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A diagnostic machine which can identify the precise defective component would be the perfect Christmas gift for most technicians. Photo by Carl Babcoke.

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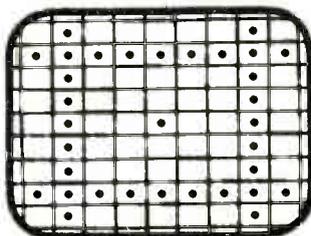


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news of the industry

Harold S. Geneen, chairman and chief executive of International Telephone and Telegraph Corporation, and Richard Rodgers, noted composer, were presented recently with the 1976 Communications Awards of the ICD Rehabilitation and Research Center. These quotations are taken from Mr. Geneen's acceptance remarks: "...we stand on the threshold of three very new technological developments...these are LSI (large-scale integrated circuits)...fiber optics, and PCM (pulse-code modulations)...For those of you who own a pocket electronic calculator, there is a small logic chip in it, which is its heart and brains...If the equivalent of this chip were made 15 years ago, it would have weighed a full ton, and would have cost over a million dollars. That chip now sells for about \$5...Let me point out that the human brain is a marvel of computer application...It has a memory capacity of about one billion bits of information...it weighs about three pounds and operates on one watt of power...it is one of the few complex objects readily reproducible by comparatively unskilled labor...if we had attempted to make an equivalent of the human brain in the tube technology of only 20 years ago, it probably would have required a computer the size of a block-square building 20 stories high, an electrical generating station to power it, and the East River to cool it. One human brain! But by 1985...we will be able to equal this human brain at both a reasonable cost and of a size not much different from the actual brain itself. But information of itself is of little value unless it is communicated to people...two bundles of optical fibers, each fiber the size of a violin string, would have the capacity to carry all of the telephone calls originated by the entire population of New York City!...And along with it is PCM, which also opens up the application of mass, cheap transportation of information over all presently-existing channels...we are on the threshold of a tremendous ability both to create brain power economically and to transmit the resultant information in the cheapest possible fashion, and for the first time mankind will have at his beck and call something beyond even the talents of the fabled genie of the Arabian Nights."

New features of the 1977 Zenith TV line include an automatic picture-control system, which adjusts five circuits. A light sensor regulates the picture brightness according to the room light level. The EFL gun in the picture tube has four electron lens elements (rather than the conventional two), and it's said this produces a beam size as much as 60% smaller. Some receivers have the Touch-Command channel-selection system in conjunction with the Electronic Video Guard tuning system.

Fred Wellner, general manager of General Electric's TV Department, predicts an increase in color-television sales to 8.5 million in 1976. Although GE is expected to have a successful year, Japanese competition is growing, and could push an important, unnamed U.S. television manufacturer out of the market, according to **Retailing Home Furnishings**. The U.S. television manufacturers have not been able to raise prices even though production costs (which comprise 50% of total costs) have increased greatly. Consequently, the industry has attempted to increase the per-unit selling price by emphasizing consoles. The 25-inch-screen size now accounts for 50% of the dollar totals.

(Continued on page 6)

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*Limited Warranty, naturally.
It doesn't cover labor for replacing a tube.

GTE SYLVANIA

GTE Sylvania, Electronic Components Group, 100 First Ave., Waltham, MA. 02154

(Continued from page 4)

Central Tuner Service has become PTS Electronics' newest service center. Roland Nobis, president of PTS, announced that Les Bertolini will remain general manager of the new PTS branch in Berkeley, Illinois. There now are 42 PTS Electronics service center branches in the United States and Canada.

Sony Corporation is being sued by Universal City Studios and Walt Disney Productions for copyright infringement because of the Betamax video cassette recorder. The Betamax can record a program on one television channel while a different program is being viewed, or it can record while the owner is away from home. The plaintiffs claim their TV contracts will become endangered if consumers build a film library and have no further desire to watch TV. Sony counters that the Betamax is a "time-shift" machine which should enlarge the TV audience, and thus not harm the entertainment industry. Harvey L. Schein, president of the American subsidiary of Sony Corporation has stated, "We do not believe that the copyright law was intended to prevent members of the public from deciding how and when they see the television programs which are beamed into their homes. With Betamax, the consumer gets the opportunity to see programs that otherwise would be missed. We are confident that Sony will be successful in defeating this lawsuit." In comments about the suit, **Electronic News** reminded us that Congress in 1972 passed an amendment to the copyright law which exempted home audio recording.

The home microwave-oven industry is expecting 1976 to be its biggest record-breaking year, with a forecasted increase in sales of 60% over 1975.

Double-sideband AM marine radiotelephones, of the kind recreational and professional mariners have used for the past 50 years, will become illegal after January 1, 1977. Replacing the old radiotelephones are two superior radio systems. The VHF/FM radiotelephone, for short range communications, provides static-free service. Because they travel in straight lines the frequencies are limited to line-of-sight, which minimizes interference from distant stations and does not require a ground plate on the boat. The boat-owner can add a single-sideband (SSB) radiotelephone for long range communications. Conversations over hundreds of miles at sea are possible using a modest amount of power. SSB systems operate over the medium-and-high-frequency marine bands.

ITT Space Communications has introduced a satellite communications earth station for cable television systems. Complete with all key features, the new receive-only stations offer both the small-aperture (4.5 meter) system and the standard 10/11-meter system. Besides full systems provisioning, ITTSPC offers Earth Station TV Receivers for CATV operations. The TVR 3700 series receiver is available in several versions, including the model 2016 which uses a single-conversion down-converter.

Switchcraft, Inc. will become a subsidiary of the Raytheon Company in early 1977. The company will retain its present personnel and facilities in Chicago and Paxton, Illinois. Switchcraft manufactures more than 6000 different electro-mechanical components. □

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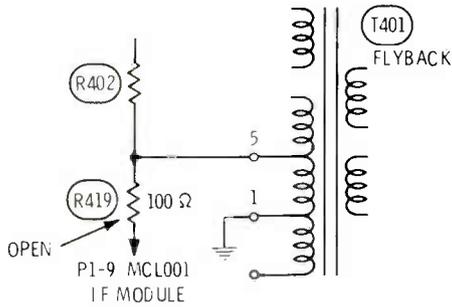
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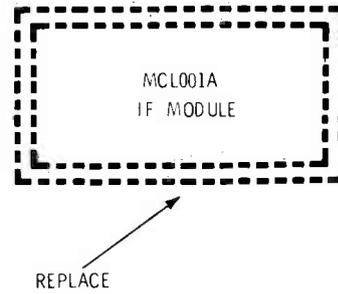
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Chassis—RCA CTC74
PHOTOFACT—1588-1



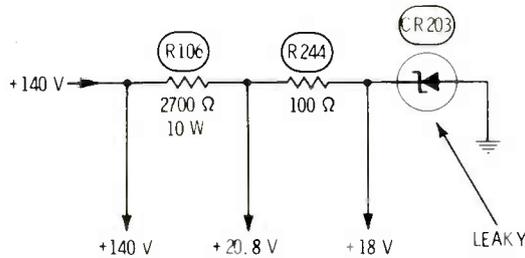
Symptom—AGC overload, no locking
Cure—Check R419, and replace it if open

Chassis—RCA CTC74
PHOTOFACT—1588-1



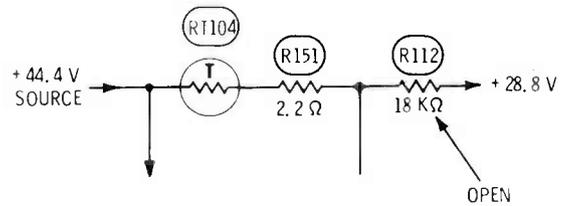
Symptom—Upper-left corner of raster is dark
Cure—Replace the MCL001A module

Chassis—RCA CTC51
PHOTOFACT—1201-1



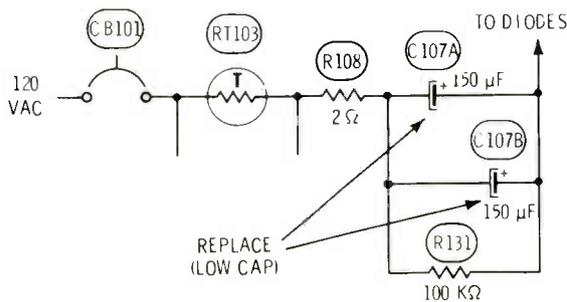
Symptom—Intermittent vertical sync
Cure—If 18-volt supply is low, replace zener CR203

Chassis—RCA CTC72
PHOTOFACT—1439-2



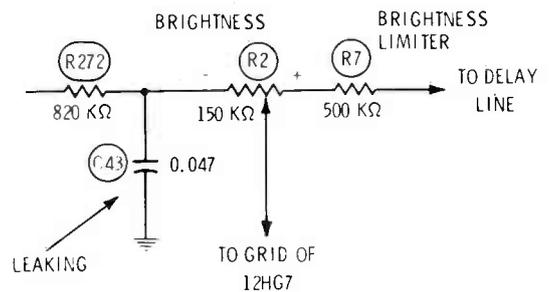
Symptom—No vertical sweep
Cure—If 28.8-volt supply is low, check and replace R112

Chassis—RCA CTC51
PHOTOFACT—1201-1



Symptom—Small raster
Cure—Check or replace dual electrolytic C107A

Chassis—RCA CTC39
PHOTOFACT—1126-3



Symptom—Brightness is too bright, but adjusts
Cure—Check C43, and replace it if leaking

readers exchange

There is no charge for listing in *Reader's Exchange*, but we reserve the right to edit all copy. If you can help with a request, write direct to the reader, not to *Electronic Servicing*.

Needed: Schematic or information for an AM-FM-SW radio with stereo turntable. Telefunken is on the turntable while Delmonico and Korting is on the front cabinet. The tubes used are ECG85, ECH81, EBF89, two ECL86 and EZ81; no Model number.

Carol A. Jones, Jr.
22 Highland Drive
Fort Walton Beach, Florida 32548

Needed: Rubber-tired drive wheel for AEG (Telefunken) Megnetaphon 97 reel-to-reel tape recorder, or address of Telefunken company in the United States where I may purchase this part.

Kenneth R. Herberger
5433 Vancouver St.
El Paso, Texas 79924

Needed: September 1969 issue of *Electronic Servicing* magazine. Will buy.

Stanley Anderson
615 S. 4th St.
Clinton, Indiana 47842

Needed: Supply reel and clutch assembly for Concord Model 550 reel-to-reel recorder manufactured by Benjamin Electronics Sound.

K&W Electronics
P.O. Box 692
S. 215 Washington
Newport, Washington 99156

Needed: Alignment instructions for a Knight-Kit CB, Model C-22. Will buy, or copy and return.

Stanley G. Boler
116 S. Washington
Knightstown, Indiana 46148

Needed: An operating manual for Dumont scope, Model 401. Will buy, or copy and return.

Edward Schertzer
2815 Weeks Ave.
Oceanside, New York 11572

Trade: B&K Model 650 tube and transistor tester, Heathkit laboratory oscilloscope Model 10-30, Superior Instruments Model 83 CRT tester and rejuvenator, Sencore Substitutor Model RC121. Trade for electronic home study courses, or transistor/FET tester.

Chester W. Barrett
R.F.D. 3, Box 199
Wapakoneta, Ohio 45895

(Continued on page 11)

December, 1976



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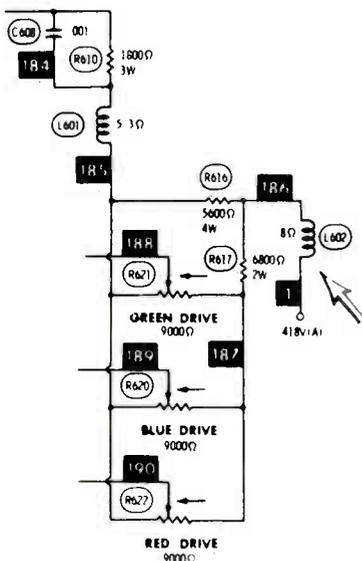
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No raster; red 6LQ6 Magnavox T974 (Photofact 1305-1)

Occasionally, the raster would black out. When it did, the 6LQ6 grid would glow a dull red and the grid DC voltage became low.

The high voltage was eliminated during those times. However, it would come back if I removed the socket of the picture tube. Evidently, the picture tube was drawing too much current, thus killing the HV.



Resistance tests of the circuits connecting to the picture tube found an open in peaking coil, L602. When it opened, the positive voltages were removed from the three CRT cathodes (but the grids still had positive voltages). The grids were more positive than the cathodes, and the resulting excessive CRT current loaded down the HV, killing it.

I have found similar defective coils in other brands, such as RCA, which gave the same symptoms.

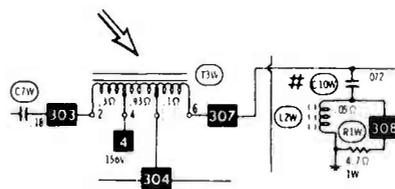
Thomas Bush
Tallahassee, Florida

No raster; faint sound Philco 4YC90 (Photofact 1407-2)

Over the past several months, I have made numerous service calls to check two of these sets. Each

case required resetting of the breaker to bring back normal operation. However, the receiver would malfunction again within a day to three weeks. I had replaced the breakers in both sets, in case they were too sensitive, but the problems continued.

Finally, I checked one of the sets when the breaker would not hold; instead, it would trip instantly. "Now, I will find the source of the problem," I thought to myself, as I brought the TV to the shop. Another of those famous "last words"!



Tests for the short were complicated by the system of interlocks which opens the power circuit when some of the modules are removed. Finally, a component-by-component check of the horizontal and high voltage accomplished nothing. But a dead short seemed proven by the fast tripping of the breaker.

Eventually, I remembered the series of articles in *ELECTRONIC SERVICING* about the RCA XL-100, which has an SCR-sweep circuit with many similarities to this Philco. I reread the part of the April, 1976 issue which stated: "When L-108 has shorted turns, the breaker will trip instantly." I can't truthfully say I understood the implications, but I'm a believer.

In the Philco is a transformer marked T3W, which corresponds to L108 in the RCA. The three windings are rated at .1, .93, and .3 ohms DC, and my good test equipment is just not up to finding shorted turns in such low-resistance coils. After much thought, I decided to replace T3W on suspicion.

While removing T3W, I found a tiny crack in the circuit board where pin 6 of T3W solders to the deflection board. I didn't understand how this could cause the breaker to trip, but I was desperate, and so I repaired the crack. Yes, you guessed it. The set has been operating perfectly since then.

What's more, I visited my other

problem Philco the next day and soldered the same #6 pin of T3W. Neither set has tripped a breaker after that day.

This proves that theory and practice should be used together, and the technical magazines can provide a valuable service by reporting experiences such as these.

Donald Kemner
Fortuna, California

Editor's Note: An open at pin 6 of the commutating coil T3W prevents the AC signal from reaching C10W and C11W. Without C11W, the signal cannot go on to the trace side of the circuit, thus killing the sweep. However, that does not produce an overload or short; instead, a lack of ringing between T3W and the sum of C10W and C11W indirectly produces a short across the power supply.

Normally, the SCR Q101 is triggered on by the oscillator signal, and then the anode current continues to flow so long as the anode is positive. During correct operation, the current through T3W and the SCR to ground is not excessive because of the current-delaying action of T3W's inductance. Ringing of T3W with C10W/C11W swings the anode of SCR Q101 negative, and it unlatches before the current becomes excessive through T3W.

But with C10W/C11W disconnected by the open circuit, the anode of Q101 continues to be positive (only about a volt is sufficient), the SCR does not unlatch, and the inductance allows the current to increase until only the series DC resistances of T3W and the SCR are between the supply voltage and ground. This probably would draw dozens of amperes, but the breaker trips, **rapidly**.

Of course, shorted turns in the commutating inductance (T3W in the Philco, L108 in RCA) also prevent proper ringing and cause a permanent heavy flow of SCR current as previously described. □

Write and tell us
what kind of articles
you would like to see
in **Electronic Servicing**

(Continued from page 9)

Needed: An audio-output/modulation transformer (part number K39035-1) for a Hammarlund HQ105TR.

John Rebhan
112 Summit Circle
Little Ferry, New Jersey 07643

Needed: One 6N6G radio tube.

David L. Bennett
1703 Rhonda Lane
Stone Mountain, Georgia 30087

Needed: Instruction and service manuals for Akai M-8 tape recorder. Will buy, or copy and return.

Richard S. Meyer
CommTronics
134 Jims Run
McMechen, West Virginia 26040

Needed: Schematic and power transformer for Cariole stereo, Code 19228.

Charles Fogt
Home Mart
9th Street NW
Waukon, Iowa 52172

Needed: Utica T&C III, Regency Range Gain, and Imperial radios in any condition.

J. M. Balidoy
LB 415
Coshocton, Ohio 43812

Needed: Schematic for Philips auto radio type ND593V, #W001909A-36W. Will buy, or copy and return.

James W. Peterson
Petes Lock & Fixit Shop
P.O. Box 802
San Angelo, Texas 76901

Needed: A sweep generator and a digital or FET multimeter, good working condition, reasonable.

S. Valer
428 W. Roosevelt Boulevard
Philadelphia, Pennsylvania 19125

Needed: UHF channel-selector shaft-extension and knob for a Motorola TV, Model 19BP101AA.

AAA TV of Wrentham
4 B Common Street
Wrentham, Massachusetts 02093

For Sale or Trade: Rider's radio and TV manuals; antique tubes such as 00A, 01A, all 7-volt types, FM 1000, 6S7, 6W7, 70A7, 70L7, 117L7, and 25B8. Also, need Rider's radio manuals #1, #1-through-5 abridged, #17, and #23.

Goodwin Radio Shop
Rankin, Illinois 60960

Needed: Schematic, parts list, and other service information for an Atwater Kent radio, Model #509. Will buy, or copy and return.

Raymond Friend
236 W. Pearl St.
Butler, Pennsylvania 16001

For Sale: B&K Model 520 transistor tester, like new with manufacturer's manual, \$95.

H. Geller
12622 N.E. 3rd St.
Bellevue, Washington 98005

Needed: Schematics or manuals for RCA WP23A regulated power supply, and Annuncionics Pacesetter electronic-cruise control. Also, have for sale Heathkit scopes; Models IO-18 and IO-103 with manuals, best offer.

Ronald W. Gillen
253 N. Ridge St., Box 383
Hustisford, Wisconsin 53034

Needed: Complete Zenith Stratosphere radio, or major components. Also, an owner's manual and tube charts for a Supreme Model 400A tester.

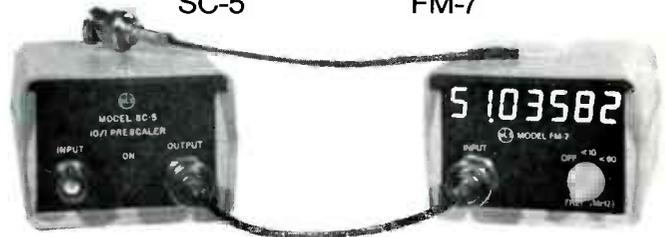
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Favorite Repairs Using A Scope



By Ron Meyer, CET

Here is another group of Ron's favorite repairs. This time, all of the TV receivers were ones which could be tested most efficiently with a scope as the main item of test equipment.

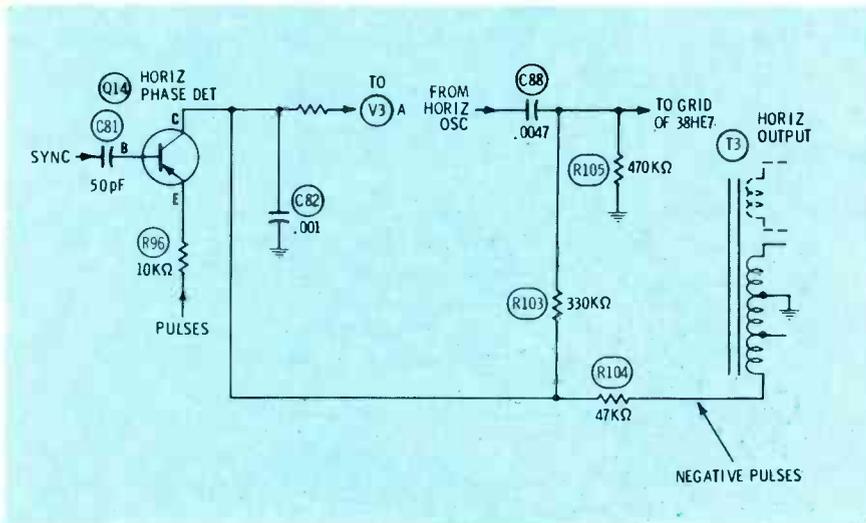


Fig. 1 In the horizontal phase detector circuit of the Zenith 12CB12X B&W chassis, a PNP transistor is used instead of the usual double-diode. Of course, a PNP is the same as two diodes with a common cathode, except for the additional transistor action. Looking at it that way, this circuit is similar to the double-diode type, except for the positive-going 12-VPP pulses applied through R96 to the emitter. Sync pulses are fed to the base and sawteeth to the collector; both signals must have the correct amplitude and waveshape for good locking. Rectification of these signals produces a DC voltage which is filtered and applied to the horizontal oscillator to hold the oscillator with the correct phase relative to the sync. In this case, too much collector signal was just as harmful as too little would have been.

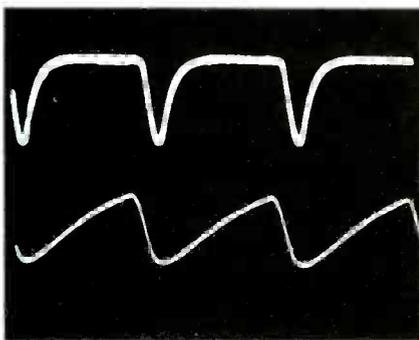


Fig. 2 Top trace shows the excessive 200-VPP collector waveform of Q14; and at the bottom is the correct 50-VPP signal after the defective resistor was replaced.



Fig. 3 R104 of Figure 1 showed no signs of damage or overheating, but the 47K had gone down to about 6K.

Case #1 Loose Horizontal Locking Zenith 12CB12X Chassis (Photofact 1252-3)

Symptoms

When the horizontal-hold control was adjusted, it could be turned only a small amount before the locking was lost. Even with the hold control set carefully, changing to another channel usually would throw it out of lock. Picture quality was normal, and the vertical locking was okay. Preliminary conclusion: defect might be in the horizontal AFC circuit.

Background facts

Regardless of the model of TV, all locking of horizontal oscillators is done indirectly by an Automatic-Frequency-Control (AFC) circuit. All AFC systems require two input signals. One is the horizontal sync, obtained through a differentiating capacitor from the sync separator; the other is a sample (usually integrated into a sawtooth waveform) of the horizontal-sweep circuit. The frequency and phase of these two signals are compared in a phase-sensitive circuit, and any difference of phase between them produces a DC voltage, which is used to force the oscillator back into the correct frequency and phase.

Therefore, the fastest method (and the one least likely to lead you wrong) is to view the AFC circuit as a "black box". In other words, make sure the two input signals are there in the proper amplitude and waveshape, and that the DC output (control) voltage has the approximate range. Then, if the test results indicate a defect in the AFC circuit,

you can test the components one-by-one.

Troubleshooting

The Photofact schematic (Figure 1) reveals an unusual phase detector. Instead of the usual double diode, a transistor is used, with the negative-going sync pulses applied to the base, sawteeth fed to the collector, and (surprise) positive-going horizontal-sweep pulses brought to the emitter. Now, I don't know why the pulses are needed at the emitter. Perhaps they are used to balance some capacitance feedthrough inside the transistor. At any rate, the 10K resistor will not permit very much pulse amplitude to reach the emitter.

The sync pulses were at the base, and the sweep pulses were at the flyback side of R96, but the expected 45-VPP sawtooth waveform at the collector was all wrong. The amplitude was about 200-VPP, and resembled pulses more than sawteeth (see Figure 2).

R104 and C82 are supposed to change the pulses into sawteeth, so it seemed likely one of them was the culprit. **Either** a capacitance of a smaller value, or a lower resistance would produce the twin excessive amplitude and insufficient filtering symptoms. However, it's far more likely for a resistor to become low in value from overload and heat than it is for a capacitor to develop a partial capacitance. Besides, it's easier to test a resistor.

I checked the resistor in-circuit and found a few thousand ohms, rather than 47K. Of course, leakage of the transistor might give a false reading, so I cut one lead of the resistor. Now, it checked about 6K ohms. I was certain that this value would account for the wrong collector waveform. But, a nagging doubt remained. After the waveform was corrected, would the locking be normal?

My worry was not justified, because a new resistor restored the proper tight horizontal locking.

Afterwards, I examined the defective resistor, and could find nothing wrong visually. It had no bulges, and the coding stripes were not discolored (Figure 3). However, the resistor was required to operate with about 200 VPP across it; therefore, I used a one-watt size to make certain the replacement would not fail.

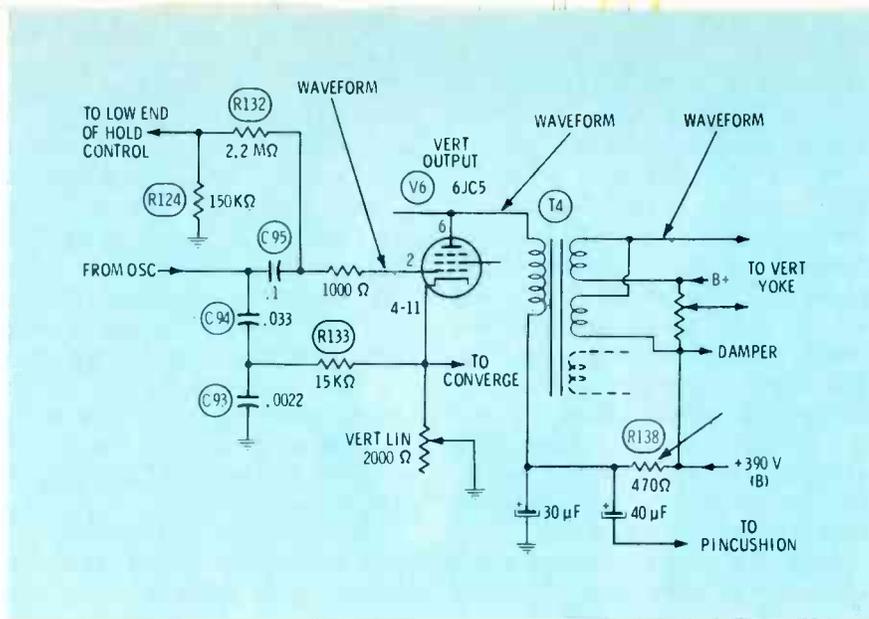


Fig. 4 This is a partial schematic of the vertical-sweep circuit of the Zenith 14Z36 color chassis which had no height. Points for three important waveforms are indicated by arrows. Don't connect to the plate unless you are sure your scope will stand the high-amplitude pulses, or the pulses are known to be weak.

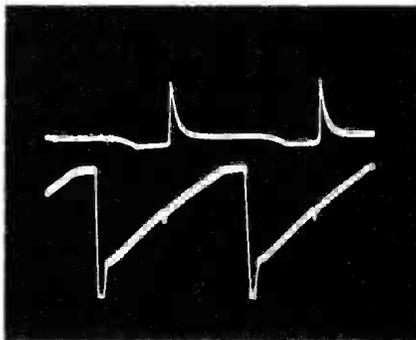


Fig. 5 Waveform at the grid of the vertical-output tube (V6) was small and flattened (bottom trace), while the plate waveform (top) was badly distorted.

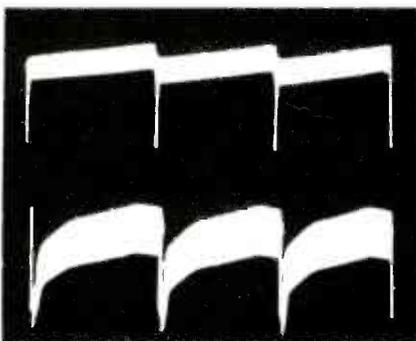


Fig. 6 These waveforms show the change of waveform at the vertical yoke when the yoke winding is open. Top waveform is the normal one; the sawtooth portion lines are thick because of the horizontal pulses there. An open yoke winding (bottom waveform) increases the horizontal pulses (fatter lines), increases the amplitude of the sawteeth and decreases the amplitude of the pulses, which are formed by the collapsing yoke inductance.

Case #2 No Vertical Sweep Zenith 14Z36 Chassis (Photofact 1197-2)

Symptoms

A slight undulation could be seen near the left edge of the horizontal line. All the tubes had heater glow, and no components seemed to be operating too warm.

Background facts

Multivibrators of this type (Figure 4) are a closed loop. Both sections of the circuit are necessary for oscillation. Therefore, a loss of signal anywhere inside the loop kills all the sweep. This limits the value of waveforms, in some cases. On the other hand, an open yoke still permits the multivibrator to oscillate, but usually with wrong waveforms and frequency.

For those reasons, I usually try a few quick waveforms. When the scope finds significant signals, it saves a large amount of time, and makes the test worthwhile. Without signals, I go on to other methods.

Troubleshooting

I chose the grid of the output tube (V6) for the first waveform. It had less than a half of the usual amplitude, and the waveform (Figure 5) was wrong, as expected.

Next, I scoped the plate of the vertical-output tube. Yes, I know that is not recommended because of the 1300-volt PP pulses which

should be there. But it's okay, when you are certain the pulses are weak enough not to damage your scope.

In this case, the plate waveform was only 300 VPP. Tubes can't operate without DC voltages, so I decided to make certain these plates did have voltage. Well, that was a good guess, because the output plate measured away low. The supply resistor (RR138) had increased greatly in value.

I installed a new resistor, fully expecting to find vertical sweep. But the raster was still condensed into that one horizontal line.

Back to the scope, I found about 1200 VPP at the output plate. The waveform was wrong, too.

Now was the time to do some thinking. Regardless of the incorrect plate waveform, that much signal should give **some** vertical deflection. Therefore, something was preventing the signal from deflecting the CRT beam.

Perhaps the secondary of the vertical-output transformer was open. That's not likely, when there are two windings wired in the vertical-centering circuit (Figure 4). Two possibilities remained: the centering control might be open; or the yoke was open.

An ohmmeter test proved the yoke was open, and **a new one brought back the height**. Usually, that's the end of any repair. But it

started me thinking about why the yoke waveform showed insufficient pulses when the yoke was open.

Then I remembered some articles previously printed in *ELECTRONIC SERVICING*. The point had been made that **inductances** in the plate circuit produced most of the pulse amplitude when their fields collapsed during retrace. An open yoke removed most of the inductance, but the inductance of the output transformer remained. Therefore, the pulses were reduced, but not enough to serve as absolute proof of an open yoke (Figure 6). I know now how to interpret the waveforms, and this should save much time in the future.

Case #3 Parasitic Oscillation RCA Chassis CTC63XC (Photofact 1276-3)

Symptoms

When the picture went blank between scenes, or when I turned down the brightness, the horizontal would go out of lock and have some

kind of a collapse (or perhaps a parasitic oscillation) near the center of the picture (see Figure 7). Never before had I seen such a malfunction.



Fig. 7 At low brightness the RCA CTC63 chassis would develop a parasitic oscillation that appeared as a jagged line down the center.



Fig. 8 The drive waveform at the grid of the horizontal-output tube was normal except the lines were broad, indicating some low-frequency signal was mixed with the sawteeth.

Background facts

At this point, I had no idea what kind of defect could cause this symptom. But, over the years, I've found out that a technician should make several guesses, and check them out. Then, while working, he should be alert for some clue indicating a defect. Usually he will find one.

Troubleshooting

What was the significance of the problem starting only at low brightness? Could that indicate a HV regulation problem?

The CTC63 has a varistor that "rectifies" horizontal pulses, and the negative voltage produced is added to the negative voltage at the grid of the horizontal-output tube to regulate the high voltage. Increased negative grid voltage reduces the maximum plate current, and with it the width and high voltage.

As a quickie test of the regulation, I grounded the hot end of the varistor. At low brightness, the strange parasitic remained. That test cleared the regulator of all suspicion.

Next, I scoped the grid drive of the output tube. The waveform seemed to be normal at high brightness; and at low brightness, the amplitude did not change, but

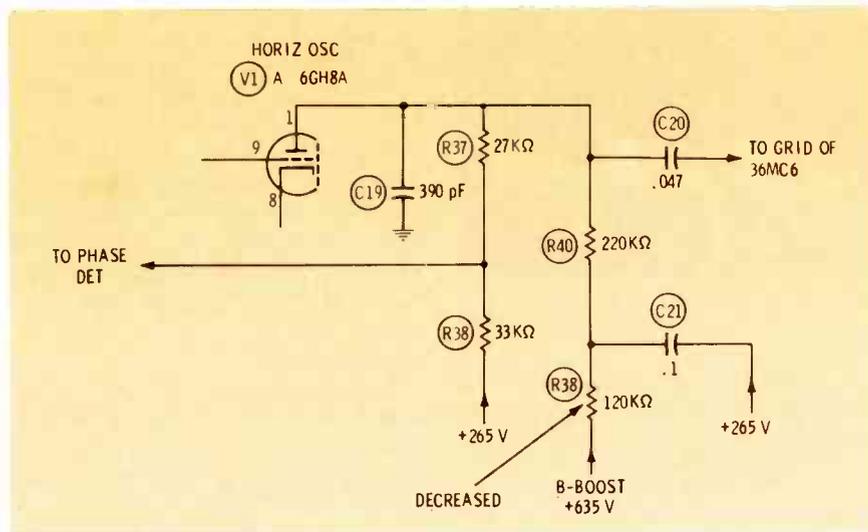


Fig. 9 This partial schematic of the RCA CTC63 shows the plate resistors of the horizontal-oscillator tube. C19 makes sawteeth out of the pulses, so it is important to the drive, too. R38 was the defective component.

the lines appeared thick (which usually means hum, noise, or an extra frequency has been added) as shown in Figure 8. One other discrepancy: the amplitude was 300 VPP, instead of the expected 250 VPP. Was this important? I decided it was a clue, and started to check the horizontal-oscillator circuit.

Now then, what can cause higher amplitude of the sawtooth drive waveform? If you have ever tried to obtain increased drive, you know the answer. The waveform-shaping parts might be bad, or the oscillator plate voltage could be too high (perhaps because of a low-value plate resistor).

With this thought in mind, I checked all the resistors in the horizontal oscillator. All were within tolerance, except R38 (Figure 9), which measured less than 40K ohms. Although I didn't understand what effect the low resistance

would cause, I installed a new resistor. You guessed it. **There was no problem at any brightness level.**

I thought about the puzzle for some time. Finally, I decided the horizontal ripple on the B-boost supply was interfering with the oscillator signal (remember the horizontal pulses from the flyback occur at the center of retrace, and the grid current of the output tube starts at the center of trace). Normally, R38 and C21 filter out the ripple, keeping it from the oscillator. But a low value of R38 would permit more ripple to reach the oscillator.

Of course, there is another explanation. The increased plate voltage at the oscillator would force it to work harder. Many oscillators are susceptible to "double-triggering" or "squegging" when they operate too strong. Which explanation is right? Perhaps both play a part!

Case #4 Loss Of Horizontal Locking Zenith Chassis 19FC45 (Photofact 1466-3)

Symptoms

When the floating picture was slowed by the hold control, it seemed normal. Vertical locking was normal, also.

Background facts

Almost never is the oscillator stage at fault when there is no horizontal locking. The trouble is in front of that stage. Circuits of the 19FC45 are conventional, although

they are on modules, but the modular construction does allow us to use variations of the usual servicing methods. For example, if you question the horizontal sync (and a module is available), you just substitute it for a test. The same substitution procedure works fine for the oscillator module, as well. Of course, there are exceptions!

Troubleshooting

Horizontal sync for the 19FC45 comes from the 9-87 video-processor module. Substitution of a new module made no improvement.

Next, a 9-90 horizontal module was tried. Again, there was no change. Some concentrated thinking was called for now. By the changing of modules, the entire sync section, the duo-diode phase-detector circuit, and the sawtooth shaper stage (that makes sawteeth out of horizontal-sweep pulses) had been replaced.

That didn't leave very much except the horizontal pulses from the flyback. These pulses enter the module at U2, a convenient test point, and only a moment was required with the scope to find the pulses were missing. I disconnected the purple wire at the flyback, and checked both wire and flyback for

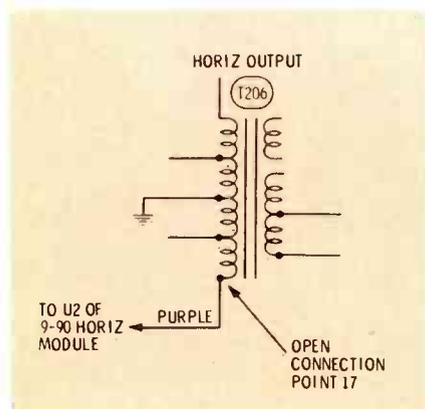


Fig. 10 An open circuit at the flyback terminal of the Zenith 19FC45 eliminated all horizontal locking.

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shorts to ground. There were no shorts. While the wire was removed, I powered the chassis and checked for pulses at the transformer. The pulses were there, but the amplitude was only about 30 VPP. I connected the purple wire, and the pulses were missing again.

After some thought, I concluded the problem must be an open in the

winding or the terminal. In that case, the low impedance of the circuit would reduce the pulses to almost zero amplitude. But with only a 10-megohm scope probe for a load, the capacitance across the open circuit could couple a nearly-normal amplitude of pulses to the scope.

My magnifying glass showed

unmelted insulation on the wire of the winding that was wrapped around the flyback terminal lug (Figure 10). **I gave the joint a good, hot resoldering, and was rewarded with a picture that locked solidly.** Of course, I felt a little sheepish, since I must have overlooked the open reading when I checked for a short to ground.

Case #5 Picture Dark At The Top RCA CTC30 Chassis (Photofact 926-2)

Symptoms

White flashes across the screen were described by the customer. The flashes now were gone, but the top of the raster was darker than the bottom (Figure 11).

Background facts

Shaded rasters can be produced by open filters; however, usually one side is dark and not the top. Darkened areas from hum will move constantly during color broadcasts, and this one was not moving. Perhaps the shading was caused by a defect in the blanking circuit.

Troubleshooting

If the shading had been produced by some kind of modulation in the RF or IF circuits, the effect should be missing when the tuner was turned to a blank channel. However, the raster also was shaded

when the RF signal input was removed, proving RF/IF modulation was not the cause.

Sweep that travels too fast makes that part of the picture too dark. I tried the crosshatch pattern of my color-bar generator. The vertical linearity was good, so the beam-speed defect was disproved.

Blanking, either the intended effect gone wrong, or accidental blanking from a component defect, remained as the only possibility. It was a job ideally suited for a scope.

To prevent the station video from confusing the analysis, I tuned to a blank channel. The waveform at the grid of the video output tube (V4B in Figure 12) had a sawtooth component between the vertical pulses from the blanking signal from the plate of the vertical-output tube. Because the slope was correct for darkening the top of the picture, I was certain this was the cause of the shading.

One last test verified my suspicion of the bad component. C49 is supposed to remove the sawtooth from the vertical signal, leaving

only the pulses, which blank the raster during retrace. The waveform was the same on both sides of C49. **Yes, C49 was shorted.** Of course, the short placed a DC voltage across the resistors, so I checked them with an ohmmeter. R78 had been changed in resistance by the overload; therefore, I replaced it and C49 at the same time. The top of the picture now showed the same brightness as the bottom.

Comments

The only common characteristics of these various repairs were that a scope was the instrument chosen to identify the location of each defect, and it did so without wasted time or too many false trails.

Of course, the use of special probes can permit scope viewing of many modulated carriers. And this is a valid and valuable optional method. But, it seems to me that a scope is an absolute **necessity** for troubleshooting sweep, video, and audio circuits. These case histories should have proved this firm belief of mine. □



Fig. 11 Both the raster and the picture of the RCA CTC30 were darkened at the top. The shading began gradually, and was not changed by rolling the vertical or removing the station signal.

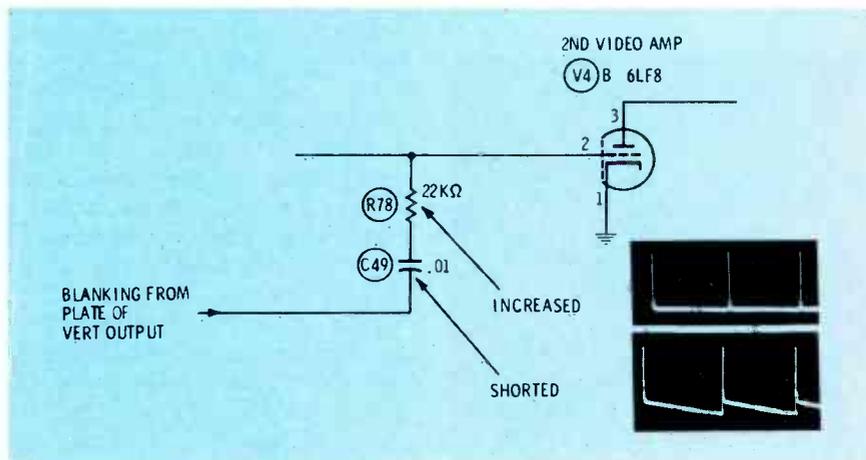


Fig. 12 C49 of the vertical-blanking circuit in the CTC30 is supposed to remove the sawteeth and leave the vertical pulses. When it is shorted, the top of the picture is shaded dark.

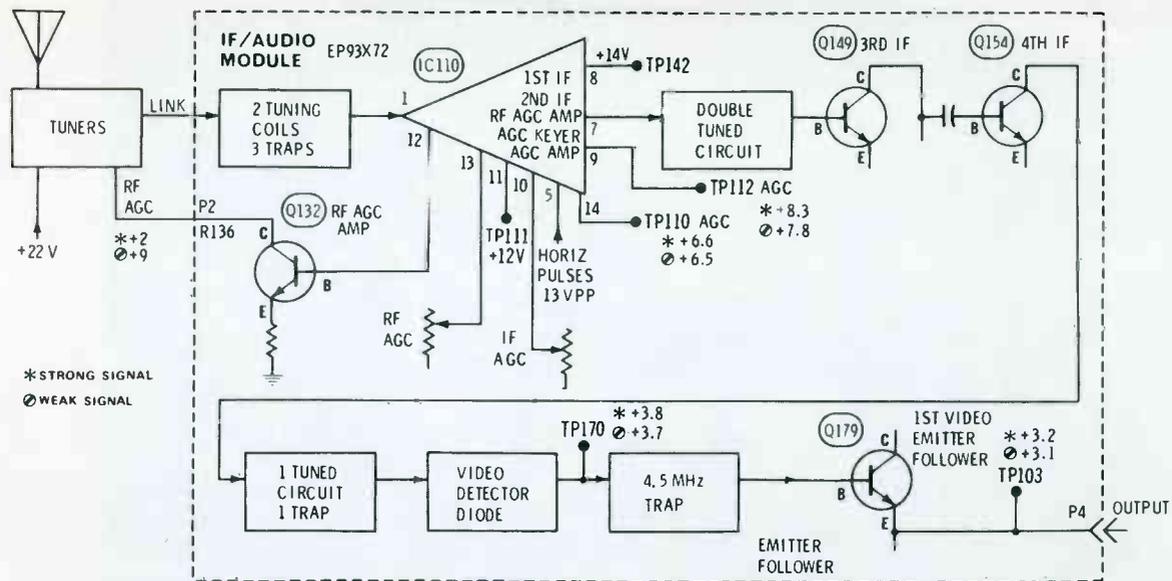


Fig. 1 Two IF amplifiers and two AGC stages are inside the IC. Discrete transistors are used for the other stages of the EP93X72 IF/audio module. Typical DC voltages are shown for weak and strong TV input signals.

Servicing GE Modular Color TV



Part 5/By Gill Grieshaber, CET

Video-IF and video-amplifier circuits of the GE 19YC-2 chassis are analyzed here. When tubes were kings, a B&W TV probably had one video tube, and a color TV included two or three video stages. But, solid state has complicated video circuits. Pre-CRT matrixing adds one stage. Emitter followers are used anywhere a change from high impedance to low is needed. Additional transistors are required for other circuit refinements; so the new color receivers have as many as nine video stages, often with several direct coupled. You can't afford to ignore the variety of defects that are possible from so many components. Read these explanations, then apply them to other similar circuits.

Picture IF's

More and more, IF circuits in the new modular TV's are becoming like "black boxes". Some have nothing but IC's, and others have IC's and transistors. The EP93X72 IF module of the General Electric

19YC-2 chassis has one IC and two discrete transistors before the detector (Figure 1).

The reference to a "black box" tells us how we troubleshoot these circuits: by checking input signals, output signals, DC voltages, resis-

tances, and input waveforms (such as keying pulses).

Figure 2 identifies many of the components we will be mentioning. We believe that the most-valuable information for testing the IF's (in addition to the Photofact folder) is

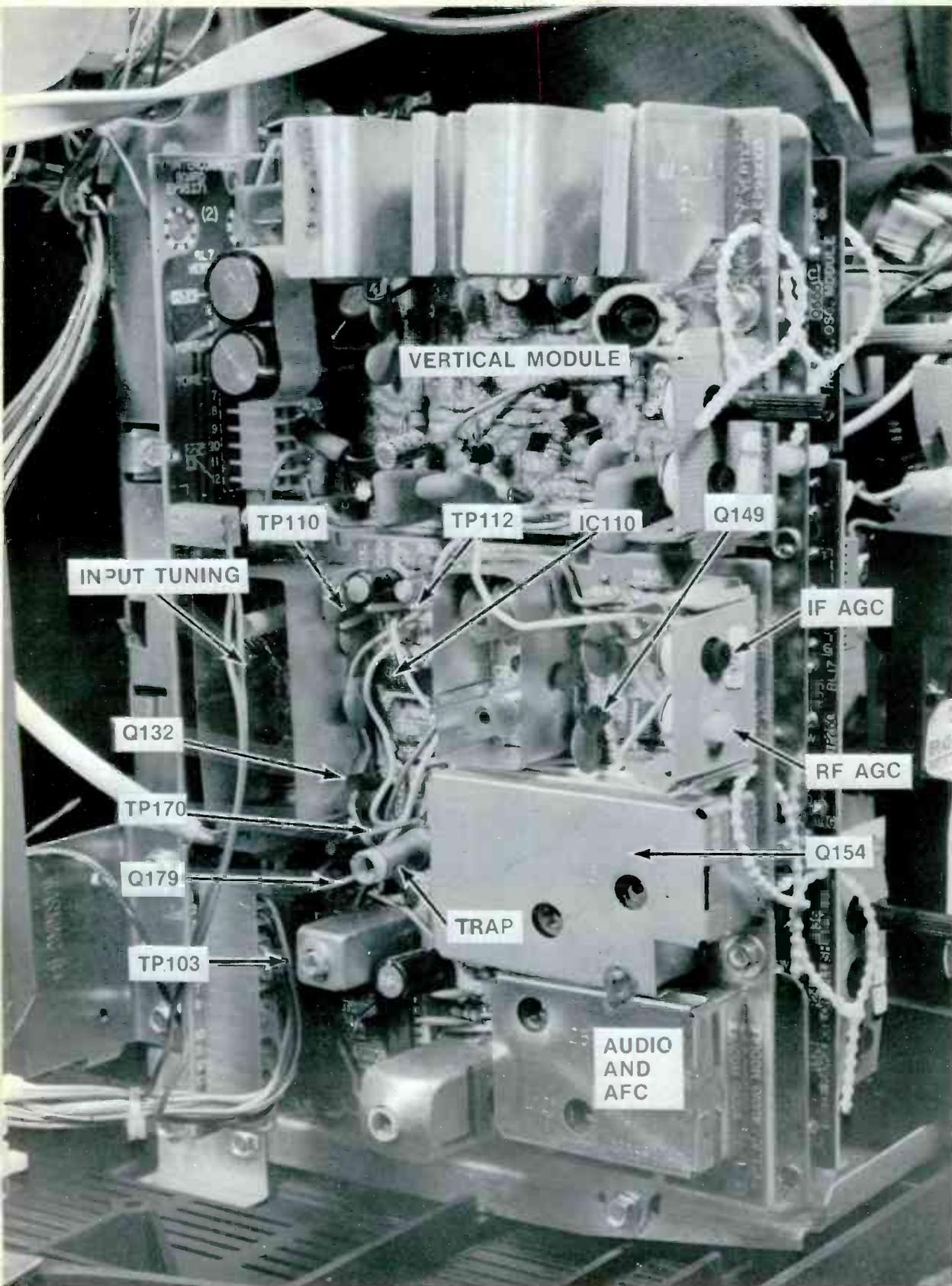


Fig. 2 Locations of many test points and components on the IF/audio module are shown by the arrows.

the location of the terminal pins, IC pins, and the marked test points.

For IF circuits, a complete set of DC voltages, both when the station signal is strong and when it is missing, is of vital importance. These voltages, taken from our test

receiver, are included with Figure 1.

The module is held in place by a 12-pin connector and guide slot at the front, and one screw at the rear. To remove the module, it is necessary only to remove the screw, unplug the IF cable coming from

the tuner, and pull straight back on the module. When you insert the module, line up the module with the slot (or groove) at the top/front corner, then line up the connector pins at the bottom/front corner as you move the module forward.

Both IC's (one for IF and one for sound) plug into sockets (very tight sockets), but the transistors are soldered to the board.

General IF Troubleshooting

Suppose you suspect the IF module is dead, and is causing a

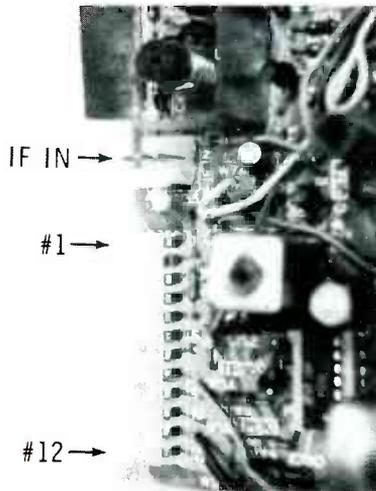


Fig. 3 With the IF/audio module in the chassis, the connector pins are numbered as shown; and the three-prong IF input plug is just above the connector. Pin 3 should have +22 volts, the tuner AGC voltage is at pin 2, and the video comes out at pin 4.

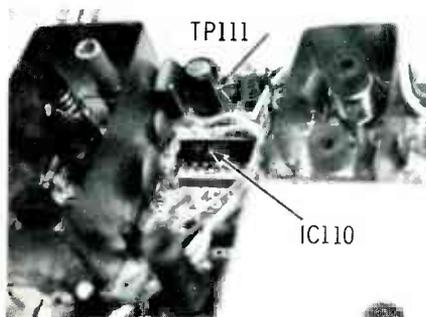


Fig. 4 The testpoints are metal posts; they are well-marked and convenient for you to measure voltages and signals.

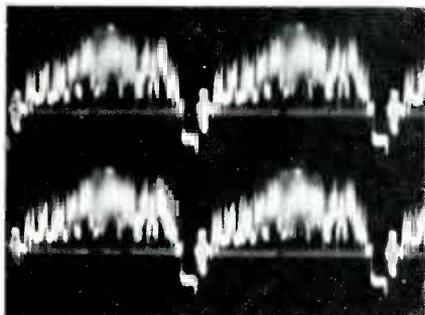


Fig. 5 Negative-going video should be found at TP170 and TP103. Notice the strong burst amplitude.

loss of video and chroma (raster is okay). Good practical troubleshooting demands that we try the easy things first, so this sequence of tests is recommended:

- Turn to a blank channel. Look for snow. If there is none, we can almost rule out an AGC problem. But, with good snow off channel and a blank raster on strong stations, the indications point to an AGC failure;
- Check for +22 volts at terminal 3 of the 12-pin socket (Figure 3). Other secondary B+ points are TP142 and TP111 (see Figure 4). Loss of B+ at any of these will kill all signal;
- Use a tuner substitute to test for the possibility of a bad tuner;
- At this point, we must consider whether or not there is sound. The sound takeoff is from the collector of the fourth (last) IF, so normal sound probably means the video-detector diode (Y170) or the video emitter follower is at fault;
- On the other hand, no sound and no snow either on or off channel points to trouble before the fourth IF stage;
- Strong sound and a normal video waveform at both TP170 and TP103 suggests a video failure on the chroma/video module.

AGC analysis

The gain of transistors and IC's can be reduced by AGC DC voltages that either increase or decrease from the voltage giving maximum gain. No analysis of AGC problems can be efficient without knowing which kind of AGC gain reduction is used for the IF's and for the tuner.

A careful analysis of the detector and AGC voltages proved that the AGC reduced the IF gain by saturation (more forward bias with a stronger signal), and the tuner AGC was of the cutoff type (less positive with a stronger signal). And the polarity of the detector diode (Y170) produced a negative-going video signal (sync tips at the bottom of the waveform, as shown in Figure 5). Of course, the video emitter follower (Q179) receives forward bias from the detector circuit, so the video-detector signal rides on a fixed positive voltage.

Therefore, according to theory, the DC voltage at the video test point (TP170) should become less

positive, the IF AGC should test more positive, and the RF AGC should measure less positive, when the channel signal becomes stronger. Well, the theory is correct. But when it was applied to these actual DC measurements, several problems were encountered.

First, it seemed that elimination of the channel signal caused the DC voltages to swing in the **wrong** direction. This was traced to two factors. I had been switching to an unused channel, rather than taking the extra time to remove the antenna. Unfortunately, carriers of other channels came through strongly enough to upset the readings, although no station could be seen on the screen. Hint: remove the antenna and turn to a blank channel, when you want zero signal.

Also, the heavy normal snow produced some readings that were nearly identical to those with the usual signal amplitude.

Evidently, these AGC tests demanded better precision. Measurements were made of the DC voltages from all local stations. Then, to obtain repeatable stronger and weaker signals, I connected an American Technology Model ATC-10 television servicer. It has a calibrated attenuator that can reduce the signal right down into the snow.

After several pages of measurements were made and studied, I was forced to come to the discouraging conclusion that my favorite method of analyzing AGC problems from the RF, IF, and detector DC voltages was of limited value with this particular model of TV.

The worst problem was that the IF AGC and the detector voltages changed very little when the signal strength was changed. For example, an IF AGC voltage of +6.50 from a weak signal might increase to +6.55 for a stronger signal. That's not enough change to be significant. Although a digital meter can provide that kind of measurement accuracy, the next individual receiver might require a different voltage. In other words, we cannot say the DC voltage **must be** +6.55 volts with a strong signal.

Therefore, I recommend this procedure for checking the AGC action on the GE YC-2 chassis:

- Measure the DC voltages at the

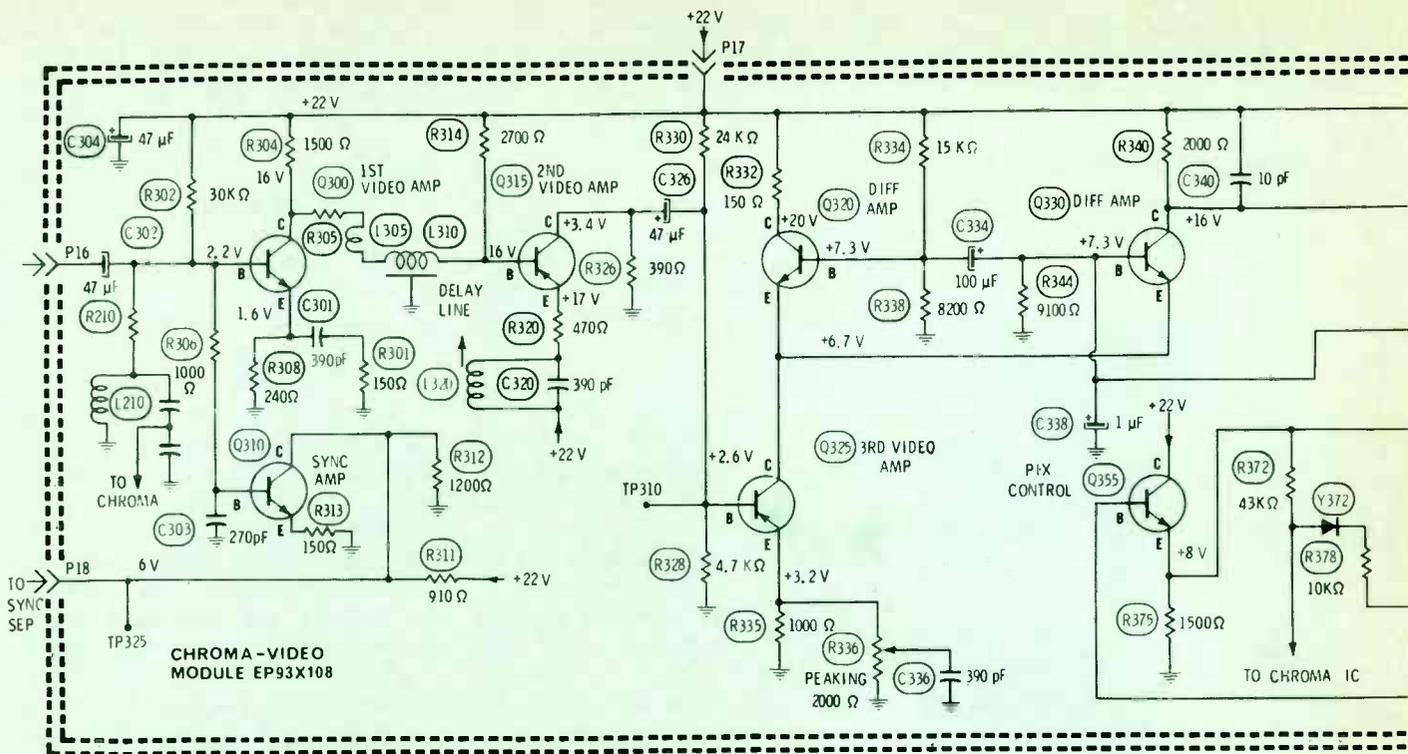


Fig. 7 In addition to six stages of video on the EP93X108 chroma/video module, there are several transistors for simultaneous control of color, brightness, and contrast, and one transistor for vertical and horizontal blanking. Transistors Q300 and Q315 are used to match the delay line and trap out the 3.58-MHz signals (L320). They are direct coupled, but input capacitor C302 and output capacitor C326 prevent them from having any effect on the brightness. Q325, Q330, and Q335 form the next direct-coupled group. Q325 has a huge loss of gain, because it drives the emitters of Q320 and Q330. Q320

stabilizes the DC voltage of those emitters. The bias of Q330 is varied by Q355 (the picture-control amplifier) to change the gain and with it the contrast (see Figure 12).

Although the DC voltage fed to Q335 changes along with the contrast, the brightness is not affected since C348 blocks the DC component before it reaches the base of Q345. Brightness is determined by the voltage at the base of Q345, and four sources act to change this voltage. First, the external brightness control varies the DC positive voltage at P14, which goes through R359, L352, Y345/R352, and R347 to the base of Q345. Next,

pins of IC110 to see if they are sufficient for normal operation;

- Make certain the negative-going AGC keying pulses are at pin 5, and have at least 12-volts PP of amplitude (Figure 6). The 100-VPP

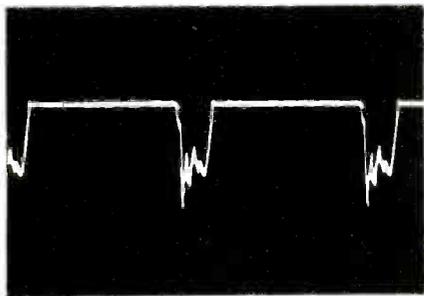


Fig. 6 Keying pulses for the AGC enter the module at pin 6 (100 VPP). They are reduced in amplitude to about 12 VPP at pin 5 of IC110.

pulse source at module pin 6 has the same waveform;

- If video can be seen, but the picture is not quite right, tune in a strong channel and rotate the IF AGC control for the maximum contrast that can be obtained without compression of the sync tips (as scoped at TP103);
- Tune in a channel of medium signal strength and adjust the RF AGC control barely past the point that minimizes the snow; recheck the previous step; and
- If the raster is blank on channel, but has strong snow on an unused channel, a loss of AGC is indicated. That symptom, combined with any out-of-tolerance DC voltages at IC110, is reason enough to replace IC110.

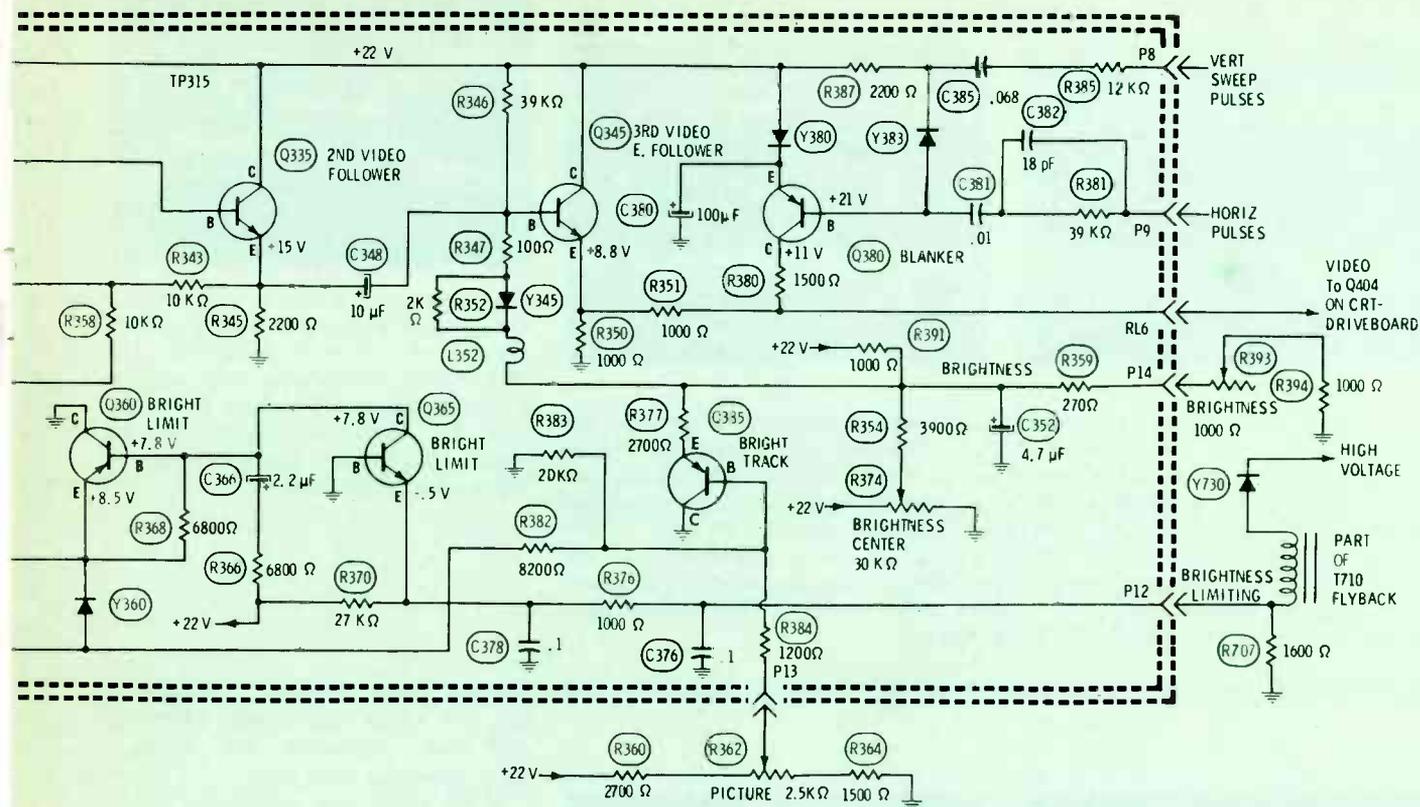
These tests should find the

defect, or remove the problem, if the cause was a wrong adjustment. If not, the IF/sound module probably should be replaced, because the shields make troubleshooting more difficult than with the other modules.

Tracing The Video Signal

Before we dive into the details, we should notice that **nine** stages of video are used altogether, including the outputs which handle both video and chroma.

One emitter follower is on the IF/sound module, six stages are on the chroma/video module (see Figure 7), and later we'll find two final stages on the board that forms the CRT socket. This totals 13 transistors, plus four more for contrast, brightness limiting, and blanking.



the picture control adjusts contrast (bias of Q355 and Q330), brightness (bias of Q385 and Q345), and chroma level (bias of Q355 and chroma IC). Third, the picture-tube current is monitored at pin 12 of the module. Negative voltage from there goes to the emitter of Q365, and then through a complex path (including Q360) to the base of Q385, so that CRT beam current above a certain limit darkens the raster. Fourth, Y345 (at the base of Q345)

functions as a DC restorer. It rectifies the video, making a negative DC voltage (shunt rectification with C348) which decreases the bias of Q345 to increase the brightness of the picture. In addition to all of those operations, R374 can be adjusted so the brightness control produces an adequate range of brightness.

The video signal leaves the module at pin 6 of the 6-pin connector, going on to the CRT-base circuit board.

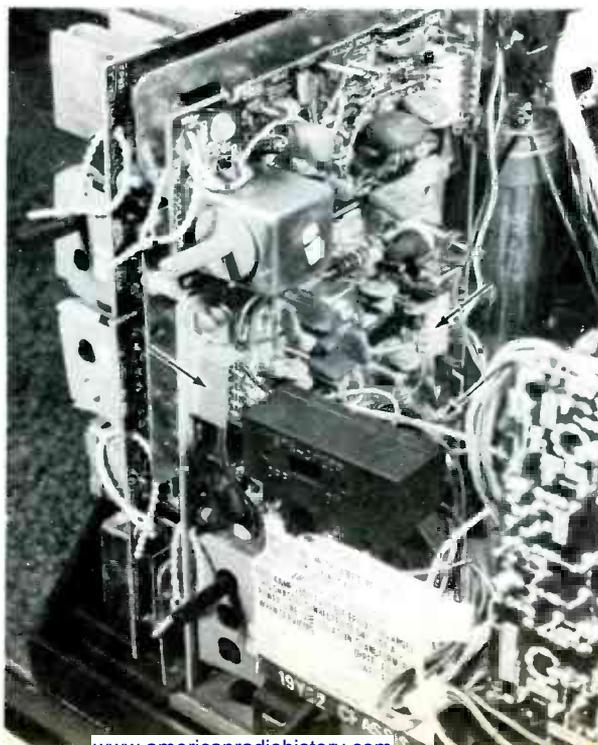
DC coupling

Direct coupling is the rule, rather than the exception, with solid-state video circuits. The GE YC-2 chassis has several direct-coupled stages. But nine stages all direct coupled are a bit much. So, we find four sets of direct-coupled stages, separated in three places by coupling capacitors.

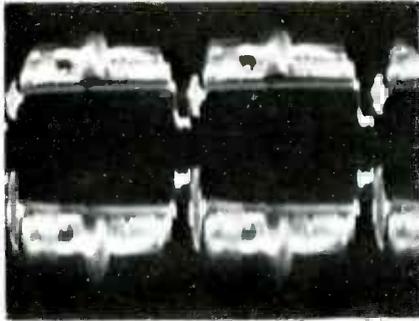
Now, with the coupling capacitors breaking the DC chain, the advantages of automatic black level are lost. To bring back the effect of direct coupling, the YC-2 has a diode (Y345) which rectifies the video to give DC restoration.

Dividing the signals

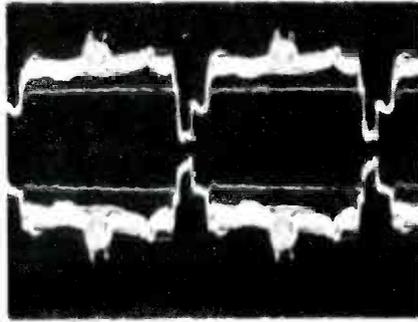
Following the input coupling capacitor (C302) on the EP93X108



The chroma/video module is below the horizontal module and behind the power-input bracket. However, the power bracket can be unscrewed and moved aside to make a fair amount of room for tests. In tight spots, the insulated-hook type of test prod is recommended; the module can be removed for connections, then pushed back in place for live tests. Arrows point to the 6-pin and the two 9-pin connectors. Part of the CRT-base board can be seen at the lower/right corner.



(A)



(B)

Fig. 8 These video waveforms show the different frequency response of the transistor stages. (A) Top waveform is the 1 VPP base signal of Q300. Notice the normal, strong burst amplitude. Below is the 5 VPP collector signal, with the overpeaking and doubled amplitude of the burst showing the increased high-frequency response from C301 in the emitter circuit. (B) The 1 VPP waveform at the top is found at the base of Q310, the sync amplifier. At the collector is the 2 VPP signal (bottom trace). Gain is low because of the small-value collector resistors. Both waveforms show reduced high frequencies, because of the high-pass filter, R306 and C303.

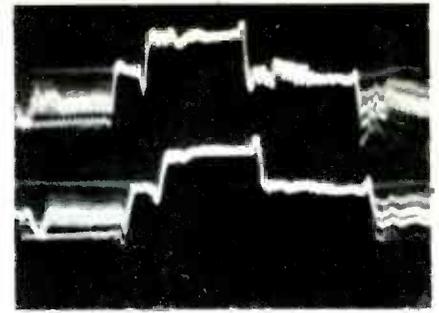


Fig. 9 By using the dual-trace and X5 functions of a triggered scope, we can see the amount of time lag from the delay line. Of course, the chroma must be taken off before the delay line, but a second reason is the reduction of burst (bottom trace) at the output of the line.

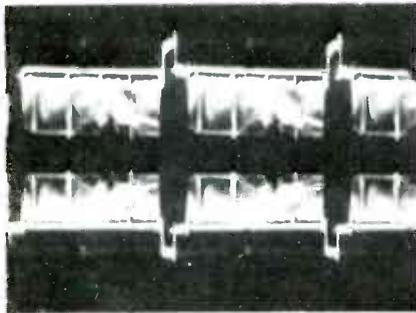


Fig. 10 Top trace is the video waveform at the base of Q315, while the collector waveform is shown by the trace below. Burst and other high-frequency components are attenuated at the collector because of the 3.58-MHz trap in the emitter circuit, which reduces the gain at the trap frequencies.

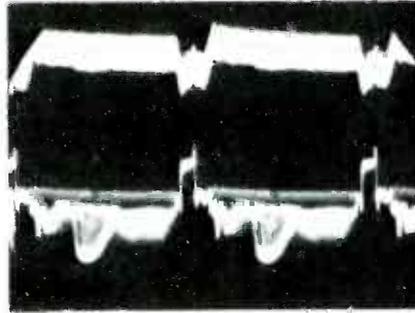


Fig. 11 The top waveform is made up of hum and horizontal pulses scoped at the collector of Q325 (also emitters of Q320 and Q330). But Q330 must have had a small amplitude of the correct signal, because the collector (bottom trace) had normal video.

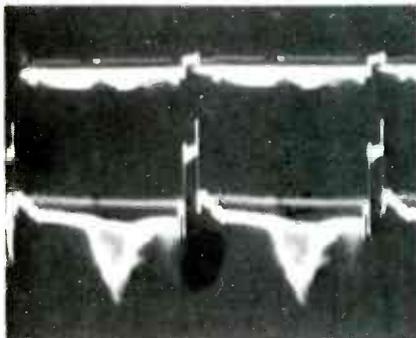


Fig. 12 The effects on the contrast by adjusting the "picture" control are shown by the top trace (minimum contrast) and the bottom trace (maximum contrast). The scope was connected to the base of Q335.

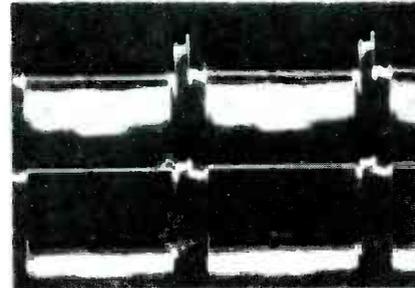


Fig. 13 The top trace shows the 2.5 VPP signal at the emitter of Q345 before blanking is added. With blanking added, the waveform at the junction of R351 and R380 (or RL6 connector) shows wide horizontal pulses which increase the amplitude to 6 VPP.

chroma/video module, the signals for the video amplifiers, chroma, and sync separator are divided, each going its own way.

R210 feeds the composite video signal (including the burst and chroma) to a broadly-tuned takeoff-coil circuit (L210, C211, and C210). All of the video except the chroma and burst is removed by the takeoff coil, and the remaining chroma goes on to IC210, the chroma IC. The remainder of the chroma circuit will not be analyzed until after the video.

Q300, the first video amplifier, inverts and amplifies the video signal, feeding it from the collector to the delay line (L310) and on to the base of Q315. R304 and R314 load the two ends of the delay line to prevent reflections that would appear similar to ghosts. R305 and L305 help the loading and peaking of the delay line.

Video for the sync separator is inverted and amplified by Q310. I say "amplified", but that's almost an exaggeration. There is a gain of only 2, because the collector resistors (R311 and R312) have very low values.

Notice that the frequency responses of Q300 and Q310 are not flat. C301 and R301, in the emitter circuit of Q300, provide some high-frequency increase at the collector. And R306 with C203 reduce the high frequencies that are applied to the base of Q310.

The differences of frequency re-

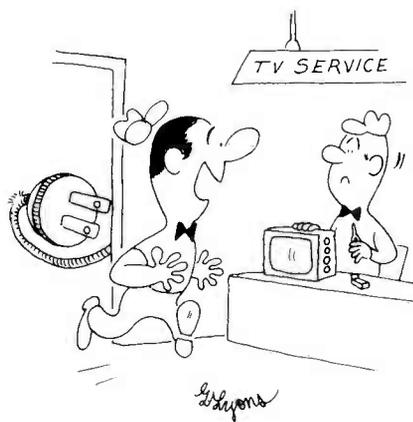
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Servicing GE Modules

(continued from page 24)

sponse are very plain in the waveforms of Figure 8, especially in the amplitude of the burst.

Delay line

Any delay line should slow down the arrival of the video signal, so when it is matrixed with the chroma, the two blend exactly. Figure 9 shows that the output signal of the delay line is displaced slightly to the right of the input signal. The X5 scope feature was used to spread the waveform. Burst and other high-frequency parts of the signal are attenuated, as is customary with delay lines.

Non-amplifying amplifiers

The next transistor, Q315, inverts the video signal (see Figure 10), but gives a slight loss of gain. That's because of the small 390-ohm collector load resistor. Q315 has a PNP polarity.

A coupling capacitor feeds the video to the base of Q325. High-frequency boost for the signal at the collector is furnished by the

"sharpness" control in the emitter circuit. R336 gradually connects C336 from the emitter to ground.

My first scope pattern of the collector signal from Q325 convinced me the signal was very weak and consisted of horizontal pulses mixed with hum. Finally, I realized the extra test lead at the collector was picking up signals by stray capacitance.

Perhaps I should explain why I use several test leads having the insulated-hook probes, while checking waveforms and voltages on a module. The space around most modules is very crowded, and it's difficult to find room for the large scope probes. Also, by connecting three or more extra probes, the scope and meter can be tied externally to any of them without pulling the module each time. Without these shortcuts, wasted time would have limited the number of measurements that could be made in a reasonable length of time.

I repeated the waveform test by clipping the scope probe direct to

the emitter of Q330, which is driven by the collector of Q325. Amplitude of the unwanted horizontal pulses was reduced, but more hum and pulses remained than I could account for, as shown in Figure 11.

Probably the reason for the peculiar waveform is that the scope looks at the signal relative to ground, but the transistor Q330 operates from the base-to-emitter voltage. The drive signal enters from the emitter, but the base is supplied by the +22-volt supply, and thus will have all of the ripple components. In any event, the video signal at the collector of Q330 is normal (Figure 11).

Differential stages

Now, when we try to guess why the circuit designer included transistor Q320, we have a problem at first. **Q320 doesn't seem to do anything!** The video signal from Q325 is fed to the emitter, and the base is bypassed to ground (leaving no signal but ripple). This should produce an amplified (but not



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phase inverted signal at the collector). Yet the collector signal is not used. The 150-ohm collector resistor is the only component connected to the collector.

On the GE schematic, Q320 and Q330 are called "video differential amplifiers". However, this is not a true differential stage. Instead, Q320 stabilizes the common emitter voltage, improving the performance when the bias of Q330 is changed to vary the contrast.

In the schematic of Figure 7, the "picture" control and the brightness-limit circuit (including Q365, Q360, and Q385) combine to vary the base voltage of Q330 (part of this voltage also goes to the emitter of Q335 to offset part of the change of base voltage). Base-to-emitter forward bias of Q330 changes from +0.60 volts at low transistor gain (low contrast) to +0.65 volts for high gain (see Figure 12), producing high contrast.

Q320 stabilizes the common emitter voltage in the same way that an emitter follower would: if

the forward bias of Q330 is increased, the C/E current increases also, raising the common emitter voltage. However, this higher emitter voltage is a decrease of forward bias for Q320 (it acts the same as a decrease of base voltage), so Q320 draws less C/E current, bringing the common emitter voltage down to approximately where it was at the beginning.

Two benefits result from the fixed emitter voltage. It makes the change of Q330 base voltage more effective, and the circuit voltages and gain are stabilized against changes of the ambient temperature, because the two transistors vary together.

It's an advantage here for the contrast to be controlled by a DC voltage, for we'll find out later that the same circuit also changes the chroma gain for better tracking (and compatibility with the VIR system).

Remember that DC voltage changes in these stages, up to and including Q335, do not affect the

brightness, because coupling capacitor C348 at the output of Q335 blocks all of the DC. But that's getting ahead of the story.

Collector signal of Q330, after contrast control of the gain, goes direct to the base of Q335. Of course, this base voltage varies with contrast changes. To compensate for such variations of base voltage, some of the DC voltage from Q355 (picture-control amplifier) that controls the base voltage of Q320 also goes to the emitter of Q335. It is filtered by C338 to prevent feedback.

Brightness

C348 couples video from the emitter of Q335 to the base of Q345, while blocking the DC voltage. Three important things happen in the Q345 stage. All the stages from Q345 to the picture tube are direct coupled; therefore, the bias of Q345 is varied as a method of changing the brightness. Blanking and DC restoration also take place here. We'll discuss them

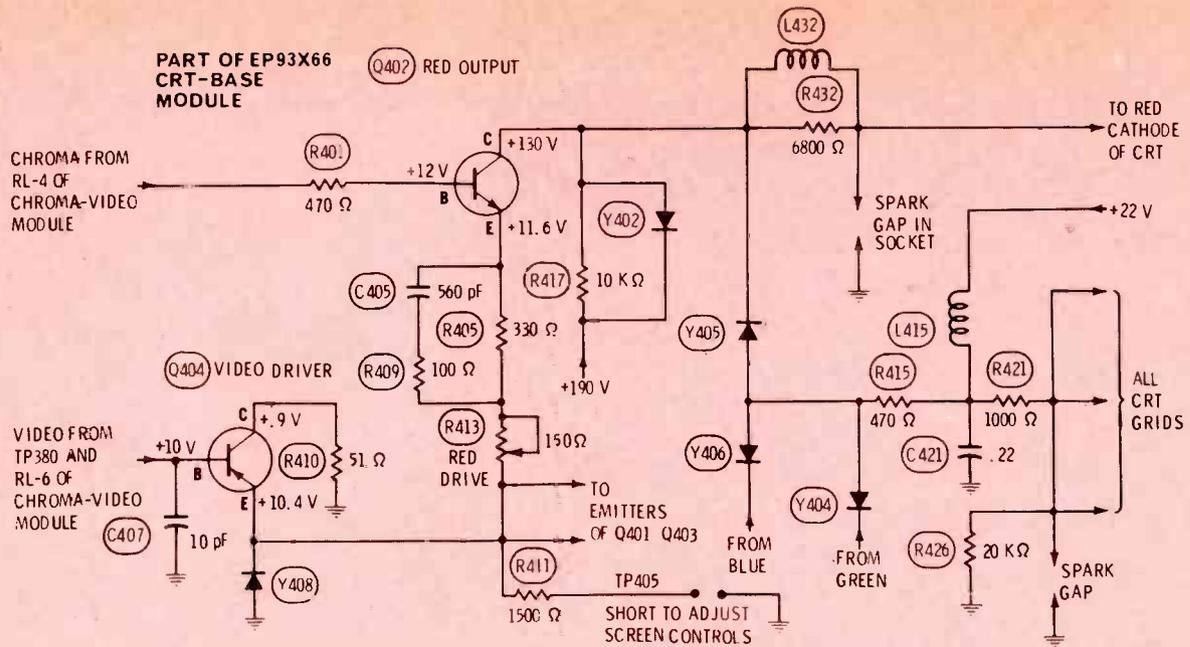


Fig. 14 Only the red-output channel of the EP93X66 CRT-base module is shown completely in this schematic. Of course, Q404 feeds video to all three similar color channels through the drive controls. Demodulated color goes to the three bases for matrixing inside the transistors. The diodes are for arc suppression only.

separately.

Positive voltages come from the brightness control (Pin 14 of the module), and from the brightness-range control (on the module). These combined voltages are modified by the emitter voltage from Q385, the "brightness-tracking

amplifier", then the sum of those voltages is changed again by the DC restoration action of Y345 (to be described later). Finally, this much-changed DC voltage arrives at the base of Q345, where it travels down the remaining video stages to the cathodes of the picture

tube and determines the brightness. **DC restoration**

Diode Y345 rectifies the video at the base of Q345, producing a negative DC voltage which decreases the positive forward bias (of course, increased video level causes a higher rectified DC voltage). This negative-going voltage is passed on to the cathodes of the CRT, making them less positive and producing increased brightness.

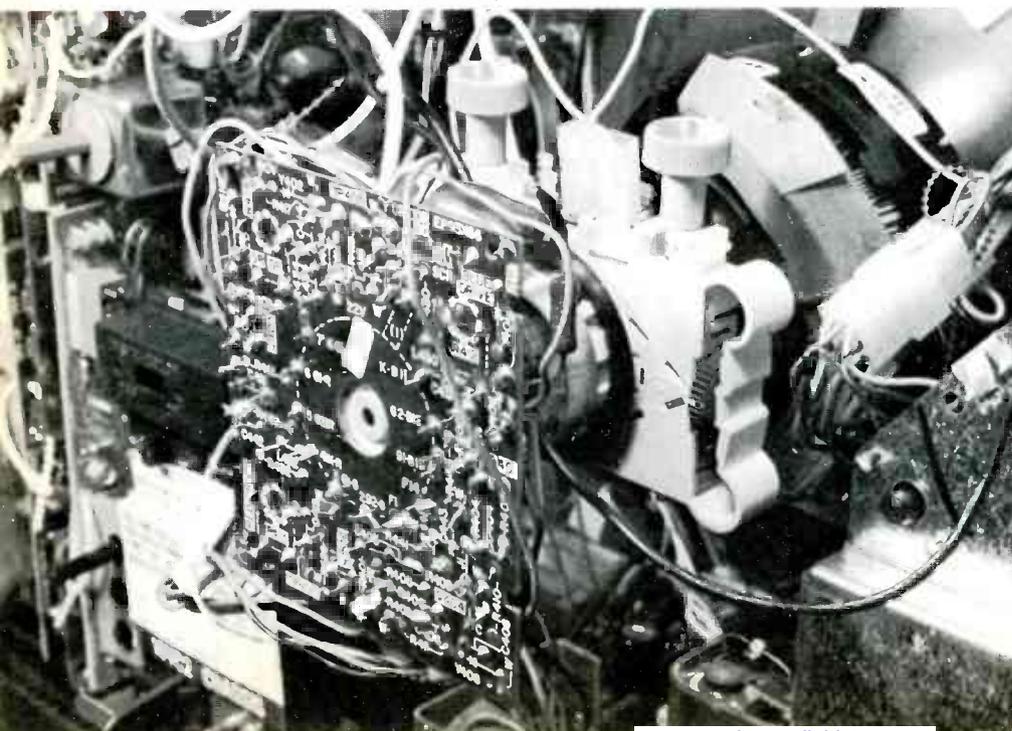
Therefore, increased video amplitude at the base of Q345 also produces increased brightness at the picture tube. Such operation is called "DC restoration". One advantage is that low-contrast scenes are reproduced with decreased brightness, thus preventing the black parts of the picture from looking gray.

If diode Y345 were to become open, any increase of contrast by rotation of the picture control would not change the DC voltage at the collector of the three color output transistors. But, with normal operation, an increase of contrast decreases the output collector voltages, causing an increase of brightness.

Blanking

Samples of vertical and hori-

Fig. 15 The CRT-base module acts as the base socket and also as a circuit board with transistors and components mounted on the front side.



zontal sweep are shaped and applied to the base of Q380, the blanking amplifier. It acts as an emitter follower, feeding horizontal and vertical blanking pulses through R380 to the video that comes from Q345 through R351. Waveforms of video before and after blanking are shown in Figure 13.

The video with blanking exits from the chroma/video module at pin 6 of RL17, the little 6-pin plug at the corner of the module, and it is wired directly to the base of Q404 (schematic is shown in Figure 14).

CRT Base Board

Four transistors, and other components are on the board that also serves as the picture-tube base socket (Figure 15).

Chroma goes directly to the bases of the red, blue, and green output transistors. Video comes through the video emitter follower, Q404, is adjusted for amplitude by the three drive controls, and then is applied to the three emitters of the output transistors.

The chroma and video, therefore, are matrixed in the output transistors. This is called "pre-CRT matrixing", because the matrixing occurs before the picture tube (and not inside it, as was commonly the case in the past).

Figure 16 traces the video waveforms through Q404 and the output transistors to the picture tube. While Figure 17 gives the waveforms at Q402, the red output, when a color bar pattern is used.

Although, the screen (G2) controls are on another module, these voltages travel through the CRT-base module (see Figure 18).

Comments

Who would have guessed that video circuits could be so complicated? Just remember that a good triggered scope and an accurate high-impedance DC voltmeter (perhaps digital) are your best items of test equipment. Signal levels are high enough (with the exception of the emitters of Q320 and Q330) to permit signal tracing with a scope anywhere in the video. Learn the correct waveforms so you'll know when they are wrong.

Next month we'll study the chroma section. □

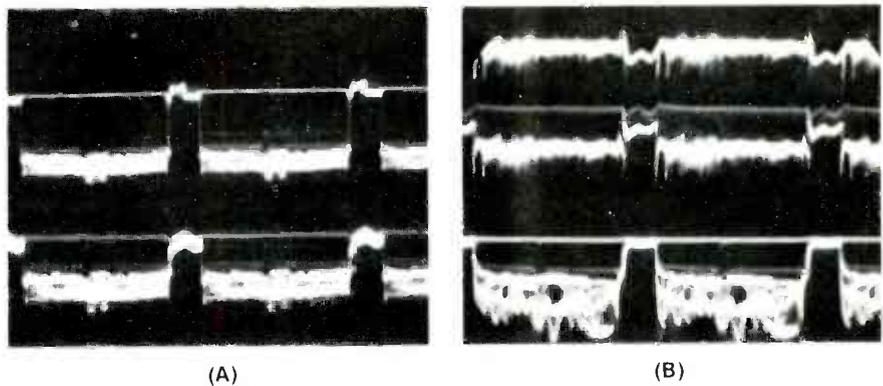


Fig. 16 These are typical video waveforms on the CRT-base module. (A) Top trace is the 6-VPP video/blanking signal at the base of Q404, and the 3.5-VPP signal at the emitter is shown by the bottom trace. (B) With the color turned down, the base of Q402 has a video signal, coming from the emitter (top trace). The center trace shows the normal Q402 emitter waveform of only 0.4-VPP. The 100-VPP collector waveform is shown at the bottom.

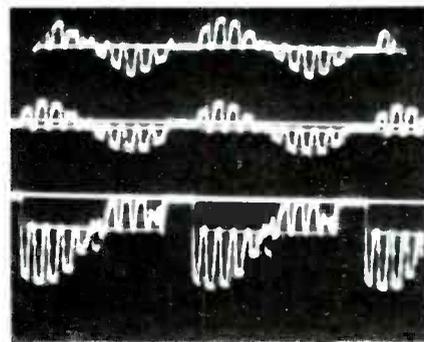
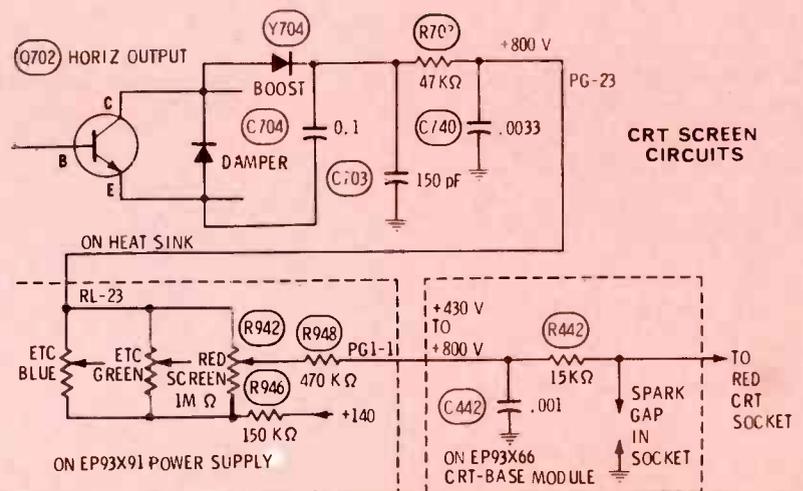


Fig. 17 Top trace is the 7-VPP color-bar signal at the base of Q402. At the emitter (center trace), the 6.5-VPP color signal is developed across the unbypassed drive circuit. It subtracts from the base signal to give the true color drive. A 135-VPP bar signal drives the red cathode of the picture tube (bottom trace). The bright red bars are negative-going, since they are applied to the cathode.

Fig. 18 A portion of the screen-grid (G2) wiring is on the CRT-base module, and the voltages are easier to find there for tests.



Those Mysterious Single-Sidebands



By Forest H. Belt, CET

Perhaps it's because the signal disappears when the modulation stops. Or, maybe the lack of reliable information about sidebands has left a technical vacuum. At any rate, single-sideband radios are not well-understood by many technicians. Here are some basic facts about single-sideband CB transmitters.

Soon you'll be involved with Citizen's Band radios having 40 channels instead of 23. In most brands, that means a change to the newest kind of frequency control: the phase-locked loop. More technology to learn.

Yet, in meeting with many technicians around the country in preparation for my 1977 **Forest Belt TRAINING WORKSHOPS** (see details elsewhere in this article), I find techs who haven't yet mastered the technology of present-day CB transceivers. Quite a few understand frequency synthesizers (one important complexity of modern transceivers). But I found surprisingly few who truly felt comfortable with single-sideband models.

And no wonder. A while back I thumbed through a book that professed to "teach" CB radio. That particular book was filled with misinformation about single-sideband CB. I've read magazine articles that failed to present the subject in specific detail, or show sufficient technical data, to let you feel that you could deal with troubleshooting a "sidebander" CB unit. Maybe in this article I can enlighten you at least a bit. You really do need to know single-sideband theory and practice. You'll be seeing a lot more of it as you continue servicing CB and

Editor's Note: Portions of this article were adapted from the author's book 1-2-3-4 **Servicing Transistor CB and Two-Way Radio**, available from your electronic distributor, or directly (stock number 20965; price \$5.75) from the publisher, Howard W. Sams & Co., Inc., Indianapolis, Indiana 46268.

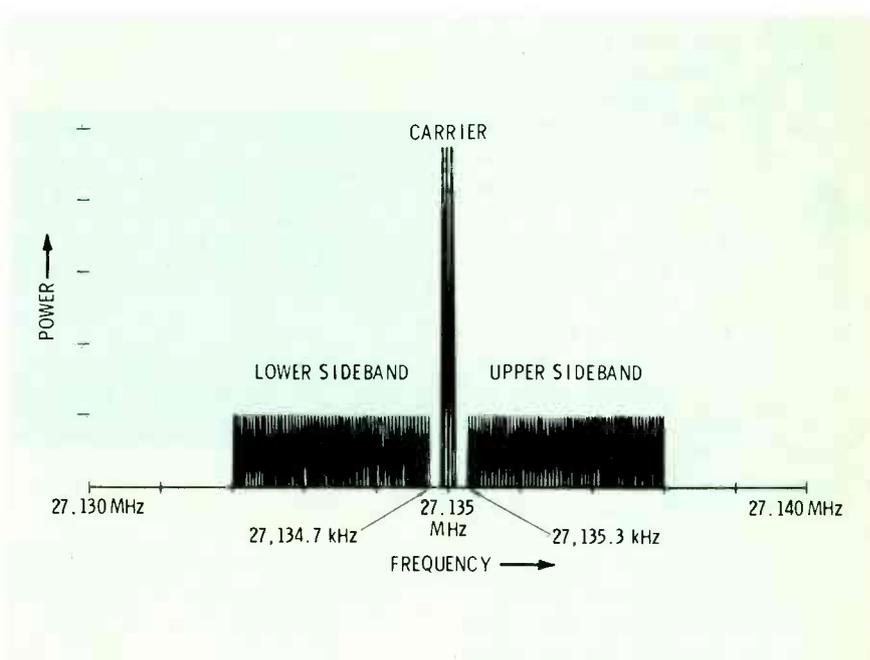


Fig. 1 Spectrum analysis of an AM signal shows the relationships of carrier and the sidebands.

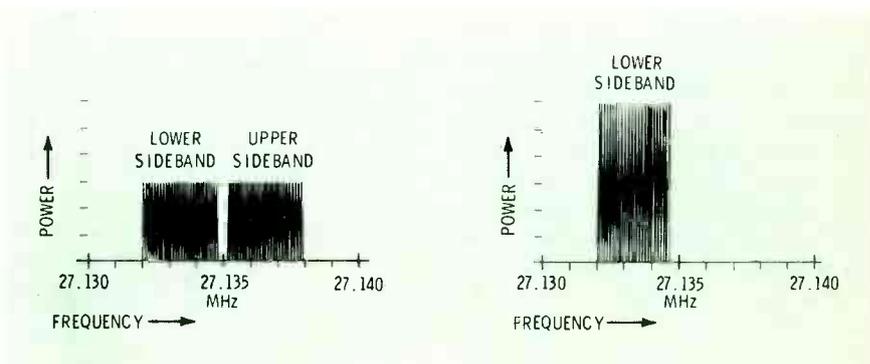


Fig. 2 When the carrier is removed, both sidebands can have increased power (shown by A). Even more power (B) can be used when only one sideband remains.

personal-communications equip- ment.

Origin Of Sidebands

Single-sideband signals come from double-sidebands, so let's look at the spectrum graph of an AM double-sideband signal in Figure 1. The AM signal consists of: (1) a carrier, of the frequency assigned to the transmitter; (2) a lower sideband, which is the difference frequency formed by heterodyning of the RF carrier and the audio modulation; and (3) an upper

sideband, the sum frequency. Notice, too, that the carrier contains most of the power.

However, only the sidebands "carry" the voice signal. The RF carrier is needed only to generate sidebands. It can be eliminated after that. Further, the two sidebands are exact mirror images of each other. Only **one** of them really is necessary to convey the voice intelligence.

Figure 2A graph shows what is left after you eliminate the carrier. All of the transmitter-output power

can be concentrated in the sidebands. Each one is nearly three times as powerful as before without working the output stage any harder. When one sideband is eliminated (Figure 2B), the entire transmitter output power goes to the one remaining, and the transmission becomes very efficient.

The only problem with the single-sideband system seems to be with the receiver, because a carrier is necessary to recover the voice frequencies. But there are methods of doing this with a reinserted carrier. These are the secrets of single-sideband communications.

How A Single-Sideband Transmitter Works

The diagram and graphs of Figure 3 illustrate how a simple single-sideband transmitter generates its signal. The example is taken from an actual CB model. At this time, don't worry about stages and circuit details. Just follow the general functions.

A **master oscillator** generates a crystal-controlled, fixed-frequency signal. This stage sometimes is called the basic oscillator, sometimes first transmitter oscillator, sometimes **carrier oscillator**. Its sole job is to produce an RF signal that can help generate sidebands. Later, once the sidebands exist, the carrier is eliminated.

Sidebands can be created in several kinds of modulator stages. The most popular is a **balanced modulator**. It has the attractive advantage of eliminating the carrier at the same time it creates the sidebands.

One input signal of a balanced modulator is RF from the carrier oscillator. The other is the audio voice signal. In Figure 3, the master oscillator of the transmitter chosen for an example generates a 7.7985-MHz (7798.5-KHz) signal. Voice frequencies for communications can be considered to occupy the audio spectrum between 300 and 3000 Hz (0.3 to 3 KHz).

Output of the balanced modulator is the double-sideband suppressed-carrier (DSBSC) signal of Figure 2A. Both upper and lower

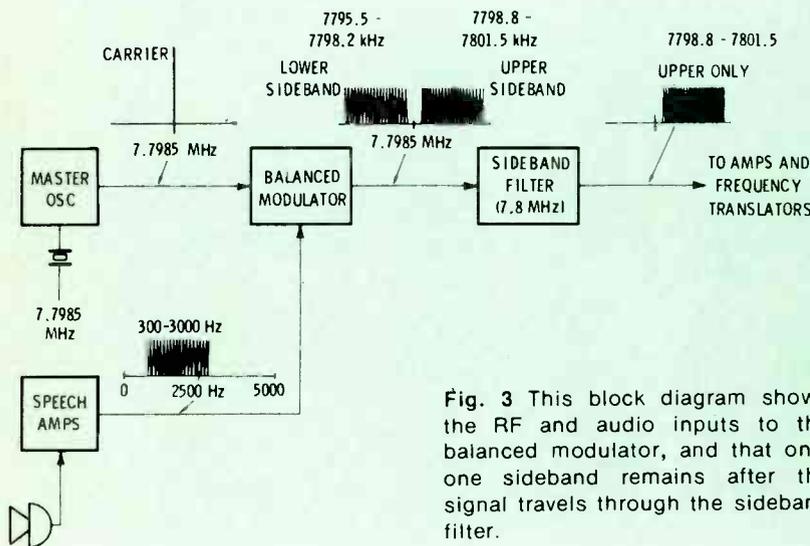


Fig. 3 This block diagram shows the RF and audio inputs to the balanced modulator, and that only one sideband remains after the signal travels through the sideband filter.

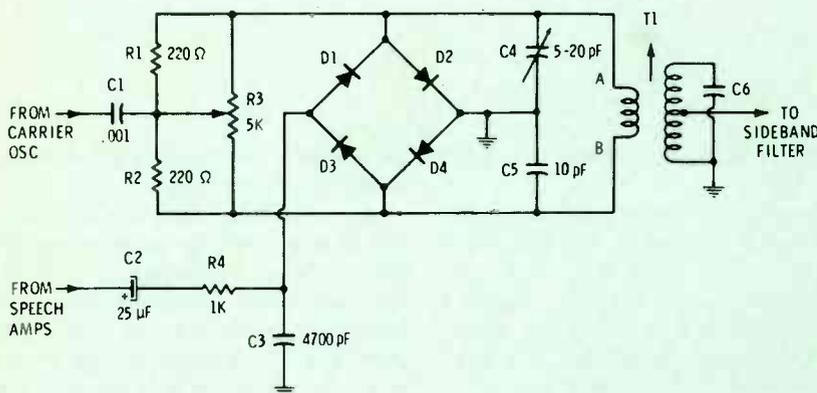


Fig. 4 One kind of ring-type SSB balanced modulator resembles a bridge, except for different polarity of diodes. Without voice modulation, the same amplitude and phase of RF signal reaches the primary of T1, at points "A" and "B"; therefore phase cancellation eliminates the carrier.

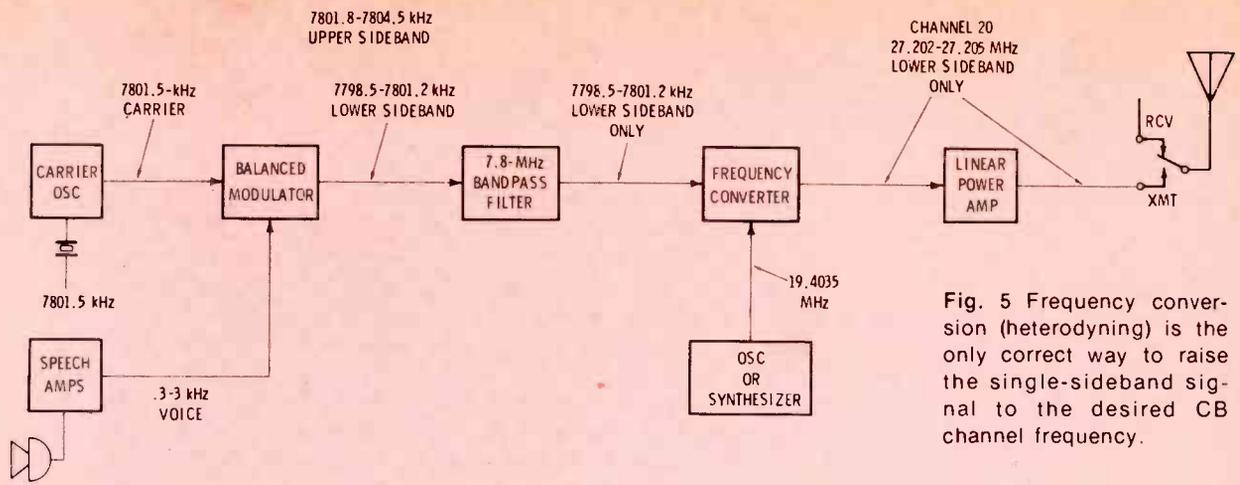


Fig. 5 Frequency conversion (heterodyning) is the only correct way to raise the single-sideband signal to the desired CB channel frequency.

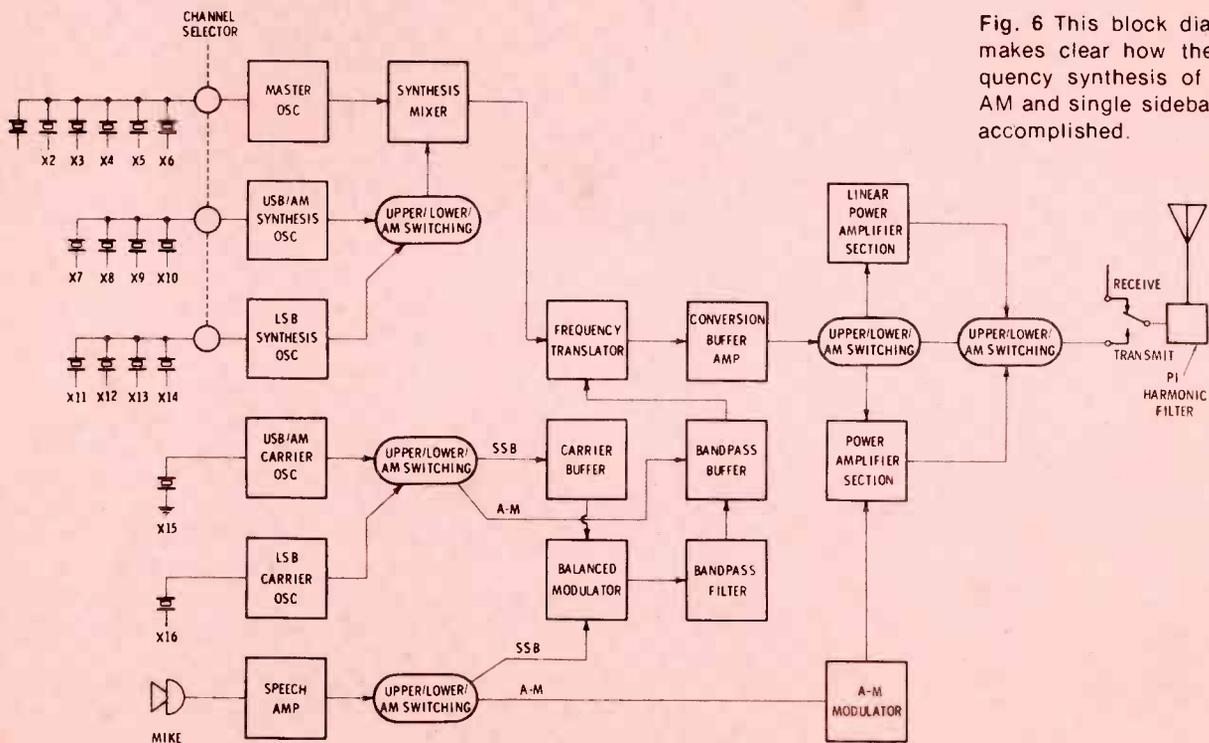


Fig. 6 This block diagram makes clear how the frequency synthesis of both AM and single sideband is accomplished.

sidebands have been produced, and the carrier canceled by the same process. Next, a bandpass filter gets rid of the unwanted sideband. The filter in this example is centered at 7.8 MHz, and has a bandwidth of 3 KHz. In other words, it passes everything between 7798.5 and 7801.5 KHz, including the upper sideband, which occupies 7798.8 to 7801.5 KHz.

Therefore, the lower sideband (7795.8 to 7798.2 KHz) is blocked, and only the upper sideband re-

mains to feed the transmitter stages that follow.

To pass the lower sideband, you only need to change the frequency of the master oscillator. Use your calculator on the figures. Suppose you switch-in a 7801.5 KHz crystal for the master oscillator. The sidebands from the balanced modulator then are: upper sideband, 7801.8 to 7804.5 KHz (will not pass through the filter); and the lower sideband, 7798.5 to 7801.2 KHz (will pass through the filter). This time it is

the **lower** sideband which remains to drive the transmitter.

A tuned filter that could remove the carrier, without attenuating the sidebands, is not practical. It would be excessively complex and prohibitively expensive. So, the simplest way of eliminating the carrier is to use a stage which cancels it as a **byproduct** of the modulating process.

Figure 4 shows one kind of **balanced** modulator that both modulates and cancels. It's called a

ring modulator, from the round-and-round hookup of the diodes. (Notice that the diodes do not have the same polarity as those in a power-supply bridge.)

The carrier is canceled by applying RF signals of identical amplitude and phase to the two input terminals ("A" and "B") of the T1 primary. To the transformer, this appears to be a zero input signal. In other words, the carrier is phased-out.

The effect of a centertapped primary winding is provided for T1 by C4, C5, and the ground between them, which gives a push-pull action. Since C4 is adjustable, the balance can be much better than if a centertapped coil and single tuning capacitor were used.

Two adjustments are provided to allow maximum cancellation of the carrier; they are C4 and the input potentiometer, R3. During tuneup, there should be no audio coming from the speech amplifier stages. Then T1 is adjusted for **maximum** RF output, while R3 and C4 are turned for **minimum** RF output. These three adjustments affect each other, so they should be done alternately several times for best accuracy.

When audio voice signals are applied to the "hot" corner of the diode ring between D1 and D3, the balance is upset. Let's take an extreme case. Suppose the voice audio has a large amplitude and is positive-going. Diodes D1 and D2 are forward biased, with D1 making a loss path for the RF through to C3, which acts as an RF ground. Also, D2 conducts, grounding the RF. Both diodes conduct, virtually shorting all the RF of the "A" side to ground. However, D3 and D4 are nonconducting because of the reverse bias, so the "B" side of the circuit has full RF amplitude.

A zero RF amplitude at "A" and a strong amplitude at "B" represents a large input signal for T1, which is sent by the impedance-matching secondary to the sideband filter.

During the negative peak of the voice waveform, D3 and D4 short out the RF, while D1 and D2 are open. Thus, "B" has zero RF, and

"A" has strong RF, providing a large signal to the sideband filter. Of course, the phase of the RF signal is reversed relative to the previous condition of a strong output. The phase has no effect on the circuit operation; it's just mentioned to keep the record straight.

Three conditions have been described. But in practice, the audio rarely has enough voltage to reduce the diode resistance that much. Instead, the resistances vary smoothly according to the voice voltages. The cancellation of the carrier is upset, but not completely. During those times a partial phase cancellation takes place, and the output RF voltage has some intermediate amplitude between maximum and zero.

When no voice audio is present, the diodes **do** conduct, because they return to ground. Positive peaks of the carrier through C1 cause conduction of D2 and D3, while D1 and D4 have current during negative peaks. These conductions are of no consequence, for the DC voltages created have opposite polarity and cancel. Also, the RF voltage has such low amplitude that the diode current is negligible, never acting as a short.

Balanced modulator—a summary

When the circuit is properly adjusted, and the audio level is correct, the output waveform will appear to be similar to a conventional amplitude-modulated RF signal. And, without any voice signal, the RF output is zero. The carrier either appears modulated or it's missing. We haven't mentioned sidebands, but they are the signal we want.

Mixing of the audio and the RF by the non-linear diodes during the modulation process produces sum-and-difference frequencies. These are the upper and lower sidebands.

Voice audio at the input of T1 does not cancel, but it cannot pass through the tuned circuit consisting of C4, C5, and T1.

Reaching The Channel Frequency

It's easy to reach the final frequency for AM or FM transmitters;

just use a few stages of frequency multiplication. That won't do for single sidebands. The complex signals of one sideband would become too wide (each doubling also doubles the bandwidth) if multiplied. What's worse, the relationships that are important to recovery of the voice signals in the receiver would be lost.

For single-sideband transmitters, another method is used. It's called frequency **translation**. The stage handling the frequency change is called a frequency **converter** or frequency **translator**. Figure 5 gives an example of how this system works.

In the balanced modulator, the 7801.5-KHz RF carrier mixes with the 0.3-to-3 KHz voice frequencies, producing an upper sideband covering 7801.8-to-7804.5 KHz, and a lower sideband of 7798.5-to-7801.2 KHz. The filter that passes a bandwidth of 3 KHz centered at 7.8 MHz rejects the upper sideband and passes the lower one. But that's miles from any CB channel frequency.

Suppose we select CB Channel 20. The conversion oscillator (or frequency synthesizer) generates a signal of 19.4035 MHz. In the frequency-conversion mixer, the lower sideband combines with this signal, producing these four signals:

- the original 19.4035 MHz signal;
- the original lower sideband from 7798.5 KHz to 7801.2 KHz;
- the difference frequency, a sideband group between 11.602 MHz and 11.605 MHz; and
- the sum frequency, a sideband extending from 27.202 MHz to 27,205 MHz.

The broadly-tuned output circuits center around 27 MHz. They easily reject all of the conversion products except the one sideband of 27.202 MHz to 27.205 MHz. That's the lower sideband of CB Channel 20, and it is the one transmitted.

Other channels

Change the CB dial to Channel 4, for example, and the oscillator feeds a 19.2035-MHz signal into the frequency converter. Of the four output signals, the only one accepted by the tuning of the RF output stage is the lower sideband

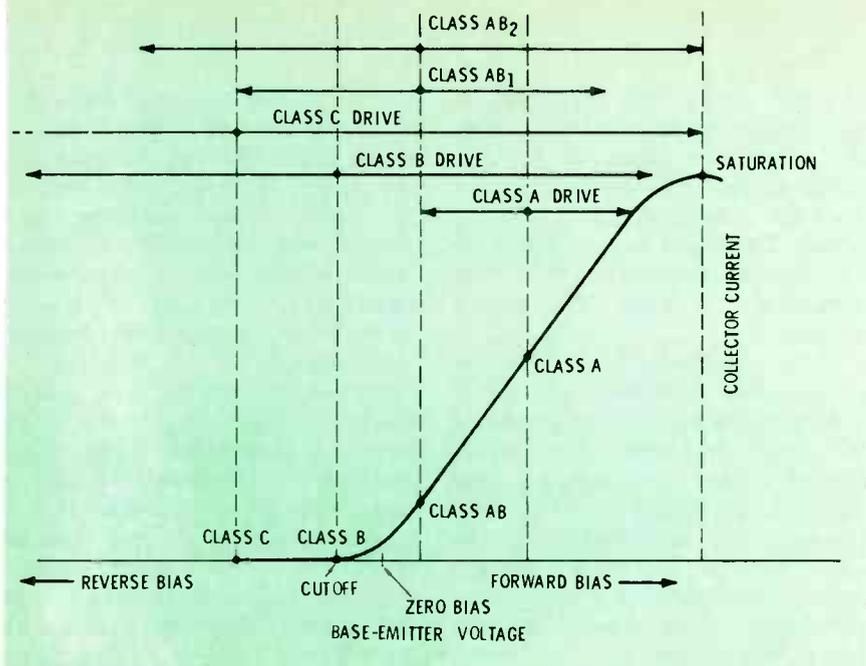


Fig. 7 A graph is the best way of showing the operating points of the transistor bias for various classes of amplification.

Crystal Frequencies and Purposes

MASTER OSCILLATOR		
Crystal	Frequency	Channels Covered
X1	11.705 MHz	1-4
X2	11.755 MHz	5-8
X3	11.805 MHz	9-12
X4	11.855 MHz	13-16
X5	11.905 MHz	17-20
X6	11.955 MHz	21-23
UPPER-SIDEBAND/AM OSCILLATOR		
Crystal	Frequency	Channels Covered
X7	7461.5 kHz	1, 5, 9, 13, 17, 21
X8	7471.5 kHz	2, 6, 10, 14, 18, 22
X9	7481.5 kHz	3, 7, 11, 15, 19
X10	7501.5 kHz	4, 8, 12, 16, 20, 23
LOWER-SIDEBAND OSCILLATOR		
Crystal	Frequency	Channels Covered
X11	7458.5 kHz	1, 5, 9, 13, 17, 21
X12	7468.5 kHz	2, 6, 10, 14, 18, 22
X13	7478.5 kHz	3, 7, 11, 15, 19
X14	7498.5 kHz	4, 8, 12, 16, 20, 23
THE OTHER OSCILLATORS		
Crystal	Frequency	Comments
X15	7798.5 kHz	Carrier oscillator for upper sidebands and a-m
X16	7801.5 kHz	Carrier oscillator for lower sidebands
X17	7343.5 kHz	A-m receive oscillator
7.8-MHz BANDPASS FILTER passes 7798.5-7801.5 kHz bandwidth		
A-M SELECTIVITY FILTER passes 452-458 kHz bandwidth		

Table 1 These are typical crystal frequencies and their purposes.

of Channel 4, which extends from 27.002 MHz to 27.005 MHz.

In the same way, other channels and either sideband can be selected.

Synthesizing SSB and AM Signals

Either SSB or AM can be obtained without much complication. The large block diagram in Figure 6 shows the functional relationships between the stages and major sections in one brand of CB transmitter. It operates in either mode of operation at the flip of a switch, and either sideband can be selected.

AM

Consider amplitude modulation first. The signal is started by crystal X15 at 7798.5 KHz in the USB/AM carrier oscillator. The upper-lower-AM (U/L/AM) switch connects that signal directly to the bandpass buffer, bypassing the balanced modulator, filter, and the SSB components.

This 7798.5 KHz signal is the initial carrier for all CB channels during transmitting. Then, the channel selector determines the appropriate synthesizer crystals for the CB channel you wish to use.

Take Channel 5 as an example. (See Table 1 for the crystal frequencies.) The channel switch selects crystal X2 in the master oscillator and crystal X7 in the USB/AM synthesis oscillator. These heterodyne in the synthesis mixer to make 19.2165 MHz. From the mixer, that signal goes to the frequency translator where it's mixed with the 7798.5 KHz carrier. The result is 27.015 MHz; Channel 5.

You can make similar calculations for any other channel, to prove the system works.

A tuned power amplifier builds up the output so that 4 watts of RF power is sent to the antenna. The modulator receives voice signals through the U/L/AM switching from the speech amplifier, and then alternately increases and decreases the RF output, in typical AM fashion.

SSB

For single sideband, the U/L/

In-Person TRAINING WORKSHOPS Start in 1977

One answer to the shortage of CB/communications technicians lies in more training. Electronic schools have not yet met the need. Some manufacturers offer repair seminars, but only for their own brands.

Soon now, you can attend a **Forest Belt TRAINING WORKSHOP** that teaches high-speed servicing for all brands and models of CB radio. Beginning in February 1977, Forest Belt—a leading writer of CB and electronic training books and a popular teacher/lecturer—begins conducting five-day **Training Workshops** in cities around the country. Sometime during the year, there will be a **Workshop** within your traveling distance.

All Training Workshops planned so far feature **CB Radio Servicing**. Each workshop comprises two sessions.

Three-day session "A" brings you comprehensive, understandable explanations, illustrations, and demonstrations of CB communications, of how AM and single-sideband CB transmitters and receivers work, and of a logical system for troubleshooting symptoms in any kind of transceiver. You learn to read complex CB schematics, for tracing defects.

On the third day you move into **Advanced CB Servicing**. Here you dig into the nitty-gritty of CB troubleshooting. You see how professionals pin down faults in antenna installations, in frequency synthesizers, 40-channel phase-locked loop circuits, single-sideband modulators and detectors, and the like. You learn alignment, performance measurements, transistor and integrated circuit testing, and how to use special CB instruments. Through unique, copyrighted **Forest Belt** training materials and training methods, you'll absorb more than you thought possible in so brief a time.

As you know, any technician who legally services CB transmitters, must have the FCC Second Class Radiotelephone Operator License. Session "B" of each **Forest Belt Training Workshop** in **CB Radio Servicing** offers a **Second Class License** option. Anyone completing Session "A" needs only this additional training to be ready for the FCC exam.

These final two days familiarize you with FM transceivers such as those used for marine, police, fire, taxi, and other land-mobile com-

munications. You learn vital FCC law, and about HF, VHF, and UHF antennas. You also take two short exams and a longer **Preparation Test**—all similar to actual FCC exams.

Each five-day **Workshop** closes with an **Awards Dinner** on Friday evening. You receive your **Diploma**, and the results of your **Second Class License Preparation Test**. Several special awards go to attendees who earn them.

Forest Belt, who will conduct the majority of his 1977 **Training Workshops** himself, says, "The breadth and depth of these **Workshops** suits them to beginners in communications as well as experienced technicians. They fit anyone in electronics who wants to build competence quickly to service **Citizens Band** and other personal communications gear." He also points out, "We're limiting the number in each **Workshop** so there's time for personal help and guidance."

For more details, a schedule of locations and dates, and enrollment applications, write: **Forest Belt Training Workshops**, P.O. Box 68120, Indianapolis, Indiana 46268. □

AM switch is turned to the upper or lower sideband position. One carrier oscillator or the other feeds the balanced modulator through a buffer amplifier. The speech amplifier also sends voice signals to the balanced modulator. Sidebands from the modulator go to the 7.8-MHz bandpass filter which blocks one sideband.

After that, the selection of output frequency goes the same as described for AM. Except that a linear RF power amplifier is substituted for the AM one. The linear operation is necessary to prevent upsetting the sidebands' relationships to each other.

RF power amplifiers for AM can operate Class "C" and achieve higher efficiency. The distortion from the extreme nonlinearity is

smoothed by the tuned circuits in the output.

But a single-sideband signal must be power amplified without any nonlinearity. Any extraneous frequencies developed from beats between the sidebands or added by a stage are very undesirable.

Linear SSB Amplification

The most-linear operation of any amplifier is Class "A". Transistor (or tube) bias is selected to place the operation on the linear portion of the base-voltage/collector-current (or grid-voltage/plate-current) transfer curve. Figure 7 is a graph of the base-voltage/collector-current characteristics of one power transistor, spread slightly to allow an explanation. A dot marks the spot on the curve where the forward bias

establishes Class "A" operation.

So long as the RF drive to the base is not too strong and swings the bias beyond the straight (linear) part of this operating characteristic curve, the Class "A" amplifier introduces no distortion.

But, the problem with Class "A" is its poor efficiency. At best, efficiency never can exceed 50%; normally, about 35% is considered to be good. Even with the advantages of SSB, where all the power is concentrated in one sideband, you'll have trouble getting more than 8 watts or so of peak-envelope power (PEP) from the 5-watt DC input that's all the law allows for CB. Real power amplification is needed; not merely high voltage amplification.

Class "B" offers one answer,

THE CB PROFIT GENERATOR



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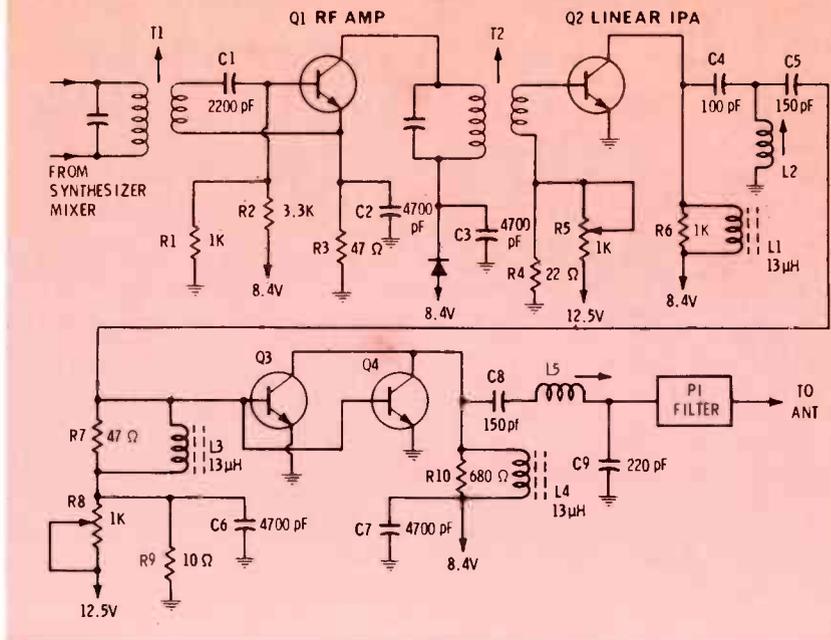


Fig. 8 Sometimes two output transistors are operated in parallel to provide sufficient power for overcoming the losses that are necessary in reducing the distortion.

despite its distortion. With Class "B", the bias must barely cut off the collector current when there's no signal. Usually that takes a slight reverse bias. The transistor has collector current only about half the time, and from the 5-watts of DC power allowed for the CB final, a Class "B" stage can safely develop up to 18 or 20 watts PEP. There are ways to reduce the distortion, and some linear amplifiers operate in Class "B". However, there's a compromise. A Class "AB" stage generates less distortion than Class "B". The operating point is between A and B on the transistor curve, right at the knee. Much of the transistor action is on the linear portion of the curve, and the power gain is only a bit less than for Class "B".

There are even two modes of Class "AB". Class "AB-1" has less drive and is more linear. Most RF output stages in single-sideband CB are run in Class "AB-1", as the best compromise. Negative feedback often is used to minimize the distortion, and two transistors might be paralleled to raise the maximum power.

SSB Transistor Power Stages

Typical SSB power-amplifier sections (Figure 8) amplify the sidebands without noticeable distortion. The first stage, operating in Class

"A", provides voltage amplification of the signal from the translator (synthesizer mixer).

Power gain is contributed by the Intermediate Power Amplifier (IPA). Q2 runs in Class "AB-1", with the exact bias point adjusted by R5 to accommodate the drive level. L2 tunes the output of the IPA. The bandwidth is fairly broad, but tuning helps the efficiency and reduces the harmonics.

Bias for the paralleled output transistors (Q3 and Q4) is set by R8. It can be readjusted for Class "AB-2", if higher power is needed. C8, C9, and L5 provide most of the tuning of the output RF signal, aided by the pi harmonic filter, before it reaches the antenna.

Comments

That about covers the SSB transmitter stages and circuits you need to know about in order to service them. You should have acquired a basic understanding of this CB function.

But transmission is only half of the job. Communications go in two directions. For every transmitter, there is a receiver. And SSB receivers are somewhat different from conventional ones. Later, we will examine the functions of SSB receivers, including sideband demodulation for recovering the voice signals from CB transmissions. □

SERVICING ELECTRONIC ORGANS



Part 7/By Norman H. Crowhurst and Carl Babcoke

This concluding article of the series gives answers to many questions about how to start an organ-repairing business. In addition, some miscellaneous technical subjects are explored.

Would you like to become a professional organ-repair technician, either full-time or part-time? Or, if you are interested in audio and music, perhaps you are attracted to the organ field as a fascinating hobby? Either way, we'll try to give you some pointers. The opportunities are there, if you are qualified and plan wisely.

Certainly, the thousands (perhaps millions) of organs now in use indicate a potential huge demand for capable technicians. Only a few years ago, a city might have had only three organ retail dealers (Wurlitzer, Baldwin, and Hammond). Most sales then were to churches, with a few organs going to private homes, supper clubs, and

baseball stadiums.

But now the trend has reversed. A large majority of the organs sold are for home use by amateur musicians. It's not unusual for an organ owner to contact a dealer or technician 50 or 100 miles away, when service is needed. Yes, in many areas, more organ technicians are needed.

Our advice and tips will be in two parts: first, the business aspects; and then electronic and musical suggestions.

Starting A Business

Details such as obtaining a building, getting utilities, and financing will not be discussed here,

because they are not unique to organ repairing. Some of you might have that much of the business operating already.

Apprenticeship

If you are a young man who has finished a trade-school electronics course and are ready to specialize in some kind of repair work, one practical and time-tested way is to become an assistant of a technician who is experienced and has a going business.

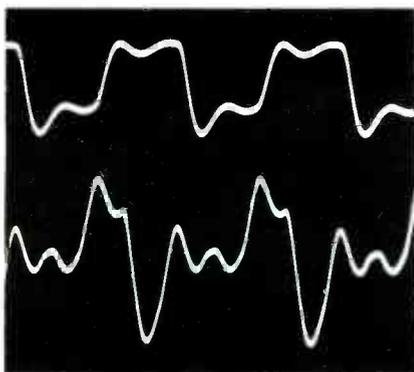
During your apprenticeship time, you would be expected to attend all local seminars sponsored by the organ manufacturers, read books and magazines about organs, and learn as your "boss" instructs you



The owner of this old-timer declares he never will trade it. Of course, it has been partially modernized by the addition of a percussion unit, a mechanical harp with Wurlitzer variable-phasing vibrato, and external speakers including an 18" woofer.



Some of the older Baldwin's returned each pedal to the top with a flat spring. Unless they are adjusted periodically, the spring aging might allow a note to speak softly all the time. This can sound like hum. Adjustments are easy to make using an open-end wrench.



Organ notes add in amplitude. A single clarinet note is shown by the top trace. When that note and one an octave higher were sounded together, the amplitude was approximately doubled (bottom trace). Common chords of five notes plus one pedal would increase it even more. Beats between notes also create crests of high amplitude. These are reasons why organs require powerful amplifiers and speakers.

during the daily work. The advantage is that you can learn the business without any investment or responsibility.

Then, after you become experienced and capable of servicing solo, you must decide whether to work for the present employer, solicit employment with a retail organ dealer, or start your own repair business.

Expand from TV

Many of you already have an electronic-service business of some kind, either TV, stereo, auto-sound, or CB. From that start, it's an easy matter to ease into organ servicing by advertising, contacting non-servicing organ-sales dealers, and passing around the word that you're ready and willing.

Probably you now have sufficient tools and test equipment for the new venture. Next, you need a stock of organ components and some service information.

Licensing

Many of the organ manufacturers "license" repair organizations. This is a mutual agreement for you to stock the required parts kits, observe the factory warranty, and attend seminars; and for the manufacturer to sell you parts and service information. A repair by an unlicensed technician could give the manufacturer a valid reason to void

the warranty on the organ.

Of course, licensing is not mandatory for servicing organs, but it can be a great help, especially for parts and data. And it's not necessary to be licensed for any repairs on older models.

Components

The general run of replacement parts usually are satisfactory for the older tube-equipped organs. Most of the tube types are still available, although one convenience has been stopped. The pre-amp stages of many organs need tubes with low noise and hum. Away back when, the organ manufacturers and tube manufacturers (for an extra price) offered pre-tested tubes with low hum and noise. These days, you must buy too many and test them yourself to find the few best ones, then hope you can use the culls for less critical replacements.

Newer organs have such a wide range of LSI-type IC's that they can't satisfactorily be replaced from off-the-shelf stocks. Such cases make the "licensing" worth the trouble.

For many replacement uses, you might say any diode is okay, just so long as the voltage rating is high enough. Not necessarily so with organs. Is the reverse current low enough to cut-off completely the sound of one note? Or, if the internal capacitance is too high, the diode can act as a small coupling capacitor, feeding through the harmonics of that note. Few things in music are as annoying as a note playing softly and constantly.

Parts availability, or rather unavailability, can affect the costs of organ servicing even more than in the TV or stereo business. That's because the service area is not the immediate neighborhood, or even a complete town or small city, but often encompasses as much as several counties. A second service call, made necessary because of a lack of parts, becomes quite expensive, when a 300-mile round trip is involved.

Mechanical Repairs

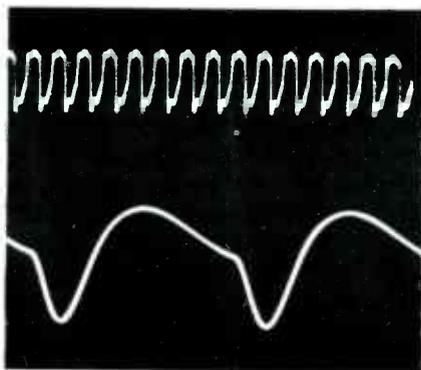
Because the organs have strictly electronic circuits, a beginner might believe all repairs will be the replacement of shorted diodes and open filter capacitors. Not so. Organ work has more than its share of mechanical complications.

Some of the obvious ones include the motors for spinning the rotors of mechanical tremulants, or (in the case of older Hammonds) used to rotate the tone generator.

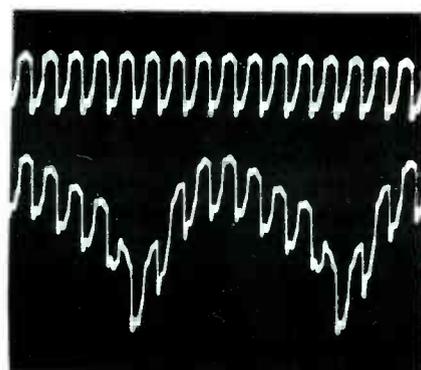
Many expression pedals which were stuck at full or minimum volume have been repaired merely by tightening a set screw where the collar fits on the shaft of a rotary control, or by straightening a bent linkage.

Keying switches, under the notes, often appear to be only pieces of spring wire. Sometimes, they take a "set" and require rebending so they open and close at the proper point. Is that an electrical or a mechanical repair?

Older Baldwins with the long pedalboards require periodic tightening of the flat springs (one for



(A)



(B)

The amplitude of a pedal note is several times larger than that of a single manual note. Top trace of (A) is Middle "C" of the clarinet stop, and below it is the low "C" pedal note. The same scope gain was used. When played together, the higher-frequency note "rides" on the pedal note (B), and the total is more likely to overload the amplifier.

each pedal) that return the pedal to the up (off) position. When a spring becomes weak, the note will not shut off completely, and sometimes the weak note sounds exactly like hum. Other brands might break a pull spring, so the note sounds continually.

Problems Outside The Organ

Organs have been blamed for many problems that were not due to any organ defect, although sometimes the organ triggered it. I'm referring to miscellaneous noises, rattles, and buzzes which appear to come from the organ, but in actuality are sympathetic vibrations (a kind of mechanical ringing) set in motion by the speaker-cone movements and air currents from the speakers. Many times the trouble is triggered only by a certain note, usually one of the pedal frequencies.

For example, one experienced technician solved a bad case of "speaker rattle" by removing all of the wire coat hangers from a hall closet located near one of the external-speaker cabinets! And it's common for knick-knacks on top of a spinet organ to tinkle or rattle during certain notes or chords.

Reverberation

The first organs of several centuries ago were pipe organs which invariably were installed in cathedrals of sizes and shapes that automatically provided a huge amount of reverberation. Therefore, the traditional organ music was written for and performed with this reverberation. Listeners became accustomed to it. Perhaps that's why organ music today seems smoother, more alive, and better than without reverberation (when it is described as "dry" and "dead").

Also, reverberation tends to mask the clicks always present when continuously-operating sine waves are keyed instantly. These clicks are not a defect, but switch keying adds a vertical line to the waveform at the beginning or ending of each note; to the ear, this sounds like a "click". More than one musician has thought an older Hammond (without reverberation) was malfunctioning when these clicks were noticed.

Anyway, some extra precautions are necessary in servicing reverb units. Most models have one or more coils of spring material, which slow down the movement of mechanical vibrations along the springs. And, because the spring is not damped (terminated) at the far end, the vibration bounces back and forth from input to output and output back to input many times before the losses eliminate it gradually. Music signal fed to the magnetic drive unit at the input shakes the spring, and a magnetic pickup changes the vibrations into an audio signal at the far end. This reverb signal is fed into the main amplifier.

Such units are far from perfect. The response is peaked and narrow band, the pickup unit tends to generate hum, and there is some distortion. However, the majority of people would rather accept it with the shortcomings than be without **any** kind of reverb.

The old, old Hammond units had four springs (as I remember) that were damped in oil, a modified speaker without cone for a driver, and a crystal-type pickup. If you move one of those tone cabinets, be certain it isn't tipped too much, else the oil will run out (that gets a bit messy).

Usually the reverb units have hold-down mechanisms to secure the springs against damage and dislocation during shipping and moving.

Also, these units are microphonic. If the cabinet is bumped, a loud sound like thunder occurs because of excessive movement of the springs.

The "reverberation" stop on a few models does not give actual reverb. Instead, it's a type of sustain that allows each note to die away slowly.

(A) 16' tibia, played by middle "C"

(B) 4' salicet, played by middle "C"

(C) 8' French horn, middle "C"

(D) 8' diapason, middle "C"

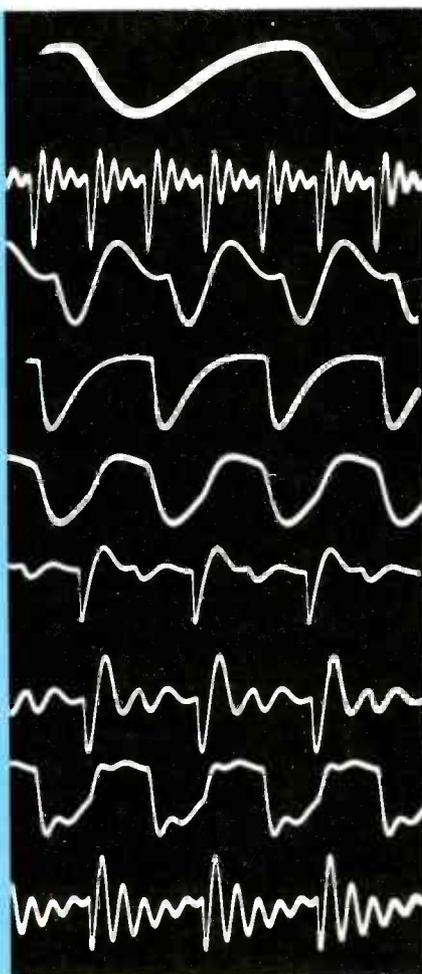
(E) 8' tibia, middle "C"

(F) 8' salicional, middle "C"

(G) 8' trumpet, middle "C"

(H) 8' clarinet, middle "C"

(I) 8' oboe, middle "C"



Here are some waveforms from one model of organ. Such waveforms might appear to be very different if viewed on another brand and model.

Hi-Fi Speakers

Beware of the organist who asks you to connect the organ so it plays through the PA system directly, or through external hi-fi speakers. In most such installations, the tone quality will be very poor.

I admit it seems logical to replace a built-in standard-fidelity speaker with an external wide-range speaker system that has tweeters to extend the range beyond the high-frequency cutoff of the original speaker.

But both you and the customer must understand that **the speaker system of an organ is a vital part of the "voicing"**. Extreme high-frequency response is not desirable with most organs, especially those having sawteeth or square waves which are filtered by the stop circuits to create the distinctive voices. Excessive highs cause a kind of buzzing sound from several of the stops, which can be distressing to a sensitive musical ear.

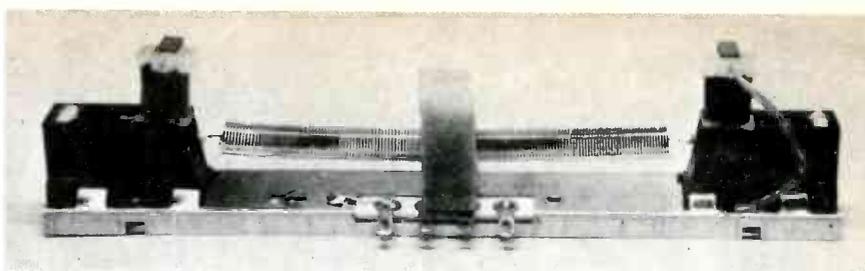
The rolloff of high frequencies in a standard speaker (without tweeter or "whizzer" cone) can be more pleasant to the ear than the sounds from most electronic rolloff filters. (It's cheaper, too.)

Another factor is the direct versus the diffused distribution of sounds from speakers. Organ music does not sound very natural with the speakers pointed directly at your ears. Years ago, one manufacturer discovered that the clicks from abrupt keying were minimized if the sounds from the rear of the speakers were heard, rather than those beamed from the front. It was a valid solution to a sticky problem.

Ideally, organ speakers should be baffled inside a reverberation chamber, with only a small window feeding the diffused and reverberated sounds out into the listening area. Obviously, not many people will spend that much money or provide so much space.

Bass response

Loud pedal volume with even frequency response so the pedal notes have the same loudness (to the ear) is very important for good organ reproduction. Few, if any, organ speakers have flat response down to 32 Hz, the bottom 16' "C" pedal note. Next best is a smooth,



This tiny reverberation unit illustrates the basic principles of "spring" systems used in many organs, although it has only one spring (others have two or three) and was intended for use in an auto stereo system. When driven by audio power, a winding with iron core shakes one end of the spring. The spring continues to vibrate even after the sounds are finished. Vibrations of the spring shake a similar magnetic pickup at the other end, creating an audio electronic waveform that decays slowly. The signal is fed back into the main amplifier.

gradual bass rolloff.

Surprisingly, the bass response of many small console organs with internal speakers is smoother, with fewer objectionable peaks, than some hi-fi stereo-type speakers. The reason? Well, an organ console provides a fairly-large air volume with several openings preventing a single large resonance. While the hi-fi speaker might be a bass-reflex type with one large peak and a smaller-amplitude peak in the pedal range. All speaker systems that have a large bass peak have a severe falling response below the peak, and this adds to the problem.

Of course, organ speakers and special external organ speakers can exhibit peaks, also. For example, the older Leslie (with rotating speakers to give a pleasing doppler-type vibrato) peaked at about the pedal 16' "G" and was much softer below that point.

We suggest you use discretion about any requests for modifications of the original organ speaker systems. Remember that organ speakers are "producers" of tone timbre, and not just "reproducers". And you should study acoustics so you can answer questions or unfounded complaints from customers, as well as become competent to design good-sounding speaker systems.

Repairs Versus Tradein

There is no clear-cut answer to the questions about when an expensive organ repair is justified, or whether you should recommend the customer trade the old organ on a new one.

Of course, the newer organs have many benefits from solid-state technology: the synthesizers for making up your own distinctive sounds; circuits that play percussion instruments (drums, cymbals, etc.) in rhythm for you; and others playing chords or pedals automatically.

As electronics men, we are fascinated (and rightly so) by the exotic circuits, and what improved things they can do. But let's be honest and realistic. Many musicians are not attracted to or curious about such gadgets. They couldn't care less whether tubes, transistors, or compressed cabbage makes the notes. And often they are accustomed to the sound of their old organ and don't want to change. A large repair bill probably won't dismay them.

Perhaps the middle road is best in giving advice. If a repair customer asks about the new organs and their advantages, then answer as completely as he desires. But, don't volunteer much more than you are asked.

Remarks

Organ sales continue to spiral, with no plateau in sight. Therefore, organ repairing can be an excellent field to enter while it's expanding.

Musical knowledge or ability is not absolutely necessary, just so long as you are not completely tone-deaf. But we will admit that at least a liking for music would be an asset.

This article is the last of the series, for now. Write to the editor, if you have comments or suggestions. □

Reports from the test lab

By Marvin J. Beasley, Vice President, Technical Associates, Inc.

Each report about an item of electronic test equipment is based on examination and operation of the device in the ELECTRONIC SERVICING laboratory. Personal observations about the performance, and details of new and useful features are spotlighted, along with tips about using the equipment for best results.

New items of CB-radio test equipment are pouring out in a flood. Most are of the second generation, and offer CB technicians improved speed and ease of operation, along with better accuracy and stability. The B&K-Precision Model 2040 CB Signal Generator is designed to test all receiving characteristics of both conventional AM and single-side-band (SSB) radios on all 40 channels. Considering all of the measurements the 2040 will make, the generator panel is relatively uncluttered (Figure 1). Both meters are lighted, when the power is on.

Channels

Channels are selected by a rotary switch, in the same way as with CB receivers. But in addition to the channel dial window up above the knob, there is a smaller window at the right with the exact frequency displayed.

All channel frequencies are produced by a programmable crystal-

controlled phase-locked loop (PLL) that has a capacity of 50 channels. Only one crystal is used. Therefore, all channels have precisely the same frequency error. This individual generator was 53 Hz low in frequency on all 40 channels. That's excellent accuracy.

A temperature-regulated oven for the crystal maintains the frequency within $\pm 0.0005\%$ or ± 5 parts-per-million (PPM). When the power switch is in the "off" position, the oven heater still has power. Therefore, the frequency accuracy is within specs immediately after turn-on. If the generator is unplugged, or the outlet is switched off when not in use, a warm-up period of 15 minutes is necessary before the frequency becomes stabilized.

The channel RF signal emerges from a standard 50-ohm jack located near the lower-right corner of the front panel, directly underneath the attenuation-range switch.

If the transmitter is keyed-on while the generator is connected,

the full power is applied to the generator output circuit. No generator damage should occur, because the circuit is protected against the legal 4-watts of power for a period of less than one minute. But it's best to not take chances. So, we suggest you remove the microphone plug from the radio while you test the receiver functions, to prevent accidental turn-on.

Attenuator

Calibration of the RF-output signal is accomplished by a combination of an RF Level meter, an 11-position precision attenuator which is calibrated in both microvolts and dBm per 50 ohms, and an uncalibrated RF Level knob. With the meter readout, it is not necessary for the knob to be calibrated; the meter is much more accurate.

Levels down to 0.3 microvolt can be measured accurately. If lower levels are needed, a 20-dB loss pad should be added externally. This reduces the output voltage level by a factor of 10 (down to 0.03 microvolt).

Figure 2 shows one reason for the low level of stray radiation: an extensive system of double shielding with inductors and feedthrough capacitors on all of the wires. Also, the sections of the attenuator switch apparently are in separate shielded compartments (Figure 3) and operated by plastic cams (the long white object on the left).

Noise Generator

A feature seldom found in signal generators is a noise source for testing and servicing automatic noise limiters and noise blankers.

Fig. 1 Controls of the B&K-Precision Model 2040 CB Signal Generator are laid out logically, to speed operation and minimize mistakes. Modulation controls and meter are on the left, channel selector is in the center, and attenuation controls, meter, and RF/IF output jacks are located on the right.



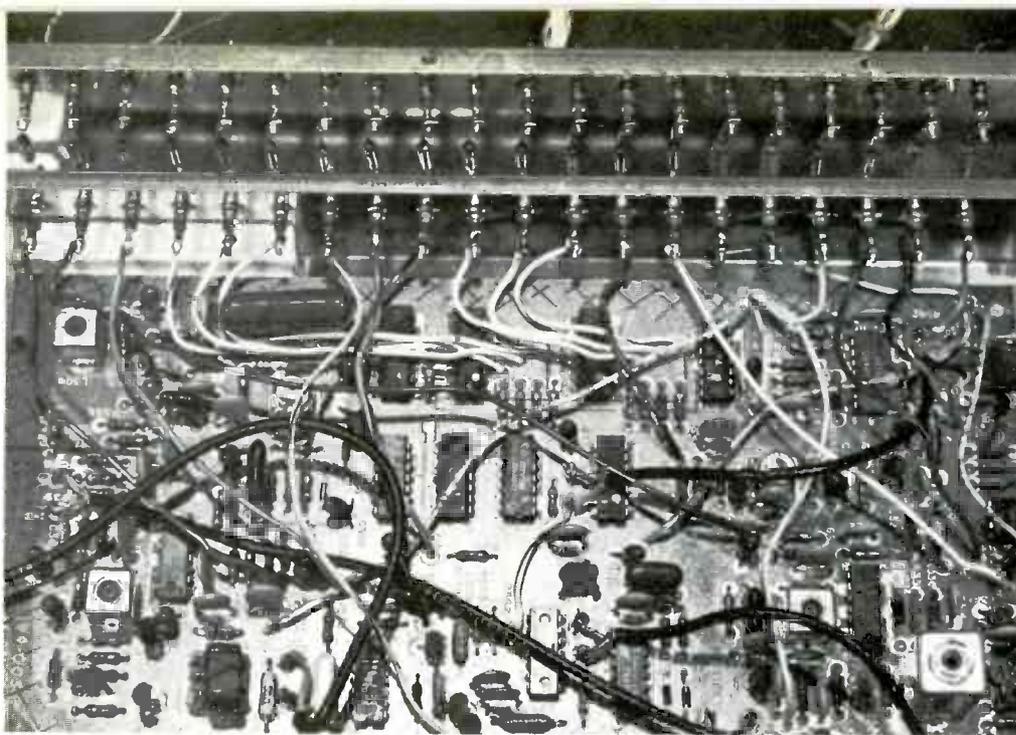


Fig. 2 Double-chassis design plus cabinet shielding and double feedthrough capacitors with inductors between each pair minimize undesired radiation of the signal.

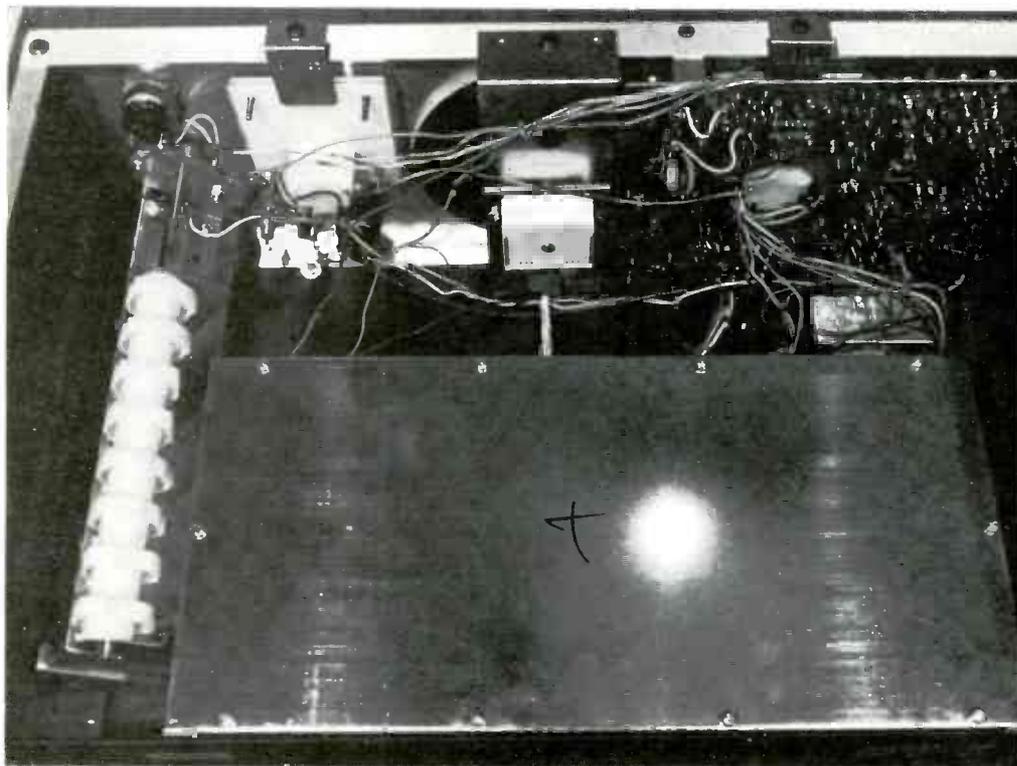


Fig. 3 The main PLL shield is shown in place. The long white object at the left is the plastic cam which operates sections of the attenuator switch. These sections are inside separate shields to minimize leakage.

The B&K Model 2040 adds pulse noise to the receiver along with the regular signal when the RF Level knob is pulled out.

IF Signal

For alignment adjustments of the receiver, a 455-KHz crystal-controlled signal, with fixed 30% modulation, is available from ba-

nana jacks. The attenuator is not calibrated. An LED lights when the 455-KHz signal is turned on.

Modulation

On the left side of the panel are the controls and meter for the various kinds of modulation. A switch selects CW (no modulation), 400 Hz, 1000 Hz, 2500 Hz, or

external modulation input (from banana plugs). Any of the three frequencies can be used for conventional amplitude modulation, producing double sidebands. Distortion is quite low, and these tones can serve as the source for a distortion check.

The Modulation Percentage meter is calibrated directly in percent,

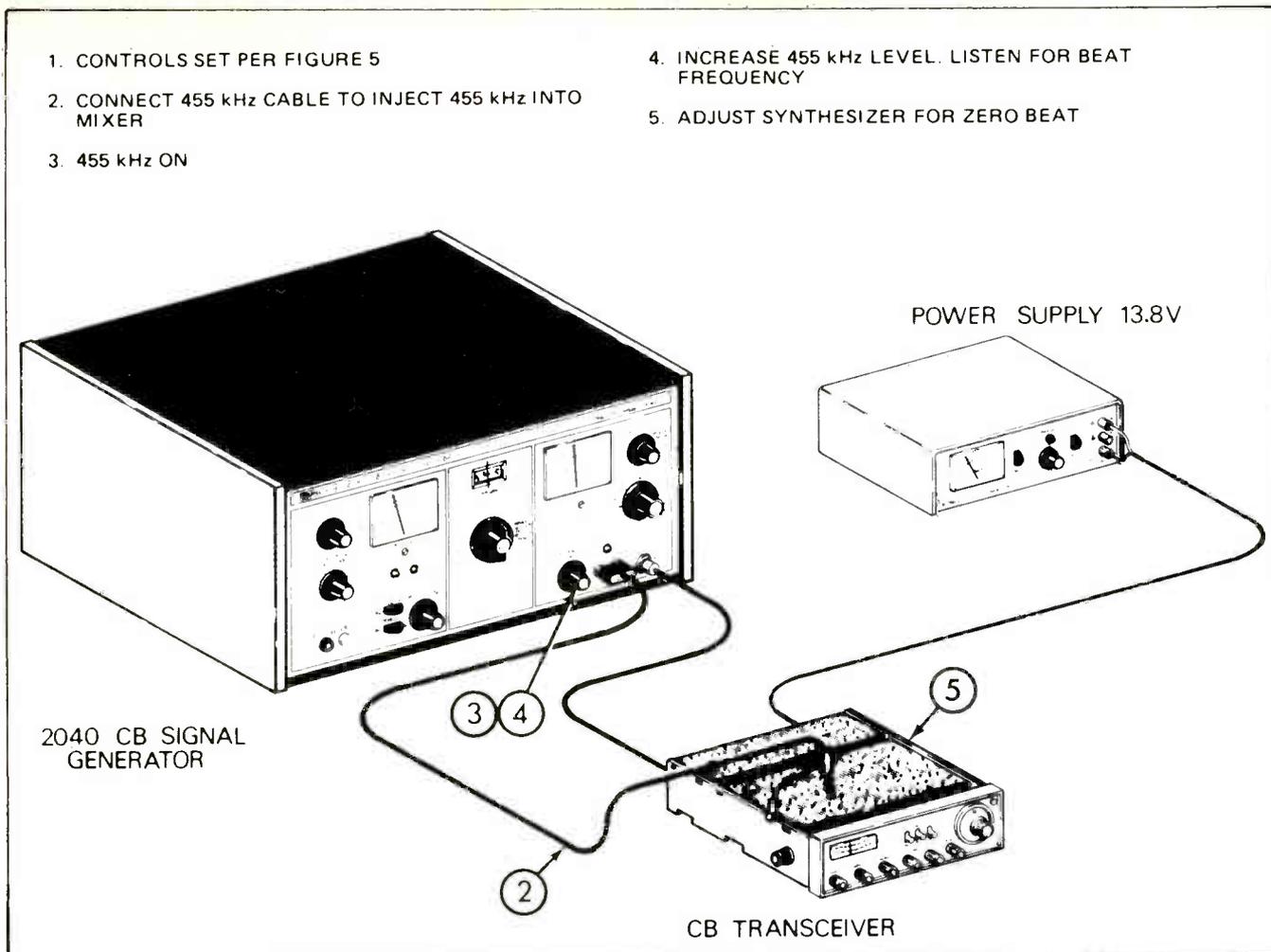


Fig. 4 Here is a sample of the 17 large illustrations in the Model 2040 operating manual. This one shows the equipment, external wiring, and all steps for a check of the receiver synthesizer frequency. The manual is a valuable source of adjustment and servicing information, and it can be purchased for \$5 from B&K. (Courtesy of B&K)

with a mark every 5% up to 100%. (A second scale shows the frequency offset in kiloHertz for checking SSB.) The modulation is continuously variable.

A Meter Function switch selects percent of modulation or the frequency offset. To obtain the frequency offset, pull out on the knob, and turn it either to the right or to the left. The amount of frequency change is read on the meter and two LEDs indicate whether the offset is simulating the upper or lower sideband signal.

Instruction Manual

The instruction manual for the B&K Model 2040 generator is one of the best I have seen. In addition to describing the functions of the

2040 and the specifications, the manual takes about 25 pages to explain and illustrate in detail how to connect the generator, the receiver, and any other needed equipment for all of the receiver tests.

For example, 17 large line drawings (see Figure 4) show all of the connections and list all of the steps for the specific tests.

Comments

One peculiarity was noted in the channel switching. All of the channels are in sequence from 1 to 40, except for Channel 23, which is located between 25 and 26. Some requirement of the PLL probably made this necessary.

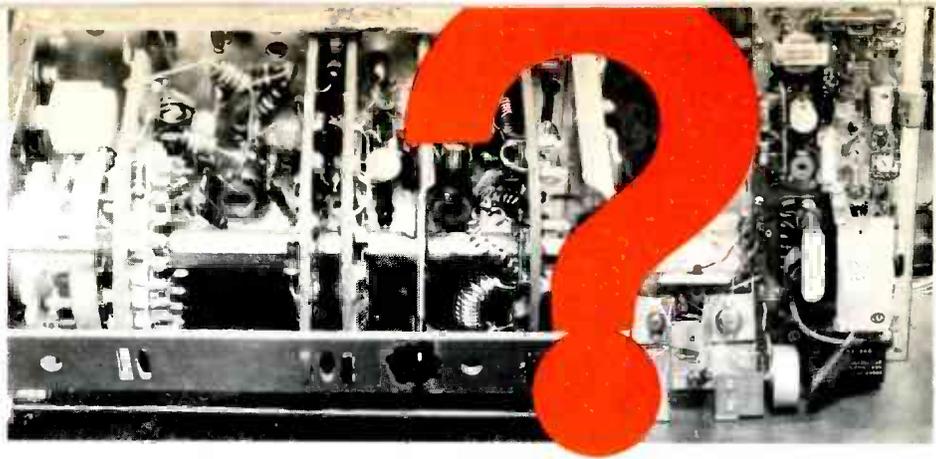
Also, the generator has normal output on the unassigned channels

that occur every 10 KHz. The dial merely has a dot for these channels. They are included to permit checking for adjacent-channel rejection on all of the assigned channels.

With the attenuator turned completely down, a sensitive CB receiver could not detect any stray radiation by the use of a cable probe held near the generator cabinet.

The frequency accuracy of 53 Hz is 1.9 PPM (or .00019%), which is 2½ times more accurate than the B&K specs and 25 times more accurate than the FCC requirements for CB transmitters. This is excellent performance.

In summary, the B&K Model 2040 CB generator operated satisfactorily in every way. □



Is The Tuner Or Chassis Bad?

An expert tuner technician tells us how to know that a tuner is (or isn't) defective.

By Ted Foster
Manager of Texas Tuner Service

Are you **always** certain that a symptom is caused by the TV tuner, and not by the chassis? If so, you are fortunate, because the answer isn't always easy. But, if you occasionally make a wrong diagnosis, then read on, and I'll try to help you.

Because I work for a tuner repair service, I know that these companies dislike receiving "good" tuners for repair. You see, except for the rare intermittent that won't "intermit", **the technician goofed, and he will have the same problem after the tuner is re-installed.** Afterward, he'll resent the tuner company, and likely will send his business elsewhere.

What's more, a good tuner requires more time and work than a defective one does. Searching for a problem that doesn't exist is harder than finding an actual trouble!

Substitute Tuners

Let's discuss substitute tuners as test instruments. They might be called "Subber", "Substituner", "Port-A-Tuner", or other brands, and they have different features, but they all basically do the same job. Each is a complete tuner with its own power supply and adjustable-bias control for the RF transistor. (The power and RF bias either can be a help or a trap.)

All you do is connect the test tuner to the chassis IF cable instead of the set's tuner. If no

stations were received originally, but all the usual channels tune in with the test tuner, then we say the original tuner is bad. This method sounds simple and foolproof.

Well, if the procedure is all that infallible, why were 3-out-of-5 of the tuners we received (after test tuners became popular) found to be normal?

Let me make my position clear. **I sincerely believe that a substitute tuner is an excellent piece of test equipment;** every technician should have one. **But problems seem to happen when a technician uses his "Subber" as a substitute for BOTH tuner and brains.** That's asking too much of any kind of test equipment! Until some test-equipment manufacturer builds a machine like the one on the December cover of *Electronic Servicing*, we either must supplement or interpret the results given us by **all** test equipment.

The problems of the "good" tuners seem to come when technicians try the sub tuner, obtain pictures, and then remove the set's tuner without any further tests.

In such cases, the convenience of having a separate power supply and AGC voltage for the test tuner might have become a trap. Let's discuss some true examples.

Check The B +

A supposedly-dead tuner was brought to us for an overhaul. After cleaning and lubrication, we found nothing wrong, even after several separate checks and a time-test. The client was notified.

The tuner was picked up. Next day, the technician was back, laying the tuner on the counter, and saying, "It's still dead." I asked him if he had measured the B+ and the AGC. "Yeah, I checked all that stuff," he replied. Then, I asked what the voltages measured. He didn't remember, but they were about right, and his subber was getting a good picture. "Are you checking according to the schematic?" I asked. "Yeah," was the answer.

I wired his tuner to our air-monitor and tuned in all of the local stations. He agreed that he might have wired it wrong, and he left. Next morning, he was back again, accusing us of having a "souped-up" monitor that would get good pictures from dead tuners. We wasted about an hour as I tried to convince him our monitor was only an ordinary portable TV, and not modified.

Well, to make a long story shorter, I learned later that he had "farmed" the set to another technician. When I called this second tech, I found the problem had been a loss of B+ voltage. He said the other technician had been very surprised, but finally admitted he never measured B+, AGC, or anything else because he considered it a waste of time. After all, his sub tuner had given a good picture!

So, I urge you to check the B+ voltage at the tuner, both tube-type and solid-state models. Take an extra second and notice the EXACT voltage. If it should be +135, then +31 will not do. Or, a transistor

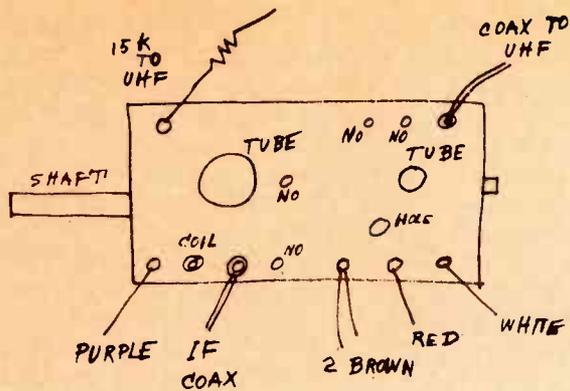


Fig. 1 Before you pull any tuner, make a simple rough diagram (like this one) of all connections to the tuner, plus all tie-lugs or feed-through capacitors which are not connected to anything. This easy precaution might save you hours of frustration.

tuner needing +18 volts cannot work properly with only +4. If the B+ is okay, measure the AGC.

Check The AGC

Next in importance is the AGC voltage for the RF stage. Too little gain-reduction action causes overload when the TV signals are strong; while too much gain reduction adds **snow** to medium-level signals. In weak signal areas, too little gain reduction might not be noticeable, while too much could **eliminate** weak stations.

Tube-type tuners invariably apply a negative voltage to the grid of the RF amplifier. Increasing the negative voltage decreases the gain of the RF tube. Therefore, a quickie test is to short the AGC to ground. Any decrease of snow proves the negative voltage was too high. This test also is acceptable for MOSFET RF stages.

But, don't ever ground the AGC of a bi-polar transistor. No! The AGC voltage is the forward bias for the transistor, and a zero AGC voltage gives zero gain of the RF transistor. Even worse, such a short might destroy a diode or transistor that supplies the RF AGC voltage.

Instead of grounding the AGC for a transistor, measure it accurately. The voltage is quite critical. A difference of only a volt, for example, might reduce the RF gain nearly to zero. If the schematic does not list the AGC voltage with a signal, then try the next test.

Bias supply

Varying the RF AGC voltage and

watching for improved reception is a good method. However, with transistors, you must use precautions to prevent damage to tuner or the AGC circuit in the chassis.

So, instead of connecting your positive variable-voltage bias supply to the tuner, add a 1000-ohm resistor between the positive bias supply and the AGC terminal or feedthrough on the tuner. Vary the voltage at the tuner from +1 to about +3. Most bi-polar transistor tuners will produce maximum gain somewhere in this range. MOSFET's require up to +6 or +8 volts for maximum gain.

If normal performance can be obtained by adjusting for a reasonable AGC voltage (for tubes zero to -12; or +1 to +3 for transistors), the problem is an AGC defect in the chassis and the tuner is okay. However, if you can obtain good results only with excessive voltage (for that particular model), perhaps there is an out-of-tolerance resistor or leaking capacitor in the tuner.

Ship the tuner

After you've checked the exact B+, measured the tuner AGC voltage or tried varying the RF AGC supply, and all is normal except the old tuner doesn't work while the sub tuner does, then ship the suspected tuner to your favorite tuner service.

Sometimes, a tuner is shipped to us a second time, with a note attached saying, "still doesn't work". Of course, we test it. Then if it works correctly, we examine it

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B&K-PRECISION SWEEP/MARKER GENERATOR

Model 415, \$485

With the B&K-PRECISION Model 415 you can complete a TV alignment in about the time you would spend hooking up the instruments for conventional alignment procedures. It's ideal for testing adjacent channel interference in CATV installations, too.

Everything you need is built into the Model 415—sweep and marker generators, a marker adder and three bias supplies. The 10 crystal-controlled IF markers can be shown either vertically or horizontally on your scope, and they light up on the front panel IF response and chroma bandpass diagrams as you use them.

Proper set alignment is assured and is almost automatic when you follow the Model 415's programmed alignment procedures.

Contact your local B&K-PRECISION distributor for a demonstration, or write for detailed information on how the Model 415 can save you time and increase your profits.

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 - Custom made to ensure quality, dependability, and high laboratory accuracy.
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 - AC/battery operated.
 - Exclusive performance features that our competitors cannot match.
- "ELTONE 76" \$245.00, GN-1375B 40 Channels \$755.00. Special Holiday Offer: Both units \$895.00. Direct factory sale only. All accessories, charger, and Ni Ca batteries included in price.

Nikoltronix

2437 W. Peterson Ave.
Chicago, Ill. 60659
(312) 275-4727

For More Details Circle (16) on Reply Card

visually to see if a **wrong** feed-through has fresh soldering on it. Either the technician didn't make a drawing of the connections, or the drawing was incomplete.

Now, making a simple drawing takes only perhaps two minutes (see Figure 1), and it is very important for anyone who does not have total recall (I don't!). Attach the drawing to the tuner-mounting assembly (TMA), so it will be found easily when needed.

UHF Tuners

Our company receives a much higher percentage of non-defective UHF tuners than VHF tuners. This probably indicates that technicians have more difficulties determining whether or not a UHF tuner is bad. Here is a way to determine accurately the tuner's condition in less than four minutes.

Measure the B+ at the UHF tuner itself (not at the VHF tuner). If it is low by several volts, measure the dropping resistor between the VHF and UHF tuners, to determine if the resistor has increased in value.

If the resistor is within tolerance, break the B+ line to the UHF tuner and connect a meter (set on the millampere range) in series. A good rule-of-thumb is to expect 10 mills (about five for the base resistor and five for the transistor). When the current is over 10 mills, and the voltage is low, pull the tuner and ship it; probably it has a short.

I know someone will wonder about the opposite condition where the UHF tuner draws too little current. Let's bypass a direct answer, and test the tuner by a simpler method.

Incidentally, the older 26-MHz, tube UHF, and varactor UHF tuners are so rare that we are ignoring them as though non-existent. Likewise, UHF tuners with RF stages are scarce. That's why we are considering only the UHF tuners with one oscillator transistor, and a diode mixer.

The similarity of most UHF tuners allows you to try another UHF tuner, using it as you would a sub tuner. Of course, some of the newer commercial sub tuners include a UHF tuner. That's even better.

Perhaps you could keep the UHF

tuner taken from a junker, using it only for tests. In that case, check it with various supply voltages, to find the minimum voltage for dependable operation, then scratch or mark this voltage on the case of the tuner. Henceforth, the tuner should operate with any TV having the marked voltage (or slightly more).

With the test UHF tuner (either a commercial one or from another set) connected to the TV and an antenna, check the performance. If the sub tuner brings in stations, and the original tuner does not, ship it for an overhaul.

But what if it doesn't tune in stations either? That's a good question, and there is a good answer. Try the VHF performance. (If the VHF tuner doesn't work, why worry about the UHF?)

If the VHF operation is good, that eliminates the chassis from suspicion. Because the sub UHF tuner didn't work any better than the original, the UHF tuner probably is okay. That doesn't leave very much except for the possibility of a VHF tuner which doesn't amplify the UHF correctly. Write the details and your conclusion, then ship the VHF (not the UHF) tuner in for repairs.

Shipping

When you pack a tuner for shipment, use a **big** box. You pay charges by weight, not size, and the packing doesn't weigh much. The post office specifies at least two inches of shredded paper (or the equivalent) on **all** sides of the contents. And, believe me, it is needed to prevent damage. Tuner shafts are the most susceptible to damage, so use extra care and packing material there.

Comments

To sum up what I've said: use a sub tuner (if you have one) but before you pull the suspected tuner, test both the B+ supply voltage and the AGC. Don't just glance at the meter, but notice the precise readings; and make a rough drawing that shows all of the wires by numbers and colors. Also mark all feedthroughs with **no** wires attached.

These few simple precautions will save you (and your tuner service center) much wasted time, postage, and ruffled feelings. □

bookreview

Commercial Radiotelephone License Question And Answer Study Guide (3rd Edition)

Author: Edward M. Noll

Publisher: Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, Indiana 46268

Size: 304 pages, book number 24033

Price: \$7.95 (Canadian Price Slightly Higher)

Purpose of the guide is to help readers pass the examination necessary for obtaining a Commercial Radiotelephone license from the FCC. Detailed answers are given to questions that are similar to those of the test. Supporting diagrams and additional explanations ensure the reader of a better understanding of the "how" and "why." This new edition stresses some of the most important subjects and those most likely to be misunderstood. Formulas, radio mathematics and calculation, and schematic symbols appear in the appendices.

Contents: Basic Law; Basic Operating Practice (Series O)—(Series M); Basic Radiotelephone; Advanced Radiotelephone; Formulas; Radio Mathematics and Calculation; and Schematic Symbols.

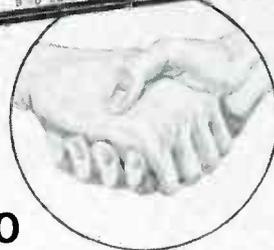
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CORONADO TV6-16385A, TV6-16393A, TV6-16518A	1623-1
HITACHI Chassis NP5AX	1622-1
JCPenny 2025AA (855-0097)	1611-1
MIDLAND 15-243	1626-1
QUASAR Chassis L19TS-/N19TS-/AN19TS-/YAN19TS-945 ...	1619-2
Remote Control Receiver, Transmitter TRT-12 ...	1619-2-A
RCA Chassis CTC72AE/AF/AH/E/F	1622-2
Remote Control Receiver, Transmitter CRK25A ...	1622-2-A
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SHARP 3K-43, 3K-44	1593-2
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Proven the best American made test meter for tuning all types of antennas, the THRULINE[®] Wattmeter is an extremely accurate instrument for continuous monitoring of RF power output and antenna SWR.

Model 10043 Wattmeter measures forward RF power up to 10 watts, reflected power to 2.5 watts as well as giving direct reading SWR of the antenna system — does not require a perfect (50 ohm) line impedance to provide accurate readings in either power or SWR modes — designed to be left permanently in the line for continuous monitoring or to be used as a highly accurate portable test instrument by dealers, servicemen, technicians or installers during initial installation and tune-up of CB systems.

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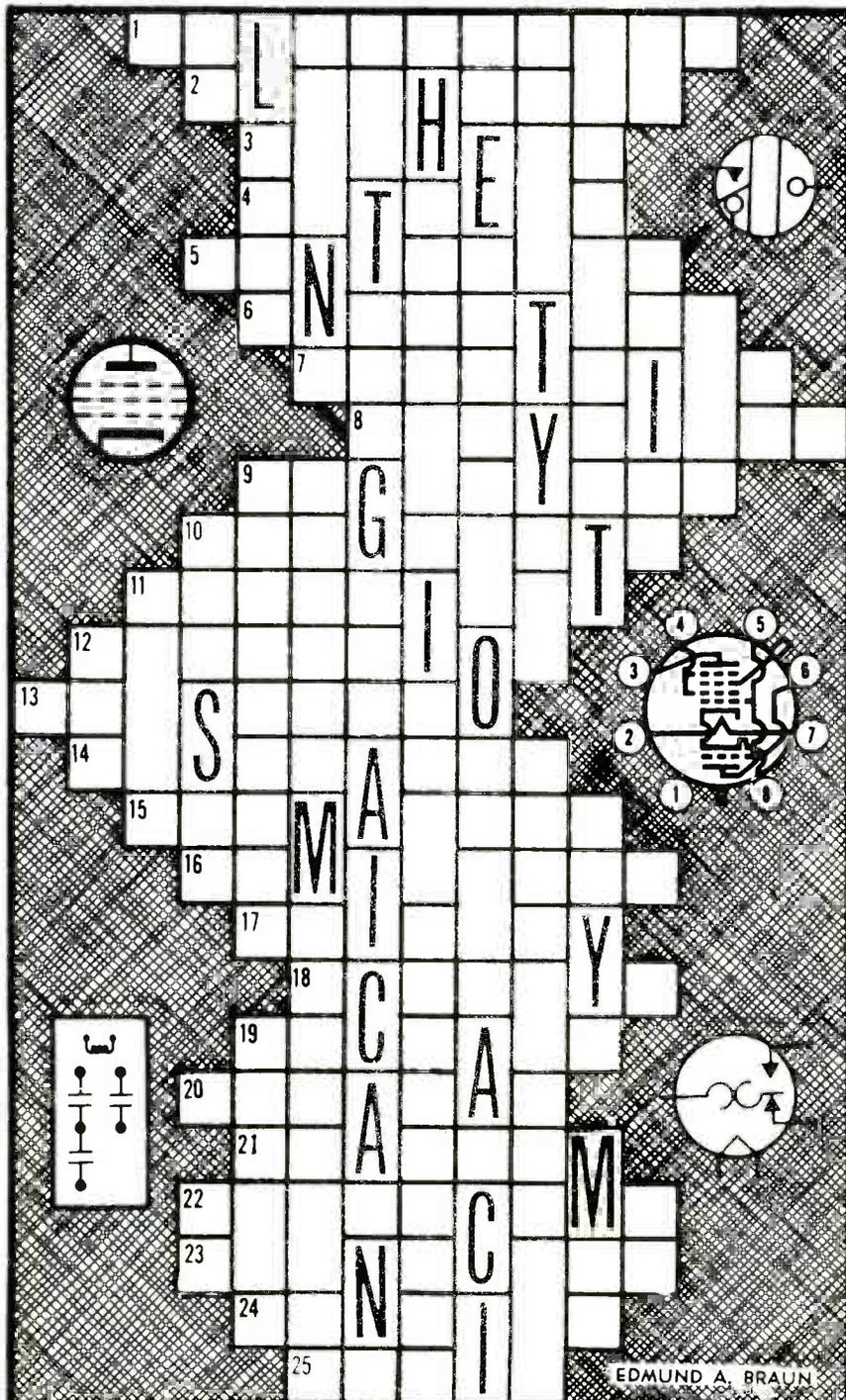
® Trade mark of Bird Electronic Corp.

For More Details Circle (17) on Reply Card

PAGING SHERLOCK OHMS!

Hi there! For a change of pace, have fun solving this Just-across-word Puzzle based on Electronics. Each word is connected to the word above and below by one or more letters although only one is shown as a clue. Each correct answer is worth 4 points; a perfect score is 100. It should prove fairly easy to get a high rating except perhaps for someone who thinks "rivet" is a small river, or that "uncharged" means purchased for cash! Pencil sharp? Your "thinker" sharp? Then, GO!

Edmund A. Braun



- 1 One one-thousandth of a unit of electric current or rate of electron flow.
- 2 A disruptive discharge through the air.
- 3 Small gaskets of metal or other material.
- 4 The means of specifying the character of a wave in a guide.
- 5 Electron tube having five grids plus an anode and a cathode.
- 6 An original creation or a new device.
- 7 Flash accompanying the discharge of atmospheric electricity.
- 8 Specially designed type of speaker baffle.
- 9 One million changes per second.
- 10 Specially varnished tubing used as insulation.
- 11 Giving a relatively high output.
- 12 Pertaining to a measurable extent as length, breadth, or thickness.
- 13 A tone that slides smoothly from one pitch to another.
- 14 Release of energy stored in a capacitor.
- 15 Grayish-white metallic element with many electronic applications.
- 16 Type of construction used for iron cores of transformers, etc.
- 17 Oriented intergrowth between two crystals.
- 18 Word formed from initials or syllables of other words; i.e. radar, sonar, etc.
- 19 Removes unwanted portion of a printed circuit during fabrication.
- 20 A unit of quantity of electricity, being 96,500 coulombs.
- 21 Any graphic representation which explains rather than represents.
- 22 A coil with turns wound crisscross to reduce distributed capacitance.
- 23 Device for electrically joining one or more electronic circuits.
- 24 A measure of light reflecting or transmitting of an area.
- 25 Any number under ten.

We're betting the solution is on page 55.

productreport

These features supplied by the manufacturers are listed at no-charge to them as a service to our readers. If you want factory bulletins, circle the corresponding number on the Reply Card and mail it to us.

Tone Pager

Motorola recently introduced the dual-function tone-alert Metrx paging line.

The new pager utilizes Large Scale Integrated Circuits (LSI) in a combination of discrete components and Dual-In-Line Packaging (DIP) techniques. This results in reliability, with small size and ruggedness.

Using two separate tones, messages from two different locations may be received. The coding system consists of a preamble and six sequential tones, and provides a maximum calling capability of 1,000,000 codes, each with dual-function.

Other features include the Mem-o-Lert deferred-paging memory; inexpensive standard AA penlight cell operation; extended battery life of up to six months use per battery; and a battery-condition indicator.

For More Details Circle (26) on Reply Card

CB Power Supply

Clifford Industries has added the Vista CB-IIIR to its line of power supplies. This model provides 13.8 VDC at 3 amps of continuous power.



It incorporates a built-in slide mount for easy attachment of power and antenna connectors. It has a built-in speaker, thereby making it possible to create a base station from a mobile CB. The Vista CB-IIIR will accommodate either 23-channel CB sets, or the new 40-channel CB sets.

For More Details Circle (27) on Reply Card

CB Antennas

Two new mobile CB antennas are now available from EICO. The Gutter-Clip Model, CA-20, has a tunable,

center-loaded, stainless-steel whip that attaches directly to the rain-gutter clip of any vehicle without drilling or screws. It is 21-inches high, and has a nine-foot coaxial cable terminated with a PL-259 standard coaxial connector.

The Trunk-Lid Model, CA-10, is a base-loaded unit that attaches to the trunk lid without screws or drilling. It has a neutral-grey coil housing, and a chromed base and spring that seats on a rubber base cushion. Overall length is 45 inches, and the unit comes with 15 feet of coaxial cable terminated in a standard PL-259 connector.

The Model CA-20 is priced at \$19.95, and the Model CA-10 at \$24.95.

For More Details Circle (28) on Reply Card

Projection TV

Projection Electronics now has available a projection TV set. The Model 351-S1 "Super Video" consists of a projection console unit with a separate, free-standing 50" screen.



Projection distance is 5 feet from the 1280 square-inch screen. Controls are conveniently located for easy adjustment. The custom-designed console is available in a wide variety of wood-grain finishes and solid colors. It measures 27" high X 20" wide X 20" deep and is mounted on casters for easy mobility.

Price to dealers is \$795.

For More Details Circle (29) on Reply Card

CB Noise Filter

The EMI-15A is a CB noise-suppression filter from Marine Technology. It is a three-element low-pass LC filter designed to control ignition system generated noise. It prevents coupling of ignition impulses into the vehicle primary wiring system and supplements suppression-type plug wiring. Installation is at the A+ connection to the coil or electronic system.

Suggested retail price is \$6.95.

For More Details Circle (30) on Reply Card

(continued on page 52)

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I.C.C., RCA, SYLVANIA

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<input type="checkbox"/> 6BK4	5 for \$9.95	<input type="checkbox"/> 6J88	5 for \$5.90
<input type="checkbox"/> 6CG3	5 for \$5.25	<input type="checkbox"/> 6KA8	5 for \$6.50
<input type="checkbox"/> 6CJ3	5 for \$5.00	<input type="checkbox"/> 6KE8	5 for \$8.15
<input type="checkbox"/> 6DW4	5 for \$5.00	<input type="checkbox"/> 6KT8	5 for \$7.25
<input type="checkbox"/> 6EH7	5 for \$5.10	<input type="checkbox"/> 6KZ8	5 for \$5.25
<input type="checkbox"/> 6EJ7	5 for \$4.75	<input type="checkbox"/> 6LB6	5 for \$10.75
<input type="checkbox"/> 6F07	5 for \$4.05	<input type="checkbox"/> 6LQ6	5 for \$11.15
<input type="checkbox"/> 6GF7	5 for \$7.05	<input type="checkbox"/> 8FQ7	5 for \$4.05
<input type="checkbox"/> 6GH8	5 for \$4.20	<input type="checkbox"/> 12GN7	5 for \$7.40
<input type="checkbox"/> 6GJ7	5 for \$3.70	<input type="checkbox"/> 17J28	5 for \$4.75
<input type="checkbox"/> 6GU7	5 for \$5.55	<input type="checkbox"/> 23Z9	5 for \$6.35
<input type="checkbox"/> 6HA5	5 for \$5.10	<input type="checkbox"/> 33GY7	5 for \$8.05
<input type="checkbox"/> 6HQ5	5 for \$6.75	<input type="checkbox"/> 38HE7	5 for \$9.75
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<input type="checkbox"/> 6F07	5 for \$5.47	<input type="checkbox"/> 21L8	5 for \$8.37
<input type="checkbox"/> 6GH8	5 for \$5.67	<input type="checkbox"/> 23Z9	5 for \$8.57
<input type="checkbox"/> 6HA5	5 for \$6.89	<input type="checkbox"/> 35LR6	5 for \$13.84
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<input type="checkbox"/> 714	<input type="checkbox"/> 718	<input type="checkbox"/> 719	<input type="checkbox"/> 720	<input type="checkbox"/> 722	<input type="checkbox"/> 723
<input type="checkbox"/> 725	<input type="checkbox"/> 731	<input type="checkbox"/> 740	<input type="checkbox"/> 743	<input type="checkbox"/> 748	<input type="checkbox"/> 783
<input type="checkbox"/> 788	<input type="checkbox"/> 790	<input type="checkbox"/> 793	<input type="checkbox"/> 912		

221-31-32-34-42-45-46-48-51-52-62-65-79

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<input type="checkbox"/> 3024	128	<input type="checkbox"/> 3124	123A
<input type="checkbox"/> 3025	129	<input type="checkbox"/> 3132	161
<input type="checkbox"/> 3114	157		

MINIMUM FIVE (5)

SK	ECC	SK	ECC		
<input type="checkbox"/> 3021	124	ea. 60c	<input type="checkbox"/> 3079	165	ea. \$2.50
<input type="checkbox"/> 3103	157	ea. 60c	<input type="checkbox"/> 3115	162	ea. \$2.50
<input type="checkbox"/> 3041	152	ea. 70c			

CB HARDWARE WIRE MINIMUM

<input type="checkbox"/> PL259	10 for \$3.90	<input type="checkbox"/> PL258	10 for \$4.90
<input type="checkbox"/> 3 FT. RG58U Cable 2PL259			ea. 79c
<input type="checkbox"/> 20 FT. RG58U Cable 2PL59			ea. \$1.69
<input type="checkbox"/> 20 FT. RG58U PL259 Spade lugs			ea. \$1.49
<input type="checkbox"/> 50 FT. RG58U 2PL259			ea. \$2.95
<input type="checkbox"/> 50 FT. RG8U			ea. \$7.95
<input type="checkbox"/> 100 FT. RG58U Cable 2PL259			ea. \$4.95
<input type="checkbox"/> CB Lightning Arrestors			ea. \$1.50
<input type="checkbox"/> 300 Ft. 59U Coax Cable Mill Ends			\$7.50

YOKES

<input type="checkbox"/> Y130	<input type="checkbox"/> Y94	<input type="checkbox"/> Y105	<input type="checkbox"/> 95-2779	ea. \$6.95
<input type="checkbox"/> Y153	<input type="checkbox"/> Y162/Y132	<input type="checkbox"/> Y137		
<input type="checkbox"/> Y147	<input type="checkbox"/> DY92C			ea. \$12.95

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<input type="checkbox"/> 6500 PIV Color Focus Rectifiers	10 for \$6.00
<input type="checkbox"/> 2.5 amp 1000 PIV IR-170	100 for \$11.00
<input type="checkbox"/> Syl.—Zenith Tripler	ea. \$6.95

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<input type="checkbox"/> 20 Asst. Belts (Reg. \$70.00) Your Cost	\$7.00
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<input type="checkbox"/> 60 minute Irish cassette tapes	12 for \$6.00
<input type="checkbox"/> 90 minute Norelco type boxed	10 for \$10.00
<input type="checkbox"/> 5 x 7 Speaker Kit	\$2.95
<input type="checkbox"/> B&K Digital Meter #280	ea. \$85.00
<input type="checkbox"/> 72 ohm to 300 matching transformers	10 for \$4.95
<input type="checkbox"/> 25 ft. Telephone extension cords	ea. \$1.50
<input type="checkbox"/> 500 Ft. Speaker Wire	\$5.00
<input type="checkbox"/> BSR Deluxe Changer	\$24.95
<input type="checkbox"/> \$300 Surprise Package	\$10.00

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<input type="checkbox"/> Astatic—	<input type="checkbox"/> 133,	<input type="checkbox"/> 142	ea. \$1.47	
<input type="checkbox"/> BSR SC7M2			ea. \$1.95	
<input type="checkbox"/> EV	<input type="checkbox"/> 26—\$1.49	<input type="checkbox"/> 5015	ea. \$1.95	
<input type="checkbox"/> GE	<input type="checkbox"/> 650,	<input type="checkbox"/> 660	ea. \$2.50	
<input type="checkbox"/> TETRAD—All Numbers			ea. \$1.95	
<input type="checkbox"/> VARCO—	<input type="checkbox"/> TN4B,	<input type="checkbox"/> CN75	ea. \$1.50	
<input type="checkbox"/> ZEN—	<input type="checkbox"/> 142-167,	<input type="checkbox"/> 142-168	ea. \$1.95	
<input type="checkbox"/> N44,	<input type="checkbox"/> 75,	<input type="checkbox"/> N91,	<input type="checkbox"/> V15	ea. \$1.95
<input type="checkbox"/> N3—89c	<input type="checkbox"/> TETRAD Dia. Univ.		10 for \$5.90	

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For More Details Circle (71) on Reply Card

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Highway accidents like the one Jack had take the lives of over 28,000 employees every year. It's a terrible waste. And one that you could be doing something about.

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So send for our survival course. Maybe you'll save some of your employees on the way up from an early ascension.

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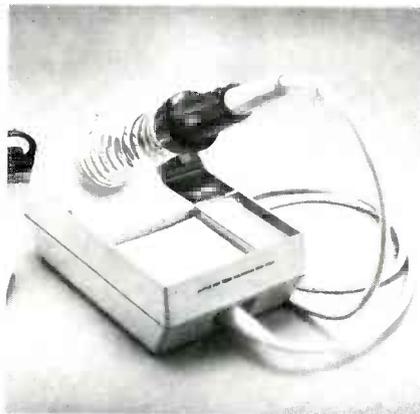
TRAFFIC SAFETY CAMPAIGN

productreport

(Continued from page 51)

Soldering Station

An improved controlled-output soldering station, replacing the WTCPL model, has been introduced by **Weller**.



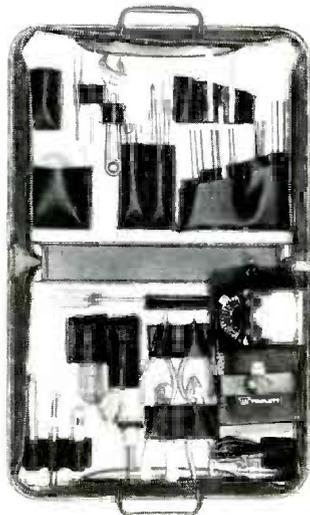
The WTCPL is a transformer-powered unit complete with a low-voltage, temperature-controlled soldering pencil and heat shield. It features the Weller "closed loop" method of controlling maximum tip temperature, protecting heat-sensitive components while the grounded tip protects voltage-sensitive parts.

The WTCPL uses any of 17 types of replacement tips, each available in 600°, 700°, and 800°F, heavily iron plated with anti-oxidation coating.

For More Details Circle (22) on Reply Card

Electronic Tool Kit

For the technician who wants to travel light, but well-equipped to do field inspection, troubleshooting, and repair work, there's a 40-piece electronic tool kit available from **Electronic Tool Company**.



The ETK-131 is a compact kit that contains a large selection of screwdrivers, pliers, hex blades, soldering tools, spline blades, etc., in addition to more sophisticated specialty tools. The tools are contained within a leather zippered case that measures 16" X 11 1/4" X 2 1/4".

The ETK-131 is priced at \$139. An optional Triplett #310 meter and case is available.

For More Details Circle (23) on Reply Card

Auto Combination Lock

Model LAP-2000, an auto-electronic-equipment lock from **ASAP International**, secures CB radios, 8-track and cassette players, AM/FM radios, or other units in place under the dash of most vehicles, to prevent theft of the equipment.

The combination can be set to any number, an alert band indicates when the unit is unlocked, and the lock is constructed of heavy-gauge metal.

Model LAP-2000 comes with all necessary parts, and lists for \$24.95.

For More Details Circle (24) on Reply Card

ERRATA

A mistake about CB output power occurred on page 52 of the October 1976 issue of *Electronic Servicing*. The corrected paragraph should read: "When a transmitter is amplitude modulated at 100%, the maximum allowed is 16-watts PEP (or 12 watts, if single sideband), and this will read on the meter." We thank the FCC for supplying this correction.

Norman Crowhurst points out an error of editing on page 44 of the September 1976 issue in his article about servicing organs. The statement is wrong that says: "suppose the LSI skips one of the final small counts...then the top note will be flat by 8 Hz." Actually, 8 counts short, making 529 instead of 537 counts, would produce 5671.1 Hz rather than 5586.6 Hz (with a 3-MHz master frequency), and this is 84.5 Hz sharp, not flat.

ELECTRONIC SERVICING

catalogs literature

Circle appropriate number on Reader Service Card.

80. Belden Corporation—has an 8-page illustrated booklet that features antenna, microphone, and speaker cables for CB radio systems. It offers more than 60 products for use with fixed and mobile CB, amateur, and marine radio systems and for industrial/commercial land/mobile applications.

81. Arista Enterprises—offers a 16-page catalog of two-way communication accessories. Some items featured are: microphones; CB speakers; CB transistors and semi-conductors; CB antenna mounts and accessories; coaxial connectors; connector cables; noise elimination filters; CB meters; and power supplies.

82. Telematic—this 16-page #76-1 catalog features TV test rigs, yoke and convergence adaptors, color brighteners, replacement parts, and color service accessories. Also included are two cross-reference charts; one for test rigs, and one for brighteners.

83. Antenna Specialists—has recently published an informative booklet for everyone interested in CB radio. Written by Forest H. Belt, "CB Facts and Fables" analyzes the nature of CB antennas; how they work, which types work better than others, and why.

84. Bird Electronic Corporation—4-page form catalog SF-76 lists "ThruLine" wattmeters, coaxial loads, RF termination wattmeters, and attenuators covering from 500 KHz to 2300 MHz and from milliwatts to 250 kilowatts. Also included is a new multirange digital wattmeter for 2-way radio service, as well as portable and panel instruments with RF output ports for frequency analysis.

85. Sperry Instruments—has issued a new product bulletin, SP-73, that features the complete Sperry line of

multi-testers. The bulletin offers detailed specifications, product descriptions, a list of features, packaging information, and prices for each of the nine multi-testers. Additionally, there is a price list of accessories.

86. Techni-Tool—offers a wide selection of tool kits in their 20-page catalog. Some kits featured are: security installation kits; office machine kits; hospital/laboratory kits; electronic assemblers kits; engineers tool kits; and many others. They also feature a design-a-kit section in which tools and accessories are listed separately; the customer can order from this form and build his own personalized kit.

87. Saxton Products—the 52-page catalog features coaxial and twin-lead cables for CB, amateur radio and television use, plus antenna-mounting hardware, tools, hook-up wire, intercoms, audio connectors, and decorator telephones.

NATIONAL ELECTRONIC

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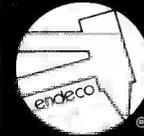
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audio systems report

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FM/TV Weather-Band Converter

The **Audiovox** FM/TV/weather-band converter allows listening to FM programs, the sound of TV broadcasts, or the government weather forecasts on any AM car radio. The FM-broadcast band, the 162.40 MHz and 162.55 MHz weather bands, and the sound carrier of TV channels 2-through-13 are converted to AM. Pushbutton switches select the desired function.



The converter is small enough to be mounted under the dash of most cars. It uses 1 IC, 9 transistors, and 6 diodes.

List price of the Model FMC-TV is \$59.95.

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Reflex Horn

This heavy-duty 5½-inch aluminum reflex-horn speaker is anodized for either indoor or outdoor uses. List price of the Model CBH-550 speaker from **RMS Electronics** is \$12.95. It is suitable for use with CB radio, or for paging and patio operation, anywhere the higher efficiency and clear voice reproduction of a horn is needed. Rated at 8-ohms and 8-watts, the CBH-550 speaker comes complete with a long cable and the mounting bracket.

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CB Speaker

Model FS-10 speaker from **Neosonic** has an internal LC filter to minimize noise by eliminating the high frequencies above the voice range. Designed for CB or communications uses, the speaker has a range of 300 Hz to 4000 Hz, with an impedance of 8 ohms. The 10-foot cable has a 3.5

MM plug which fits most CB receivers.

Suggested resale price is \$14.95.

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Bi-Directional Loudspeakers

Atlas Sound has available a 30-watt bi-directional horn loudspeaker, Model APT-15, for use in large areas. Each assembly consists of two independent speakers with drivers and re-entrant horns, thus allowing different sound levels in the two directions when



desired. Two line matching transformers are located in the mounting

base. Frequency range for the APT-15 is from 475 Hz to 14 KHz, and the impedance of each driver is 8 ohms.

The housing is heavy-gauge brushed-aluminum with black diffusers, and the assembly can be mounted from a standard electrical box in ceiling or wall.

For More Details Circle (34) on Reply Card

Cassette Tape Player

Features of the Model T602 in-dash cassette stereo tape player by **Craig**



include pushbutton operation, slot cassette loading, manual or automatic eject at the end of tape, locking fast forward, and AM/FM stereo radio with AFC.

The unit is small, with adjustable control-mounting centers for easy installation. Suggested retail price is \$119.95.

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We are. Parents, teachers, community leaders, elected officials... all of us. There are seven million handicapped children who need special education. And millions of these children are being cheated out of their right to the education they need.

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test equipment report

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Ground Tester

Ungrounded or poorly-grounded electrical equipment or AC outlets are common hazards often cited by OSHA inspectors. Such penalties average \$26.60 per receptacle or electric tool. Avoid these expensive citations and maintain a safer environment by checking the ground on outlets, equipment, tools, and adapters. **Butrick Manufacturing Company** sells for \$8 the Model 317 Ground Tester for performing 10 tests with 29 different indications on 2-wire or 3-wire circuits.

For More Details Circle (75) on Reply Card

Frequency Counter/Clock

A new combined frequency counter and selectable 12- or 24-hour digital clock is the TF-1000 from **Pride Electronics**. The unit, utilizing FET switching techniques, supplies an accurate visual readout of frequency during transmissions. The TF-1000 also is an accurate clock with a six-digit LED display, which switches to the frequency-counter mode when the transmitter is used, then returns



to the correct time display after the transmission is completed.

Citizens-Band and amateur transceivers with 3- to 200-watts output can be used with the Pride TF-1000, which operates from 1 MHz to 40 MHz.

The unit requires no additional accessory equipment and can be

installed in the coaxial antenna line, with negligible transmitting or receiving loss. Measuring 8½ X 3 X 9¾ inches, the unit operates on 120 volts and uses less than 10 watts of power. Suggested user's price is \$179.95.

For More Details Circle (76) on Reply Card

Sweep/Function Generator

Function generators are replacing audio oscillators for many uses. Most models can be switched to produce sine, square, or triangle waveforms. **Eico** has introduced the new Model 390 Sweep/Function Generator which has those waveforms, but in addition has the internal circuitry for either a linear or logarithmic sweep of frequency, with a choice of slow, medium, or fast rates. With sweep, the response curve can be seen on a scope. Operation as a Voltage-Controlled Oscillator (VCO) from an external voltage also is possible.

Four frequency ranges cover from 0.2 to 200 KHz, and the calibrated tuning dial gives a 1000-to-1 variation of frequency. Attenuation totalling 60 dB is provided for the 50-ohm output signal of 10 volts peak-to-peak.

User net price is \$169.95 assembled.

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Autorangeing DMM

The Model 465 3½-digit DMM by **Simpson** automatically selects the proper measuring range and displays it with bright 0.43-inch 7-segment LEDs. When repeated measurements of approximately the same readings are to be made, the desired range can be locked by a "hold" button.

Accuracy of the Model 465 is 0.1% on DC volts. It measures voltages from 100 microvolts, and resistances from 0.1 ohms. In addition, 10-ampere AC and DC current ranges, and low-power or standard-power resistance ranges are furnished by the five-function digital meter. Other features include pushbutton selection of functions, automatic polarity for DC ranges, and good temperature stability.

Model 465A, costing \$295, is for operation on AC power only, while Model 465D has provisions for AC or battery operation (with ni-cad cells, batteries not included), and is priced at \$332.

For More Details Circle (78) on Reply Card

RF Wattmeter

A new four-range Termaline absorption wattmeter from **Bird Electronic Corporation** covers two-way

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Start with 100 points and deduct 4 points for any part you may not have answered correctly.

Your rating:

60 - 64 Fourth best.

68 - 72 Third best.

76 - 84 Second best.

88 - 96 First best.

100 PERFECT! Best best! (Huh?)

*Faraday, Michael.

English chemist and physicist.
(1791-1867)

communications frequencies from 25 to 512 MHz; from as low as 5 watts full scale through 15, 50 and 150 watts. It features ±5% accuracy and an integral 150-watt RF load. Maximum VSWR is 1:1 at its 50-ohm female N input connector.



The meter has squared scales for easy downscale reading and its housing can be detached from the load for operational convenience. Model 6156 is portable and weighs 8 pounds. Suggested price is \$249.

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The MARKETPLACE

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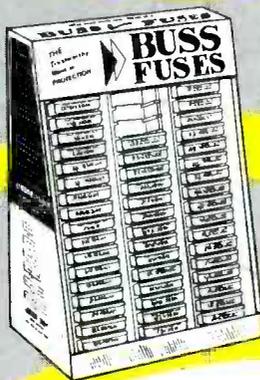
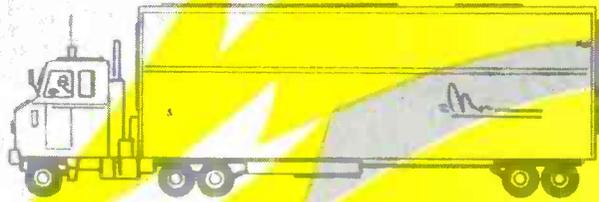
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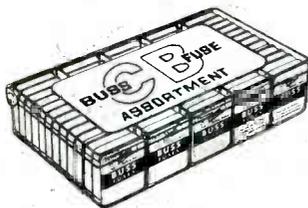
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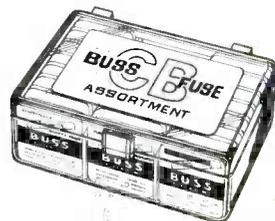
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Metal Display Stand



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