THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

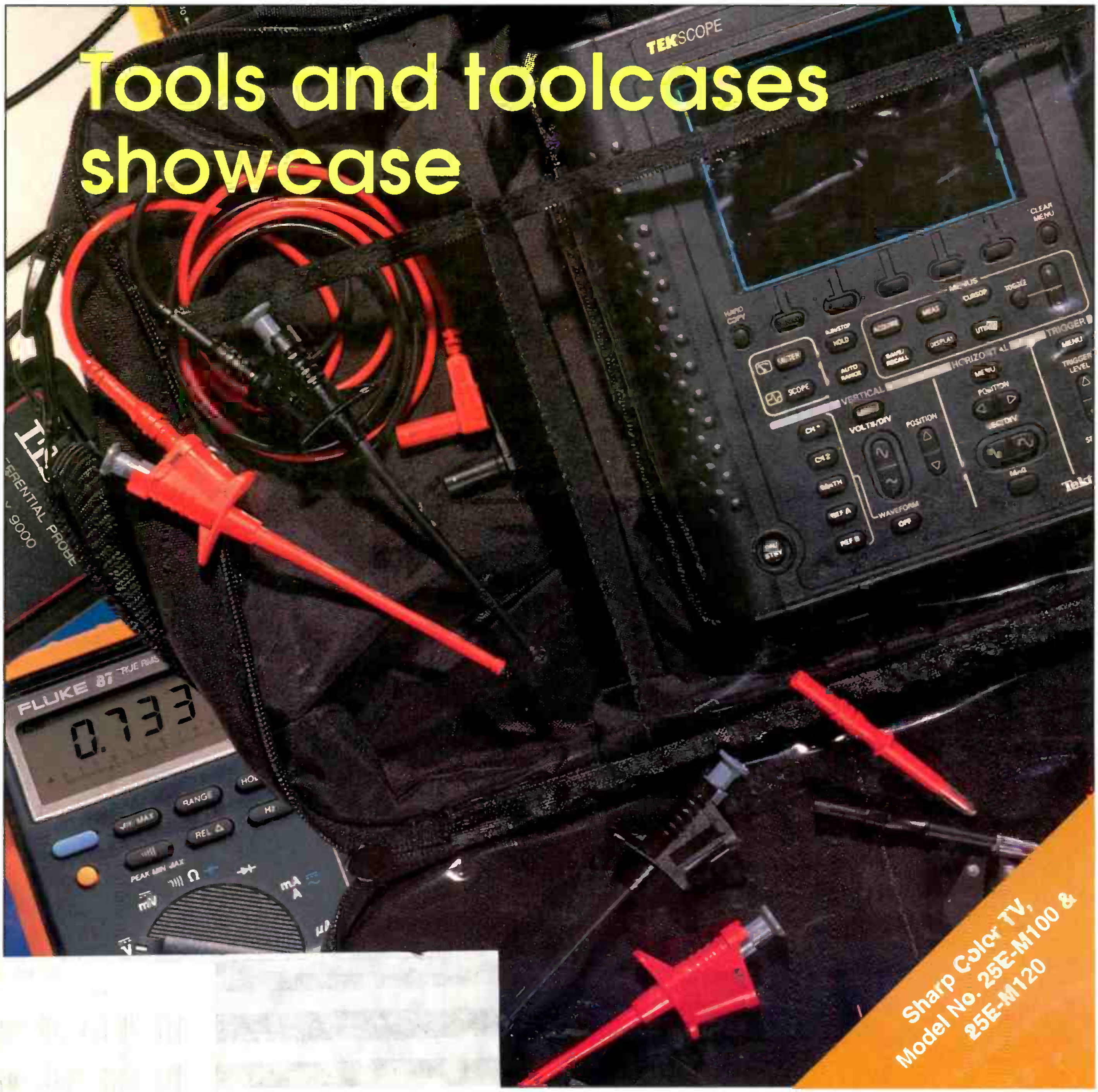
ELECTRONIC Servicing & Technology

May 1996

Troubleshooting tips for RCA CTC157

Testing audio power amplifiers

Tools and toolcases showcase



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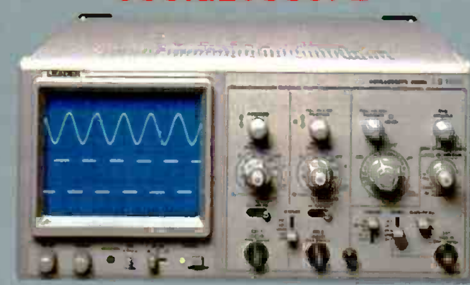

Developed specifically for the electronics production and service industries, the LS 1020 is equipped with features typically found only on higher bandwidth scopes. It is ideal for use on the audio bench, and can be used as a second scope for video troubleshooting as well. The unit is equipped with TV-V and TV-H coupling, has a 5 mV/div sensitivity (0.5 mV/div with X10 on), and includes both CHOP and ALT vertical mode functions. Rugged and reliable, the LS 1020 provides service professionals with an affordable choice without compromising features or quality.

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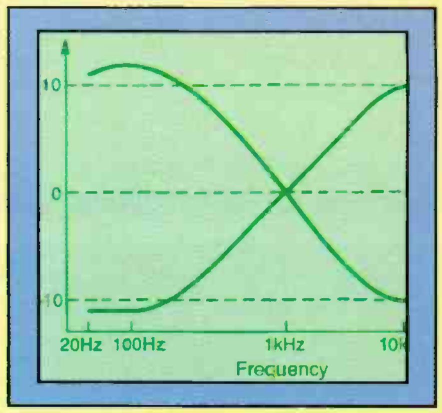
THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC Servicing & Technology

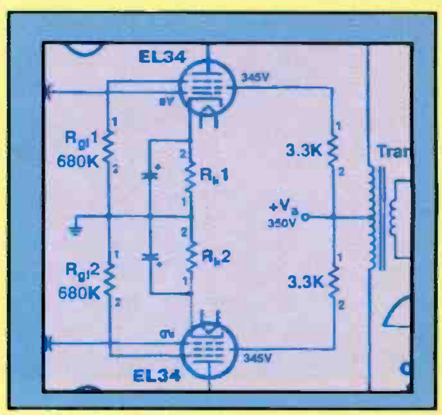
Volume 16, No. 5 May 1996

Contents

page 8



page 16



page 54

ON THE COVER

Consumer electronics servicing is a demanding profession, and practitioners of the profession need test equipment, accessories, tools and tool cases that can stand up to those demands. (Photo courtesy ITT Pomona)

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Electronics servicing is a business

We have received many inquiries from readers about the business side of electronics servicing. Some of the questions most commonly asked are, "How do I determine how much to charge to service a product?", "How can I calculate how much to pay my technicians?" and, "How do I calculate a fair price for parts?"

Finding the answers

The right answers to those and other important business questions can make a service center successful and prosperous. The wrong answers can lead to ruin.

In most businesses, answering these questions for a consumer electronics service center requires a delicate balance. Take, for instance, the first question. If a service center charges too much to service a product the customer will simply go elsewhere, or just buy a new unit. This is especially true for the lower cost items where the cost to service the product may be as much as one-half of the replacement cost for the unit. On the other hand, if the amount charged for service is consistently too low, the company will lose money. If the books are running with red ink for any length of time the business will fold.

The answers to these questions are never easy, and, of course, vary from service center to service center. The rules for charging for service in New York City aren't the same as they are in Liberal Kansas or Fargo North Dakota but the same basic considerations still apply regardless of location. It's important to charge enough to pay all expenses and make a reasonable profit as well.

Similar thinking applies to the issue of technician pay. You have to pay them an amount that's in the same ballpark as they could command from other companies in the area for the same type of work, but you can't pay them so much that the business suffers.

What we're doing about these concerns

The difficulties of many service centers in dealing with business-related questions have become more and more clear to the **ES&T** staff. We receive letters and telephone calls asking business-related questions, and field questions and comments in person from servicers at trade shows, association conferences and meetings. We have begun to publish articles that address some of those questions.

For example, in a special issue, "Strictly Business," published in January, we addressed such subjects as the importance of quality of service, how to select insurance to cover your business, and how to set up and administer service contracts. Since then we published an article on paying techs on an incentive basis, and, in this issue, Charles Varble, Jr., a highly successful service center owner, now retired, and author of several other recent articles on business, provides some tips on pricing parts.

Is it helping?

It would help us to plan future business-oriented articles if we had some idea of how we're doing so far, and what specific business-related questions are on the minds of our readers. So let us hear from you. What have you liked about recent business-type articles in **ES&T**? What have you been disappointed in? What types of business-related articles would *you* like to see in future issues?

Nils Conrad Persson

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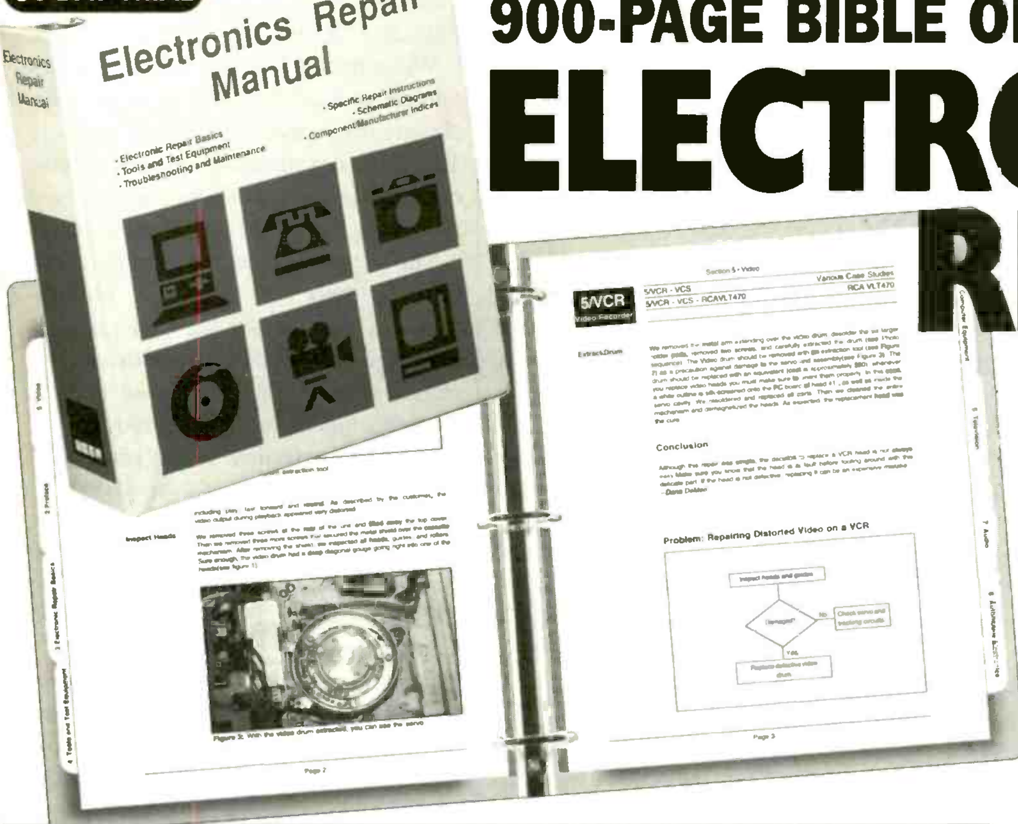

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Hatton elected vice chairman of IVTO technical committee

The Consumer Electronics Manufacturers Association (CEMA) announces that Don Hatton, vice president of CEMA's Product Services Department, was elected vice chairman of the International Vocational Training Organization's (IVTO) Technical Committee. Hatton was also appointed as a member of IVTO's Executive Committee.

With representatives from 33 countries, IVTO is dedicated to promoting international technical skill standards. The organization encourages worldwide competition in a full range of vocational skills. IVTO's Technical Committee oversees the operation of the International Youth Skills Competition (IYSC), a biannual competition for students and workers up to age 22.

"Don Hatton has been instrumental to the growing success of the U.S. in vocational skills competitions," said CEMA president, Gary Shapiro. "As vice chairman of IVTO's Technical Committee and member of the Executive Board, he will have an even greater role in advancing the international competitions and ensuring that our nation's electronic workers are trained with cutting-edge technologies."

CEMA sponsors U.S. contestants in the Electronic Applications portion of the IYSC. Finalists competing for the national title—and a chance to compete at IYSC—will face each other on the floor of CES Orlando, May 23-25 in Orlando, FL. At last year's IYSC in Lyon, France, Tim Perry received the first-ever American silver medal for his abilities in a variety of electronic applications. Perry was co-sponsored and trained by Matsushita Factory Service.

Electronics Technicians can test on computer

Electronics Technicians can now take the Associate CET (Certified Electronics Technician) exam at a computer keyboard. The Certified Electronics Technician (CET) program, now in its 31st year of recognizing the professional capabilities of electronics technicians, is overseen by the International Society of Certified Electronics Technicians (ISCET).

There is no more waiting for weeks to find out if the technician has passed the exam. The computer not only prints out a "congratulations, you passed" message; it also prints a section-by-section score showing the students which areas they were strongest and weakest in.

The computerized Associate CET exam can be ordered from any ISCET CET Test administrator who has the necessary hardware. Subjects covered on the Associate Test include electronic math, ac and dc circuits, semiconductors, components and circuits, instruments, tests and measurement, and basic troubleshooting. Study material either on paper or computer disc is available from ISCET.

For more information on ISCET and the CET program, contact ISCET headquarters, 2708 W. Berry, Fort Worth, TX 76109. 817-921-9101, fax: 817-921-3741, or E-Mail iscetFW@aol.com.

Technician certification exams funded by military education branch

Electronics technicians in the United States Military, as of February 1, 1996, are eligible to receive funding for the cost of the ETA Certified Electronics Technician (CET) examinations. Heretofore enlistees could only receive financial assistance for certain degreed and college accredited programs.

ETA's Greencastle, Indiana headquarters said that personnel in certain military occupations are eligible. These include ET—Electronics Technician; AT—Aviation Electronics Technician; FC—Fire Control Technician; Interior Communications Technician and other electronics related job codes.

Military technicians must go through their base DANTES education office in order to qualify. Most United States military bases are acquainted with the CET skills and knowledge recognition and registration program, as ETA has been an official DANTES certification agency since 1980. DANTES (Defense Activity for Nontraditional Educational Services) is the branch which supports military educational efforts, encouraging and assisting personnel in obtaining GED, college level equivalency, degreed and distance learning education, including some satellite courses through Mind Extention University.

While the CET program has been recognized around the world in much of the electronics industry since it was begun in 1966, the idea of certification of technical knowledge and skills has received increasing interest in the past few years.

The states of Indiana and Oregon have dropped their state licensing requirements in part because the CET program is recognized as being more current and technically superior. Increased interest from the military is in part because of the downsizing currently taking place. Detaching personnel can add the CET certification to their credentials prior to leaving the service, thus assisting in their job searches. Many military technicians gain CET, as well as FCC Commercial Licenses while serving.

For an informational brochure outlining the ETA Certification Program, contact ETA, 602 N. Jackson, Greencastle, IN 46135-1035, fax: 317-653-8262, E-Mail: LTAL30A@prodigy.com.

CEMA supports FCC actions to revise satellite dish zoning rule

The Consumer Electronics Manufacturers Association (CEMA), a sector of the Electronic Industries Association, said today that it supports the Federal Communications Commission (FCC) action pre-empting local restrictions on satellite dish usage.

The FCC took action to revise the rule governing satellite dish zoning preemption in response to evidence that, under the current law, some local jurisdictions were inhibiting the expansion of residential satellite services by enforcing overly-restrictive and unreasonable zoning laws.

Under its new ruling, the FCC will review local disputes after exhaustion of only non-federal administrative remedies. In addition, it adopted two new standards to determine reasonableness of non-federal regulations and created two categories of rebuttable presumptions against regulation of small antennas. It also approved procedures by which non-federal authorities can request waivers of the rule in cases where unusual circumstances are shown. ■

Parts and accessories

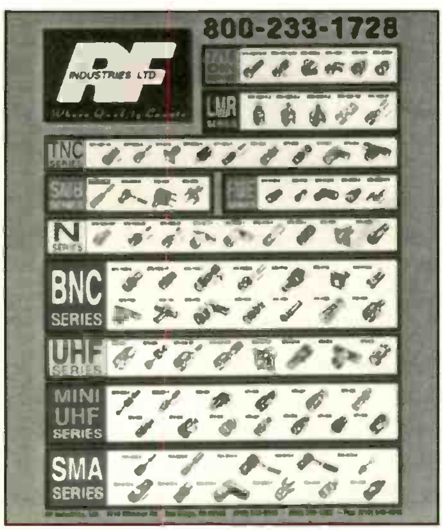
Parts Express announces the release of their 228 page, 1996 Catalog.

Items include a large array of CATV and VCR repair parts, semiconductors, tools and technician aids, test equipment, computer accessories, chemicals, adhesives, telephone products, specialized connectors, instructional books and videotapes, pro sound equipment, wire, and audio accessories including raw loudspeaker drivers for home, and car and home theater applications.

Circle (90) on Reply Card

Coaxial connector catalog

RF Industries' new 100-page catalog presents an expanded range of coaxial connectors, including 300 new items.



Extensive coverage of BNC, TNC, N, UHF, mini-UHF, MB, SMB, SMA, MCX, 7/16 DIN, FMR, LMR series, 1/2" and 7/8" corrugated cable connectors.

The catalog includes over 1500 coax products, including cable assemblies, connector kits, Unidapt and Celludapt universal adapter products, cellular products and hand tools. Products specifications and photographs are included.

Circle (91) on Reply Card

Catalog of instrument-specific accessory kits

ITT Pomona's 1996 Short Form Catalog extends the company's line of test accessories designed to enhance test equipment from leading manufacturers and highlights its most popular products from a broad selection of test accessories.

Leading off the newest products are

complete "take-it-with-you" test kits in carrying cases designed specifically for use with Fluke, Hewlett-Packard or Tektronix meters and oscilloscopes.

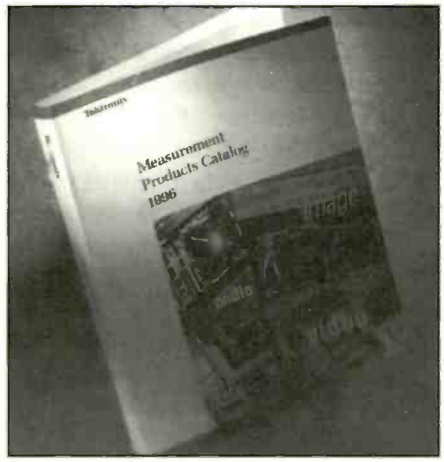
The Test Companion kits also include test leads, probes, grabbers and clips, all organized in lightweight, durable Cordura carrying cases. Also available through the catalog is a full line of the latest and most popular accessories which includes DMM test accessories and kits, test clips, oscilloscope probes, cable assemblies, coaxial adapters and kits, banana plugs, enclosures and IC test clips for popular 2- and 4-sided devices, including new solder-on adapters.

Circle (92) on Reply Card

Measurement products catalog

Tektronix, Inc. announces the availability of its 1996 Measurement Products Catalog, which lists nearly 100 new products.

The catalog includes a full-color new product section that presents a synopsis of the company's business focus and features a variety of new form-factor measurement solutions. Throughout, the catalog highlights products manufactured in ISO 9001-certified facilities.



The catalog's detailed product descriptions are backed by an on-demand fax service, available via a toll-free 800 telephone number, offering extensive application and technical notes. Comprehensive indexes in the catalog, list products by name and by function.

Circle (93) on Reply Card

Laser and electro-optic

Newport Corp. has introduced Newport Online, for the lasers and electro-optics industry. With customers as the focus, the site provides them with access to the company's new product reviews and previews. In fact, some products will be introduced for the first time via the site. Other in-depth features encompass informative tutorials, application notes, financial information, searchable product listings, and access to the manufacturer's family of companies.

Not only will individuals anywhere in the world be able to browse through a virtual tour of the company's manufacturing facilities via video clips and ask questions of product experts, but they'll be able to see new products the moment they're released and in some cases have direct input into new product designs.

Circle (94) on Reply Card

Troubleshooting tips for the RCA CTC157

By Homer L. Davidson

The RCA CTC156, CTC157, CTC158 and CTC159 chassis are all very similar in design. The CTC156 and CTC158 chassis are used in models with 20-inch picture tubes, while the CTC157 and CTC159 are used in sets that have 26-inch or 27-inch CRTs (Figure 1). The CTC156/157 chassis are used in the lower priced sets while the CTC158/159 chassis are used in sets that occupy the middle of the TV price line up.

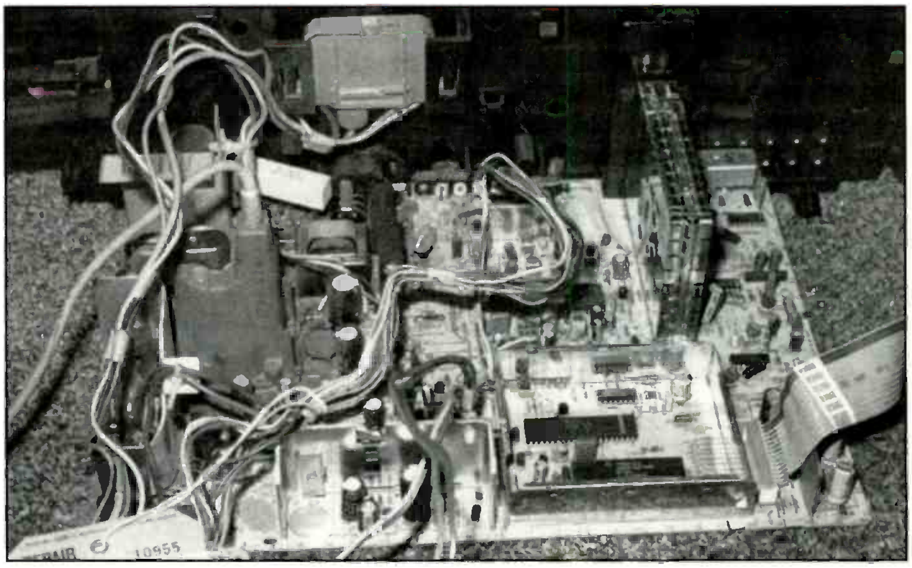


Figure 1. TV circuits in the RCA CTC157 chassis are similar to the circuits in the same manufacturer's CTC156, 158 and 159.

Low voltage sources

The power supply in the CTC157 is a transformerless raw power supply that feeds the horizontal output circuit (129V) and the 33V source. As in early sets, an SCR4101 regulator regulates voltage to the horizontal and flyback circuits. When the dc output voltage is excessively high at the anode of the zener diode and the voltage at its cathode terminal is extremely low or zero, suspect a defective SCR-4101 or defective components within the gated circuits of the set.

The gate circuits consist of an error amp (Q4104), a sawtooth generator (Q4103), and two separate oscillator transistors (Q4102 and Q4101). When troubleshooting these circuits, observe oscilloscope waveforms and measure voltages in the SCR circuits.

Remember, the gated transistors are

Davidson is a TV servicing consultant for **ES&T**.

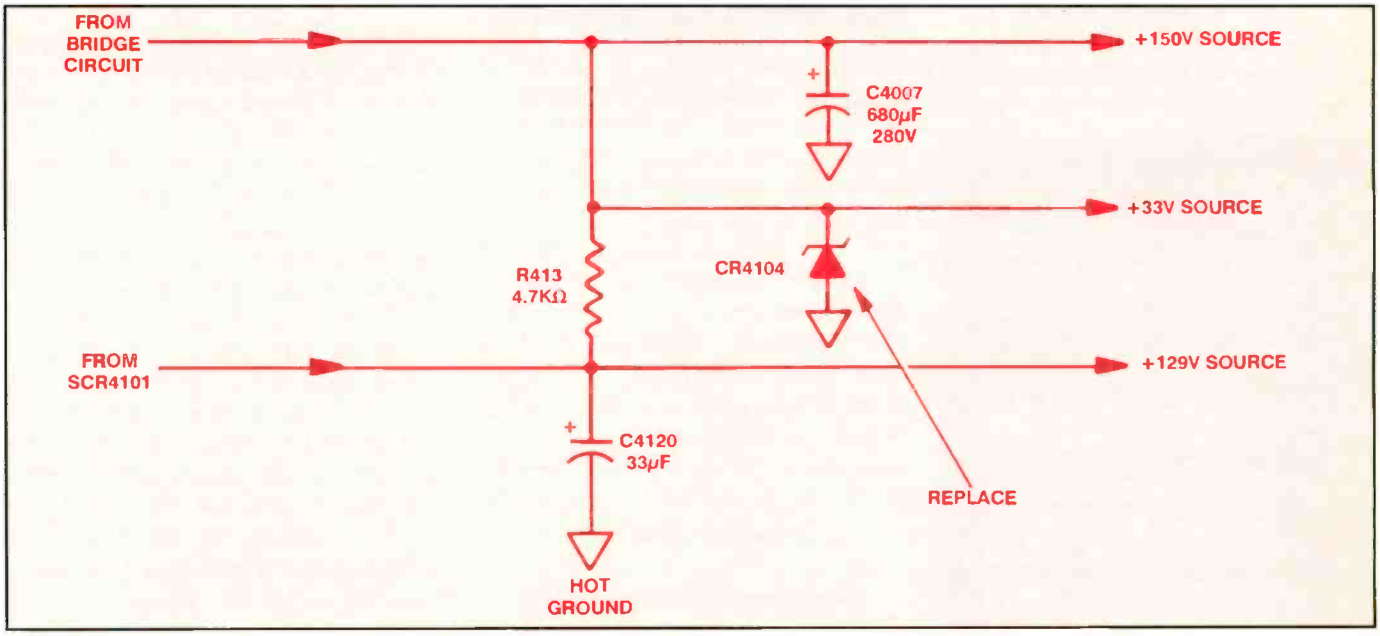


Figure 2. If the voltage from the 33V supply is low, or 0V, it may be caused by leaky CR4104 in the low voltage circuits.

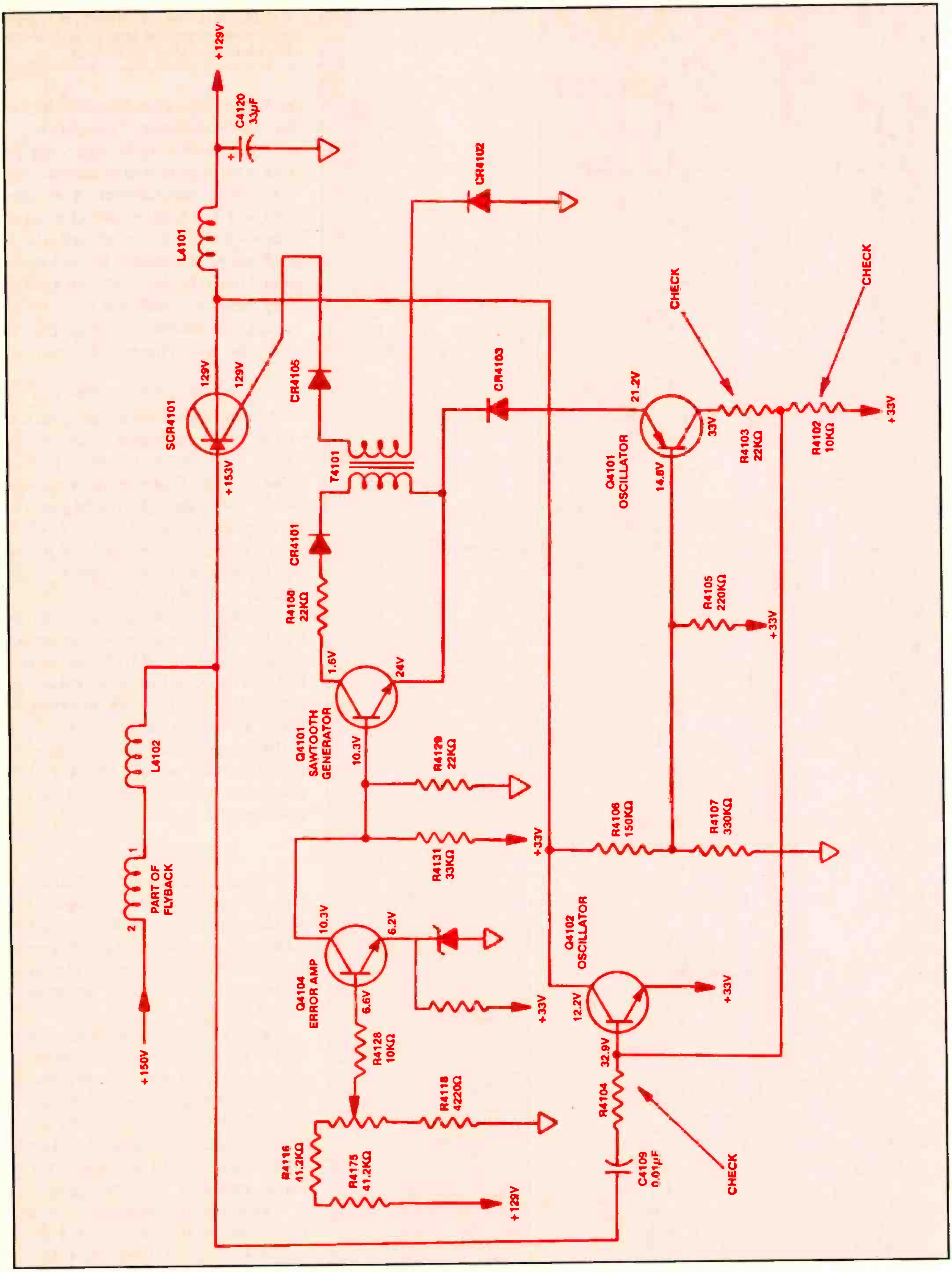


Figure 3. The B+ regulator in the CTC157 chassis is an SCR system, similar to those found in earlier model sets.

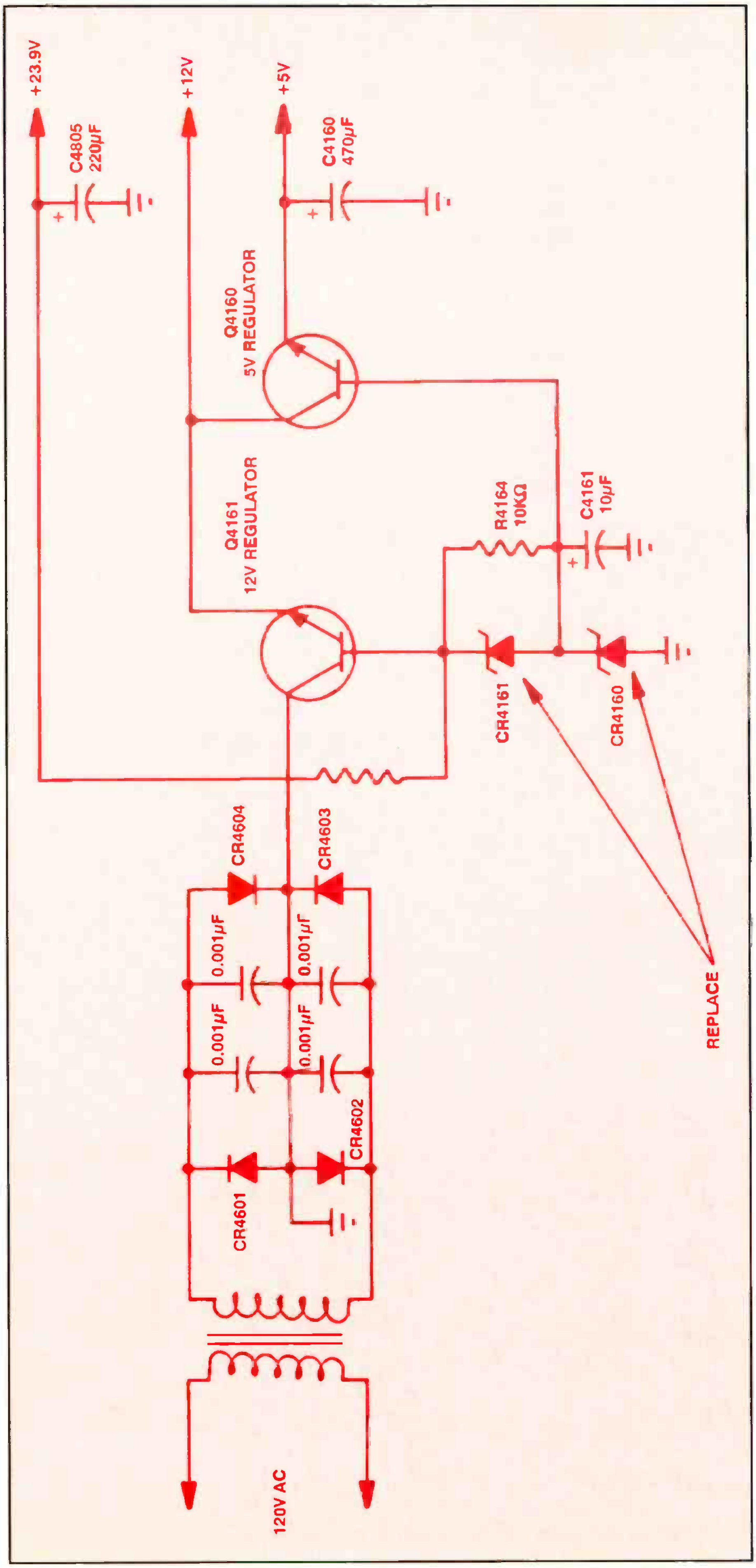


Figure 4. The standby circuits operate continuously to provide start-up and remote control functions when the set is off.

fed from a 33V source. Be careful here as there are two different 33V sources in this set: one in the raw 150V supply and the other in the scan-derived flyback circuits.

All voltage measurements in the 150V, 129V and 33V supplies should be taken with respect to the hot ground side. A good place to connect the voltmeter ground lead is the horizontal output transistor metal heat sink. For cold ground voltage measurements, clip the ground lead to the case of the varactor tuner.

Frequent problem causes

Problems commonly found in the low voltage power supplies in these sets are: blown fuse (F4001), open resistor (R4001), leaky diodes in the bridge circuits (CR4001 through CR4004), and filter capacitor C4007 (680µF). A +33V source is tapped off of the 150V power supply via R4101 (15KΩ) and a 33V zener diode CR4104 (Figure 2).

A leaky CR4104 can cause chassis shutdown or in some cases cause the set to turn off and on. CR4104 may cause a high-pitched squeal, excessive noise, picture foldover, and chassis shutdown. A leaky CR4104 can cause low voltage and if it becomes open, the supply voltage will be higher than normal. Check R4101 when zener regulator (CR4104) has become shorted.

Gated SCR circuits

If one of these sets is dead, SCR4101 does not turn on. If the dc voltage at the collector terminal of the horizontal output transistor (normally +129V) is low or zero, check the gated circuits. The regulator control circuits control turn on time of the SCR.

Compare the various waveforms specified in the service literature with those actually observed at the gate transistors. Test each transistor in the circuit. Check diodes CR4105, CR4112, CR4103 and CR4120 (Figure 3). Solder all terminals of transformer T4101 for no start up or chassis shutdown. Measure voltages on each transistor. Remember the +33V and 129V sources are the correct voltage sources for the gated circuits. All voltages in these circuits have a hot ground.

Measure the resistances of R4102,

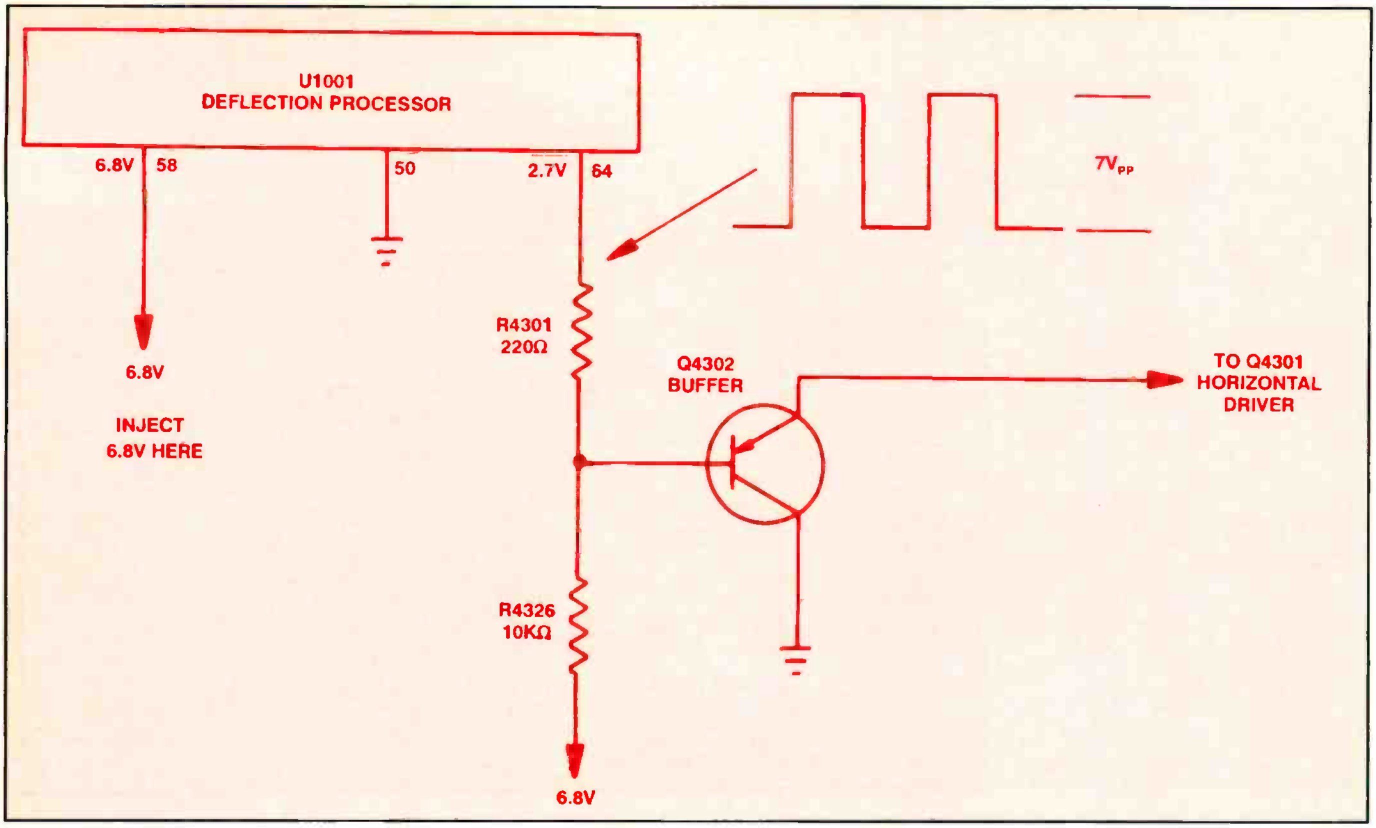


Figure 5. When the horizontal circuits are in shutdown, check the 6.8V input to pin 58 of U1001, and connect the oscilloscope to pin 64 to see if there is a square wave pulse.

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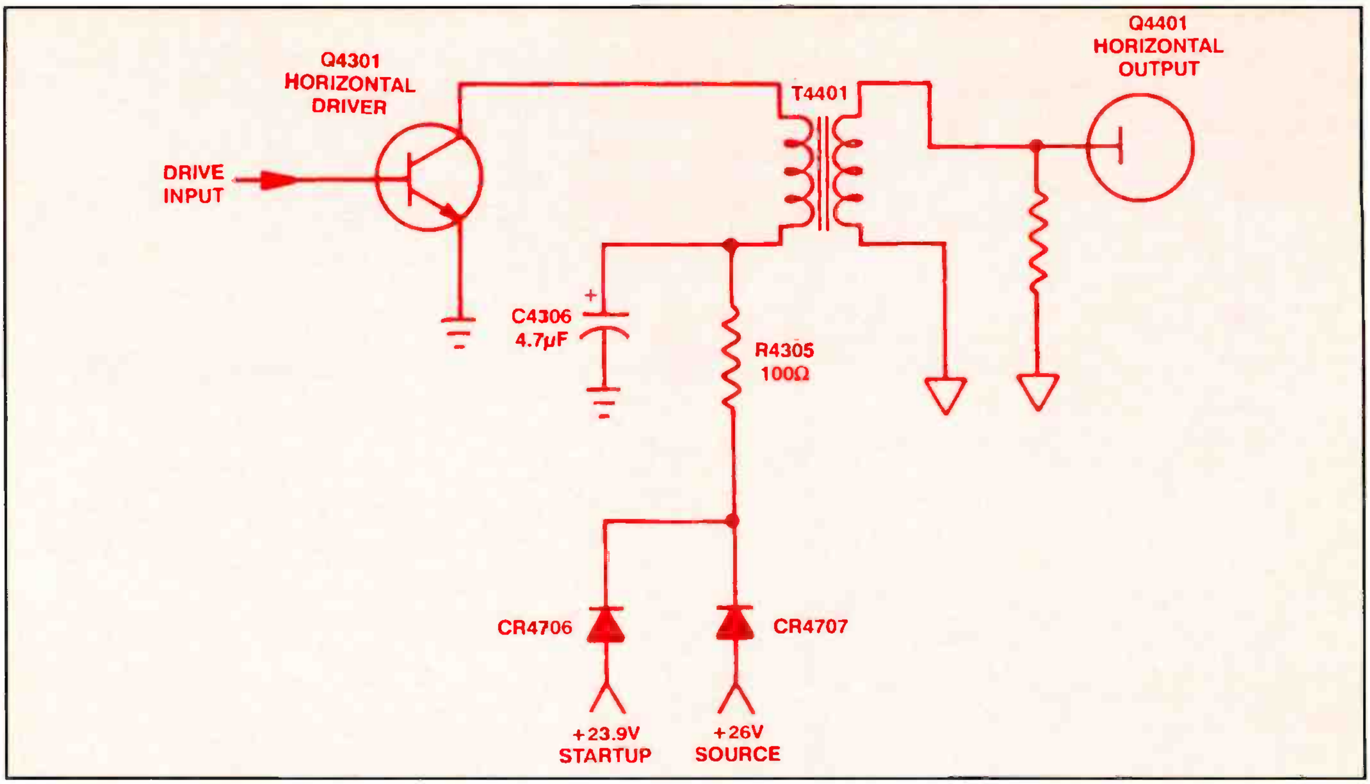

Figure 6. The horizontal driver circuit waveforms can be checked by using an external power supply to apply +6.8V at pin 58 of U1001 and +26V to the cathode of CR4707.

R4103 and R4104 to see if the output of the power supply is pulsating. If there is no picture or sound the cause may be defective resistors. These resistors have been known to increase in value or become open.

Standby voltage sources

The standby power supply circuits operate from a stepdown low voltage transformer (T4601). Bridge rectification supplies a +23.9V source to the +12V standby regulator Q4161 (Figure 4). This standby voltage source (+23.9V) supplies voltage to the horizontal driver transformer for startup.

The regulated 12V source powers the IR receiver and keyboard circuits. The on/off switch transistor, Q4162, is supplied by the 12V source. Regulator Q4160 supplies a 5V source to processing IC U1001 and system control AIU IC. These circuits are on all the time so that the remote control circuits can operate even when the set is turned off.

When the remote transmitter will not turn on the TV chassis, check the standby voltage circuits. If regulator Q4161 is open, the voltage output of the 12V source will be 0V, while a leaky 12V regulator may have an output voltage that is higher or lower than the output voltage specified in the service manual. If Q4160 is open, the actual voltage of the +5V source will be 0V. If the regulator has current leakage the voltage of the sources may be higher or lower than the specified values.

Notice that the standby regulator transformer isolates the cold ground from the hot grounds. All voltages in the standby circuits are measured with respect to chassis ground.

Problems in the low voltage standby circuits may be caused by open or leaky transistor regulators and leaky zener diodes. If the voltage at the collector of Q4161 is 0V, the cause may be a leaky or shorted diode in the bridge rectifier, or an open circuit in the primary winding of power transformer T4601.

If the screen is black, zener diodes CR4160 and CR4161 may be leaky. If CR4160 becomes open, both the 12V and 5V sources will increase in voltage. Low voltage at the 23.9V source may be caused by an open C4505 (220µF) electrolytic capacitor. If the set will not respond to the remote control the cause may be a defective 12V source.

Horizontal drive and output problems

If the set is in shutdown, you have to determine if it's in chassis shutdown or high-voltage shutdown. To make this determination, disconnect one lead of CR4901 from the circuit. Plug the ac cord into a variable ac line transformer and raise the voltage to 80 or 90Vac, then measure the anode voltage at the picture tube. If this voltage is above 27KV, the problem is most likely high-voltage shutdown. Check and repair components in the horizontal output circuits.

IC U1001 contains the horizontal countdown circuits and produces a drive for the horizontal driver transistor at pin 64. If the drive signal is absent, suspect a defective U1001 or incorrect supply voltage. To further isolate the cause of this problem, measure the voltage on pin 58 of the integrated circuit to see if the 6.8V source voltage is present. If this source is low, or at 0V, check the supply voltage source in the flyback circuits.

The horizontal output circuits must operate in order to generate the 6.8V source that is applied to pin 58 of U1001 (Figure 5). You can check the operation of the IC by using a bench power supply.

Disconnect the TV's power cord and apply 6.8V at pin 58 from an external power supply. Now check for a square drive waveform at pin 64. If this signal is

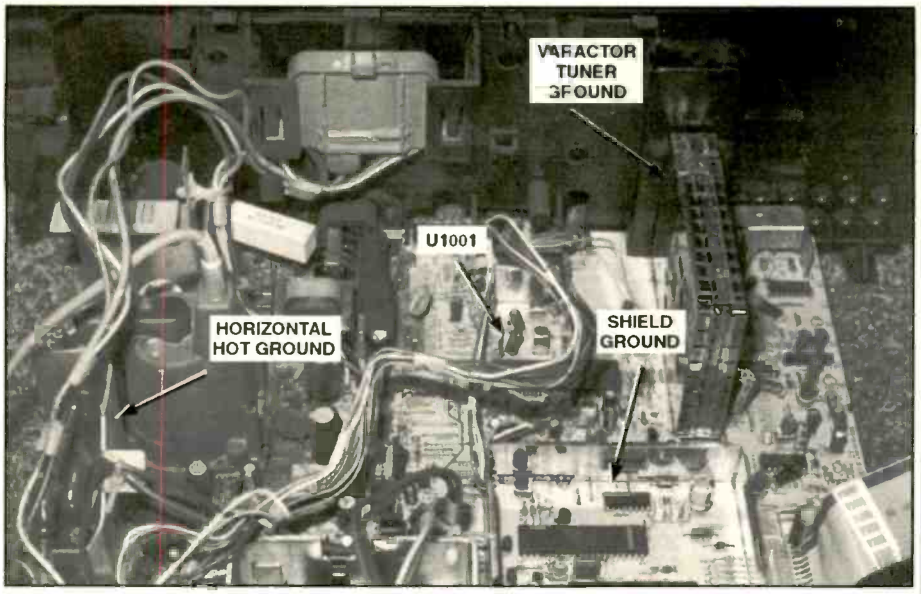

Figure 7. The case of the varactor tuner or the shielded area makes a good place to connect to for a cold ground. The horizontal output heat sink makes a good hot ground connection point.

present, you know that the countdown IC, U1001, is functioning.

If you do not observe a square wave at pin 64, the problem might be a bad IC, or it also might be a problem in one of the circuits connected to the IC. Measure the voltages at all pins of U1001, and check the countdown frequency (503KHz) at pin 62 before replacing this IC.

The output drive signal of U1001 is applied to the base of buffer transistor Q4302. This transistor is in the circuit to reduce current demand upon U1001. A buffer transistor between countdown IC and driver transistor is not found on most TV chassis. The drive output of the buffer transistor is coupled to the base of the horizontal driver.

The supply voltage for Q4301 is obtained from a scan-derived 26V source of the flyback (Figure 6). A 23.9V startup voltage is applied to the driver transistor from the standby power supply. This voltage is applied even when the set is off.

To determine if the horizontal driver circuit is operating, use an external power supply to apply 6.8V at pin 58 of U1001 and 26V at the cathode terminal of run diode (CR4707) tied into the driver transformer winding. Now connect the oscilloscope to the output pin 64 of U1001, and to the base and collector terminals of

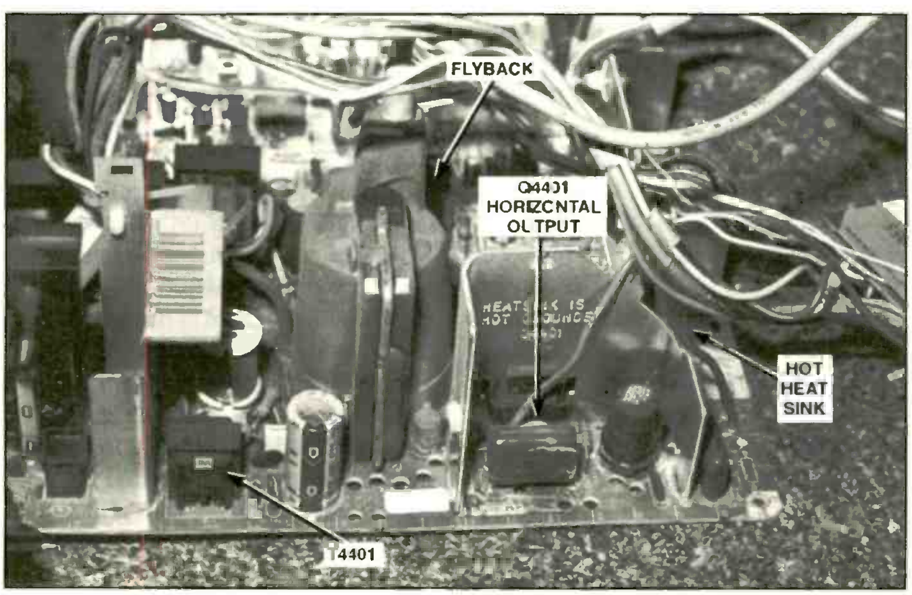

Figure 8. Q4401 is mounted on a separate heat sink with the hot heat sink as ground.

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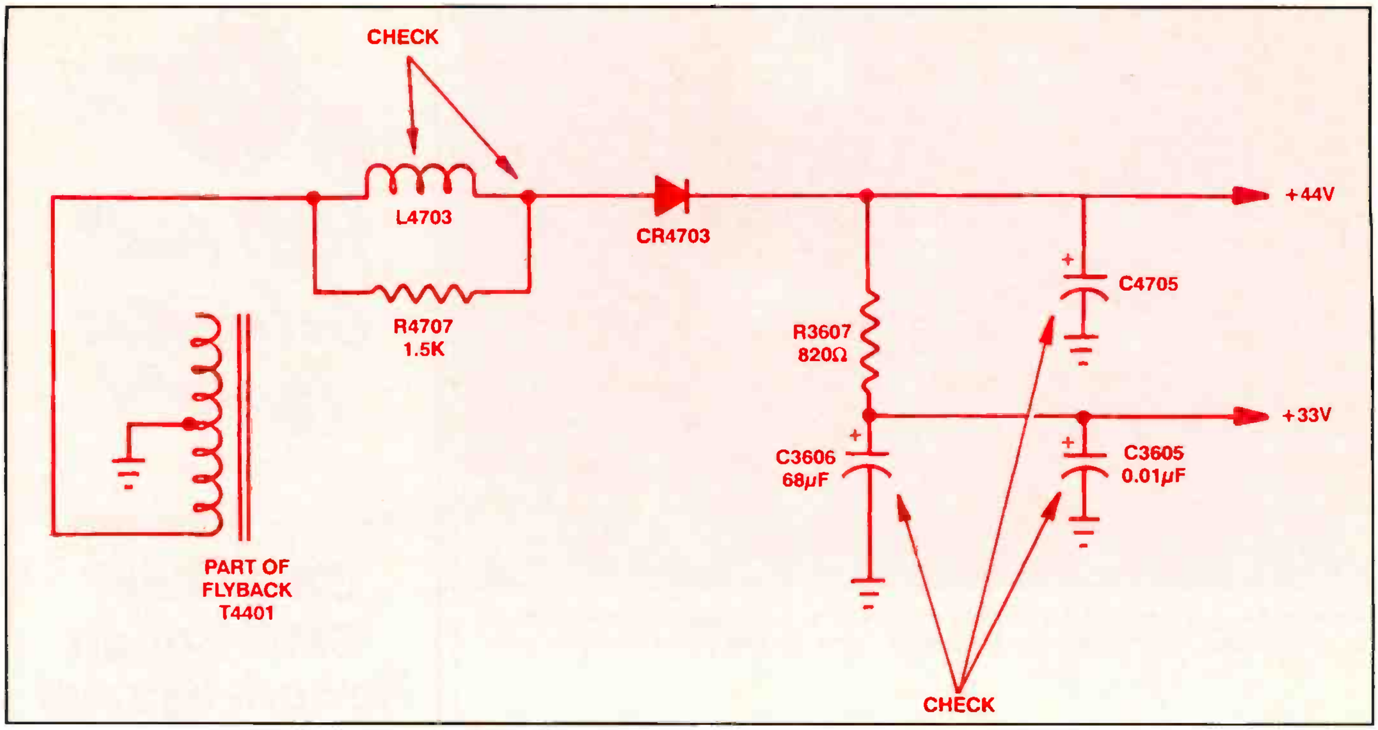

Figure 9. If the outputs of the +44 and +33V sources are not correct, check for poor connections at L4703, leaky CR4703 and shorted or leaky C4705, C3606 and C3605.

horizontal driver Q4301, in turn, to determine if a drive waveform is present. Most problems in the driver circuits are caused by a defective Q4301, R4305, or poor soldered terminals of T4301.

The horizontal driver transformer (T4301) couples the drive signal to the base of the horizontal output transistor (Q4401). Notice that T4301 provides isolation between the hot and cold ground circuits in the drive and output circuits. Measure voltages and observe waveforms at all leads of the output transistor with the common ground lead attached to the hot ground (Figure 7). If you don't make measurements this way, voltages and waveforms may be different than those upon the schematic.

If there is no picture, or raster, suspect horizontal output transistor (Q4401) and no drive voltage. The damper diode is constructed inside Q4401, so replace this transistor with the manufacturer's exact replacement, RCA part number 190483. The output transistor voltage supply is taken from the +129V source supplied by regulator SCR4101.

If the problem is intermittent turn on, or off and on operation of the set, or chassis shutdown, in addition to checking Q4401, resolder terminals 11 and 12 of the flyback transformer, T4401 (Figure 8). Observe the waveform at the base of Q4401 to determine if horizontal circuits are operating to this point.

Scan-derived voltages

A number of different voltage sources are derived from the flyback transformer windings. A defective silicon rectifier, transistor regulator, zener diode, or filter capacitor can cause improper voltage in the flyback sources.

If the 6.8V source voltage that supplies the horizontal countdown IC, U1001, is absent, look for a defective diode CR-4162, Q1402 on/off switch transistor, or CR4164 zener diode. A 33V source tapped off the 44V source feeds the band switching circuits (U3600). If there are problems in this circuitry, it may not be possible to switch tuning bands, or tune in stations.

If there are tuning problems, check the supply voltage on pin 10 of U3600 to see if this voltage is low, or 0V. Go directly to the +33V source in the scan-derived circuits and check to see if L4703 is open, or if CR4703 has leakage. Low voltage can be caused by open C4705 or C3606. A shorted C3606 or C3605 can impair tuner operation (Figure 9).

Vertical sweep problems

The vertical circuits in this set are quite different from the vertical drive and output circuits in most TV sets. Ordinarily the countdown drive IC is coupled directly to a vertical output IC. Here the CTC processing IC U1001, vertical reset transistor (Q4503), sawtooth generator (Q4501), and error amplifier (Q4502) are found before the vertical output IC U4501. Q4503 and U1001 provide a reset pulse that begins the vertical retrace. Q4501 discharges the sawtooth capacitor (C4506) during the retrace interval, while Q4502 amplifies the vertical drive signal.

The vertical drive signal is applied to pin 6 of the vertical output IC (U4501). U4501 contains both top and bottom sweep output devices with a boost switch to increase the peak voltage supplied to the output stage. The output vertical pulse found at pin 4 of U4501 is directly coupled through R4528 to the yoke winding (Figure 10). Resistor R4510 and capacitor C4507 connect the vertical return circuit to common ground.

When the problem in one of these sets involves the vertical circuits, check the vertical circuits by observing waveforms and measuring voltages at all leads of the output IC and transistors. Observe the output waveform at pin 4 and the input waveform at pin 6 of U4501. Go directly to pin 55 of countdown IC (U1001) and observe a drive waveform.

If this waveform is absent, suspect a

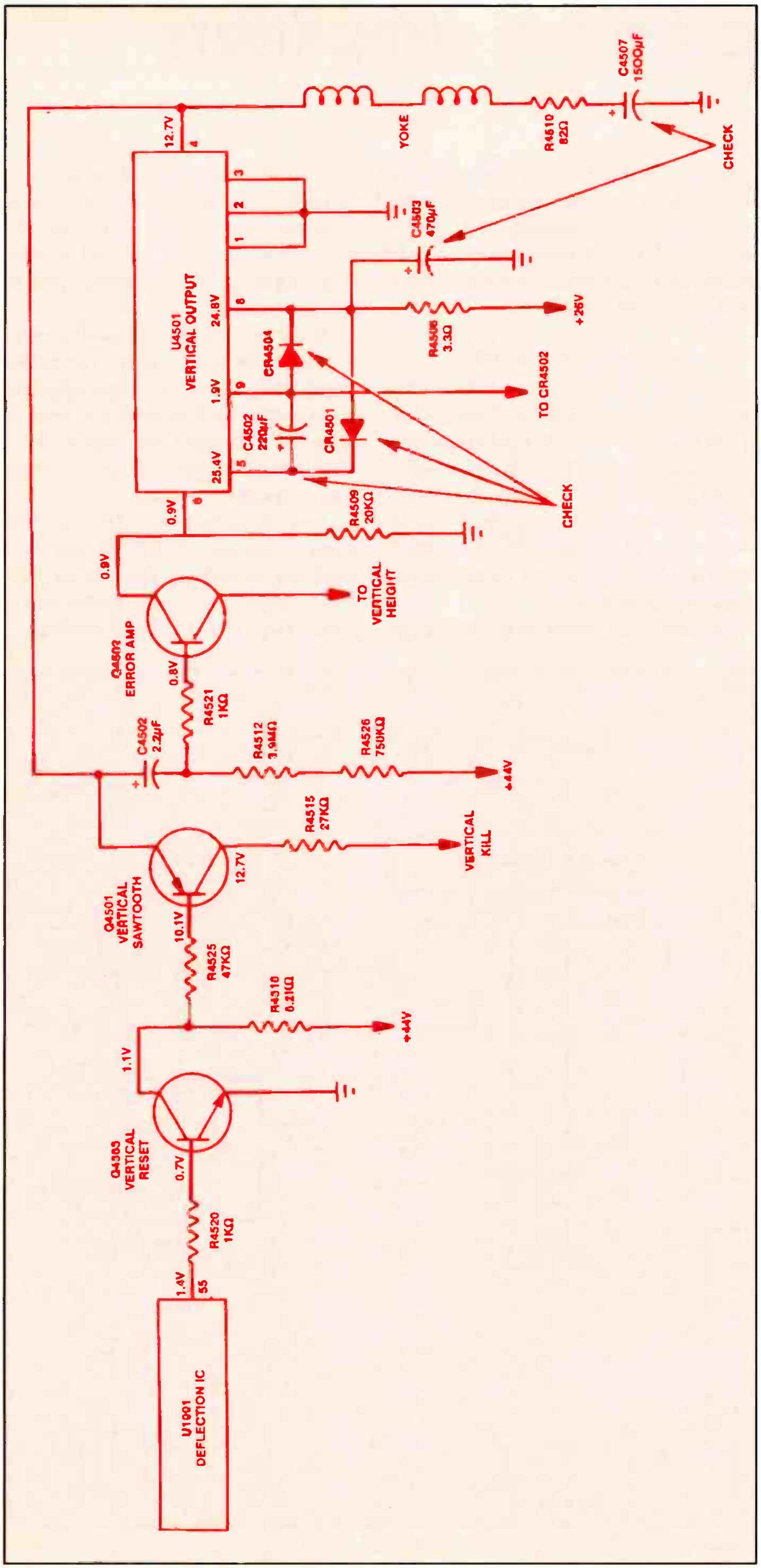

Figure 10. The vertical drive and output IC has an unusual vertical reset, sawtooth, and error amp transistor between the output IC drive circuit and the output circuit.

defective U1001, improper supply voltage, or corresponding circuits. Check the waveform at the emitter of Q4501 and collector terminal of Q4502. Check each transistor in the circuit for leakage or open conditions. Measure voltage on each transistor. Remember Q4503 and Q4501 are directly coupled and the voltage will change on each transistor when one is found open or leaky.

If the waveform at input terminal 6 of U4501 is a fairly normal 1.1 V_{PP} but there is no output waveform at pin 4, suspect a defect in U4501, an improper voltage source or terminal connected components. If the dc voltages on pins 6 and 4 are high, suspect a leaky U4501. When the voltage on pin 4 is near 0V and the voltage on pin 5 is high, replace U4501, it's probably leaky. Before replacing U4501, however, check each component tied to every terminal.

If the screen shows only a horizontal white line, or if the vertical is intermittent, suspect U4501. Replace U4501 with original part number 176853 or an SK-9753 universal replacement.

If the picture is collapsed, or if the vertical is intermittent vertical, or if the vertical sweep is poor, replace C4502. Check CR4504 for insufficient vertical sweep, poor soldered connections for intermittent sweep, and a leaky CR4504 for vertical foldover.

C4507 can cause insufficient vertical sweep and foldover. Check the vertical feedback capacitors and bias circuits for poor vertical linearity and foldover. Especially, shunt electrolytic capacitors C4502, C4503 and C4505 in turn with known good capacitors. Clip the replacement capacitor across each suspected capacitor in turn with the power off.

Vertical kill problems

Another possible cause of vertical problems in the CTC157 chassis is the vertical kill output circuit of the control U3100. When the voltage at the vertical output IC (U4501) is less than 2V, check the dc voltage at pin 5 of U3100 (5.1V). If U3100 or vertical kill transistor is leaky the vertical output sweep can be shutdown at U4501. ■

Testing audio power amplifiers

By Jurgen Ewert

Big stereo systems are not the only consumer electronics products that contain audio power amplifiers. All home entertainment equipment that puts out sound uses audio power amps. These amplifiers nowadays are usually built with integrated circuits with little surrounding circuitry. But there are still many pieces of equipment in use with amplifiers that are built with discrete components. Even tubes are used in some special audio power amps.

Most of these amplifiers work basically the same way and troubleshooting them is similar. To find out what is wrong with the amplifier, a good approach is to test the unit for the basic specifications first. Usually the rough testing of an audio amplifier is done by listening to the speaker output. Based on these test results it is easier to make a decision for the repair that is to be performed.

Ewert is an independent consumer electronics servicing technician.

A typical audio amplifier

Figure 1 shows a general block diagram of an audio amplifier. This could be a separate unit or it might be inside of a receiver or a stereo TV. The audio signal is fed into one of the inputs. A selector switch connects the audio signal source to the appropriate input. The volume, balance and tone controls are located in the preamplifier section.

To provide an output for recording, the audio signal is connected to the tape output before it is modified by the volume, balance and tone controls. The preamplifier is a low-noise amplifier and increases the signal level of the input signal to between about 0.7V and 1V.

The driver stage provides enough power to drive the power stage. The power stage is designed to put out enough audio power to drive the loudspeakers. Depending on the application, the maximum output power can range from less than one Watt to hundreds of Watts.

Power amplifiers are often protected against overload, overheating and short circuits on the outputs. The overload protection circuit senses the operation of the power stage and if there is something

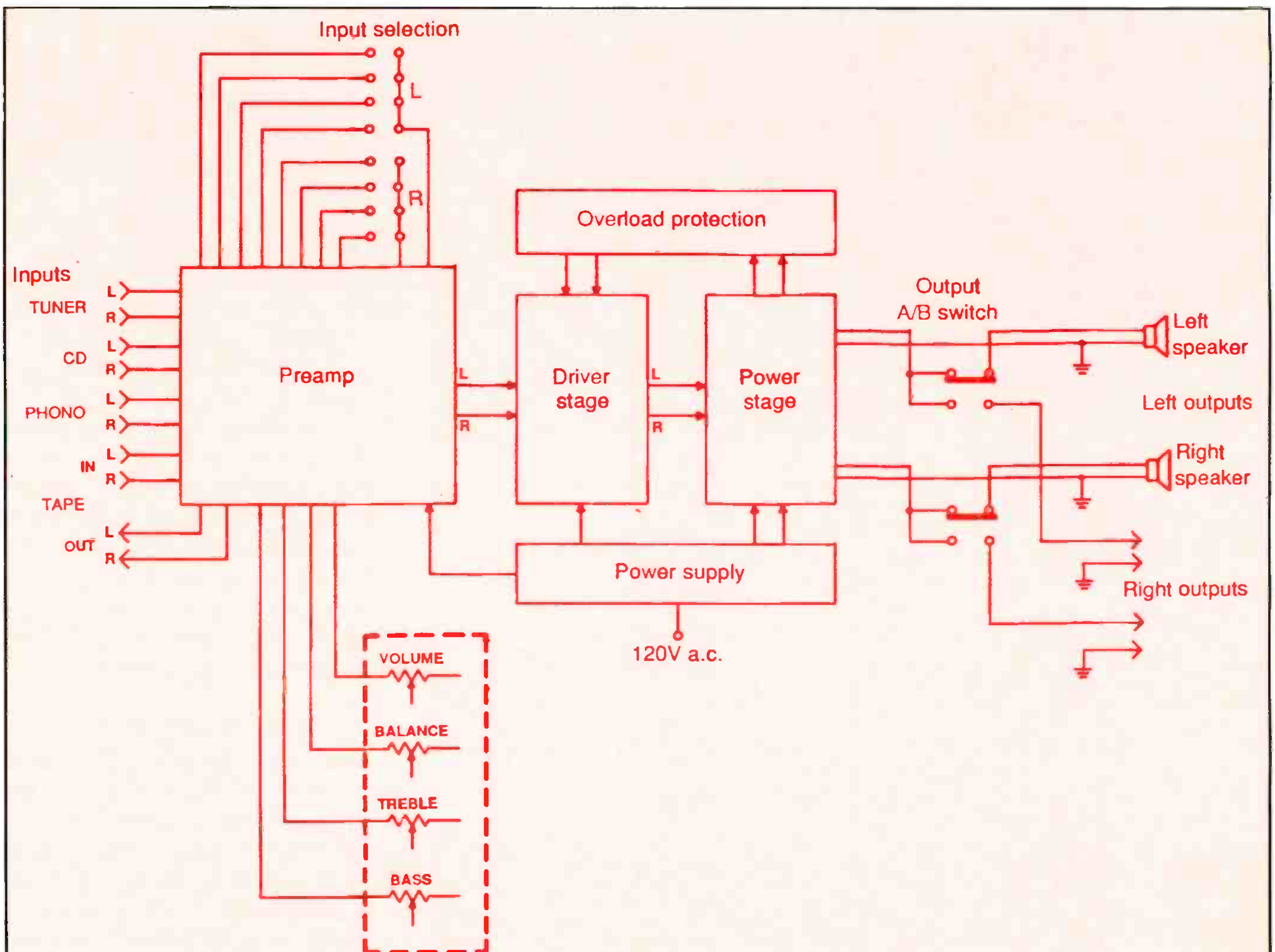

Figure 1. Block diagram of a typical audio stereo amplifier.

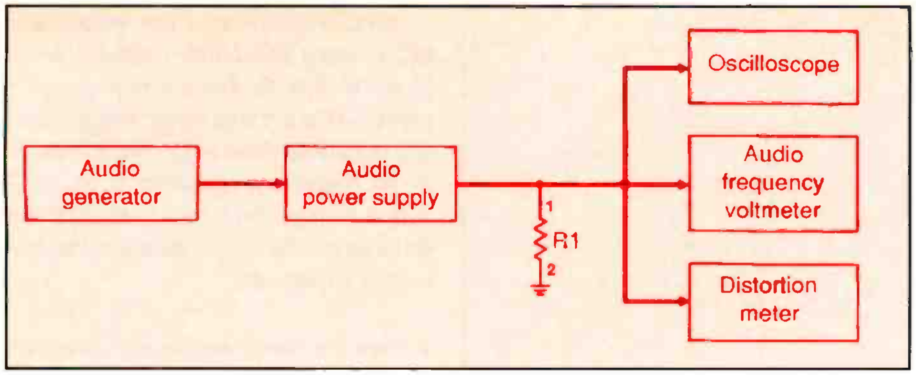

Figure 2. Test circuit for measuring audio power amplifiers.

wrong in these circuits, for example, if the temperature of the power transistors is too high, this circuit shuts off the audio signal at the driver stage.

There are many different protection circuits, and they do not always provide 100% protection for the power stage. Protection for the driver stage, power stage, and overload protection are sometimes incorporated into one IC which simplifies the design of audio amplifiers.

The power supply of an audio amplifier provides the different dc voltages for all stages. For the preamplifier the dc supply voltage is often stabilized and filtered to minimize the remaining hum and noise. The dc voltages for the driver and power stages are usually connected directly to the smoothing capacitors.

Tests on audio power amps

An audio power amplifier provides the power to drive the cone of the loudspeakers in the audio frequency range from 20Hz to 20kHz. The maximum power output of power amplifier ranges from about 0.1W to 200W or more depending on the application. Other important technical data are the signal to noise ratio, the total harmonic distortion (THD), and the frequency response.

Figure 2 shows a test circuit used to measure the electrical data of an audio power amp. The signal source for testing audio amplifiers should be an audio frequency generator with a frequency range of 10Hz to 20kHz. The output voltage of the generator should be adjustable between 0.5mV and 2V and the THD of the output signal should be less than 0.05%.

If a generator is not available, it is possible to make these tests with a CD-Player and a test CD. On some CD-Players you can find an adjustable headphone output that can be used to test the amplifier. If a CD-Player is used, check the player first to make sure the signals are good enough and the output voltages on both the left and right channels are equal. In some cases I prefer using a CD-Player because it plays two channels at once and puts out specific signals that I need anyway for testing the amp. It would not be economical for me to buy two AF-signal generators. Another advantage of a CD-Player as a signal source is that you can perform a quick listening test with any music signal to get a general impression of the performance of the unit.

To evaluate the output signal of the amplifier, an oscilloscope and a load resistor (Rl) with appropriate wattage are necessary. The output voltage at the load resistor is measured with an audio frequency voltmeter.

For accurate testing of THD and signal to noise ratio (S/N ratio), it is important to use a distortion meter. Not every service center can afford such specialized equipment. If a distortion meter is not available, the oscilloscope and the audio voltmeter are used to check for distortion and noise at the output. However this check is not very accurate and cannot be used for checking the specifications of high quality amps.

Power measurement

If your customer complains that the power output of the power amplifier has decreased, you will want to measure the amount of power that the amp puts out. Before you start these power measurements, check a few things first. It is possible that the power output capability of the power amplifier is fine but the gain is less than normal.

Audio amplifier specifications include the sensitivity in [mV] for 1-Watt of output power (e.g. 200mV). For example, an input voltage of 200mV (sine wave) creates one Watt at the speaker output.

Usually only one of the channels, either the right or the left channel, has decreased in power or sensitivity. If the power is in fact low, you will see that the output signal starts clipping at relatively low output power. You can hear very high distortion at a relatively low sound level if you play some music. The problem is a reduction in sensitivity (less gain) if the problem is that you need a high input signal to get the nominal output power.

If one or both channels are completely dead, check the power voltage and the fuses in the power supply and at the speaker outputs. If the sensitivity is bad, check the settings of all controls first. Variations in gain can occur in almost any part of an amplifier. The best approach is to inject a signal starting at the power or driver stage, then proceed backwards stage by stage until you find the point at which the problem exists.

To measure the maximum output power, set the frequency of the generator to 1kHz and increase the input voltage starting from a very low value until the amplifier starts to clip the positive and the negative peak of the sine wave at the output. The sine wave is shown in Figure 3. A good amplifier should clip positive (+Vc) and negative (–Vc) peak symmetrically. If you measure the RMS output voltage, the power at the load resistor is:

$$P_{out}\,[\mathrm{Watt}] = \frac{V_{out}\,[\mathrm{V\ rms}]}{R_{load}\,[\Omega]}$$

Most AF voltmeters are calibrated to show the RMS value of a sine wave, but they really measure the peak value (i.e. the measurement is only accurate if the voltage is a sine wave). To measure the RMS output voltage of the amplifier, a regular multimeter is good enough to perform this test, but check the specs of your meter to make sure it is rated for the audio frequency range.

If you want to measure the output power with an oscilloscope you will measure the peak to peak voltage (V_{pp}) of the signal. Using this method, the output power (P_{out}) is:

$$P_{out}\,[\mathrm{Watt}] = \frac{(0.125 \times V_{pp})\,[\mathrm{V}]}{R_{load}\,[\Omega]}$$

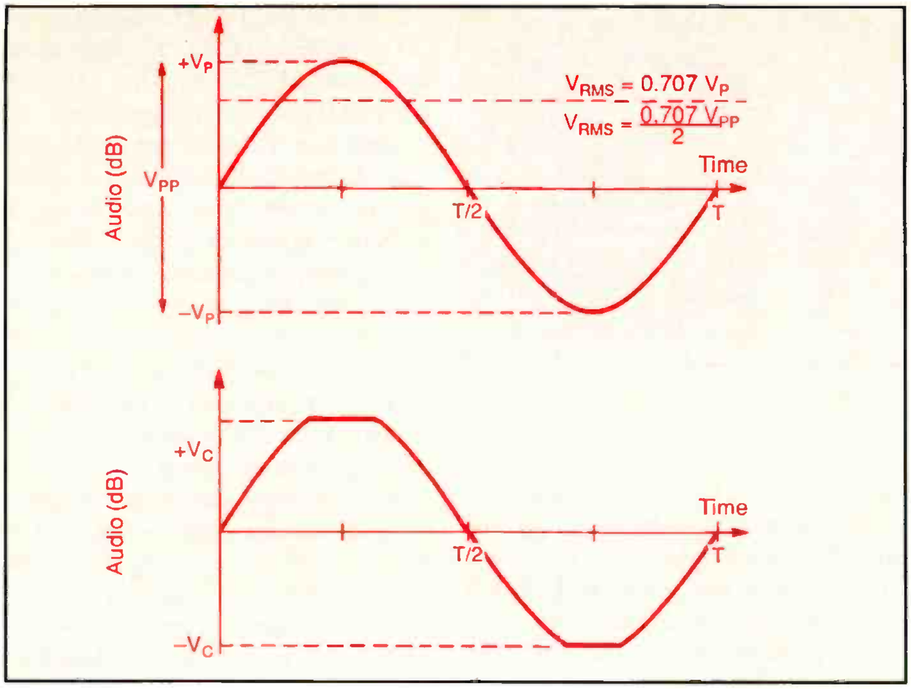

Figure 3. To measure the maximum output power, set the frequency of the generator to 1kHz and increase the input voltage starting from a very low value until the amplifier starts to clip the positive and the negative peak of the sine wave at the output. A good amplifier should start to clip the positive (+Vc) and negative (–Vc) peaks symmetrically.

The advantage of measuring the output voltage with an oscilloscope is that you can see when the signal starts clipping. Measurements with the oscilloscope are usually not very accurate, however.

Frequency response

You will hear a difference in sound if one of the stereo channels has a different frequency response than the other. The trouble spot can be anywhere in the signal path. Concentrate on coupling capacitors. I have found that electrolytic capacitors are the most likely troublemakers if the frequency response is bad. If it is possible, inject the signal into the power amplifier, bypassing the preamplifier and tone control. If the frequency response is still not right, the fault is located in the power amplifier.

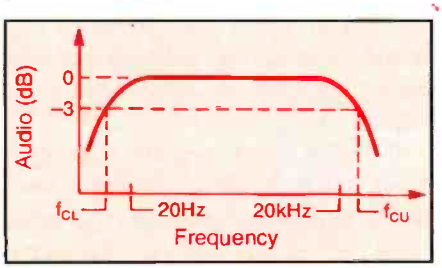

Figure 4. The frequency response of a good audio power amplifier should be flat from 20Hz to 20 kHz. The difference of the output voltage should not exceed 1dB across the entire audio frequency range.

For troubleshooting a bad frequency response you can use a square wave of approximately 400Hz at the input, and an oscilloscope. The shape of the signal at the output reflects the frequency response. This method is fast and accurate enough. After the problem is corrected, you should measure the frequency response with sine wave signals to confirm that the frequency responses of both channels are within specification.

To check the frequency response, set the generator frequency to 1000Hz and the output signal to a value far below the maximum output power (e.g. 100mW). If you want to test the frequency linearity of the amp, set the tone control or the equalizer to linear, turn off all filters and set the loudness switch to off.

The value of the output voltage at 1000Hz is the reference value. Set the volume so that the needle of the meter points to 0dB on the scale.

Switch the generator frequency to various frequencies between 20Hz and 20-kHz and note the difference of the output voltage in dB from the 1000Hz reference. The frequency response of a good audio power amplifier should be flat from 20Hz to 20kHz (Figure 4). The difference of the output voltage should not exceed 1dB across the entire audio frequency range.

More sophisticated test laboratories use a sweep generator combined with a plotter to draw the frequency response on paper but the average repair shop can usually not afford these high-tech setups. An audio frequency generator with stable output voltage and an AF voltmeter with dB scale can do the job quite well and are far less expensive.

Testing the tone controls and equalizer

If your customer told you that the amplifier does not sound right and he noticed different sound at the speakers, there might be something wrong with the tone control, but there is also a good chance that one of the speakers is bad. So before you start troubleshooting the amp, hook it up to your test speakers and listen to your favorite music. If it still doesn't sound right, check all of the controls, especially the equalizer if there is one. Try all the inputs and see if the sound is different using a different input. If only one input sounds odd, the trouble spot might be located in the preamp.

To test the tone controls, equalizer and filters you need to know the specifications of these circuits. For the test of the tone controls it is usually good enough to measure the frequency response at the maximum and minimum settings of the bass and treble control. Make sure that the signal level is well below clipping of the output signal. The balance control should be in the center position and high and low filters should be switched off. Figure 5 shows the frequency response of an audio amplifier with the tone controls set to maximum and minimum respectively. In a stereo amplifier both channels should have equal characteristics (less than +/-1dB difference at each test frequency).

An equalizer is a tone control circuit that is capable of controlling the gain of small portions of the audio frequency band separately. In contrast with a simple tone control, the equalizer usually controls left and right stereo channels separately. Therefore you need to set both channels to equal positions to be able to compare the frequency response.

THD and signal to noise ratio measurement

If the audio sounds "scratchy," the THD (of the output signal is probably high. Common causes for high distortion

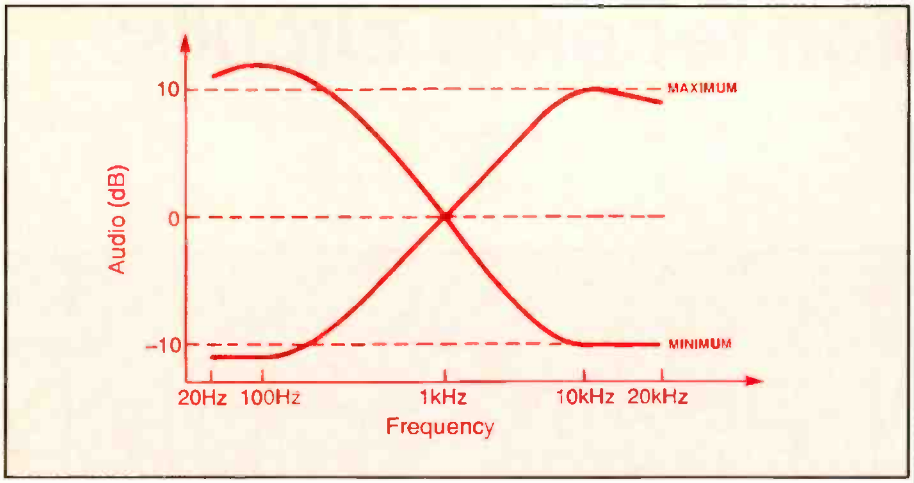

Figure 5. This is the way the frequency response of an audio amplifier will look with the tone controls set to maximum and minimum respectively. In a stereo amplifier both channels should have equal characteristics (less than ±1dB difference at each test frequency).

are overloading of an amplifier stage or nonlinear characteristics of active components. The source for distortion can be anywhere in the signal path. Use your test speakers to eliminate the speakers as the cause for distortion. Avoid any overloading of the input by setting the volume and tone controls to appropriate levels. To troubleshoot the amp, check the sine wave signal for distortion at the output of every stage with an oscilloscope.

The average service center will use the oscilloscope to find the source of excessive noise. The first test is to listen to the speakers to find out if one or both of the channels are noisy . If the noise is present on both channels, check the power voltage at the preamp with an oscilloscope for noise. In most cases you will find excessive noise on only one channel. Usually the source for the noise is an active component in the signal path of the preamp.

A service center that specializes in audio repair should have a THD meter to be able to check equipment to see if it is operating to its specifications. The THD meter and the signal-to-noise meter (S/N-meter) are often the same instrument. If you use a THD meter use an input signal with low distortion to get precise results.

The signal-to-noise ratio is simply the ratio of the output voltage at nominal level to the output noise level which is superimposed on the output signal. This ratio is measured in decibels (dB). You can measure the signal voltage with the voltmeter at nominal power output or at 1-Watt output (depending on the specification of the amp) and the noise level on the output with no input signal to check the S/N ratio roughly. To calculate the S/N ratio use the following formula.

$$S/N\ [dB] = 20 \times \log \frac{V_{signal}\ [mV]}{V_{noise}\ [mV]}$$

The THD is the ratio of the RMS value of all harmonics to the RMS value of the signal voltage plus all harmonics in percent.

$$THD\ [\%] = \frac{V_{harmonics}\ RMS}{V_{signal}\ RMS + V_{harmonics}\ RMS} \times 100$$

THD and S/N meters measure the values "weighted." That means that a built-in filter simulates the frequency response of the human ear.

In cases where the distortion is very high it is possible to make a judgment by watching the output signal on the oscilloscope screen.

Hum and noise at the output of an amplifier can be measured with a S/N meter. For the audio repair shop that works on high quality audio equipment, a S/N meter is necessary to detect noise that is, for example, 90dB below the signal level. Often THD and noise are combined in one value for distortion (THD+N).

The test and troubleshooting procedures described in this article will perhaps help you to make your next audio repair a little easier. A future article will provide more specific suggestions about troubleshooting the power stages in audio amps.

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Color television receiver circuits: Part 2

By Lamarr W. Ritchie

Part 1 of this article provided an overview of the circuits in a color TV receiver, including definitions of the operation of the major stages (Figure 1). This second part of the article will detail the operation of the video IF amps, the video amps, the sync circuits and the AGC circuits.

RF tuners

The VHF tuner contains, at a minimum, an RF amplifier, local oscillator, and mixer stages. The local oscillator operates at a frequency that is 45.75Mhz above the visual carrier frequency. This produces video IF frequencies of:

- Picture 45.75Mhz
- Sound 41.25Mhz

Notice that in the video IF passband, the picture carrier is 4.5Mhz above the sound carrier. This arrangement is opposite to the way the carriers are oriented for the original RF signal.

To receive an acceptable, snow-free picture, the S/N (signal to noise) ratio at the tuner input should be at least 30:1. This normally requires about 500μV of signal strength in the VHF band.

Signal strength is also measured in dBm (dB relative to 1mV). Often dBm is shortened to dB for conversational purposes; therefore 0dB = 1000μV of signal. To maintain a good quality picture, the signal level usually must be above 0dB. The output of a typical VCR or computer/game modulator is about 6dB (2000μV).

Most older tuners had wavetraps for the FM radio band (88MHz to 108MHz) but newer "cable ready" receivers do not because these frequencies are used for cable-only channels.

Tuner inputs

Tuners have 300Ω balanced inputs, using two terminal connectors, and/or a

Ritchie is an electronics instructor at Kentucky Tech, Hazard Campus.

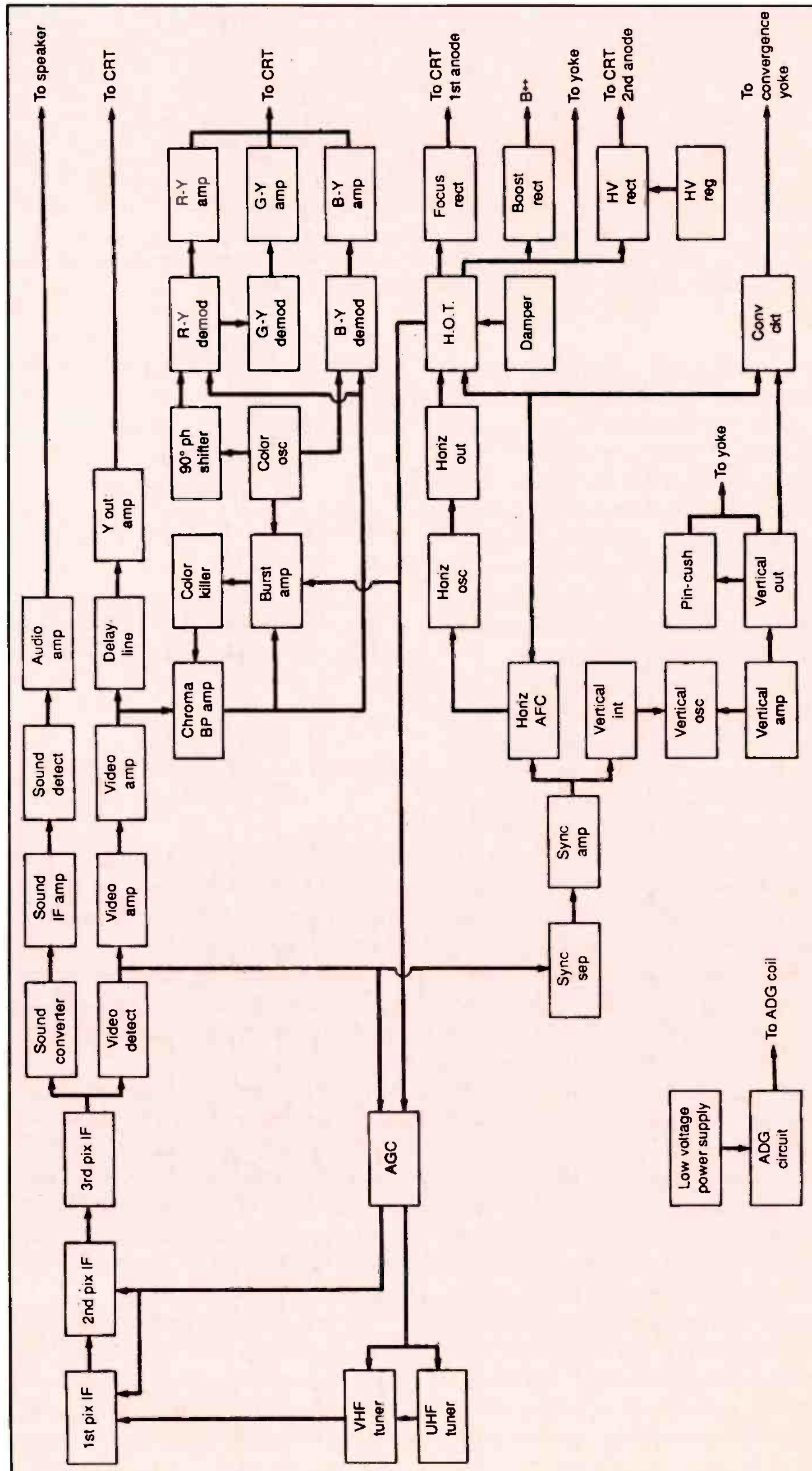

Figure 1. The circuitry of most modern television receivers is similar to that shown in this block diagram. →

75Ω "F" type cable connector. The 300Ω balanced type of input is primarily for antenna connections for the reception of local television signals.

The balanced connections provide minimum pickup on the lead-in wires of signals that would cause ghosts and interference, and 300Ω is the most common impedance for TV antennas. For long distances, however, 75Ω coax cable is preferred, and many modern receivers have only this type of connection.

For changing the connection from one type of lead-in wire to the other, a BALUN (balanced to unbalanced) transformer is used, having an "F" type cable connector on one end and two terminal connectors on the other.

Each time the received channel is changed, at least four circuits in the tuner must be changed in frequency. The antenna input tuning, RF output amp tuning, mixer input tuning and local oscillator frequency. To accomplish this, older tuners usually used one of two mechanical arrangements to change the coils for the circuits for each channel.

Mechanical tuners

The "turret type" tuner used long rectangular turrets, each of which contained all of the coils needed to tune a particular channel. These were arranged like the old Gattling gun. As the channel was changed, a turret moved around until it was in position against a set of contacts for each coil. Usually, the local oscillator coil was in front and had a gear-driven core, driven externally by a knob to adjust the fine tuning for each channel.

The other popular type of mechanical tuner was the "wafer type". This one used stacked/ganged wafer switches to change the coils. The biggest problem with these tuners was that the contacts would become dirty and/or worn, requiring frequent cleaning or adjusting.

Varactor-diode tuners

Modern tuners use varactor diodes to accomplish this tuning. The use of varactor diodes allows the circuits to be tuned using only a dc control voltage. In this type of tuner, switches connected to different voltage dividers can be used to change channels, or the voltages can be generated digitally using a D/A (digital-analog) converter.

In order to receive a broad enough bandwidth, the tuner's passband extends a little into adjacent channels. The video IF circuits are provided with traps to eliminate the unwanted frequencies. A typical tuner frequency response for channel 2 is as shown in Figure 2.

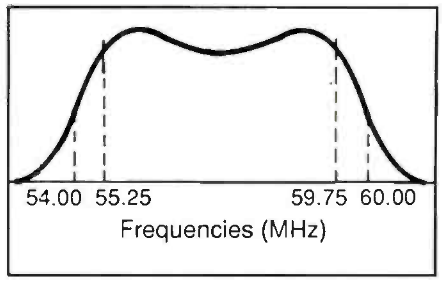

Figure 2. A typical tuner frequency response for channel 2.

Tuners in color receivers always have an AFT (automatic fine tuning) circuit because the tuning must be exact; high enough to receive the color sidebands but not too high as to cause interference from the audio carrier. Figure 3 shows a possible tuning arrangement for the VHF electronic tuner, using switches to select channels and pots for fine tuning.

A varactor diode does not have enough tuning range to enable tuning through the full VHF band with a single coil. Switching diodes are used when tuning from low band to high band VHF that "short out" some of the coils' turns. Figure 4 shows how the switching diodes connect to the coils in the previous diagram.

When high band channels are selected, the switching diode is forward biased. A forward biased diode has very low resistance, which effectively grounds the tap in the coil. The coil, now with fewer turns, has a lower inductance and resonates with the varicap at the high band VHF frequencies.

The UHF tuner, as shown in Figure 5, is made similarly, but the narrower tuning range (less than a 2:1 ratio between highest and lowest frequencies) makes it possible to tune the entire band without switching diodes.

In the older, mechanically-tuned, UHF tuners, resonant sections of the tuner were used as tuned cavities. Openings in the cavities coupled energy to each section and ganged variable capacitors varied the resonant frequency for each section. Most older UHF tuners were nothing more than three tuned sections (RF tuning, oscillator and mixer out), a transistor

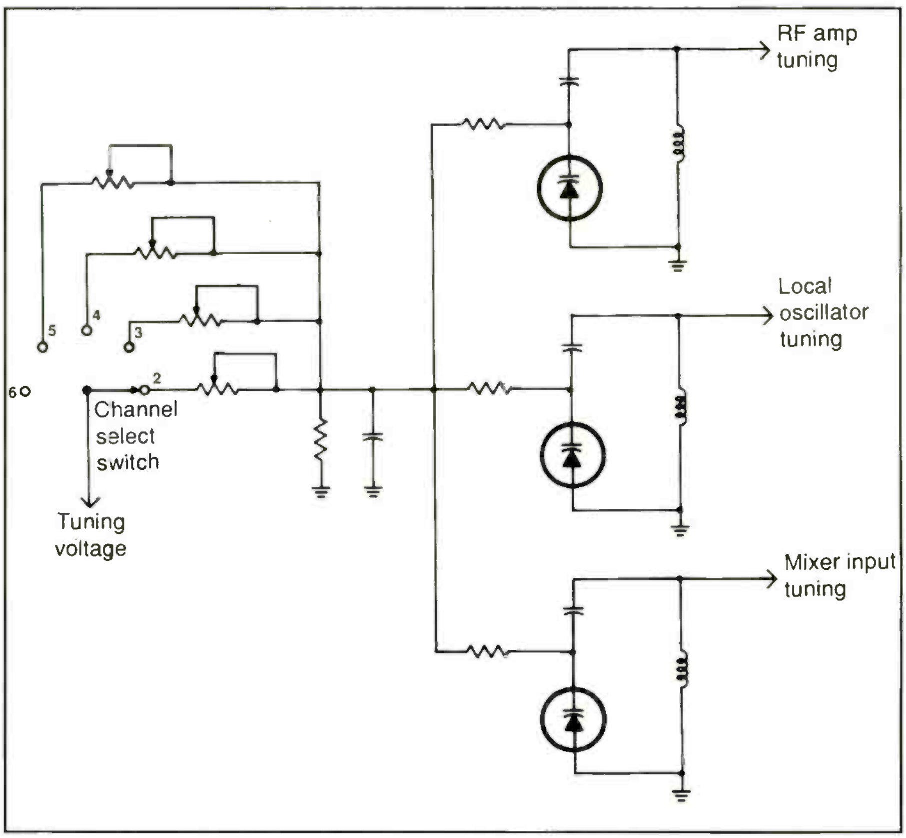

Figure 3. This possible tuning arrangement for the VHF electronic tuner uses switches to select channels and pots for fine tuning.

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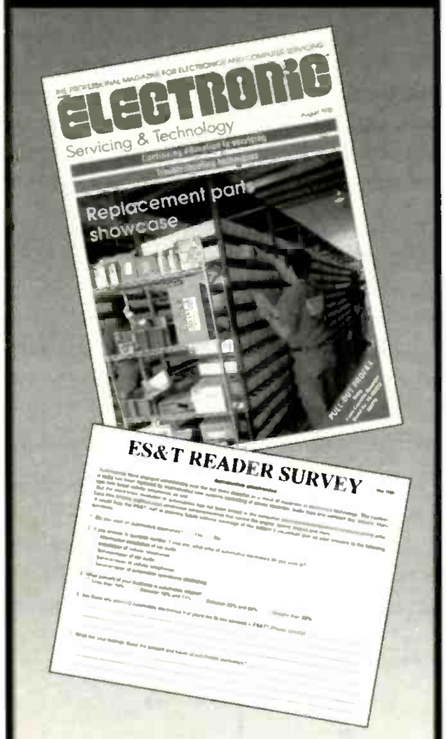

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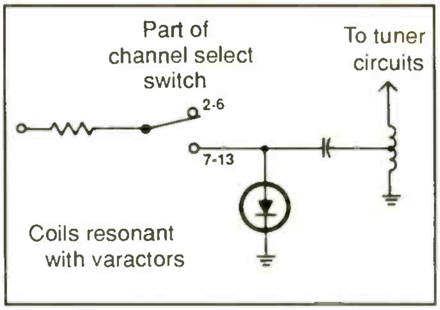

Figure 4. The switching diodes shown in Figure 3 connect to the coils as shown here.

local oscillator and a hot-carrier diode for the mixer. When UHF was selected, the VHF tuner's mixer and, in some receivers, the RF amp became extra IF amps to boost the gain because there was no amplification in the UHF tuner.

In tuners manufactured today, a single unit tunes both VHF and UHF. Most can also tune to the extra VHF cable channels. These tuners are compact and have no moving parts.

Tuner terminals

The modern tuner usually consists of a small shielded box containing a single circuit board. All tuning and band switching is done with voltages input to the tuner's terminals.

The connections to the tuner will be identified in a way similar to that shown in Figure 6. The VHF INPUT, UHF INPUT and IF OUTPUT are self explanatory. The other connections and voltages in the tuner are:

AGC - This is an analog (varying) voltage from the AGC circuits that controls the gain of the tuner's RF amps.

BH - This is a digital voltage, meaning it is a voltage that will either be there, called "high", or not, called "low". The "high" can be around 5V to 15V, with 12V being common. When this pin is made to go high, high band VHF is selected.

BL - Same as for BH, when this pin is made high, low band VHF is selected.

BU - Digital voltage also, like BH and BL, when this pin is made high, the television set's UHF is selected.

VT - This is an analog voltage, the tuning voltage. This voltage is developed by external circuits, possibly a microprocessor, that determines the frequency the tuner will receive.

B+ - This is the power supply voltage for the tuner, typically 12V.

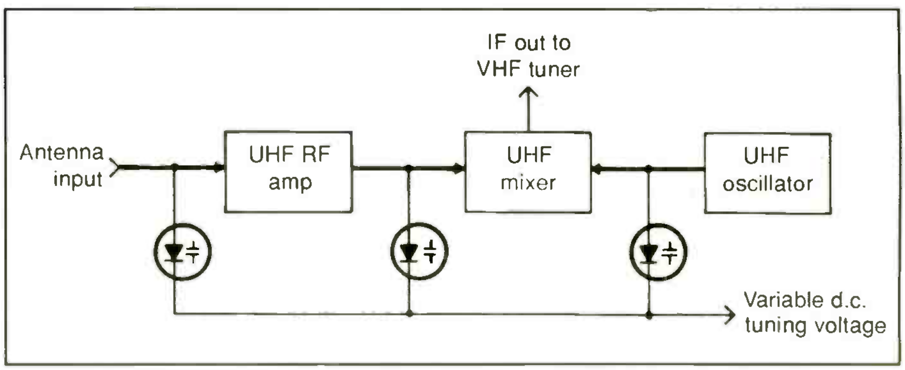

Figure 5. The UHF tuner, as shown here is similar to the VHF tuner, but the narrower tuning range (less than a 2:1 ratio between highest and lowest frequencies) makes it possible to tune the entire band without switching diodes.

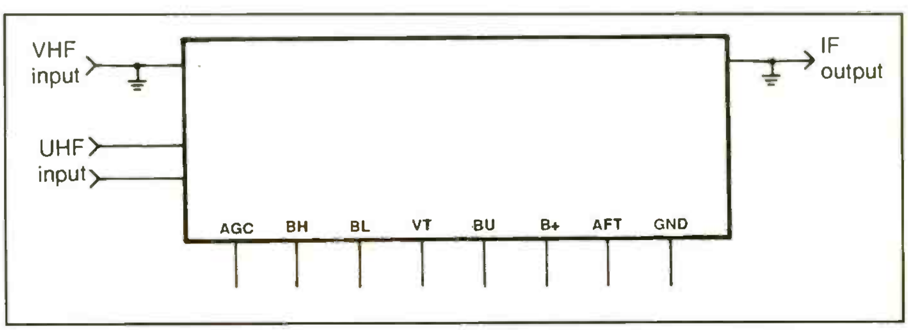

Figure 6. The modern tuner usually consists of a small shielded box containing a single circuit board. All tuning and band switching is done with voltages input to the tuner's terminals. The connections to the tuner will be identified in a way similar to that shown here.

AFT - An analog voltage from an AFT detector or PLL circuit in the video IF stages keeps the tuner "locked in" to the correct channel frequency.

GND - The ground connection.

The AFT circuit may consist of a discriminator tuned to 45.75MHz. If the video IF's picture carrier is at exactly this frequency, no control voltage will be developed. If the oscillator drifts or the fine-tuning is misadjusted, the picture IF will beat to a different frequency and the discriminator will develop an output voltage. This voltage will be fed to the local oscillator's varactor to either add to or subtract from its tuning voltage, depending on the direction of the drift.

In many modern tuners, reference frequencies are generated and digital circuits used along with a phase-locked loop (PLL) to keep the tuner locked in to precisely the correct frequency.

Video IF amps

The Video IF amps are basically small-signal tuned RF amps. In addition to amplifying the video and audio frequencies, these stages must have a wide bandwidth.

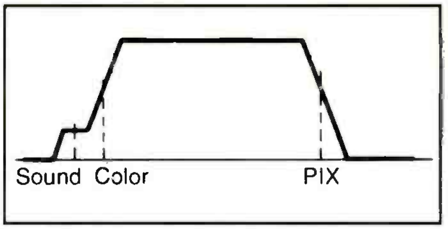

Figure 7. Ideally, the overall response of the video amps should be as shown here.

In addition, these amplifiers contain traps to eliminate the adjacent channel video and sound frequencies.

A trap is also used at the sound frequency of 41.25MHz to reduce the amplitude of the sound carrier to about 10% of that of the picture carrier. This is enough amplitude to demodulate the sound and helps prevent interference with the picture carrier. Ideally, the response of the amps should be as shown in Figure 7.

In actual practice, this response is difficult to obtain. In addition to traps, the video IFs use stagger-tuned stages along with one or more wide band, heavily damped stages. In some, overcoupling may be used in one or more stages to

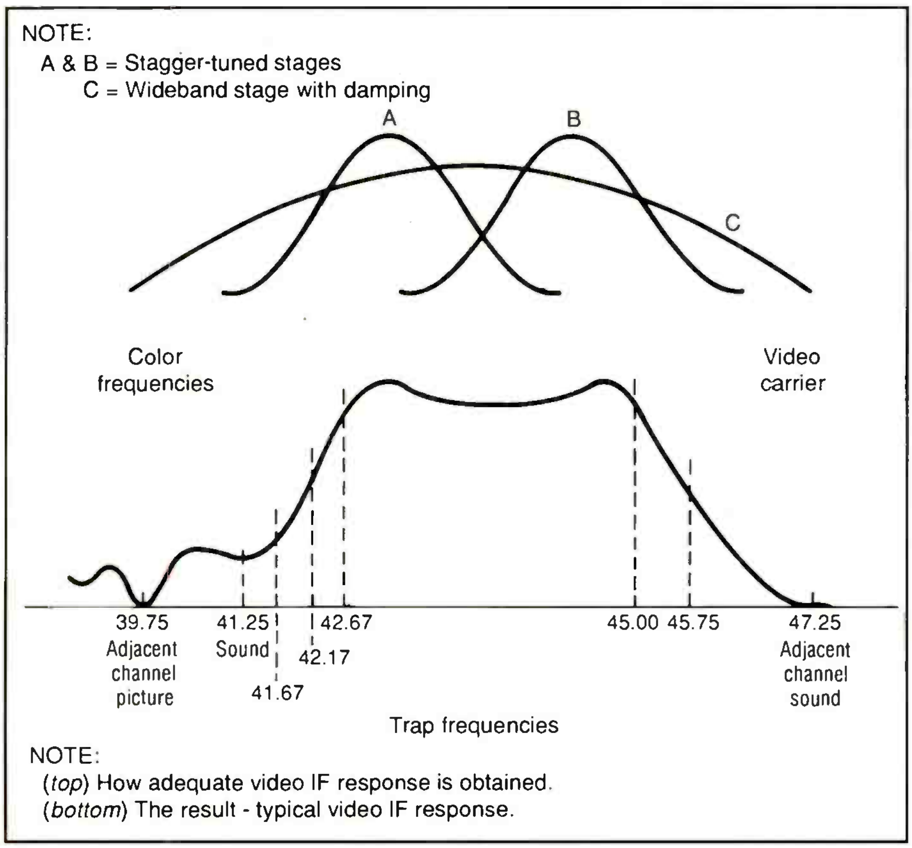

Figure 8. In some video amps, overcoupling may be used in one or more stages to widen the bandwidth, as shown in the upper drawing. The video IF stages would have a typical overall response similar to that shown in the lower drawing.

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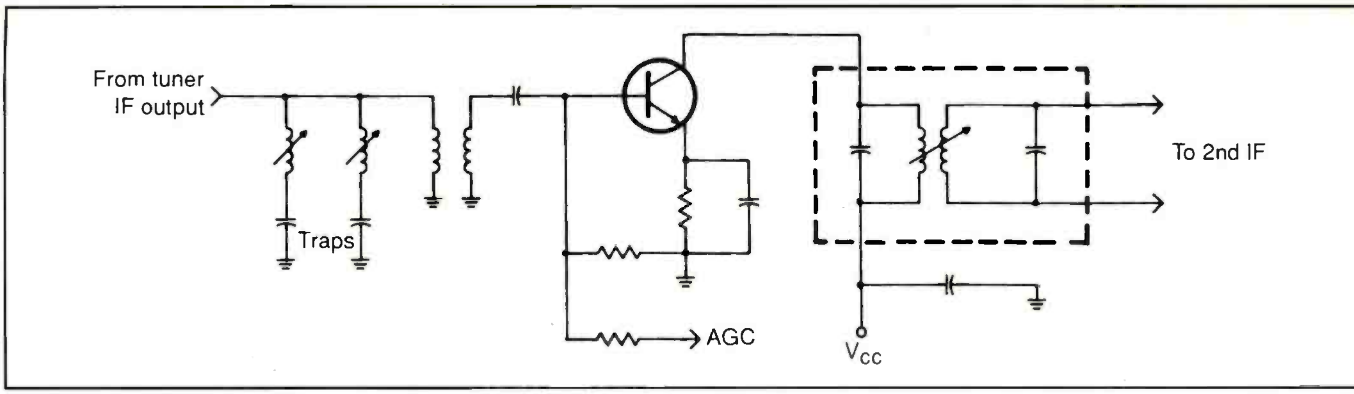

Figure 9. A typical transistor video IF amp stage.

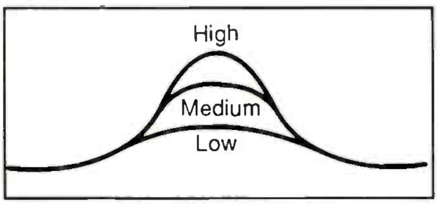

Figure 10. Lowering the gain serves to widen the frequency response of the amplifier.

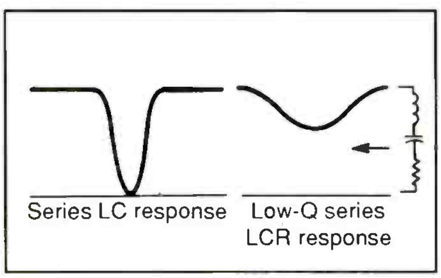

Figure 11. The response of the amplifier can be flattened by adding a low Q series resonant circuit, or series LCR. The one shown here is a "shunt peaking" circuit, so called because it is used in parallel with the output of one of the video amps.

widen the bandwidth, as shown in the upper drawing of Figure 8. The video IF stages would have a typical overall response similar to that shown in the lower drawing of the figure.

All frequencies shown are, of course, in MHz. The dip, or "hump" in the response curve should not fall below 90% of the peak amplitude. The 41.25MHz. point should be at 10% amplitude. A typical transistor video IF amp stage is as shown in Figure 9. Many modern receivers have the video IF stages within integrated circuits, but will still have external tuned circuits and traps.

Video amplifiers

Video amplifiers are basically high quality wideband amplifiers. Video amplifiers must have approximately a 4MHz bandwidth. They must also have the proper phase output, and must not introduce phase distortion or "lag".

If the signal passes through an RC network, lower video frequencies will exhibit more phase shift than the higher frequencies because of the greater reactance. This amounts to a small difference in time between input and output.

Since it takes only 63.5µsec to scan one horizontal line, a small amount of lag can cause a problem, causing objects in the picture to be displaced to the right. This can produce a "smear." Where possible, direct-coupled video amps are used to eliminate the reactive phase lag.

To obtain the proper bandwidth, several things may be done. The video amps may use lower values of load resistances to produce an overall wider bandwidth. Since gain is proportional to the load resistance and the gain-bandwidth product of an amplifier is a constant, lowering the gain serves to widen the frequency response of the amplifier. The drawing in Figure 10 illustrates this.

Obtaining a "flat" response

The response will still taper off on the upper and lower ends of the band. If we had a load resistance that had a higher impedance on the upper and lower ends and lower impedance in the middle of the curve, we could get a gain compensating curve to flatten the response. This can be accomplished with a low Q series resonant circuit, or series LCR.

This circuit, shown in Figure 11, is called shunt peaking because the circuit is used in parallel with the output of one of the video amps.

Series peaking circuits are also used. This type improves only the high frequency response. Series peaking uses an inductor to resonate with the input capacitance of a video amp stage. If the resonant frequency is chosen above the video pass-

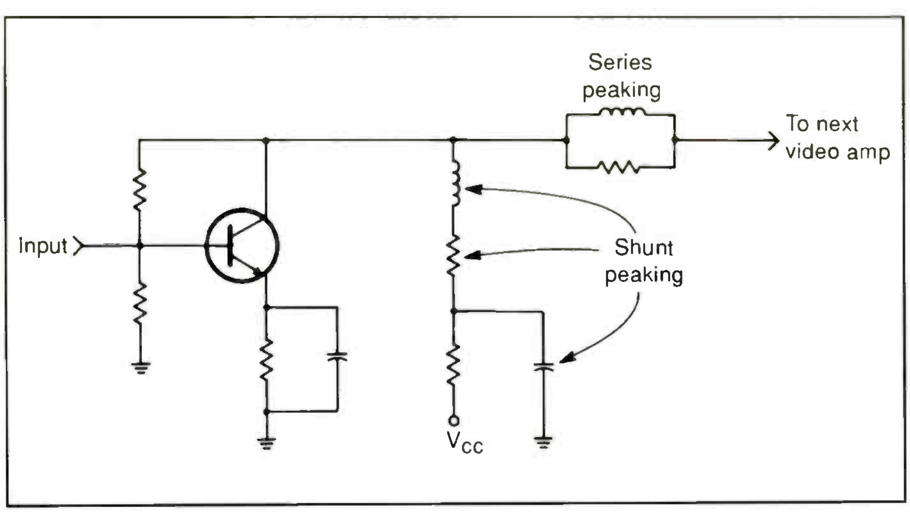

Figure 12. The peaking circuits in video amps are not normally adjustable, but some receivers have a variable resistor in the peaking circuit called a sharpness control. This is an example of a video amplifier employing both series and shunt peaking.

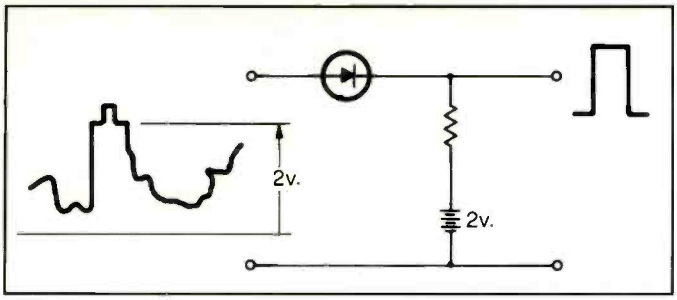

Figure 13. This is the basic operation of the sync separator.

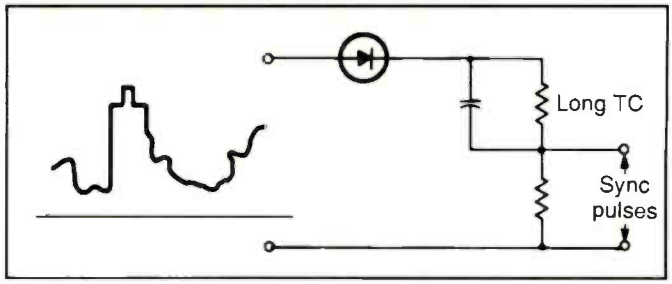

Figure 14. The sync circuit can be modified so that the bias voltage for the diode varies with the peak level of the video as shown.

band, a rising response will be observed at the upper frequencies as this frequency is approached. To prevent a sharp rise from occurring, swamping resistors are often used across the coil.

The peaking circuits in video amps are not normally adjustable, but some receivers have a variable resistor in the peaking circuit called a sharpness control. Figure 12 is an example of a video amplifier employing both series and shunt peaking.

Video amplifier design

The emitter follower is often used for video amplifiers and can be used without frequency compensation because of its low output impedance. It cannot provide voltage gain, however, and is sometimes followed by a common base amp to provide this gain. This works well because the common-base amp's low input impedance can closely match the output impedance of the emitter follower.

A common-emitter amp direct coupled to a common base amp also works well. With this arrangement the two devices are essentially in series. This is often referred to as a "cascoded" video amplifier.

The dc restorer

If capacitive coupling is used in any of the video amplifiers, the dc component of the video signal will be lost. If this occurs, a change in peak value of the video signals will cause the value at both extremes of the signal to change. For example, if a brightly colored object appears in the video, the negative voltages (representing darker objects) would become more negative to compensate and maintain an average of 0V. In a situation like this the gray tones might then become black, and the darker shades might be lost altogether.

To compensate, the dc component of the signal can be reinserted by a *dc restorer* or *clamp* circuit. A diode clamp circuit is often used that clamps the video to 0V at the peak sync level. Of course, if direct coupling is used throughout, dc restoration is not needed.

Many smaller monochrome receivers do without dc restoration by adding a fixed amount of dc to the video. The peak levels will still vary but modern CRTs have better contrast ratios that can still produce acceptable pictures this way.

Sync circuits

The sync circuits consist of the sync separator and sync amplifier. Some receivers may not use a sync amp if the level of sync from the sync separator is sufficient. The sync separator separates the sync from the video so that it can be used by the sweep circuits. Figure 13 shows the basic operation of the sync separator.

If the dc voltage at the blanking level is 2V, as shown, for most of the video the voltage will be less positive than 2V. Since the cathode of the diode is connected through a resistor to a positive 2V, it will be reverse biased during this time and will not conduct. The only time it can conduct is during the sync pulses, when the anode voltage exceeds 2V. We are assuming for this example that this is an

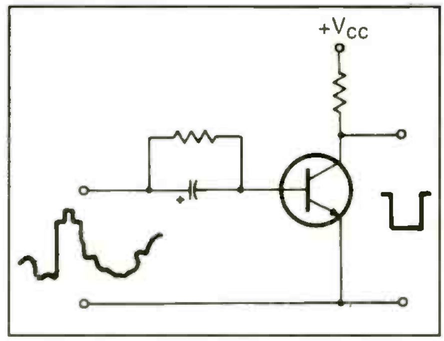

Figure 15. A simplified diagram of the transistor sync separator.

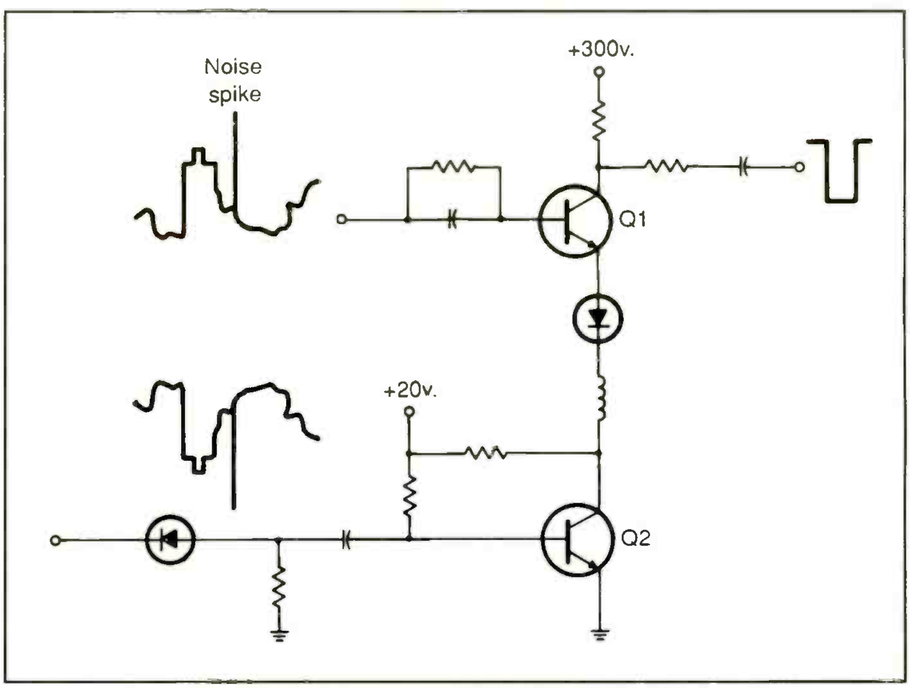

Figure 16. Some receivers employ a noise gate, such as this, to prevent impulse noise, such as static or lightning, from interfering with the sync.

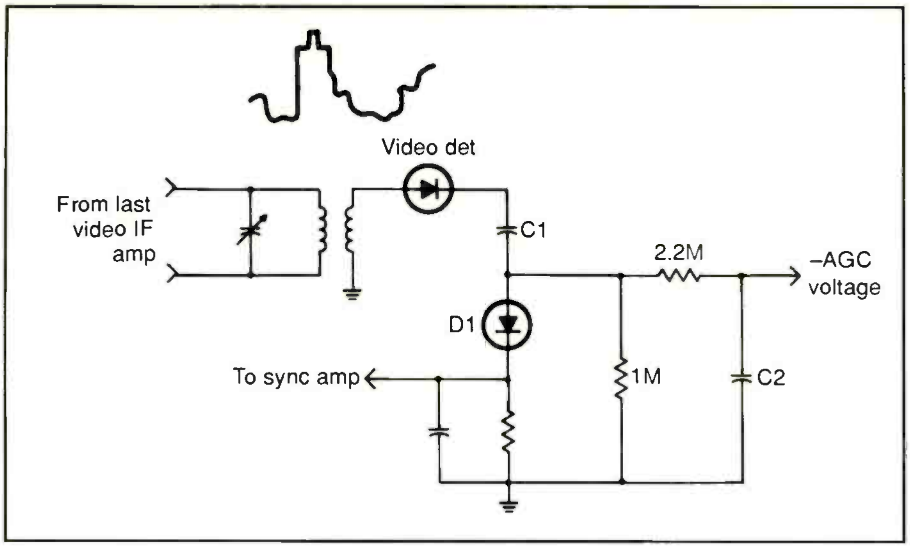

Figure 17. The AGC detector works similarly to the sync separator and in some receivers may be integral with it. This is a simplified diagram of a peak AGC circuit.

ideal diode. When dealing with actual diodes the barrier voltage would have to be taken into account.

This circuit is not used in practice because the video signal is subject to vary somewhat. The circuit can be modified, however, so that the bias voltage for the diode varies with the peak level of the video as shown in Figure 14.

For this circuit, as the diode conducts the capacitor develops a charge equal to the peak sync level. The time constant is such that the capacitor discharges only a small amount, not enough to bring the voltage down to the blanking level, after one complete horizontal line. At this time another sync pulse occurs which now exceeds the capacitor's charge by a small amount so the diode does conduct during this time and produce an output pulse. For longer term variations the capacitor's charge can adjust to the signal level.

An amplifying device as sync separator

Although the diode sync separator works, it does not produce a square pulse. It is much more common to use an amplifying device, such as a transistor, as the sync separator. A transistor can be biased so that it is driven between saturation and cutoff by the sync, thus squaring off the pulses. A transistor also provides a larger amplitude for the sync and, in many cases, makes a sync amp unnecessary. Figure 15 is a simplified diagram of a transistor sync separator. Most color receiver sync circuits use a sync amplifier following the sync separator.

The noise gate

Some receivers employ a *noise gate* to prevent impulse noise, such as static or lightning, from interfering with the sync. If the noise were to be sufficient in amplitude to exceed the sync level, it would cause the picture to roll or tear. The diagram of Figure 16 is an example of a noise gate. In this diagram, Q1 is the sync separator and Q2 the noise gate. Notice that two opposite-phase video signals are used for this particular circuit.

The bottom transistor is biased such that it is normally saturated and thus connects the emitter of the sync separator to ground. A signal that is sufficiently negative, like the noise spike shown, can override the positive voltage causing Q2 to go into cutoff during that time. This effectively disconnects the emitter of the

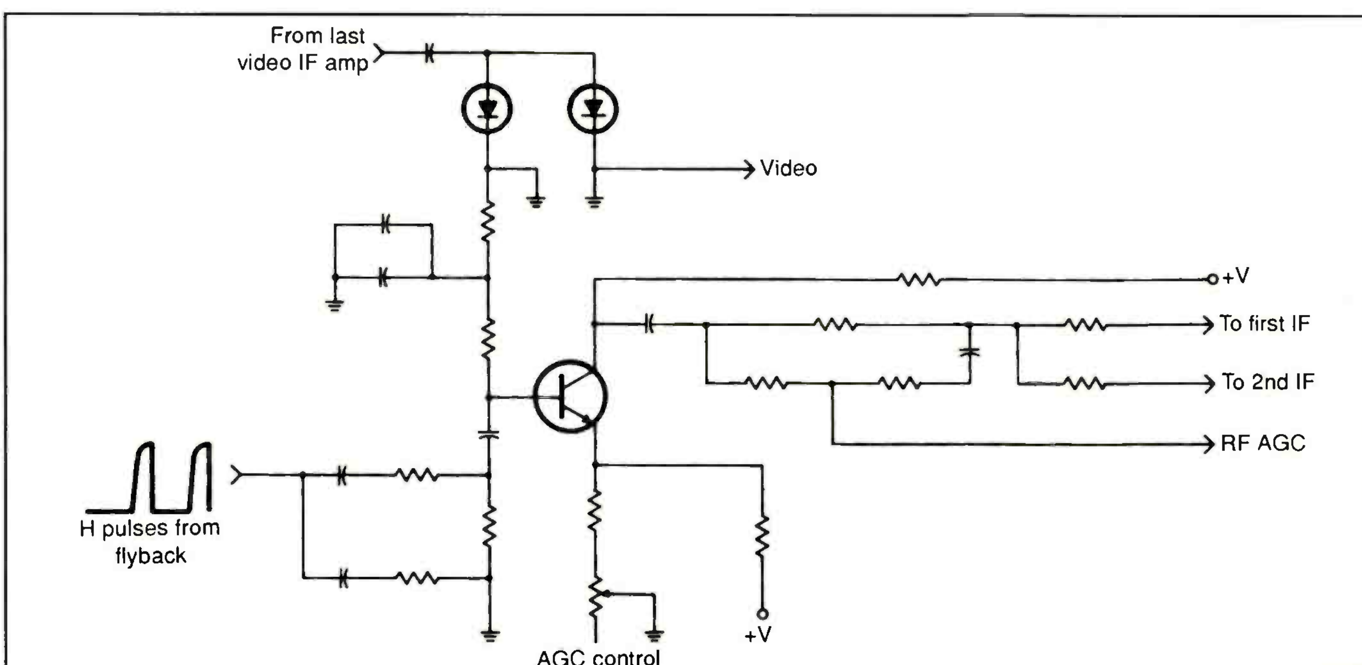

Figure 18. In some cases the AGC control voltage may not be large enough to control the gain of the IF amps, so an AGC amplifier, such as the one shown here, may be used.

sync separator from ground and does not allow it to work during this time.

AGC circuits

It is apparent that differences in reference levels for the video signal cannot be tolerated to any great extent. Therefore, the carrier level at the video detector must remain fairly constant, regardless of the received signal strength.

AGC circuits must develop two different AGC voltages. One is for the tuner, called the RF AGC voltage and the other is the IF AGC voltage for the video IF amps. Since the signal levels at the tuner input are very small, much less variation in the AGC voltage is needed there. Resistors may be used to lower the IF AGC voltage to the correct value for the RF AGC. Variable resistors may be used for these to allow the AGC voltages to be set to the optimum point.

The AGC detector works similarly to the sync separator and in some receivers may be integral with it. Figure 17 is a simplified diagram of a peak AGC circuit.

The only change from the operation of the sync separator is that another RC circuit is added with a much longer time constant. Capacitor C2 is capable of holding a dc charge equal to the peak sync for several horizontal lines. This produces a smooth output voltage.

This voltage will follow any longer term changes in peak amplitude. In some cases this control voltage may not be large enough to control the gain of the IF amps, so an AGC amplifier may be used. The circuit of Figure 18 is an example.

Some earlier receivers used a local/distance switch to select low or high gain for the AGC amp. This helped prevent overloading of very strong signals or reducing the gain too much for very weak ones.

The peak AGC uses a long time constant and thus cannot follow signals that change quickly in signal strength. This can cause the picture to "flutter" when the signal reflects from cars, trains or other moving objects. Another problem it has is that it is responsive to any peak signal. This can cause noise spikes to "set" the AGC level and weaken the actual video when noise occurs.

Keyed AGC

Most receivers today use a *keyed AGC* system. The keyed AGC is an improvement because it is made to be responsive to the signal only during the sync. It is then not responsive to noise during horizontal scanning time. It can also use a much shorter time constant during the sync time allowing the AGC voltage to adjust quickly. Usually, pulses from the flyback transformer are used as the supply voltage for the AGC stage so that it is only operative during this time. Figure 19 is a circuit example of a keyed AGC stage.

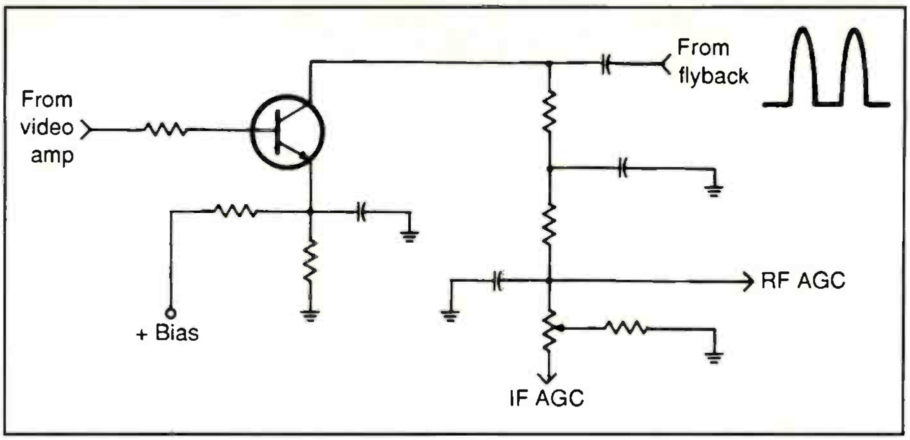

Figure 19. Most receivers today use a keyed AGC system, which is made to be responsive to the signal only during the sync. It is then not responsive to noise during horizontal scanning time. It can also use a much shorter time constant during the sync time allowing the AGC voltage to adjust quickly.

In most receivers made today, the AGC circuitry is contained within an integrated circuit along with the sync circuits and possibly, many other circuits.

The color and brightness circuits

The color and brightness circuits of a TV receiver will be covered in a future article segment in a future issue. ■

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Test Your Electronics Knowledge

Basic theory and basic math

By Sam Wilson

1. An example of an analog meter movement is the one used in the Simpson 260. The movement is usually called a D'Arsonval Meter Movement. The deflection of the pointer is dependent upon the

A. average value of sinewave current.
B. RMS value of sinewave current.

2. The NiCd (nickel-cadmium) battery was invented by

A. Tesla.
B. Edison.
C. Armstrong.
D. Fleming

3. Is the following math correct?

$$\frac{2\pi}{T} = 2\pi f$$

Where f is the frequency of a sine wave and T is the time for one cycle of the same sine wave

A. It is correct.
B. It is not correct.

Wilson is the electronics theory consultant for **ES&T**.

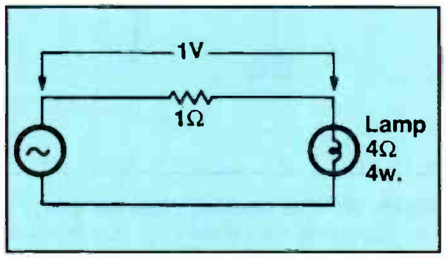


Figure 1. How much current is flowing in this circuit?

4. How much current is flowing in the circuit of Figure 1?

5. The diameter of a wire is 100 mils. What is its diameter in circular mils?

6. Convert 47 degrees to radians.

7. Name four things on which the resistance of wire depends.

8. Is the following addition of phasors correct?

$$3\angle 20^\circ + 5\angle 4^\circ = 8\angle 24^\circ$$

A. Correct
B. Not correct

9. True power divided by apparent power equals

A. tangent of the phase angle.
B. Vars.
C. power factor.
D. None of the above.

10. What is the numerical value of omega for a 60Hz sine wave?

BOOKS

Troubleshooting Analog Circuits, By Robert A. Pease, Butterworth Heinemann, 217 pages, $26.95

Now available in paperback, this guide by one of the legends of electronic design walks the reader through methods for debugging and troubleshooting analog circuits. The text includes generous helpings of Bob's unique insights, humor and philosophy regarding analog circuits.

Butterworth Heinemann, 313 Washington Street, Newton, MA 02158-1626

Digital Electronics for the Hobbyist, Technician & Engineer, By Stephen Kamichik, PROMPT Publications, $16.95 paperback, 300 pages, illus

Digital Electronics is designed to supplement an introductory course of digital electronics, teach the electronics hobbyist about digital electronics, and serve as a review for practicing technicians and engineers. Illustrated with figures, tables, and examples, each chapter is a lesson in digital electronics with problems included to test your understanding. With the proper equipment, you can also build the circuits described Digital Electronics. Building and testing a circuit is the best way to fully understand its operation. The information covered in Digital Electronics includes: Logic Gates, Logic Families, Logic Function Implementation, Flip-Flops, Control Circuits, Codes, Registers, Encoders, Decoders and Multiplexers, Comparator and Exclusive-OR Circuits, Counters, Arithmetic Circuits, Memory, Digital-to-Analog and Analog-to-Digital Converters, and more.

Author Stephen Kamichik is an electronics consultant who has developed dozens of electronics products and received patents in both the Unites States and Canada. He holds degrees in electrical engineering, and was employed for several years as an electronics technician at SPAR in Montreal, where he worked on the initial prototyping of the Canadarm. His other books include Advanced Electronic Projects for Your Home & Automobile and Semiconductor Essentials for Hobbyists, Technicians & Engineers, also published by PROMPT Publications.

PROMPT Publications, 2647 Waterfront Parkway, E. Dr., Suite 300, Indianapolis, IN 46214-2041

Understanding electronics, By Owen Bishop, Butterworth Heinemann, 256 pages, 172 illus., Paperback $24.95

Understanding Electronics provides a readable introduction to the exciting world of electronics for the student or enthusiast with little previous knowledge of electronics. It covers the basic theory, diodes, transistors and integrated circuits, computer applications of electronics - binary arithmetic, ROM and ram, interactive CD/I—and other applications of electronics in microwaves, medicine, industry, and sound and video recording.

Butterworth Heinemann, 313 Washington Street, Newton, MA 02158-1626

★ ★ ★ SHOWCASE OF TOOLS & TOOL CASES ★ ★ ★

Getting the job done, whether it's repairing a fine watch or changing the spark plugs of an engine that's in a hard to reach place is made easier with the right tools. And much of what's true of watches or automobiles is every bit as true when it comes to trying to desolder a tiny surface-mount semiconductor or replacing a 35-inch picture tube.

Here's an example that many service technicians can relate to. You're performing some type of service on site and you find that completion of this procedure requires that you strip about a half inch of insulation off the end of a piece of stranded wire. Somehow your wire stripper isn't in the toolkit. So you take out your trusty jackknife and use it to cut partway through the insulation. But either the knife is dull and just won't penetrate the insulation, or it's too sharp and cuts right through the insulation and nicks several of the hair-fine strands.

This is a fairly common problem, and we're not even talking high tech in this instance. All we're trying to do is remove a small amount of plastic from a few strands of copper. When it comes to removing and replacing a hundred-leaded IC, the problem escalates.

Because of the unique and difficult problems faced in consumer electronics service, it is important to carefully plan what tools to buy, to make sure that the tools purchased are quality tools, and to use an orderly system of storage, whether it's a rack at the service bench or a tool kit that's carried on service calls.

Selecting a vendor

You can buy most tools just about anywhere. Every hardware store, department store or discount store has a tool department where you could probably obtain many of your tools. But then the tool needs of a consumer electronics servicing technician are pretty demanding and many of the tools needed to service a TV, VCR, camcorder or personal computer are special-purpose tools. It might, therefore, be more effective to select tools from vendors who know the special needs of the technician.

The showcase

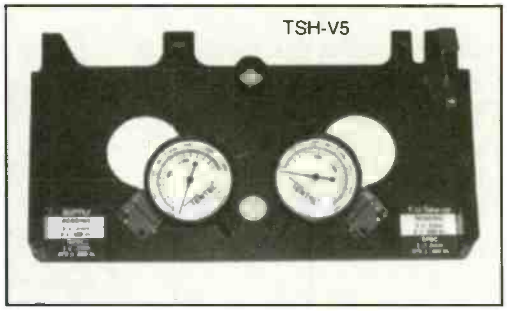
This Tool and Toolcase Showcase is designed to provide readers with a little more information than is ordinarily available about tool vendors. Each advertiser in this showcase has been given an additional amount of space to tell readers about their company in the hope that it will help in the process of determining who is most likely to carry the kinds of tools most targeted to consumer electronics service.

As you read the descriptions of these companies, written in their own words, you might want to keep these questions in mind:

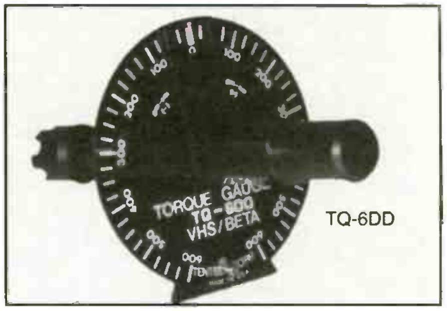
- How long have they been in business?
- How often are they able to fill orders from stock?
- What payment options do they offer—open order account, credit card?
- How soon after receipt of an order to they ship?
- Do they add a shipping surcharge?
- Do they have a toll free number?
- What ordering options do they offer?
- What is their return policy?
- Do they offer a warranty?
- Is there a minimum order amount?
- What shipping options do they offer?
- What special services do they offer?

Tentel

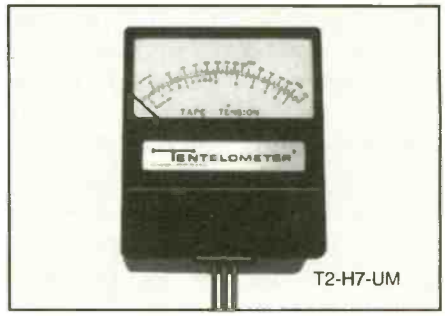
**4475 Golden Foothill Pky.
El Dorado Hills, CA 95762
Phone: 916-939-4005
800-538-6894
Fax: 916-939-4114**



TSH-V5



TQ-6DD



T2-H7-UM

Over 90% of VCR and camcorder problems are due to mechanical malfunctions. Mechanical components fail due to wear, oxidation, and abuse. There are literally dozens of mechanical parameters in a typical machine. These mechanical problems can be categorized as 1) carriage alignment, 2) tape hold back tension, 3) guide and reel table heights, and 4) video head wear problems. Most TV shops only guess about VCR problems since they have thousands of dollars in electronic testing equipment but virtually nothing for the critical mechanical VCR parameters.

Tentel manufactures the only universal test instruments to provide fast, accurate measurement of these mechanical tests. Elimination of guessing provides better repairs without costly and embarrassing call backs, while actually cutting down the time spent on VCR service.

Tentel has been providing test instruments to the video repair and maintenance marketplace for over 22 years, and is recognized throughout the world as the leader in supplying easy to use powerful test instruments for the mechanical measurements on video transports. Over 70,000 **TENTEL** test instruments are in use for testing and repairing video transports.

IMAGINE THE **BEST** VCR TEST INSTRUMENTS!

These are EVEN BETTER!

These VCR test instruments will actually help your business, by allowing BETTER and FASTER VCR repairs.

It's interesting how veterans of *trial and error* VCR repair, *suddenly* become our BEST supporters.

Try these gauges in your own shop, with a 100% satisfaction **money back guarantee**. STOP guessing and wasting valuable service time by continuing TRIAL and ERROR VCR repairs. The RIGHT tools make any job easier to do; these ARE the RIGHT tools for VCR repair!

EVERY VCR service manual shows a method of performing critical mechanical tests which cause the majority of VCR problems. **TENTEL offers the ONLY Universal** gauges for tape tension, guide heights, torques, video head wear, reel table heights, and MORE.

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24 hour FAX line: (916) 939-4114

Circle (65) on Reply Card

ITT Pomona Electronics

Providing Unique High-Performance Toolcases for Test & Measurement
1500 East Ninth Street
Pomona, CA 91766-3835
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Fluke, H-P and Tek-Specific Kits

A specialized type of Test Companion™ toolcase from ITT Pomona Electronics comes outfitted with a complete set of test accessories specifically designed for use with Fluke, Hewlett-Packard and Tektronix DMMs, graphical multimeters and oscilloscopes. Carrying cases are lightweight Cordura for easy portability and accessibility when servicing office, plant or field locations. They hold and protect instruments, test leads, probes and tools and provide a variety of zippered and Velcro-sealed pockets for manuals, service forms and miscellaneous items.

Also available are smaller, shoulder-pack kits and tri-fold pouch styles. Most accessories in the cases are IEC1010-compliant, and each Test Companion™ kit is expressly tailored to provide maximum test versatility and performance levels not typically experienced with factory-supplied test accessories. Kits range in price from $80-$390. An easy-to-read chart in the '96 ITT Pomona *Short Form Catalog* facilitates kit selection, coded to Fluke, H-P and Tek instrument model numbers.

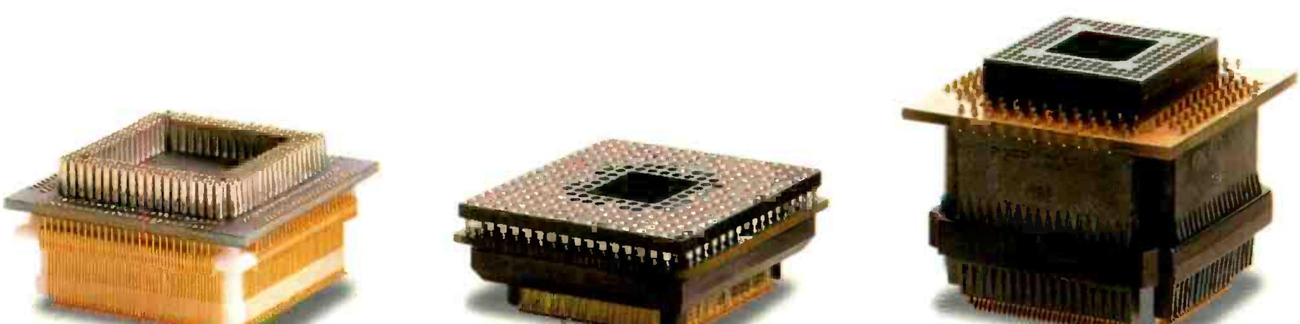
The Company

ITT Pomona Electronics is a leading supplier of electronics test accessories. The company's products are recognized worldwide as being of the highest quality, dependability and reliability. Additionally Pomona's products, designed for a wide range of test and design applications, are immediately available from stock.

What is now ITT Pomona Electronics began as a radio and television repair service, started by two civilian soldiers returning home from World War II. To do their jobs more efficiently, they began to develop their own accessories. Within a fairly short time, a family of easy-to-use accessories emerged to answer testing problems. From the beginning, quality was as important as functionality.

Through periods of very accelerated growth, Pomona has continued to maintain its high standards of quality and market responsiveness. Today, Pomona has the broadest product line of test accessories in the world. Its focus has remained constant: to contribute directly to the efficiency and productivity of electronics testing by providing quality test accessories second to none.

ITT Pomona Electronics prides itself on its on-site ability to produce quality products in volume quantities for the industry's most popularly based design and test needs. Its products, such as the new Test Companion™ Accessory Kits, are recommended by leading manufacturers of test equipment and instruments. For more information on these very special types of toolcases, contact 1-800-241-2060, fax: 909-629-3317 for more information.



Save the Chip, Solder the Clip.

Before you commit that expensive chip, validate your circuit board design the safe, effective way with a Solder-On IC Test Adapter from Pomona. Solder-On Adapters are uniquely designed to provide a secure, readily accessible interface between your circuit board and test instrumentation such as logic analyzers and emulators to assure compatibility and safety before your chip is ever installed.

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- **Cirrus Logic** CL-SH2601
- **Emulex** FAS256
- **Hitachi** HD64180, H8/3001, HD 6473332
- **Intel** 80C186XL, 80386DX, 80386EXS, 80960KA, 80486DX2E
- **Motorola** 68EC020F, 68360
- **NEC** 77017
- **Phillips** SAA7186
- **Seimens** 80C166,
- **Symphony** SL82C492
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With broad support that includes the most popular Intel and Motorola devices, Pomona's Solder-On Adapters streamline development and assure safe, accurate test results. Call Pomona today at (909) 469-2900 for a free catalog. Or write to 1500 E. Ninth Street, Pomona, CA 91766-3835. **For Technical Assistance, Call Toll-Free 1 (800) 241-2060.**

Unique Accessories For Test & Measurement

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AN ITT CANNON COMPANY

Circle (56) on Reply Card

Andrews Electronics

PO Box 914
Santa Clarita, CA 91380-9014
Phone: 800-289-0300 Fax: 800-289-0301

Andrews Electronics is housed in 50,000 square feet of warehousing and office space. Miles of shelving are arranged for immediate identification and easy accessibility for over 250,000 different parts that we carry.

Andrews is the largest supplier in America for the majority of the manufacturers we represent. Our average fill rate is over 90%, and our dealer order desk has 30 sales representatives available to take care of all your ordering needs.

In addition to being the foremost O.E.M. parts supplier in the country, we also carry many of the tools and supplies necessary to get the job done. Our newest addition is **Den-On Instruments**, manufacturer of the popular and portable SC-7000 desoldering and SMD removal tool. The line also includes soldering equipment and the new SD-2000 SMD rework station. We also represent **Xcelite** (makers of almost every type, size, and shape of every technical tool imaginable). **Weller** (has the widest possible variety of soldering guns, stations, irons, tips, and accessories), and **GC** (tools, service aids, chemicals, and more!). In conjunction with all these tools, you'll find **Multicore** brand solder, **Solder-Wick** solder removal braid, and a full line of service chemicals from **Four Star**, **Zenith**, and **GC**!

We've built our reputation on a very simple philosophy...service. Not very fancy, but very effective. Our constant growth attests to it. You see, all of our policies that have been developed over the years have been based on that one simple thought: "How may we better serve the industry?" How about:

- 16 major brands to save you time, frustration, and money with "one-stop shopping."
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Our newest feature is an online system that allows select customers to directly access our computer! This program offers the widest possible range of servicing including:

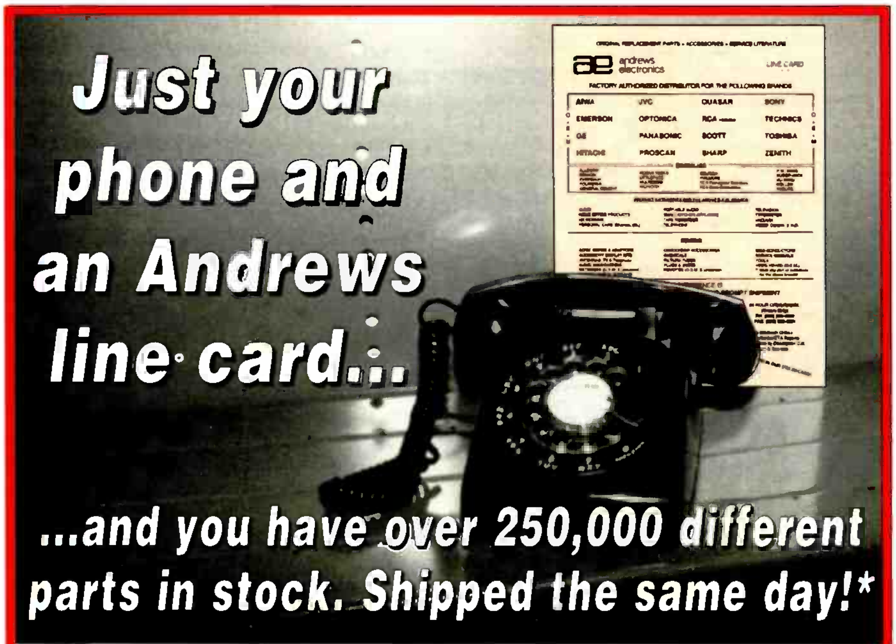
Placing orders that are automatically prioritized and will accept multiple purchase order numbers, research, etc., viewing previous orders, access to our model file, will enable customers to perform the majority of their research immediately.

You'll be able to view backorders with ETA's, part inquiry for pricing and availability on a system that also provides information on substitutes and allows partial part numbers to be entered.

This is just one more reason to make us your "one-stop shopping" distributor.

At Andrews we only bill you for the actual UPS charges, not a penny more! Or under our freight program, you'll pay less than that or nothing at all!

In case you've heard this elsewhere before, now's the time to let us prove it to you. By investing a mere two minutes of your time, you can discover what thousands of others have: that there is a difference. When you place your next order with your local supplier, check the availability of all the items. Then call or fax Andrews and check our stock levels. We believe you'll be pleasantly surprised! Wouldn't getting those extra units repaired a week or two sooner be good for your reputation? Sure it would! And we can help! After all is said and done, it is performance that counts. We know that your ability to perform your job depends on how well we perform ours. Our regular office hours are from 8:15 to 4:45 PST and we're closed for lunch between 12:00 and 12:30. When you think of electronic parts...think of Andrews. ■



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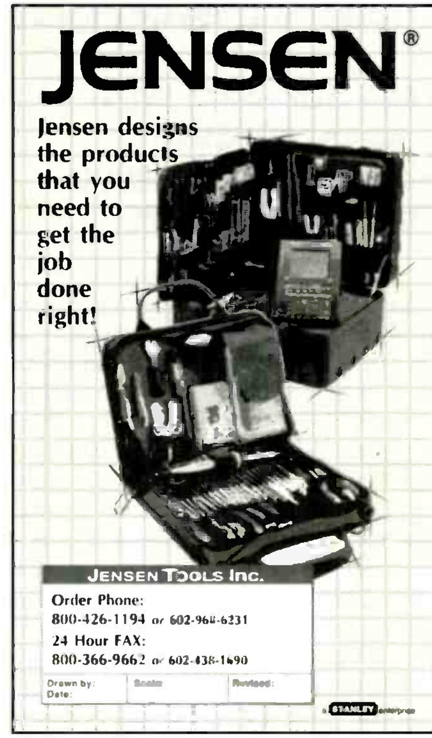
Circle (51) on Reply Card

★ ★ ★ SHOWCASE OF TOOLS & TOOL CASES ★ ★ ★

Jensen Tools

7815 South 46th Street
Phoenix, AZ 85044-5399
Phone: 800-426-1194 Fax: 800-366-9662



Jensen Tools Inc., foremost developer and designer of tool kits and cases, presents a new kit series. The Vantage Kit line offers select high quality tools at economy prices. Included are "VK" kits for: basic field services; general purposes; PC repairs; telcom installation; and more.

Many additions have also been made to the company's famous hard case JTK-87 kits for field engineers: The JTK-87WP is waterproof, airtight and floats, even with its 109 tools; the JTK-87WW, a "tote" kit, has wheels and handle built into the case for easy mobility.

A number of zipper kits have also been added. Among these are the JTK-34 PC Technician's Kit (49 tools), and the JTK-10 General Electronic Service Kit (over 50 tools). Other new Jensen offerings include: a 10-piece electronic pliers kit, a 54-piece Stanley Tool set, Fluke service kits for troubleshooting, and many other unique service products and hard-to-find tools.

Jensen's catalogs feature a full range of state-of-the-art electronic test equipment—oscilloscopes, DMMs and a wide variety of other meters—all from leading manufacturers. In addition, the company offers a custom kit/case design service to meet individual needs; free technical support for customers; and a lifetime guarantee on all Jensen brand hand tools.

If you haven't bought from Jensen lately, request a free catalog. Call 800-426-1194 or FAX your request to 800-366-9662.

Circle (58) on Reply Card

PanaVise Products Inc.

1485 Southern Way
Sparks, NV 89431
Phone: 702-353-2900
Fax: 702-353-2929

The PanaVise tradition of innovative quality began over 40 years ago with tool and die maker Otto Colbert. Otto was looking for a way to make his job easier: he wanted a vise that could tilt, turn and rotate his work without continuous removal and repositioning. After some time at the drafting board, he invented the now famous "split ball," an ingenious device that allows a vise head to move through three planes with the turn of a single knob. That simple, helpful invention created the beginnings of the PanaVise product line.

From our original Model 301 which features the "split ball" to our Circuit Board Holders, IDC Bench Assembly Press and the very popular PVJr. 201, PanaVise products now serve a variety of needs and industries. By reacting constantly to specialized holding requirements, we have created a full line of work holding devices for the electronics, computer, hobby and metal working industries. There's nearly an endless choice of combinations when you mix and match heads, bases, mounts and accessories. You will work more efficiently and with greater pleasure when you select the PanaVise that's right for you.

Currently distributed throughout the United States and around the world, PanaVise represents superior quality in design, materials and craftsmanship. From simple beginnings 40 years ago, we've become the solid leader in work holding devices.

In celebration of our 40th year, PanaVise has prepared a new Work Holding Products and Accessories Catalog which features our full line of electronics vises. This full color, 24-page catalog is available through your local PanaVise representative or by contacting PanaVise directly at 1485 Southern Way, Sparks, NV 89431 USA. Telephone: 702-353-2900, Fax: 702-353-2929.

For all your service and repair workbench needs, remember PanaVise: the "hold it anywhere you want it" company.

Circle (60) on Reply Card

Parts Express

340 E. First Street
Dayton, OH 45402-1257
Phone: 800-338-0531
Fax: 513-222-4644

Parts Express is a full line distributor of electronic parts, tools, and accessories geared toward the consumer electronics industry and the technical hobbyist. In business since 1986, Parts Express has quickly established itself as a leader in the industry by consistently providing quality products, first rate customer service, low prices, and toll-free technical support.

Parts Express stocks an impressive array of CATV and VCR repair parts, tools, semiconductors, test equipment, chemicals, computer accessories, adhesives, telephone products, educational materials, pro sound equipment, raw loudspeaker drivers for home, car, and home theater applications, crossover parts, specialized connectors, batteries, cellular accessories, and a huge selection of wire and cable. Parts Express stocks over 15,000 items and strives to continually expand its product line to offer the customer a wide and diverse selection of sometimes hard to find products and accessories. Some of the items stocked are from names like 3M, Fluke, Tripplett, Littelfuse, Klein, Goldstar, Mueller, Electro-Voice, Catamount, NTE, Motorola, Pioneer, Eminence, Pyle, Pyramid, Celestion, Audax, Vifa, Morel, Monster Cable, Sherwood, Dynamat, Ultimate, Kester, Neutrik, Augat, Cambridge, GC Electronics, Tech Spray, Rite Off, Caig, GB, Lisle, Phoenix Gold, Easypower, Mag-Lite, Weller/Ungar, Panavise, Carol, Ferrofluidics, and many more. All of these products are stocked and ready for immediate shipment (most orders shipped within 24 hours).

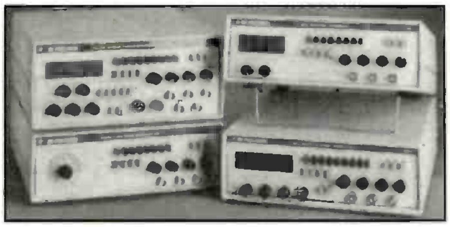
The sales department at Parts Express prides itself on offering fast, friendly, dependable service and complete customer satisfaction. The phone representatives can provide information about current pricing and availability and the technical support staff is happy to provide answers on a wide variety of questions. Orders can be placed 8:00 A.M. - 8:00 P.M. ET Monday through Friday, and 9:00 A.M. - 5:00 P.M. ET on Saturday.

Each year Parts Express produces a full line catalog, showcasing the complete product offering plus detailed descriptions and specifications. This catalog is supplemented with numerous sales flyers during the year, offering special bargains and hot deals. For more information or to request a free 228 page full line catalog, please call 1-800-338-0531. ■

Circle (61) on Reply Card

Function generators

New function generators are available from *B&K Precision*. A proprietary inte-



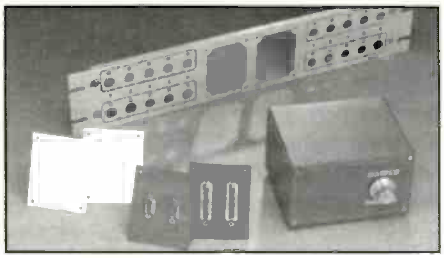
grated circuit reduces the number of parts and doubles the bandwidth for improved reliability and performance.

The new line consists of four models, with bandwidths from 2MHz to 20MHz. Model 4010 has 0.2Hz to 2MHz bandwidth and all the basic functions, including sine, square, triangle waves, TTL and CMOS outputs, variable waveform symmetry, and variable DC offset. Model 4011 is a step up with 0.2HZ to 5MHz bandwidth and a built-in 4-digit LED counter. Model 4017 has 0.1Hz to 10MHz bandwidth, a 5-digit counter, and lin/log sweep. Model 4040 has 0.2Hz to 20MHz bandwidth, AM, FM, and burst operation in addition to all the features of the 4017.

Circle (100) on Reply Card

Universal patch panels

L-Com offers a 3-1/2 inch x 19 inch rack panel especially designed for a variety of video patching applications. The product is available as a basic kit with a four inch "set of 5 inch, 0.5" D-holes ready to accept BNC, TNC or RCA feedthrough adaptors.

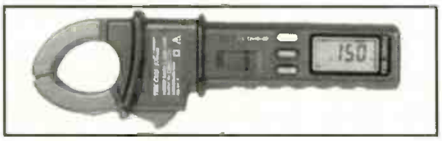


Two blank plastic sub-panels are also included that fit in the two center openings and are used for custom fabrication. Other options exist for the two center openings to accept a choice of A-B switch boxes including: high density DB15, BNC, DB25 connector types.

Circle (101) on Reply Card

Pen meter

The TekDMM from *Tektronix* 150 is 42 x 145 x 25 mm in size— small enough to fit into a shirt pocket. It is an autoranging DMM with range hold on an analog display. The DMM 150 dc range is 300mV to 600V with a resolution from 100µV to



1V and the ac range is 3V to 600V with a resolution of 1mV to 1V. It tests resistance, continuity and diode. Ease-of-use features include auto power off, continuity check beeper and a low battery indicator. An optional clamp probe attachment, the CMM 150, turns the unit into a 300A general purpose clamp meter.

Circle (102) on Reply Card

True RMS power analyzer

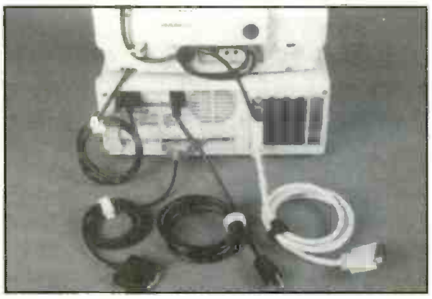
Extech's new portable, battery operated True RMS Power Analyzer features four large LCD's that display watts, power factor or VA, voltage or Hz, and amps for monitoring and auditing power consumption of single phase devices. Included are an RS232 interface and Windows based data acquisition software that enable the user to capture data for PC display and analysis.

Measurement ranges include autoranging ac/dc watts from 0.1 to 200W with ±0.9% accuracy, power factor from 0 to 1 with 0.01 resolution, frequency from 1Hz to 20MHz, autoranging true RMS voltage from 0.1V to 750V, and True RMS Current from 0.1A to 20A. True RMS voltage and current measurements are accurate for sine, square, triangular, and nonlinear wave forms with crest factor <5. Power factor is computed as effective power (watts) divided by the apparent power (volt-amperes). To operate, simply plug the device to be tested into the power analyzer and results are displayed. Features also include max recall, data hold, and overload protection.

Circle (103) on Reply Card

RF detector probes

For instrument enhancement, *ITT Pomona Electronics* introduces new, narrow-bodied, monolithic RF detector probes for use with a wide angle of digital multimeters. The product family is capable of RF measurements from 500Hz to 1GHz ±2dB.



The new model numbers 6104 (500MHz - 30MHz), 6105 (100kHz - 300MHz) and 6106 (1MHz - 1GHz) are all IEC 1010 compliant. They come with twin 4mm banana plug connectors to accommodate DMM attachment, and a replaceable gold-plated test tip. All components are laser-trimmed to ensure the highest accuracy.

Electrical characteristics include 1Vdc output for a 1Vrms sinewave input and low (10^{-6}pF) input capacitance.

Circle (104) on Reply Card

VCR REPLACEMENT PARTS

VXP0521	Panasonic Idler Orig.	$2.99ea (10 min)
164113	RCA Idler Original	$2.99ea (10 min)
NPLY0111GEZZ	Idler Original	$8.95ea
613-022-2534	Sanyo/Fisher Gear	$.29ea (10 min)
199347	RCA Replacement Belt Kit	$1.99ea
VTK-1	Video Tool Kit (15 Pc) w/case	$39.95ea
VEMS0099	Panasonic Motor	$8.95ea

POPULAR SEMICONDUCTORS

2SD1427		$1.89ea (10 min)
2SD1555		$1.99ea
SDA-3202-3		$5.95ea
2SC4664	$3.50ea	10/up $2.95ea
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AN217	1.25	BA6302A	1.65	HA11227	1.85	LA3365	1.25	M54521P	1.45	NJM4558S	.55	STR58041	5.75	TDA1512	3.25	UPA2001C	1.75	82-146-642-1	5.95	610441-1	.55
AN236	1.95	BA6993	1.20	HA11235	1.50	LA3375	1.35	M54533P	2.10	NJM4562D	1.50	STR59041	5.75	TDA1512A	3.25	UPB553AC	1.45	83-133-610-1	6.95	610442-1	.55
AN240P	.75	BAV99	.25	HA11423	2.25	LA3376	1.35	M54543L	2.45	NJM4562DD	1.50	STRD1005T	4.95	TDA1514A	5.95	UPC16C	1.50	84-124-635-1	5.95	610449-1	.20
AN262	1.25	BF819	.35	HA11510NT	3.30	LA3400N	2.30	M54560P	1.70	NSD3440T	1.25	STRD1206	6.25	TDA1515BQ	2.95	UPC30C	1.75	84-133-610-1	6.95	610460-1	.45
AN277	1.75	BF869	.85	HA11714	5.50	LA3401	1.95	M56770FP	3.95	OEC0001B	5.80	STRD1806	5.85	TDA1554Q	4.95	UPC78L05	.45	84-711-616-1	2.35	610462-3	.95
AN301	1.60	BF871	.65	HA12005	2.40	LA3600	.95	M58473P	1.90	OEC1002	5.80	STRD3010	4.95	TDA1675A	3.95	UPC393C	.50	84C85/005	8.50	610462-5	.42
AN305	1.95	BF960	.55	HA12026	1.25	LA4182	2.45	M58618-83P	2.95	OEC2003	5.80	STRD3015	4.95	TDA2005M	1.75	UPC554C	1.25	84C85/017	8.50	610499-1	.25
AN321	2.45	BF964S	.75	HA12411	2.35	LA4260	1.35	M58626-002P	2.65	OEC3006	6.10	STRD3030	4.95	TDA2008V	1.50	UPC566H	1.50	93C5-10	.25	610503-1	.35
AN335F	1.95	BFR90	.70	HA12413	2.25	LA4261	1.90	M60025-100SP	5.95	OEC5003	5.50	STRD3035	4.95	TDA2009A	2.10	UPC571H	1.50	ZENITH	SEMI'S	610509-1	1.95
AN362	1.25	BFR91G	.70	HA17458	.55	LA4265	1.40	M65607SP	16.95	OFWM1962	4.95	STRD6602	5.45	TDA2030V	1.55	UPC574J	.75	103-305	.60	610511-1	.25
AN2253FA	5.95	BFW92A	1.25	HA17901P	.75	LA4270	1.75	MA6301	2.45	OFWM1963	3.95	STRS5041G	6.95	TDA2541	2.25	UPC577H	1.60	121-755	1.55	610517-3	1.75
AN3230NK	4.95	BFW92G	1.25	HA2100IMS	6.95	LA4422	1.35	MAB8421PF047	6.00	OFWM3251	4.25	STRS5241	6.95	TDA2545A	3.85	UPC585C	1.45	121-868-01	.65	610529-1	.25
AN3311K	2.95	BT138-600	1.20	HD6301V1P684	4.95	LA4510	1.95	MAB8441PT038	7.50	OFWM3950	5.95	STRS5241G	6.95	TDA2546A	2.25	UPC587C2	1.40	121-1007	.00	610535-1	.20
AN3313	2.95	BT151-500R	1.25	HD6305Y1D23F	9.50	LA4520	1.75	MAB8461PW086	9.50	P8049AH	3.95	STRS6301	6.95	TDA2577A	3.95	UPC592H2	1.25	121-1028-01	.70	610551-1	.95
AN5015K	2.95	BU126	2.45	HEF4040BT	.25	LA5512	.95	MAN6660	1.50	P8748H	4.95	STRS6301A	7.95	TDA2579A	3.95	UPC1018C	.75	121-1035	.70	610554-1	.45
AN5020	1.35	BU208A/SGS	1.95	HG61H04N01P	4.50	LA5521D	1.25	MB3202	1.50	PC000050	6.20	T-60X-1	2.35	TDA2593N	1.70	UPC1026C	1.25	221-42	1.65	610558-1	.25
AN5111	3.75	BU208D/SGS	2.30	HM6116P-4	2.50	LA6358	.75	MB3761	1.85	PC000051	6.20	TA71	1.40	TDA2595	2.95	UPC1032H	1.25	221-43	2.35	610565-1	1.50
AN5151N	2.95	BU508A	1.95	HN623257FC44	3.95	LA6510	1.85	MB4204	1.25	PC000083	5.50	TA2003	1.25	TDA2611A	1.75	UPC1094C	3.25	221-45-01	2.60	610584-2	1.75
AN5301NK	5.40	BU508D	1.95	HP4510	3.95	LA7016	1.50	MB8464A80LSK	5.45	PC20619	6.00	TA7061AP	1.10	TDA2822M	1.55	UPC1158H2	1.45	221-46	1.75	610587-2	1.85
AN5316N	2.45	BU508DF	1.95	HVR-1X-32B	1.95	LA7031	1.75	MB8726	2.45	PC20623	6.00	TA7130P	1.25	TDA3048	3.75	UPC1158HA2	1.45	221-48	1.25	610611-1	.25
AN5352	4.25	BU508DFI	1.65	ICM7555	.45	LA7032	4.95	MB8303	6.95	PC74HC123P	.65	TA7140P	1.80	TDA3190	1.75	UPC1167C	2.45	221-69	1.95	610970-1	.45
AN5512	1.25	BU806	1.25	IR2E01	1.50	LA7033	4.45	MBR1045	.55	PC74HC138P	.45	TA7157AP	1.45	TDA3561A	4.20	UPC1171C	2.75	221-77	3.20	611018-1	1.50
AN5515	1.65	BU2444-06	2.95	IR2E02	1.50	LA7034	3.25	MC68A09P	4.75	PC74HC161P	.35	TA7157P	1.45	TDA3563A	5.70	UPC1187V	1.85	221-78	2.85	611018-3	1.50
AN5521	1.60	BU2508A	1.95	IR2E05	1.50	LA7213	3.30	MC74AC157D	.65	PC74HC245P	.65	TA7208P	1.95	TDA3564N	6.95	UPC1191V	1.95	221-79-01	2.35	612042-2	2.75
AN5700	1.10	BU2508AF	2.25	IR2E19	1.50	LA7221	1.50	MC74HC04	.25	PC74HC574T	.20	TA7222AP	1.45	TDA3568	3.75	UPC1197C	.85	221-83	1.75	612069-1	2.35
AN5703	2.25	BU2508DF	1.95	IR3P07	1.50	LA7505	1.95	MC74HC00AN	.25	PC74HC4046AT	.47	TA7223	1.95	TDA3569	3.85	UPC1215V	1.90	221-87-01	2.15	612070-1	1.80
AN5710	1.25	BU2520AF	2.45	IR3P08	2.95	LA7520	2.95	MC74HC74AN	.35	PC74HC4053P	.25	TA7226P	2.45	TDA3611	4.95	UPC1225H	2.40	221-92	.95	612072-1	1.95
AN5720	.95	BU2527AF	2.75	IR85C4V7	.15	LA7530	2.10	MC74HC245A	.45	PC74HC4066T	.44	TA7230P	1.50	TDA3653B	3.85	UPC1227V	1.95	221-97	1.75	612076-7	2.85
AN5730	1.10	BUH413	2.95	IR2403	1.80	LA7571	3.75	MC74HC245AD	.25	PC74HC4351P	.65	TA7281P	1.80	TDA3653CQU	2.95	UPC1228H	.75	221-97-02	1.75	612094	2.15
AN5750	1.35	BUH417	2.10	IR2410	1.50	LA7610	12.99	MC78L12ACP	.35	PC74HC4538P	.35	TA7310P	1.35	TDA3654	2.45	UPC1228HA	.75	221-102-01	1.45	612120	3.80
AN5760	1.60	BUT11AF	1.55	IRC5	.95	LA7652	5.95	MC1309P	1.25	PC74HCT163P	.35	TA7313AP	.85	TDA3654Q	2.45	UPC1245V	1.20	221-104	1.95	612160-3	2.95
AN6250	1.75	BUT21C	1.95	IRF730	3.95	LA7655N	5.65	MC1310P	.75	PCF8571P	4.50	TA7323P	1.30	TDA3810	3.75	UPC1252H	1.95	221-105	2.95	612313-2	6.95
AN6306	2.75	BU2901	4.95	IRF830	3.95	LA7670	7.75	MC1349P	1.40	PCF8583P	9.75	TA7324P	1.25	TDA3830	2.34	UPC1253H	1.95	221-106	2.95	612331-2	5.50
AN6307	1.40	CA3012T	2.95	JA1350W	.20	LA7671	6.95	MC1352P	1.45	PCM54HP	4.95	TA7325P	1.35	TDA3830/V1	2.95	UPC1335V	2.95	221-121	1.75	612338-3	5.10
AN6326	1.95	CA3053T	1.75	JE8050	.45	LA7672	6.95	MC1394P	1.40	PH302	.90	TA7330P	1.25	TDA3830/V2	2.95	UPC1350C	1.30	221-157-02	1.65	612342-1	6.95
AN6327	2.95	CA3065E	.65	JE8550	.50	LA7696	3.95	MC1496P	2.00	PH309	.95	TA7331P	1.35	TDA3830V1/S1	2.95	UPC1352C	5.95	221-158-03	1.65	612347-2	1.95
AN6328	2.25	CA3072E	1.75	JE9011	.15	LA7760	2.50	MC3022P	1.75	PL22V10-10N	4.95	TA7342F	.95	TDA4433	2.75	UPC1353C	1.35	221-160-01	3.25	612351-1	1.10
AN6337	1.95	CA3078E	.95	JE9014	.20	LA7800	1.90	MC3335DW	1.75	RFP8N20	1.50	TA7342P	.95	TDA4504B	8.95	UPC1363C	2.25	221-164	2.75	612364-1	1.55
AN6341	2.95	CA3080E	.75	JE9016	.20	LA7810	3.95	MC3335P	3.95	RHIX0137CE22	3.95	TA7343AP	.95	TDA4505A	6.75	UPC1363CA	2.25	221-166-04	.45	612405-1	2.50
AN6341N	2.25	CA3121E	2.25	K2619	1.25	LA7830	1.75	MC3357P	1.75	RHIX0179GE22	7.95	TA7343P	.95	TDA4850	3.95	UPC1371C	4.25	221-174-02	2.75	612412-2	5.50
AN6342	1.55	CA3126E	1.70	KA1222	1.50	LA7831	1.85	MC3361BD	2.95	S042P	1.50	TA7358P	.85	TDA4851	5.95	UPC1373H	.95	221-175	7.95	612463-1	1.25
AN6342N	1.99	CA3146P	1.15	KA2102A	1.90	LA7833	1.50	MC3403N	1.95	S1854	2.55	TA7373F	1.55	TDA4852	6.95	UPC1373HA	.95	221-178	2.75	612469-1	.95
AN6343	2.25	CA3151E	4.95	KA2130A	1.45	LA7836	1.75	MC3403P	1.95	S2000A3	3.25	TA7378P	1.50	TDA4866	4.95	UPC1378H	1.55	221-179-01	7.95	612479-4	.35
AN6346	1.85	CA3156E	5.45	KA2131	1.95	LA7837	2.45	MC7809CT	.45	S2055AF	2.75	TA7401AP	1.75	TDA4881	4.25	UPC1382C	.85	221-190 DSE LM1822N		612480	1.55
AN6350	3.95	CA3166E	4.50	KA2223	1.55	LA7838	2.45	MC7813CT	.50	S2560G-1	1.85	TA7607AP	2.35	TDA5030AH	2.95	UPC1393CA	2.95	221-192-01	1.25	612508-1	6.10
AN6359	2.90	CA3177E	2.75	KA2245	1.20	LA7913	1.20	MC7818CT	.55	SAA1043P	14.95	TA7611AP	1.95	TDA5630	2.45	UPC1397C	2.45	221-193	2.10	612552-1	4.95
AN6360	1.75	CA3183E	.75	KA2261	1.45	LB1252	1.95	MC7908C	.55	SAA1061	5.75	TA7613P	1.55	TDA5666-5	1.98	UPC1470	1.10	221-201-06	2.95	612553-1	4.50
AN6361	1.90	CA3195E	1.45	KA2263	1.05	LB1292	1.25	MC7912C	.55	SAA1250A	3.75	TA7628P	1.75	TDA7052	2.55	UPC1473HA	1.45	221-202	1.75	612554-1	17.95
AN6362	2.75	CA3202E	2.30	KA2281	1.20	LB1403	.85	MC13020P	1.75	SAA3006P	4.95	TA7640AP	1.45	TDA7053	4.25	UPC1474HA	2.20	221-246-02	3.95	612565-1	4.50
AN6366NK	2.45	CA3210E	6.50	KA2284	1.25	LB1405	1.35	MC14011BSM	.15	SAA3010P	2.75	TA7644BP	5.75	TDA7211	1.55	UPC1486C	2.75	221-249	5.95	612566-1	1.25
AN6387	2.95	CA3217E	5.75	KA2912	2.50	LB1409	2.10	MC14049UBCP	.25	SAA5245P/A	7.75	TA7658P	1.55	TDA7240A	2.45	UPC1504C	2.45	221-261	4.10	612584-7	12.75
AN6650	.90	CA3218E	1.55	KA22211	1.45	LB1416	1.75	MC14066BCP	.25	SAA7188WP	7.95	TA7668BP	.95	TDA7263	3.45	UPC1514CA	2.35	221-285-02	1.75	612624-1	12.45
AN6886	3.05	CA3224E	1.15	KB4409	1.50	LB1450	1.25	MC14426P	1.25	SAA7210P	5.80	TA7670P	5.75	TDA8172	2.95	UPC1525C	2.95	221-289-09	1.75	612658-3	12.00
AN7025K	1.10	CA3234E	6.95	KB6404A	1.60	LB1620	1.65	MC34065P	3.75	SAB3035	5.50	TA7680AP	4.95	TDA8174	4.75	UPC1870CA-1	5.95	221-289-38	2.95	612668-2	3.95
AN7110	.65	CA3236E	6.95	KDS2236	.25	LC7131	2.35	MC34065P-H	3.95	SAB3036	4.50	TA7680P	3.95	TDA8175	4.45	UPC1870CA-2	5.95	221-301	1.75	612674-3	5.95
AN7130E	.95	CA3237E	1.75	KE140W	.85	LC7132	2.55	MC44615AP	5.95	SAB3037	4.25	TA7681AP	3.45	TDA8305A	6.95	UPD261C	2.95	221-303	3.30	612682-1	11.75
AN7142	1.00	CA3238E	1.95	KIA6003S	.85	LC7267	4.25	MC44802AP	4.95	SAB80513P	3.00	TA7687AP	2.60	TDA8350Q	3.25	UPD262C	2.95	221-365-01	3.25	612682-2	11.95
AN7145M	2.75	CA7611E	1.65	KIA6043S	1.25	LC7456A	1.95	MC44817D	4.49	SAD1024A	2.95	TA7688F	1.75	TDA8351	5.95	UPD547LC	2.75	221-369	3.95	612692-1	8.95
AN7205	1.10	CAT35C102P	3.95	KIA6225S	1.45	LF347N	1.55	MC144143P1	3.95	SAF1039P	1.90	TA7709F	1.50	TDA8362B	7.95	UPD554C-036	5.95	221-373-02	4.95	612702-1	4.95
AN7213	.75	CD4011BCM	.15	KIA7130P	1.25	LF356H	1.95	MCR100-6	1.45	SC5889P	2.50	TA7757F	.95	TDA8425	4.95	UPD865C	1.75	221-379	2.00	612744-1	5.10
AN7222	.80	CD4011UBE	.15	KIA7280P	2.75	LH236301	3.25	MDA970-1	1.45	SDA2516-2	2.10	TA7777N	8.75	TDA8426	6.25	UPD940C	3.95	221-418	5.95	612745-1	5.95
AN7224	1.40	CD4025BE	.50	KIA7281P	2.75	LI2006	1.25	MGP3002X	3.75	SDA3202-3		TA7784P	1.55	TDA8444	4.95	UPD946	5.50	221-419	1.80	612758-1	5.95
AN7273	1.50	CD4027BE	.25	KIA7303P	.85	LM78L05ACZ	.25	MGP3006X	3.75	USE SDA3412		TA7792F	1.25	TDB2033	1.50	UPD1200	6.95	221-463	4.95	612766-1	4.95
AN7310	.75	CD4029BE	.15	KIA7324P	1.25	LM358D	.35	MGP3006X6	3.95	SDA3412	3.45	TA8105N	1.95	TEA2114	.75	UPD1203C	2.00	221-467	7.95	612771-2	7.95
AN7311	1.10	CD22402D	6.95	KIA7325P	1.25	LM358N	.95	MJE130	.65	SDA3412X6	3.95	TA8110P	1.25	TEA5581	2.50	UPD1701CT113	4.95	221-473	6.95	612792-1	6.95
AN7320	1.25	CIC7230	1.55	KIA7343AP	1.35	LM380N	1.25	MJE243	.50	SG3524N	1.95	TA8127F	1.35	TEA5582	3.95	UPD1708AG023	5.25	221-485	6.25	612818-1	5.95
AN7320E	1.25	CIC7325E	1.50	KTA7401AP	1.25	LM393D	.55	MJF11AF	1.95	SG7815ACP	.30	TA8167N	1.25	TL061CP	.55	UPD1716C-524	4.35	221-498	2.95	612818-2	4.75
AN7410	1.25	CNX35U	1.55	KIA7411AP	1.35	LM393N	.35	MJF15030	1.55	SJE2164	.80	TA8200AH	3.95	TLC272CP	.75	UPD1943G	2.50	221-516	5.75	612825-2	14.95
AN7420	.85	CNY17I	2.00	KIA7640AP	2.45	LM1391N	1.45	MM4001BSM	.15	SJE2678	1.50	TA8205AH	3.75	TLG2110	1.75	UPD4053BC	.75	221-528	2.60	612846-1	6.95
AN7809	.45	CS3842AN	2.50	KIA8125S	1.45	LM1822N	7.95	MM5387AA	2.00	SJE2685-1	1.50	TA8210AH	4.25	TLP560G	1.50	UPD5471C	3.25	221-545	2.75	612854-1	7.75
AN7815F	.55	CX770	5.25	KIA8129Z	1.35	LM1823N	5.40	MM5456N	1.60	SP500	1.50	TA8218AH	3.95	TLP631	.85	UPD6104C	2.95	221-657-50	4.15	612855-1	6.95
AN8005	.65	CX7930A	4.95	KM44C256CP-8	.45	LM1863M	1.95	MM73178N	1.25	SP1200	1.55	TA8410K	2.45	TMC1073NL	3.40	UPD6111	6.45	221-657-63	4.15	612856-3	9.75
AT24C01A	5.25	CX7982	5.25	KM6264BL-7	6.95	LM1881N	1.45	MM53130N	1.45	SP4653	2.95	TA8654N	7.95	TMM2364P	2.80	UPD6336C	3.95	221-808	9.95	612857-1	15.95
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B9840C12	1.95	CX20023	3.95	KS74AHCT32N	.35	LM2877P	1.80	MN1277B	4.75	STA401A	1.99	TA8659CN	7.95	TMP47C634N8401	4.95	UPD8039HLC	2.85	340313-5	29.95	612879-2	14.95
BA30C	1.60	CX20077	3.60	KS540-8	.55	LM2901N	1.45	MN1280R	1.35	STK430III	5.90	TA8677N	7.95	TMP47C634NP402	4.95	UPD41264V15V	3.95	362127-2	24.95	612888-1	12.95
BA235	1.25	CX20078	3.45	KS3154	.85	LM8363	2.95	MN3007	2.95	STK563F	5.95	TA8680BN	6.25	TMS1045NL	5.60	UPD75106CW18	5.45	364083-1	19.99	612894-2	2.45
BA301	.95	CX20106A	1.95	KS3158	.85	LM8460	1.75	MN3817S	2.25	STK730-010	6.95	TA8680N	6.25	TMS1071NL	4.40	W005	.65	610083-1	.45	612895-1	9.95
BA328	.95	CX20111	2.95	KSC941	.20	LM8560	1.95	MN6076	3.95	STK730-020	6.95	TA8792N	5.95	TMS1943N2L	2.50	W06M	.45	610083-4	.45	612901-2	4.95
BA333	.60	CX20180	3.95	KTC388A	.15	LR40993	2.45	MN6163A	3.95	STK4191II	11.75	TA8825AN	7.95	TMS1943NL	2.50	XR3524CP	1.55	610083-6	.45	612904-3	14.40
BA338	2.30	CX23035	3.95	KTC1815	.10	LU116278	3.00	MN6550B	4.95	STK4273	5.65	TA8845AN	12.99	TMS1944N2L	3.55	X0137CE22	3.95	610113-2	.25	612906-1	12.95
BA401	1.50	CXA1019	2.25	KV1260	.65	LV1140	1.10	MN12973NAB	5.00	STK4274	5.65	TA8850N	7.95	TMS3450NL	2.90	YM3428	6.95	610146-3	.45	612928-2	11.95
BA402	.75	CXA1124BQ	3.95	L78M12	.35	M5M5165P70	5.05	MN15823FVG	3.75	STK4275	5.95	TA8864AN	4.95	TMS3451NL	2.45	1A66102-02A	6.95	610217-5	1.45	612928-3	11.95
BA514	1.35	CXA1125P	1.75	L4916	.95	M74HC244P	.55	MN38175	.95	STK4392	6.75	TA8879N	8.95	TSA5515TD	3.95	1A66102-02D	6.95	610226-1	.45	612929-1	12.95
BA526	1.00	CXA1261M	2.50	L5630	.75	M74HC4078B1	.75	MN67461VDSF	9.75	STK5326	5.45	TA75358P	.65	TUA2007X	1.80	1A66102-06B	6.95	610226-4	.45	612930-1	5.95
BA547	1.45	CXA1594L	3.95	L7815CV	.55	M70881	2.45	MN1872419T2A	4.95	STK5372	4.45	TAA621A11	2.95	TUA2017X	1.80	1A66103-04A	6.95	610226-5	.45	612933-2	6.95
BA612	.90	CXD1125	3.50	L7905CV	.55	M5152L	.85	MP1908	3.40	STK5431ST	5.95	TBA530	3.95	U416B	3.10	1A66103-04B	6.95	610227-1	.45	612934-1	17.80
BA614	1.10	CXD1176Q	3.95	L7912CV	.55	M5193P	2.95	MP3484AN2	2.25	STK5471	4.95	TBA540	2.50	U417B	2.30	1A66107-02A	6.95	610228-4	.70	612951-1	12.95
BA664	1.75	CXD1251Q	5.50	L7915CV	.55	M5218L	.75	MPS3906	.15	STK5474	4.95	TBA950	2.75	U420B	2.75	1A66107-07E	6.95	610228-5	.70	612953-5002	9.50
BA718	.65	CXK5816M-15L	4.90	L7924CV	.55	M5223L	.75	MPS9410	.30	STK5479	5.95	TC40H368	.95	UA78L82AWC	.15	1A66107-30B	6.95	610233-2	2.75	612969-1	3.95
BA728	1.25	CX564171	5.95	LA1111	1.25	M5228P	1.75	MPS9426	.15	STK5481	8.95	TC5080P	1.90	UA7824	.45	1A66107-33B	6.95	610249-1	.45	612970-1	9.95
BA841A	3.95	D3SB20	1.50	LA1130	1.25	M5238L	1.65	MPS9625	.15	STK5482	6.95	TC9130P	2.25	UAA170	1.80	1A66107-35C	6.95	610249-2	.45	612994-1	4.95
BA1102F	2.45	D43C8	.20	LA1135	1.45	M5278L56	.60	MPS9626	.15	STK5490	8.45	TC9145P	2.55	UAA1008A-DP	.65	13-34046-6	.55	610250-1	.55	612995-1	3.95
BA1310	1.75	DBL1019	2.35	LA1140	1.25	M47020	2.45	MPS9696	.15	STK6982H	6.50	TC9303AN-014	5.95	UC3842AN	1.75	13-45321-1	.45	610324-1	.85	613007-1	5.95
BA1320	1.45	DBL1021	2.95	LA1145	2.50	M50117AP	4.40	MPSA13	.15	STK7309	6.95	TC9311	1.90	UC3843AN	1.75	14DN209	6.75	610361-1	.45	613026-1	5.95
BA1356	1.15	DTA114EK	.15	LA1180	1.65	M50198P	7.95	MPSA92	.20	STK7310	5.25	TC35300AP	1.55	UHP490	.35	14DN233	5.10	610369-2	.65	613028-1	7.95
BA1360	.95	DTA114TK	.15	LA1185	.95	M50572ASP	17.95	MPSD52	.20	STR451	7.95	TCA830SM	.85	ULN2003A	.50	15-35059-2	1.25	610369-3	.65	613085-3	9.95
BA3306	1.05	DTA114YS	.15	LA1201	.95	M50743FP	7.95	MRF239	2.95	STR3125	5.95	TCA4500A	.95	ULN2110A	1.45	15-37701-2	2.95	610390-1	.25	613104-2	14.95
BA3308	.90	DTA124ES	.15	LA1210	1.50	M51102L	2.85	MSL2318RS	2.75	STR3130	5.95	TCP4621-9081	2.75	ULN2212B	2.05	15-37702-1	1.85	610395-1	.65		
BA3416BL	1.25	DTA144ES	.15	LA1222	.75	M51172P	1.50	MSL9372RS	3.75	STR3135	5.95	TD6359N	2.90	ULN2216F	1.00	15-39207-1	4.95	610420-1	.55		
BA3516	1.75	DTC114ES	.15	LA1231N	2.00	M51307BSP	8.25	MSM561	1.35	STR3220	5.95	TD6359P	2.90	ULN2225P	2.85	15-39208-1	2.25	610427-3	.70		
BA3708F	1.40	DTC124EF	.15	LA1235	1.95	M51408SP	6.95	MSM5807	2.75	STR5412	5.95	TD62105P	1.80	ULN2269A	1.90	15-39209-1	2.50	610428-2	.30		
BA3828F	2.45	DTC143XK	.15	LA1245	1.45	M51533L	1.50	MSM5816RS	2.45	STR10006	4.35	TD62503P	2.65	ULN2290Q	1.95	15-41627-2	2.20	610433-2	1.95		
BA4110	1.40	DTC144EK	.15	LA1260	1.35	M51721L	12.99	MSM58301RS	4.85	STR13006	5.95	TD62504P	.95	ULN3810A	1.65	15-41764-1	4.10	610434-1	.20		
BA4210	.95	DTC144ES	.15	LA1266	1.95	M51782ASP	8.95	MTD1N45	.45	STR30110	3.95	TD62506P	.95	ULN3859	1.45	15-43098-1	4.40	610434-2	.20		
BA4232AL	2.25	DTC144EU	.15	LA1816	1.55	M51903L	1.80	MUR810	.75	STR30115	3.95	TD62553S	2.85	UN4112	.60	15-43703-1	1.35	610435-1	.25		
BA4234L	2.00	GH3F	.40	LA2000	1.50	M52025SP	5.95	MUR3005PT	1.75	STR30120	3.95	TD62555S	2.20	UN4122	.50	15-45300-2	1.30	610435-2	.25		
BA4403	.75	HA1197	1.65	LA2110	2.50	M52030ASP	5.45	NE5532P	1.50	STR30123	3.95	TDA440	1.25	UPA53C	1.25	82-104-601-1	7.50	610437-1	.25		
BA5101	1.55	HA1199	2.75	LA2770	4.95	M52030SP	4.95	NE5534N	2.75	STR30125	3.95	TDA1002	2.65								
BA5102A	1.85	HA1388	2.75	LA3115	1.35	M52303SP	6.65	NIS7264B2	3.95	STR30130	3.95	TDA1003A	2.95								
BA5115	2.15	HA1389R	3.05	LA3155	1.25	M52686AP	3.95	NJM072D	.65	STR30135	2.95	TDA1010A	1.25								
BA6104	2.25	HA1392	2.45	LA3160	.60	M52690SP	4.95	NJM78L08A	.25	STR40090	4.95	TDA1013B	2.25								
BA6109	1.10	HA1406	1.75	LA3161	.65	M52692SP	14.95	NJM2043S	1.30	STR50041A	5.25	TDA1072	1.60								
BA6146	1.70	HA11107	1.45	LA3220	.90	M54408P	2.75	NJM2063A	1.50	STR50092	6.85	TDA1170N	2.25								
BA6209	1.35	HA11211	2.75	LA3301	.65	M54450L	1.90	NJM2063AD	1.60	STR50103A	4.25	TDA1190Z	2.10								
BA6219B	1.35	HA11219	1.65	LA3350	1.75	M54514AP	1.90	NJM2068S	1.50	STR50115	6.95	TDA1220B	.75								

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Troubleshooting audio power amplifier circuits

By Jurgen Ewert

The power stage of an audio amplifier provides the power to mechanically move the cones of the speakers. The power stage is the workhorse in the audio amp and it is sometimes exposed to shorts or overloads. The power stage is called on to generate the power throughout the audio frequency range from 20Hz to 20kHz. If an audio amplifier quits working, in about 90% of all cases it is the power stage that has failed.

Power stages of audio amps can be built in very different ways. The manner in which the amplifier is designed depends on the output power, efficiency, sound quality and cost that is desired.

To determine if the power stage of an audio amp is defective, listen to the output of the speakers to find out how the music sounds. If there is no sound at all, check the speakers, fuses, speaker A/B-switch and the connections.

If all of these things are in order and there is still no sound, measure the power supply voltage. If the power voltage is present, start checking for the audio signal at the power stage beginning at the output. The power stage is bad if you detect a good signal at the input of the stage and a bad signal, or no signal, at the output of the stage.

It is usually faster to measure the dc voltages at the power stage to find the trouble spot. Sometimes the signal at the speaker output is distorted or weak. It is always a good start to measure the dc voltages at the terminals of the active components. The following will discuss some basic schematics of power circuits.

Tube-type audio power amplifier circuits

Power stages in most audio amplifiers are push-pull types and they work in class B or class AB mode. You may still run across a simple power stage, however, if you get into one of those vintage radios or old phonographs. In older audio equipment, tube amplifiers were used exclusively (Figures 1 and 2).

The reason that tube amps are mentioned here is not nostalgia. Tubes are still used for specialty equipment especially for guitar amplifiers. Users of this equipment like the difference in sound if the amplifier starts to clip the output signal.

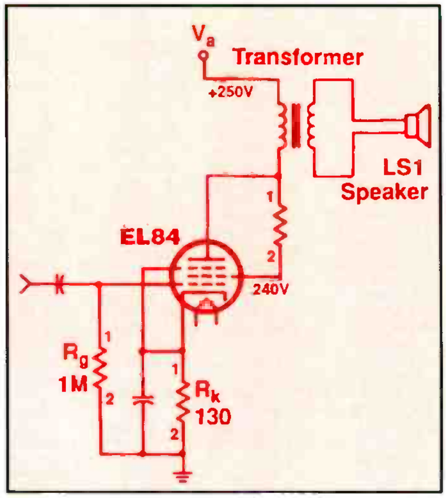

Figure 1. In this simple power stage, a pentode tube is used to amplify the audio signal from the driver. A transformer is used to match the high impedance at the plate of the tube to the low impedance of the speaker.

A simple power stage

Tube amps built nowadays are usually push-pull amplifiers (Figure 2). In the simple power stage of Figure 1, a pentode tube is used to amplify the audio signal from the driver. A transformer is used to match the high impedance at the plate to the low impedance of the speaker.

This power stage is working as a class A amplifier, that is, a relatively high plate current flows regardless of whether there is a signal present or not. The plate current is controlled by the audio signal, which is coupled through a capacitor into the control grid. A small variation of the control grid voltage results in a large variation of the plate current. These plate current variations create an ac voltage in the secondary winding of the output trans-

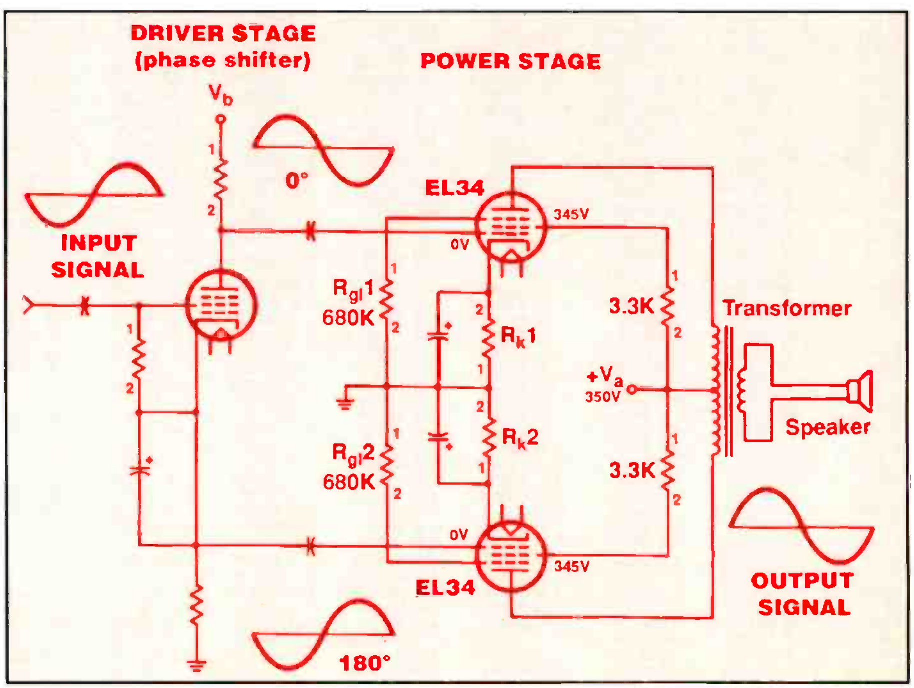

Figure 2. The circuit of the push-pull power stage is a little more complex than that of the simple power stage. Each active component in the power stage amplifies only a half wave of the audio signal. Both half waves of the output signal are put together again in the output transformer. A phase shifter stage ensures that each tube of the power stage gets the appropriate input signal.

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former. The loudspeaker is connected to the output of the transformer.

To troubleshoot this power stage, measure the dc voltages starting with the operating voltage (250V). The voltage at the plate and g2 are a little bit less (around 240V). The plate current is about 45mA. The voltage at the cathode should therefore be 0.045A x 130Ω = 5.85V. If the cathode voltage is much less than that, the tube is probably weak.

The push-pull power stage

The circuit of the push-pull power stage (Figure 2) is a little more complex. Push-pull amplifiers operate mostly in AB or B mode; which means they draw only a small idle current and the current increases if a signal is applied. Each active component in the power stage amplifies only a half wave of the audio signal. Both half waves of the output signal are put together again in the output transformer. To ensure that each tube of the power stage gets the appropriate input signal, a phase shifter stage is necessary.

The voltages shown in Figure 2 are about what you might expect in a push-pull tube amplifier. The plate voltages will be approximately the same as the operating voltage, Va, (350V). Different types of tubes require different voltage values. The operating voltage may vary from 150V to 450V with different tubes.

Troubleshooting the push-pull amplifier

If you see symptoms pointing to a bad power stage in a tube push-pull amp check the plate voltages. If the plate voltages are there, measure the cathode voltages. The current through the cathode resistors (Rk1 and Rk2) supplies the control grids with bias voltage through Rg1-1 and Rg1-2. There could be a faulty resistor if the cathode voltage is too high or too low. There is also a good chance that a tube is bad. To find out, replace the tube, or, if you own a tube tester, check it.

The electrolytic capacitors across the cathode resistors provide a low impedance for the audio signal. If one or both of these caps are bad the gain can drop, or, in case of a short, the cathode voltage will not be present.

If you have checked all dc voltages and found them to be within specification, check the signals at the driver stage. Both signals at this point should have the same amplitude but the phase difference should be 180 degrees.

Be careful troubleshooting tube amps because of the high operating voltages. Except in the high voltage section of TVs and computer monitors and the line input of power supplies we are not used to high

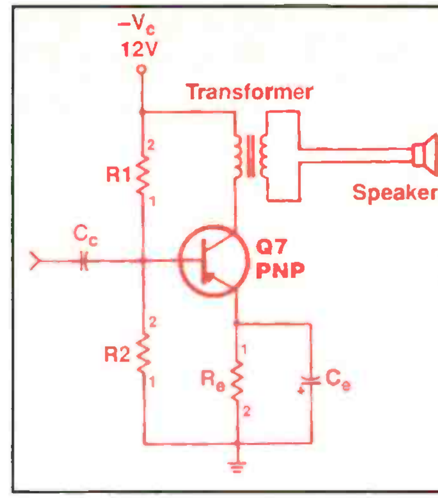


Figure 3. Audio power amplifiers in most systems sold today are solid state, they use transistors or power ICs. This is an example of a simple transistorized power stage configuration with output transformer.

Circle (64) on Reply Card

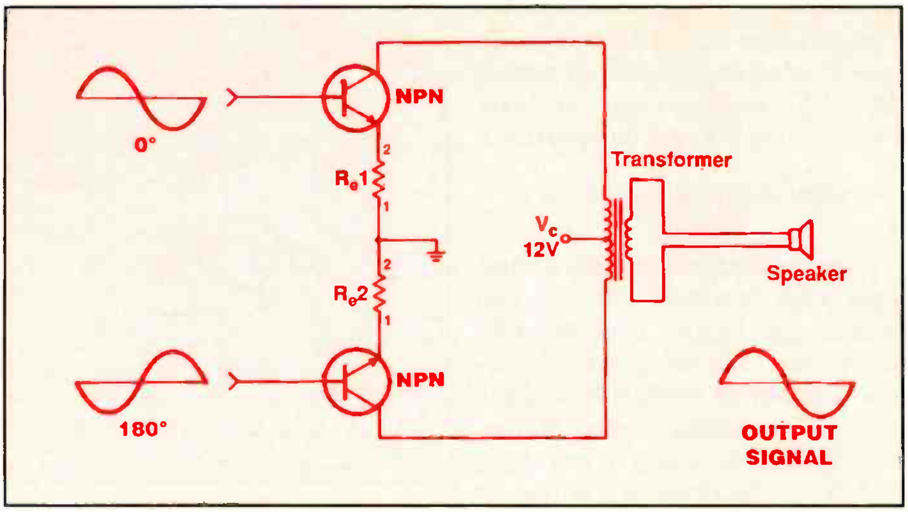


Figure 4. This circuit is that of a push-pull stage with output transformer. These circuits are similar to those with tubes. The active components are simply transistors instead of tubes.

voltages anymore. The voltages in Figure 1 and Figure 2 are approximate values and will vary depending on the design.

Transistor audio power amplifiers

Audio power amplifiers in most systems sold today are solid state, they use transistors or power ICs. Figure 3 shows a simple transistorized power stage configuration with an output transformer. The circuit in Figure 4 is a push-pull stage with an output transformer. These circuits are similar to those with tubes. The active components are simply transistors instead of tubes.

Circuits like these were used in older transistor radios. Transistor power stages with transformers are not used anymore in modern audio amps because the transformers are heavy and expensive, and add distortion to the signal.

Troubleshooting these power stages is similar to troubleshooting their counterparts with tubes. Keep in mind, however, that a transistor is controlled by a small current into the base instead of a control voltage at the grid of a tube. Of course the voltages in transistor amplifiers are a lot lower than those in tube amps.

Modern power amplifier circuits are transformerless, like the circuits shown in Figure 5 and Figure 6. These transformerless circuits are push-pull amplifiers. They usually work in class AB mode, meaning that a small quiescent current is drawn to minimize distortion at low output power (class A). At higher output power the amplifier goes into class B mode where the current drawn from the power supply depends on the amount of output power.

Transformerless audio power amplifiers

Complementary power transistors were not available during the early days of solid state audio systems, but their availability of complementary transistors (NPN and PNP) has now made is possible to design audio amplifiers using very simple circuits (Figure 5). The two transistors work essentially like two variable resistors controlled by the audio signal amplitude, each transistor for one half wave of the audio signal. At the positive half wave the NPN-transistor draws current and the PNP-transistor takes over for the negative half wave. The advantage of using complementary transistors is that no phase shifter is necessary to drive the power stage.

To use the advantage of complementary transistors in audio power stages, a pair of small-signal complementary transistors is used in the phaseshifter-driver stage to drive the NPN power transistors (Figure 6). The circuit of Figure 6 uses only a single power supply and includes an output capacitor to avoid causing a dc current through the speaker. The supply voltages shown in Figures 5 and 6 depend on the desired output.

Basic rules for voltages in transformerless stages

There are some basic rules for the voltages in transformerless power stages. If two supply voltages (Vc+ and Vc-) are used, the dc output voltage is always zero. In power stages with one supply voltage (Vc) the center voltage at both power transistors is always half of the supply voltage (Vc/2). That makes it easy to troubleshoot transformerless power stages even if you do not have a schematic.

If you suspect that the problem is in the power stage, check the supply voltage(s) first. Then check the voltage at the center node of the output transistors. In many cases you will discover that the dc volt-

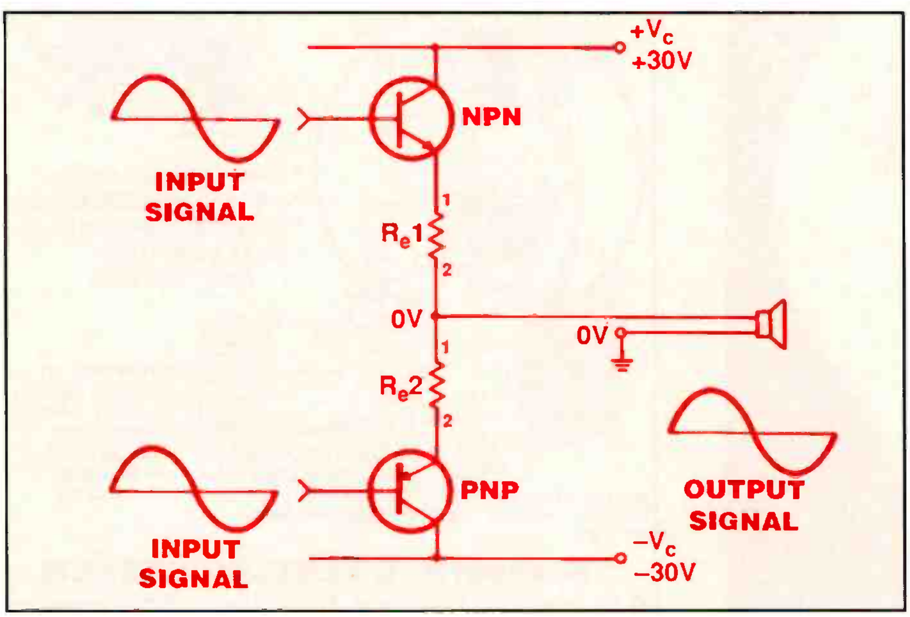


Figure 5. The availability of complementary power transistors has made is possible to design audio amplifiers using very simple circuits. The two transistors work like two variable resistors controlled by the audio signal amplitude, each transistor for one half wave of the audio signal. At the positive half wave the NPN-transistor draws current and the PNP-transistor takes over for the negative half wave.

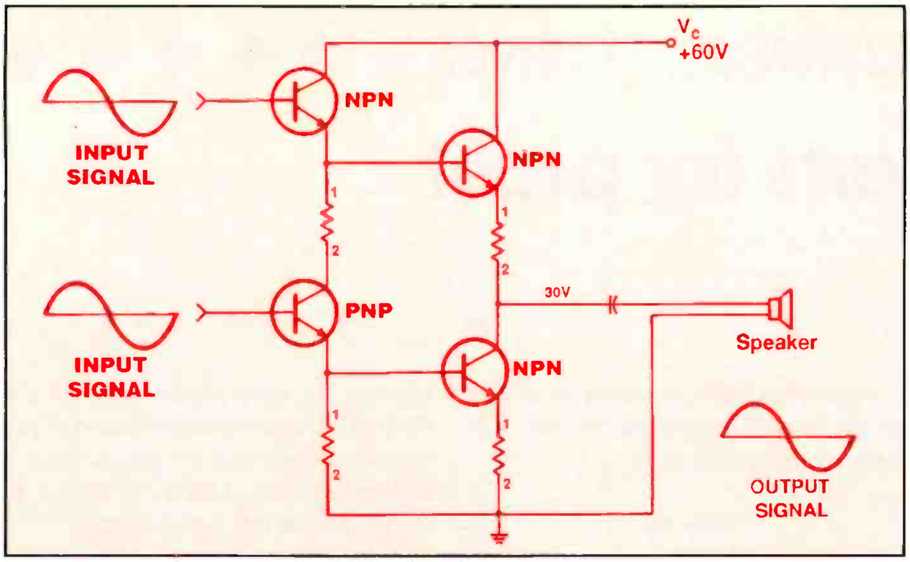


Figure 6. To use the advantage of complementary transistors in audio power stages, a pair of small-signal complementary transistors is used in the phaseshifter-driver stage to drive the NPN power transistors, as shown here. This circuit uses only a single power supply and includes an output capacitor to avoid causing a dc current through the speaker.

age at the output is either too high (almost Vc or Vc+ respectively) or far too low (0 or Vc- respectively).

A common fault in these cases is a shorted power transistor due to an overload or a shorted output. Sometimes these breakdowns occur after your customer has tried to rearrange his stereo setup. If this happens you know that he probably shorted one of the speaker outputs. Check the resistance between emitter and collector of the power transistors to determine which transistoris shorted.

Once you have found the shorted output transistor, check the corresponding driver transistor as well. It sometimes happens that the emitter-base or collector-base PN-junction of the power transistor breaks through causing the driver transistor to become overloaded. This overload results in an emitter-base short in the driver.

Audio power amplifiers with integrated circuits

Integrated circuits simplify the design of electronic equipment. Nowadays you will find that most audio power amplifiers are designed with ICs. These power ICs work basically like the transformerless audio power amps. Most of these ICs contain circuits to protect the power stage from overload and shorts at the output and from overheating.

A basic circuit of an audio amplifier with IC is shown in Figure 7. In this circuit two supply voltages are used (+Vc and -Vc). The dc voltage at the output is zero, as in the circuit shown in Figure 5. It is possible to operate some power ICs on one supply voltage similar to the circuit in Figure 6. An output capacitor would be necessary in this configuration.

In the schematic of Figure 7, only a few components of the surrounding circuitry of the IC are shown. You will find these components in most circuits. In this circuit resistor R1 provides negative feedback, and with R2 it determines the gain of the power amplifier. Resistor R3 holds the output on zero potential and stabilizes the dc output voltage.

The dc output voltage must be very low, ideally zero, because speakers cannot handle a dc voltage. The cone stays on one side if a dc voltage is applied to a speaker. If the dc voltage is too high the speaker can be permanently damaged.

Troubleshooting IC-based power amps

Troubleshooting power amplifiers with ICs is similar to troubleshooting a transformerless transistor amp. Power ICs contain the power transistors and the output pin is connected to the output node, similar to the circuits in Figures 5 and 6. You may check the internal output transistors in a power IC for shorts between emitter and collector in the same way you can check discrete transistors.

ICs are sometimes very complex and they are galvanically coupled inside. That makes it necessary in some cases to remove them from the printed circuit board to get an accurate reading.

Since stereo amplifiers always contain two identical power stages, troubleshooting is easy because you can use the good channel as a reference. If I find one bad channel I check the dc-voltages at each pin of the IC in the good channel and write the values down, then I write the values of the bad channel in the next column. Comparing the values I get a good idea of what's wrong with the amp. This strategy works for power amps with discrete components as well, especially if the schematic is not available.

We hope that this article will give you some guidelines for your next repair of an audio power amp. In future articles, I will provide some examples of my own practice in audio power amp repair. ■

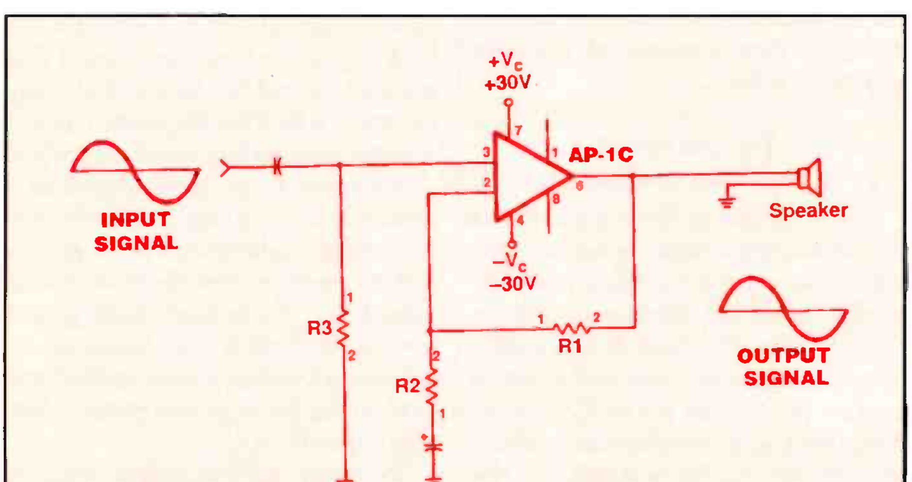


Figure 7. In this circuit diagram, only a few components of the circuitry surrounding the IC are shown. You will find these components in most circuits. Resistor R1 provides negative feedback, and with resistor R2 it determines the gain of the power amplifier. Resistor R3 holds the output on zero potential and stabilizes the dc output voltage.

Price your parts for profit

By Charles Varble, Jr.

Parts are a major factor in the electronic service industry today. They play a large role in determining whether or not you make a profit in your business. This article will examine parts from many angles and consider the many elements that must be factored into the cost of parts.

The price of parts on the distributor's invoice does not reflect the total cost of those parts to you by any stretch of the imagination. The amount on the invoice plus any shipping charge is the amount that it cost to get the part to the service center location, but this fails to cover much of the cost of obtaining the part. We will discuss the real cost in detail later.

Pricing parts - markup

Markup is one method of pricing items for sale; perhaps the easiest way to establish the price for parts. Using this approach, you add the markup percentage to 1 as a decimal amount, then multiply that times the cost price.

Let's say, that you wish to mark up items by 40%. Your multiplier would be 1 + 0.4, or 1.4. If an item cost $10.00, then its selling price would be $14.00 based on a 40% markup (1.4 x $10.00).

There are some major disadvantages to this method. Let's say, continuing with this example, that you decide that you want to sell this item quickly. You decide to have a 30% off sale, figuring that you will still make 10% profit on this item (after all, 40% - 30% = 10%, right?).

Unfortunately, it doesn't work that way. If you discount the selling price of $14.00 by 30% this will give you a discount of $4.20 and a net selling price of $9.80 leaving you with a loss instead of the 10% profit that you anticipated. How can this happen when your markup was 40% and you only gave a 30% discount? It's because markup was based on the cost of the product, while the discount was based on the selling price.

Varble is a retired electronics service business owner.

Margin

Margin is a better way of determining the selling price. Using this method, you divide the cost price by 1 (100%), less the desired margin. In the example above, with $10.00 as the cost price, if you wanted a 40% margin you would divide the cost price of $10.00 by 1 minus 40% (1 - 0.40) or 0.6. In this case, the cost is 60% of the selling price.

Using the margin method of pricing, the resulting selling price would be $16.67, which provides you with a forty percent margin on the sale. If you later decided to discount this price by 30%, the discount would be $5.00 and you would still have a 10% margin on the sale price which would be $11.67.

You will note that the $1.67 margin is still 10% of the original selling price of the product. Using margin to establish prices instead of markup, the same percentage gives you a greater gross margin and will never exceed 100%. Some people say that they just double the cost and this gives them a margin of 50% or a markup of 100%.

The true cost of replacement components

The actual cost of obtaining a product from a vendor for resale varies considerably. For most purchases concerning electronics repair, the distributor's invoice price is not your true cost. If your technician determines that you need a part to repair a product, he has to identify the component, look at a schematic to determine the part number, and then give this to someone to order.

The parts person then has to check the price sheet to see if this is a valid part number. The parts person may find that this part has been replaced by another part number. Sometimes the part number is replaced by a kit of parts that have to be installed when that part is needed.

After you have determined the correct number of the part to order you now have to place the order either by phone, fax or computer, but even this is not the end of the process. You have to talk to the distributor to determine the availability of the needed part. Many times the distributor does not have the part in stock and you have to try to locate it from a different source, usually from a different distributor and sometimes from another service company. The cost of determining the correct part number and locating the proper place to purchase it is the most significant cost when it comes to obtaining many small parts.

Shipping costs

Shipping costs are also a constituent of the cost of most parts. You may order a small part that has an invoice price of $1.80 and find an additional charge of $5.00 added to it for shipping and handling. If you elect to pick up the part with your own vehicle you have an even greater cost involved because in addition to the vehicle cost, you have the cost for the time that someone spent picking up the needed part.

Minimum charges are also added on to some invoices. You may find that the minimum charge, which could be as much as $20.00, greatly exceeds the charge for the needed part. The urgency of completing the repair sometimes outweighs the sound reasoning of waiting and accumulating an order so that you meet the minimum shipping requirement.

Receiving and checking in the parts when they are received and getting them to the technician also add directly to your parts costs. Someone has to check the parts in and verify that they are the correct parts as billed and then refer to the computer, purchase order, or parts list and see that they are delivered to the technician who is working on the product.

Obsolescence

Obsolescence is another factor that adds to parts cost. In the interest of reducing turnaround time, a service center may stock common parts used often for repairs. Eventually these parts will no longer be necessary, but there may still be some in inventory that cannot be sold. Does anyone want to buy some selenium rectifiers and tube brighteners? Vacuum tubes are an even better example of items that you purchased to sell and which now have little or no value. This cost of course must be factored into the cost of parts.

Shelf stock, shrinkage and damaged parts

The money you have tied up in stock parts so that you can offer your customers quick service is money that you can't invest elsewhere. And you pay for the cost of the space to store those parts. The cost to the average service center of maintaining shelf stock on parts has been computed to be around 25 percent of the value of the total inventory of parts per year, even while they are still active parts. This means if you have $25,000 in parts inventory, each year you also had a cost of $6,250 just to keep the parts in stock.

Shrinkage is also a cost that must be factored into your parts cost. This does not necessarily mean parts that are stolen, but includes parts that are lost or that are misfiled so that you can not sell them when you need them.

Free parts also add to the cost of all of your parts. If you blow a few fuses while troubleshooting the problem, do you charge the customer for them? When you install some new parts and the set still has an obscure short and destroys them, do you collect from the customer for these parts twice?

Re-service

Re-service also takes additional parts for which you do not collect. Even if parts that fail are covered by warranty, it is not cost effective to return them. Your time is worth more than the price of the parts. This proves that your true parts cost is not the invoice price.

Less costly parts

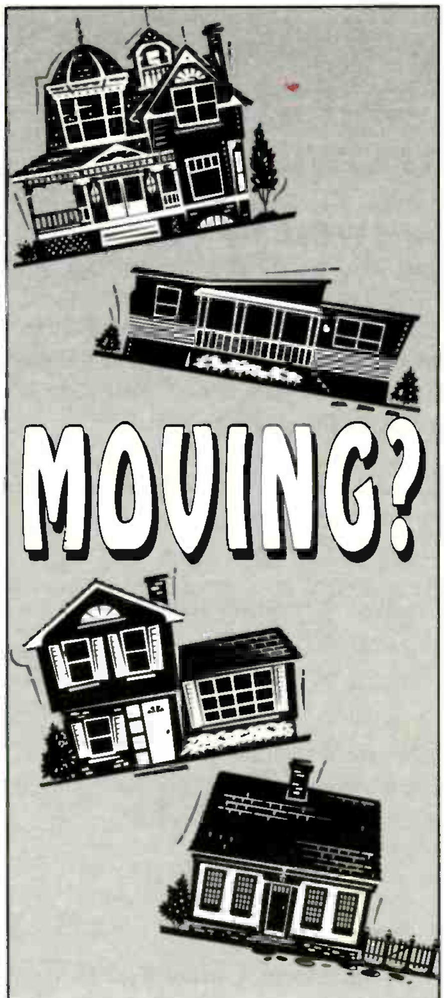
Not all parts that you sell have the above costs incurred. You may purchase rabbit ears a case at a time and figure a fifty percent margin and be very happy with the return. You probably buy fuses in quantity and sell them with a modest margin because the customers come in and purchase them to replace themselves. If you sold the fuse over the counter for your true cost you might get a reputation for being "high".

Picture tubes are an item that does not have your normal margin computed into the selling price. Although your margin on these items is smaller, it still produces more income because of the higher selling price. When pricing picture tubes, be sure to add the shipping charges and any charges incurred for the disposal of the old tube. Some manufacturers now have you return the old tube to another location for disposal. You will see that this will become a bigger problem in the future as the Environmental Protection Agency is considering ways to reduce the pollution that comes from many products that are used in electronics devices.

The pricing process

Of course you cannot take the time out to price every part that you order for your normal service repairs, however, you should take time to review how you are pricing parts now and see if the parts are returning the proper margin. If you have any people that order and handle parts exclusively then their total payroll costs must be applied to the parts burden. Usually people only handle parts part of the time, but that portion should be added to the total parts cost. Other expenses might include a computer that is used only for parts, or a portion of a computing system that also supports the parts function.

A review of your current pricing policy might surprise you. I had a friend who was giving his friends a discount on bat-



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Test Your Electronics Knowledge

Answers to TYEK

(from page 30)

1. A - The voltage and current values are marked on the scales as RMS values. However, the amount of deflection is related to the average value.

2. B - Edison; for a man with very little formal education he was a great technician for his time.

3. Yes. Remember that 2π radians = 180 degrees.

$$2\pi f = \frac{2\pi}{T}$$

Where T is the time for one cycle of one waveform, f is the frequency of the same waveform, and T = 1/f.

$$\frac{2\pi}{T} = 2\pi + \frac{1}{f} = 2\pi f$$

4. One ampere. Current is the same in all parts of a series circuit. For the resistor,($I = V/R = 1V/1\Omega$) and for the lamp: $I^2 = P/R = 1A$. (negative value discarded)

5. Area in circular mils = D^2, where D is the length of the diameter in mils

$A = (100)^2 = 10{,}000$ cir mils

6. Remember that π radians = 180°.

$$47^\circ \text{ x } \frac{\pi \text{ radians} = 0.82 \text{ radians}}{180^\circ}$$

7. In any order:
- Cross sectional area
- Length of the wire
- Resistivity of the wire material
- Temperature of the wire

8. B - You cannot add quantities in polar form! To solve the problem convert each to rectangular form and add.

9. C - Power Factor, or, Cosine of the phase angle.

10. Omega(ω) = $2\pi f = 2\pi \times 60 = 377$

teries thinking that he was still making a small profit on them, but he was actually selling them at a lower price then he paid for them. If you do not have firmly stated policies on pricing and discounts then they should be established. If you have always sold fuses for \$.50, you will be shocked when you discover the net cost of some of the ones you purchase today.

Pricing formulas

Formulas for pricing parts have been used for years. Some companies sell a pricing system that gives the price of the most common parts and gives you the ability to compute the price on parts that are not listed. These systems are updated yearly and some even have a service available that updates them monthly or quarterly. The cost of these systems is certainly justified by the updates and the gross return on all of the parts when analyzed on a yearly basis.

Most of the pricing systems that are available give the dealer the opportunity to choose the margin that he needs for his business and area. Some small shops have their own formula, such as \$2.00 plus 5 times the invoice price for a part that costs less then a dollar. The multiplier decreases as the cost increases.

Pricing modules

Modules are not as prevalent now as they were a few years back when most manufacturers used them in their sets, but they're still around. Many service companies used a margin and also a flat dollar amount on each one.

If the margin was 40% and the flat charge was \$4.00 then a module that costs \$12.00 would sell for \$24.00. The \$12.00 divided by 0.6 (1 - .04) equaled \$20.00 and then the \$4.00 charge was added to give a selling price of \$24.00.

Modules need a special formula because the manufacturer requires you to turn the old one back in, which requires handling and sometimes a shipping charge. Moreover, manufacturers refuse some modules either because they are obsolete or they were damaged or soldered on and were not an "acceptable dud".

Modules are another good example of items that are usually carried in stock and have become obsolete. With modular sets you were expected, even required by most manufacturers, to carry a full line of replacements in your inventory for rapid repair of the products. But now, the manufacturer or distributor won't even take them back for credit.

Manufacturer pricing

Manufacturers price parts based on their needs. They do not consult anyone to see if these prices are acceptable. Manufacturers of course buy in OEM (original equipment manufacturers) quantities, thereby receiving the very lowest price on the items that they purchase. They have a cost analysis report on their procedures and they know exactly how much margin they have to put into each part that they sell. They would never sell a part with only forty percent margin in it because they could not afford to.

Of course manufacturers have most of the problems that you do with parts, and obsolescence is an even bigger problem for them. In the past they initially ordered a long-term supply of replacement parts at the same time they ordered the parts to manufacture the sets. Now the MBA's have told them that they should only order a small supply of parts and reorder them later as needed, raising the prices as necessary to cover any additional costs.

Parts should stand on their own

Service income should not be used to subsidize parts, nor should parts subsidize labor income. In a well run business each segment produces the necessary income to pay its own way. Many years ago the sale of tubes frequently subsidized the labor income and today usually the reverse is true.

Profits are necessary for you to stay in business and give good service to your customers. You must price your parts so that they pay all of the expenses and still return a profit. You are not doing your customers a favor if you charge lower prices and then go out of business because you did not make a profit. ■

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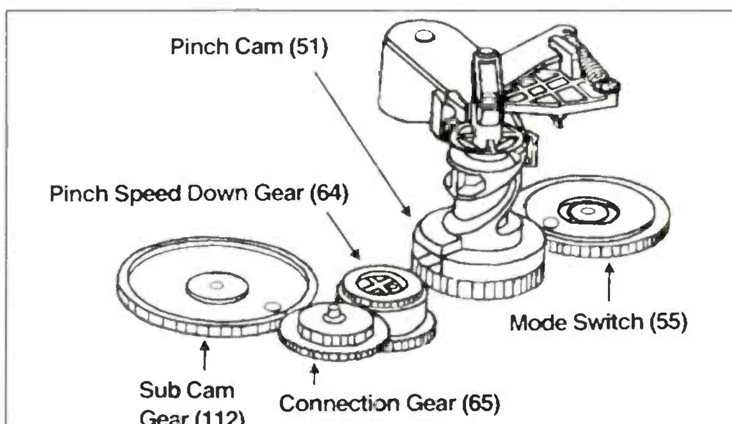

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Circle (26) on Reply Card

Look what's on the 'Net'

By David F. Norman

What's on the Web for Electronic Servicers? One of my favorite sayings when discussing the Internet with newcomers is that the Internet contains the sum total of the knowledge of mankind. In truth, that is a slight exaggeration, but only slight. As new resources are added to the World Wide Web, the pretty face of the Internet, each day brings new wonders.

However, there is still a major problem: a lot of these goodies are hard to find. Perhaps someday a perfect catalog system will exist that will automatically make finding everything you want to know about anything on the web as easy as looking in your Yellow Pages. Then again, probably not.

Search engines

There are literally hundreds if not thousands of "search engines" on the Web. Typically the way they work is to offer you a form in which you enter "keywords" pertaining to the information you are seeking.

Norman is an independent computer consultant.

For example, if you access Yahoo, http://www.yahoo.com, and enter "television service," you get a listing of sites mostly concerned with television services such as production editing, etc. If you enter "electronic repair," you will get a much smaller listing of sites concerning automotive electronic repair, a few actual servicing shops such as InfoSouth (http://fly.hiwaay.net/beangl/infosouth.html) a shop located in Madison, AL, and other listings which may or may not be of any use to you.

If you use the same keywords at InfoSeek (http://www2.infoseek.com/) another search engine, "+television +service" gets you a long list similar to and including some of the same references as that found by Yahoo. Entering "+electronic +repair" will give you a list of documents or page titles which contain both words somewhere in the text. Some of the later listings are pointers or links to manufacturers or service companies, but occasionally you will find a real jewel.

One of the links, number 50 of 100, is to: Rec.antiques.radio+phono FAQ (http://www.ce.washington.edu/davidb/rarp_faq.html) which is a collection of newsgroup articles with a wealth of information for collectors of antique radios and phonographs. In short, the information is where you find it, but you may have to hunt for it.

Another interesting site I came across is Leper's Schematics (http:// www.wwu.edu/n9343176/schems.html). This site has a lot of schematics diagrams for older guitar amps and accessories. The Armstrong Green Ringer shown in Figure 1 is one example.

Schematics on line?

According to some recent reports, we will soon be seeing commercial service information on the Web. Actually, almost any illustration can be scanned and saved as a picture file. This brings closer the day when much of our information will be stored in easily indexed files on personal computers and larger systems accessed online. This strikes me as a good idea if

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Figure 1. I found this schematic on the web, made up completely of printable characters using a non-proportional font. It shows a way to turn telephones into intercoms.

Armstrong Green Ringer

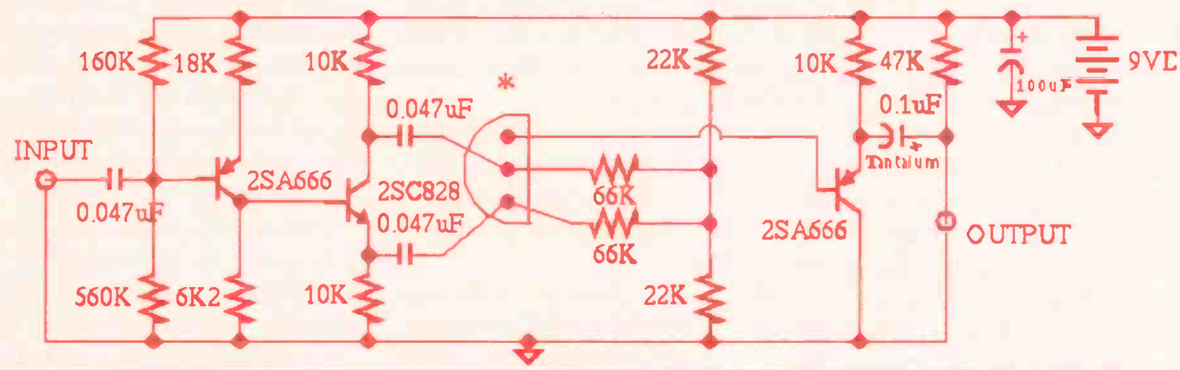

Figure 2. This is a schematic of a guitar amplifier taken right off of the internet.

for no other reason than the fact that you can get the specific schematic you need without having to file and store thousands you will never need.

I decided to search for "schematics" and see what rose to the top of the cauldron. One of the links provided a series of "ASCII" schematics. This type of schematic is drawn using printable characters, and works as long as you use a non-proportional font such as Courier or Lineprinter. From ASCII Schematics

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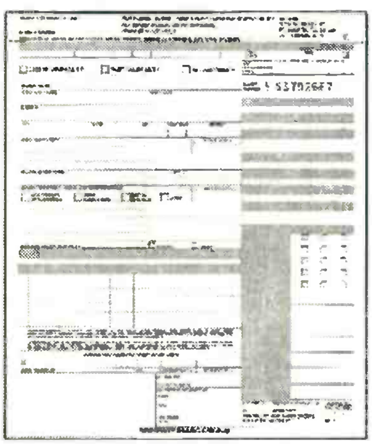

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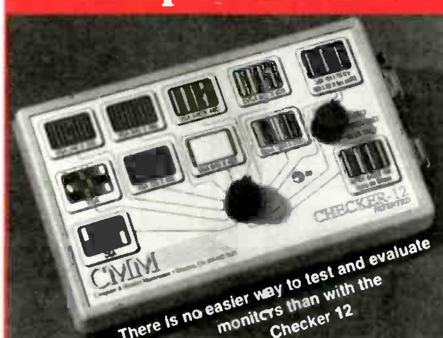

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Circle (52) on Reply Card

(http://alpha.smi.med.pitt.edu:9000/SCHEM/), I got the little gem shown in Figure 2, which shows a way to turn old telephones into intercoms.

Service centers on the web

What else is out there? A search for "vcr service" on Webcrawler (http://webcrawler.com) gave me a list of 25 resources out of a possible 2143 it found. One which struck my eye was "Welcome to Video Tech on the Internet" (http://www.polaris.net/user-www/vidtech/). This page introduces the company, located in Tallahassee, FL, and has a list of the products on which they do authorized warranty repairs. As a customer service, the pages also contain a link to Sony Online (http://www.sony.com).

Looking for marine electronics

Here is a shot in the dark. Once upon a time, I made a pretty fair living as a marine electronics technician. Plug and play mail order pretty well made me a dinosaur; that and time. I thought that a search for "marine electronics" might be fun. Let's see what we find.

Well, well. I got 25 out of 650 documents using Webcrawler. Most were references to government documents at military Web sites. One document looked like a pretty good idea.

The idea at the page is to enter the type of marine product or service you desire, add your location, and the query will return the facility nearest you offering such goods or services.

It didn't work! Actually, I don't hold that against them at this point, as so many of these sites are still in the startup stage and not fully operational. Before I put *my* site on the internet, it was ready. Okay, it was *nearly* ready.

Another site I checked was listed simply as Marine Electronics so I checked it out. This one is the type of company that put me out of business as a marine electronics technician; another plug and play mail order house. Thus, this particular company shall go unnamed in this article. Which petty little revenge, by proxy probably, brings me to another point.

Should you be on the web?

If a large service organization is to compete with the really big guys, said company had better consider getting some sort of Web Presence. Even if you normally only service a finite area geographically, a Web presence can't hurt.

So you live in Dodge City, KS, and your company only does warranty repairs on microwave ovens. So why should you have a Web Presence? Check it out.

Henry and Jenny Smith are traveling cross country in their motorhome and the microwave has gone on the fritz. Henry picks up his cellular and calls his daughter in Winston-Salem.

"Hi, Sweetie. Look, do me a favor. We are going to be spending all day tomorrow in Dodge City. Your Mom wants this microwave fixed. Can you do a search on the Internet and see if you can find an electronics repair place here that does this type of work and get back to me. You have that roaming guide I gave you? Fine. Talk to you later."

Does Henry's wife get her nuker fixed? I don't know? I only got one transmission over my crystal ball before *it* quit. That's not the point.

The point is that in this increasingly smaller world we live in, every business' potential market goes far beyond its local area. The farther you live from a major market area, the more important it is to let those who may be passing through know what you do.

If you live in a major market, you have to keep up with the competition. If you have nationwide 800 service, you are already after the world's business. The Web is just another tool and it costs less than you might think to have a Web Presence.

I will use my Web site (http:// www .gunnyragg.com) as an example. In Bakersfield, CA, the going rate for a set of Web pages is about $45 per month. I usually charge $200 as a setup fee if I have to design the pages. If the customer can maintain his own pages, make changes, additions, deletions, the monthly fee is all it costs him. If I have to maintain the pages, I charge $25 additional per month.

Nationwide, these rates vary. In some areas, usually major markets, pages go much higher; in other places a little less. If you don't have a local provider you can live with and your Internet Access is limited to America Online or Compuserve, don't despair. Several of the customers using my system and others in this area are located elsewhere.

One large computer mail order outfit in New York keeps their pages here in Bakersfield. Where you are and where the Presence Provider is mean absolutely nothing. What is important is the type of service you get from your provider and the effort he makes to get traffic to your pages. Just because you build it doesn't mean they'll come. They must know where to find you on the internet.

InfoSouth is a perfect case in point. Most of the searches I conducted using several different search engines turned up InfoSouth. Someone did their homework. When you decide to get your business on the 'net,' do your homework, at least when it comes to selecting the company that will be your Web Presence Provider.

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What Do You Know About Electronics?

Integral Calculus

By Sam Wilson

For a while now I have been discussing calculus because I believe a better understanding of math may improve your understanding of electronic fundamentals.

I have explained that differential calculus can be used to tell the rate of change of one variable with respect to another variable. I have also shown that you can find that rate of change graphically and with reasonable accuracy. I will have more to say about how differential calculus helps your understanding of electronics as this math series develops.

Integral calculus

At this time I want to start a series on *integral* calculus. One way to get into this subject is to look at the way integral calculus is taught in text books. I will start by using the book I used in college.

The book introduced me to this subject by telling me that integral calculus is "the opposite of differential calculus." It goes on to say: "Just like subtracting is the opposite of adding, and, dividing is the opposite of multiplying, integral calculus is the opposite of differential calculus."

I was off to a bad start right from the beginning. I didn't believe any of those things and I don't believe them now.

Subtracting can be accomplished by *multiplying* (by -1) and *adding*. Dividing is more like *multiplying* by the *reciprocal*. Those things don't sound like opposites to me.

I think what the author was trying to say is that *in some cases* you can solve an integral calculus problem by reversing the process used to find a derivative. In other words, by using some very fancy footwork you can work backwards from the derivative to get the integral.

Finding the derivative

Let's look at the rule for finding a derivative. Previously in this series I showed you how to find a derivative by using a graphical method. The mathematical way of finding a derivative is given here:

Assume you are given the equation $y = x^n$. In this case the derivative can be expressed as

$$\frac{dy}{dx}(x^n) = nx^{(n-1)}$$

So if $y = x^5$, using the above relationship, $dy/dx = 5x^4$. To arrive at this just multiply x by the original exponent (5) and subtract 1 from the exponent to get the new exponent.

Exercise problems

Find dy/dx for the following:

1. $y = x^3$ - answer: $dy/dx = 3x^2$
2. $y = 3x^5$ - answer: $dy/dx = 15x^4$
3. $y = 3x$ - answer: $dy/dx = 3x^0 = 3$

Note: any number that is raised to the zero power equals 1.

You may need a lot more practice if you haven't done this type of problem before.

The math rule for integral calculus

Now we can give a math rule for integral calculus based on the reversal of the math procedure for finding a derivative.

$$\int x^n\,dx = \frac{1}{n+1}x^{(n+1)}$$

Now you can work calculus problems without knowing anything about the subject. Here is the solution of an integral calculus problem. Observe that it can be worked without knowing anything about calculus except for the rules I have given.

$$\int 3x^2 = \frac{1}{2+1}x^{(2+1)} = \frac{1}{3}x^3$$

By following the equations for the two types of calculus (differential and integral) you can actually solve calculus problems without knowing any thing about the subject.

Stay with me a little while longer. We will now work with the answer and the problem for number 1. If I'm right, we should be able to take the derivative of the answer and get back to the problem. We will use the math method of finding the derivative.

$$\frac{dy}{dx}(1/3x^3) = (3x1/3)x^{(3-1)} = x^2$$

What we have done is take the derivative of the answer to an integral problem and got back to the original problem. Clear as mud. We have shown that you can start with the answer and got back to the problem without any mention of why we would want to do that. Also, we can solve a problem in integral calculus and prove that we figured out the right answer without really understanding what we can do with the information. Remember, I'm following the text book.

Integral calculus through graphic solutions

Now I am going to use graphics to solve a problem in integral calculus. By doing

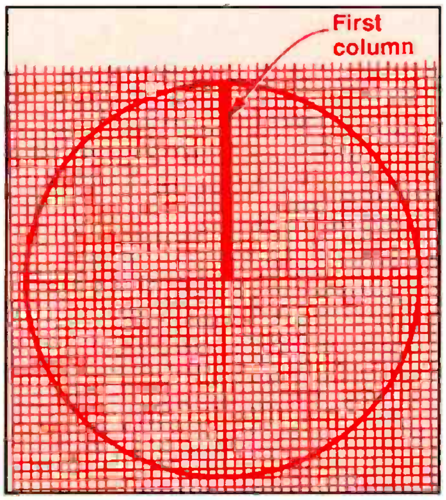

Figure 1. A graphical approach makes it possible to get an approximate solution to a calculus-type problem without calculus. In this case, the area of the circle is approximately equal to the sum of the areas of the small squares bounded by the circle.

Wilson is the electronics theory consultant for ES&T.

this I believe I can give you insight into integral calculus and at least one thing you can do with it.

The only way integral calculus really started to sink in for me was to read the history of mathematics. In the history book—under the subject of astronomy—I learned that the first practical application of integral calculus came from an astronomer, Kepler. He needed to find the area of sections inside an ellipse and he learned that a brilliant mathematician, Newton, had already shown the way to a solution with calculus.

In the next issue I will finish that story. For now, I will show you how it works by finding the area inside a circle. I will use a graphical solution of an integral calculus problem to solve it.

To be fair, you should know that there are better graphical solutions than the one I am giving here, but, this one is easiest to understand.

Problem: Use graphical method of integral calculus to find the area of the circle in Figure 1.

Solution: Observe that the circle has been drawn on a piece of graph paper. All of the little squares have exactly the same area. I used the sides of the squares as the unit of distance, and I counted the squares in each column in the quarter circle.

For example, I counted 22 squares in the first column. By the time I had finished counting I found that there were 398 little squares in the quarter circle. I multiplied that by four to get the total number of squares in the complete circle. That gave an area of 1592 squares (or, square units). So, the circle has an area of 1592 square units.

The next step is to check my answer.

You will remember from grammar school days that the equation for the area of a circle is:

$$A = \pi r^2,$$

where A is the area and r is the radius. I counted 22 units for the radius. Therefore, the area is:

$$A = 3.14 \times (22)^2 = 1521 \text{ square units.}$$

The percentage error between the graphical integral calculus method and the arithmetic area is slightly less than 5%. One error is due to estimating parts of squares. Another is the wide line that defines the circle.

Remember—I have told you there is a more accurate method coming!

The integral calculus symbol in mathematics is shaped like the letter S. See Figure 2. It is purposely designed to look like an S and it stands for Sum. One of the processes important to integral calculus is to find the sum of the square areas. That was just shown with a graphical solution.

At least we now know one thing you can do with integral calculus. That puts us on page 114 in my college text book. However, we did it by side-stepping many, many practice problems.

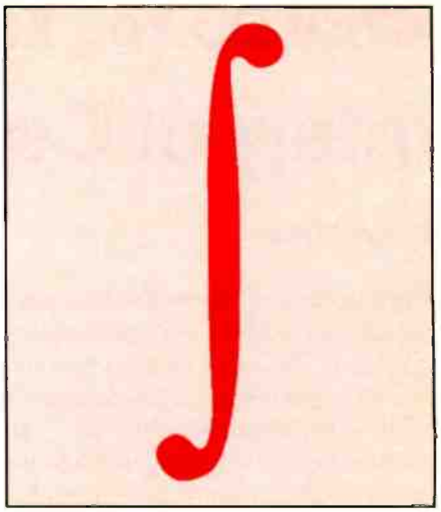

Figure 2. The symbol for integration resembles the letter "S" because it stands for "sum".

Calculus is useful in electronics

Here are two examples of how integral calculus can be useful in electronics:

A. In a hysteresis curve the open area between the individual curves is directly related to the hysteresis loss of an iron-core coil. That area between the curves can be dermined by integration.

B. Using integration, you can show how the average value of a half cycle of sine wave current can be determined.

To be continued

A tourist in New York city who was looking for directions walked up to a hippie character who was carrying a case for a musical instrument and asked, "How do you get to Carnegie Hall?"

Hippie: Practice, practice, practice.

Next question—How do you get to be proficient in math

Note: I do not propose to give a graduate course in integral calculus in this series of articles.

I want to give you some basics to get you started and show you some useful things you can do with calculus. If you find the material interesting and want to go further than I will take you in a few lessons, be advised that you can take a full range of math courses through a correspondence course. Also, there are now some excellent calculus courses on video. ■

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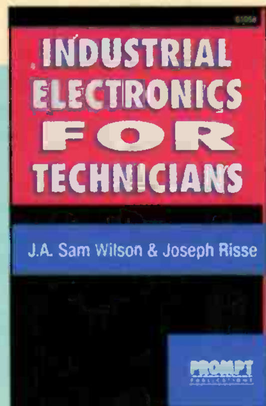

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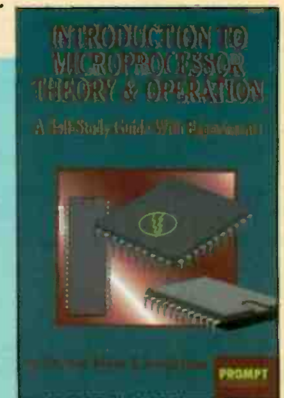

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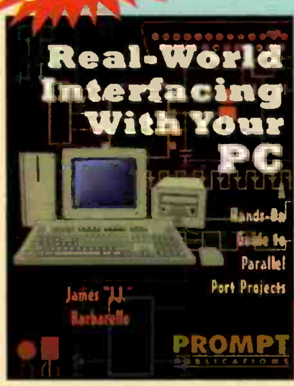

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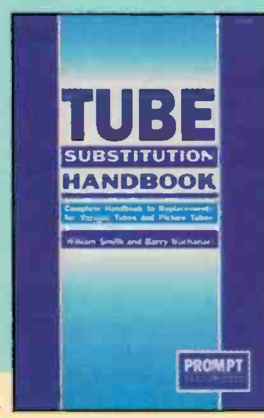

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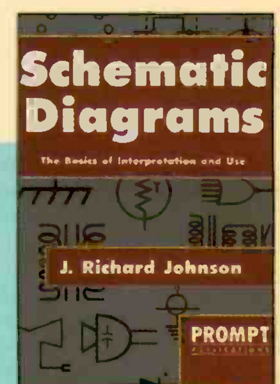

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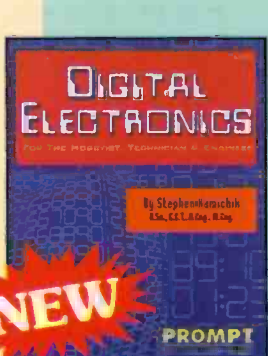

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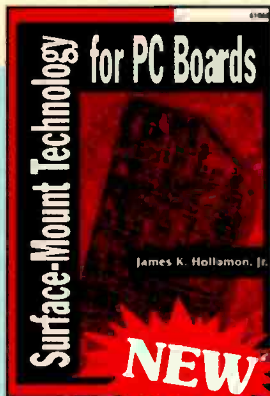

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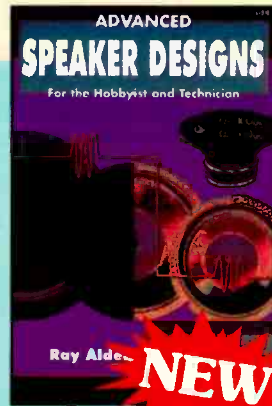

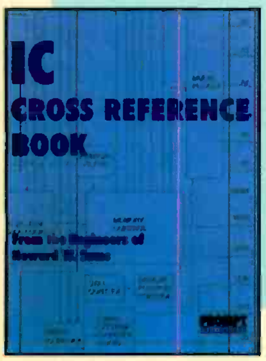

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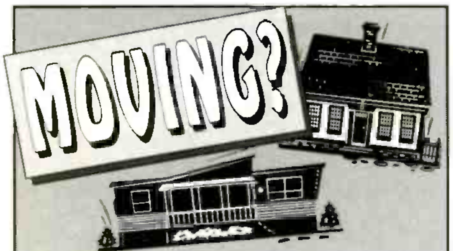

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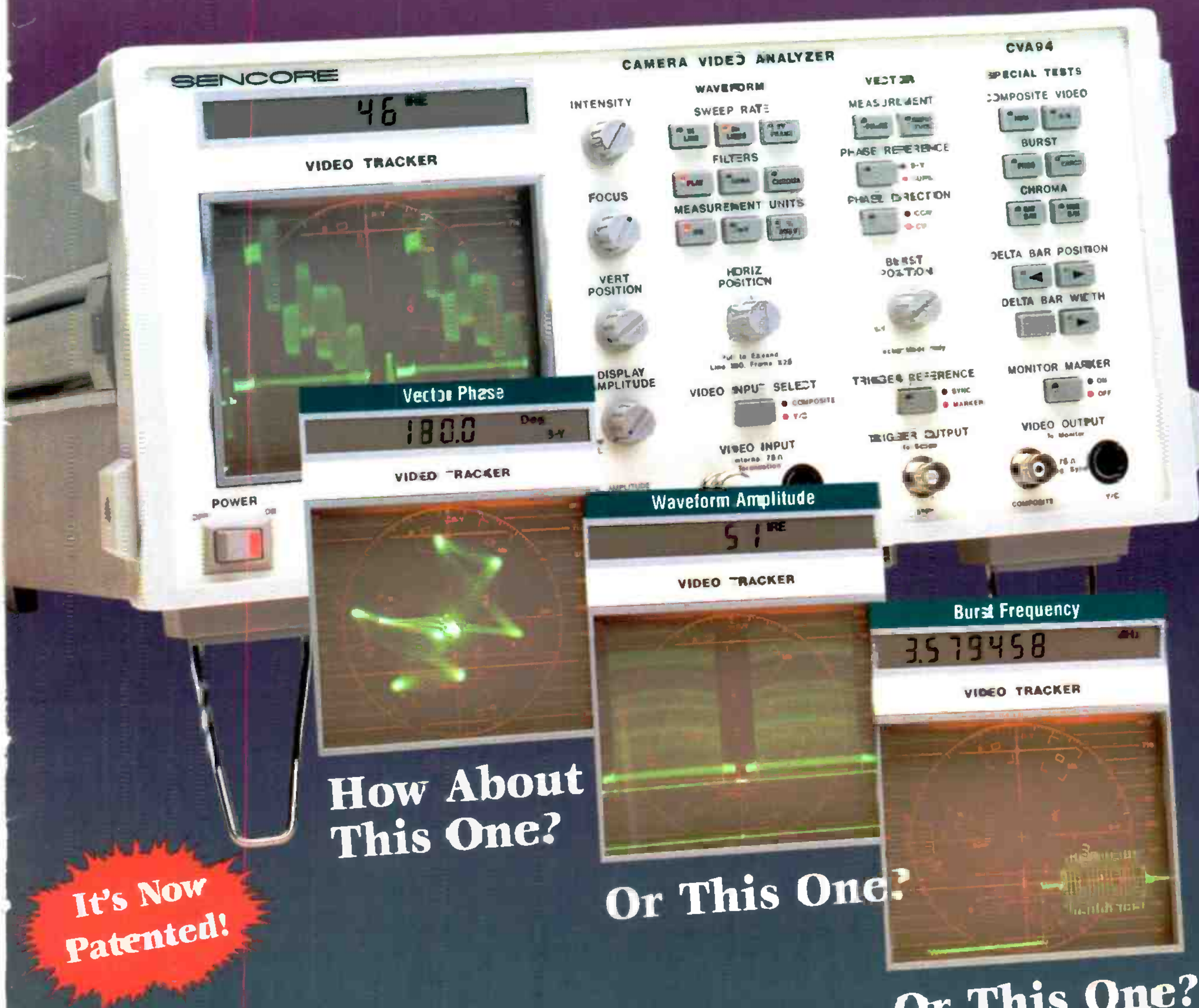

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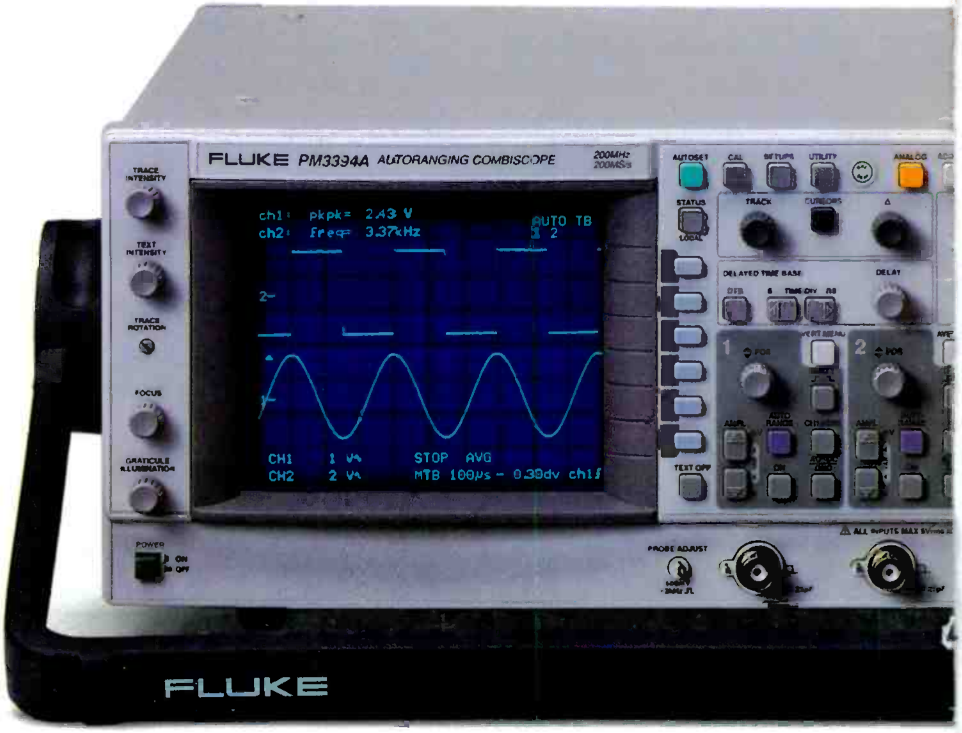

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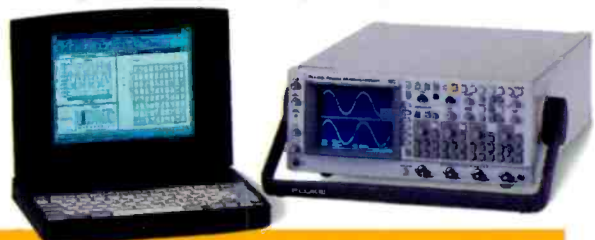

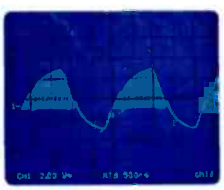

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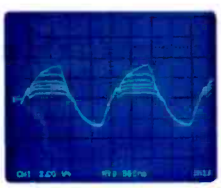

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