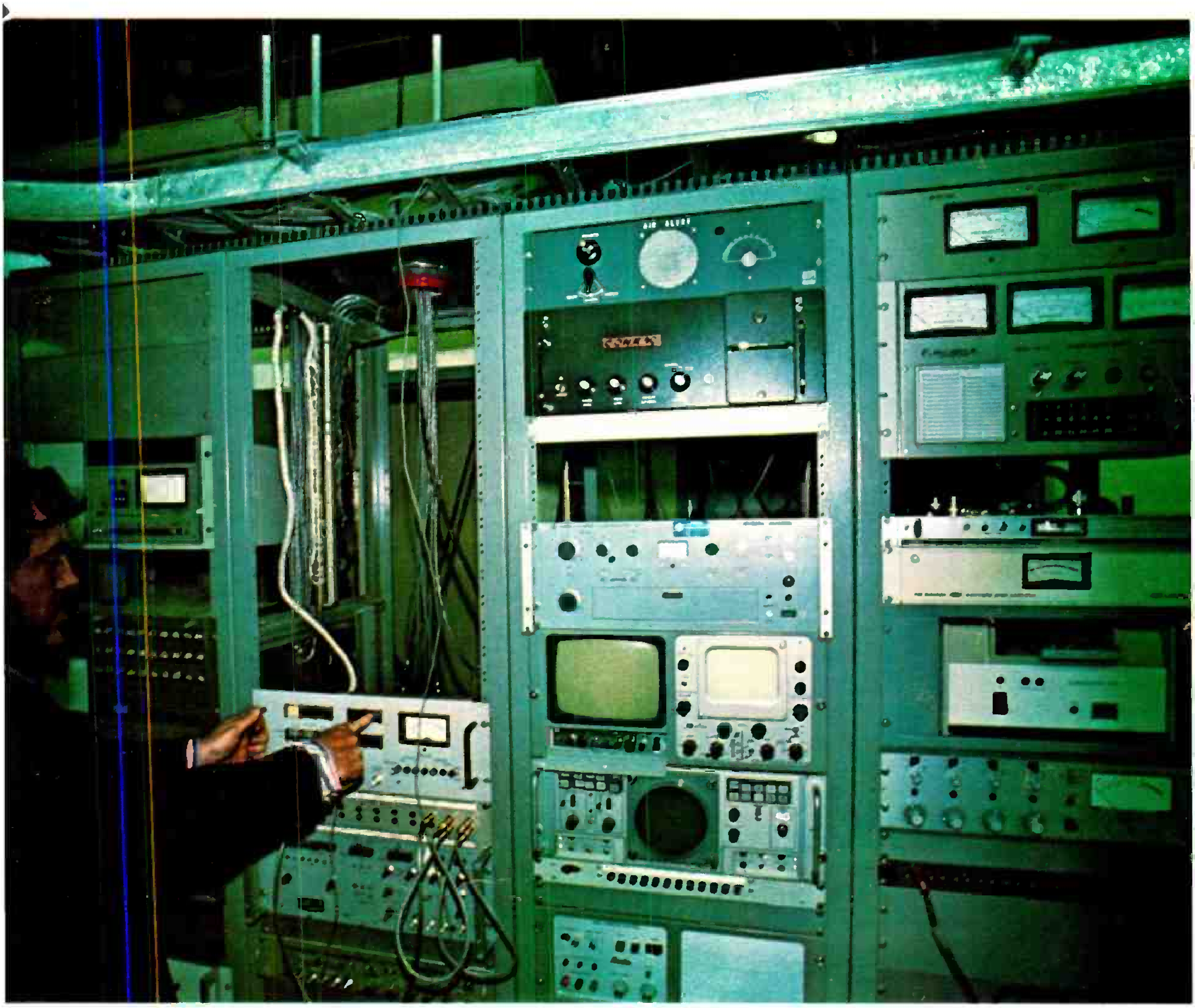
BROADCAST ENGINEERING

December, 1975/75 cents



FM TRANSIENT RESPONSE

page 38

Counting On Counters

Comparing AM Techniques

Function Generators

460 SERIES

Unmistakably Ward-Beck

WBS

Tomorrow's Technology Today.

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For More Details Circle (1) on Reply Card

super!

That's the word for CDL's New AFM-10 Broadcast Quality, Audio Mixer/Switcher... all in one package.

The AFM-10 is the NEW "teammate" for CDL's VS-10 and VS-14 video switchers . . . or *any other* video switcher designed for Mobile, Studio, Master Control or Post Production applications.

Sure it can be used as an Audio Mixer . . . but what sets it apart from all others is its "teammate" power and flexibility to *automatically* operate as an Audio Follow or an Audio Mix/Follow Switcher . . . *Plus* its "hands-off" *automatic* gain riding Compressor/ Limiter.

Consider what that really means!

In the Follow Mode, the AFM-10 becomes an *automatic* remote controlled switcher. A pushbutton or tally contact feeds one or more audio inputs via the Follow gain control and Comp/Lim to the Line outputs. LED's identify active status.

In the Mix/Follow Mode, the AFM-10 beautifully performs a "voice over", manually or automatically. For remotes . . . the Comp/Lim *automatically* maintains Telco Line levels.

As an Audio Mixer, the AFM-10 handles many jobs with its 7 inputs with individual channel gain pots, independent Master and Auxiliary Line level outputs, and Comp/Lim that can be switched IN or OUT.

And you also get all these important features:

- Individual pots adjust line input sensitivity as required for Broadcast, CCTV and Hi Fi equipment.
- Bridging or matching inputs (all equipped with XLR's) and low impedance outputs.
- All 7 inputs are Line or Mic switchable.
- Test oscillator (1 KHz) built-in . . . and with separate input.
- Headphone jack on front panel.
- Cermet pots for gain control.
- Audio crosspoints . . . solid state.

Frequency Response: ± 0.5dB, 30Hz-20KHz
Distortion: < 0.5%, 30Hz-20KHz (Limiter off)
Noise: -116dBm equiv. input noise
Input Levels: (Max) 100mV p-p Mic; +18dBm Line
Output Levels: (Max) +18dBm into 600 ohms
Power: 110/220 VAC, 50/60 Hz (switchable)
Dimensions: 2 RU's x 7" deep; Desk or Rack Mount

Availability: We're in production now!

Price: Economical? . . . and how . . . because CDL's unique Audio Mixer/Switcher is like getting 2 for the price of 1.

Find out why . . . call or write for our AFM-10 brochure.

Remember . . . the CDL Brand Name on the AFM-10 is your assurance of Quality, Reliability, Performance and the latest solid-state technology.

CENTRAL DYNAMICS LTD

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BROADCAST ENGINEERING.

The journal of the broadcast-communications industry — December, 1975 Volume 17, No. 12

About The Cover

The photo this month and the articles are focused on tests and measurements that concern us all at the communications facility. (Photo, courtesy of WCVB, Boston).

Departments

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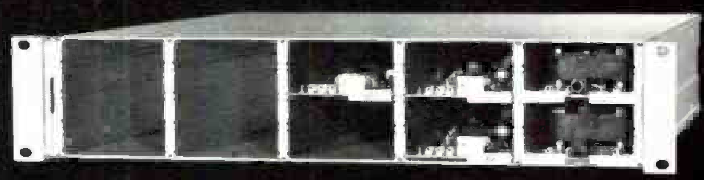
Introducing the 3400 SERIES

Model 3402 distribution amplifier is the first product in a new series of video terminal equipment. Six outputs are provided in this versatile, high-performance, compact unit which represents the latest in the state of the art.

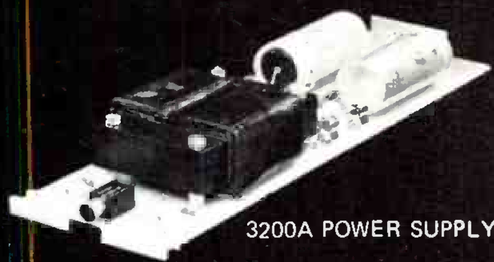
The 3402 gives exceptional performance in the areas of stability, distortion, and noise. Power consumption is only two watts per amplifier. It is an all-purpose video amplifier, featuring switchable DC restorer, differential input, controlled time delay, selectable gain adjustment up to +11 dB, and provision for cable equalization.

A two-rack unit mounting tray, illustrated below, accommodates eight 3402 amplifiers and a 3200A power supply, with provision for a second optional supply for emergency protection. A one-rack unit, four-amplifier mounting tray is also available.

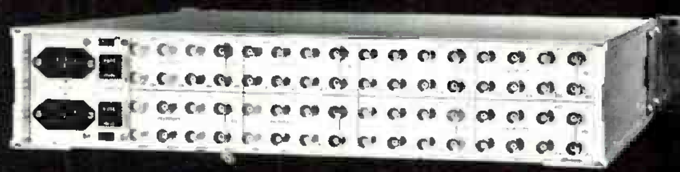
3402 DA



FRONT VIEW (LESS COVER)



3200A POWER SUPPLY



REAR VIEW

TECHNICAL HIGHLIGHTS/MODEL 3402 AMPLIFIER

Frequency Response	±0.05 dB, 10 Hz to 5 MHz +0.05 dB, –0.1 dB, 5 to 8 MHz +0 dB, –0.3 dB, at 10 MHz	
Differential Distortion	1 V p-p	1.4 V p-p
Gain	$<$0.15%	$<$0.3%
Phase	$<0.1^\circ$	$<0.25^\circ$
T Pulse to Bar Response	±0.5%	
Common Mode Rejection	$>$60 dB, at 60 Hz	
Line or Field Tilt	$<$0.5%	
Chrominance/Luminance Delay	$<$10 nanosec.	
Output Noise (Independent of gain setting)	$>$70 dB RMS below 1 V p-p 10 MHz band width	

FOR ADDITIONAL INFORMATION, CONTACT:

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DIRECT CURRENT FROM D.C.

December, 1975/By Howard T. Head and Harold L. Kassens

Commission Bars Restrictive Program Agreements

In May, 1973, the FCC issued a Notice of Inquiry looking into subscription agreements between broadcast stations and companies supplying taped musical programs. What appeared to be worrying the Commission was that the agreement required the station to operate a minimum number of hours a day; prohibited SCA programming or AM/FM duplication; required a fixed number of minutes of supplied music each hour; prohibited announcement of names of musical selections; limited the number of commercials per hour; prohibited triple-spotting; required all talk programming to be public affairs or religious; required news to be a certain percentage (or less) of total air time; and limited the number of newscasts during certain times. We even heard of a case where the music supplier required the use of a certain type transmitter because it sounded "crisper"!

Of particular interest to engineers in this matter is the SCA prohibition. Some time ago, many FM stations operating with both stereo and SCA were getting complaints of a 9 or 10 kHz "birdie" caused by the 3rd (57 kHz) or 4th (76 kHz) harmonic of the 19 kHz stereo pilot subcarrier beating with the 67 kHz SCA signal. Stations transmitting classical music with a large dynamic range were particularly vulnerable. After a careful and detailed study, it developed that the effect was primarily a receiver problem brought about by a lack of, or misadjustment of, a 67 kHz SCA trap.

At the time some stations used this information to get out of the background music business and, it appears, some of the music program suppliers would not permit the use of an SCA. The FCC has now resolved the problem by issuing a policy statement which, in effect, bars contracts which prohibit subcarrier authorizations. What they plan to do about the receivers they haven't said.

Realism in AM Allocations Involving Caribbean Area

Recent Commission actions might help favorable action on applications for nighttime operation involving foreign stations in the Caribbean area. In one case, the FCC noted that although a Cuban assignment was duly notified (pre-Castro), the Foreign

(Continued on page 6)

None for the money...

or even MORE money, compare with the Sparta Studio/Remote Audio Control Centers. They are classed by themselves in providing **complete** production-and-remote broadcast facilities, as we discovered when we tried to measure up "competing" units. Which is probably why even our competitors sometimes buy them!

Instead of offering the familiar comparison of our equipment **versus** others' in this space, in all fairness we can only list some features of ours and let you try to find an equal . . . we cannot.

Sparta AC155B/ ASC305B	Any Other Maker?	
☑	☐	5-Mixer mono (AC155B) with 14 inputs
☑	☐	5-Mixer Stereo (ASC305B) with 9 inputs
☑	☐	Pushbutton multiple input selector
☑	☐	Studio quality audio performance
☑	☐	Console removable battery-operable
☑	☐	Four selectable outputs, plus earphones
☑	☐	Monitor speaker built-in
☑	☐	Cue (all mixers) to built-in speaker
☑	☐	Muting standard

Sparta AC155B/ ASC305B	Any Other Maker?	
☑	☐	Custom instant-start turntables
☑	☐	Micro-balanced tone arms
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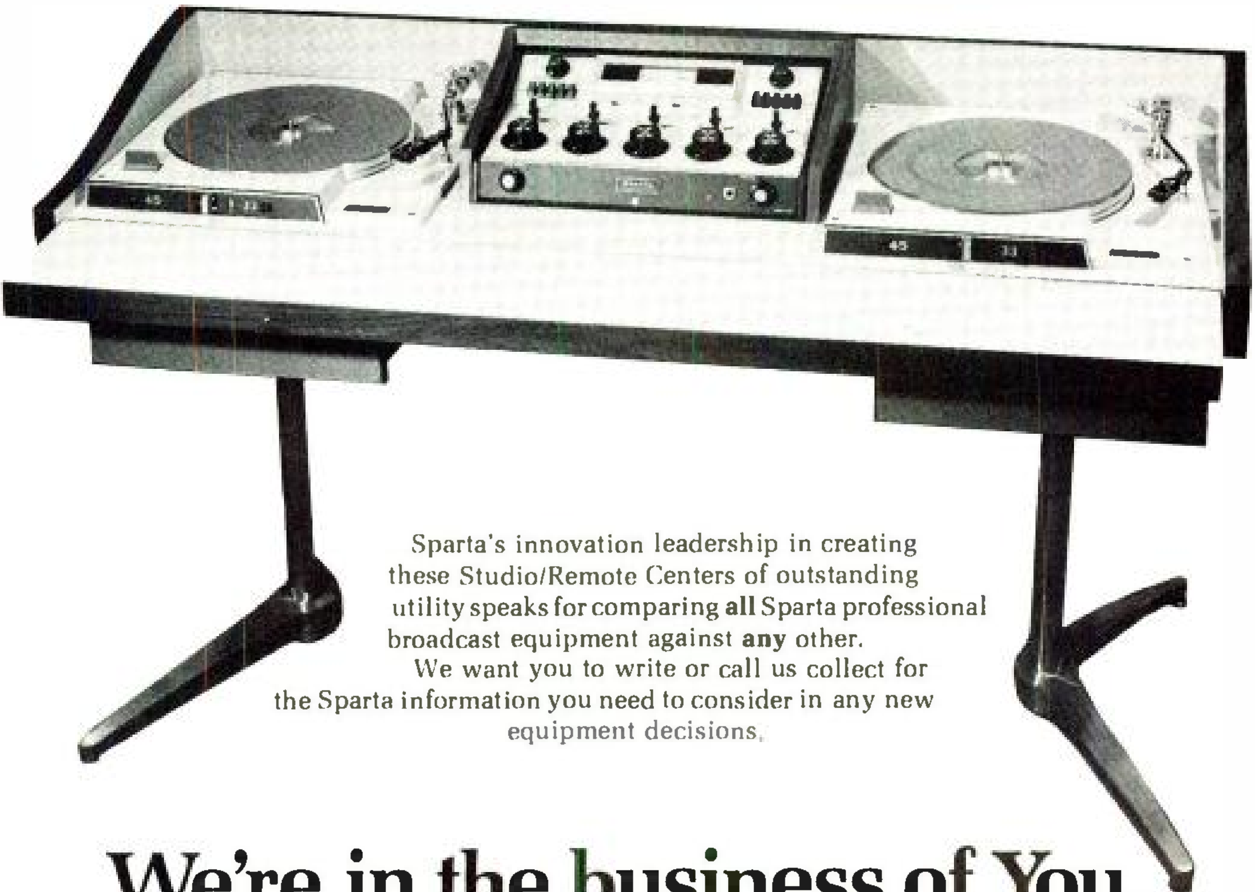
☑	☐	Matching bench-&-lid accessory
☑	☐	Lift-leaf table extension
☑	☐	Designed to do two jobs interchangeably and perfectly!
☑	☐	So reasonably priced that do-it-yourself can't compete!



Sparta's innovation leadership in creating these Studio/Remote Centers of outstanding utility speaks for comparing **all** Sparta professional broadcast equipment against **any** other.

We want you to write or call us collect for the Sparta information you need to consider in any new equipment decisions.

We're in the business of You.

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DIRECT CURRENT FROM D. C.

(Continued from page 4)

Broadcast Information Service, the World Radio Handbook, and listening tests made by an AM station and the FCC monitoring station all indicated that the Cuban station was not in operation. The FCC granted the application of the AM station to add nighttime operation on condition that protection would be required to be afforded to the Cuban station if it should start operation again.

In another case, an AM station had its application to add nighttime operation originally denied by the FCC because it would only serve 74% of the population and 49% of the area of the city at night. Upon appeal, the U.S. Court of Appeals sent the case back to the Commission, which then granted it with the explanation that: (1) the city is large; (2) it is irregularly shaped; and (3) it has expanded markedly in recent years.

Next: "Ball Game" Radio?

The Commission has instituted an inquiry into the possibility of opening a new broadcast service at sports events which would transmit information on the progress of the game to spectators. As it did so, it denied a request for an authorization in the Business Radio Service to provide spectators at professional golf tournaments with information as matches progressed. The applicant proposed to use the frequency 154.570 MHz and to rent receivers to the spectators. The FCC said it was opening the inquiry because of the continuing interest in this type of service.

Short Circuits

In a paper-saving drive, the FCC has reduced the number of copies of papers required to be filed in certain FCC proceedings; petitions for rule-making to add or change FM and TV channels now only require an original and four copies rather than the former fourteen copies . . . The Commission returned a petition for rule-making proposing a Class D (10 Watt) educational FM station in the commercial portion of the FM band, on the grounds that it was short-spaced . . . A developmental authorization has been granted in the business radio service for remote reading of public utility meters in a New York county, using 928.050 and 937.550 MHz for 2 fixed stations, 35 fixed relay stations and 625 meter-attached transmitters.

Radio Deregulation Derailed?

The president of the National Association of Broadcasters and chairmen of two NAB radio committees, appeared recently before the Senate Communications Subcommittee and testified in support of the Federal Communications Commission's deregulation of radio.

Representing the NAB before the committee were President Vincent T. Wasilewski, Richard W. Chapin of the Radio Reregulation Committee and Wayne C. Cornils of the Small Market Radio Committee.

Wasilewski told the committee that the Commission's plan is working and that "a handful of well-meaning special interest groups should not be allowed to derail it."

He added that "broadcasting is for all the people—not just for those foundation-funded groups which have the know-how and economic backing to constantly occupy the halls of Congress and the FCC on behalf of their special interests."

The NAB president also said NAB agrees with the FCC reinterpretations of Section 315 and welcomes these relaxations regarding broadcast coverage of debates and press conferences.

Wasilewski stated that NAB supports the experimental suspension of the Fairness Doctrine, pointing out that the experiment "ought to include at least some small markets if the FCC is to obtain the most meaningful evidence possible and make it a true test of licensee responsibility."

Chapin, president of Stuart Enterprises, Lincoln, Neb., and former chairman of NAB's Board of Directors, urged the committee to encourage the Commission to accelerate its efforts in deregulating radio.

NAB Agrees With Commission

The National Association of Broadcasters has asked the U.S. Court of Appeals for permission to intervene in a court test of a Federal Communications Commission order exempting certain political debates and on-the-spot coverage of news conferences from the equal time provisions of Section 315.

NAB said in a motion filed in the U.S. Court of Appeals for the District of Columbia that it seeks an opportunity to show that the FCC order reversing earlier rulings of 1962 and 1964, "promotes the public interest and represents a correct reading of Congressional intent."

The motion said NAB's objective is "the maintenance of the broadcast industry's ability to serve the public" and to "avoid the undue stifling of broadcast coverage of news events involving candidates for public office which has occurred over the course of the past thirteen years."

The motion was filed in a consolidated case in which the Democratic National Committee, Rep. Shirley Chisholm (D-N.Y.), the National Organization for Women and others challenge the FCC ruling.

Cable....Again

The National Association of Broadcasters has proposed that cable television systems be permitted to carry specialty programs broadcast by specialty format stations on a regulated basis.

However, the NAB suggested to the Federal Communications Commission that such carriage be on a program-by-program rather than a station-by-station basis. The NAB's proposals were submitted in response to various Commission proposals for deregulating carriage of special format stations or programs.

In its filing, NAB noted that there now are three recognized classifications of specialty stations: foreign language, religious oriented, and those which devote day time programming to financial reports.

HOW TO GET A SECOND CAMERA WITHOUT PAYING FOR IT.

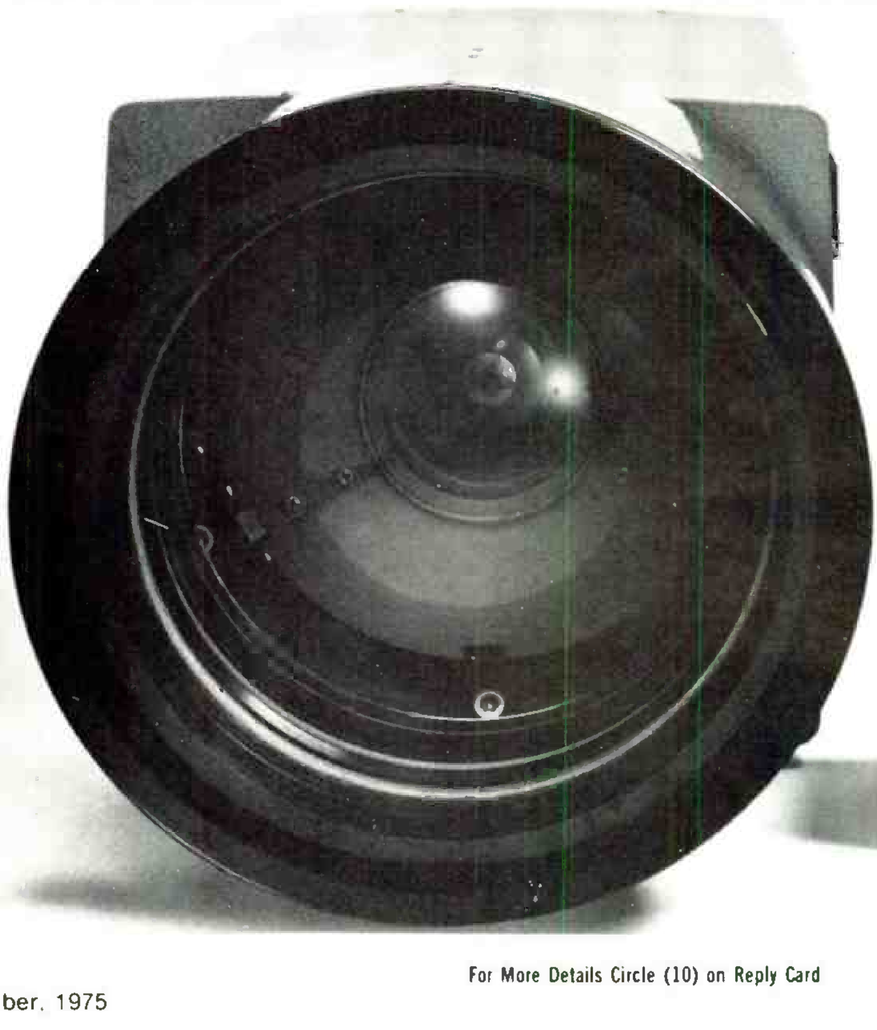
Economic realities being what they are, improving your camera setup often boils down to a battle of program quality versus pocketbook: For some assignments, you want the mobility and compactness of a hand-held camera. For others, the long focal length and high zoom ratio of a first-rate mobile. And sometimes, of course, the virtues of both. But what can you do on a one-camera budget?

Logical question. For which we have a logical—and economical—answer: Canon Versatility Packages. A family of two-lens systems which give you both capabilities, plus a quick, positive attach/detach system that's the closest thing to two cameras for the price of one.

Take our Plumbicon* Package, for instance. When you need compactness and high mobility, there's the PV10x12B—the world's most popular electronic news gathering lens. Featuring an 18" minimum object distance and a 55.4° wide angle, it's the lightest professional 10:1 around. One of the smallest of its type, the PV10x12B features remote CCU iris control with manual override, and fully-motorized variable-speed zoom.

Where applications require a longer focal length, there's the other half of the Package: our PV34x24B-DZ for 25mm and the P34x32 for 30mm. A mouthful of numbers which add up to the most versatile remote lenses available today. The basic lens is a 24-400mm automatic iris f/1.8 with built-in double zoom that yields a long, long 800mm. Thanks to its continuous, stepless magnification, you can operate at maximum light efficiency while tailoring the focal length precisely to your needs. Vary field of view from 29.8° to 0.9° controlled by the cameraman on the air, with no blanking periods or cumbersome supplementary lens insertions. And work to a minimum object distance of just 1.8 meters. Mounted on a rugged, lightweight camera base plate with a universal head fitting, either lens is easily attached and detached from the camera.

The Canon Plumbicon Versatility Package comes complete with all controls, accessories, and protective cases. Like the other Versatility Packages we offer for other formats, it's a great way to keep your cameramen happy. Without upsetting your controller. For more information, please write or call.



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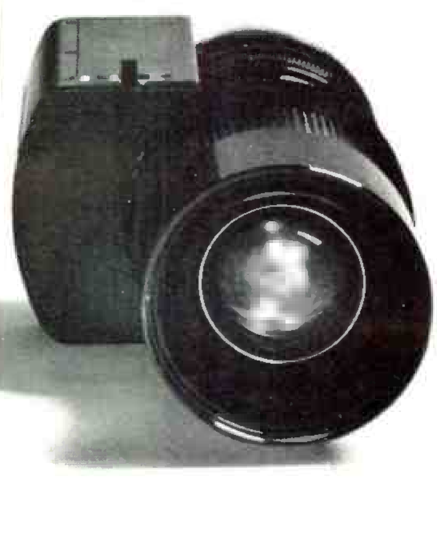

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AVR-2 – your b
Over 400 units

The bottom line is this: Higher productivity in the tape room means increased operational economy and a better on-air look.

How does AVR-2 help? Simpler design, for one thing, inside and out. It lets your operator function at top efficiency, regardless of his experience or workload. Look at the design and location of controls shown here for proof.

Contact your local Ampex sales representative for more information on how to improve your bottom line.

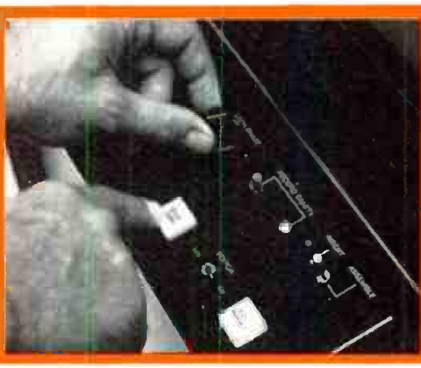
AMPEX

Ampex Corporation
Audio-Video Systems Division
401 Broadway
Redwood City, California 94063

est investment.
in use prove it!

Operational and Editing Controls

All controls are on open, visible panels. Operational and editing controls are user-located at fingertip level, so your operator (experienced or not) is never confused by exposed electronics.



Fast editing. It's easy to align the playback of AVR-2 to match the new program material from any camera, tape machine, or remote telco line. The program doesn't even have to be synchronous with your system!

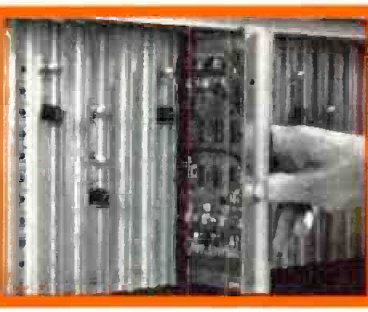
Your operator simply pushes one button and sets one control to line up vertical lines on a unique split screen display. **Result:** fast, easy, perfect edits—especially for inexperienced operators. And all from one control panel.

Secondary Controls

Playback equalization and differential gain controls—necessary in highly critical editing operations—are located conveniently on a tilt-out panel to allow for quick playback setup.

Video head optimizing takes less than a minute on the AVR-2. It's a simple, one-hand operation, as easy as tuning a home hi-fi receiver.

Setup Controls



Instant visibility, accessibility, changeability. Maintenance is a cinch on AVR-2 because everything is clearly marked and accessible. There are no confusing, unmarked boards or flashing lights.

You can operate most AVR-2 set-up controls in unity (fixed position) with the door closed, for normal operation or inexperienced operators.

—or open the door and quickly switch into variable operation to adjust for any unusual condition. Switches are locking type toggles, so a knee-bump can't change their position. And don't worry about air circulation, either. AVR-2 is air-cooled whether the door is open or not.

SOCIETY OF BROADCAST ENGINEERS, INC.
P O Box 88123 Indianapolis, Indiana 46208

From The SIGNAL Office in Washington, D.C.

Hope everyone has been receiving his copy of **The Signal** regularly, because another issue will be of interest to members. The SBE Certification Program was finalized, and the formal rules were published in the November issue. Now **The Signal** is preparing to notify members of the Society's position with respect to the "automatic transmitter system" docket which is currently before the FCC. We will be printing this statement as soon as the SBE Board formalizes its stand.

Attention Chapter Chairmen: If you need additional copies of **The Signal** to distribute at Chapter meetings, please drop a note either to Vince Flanders in Indianapolis or to **The Signal** office at 2000 N Street, N.W., Suite 210, Washington, D.C. 20036.

Regional Convention In The Southwest

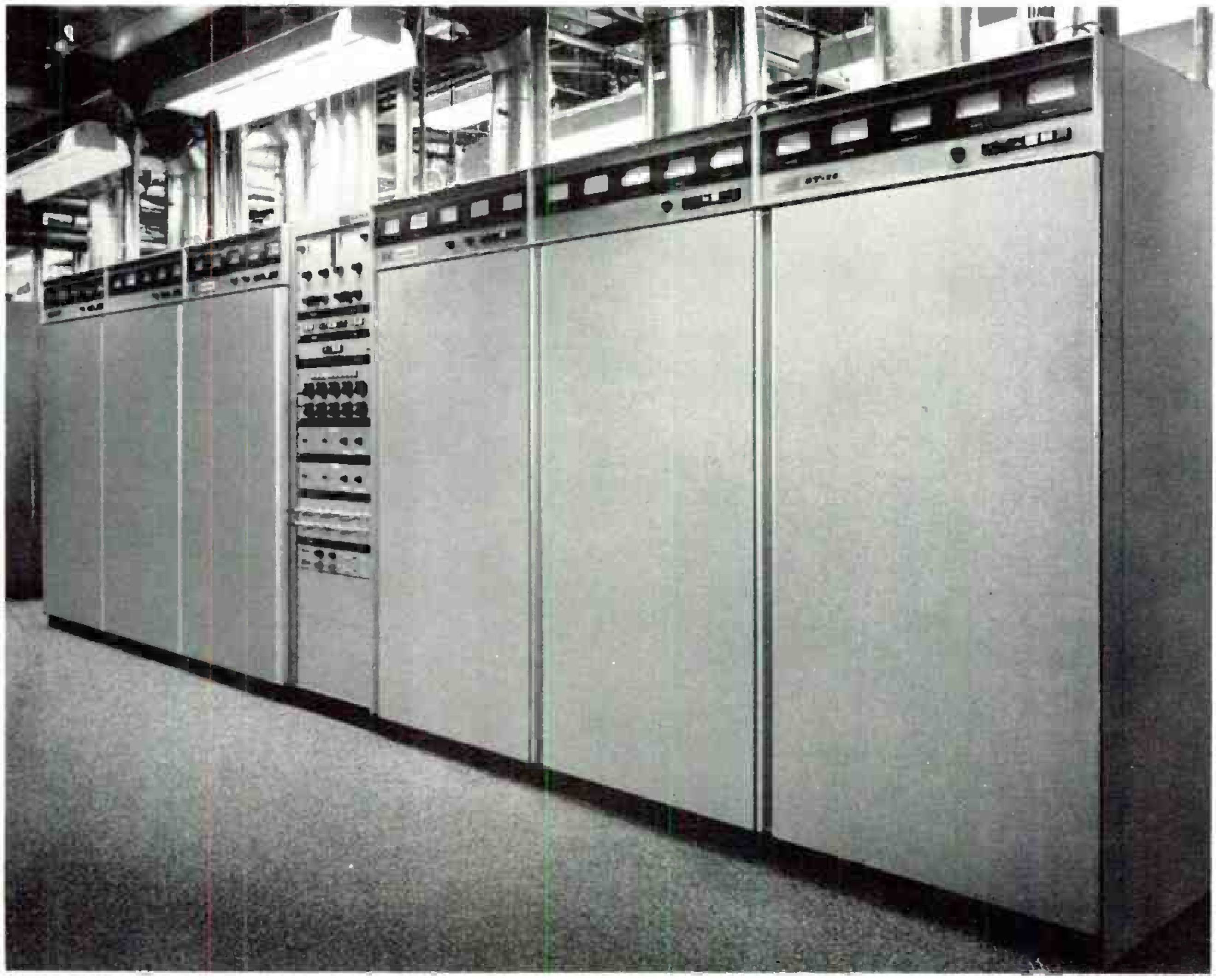
Chapter 9 is putting the final touches on its December Regional Convention at the Sunburst Hotel in Scottsdale. This event will be held concurrently with the Arizona Broadcast Association winter meeting and will offer four hours of technical papers, as well as exhibits.

Specifically, registration will begin on Thursday, December 4, at 3:00 p.m. and swing into the evening with an invitation to the ABA Associate Night. Friday will start with registration at 8:30 a.m., followed by a technical session at 9:15 and exhibits opening at 11.

Friday afternoon offers a luncheon, another technical session, cocktails, and an evening banquet. Exhibits will continue on Saturday, December 6, until 2:30 in the afternoon. A partial list of exhibitors shows that Ampex, A/V Recorders, Broadcast Communication Devices, Grass Valley, Lenco, Microwave Associates, RCA, Roh Corp., Tektronix, Tritronics, Sony Corporation, Sparta, and Zonar will all be there.

Before finalizing your own plans, please be sure to check with Al Hillstrom at KOOL-TV, 511 West Adams, Phoenix, Arizona 85003, (602) 257-1234, for the last-minute changes. The above information

(Continued on page 16)



SOCIETY OF BROADCAST ENGINEERS, INC

(*Continued from page 14*)

was taken from a tentative schedule only, and a quick call may save needless confusion.

Another Chapter In The Making

The San Diego Chapter is apparently going to get a new neighbor. **The Signal** was advised of the formation of a new group in San Francisco. Two meetings have already been held, and official recognition may come after the third meeting—way to go, Californians!

The first gathering on September 9 heard guest speaker Frank Miller of Sescom, Inc., discuss audio transformers, their construction and application, via a slide presentation.

The second meeting was held October 8 when Bob Morrison of Standard Tape Labs (a nationally known manufacturer of precision alignment tapes, located in the Bay area) was invited to lead the program. Mr. Morrison spoke on the new NAB standards proposed for tape cartridges and elicited some pretty lively comments and questions.

The next meeting was yet unannounced, but one of the items on that program is the election of officers.

For further information about this new and upcoming chapter, please contact Mr. Robert B. Daines, Western Region Manager, Telemet, Western Region Office, 1261 El Curtola Blvd., Walnut Creek, California 94595, (415) 938-8887.

SBE Chapter In Profile

Chapter 21: Spokane, Wash.

Chapter 21 was founded in 1968, and everyone involved in the radio and television broadcast system was invited to attend. Radio and TV station engineers, receiver servicemen, parts distributors, telephone and power company representatives, communications departments, CATV, and translator people all came together for the event.

Today the group consists of radio broadcasting and television station people, station engineers, and consulting and service engineers. It originally started out to meet as a weekly "luncheon and discussion" group, and this has worked out quite well. For several years now the Chapter has been meeting during the Monday noon hour when all technically oriented people are invited to attend, including any traveling people who might have that hour open. Several evening meetings are also planned during the year, and they have always produced a good turnout.

Last spring, Mr. Pritchard of KREM and Mr. Valley of KSPS discussed digital remote-control systems which led into a lively discussion on automatic transmitter controls.

On another occasion, Mr. Pritchard, chief engineer of KREM-TV, invited everyone to come to the station to see a tape recording of the new Gamma correction system to be employed in the RCA TK28 film camera.

Chapter 21 also takes time out to honor the "old timers." Last year, Chairman Jorgenson wrote a letter honoring Mr. Langsford on his 72nd birthday, reviewing his long career in radio and television. The Chapter also tries to advertise its consultants and technical people who service their stations.

In the future, we hope to be hearing more from Mr. Jorgenson. He tells us that he has some nearly finished articles on Mt. Spokane, where KXLY-TV and FM, snowed under and iced in for over half the year, operate a station at 6,000 feet AMSL. Also, he's tendering an article on simple microwave tests as soon as he completes his search for appropriate circuit prints and photos. We hope to be publishing these soon in one of **The Signals.**

CHAPTER MEETINGS

Chapter 2: Northeastern Penn.

Members of Chapter 2 met Monday evening, October 6, at the WVIA-TV and FM studios in

(*Continued on page 50*)

Some day, somebody may imitate the Product...

...but nobody will ever duplicate the Service!

And in TV Broadcasting, it's the service behind the product...that keeps the product out front

On the way to selling more than 30,000 Plumbicon* TV camera tubes, we learned how important Service is to the broadcaster. The first thing we learned was about availability — No TV station, commercial or educational, can ever afford to shut down an operation while "waiting for parts." Plumbicon tubes are instantly available, at all times, through local franchised distributors and through Amperex factory sales representatives.

And we learned the importance of the name Plumbicon to TV stations who have come to depend on it as their assurance of consistent performance and quality.

Because no product is ever "good enough," we taught ourselves to build smaller and smaller Plumbicon tubes that provide performance standards similar to the original (we're down to ⅔ inch tubes now.) and we learned to produce tubes with reduced comet tailing, with higher resolution and modulation depth, with extended-red response, and with minimum lag. Contemporary camera tubes outperform the original Plumbicon by a wide margin.

We learned that the TV camera user is concerned about the operation of his camera . . . not merely about the performance characteristics of our tubes. So we provide him with a wide range of expert and valuable information, in print and via our field engineers, to help him get the most out of his TV camera-system. Plumbicon users who are about to install a new camera need only give our field engineering staff a call and we'll have an expert there to help with the job.

Our franchised distributors, (your own local business-men,) are carefully selected for their ability to support Plumbicon TV camera systems with on-the-spot customer support and service. We, in turn, support our distributors with two kinds of "seminars" for Plumbicon camera users. One is on video tape, the other is presented "live" by an Amperex field engineer. The purpose of both is to maximize the value of Plumbicon camera systems.

Finally, we learned that the best way to deal with warranty questions was to design the warranty for the customer's benefit — not to protect ourselves . . . and even then, to interpret the warranty in the customer's favor whenever possible. For example, a customer may return any Plumbicon tube for testing (even one that's technically out of warranty) and we'll subject it to a complete technical evaluation at our expense . . . and send the customer a detailed engineering report on the tube.

Yes, we've learned a lot about the importance of Service in the ten years, in the more than 30,000 tubes sold, in the 600-plus TV stations served, since the Plumbicon tube won the Emmy award. Little wonder, then, that the Plumbicon, after all this time, still offers the best all-around package of performance, price, reliability and service available. Little wonder, then, people keep on saying, "There's only one Plumbicon."

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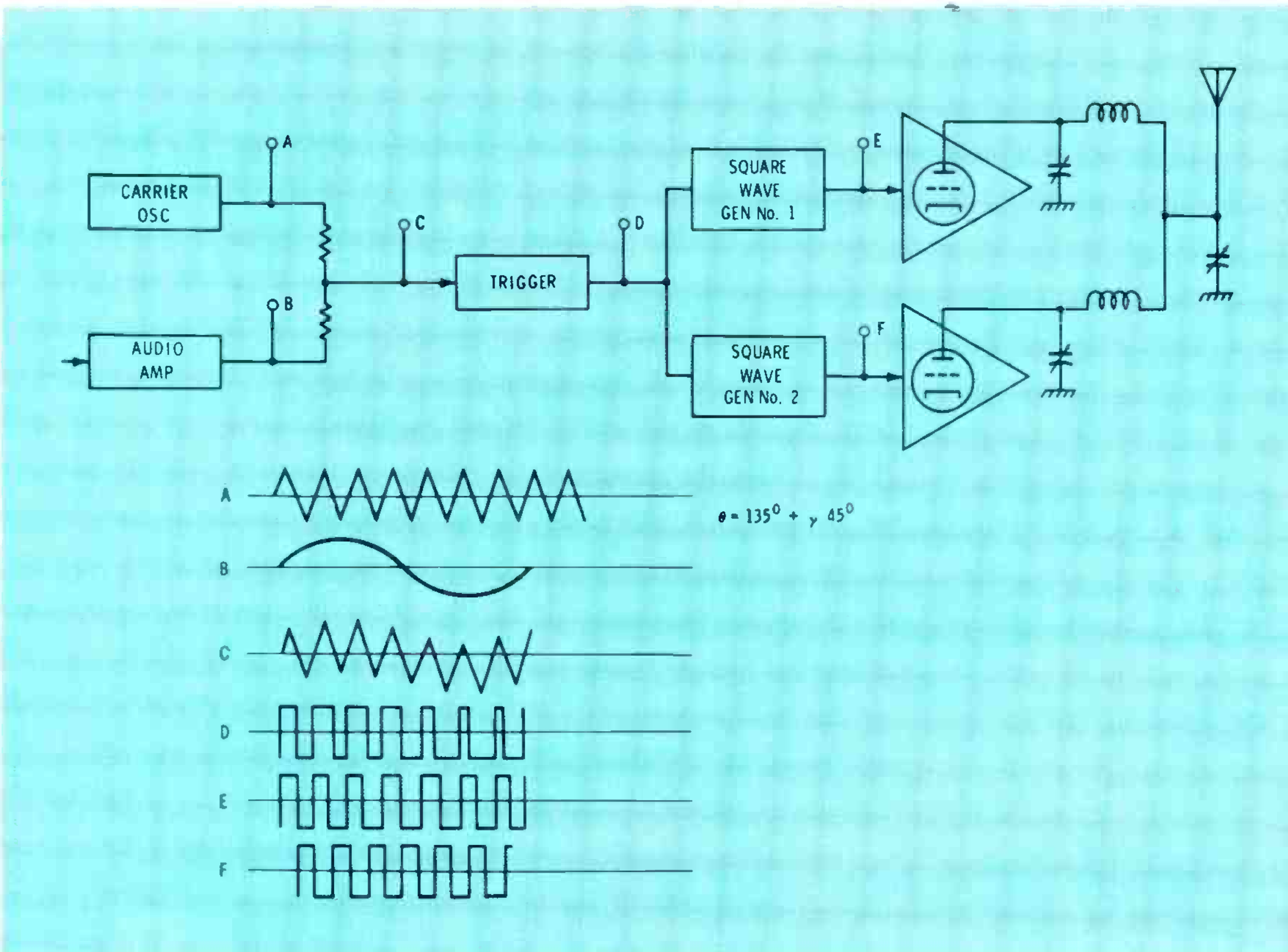

Figure 4

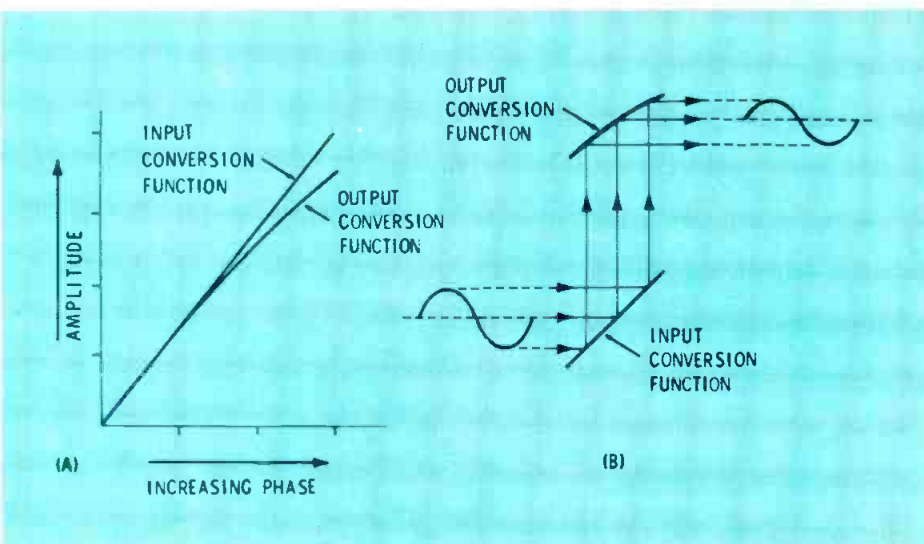

Figure 5

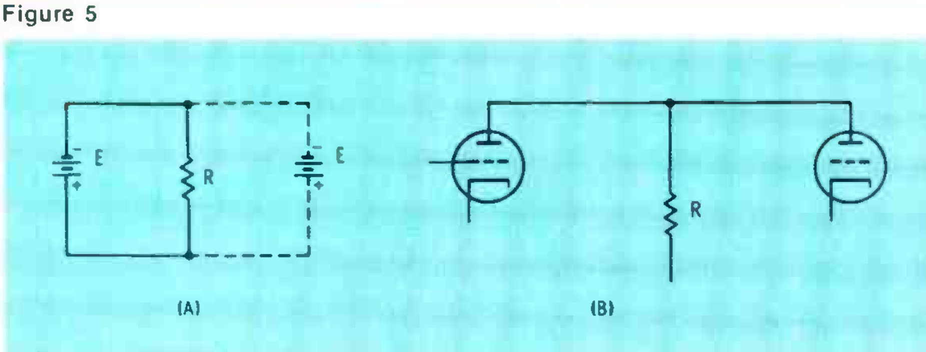

Figure 6

United States now do not use plate modulation.

The following comparison of all four systems details the reasons for the trend away from plate modulation, why it may be expected to continue, and what the advantages of the new systems are.

Plate Modulation

The plate-modulated transmitter has two primary signal paths, the audio-frequency (AF) and the radio-frequency (RF) chains. They amplify the program audio and the crystal oscillator output, respectively, such that the audio power will be equal to one-half of the dc input power to the final RF amplifier. The ac audio signal is then superimposed upon the dc $B+$ voltage on the plate of the power amplifier (PA) by a modulation transformer. The PA plate voltage, and hence the RF output, will vary or be modulated in accordance with the audio signal.

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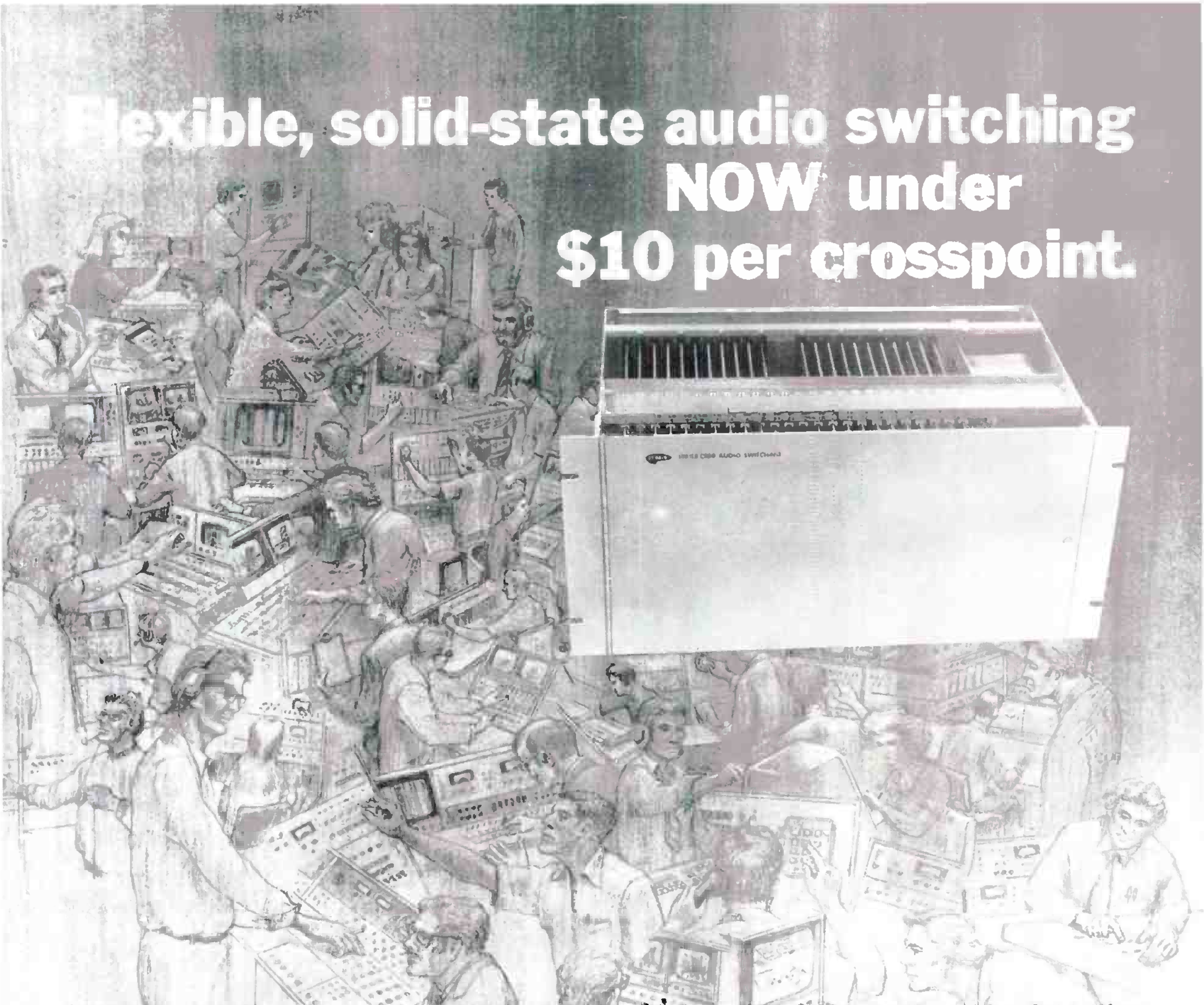

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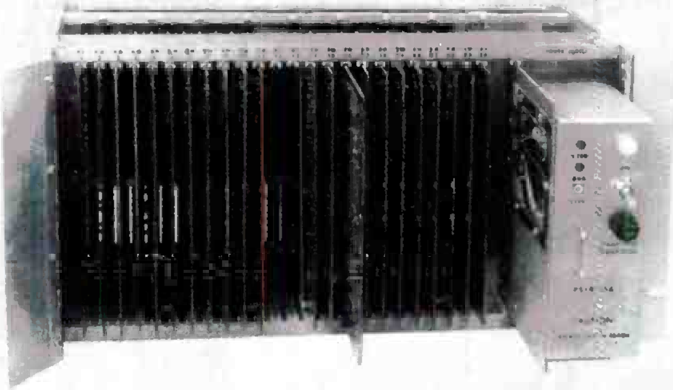

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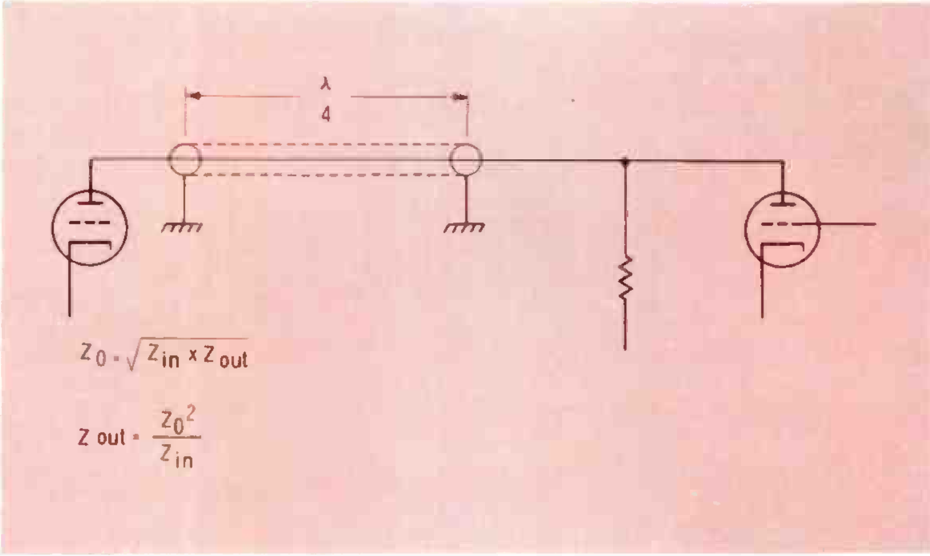

Figure 7

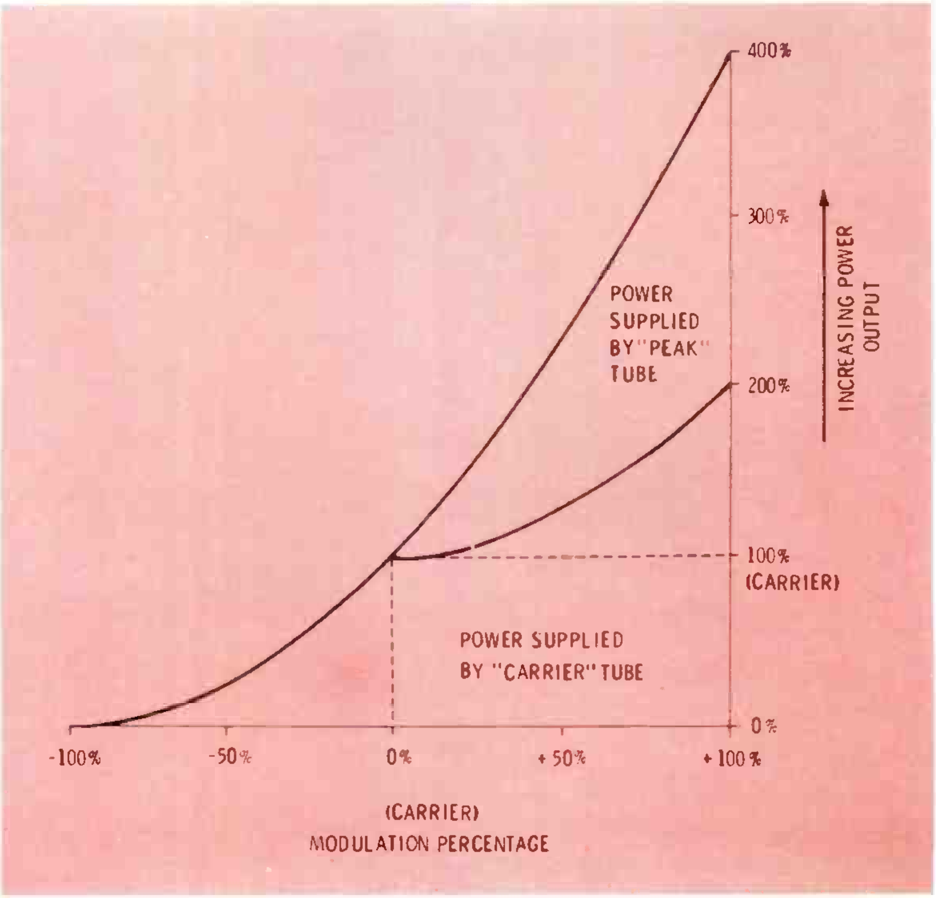

Figure 8

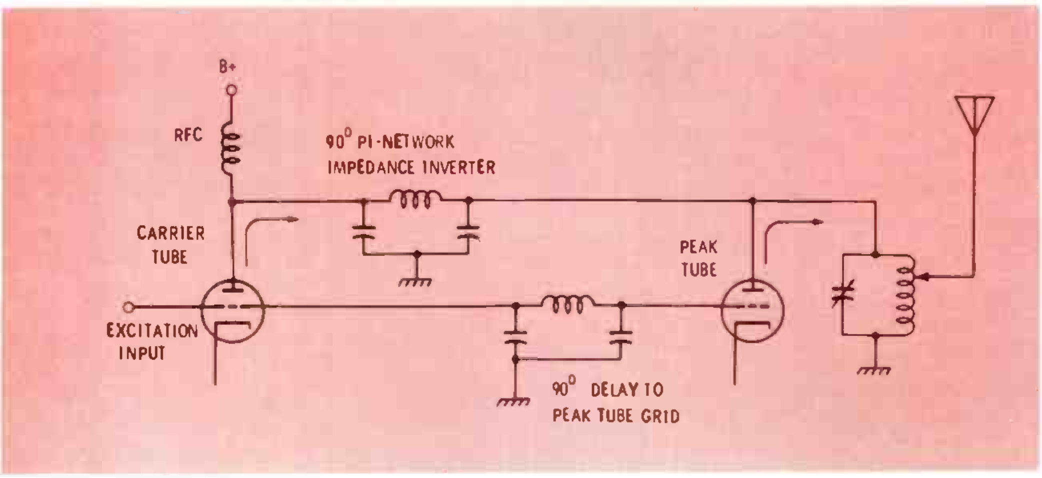

Figure 9

push-pull modulator tubes operating in class *B* or *AB*, as in Fig. 1. Some form of internal audio feedback is normally employed, sampling the audio signal immediately before the primary of the modulation transformer, and feeding it back out of phase, to some point early in the audio chain.

Efficiency of the PA's is normally high; that of the modulators, low; thus the overall efficiencyis moderate. A typical plate-modulated 50-kW transmitter requires 145-kW total power input when modulated at 100 percent with a steady-state sine wave.

Ampliphase

The current trade name Ampliphase system is a refinement of a system called "outphasing" proposed by Henry Chireix (1) in 1935. Its basic principle is the vector addition of the outputs of two identical RF amplifiers as the relative phase of the two constant amplitude output waves is varied (Fig. 2).

When the outputs are in phase the combined output is equal to the sum of the two powers. When the outputs are 180° out of phase they cancel and the combined output is zero. At points of intermediate phase relationship, the combined output current is determined by the formula

$$I = 2\cos\frac{\Phi}{2}$$

where Ø is the relative phase angle in degrees and the output currents of the individual amplifiers are assumed to be 1.

From a system standpoint, Ampliphase can be thought of as two complimentary conversions: on an amplitude-to-phase conversion, and the other a phase-to-amplitude conversion as shown in Fig. 3.

The phase-to-amplitude or output conversion is accomplished in the common output network of the two RF amplifiers as was shown in Fig. 2. The input conversion from amplitude to phase is produced by an Ampliphase "exciter." A block diagram of the exciter is shown in Fig. 4.

A triangle wave at carrier frequency is presented at point *A*. An audio signal of much lower frequency is presented at point *B*. The two are combined at point *C*, producing a triangle wave with low-frequency baseline shift. The waveform is subsequently fed to a trigger circuit which produces a pulse train at point *D*. The repetition rate of the pulse train is that of the triangle wave (carrier frequency). The duty cycle of the pulse train varies, however, in proportion to the audio signal which was superimposed on the triangle. The duty cycle Θ is given as

$$\Theta = 135^\circ + \gamma 45^\circ$$

where γ is the amplitude of the audio signal. (While it is convention to speak of duty cycle in terms of percent or time, the notation here is given in degrees because of the correlation with a subsequent phase displacement. It is understood that a duty cycle of Θ° is equivalent to Θ/360° percent.) This pulse train in turn triggers two square-wave generators. The first such generator triggers on a positive-going zero crossing of the triggering wave. The second generator triggers on the negative-going zero crossing. The outputs of these two generators drive the grids of the two RF amplifiers.

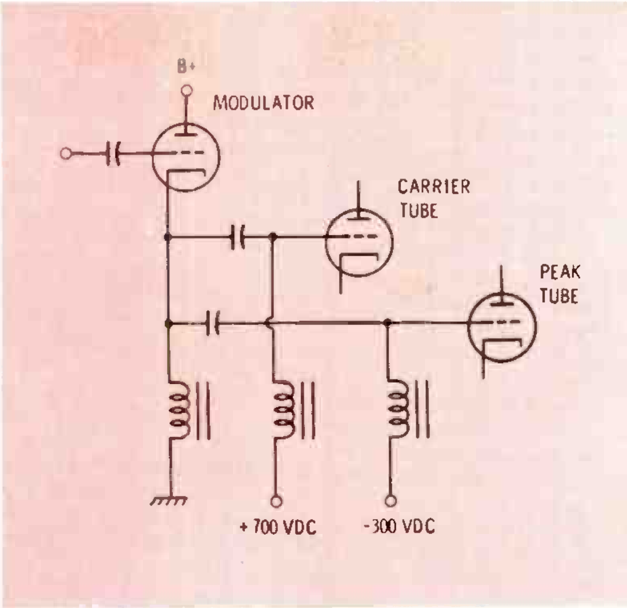

Figure 10

One can readily see that the phase displacement of the signals fed to the RF amps (at points *E* and *F* in Fig. 4) is the same as the positive duty cycle (Θ) of the pulse train at *D*, which is proportional to the amplitude of the audio input signal. With no audio input, the trigger threshold is normally adjusted so that Θ is approximately equal to 135°, or carrier condition.

These constitute the two stages of conversion. Unfortunately, in this form they are not true complements of one another; the function of one is not precisely the inverse function of the other. The input conversion relationship (2) is a linear function. The output conversion relationship (1) is trigonometric. Graphed together as in Fig. 5(a), they track rather closely except at the high end, where the output function falls off more rapidly. The net result

(Continued on page 37)

WLBC engineer Steve Brown uses a counter to measure the frequency of a portable transceiver on the bench. While the readouts did not show up in the photo, they usually are easy to read at some distance.

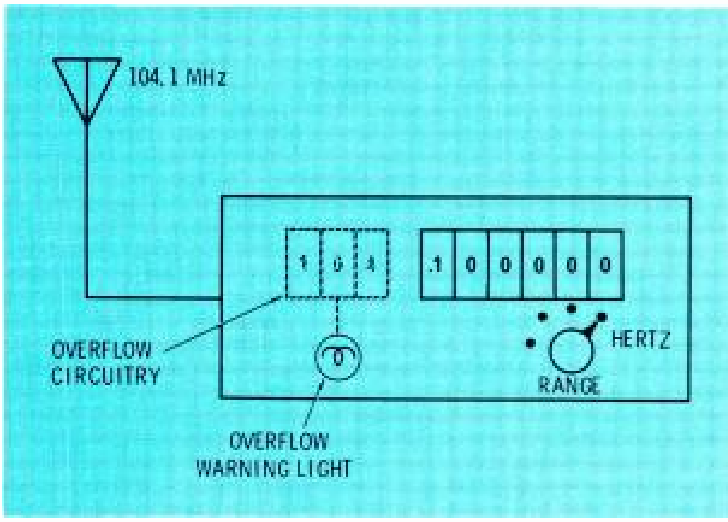

Fig. 1 When resolving to the lowest units and there are not enough readouts, the first digits move into the overflow. When digits are in the overflow circuitry, the unit will either blink all readouts or light an overflow lamp.

Counting on counters

By Pat Finnegan

Progress made in solid state technology in recent years has taken the frequency counter out of the laboratory category and into the field. These new portable units are very accurate, stable, and the price range is very attractive.

A station will ordinarily buy a frequency counter so that it can measure its regular broadcast transmitter carriers, as required by the FCC. Equally important, a portable counter can be used for trouble-shooting and maintenance where accurately known frequencies are very desirable or necessary.

There are many makes and models in a wide price range. As with most test instruments, some models will include some secondary features that satisfy different industry needs.

A counter is essentially a 're-ceiver' in nature, and not a signal generator, although some models do provide some fixed output frequencies that may serve a useful function in your applications. Also, the front end is broadband, so a particular signal cannot be tuned in. The counter will lock on the most predominant signal that will provide it with enough signal (within its range) to make an accurate measurement.

Desirable Features

For portable use, the important features to consider are: basic range, method of calibration, readouts and power source.

Try to select one that will cover the majority of signals in use at the station and those which can be anticipated. This won't be possible for all stations. One small counter, for example, may cover 5 Hz to 175 MHz in its basic range. This will cover AM, FM broadcast, subcarriers, and VHF mobile units.

For those measurements required by FCC Rules, the counter must be calibrated. The best method for 'on site' calibration is comparison with the carriers of WWV. The model selected should have some provisions for calibration.

The number of readout elements the instrument has does not affect its accuracy, but it does affect the number of significant figures you can have displayed at one time, and the operations necessary when resolving a high frequency signal down to its lowest parts. In some units, if the frequency is too high for the range in use, the figures left of the decimal point will 'slide over' into the overflow circuitry and a light (sometimes called an over-range light) flash on to warn the operator that there are numbers in the overflow.

For example, a mobile unit on 166.25 MHz, to be read in its basic units of Hz is: 166,250,000 Hz. If the instrument has the typical 6 readouts and the range switch set to resolve to its basic lowest units, 250,000 will be displayed, and the over-range indicator will come on. The 166 will be in the overflow. You must switch the range until all figures are out of the overflow.

When checking mobile units in a vehicle, instrument power and cables can be a problem. The unit should be able to operate directly from the battery in the vehicle, and with appropriate cable adaptors to attach to the battery easily.

Calibration

A communications receiver will be adequate for calibration of the counter against WWV. You will need to get a zero beat between the counter reference oscillator and WWV. It is not possible to measure the frequency of WWV direct, because the local oscillator in the receiver (almost all are superhets) will be the predominant signal.

Couple the calibrating output of the counter to the antenna terminals of the receiver (after you have tuned in a good strong WWV signal). Couple only enough to get a good beat with WWV—not override it. If there is a tone heard, the counter is off and needs to be adjusted. Make a careful adjustment so the beat note (or no sound) is right in the center of beat. If the receiver dial is off, use the BFO in the receiver to get a beat with the counter signal. Remove the counter signal, and WWV will be right there or very close. Also, make the final calibration during a period when WWV is not sending tone or voice.

Operation

Observe the maximum input level specs so that high level signals will not damage the input circuitry of the instrument. This is important not only in regular measurements, but especially when doing maintenance or troubleshooting equipment when the pickup loop is close to coils or circuitry inside the transmitter. There may be very high RF signal levels, or high DC voltages

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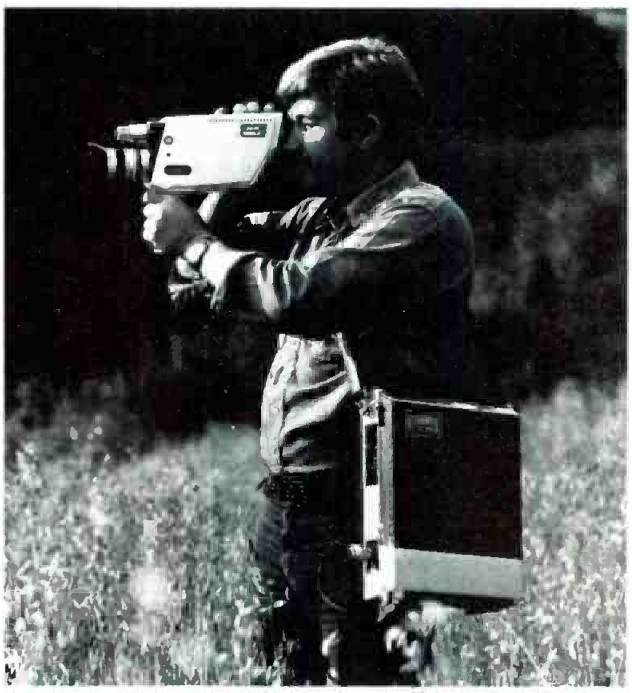

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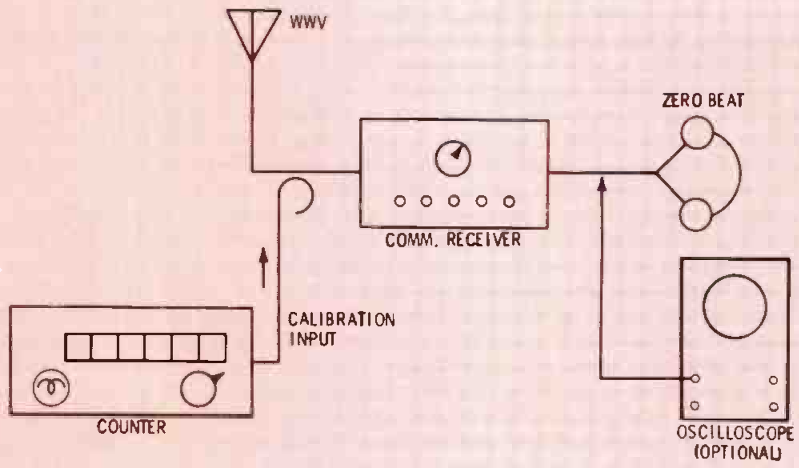

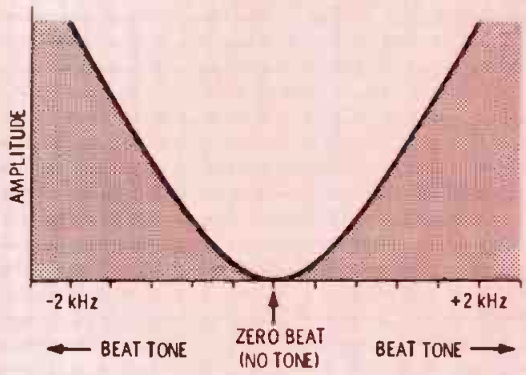

Fig. 2a The setup for calibration against WWV. Listen for a zerobeat in the phones. The scope also can be used to detect a more exact null.

Fig. 2B When the counter frequency is above or below WWV, a beat tone will be heard. The objective is zero tone in the center.

may arc to the probe. This could damage the unit and zap the operator!

Couple only enough signal to the counter to allow all the numbers in the readouts to remain stationary. The input required is usually somewhere around 100 to 200 millivolts of signal. Be careful when coupling to broadcast transmitters, especially to RF cables that carry signal to modulation or old style frequency monitors. There can be 10 to 20 volts RMS of signal in the cable.

Measuring Carriers

Always follow the instruction manual of the instrument for the first measurements. It won't be long, however, until you develop your own procedures. That is, you will discover the best locations for samples of the different transmitters you must measure. The FM transmitter can best be measured when there is no modulation, unless your instrument has some storage and averaging capability. But there are usually some pauses in modulation, or you can do it after sign off.

The FCC Rules require a different logging entry than was done in former years. Now, you must log the **actual measured frequency** rather than difference from assigned. For example, your AM is assigned 1390 kHz, but is now operating 2 Hz low. The counter will measure the carrier as 1389.998 kHz. This is the figure to log.

Other Uses

Many other uses will soon be self evident, once the counter is available. The following are just a few of these where accurate frequency measurement is important.

Calibration of the FM modulation monitor is often done by use of a communications receiver to observe the nulls in the carrier while modulating with a specific audio tone. The accuracy of the calibration depends upon the accuracy of the audio signal. But very few audio generators have a dial that accurate, and besides, the odd-ball figures fall between dial markings that require 'eyeball' interpretation. The counter can measure the audio out of the generator, so you can set it exactly. For example, the audio signal required for 100% modulation (75 kHz deviation) is 13.586 kHz (for the second null). Couple the output of the generator to the system as is normal, but also couple this signal to the counter. Leave the counter coupled while the calibration is taking place so that you know the audio is exactly what it is supposed to be.

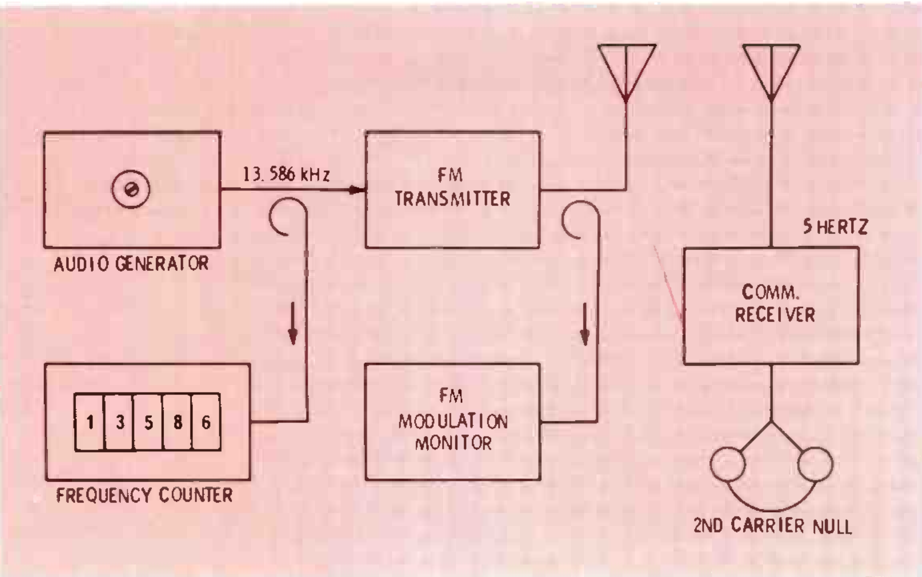

Fig. 3 Setup for calibration of FM modulation monitor. Measure the audio frequency so that it is exact.

Mobile Units

Mobile transmitters can best be checked for frequency when they are on the bench for repairs. If maintenance must be done on the bench, make it a practice to run a frequency check. When working into a dummy load, you may need to couple the counter near the output circuitry to get enough signal pickup.

In the vehicle, don't attach the pickup loop to the antenna itself.

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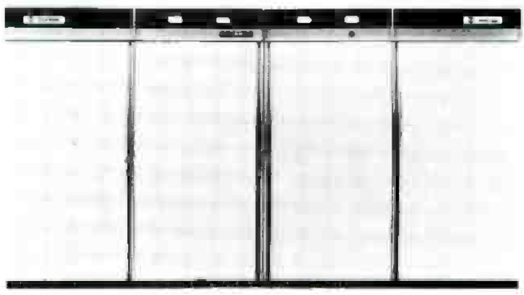

Harris' MW-50 provides superior AM broadcast service performance through a combination of EIMAC power tubes and Harris' exclusive Pulse Duration Modulation system. The Pulse Duration Modulator employed in the MW-50 is nearly 90% efficient, enabling the transmitter to achieve an overall efficiency greater than 60%—power line to antenna. This efficiency is attained without the use of large iron core components.

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Place it in a spot that will give a suitable pickup, and preferably without holding it by hand. Body movements can affect the signal pickup and, in turn, the measurements.

Multiplier Stages

Most high frequency transmitters have many multiplier stages to bump the crystal frequency up to the carrier frequency. When major changes are done, such as changing channel or replacing a transformer, the counter can be very helpful in indicating that a multiplier is tuned to the correct multiplication rate.

The normal transmitter metering is used for tuning purposes (and power stages protected from lack of proper drive), but often there can be several tuning points at which the meter will peak. You probably have to couple very close to the particular circuit since the counter will lock onto the predominant signal. Use the regular meter for peak indication and then the counter to make sure that is the correct frequency. Some counters do provide various tuned pickup loops that can give some degree of frequency selection to the counter.

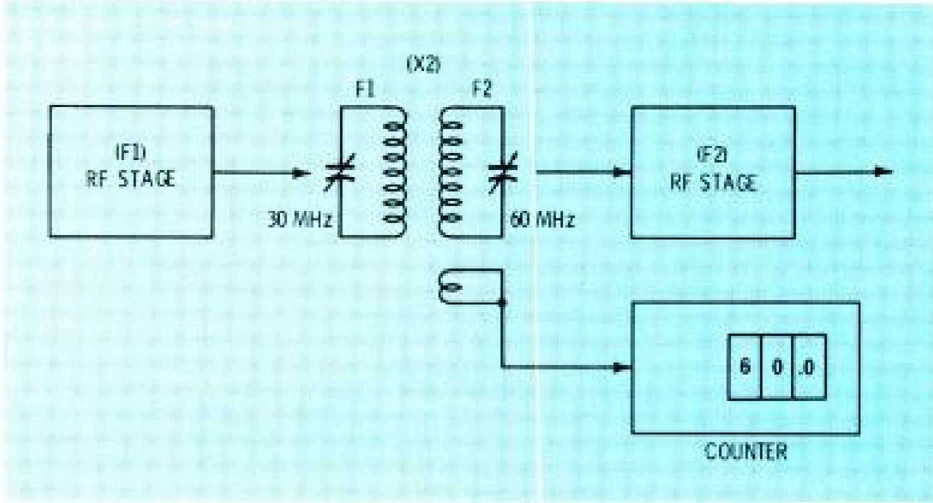

Fig. 4 Use tight coupling to the secondary of the RF transformer in a multiplier circuit.

Crystal Quits

The counter can be coupled close to the crystal holder or its terminals. If the crystal has no output, the counter will read zero. Crystals will have an aging factor. That is, over a long period of time, they will change their resonant frequency. The same is true of the components in the circuit itself. When all these factors age enough and drift far enough, the oscillator may not oscillate at all, or you may not be able to trim it back to the correct frequency. The counter can tell you both these effects. You read all zeros if the oscillator is not oscillating, and if all the meter indications seem normal and the oscillator is oscillating, the counter will tell you if it is on the correct frequency.

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(*Continued on page 49*)

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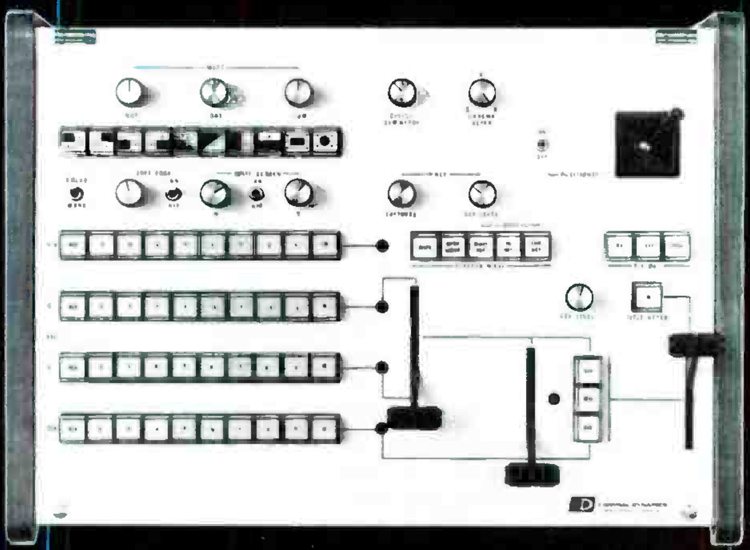

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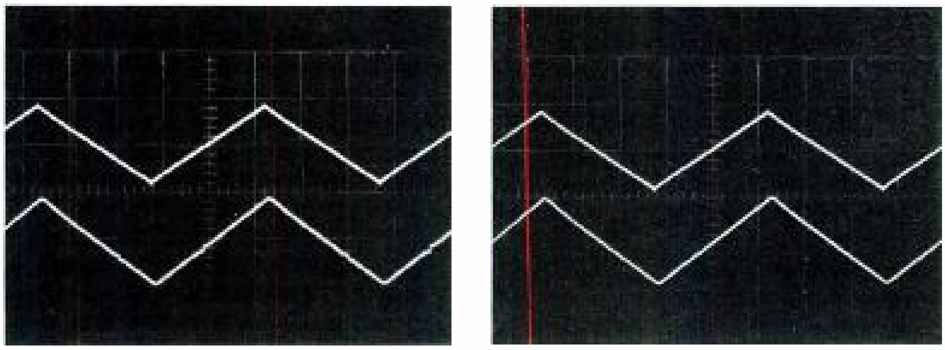


A B

Fig. 1 Detecting amplifier crossover distortion with 10 kHz triangle wave. (A) Clean input (top), output notches (bottom). (B) Clean input (top), clean output (bottom).

Let's put function Generators to the test

By Walt Jung

How many BE readers are familiar with the function generator and what it can do as a general purpose signal source? Well, as a matter of fact, the function generator is one of the most useful tools you could ever hope to have around the station shop.

This article, being somewhat of a departure from my past BE efforts, will outline a variety of function generator uses of value to the station engineer.

What's A Function Generator?

A function generator is simply a signal generator which generates the waveforms (or functions, if you will) of sine wave, square wave and triangle wave. These three waveforms may be considered as a minimum, and many of the devices available include modifications or extension of performance which allow generation of sawtooth and pulse waveforms as well. Even more sophisticated units allow AM or FM modulation, although all of these ramifications will not be covered here. What we're trying to do is first get a handle on what a function generator can do, in general. Then we can progress to bigger and better things.

Generally speaking, function generators have a frequency range which is usually much broader than the audio spectrum, for instance from 1 Hz or lower to 1 MHz. Others go further (both up and down), but at higher cost of course. With this kind of range then, it is not only suitable as an audio source, but as a general purpose clock for logic use, or even video work. Thus there is the connotation that a function generator **is** a universal signal source, so the subtitle which heads this article.

Function Generator Characteristics

One of the keys to maximum utility in using a function generator lies in understanding its pro's and cons. There are things it can do well, and some that it can't. Since, by its very nature, a function generator is a universal type of signal source, it will in most cases be overshadowed performance-wise by a generator which is specifically designed for a certain application. There are several aspects of this which should be appreciated, so let's take them one at a time.

As a sine wave source, the advantage of a function generator over a classical RC (or LC) oscillator is in amplitude flatness. The sine wave in a function generator is created from a triangle wave, the peak limits of which are regulated in amplitude by precision comparison. This imparts a "solidness" to the waveform, without any of the miseries of lamp or AGC bounce we've all seen at one time or another in a sine wave oscillator.

It's not unusual to see a function generator output stable within millivolts over a band. This can be a decided advantage if you're checking that input level every time you change frequency.

On the minus side, sine waves from a function generator will almost always have a greater distortion content than a standard RC oscillator. This is because of the waveform synthesis method of generation used. Actual numbers will vary from one unit to another, but THD will usually be in the 1 to 3% range. Even the best units do not get much below 1%, and 0.5% is relatively rare.

Further complicating the picture is the fact that the sine wave THD may also vary with where you actually are operating on a given range, with best performance usually at the higher end of a 1-100 or 1-10 span, for instance. And, as you get up to 100 KHz or more, THD rises in general, due to circuit limitations.

Another aspect of performance is frequency accuracy and stability. Both of these are not as good as a typical sine wave or LC oscillator, because of the basic method used to establish frequency. There are

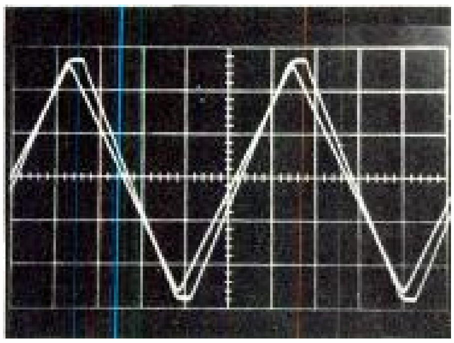


Fig. 2 Checking clipping and overload recovery time. Full power, undistorted 20 kHz triangle wave (lower level trace); clipped triangle with fast recovery. Scales are 20V/cm vertical, 10 us/cm horizontal.

just more variables which can drift to cause instability, and precise tracking of dial calibration means very close control of tolerances, and/or trimming. So, don't expect a function generator dial reading to be gospel. If the precise frequency is important, it's best to use a counter to be sure. And, don't count on the exacting calibrations of an RF generator, nor it's resolution of tuning. Tuning accuracy or resolution is usually on the order of a few percent, and this too can vary as to where you are on the dial.

Fidelity of the triangle and square waveforms can be quite good, the most noticeable deterioration occurring at high frequencies; 100 KHz or more. In this region, triangle amplitude may vary and square waves become rounded due to risetime limitations. Also, the degree of symmetry may depart from the 50% of an ideal waveform. This shift of symmetry is one major cause of the above-mentioned sine wave distortion.

If the picture by now sounds not so rosy, don't be too hasty to judge the function generator as second rate. The comments above are intended to give some perspective against types of signal sources which may be familiar. However, those mentioned are specialized instruments and specialized instruments optimized in one regard can always outperform a type which is not specifically designed for that function. So while it can be bettered in almost any of its individual performance parameters, the function generator's beauty lies in its utility. Where else can you find a single instrument which produces such a variety of waveforms, over such a broad range, with such economy?

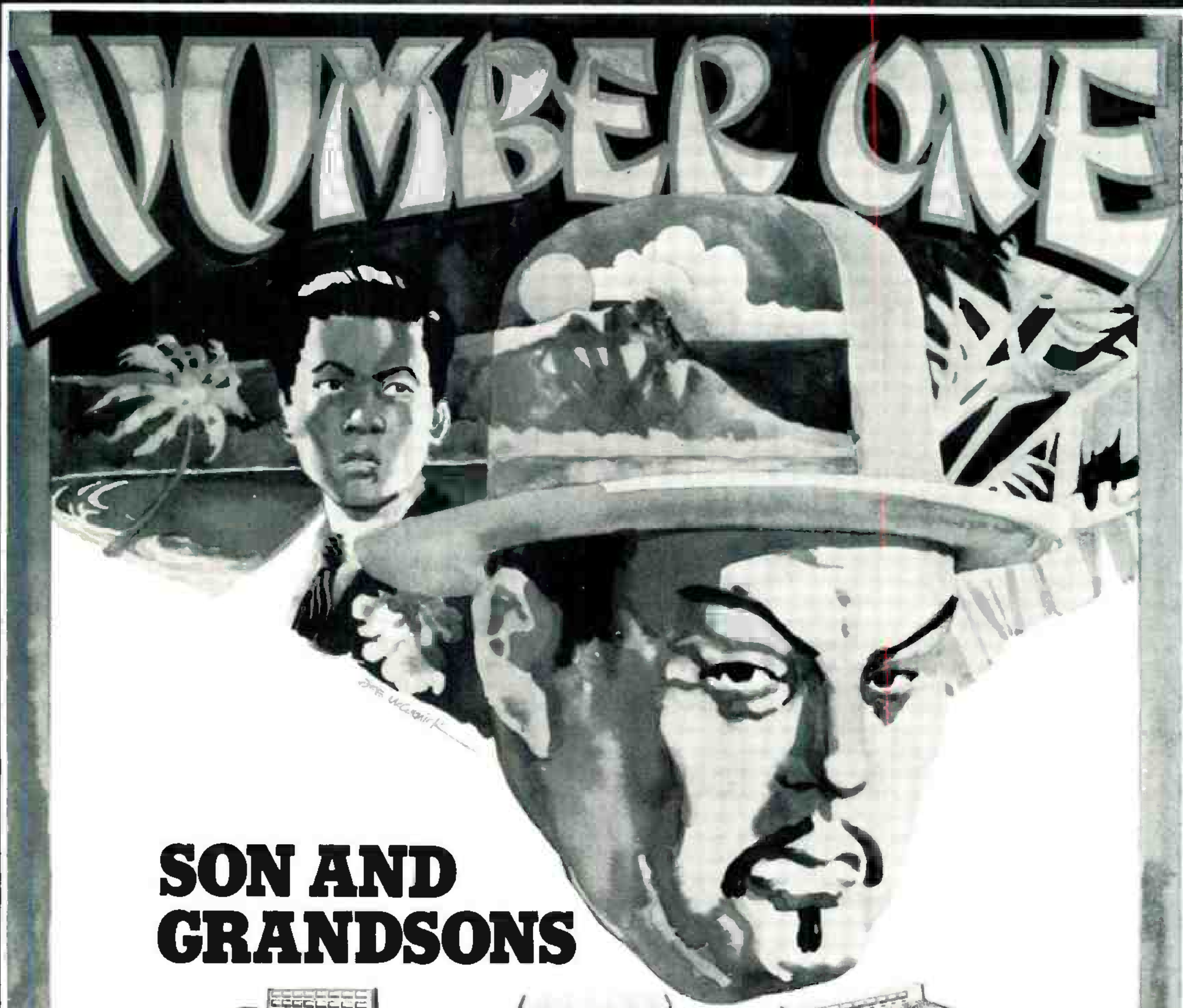
The latter point is a good one, of course: The value of having three or more instruments in one. The function generator has a definite place in the arsenal of a well-equipped shop; and once you find out how handy it can be, I'm sure you'll agree.

Function Generator Uses

The following are but a few uses of a function generator illustrated (where possible) by actual waveform photos using the Heath IG-1271 as source.

Crossover distortion in an audio amplifier is one of the most obnoxious forms of distortion to the ear. Usually caused by insufficient bias in the output stage, it can be spotted, measurement-wise, by excessive low level IM. But, a quicker way is to examine the output of an amplifier operating into its rated load while driven from a low level (about 2-5 volts p-p) 10 kHz triangle wave. If you've got crossover distortion, it will show up as an abrupt discontinuity in the linear rise and fall of the triangle. A gross example is shown in Figure 1a; a more subtle form might be slight glitches where the wave goes through zero. The remedy is of course, the correct bias adjustment, illustrated by Figure 1b.

Another excellent use for the triangle wave is in checking the power output of an amplifier and its overload recovery time. In Figure 2, the output level is raised until the sharp tip of the triangle becomes compressed, indicating clipping. This is much easier to discern than with a sine wave which is (by contrast) flat on top. If this test is run at a high frequency, say 10 or 20 kHz, the overload recovery of the amplifier can be measured. The more quickly and cleanly an amplifier recovers from overload, the better will be its sound. The



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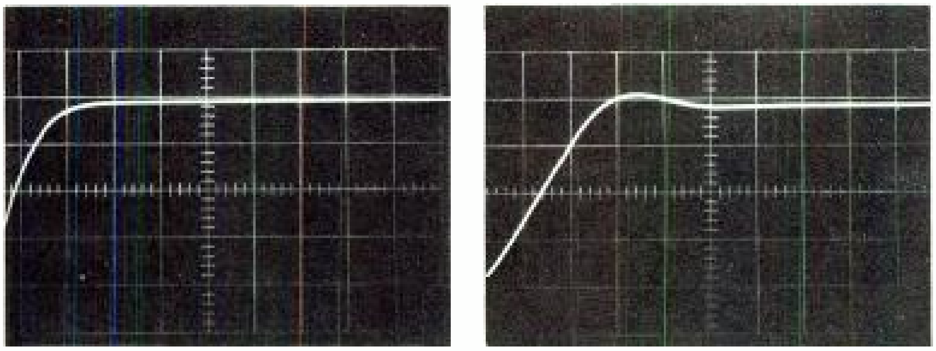

Fig. 3 Checking risetime of medium power amplifier with 10 kHz square wave. **(A)** 3 us risetime shows exponential rise. **(B)** Longer, linear risetime is slew-limited. Scales are 5V/cm vertical, 2 us/cm horizontal.

example shown is a commercial 200 watt per channel unit driven to clipping at 20 kHz in one trace, the other just below clipping.

Square wave testing tells a great deal about the frequency response characteristics of a transmission system. This is true, because to reproduce a square wave faithfully, an amplifier must have both wide bandwidth and low phase shift, and both of these far in excess of the working range. Thus, a square wave response check tells you a great deal about the quality of a system virtually instantaneously. You must, of course, use a high quality source (free from tilt, and with fast rise and fall times) in the testing, as well as a wide bandwidth scope. Several examples of this type of use follow.

An audio power amplifier can, and often does, have two different bandwidths. One of these is its power bandwidth, or large signal frequency response. The other is the small signal frequency response, taken at a lower level, typically around 1 watt.

Figure 3a illustrates the output of an amplifier driven to a medium level with a 10 kHz square wave. Under these conditions, this particular amplifier is operating essentially at its small signal bandwidth, and the measured rise (or fall) time will be related to its small signal frequency response. The two are related by

$$\text{Bandwidth} = \frac{0.35}{\text{Risetime}}$$

In the example illustrated, the bandwidth would be over 100 kHz. This relationship will hold for any system where the rolloff is 6dB per octave. Obviously then, this is a faster method of bandwidth measurement than plotting the frequency response. To be sure that the risetime being measured is truly small signal bandwidth limited, watch for the typical exponential rise of an RC time constant, as shown.

As the power level is raised, the amplifier's output will usually become limited by its slewing rate, or output rate of change for large signals. In 3b, an example of slew rate limited risetime is shown. This case happens to be only slightly longer, but you can note the risetime is linear or ramp-like, a characteristic of slew limited operation. This "ramping" is the visual clue that the amplifier is being driven into slew limiting. In this example, the slew rate is about 4V/uS.

Slew rate, if inadequate, can cause a form of distortion as irritating as crossover problems. The general term for it is transient intermodulation distortion, or TIM. It is caused by the fact that the amplifier is actually in an open loop state during the slewing interval and consequently cannot amplify any detailed components of the input waveform. Therefore, the intervals of slewing actually cause momentary loss of input-output signal transfer (like crossover distortion, where the output stage is momentarily off). So, it is hardly any revelation that it sounds bad.

Once you've become familiar with the information a square wave test can give you, you can then in turn apply it to your equipment as a very quick maintenance check.

As one further example, take the case of an equalizer, a device which purposely introduces frequency response variations into an audio channel. If you wanted to test one out by the traditional sine wave method, it could take hours, particularly if it is a multi knob version. However, you can quite quickly give it a qualitative check with an input square wave. Figure 4 shows the output response from a tunable reciprocal equalizer, with a 1 kHz square wave as an input.

In 4a the equalizer is in the circuit, but adjusted for a flat response. Note that the bottom output trace is barely distinguishable from the input, indicating truly flat response.

4b illustrates 15 dB of boost applied, with the equalizer peaked at 1 kHz. Therefore, the output shows a large amplitude sine wave (the fundamental) plus the basic square wave (the stepped portion). The bottom scale factor is 5 times that of the top, illustrating the increase in sine wave level.

4C shows the same frequency setting, but with 15 dB of cut applied at 1 kHz, greatly reducing the fundamental, and leaving the odd harmonics.

These equalizer responses are, of course, somewhat specific examples, but they should show what square wave testing can quickly tell you. Your actual responses will vary, particularly if transformer coupled units are being observed, or AC coupling is used. However, once you familiarize yourself with your own general pattern, you can quickly spot and isolate problems. And, you'll be amazed how quickly!

Above there was also some discussion on sine wave testing for frequency response. When this type of test must be done, it can be greatly speeded up, if a **swept** function generator is available. The theory is the same as sweeping RF or IF stages; just slow everything down to audio rates. Then you can see your whole frequency response right on the scope face!

This article could go on with further examples, but space does not permit it in this installment. I hope your enthusiasm has been tickled towards some new tricks in testing methods, perhaps you can think of further variations and other uses for the function generator. If so, let us know so we can share them with BE readers. □

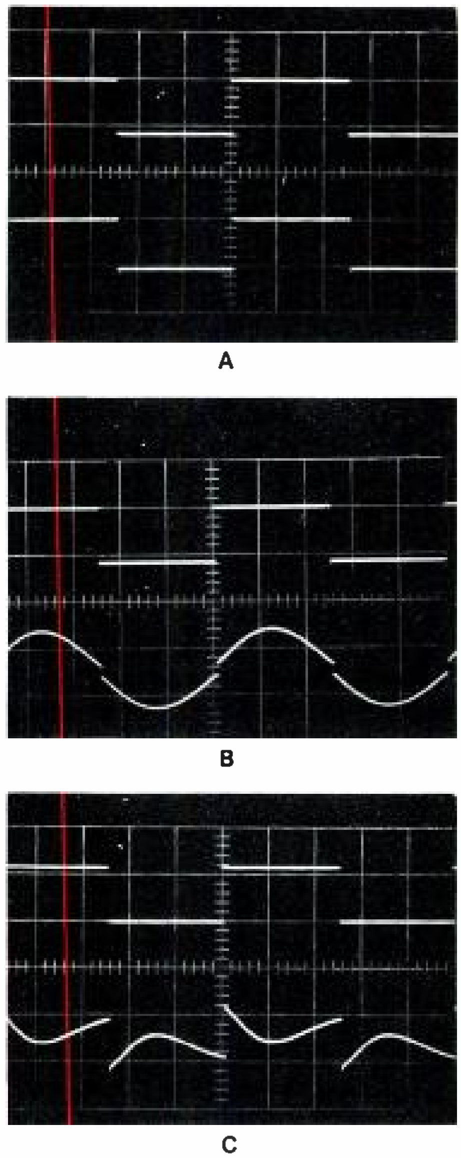

Fig. 4 Checking variable equalizer performance with 1 kHz square wave. **(A)** Input (top)/output (bottom) A/B comparison with controls flat. **(B)** Input (top)/output (bottom) with 1 kHz peak. **(C)** input (top)/output (bottom) with 1 kHz dip.

Additional Reading

1) Middleton, R.G., "Know Your Square-Wave and Pulse Generators"—Howard W. Sams
2) Middleton, R.G., "101 Ways to Use Your Square-Wave and Pulse Generators"—Howard W. Sams
3) Tremaine, H.M., "Audio Cyclopedia"—Howard W. Sams

(Continued from page 25)

would be distortion due to flattening of the positive peaks as shown in Fig. 5(b). To compensate for this and other nonlinearities of the system (and to increase efficiency), a predistorted amplitude-modulated RF signal is introduced at the control grid of the PA. Overall rectified RF feedback is utilized to further reduce distortion and maintain flat response.

Both PA's are operated class *C*, with resultant high amplifier efficiency. As there are no other high power stages, overall efficiency is also high.

The Modified Doherty

The Doherty amplifier (2) also relies upon the interaction of the outputs of two RF amplifiers for its operation. In this case the interaction is impedance modulation.

Consider the battery and resistor in Fig. 6(a). The current drawn from the battery is described simply by

$$I = \frac{E}{R}$$

If a second battery of the same voltage is added in parallel with the circuit, the current through the resistor will remain the same. However, the current drawn from the first battery will be only half its original value; or

$$I = \frac{E}{2R}$$

The apparent load seen by the battery is now $2R$. When the current was halved, the power output of the battery was also reduced by half. The introduction of additional power in the circuit from an external source has increased the apparent load resistance of the first battery.

Now substitute for the batteries in the circuit of Fig. 6(a), the vacuum tubes in Fig. 6(b). Assigning fixed values to the voltages applied to the tube on the left, it will be possible to control its power output by varying the grid voltage of the *right*-hand tube. Increasing the power delivered by the right-hand tube will cause the apparent load resistance seen by the left-hand tube to increase, causing the left-hand tube's output to decrease. This is an example of impedance modulation.

Now insert a one-quarter-wavelength section of coaxial line between the left-hand tube and the load resistance as shown in Fig. 7. Such a section of line, known as a quarter-wave transformer, has the ability to invert impedances according to the relationship

$$Z_0 = \sqrt{Z_{in} \times Z_{out}}$$

where Z_0 is the characteristic impedance of the line. This property can be seen more clearly by rewriting the equation in the form

$$Z_{out} = \frac{Z_0^2}{Z_{in}}$$

Because Z_0 is a constant, the output impedance increases inversely with the input impedance. This reverses the original relationship between the power in the tubes. Increasing the power supplied by the right-hand tube increases the apparent value of R_{load}. However, viewed through the impedance inverter, this appears as a *decrease* in load impedance to the left-hand tube, causing it to deliver more power. Under this arrangement, an increase in the power delivered by one tube will cause an increase in the power delivered by the other tube. This property is used to create positive peak modulation in the Doherty amplifier.

In the Doherty, the left-hand tube as we have described it is referred to as the "carrier" tube; the right-hand tube, the "peak" tube. During operation, the static bias of the carrier tube is at cutoff, or class *B* service. The peak tube is biased well past cutoff, or class *C* service. Under carrier conditions, sufficient excitation is applied to the grids to drive the carrier tube just to the point of saturation, or the point where any further increase in grid drive will not produce any further increase in its output. The peak tube, because of its higher negative bias, is just below the point of conduction.

Increasing the grid drive past carrier condition will cause the peak tube to conduct, adding its power to the output, and also causing the output of the carrier tube to increase. Note that the increase in output of the carrier tube is the result of impedance modulation of its load and not directly because of the increased grid drive to the peak tube.

(Continued on page 56)

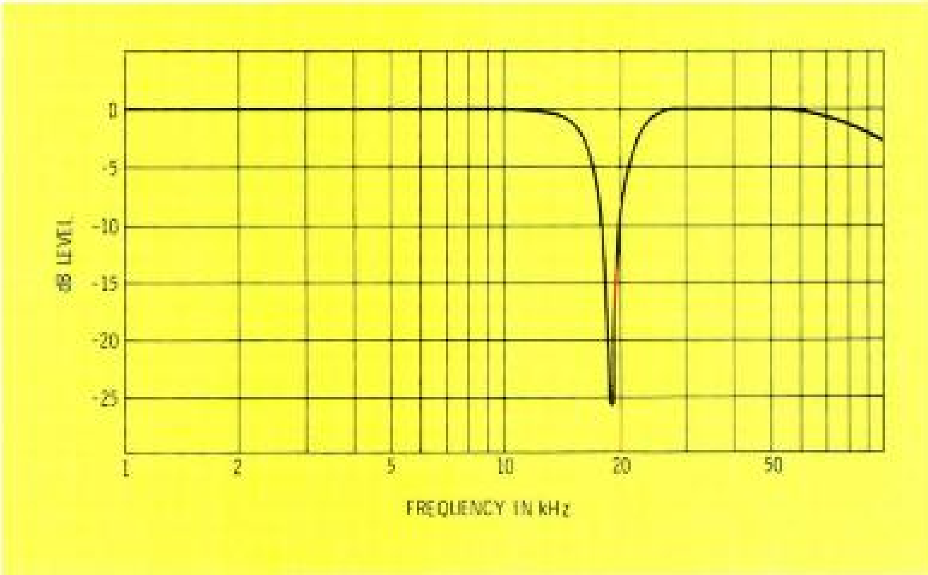

Fig. 1 Frequency response of a 19 kHz notch circuit.

Just How Important Is Transient Response?

Part 1 of a 2-part series

By Dennis Ciapura
BE Audio Editor and Director of Engineering, WLAK-FM. Chicago.

While audiophiles often criticize FM broadcasting as being something less than state-of-the-art, a growing number of broadcast engineers are looking at their broadcast systems as musical instruments rather than simple communications networks.

Last year when **BE** ran some articles on I.M. distortion, there was enthusiastic response from many engineers, indicating that people in the industry are eager to look beyond the usual frequency response and harmonic distortion tests for ways to improve the audio fidelity of their FM facilities.

A few years ago, much was said and published in hi-fi circles about transient response in audio systems and most experts agree that systems with better transient response reproduce music more accurately. Most test reports on stereo gear for the consumer include square wave response data. The average home stereo amplifier today is quite good in this respect because the advent of transformerless solid state circuitry has enabled design engineers to evolve inexpensive amplifiers with excellent bandwidth.

Very little attention has been given to transient response in broadcast systems, however, and this is an area where improvements can be made. The studio end of the system is relatively easy to handle, because at that stage of the game, we are dealing with audio only where good quality equipment and transformers can deliver very good square wave response. FM stereo signal generation is another story.

Some transmitter design engineers feel that the 19 kHz pilot should be protected by notch filters in the audio to prevent musical harmonics, and possibly distortion components, from interfering. There is also the 38 kHz spectrum to protect, as well as the S.C.A. signals. Although there is some question as to whether there is really any energy of sufficient amplitude above 15 kHz to cause any interference, even to the 19 kHz pilot, the fact remains that many transmitters do have some sort of filtering installed.

Because 19 kHz notch and 15 kHz low pass filters are very common, we decided to see just how much of an effect these circuits have on a square wave input. Part 1 of this series will deal with the electronic results of this filtering and in Part 2 we'll take a listen to the audible results.

Some manufacturers' feel so strongly that the pilot and subcarriers should be protected that they employ 15 kHz low-pass filters in the input circuitry of their stereo generators to prevent anything at all from getting outside the 15 kHz bandwidth specified by the FCC. At the same time, some other designers, Sparta Electronics for one, feel that transient response should be optimized and see no need for the 15 and 19 kHz filters because they feel that there just is not enough energy above 16 or 17 kHz to make the filters necessary. C.C.A. Electronics also subscribes to the wide-

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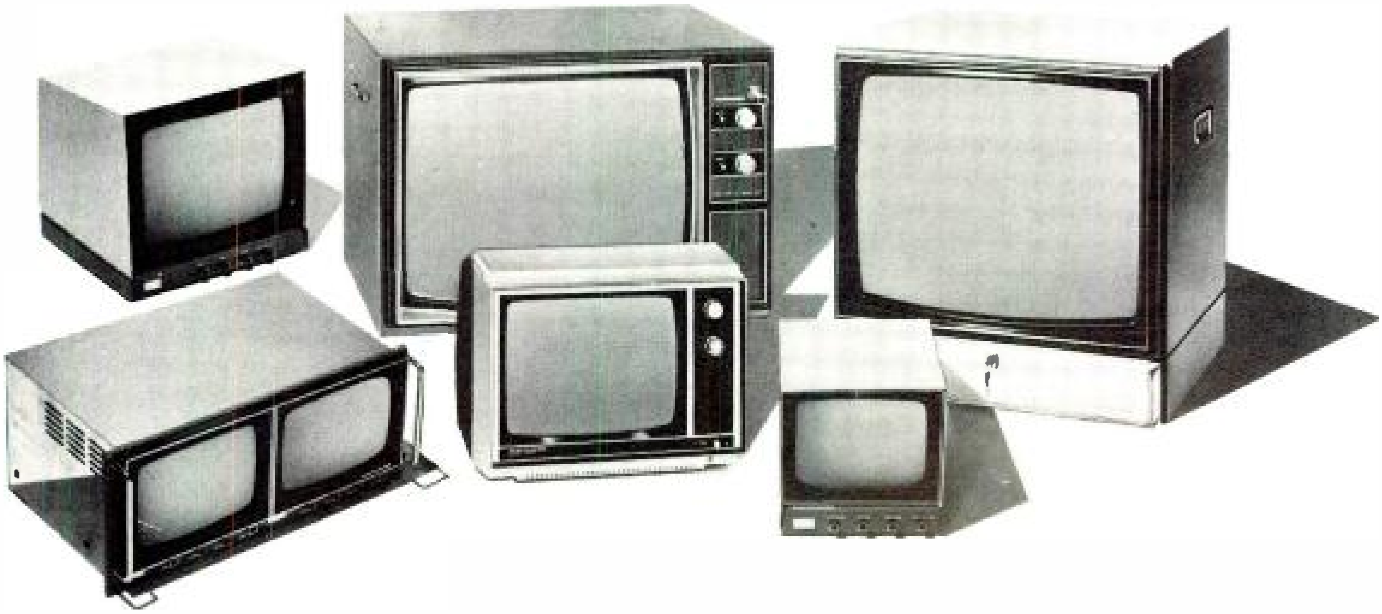

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band theory in the new C.C.A. SG1E stereo generator.

In the case of C.C.A. stereo generators, it is interesting to note that the previous C.C.A. stereo generator did employ both 15 kHz low pass and a very sharp 19 kHz notch in a single Torotel filter network at the input of each audio channel. Then a direct reversal in design philosophy took place. Where the older C.C.A. units chopped the audio off at 16 kHz, the new generators are flat to 53 kHz.

Harris Broadcast Products (Gates Radio) is firmly committed to protecting the 19 kHz pilot, because their engineers feel that there is sufficient energy in the 19 kHz region, with highly processed audio inputs. Harris engineers feel that the 19 kHz notch is not audible and its presence forestalls interference in the stereo demodulators which regenerate the subcarrier by either doubling the pilot or synchronizing an oscillator to it.

The Harris TE-3 exciter uses the 19 kHz notch filter only and does not employ a 15 kHz low pass function. Also, since the notch filters in the TE-3 are only about 25 to 30 dB deep, the Harris design can be considered a mild alteration of the wideband approach.

The Moseley and Moseley/R.C.A. stereo generators use a low pass function with a very sharp 19 kHz notch.

While there may be a difference of opinion as to how audible the filtering may or may not be, the result of the 2 dB overshoot on modulation control cannot be disputed. Stations that feed highly compressed audio into a transmitter with the 19 kHz notch filter will find that the peak modulation level will be about two dB higher than expected because of this overshoot. Conversely, the use of the 19 kHz filter results in about a two dB loss of modulation capability, **if the input is highly processed and clipped.**

Program limiters that employ clippers which allow substantial square wave output to be fed to the transmitter can keep the filters excited for sufficiently long intervals to result in overmodulation. Obviously, normal audio will not produce the same effect unless the program material itself is clipped.

Rock operators find that the program material itself is often processed enough to make the overshoot a problem, even if the station's compression level is moderate. The wideband advocates say that their systems offer inherently superior performance in this respect and are quick to point to the higher modulation level that can be achieved.

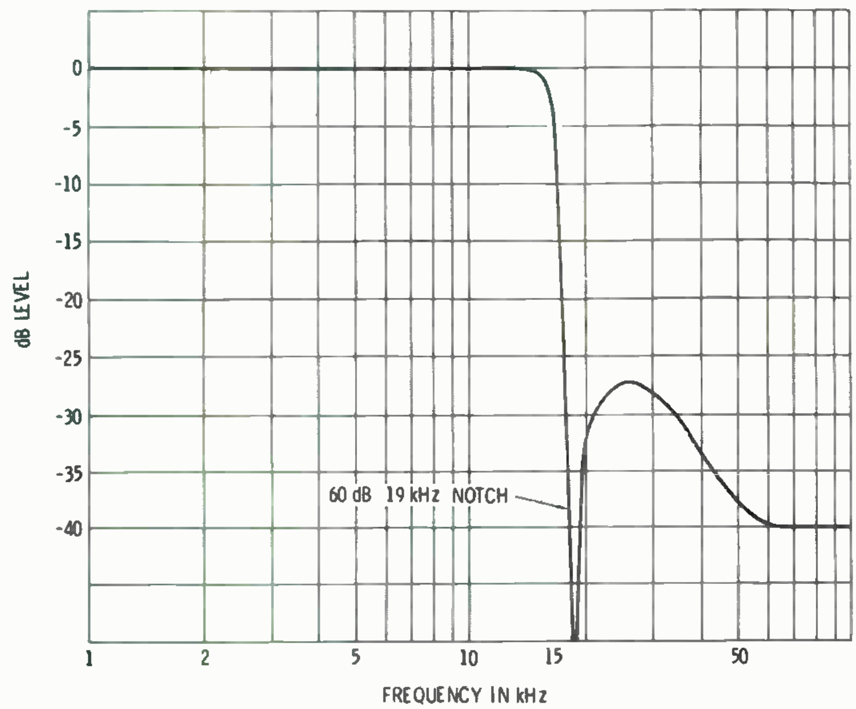

Fig. 2 Frequency response of a 15 kHz low pass filter with 19 kHz notch.

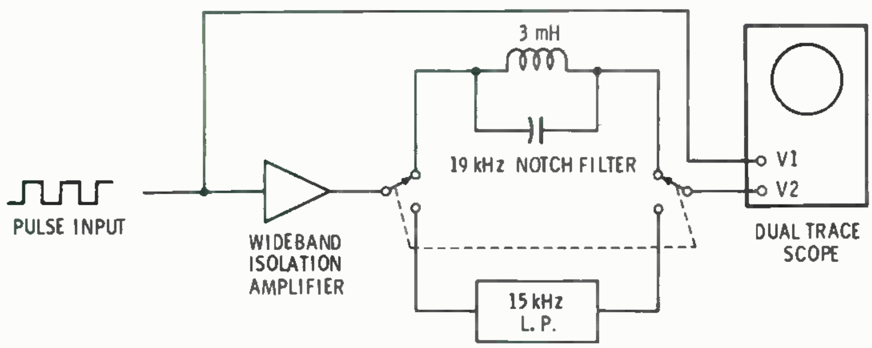

Fig. 3 This is a simplified diagram of a test setup to check the affect of 19 kHz notch and 15 kHz low pass filters on transient response.

Looking At Both Sides

To better understand both sides of the controversy, it is necessary to take a closer look at all of the factors involved.

First of all, you have to appreciate the fact that pre-recorded musical program material usually contains very little energy above 12 kHz, which lends credibility to the wideband theorists who say that there isn't enough energy left in the 19 kHz pilot region to cause any malfunctioning of the receiver's demodulator circuitry. But, if this is true, how would we find any fast rise time signal components in that program material that would benefit from frequency response beyond the normal audible range? If, however, the 75 usec. pre-emphasis curve is allowed to continue unattenuated out past 15 kHz and right

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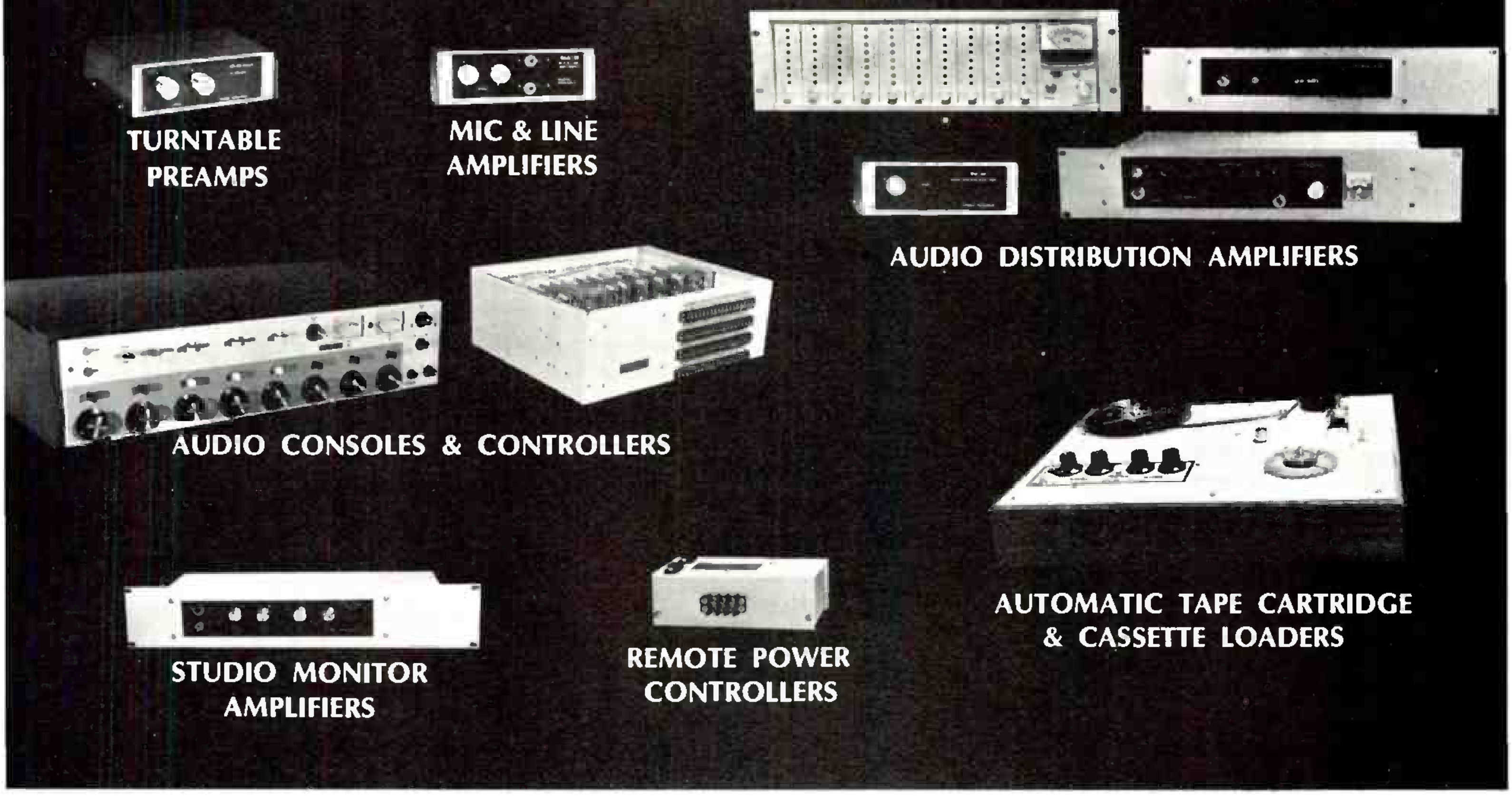

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up to 19 kHz, will this degree of high frequency boost bring the hypersonic components up to a high enough level to compete with the stereo pilot?

To accurately view the effect of the various response shaping circuits in the transmitter, one must consider the transmitter and receiver to be a closed loop: a single system with an overall response characteristic. Assuming that the transmitter and receiver complimentary 75 usec. pre and de-emphasis alone would cause some rounding. This is the situation that the wideband folks try to attain.

If we want to take a look at the spectral distribution of the program material, the same considerations apply, except that the 19 kHz pilot is processed **before** the receiver de-emphasis circuits, so, the demodulator must work with the pre-emphasized audio.

Stereo generators with a moderate 19 kHz notch have just about enough attenuation to make up for the pre-emphasis and bring the program peaks back down to their original amplitude. The units with very sharp 50 to 60 dB notches cancel the pre-emphasis and yield another 20 to 30 DB of 19 kHz rejections to boot. The sharper filters exhibit more waveform distortion with pulse inputs, however, so we begin to see where we have opened up a real can of worms.

Protect the Pilot?

Should we protect the pilot? If so, should we simply protect it from the pre-emphasis effect on hypersonic components or should we go all the way and completely clean up our act at 19 kHz? If we do introduce some filtering, what will its audible effects be, and if we don't, what will the audible results be?

Then there's the question of the modulation robbing overshoot. If the pilot must be protected, one of two things must be done: either great care must be taken to see that only clean audio with as little waveform clipping as possible is fed into the system, or else some method of notching 19 kHz without producing an overshoot with an input at the third sub-harmonic frequency must be found. Another alternative would be to allow for the overshoot and adjust the station's modulation limit accordingly.

Stations that do not employ a great deal of audio processing usually find the overshoot to occur for such short time periods that it is not a factor, with respect to overmodulation, and are able to run at normal levels since very little energy will fall into the skirt area of the notch where the phase shift can cause an overshoot.

One must also consider how the audio will be fed to the transmitter.

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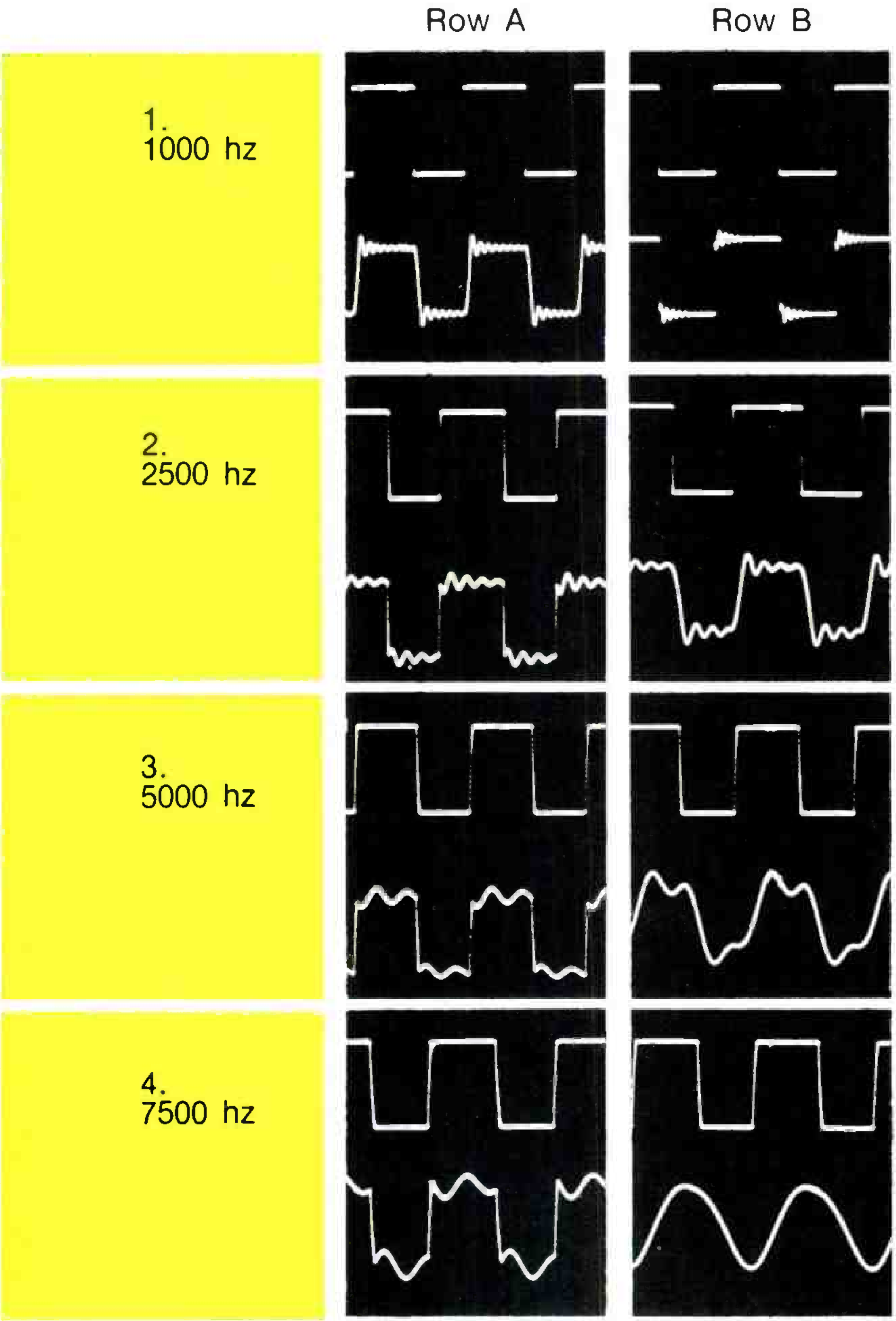

Fig. 4. These dual trace photos illustrate the waveform distortion that can be expected from each type of filter circuit. In each case, the top trace is the input signal and the bottom trace is filter output. Row "A" is for the 19 KHZ notch circuit and row "B" is for the 15 KHZ low pass filter which also includes a very sharp 19 KHZ notch. Input frequencies are as follows: 1. 1000 hz, 2. 2500 hz, 3. 5000 hz and 4. 7500 hz. The higher frequency traces have been expanded to the same scale as the 1000 hz traces so that comparisons can more readily be made.

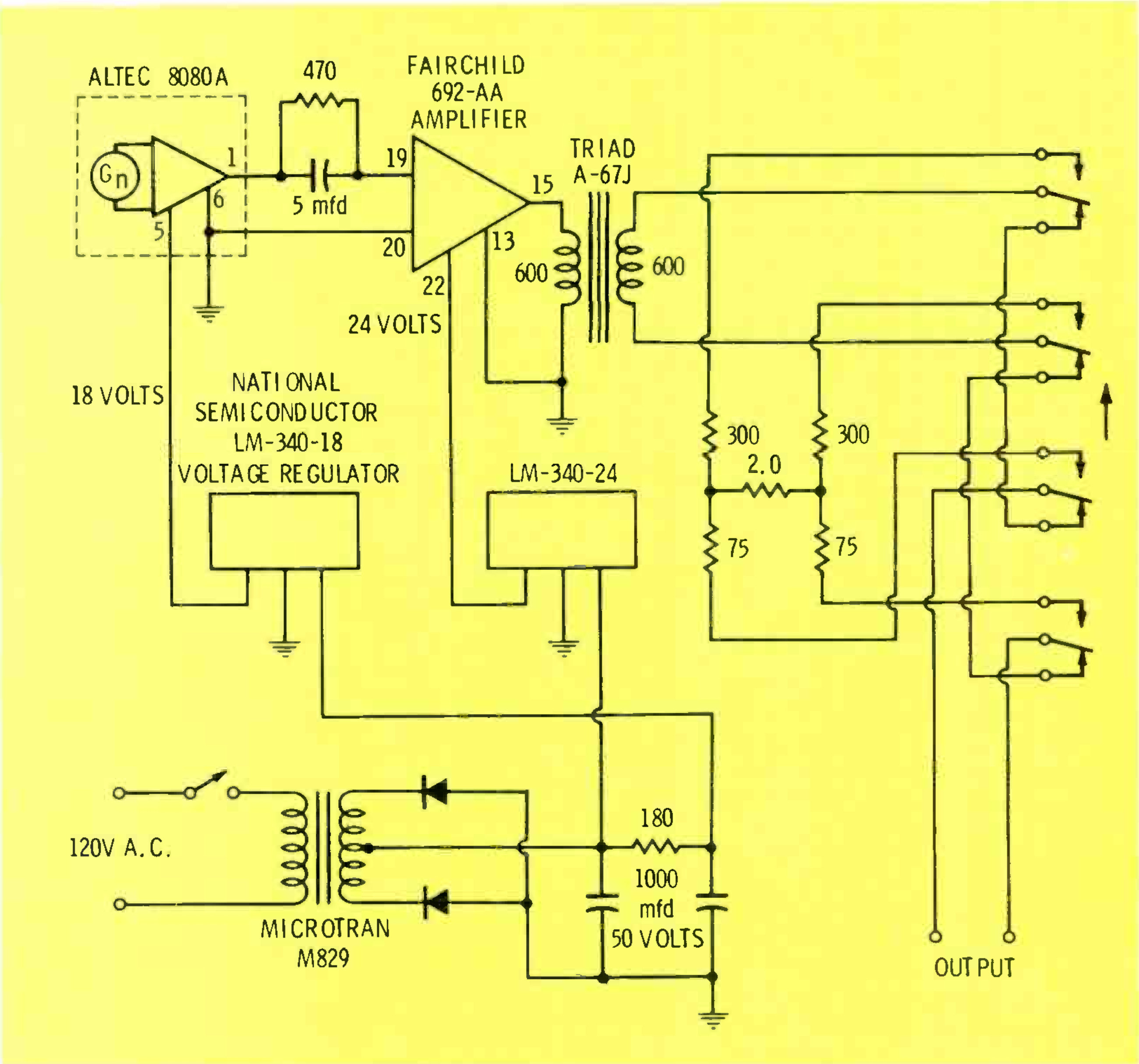

Fig. 1 This is the schematic for the pink noise generator.

Taking The Drudgery Out Of Audio Tests

By Elmo Reed

VP, Engineering,
Broadcast Div.,
Post Corporation.

A new test instrument has recently appeared on the market that greatly speeds up and takes the drudgery out of audio frequency measurements. The instrument is the Real Time Analyzer and, when used in conjunction with a Pink Noise Generator, makes it possible to check the frequency response of amplifiers, tape machines, and telephone lines in a fraction of the time required by the conventional point by point method using an audio oscillator.

Although not quite as accurate as the oscillator/VU meter method, it is accurate enough for quick checks where many systems are involved and one is interested in learning whether there has been any variation since the last check. The results can be obtained to an accuracy of plus or minus one dB, and we feel this is sufficiently accurate for quick routine checking.

From White To Pink

The instrument we use at Post Corporation stations is the Altec Lansing Model 8050A which is manufactured by Hewlett Packard. The signal source is the Altec Lansing Model 8080A Pink Noise generator. The heart of the generator is a circuit for generating white noise, or random noise, as it is sometime called. White noise is the sound one hears when tuning between stations on an FM receiver. It is generated by a reverse bias diode and then amplified to produce a useable output level.

White noise is random in nature, and, therefore, covers all frequencies in the audio spectrum. It has equal energy level at all frequencies, and if viewed on the oscillo-

scope of the real time analyzer, where the audio spectrum is broken down into one-third octave segments, the response will show a 3 dB rise per octave. The white noise signal is, therefore, passed through a filter that has the reverse characteristics of the above, i.e., 3 dB attenuation per octave, and comes out of the generator as pink noise. The presentation on the scope now has a flat or uniform amplitude trace across the entire audio spectrum. Pink noise has equal energy within any octave or fraction thereof.

The Altec Pink Noise Generator did not have sufficient output to meet our requirement, so we combined the generator, power supply and Fairchild Model 692AA transistor amplifier into a small cabinet as shown in the photo. We felt it was necessary to have plus 8 dBm at 600 ohms for feeding tape recorders, telephone lines, line amplifiers, etc., and minus 50 dBm at 150 ohms for feeding low level microphone inputs.

The diagram of the complete Pink Noise Generator is fed through a highpass filter to compensate for a slight rise in response that we had at the low frequency end of the spectrum.

From the filter it is coupled into the Fairchild amplifier. The output of the amplifier, with an unbalanced output, is coupled into a

The author using a real time analyzer and a pink noise generator to speed check the frequency response of a tape machine.

Closeup of the pink noise generator and the audio analyzer.

600/600 ohm transformer for a balanced output and from there into the attenuator and switch so that the various output levels can be obtained. The power supply is conventional, with solid state voltage regulators for obtaining the two different operating voltages.

The Display

The display device for the system is a real time analyzer. The instrument covers the frequency range from 40 Hz to 16 kHz. The incoming signal, after amplification is passed on to 27 parallel band pass filters spaced at one-third octave intervals across the 40 Hz to 16 kHz spectrum. Detectors following the filters then convert the ac filter output to dc levels proportional to the rms value of the ac signals. A scanning circuit then sequentially connects the 27 detector outputs to the CRT screen in terms of level against frequency.

All 27 channels are scanned in 22 ms. A logarithmic amplifier is interposed in each filter output to convert the voltages to signals that can be displayed on a db scale. Variations of input signal level of plus or minus 10 db for each of the 27 channels can be read from the scope presentation. The input signal range varies from 3.16mv to 3.16 volts in two bands.

Rapid Response

We have found many uses for the instruments, one of the most important being the rapid checking of the frequency response of the audio tape machines and the audio portion of video tape machines. In making the check, a recording of approximately 15 seconds is made of pink noise and then the tape is played back while viewing the output on the real time analyzer. Within just a few seconds it is possible to ascertain whether there is any deviation from the correct or flat response.

In machines equipped with a separate playback head and amplifier, and where the frequency response of the playback system is known to be correct, it is possible to make adjustments on the record bias and equalization while simultaneously recording and playing back pink noise. Also, if one has a record system with a known correct frequency response, a few minutes of pink noise can be recorded and this tape then used to check the frequency response of all tape play back systems.

A cartridge of pink noise can be retained and used to check play-back machines at frequent intervals. In this manner it is easy to check the condition of the playback heads and at the same time touch up the equalization controls if needed.

Equalizing Telco Lines

Another use for the equipment is in the equalization of telephone lines. We recently equalized a non-loaded line connecting our studio in Chippewa Falls with our studio in Eau Claire, Wisconsin, a distance of approximately ten miles. With the pink noise generator located at the sending end and with the real time analyzer and line equalizer at the other end, it was possible to equalize the line in a few minutes. Each change in the value of resistance or capacitance in the equalizer is noted instantaneously throughout the entire audio spectrum and, as a result, it is possible to complete the equalization in a fraction of the time required by the point-by-point method using an audio oscillator and vu meter.

We have put the equipment to good use in fast checks of the complete audio facilities of our TV and radio stations. With the real time analyzer connected to the line output and with all of the keys on the console placed in the "on" position, it is possible to connect the pink noise generator by means of a patch cord and jack field into each input channel in turn and within a few seconds ascertain the overall system response.

Post Corporation either has or is in the process of installing remote control operation for its television transmitters. With the off-the-air demodulator located at the studio, we have checked the overall audio system by inserting pink noise into a microphone input at the studio and then viewing the system response by feeding the real time analyzer with the audio output from the demodulator.

We feel that the system described greatly facilitates audio frequency response checks and results in more frequent observation of our audio performance, something that is often neglected in a television station. □

Transient Response

Continued from page 42

If telco loops are used, the response past 15 kHz will usually fall off very rapidly, so, a square wave over 6 or 7 kHz will begin to be integrated into sine wave anyway. If this is the case at your facility, the whole situation is very much simplified: no square waves are ever going to tickle the input of your transmitter. If the studio is located at the transmitter site and a direct audio hook-up is employed, or if you are feeding a composite signal over an S.T.L., the transmitter will see pulse inputs as sharp as your studio equipment can pass.

The Plot Gets Thicker

Thus far we have considered what happens to a simple main carrier square wave input. Now let's consider the fate of a left only input.

An input into the left channel would require a L+R and L—R generation, the L—R appearing in the suppressed carrier, 38 kHz double sideband subcarrier. The

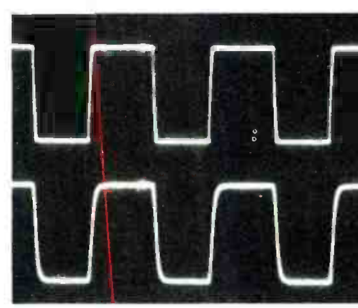

Fig. 5. 7500 Hz input and output for system with flat response to 50 kHz and a 10 dB roll-off at 100 kHz. Note that with the exception of some slight rounding, the waveform is intact.

upper sideband of the subcarrier is limited to 53 kHz (38 + 15 kHz) and the first S.C.A. appears at 67 kHz. So, now we have the decision of whether to use filtering to cut off

Continued on page 57

DECEMBER, 1975

CABLE ENGINEERING

COLOR BARS REALLY CAN HELP

By Oliver Berliner, *Ultra Audio*

More than two-dozen years ago, when cablemen were in another business or perhaps going to school, television was such a novelty that people would actually sit and stare at test-patterns (remember the traditional old Indian-head pattern with the 1 kHz tone accompanying it?). That test signal was there to not only help the TV station test an tune its equipment, but to (supposedly) assure the viewer that his TV was working properly, and to assist him in setting fine-tuning, brightness and contrast.

As sets improved, viewers became more experienced, and program volume increased, such test-signals all but disappeared, and are now available only intermittently and late at night . . . usually in the form of staircase, colorbars or multiburst.

But the advent of color, the emergence of hard-to-tune UHF stations, and the practicality of community-antenna television have reintroduced the need for transmission of test signals often, or continuously, and at convenient hours. These test-signals could not only inform the viewer as to whether he's experiencing difficulty with **his** TV, the cable system, or the TV station he's watching. If the viewer could reach the right conclusion, he could then avoid blaming you, the cable TV operator, for troubles not created by the cable network.

However, test-patterns do the viewer (and you) no good unless he knows how to interpret them. There are two ways to inform him of this valuable service. You can enclose a descriptive flyer with your monthly bill. Do this twice a year. And, you can transmit instructions that he can see in conjunction with the test-patterns. You should really do both.

Colorbar Tests

The most important single test signal you can transmit today, as far as your viewers are concerned, is **colorbars.** I have been in innumerable homes, including those of various entertainers who are (supposedly) more critical when it comes to their sets' display, and have been horrified to find color levels, phasing ("tint"), brightness and contrast all wrong.

Sadly, they seem content to live with it that way; but I like to think it's because they haven't tried for anything better. Incidentally, one of the gravest, yet most common, mistakes is to let light "spill" onto the kinescope. This type of light will reduce contrast and will affect colorimetry. Warn your viewers about the bad effects of improper viewing conditions. They'll be grateful you did. And don't forget that a receiver's colorimetry changes frequently, so transmissions should be daily.

The Staircase

The second-most important test signal for your viewers' purpose is 10-step **staircase** with each of the ten steps, of course, differing in intensity from the adjacent two by ten percent. Usually, the first step is 10 IRE Units of video (in effect—black), the last is 100 IRE (highest level-white). Some "step" generators reverse the staircase sequence. By the way, these devices are correctly designated as staircase generators or (the slang) step generators. They are sometimes incorrectly referred to as "stairstep" generators, which is redundant and wrong.

You can use these step and bars generators to great advantage in your own studio for equipment checkout and setup of your color and monochrome monitors. There are available generators that present what is known as **split-field** colorbars. These devices display simultaneously not only colorbars but also I and Q signals (these are "NTSC Standard" bars) plus a 5-step staircase pattern. Split-field is excellent, but offers some important disadvantages:

1. These generators are quite expensive. Separate full-field colorbars and staircase generators may actually total less than the cost of a single split-field generator.
2. With all patterns created by one device, you lose everything in the event it fails.
3. The staircase portion offers only 5 steps which are often too difficult for the non-professional to use to set his Brightness and Contrast properly. The 10 steps are easier to work with (besides offering a more critical test of the equipment involved, plus the fact that they would be full-field). (However, split-field is excellent for **your** use in checking luminance-chrominance cross-modulation.)
4. The split-field display does not lend itself to superimposing instructions to the viewer over the display, because there just isn't room.

Other Test Signals

There are, of course, other valuable test signals, such as 2T +

window, but these are for use by experienced technicians and are too sophisticated for televiewers. Even if your cable customers could interpret these displays, they would be hard put to do anything about it, anyway. For example, if they detected **ringing** in their receivers, it would probably be impossible for a repairman to get rid of it.

So, your best bet is to start with an inexpensive full-field colorbars generator. In fact, the right product will have a **chromakiller** provision so that it can generate unmodulated bars which are, in effect, 8 non-linear shades of grey, starting with white and ending in black. If you go this route, here's what you do.

First, enclose a semi-detailed non-technical description of your colorbars pattern with your monthly subscriber billings. Tell your subscribers that during certain hours of the day you will be transmitting colorbars on a spare channel you've set aside for this purpose. Explain

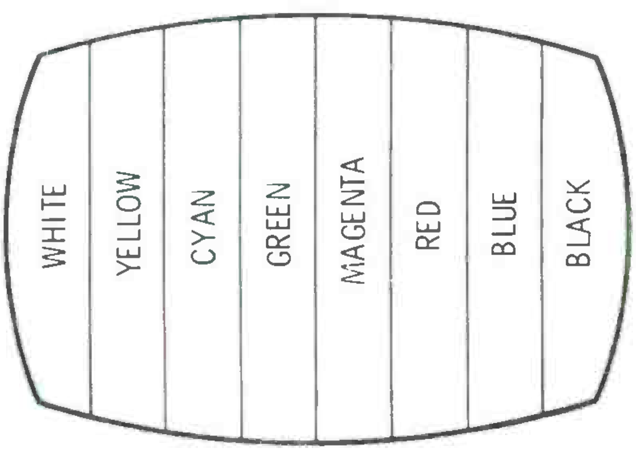

Figure 1

that by adjusting the color level and tint controls on his receiver, the viewer can make studio-type adjustments to his TV which will improve picture reproduction. (Don't forget to also discuss the previously mentioned matter of room lighting.) Include a drawing of a TV screen (Figure 1) with the 8 colorbars marked, from left to right: WHITE-YELLOW-CYAN (blue-green) -GREEN-RED-MAGENTA-BLUE-BLACK. Tell the viewers to adjust both Color and Tint controls until these colors appear in **this sequence.** Explain that improper phasing (tint) will alter these colors and degrade viewing pleasure.

Second, prepare 2 TV "billboards," such as those shown in Figure 2. You'll notice that I've shown the listing of the colors in the lower-half of the raster (2b), only. By printing your key-camera titlecard in this fashion, you can first show Billboard 2A, then Billboard 2B, then switch-in the colorbars, then (if you desire) key-in the color listing over the colorbars themselves. This will remind the viewer of what colors to set up for, in case he's forgotten or mislaid your mailer.

After, say, two minutes of bars, repeat Billboard 2A and 2B and the entire procedure. After another two minutes do it one more time and this time leave the colorbars on for an hour . . . or all day, if you wish.

The white and black bars will, theoretically, permit contrast and brightness setting. But unfortunately, most viewers cannot be expected to grasp this; so your colorbars procedure should be preceded with staircase and its instructions, such as the billboard of Figure 3. Use the presentation format described for the colorbars. Of course, you will have to alter the description if you use your bars generator, with chroma off, to create your (non-linear) staircase pattern. By turning your chroma off, you avoid the problem created by your viewers' failure to do so on their receivers during the Brightness/Contrast-setting interval.

These test-signals will prove most helpful to your field-service technicians both in the case of hooking-up new subscribers and in the checking of your many cable-amplifiers. Coupled with their use in your studio, they help create an atmosphere of viewer confidence while permitting many of your subscribers to determine for themselves the condition of the video you're providing them along with their receivers' performance. Thus this modest investment can repay you manyfold.

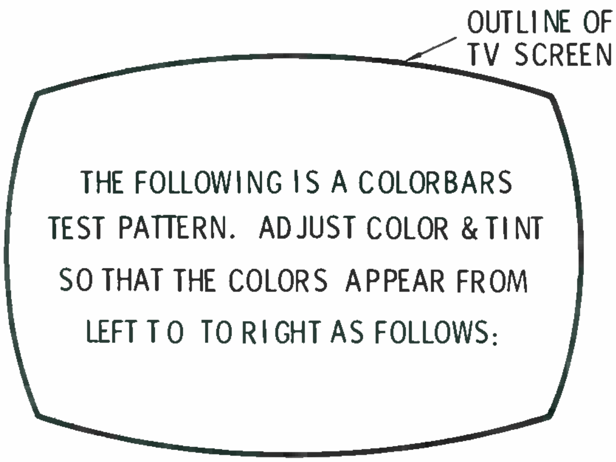

Figure 2a

Figure 2b

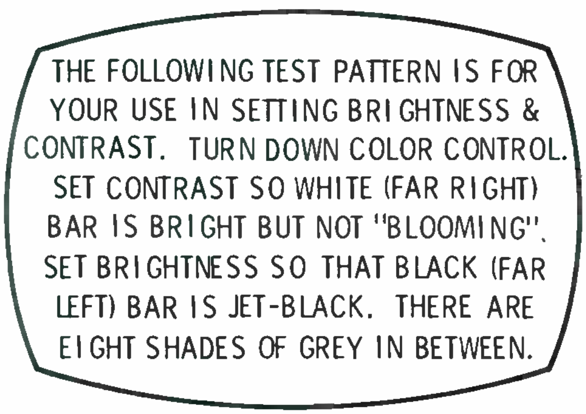

Figure 3

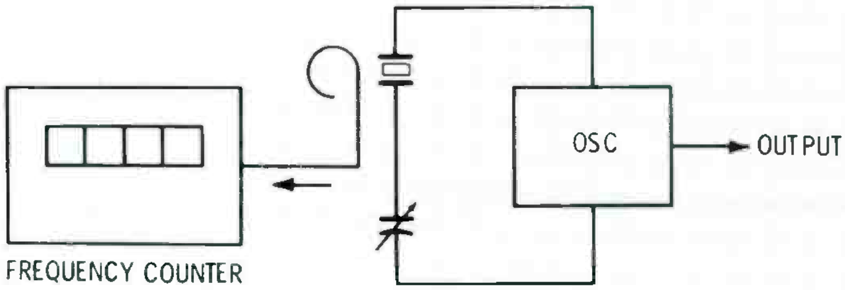

Fig. 5 When testing a crystal oscillator, couple close to the crystal itself. Then you can determine the actual frequency. When some counters indicate digits are in the overflow circuitry, the readouts will give a reading of digits after the decimal, adding to the unit's capability.

(Continued from page 30)

traps and filters, require accurate test signals to adjust them correctly. Most signal generators do not have accurate dials. The counter can measure the signal out of the generator and the generator can be adjusted so that the required signal is exactly on frequency. Leave the counter coupled to the generator while making the adjustments to the traps, in case the generator is not too stable. But with RF type circuits in the receivers, make sure there are no signals radiated from the counter local oscillator that can be picked up and mistaken for one from the signal generator.

Summary

If your station has many carriers that require measurement according to FCC Rules, you should use a frequency counter, but the instrument must be accurate, stable and calibrated. Once you have a counter, you'll find a bonus in its endless uses in maintenance where accurate frequency measurements will help keep the equipment operating at peak performance. □

SBE

(Continued from page 16)

Pittston. The speaker, Mr. Oded Ben-Dov, an engineer from RCA's research and development lab, spoke on the future of TV and FM broadcasting, especially as it relates to the use of circularly polarized FM and TV transmitting antennas. Mr. Ben-Dov traced the development of the broadcast transmitting antenna from the superturnstile state to the present. *John Kowalchick (Chairman) RCA Solid State Division, Crestwood Rd., Mountaintop, Pennsylvania 18707, (717) 474-6761.*

Chapter 15: New York City

Chapter 15 met October 9 at the WQXR Presentation Theater to hear Mr. Mark Schubin, technological consultant at the Lincoln Center for the Performing Arts. Mr. Schubin gave a slide presentation and spoke on new developments and the state of the art of television as it affects both the manufacturer and consumer. *John Lyons (Chairman) WWRL Radio, 41-30 58th Street, Woodside, New York 11377, (212) 335-1600.*

Chapter 36: San Diego, Calif.

The San Diego Chapter met on October 23 at KFMB-TV8 to participate in a program on "audio problems and solutions and the impossible situations we have in commercial broadcasting." Heading the discussion was Mr. Charles Able who led the group in answering questions and resolving problems. *Bob Boulio (Chairman) 6841 Convoy Court, San Diego, California 92111.*

Chapter 37: Washington, D.C./ Alexandria, Va.

This new Chapter is also growing rapidly. Their October meeting was held at the U.S. Information Agency in Washington, D.C., where Mr. W. Mitchum led members on an extensive tour of the USIA radio and television facilities. A business meeting followed to discuss the election of officers. *Charles Riley (Chairman) Tele-Color Productions, 708 N. West Street, Alexandria, Virginia 22314, (703) 683-3203.*

PEOPLE IN THE NEWS

On the 31st of December, **Robert W. Sarnoff** will step down as Chairman and member of the board at RCA. **Anthony L. Conrad** has been designated President and Chief Executive officer. Sarnoff will receive the Electronic Industries Association (EIA) 1976 medal of honor at a meeting to be held in March.... On the other coast, **Nyal McMullin** has been named President of Consolidated Video Systems by the board of directors. In an earlier move at CVS, **Harry Mueller** was appointed Director of Manufacturing....

Datatron's President, **Clyde J. Davis,** announces that **Herbert Perkins** has been elected a vice president. Perkins had been general manager of the editing systems division of Datatron....

Following a prolonged illness, **George A. Sauppe,** co-founder of Spindler & Sauppe, died in his sleep at the age of 88. Known for his "firsts" in the A-V industry, his last major development was the first random access slide projector....

Robert Hawkins has been appointed national sales manager, professional products, of Sharp Electronics Corp. Hawkins formerly worked with Sony and General Telephone in Michigan....At TEAC Corporation of America, **Allen Novick** is now the national sales director, and **John Bennett** is their new director of operations....

Louis Siracusano has joined A.F. Associates as Vice President-Sales. Siracusano was formerly a sales engineer with Ampex....3M's board of directors has elected two new group vice presidents. They are **Allan Huber** and **Allen Jacobsen.** Jacobsen was elected VP of the Tape and Allied Products Group.

Mike Snyder has joined the engineering staff of New Jersey Public Television. He previously was with the Kentucky Educational Television Network....**Lee Whitehurst** has drawn the assignment of Technical Director of WSM-TV, Nashville, Tenn....And as of December 1, **Stanley Mouse** became head of all Cox Broadcasting Corporation broadcast operations. Mouse joined CBC in 1945 as promotion manager of WHIO, Dayton....

If you have news of position changes in your station or operation, send details to The Editor, Broadcast Engineering, 1014 Wyandotte St., Kansas City, Mo. 64105.

Frederick DeTurk, President of Phelps Dodge Communications Company, has named **James F. Jennings, Jr.,** Executive VP, and **Albert Gallick** to the post of Sales Manager....

At press time . . . we learned that **Chuck Rockhill,** formerly regional sales manager for Sparta, has joined Time & Frequency Technology as national sales manager. Rockhill's first assignment will be to promote TFT's EBS equipment. . . .

NEW PRODUCTS

Two Tone EBS Package

McMartin Industries, Inc., can now provide complete EBS alerting capability for the new FCC two-tone attention system which must be in operation at all AM, FM and TM broadcast stations by April 15, 1976.

The FCC Type-Accepted Model TG-2/EBS Two Tone Generator meets the new encoder requirements in providing a minimum +8 dBm, 600 ohm output of the required 853 and 960 Hertz tones within ±0.2 Hertz tolerance. The tones are produced by digital logic division of a highly-stable crystal oscillator frequency source. Tone transmission duration is controlled by an automatic electronic timing device. The TG-2/EBS is designed for standard 19" rack mount.

An appropriate decoding system, conforming with the new FCC Rules, is comprised of either the McMartin Model AMR-1, AM; or Model FMR-1, FM, fixed frequency receivers used in conjunction with the FCC-certified Model EBS-2, Two Tone Decoder. The system is normally in a "muted" condition.

For More Details Circle (80) on Reply Card

Color Disc Recorder

The first "Instant Replay" color disc recorder under $10,000 has been introduced by **Eigen Video,** Grass Valley, California. The magnetic disc recorder can do jitter-free forward and reverse slow-motion as well as freeze-frame.

The recorder has a time capacity of

10 seconds, twice the length of an average football play, and a variable range of record/play rates from 60 fields per second down to still image. The signal to noise ration is greater than 46dB. The recorder uses standard video inputs and the output can be used directly in a non-broadcast application, or time-base corrected for broadcast use. The recorder locks to station vertical sync.

A TV studio could use the disc recorder not only for sports "Instant Replay," but also could add animation, time-lapse and electronic slides for titles, commercials and station promos. Any news show could add the "Instant Replay" effect to sports film and tape even though the original was shot at standard rates.

For More Details Circle (81) on Reply Card

UHF-VHF Antennas

Bogner Broadcast Equipment Corp. has omni-directional, 120 kW slot-director transmitting antennas that are already in use. They incorporate a very successful feed system that has been in the field for three years.

The dual inputs can each be used with a pair of 60 kW transmitters and can be alternatively operated with the combined 120 kW into either half of the antenna.

This line of VHF and UHF horizontally polarized antennas is also available for low cost on-site conversion to circular polarization.

For More Details Circle (82) on Reply Card

Studio Color Monitor

Unimedia announces a feature loaded studio color monitor.

The new SMT-12 includes Full-View Tally Identification, A-B Electronic Video Selection, Internal-External Sync Selector Switch, Keyed Back Porch Clamp with Full DC Restoration and Variable Aperture Control. A new set up switch allows the user to set color threshold and grey scale tracking.

The SMT-12 now features front panel doors for concealing secondary controls which include RGB background adjustments and variable aperture control on the right side. The left panel conceals hori-

For More Details Circle (39) on Reply Card

For More Details Circle (40) on Reply Card

zontal, vertical adjustments and the new set-up switch. Options such as pulse cross and underscan are accessible from behind the left side.

The SMT-12 has a new look about it with satin pewter anodized front panels and new extrusions mounted on the sides of the cabinet. Now available as an option with the new SMT-12 are Rack slides for ease in removing the unit from the rack.

Other models in the SMT series include 19-inch, 17-inch, 15-inch and 12-inch yoke mount and cabinet versions as well as a 9-inch portable.

For More Details Circle (83) on Reply Card

Tape Tension Meter

The control of tape tension in any VTR is important to the accurate timing of recorded and reproduced TV signals. It is particularly important in helical recorders which use a single head scan per field. The tension differential between the record and replay modes produced a very annoying effect at the top of the picture known as skew or flagging.

A very useful device to check and maintain proper tension levels in VTRs is made by **Tentel** and was tested by B.E.'s video editor.

The unit has a large scale calibrated in grams and ounces, two fixed and one movable pins extend from the bottom and are long enough to encompass all tape widths in common use today (quarter-inch to two inches.).

Inserted into the tape path, the meter reads the dynamic tape tension and the fluctuations that may be caused by mechanical defects.

Tested on an open Sony U-matic, the Tentelometer read a steady 80 grams at the entry point of the scanner. By manipulating the skew control away from its detented position to maximum and minimum conditions, the tension meter showed a range of 60 to 120 grams. This range is quite adequate to accommodate the nominal Sony recommended value of 90 grams for U-matic format tape tension. In addition, there was adequate control in case a poorly recorded tape needed to be played.

Inserted into the tape path after the exit guide, the gauge showed a reading of 20 grams.

The Tentelometer comes in a small foam-lined plastic case, has a clear set of instructions, can be easily calibrated, and is simple to use. It should prove to be a handy device for certifying proper VTR operation for owners of any magnetic recording equipment.

For More Details Circle (84) on Reply Card

Rugged Headphones

Radio stations looking for really rugged headphones will be interested in the **Television Equipment Associates** new Astrolite Hi-Fi phones, available either stereo double phone, or single side. The headphone has a frequency response of 50-15,000 Hz and impedance of 200 ohm (or, optionally 6,000 ohm).

The Astrolite stereo phone weighs only eight ounces and, like the range of the Astrolite headsets, is fabricated from practically unbreakable components such as all-nylon plastics (that won't break when you drop them), a steel headband with padded cover, and tinsel cable.

Astrolite offers a choice of ear-enveloping cushions or ventilated cushions which eliminate perspiration and accommodate eyeglass frames.

For More Details Circle (85) on Reply Card

Audio Switching And Patching Center

Russound/FMP, Inc., the switchbox people, announce their new portable audio patching center which allows small studios, broadcasters, and semi-pro recordists to connect all their accessory equipment together and to switch components for live recording, mixing, signal processing and dubbing in up to four channels.

The QT-1 solves the problem of interfacing multiple audio accessories such as outboard Dolby or dbx noise reduction devices, graphis equalizers, matrix (SQ, QS, RM) and CD-4 encoders and decoders, limiters and other signal processing units. The QT-1 provides the same flexibility expected of a hard wired studio patchbay.

The QT-1 audio switching and patching center has 72 RCA type phono jacks on the back panel which permit the user to simultaneously connect up to four tape recorders, plus other required accessories and leave them connected to the rear panel of the QT-1. All inter-connection functions may then be conveniently performed by front panel switching or changing patch cords just as is done with a permanent console patchbay.

For More Details Circle (86) on Reply Card

(Continued on page 60)

(Continued from page 37)

On negative peaks and up to carrier condition the Doherty acts as a conventional class *B* linear amplifier. On positive peaks, where the majority of the power is consumed, it functions as an impedance-modulated amplifier operating in class *C*. The amount of power supplied by each tube over the range from 100-percent negative modulation to 100-percent positive modulation is shown in Fig. 8.

In practice, two additional refinements to the theoretical quarter-wave transformer are necessary to make the system function. First, because the transformer follows the power amplifiers, it must have a power capacity of twice the carrier power of the transmitter. Unfortunately, a quarter-wavelength of 3-1/8-in line at 300 m is not easily realized. The transformer is therefore synthesized using a 90° π network.

Secondly, the 90° shift of either of these methods will cause the output of the carrier tube to lag that of the peak tube by 90°. To compensate, the input to the grid of the peak tube is delayed by 90° by similar means. The resulting Doherty amplifier appears in Fig. 9.

The comparatively recent availability of tetrode transmitting tubes with dissipation ratings in the tens of kilowatts has made possible the more efficient adaptation of the Doherty amplifier in use today. In this design, the control grids of both tubes are fed an essentially constant level of RF excitation. Control of the output level of each tube is accomplished by modulation of the screen grid voltage as in Fig. 10.

In this modified version, the proper operation of the system is not dependent upon the linearity of the control grid, and both tubes may be operated class *C*, yielding a high PA efficiency and also a comparatively high overall efficiency. The present 50-kW version of this system requires 120-kW total power input when modulated at 100 percent with a steady-state sine wave. Overall recovered RF feedback is also employed to linearize the system. ☐

Transient Response
(Continued from page 48)

the response at 53 kHz or rely on the natural distribution of energy to prevent the upper sideband of subcarrier from entering the S.C.A. passband.

The lower sideband (38 — 15 kHz = 23 kHz) is reaching down toward the 19 kHz pilot and similar considerations exist on this side of the subcarrier. You can see where the use of 15 kHz low pass filters right at the audio input of the stereo generator is, in many ways, a very attractive proposition. Limiting the input audio to 15 kHz right at the very start means that the L+R pass-band and the upper and lower sidebands of the 38 kHz subcarrier will be automatically limited and the pilot will be protected, all in one fell swoop. The design engineers who employ these filters in their stereo equipment obviously feel that these advantages outweigh the disadvantages that exist in the transient response department.

On the other hand, if we operate wideband up to 53 kHz and then cut off, the stereo demodulator will find itself adding square waves to sine waves because a pulse input will be faithfully reproduced in the L+R 15 kHz spectrum, but the upper sideband of the 38 kHz sub-carrier transmitting the L—R component will be limited by the 53 kHz filter to an audio response limit of 15 kHz, at least on the upper sideband. Remember, however, that when we talk about waveform distortion, we are looking at square wave inputs. The harmonic distortion is not affected, except that in the case of harmonics past 15 kHz, where the low pass filter actually reduces the total harmonic distortion.

Getting back to our demodulator, which was trying to add one faithful and one unfaithful square wave, the result is of course,

Transient Response

(Continued from page 57)

something less than a reproduction of the original square wave input. To get good transient response up to 53 kHz requires a bandpass extending to about 150 kHz, if we are talking about faithfully reproducing stereo audio inputs with square wave content up to about 6 to 7 kHz. The actual bandwidth requirement is rather flexible in that it is directly related to how much rounding of the waveform one is willing to tolerate. At any rate, if the response is allowed to continue out that far, the designer must feel very strongly that there will be very little energy to interfere with the pilot or subcarriers by virtue of natural spectral distribution.

Filter Effects Vs. Frequency

Figure 4 shows some oscilloscope photos of filter effects on square wave inputs at various audio frequencies. As you can see, the filters do result in quite a bit of waveform distortion **with pulse type inputs.** The big question is whether the human ear can actually hear these aberrations; one of the topics we'll investigate in Part 2 of this series. Another big question is whether the transmitter audio input will ever see any square waves of this type with program material for a signal source, which we will also investigate in Part 2.

Figure 5 shows a 7.5 kHz square wave as reproduced with a bandwidth function flat to 50 kHz and about 10 dB down at 100 kHz. Note that there is very little rounding, but also note that we have not begun to cut off until ten octaves above the frequency of the input signal. If you would like to test the transient response of your system, you will have to do more than simply tack a scope onto the audio line when you get to the transmitter. FM modulation monitors usually have 15 kHz low pass filters in the stereo section, so any test made in the audio circuits past these filters is not valid: at higher frequencies you will simply get a sine wave output with a square wave input no matter how good the transient response of the transmitter is.

You could use the composite output, but a de-emphasis network will have to be inserted between the monitor and scope to simulate the de-emphasis in the receiver. Connecting at the composite output will not give you any idea of what the stereo transient response is like because you're ahead of the demodulator. The easiest method is to use a good quality stereo tuner, keeping the modulation low to minimize the I.F. bandwidth required. Simply connect the scope to the left or right channel outputs, being careful to keep the cable capacitance low or use a low cap probe.

Be sure that the tuner you choose does not have any 19 kHz filters built in! Some receivers included these filters to prevent beats with the bias oscillators in tape recorders when recording FM programs. Modern tape gear has much higher bias frequencies and most of the newer tuners have the standard de-emphasis only, so you shouldn't have too much trouble finding a suitable unit.

Checking transient response in FM systems is a little complicated but well worth the effort. For instance, you may find that your transmitter is superior to your telco loops in this respect. A phase shift at the high end of the telco loop passband can result in overshoot, too, so if you really process your audio and want to transmit those clipped waveforms, you may want to look into a composite microwave transmission system. Or perhaps you're an audio perfectionist who believes in transmitting everything exactly as it was recorded, audible or not. On the other hand, maybe you're more concerned about optimum stereo decoding and would rather see the response take a dive at 16.5 kHz and not worry about interference with the pilot or S.C.A. In either case, there will be something of interest for you in Part 2 of our transient response investigation; CAN ANYONE FEEL MY PULSE? □

Products

(Continued from page 55)

Pulse Generator

Systron-Donner has introduced the Model 110C Pulse Generator featuring an output amplitude of 20 volts with a 5 nonosecond rise time. The output amplifier has independent controls for rise time, fall time, and voltage upper and lower levels, which may be set independently between +20 and - 20 volts. Output impedance is switchable to 50 or 1000 ohms and may be operated in a normal or complement mode. The complement mode allows negative pulses to be produced or simulation of pulses with duty cycles approaching 100 percent.

Repetition rate is variable from 0.5 Hz to 50 MHz. Delay and width are variable from 10 nsec. to 1 sec. Additional controls include external trigger, external drive, manual trigger, synchronous gating, asynchronous gating, square wave, and double pulse.

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Digital Multimeter

A built in provision for temperature measurements which can be made with an optional probe, is one of the features of the new compact digital multimeter announced by **Philips Test & Measuring Instruments, Inc.,** a subsidiary of North American Philips Corporation. Designated the PM2531, this new DMM offers a number of features.

The heart of the PM2531 is an LSI circuit which performs part of the analog circuit functions, the A/D conversion and the digital signal evaluation. The LSI chip reduces the total number of circuit components and is thus responsible for the compact dimensions, the low weight and the moderate cost of the instrument. The integrated circuit directly drives a bright, 3½ digit, seven segment 0.315 inch LED display with automatic decimal point. The display is recessed to be more readable even under high ambient light conditions. The instrument also features a polairty indication, as well as indication for range overloading and low battery loading.

The normal multimeter functions are selected by pushbuttons and the range is set by means of a rotary switch. The same input sockets are used for voltage and resistance measurements, so that for approximately 90% of the instruments use the leads do not need to be changed. AC and DC voltage are measured in 5 ranges each from 0.1 to 600V and 0.1 to 1000V, respectively.

Resolution is 100uV in the 0.1 V range and accuracy is ±0.2% fsd ±0.3% rdg for DC and ±0.2% fsd ±1% rdg for AC. Errors due to the instrument loading the circuit under test are eliminated by the highinput impedance of 10 MOhms. Five AC and DC current ranges extend from 100 uA to 1 A fsd, with a resolution of 100 uA in int lowest range.

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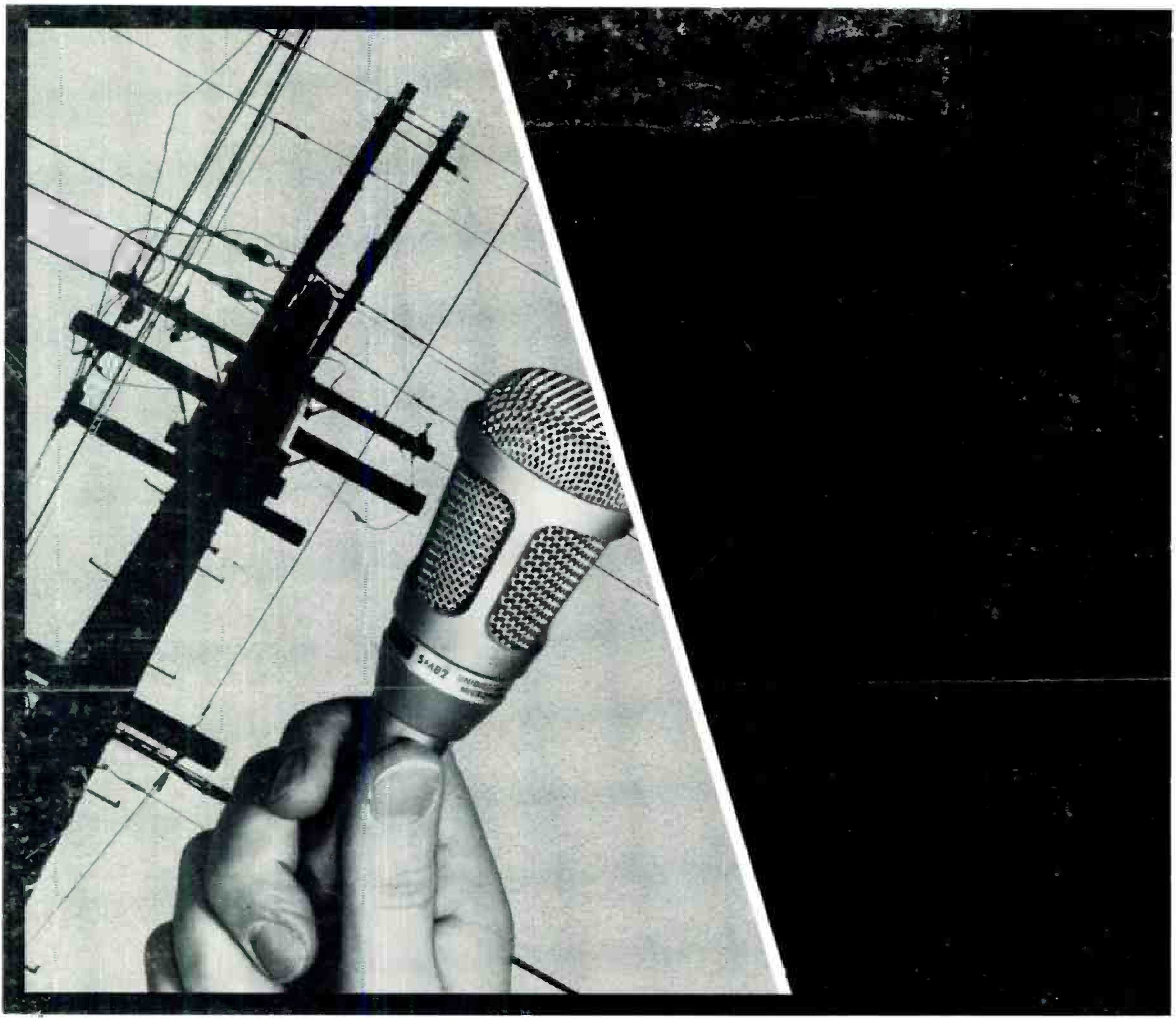

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