The how-to magazine of electronics...

ELECTRONIC Servicing & Technology

AUGUST 1986/$2.25

Horizontal and color, RCA CTC107 • Satellite receiving antennas

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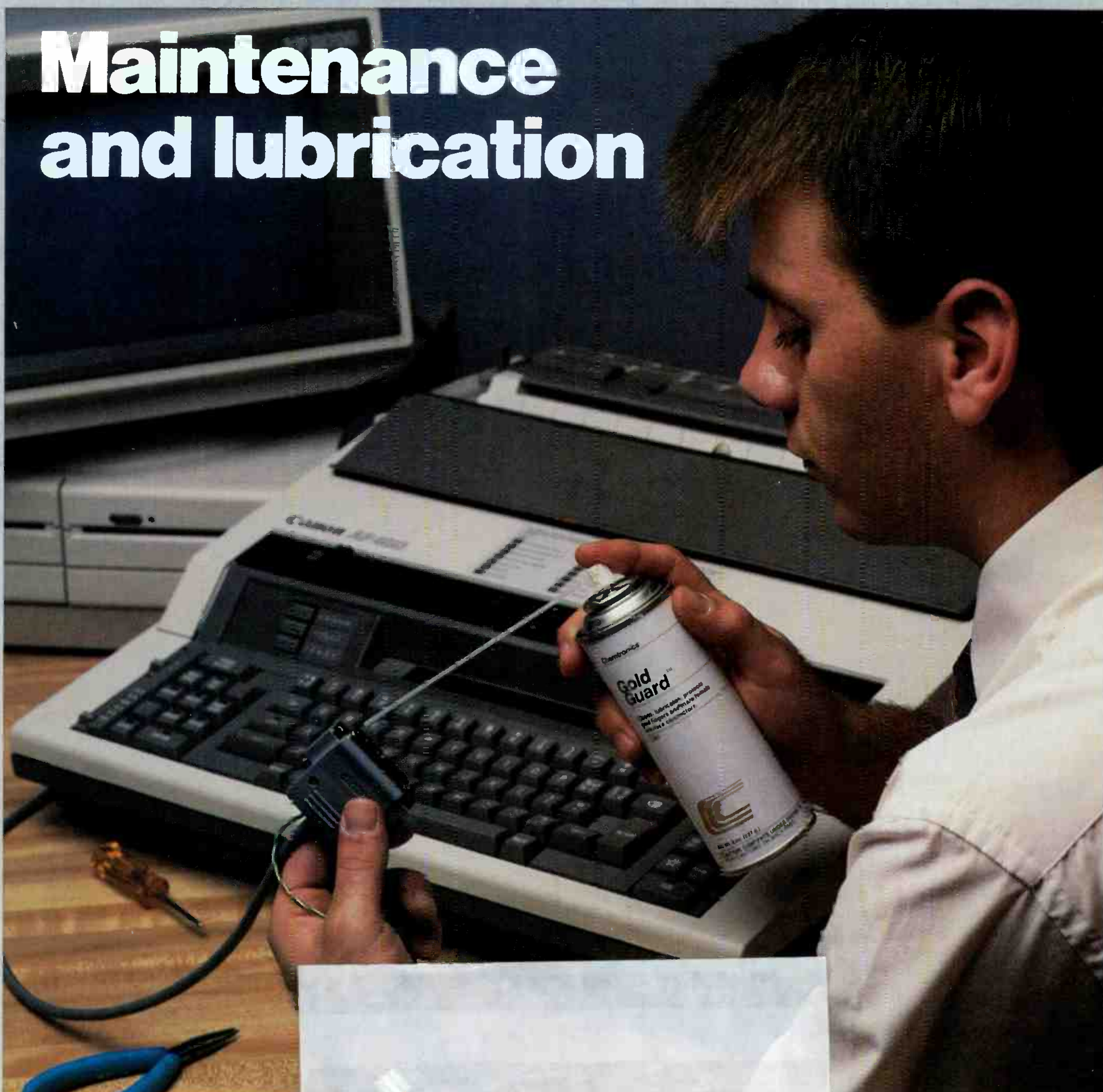

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The how-to magazine of electronics...

ELECTRONIC
Servicing & Technology

Volume 6, No. 8 August 1986

Page 22
Top-quality products, technical knowledge and a deft hand are requisite when maintaining electronic equipment.

Page 9
To capture any desired image from TV screen or videotape, press a button on this Digital Video Copier. *(Photo courtesy of Toshiba Corporation.)*

Departments:

News

Hitachi to produce VCRs in U.S.

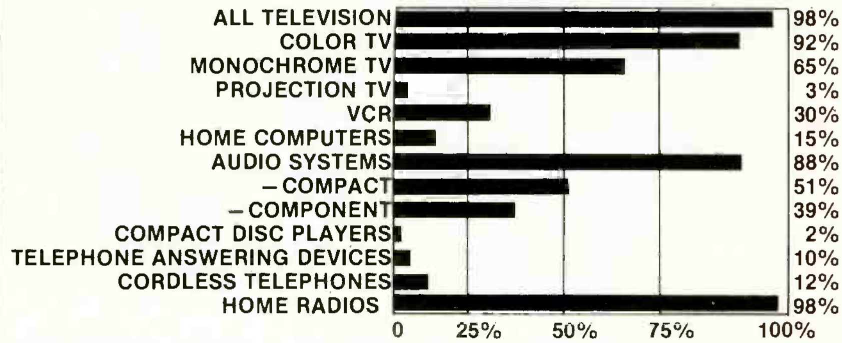
Hitachi announced that its wholly owned subsidiary, Hitachi Consumer Products of America, (HCPA) has begun VCR production in Anaheim, CA. Hitachi is the first company to produce VCRs in the United States.

HCPA initially will produce 100,000 VCRs per year at its Anaheim plant. The plant currently annually produces 140,000 color TV sets and 60,000 projection TV sets. The company invested about $1.5 million in setting up the VCR production facilities.

"Expansion of VCR production in the United States is an integral part of our international strategy in the consumer electronics field," said Shoei Yashima, senior executive managing director and chief of consumer products operations at Hitachi in Tokyo.

Kazumitsu Minami, president of Hitachi Consumer Products of America, said the production of VCRs in the United States represents a "strengthening of HCPA's position as a manufacturer of consumer electronics goods...HCPA hopes to expand its workforce in Anaheim as well as its purchases of U.S.-made components for the new manufacturing line."

Estimated household penetration by product
(AS OF JANUARY 1986)



Source: "Consumer Electronics Annual Review," EIA/CEG

Two up-and-coming classifications are not included in this list because they are still relatively new on the consumer scene: camcorders and cellular telephones.

Camcorders represent a new breed of portable VCR; it is the combination camera-recorder that has replaced 2-piece camera/recorders in popularity. Now available in Beta, VHS and 8mm formats, camcorders were tracked separately from video cameras for the first time in 1985 sales: Approximately 400,000 were purchased last year.

Cellular telephones are in demand for business use, but still are too expensive for most consumers. As the number of areas increases where cellular radio services are offered and as sales rise, pricing is expected to decrease to consumer-affordable levels. ES&T

ELECTRONIC Servicing & Technology

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INTERTEC PUBLISHING CORPORATION

Feedback on "Feedback"

In the July 1986 issue of ***Electronic Servicing & Technology***, we reinstated a department that we formerly published: our "Feedback" department (letters to the editor). I really don't have any explanation of why we discontinued it; it just fell by the wayside.

And that's too bad, because we find letters from readers to be immensely helpful, and many of them deserve to be shared with other readers.

Some of the letters we receive are complimentary. We like those, naturally. For example, there are those letters from readers who have found a particular article to be not only interesting and informative, but that actually has provided specific information useful in correcting a problem which previously had been unsolvable.

We really can't say that we like to receive *un*complimentary letters: letters that point out that we've made an error in an article, or that we made reference in the text to a figure that was seven pages away from the text that described it, or that we left it out altogether. And we really don't like to receive letters that suggest that we have been misconstrued. For example, last month's Feedback contained a letter from a gentleman who felt that an editorial in an earlier issue suggested that we viewed servicing technicians as "reckless" (that's not at all the case).

No, we don't like to receive letters like that, but we're glad that you send them. It tells us that you're reading the magazine carefully and that you care deeply enough about what we publish to try to correct us when we're in error. And it lets us know when we've in fact made an error, or haven't made ourselves clear so that we can correct the error or clear up the misconception.

And other kinds of letters are helpful too. There's one in this month's Feedback department that provides information and suggestions supplementing Joe Carr's article, which appeared in the February issue of ***ES&T***, entitled "Splish, Splash," on salvaging water damaged electronics products.Some of your letters suggest specific articles that you'd like to see us publish. While we can't promise that we'll be able to fulfill specific article requests, we'll certainly give serious consideration to any such requests that we receive. It is, however, entirely possible that a request by one of our readers will be used as an idea for an article. After all, the technicians who are working every day on sick electronic products know better than we do what kind of information they need.

So, if you have something to say to the editors of ***ES&T***, to any of our writers, or to other readers, write. Who knows, your letter might help other readers, or even yourself.

This seems like a good place to state ***ES&T***'s editorial policy about letters from readers. Any and all letters addressed to ***ES&T***, or to any of ***ES&T***'s writers concerning subject matter published in ***ES&T***, are considered by the editors to imply consent by the writer to publish the contents of those letters in ***ES&T***, including the name and city of residence (not only in the Feedback department, but in any article or other department). However, if you wish to write to anyone connected with ***ES&T*** and *not* have your comments published, simply tell us that you don't want your letter published and we will honor your request.

But we would like to hear from you either way, so write.

Nils Conrad Persson

Technology

Make instant color prints from your TV screen with the

Digital Video Copier

Photo courtesy of Toshiba Corporation.

This new device electronically produces vivid color prints directly from images on a TV screen or videotape. Developed by the Toshiba Corporation of Japan, in cooperation with the Polaroid Corporation, USA, the Digital Video Copier combines the photographic technology of Polaroid with Toshiba's digital memory technology. The prints show remarkable resolution, according to reports; brightness, contrast, hue and chrominance can be adjusted as desired while the image is frozen on the display screen.

Toshiba foresees a broad range of applications where it is important to capture images: from data-processing equipment, medical equipment, computer graphics and office equipment as well as for storing TV/broadcast information and obtaining hard copy of video camera images.

The system can be operated with the touch of a button. It incorporates just three main components: a video signal memory circuit, a 3.5-inch picture tube and an instant camera that uses Polaroid's 3" x 4" instant color film. When the VIDEO COPY button is pressed, the TV image is captured instantly and stored in the digital memory circuit.

The digital memory circuit can store 1.34Mbits of information: 256K x 5 plus 64K x 1. The stored image is resolved into its three primary color components, red, green and blue, which are converted separately back into analog signals. These are then displayed sequentially on a B&W CRT. An RGB filter is rotated in synchronization with this sequence, exposing the three primary colors onto the film. (See diagram).

The reportedly perfect color registration is achieved because all three primary colors are exposed at exactly the same place on the film, causing no color-shear errors. Because of the high-capacity digital memory and sophisticated microprocessor, each picture element can be reproduced with 128 gradations, offering vivid, accurate photographs from picture signals in the NTSC TV format, or RGB signals that come directly from a personal computer.

Heretofore, photographs of images on TV screens could only be made by photographing the TV screen with a camera, or by making a hard copy of the digitized picture signal, using a thermal-transfer printer. Neither method was totally satisfactory.

Soon to be released: a special 35mm camera that can reproduce TV pictures on conventional film, making it easy to produce multiple prints or slides.

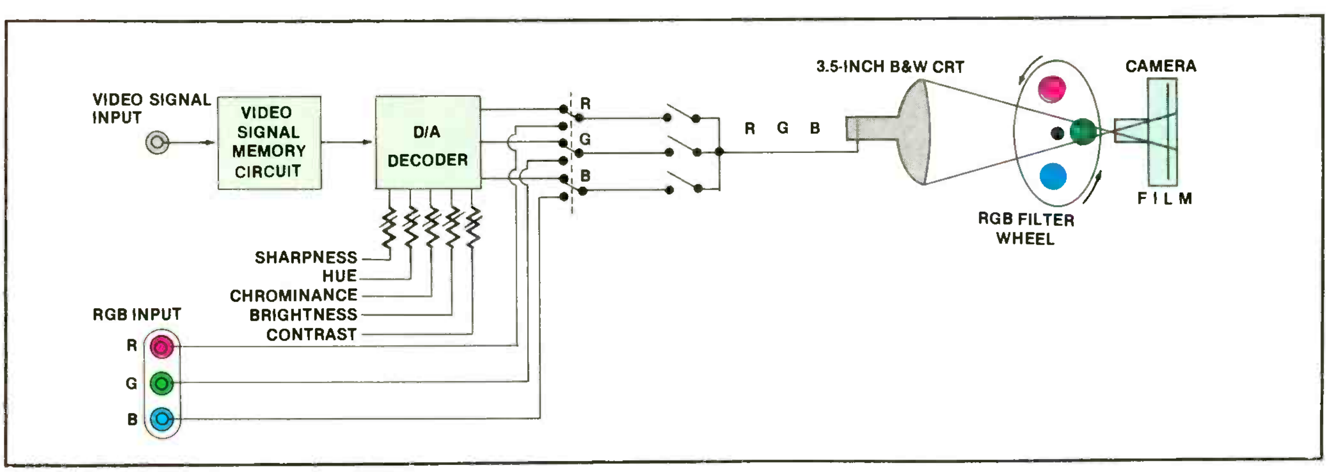


Figure 1. This diagram shows the principles of the Digital Video Copier. *(Diagram courtesy of Toshiba Corporation.)*

Feedback

Water-damaged equipment

Read with interest the article by Joseph J. Carr CET on page 49 of your February issue concerning water damage.

I had experience with this problem twice on board ship during my service as a U.S. Navy officer. Each time, we were able to save all of the equipment. Both times, the equipment stood in sloshing salt water for several hours during rough weather.

I had the electronics technicians working for me remove the covers and cases from the equipment and then had one man get in the shower and wash and flush everything out in a warm shower. Since the fresh water on board ship is distilled at sea we have very good water to use.

We then took everything to the galley and dried it all in the bake ovens at low heat and good air circulation.

From my own experience, I agree completely with Mr. Carr's article. Where distilled water is not available, care must be exercised in the use of faucet water due to possible hard water scale deposits. Softened water also may cause problems.

Sometimes you run across a chassis covered with oily dirt and fuzz. These can be cleaned by dunking in a mixture of about eight ounces to 10 ounces of household ammonia, four ounces to six ounces of Mr. Clean, Lysol cleaner, or Murphy's oil, four ounces to six ounces of acetone and enough distilled water to make up a gallon.

If the chassis is too big to submerge, use a small sprayer like an old dental "Water Pik" to hose it off. Wash with distilled water and dry for four hours to five hours in an oven set at 140°F to 150°F. All mechanical bearings, switches, etc., must be relubricated with the appropriate lubricant.

Another bit of information that may be useful. Over a period of years I had several transformers overheat and asphalt-flood some of the components and tube sockets. We removed the asphalt very easily by chilling it with dry ice from a CO_2 fire extinguisher. The asphalt became brittle and flaked right out with the use of some dental tools.

Roy A. Norman
LCdr USN Ret
Brunswick, GA

A very special compliment

Ever since I have been receiving issues of ***ES&T***, I really enjoy reading them. In fact, ***ES&T*** is extremely interesting! Of course, I have read other electronics magazines but they really did not have the kind of interest that I was expecting. Interest such as: advanced, high-quality advertisements (digital test equipment, for example), tips on repairing televisions, using schematics diagrams; quizzes to read and to expand my memory with even more knowledge–this, and much, much more is what I pick up from this magazine. Speaking overall, I pick up a lot of good information from this magazine, but this is what I was searching for: an advanced-learning electronics magazine. And that is why I love reading ***ES&T***. It does two special things for me: It sharpens (or expands) my knowledge and brightens my interest. Thank you.

Robert Posner
Brooklyn, NY

And thank you, sir. **Ed.**

CET confusion?

A "News" article appearing in the May issue does nothing to clear the confusion over CET exams. The next-to-last paragraph hardly makes any sense at all. First a statement from the U.S. Copyright office, then a thoroughly confusing statement that technicians understand whether the CET is recognized by ISCET. So what? Must a degree from one university be recognized by another to be valid?

I think in all journalistic fairness, a statement should be printed to inform readers of ETA-I's equal ability to grant CET certification, as well as any other organizations so authorized.

J Larsen
60835 N. Hwy 50
Montrose, CO 81401

To: M.B. Danish,
Aberdeen P.G., MD

Thank you very much for your note regarding answers to "Test Your Electronic Knowledge" in the January 1986 issue of ***ES&T***.

The answer should have been *D*–not *C* as given on page 59. No matter how hard I try to avoid mistakes like this, they sometimes get through because of misprints or typing errors.

In reference to the Gain/bandwidth relationship, it is always true that a shorter rise time represents a wider bandwidth.

I am always grateful to readers for taking the time to send their comments. Thank you very much.

Sam Wilson

Letter to Sam Wilson:

This letter is in reference to your article "Capacitors and Triggers" in the March 1986 ***ES&T***.

First, I want to say that I have enjoyed your books and articles for many years.

The transistor parameter *gamma* [γ] is pretty obscure, alright. Your article brought it to mind after many years.

Gamma is defined as the common collector current gain.

$$\gamma = \frac{\Delta I_E}{\Delta I_B} \quad V_{ce} \text{ constant}$$

It also equals $B + 1$ and $\frac{1}{1\text{-}a}$

I looked in a lot of my material and only found it mentioned in the following: "Basic Electronics Vol. I," U.S. Navy training manual NAVPERS 10087-C. This also is available n a DOVER Publishing Company reprint.

Terry L. Stivers
Electronics instructor
ITT Technical Institute
St. Louis, MO

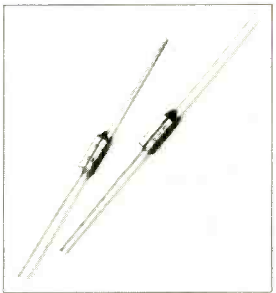
Also to Sam Wilson:

Just a short note to let you know how much my Vocational students and I have enjoyed your articles over the years. Your articles are required reading....

Robert P. Saunders
Vocational electronics instructor
John Adams High School
South Bend, IN

ES&T

ECG® Thermal Cut-Offs



Industrial equipment should be protected from temperature overload, as well as current overload. Philips ECG Thermal Cut-Offs are fuses that react to temperature, instead of current, to prevent equipment from overheating. The thermal cut-offs offered by Philips ECG operate within a tolerance of +0 and −4 degrees Celsius of their nominal value. They are available in 20 temperature values ranging from 66°C (151°F) to 240°C (464°F).

Common applications:
All types of heaters, cookers and distilling apparatus as well as motors for fans, drills, saws, tools, coffee pots and hairdryers.

Circle 000 on the reply card.

ECG® Digital Multimeter

No need to read between the lines with this accurate DM-25 Multimeter. The parameter value appears on the 3½-digit LCD readout. One of a new line of meters for service technicians being offered by Philips ECG, the DM-25 can be carried easily in pocket or tool box.

In spite of its small size, the DM-25 has 14 ranges: DC voltages from 1mV to 1000 Volts in 4 ranges. DC current from 2000 microamps to 2000 milliamps (2 amps) in 4 ranges. AC voltages to 750 VAC on 2 ranges. Resistance from 1 Ohm to 2 Megohms in 4 ranges. Basic DC accuracy is ±0.5%.

Input impedance is 10 Megohms on DC and 4 Megohms on AC, to prevent overloading the circuit under test. The input has overload protection on all ranges. No need to fear hooking it up backwards, as it has an auto-polarity feature.

Not only do you get 2000 hours of operation from a 9 Volt alkaline battery, you also get a warning flag when the battery life is down to 10%. In addition, the DM-25 comes with carrying case, battery, test leads and instruction manual. It's one of the five new multimeters being supplied by Philips ECG. For more information, see your local Philips ECG distributor, or circle the reader service card number.

Circle 000 on the reply card.

ECG® Made-to-Match Wrenches for VCRs

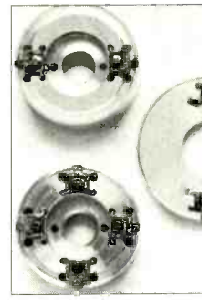
Those special adjustment requirements on VCRs have finally met their match. Philips ECG offers 8 special wrenches designed to match the configuration of the recesses that adjust tape feed, tape tensions and other functions.

Made-to-match for both VHS and Beta units, there are VHS wrenches for tape feed guide, tape tensions, control head and control head phase, plus audio head and audio head phase. While for Beta, wrenches are for the audio and control heads. One tape transport adjuster wrench works on both VHS and Beta.

Philips ECG has also simplified and speeded up the diagnosis and repair of torque problems in VCRs. Torque Meter Cassettes for PLAY and FAST-FORWARD/REWIND, for both VHS and Beta VCRs, give you a fast and accurate diagnosis of the problem.

Circle 000 on the reply card.

ECG® Dual and Quad Head Assemblies for VCRs



Philips ECG offers a high-quality line of drop-in replacement heads for both VHS and Beta VCR equipment.

Included in the new line are dual and quad heads for VHS, and dual heads for Beta VCRs.

Because they equal or surpass original manufacturer's specifications, these Philips ECG heads can be used to replace the heads in VHS units sold by Curtis Mathes, GE, Penney, Magnavox, Panasonic, Philco, Quasar, RCA, Sylvania, Akai, Hitachi, JVC and Mitsubishi. Beta heads are available for VCRs by Marantz, Toshiba, Sony and Zenith.

When you have to replace a head, just check out the replacement you need in the comprehensive cross-reference section in the Philips ECG Audio and Video Brochure, or call your local Philips distributor. You'll find a replacement head that fits and works, fast.

Circle 000 on the reply card.

Horizontal and color problems in RCA CTC107

Technicians save time by remembering what service procedure worked well before with another receiver of the same model. The same components tend to fail in many receivers of the same brand and model. Davidson supplies that type of information for the 13-inch RCA CTC107 model.

By Homer L Davidson

In our experience, the horizontal-output and color-output stages in the RCA CTC107 have accounted for most service problems. Those two areas are featured in this article.

Photofacts 1969-2, 2032-2 and 2104-1 cover the various versions of the CTC107A and CTC107C. All are 13-inch table models. Many of the tips and suggestions about the CTC107 can be applied also to RCA CTC108 and CTC109 models.

Review

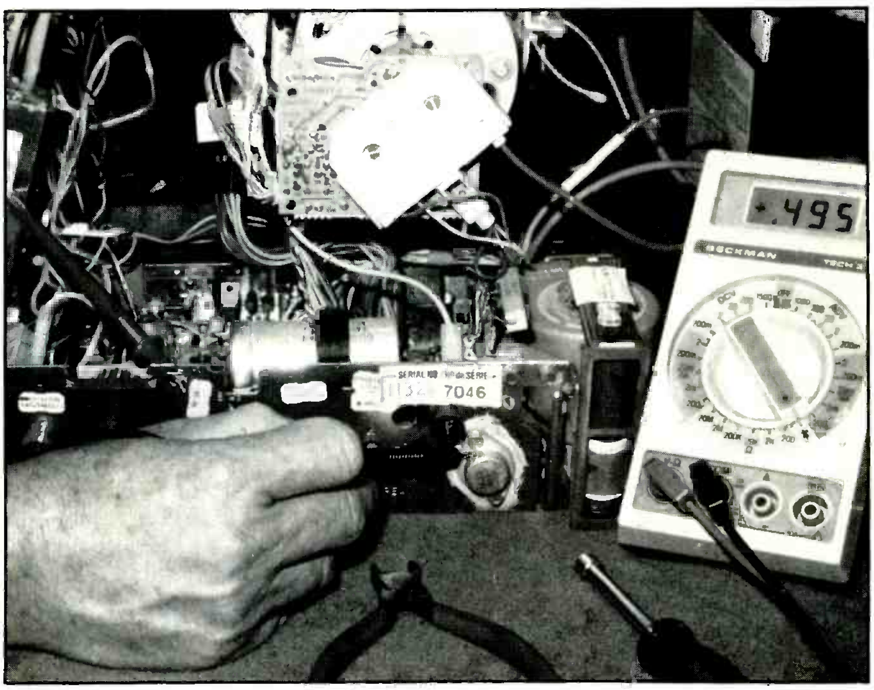
The RCA CTC107 is one of the many models that cannot operate unless both the +120V regulated supply and the horizontal-sweep circuit are operating at almost full power. If the horizontal is dead, the +120V regulator will not operate. If the +120V regulator is dead, the horizontal will not operate. In both cases the receiver is totally dead. (In normal operation, the +120V SCR regulator is kick-started long enough to start the horizontal, etc.) No detailed description of this operation will be given here. See my last article for an explanation about SCR regulators.

An X-ray safety circuit is designed to shut down the horizontal sweep (stopping all operations) if the high voltage is excessive or the picture tube current is excessive. That circuit is explained later. Notice, however, that shutdown from excessive high voltage mimics a failure to start-up.

As in all troubleshooting, keep in mind that a heavy short in one circuit might cause damaged components in the power supply or other associated circuits.

No sound—no raster

In general, these symptoms might indicate dead horizontal, dead power supply, failure to start-up or a start-up followed instantly by shutdown. It is helpful and a good time-saving, troubleshooting technique to determine first whether the problem primarily is in the power supply or in the horizontal-deflection system. With ac power applied, attempt to measure the collector (case) dc voltage of Q412 horizontal-output transistor. A lack of voltage hints at an open circuit or a malfunctioning SCR-regulator circuit. Next, switch *off* the ac power and check in-circuit the forward and reverse conditions of the Q412 transistor and the CR405 damper diode. For forward conductions, use the diode test to measure the voltage drop across solid-state junctions. As shown in the picture (with positive probe grounded and negative to the output-transistor case), the damper forward conduction has



The CR405 damper diode's forward-biased conduction is measured by grounding the positive probe and connecting the negative meter probe to the horizontal output-transistor's case (collector). By the solid-state-junction voltage-drop method, the diode tested 0.496V, which is average for dampers. With the positive meter probe on the base, touch the negative probe first to the emitter and then to the collector. (The base/emitter reading will be a near short in-circuit because of the low-value base resistors.) Reverse the polarity of the damper-diode test, and the base/collector test should show an 0L overrange condition. Change to the ohmmeter function and check for reverse-voltage leakage. If the results are not clear, remove Q412 for out-of-circuit tests.

produced 0.495V, a normal reading. With the test lead polarity reversed, two tests are necessary using the positive probe to the base and the negative probe, first to the collector and then to the emitter. When made on a transistor externally, the readings should be between 0.55V and 0.6V, but in-circuit the paralleling resistances, particularly between base and emitter, might reduce those readings.

If the readings are questionable, the transistor should be removed and tested out of circuit. Leakage readings are taken by using reversed-polarity higher ranges of the low-power ohmmeter, and should show a minimum of several megohms for these reverse-biased junctions. Lower readings are causes for suspicion.

The preceding tests around Q412 should have located the most obvious causes of excessive current to the horizontal-sweep system, but in this case there was nothing malfunctioning. Therefore, the next step is to examine the SCR regulator and its low-voltage source.

The SCR regulator and dc power – No dc voltage was measured at the SCR101 anode (case), although a normal reading is +161V. This indicated a major defect in the low-voltage +162V unregulated supply (Figure 1). Arrows on the schematic show the components that are most likely to fail or suffer damage from the failure of other components. In this case history, two of the bridge diodes had developed severe leakage, blowing fuse F101 (5A) and opening surge resistor RF101. Incidentally, the separate bridge diodes can be tested with ohmmeter and diode-junction tester without removing them from the circuit. Use 3A diodes as replacements when new ones are needed.

After all known-defective components of the +162V supply have been replaced, use care to avoid ruining them a second time by any serious overload that has not yet been found or corrected.

One solution to questions about the SCR regulator is to eliminate it during a few tests. First, remove SCR101 for out-of-circuit resistance tests. A low reading of about 100Ω between gate (G) and cathode

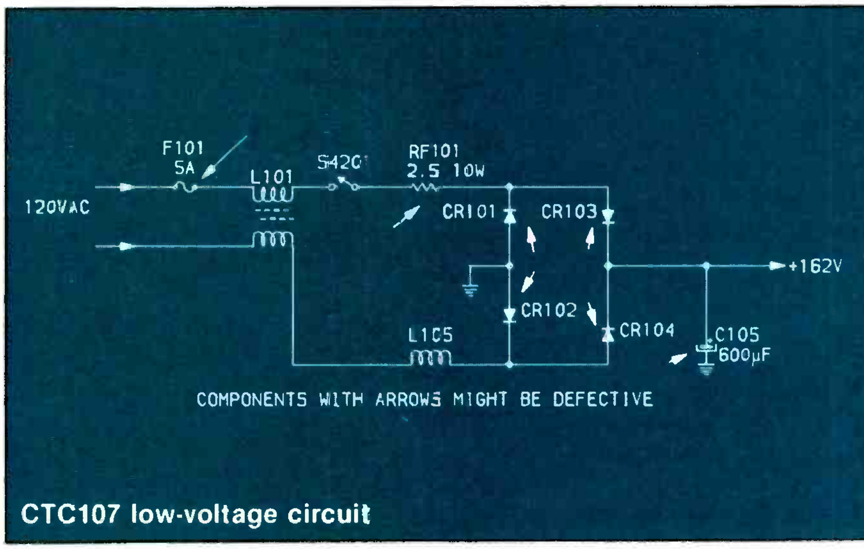
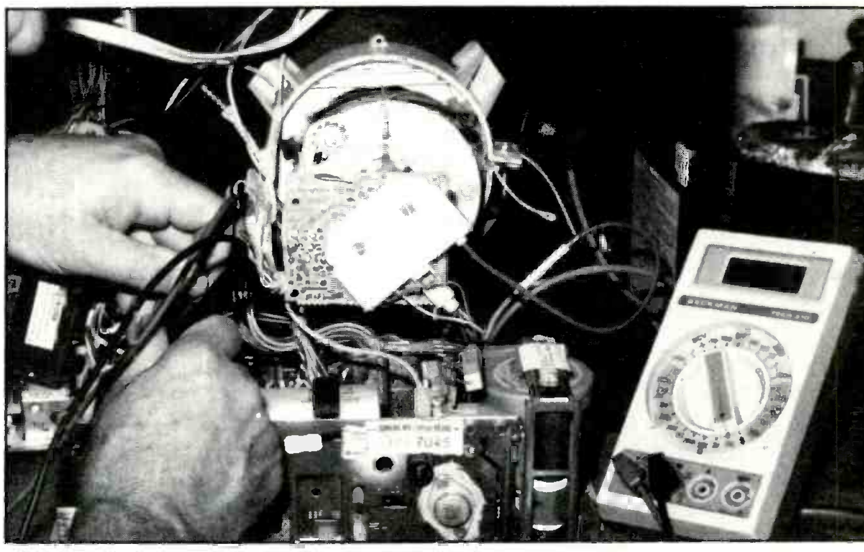


Figure 1. Arrows point out diodes CR101 through CR104 and C105 as components likely to fail and blow fuse F101 and resistor RF101, also identified by arrows on this schematic of the RCA CTC107 low-voltage power supply.



Use the solid-state-junction voltage-drop diode test and the regular ohmmeter ranges to check leakages in the bridge diodes CR101, CR102, CR103 and CR104.

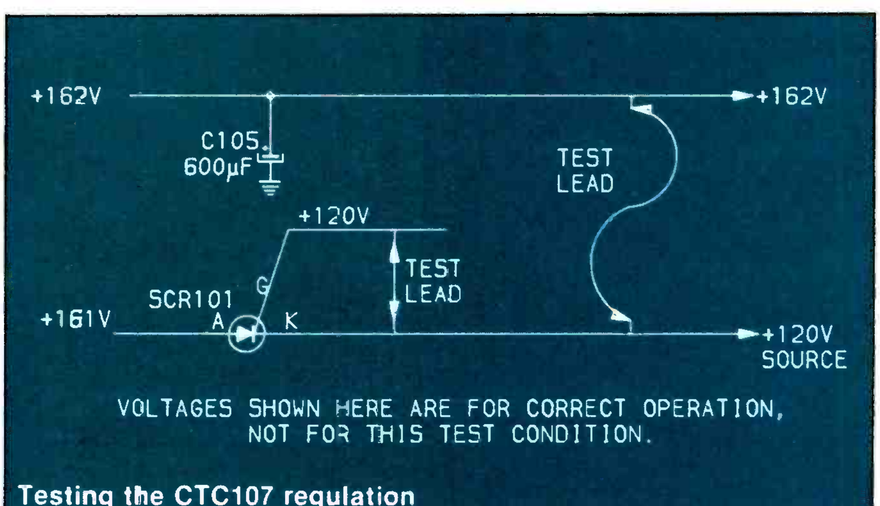


Figure 2. A continuously operating horizontal sweep is necessary for a continuously operating SCR regulator. But good SCR operation is necessary for normal horizontal sweep. This puzzle can be solved during troubleshooting sometimes by eliminating the SCR regulator circuit and reducing the input line voltage to compensate. Add two jumper test leads as shown during these tests. Remove them later.

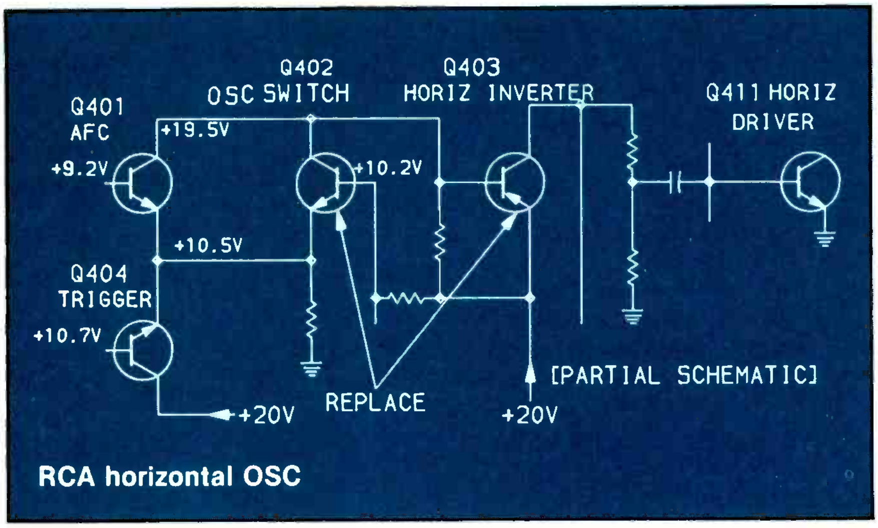
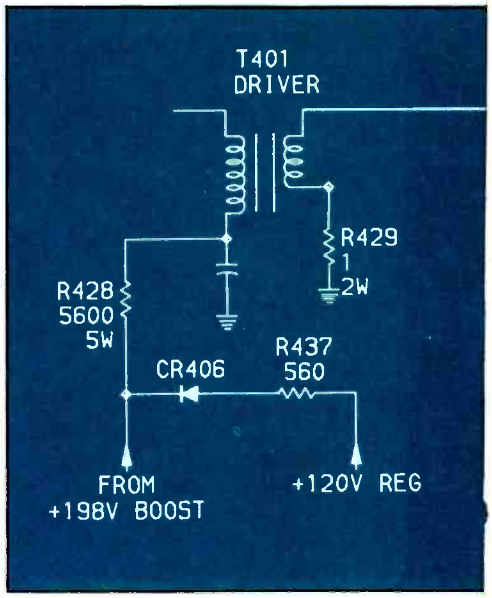


Figure 3. As shown by this partial schematic, Q402 oscillator switch and Q403 horizontal inverter are two transistors in the horizontal oscillator circuit. They have caused some problems in the past and required replacement.



(K) is normal. A reading above 1MΩ should be measured between anode (A) and cathode (K). Replace any SCR that has an open gate reading or a low anode-to-cathode reading.

While SCR101 is removed, clip test leads between the SCR101 socket from cathode to gate and cathode to +164V supply (Figure 2). Disregard the voltages shown in Figure 2, they are for normal operation. Obviously, all three terminals of SCR101 should have the same voltage.

Plug the ac-power plug into a variable-voltage transformer. Begin at a very low voltage, say 30Vac, and slowly increase the receiver's ac input voltage until approximately +80V to +85V is measured at the horizontal-output transistor's collector. It is a good sign when a picture or raster appears, for it indicates the horizontal-sweep system is operating (at least under those special conditions). If smoke or any other symptom of overload appears (such as the low-voltage dc voltage not increasing in step with the increasing ac input), switch off the TV and do more power-off testing; the job is not finished, although the SCR has had a negative test and probably is not at fault.

Determine if the horizontal circuits are normal by scoping the base of the Q412 horizontal-output transistor. A lack of signal there indicates problems in the horizontal-driver stage or in the oscillator system. If the base signal has sufficient amplitude with a normal waveform, check the Q412 collector waveform. A well-shaped single, strong pulse for each cycle indicates all is well. But a weak pulse with a weaker pulse between each pair of correctly placed pulses indicates an excessive load on the flyback.

Singing flybacks

A flyback can *sing* only when supplied with frequencies much lower than the normal 15,734Hz operating signal. This lower frequency might be there instead of the correct 15,734Hz signal, or it might be mixed with it. The defect might or might not allow something to be seen on the CRT screen. There are many possible causes for a singing flyback, so some general tips will be given.

Arcs seldom are steady enough to cause a singing sound. Also, arcs usually have a distinctive sound that identifies them immediately to technicians who have heard several kinds of arcs.

Some singing flybacks are caused by parasitic oscillations in the horizontal-sweep circuit produced by open B+ filter capacitors, open decoupling capacitors or defects in the horizontal circuitry, especially the oscillator stage.

For the first test, scope the base waveform of Q412 horizontal-output transistor. A distorted waveform (or a good waveform with a smaller waveshape traveling across the main waveform) indicates the problem is upstream from Q412. Scope the input and output waveform of Q411, the horizontal-driver transistor, while noticing such common symptoms as incorrect dc voltages at base and collector or Q411 operating too warm. If the Q411 waveform is no better than the one at Q412's base, go back to the horizontal-oscillator circuit, particularly the Q402 oscillator switch transistor and the Q403 oscillator horizontal inverter. Test these two transistors carefully for junction-conduction voltage drops and for reverse leakage. If there is any doubt about their condition, replace them (Figure 3); they have a history of failures. Use original RCA transistors or GE-20 for Q402 and GE82 for Q403. If the singing flyback is not quieted, concentrate on the Q412 output stage.

If the screen is blank and without a raster, measure the high voltage. Also, scope the Q412 collector, checking for correct waveform, amplitude and frequency. Those of you having a scope with an internal frequency counter are fortunate. Others can obtain an approximate frequency by noticing where the scope's frequency-sweep or sweep-time controls must be adjusted to obtain a single cycle of reasonable stability. A frequency of perhaps 8kHz can make a flyback sing, but the high voltage and deflection probably will be verv low.

The most likely cause of flyback singing has been held until the end: insufficient drive to the Q412 horizontal-output base. Verify this by scoping the base. Check for shorted turns in the T401 driver-transformer windings. Serious shorts can affect the coil's resistance readings. Also, visually

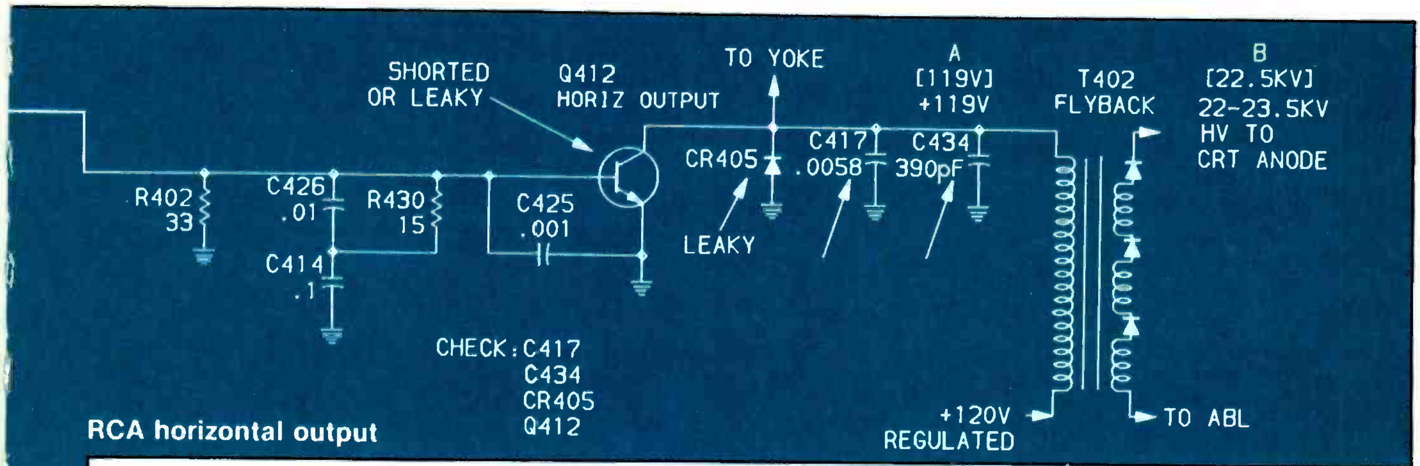


Figure 4. The horizontal-output stage in RCA CTC107 color receivers is not different in general from many other brands and models. However, many details are different. Arrows point to components most likely to cause overloads or excessive high voltage. Notice the flyback is the integrated type having HV diodes inside the HV windings.

examine all four soldered joints at T401. Resolder them carefully if there is the slightest doubt about their conditions. Accurately test R428 (5,600Ω), R429 (1Ω), C414 (0.1μF) and other resistors in the Q412 base circuit. If no defects are found around T401 and the Q412 base, work upstream to the horizontal-driver transistor, and then to the horizontal-oscillator transistors, as discussed before.

Some of these tests are almost certain to find the defect causing the singing flyback.

Chassis in tick-tick mode

A faint tick-tick-tick sound from the flyback is evidence that the SCR-regulator circuit is attempting to regulate the +120V to the horizontal-sweep system that is not operating. Without horizontal, the regulator cannot operate correctly, and the very-low frequency sawtooth that results sounds like a tick.

We have found several leaky CR407 diodes (in the +45V power supply) that produced the tick-tick (and stopped the TV operation).

Another cause of tick-tick without picture has been defective

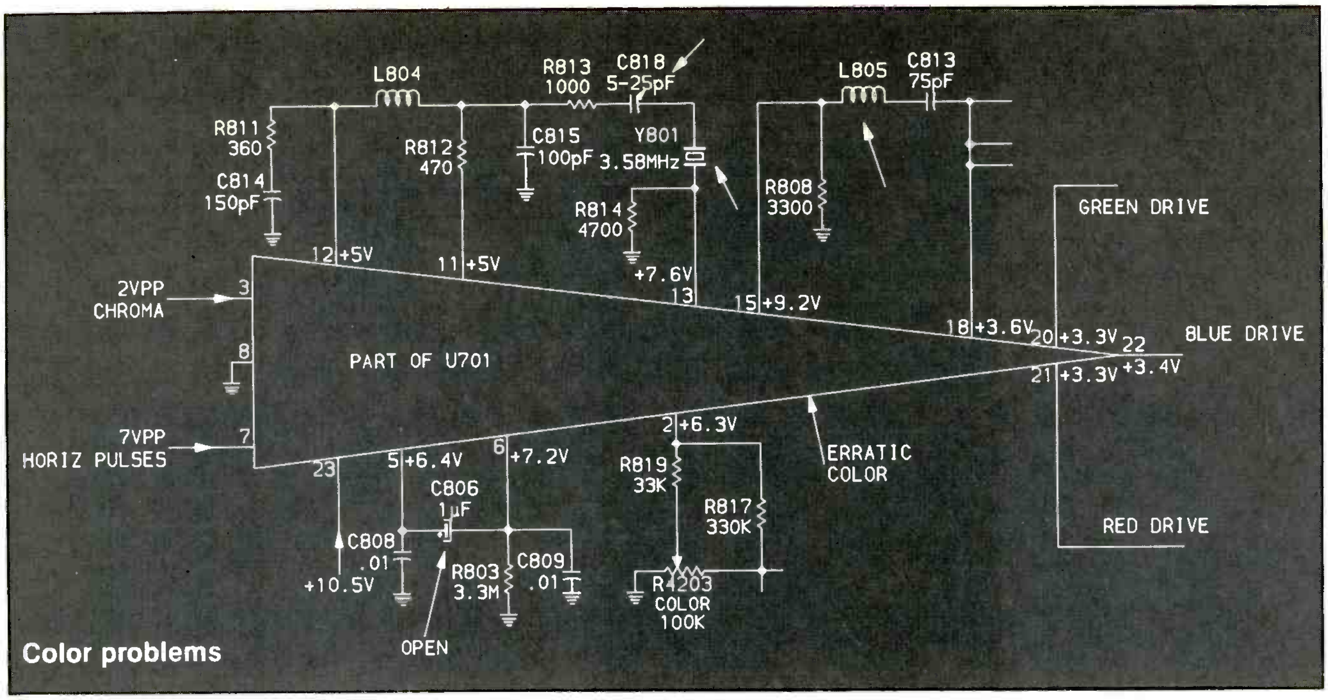


Figure 6. Arrows point to components around U701 that have caused color problems in the RCA CTC107.

damage can occur from excessive high voltage. Therefore, the variable ac-voltage transformer must be connected to the chassis ac cable.

Monitor the +120V source (or the Q412 collector) and the HV at the picture tube as you slowly increase the line voltage. If shutdown occurs with only about +90V at Q412 but the high voltage before shutdown was more than 24.5kV, the suspect is the Q412 and the flyback/yoke system. C417 (0.0058μF) is the prime suspect; an open capacitance tunes the output circuit to a higher frequency thus producing narrower and higher-amplitude pulses at the Q412 collector. An intermittent SCR101 can produce a picture, give an erratic squeal and then cause shutdown. However, those are not the symptoms we described.

If a variable-voltage transformer is not available, the procedure is different. C417 should be tested and replaced if open or suspected. Temporarily disconnect the X-ray safety shutdown circuit (Figure 5) by unsoldering the Q414 emitter wiring where it is sent to the Q411 horizontal-driver transistor's base. Arrange for monitoring of the horizontal-output transistor's collector dc voltage and the high voltage (using a HV probe). When the meters are connected securely, plug the ac power and switch it *on*. Read the meters as soon as possible, write down the readings and then turn *off* the receiver power. Analyze the two voltages. If the Q412 collector reading is +119V to +120V, that is normal. If the high voltage is between 22kV and 23kV, there is no problem with the sweep output. Therefore, it is safe to reconnect the Q414 emitter wiring to the Q411 base wiring, as required to protect the receiver. However, if the high voltage tests 25kV or higher, this must be repaired before Q414 can be connected, otherwise shutdown will result.

For curious technicians, the latch works like this: Q414 and Q413 form a regenerative latch with the base of one connected to the collector of the other. When not activated, one transistor has about zero bias while the other has reverse bias, so no operation is possible. When the flyback pulses exceed a certain level, the Q413 emitter becomes more positive than its base. This is forward bias for the PNP and Q413 conducts some of the positive emitter voltage through the E/C path to the base of Q414. Of course, this positive base voltage is forward bias for the NPN and Q414 draws current and amplifies. As the Q414 collector voltage decreases so does the Q413 base; Q413 draws more current causing its collector to become more positive. The collector is tied to the Q414 base so this increases the forward bias. Almost instantly, both transistors become completely saturated with maximum current, and a fairly high positive voltage at the Q414 emitter. This voltage is sent to the base of Q411, the horizontal-driver transistor, where the excessive forward bias produces saturation driver current for a fraction of a second. During that time, the saturation current reduces the driver gain to zero, so the horizontal sweep stops.

That's all, except for the Q415 section that indirectly measures the CRT current (by monitoring the voltage from the cold end of the HV winding). Normal bias for Q415 through R452 and R451 (reduced by R450) is saturation bias. Going back a step, the rectified voltage from flyback pulses is divided by two precision resistors (R434 and R436). But R436 is grounded through Q415 for safety operation against excessive flyback and HV voltages. Q413 is easier to trigger if R436 is increased in value, which is the operation of the overcurrent shutdown. When the CRT draws excessive current through the flyback, the pin-2 voltage becomes less positive than before. This less-positive voltage comes through R450 to the Q415 base where most of the saturation bias is cancelled. Q415's collector resistance and voltage rises, and with it the Q413

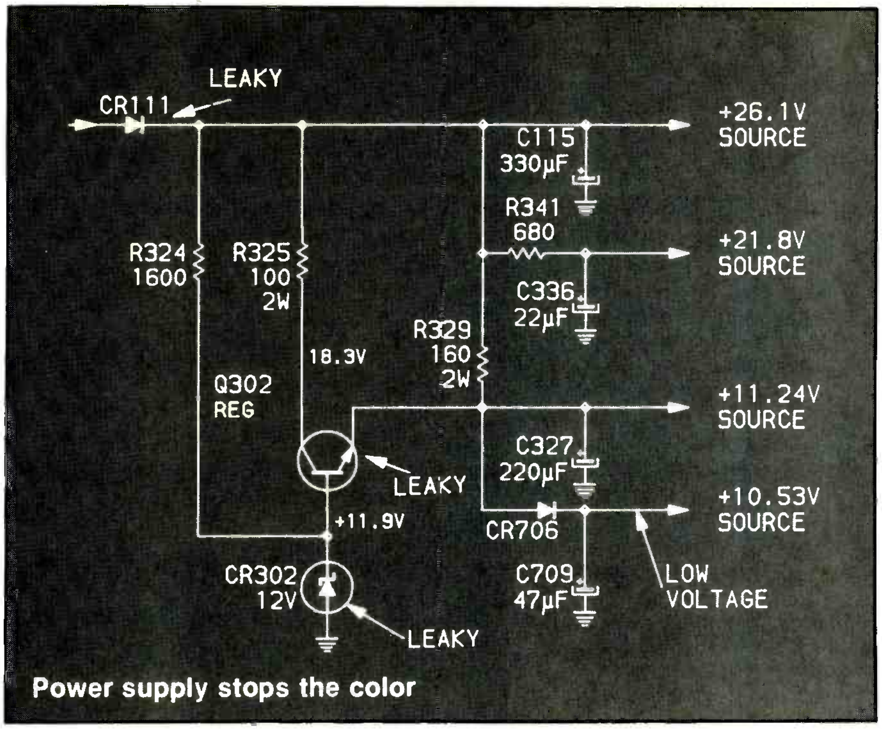


Figure 7. Although the schematic shows many components that can possibly affect the power-supply voltages, the one most often affecting the + 11.24V and + 10.53V supplies is zener diode CR302. Place it at the top of our testing list.

emitter voltage, initiating shutdown.

After all repairs have been made, and you believe all circuits (including the shutdown) are operating correctly, test the shutdown operation by connecting together testpoints XT1 and XT2. Immediately the receiver should go into shutdown. If it does not, the shutdown circuit must be repaired. These testpoints are supplied for this purpose and are very helpful. They are located in front of the flyback.

Other horizontal problems

Arc-type noise lines in the raster might be caused by a defective integrated-diodes high-voltage transformer. Bands of noise at the top of a picture can be produced by a defective horizontal-drive Q411 transistor. For a case of horizontal jitters, check capacitor C410. An open C417 and or C117 can cause narrow width with excessive high voltage. Arcing that cannot be seen or located might be in the yoke, but making lines in the picture.

Color problems

In the RCA CTC107, color originates in the luminance/chroma U701 IC. The color signals are best checked with a scope at IC terminals 3, 7, 13, 15, 20, 21 and 22. A carrier of the 3.58MHz chroma oscillator should appear at pin 13. Horizontal pulses (sandcastle waveform) enter at pin 7. Three demodulated output color signals exit from pins 20, 21 and 22. If any of these are missing, you must find out if the IC or other circuitry is responsible, and the missing signal must be restored before you proceed (Figure 6).

Many problems are caused by U701 itself. These include no color, very weak color, incorrect tint, lack of color sync or a missing output color.

After scoping all the points mentioned previously, take accurate dc voltage measurements at pins 23, 2, 20, 21, 22 and 27. If the + 10.5 voltage source at pin 23 is low, suspect a leaky IC or a power-supply problem. Check the IC by removing pin 23 from the circuit using solder wick and soldering iron. If the + 10.5V source returns to normal or increases significantly, U701 is leaky and should be replaced.

No color

Scope the various color terminals on U701 when there is no color. Accurately measure all IC dc voltages. A low reading or zero at the + 10.5V source is likely to originate in the low-voltage power supply (Figure 7). The most likely failure is zener diode CR302. If not CR302, then check CR706 with the DMM's diode test, and check C709 (47μF) and C327 (220μF) with a capacitance meter. One is almost certain to be defective.

If the proper 3.58MHz sinewave waveform is not scoped at pin 13 of U701, replace Y801, the color oscillator crystal. The color padder C818 also has been known to kill the color. Other color problems were caused by bad soldered connections at R803 and C806. Make certain the 7VPP horizontal pulses are at pin 7.

Replace U701 IC if all these tests have been negative.

Weak color

Rotate the R4203 color control completely clockwise and adjust the tint control to the center of rotation when the color is weak. Test Q801 in-circuit. Rotate R805 the chroma peak-level control for maximum color (it must be reduced later). Check L805 for an open circuit. One of these should have found the original problem. If not, replace U701. Readjust R805.

Intermittent color

Color crystal Y801 and trimmer capacitor C818 have caused many intermittent color symptoms. Replace them, and then adjust C818, because C818 can cause color stripes when it is misadjusted. Also, intermittent color can be caused by a defective 1μF C806 (Figure 6). IC U701 is often responsible for erratic color. When it has color, spray U701 several times with canned coolant to determine if the color is affected.

An intermittent + 10.53V power source can cause intermittent color. Check for bad soldered connections around the Q302 12V regulator. If the supply continues to be intermittent, replace Q302.

When one color is missing from the color and from the raster, scope U701 pins 20, 21 and 22. Replace U701 if the video waveform is weak or missing at any of these terminals.

However, if all three signals are good at U701, go to the color-

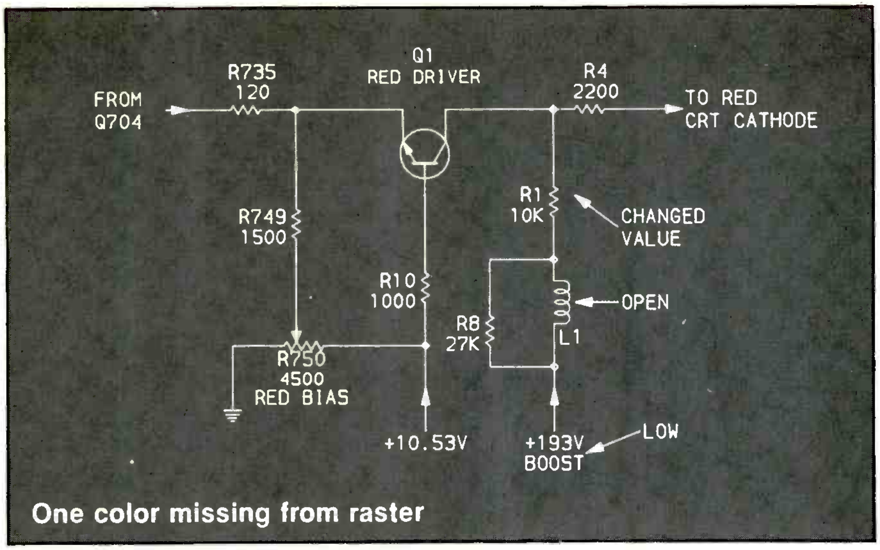


Figure 8. Problems in the three power transistors that apply complete red, green and blue color signals to the separate picture-tube cathodes can change the raster and picture color drastically. Some defects can brighten one color and dim the other two. Another problem can dim one color and brighten the other two. If the specific problem is an open L1, the Q1 collector voltage would be reduced, and with it the red cathode. Therefore, the red color would become much brighter.

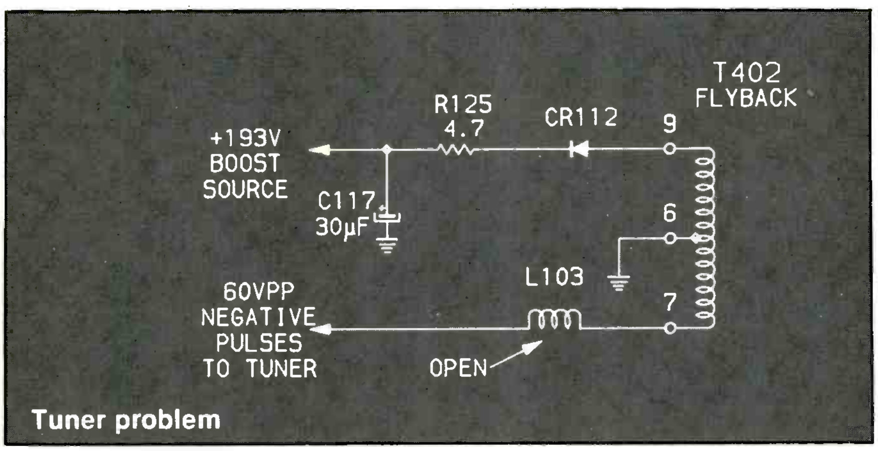


Figure 9. An open circuit in L103 removes the 60VPP from terminal 5 on the tuner-control unit so the tuner cannot receive any channels. Some of these opens are bad joints at the ends of L103. Resolder or replace the coil as required.

driver transistors (Figure 8). Don't neglect the other two entirely, but concentrate on the one for the missing color. Accurately measure the base, emitter and collector voltages.

In this example, the Q1 collector voltage was low. There are basically three possibilities for a low collector voltage; the transistor is drawing excessive current; the collector resistor has increased in value; the L1 peaking coil is open and its 27k damping resistance (R8) has been added to the 10k collector load. L1 was open, as proved by the simple temporary expedient of shorting across L1. All three colors appeared on the screen.

Perhaps we should review at this time what happens with various combinations of CRT cathode voltages. Of course, you know that each of the three cathodes has a complete color signal fed to it along with a dc voltage. This dc voltage is the major factor for CRT brightness levels and for obtaining the correct *gray scale* tracking that is the correct base for the color picture.

The next important point is that each color-amplifier collector is direct-connected to its corresponding picture-tube cathode. That means the CRT cathode voltage change vs. brightness change is reversed compared to connecting the color signals to individual CRT *grids*.

Remember these facts: *increasing* the positive voltage at an amplifier and a CRT cathode *decreases* the brightness of that color. *Decreasing* the positive voltage at the amplifier and the CRT cathode *increases* the brightness of that color. That is true of all three colors.

According to the previous analysis, the example given in the schematic should have been extremely bright red with very little green and blue. It was not *one* color missing, but one increased and two decreased as the brightness was turned down.

Unusual problems

Intermittent horizontal squeals from the CTC107C flyback transformer sometimes are caused by loose particles inside the flyback. Sometimes, pushing against the plastic part of the transformer with an insulated tool will stop the noise for a time. Notice if the CRT filament winding or the high-voltage section is making the noise. Using small wood wedges or toothpicks, try to place them between the winding and the metal core. If this stops the squeals, glue the pieces of wood into place, and tighten the outside metal support strip. Replace the flyback, if the squealing noise continues and cannot be stopped.

When the channel numbers and tuner control cannot tune in any stations, suspect a missing 60VPP horizontal-frequency series of pulses from the flyback circuit (Figure 9). Because the signal is made up of ac pulses, a DMM cannot read the voltage. Instead, scope terminal 5 on the tuner-control module. If the pulses are missing, verify the diagnosis by switching *off* the power and testing the resistance from terminal 5 to ground; it should be a low reading but an open circuit will change it to a very high reading.

Bad soldering of poorly tinned terminals on L103 might produce the open circuit. Repair by carefully soldering the L103 joints and then testing from tuner-control terminal 5 to ground to verify the continuity before power is applied. When the 60VPP pulses are restored to terminal 5 of the tuner-control unit, the tuner system should tune all channels properly.

In less time than it took you to read just the first ten words of this sentence - - -

You could have diagnosed any problem, in any brand, solid state TV set down to circuit level, with 100% accuracy.

By simply plugging the set's AC cord into a self programming Mark VII computer, pushing one test button, and noticing which one of sixty lights are lit.

The light that is lit tells you which circuit or stage is not functional.

In nine out of ten instances, you can do so without even removing the back of the TV set! (Talk about fast estimates)

— INTERMITTENTS —

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As soon as the set shuts down, or otherwise fails, the Mark VII will "Zero In" on **why** it failed, lite and latch the proper indicator light, automatically turn itself and the TV set off, then, sit there idle (with one light lit) awaiting your return.

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(In certain cases of low end, LV regulator shut down, you may have to bridge the LV regulator with an LV rect. other than this occasional inconvenience, no other connections are required. An adapter plug is provided for such instances.)

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Circle (10) on Reply Card

Maintenance and lubrication

By Conrad Persson

Today's electronic and electromechanical products: televisions, stereos, compact digital audio disk players (CDs), printers, need remarkably little care and maintenance. They chug along day in and day out without complaint, bringing the world into your living room, surrounding you with beautiful music, or keeping track of your checkbook.

Unfortunately, this reliability lulls a lot of people into a false sense of security and their electronic genies deteriorate, so slowly that their performance falls off gradually. They are no longer near peak output, but the owner does not know it. Or, all of a sudden, one day they just cease to operate.

Preventive maintenance

A little preventive maintenance: cleaning, lubrication, alignment of mechanical parts, can go a long way toward keeping today's consumer electronics products operating at peak performance. Unfortunately a lot of people feel that if a little is good, a lot is better, and tend to get carried away. With preventive maintenance, a little, as recommended by the manufacturer, goes a very long way. Excessive cleaning of some components can cause excessive wear. Too much lubrication (or the wrong kind) can get onto drive components and cause slippage, or can gum up the works and cause sluggish operation.

Dust and dirt may be blown out of hard-to-reach places by using any of a number of products that consist of some kind of gas under pressure. The Dust-Off System contains, according to the manufacturer, triple filtered, purified air. *(Photo courtesy Falcon Safety Products.)*

Circle (135) on Reply Card

— NOTICE —

If your company is confronted with trouble-shooting or otherwise repairing a certain type, or piece of equipment on a frequent basis - - -

i.e. TV sets, VCR's, Electronic Cameras, Copy Machines, Amplifiers, Industrial Controls, Answering Machines, Radios, Robotics, Bio Medical, Military, Avionics, etc., etc., etc., - - -

The odds are staggering that we could custom program one of our Mark VII computers to accurately isolate any failure in any such device (down to circuit level) in less than two seconds!

INTERMITTANTS POSE NO PROBLEM

(See our display ad on page 21)

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The effects of dirt

One of the worst enemies of electronics equipment is dust and dirt. Video screens attract dust because of the static electricity they generate. High-voltage components also attract dust. Another cause of dust buildup in electronics products is natural or forced convection through heat generating parts. Manufacturers have openings in the top of equipment to let out the air heated by the electronic components, and holes in the bottom back or sides to let in cool air. This can tend to result in a buildup of dust that cuts down on the desired convection and leads to overheating and subsequent early failure of components.

Another problem with dirt occurs when audio or video, or computer disk drive heads get clogged with the oxides from the tape or disk. The most obvious of these problems is in VCRs. When video heads become clogged the symptom is absence of picture information and a so-called dropout on the screen. When audio heads become clogged the symptom may be anything from a vague loss of fidelity to drastically deteriorated sound quality. In the case of clogging of disk drive heads, the absence of a bit or two that wasn't read might be so subtle as to be undetectable except under very unusual circumstances, or it might

Kits such as this contain all products needed to keep a personal computer clean and operating properly: lint-free swabs and wipes, pressurized air cleaner, anti-static spray and more. *(Photo courtesy Philips ECG.)* **Circle (136) on Reply Card.**

WARRANTY WORK

When you compare time spent to pay received, you might find it difficult to survive on some of the warranty allowances in today's market.

If so, this ad will serve as a reminder - - -

In less time than it takes you to print the customer's name on a warranty tag, a Mark VII computer will diagnose the failure down to circuit level. In most cases it will do so - - - without even removing the back!

If your local factory field service representative says it can't be done, remind him that ***Diehl*** will pay any engineer / technician a year's wages who can troubleshoot just three of his most familiar TV sets, before a Mark VII can troubleshoot thirty!! Hopefully, this challenge will either cause him to take his foot out of his mouth, - - - or finish putting it in!

—INTERMITTENTS POSE NO PROBLEMS—

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be so severe as to render the drive virtually unusable.

Computer keyboards are another type of equipment that can cause problems when the keyswitches get dirty. The problem may be anything from a simple intermittent letter that refuses to communicate the desired information to the computer, to a full-fledged refusal to operate.

Keeping it clean

It really isn't difficult to correct the effects of dust and dirt. In fact, in many cases it's possible through the use of dust covers to reduce dirt accumulation in the first place.

When the equipment does need to be spruced up, and some of the accumulations may not be apparent without an occasional inspection, there are a number of ways and products to take care of the problem.

For example, in the case of the TV or monitor screen, usually it's pretty obvious when dust has accumulated there. In extreme cases, the dust interferes with viewing. Simply dusting the screen will remove the dust. The static electricity generated, however, may accelerate the return of dust. To combat this problem, a number of manufacturers have come up with products that remove static electricity as they clean and hence inhibit dust buildup.

For the head clog problem, there seem to be any number of products and approaches to cleaning the heads. The best method for VCRs, recommended by most manufacturers and the Electronic Industries Association/Consumer Electronics Group, is shown in the accompanying diagram. Wet a foam stick (specially made for this purpose) with the recommended amount of the recommended solvent, and rub the head in the horizontal direction only.

Audio and disk drive heads may be similarly cleaned with lint-free swabs recommended by the manufacturer, and the appropriate solvent.

The controversy about head cleaning tapes

There is a controversy concerning the use of head-cleaning tape systems for VCRs. The manufacturers of such systems, not surprisingly, recommend their regular use. VCR manufacturers, on the other hand, do not wholeheartedly recommend their regular use. For example, the Panasonic VCR owner's manual discourages regular use of VCR head cleaning tapes, stating that if the VCR picture looks good, don't use any kind of head cleaning system: in essence, "if it ain't broke, don't fix it."

At least part of the reason for discouraging regular use of head cleaning tapes is that most of them are somewhat abrasive, especially the dry cleaning tapes, and excessive use can cause premature wear of the heads.

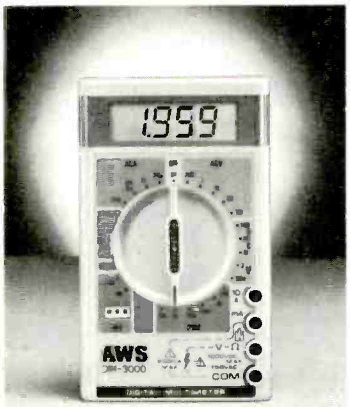
Vacuum cleaners and blow-off systems

The dust that accumulates in consumer electronic products can cause problems in a variety of ways. As mentioned earlier, it can interfere with ventilation causing heat buildup. It can create extraneous current paths, resulting in impaired operation. On a computer, dust can infiltrate into the keyswitches of the keyboard and cause intermittent key input problems. In the printer, airborne dust and paper dust can interfere with print mechanisms, cause poor

This lubricant, called Super Lube, is a multipurpose lubricant formulated from Teflon and a synthetic grease. According to the manufacturer, it is non-corrosive and non-polluting, making it suitable for use in the maintenance and repair of electronic office equipment, including computer printers, typewriters and calculators. *(Photo courtesy Falcon Safety Products.)*

Circle (137) on Reply Card

AWS MULTIMETERS



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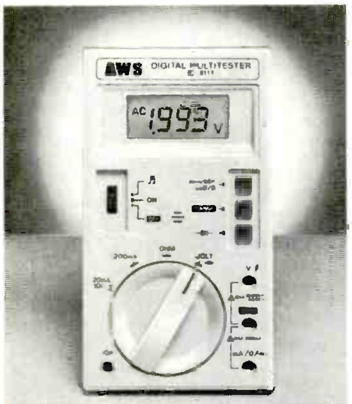
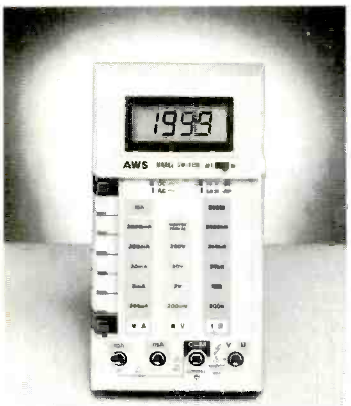
Just one of three DMM's in our Economy Series that combines quality with economy. Features include built-in HFE, battery and diode testing; conductance function; 300 hour battery life; 10Adc range; electronic overload protection on all resistance ranges; pocket-sized. (Also available models DM-1000 & 2000). **Ranges:** 0-200m/2/20/200/1000Vdc; 0-200m/2/20/200/750Vac; 0-200μ/2m/20m/200m/10Aac/dc; 0-200/2K/20K/200K/2M/20MΩ; 1.5V battery test; 0-1000 Hfe test; 2KΩ diode test. DM-1000: **$39.95** / DM-2000: **$54.95** / DM-3000: **$69.95**.



EZ-6111 3½ DIGIT AUTORANGING DMM

Unique and sophisticated in design, you'll find measurement taking a breeze. Loaded with features like autoranging in volts and ohms; manual range selection in all functions; diode test function; audible continuity indication; normal and low power ohm ranges; 10Aac/dc range; overload protection on all ranges; 300 hour battery life. **Ranges:** 0-200m/2/20/200/1000Vdc; 0-2/20/200/600Vac; 0-20m/200m/10Aac/dc; 0-200/2K/20K/200K/2MΩ; 0-2K/20K/200K/2MΩ LoΩ. **$99.95.**



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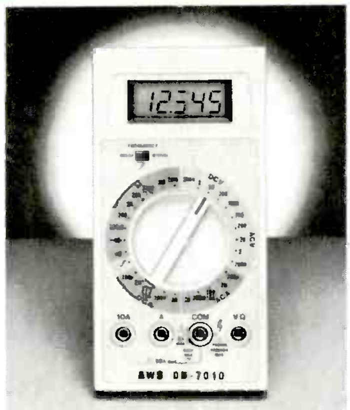
The standard in tough, job-proven digital multimeters. Housed in shock resistant ABS plastic, you'll find safety was a prime design consideration. Also equipped with overload protection on all ranges; special electronic protection to 500Vac/dc on resistance ranges; UL1244 type test leads; normal and low power ohm ranges; 10Aac/dc range. auto zero and auto polarity; built-in tilt stand. **Ranges:** 0-200m/2/20/200/1000Vdc; 0-200m/2/20/200/750Vac; 0-200μ/2m/20m/200m/2/10Aac/dc; 0-200/2K/20K/200K/2M/20MΩ. **$80.00.**

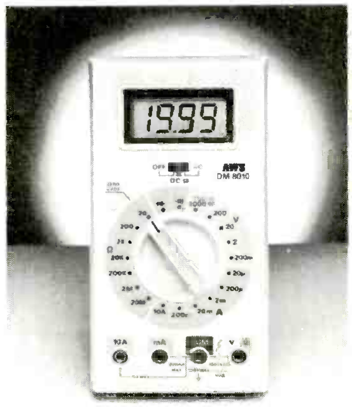
DM-6500 3½ DIGIT AUTORANGING DMM

This sensitive yet rugged instrument is loaded with features you'd expect to pay much more for. The 6500 offers autoranging; low battery consumption; fuse protection; safety test leads; audible continuity buzzer; auto zeroing; shock resistant housing. **Ranges:** 0-200m/2/20/200/1000Vdc; 0-2/20/200/600Vac; 0-200m/10Aac/dc; 0-200/2K/20K/200K/2MΩ. **$80.00.**



DM-7010 4½ DIGIT ROTARY SWITCH DMM

High accuracy readings in the laboratory or in the field. Features include 4½ digit 19999 max. display; built-in frequency counter to 200KHz and conductance function; 0.05% basic dc volts accuracy; overload protection on all ranges; special electronic protection to 250Vac/dc on resistance ranges; UL1244 type test leads; diode and continuity tests. **Ranges:** 0-200m/2/20/200/1000Vdc; 0-200m/2/20/200/750Vac; 0-200μ/2m/20m/200m/2/10Aac/dc; 0-200/2K/20K/200K/2M/20MΩ, 0-200nS conductance; 0-20K/200KHz frequency. **$170.00.**



DM-8010 3½ DIGIT ROTARY SWITCH DMM

This easy to use DMM features a dc Volt accuracy of 0.25% of reading; overload protection on all ranges; special electronic protection to 500Vac/dc on resistance ranges; instant audible continuity buzzer; UL1244 type test leads; auto zero and auto polarity; diode test function; built-in tilt stand. **Ranges:** 0-200m/2/20/200/1000Vdc; 0-200m/2/20/200/750Vac; 0-20μ/200μ/2m/20m/200m/10Aac/dc; 0-20/200/2K/20K/200K/2M/20MΩ. **$84.95.**

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One of the smallest, most convenient hand-held DMM's you'll ever own. It's both autoranging and manual and is the perfect instrument for taking readings easily and accurately in hard to reach areas. Other features include instant audible continuity buzzer; one-hand operation; electronic overload protection on all ranges; data-hold button. **Ranges:** 0-200m/2/20/200/500Vdc; 0-2/20/200/500Vac; 0-200/2K/20K/200K/2000K/20MΩ. **$65.00.**

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Big features are packed in this pocket-calculator sized DMM. You'll find autoranging; electronic overload protection on all ranges; auto-polarity; audible and visual continuity indication; built-in test leads; "booklet-type" carrying case is designed to fit easily in shirt pocket. **Ranges:** 0-2000m/20/200/400Vac/dc; 0-200/2000/20K/200K/2000KΩ; 0-200Ω continuity. **$29.95.**

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Circle (11) on Reply Card

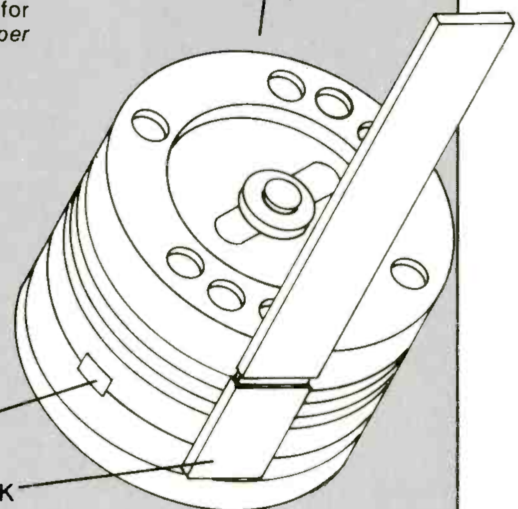
Procedure for cleaning upper cylinder unit

Head cleaning sticks, as shown, are recommended both by VCR manufacturers and by the Electronic Industries Association/Consumer Products Group. Using them as described will "provide adequate results with the least possible chance of damage to the video heads." (***Electronic Servicing & Technology, January 1986.***)

This article also advises that only manufacturer-recommended materials be used for any VCR maintenance, and that, when a video head needs replacing, *the entire upper head cylinder* be replaced, instead.

1. Position the video head to permit access for cleaning and hold the upper cylinder to keep it from turning while cleaning.
2. Gently rub the video head in direction of tape travel with head cleaning stick (CFK27) moistened with Freon TF.
3. Repeat for the other video head

Note:
1. Do not rub vertically.
2. Do not apply any pressure to head. If contaminant is not easily removed, continued gentle wiping will usually remove the contaminant.



quality printing and sluggish operation.

Regularly cleaning dust and dirt out of consumer electronics equipment will eliminate these problems. A standard vacuum cleaner with crevice tool and upholstery brush attachments will remove a lot of these dusty problems. Unfortunately, compared to the dimensions of many of today's consumer electronics products, a standard vacuum cleaner is very large. For these situations, specially manufactured miniature vacuum cleaners can get into those hard to reach places.

For still other situations, gas under pressure may be used to blow dust and dirt away. A number of manufacturers offer cans of air under pressure or similar products with spray nozzles to be used for this purpose.

Lubrication

For years, the only consumer electronics products that might need lubrication were the turntable and the tape recorder. That has changed dramatically. A well-equipped home entertainment center of today might boast not only the audiotape recorder and turntable or changer, but a VCR and a CD player, as well. In the office at home, there might be a computer system, including a disk drive and a printer. Strangely enough, the manufacturers' available servicing literature seems to be silent on the subject of lubrication.

At this moment, we're still researching the subject of lubrication of mechanisms, but here's what we have turned up so far. On the subject of VCR's, Howard W. Sams Photofact folders recommend that bushings and bearings be lightly lubricated with machine oil and cam surfaces be lightly lubricated with a non-drying grease. Please note the word "lightly." Keep in mind that any

These head-cleaning sticks, according to the manufacturer, have tips of ultra-cleaned natural chamois leather for cleaning and polishing video/audio heads safely and effectively. *(Photo courtesy Chemtronics.)* **Circle (138) on Reply Card** lubricant that is not doing a job of providing slipperiness between two surfaces that need it is nothing more than another contaminant.

A search of literature on maintenance of electromechanical devices related to computers also turned up a great silence on the subject of lubrication. One source, "The 1541 Repair and Maintenance Handbook" (the 1541 is the disk drive manufactured by Commodore for use with the Commodore 64), by Rienhold Herrmann, published by Abacus Software, Grand Rapids, MI, discusses lubrication (in addition to a thorough treatise on just about every aspect of repair and maintenance of these units).

This guide recommends applying a thin film of acid-free grease (Vaseline, for example) to the read/write head carrier guide rails and application of a drop of sewing machine oil (one drop, not two) to such points as the disk drive axle, the disk ejection lever and the lock wheel, washer and shaft.

Uncommon sense

It would seem that cleaning, maintenance and lubrication of electromechanical components of electronic systems would be dictated by common sense: if two parts run or slide on one another, lubricate them. This is apparently not always the case. My Star SG-10 printer, for example, has a dot-matrix print head that is driven along a smooth, cylindrical shaft. Nowhere in the thick, exhaustive operation manual does it say anything about lubricating the shaft. I have no plans to put anything on it until I learn otherwise, or until it somehow shows evidence of needing it.

When it comes to routine cleaning, lubrication and maintenance of electromechanical portions of electronic systems, *un*common sense suggests that you check with the manufacturer, if possible, before you take a chance on gumming things up. ES&T

Test your electronic knowledge

By Sam Wilson

I have heard many technicians comment that the Second Class FCC license test was the most difficult of all FCC tests. It was a test that covered a wide variety of subjects. The other tests were more specialized.

Because this test covers a wide variety of subjects, you will probably find it difficult. A score of 50% is good for a test like this.

1. You have a transformer designed for use on a 400Hz, 115V power line. If you connect this transformer to a 60Hz, 115V power line,
 A.) the transformer laminations will vibrate.
 B.) the transformer will run hotter.
 C.) the transformer will run cooler.
 D.) the transformer will operate very efficiently.
 E.) (none of these choices is correct).

2. You cannot improve the image rejection of a receiver by
 A.) increasing the IF.
 B.) phase locking the local oscillator.
 C.) using a pre-amplifier.
 D.) using high-Q circuits in the RF amplifier.
 E.) (all of these choices are correct).

3. Eutectic solder
 A.) does not require heat.
 B.) has a bismuth core.
 C.) goes directly from a solid state to a liquid state when heated.
 D.) is used for connecting plastics.
 E.) does not actually exist.

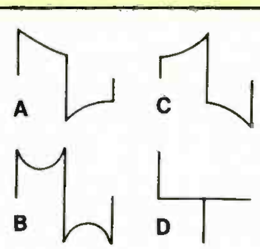


Figure 1.

4. A square wave test on an amplifier shows that it has an excessive high-frequency response. Which of the waveforms in Figure 1 would you expect to scope at the output?
 A.) the one marked *A*
 B.) the one marked *B*
 C.) the one marked *C*
 D.) the one marked *D*
 E.) (none of these choices is correct.)

5. Which of the output waveforms in Figure 2 is correct for the circuit and input waveform?

6. Connect the coils and battery circuit in Figure 3 to obtain maximum flux in the iron core.

7. Everyone knows that the Wheatstone Bridge is used for measuring resistance. When modified, it can also be used to measure inductance and capacitance. The Hay Bridge and Maxwell Bridge are compared as follows:
 A.) Both are used to measure capacitance.
 B.) The Hay Bridge is used to measure capacitance and the Maxwell Bridge is used to measure inductance.
 C.) The Hay Bridge is used to measure inductance and the Maxwell Bridge is used to measure capacitance.
 D.) Both are used to measure inductance.

8. The Lissajous pattern of Figure 4 is obtained by using the following sine wave signals:
 A.) horizontal = 300Hz, vertical = 400Hz.
 B.) horizontal = 400Hz, vertical = 300Hz.
 C.) Neither choice can be correct.

9. The Z-axis of an oscilloscope:
 A.) is used for making Lissajous patterns.
 B.) is used for blanking the trace.
 C.) permits it to be used for making 3-dimensional computer drawings.
 D.) is another name for the sweep (or trace).

10. To check the *on-off* switch of an electronic circuit, a milliammeter is connected across the switch. The meter should read 0mA when the switch is:
 A.) open.
 B.) closed.

Answers are on page 62, 63.

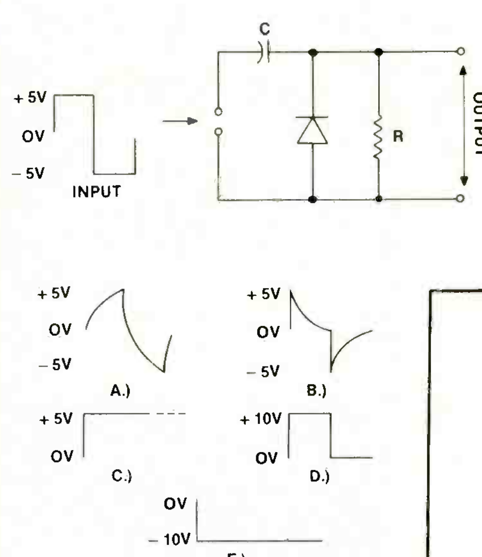


Figure 2.

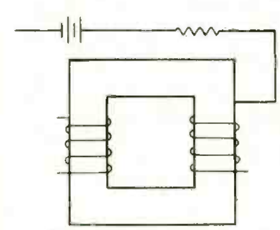


Figure 3.

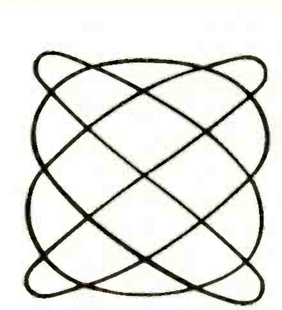
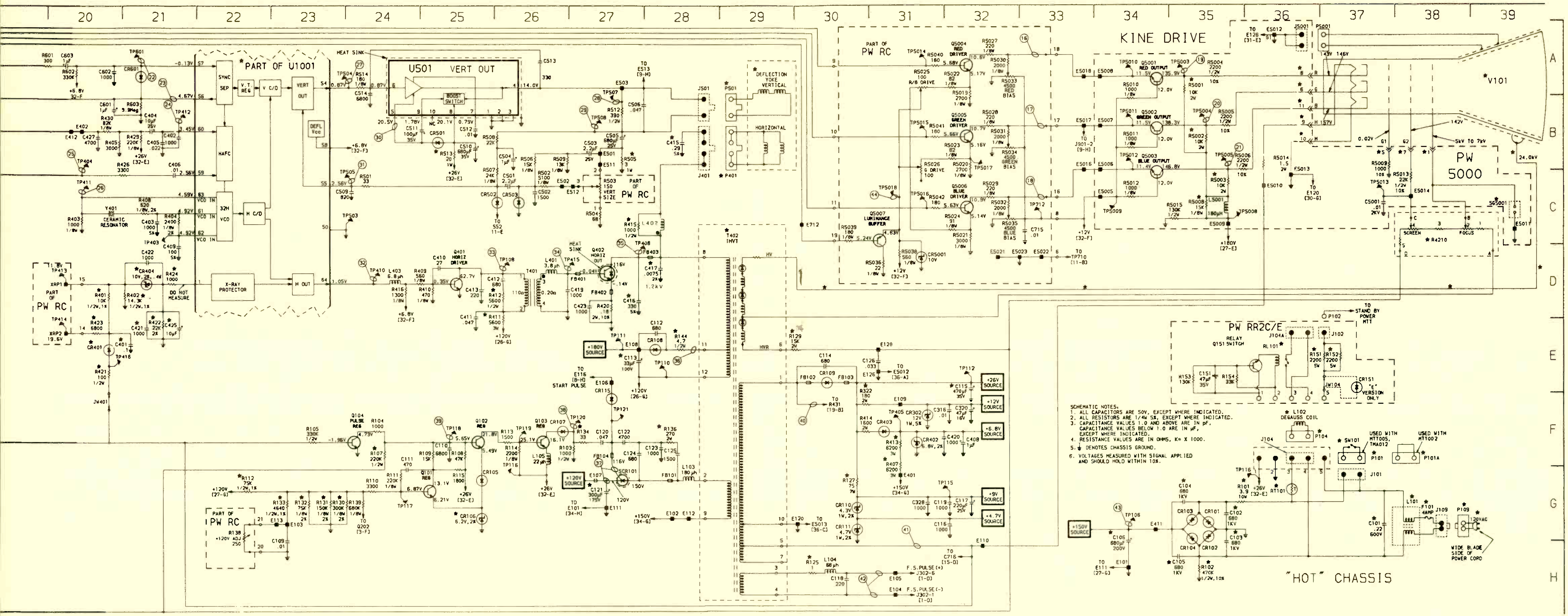


Figure 4.

Product safety should be considered when component replacement is made in any area of a receiver. The shaded areas of the schematic diagram designate the componens in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

CTC136 DEFLECTION AND POWER SUPPLY SCHEMATIC



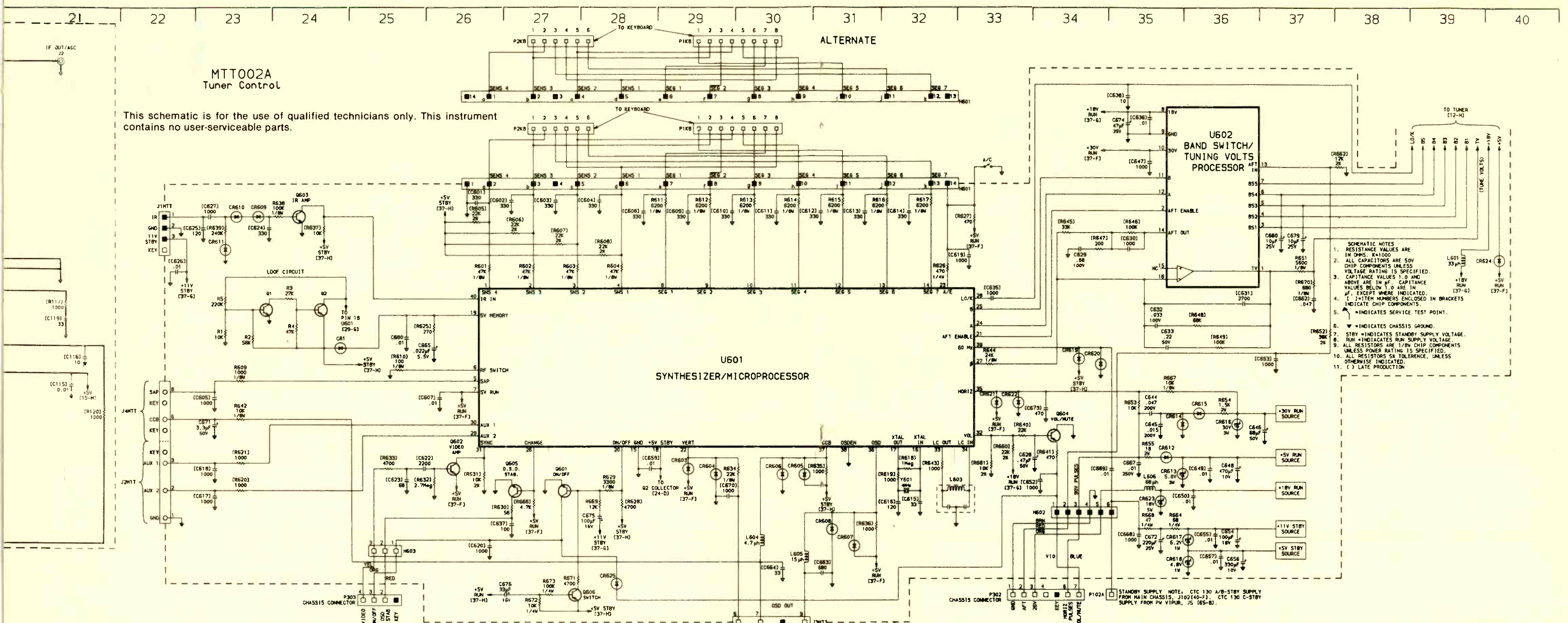
Use of substitute replacement parts that do not have the same safety characteristics as recommended in factory service information may create shock, fire, excessive x-radiation or other hazards.

This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

The other portions of this schematic may be found on other Profax pages.

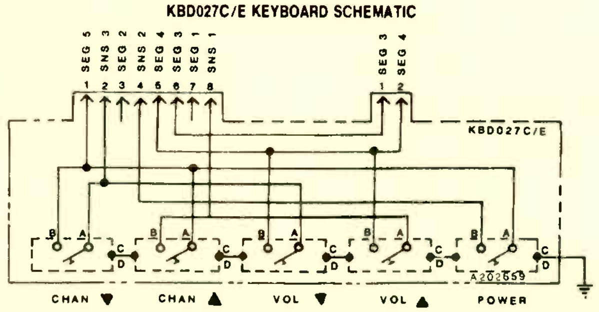
MTT002A TUNING SYSTEM (CONTROL SECTION) SCHEMATIC

ES&T Manufacturers' schematics PROFAX 2089

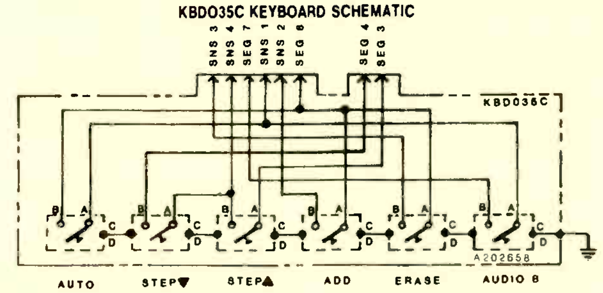


This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

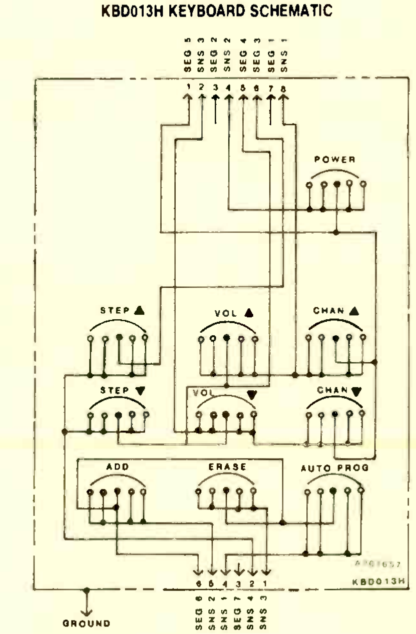
KBD027C/E KEYBOARD SCHEMATIC



KBD035C KEYBOARD SCHEMATIC



KBD013H KEYBOARD SCHEMATIC



Product safety should be considered when component replacement is made in any area of a receiver. The shaded areas of the schematic diagram designate the componens in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

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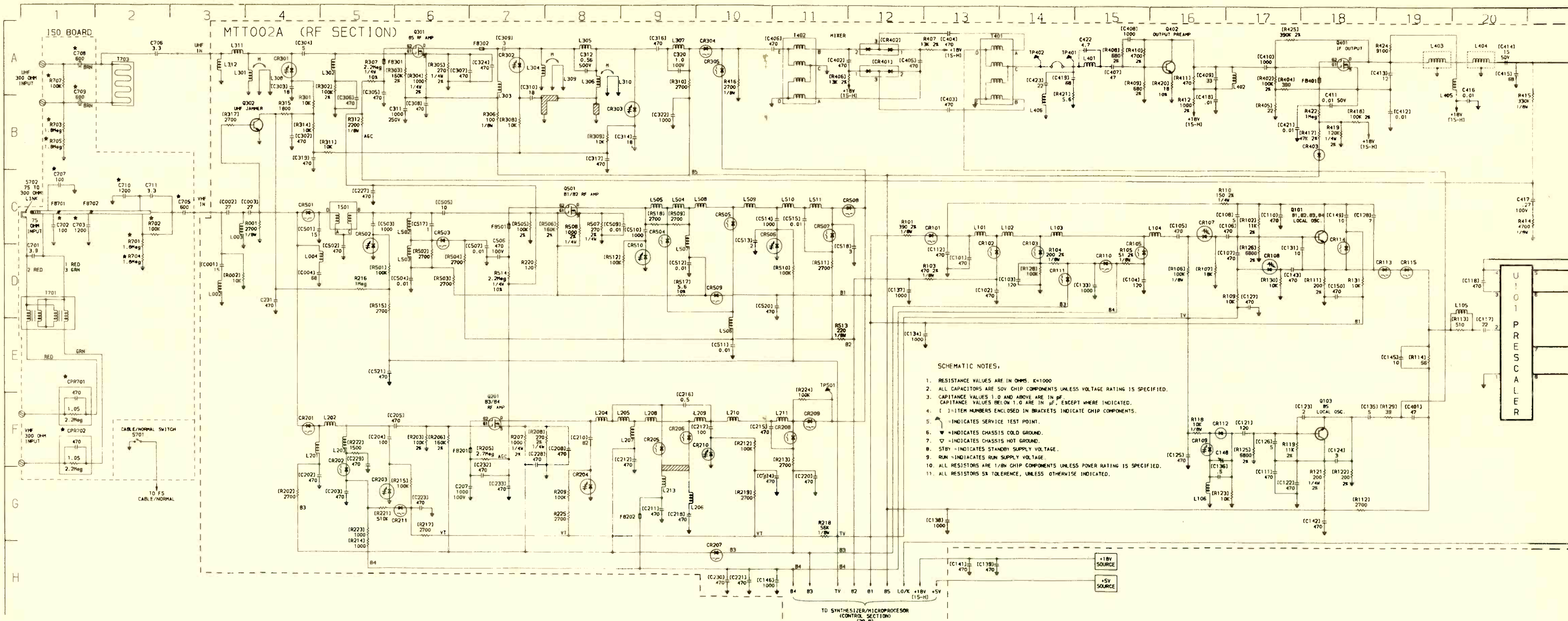
MTT002A TUNING SYSTEM (RF SECTION) SCHEMATIC



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ES&T Manufacturers' schematics PROFAX 2089

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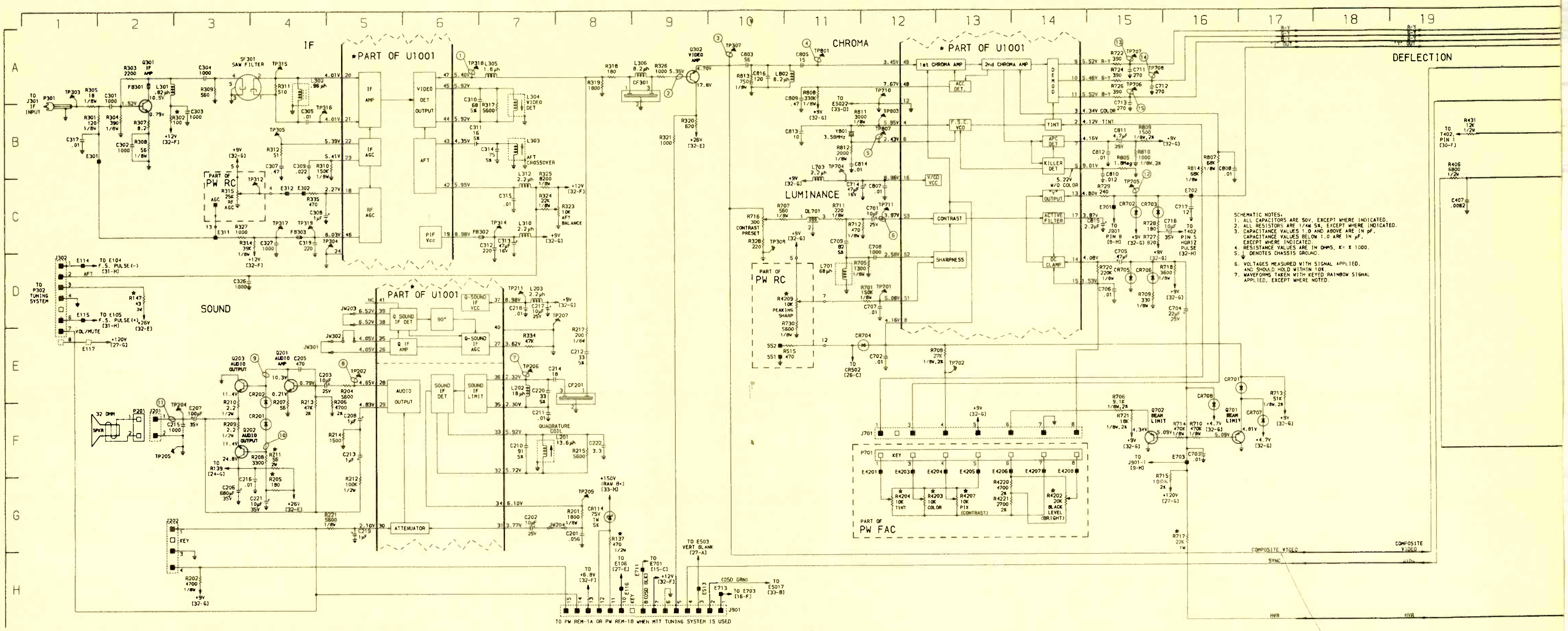
CTC136 SIGNAL CIRCUIT SCHEMATIC



ES&T Manufacturers' schematics PROFAX

AUGUST 1986

Schematic No.

RCA
Color TV, CTC 136 chassis 2089
(includes tuning system schematics)

Product safety should be considered when component replacement is made in any area of a receiver. The shaded areas of the schematic diagram designate the components in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

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Literature

Sorensen, a **Raytheon** company, has published a 4-page "Laboratory Power Supplies" brochure describing key features and specifications for 58 models of its resistance, voltage and IEEE-488 programmable power supplies for laboratory/industrial applications.

Included is the new listener/talker 488 Micro DAP digital-to-analog interface unit for computer control of power supplies.

Circle (125) on Reply Card

The latest edition of the Philips Test & Measurement catalogue for 1986/87 is now available. The 250-page catalogue provides details on Philips range of test instruments, with full information on all new products introduced in the last year.

Circle (126) on Reply Card

More than 200 new additions to **Keystone Electronic's** component and hardware lines are featured in a recently published "1986 New Product Supplement."

The 12-page multicolored catalogue details all technical data, specifications and illustrations on nine major new product groups that include patch cords, test leads and accessories, jumper cables, ceramic spacers, steel hole plugs, nylon cable clamps, rubber and vinyl bumpers, and panel hardware. The publication also details expanded listings of Keystone battery holders, battery clips, plugs and jacks, fuse clips, washers and grommets.

Circle (127) on Reply Card

A catalogue from **Automated Production Equipment** features seven pages of PCB repair equipment in full color. Of special interest is the model SMD-2000, a complete repair and rework center for conventional as well as surface mount PCBs. Also featured are models of track repair kits used to repair damaged circuitry, plated-through holes and laminates to PCBs.

Circle (128) on Reply Card

Books

*Editor's note: Periodically **Electronic Servicing & Technology** features books dealing with subjects of interest to our readers. Please direct inquiries and orders to the publisher at the address given, rather than to us.*

Principles of Digital Audio, by Ken C. Pohlmann; Howard W. Sams; 288 pages, $19.95 softbound.

Much of the information in this book is being published for the first time. The reader is introduced to the integration of digital electronics and sound, a relatively new concept to many in the audio field. Illustrations and formulas enhance the eight chapters that cover digital audio basics, fundamentals of digital audio, digital audio recording, digital audio reproduction, digital audio media, error protection, the compact disc and "a new beginning."

Published by Howard W. Sams & Company, 4300 W. 62nd St., Indianapolis, IN 46268; 317-298-5400.

Pocket Digital Multimeter Techniques, by Homer L. Davidson; Tab Books; 368 pages, $14.45 paperback, $22.95 hardbound.

By an author well-known to ***ES&T*** readers, this sourcebook provides hands-on guidance for troubleshooting, with your pocket-size DMM, everything from small electronic components to complex cassette players and TV sets.

There are tips and shortcuts, drawings, diagrams and troubleshooting charts to fortify instructions for checking diodes, transistors and ICs. These also illustrate 15 procedures for testing the color tube chassis, 51 tests for checking solid-state color televisions and 21 tests for B&W televisions. Eleven 1-minute tests for portable radios, nine checks for AM-FM-MPX radios, 10 speaker tests and 12 simple phono repairs also are reinforced by many of the 390 total illustrations.

Published by Tab Books, Blue Ridge Summit, PA 17214; 717-794-2191.

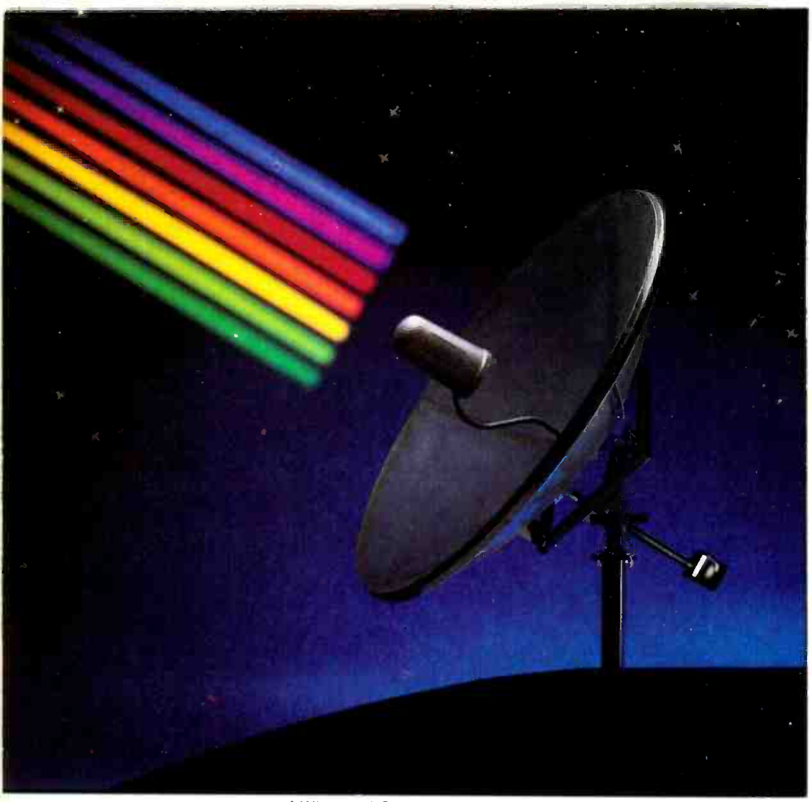


Photo courtesy of Winegard Company.

Satellite receiving antennas

TVRO antennas and a family of strange terms: birds, feeds, dishes, hooks, horns, GSOs, LNAs, LNBs, LNCs and GASFETS, to name a few.

By James E. Kluge

For the uninitiated, shopping for a satellite receiving system can be confusing because of the acronyms and jargon tossed around by those in the trade. Even the technically trained person who doesn't work every day with *birds* and *dishes* may welcome the following review of basics before becoming involved with TVRO antennas and how they work.

Television receive only (TVRO) signals emanate from a satellite (bird) out in space. The signals are first beamed up to the satellite (uplink) from a location here on earth. There, the carrier frequency is converted by a transponder and the signals transmitted back down to earth (downlink).

Originally, the satellite is launched into space on a rocket or other space vehicle and then maneuvered into a geosynchronous orbit (GSO) and positioned at a predetermined longitude relative to the earth. The orbit is sometimes referred to as *geostationary* orbit. This is a misnomer.

A geosynchronous orbit is a circular orbit directly over the earth's equator and 22,300 miles above it. This is the distance necessary to

James Kluge is Technical Editor for the Winegard Company, Engineering and Research Division, Evergreen, CO.

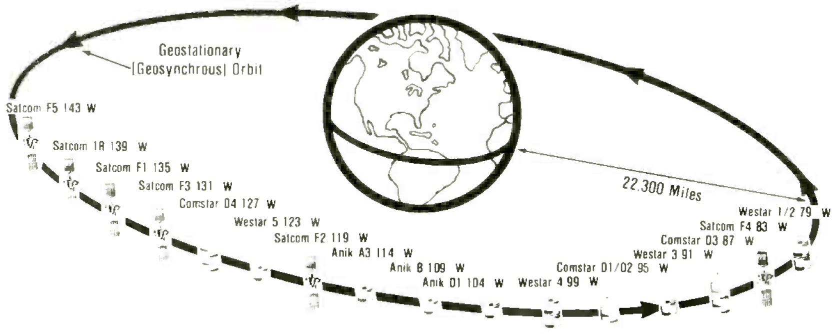


Figure 1. All of the domestic television *relay* satellites are located in an orbit directly above the earth's equator between 79° west longitude and 143° west longitude.

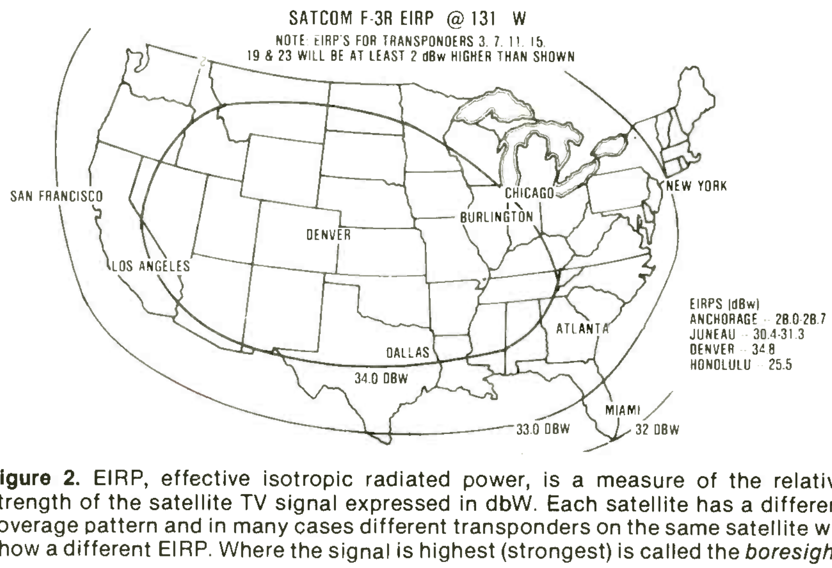
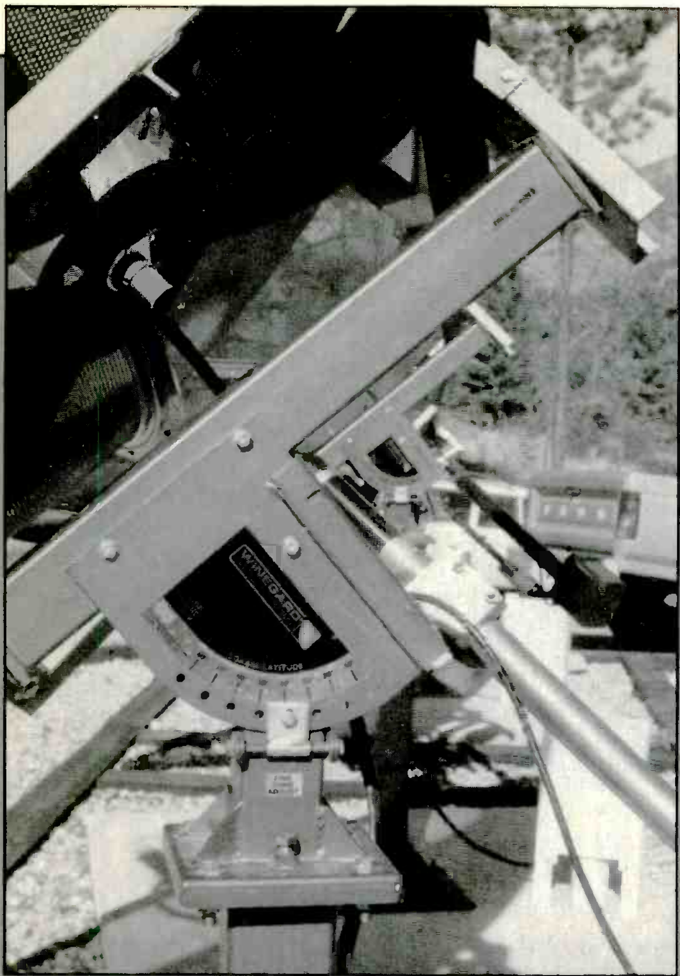


Figure 2. EIRP, effective isotropic radiated power, is a measure of the relative strength of the satellite TV signal expressed in dbW. Each satellite has a different coverage pattern and in many cases different transponders on the same satellite will show a different EIRP. Where the signal is highest (strongest) is called the *boresight.*

balance the gravitational force of the earth with the centrifugal force of the orbiting satellite. By positioning it over the equator, it orbits in synchronism with the earth as the earth rotates on its axis. Thus, the satellite appears stationary in orbit when viewed by an observer here on earth.

This is necessary so that an antenna pointing at it from a location here on earth does not have to be continually repositioned, as with tracking antennas, but can remain stationary once installed and positioned. The geosynchronous orbit also is called the Clarke orbit, named after Arthur Clarke, who in 1945 first proposed using the GSO for global communications.

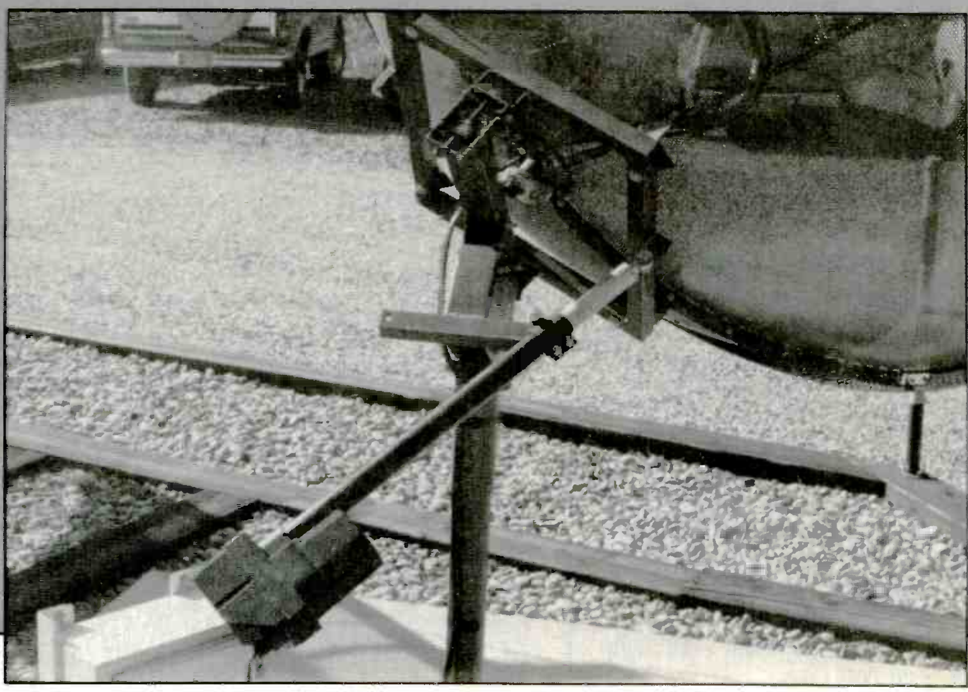
Once placed in orbit, the bird is said to be "parked." Its precise orbital location is allocated by the FCC, which is the government agency that coordinates, along with other North and South American countries, the number and location of geosynchronous satellites in the Western Hemisphere. In addition, it also sets technical operating standards. Satellite locations are designated by a longitude corresponding to an earthly longitudinal plane that extends out from the earth through the parked satellite.



The polar antenna mount allows the dish to rotate on its axis defined by the square-cross-section structural element. The reflector is attached and pivoted at the ends of this element as it sweeps the antenna through the Clarke orbit. The elevation angle, when pointing south, is adjusted by the positioning devices in the lower foreground.

The business end of a feedhorn is shown through the perforated-aluminum surface of the reflector; reflected energy is beamed into the waveguide opening in the center of the feedhorn.

A linear motor-driven actuator causes the dish to rotate on its polar axis thus tracking the geosynchronous orbit across the sky as it searches for the desired satellite.

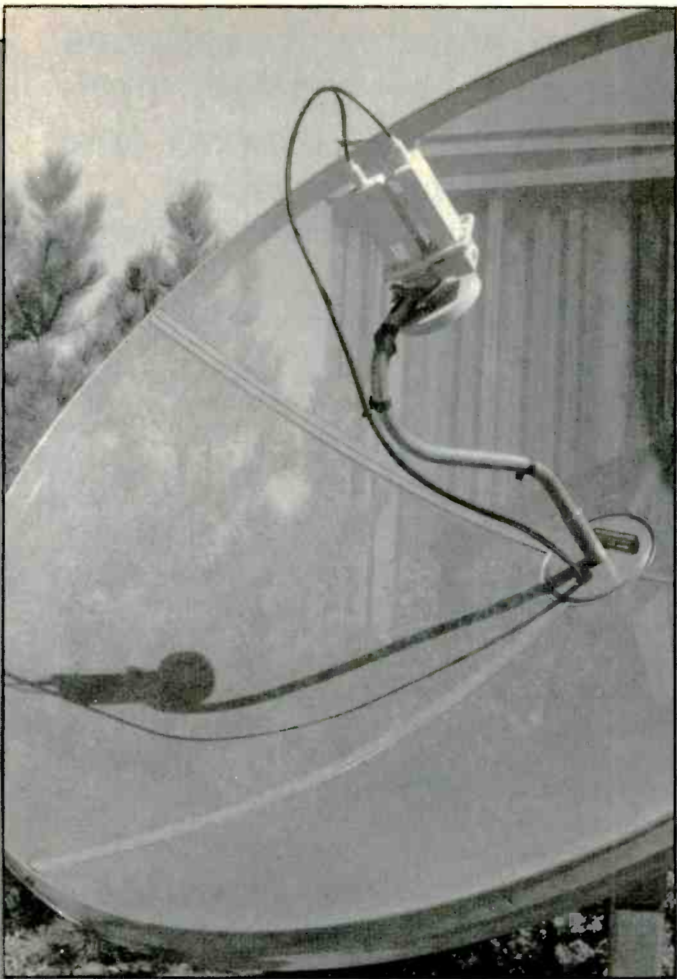


A TVRO receiving antenna must be pointed at a particular satellite to receive its signals. You must know the bird's location in degrees west longitude, your location in degrees longitude and latitude, and after computing the elevation and azimuth angles of the antenna axis, point the antenna in that direction.

A convenient alternative is to use a polar antenna mount. Polar antenna mounts are so designed and constructed that they permit the antenna, by simply turning it on a polar axis, to sweep or track the geosynchronous orbit between its visible east and west extremities that generally are determined by the earth's horizon. Such an arrangement allows the dish to be turned by a hand crank or a linear motor-driven actuator, the latter being powered by a dc motor and controlled remotely at the receiver.

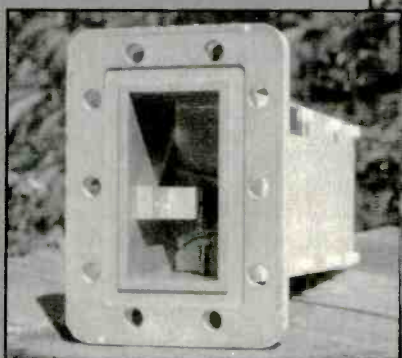
Once the antenna is set up and adjusted, the signals arriving from the satellite strike the metallic dish reflector surface and bounce off in the direction of the feedhorn. The feedhorn is supported by a buttonhook-shaped device. The surface curvature of the dish is such that wherever on its surface the energy strikes it, that energy always is reflected to the feedhorn, which is located at the focal point of the parabolic-dish surface.

A *reverse* analogy would be that of a spotlight in which the light energy emanating from the bulb filament located at the focal point strikes the reflector, and from any point on the reflector surface the beams of light radiate out parallel to the axis of the reflector (and, of course, parallel to each other). Because the signal energy from the satellite arrives in parallel beams (or, technically speaking, as a plane-wave front), the energy is reflected toward the focal point and collects at the feedhorn, which is placed at the focal point of the reflector. The electromagnetic energy arriving at the feedhorn is channeled into a waveguide, which delivers the signal to the LNA/LNB. The low-noise amplifier (LNA/LNB) is physically connected to the feedhorn to minimize any interconnection losses.



In conjunction with the TVRO antenna (pointed at a satellite in the geosynchronous orbit, see Figure 1), a buttonhook device supports both the feed, and the dual LNB assembly that converts as a block the frequencies from all 24 transponders: 12 vertical channels in one LNB and 12 horizontal channels in the other.

The electromagnetic motor atop the feedhorn assembly rotates the signal element inside the feedhorn from one position through 90° to another when switching from vertical to horizontal signals (or vice versa) as the 24 channels at the receiver are sequentially stepped through.



A typical LNA, standing on its feedhorn flange, shows the coaxial output connector at the opposite end. Dc operating voltage is supplied to LNA circuits via the coaxial cable and connector. It is the feedhorn end of LNA that terminates the waveguide where electromagnetic energy is converted to a signal voltage at the LNA input (inset).

At this interconnection point, any signal loss is critical with regard to adding noise to the feeble signal. Once the signal is amplified in the LNA and converted to an intermediate frequency (IF) in the down converter, the handling of the signal and possible introduction of noise is much less of a problem.

Downconverters, which translate the frequency of the signal down to a much lower frequency, are generally of two types: 1.) a tunable downconverter, or 2.) a block downconverter. Early receivers generally employed a tunable downconverter with single-channel output at 70MHz controlled remotely at the receiver. This type downconverter operates similarly to the tuner (channel selector) in a TV receiver except that in the case of a TV receiver the tuner is mounted within the same cabinet receiving its power and delivering its IF output over a short coaxial cable to the main TV chassis. In a TVRO system, it is necessary to locate the *tuner* downconverter at the antenna attached to the LNA and remotely tune it, using a variable dc voltage from the receiver (electronic tuning).

Newer TVRO systems employ block downconversion. It has the advantage of making available, simultaneously, all programs from a given satellite instead of only one at a time. This means that in a given household, one member of that household can watch one program while the other members of the household can watch programs of their own individual preference. Of course this necessitates that each viewer have a separate TVRO receiver and a TV set or monitor.

The basic difference between the tunable converter and block converter is that with the former, the tuning is accomplished at the antenna whereas with the latter the tuning is done indoors at the receiver. In either case, the first downconversion is accomplished at the antenna.

The tunable downconverter/LNA assembly (commonly referred to as the LNC) accept the 3.7GHz to 4.2GHz signal, tunes to one of the 24 transponders (each 36MHz wide) and converts it down to 70MHz. The block converter/LNA assembly (commonly referred to as the LNB) accepts the 3.7GHz to 4.2GHz signal and downconverts the entire 0.5GHz band as a block. This block of signals is then transmitted over coaxial cables to the tuner indoors where the individual channels are selected for viewing.

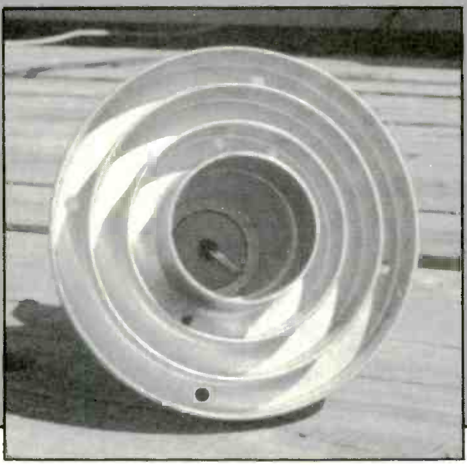
You might ask, why downconvert? Why not simply transmit the 3.7GHz to 4.2GHz block indoors to the receiver and, there, tune the signals you want to view? It's a matter of economics. The coaxial cable required to transmit 4GHz signals without appreciable loss or attenuation is costly, bulky and difficult to handle. By downconverting the frequency, standard MATV cable may be used, which is economical and readily available. Downconverted frequencies may vary with various manufacturers and even between products of a given manufacturer. The industry is standardizing gradually as it matures. The frequency block, 950MHz to 1450MHz, seems to be emerging as a de facto standard.

Located between the feedhorn and the downconverter (electrically) there must be a low-noise amplifier to boost the extremely weak signals from the probe or antenna element. The purpose of the LNA is to amplify these tiny voltages about 40dB to 50dB without adding a significant amount of noise to the signals. State-of-the-art gallium arsenide field-effect transistors (GASFETS) [pronounced gas-fets] are employed to accomplish this difficult task. They are relatively expensive, but at this point necessary to do the job.

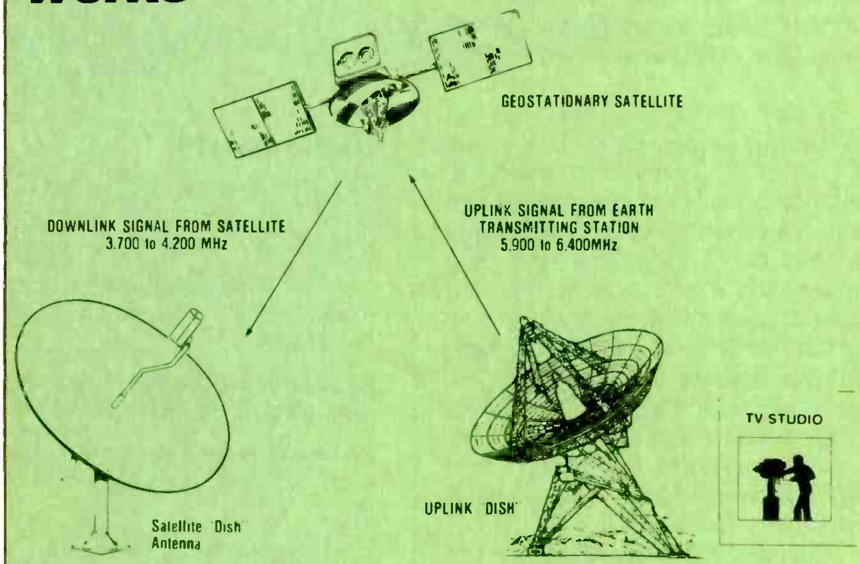
In addition to specifying LNAs by how much gain they have, another equally important specification is noise temperature. It is an indication of the noise power generated within the LNA and is expressed in kelvins (K).

We use temperature in this case because the noise-figure numbers are getting very small. For example, a temperature range from 75K to 120K covers a noise-figure range of only 1.0dB to 1.5dB. The noise temperature rating is cor-

A corrugated feedhorn, showing the rotatable signal element in its vertical position to receive vertically polarized signals. The signal element inside the feedhorn has been rotated 90° to receive horizontally polarized signals (below).



Uplinks and downlinks
How the satellite TV system works



There are over 16 geostationary satellites in operation. These communication satellites are basicaly relay stations in space. The transmission of the satellite programming is carried to a satellite uplink station (via cable, microwave or combination of the two) then sent from the uplink antenna on the C-band (5.9GHz to 6.4GHz) to the transponders (also known as microwave repeaters) on the desired satellite 22,300 miles above the equator. The transponder receives the signal, amplifies it, then changes the frequency to 3.7GHz to 4.2GHz. The downlink transmitter provides additional amplification and sends the signal to the receiving earth stations.

rectly designated as an effective temperature rather than a physical temperature because it includes both thermal and non-thermal noise.

The most popular LNAs, LNBs or LNCs have a 100°K rating. They are the best compromise between performance and cost. Also available are 85K and 120K units. The former is more costly but may suffice where dish size is an important limitation. The latter is less costly, but often requires a larger antenna.

Low-noise block (LNB) downconverters are broadband devices that amplify all the signals from a given bird. They do not require tuning. LNBs are used singly or in pairs (duals).

When using a block downconverter, signals from the even and odd (i.e. horizontal and vertical) transponders can be received individually (i.e. one at a time) or simultaneously, depending on the type of feedhorn assembly being used. If the feedhorn assembly has two orthogonal probes each feeding a separate LNB, then the LNB outputs can be delivered to a receiver with dual inputs. This permits all the transponder programs to be viewed simultaneously using separate receivers.

Currently, many feedhorns use one probe, which must be rotated 90° whenever switching from even to odd (or vice-versa) transponders. This means that the cable that is carrying signals to receivers will contain only even or odd transponder signals at any given time. So, the advantage of dual probes and dual block downconverters allows you to view all programs on a given satellite simultaneously plus it eliminates moving parts in the feedhorn. That way, dad can watch football while mom and the kids watch the *National Geographic Society* special in another room.

Antennas have been, and will continue to be, the most important link in the chain of satellite receiving equipment. Unless they perform well and achieve high efficiency, there is little anyone can do to improve or correct TV picture efficiencies further on in the chain. ES&T

Are you being chased by an overheated boomer

By Joseph J. Carr, CET

Have you ever been cursed with a *boomerang* service job? These are fault symptoms that always seem to come back. Some equipment just seems failure prone. When you are facing a boomerang, be sure to consider overheating as a possible cause. It is widely recognized that heat is a great killer of electronic equipment.

Many device ratings are based on maintaining certain operating temperatures. One *bargain pack* audio power transistor, for example, offers a seemingly tremendous collector-power dissipation (which is prominently advertised), but the power is only available at room temperature (25°C to 30°C). At temperatures above 30°C the transistor must be derated substantially. Almost *anyplace* that the transistor is used inside a cabinet or box, the temperature will exceed 30°C.

Similarly, RF power transistors in CB and land mobile transmitters die as often from overheating as from that elusive gremlin VSWR, but the problem is less well recognized. I know one case where there were constant failures of the RF power transistors in a trunk-mounted 100W VHF power amplifier. Technicians repaired the rig several times before they drew the connection with heat. The trunk of a car during the summer months sizzles while the passenger compartment cools off with air conditioning in only a few minutes. Moving the amplifier behind the dashboard cured the problem.

Reliability experts measure equipment performance in terms of *mean time between failure* (MTBF), which usually is expressed in hours. For example, an MTBF of 1,000 hours implies that, for a large number of samples of the equipment, the average will be one failure per 1,000 hours of operation. One source claims that a 10°C rise in operating temperature will cut the MTBF almost in half.

How important is cooling in electronic equipment? Let's consider some examples. About 10 years ago I worked in a university hospital repairing patient monitoring equipment. The slave EKG oscilloscopes at the nurses' central station were a reliability nightmare. About once a week, usually at 3 a.m., the staff would call me to come repair one of the four scopes. Yet the same model scopes at bedside operated reliably. The problem was overheating of the central station scopes, which were mounted inside a completely closed desk/console. After cutting 10 1-inch ventilation holes, and installing a pair of 100-cfm whisper fans, the central station scopes became as reliable as the bedside scopes.

A second example is a story of tragedy prevented. My first personal computer was a Digital Group Z80-based machine with 26K of static (2,102 chips) memory. In those days, my kilobuck bought (in kit form) a motherboard, three 8K memory boards, a CPU board, a 64 line TV/cassette interface board (with some static memory chips on board), and several input/output boards. All of those boards contained lots of TTL devices, and they generated a large amount of heat. The builder had to supply the cabinet, a ± 12 Vdc at 1A dual-polarity power supply and a + 5Vdc at 10A regulated power supply.

At first, all those cards and the two dc power supplies were buttoned up inside an almost totally unvented aluminum cabinet. Needless to say, the temperature of the cabinet rose to egg-frying levels, and the HEP S-7000 power transistor used as the series-pass element in the voltage regulator operated hot enough to take off skin when touched. That computer would have been a reliability headache if the heat wasn't removed. I installed a pair of 40 to 50 cfm fans: a 3.5-inch unit blowing across the S-7000 heatsink and a 4.5-inch unit cooling the printed wiring board compartment.

Avoiding heat-induced failures

No one with *any* professional electronics experience will deny that heat is the great killer of electronic devices. Equipment that passes or delivers large amounts of either current or power must be kept cool for proper operation. The methods given in this article are simple and sufficient for most servicing applications. Although reliability engineers and the thermodynamicists will flinch at the lack of mathematical elegance, the methods are nonetheless effective.

ang?

There is only one simple rule: where there is excessive heat, remove it. What does *excessive* mean? If the equipment feels too hot to the touch, or has a history of unexplained failures and/or repairs, then it is probably running too hot. An engineer will have specifications to meet and calculations to make, but they are beyond the scope of this article. The empirical *skin of the thumb* rule, however, suffices for our needs.

There are three basic tactics that can be used either singly or in combination: 1.) radiate more of the heat, 2.) improve natural ventilation, or 3.) add or increase forced-air cooling. Water cooling is not an issue for most readers even though some commercial broadcast transmitters and high-power industrial electronics devices use circulating water for cooling. (I once worked in a 10kW AM broadcasting station that used the waste heat from the transmitter's water radiator to heat the transmitter building.)

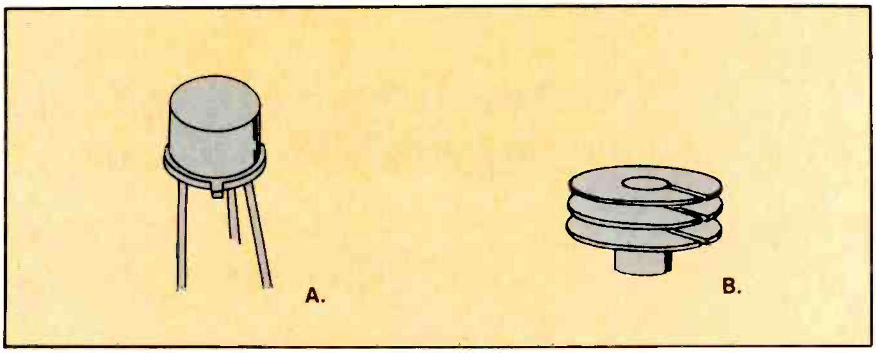


Figure 1. A heat sink such as the *top hat* device shown here slips right over a transistor, helps radiate heat away.

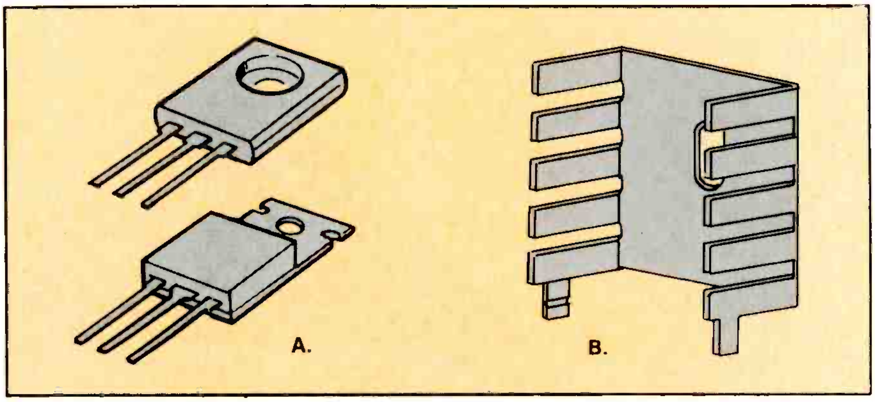


Figure 2. Transistors such as these plastic encapsulated devices can be mounted to finned heat sinks. Be sure to use heat sink grease to improve thermal transfer and tighten mounting screws just enough to ensure good contact.

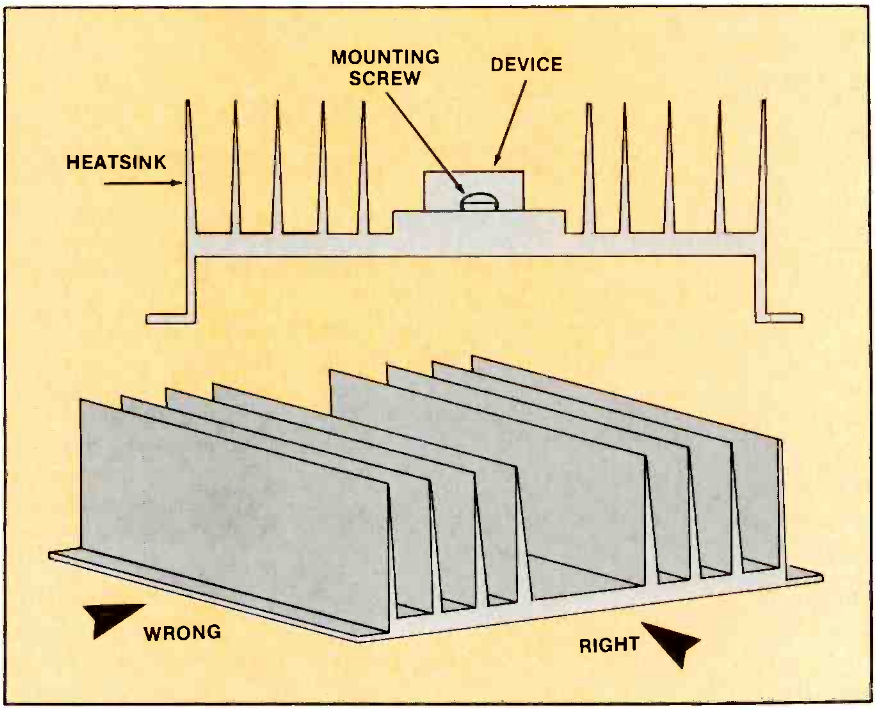


Figure 3. A.) A finned heat sink such as this one has a large thermal mass to conduct heat away from the electronic device and fins to increase the rate of heat radiation. B.) If you add forced air cooling with fans, make sure that the direction of air flow is through the heat sink.

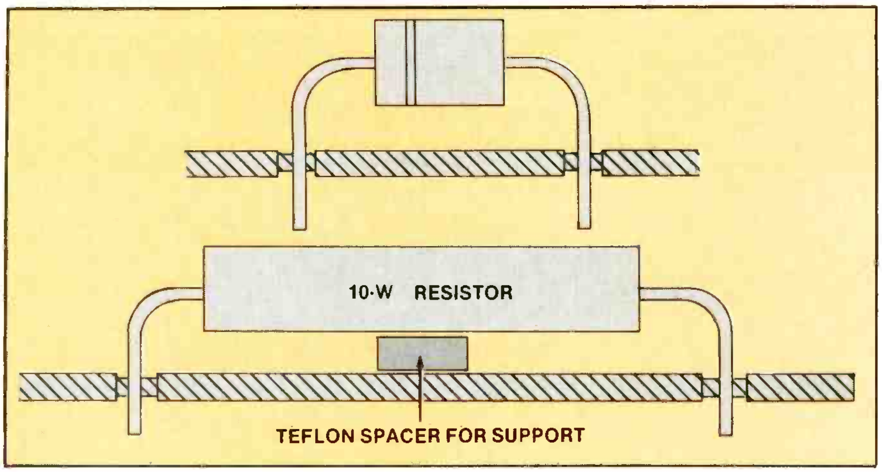
Protecting transistors & IC regulators

On small equipment, it is not practical (or possible) to use forced air cooling, so you will have to provide heat sinking for the semiconductors. In fact, even most forced-air cooled projects will need these metal radiators. Figure 1A shows the metal TO-5 transistor package. Most of these transistors are mounted on printed wiring boards, and are low-signal (and low-heat) devices. But certain TO-5 transistors, such as the 2N3053 and certain 3W to 10W RF power transistors, operate at moderate power levels (in audio drivers, for example). A *top-hat* finned heat sink such as shown in Figure 1B is mounted on the TO-5 package to radiate heat. There are also certain other *spring clip* versions of this same kind of heat sink.

Figure 2A shows two forms of plastic power device package. You will find these packages in audio power transistors (e.g. 2N5249), thyristors and 3-terminal IC voltage regulators. In the regulator case, the devices are usually rated at 750mA in free air and 1,000mA when heat sinked. Either vertical or horizontal finned sheet metal heat sinks such as Figure 2B are used to provide heat dissipation. Be sure to use a thin layer of silicone heat transfer grease between the metal tab surface on the transistor (or regulator) and the heat sink. Also be sure to tighten the mounting screw properly in order to facilitate heat transfer to the heat sink. One of my boomerangs from my consumer electronics days was a low-cost stereo compact that used unheat- sinked, TO-220 transistors in the AF power amplifiers. We rarely got one of those monsters out of warranty before another failure occurred – that is, until we gratuitously added heat sinks to the transistors.

Sheet metal heat sinks are suitable for TO-3 transistors and 3-terminal regulators that are mounted on a PWB. The bent sheet metal heat sinks are good for up to about 10W of power, or

Figure 4. Rectifier diodes and high-power resistors should be mounted far enough above the circuit board so that the heat they generate does not damage the board. Large components may have to be supported with a heat-resistant spacer, as shown, lower right.



voltage regulators up to 1.5A. For the 3A, 5A and 10A voltage regulators that also use a TO-3 package, it would be better to use a larger finned heat sink.

In many units, the metal chassis is used for heat sinking. In those cases, the transistors are bolted either directly to the metal chassis or mounted via mica insulators. In both cases, silicone heat transfer grease is used between the semiconductor device and the chassis. This method is especially successful when the chassis is large, or when it is particularly thick (i.e. has a high *thermal mass*).

Some printed wiring boards use large areas of unetched copper foil and/or large metal ridges or blocks to provide better heat sinking. This method is used especially where there are not single devices that can be individually heat sinked (e.g. a TO-220 transistor), but rather when there are a large number of heat-producing devices (such as TTL ICs).

There are many different forms of large, finned heat sinks used for TO-3 (and other) transistors, high-current voltage regulators and high-current diodes and SCRs; Figure 3A shows a side view of one of these heat sinks. In this case, the TO-3 transistor (or other device) is mounted on the flat central surface of the heat sink with screws. In most situations, it is wise to use a thin smear of silicone heat transfer grease between the device and the heat sink. This grease is especially needed when a mica insulator is placed between the semiconductor device and the heat sink. Again, it is necessary to make sure that the mounting screws are cinched down tight enough to allow maximum heat transfer (but not enough to distort the device package). The big issue in selecting a heat sink is the surface area in square inches.

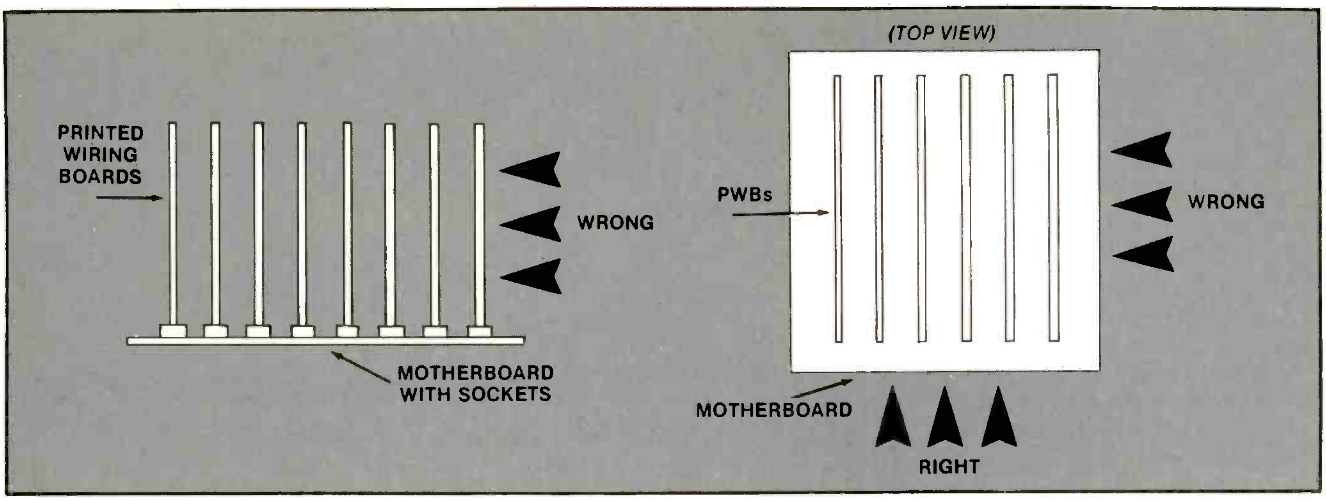


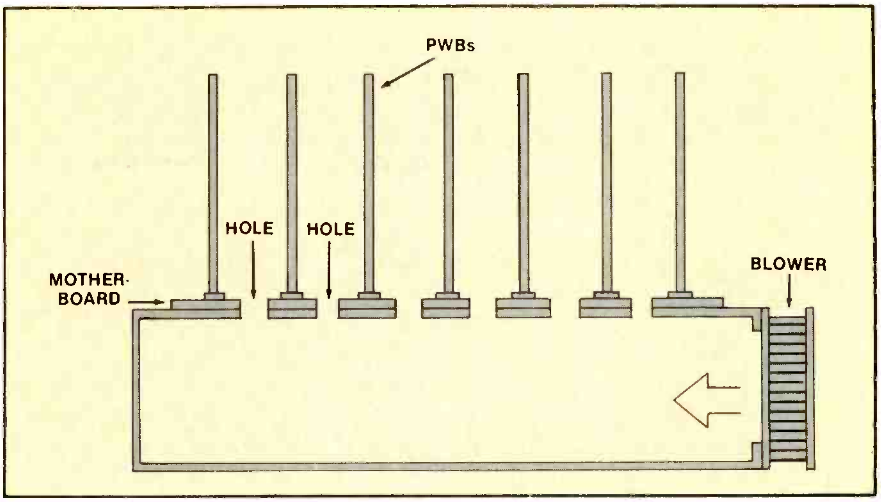
Figure 5. When you add forced-air cooling to a unit that consists of a motherboard with other circuit boards plugged in, be sure that the air flow is in a direction such that it flows through the plugged in boards.

When forced air is used to cool a heat sink – a good idea when the power and/or current is high – then the orientation of the heat sink with respect to the airflow is sometimes important. Figure 3B shows the right and wrong ways to force air over the finned surfaces. Keep in mind, however, that orientation is not always critical, especially when air from the *wrong* direction is sufficient or blows over the entire surface. The designations *right* and *wrong* are merely general considerations for some critical applications.

Other components

Certain components other than power transistors generate heat. Rectifier diodes and power resistors should be mounted with their bodies 0.125 inch to 0.250 inch off the PWB (see Figure 4). This procedure allows the heat to dissipate into the air instead of the PWB material. I have seen many phenolic and some fiber glass printer wiring boards badly damaged from the effects of a 10W power resistor mounted flush to the surface. Some "bargain basement" rectifier diodes can meet their rated forward current only when the rectifier is mounted 0.050 inch off the board and the axial leads are cut to 0.75 inch or

Figure 6. Another way to provide for forced-air cooling is to direct the air flow through holes in the motherboard as shown in the drawing at right.



longer. Those diodes are overrated and either should be used only in lower current applications or shunned entirely.

Besides reducing the operating life or limiting the power output of circuits, overheating also can decrease performance in other ways. Certain circuits, oscillators for example, are inherently sensitive to heat. There was once a popular 2-way radio transciever that suffered terrible frequency drift because the master oscillator was located next to the RF/IF strip vacuum tubes. Although that was such a bad design error that nothing would really repair the situation, a lot of people markedly improved the frequency stability by adding some Teflon thermal insulating material between the RF/IF PWB and the aluminum oscillator shielded housing.

Large multiboard equipment

When I first felt the temperature of my Digital Group computer cabinet, I took steps to get rid of the heat, and reliability was improved. Rarely does the homebrew builder have the flexibility that I had with my Vector Electronics S-100 cabinet. In most cases, the builder must do with only a single fan and must be clever to make best use of it. Figure 5A shows a typical large-scale multiboard project – such as a microcomputer or transceiver – in which plug-in printed wiring boards are installed on a socketed motherboard. Usually, these PWBs will be mounted in a closed cabinet for both EMI and aesthetic reasons. If we apply air broadside to PWBs, then only the first one in the line-up will benefit. Figure 5B shows a top view that permits you to see right and wrong airflow directions. Obviously, air coming in from the sides is able to remove heat from more of the PWBs more effectively.

Figure 6 shows a method used in a 6502-based microcomputer. The builder used a large metal chassis with a motherboard mounted on it to hold the PWBs. There were 0.75-inch holes cut in both the chassis top and the motherboard to admit air between the boards. Although only one hole is shown between each board in this side view, there were four per row in the actual computer. Air from the blower flowed up through the holes and across the electronics components on the PWBs.

Radio-frequency power amplifiers and high-power transmitters pose special heat problems. Some linears, for example, are only 45% efficient. Therefore, a 1,000W linear amplifier delivers 450W of usable RF power and 550W of waste heat. To make matters even worse, the necessity of keeping harmonics at home means we button up all that heat in a shielded metal cabinet.

Most RF power amplifier tubes used in medical diathermy and electrosurgery equipment, industrial inductive heaters and radio transmitters must be forced-air cooled in order to realize their full ratings (some are absolutely dependent on cooling). Figure 7 shows two methods for providing the needed cooling air. In Figure 7A, the blower is mounted so that the air flow is directly over the glass envelope. The fan may be mounted either exterior to the RF compartment (as shown) or inside.

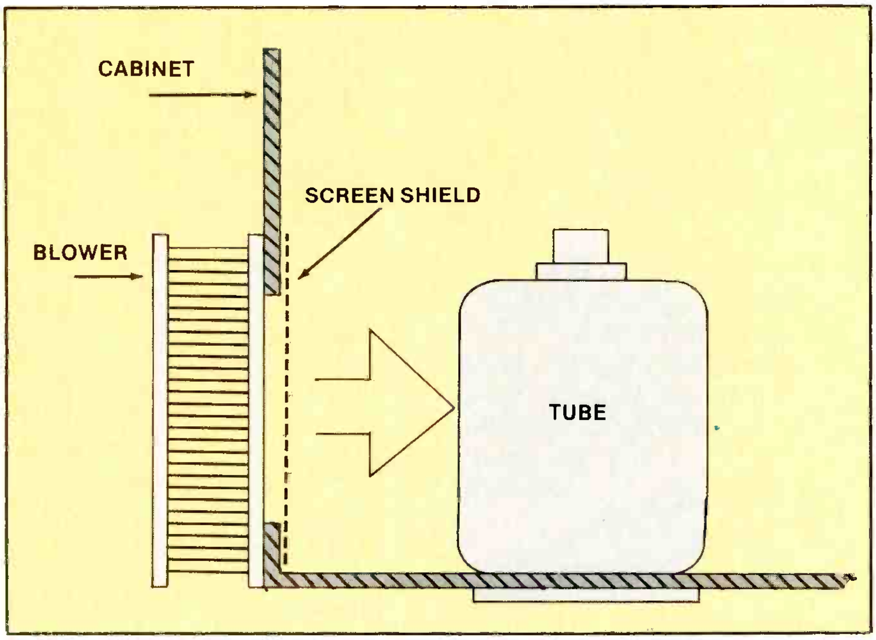
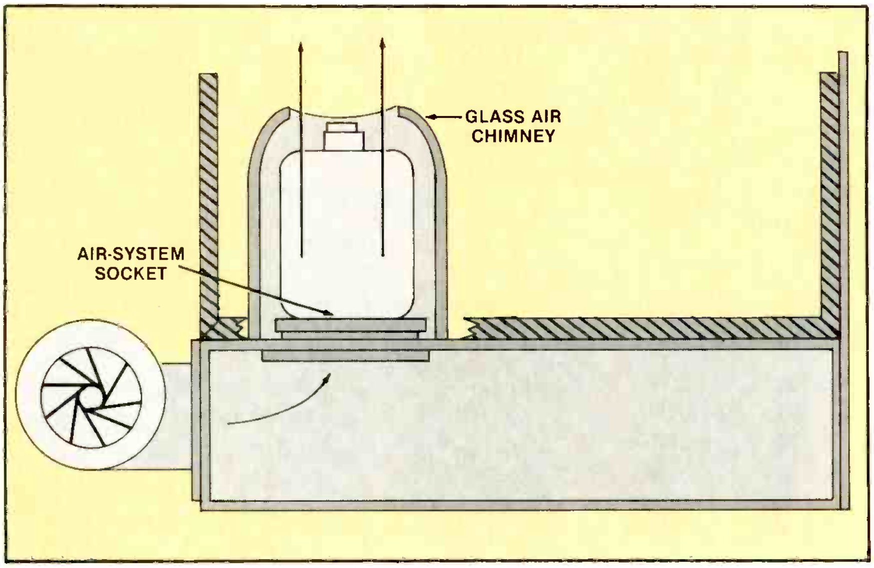


Figure 7. A.) If the unit to be cooled must be shielded from RFI, the cooling air may be ducted through a screen shield.



B.) Air system tube sockets direct the cooling air to ensure that it flows past the component that needs cooling.

The other method, shown in Figure 7B, assumes the use of *air system* tube sockets. A blower or fan supplies air to the bottom side of the socket, and the air is directed upward through holes in the socket and around the glass envelope. A *chimney* aids in keeping the airflow against the glass. Some air system sockets have plumbing connections for the air hose, while others depend on pressurization of the lower compartment. In either case the reason this socket is better is that the pin seals with the glass are kept cooler. The plate cap pin seal should also be kept cool, if possible. Toward this end some builders use a finned heat dissipating plate cap to make electrical connection to the anode.

Modify when you can

Heat is the great destroyer of electronic components. If a piece of equipment runs too hot, then the result will be flaky operation, frequent breakdowns and all the headaches that accompany low reliability. Although it is ordinarily unwise for professional servicers to modify equipment without expressly written instructions from the manufacturer, there are sometimes exceptions to this rule. An obviously overheating piece of equipment that can be modified with no adverse effects is a candidate for exception to the rule. The simple methods shown in this article will permit you to modify equipment to gain the longest and most reliable use possible for yourself, your customer or your employer.

Photofact

These Photofact folders for TV receivers and other equipment have been released by Howard W. Sams & Co. since the last report in ES&T.

EMERSON
ECR-135 2418-1

HITACHI
CT-1957, CT1957B 2419-1

HITACHI
CT 1958 2420-1

HITACHI
CT2647, CT2648, CT2649 2421-1

HITACHI
CT19B3, CT19B5, CT1953, CT1956 2423-1

HITACHI
CT1951 2424-1

MAGNAVOX
Chassis 25C508,09/11/15/16/17/22/23/31/47/48/49/53/54/63/64/65 2418-2

MGA/MITSUBISHI
CS-1904, CS-1905 2422-2

PANASONIC
CTF-2501/02/09, CTG-2501/02, PC-26L01/02/09 . . 2422-3

RCA
Chassis CTC125E 2419-2

RCA
Chassis CTC120C 2423-2

SEARS
564.48700550 2420-2

SONY
Chassis SCC-548N-A/O-A, SCC-552K-A 2421-2

SONY
Chassis SCC-548V-A, SCC-552L-A, SCC-648D-A . 2424-2

MONITOR

APPLE
Monitor II A2M2010 2422-1

OKIDATA
Microline 92 . . . . CP20

RADIO SHACK
MODEL 4 (Gate Array Version) CSCS13

ES&T

By Sam Wilson

What do you know about electronics?

Tests for low-frequency amplifiers

In a recent article we illustrated the difference between a time domain and frequency domain display. The illustration (Figure 1) is repeated here to show the difference between those displays. In this article we will discuss some tests based upon a frequency domain display.

As you know, an oscilloscope can be set up to show a frequency domain display. However, there is a test instrument, called a *spectrum analyzer*, that is especially designed for this. If you do much quality audio work, you will find this a very useful instrument.

> **Review of terms**
>
> *Bandwidth*—The range of frequencies between the points on a frequency response curve where the voltage amplitude drops to 70.7% of the maximum value. This assumes that the input amplitude is constant for all frequencies.
>
> *Rise Time and Decay Time*—With an input step voltage the rise time and the decay time are both equal to the time between 10% and 90% of the output voltage range.

Some thoughts on testing

One of the accepted procedures for troubleshooting is based upon measurements. The procedure is to make a measurement at some point in the faulty circuit, and if the result of the measurement is what you expect to get at that point, you know you are not at the source of the trouble. So, you move to the next logical point, make another measurement, and evaluate the result. You continue to do that until you come to a point where the test result is not correct for that point. In that case, you have most probably located the site of the trouble. A key to successful troubleshooting by this method is to make accurate tests.

Qualitative and quantitative tests

For troubleshooting purposes, technicians make two types of tests. A *quantitative* test gives numerical values as evidence that a circuit is or is not working properly at some point. An example is measurement of the collector voltage of a transistor. A value of 10V would be a quantitative result.

A *qualitative* test requires the technician to make an evaluation based upon some evidence that is not a numerical value. A good example of a qualitative test is using an oscilloscope to examine a waveform at some point in a circuit.

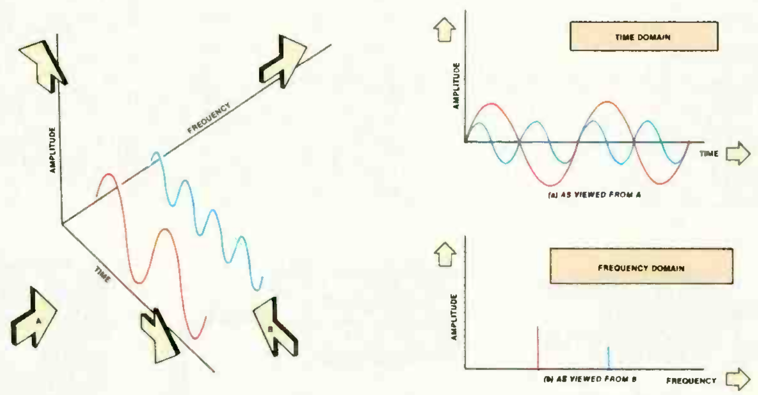


Figure 1.

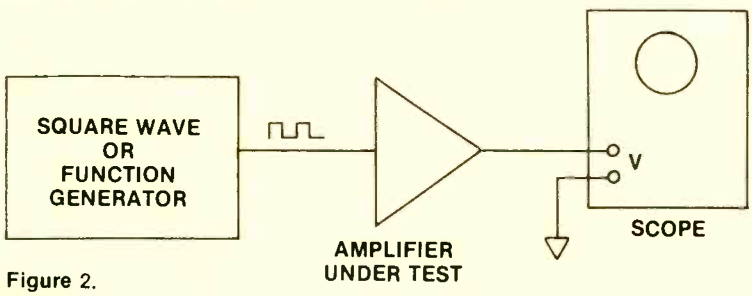


Figure 2.

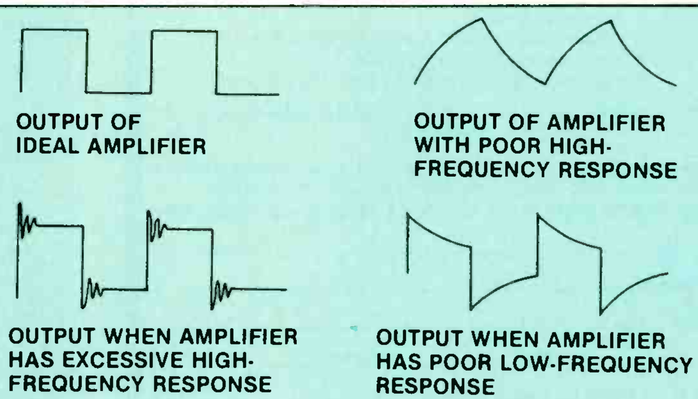


Figure 3.

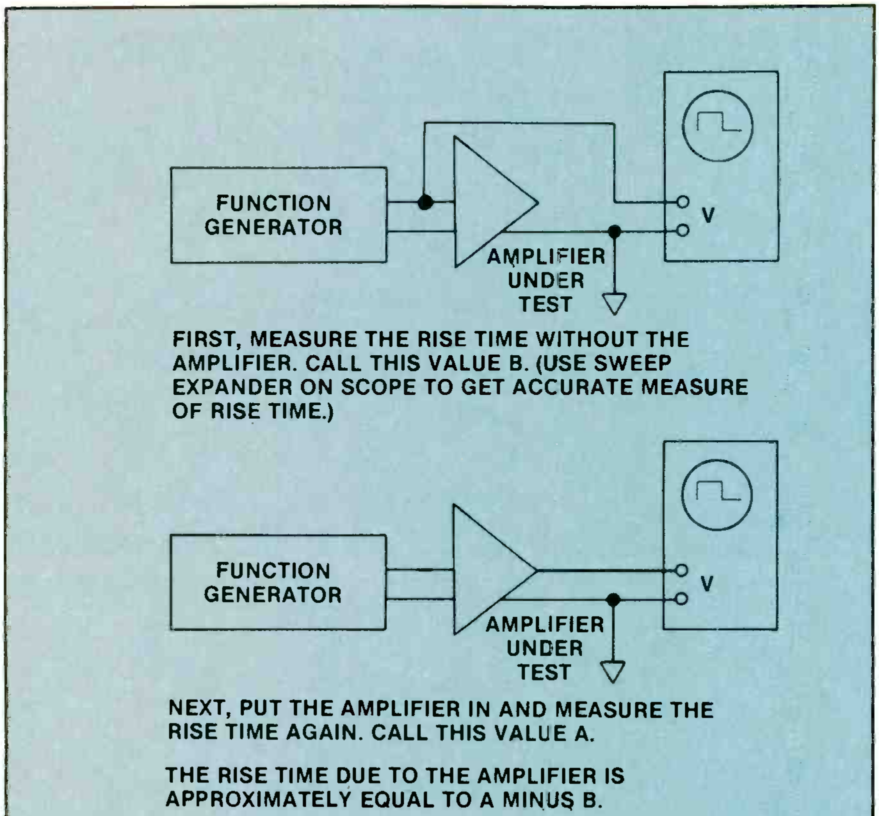


FIGURE 4.

The technician makes a decision as to whether or not the waveform is sufficiently close to the expected result.

Very often the expected result is provided by the manufacturer of the equipment.

The square wave test

Square wave analysis of amplifier performance is a good example of a qualitative test. As shown in Figure 2, a square wave is delivered to the amplifier input. The output waveshape on the oscilloscope is evaluated by the technician. Anything other than a square wave at the output indicates that the amplifier has in some way modified the waveshape. Some examples are given in Figure 3. By interpreting the output waveshape, the technician makes a qualitative judgement about the bandwidth of the amplifier.

There have been a number of attempts to make the square wave test quantitative. For example, you may have heard that you can multiply the square wave frequency by 5 to determine the bandwidth of the amplifier. According to this rule, if the amplifier can pass a 5,000Hz square wave (without modifying it), it has a bandwidth of at least 5 x 5,000, or 25,000Hz.

That rule is easy to use. Unfortunately, it isn't valid. *You cannot accurately determine the frequency response of an amplifier with a square wave test.* The square wave test should be used as a quick qualitative evaluation of amplifier bandwidth.

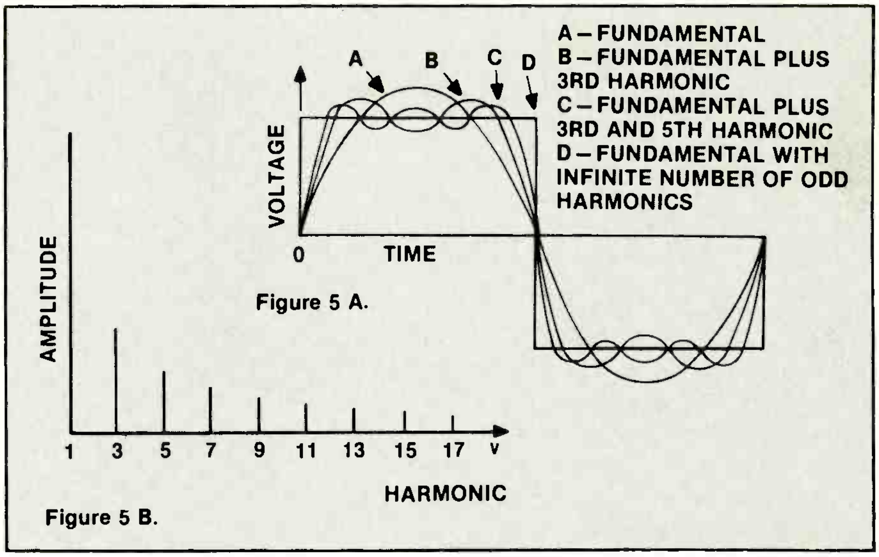


Figure 5 A.

Figure 5 B.

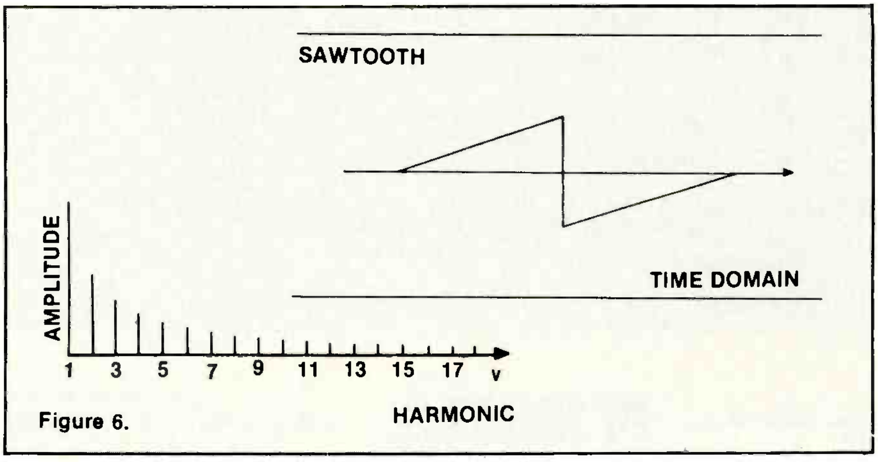


Figure 6.

The bandwidth/rise time square wave test

There is one quantitative evaluation that can be made using the square wave test of Figure 2. It is based upon an *empirical* equation. (An empirical equation is based upon experience rather than upon a mathematical procedure.) Here is the equation:

$$\text{Bandwidth} = \frac{0.35}{\text{rise time}}$$

That equation gives a reasonably accurate approximation of bandwidth provided certain precautions are observed.

An important step is to determine how much of the square wave leading-edge rise time is due to the amplifier itself. The oscilloscope amplifiers and the square wave being used for the test also will have a certain amount of rise time that must be taken into consideration.

Figure 4 shows how the test is performed. The rise time of the signal at the input to the amplifier is first measured. This must be done with the amplifier attached. Then, the rise time of the output signal is measured.

The values are subtracted to determine how much of the rise time is due to the amplifier. This value is plugged into the equation. If you were careful with your measurements you have a good idea of the bandwidth.

An alternative quick test

The square wave test is based upon the fact that a square wave can be considered to be made up of a fundamental sine wave and a large number of odd harmonics. This makeup of the square wave is illustrated in Figure 5.

In (a) of this illustration, you can see how each additional odd harmonic frequency brings the waveform closer and closer to a square waveform.

In (b) of the illustration, you can see the harmonic content of the square wave on a frequency domain display. *Note that the amplitude of each harmonic must be reduced for a true square waveform.*

In theory, it would take an infinite number of harmonics to produce a perfect square wave. In practice, if the first 10 harmonics are present, the waveform is quite satisfactory.

The very low amplitude of the upper harmonics accounts for the fact that the square wave test does not give a true picture of bandwidth. Their amplitude is not sufficient to extend into the non-linear portion of the amplifier characteristic, so no modulation can take place.

Compare the harmonic content of the square wave with the harmonic content of a sawtooth wave as shown in Figure 6. Note that *every* harmonic, both even and odd, is present. This gives a better view of the amplifier linearity because some amplifiers eliminate only the even harmonics. Those would not show distortion when you conduct a square wave test.

Another advantage of using the sawtooth waveform is that amplifier clipping will show in the test. Clipping cuts off the top and/or bottom of the square wave, but you cannot see any effect. The sawtooth waveform gives a steep decay time that can be used in the rise time/bandwidth equation given earlier. In fact, despite its popularity there doesn't seem to be any good reason for the use of square waves instead of sawtooth waves.

Having presented the case for the sawtooth waveform test, the next question is: *Why is it seldom used?* Technician readers will have to send me the answer to that one. I don't know.

If you write to me concerning an article in ***Electronic Servicing & Technology,*** the editor considers

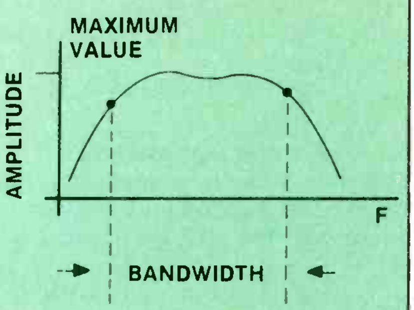


Figure 7.

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If you write a letter to me in care of ***Electronic Servicing & Technology*** and you *do not* want it to be published in ***ES&T*** in any form, you must so indicate.

Using the function generator

Most function generators can be used as sweep generators. The oscillator that sweeps the generator frequency is usually referred to as the VCO (voltage controlled oscillator). The VCO frequency output is used to sweep the scope trace back and forth as the generator frequency is swept up and down. The result is a frequency domain display similar to one shown in Figure 7.

You easily can see the response of the amplifier with this setup, but it is difficult to determine the exact frequency where the output is down to 70.7%.

It helps to mark the trace with an accurate signal generator signal. An audio generator works very well for this purpose. This marker can be delivered to the Z axis to intensity modulate the trace. The result is a bright spot on the curve to mark the audio frequency. (Important: Keep the marker amplitude as low as possible to prevent mixing of the signals inside the CRT.)

By adjusting the audio generator frequency you can move the marker to the high-frequency point, where the response is down to the 70.7% mark. The audio generator setting tells you the upper limit of the bandwidth.

You must repeat the procedure to find the lower limit of the bandwidth. If the amplifier under test is dc coupled, the response will fall to 0Hz, making it unnecessary to measure the low end of the bandwidth.

With the tests described in this article it is possible to check quickly the frequency response of an amplifier. These tests are useful for troubleshooting an amplifier that performed well in the past but is now giving unsatisfactory performance.

In the next issue I will review another quick test, then show some more advanced tests that give a better evaluation of an amplifier's capability.

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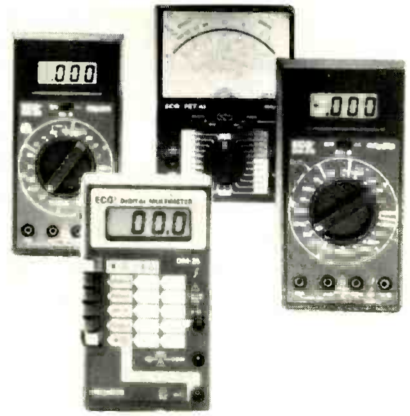
Products

Multimeters and accessories

A line of ECG multimeters, an oscilloscope probe and accessories are now available from *Philips ECG,* a division of *Amperex Electronic,* a *North American Philips* company.

The multimeters are models DM-300, DM-25, FET-43, DM-310 and model DM-74. The complete



line consists of four digital multimeters, an analog meter, an oscilloscope probe and various accessories.

Circle (75) on Reply Card

Technical service data

Howard W. Sams & Co., a division of *Macmillan,* has introduced new "Computerfacts" technical service data for eight Commodore products, in addition to Computerfacts manuals for more than 70 other microcomputers, printers, disk drives, systems and monitors.

Computerfacts follow one standard format, regardless of the manufacturer. Each manual contains standard-notation schematics created by a computer-aided design (CAD) system, reproductions of actual waveform photos taken from test equipment, preliminary service checks, troubleshooting tips, replacement parts lists and semiconductor cross-references.

Circle (76) on Reply Card

Precision frequency source

A low-cost, portable precision frequency source that is battery powered for absolute line isolation and features high stability and accuracy with a total of 58 discrete frequencies between 4MHz and 0.008Hz is now available from *Technical Novations.*

Designated the model 130, it provides both decade and binary division of its basic high stability, temperature compensated 4Mhz crystal oscillator. Provisions are included to use an external crystal or use the decade/binary dividers only with an external signal input.

Circle (77) on Reply Card

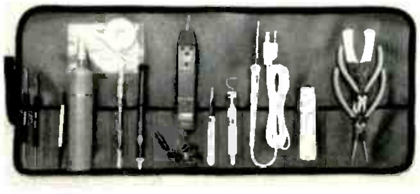
TV stereo synthesizer

The *Televonics Sound Systems'* model 2001 is a TV stereo synthesizer that is installed directly into any TV set to provide the listener with full-spectrum sound with no cutoff of high frequencies. Breaking the audio spectrum into distinct frequency bands enhances the stereo effect of the synthesized sound by adding directivity. A theater-hall effect results when proprietary phasing circuitry adds the necessary depth at precise frequencies.

Circle (78) on Reply Card

Printed circuit board repair kit

Jensen Tools has introduced a compact kit of essential tools for circuit board technicians. Recommended for in-the-field CB troubleshooting and repair, this versatile kit in a roll pouch contains: a cordless mini-drill with half-moon bit for fine circuit board drilling; miniature 12W soldering iron; a pocket pack of 60/40 solder; two soldering aid tools; spring-

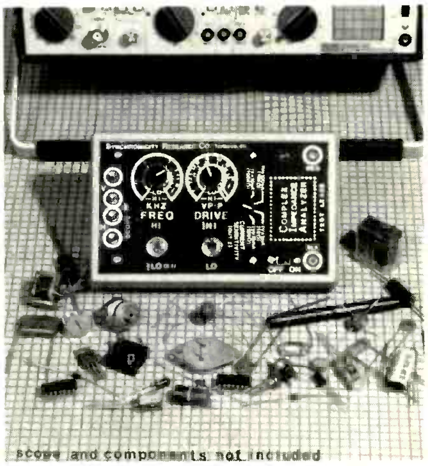


loaded piston-type solder remover; DIP insertion and extraction tools; wire stripper/cutter; needle-nose pliers; miniature diagonal cutter, and more.

Circle (79) on Reply Card

Component analyzer

Synchronicity Research has developed the Complex Impedance Analyzer. The CIA uses your scope to display the E-I signature of the component under test. Although



all other component analyzers use a sine wave test signal, the CIA uses a triangle wave test signal of variable frequency (to 10kHz) and variable amplitude (to 30Vp-p). In addition to improved semiconductor tests, the triangle wave and wide frequency range make possible accurate inductance and capacitance tests over a wide range of values (from under 10pF to over 20μF and under 2mHz to over 200Hz). The impedance of complex networks (such as amplifier inputs and power supplies) and transducers (such as mics and speakers) can be measured.

Circle (80) on Reply Card

Shaft cutter

The model 85 shaft cutter, from *Turnex International,* is designed for use in production, prototyping, and maintenance of electronic devices. It is easy to use, says the company, and the cutting is done in a second. It will cut all shaft materials including stainless steel and most plastics.

This guillotine-type tool is made of high quality steel that is hardened to 62 HRC hardness. All parts subject to wear are bonderized to minimize friction. The tool has seven holes for cutting of all standard-shaft diameters.

Circle (81) on Reply Card

Readers' Exchange

Wanted: SG165 stereo analyzer, will pay as much as $400, you ship; late model Heathkit CRT tester, will pay as much as $50, you ship; for VCR repairs – tape tension, spindle gauge. VCR manuals. *Michael P. Mena. P.O. Box 1479. APO New York. NY 09193.*

Wanted: Service manuals for Topaz Anti-Brownout ac Line Regulator, model 2LRA117SN; Motorola/McGraw Edison RF signal generator, model XT1034C/T1034C; Plessey Tellurometer, model MRA 101; Motorola walkie talkie, model HT-200 lowband; Supercall mobile telephone, model 60 80 KM; CB radio, Claricon Raider model; J.L.L. model 615CB; RCA radio phone, model CRM-P3A-5 Mark VII and for numerous other items. Send s.a.s.e. for list. *Réjean Mathieu. VE-2-EUI. 1897 3rd Ave.. Val d'Or. Quebec J9P 4N7 Canada.*

For Sale: Sencore VA48, mint condition, all probes and manuals, $600; Tektronix 50MHz dual-trace D75 model, $400. *Anthony Ruoppolo, 182 Kimberly Ave., East Haven, CT 06512; 203-469-2205, after 6 p.m.*

For Sale: Royal electric correctable typewriter, model SE5000, three type elements and box of film ribbons. Used very little and in mint condition. Cost, new, over $1,000; an excellent buy for $395. Will ship UPS. *Bob Goodman, P.O. Box 452, Alexandria, LA 71301; 318-640-1466.*

For Sale: B&K 415 sweep/marker generator, with cables and manual, excellent-plus condition, $350, or will trade for a Sencore SC61 in good condition, or other dual-trace, dc to 50MHz scope. *Paulmer L. Williams, 322 North Court St., Lewisburg, WV 24901; 204-647-5414.*

For Sale: Mercury all in-circuit capacitors tester, model 1400, with electric eye, in mint condition, $25 plus postage. *Jos. A. Gontarz, JAG's Radio & TV, 14 Rudolph Road, Forestville, CT 06010; 203-583-7532.*

For Sale: Clough-Brengle model OC signal generator, 65kHz to 30MHz, six bands, modulated or unmodulated, 400Hz audio output jack, factory hand-calibrated, $35; Dumont No. 164E 3-inch oscilloscope, $35; EICO model 221 VTVM, factory wired, $35; TOBE condenser analyzer, $15. All in perfect condition, with manuals. All prices plus shipping. *M. Seligsohn, 1455-55th St., Brooklyn, NY 11219.*

For Sale: Hickok model 610A alignment generator with manual, $45; Dumont battery-operated communications frequency meter, $25; 24 B&W 7-inch video tapes, $20 for all; model 7 Webster-Chicago wire recorder, $20; Precision E-200-C signal generator with manual, $40. Add $5 for shipping. *Clark Trissell, 3530 Pawnee, Lincoln, NE 68506; 402-488-5263.*

Wanted: Cartridge head shells (white) for Garrard A-2. **For Sale:** NOS (boxed) Collard RC-456 changers, $20; RCA WR502A (battery portable) WR502A chro-bar generator, matches WV-510 TVM, $25; 2-tube UHF converters, $10 each. All working and prepaid. *Jim Farago, P.O. Box 65701, St. Paul, MN 55165.*

Wanted: Service manuals or schematics, or both, for two R.J. MacDonald products: AM/FM radio/record player, model M-9040; portable stereo radio/cassette model code No. 06-33-67. I will gladly pay for original manuals or copies of same. *J.L. Wingfield, P.O. Box 685, Cedaredge, CO 81413; 303-856-6341.*

Wanted: Sams Photofact VCR series No. VCR67 (out of print). Will buy or copy Sylvania No. VC2210 chapter and return. *Ed Duda TV and Repair, Linwood, NE 68036, 402-666-5842.*

For Sale: RCA VTVM, model WV-98A senior voltohmyst, $50. *Barnes TV-Radio Service, 118 W. Main St., Camden, TN 38320; 901-584-6411.*

For Sale: Sams Photofact CB radio series – CB11, 12, 15, 16, 21, 22, 23, 25, 34, 42, 46, 48, 49, 52, 54, 55, 63, 65, 109, 113, 115, 123, 129, 249. **Wanted:** Sams Photofact CB radio series – CB170, 172, 173, 175, 176, 177, 178, 180, 182, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 201, 202, 203, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 219, 222, 223, 224, 225, 227, 229, 230, 231, 232, 233, 234, 236, 239, 240, 241, 243, 244, 245, 246, 247, 248, 252 and up. *Paul Garner, P.O. Box 636, Millbrook, AL 36054; 205-285-5839.*

For Sale: B&K 5-inch triggered scope, model 1461, $225; B&K color generator, model 1248 (transistor) $59; B&K bench DMM, $79.50. All good condition. Old-time RCA voltohmyst, model WV-87-B, very big scale, $45. Prices plus shipping. **Needed:** Instructions and service information on Hickok Cardmatic tubetester, model 121. Will copy and return, or buy if reasonable. *Maurer TV Sales & Service, 29 S. 4th St., Lebanon, PA 17042; 717-272-2481.*

Answers to the Quiz

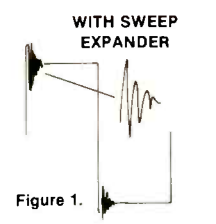


Figure 1.

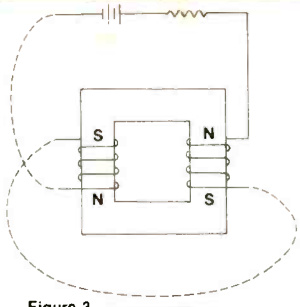


Figure 3.

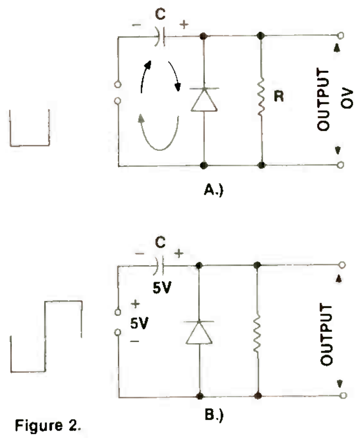


Figure 2.

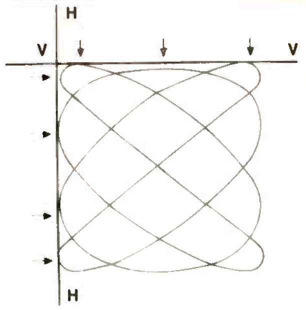


Figure 4.

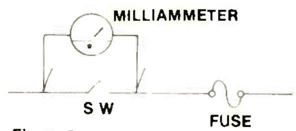


Figure 5.

Wanted: Service information and/or schematic for Kenwood KR-4200 AM-FM stereo receiver. Will copy and return, or will pay for copies. *J.R. Janeczko, Accurate Electronic Service, 409 4th Ave., Haddon Height, NJ 08035.*

Wanted: Heath model IB-2A impedance bridge, in good condition, with manuals. *Bob Kramer, 919 Grove St., Aurora, IL 60505; 312-898-8946.*

For Sale: New receiving tubes, all types but mostly RCA, in original cartons, 80% off list price. Send s.a.s.e. with wanted list. Shipping: 50¢ per tube. *James Vandemark, Box 3472, Santa Rosa, CA. 95402.*

For Sale: World War II-era capacitors, tubes, etc., for sale, or will trade for panel meters, solid-state electronics books or back issues of magazines on electronics and photography. *Ransom Beers, Box 758, Blythe, CA 92226.*

For Sale: ***Electronic Servicing & Technology*** magazines, September '76 to date; *Popular Electronics*, January '77 through October '82; schematics, *Electronics Technician Dealer* Tekfax, No. 1 September '52 through No. 1923 April '82; ***ES&T*** Profax, No. 2000 October '82 to date. *James B. Geier, Jimco Services, Box 341, Ketchum, ID 83340.*

Wanted: Tektronix 321A or 321 oscilloscopes, any condition. *Marv Loftness, 115 W. 20th Ave., Olympia, WA 98501; 205-357-8336.*

For Sale: Sencore SC61, $2,500; Sencore VA62, $300 and assume; several other pieces at reasonable prices. Sams Photofacts, RCA and Zenith tech data, RCA and Zenith parts at 25% of cost. Send s.a.s.e. for list. *Jim Frost, Jim's TV Service, 95 S. Wintzell Ave., Bayou La Batre, AL 36509; 205-824-2262.*

Needed: Service information and schematics for the TOCOM converter/descrambler, model 5503. Will pay price for information that can be delivered. *D.G. Seibel, 6201 35th St., Lubbock, TX 79407; 817-232-3838.*

Wanted: Schematic for Panasonic model CT702 Quatre color, and for Texas Hitech model THT-606. Will purchase or copy and return. *C. Bufano, 15 Green Hills Drive, Shelburne, VT 05482; 802-985-2419.*

Wanted: Panasonic color picture tube No. A-26JAS31X, Sams TSM service, B&K's CRT tester model 470 test adapter sockets CR12 to CR29. *Ed Herbert, 410 N. 3rd, Minersville, PA 17954.*

For Sale: Diehl Mark V, new in box, $500; Diehl Mark III, new in box, $300. *Dwight's Electronics, 9875 Piute Drive, Salida, CO 81201; 303-539-7571.*

1. B – At 400Hz the primary current is limited by the inductive reactance.
($X_L = 2\pi fL$)

Lowering the frequency reduces the inductive reactance. With less opposition to primary current, there will be a higher current and resulting heat.

2. B – The ability of a receiver to reject image frequencies is not related to oscillator stability. So, phase locking the oscillator will not have any effect. Choices A, C, and D are the methods usually used to improve image rejection.

3. C – (This is the definition of eutectic solder.) When solder is made of 63% tin and 37% lead, it is eutectic. For all other combinations of tin and lead, the solder passes through a plastic state between the solid and liquid states.

A quick change from solid to liquid is desirable because heat is applied for less time. That is important for preventing heat damage to components.

4. E – The waveform shown in Figure 1 represents excessive high-frequency response. The small enhanced areas following the leading edge represent oscillations that are characteristic of this type of amplifier.

5. D – The circuit is known as a *clamp*. It has also been called a *baseline stabilizer*, and a *dc restorer*.

On one-half cycle, the capacitor charges through the diode as shown in Figure 2 (A). The output voltage is zero at this time. On the next half cycle, the capacitor voltage is in series with the generator voltage. The total output is their sum, or, +10V. This is shown in Figure 2. (B).

6. The completed circuit is shown in Figure 3. Use the left-hand rule, which states: grasp the coil so that your fingers are pointing in the direction of electron flow. Then, your thumb points in the direction of the North Pole. The resulting north and south poles are shown in Figure 3. Note: the poles of the electromagnets are in series; they produce maximum magnetic flux.

7. D – The Maxwell Bridge is used for measuring inductance with a low Q. When inductors have a high Q their inductance is measured with a Hay Bridge.

8. B – The ratio of vertical frequency to horizontal frequency is measured as follows. Draw two lines touching the sides as shown in Figure 4. The ratio of vertical to horizontal frequency is equal to V divided by H. In this case:

$$\frac{V}{H} = \frac{3}{4} = \frac{300}{400}$$

9. B – The Z-axis terminal is connected to the grid or cathode of the CRT. One example of the use of the Z-axis is for marking frequencies during a sweep alignment. When the marker is fed to the Z-axis, there is less chance of it distorting the trace.

10. B – See Figure 5. If the meter reads zero when the switch is open, then it may be defective. However, you must have some knowledge of the circuit. For example, if the fuse is open, the meter reads zero regardless of the switch position. (In that case, put the meter across the fuse.) ES&T

Audio Corner

By Kirk Vistain

Mention the word *microcomputer* and most folks think of the typical CRT, keyboard, disk-drive combination that they've seen in the office or on television. Ask the typical individual how many computers he has at home, and he'll likely say none. But if he owns a late model receiver, cassette deck or VCR, he probably owns several dedicated microcomputers, for they proliferate in audio and video products. Granted, the micros inside consumer equipment are *dedicated*: that is, can perform only functions related to the device they control. That's why there's no console or CRT display. They are preprogrammed. From the owner's point of view, they are hidden or *transparent*.

So, love them or hate them, you still have to deal with microcomputers if you service today's home electronics. This article will discuss the basic makeup of dedicated micros, show what products make use of them and why, and offer tips for those of us who have the pleasure of servicing them.

Terminology

We often hear the terms *microprocessor, microcomputer* and *microcontroller* used interchangeably. To prevent confusion, let's try to define each one. For the following discussion, refer to Figure 1.

The most elementary microcomputer comprises three separate blocks:

1. microprocessor;
2. memory;
3. interface adapter.

The microprocessor performs arithmetic, logical and control operations for the system. As you can see, the processor is part of a microcomputer, and, strictly speaking, the two terms are not synonymous. All the same, you may notice that some technicians, as well as manufacturers, confuse the two.

There are two kinds of memory used by the processor. ROM is programmed during manufacturing and can be read only, and normally contains the program, or set of instructions, that configures the microcomputer for a given function. More sophisticated devices also use RAM, which can be written into as well as read, to store temporary information, such as switch settings.

The interface adapter buffers and conditions signals to and from the outside world. It offers the processor a measure of protection from externally caused damage and translates between the signals understood by in/out devices and those produced by the processor.

I/O devices are the solenoids, motors, sensors and indicators that communicate with the processor. Some units have I/O expanders attached to them that allow the micro to control more devices than it has outputs.

So the term microcomputer is really quite accurate when applied to the controllers inside modern home entertainment equipment. They all have a microprocessor *command center,* memory (although not much) and an I/O interface.

Why use them?

Because they are complex and, though generally reliable, sometimes cause puzzling failures, microcomputers may seem to be a bit of overkill for consumer devices. So why are they so popular? One reason is that customers love a wide variety of flashing lights and esoteric functions (or at least the manufacturers think so). The microcomputer is perfectly suited to this sort of thing. It also helps manufacturers offer consumers a large variety of units at different price points. The micro's programmability allows manufacturers to produce a wide range of products with similar chassis types, thus cutting production costs.

By programming the processors differently, and perhaps adding a subassembly here and there, a variety of products at different price points can be produced inexpensively, giving the consumer an apparently wide choice, and the manufacturer a more comprehensive market.

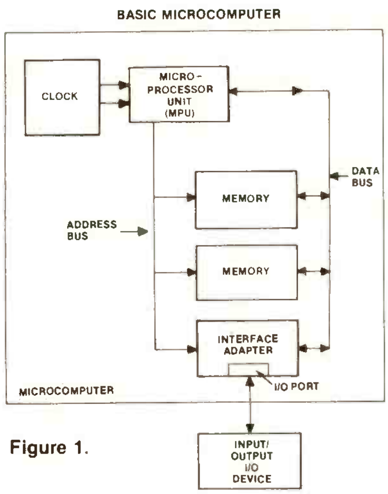


Figure 1.

KEY MATRIX CHART

OUT \ IN	K_0	K_1	K_2
S_a	FF	REV	DOLBY
S_b	REW	MEM	VOL. DN.
S_c	PLAY	REC	VOL. UP

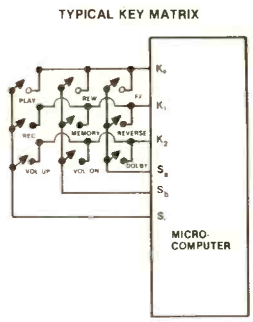


Figure 2.

The micro replaces thousands of discrete transistors, reducing parts count. For a dramatic example of this, take a look at a full logic cassette deck from the late '70s, then compare it to this year's models. Gone are the separate logic boards with 20 or 25 discrete TTL chips plus a few dozen transistors. All are now replaced by a couple of LSI (large scale integration) packages and a handful of driver transistors. Fewer parts should mean less trouble and easier repair if something goes wrong.

Servicing

There are many good books that describe the inner workings of microcomputers, so we'll skip that for now. Troubleshooting is done using a *black box* approach. We find out what's supposed to go in and what should come out. If the inputs are there and the output isn't, the chip is probably bad. If the inputs aren't there, back up to the previous stage.

•Program Number

Most microprocessor ICs have a designation such as LM6413E-027. The number to the left of the dash is the type; the one to the right is a program number. The same device may be used in a television or a cassette deck, but the program numbers will be different. It is important to ensure that you have a chip with the correct program or it won't work.

•Power Supply and Clock

Troubleshooting begins with, what else, checking supply voltages. They should be within 10% of their nominal value, with no ripple. Next check the clock. A microprocessor generally needs a clock to synchronize its operation. If the clock is bad, the chip won't function. A clock is really just a tightly controlled crystal oscillator. Look for proper amplitude and frequency.

•In/Out

Several input schemes are used to provide commands to the microcomputer:

1. Constant dc voltage (high or low);
2. momentary connection to high or low dc;
3. scan.

Before we elaborate, a quick tip – you can usually tell from the schematic what polarity of signal should appear at a particular pin. A bar over a function means it is active low. No bar normally means it is active high.

Constant dc voltages are easy to check. They are there or not. So are momentary dc levels. Just activate the switch or other input in question and see if the input pin gets the signal. If not, the driving circuitry may be bad. Scanned inputs are more difficult to test, but in general, you'll need a scope. See Figure 2.

Instead of using fixed dc voltages, a scanned input scheme takes a coded output from the microprocessor and connects it to the input pin selected by a switch. To test one, use the oscilloscope to see if the signal from the scan pin connected to the switch in question is sent to the appropriate input pin when the switch is activated. You'll probably just see a train of square waves, which are difficult to decipher, but you don't have to. It's enough to know that the pulse train is getting to the pin.

No static

Nothing ruins a day on the bench like trashing the expensive 24-pin IC you've been waiting several weeks for. So, by all means, take care to prevent static damage. Most microcomputers are CMOS devices, inordinately sensitive to high voltage static charges, which punch through the gate insulator. Use a grounded work surface and iron, as well as a wrist strap connected through the 1MΩ resistor to ground. Leave the chip in the conductive foam it's shipped in until just before it's installed. Then take care not to touch the pins while inserting it into the board. In most cases, these precautions are adequate. But if you work in a dry environment, and can draw an arc from the doorknob after shuffling across the carpet, think about humidifying the shop.

Computerized operation is nearly standard on even the least expensive audio and video equipment. Many sophisticated functions, which you couldn't have had for $2,000 just a few years ago, are currently available in $100 cassette decks. No matter how you feel about computers, you can't get away from them in the servicing business. Now is the time to study them and learn to boost your productivity for the present and future. **ES&T**

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ANDREWS ½ INCH 50 ohm heliax rf cable. Brand new, never used. 1,300 feet $900.00 plus shipping. Will ship Freight collect. PH 619-690-1774. Leave Number. 8-86-1t

HELP WANTED

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VIDEO/AUDIO technician needed. Top pay and benefits for well trained and experienced technicians who are expert with consumer TV and audio equipment. Training by manufacturers such as: Sony, Hitachi, RCA, Panasonic, etc. are necessary for job experience. Write or call: Atlantic Electronics, Inc., 1881 NE 26th St., Ft. Lauderdale, FL 33305, 305-564-8274 (10 AM 6:30 PM). Ask for Dave or Joe. 06-86-tfn

BUSINESS OPPORTUNITIES

WORKING PARTNER needed to expand present business. Pay ½ down & balance from profits. Precision Picture Tube, Rochester, NY 14612. (716) 621-5250. 7-86-tfn

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Bus. Opportunity (Cont.)

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New GPS Series: Tek sets the pace with SmartCursors™ and push-button ease.

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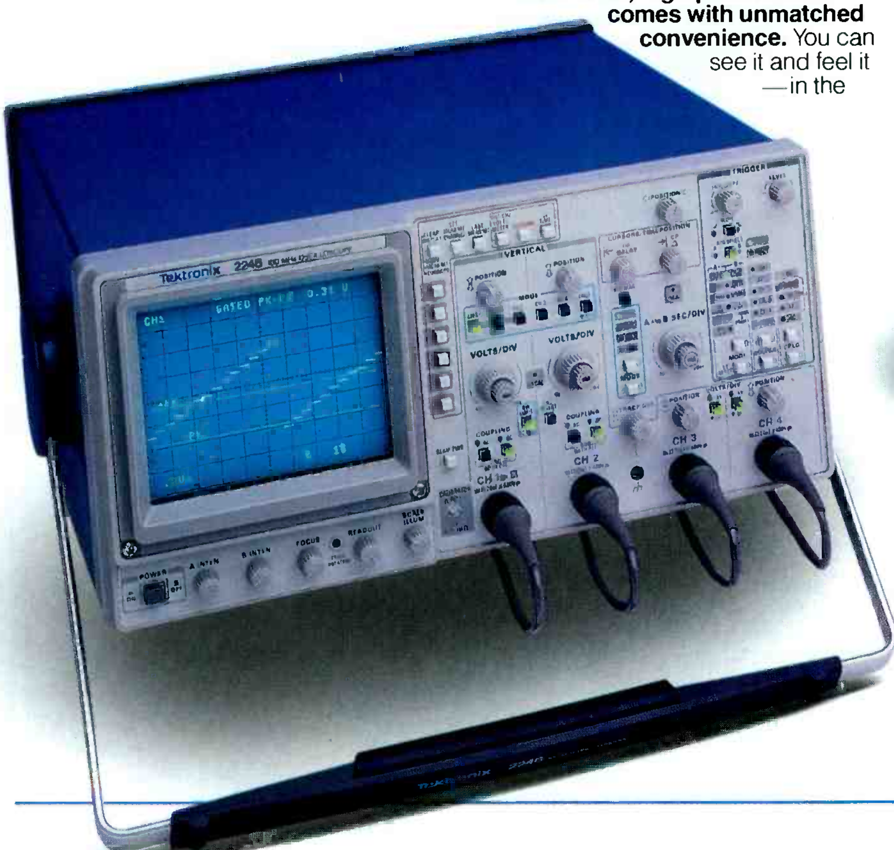
Features	2246	2245
Bandwidth	100 MHz	100 MHz
No. of Channels	4	4
Scale Factor Readout	Yes	Yes
SmartCursors™	Yes	No
Volts Cursors	Yes	No
Time Cursors	Yes	No
Voltmeter	Yes	No
Vertical Sensitivity	2 mV/div	2 mV/div
Max. Sweep Speed	2 ns/div	2 ns/div
Vert/Hor Accuracy	2%	2%
Trigger Modes	Auto Level, Auto, Norm, TV Field, TV Line, Single Sweep	
Trigger Level Readout	Yes	No
Weight	6.1 kg	6.1 kg
Warranty	3-year on parts and labor including CRT	



Featuring four channels, flexible triggering, extensive CRT readouts and push-button ease of use, the new Tek 2246 (left) and 2245 (above) bring high-quality, low-cost analysis to diverse applications in digital design, field service and manufacturing.

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