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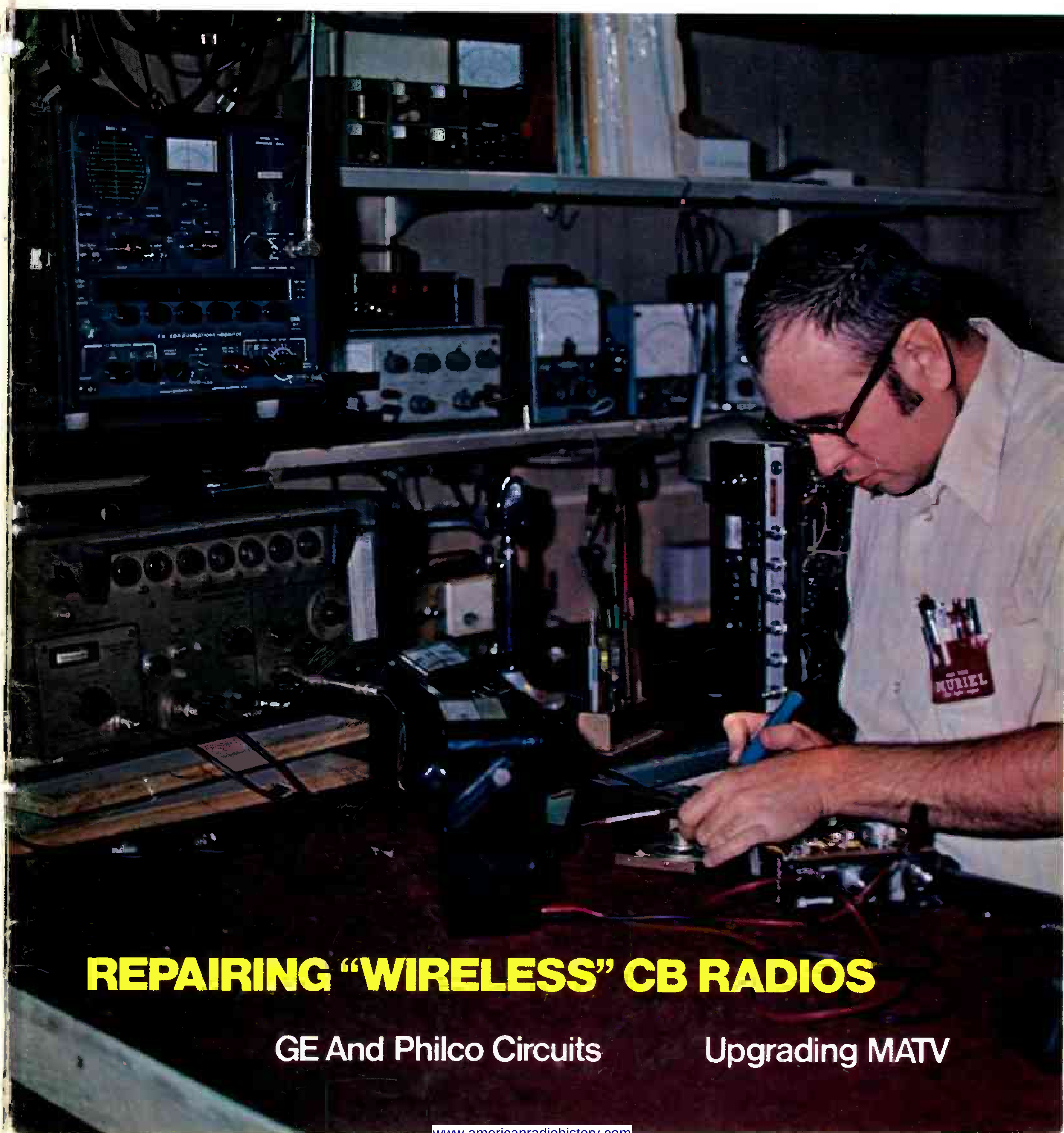

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November, 1976 ☐ Volume 26, No. 11

Electronic Servicing®

in this issue...

ABOUT THE COVER
Don Clayton was too busy to pose for the photographer, as he worked in Westcon's, a well-equipped CB service facility in Kansas City. Picture is by Marvin Beasley.

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electronicscanner

news of the industry

About 50% of the 40-channel CB radios have failed the FCC tests for chassis radiation. A specially-designed test system measures the frequency error and power output of all 40 channels, with results recorded by a printer. Next, a test for over-modulation is made, then the chassis-radiation testing is done outdoors, followed by visual inspections to make sure the sample is not a "lab queen" which has been doctored to pass the strict specifications.

Frank Moch, Executive Director of NATESA, **writes that our summary of his beliefs about state-versus-city licensing of TV shops was not quite correct** (see page 6 of September ELECTRONIC SERVICING). Frank does not think **either** kind of licensing is needed, but state licensing would be preferable to Chicago licensing. He writes, "The days of incompetent tube jockeys...are gone. They can't cope with solid state, modules, and unitized chassis." "Our study reveals that 80% of **all** (Chicago) complaints are against about six well-known sharpshooters. The answer is for law-enforcement agencies to eradicate these offenders." "Continuous maligning of ethical and professional servicers is doing nothing to assure availability of service tomorrow. It will increase service costs, as in the medical profession faced with many get-rich-quick malpractice suits, because abuse **has** to have a price."

Sanyo has purchased for a reported $10 million **the 57% of Warwick Electronics owned by Whirlpool.** Sears retains a 25% interest. TV manufacturing will be continued by Sanyo Manufacturing Corporation, a subsidiary of Warwick.

If you think electronic magazines are too expensive, consider the "AMR Reporter" (an anti-union publication) which has a subscription rate of $95 for 12 monthly issues!

Technicians in the Chicago area are mourning the death of George (Gus) Cook, one of the pioneers in electronic servicing. Also, **John B. (Mac) McCulloch** died in July. He was active in NATESA-Detroit for 20 years.

RCA Sales Corporation has sold three branches of the RCA Distributing Corporation, and is attempting to sell the remaining six. Facilities in Lenexa, Kansas; San Antonio, Texas; and Chicago, Illinois now operate under new management. Most of the former RCA employees and executives are being retained. Although the sales reduce the cash tied up in the branches, RCA says the main reason for the change is that independent distributors can do a better job in those areas.

A sales ban and a recall of all smoke detectors of the ionization type has been requested from the U.S. Nuclear Regulatory Commission by the Health Research Group, according to **Retailing Home Furnishings.** A small amount of the radio-active element americium is used in such detectors. Dr. Sidney Wolf, of HRG, maintains that the amount of radioactivity from the detectors has been found to cause cancer in animals, and that HRG believes the alternate photoelectric type of detector will be more reliable in the long run. In rebuttal, Richard Cunningham, an assistant director of the National Regulatory Commission, says the radiation

(Continued on page 6)

(Continued from page 4)

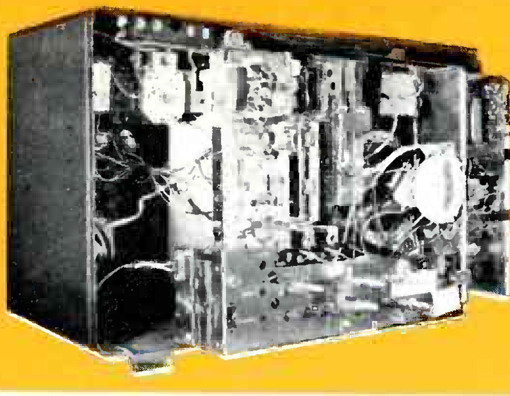
from such a smoke detector is less than from a color TV, and so the danger is negligible.

Oldsmobile Toronados for 1977 have an electronic spark-timing microprocessor. The "Microprocessor Sensing and Automatic Regulation" (MISAR) system is built around a Rockwell 10-bit custom microprocessor by the Delco-Remy division, reports **Electronic News.** Engine speed, crankshaft position, manifold vacuum, and engine coolant temperature are monitored, and MISAR determines the precise time the high voltage is applied to each spark plug. An improvement of fuel economy, and a reduction of emission are expected to result. Ford Motor Company plans for 1978 models a microprocessor control of engine and exhaust gas recirculation. Within two years, Chrysler Corporation expects to have microprocessor control of the new lean-burn engine, and eventually might have a total of three or four microprocessors in each car. General Motors is the only auto manufacturer making IC's, at this time.

A portable heart-defibrillator weighing only 8 pounds recently was demonstrated at a medical convention. The machines operate from internal batteries. It was estimated that as many as 200 heart-attack victims **per day** could be saved, if the defib machine became as readily available as a fire extinguisher.

Have you ever heard of the "Shakespeare College of Electronic Knowledge"? Well, perhaps it's not in a class with Harvard and Yale, but "Shakey U" operated for two days in September at Hilton Head Island, South Carolina. Fifty sales representatives of the Shakespeare Electronics and Fiberglass Division (CB and radio manufacturer) earned their "Bachelor of Antenna Arts" degree. As you have guessed, the theme was borrowed from colleges and universities, and the courses covered electronic theory, product engineering and sales management.

Tuner Service Corporation



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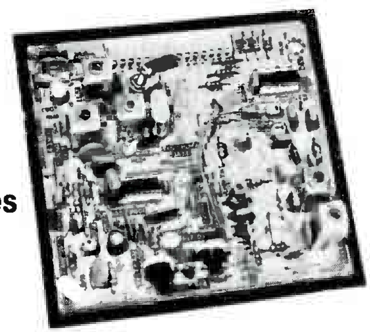
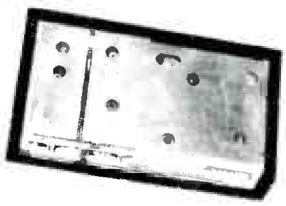
as well as Zenith IF subchassis.





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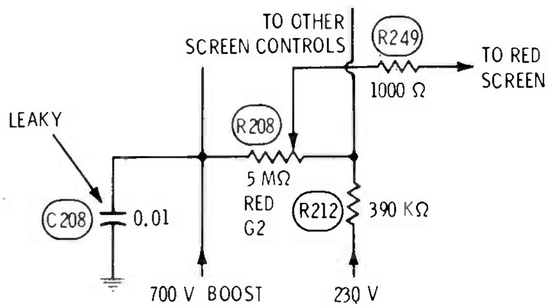
symcure

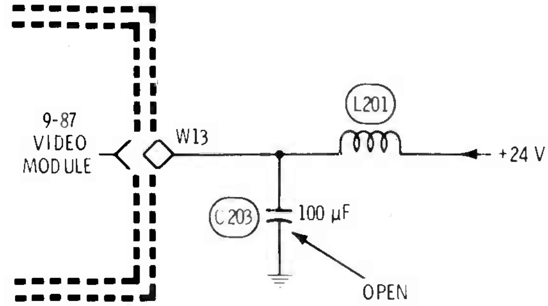
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Zenith 25FC45
PHOTOFACT—1466-3



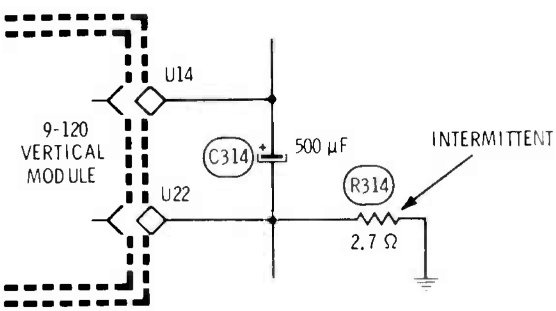
Symptom—Low brightness (sometimes color smear on b-w)
Cure—Check C208, and replace it if leaky

Chassis—Zenith 25FC45
PHOTOFACT—1466-3



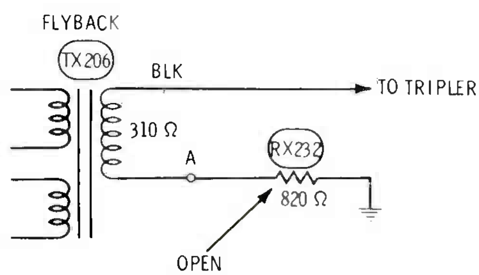
Symptom—Loss of horizontal sync
Cure—Check filter C203, and replace it if open

Chassis—Zenith 13GC10
PHOTOFACT—1540-2



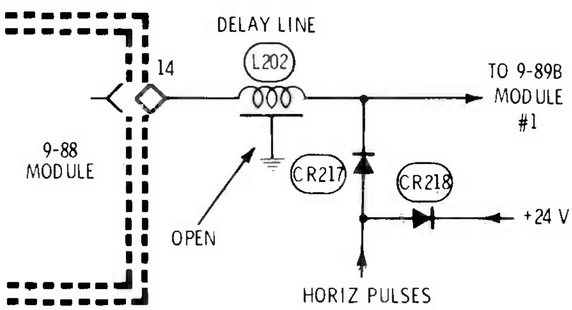
Symptom—Height varies at top and bottom
Cure—Check R314, and replace it if intermittent

Chassis—Zenith 19GC45
PHOTOFACT—1546-2



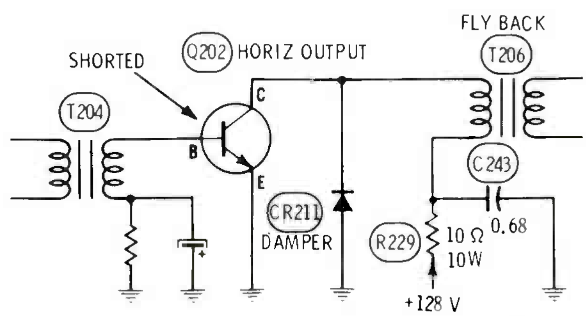
Symptom—Low HV (perhaps 12 KV)
Cure—Check RX232, and replace it if open or increased

Chassis—Zenith 23GC45
PHOTOFACT—1558-2



Symptom—No control of brightness; retrace lines; foldover on left
Cure—Check the delay line, L202, and replace it if open

Chassis—Zenith 25FC45 (others, also)
PHOTOFACT—1453-3



Symptom—Loud hum, no HV
Cure—Check horizontal-output transistor, and replace it if shorted

□

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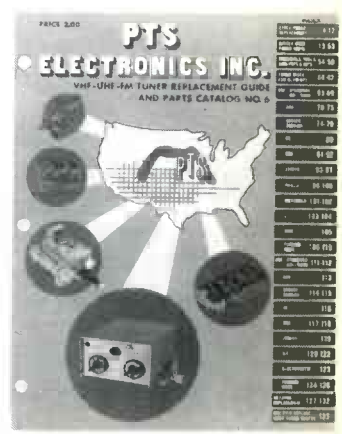

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troubleshooting tips

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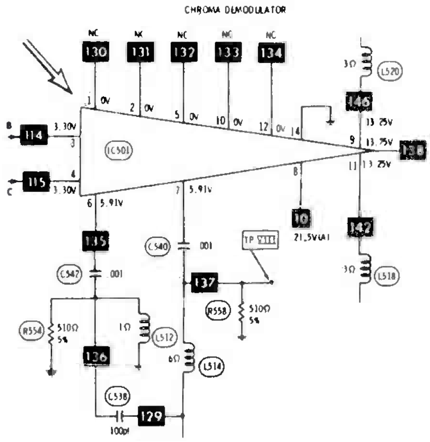
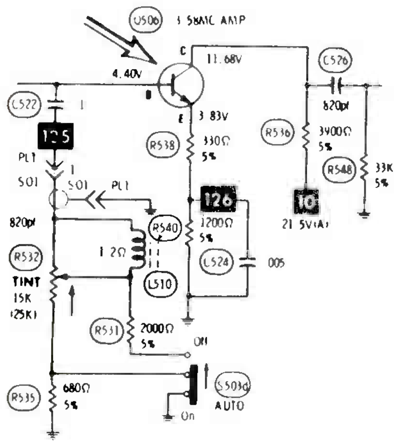
Blue picture; vertical-retrace lines, General Electric 16JA (Photofact 1335-2)

The raster was a bright blue, with blue retrace lines. I checked the collector DC voltages of the three chroma/video output transistors (Q606, Q600, and Q604). The



blue output had near-normal voltage, but Q606 and Q604 measured the same as the supply voltage. This proved the two transistors were cutoff (that is, had insufficient forward bias).



Q606 and Q604 did not have enough positive voltage at their bases. So, because the bases were supplied by IC501, I replaced the IC. This restored normal voltages to the two transistors, allowing adjustment of good gray-scale tracking without retrace lines.

However, the color bars did not have enough red saturation. Some extensive testing uncovered these voltages at the 3.58-MHz amplifier, Q506:

collector was +21 volts
base was +5 volts
emitter was +2 volts

A forward bias of 3 volts, but without collector current, indicates an open transistor. I replaced Q506, adjusted the AFC, touched up the gray-scale screen color, and returned the set to the customer.

Ed Pena
Oaks, Pennsylvania

No horizontal locking Zenith 17EC45 (and others using 9-57 and 9-70 horizontal modules—Photofact 1377-3)

Visual examination of the horizontal module located a burned R808, which brings in horizontal pulses that are integrated into sawteeth for the horizontal phase detector. After removal, the 330-ohm R808 measured above 50K ohms. Installation of a new one gave good locking.

Since that first repair, I have found four more open or burned R808's. Evidently, a half-watt size is not enough; late production 9-90 modules have 1-watt resistors.

(Continued on page 17)

reader's 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: *Operating/servicing literature, schematics, and tube charts for B&K Model 650 Dyna-Quick tube and transistor checker, 610 and TC-615 adapter panels. Will buy, or copy and return.*

Tom's TV & Electronics
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For Sale: *Bell and Howell color TV course, complete, sell all or parts; make offer.*

Roman Watashi
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Minneapolis, Minnesota 55404

Needed: *2EP4 picture tube for Philco TV, Model H2010.*

Larry Auman TV
Route 1, Box 368
Dover, Ohio 44622

For Sale: *Heath Model 10-18 oscilloscope with probes, perfect, $75. Also, Leader Model LSG-11 RF signal generator, like new, $35.*

C. J. Porcari
630 N. 65th Way
Hollywood, Florida 33024

Needed: *Schematic, parts list, and other service information for an old Crosley radio, Type 1121. Will buy, or copy and return.*

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

Needed: *19-KHz transformer for Knight Model KG-765A stereo tuner. Original part #142-135L3, 273F6652. Will pay reasonable price for new or good used transformer.*

Allan Siirila
P.O. Box 561
Belvidere, Illinois 61008

Needed: *Schematic and/or service manual for Martel Model 40W AM-FM stereo receiver (made in Canada), or address of company. Also, need manual for Tektronix Model 316 scope.*

Stony Point TV
Route 9W, Liberty Drive
Stony Point, New York 10980

Wanted: *Schematic and service data for a Grunow Teledial cabinet type radio, chassis 10D. Manufactured in 1930's by General Household Utilities. Will buy, or copy and return.*

Larry Frank
13701 Force Street
Houston, Texas 77015

Needed: *Vertical-output transformer, #TO-0061, for a Muntz b-w TV combination, Model 3521W, chassis A5001. Part can be new or used, but good.*

E. J. McCain
Town & Country TV Service
600 Cate Avenue
Jonesboro, Arkansas 72401

Needed: *Source of 1 RPM, 60 Hz, 120-volt motors for various Japanese-made digital clock radios. One is marked "OMRON 1 RPM 60 Hz Japan". Motor capsule is similar to Telechron type, but much smaller.*

Bernard Serota
2502 South Phillip St.
Philadelphia, 19148

For Sale: *Sprague/Jud Williams Model A transistor curve tracer, good condition, $75.*

Casco/Maitland
2241 Gillis Court
Maitland, Florida 32751

Needed: *Complete series of "programmed instruction" publications (1964-1966) by Tektronix, titled "Semi-conductors, Diodes, and Transistors". I have Volumes 1 & 2. Will pay shipping. Send price and titles of other volumes, or I will copy and return. Also, would like information on source of any "Programmed Instruction" course, manuals, or books on digital concepts, electronics, etc.*

S. O. Sellers
1504 51st Street West
Birmingham, Alabama 35208

Needed: *Hammond organ service manual and schematic for Model B, C, or D, circa 1940. 2A3 and 56 tubes used in power amp. (Will buy complete Hammond power amplifier, any condition.) Also, need Sams "Electronic Organs, Volume 1", #20188.*

ATS Instrument Co.
P.O. Box 86
Farmington, Connecticut 06032

Needed: *Schematic for Euphonics intrusion alarm, Model #SA-3A, manufactured by Euphonics Corporation, Guaynabo, Puerto Rico 00657. Will buy, or copy and return.*

Gordon H. Williams
859 N.E. 121st St.
N. Miami, Florida 33161

(Continued on page 14)

(Continued from page 13)

Needed: *Pages one through six of the tube-chart book for Model 157 Accurate Instrument Company tube tester. Will pay postage, copy and return.*

D. L. Konicki
4443 N. Greenview Avenue
Chicago, Illinois 60640

Wanted: *Howard W. Sams book #24014 "Single Sideband: Theory & Practice." Quote price and condition.*

Barnes TV & Radio Service
118 West Main Street
Camden, Tennessee 38320

Needed: *Instruction book or service manual for Model 30-B Fleet Courier receivers. Will pay for copying, or will copy and return.*

John Havery
Specialist, Electronics
Oregon Department of Education
942 Lancaster Drive, N.E.
Salem, Oregon 97310

Needed: *Schematic or service manual for Bradford TV, Model 1004B30, W.T.G. #30-55988. Will buy, or copy and return.*

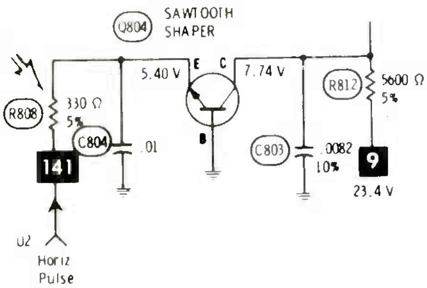
William S. Reid
18506 Indiana
Detroit, Michigan 48221

(Continued on page 18)

(Continued from page 11)

These defects remind us that **both** the sync pulses and a sawteeth sample from the horizontal-sweep circuit are necessary for proper operation of this type of phase detector.

George Persico
Thiells, New York



Editor's Note: This typical defect has been reported and published several times, but we are telling it again for any technicians who might have missed it before. Refer to page 30 of the August issue of ELECTRONIC SERVICING for another case history.

Insensitive remote
Zenith Chassis 23DC14
(Photofact 1306-3)

The complaint against the remote-control operation was that the hand unit had to be very near the TV, else it would not change channels. I pulled the remote amplifier, transducer, and hand unit for the shop.

While checking the DC voltages at the amplifier transistors, I found a high collector voltage for Q1, the first amplifier. Much additional testing proved nothing, until I disconnected the transducer. That reduced Q1's collector voltage to normal.

After I obtained a new transducer and connected it, the abnormal voltage was gone and the sensitivity of the remote was good.

The defective transducer measured about 20K ohms, and it should have checked open. Strangely enough, the bad one worked okay in a tube-equipped remote!

In my 43 years of servicing, I have replaced only one other transducer.

D. W. Alleeson
Los Angeles, California

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'76

(Continued from page 14)

For Sale: *B&K television analyst, Model 1075, and Dyna-Sweep circuit analyzer A107; best offers.*
Max Stern
2011 Picton St.
Ocean, New Jersey 07712

Needed: *One 4GZ5 tube.*
Sam Yuppa
16191 Melody Lane
Huntington Beach, California 92649

Needed: *Schematic or technical manual for Bell Boy personal pager, Bogen Model TR-54B.*
Derek Watson
R.R. 3
Bridgewater,
Nova Scotia, Canada

Needed: *A Setchel Carlson Model U800 color chassis, or any plug-ins for it.*
Malcolm McCarty
4401 Wildwood Road
Dallas, Texas 75209

Needed: *Service information on Mercury vacuum tube voltmeters, Model 1700C in particular.*
R. S. Hamilton
4509 Richardson
Fort Worth, Texas 76119

Needed: *Schematics and operating manuals for Century VTVM, Model VT-10; also probe, or schematic of probe. Also, need schematics and/or wiring diagrams for Eico VTVM, Model 232; and Supreme Instruments Model 542 multimeter.*
Allen C. Fryou
3735 Fairmont Drive
New Orleans, Louisiana 70122

Needed: *Operating and servicing literature or schematics for Solar capacitor analyzer Model CB-1-60. Will buy, or copy and return.*
Tom Garz
R. R. #1, Box 218A
Hortonville, Wisconsin 54944

Needed: *Service manual for a B&K Model 1450 scope. Will buy, or copy and return.*
Dan L. McGrath
616 Paris Ct.
Columbia, Missouri 65201

For Sale: *One Sencore CR143 picture-tube tester/rejuvenator, just overhauled and calibrated, with all manuals and test sockets, for $30 or best offer.*
Al Hawkes
U.S. Route 302
Westbrook, Maine 04092

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534 W. Addison St.
Suite One South
Chicago, Illinois 60613

For Trade: *Will trade radio and TV tubes for test equipment and Rider's radio manuals.*

Troch's TV
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Spotswood, New Jersey 08884

Needed: *Schematic for Zenith transoceanic portable radio, Model 8G005TZ1. Will buy, or copy and return.*

Walter J. Theurer
Fulton-Montgomery Community College
Johnstown, New York 12095

For Sale: *B&K 1460 scope, B&K color bar generator, Sencore 7-in-1 bias supply, like new; all for $300.*

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Bronx, New York 10466

Needed: *Service data for a Model 2085 8-track tape recorder/player by Mayfair Sound Products. Also, need service data for a stereo receiver Model STA-2100 manufactured by Monarch Electronics International.*

John Nicoll
18812 Cypress
Tinley Park, Illinois 60477

Needed: *Power transformer for Jackson oscilloscope Model CRO-2 (part #14-59); and a power transformer for Mercury tube checker Model 301, (part #10066410 or 10-1-6).*

St. George Electronics
P.O. Box 7, Water Street
St. George, Bermuda

Needed: *One power transformer 54-26 for Heathkit Model 0-12 oscilloscope.*

Joseph J. Babis
66 Pumpkin Ground Road
Stratford, Connecticut 06497

Needed: *Schematic and/or assembly manual for Lafayette Genometer Kit 38-1001, Model 156, manufactured by Accurate Instrument.*

Bill's TV Service
William E. Schaefer
1136 Limekiln Pike
Ambler, Pennsylvania 19002

"Wireless" Radio Repairs

Servicing the "wireless", modular CB transceivers by Royce is different from repairs of conventional radios having circuit boards and many connecting wires. The basics of Phase-Locked Loops (PLL) also are explained.

The outside appearance of the Royce Model 655 CB radio transceiver gives no hint of the unusual construction inside.

By Marvin J. Beasley, CET
Technical Associates, Inc.

Wires Versus Modules

We technicians have no reasons for judging the merits of various kinds of wiring or mechanical layout, except as they affect either the performance, or the difficulty of making repairs. And we tend to ignore most claims made by manufacturers about the products. In fact, most technicians might be described as being blasé.

Even so, my first glance inside a Royce "wireless" type of CB radio transceiver startled me. Much of the works seemed to be missing (Figure 1), as though the radio might be a sample or a mockup.

But a closer look revealed a "mother" circuit board (Figure 2), into which the terminals of four modules and a shielded synthesizer were inserted and soldered. The mother board had all of the copper-foil type of connecting wires on it, and this eliminated the usual clutter of wires that tend to hide the components and give an untidy appearance to radios of conventional construction.

The modules are spaced rather close together. In fact, there's not enough room for any extensive testing on the modules. A solution is shown in Figure 2; unsolder the terminal pins, remove the module, place it in the same position **below** the circuit board, solder the pins, and you have unlimited space on both sides of the module for "live" tests.

Figure 3 pictures three of the modules, removed from the radio. And Figure 4 shows the conventional 23-channel Royce synthesizer, which uses 14 crystals and 4 transistors. Not shown is the Phase-Locked Loop (PLL) module and switch; in appearance it is merely a shielded box.

Good accessibility to most circuits and components is shown by the two pictures in Figure 5. Both metal sides have cutouts.

Servicing Procedures

Efficient servicing requires you to match the trouble symptoms with the functions of the basic circuits. Now then, if you can do that (without problems) from the full schematic alone, you need nothing else. But, when the maze of symbols interfere with your logical analysis, you should have a block diagram (Figure 6).

Incidentally, the service literature from Royce is excellent. It includes specifications, troubleshooting charts (Figure 7), voltage charts, and alignment instructions.

If you are tired of squinting over the usual 3-inch schematic, the Americanized 11-by-17-inch schematic (that's supplied with each

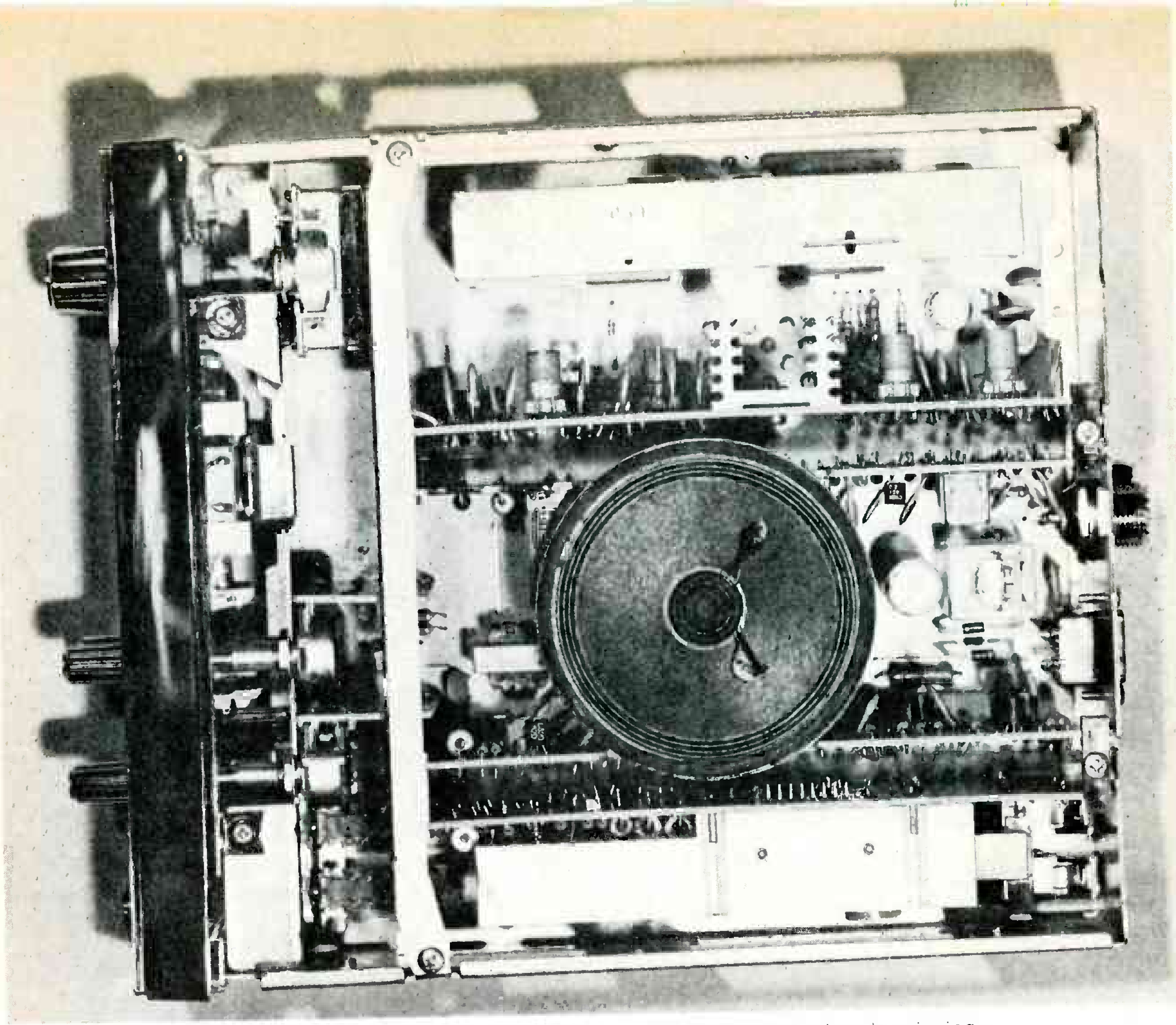

Fig. 1 The Model 655 seems to be unfinished; the usual maze of connecting wires is missing.

radio) will be a relief.

Warranty

Although the terminals of the Royce modules are soldered to the mother board (as a precaution against intermittent connections in rough mobile service), any module can be unsoldered and removed in less than 5 minutes. Therefore, the Royce warranty provides for the no-charge exchange of a new module for the defective one, and for labor to replace (**not** repair) the module.

Royce appoints warranty stations, but independent shops can buy service manuals, modules, and components from the factory for out-of-warranty repairs.

Of course, if the radio is out of warranty, you either can replace individual components on the modules, or obtain and replace complete modules; it's your choice.

The exchange price of modules is about 25% of the list price of new modules.

Phase-Locked Loops

It seems likely that all of the new 40-channel CB radios to be sold after January 1 of 1977 will employ frequency synthesizers of the Phase-Locked Loop (PLL) type, rather than ones using quartz crystals.

The reason for this prediction is the high cost and scarcity of crystals. A crystal synthesizer for 40 channels might require 21 crystals, while a PPL synthesizer could use 3 crystals and 10 IC's.

Very little information has been released about the Royce PLL system; however, we can give some general data and history that should help you understand basic phase-locked loops.

History of PLL

In 1932, British engineers described a system of synchronous reception of radio signals by locked-phase signals. This method was developed in the search for a circuit to compete with the superheterodyne. However, both the cost and complexity were excessive, and PLL circuits never became popular for AM reception.

Even so, other simple applications of Phase-Locked Loops have been used over the years. For example, all of the frequency-locking circuits for horizontal oscillators in TV receivers are PLL's.

FM Automatic-Frequency Control (AFC) operation, which sampled the positive-zero-negative "S"-curve output voltage from the FM detector and used it to fine-tune the oscillator frequency, also was (and is) a type of PLL action. And what of color-oscillator locking circuits? Think of the ones that had two diodes to compare the phase of burst and 3.58-MHz oscillator signals. From the diodes came a DC

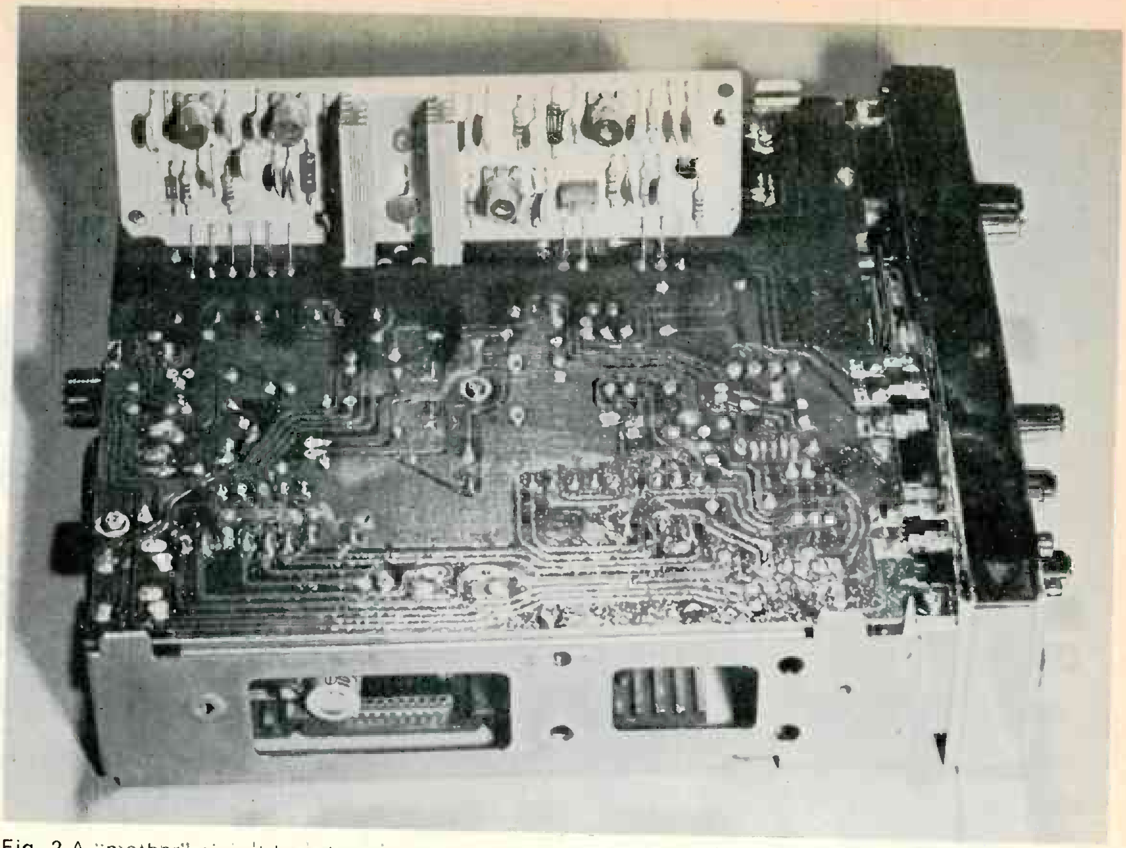

Fig. 2 A "mother" circuit board supplies the copper-bonded connecting wires, and the module pins are soldered to this board. To obtain more room for power-on servicing, the modules can be removed and soldered on the bottom of the board, as shown.

Fig. 3 These are three Royce modules. (A) The U4 module has the transmitter pre-driver and output stages; (B) the audio/modulator stages and the modulation transformer are on the U3 module; (C) U2 module contains the IF stages.

voltage used to vary the capacitance of a reactance stage. In turn, the reactance circuit determined the final frequency and phase of the 3.58-MHz oscillator. Those circuits, too, were simple examples of PLL, although we didn't call them by that term.

Notice that all of these circuits forced the frequency of an unstable oscillator to keep in step with the frequency of some standard.

Of course, having a PLL and a crystal oscillator which both produce the **same** frequency in a CB radio would not be desirable. But a PLL would have great value if it could generate a phase-locked signal at **many** different **ratios** (either higher or lower) of frequency relative to the standard stable oscillator. Even then, it's true that **the two signals supplied to the phase comparator ALWAYS have identical frequencies and a 90-degree phase.** Proper operation of any PLL depends on these primary conditions.

When the standard and the variable oscillators are locked together (even though the locking is between octaves, sub-octaves, or

other ratios), the output-signal frequency will have the **same** drift as the standard signal. If a CB radio has 40 channels from a PLL, all 40 will have the **same** drift and percentage of accuracy. This is an important advantage, because it's much easier to stabilize one oscillator than several.

Basic PLL

Figure 8 gives the block diagram of a simple basic PLL circuit. Except for a couple of details, it could be the diagram of horizontal locking, color locking, or AFC correction. Error-correction amplifiers aren't always used in locking circuits; and for AFC, the phase of a tuned circuit is the standard, rather than a separate master signal. Any loop system needs amplification somewhere, for high gain is essential for precise correction and operation over wide pull-in and lock-in ranges.

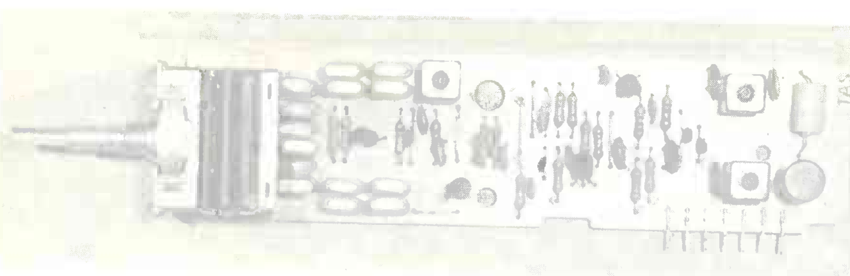

Fig. 4 The U6 Royce module contains a conventional synthesizer with 14 crystals and four transistors.

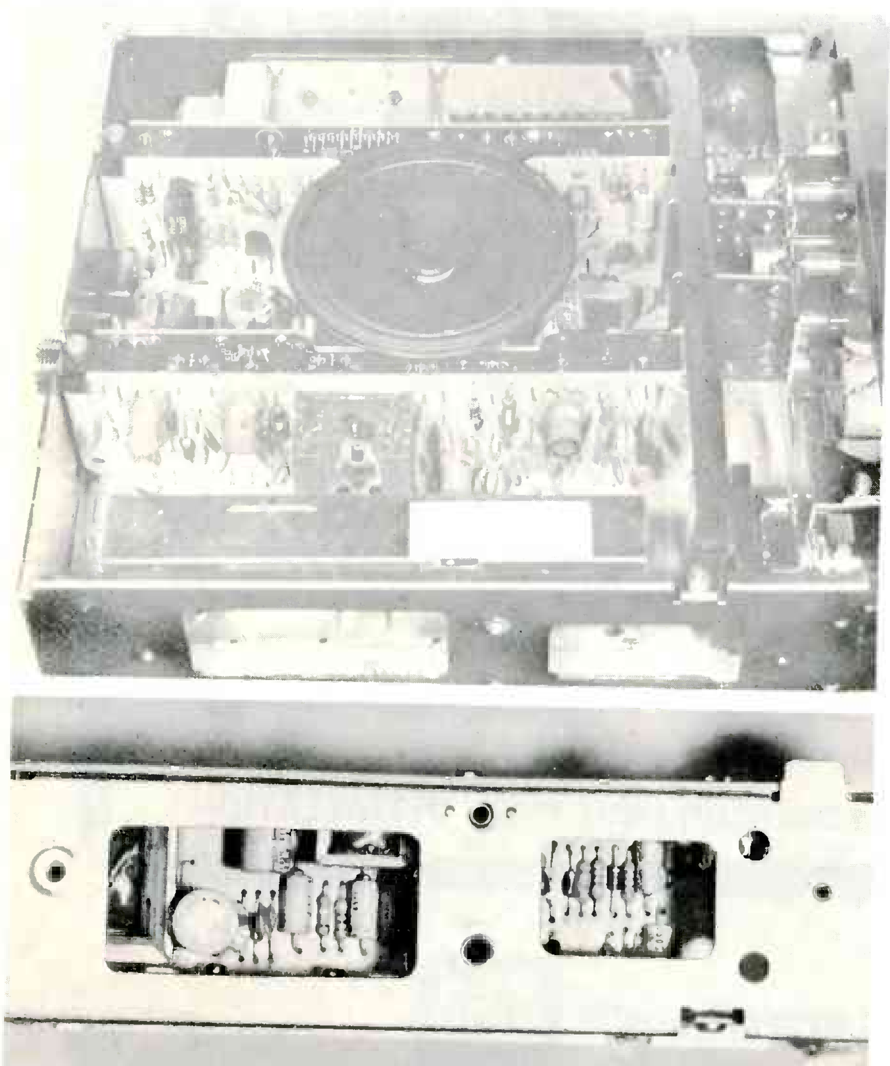

Fig. 5 These two pictures illustrate the good accessibility to most components. Both side panels have cut-outs.

PLL differences

In TV circuits, the DC error-correcting voltage from the phase comparator (detector) often is zero when the oscillator needs no correction, and it swings negative or positive as required to maintain the locking and phase.

Other kinds of PLL circuits might operate with a correction voltage of a designated positive value, with the actual voltage swinging up or down from that point to hold the locking.

PLL phase-comparator circuits usually do not have two diodes as rectifiers. Instead, a flip-flop multivibrator might be used, one which varies the width of the output pulses according to the phase difference between the input signals. After processing and filtering, the output pulses become a DC voltage whose value depends on the width of the pulses.

Also, the voltage-controlled oscillator probably would be tuned by a varicap diode, whose capacitance is determined by the DC control voltage from the phase comparator. In that case, the comparator is arranged so the control voltage is highest when the phase difference between the inputs to the comparator is the greatest. The error-correction voltage pulls the voltage-controlled oscillator in the direction of the standard input-signal frequency until locking occurs.

Adding dividers

A PLL system can be fooled into believing the voltage-controlled oscillator has the same frequency as the input standard by adding a digital frequency divider to the sample of oscillator signal that is fed to the comparator (see Figure 9).

Suppose the frequency divider gave a reduction of 10 times. When the error-correcting DC voltage brought the two signals at the phase comparatot into lock (same frequency and phase), the output signal from the Voltage-Controlled Oscillator (VCO) would have 10 times the frequency of the standard signal input to the comparator. This frequency-multiplied signal would have the same stability of frequency as the standard signal.

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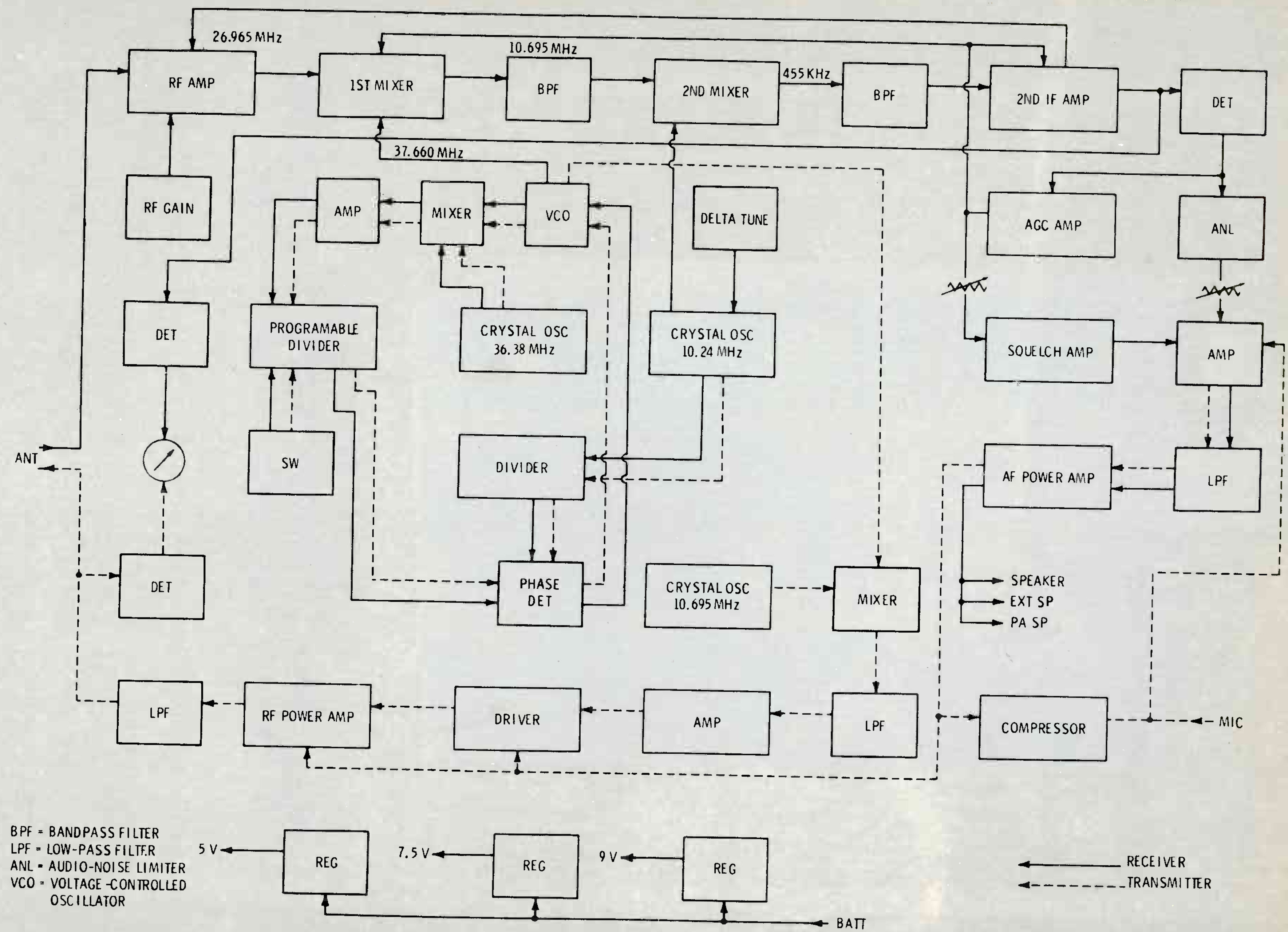

Fig. 6 This block diagram of the Royce Model 655 CB radio shows the major stages, components, and signal-flow paths.

So far, the performance has not been spectacular; after all, a series of doublers could have given 4, 8, 16, or more amounts of frequency change. But, there is more.

The fixed divider can be replaced by one giving a **series** of different divisions, the number controlled by a switch. Such a circuit is called a "programmable" or "variable" divider (even though it is not continuously variable, but has definite steps).

Also, a divider (either fixed or variable) can be added between the standard signal and the phase comparator. When variable dividers are used with both signals applied to the phase comparator, the VCO can be forced into operating at any one of a large number of stable frequencies. Also, additional crystal oscillators can be switched in, when needed, to provide even more frequencies.

Notice that the output signal from a PLL can be much more pure than it is from other synthesizers which **mix** two frequencies in a non-linear circuit, because there are no sum-and-difference frequency products in the output (only the normal oscillator harmonics).

One of the fascinations about PLL circuits in general is the many (almost endless) array of functions that can be done with variations of the basic PLL circuit.

For example, SCA demodulation of background music on FM stations can be done with one IC, six capacitors, and ten resistors. AM or FM demodulation is nearly that simple. The voltage-controlled oscillator can be made to lock to a weak signal that's buried under noise, thus giving the effect of amplification and tuning, but requiring fewer components. Or, a PLL can be locked to the harmonic of a signal, for another kind of

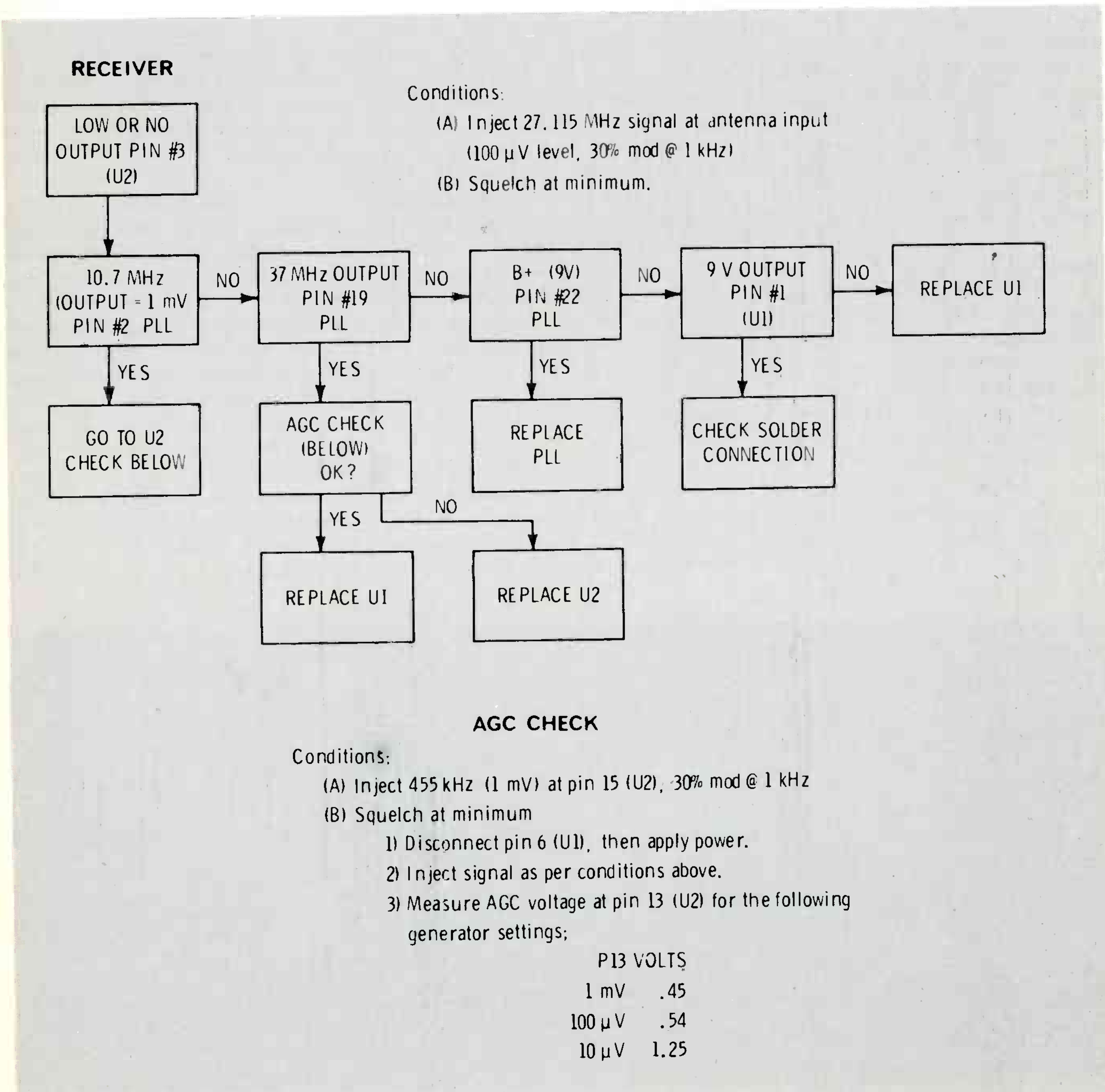

Fig. 7 Typical of the Royce service aids is this troubleshooting chart.

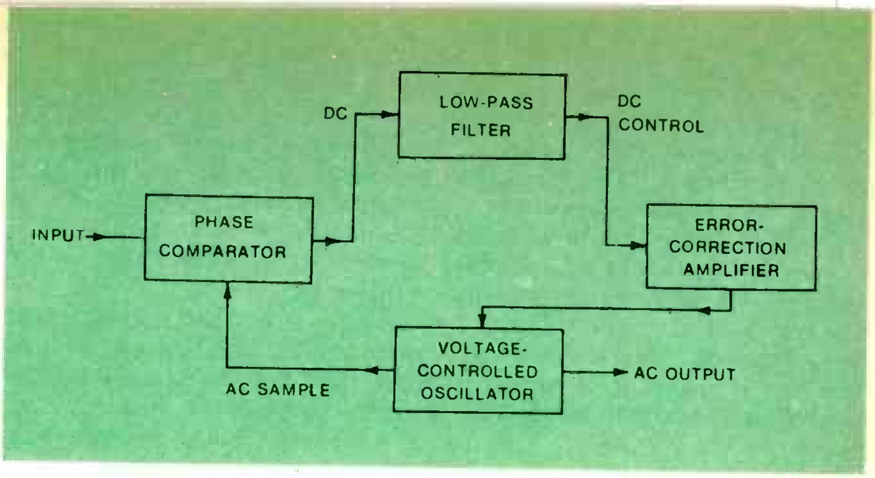

Fig. 8 The basic block diagram of a Phase-Locked Loop (PLL) is the same as many circuits used in TV receivers. When the frequency of the VCO is wrong, the phase comparator produces an error-correction DC voltage which varies the frequency until it is in lock.

frequency multiplication.

Unwanted sidebands (even those too close to be filtered out) can be removed by locking a PLL to the fundamental.

Laboratory frequency standards have been built at low cost by using a PLL that is locked to WWV, the National Bureau Of Standards station.

These are just a few of the possible applications for PLL's.

Royce PLL

At this time, Royce does not recommend field repairs of the Gyro-Lock PLL modules. For that reason, the following circuit explanation is not detailed.

Even so, we can learn part of the operation from Figure 6. Of the three crystal oscillators, two are used together at a time. One variation from the basic PLL circuit is that the variable-frequency signal is not obtained solely from a VCO, but by heterodyning the 36.38-MHz and VCO signals in a mixer, then the resultant is amplified and divided by a programmed divider before it reaches the phase comparator.

To obtain the transmitting frequency (26.965 MHz for Channel 1), the 10.695-MHz signal is mixed with the output of the VCO. For receiving, the VCO output supplies the first mixer, producing a first IF of 10.695 MHz, which is heterodyned down to 455 KHz by a signal from the 10.24-MHz oscillator.

Frequency and frequency drift during transmitting depends on both the 36.38-MHz and 10.695-MHz oscillators. All channels will have the **same** percentage of frequency error.

Frequency and frequency drift during receiving are functions of both the 10.24-MHz oscillator and the 36.38-MHz oscillator, plus the variation of the 10.24-MHz frequency by the "Delta" control. This control can vary the oscillator frequency during receiving by as much as 1.5 KHz, to allow proper tuning of any out-of-tolerance stations.

Length and position of the connections to the channel switch are not critical because only DC voltages go there.

Comments

Modular design of CB transceiver radios, and the consequent elimination of most connecting discrete wires can be important by permitting faster (more profitable) repairs. Of course, the modules must be readily available through an exchange program, and the service data should be of good quality. All of these desirable things are true about Royce "Wireless" models, and we can hope that other manufacturers will follow a similar plan, which would help the CB repair business. □

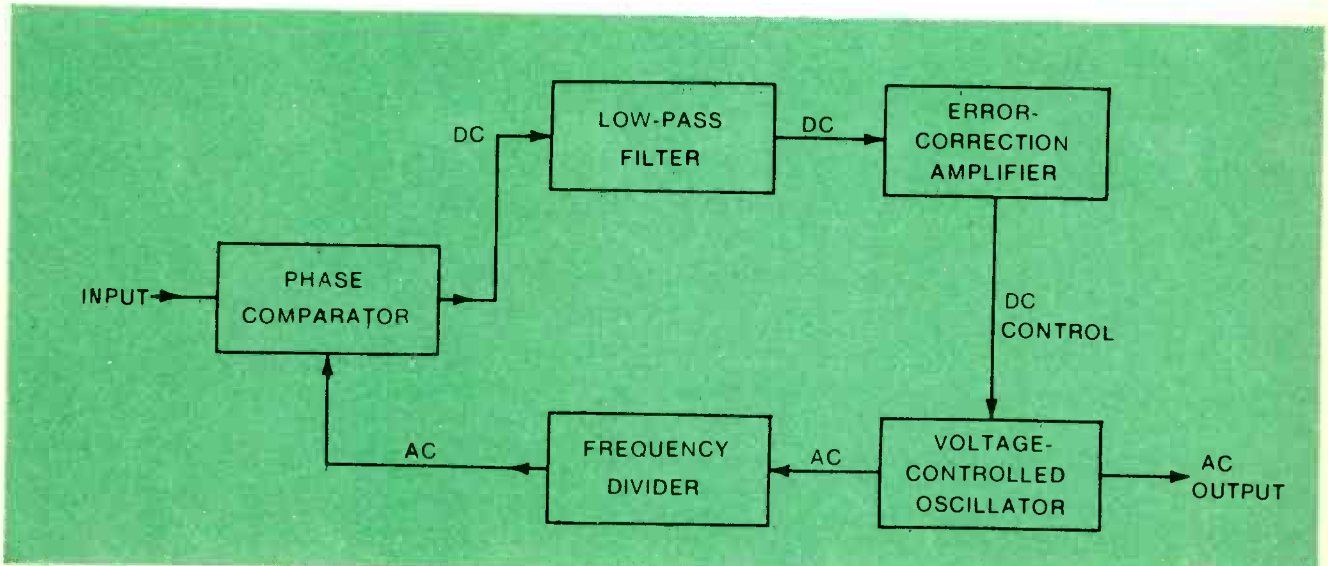

Fig. 9 For use in frequency synthesizers, a frequency divider is added so the VCO can be locked to frequencies other than the standard.

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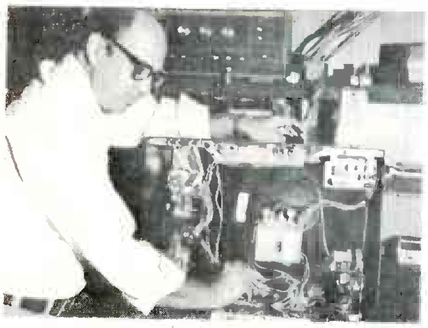
Philco E21 Chassis... Circuits and Servicing

Part 2/By John Simrell



Power supplies of the Philco E21 chassis were covered last month, including the safety shut-down circuit that kills the horizontal drive. This month, the horizontal-sweep circuits and several case histories are examined.

Functions Of IC400

Four functions are accomplished inside one integrated circuit, IC400 (Figure 1). These four are: noise-inversion; sync separation; phase comparison and oscillator control; and horizontal oscillation.

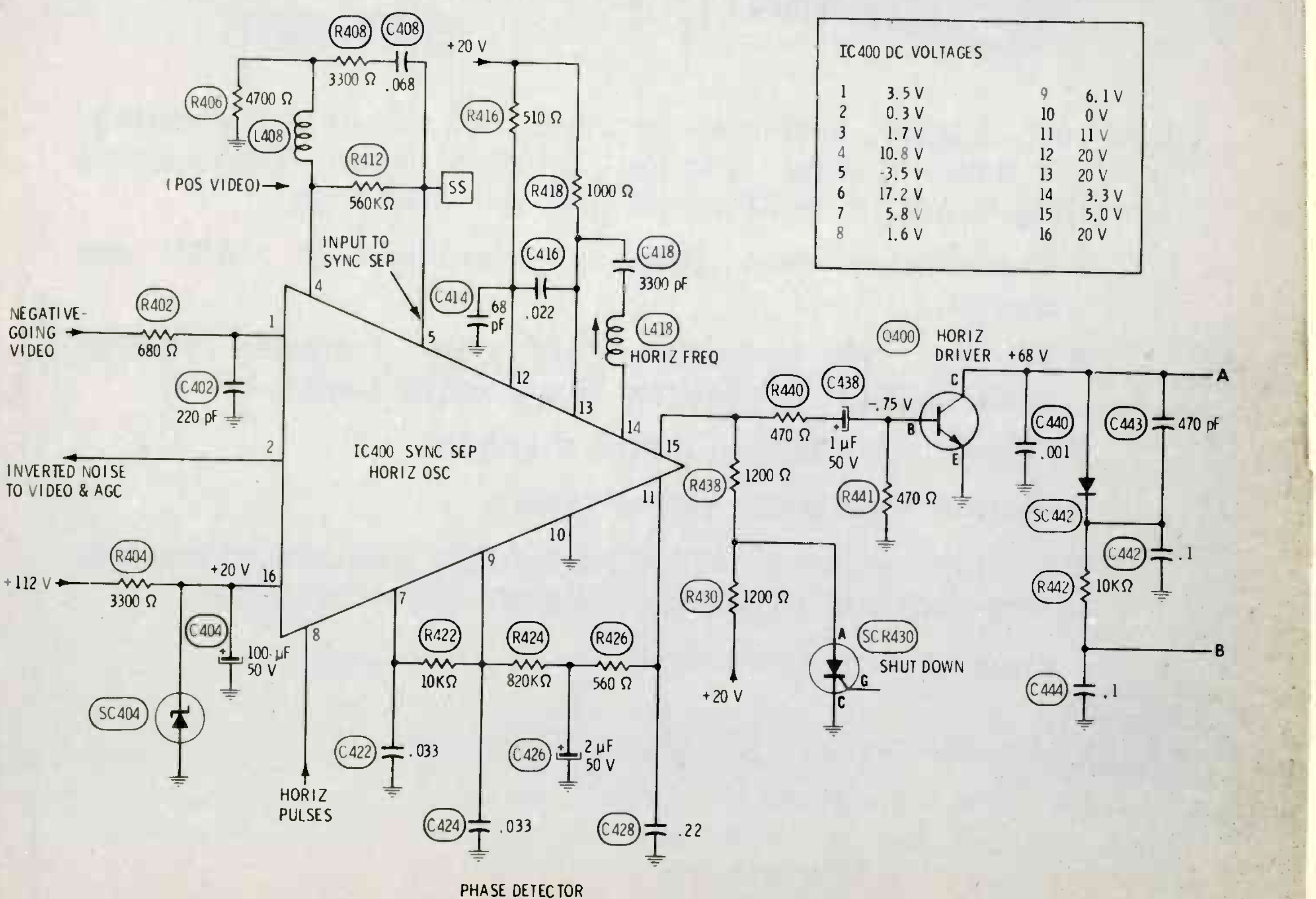
Noise inversion

Instability from impulse noise is minimized by separating the pulses from the video signal, inverting the phase, and feeding these clipped and inverted noise pulses into the video where they cancel the noise pulses of the original phase. Most of this occurs inside the IC, where you can't trace it. But the inverted noise comes out of the IC at pin 2.

Sync separation

Although the transistors are inside the IC, the network that's always supplied at the input of the sync separator is external. Positive-going video emerges at pin 4, goes through the network, and goes back into the IC at pin 5.

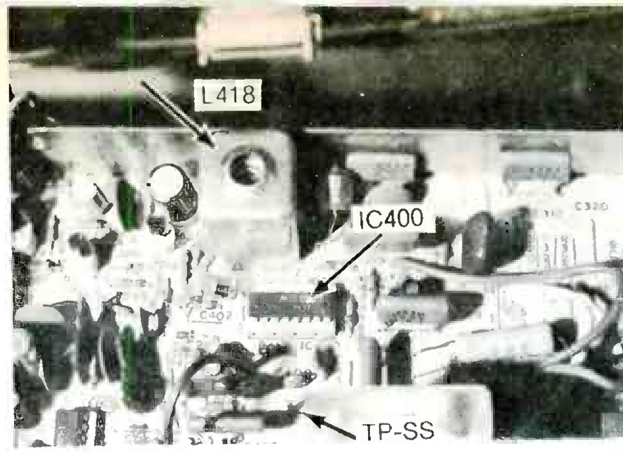
Testpoint "SS", at pin 5, allows you to observe with a scope the video after it has passed through those filtering components. But the testpoint also has another useful function. When you ground that point, all sync (both vertical and horizontal) is eliminated, thus allowing you to accurately adjust the frequency of the horizontal oscillator. Otherwise, if you don't use the testpoint, the oscillator hold-in range is so tight that it's difficult to know where to adjust the core of the oscillator coil. No hold control is provided for the customer, so it's up to you to adjust the frequency accurately.



IC400 DC VOLTAGES

1	3.5 V	9	6.1 V
2	0.3 V	10	0 V
3	1.7 V	11	11 V
4	10.8 V	12	20 V
5	-3.5 V	13	20 V
6	17.2 V	14	3.3 V
7	5.8 V	15	5.0 V
8	1.6 V	16	20 V

After separation of the sync tips from the composite video, the signal is divided, with the vertical sync emerging from the IC at pin 6, and the horizontal-sync pulses going internally to the phase detector. Some components of the phase detector are mounted outside the IC (those tied to pins 7, 9, and 11), and these points can be used to observe the waveforms.



These are the main components of the horizontal-oscillator circuit in the Philco E21-4 chassis (the Sylvania E21 is the same).

Phase detection and oscillator control

Horizontal pulses, which are filtered into a sawtooth waveform for the phase detector, come from the horizontal-blanker stage, and they enter the IC at pin 8. Of course, both sync pulses and a sawtooth from the horizontal-sweep circuit are necessary for correct phase detection and horizontal locking. The horizontal sawtooth can be viewed at pin 7.

Horizontal oscillation

The last function of IC400 is to furnish most of the components for the horizontal oscillator. Again, some components are external to the IC, and they include B+ and oscillator coil parts that are connected to pins 12, 13, and 14. Notice that no customer horizontal-hold control is provided.

A scope waveform taken at pin 14 will prove whether or not the oscillator is operating.

Typical DC voltages for IC400 are given in a block on the schematic. Keep them handy for reference during troubleshooting.

Square waves from the oscillator emerge from pin 15. Last month, we described how the shut-down circuit (which was triggered by excessive voltage of the +112-volt supply, or the excessive current of the +29-volt supply) forced SCR430 to short out most of the amplitude of square waves coming from pin 15. This reduction of drive signal turned off the driver and output transistors so they drew no current.

Of course, loss of the drive signal eliminates the high voltage and the

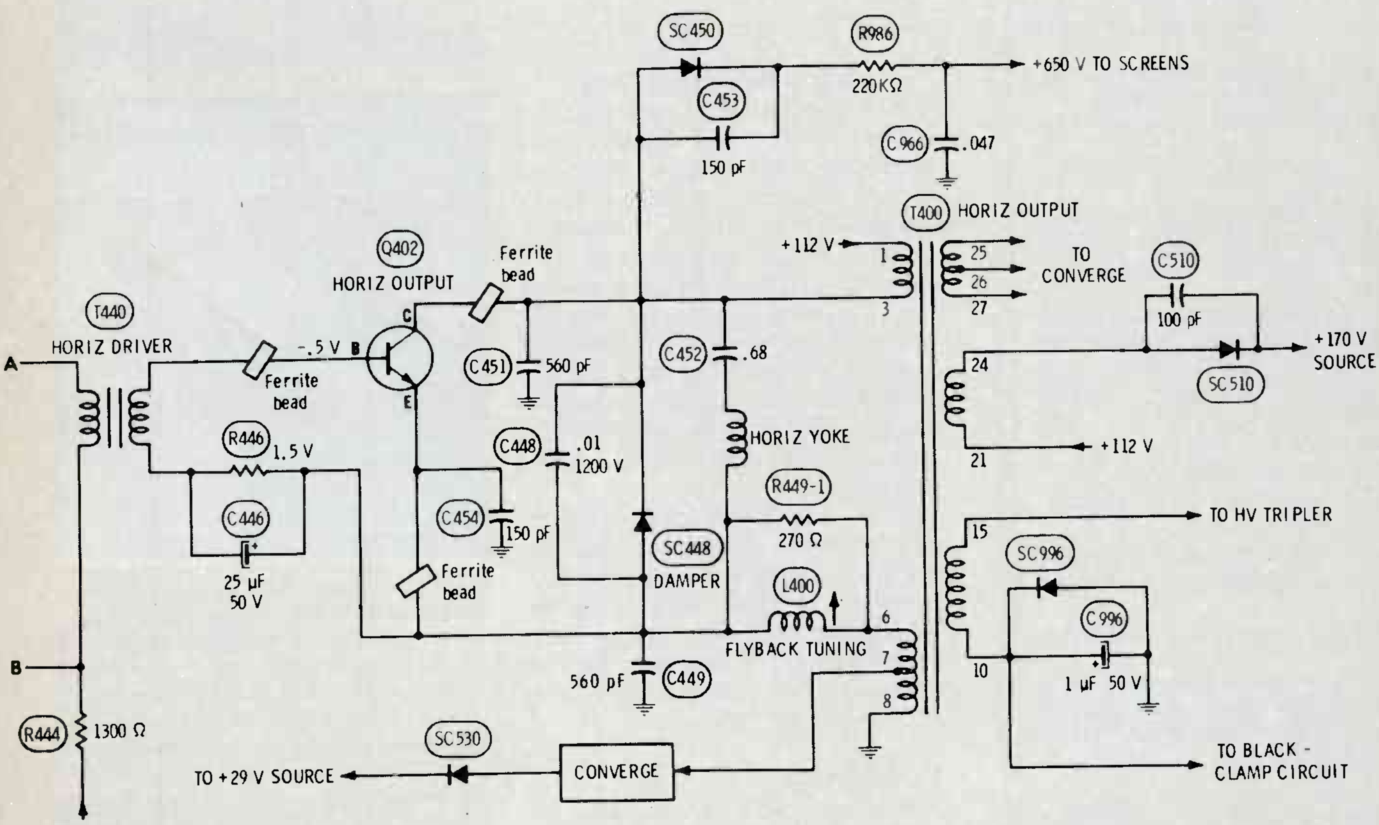


Fig. 1 Many of the components for the noise-inversion, sync-separation, and horizontal-oscillator functions are inside IC400; however, the vital waveforms can be viewed at the pins. The shut-down circuit was described in the September issue of ELECTRONIC SERVICING. Notice that the emitter of Q402 is not grounded, but drives one winding of the flyback transformer.

raster, so one of your first tests when you encounter those symptoms is to measure the frequency and amplitude of the square waves at pin 15.

Horizontal Driver

From pin 15 of IC400, the square waves go through R440 and C438 to the base of Q400, the horizontal-driver transistor. No DC bias is provided for the base; therefore, loss of the square waves there merely cuts off all the collector current of Q400.

In normal operation, each positive peak of the square waves acts as a temporary forward bias of Q400, causing it to draw heavy current during those peaks, and no current between the peaks.

Q400 is an intermediate-power type of silicon transistor, operating with a collector voltage of about +70 volts, and it does run warm. R442, C442, and diode SC442, in the collector circuit, are necessary to shape the waveform which is sent to the base of the horizontal-output transistor.

When you are checking this driver stage, your best tests will involve the DC voltages and waveforms at the base and the collector.

Horizontal-Output Stage

It is interesting to note that the collector of Q400 is the last point where the drive can be viewed (if the set is working properly). That's because the output transistor, Q402, is floated high above ground. Both the collector and the emitter feed separate windings of the flyback; therefore, a scope connected to the base or the emitter has the same 420-volt PP signal of negative-going pulses, while the collector has positive-going pulses of the same amplitude.

Both the damper diode (SC448) and the yoke with its capacitor, C452, are paralleled across the C/E terminals of Q402, in the conventional way. C448 has a major effect on the amount of high voltage, and you should not substitute any other size for the .01 value.

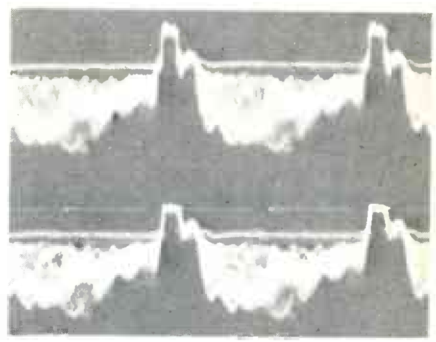
Flyback tuning

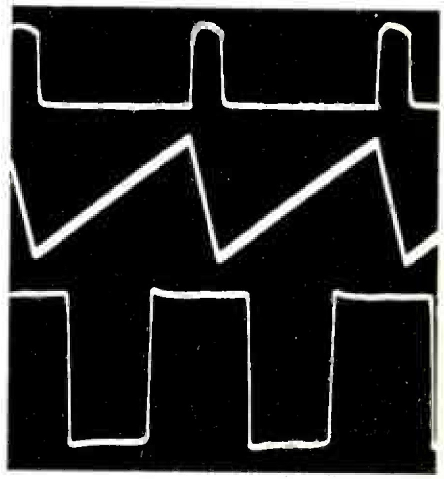
In many solid-state television receivers, the horizontal-output stage (yoke and flyback) is tuned to the third harmonic of the sweep frequency. This is done for two reasons. It gives better high-voltage regulation, and the amplitude of the flyback pulse is reduced, thus minimizing the possibility of damage to the output transistor. (The waveform at the emitter of Q402, the output transistor, changes slightly as the "flyback tuning" coil is adjusted. But the change is not sufficient to use as a symptom.)

With Philco E20 and E21 chassis, the tuning is adjustable by means of L400 coil, which is labeled "flyback tuning". The method of adjusting is simple: turn down the brightness until the raster goes black, then adjust L400 for **minimum** high voltage. That's all.

Black-clamp

The black-clamping circuit (called Automatic-Brightness Limit-





Here are typical waveforms from the IC400 and Q400 stages. The dual-trace 10-volt PP video waveforms are (at the top) pin 4 of IC400, and pin 5 (at bottom). Top trace of the three shows the 3.9-volt PP positive-going pulses at IC400 pin 7. These are inverted and integrated into 1.7-volt PP sawteeth (center trace) for the phase detector (the sync pulses do not leave the IC). The square waves at the bottom are the oscillator-output signal at pin 15 (10-volts PP).

NEW NEW NEW NEW NEW

Colorful New Beauty is Good or even better than Original Quality...

ONEIDA'S NU-COLOR **Picture Tube Restorer** provides precise color control to do what the name implies . . . restores color to original quality. It's versatile; a simple adjustment at time of installation provides the proper new color or colors to correct the weak tube. One restorer is all it takes . . . it brings back any degree of any or all of the colors . . . and it does it without damaging the basic tube or shorting any of the elements.

No More need for replacing a costly color tube because of poor, weak or missing colors...

ONEIDA'S NU-COLOR **Restorer** is available, at the present time, for use on all major makes of 70° and 90° picture tubes . . . two models accommodate most all 12" thru 25" color picture tubes. Installation is quick and simple. No wires to connect . . . Simply plug unit in. (Complete instructions are packed with each unit.) Original color strength is restored through boosted and individual biasing networks that increase emission and maintain constant color levels.

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No more need to put up with poor color because of cost of a new picture tube . . . the Oneida NU-COLOR Restorer will bring color back to "as good or better than new" and keep it that way. This restorer should not, in anyway, be confused with brighteners that can shorten tube life and possibly cause tube damage. The Oneida NU-COLOR Restorer is warranted against any defect and complete satisfaction is guaranteed.

Illustrations are simulated, not actual pi

NO RED

NO BLUE

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EXCLUSIVE WITH ONEIDA!

otos of TV screens.

NO GREEN

WEAK COLOR

Here's how it works

It Enhances the Circuitry to Operate at its Maxium Capability!

The Oneida NU-COLOR Picture Tube Restorer is a completely new concept of TV Circuitry. In essence it is a color amplifier . . . it adds a whole new power circuit to your tube so that, working with the tube, it amplifies and gives new depth, color and dimension to new as well as old weak tubes.

It does not increase the filament voltage as do some types of picture brighteners, and it will not restore color to tubes with burned out filaments, where phosphorous is gone or when the circuitry of the tube has been completely destroyed. So long as the tube has a good filament and phosphorous the NU-COLOR Restorer is capable of producing good new color results.

Ideal for NEW as well as OLD sets . . .

The modest investment of a NU-COLOR Restorer can provide untold hours of colorful new TV picture viewing. Even brand new sets can have picture quality improved . . . and old sets life can be prolonged indefinitely saving the cost of $100 to $250 new picture tubes.

Installation is quick and simple . . .

The NU-COLOR Restorer is installed as a bridge between the sets harness and the picture tube.

No need to haul your set away for this major improvement . . . NU-COLOR Restorer can be installed in just a few minutes by any qualified TV serviceman. And you can "try before you buy" for exacting color adjustments are made at time of installation . . . you can see color improvements being made and have your serviceman give you the degree of color most pleasing to you.

NOTE: The NU-COLOR Picture Tube Restorer is not a "cure-all." Its function relates only to the color correction of the TV Picture Tube. If faulty color, etc. is due to other components in the set the NU-COLOR Restorer will not solve the problem.

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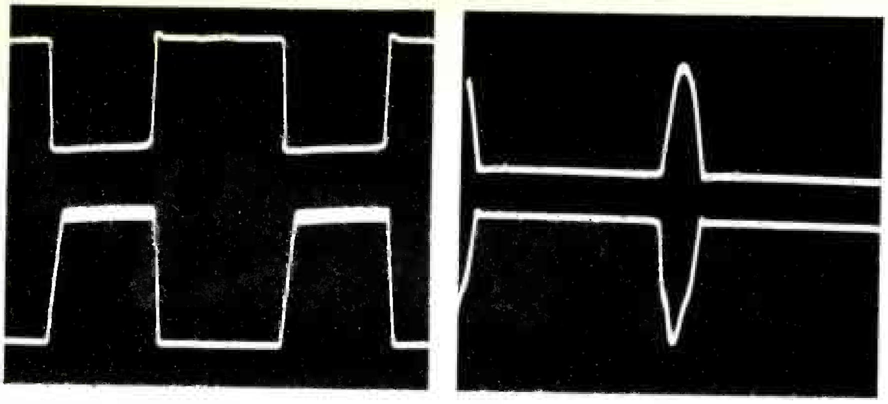


Top trace of the square waves is the 4-volt PP base waveform of Q400, the driver transistor. The 130-volt PP collector waveform is shown by the trace at the bottom. Referring to the pulses, the top ones are the 400-volt PP pulses at the collector of Q402, the horizontal-output transistor, while the bottom trace shows the 400-volt PP negative-going pulses at the emitter (and base), measured relative to ground. Be careful when you test around this area; all three terminals of Q402 have strong horizontal pulses.

er or ABL in other brands) monitors the HV current that passes through the flyback winding to the HVT401 tripler rectifier (see Figure 2).

Before you can understand the operation, you must remember the rule-of-thumb about rectifier circuits: **Any DC voltage coming from rectification will be positive if it is taken from the cathode of the diode, or negative if it comes from the anode of the diode.** Look at the tripler diagram in Figure 2; the last diode feeds the picture tube from its cathode. Therefore, the voltage is positive. At the other end of the tripler, the input AC goes to the anode of the first diode.

Now, if you could measure the DC voltage there (that's virtually impossible because of the high-amplitude pulses), you would find a negative voltage whenever the picture tube draws HV current. Similarly, if you added a resistor from the low end of the HV winding of the flyback (terminal 10, in this case) to ground, you could easily measure a negative voltage from the cold end of the winding to ground (across the resistor).

Well, that's essentially how the circuit operates, except the voltage is positive (because R996 goes to B+, not ground), and it becomes **less** positive (negative-going) when the HV current increases. This control voltage from terminal 10, C996, and SC996 acts to reduce the positive voltages at the bases of Q900 and Q902. Indirectly, the brightness control also changes the base voltages, so the action of the black-clamp circuit is to reduce the **brightness** of the picture when it tends to become excessively bright, regardless of the reason for the extra brightness. These changes of base voltages go down through the video stages, changing the operating points of each stage until the cathodes of the picture tube are reached. And there the black-clamp action raises the positive voltage at the CRT cathodes to decrease the brightness, and avoid overloading the sweep system and the picture tube.

Case Histories

Here are some actual repairs that illustrate service procedures for the horizontal sweep of the Philco E20 and E21 chassis.

Case #1

The original symptoms are no-raster and no-sound. Removing the shut-down SCR might bring back the operation. But usually output of the horizontal oscillator is lost some time later.

Voltage checks of IC400 show +17 volts at pin 14 (instead of the usual +3.3 volts). A new IC does not help. After many tests, we find C416 has excessive leakage.

This problem started happening quite often, before the factory made some corrections to prevent it. Later-production sets have the capacitor mounted off of the printed board to prevent heat damage

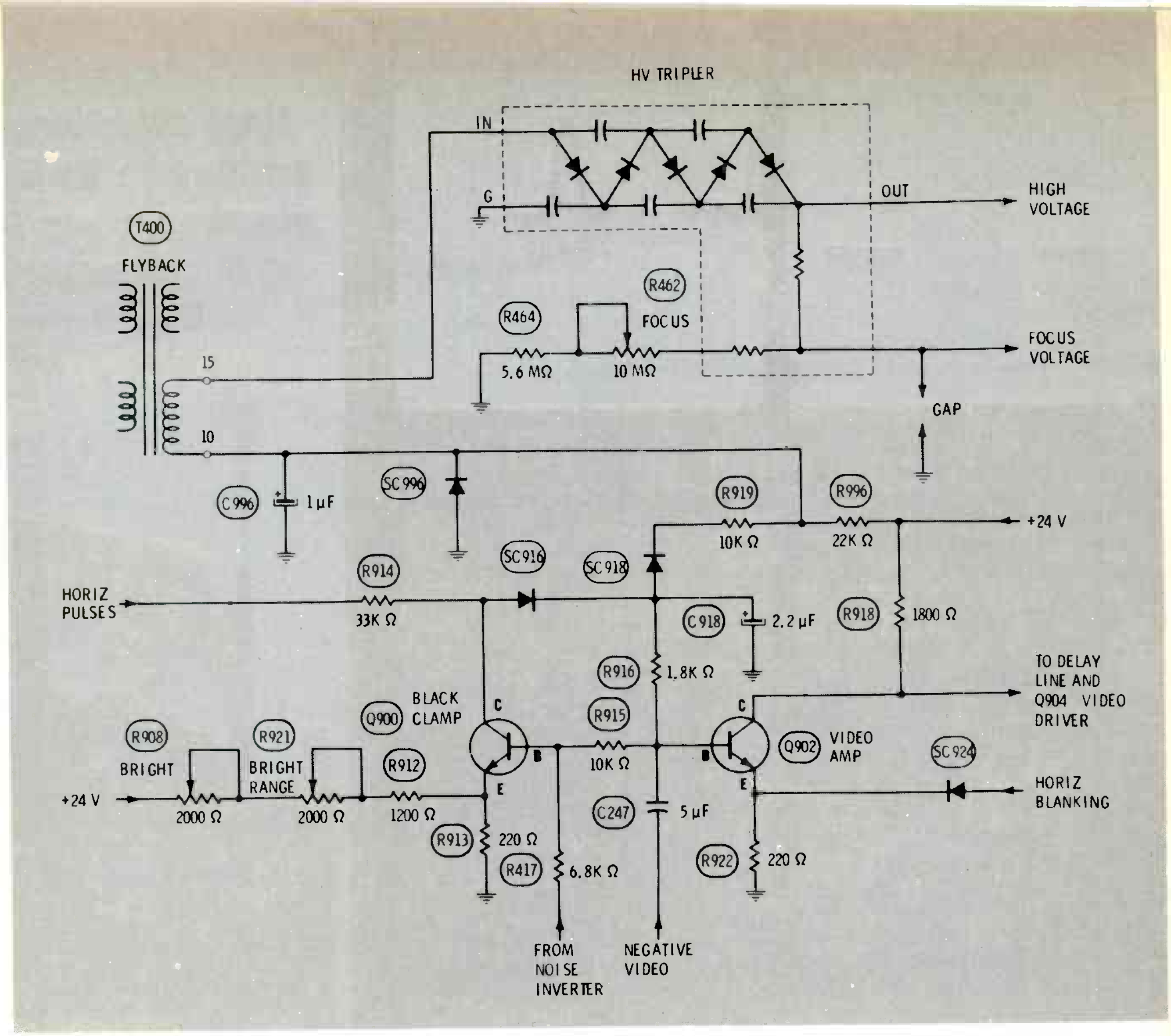
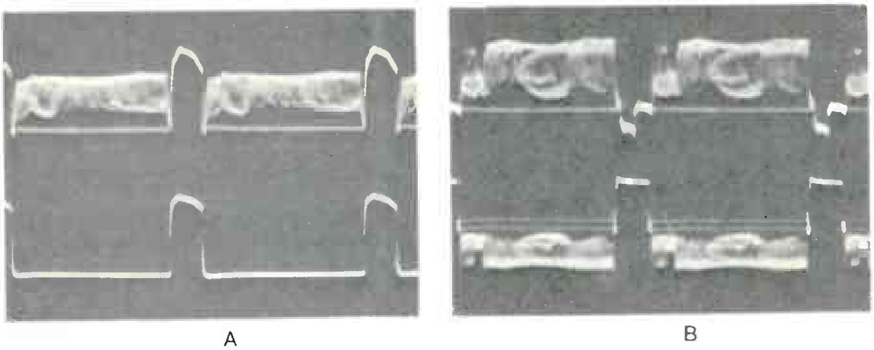


Fig. 2 Details of the automatic-brightness limiter and the black-clamp circuits are shown here. High-voltage current through the tripler to the picture tube produces negative DC voltage at terminal 10 of T400, the flyback (increased current gives higher voltage). This negative voltage cancels part of the positive voltage at the base of Q902. The circuit opposes any increase of brightness, above the design point. Also, changes of video amplitude vary the collector voltage of Q900, the black-clamp transistor, and the voltage goes through SC916 and R916 to the base of Q902, where it maintains the correct black level (brightness versus contrast).



A

B

Some Q902 waveforms are different because of the horizontal blanking that's added there. (A) Top trace shows the emitter waveform with video and horizontal blanking pulses; the pulses at the anode of SC924 are shown by the bottom trace. (B) Top waveform is the conventional composite video signal at the base of Q902; while the bottom trace shows the broadened blanking area of the collector waveform.

during the time the board is in the solder flow bath.

Use only an **exact** replacement capacitor. If you substitute a standard .0033 capacitor, the chances are good the irate customer will be on the phone the first thing next morning after he gets the set back. Since there is no customer hold control, the customer can't chase the wandering horizontal frequency as the capacitor drifts.

Case #2

This E21-04 chassis set came in with a complaint of "no horizontal locking". Replacement of IC400 made no change, and normal video was found at pin 5 of the IC.

When testpoint "SS" was grounded, the oscillator could be adjusted for a floating picture of the correct frequency, but removing the ground caused the picture to go farther out of lock.

Obviously, the defect was in the

phase detector. Pulses from the blanker at pin 8 were 3.6 VPP, which is about 10% low, but not alarming. DC voltages at the video input (pin 5) and the phase-detector reference (pin 8) were slightly high. Pin 8 was 2.4 volts instead of the normal 1.6. These voltage discrepancies were not enough to upset a technician who still thinks in "tube" language.

Perhaps the defect was in the string of capacitors and resistors around pins 7, 9, and 11. But testing them involves a lot of unsoldering. So, back to the scope again. At pin 8 the waveform was wrong. The base had a lot of "grass". In fact, half of the pulse was video!

How could video get into horizontal pulses? However, the pulses do not come from the flyback, but from the blanker transistor. Checking the schematic, I found a diode, SC924, between the emitter of the blanker and the emitter of video amplifier, Q902. When I disconnected one end of the diode, the locking improved. A new diode cured the problem.

(Continued on page 66)

SERVICING ELECTRONIC ORGANS

Part 6/By Norman H. Crowhurst

Most modern organs have very little frequency drift, and do not require tuning at regular intervals. But, if you repair old ones as well as new models, you will need to know how to tune all types of organs. And, of course, certain component replacements make a retuning necessary for the one note that is affected. Two methods of tuning by "fifths" from the audible beats are explained thoroughly.

Tuning Electronic Organs

Many of the new organs do not require tuning in the traditional way. So, as the older organs become obsolete and disappear, the need for tuning methods or tuning machines will be gone, also.

However, with the mix of brands and models at present, the tuning of organs is a necessary part of servicing them.

There are several methods of setting the "temperament" of the notes near the center of the keyboard, without any equipment other than a tuning fork for one note, plus a timing device (stop watch, etc). Two such methods will be described.

I advise you to try these methods until you become proficient with them. When you first start tuning, probably you will take so much time that each tuning will show a loss instead of a profit. Of course, you should gain speed with practice until tuning jobs become profitable.

However, I must say that both methods require close attention and careful listening. In other words, they are tiring and time-consuming. Therefore, when your number of tunings per year increases, you will save both money and strain by buying some kind of a strobe tuning device. One such machine, the Conn Strobotuner, was described in the May, 1976 issue of ELECTRONIC SERVICING, starting on page 12.

The exact method of tuning an organ depends on the basic design and how many tuning adjustments are provided. Some have one tuning adjustment, many have 12, and some have several dozens (even several hundred, in a complex model).

Single Master Oscillator

New "space-age" models have one master oscillator, which operates in the megahertz range. Some oscillators are crystal controlled (thus are not tunable), and others have one frequency adjustment. From this one oscillator, the countdown circuits produce the 12 tempered semi-tones. Next, from the 12 semi-tones, the lower octaves are obtained by some kind of frequency dividers.

If the master oscillator can be adjusted, you can tune the whole organ to any reasonable pitch (concert pitch, or any other that's desired) merely by turning one adjustment. An organ that is not defective moves **all** notes up or down in perfect step with the variations of the master oscillator frequency. Therefore, **you can zero-beat any note against a standard to tune the entire organ.** Obviously, the elaborate and traditional tuning procedure is not needed here!

Following the tuning (or a check of the tuning), try all the notes of the keyboards. If **any** note (or notes) is out of tune with the others, the problem is not tuning, but a defect in the count-down or divider circuits, which must be repaired.

Twelve Master Oscillators

Organs that have 12 identical circuit boards, each with one tuning adjustment, undoubtedly are of the master-oscillator/divider type. Those 12 adjustments tune the entire organ. One tunes all the "C's", the next all the "B's", and so forth.

A few models have more than one set of generators; for example, a second set tuned slightly sharp or flat to give a "celeste" effect from the beats produced relative to the main generator. In such cases, each additional generator will have 12 tuning adjustments.

When all the dividers are operating correctly, you can tune **any** 12 consecutive notes (all sharps and naturals) and the entire organ will be in tune. Of course, tuning is useless when one or more notes are silent, play an octave high, or have a gurgle. **Make certain all notes are playing correctly before you tune an organ.**

All Notes Tuned

An organ with rows and rows of tuning adjustments probably is

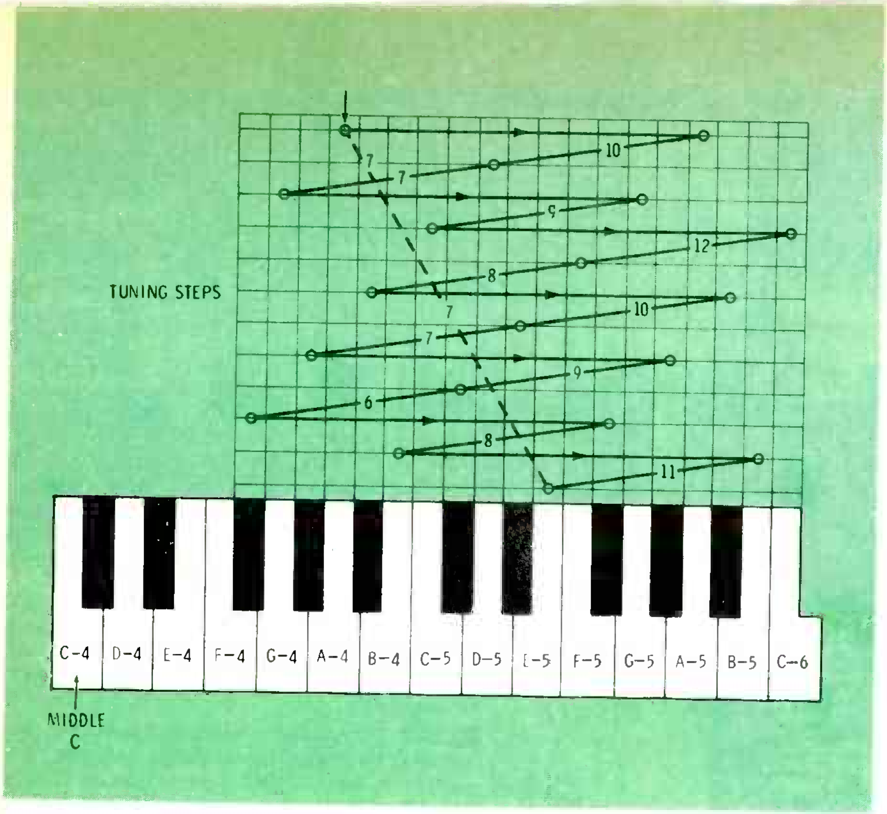


Fig. 1 Both the start and finish of this tuning method are at "A" above middle "C" (that's A-4 in universal notation). The straight lines going to the right represent tuning the higher octave to zero beat. Some of the lines that slant down to the left show two separate tuning steps. For example, the one near the top with "A-5/D-5" instructs you to play those two notes while you adjust the lower one (D-5) to obtain 10 beats (on the high side of zero beat) during 5 seconds. Then, continuing on the same line, you play "D-5" and "G-4" while adjusting "G-4" for 7 beats on the high side during 5 seconds. And so on through the chart, until you reach "E-5", which is played with the original "A-4" to see if 7 beats are obtained. If not, the sequence must be done over.

a "all-master-oscillators" type. In other words, each note can be tuned independently of all others. That sounds like a lot of hard work, but actually it's not quite that bad. After the temperament has been set near the center of the keyboard, you can tune both up and down from there by octaves. Tuning by octaves is easy.

Setting The Temperament

If the natural tuning scale were in use, you could start with one note tuned to a standard pitch, then sound the musical "fifth" above it, and tune for a zero beat. Actually, the zero beat is not between the two fundamentals, but is between the third harmonic of the first note and the second harmonic of the fifth. But in practice, the "equally-tempered" scale is used instead of the natural, and with the tempered scale, the fifth must be tuned slightly flat. This is done by counting the audible "beats".

Beats

The word "beats" is short for beat-frequency, and it is exactly the same thing in music as it is with electronics: two frequencies together in a non-linear circuit produce sum-and-difference frequencies.

In music, the non-linear element is your human ears. And the sum frequency is too high to be noticed by most ears. But audio tones are low frequency; therefore, the difference beat between them is **very** low frequency.

What's more, the beat between the **harmonics** can be even lower in frequency; as low as one beat in several seconds.

You must train your ear to listen for these beats. First, tune the second note and listen for the beat to go faster or slower. This **change** of speed will help you notice the beat. A fast beat is a continuous audio tone.

As the two frequencies are moved apart, the frequency of the beat increases (higher pitch); and that is true regardless of which one moves. Conversely, the nearer you adjust the second frequency to the fixed one, the slower the beat, until at "zero beat" there is no beat at all.

A slow beat might sound like: "a-wah, a-wah". After you have heard these beats, you will not forget the sound.

Temperament is the same

Regardless of whether the organ has 12 tuning adjustments or 176, the method of setting the tuning (temperament) is the same. It's done near the center of the keyboard.

I will explain two different methods of setting the temperament. The first one counts the number of beats in five seconds, and the second one requires you to time the number of seconds for 10 beats.

Counting Beats

Usually, an organ should be tuned to "concert" pitch, which is 440 Hz for middle "A". A tuning fork is the most inexpensive true standard, and you should invest in an "A-440" fork.

Prepare the organ by running it for several minutes, turning off the vibrato, and selecting one 8' stop, perhaps a flute or diapason. It's difficult to manage a tuning fork and play a note, so block the note down. Wedge the plastic blade of a screwdriver or an alignment tool between middle "A" and the next note, then push down on the "A" as you pull up on the other note until "A" is the only note sounding, and it stays down without any attention from you.

Next, strike one tine of the tuning fork on a piece of wood (these forks are strong, but don't overdo it), and quickly touch the fork handle to a flat surface. Without this contact, which makes the surface act as a sounding board, the fork tone will be too weak to be heard.

Slowly, tune the "A-440" organ note and listen for the beat note. Strike the fork as often as necessary to keep the tone loud. Turn the tuning in the direction to make the beat sound slower, until finally there is no beat (that's zero-beat).

Tuning fifths

As shown in Figure 1, we now jump back and forth across the middle octave, tuning for a flatted fifth. Actually, we are tuning the root note, rather than the fifth, so the root note must be tuned **sharp.** That's why the sequence calls for a certain number of beats on the **high** side.

Remember, **we will be counting the number of beats in five seconds, on the high side of zero beat.** I'll explain what that means. The beats become faster on **either** side of zero beat, but for this method the phrase "high side of zero beat" means **the note you are tuning** should be on the sharp (higher frequency) side of zero beat. You can hear the note as it goes sharp.

Here is the sequence:

- Starting with middle "A" (that's A-4 according to universal notation) tuned to the standard, tune the "A" one octave above (A-5) for zero beat;
- Using this "A" as the new standard, play it and the "D" next below (D-5). While listening for the beat, tune the "D" to zero beat, then sharp for 10 beats in 5 seconds;
- Next, using the "D" as a standard, play it and the "G" below (G-4), adjusting the "G" for 7 beats per 5 seconds;
- Zero beat "G-4" with the "G" one octave higher (G-5), then play "G-5" with the next lower "C" (C-5), adjusting "C" for 9 beats on the high side;
- Using this "C" as a standard, tune the "C" two octaves above middle "C" (C-6) for perfect zero beat;
- Play this new "C" with the next "F" below (F-5), and adjust the "F" for 12 beats;
- Play the same "F" with the next lower "A#" (A#-4), and adjust the "A#" for 8 beats;
- Adjust the "A#" one octave above (A#-5) for perfect zero beat;
- Play "A#-5" with the "D#" lower (D#-5), adjusting the "D#" for 10 beats;
- Play this "D#" with the next lower "G#" (G#-4), and adjust the "G#" for 7 beats;
- Use the "G#-4" to tune "G#-5", an octave higher, to zero beat;
- Play "G#-5" with the next lower "C" (C#-5), tuning the "C#" for 9 beats;
- Play the "C#" with the "F#" next below (F#-4) for 6 beats;
- Using the "F#" for a standard, tune the next higher "F#" (F#-5) for zero beat;
- Play the "F#-5" with the next lower "B", tuning for 8 beats;
- Tune the previous "B-4" for zero beat with "B-5", one octave above;
- Play "B-5" with the next lower "E", tuning the "E-5" for 11 beats;
- Play "E-5" with the next lower "A", and **count** the number of beats for 5 seconds. If every tuning step has been done perfectly, there should be 7 beats.

This "A-4" is the one used to start the tuning sequence, so it should **NOT** be adjusted to make 7 beats. However, it might have drifted during the time you were tuning; therefore, you should check it again with the original standard.

If the last test with the "E" and lower "A" gave more than 8 beats or less than 6 beats, you should repeat the entire sequence for better accuracy.

Fine-tuning the 5 seconds

In the event your tuning sequence consistently gives the wrong number of beats at the end, perhaps the 5-second counting time is slightly wrong.

The original "A" should not be changed, so you can sound the final "A" and "E", then carefully tune the "E", noticing which way (flat or sharp) it must be tuned to achieve the required 7 beats in 5 seconds, **on the low side of zero beat.** Notice that this count is on the opposite side of zero beat, according to the way it was done previously. That's because we are tuning the **other** note of the two. This is the true fifth tuning, in which the fifth must be flatted slightly.

Now, if the beat rate is on the low side, but is too fast (say 11 beats), it proves the other beats were not quite fast enough. **Shorten the 5-second interval used for timing the beats.**

On the other hand, if the beats are on the wrong side of zero (or are on the right side, but not fast enough), it proves the beats were all slightly fast. In that case, **lengthen the 5-second reference.**

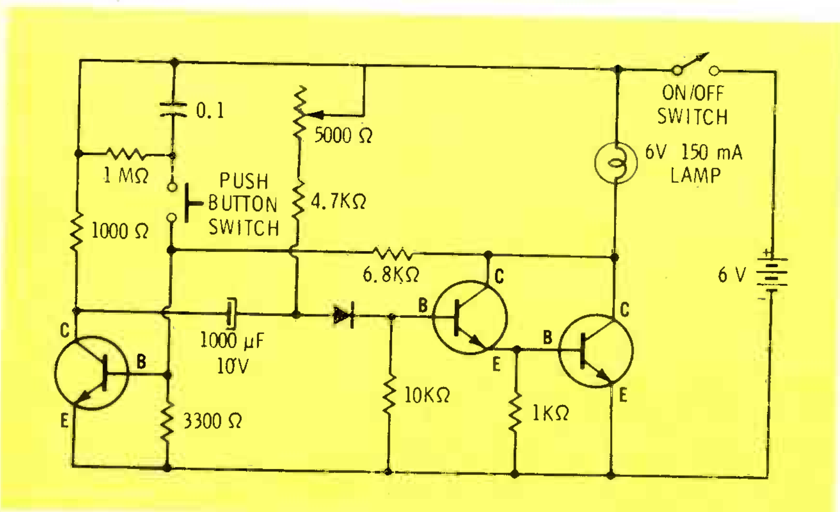


Fig. 2 This 5-second timer can be built easily, then you can fine-tune it for the precise time necessary for perfect tuning by the beats.

Home-Made Timer

Figure 2 shows the schematic of a simple timer you can build. The transistors can be almost any kind of NPN silicon, and the variable control provides a timing cycle between 3½ and 7 seconds. This range allows you to select the exact time that gives you the most accurate tuning.

In operation, you depress the spring-return pushbutton switch, which starts the cycle and turns out the lamp. At the end of the time, the lamp lights. Since the indication is visual, it does not interfere with the counting of the beats, as a audible signal would.

Calibrate the timer either with a stop watch, or with the second hand of a watch, then fine-tune the control setting as necessary to make the tuning procedure accurate.

Alternate Tuning Method

Some organ and piano tuners prefer another method of setting the temperament, as shown in Figure 3. A lower section of the keyboard is used, so the beats are much slower.

Strike the two notes shown at each step of the chart, and **time the number of seconds required for 10 beats.** The easiest way to do this is with a stop watch; hit the "start" button when you strike the two notes, and press the "stop" button after the tenth beat.

Otherwise, the method is the same as given for the other one. You adjust the **lower** note (using the higher one as a reference) to be on the **high** side (higher pitch than that for zero beat) by the correct number of seconds giving 10 beats.

Tuning Tips

Both of these systems of organ tuning demand that the two notes must be near their correct frequencies. As explained before, the beat is between the third harmonic of the lower note and the second harmonic of the higher note. Now, suppose the lower note (the one being tuned) is so far out of tolerance that its fourth harmonic beats with the second harmonic of the higher one. The beat note would sound the same, although the volume would be weaker. Also, if the beat is too fast, it is more difficult to identify than when it is slow.

So, to save much time and minimize mistakes, you should **test** the temperament of the notes which will be used for tuning, and **touch-up any that are badly off frequency.**

This can be done by ear, if you have the ability to hear in your mind the way a progression of notes should sound when one octave is played in sequence. Add to the scale of notes a few selected chords, and you can estimate whether or not the tuning is accurate enough for the tuning system to be started.

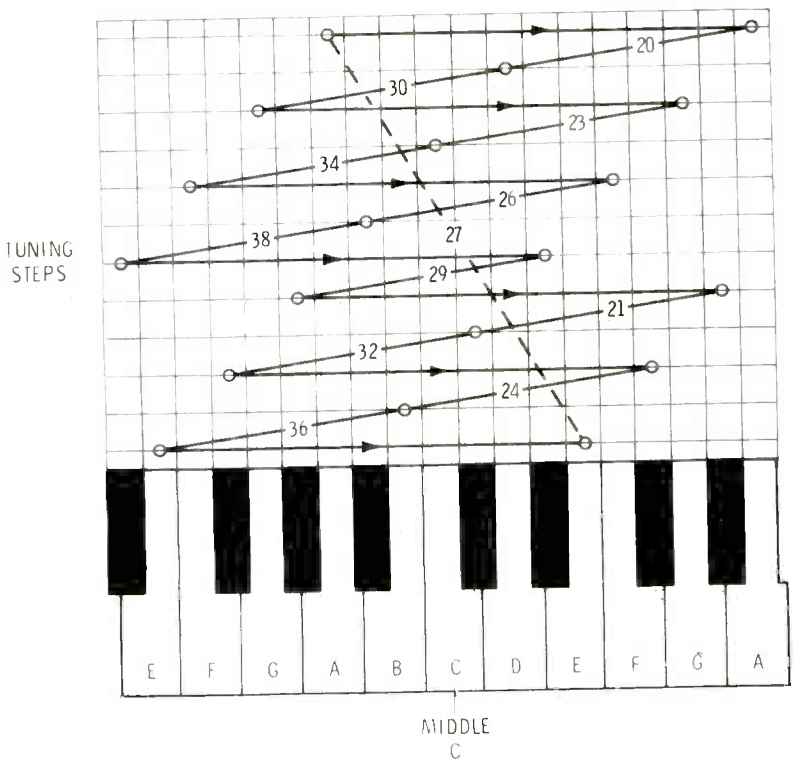


Fig. 3 Here is the chart of an alternate method of tuning for flatted "fifths" by using beats. However, more time is required for each step than for those of the other method, because you must count the number of seconds for 10 beats. The shortest measurement of beats requires 20 seconds, and the longest one takes 38 seconds. Because of the extra time required for this method, probably the other one is preferred, even including the building of the timer.

Charging For Tuning

Probably you should establish flat-rate charges for tuning. Set one figure for the oscillator/divider types with only 12 frequencies, and another for the separate-oscillator types.

Of course, if you are asked to do something different from the normal tuning procedure, the rate should be adjusted accordingly.

And the price should not be much different regardless of your experience (or lack of it), and whether or not you use a strobe device to speed up the process. If you take too long, it's likely your problem is lack of experience, and the extra time can be considered to be the price you pay to become trained.

On the other hand, if you use a strobe-tuning device which allows you to tune an organ very rapidly, part of each tuning fee must cover a pro-rated sum to pay for the machine. So, the charges should be about the same regardless of your experience or equipment. □

Upgrading MATV Systems

By Bert Wolf, Vice President of Sales, Jerrold Electronics

Many if not most of the MATV installations are in dire need of repairs and updating. Before you can bid on such work, you must know where the system is, and who to contact. Examples of direct-mail letters are given, plus many suggestions for tests and repairs of ailing MATV systems.

Just before one of the space flights, an astronaut was asked what one thing worried him most. He replied, "The fact that everything in this capsule was supplied by the lowest bidder."

Master Antenna TV (MATV) systems, too, usually are installed by the lowest bidder. If the specifications were not tight, or the inspection not made carefully, an MATV system might not have operated correctly when it was first installed. In addition, defects can occur, and the system can be tampered with. All of these causes add up to poor MATV performance, as any traveler can testify about most hotel and motel systems. Experience has shown that MATV performances in apartment houses, trailer-parks, and condominiums often fall **far** short of the best.

So, the need is there and you are competent (or can become so with our help) to make repairs or revisions. But how do you obtain the names on the dotted lines of the contracts? First, there must be an interest on the part of the owner or manager for better reception. Next, you need permission to make a survey. From that data, you submit a bid. Lastly, if you sell the contract, the work must be accomplished correctly.

Steps For Selling

Direct-mail messages are your best marketing tools for obtaining MATV upgrading business. If you restrict the mailing to hotels, motels, apartment houses, trailer parks, and condominiums, the list is short enough that you can cover every one in your area, without excessive cost.

Mailing lists

A complete mailing list is necessary before you have any sales letters printed. If you have the money to hire the whole project, check with your local Chamber of Commerce or the telephone Yellow Pages for a responsible firm which specializes in direct mailings. Give such a company a sample letter, and it will handle the whole thing, for a fee.

On the other hand, if you have more time than money, make up your own list from an apartment guide (ask your Chamber of Commerce for a source); copy from the Yellow Pages; or obtain a specialized list from Standard Rate and Data Service (SRDS).

Sample letter

As long as a system operates at all, most managers will procrastinate. An added inducement is needed to get action **now.** Perhaps the most powerful pitch is to offer a "free" survey of the MATV system.

Any answer to this offer allows you to analyze the performance and layout of the system, which is the first technical step.

Figure 1 shows one suggestion for a simple sales letter. Remember the rules of good advertising; start with an eye-catching headline, then add just enough material to induce the reader to call or write you. **After** the prospect contacts you is the time to go into details. Excessive and complicated writing is likely to make the reader toss the paper in the wastebasket.

Printing

The prospect's first impression of you comes from the sales letter. So, don't risk a drab letter from your office typewriter, with the center of the "E's" and "O's" filled with ink.

Most areas have modern "instant" printing facilities for short runs at reasonable prices. Many such firms will set the message for you. This is recommended, for it makes possible the use of different sizes of type and various styles of lettering. All of these things are important in making a good impression and maintaining the reader's interest so he **finishes** your message.

The Survey

Because you are doing the technical survey of the system performance at no-charge, you must limit the amount of time spent to perhaps 20 or 30 minutes (plus transportation). However, this time must be used efficiently; and that means planning and preparedness before the call.

A chart form, as shown in Figure 2, is essential for recording data about signal strength and picture quality of each individual channel.

Of course, an accurate, portable Signal-Strength Meter (Figure 3) is required for testing the levels, and a small battery-operated TV receiver enables you to see the picture quality.

Check the headend

Start with the signal at the output of the headend amplifiers. Check and record on the chart the signal levels of both picture and sound carriers of each active channel. And then, through a suitable attenuator needed to prevent overloading the TV used for testing, check the picture quality of all channels, using the portable TV.

Next, check the outputs of any splitters at the headend. It isn't necessary to record the sound and picture levels of all channels. Just measure the picture carriers of the highest channel and lowest channel carried by the system.

Quality at a TV

If at all possible, you should check the visual quality of all channels at a typical receiver, and record your comments on a form.

Better TV equals ***Happier Tenants!***

Sharp, steady TV pictures can help your tenants or guests to be happy with life, and satisfied with your facilities. On the other hand, ghosty, jumping, and blurred pictures contribute to their dissatisfaction.

That's why the Master TV antenna system for your building is so important to *your* long-range profits.

If the picture quality from your antenna system is imperfect, contact me for a no-charge, no-obligation checkout of your installation. After my inspection (using precision test equipment), I will submit quotations for any needed repairs, and for additional equipment to improve on the original performance.

Also, we can install security cameras, or time-weather-music channels, and provide yearly maintenance contracts to free your mind of any possible repair expenses.

Call me today, or return the enclosed reply card for prompt action.

Cordially,

(your name and title)
(address, city, and zip)
(phone number)

(Note: the word "tenants" can be changed to "guests" when the letter is sent to hotels and motels.)

A

B

Dear Mr. (your name):
Yes, I would like to have more information about the master TV antenna services you offer.

Please call to discuss our antenna needs.

Please make a no-charge, no-obligation survey of the antenna system

at ______________________________
(address, city, state, ZIP)

Signed ______________________________

Title ______________ Phone ______________

Company Name ______________________________

Address ______________________________

City ______________ State ______ ZIP ______

Fig. 1 Here is a suggestion (A) for sales letters to owners/managers of hotels, motels, apartments, trailer parks, and condominiums. If you change the wording, remember to keep it interesting and brief. Make this first contact a "soft sell". (B) shows a suggestion for a reply card.

It's very possible for the signal to be fine at the head end, but be unacceptable at the end of a cable run.

Problems

If you spot a trouble with the signal, you should take a few minutes to localize the source. A final, precise diagnosis is not necessary at this time, but it is helpful to know which branch or amplifier has the problem.

Estimates

After the survey is complete, it should be easy to make an estimate. Actually, you should make **two** estimates: one for the cost of **restoring** the system to the **original** performance; and the second for making the system work right, that is, **better than it was originally.**

For example, suppose the survey showed that one trunk line was dead because of a defective splitter. The first estimate should include the cost of a new splitter and labor.

However, the second estimate might recommend replacing the old headend amplifier with a new-type solid-state unit, adding a preamplifier to boost a weak channel ahead of the main amplifier, adding a UHF channel, wiring in filters or traps to minimize interference, or adding a closed-circuit TV and background music channel.

Make your proposals in writing, attaching a copy of the survey results as proof. **But do NOT mail these papers!** Deliver them in person, direct to the owner or manager. That way, you can sense the attitudes, and know when to add technical data or present the practical benefits of the technical suggestions.

Frequent MATV Troubles

In most cases, you must assume that the MATV system worked fairly well when it was first installed. Otherwise, the contractor would have had trouble collecting for it. (Of course, there are exceptions, where the installer was more glib than skillful. This possibility must be kept in mind.)

Therefore, you look primarily for troubles that develop with the passing of time. A knowledge of typical defects helps to identify the problems. Here are some possibilities:

- **AC Hum.** Hum appears on the TV screen as one or two horizontal dark bars, which usually move slowly upward. One hum bar indicates 60-Hz hum from a leaky tube or a defective half-wave power supply; two bars indicate 120-Hz hum, which can originate only from a full-wave power supply. If the hum shows on all TV sets connected to the system, it's certain the defect is in the MATV. Hum on one TV only indicates a fault in that TV.
- **Rolling Picture.** If the rolling is with only one channel, the cause usually is sync compression in a single-channel amplifier. Aging of the components might have decreased the AGC action, thus increasing the gain. Use the manufacturer's procedure for resetting the AGC. Of course, if the amplifier is tube-powered or without AGC, you might suggest a new solid-state replacement.
- **Cross Modulation.** Grainy pictures, perhaps with "windshield wiper", indicate excessive gain in a broadband amplifier. A maintenance man or tenant might have reset the gain, or the amplifier could have aged. Reset the levels, and add filters or traps as required.
- **Ghosts.** It's not unusual for a tenant to compensate for a bad tuner in his TV receiver by shorting out the isolation in the tap-off. This might help his picture, but it would add ghosts to other sets on the same trunkline. Another common problem is caused when a landlord or supervisor has added cable to the line. If this is done without the proper termination (75-ohm non-inductive resistor), standing waves (which resemble ghosts on the screen) are created.
- **Snow.** If snow can be seen throughout the entire system, suspect the amplifier first. Replace the tubes, or substitute a higher-gain modern solid-state amplifier. A broken downlead between the antenna and amplifier, water in a splitter or tap-off, or a new building which shields the signal path all can cause snow.

Old Problems

After you have repaired all the defects that were not present when the system was new, the picture quality still might be poor on some channels. The following are some common deficiencies.

Ghosts and smear

True ghosts are caused by multipath. That is, part of the station signal goes direct to the receiving antenna, while another part goes in another direction, is reflected by some object, and finally reaches the antenna, but at a later time. Because the CRT beam is traveling to the right, this signal that arrived later appears to the right of the main one.

Misunderstandings arise, sometimes, about the distances involved with ghosts. A mountain 5 miles to the side makes a ghost that's displaced about 8 inches to the right of the main picture on the screen of a 21-inch receiver. A ghost reflected from a watertower 400 feet behind the antenna would be seen only 1/4-inch to the right. Such a "close" ghost would appear

MATV Survey

Channel Number	Picture Carrier Level	Sound Carrier Level	Picture Quality
______	______	______	____________
______	______	______	____________
______	______	______	____________

(etc.)

Fig. 2 Make up a survey sheet, such as this, for the level data.

as ringing, or perhaps as a smear.

Certain kinds of multiple, closely-spaced ghosts are seen as a smear; not as ghosts. They are difficult to analyze sometimes, because they are similar to the smear produced by a misaligned single-channel amplifier.

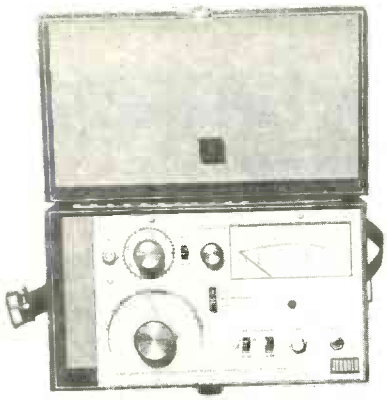


Fig. 3 A professional signal-strength meter which can measure the amplitude of both picture and sound carriers of all VHF and UHF stations is a necessity for upgrading MATV systems

A mismatched coaxial cable (perhaps from a crushed cable, or a missing termination resistance) produces ghosts from standing waves, where the signal bounces from one end of the cable to the other, and with each bounce adding a ghost. Incidentally, this is the same effect as a defective delay line (or wrong delay-line load) in a color receiver.

MATV systems slow down the passage of the signals; therefore, any pickup of signal that does not travel through the system shows as a ghost to the **left.** If the cable path is less than about 200 feet, the ghosts from the direct signal will be seen as a smear.

The solution to the problem of ghosts coming through the antenna is to obtain antennas with a narrow forward lobe and weak side and rear lobes. Then, find the best position, height, and directional orientation for them. Sometimes, it helps to stack two identical antennas horizontally (side-by-side); this cancels the signal at certain angles. The cancellation depends on the distance between the antennas, so you must experiment to find a distance that cancels the ghost. Aim both antennas directly at the transmitting tower. Watch the picture on a TV set while you move the two antennas closer or farther apart. The spacing is right when the ghost is minimized.

Multiple ghosts in one leg of a system could be caused by a partial short that changed the loading. A short caused by a single strand of loose cable shielding at a connector will do it. Also, a loose connector, a nicked or broken center conductor, or an open circuit has the same effect. One way of finding the section with the short or open is to insert a 6-dB loss pad into one line at a time. The attenuator improves the match of one line and isolates any short from the others. So, when the attenuator pad improves the picture quality, it's likely a defect is in **that** section of the cable.

Some MATV systems have 300-ohm outputs inside the wall tap-offs. This eliminates a matching transformer at the TV, but it leaves a length of unshielded twin-lead between the wall and the TV receiver. The twin-lead can pick up a signal (in strong-signal areas), causing a leading ghost. Other than changing to a coaxial cable system with a matching transformer at the TV, the only solution is to increase the signal strength at each tap-off, perhaps by a more powerful head-end amplifier.

Radio interference

Radio carriers of lower than 50 MHz can enter a MATV system in two general ways. First, any harmonics of the radio transmitter are received the same as any other signal of that frequency, mixing with the TV carriers and producing various kinds of beats. Usually, the radio carrier must be very strong (high power or very near) for this to occur.

Or, radio signals of very high intensity can overload a MATV amplifier. The overload causes non-linearity, and the radio signal modulates the TV signals.

Sometimes, you can identify the offending signal by tuning the signal-strength meter for maximum on the interfering signal, and then listening with earphones to hear what modulation is on the carrier.

A sub-channel/TV splitter added between the antenna lead and the first amplifier might help by reducing all frequencies below 54 MHz.

In some cases, filters or traps are required. **Remember, any traps or filters must be inserted before the first amplifier stage.**

FM interference

FM interference most often appears as a herringbone pattern that moves with the modulation.

Minimize FM interference by inserting either a single-frequency trap or an FM band-rejection filter before the first amplifier. The trap provides much more attenuation, but it must be adjusted for each station, and it tends to drift. Band-rejection filters give less attenuation, but do not drift. Therefore, use a band-rejection filter, if it reduces the interference enough.

Electrical interference

Arcs from power lines or inside defective equipment cause electrical interference which covers all frequencies, but is stronger at the low frequencies. UHF reception seldom

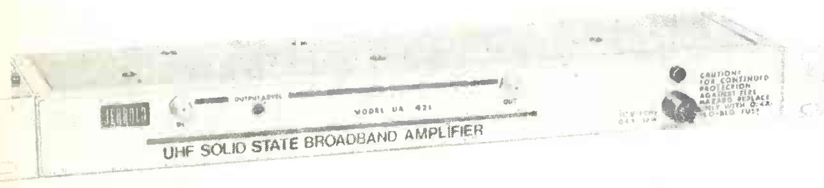


Fig. 4 New solid-state UHF broadband amplifiers, such as this Jerrold Model UA-421, allow adding UHF channels to older MATV systems.

is bothered by such interference.

Although the appearance on a TV screen often is different, depending on the source, generally the interference appears as many tiny black dots or dashes. Sometimes these black specks are random, but others are found together in horizontal bars, which move up or down slowly.

Noise pulses from vacuum cleaners, mixer, or other brush-type motors usually are random, and the source can be identified by turning them on and off as a test (the motor is very near, perhaps in your own home).

Interfering noise that occurs in regular cycles might be from some machine controlled by a thermostat. Furnaces, air conditioners, and refrigerators are possibilities, although those motors don't make noise unless there's a defect.

Arcs in the power lines or transformers are hard to identify. The power-company men don't know how to find the defect unless it burns up something or affects the flow of power. Direction-finding with portable radios is frustrating because the noise follows the power wires and radiates from every wire and pole.

Ignition noise

Ignition noise from trucks and autos looks very much the same as some kinds of random power-line noises. Sometimes the solution for both ignition and power noises is to increase the signal in the MATV

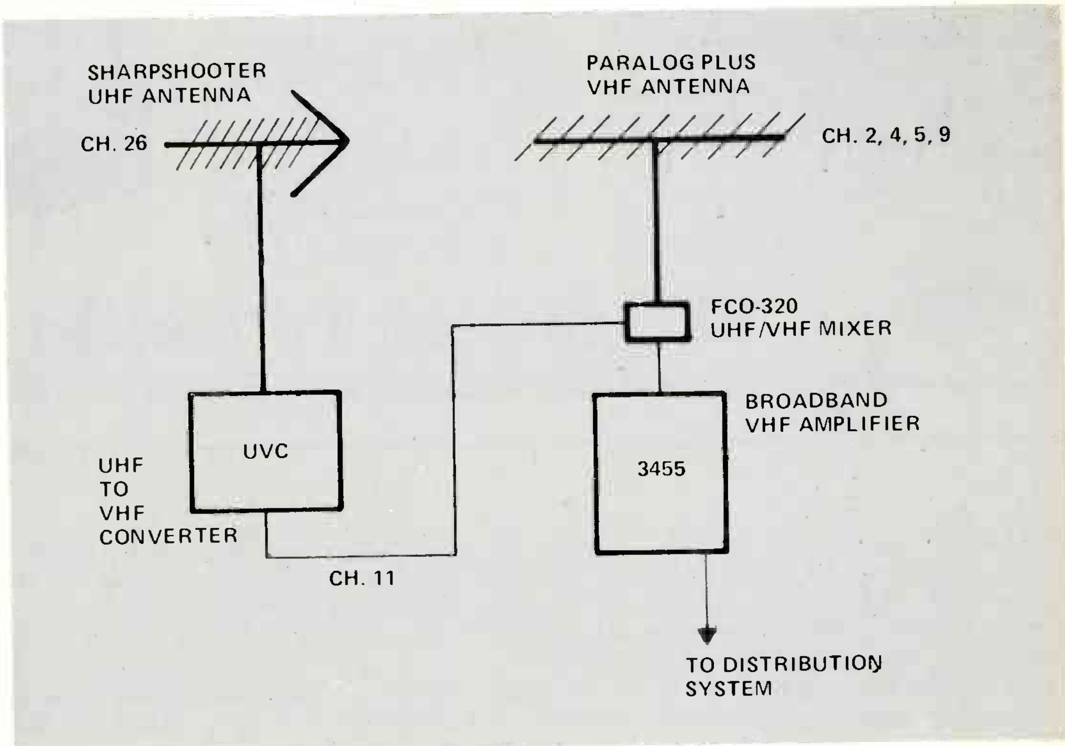


Fig. 5 Another way of adding UHF to MATV systems which are inefficient on UHF frequencies is to convert each UHF channel to a VHF channel, before it's fed into the system.

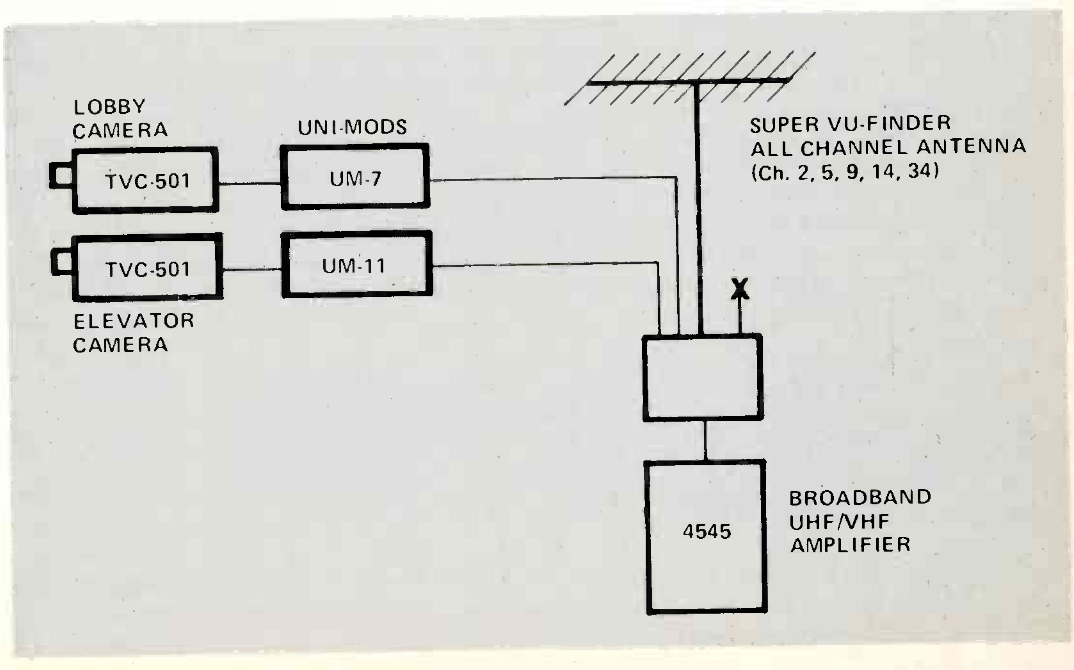


Fig. 6 Closed-circuit TV cameras can be included by having each one modulate a "Uni-Mod". The output is a VHF channel which is added to the other VHF signals at the head-end amplifier. Each camera then is tuned-in the same as a conventional TV station.

system so it overrides the noise.

Better antennas, perhaps with vertical stacking, and higher-gain amplifiers often help cover the noise. 300-ohm twin lead between the tap-off and the TV should be replaced by a shielded 75-ohm cable with matching transformer. Of course, this solution is not practical for an entire system, but it's suggested where the noise affects only a few TV's.

Converter interference

In many MATV systems, the UHF channels are converted to the frequencies of unused VHF channels. Signal losses in the coaxial cable are reduced at VHF frequencies, so lower-gain VHF-only amplifiers can be used. This can be a substantial saving on a large system.

The tradeoff is the possible interference to other channels caused by radiation from the local oscillator in the UHF converter. Although the best converters are crystal-controlled, either kind can cause problems. With crystal control, the interference is stable; and with other oscillators, the interference pattern changes with the drift.

It's very difficult to calculate all of the possible beats from converters, but the test for interference is easy: just unplug the power cable to the converter (or each converter in turn) and notice if the beat pattern is missing.

A radiating converter can be isolated by placing it in a separate shielded housing. Sometimes, rebalancing the levels will eliminate the interference; it's worth a try.

Modulators can cause beats in the same way, and the cures are the same.

Overload

Too much signal creates as many problems as produced by too little, because of overload. Of course, overload bothers only active components, such as preamplifiers, amplifiers, and TV receivers.

Overload of single-channel amplifiers weakens the sync by compressing it. Often the largest symptom is critical vertical locking on that one channel. Eliminate the overload by adjusting the AGC, reducing the gain setting, or adding a loss pad at the input signal.

Broadband amplifiers produce cross-modulation distortion when overloaded. Strong channels modulate weaker ones, although the symptoms vary according to the severity of the overload. A slight overload causes a small constantly-changing beat pattern, or a kind of grainy look. Strong overload shows a "windshield wiper" pattern: the modulating-station picture can be seen behind the desired picture. Less severe overload might appear as a tiny beat pattern and a dark vertical bar that moves slowly to one side.

It's more difficult to eliminate overload in broad-band amplifiers. The most important remedy is to balance carefully the levels of all the channels, making sure one is not dominant. Single-channel filters or frequency splitters might be added before the amplifier. Or separate yagi antennas with individual pads might be used in extreme cases.

Adding UHF or CCTV

UHF channels can be added to a VHF MATV system by either of two ways. If the splitters and tap-offs can pass UHF, an all-channel antenna and a UHF broadband amplifier is the best bet (Figure 4).

But if the system is so old that the cable, splitters, and tap-offs give excessive UHF loss, it's better to add a UHF antenna and converter, as shown in Figure 5.

Modern apartment buildings are concerned about security of the tenants, and a Closed-Circuit TV (CCTV) camera placed in the lobby and elevator can be installed without great expense. Add a Jerrold UNI-MOD for each camera, and feed the signals into the MATV system (Figure 6).

Comments

Modern MATV equipment and techniques now permit good-quality TV signals in most locations. Many systems are working poorly, and the owners and managers only need some reminders to have their systems upgraded. That's where you can make money and do them a favor, too.

Make up your sales letters, distribute them, and start making your share of the MATV profits. Now! □

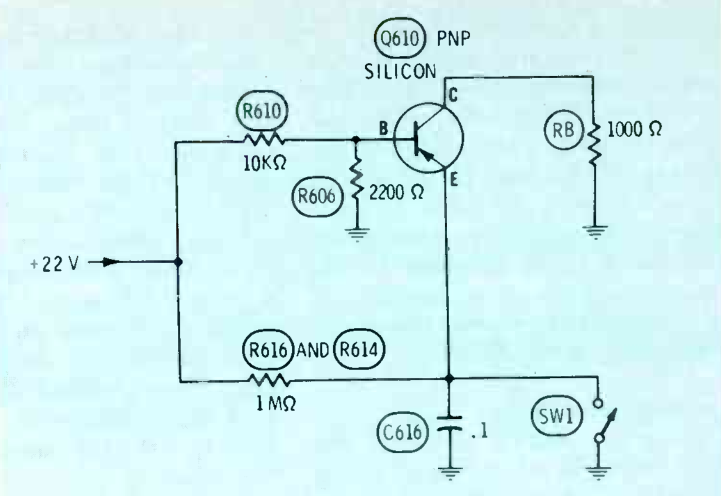


Fig. 1 In the GE 19YC2 chassis, the vertical oscillator transistor is reverse biased when power first is applied. The base voltage arrives at once, but the emitter voltage is delayed by the large time-constant R/C circuit. When the emitter positive voltage finally exceeds the base positive voltage, Q610 has forward bias, causing the collector to conduct through resistor RB (actually the next stage) and discharging C616 (shown by SW1). Two other signals at the base reduce the positive voltage (increasing the forward bias). The sync signal fires the oscillator ahead of time, for locking; and the regenerative signal causes a stronger collector current for a short period of time before C616 is discharged and conduction stops until the next cycle.

Servicing GE Modular Color TV

Part 4/By Gill Grieshaber, CET

Power supplies of two polarities for the vertical sweep come from rectification of horizontal signals. Also analyzed are other unique features and circuits of the vertical sweep in the 19YC2 General Electric solid-state, portable color-TV.

Vertical Sweep Of GE 19YC2

Although the vertical-sweep circuit of the GE 19YC2 has some superficial similarities to both the Zenith and RCA circuits previously examined in this series of articles, there are some unique differences.

The YC2 has an oscillator circuit using a PNP and an NPN transistor, without any feedback from a later stage, and so does the 19EC45 Zenith circuit. Feedback from the output stage is necessary in the RCA CTC58 to make the single switch-transistor oscillate.

Both the RCA and the Zenith employ complementary-symmetry output stages with one PNP and one NPN power transistor. However, the RCA has a single power source and an output-coupling capacitor to the yoke. The Zenith uses two power supplies to create a zero DC output voltage, and it doesn't require a capacitor to couple to the yoke. Refer to the April, 1975 issue for details of the Zenith circuit, and to the December, 1975 issue of ELECTRONIC SERVICING for an explanation of the RCA vertical circuit. A comparison of the three circuits is both interesting and informative.

This GE vertical output stage has two NPN-polarity power transistors, thus an extra phase inverter-driver is required. Two power supplies are furnished, one positive and one negative, and the output signal has practically no DC component, making a yoke-coupling capacitor unnecessary.

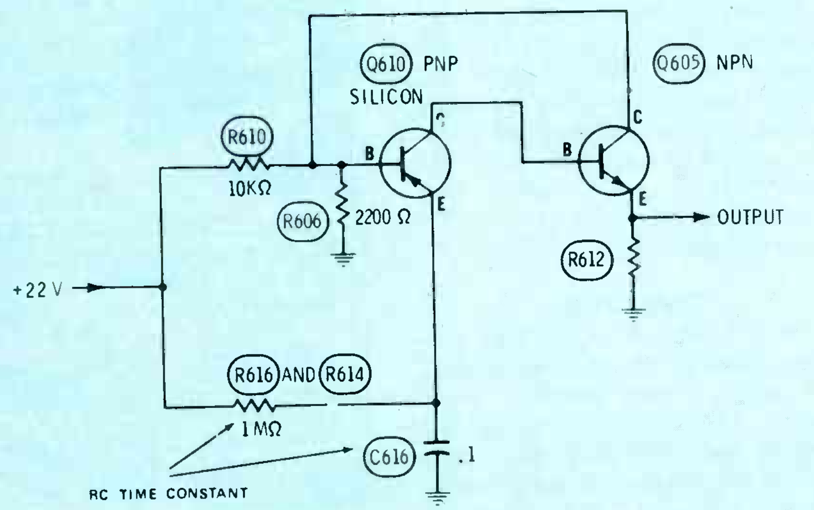


Fig. 2 Q605 acts as a switch to reduce the Q610 base voltage when Q610 collector current flows, thus increasing the Q610 current and depleting the charge in C616 more rapidly and completely. The circuit is a variation of a multivibrator, but the two transistors conduct at the same time in narrow pulses of current, and not alternately as is conventional.

Vertical Oscillator

The vertical oscillator circuit is very uncomplicated, operating with one PNP and one NPN silicon transistor. One result of this selection is that both transistors draw current at the same time, in

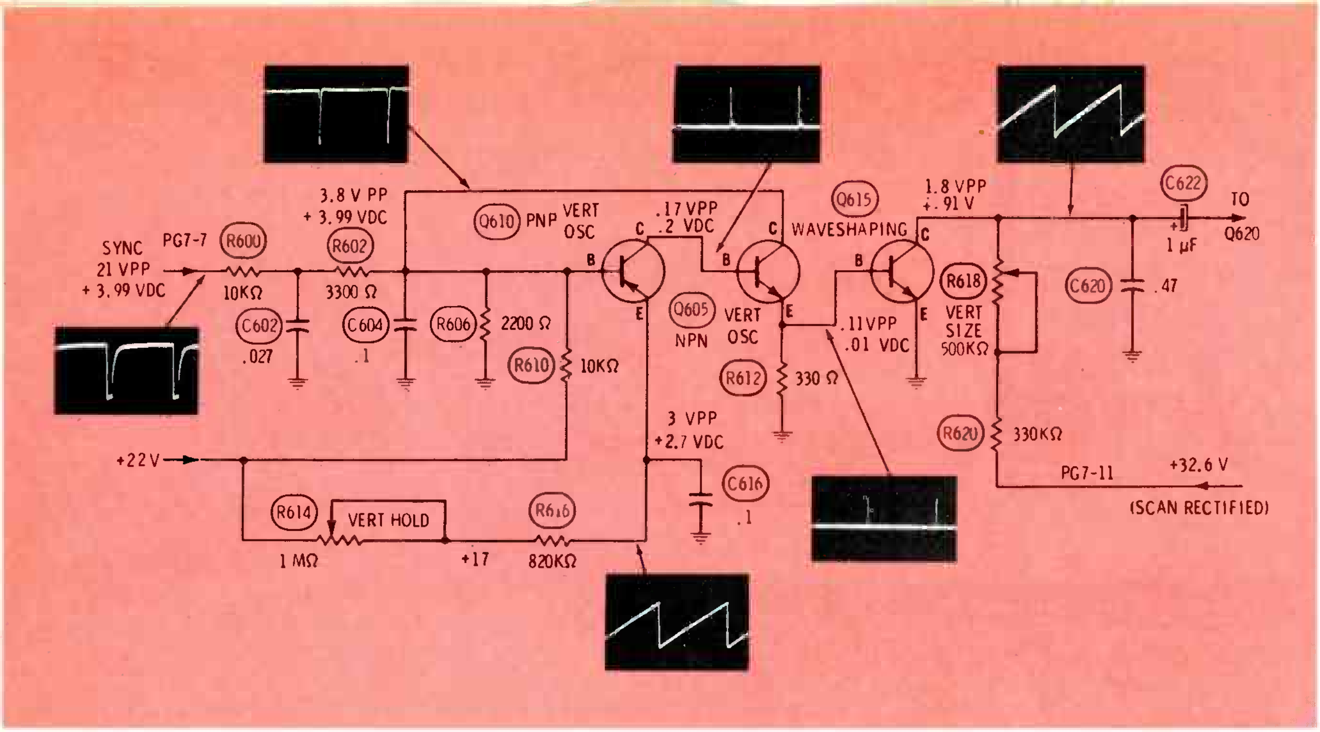


Fig. 3 Voltages and waveforms have been added to the schematic of the oscillator and sawtooth-shaping stages. All three transistors are direct coupled. The vertical-hold control changes the time constant in the emitter circuit of Q610. By the way, the "vertical size" control changes the amplitude of the sawteeth because of the variation of time constant, and not because of any change of DC voltage at the collector of Q615.

contrast to a multivibrator which has the transistors conducting alternately. Also, these two transistors oscillate by themselves: they do not require any feedback from a subsequent stage. Even though the circuit is simple, it is easier to understand when analyzed in two steps.

Bias by time constant

Figure 1 shows only the main wiring of Q610, the PNP oscillator transistor.

When DC power first is applied to Q610, the transistor is cutoff by a strong reverse bias. (Remember that transistor bias is base-to-emitter, and not base-to-ground.) A voltage divider having a very short time constant applies about +4 volts to the base. At first, the emitter has zero voltage, because the voltage must travel through R614/R616 and charge C616 before the emitter voltage can rise. And until the emitter voltage becomes more positive than the base positive voltage, the B/E junction is reverse biased (the base must be **less** positive than the emitter for the bias to be forward).

Finally, after a time determined by the time constant of R614/R616 (about 1 megohm) and C616 (0.1 microfarad) versus the amount of supply voltage, the emitter positive voltage finally rises above the base positive voltage. The transistor **now** has forward bias, and the emitter/collector current flows to ground through the collector load.

If there were no more to the circuit, the emitter voltage would stabilize. But with the next stage added, a "snap" action (type of regeneration) suddenly increases the forward bias, and the stronger emitter/collector current discharges C616.

SW1 is not in the circuit, but was shown to simulate the way Q610 E/C current discharges C616; and the resistance RB actually is the B/E resistance of the next transistor.

Regeneration

Adding a few more components (Figure 2) increases the Q610 current, and shortens the time the current flows. It does this by decreasing the positive base voltage (more forward bias), the extra emitter current bleeds C616, and the low emitter voltage is reversed bias, which turns off the C/E current of Q610.

Q605 is used as a switch, which reduces the base voltage of Q610 when it conducts. Also, Q605 acts as an emitter follower to couple the pulse signal to the next stage.

Here is the sequence, after Q605 has been added:

- At turn-on the base voltage of Q610 rises immediately to about +4 volts, but the emitter voltage increases more slowly, because of the RC circuit;
- Therefore, at first there is no Q610 conduction, but eventually the emitter voltage rises above the base voltage (forward bias), and Q610 begins to draw C/E current;
- The collector current of Q610 flows to ground through the B/E junction of Q605;
- This B/E current causes Q605 to conduct C/E current, and the collector obtains the required positive voltage from the base of Q610;
- In turn, the Q605 collector current reduces the positive base voltage of Q610. This is a large increase of forward bias (for a PNP), and Q610 conducts much more;
- The large Q610 current comes from the charge stored in C616, and the charge rapidly is drained until (when about one-third remains) the emitter drops below the base voltage, removing the forward bias and stopping the conduction. Therefore, the Q610 current has the waveshape of a very narrow pulse;
- Discharge of C616 is through the

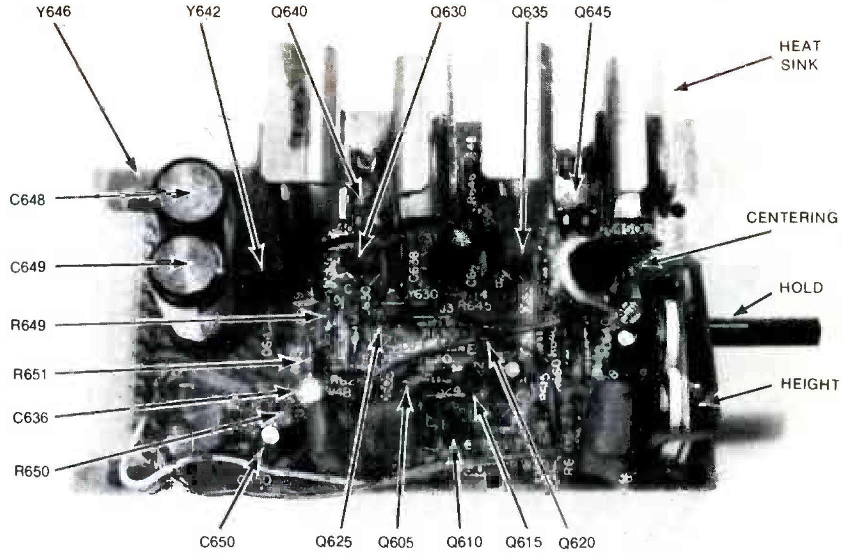


Fig. 4 Many components on the EP93X103 GE vertical module are identified.

C/E path of Q610, base-to-emitter of Q605, and R612 (the emitter resistor of Q605), which is another reason that C616 does not discharge to zero voltage; and

- Vertical sync also is applied to the base of Q610. It is negative-going, and triggers conduction just before the oscillation otherwise would occur.

Therefore, this two-transistor oscillator circuit operates at 60 Hz (determined by the sync and the time constant of the components in the emitter circuit of Q610, which includes a variable vertical-hold control). The output waveform is a series of narrow, positive-going pulses.

Sawtooth shaper

The complete vertical-oscillator schematic is shown in Figure 3, plus the waveshaping stage using Q615, along with the important waveforms.

Positive-going vertical pulses (with the baseline at zero) are the sole forward bias of Q615, an NPN-polarity silicon transistor.

Of course, normally the collector signal would be amplified negative-going pulses, because of phase inversion in Q615. But these pulses are integrated into sawteeth by R618/R620 and C620. Then, C622 couples the sawteeth to the next stage.

A better way of describing the integration is to say that Q615 acts as a switch. Conduction of Q615 discharges C620 (notice the zero line in the waveform, at the bottom tip), then C620 starts the textbook charging curve, which is interrupted (before it reaches the rounded non-linear portion) by the next conduction of Q615, bringing the voltage to zero again.

It is interesting to note that, although the waveshape is a good basic sawtooth, the current of Q615 remains a pulse shape.

Many of the components on the vertical module are pointed out in Figure 4.

Vertical Drivers And Outputs

The remainder of the vertical-sweep schematic (Figure 5) strongly resembles that of many conventional audio power amplifiers.

There is one major difference: feedback from the yoke **current** improves the linearity automatically, so no linearity control is necessary (Figure 6). Low end of the yoke goes to ground through R642 on the module. Voltage developed across the resistor goes through C636 and R636 to the base of Q625, the differential amplifier.

Operation of the two "differential" amplifiers seems rather mysterious, even with the waveforms, and needs some explanations.

Differential amplifiers

Although Q620 and Q625 are

drawn to resemble a classic differential stage, the circuit is not exactly a differential stage. Output is taken from **one** collector only.

Perhaps we should view Q620 as having two input signals, one to the base (it appears amplified and inverted at the collector), and another to the emitter (this one appears amplified at the collector, but not inverted). Also, Q625 is an emitter follower, with input at the base, and the non-inverted output taken from the emitter. This signal is connected to the emitter of Q620, where it is the second input signal.

In summary, the signal at the base of Q620 appears phase inverted at the collector of Q620, while the signal at the base of Q625 appears at the collector of Q620 not phase inverted. **The two signals subtract from each other!** If they were identical, the output would be zero.

But they are not identical. The major difference is in the rise time, and there are some differences of amplitude and linearity, also. Therefore, the signal at Q620's collector has been **pre-distorted** to cancel subsequent opposite distortion occurring later. That's why the waveform is so different from the sawteeth we would expect.

Figure 7 shows the actual Q620 input waveforms and the result of subtracting in a scope by inverting the base waveform and adding them. The resulting waveform consisted of positive-going pulses, and that's the waveform found at the collector of Q620, except for the tiny sawteeth between each pair of pulses.

Output-drive waveforms

From the preceding, you probably conclude logically that the output of Q630 driver should be negative-going pulses (Q630 inverts the polarity). Not so. You see, Q630 is a PNP, so the positive-going base pulses are in the cutoff direction. Therefore, most of the pulse amplitude is clipped, leaving amplified sawteeth. However, the B/E conduction of the output transistors leaks some of the yoke flyback pulses and the "butterfly wings" from the pincushion circuit. In fact, the base signal of Q640, the NPN output transistor, is virtually identical in waveform to that of the sweep-output signal as its emitter.

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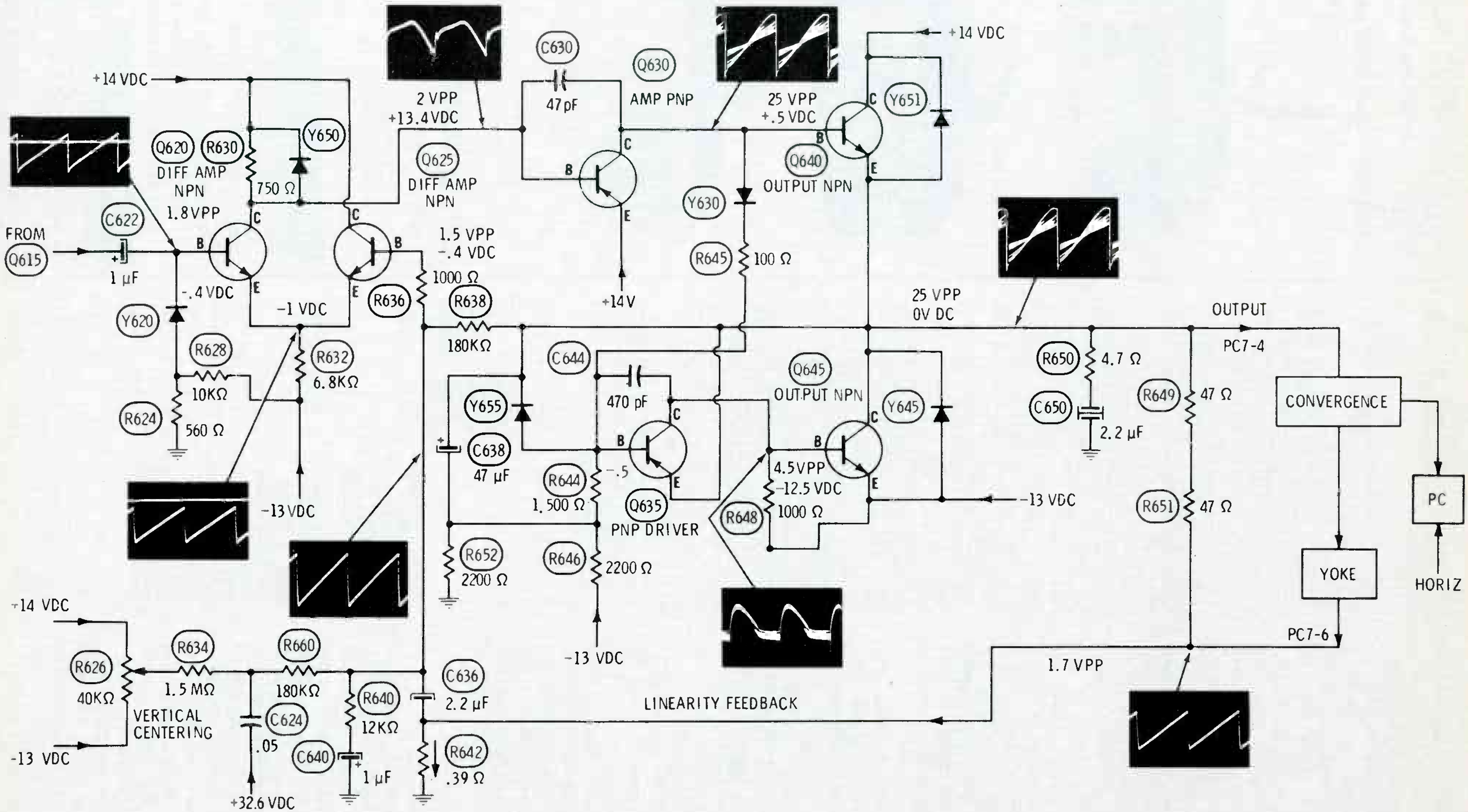

Fig. 5 Here are the waveforms and voltages of the "differential" amplifiers, drivers, and outputs. Feedback from the yoke current comes back to the base of Q625, along with a variable DC voltage for vertical centering. Notice the absence of a vertical linearity control. None is needed with this kind of circuit.

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Non-symmetrical output

As I mentioned before, the two output transistors are alike, both of NPN polarity, and not a PNP balanced against a NPN as is done in many models.

This means that the two bases cannot be tied together by a diode, as is true with the complementary-symmetry circuits. Instead, a phase inverter (Q635) must be provided. The collector of Q635 is directly connected to the base of Q645, the NPN output, and the collector of Q645, along with the emitter of Q640, drives the yoke.

Notice that both Q635 and Q645 are connected for highest gain (common-emitter type circuit; signal in at the base and out at the collector), and yet together produce a gain of approximately 1 (unity). I will not attempt to explain this phenomena; probably it's because each transistor feeds an extremely low impedance, and that always reduces gain.

Centering

Normally, the two output transistors conduct the same, and because they are fed from two separate power supplies of opposite polarity, the output signal to the yoke has virtually no DC voltage or current. Any unbalance between the two transistors causes current to flow through the yoke, thus changing the vertical centering. Going back a step, any shift of DC voltages in the differential or driver stages upsets the balance of output transistor currents.

This balance (and the vertical centering) can change because of defective components, or it can occur because of the "vertical centering" circuit which deliberately varies the balance. The base voltage of Q625 is adjustable through R626, R634, and R660. The picture can be moved about 1 inch up and down (Figure 8).

The arrow points to the vertical-centering control, at the side and in front of the vertical-hold control. The height control is to the left of the hold control.

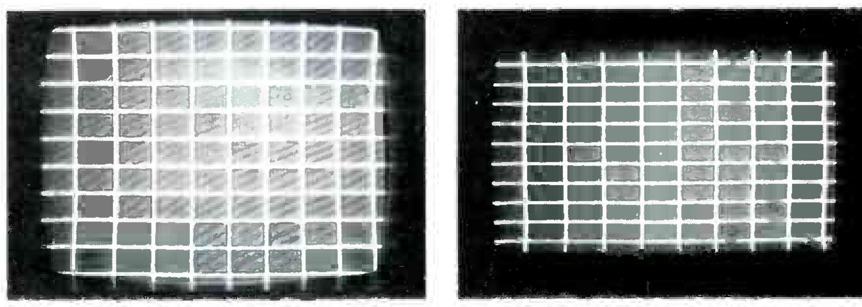


Fig. 6 When the height is reduced by the vertical size control, the linearity continues to be excellent.

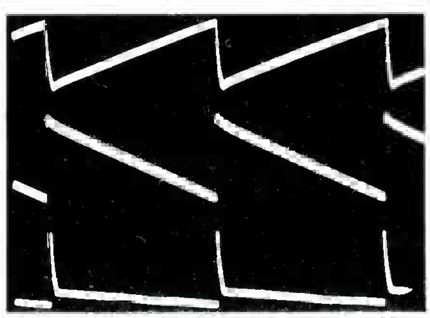
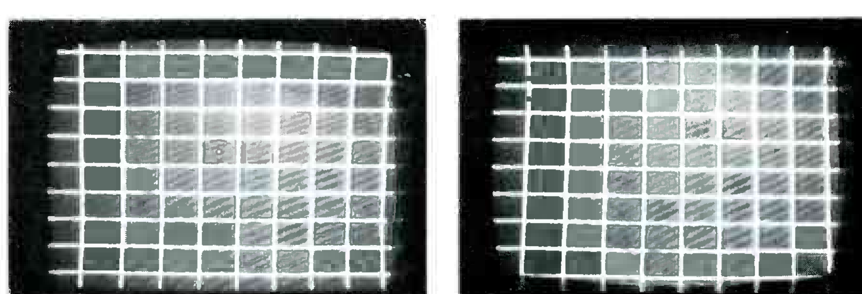


Fig. 7 When the yoke-current waveform at the base of Q625 (top trace) is subtracted from the drive sawteeth at Q615 (inverted to simulate the polarity change in Q620, shown by center trace), the result in the scope is positive-going pulses and small sawteeth (bottom trace). That's nearly the waveform obtained at the collector of Q620, produced by the action of the "differential" transistors.



A B

Fig. 8 With the vertical-centering control turned to one end, the picture was about 1/2-inch too high (notice the center dot in photo A), and -1.25 volts was measured at the yoke. At the other extreme of the centering control, the yoke had +1.5 volts, and the picture was about 3/4-inch too low on the screen (photo B).

Horizontal-Sweep Rectification

One DC supply voltage from outside the module feeds the vertical-size control. In addition, the vertical module contains two other power supplies that rectify different polarities of horizontal pulses (Figure 9). Because the vertical power comes from the horizontal, the height does not increase when excessive brightness causes blooming.

One surprise from the waveforms was the large 60 Hz (actually 59.45 Hz) ripple present at the output of both DC supplies. At first thought, it seems impossible, because the diodes are fed horizontal pulses,

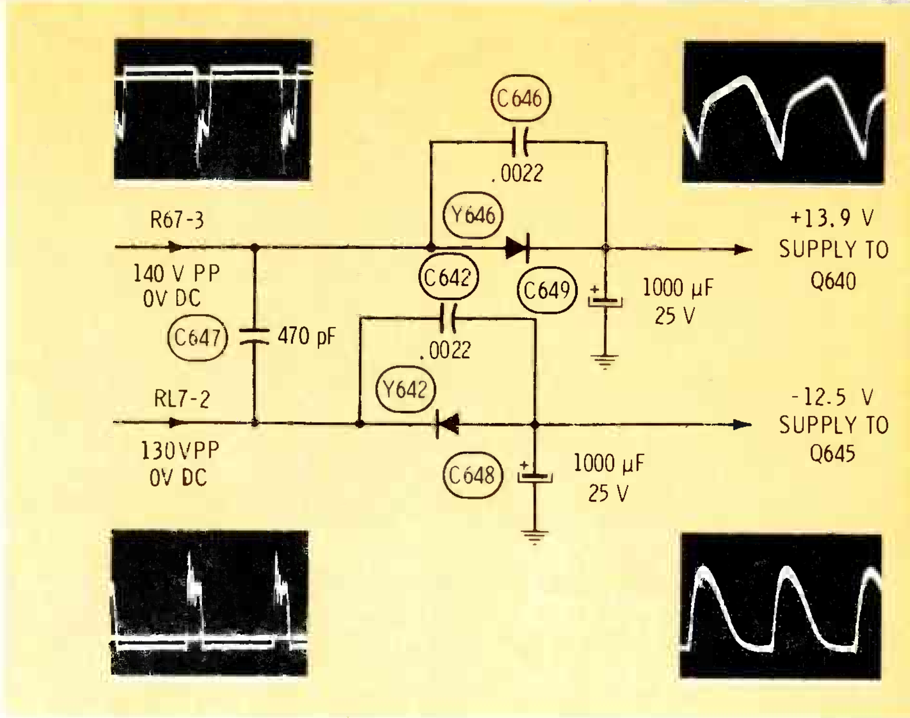


Fig. 9 Here are the circuits and waveforms of the two power supplies for the output transistors. The input waveforms were photographed at horizontal rate; the output ripples at vertical rate, as explained in the text.

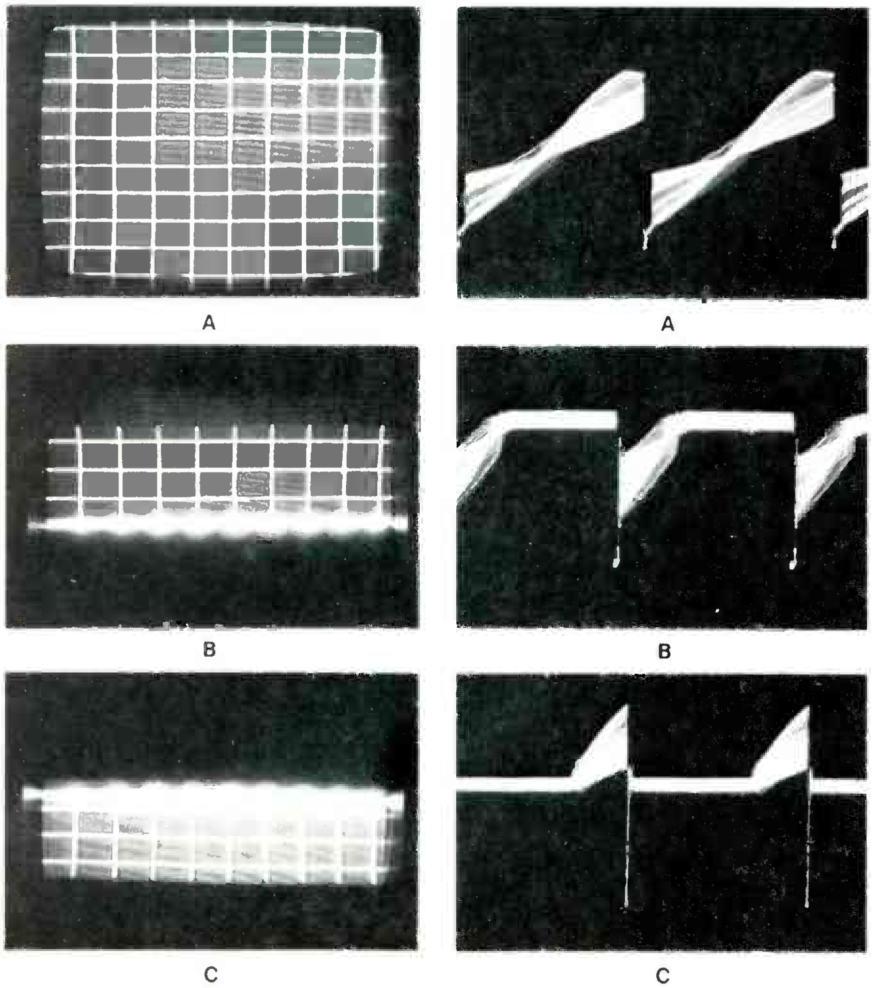


Fig. 10. These three pairs of pictures show what happens when either output transistor opens. (A) gives the normal crosshatch on the screen and the normal scope waveform at the output of the module. An open Q640 produced the crosshatch and waveform of (B), and -1 volt at the output. Evidently Q640 deflects the bottom of the raster. When Q645 was open, the crosshatch and waveform of (C) were found; the yoke had +1 volt. Q645 deflects the top half of the raster.

and this should eliminate **all** 60-Hz ripple, regardless of the size of the filter capacitors. The hum waveforms are created by the large currents of the vertical-output transistors which are not bypassed completely by the 1,000 microfarad filters (C649 and C648). In other words, **the "hum" is from the vertical, not the AC line.**

Open Output Transistors

In order to show the symptoms of an open Q640 or Q645 output transistor, I removed one at a time, and photographed the scope waveform and the crosshatch pattern from the picture tube. The results are shown in Figure 10. In addition to the distinctive patterns, the DC voltages were changed significantly. When Q640, the transistor for "bottom" deflection, was open, the positive supply voltage was high, and also the DC voltage at the yoke was about -1 volt.

When the transistor for top deflection (Q645) was removed, the negative voltage supply was high, and the yoke measured about +1 volt DC.

Even with such a huge amount of distortion, the small amount of visible height had good linearity; a tribute to the circuit design.

Incidentally, the output transistors and resistors on the module were unusually difficult to remove from the board. Even with all solder removed, and the leads

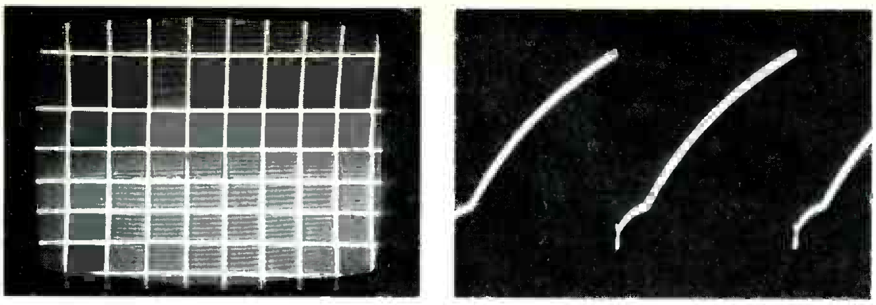


Fig. 11 An open C636 gave these symptoms on raster and scope. This is one of the few defects that can stretch the linearity. It removes the negative feedback.

wobbling like a loose tooth, the wires could hardly be removed without breaking them. Bends of the leads at the board seems to be the reason. Perhaps you can straighten out the leads of any you remove, and do it easier than I did.

Defects Causing Poor Linearity

Circuits such as these having feedback from the yoke current are **almost** immune to poor linearity because of defective components. But I did discover two interesting symptoms involving the linearity.

No feedback

Excessive height and stretched linearity at the top (see Figure 11) were caused by an open C636, the capacitor that couples the feedback from the yoke to the differential stage. Strangely enough, the "butterfly wings" from the pincushion correction were missing from the yoke waveform.

Probably the height could have been reduced by lowering the setting of the vertical size control, but the linearity would have remained poor.

Open loads

Strange crosshatch and scope patterns, like none I have ever seen before, were produced by open circuits in some of the components wired in parallel with the yoke coils.

When R649 or R651 was removed, the raster scanning lines were bent in curves near the center of the screen, leaving two oval areas without lines (Figure 12). Also, R650 burned to a crisp.

After R650 was removed to remove the heating, the open ovals were reduced to just one located slightly to the left of center. However, when R650 or C650 were opened while R649 and R651 were in the circuit, no visible defect could be seen on the crosshatch pattern.

Two scope waveforms are shown; one was at the horizontal rate, and the other at vertical. Both show unwanted movements, coming from the pincushion action. The waveform taken at horizontal rate should have shown nothing, but it revealed strong horizontal-sweep patterns, which were a cross between pulses and square waves, and they moved. These evidently obscured the usual sweep waveform, so that the picture of the pattern at vertical rate showed no resemblance to the correct waveform.

Comments

As I remember the problems we had (and still do sometimes) with the old tube-powered vertical circuits, I appreciate the new solid-state vertical systems. The tube circuits commonly changed height or linearity as they heated, they might roll or flip unexpectedly for no good reason, and often it was nearly impossible to obtain both full height and good linearity.

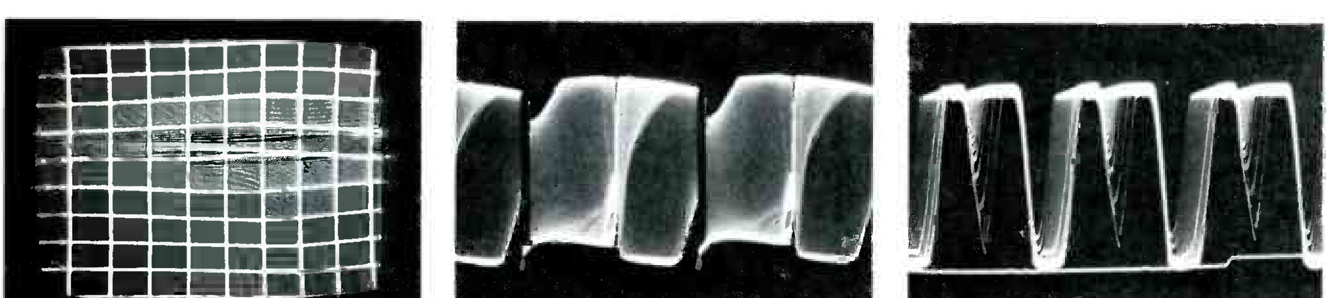
By comparison, the GE vertical circuit was totally stable, never rolled (except during a channel change), and had perfect height and linearity.

And yet I shudder a bit when thinking of the weird and difficult-to-analyze voltages and symptoms that can happen when something upsets the DC voltages in the differential, driver, or output stages (all direct coupled).

As a test, I shorted base-to-emitter of Q620. Of course, there was no vertical sweep, but the horizontal line was about 2 inches from the **top** of the screen, and the yoke measured -5 volts. Evidently Q640 was biased to cutoff, and Q645 was saturated. I chickened out, and quickly shut off the power to prevent ruining any transistors. Perhaps later, I can strengthen my courage enough to analyze some of these massive failures.

Next Month

Chroma and video circuits will be spotlighted next month. □



A B C

Fig. 12 An open R649 or R651 anti-ringing resistor produced these strange results. Unstable bending of the scanning lines near the center (A) were slightly different with and without R650 in the circuit. Output to the yoke had this waveform (B) when the scope was set for vertical rate; and the foreign areas of (B) proved to be horizontal signal when the scope was set for horizontal rate (C).

productreport

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Picture-Tube Restorer

A different method of increasing the gun current of weak color picture tubes is incorporated into the NU-COLOR Picture-Tube Restorer offered by **Oneida.** This unit does not change the heater voltage, although the physical appearance is similar to those that do. Instead, three linear controls adjust the amount of current applied to some elements of the picture tube. The color of the levers identifies the correction of red, blue, and green gun current.

The NU-COLOR Restorer is installed by plugging it in between the base of the picture tube and the CRT socket. Then, with the color control turned down, the three sliding controls are adjusted for the best balance giving a good black-and-white picture. Afterwards, the color control can be turned up for a pleasing picture. Some picture tubes, according to the manufacturer, require operation with the Restorer for several hours to achieve full correction.

Two versions are available; Model 70A with large plug and socket is for the older round color tubes, and Model 90A is for the rectangular tubes. Retail price of each is $24.95.

For More Details Circle (45) on Reply Card

Purchasing Guide

Allied Electronics' 1977 Engineering Manual and Purchasing Guide now is ready. The 212-page guide is filled with a wide selection of industrial-type electronic parts, components, supplies, and equipment. Some items featured are: test equipment, trimmers and potentiometers, transformers, tools, capacitors, new solar-energy products, CB test equipment, and even a microcomputer. Also, new in this year's guide is the introduction of metric measurements on many electronic parts and components.

A copy of the guide can be obtained by sending $1.00 to cover postage and handling to: Allied Electronics, Dept. 77, 401 East 8th Street, Fort Worth, Texas 76102.

For More Details Circle (46) on Reply Card

FM Converter

Audiovox Corporation has expanded its line of mini, under-dash units with the introduction of a tiny FM converter.

The gold-finished, micro-sized Model FMC-4C converter measures 4" X 3-3/4" X 1". It has a black-out dial with an LED station indicator, all-solid-state circuitry, and a push on/off switch. It features a built-in "Tune

Tone" which simplifies tuning to the proper frequency. A tone is emitted indicating the correct frequency for FM tuning of AM radios.

(Continued on page 66,

bookreview

CB Rules and Regulations
Author: Compiled By The Howard W. Sams Editorial Staff
Publisher: Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, Indiana 46268
Size: 44 pages, book number 21341
Price: $1.00 paperback (Canadian Price slightly higher)
The complete text of Part 95 of the FCC Rules and Regulations is included, revised to reflect the latest changes. It also contains copies of two important FCC Forms: Form 505, Application for Class C or D Station License in the Citizens Radio Service; and Form 555-B, the Temporary Permit. Complete instructions for completing these forms are given in the book. In addition, "10" signals and "Q" signals, the verbal shorthand used by CBers, and a section on CB slang are included in this guide.

Handbook Of Solid-State Troubleshooting
Author: Hershal Gardner
Publisher: Reston Publishing Company, Inc., P.O. Box 547, Reston, Virginia 22090
Size: 318 pages
Price: $15.95 hardbound
State-of-the-art semiconductor troubleshooting is emphasized, also the practical aspects of semiconductor devices, circuits, and systems, with theory held to a minimum. Test and measurement techniques are explained and illustrated for each individual subdivision of semiconductors. The broad spectrum of topics includes device testing, instruments, tools, component replacement, solid-state amplifier servicing, power-supply troubleshooting, control-circuit servicing, and test-equipment maintenance.
Contents: Solid-state Principles and Testing Procedures; Normal and Abnormal Voltages and Waveforms; Troubleshooting Basic Solid-state Amplifiers; Troubleshooting Solid-state Power Supplies; Troubleshooting Solid-state Control Circuits; Troubleshooting Solid-state Test Equipment; Troubleshooting Solid-state Radio Receivers; Troubleshooting Solid-state FM Mono and Stereo Receivers; Troubleshooting Solid-state Quadriphonic Equipment; Troubleshooting Solid-state Industrial Electronic Equipment; Troubleshooting Solid-state Television Receivers; Troubleshooting Solid-state Digital Equipment; Answers to Review Questions; Index.

(Continued from page 64)

The compact converter installs easily with grip-tight mounting strips, and uses a regular AM antenna. It weighs 11 ounces, and has a tuning range of 88-108 MHz.

Suggested list price of the Model FMC-4C is $39.95.

For More Details Circle (47) on Reply Card

Removable Mount For CB Antenna

"Hide-It", from **RMS Electronics**, is a quick-disconnect trunk mount for CB antennas. The trunk-lip half of the mount is installed permanently in place on the car. The other half of the mount attaches to the antenna, so it can be placed on the truck bracket for radio operation, or removed by loosening one screw when the antenna/mount assembly is to be hidden inside the trunk as a protection against theft or damage.

The mounting bracket fits most cars and accepts most CB antennas; also, it secures the coaxial cable in place and grounds it.

"Hide-It" Model CBTM-20 removable antenna mount is supplied with a self-adhering rubber strip to protect the finish of the car, and installation instructions. List price is $11.95. □

For More Details Circle (48) on Reply Card

Philco E21 Chassis

(Continued from page 39)

Case #3

The symptoms of this E21 pointed to power-supply problems, because the picture was shrunken on all four sides. In the past, the defect always was the filter C520, which reduced the 140 volts to about 100. Oops! The voltage was 140 volts; so it couldn't be C520. Also, the +112-volt supply was okay.

Now, this is one of the worst corners a technician can paint himself into. Your preconceived idea is proved all wrong, and you are left with no other solution. The solution is to go back to basics, and stop the short-cuts. First, what about other symptoms?

At loud volume, the vertical would pull-up even more and the width would change in step. The supply voltages were normal, except the 29-volt line which was down about 4 volts. Perhaps the vertical was drawing too much current, and loading-down the horizontal. That was wrong, because the drop across R532 (see last month) was only 0.3 volt.

Finally, I got around to measuring the high voltage, and I was astounded to find 42 KV. WOW!

Waveforms around the output transistor emitter showed a couple of foreign curves that didn't belong. And, finally, an ohmmeter test from emitter to ground showed 4,000 ohms. (The emitter should go to ground through a flyback winding of less than 1 ohm.) Yes, the winding was open.

The symptoms finally began to make sense. Lacking a return to ground through the flyback winding, the emitter of Q402 sought the next path through SC530 and the transistors supplied by that power supply.

I assumed the increase of high voltage was due to a change of the turns ratio of the flyback. Undoubtedly, the pulses were increased at the collector, and the primary has one less winding, so the voltage would be stepped-up more at the secondary.

Next Month

Vertical and chroma circuits, and some typical problems there, are the subjects for the next article. □

photofact bulletin

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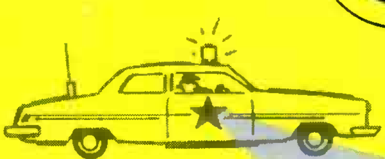

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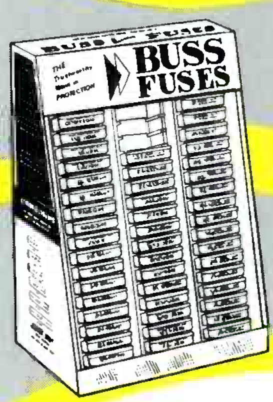

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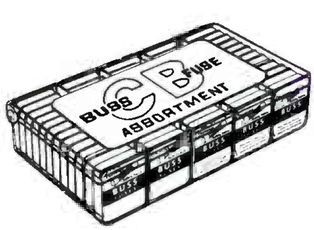

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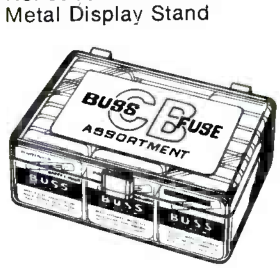

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And it only costs $235*.

True rms.	Fluke
1-year accuracy specs.	Fluke
High voltage protection.	Fluke
Diode test.	Fluke
A full line of accessories offering rf voltage, high current ac, high voltage dc, and temperature measurement probes.	Fluke

There's only one place to go for all the performance you need in a handheld DMM.

There are measurement functions in five selectable ranges for dc volts, ac volts (true rms), dc current, ac current (true rms), and resistance. DC voltage measurement is from 100 μV to 1100V with basic accuracy of ±0.1%, ac measurement is from 100 μV to 750V rms with basic accuracy of ±0.5%. DC and ac current is from 100 nanoamps to 1.999 amps with basic dc accuracy of ±0.35% and basic ac accuracy of ±1%. Resistance measurement is from 100 milliohms to 2 megohms with a basic accuracy of ±0.4%.

We added true rms response for ac measurements. Specified accuracy is still attainable when the measured waveform is distorted.

"Fluke does the impossible again."

There is extensive overload protection. It has been tested with transients up to 6000V peak across the input terminals.

Options include two battery operations: a rechargeable NiCad for 8 hours operation and throw-away alkaline cells. Accessories include probes for measurement of rf voltages, high current ac, high voltage dc and temperature.

80T-150 Temperature Probe

Sensitivity:	1 mV/°C or 1 mV/°F
Accuracy:	
+15°C to +35°C ambient:	±2°C(3.6°F) −25°C to +125°C ±3°C(5.8°F) −50°C to −25°C and +125°C to +150°C
0°C to 15°C, 35°C to 50°C ambient:	Add 1°C(1.8°F) to above

You can also get temperature measuring capabilities with the 8030A.

And because the 8030A gives you so much in performance, let us remind you once more of the price.

Only $235*.

For the first handheld DMM that's small in size, small in price, but huge in performance.

For data out today, dial our toll-free hotline, 800-426-0361.

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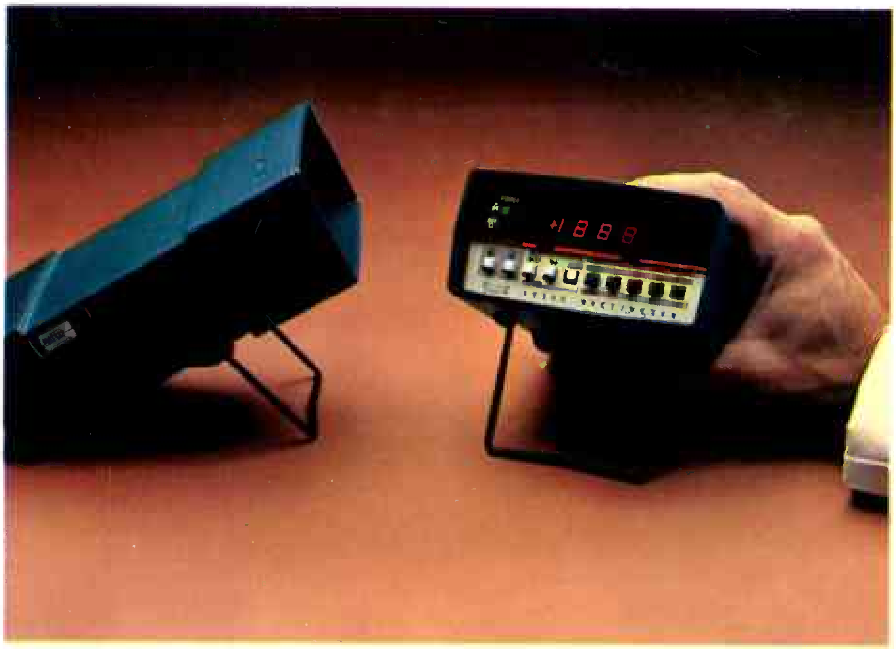
*U.S. price only.



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