay for their test equipment as well as provide an added benefit to their customer.

The CR70 can increase your profits by providing a service that has a high perceived value to your customers. Here is a typical situation where the CR70 can build your profits and give your customer an option:

A customer brings you a set with an apparent shutdown problem. After investing a few hours of troubleshooting and $30 in parts, you have the problem fixed. You power up the set only to find the CRT is weak. You restore the picture tube with your CR70 (at a $35 charge) and guarantee your work for 6 months, a year, or maybe even longer. If the tube fails within the guarantee period, you apply the restoration charge to the installation of a new CRT.

You're guaranteed the profit of this repair and/or the installation of a new CRT (less the restoration charge) if this tube happens to fail. Plus, if the tube does fail, you're guaranteed repeat business. The restoration certificate is designed to give your customer a guarantee of just how long their restoration will last as well as build their confidence by knowing you stand behind your work.

If you simply restore two sets a week at $35 each, you'll generate $3640 the first year alone. This is the kind of investment in which everybody wins — you earn your customer's confidence, and you pay for your test equipment at the same time. To receive your book of CRT Restoration Certificates, just call **1-800-SENCORE**, ext. 308. The cost is only $5 per 100 certificates.


TELEVISION PICTURE TUBE GUARANTEE

Your television picture tube described below has been restored with the patented Sencore CR70 "Beam Builder"™ tester and restorer to obtain additional hours of use.

The results of this restoration are guaranteed for _____ months of normal use from the date of restoration.

If this picture tube requires replacement during this guarantee period you will receive $_____ credit toward the purchase of a new picture tube; if you present this certificate within that period.

PICTURE TUBE DESCRIPTION — AUTHORIZED DEALER

SER. NO. / TV MODEL NO. — SIGNATURE

CUSTOMER'S NAME — DATE OF RESTORATION

CR70 "BEAM BUILDER"™ RESTORATION FILE CARD

CUSTOMER'S NAME AND ADDRESS

NAME _____

ADDRESS _____

CITY _____ STATE _____

CRT TYPE AND SERIAL NUMBER

TYPE OF SET _____

DATE _____

Figure 1: The CR70 Restoration Certificate builds your customer's trust in your service and ensures repeat business with him.

PR57 Safety Leakage Stickers

What would your customers say if they knew you went the extra steps to ensure their safety? What would it mean to your customers to know their children were safe from electrical shock when they touched the outside of their TV or VCR?

Simple, extra services separate your business from all of your competition. When you do all of the little things (such as ensure their safety) combined with fast, reliable service, it simply shows your customers that you are truly in business to serve them.

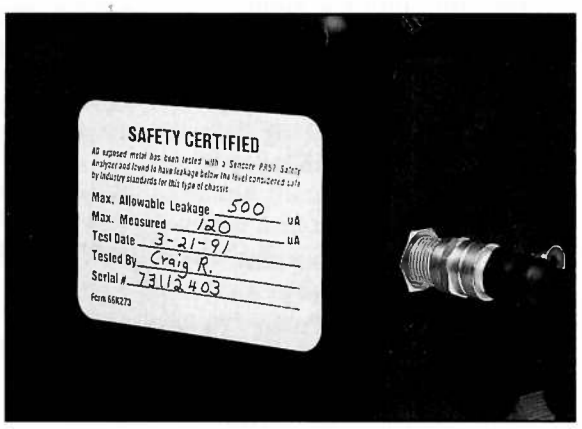


Figure 2: The safety leakage sticker tells your customer you have checked his equipment for shock potential due to leakage.

One of these "extra" services is to ensure your customer's product has no external electrical leakage that could be dangerous to them or anyone in their family. The Sencore PR57 Powerite ® lets you perform this leakage test with one probe connection. You don't need to rig any circuits or make any calculations. You simply touch the special probe to the chassis, and read the leakage level on the PR57 meter. (Laws in some states require you to perform this test on all chassis.)

So take the offensive. 1) Start by performing the leakage test with the Powerite® on all your service items. 2) Let your customer know you are performing the test and why. Tell him what you are doing verbally, and verify you performed the test by attaching a Safety Leakage Sticker to the serviced product. 3) Use the test to pay for your test equipment by adding a small charge to the final bill.
As shown in Fig. 2, the sticker is quite simple. And since it takes less than 30 seconds to perform the leakage test with the PR57, your time investment is minimal.

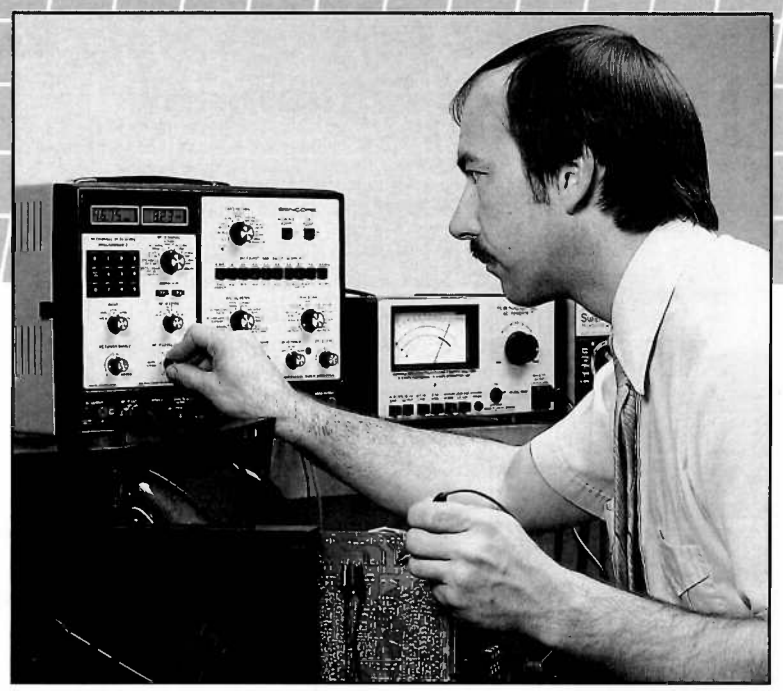
If you perform this test on every product you service, you'll generate enough extra profits to pay for all of your test equipment. By using the NESDA (National Electronic Service Dealers Association) average of 4 sets per day, and an average charge of a $3 per set for the leakage test, you'll generate over $3000 the first year. That pays for the PR57 Powerite® six times over.

These stickers are self adhesive and are available from Sencore for only $3 per 100 stickers. Call **1-800-SENCORE,** ext.308 to order your stickers today. ■

New 1991 CR70 Setup Book

The 1991 CR70 Setup book was recently mailed to all of the CR70 Beam Builder ® owners who have requested to be on our automatic mailing list. The 1991 Setup Book has 816 new CRT listings representing the largest increase since 1983. This large number of new listings represents new tubes introduced this past year using the worldwide numbering system.

The new setup book is spiral bound with the form number "4449" printed on the back cover. If you do not have this new book, order one directly from the Service Department at **1-800-SENCORE**. The price is $20.00. Ask that your name be added to the automatic mailing list if you want next year's book sent to you when it is available.



Using The Right Tools For Television Service

By Glen Kropuenske, Application Engineer

- **Use the right television service tools to save time and money**
- **Duplicate your customer's signals with the VA62A's all-channel RF generator**
- **Pinpoint circuit problems quickly with functional analyzing**

Have you tried turning in a screw with a needle-nosed pliers or making an adjustment with the wrong alignment tool? The wrong tool takes extra time, requires more effort, and may even cause damage. Sometimes the job simply cannot be completed unless you have the right tool.

Do you have the right test equipment tools for your TV servicing jobs? Do you order expensive parts only to find out they were not the problem? Do you replace the same IC twice before finding the real problem? These are all signs of not having the proper tools.

Using tools that only make signal or voltage measurements is like using a needle-nosed pliers for a screwdriver. Signal tracing is an inadequate tool because of signal levels below the sensitivity of modern scopes, interaction with defective circuits, problems in earlier stages, or defective circuit loops. These problems can make the signals and DC voltages in a stage look bad when the circuit is good. Eventually you may find the problem, but you'll waste valuable time and profits.

The right *test equipment* tools, combined with your electronic training, provide the capability you need to meet the challenges of TV servicing in the 1990s. The Sencore VA62A Universal Video Analyzer equips you with the right troubleshooting tools (substitution signals and component tests) to quickly test and isolate defects in the most modern TVs. Let's see how the VA62A is used for all of your TV troubleshooting.

Reproduce The Signals Your Customers See

Verifying your customer's complaint many times includes duplicating a signal on a specific channel or band of channels. This lets you confirm immediately if the defect is in the set or the input signal.

If the problem appears to lie with the tuner module, you've got quite a challenge on your hands. Even if you send tuners to a repair company, you need the tools to determine if the problem is in the tuner or in some associated circuit. In many newer chassis, the tuning system components such as the tuner module and control circuits are soldered on the main board (see Fig. 1) making it necessary to troubleshoot to the component level.

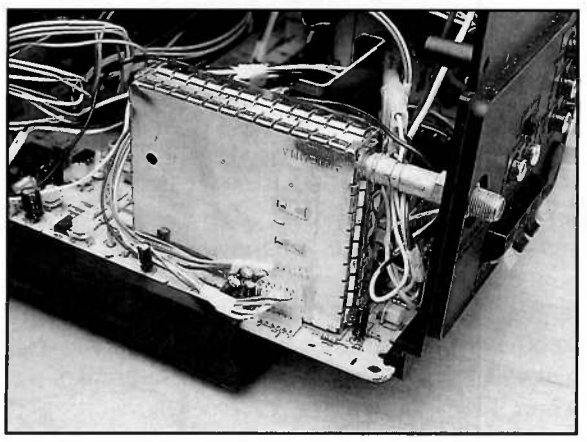


Figure 1: Since most modern TV tuners are attached to the main board, you need to confirm if the defect is in the tuner or an associated circuit.

Digital tuner problems may affect a single channel or an entire tuning band. Tuner problems include poor sensitivity, one missing channel or band of channels, one or two bad channels within each band, or channel hunting. The first step in troubleshooting tuner problems is to thoroughly performance test the tuning system and verify the customer's complaint. Here's where the right tool can save you a lot of time.

The VA62A all-band RF channel generator (Fig. 2) duplicates all off-air and cable TV signals at distant station or strong cable signal strengths right in your shop to verify customer complaints and fully test modern TV digital tuning systems. The "STD TV" generator duplicates all off-air broadcast VHF and UHF channels. The "STD CABLE" generator duplicates all FCC allocated mid band, super band and hyperband cable signals with the same numbering sequence used by most digital tuners.

The "PROG CABLE" generator lets you change the carrier frequency of any cable channel to duplicate shifted channels. You can shift the carrier up to ± 9.75 MHz from the allocated frequency in .25 MHz steps. The shift is stored in memory to avoid daily reprogramming.

To fully performance test a TV tuning system with the VA62A: 1) Select the RF channels which best duplicate the signals at the customer's location, 2) Test several channels in each tuning band to ensure proper tuning, and if the customer is complaining about particular channels, 3) Do a thorough test in each tuning band to fully evaluate the tuning system and obtain valuable information to aid further troubleshooting.

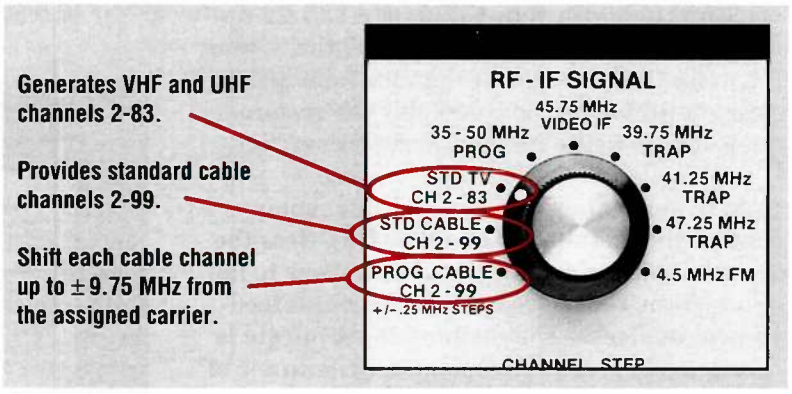


Figure 2: The VA62A digital tuner duplicates all channels to completely test any tuner.

Confirm Customer Complaints With The VA62A's Exclusive Video Patterns

The first step to troubleshooting any TV is a full performance test. Apply a 1000 uV RF signal to the TV's antenna and select one of the VA62A's exclusive troubleshooting video patterns. The VA62A provides all the convergence and troubleshooting video patterns needed to fully evaluate a TV's performance. The Multiburst Bar Sweep, Chroma Bar

Sweep and 10 Bar Staircase patterns are especially helpful in identifying defects in the video and color signal paths.

The Multiburst Bar Sweep pattern duplicates the full range of black & white (luminance) signals that are transmitted by TV stations and must be amplified through the TV's IF, video and luminance circuits. It consists of 10 square wave frequency steps from 0 (reference) to 4.5 MHz. Each step should show distinct white and black stripes on the CRT.

The Chroma Bar Sweep pattern duplicates the full range of color signals transmitted by TV stations and amplified by the TV's IF, video, and chroma circuits. The pattern consists of a 3.58 MHz cyan reference step, a 3 and 4 MHz color steps, and a 100% white background.

The 10 Bar Staircase video pattern duplicates the full range of luminance levels from black to white. If all the video stages and CRT are biased and working correctly, 10 different brightness levels should be seen on the CRT.

Duplicate Both Strong And Weak Signals To Check Sensitivity And AGC

The problem your customer is complaining about may be related to the TV signal level. Signal levels from distant, off-air TV stations require the TV receiver to operate at full receiver gain to produce a snow-free picture. Strong cable signals require the AGC circuits to reduce gain to prevent overdriving. Improper circuit gain and AGC action can result in snowy, dark pictures or sync difficulties.

The VA62A's RF-IF LEVEL VERNIER lets you duplicate weak and strong TV signals on any TV channel. To test the TV receiver's sensitivity:

1) Apply the signal to the TV's antenna input.
2) Set the VA62A's RF-IF LEVEL to HI position and the RF-IF LEVEL VERNIER to NORMAL. (This generates 1000 uV which should produce a noise-free picture.)
3) Increase the RF-IF LEVEL VERNIER to full scale and check for picture distortion which would indicate improper operation of the TV's AGC circuits.

Troubleshoot AFT And Sync Signal Loops

Once you have evaluated the tuner-related symptoms, you are ready to begin troubleshooting. What sometimes appears to be a tuner or tuner controller problem can be caused by other circuitry. A bad IF or AFT stage can cause mistuning or channel hunting.

Testing AFT and sync signal loop circuits can be difficult without the proper tool, however. If you signal trace with an oscilloscope, you will find that all the signals within the tuning and sync signal loops appear bad. Furthermore, the signal levels in the IF stages are below the sensitivity of most scopes. Troubleshooting tuning problems in IF and AFT circuits requires a way to break the circuit loops to isolate which stages are good and where things start to go bad.

The VA62A provides a variable level, crystal accurate 45.75 MHz tuner substitute signal to

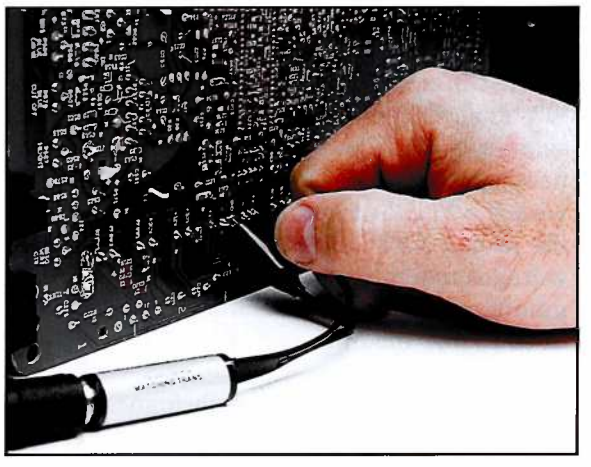


Figure 3: Confirm IF circuit problems with the VA62A's crystal-controlled 45.75 MHz tuner substitute signal.

input into any IF SAW filter or IF stage. This signal lets you break the tuning system loops to test and troubleshoot the IF, AFT, and sync circuits.

Select the VA62A's 45.75 MHz IF signal and LO (1st IF) level. Use the VA62A's matching balun as shown in Fig. 3 and attach the leads to the tuner module's IF output terminals. Some newer model chassis have an IF preamp in the tuner and require the MED (2nd IF) level. Check for proper AFT and sync input voltages to the controller to confirm the AFT and sync circuits are working properly.

Once you have repaired and confirmed the AFT and sync voltages to the tuner are good, place the digital tuner in the "TV mode."

Understanding Modern TV Tuning Systems

The local oscillator signal mixes with the incoming RF signal (see block diagram) to produce a 45.75 MHz IF video signal. Band switching voltages from the digital controller select different oscillator circuits. These "band select" voltages make it possible to tune a wide range of cable and off-air RF-TV signals with a single tuner.

The oscillator in modern tuner systems contains a PLL (phase lock loop) circuit. In the PLL circuit, the oscillator frequency is divided down (prescaled) and compared to a reference frequency which is determined by the microprocesser to match the selected channel. The comparison produces an output voltage which is filtered and applied to the oscillator. The voltage to the oscillator determines the oscillator frequency and the selected RF channel.

When a channel is selected, the microprocessor mutes the video and audio and initiates a tuning routine. While the routine varies slightly between models and manufacturer, knowing the basics can help analyze tuner problems.

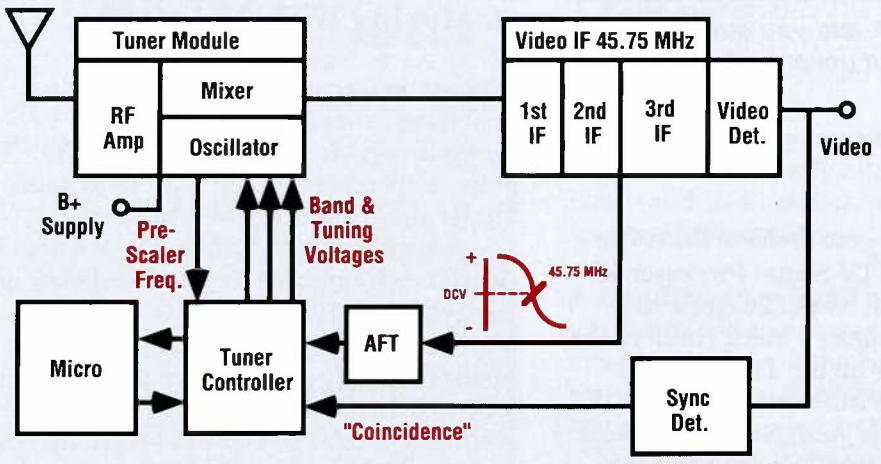


Figure 1: Block diagram for the modern television tuner.

The tuning routine for off-air ("TV mode") channels is usually different from cable mode tuning routines. The routine varies because off-air channels are always of a known frequency, while cable channels may be offset. When a "TV mode" channel is selected, the microprocessor sends instructions for that channel to the PLL. The PLL then tunes to the center frequency of the channel. The AFT voltage indicates the presence of a 45.75 MHz signal and corrects the PLL for any oscillator drift. When a channel is detected, the microprocessor unmutes the raster and sound.

In the cable mode, the microprocessor again instructs the PLL to tune to the channel. But, the routine also instructs the PLL to auto search above and below the center carrier frequency up to 2 MHz looking for the signal. This search is needed because cable systems may offset channels up to 1.25 MHz from frequencies used for off-air broadcast. When the AFT voltage indicates the presence of a 45.75 MHz signal, the sync signal is checked to verify the presence of a TV signal.

If sync is indicated, the PLL is locked, the channel location is stored in memory, and the AFT maintains channel lock. But, if no sync is detected, the search continues through several alternations above and below the carrier. If no signal is found, the tuning routine is stopped and the PLL is tuned to the center channel frequency.

Measure tuning and band switching voltages and prescaler frequencies to isolate problems to the tuner module or controller. Selecting a "TV mode" signal will prevent unwanted tuner searching while troubleshooting. It may be necessary to substitute for the 45.75 MHz IF with the VA62A to provide the controller with the proper AFT and sync input. If the tuning voltages match the values shown by the manufacturer for that channel, the problem is in the tuner module.

Be sure to do a thorough performance test in the TV and Cable modes after repair. For more information on channel numbering and servicing digital tuners with the VA62A, ask your Area Sales Engineer for Sencore Tech Tip #178.

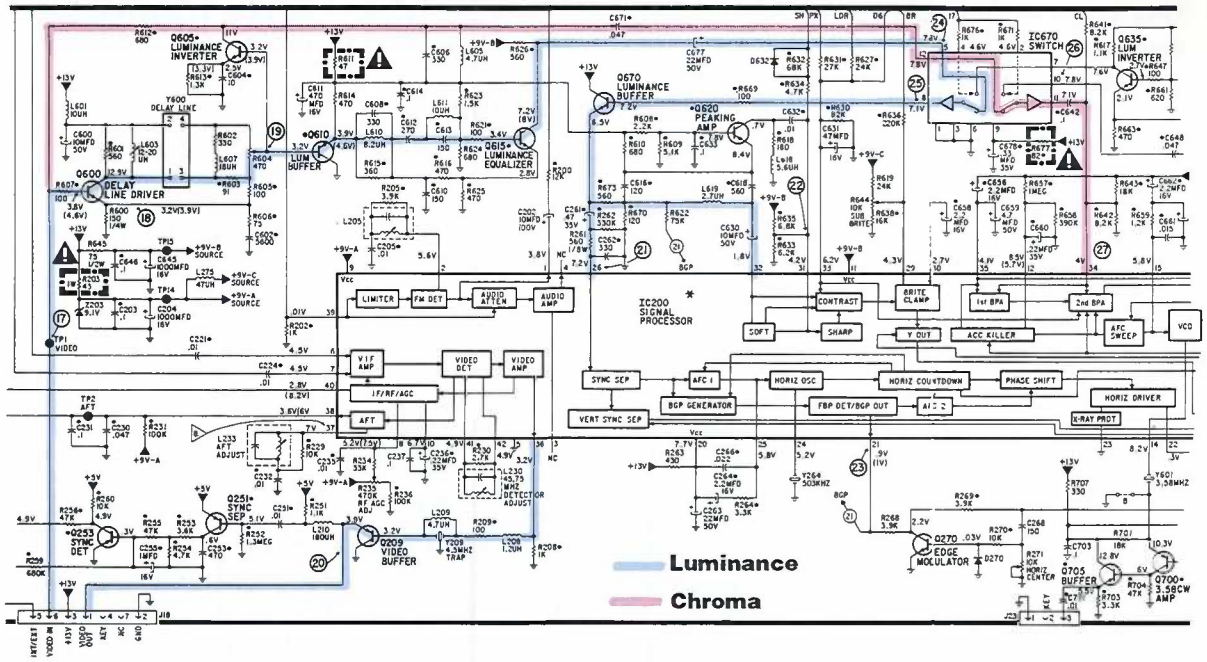


Figure 4: A modern NAP R1 chassis has over 200 components surrounding the IC. Each component is critical to the signal path and IC operation.

Test Entire Circuit Blocks Using Functional Analyzing

Large scale ICs contain much of today's TV circuitry. Many servicers think this integration means fewer components and easier troubleshooting — you just replace the chip. But, a quick look in a modern chassis such as the NAP R1 schematic shown in Fig. 4 reveals there are over 200 components surrounding the TV Signal Processor IC (IC200). The luminance signal path runs through many discrete components besides the IC. Each component is critical to the signal path and proper IC operation.

You do not need to learn new theory to troubleshoot TVs with large scale ICs. Modern TVs still have the basic IFs, deflection, video, sync, and color functional blocks you already know. To isolate defects in TVs with large ICs you need a systematic, logical approach to test the function of individual stages whether they are within or external to the IC. Proving that a stage functions properly helps you find the defective circuit block. This is "Functional Analyzing."

Functional analyzing is most effective when you combine the two proven troubleshooting methods; signal substitution and signal tracing. The Sencore VA62A Universal Analyzer provides both of these analyzing capabilities. Let's take a closer look.

Many modern TV monitors/receivers have a rear panel video input which accepts a 1 VPP video signal. The VA62A's Standard VCR output jack provides the video test signal for this input.

Switching in this signal effectively divides the TV circuits in half and tests the function of the luminance and chroma circuits all the way to the CRT. Imagine how simple it would be to narrow in on the defective stage if we could continue to switch in good signals along the signal path, or replace a suspected bad input signal to a stage to see if it restored proper operation. This is exactly what the Sencore VA62A's drive signals do.

The VA62A's drive signals are common to all NTSC TV receivers. The drive signals are correctly phased with the antenna and IF signals to keep all the TV circuits locked so the CRT provides a properly synced display to analyze the results of each signal substitution. The drive signals are fully adjustable to match any signal level from IC stages to the CRT. The best part of the VA62A's drive signals is that you don't need to unsolder components or open circuit paths (Fig. 5). The low output impedance effectively removes the signal present in the circuit and replaces it with a good substitute signal.

To get a better understanding of how functional analyzing with the VA62A works, lets look at an example in the NAP R1 chassis. The initial performance testing and rear panel video test fail to produce a good picture on the CRT. Channel and menu characters are present, indicating proper channel change and the presence of high voltage. The video on the CRT is dark colored diagonal lines, which are out of sync.

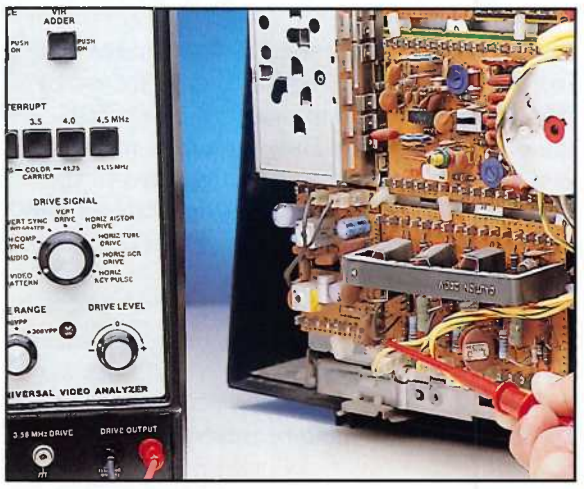


Figure 5: The VA62A lets you substitute signals in-circuit without unsoldering parts.

We'll investigate the sync problem first. The sync block inside the TV Signal Processor IC receives a video signal on pin 26 (refer to figure 4). First, let's make a quick check of the 9 VDC supply voltage on pin 11. Using the Digital Meter of the VA62A set to "EXT DCV," we verify the supply is good. Next, we make a quick check with the VA62A's peak-to-peak meter on pin 26, the sync input. We find that the signal is missing. The problem is either in an earlier video stage, or shorted sync circuitry inside the IC.

To narrow the problem further, we hook the VA62A Drive Output (Video Pattern) of the VA62A to pin 26, set the Drive Range to "3 VPP," and adjust the Drive Level to 0. We slowly increase the drive level in the negative direction to match the sync shown in the schematic. The waveform on the screen locks. This indicates the sync functional block in the IC is operating correctly. Confirming that the IC will function when we restore a proper luminance input to pin 26 means the problem must be in the video signal path before the IC.

To divide the problem down in the fewest steps, we select a point half way in the signal path — the base of Q615. Injecting video into the base of Q615 results in no change of the original symptoms. This means the problem is between Q615 and the IC. Dividing the signal path again we inject a video signal at the base of Q670 with still no change. The problem is between Q670 and the IC. We have narrowed the problem down to only a few components.

Testing the DC voltages on the transistor using the VA62A's digital meter leads us to suspect Q670. A quick check with the transistor tester confirms our suspicion. A new transistor quickly fixed the problem. The VA62A confirmed the IC was not the problem and quickly divided the signal path enabling us to narrow in on the defective circuit block in only a few steps.

It's Easy To Learn Functional Analyzing With The VA62A

It's easy to learn how to use the functional analyzing capabilities of the Sencore VA62A. Simplified guides, video tapes, and Tech Tips help you become familiar with functional analyzing — one stage at a time.

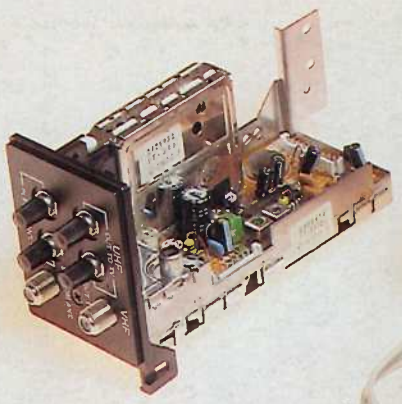
Sencore is committed to your TV servicing success in the 1990s. To order the VA62A Universal Analyzing System, pick up your phone and dial your Area Sales Engineer at **1-800-SENCORE**. He'll help put a VA62A on your bench today so you can tackle any video problem with confidence. ■

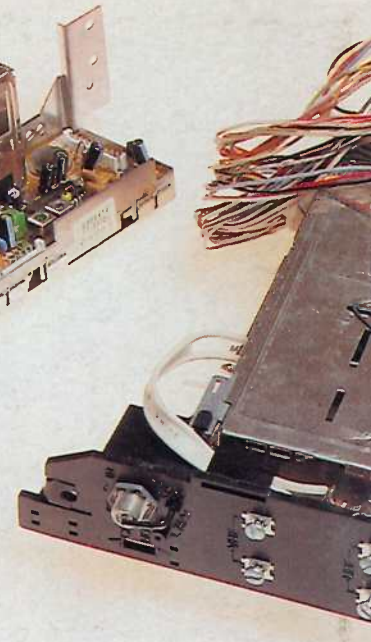
Circle Fast Facts #259 for more information on the VA62A.

Isolate These And Other Major Components In All TVs And VCRs—

Guaranteed Or Your Money Back!

VA62A Universal Video Analyzer





Plus, Cut Your Video Troubleshooting Time By 54%* With The Patented VA62A Universal Video Analyzer!

Identify tuner problems with the only integrated all-channel, VHF, UHF, and cable RF generator. Standard TV, standard cable (2-99), and exclusive programmable cable channels eliminate the question "Is it the TV or is it the cable?"

Pinpoint IF troubles with modulated troubleshooting signals and exclusive programmable IF generator. How do you presently identify if the suspected defect is in the AGC, IF/Detector IC, or caused by the tuner? Wouldn't you like to know exactly where the defect is before you order the part or pull the tuner. With the VA62A you will!

Exclusive video patterns completely performance test TVs, VCRs, and monitors — without removing the cover. Is there a picture, is it locked in, is the bandwidth correct, is the brightness and contrast correct, and is the color tint and saturation correct? You'll know in less than 60 seconds using the VA62A's exclusive video patterns.

Find defective stages, without disconnecting parts, with exclusive phase-locked drive signals. "Swamp out" the suspect signal and replace it with a known-good signal. You'll isolate the problem to a bad stage in minutes, guaranteed.

Test yokes and flybacks with the patented "Ringer". Most shops are forced to substitute yokes and flybacks instead of analyzing circuits. The VA62A's patented "Ringer" and exclusive flyback drive tests allow you to completely analyze all yokes, flybacks, and IHVTs before you order a new one.

Measure signal levels with a fully autoranged PPV and DCV digital meter. The VA62A's built-in meter shows when you are driving into a shorted circuit and prevents you from overdriving critical stages. Plus, measure bias voltages and signal levels throughout the entire TV and VCR.

It's obsolete proof: Update for new technology with exclusive phase-locked accessories. We'll provide new companion units as the manufacturers announce new formats, test patterns, etc. This makes your VA62A a protected investment.

* Based on a nationwide survey of users who reported an average time savings of 54% compared to their previous test equipment.

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