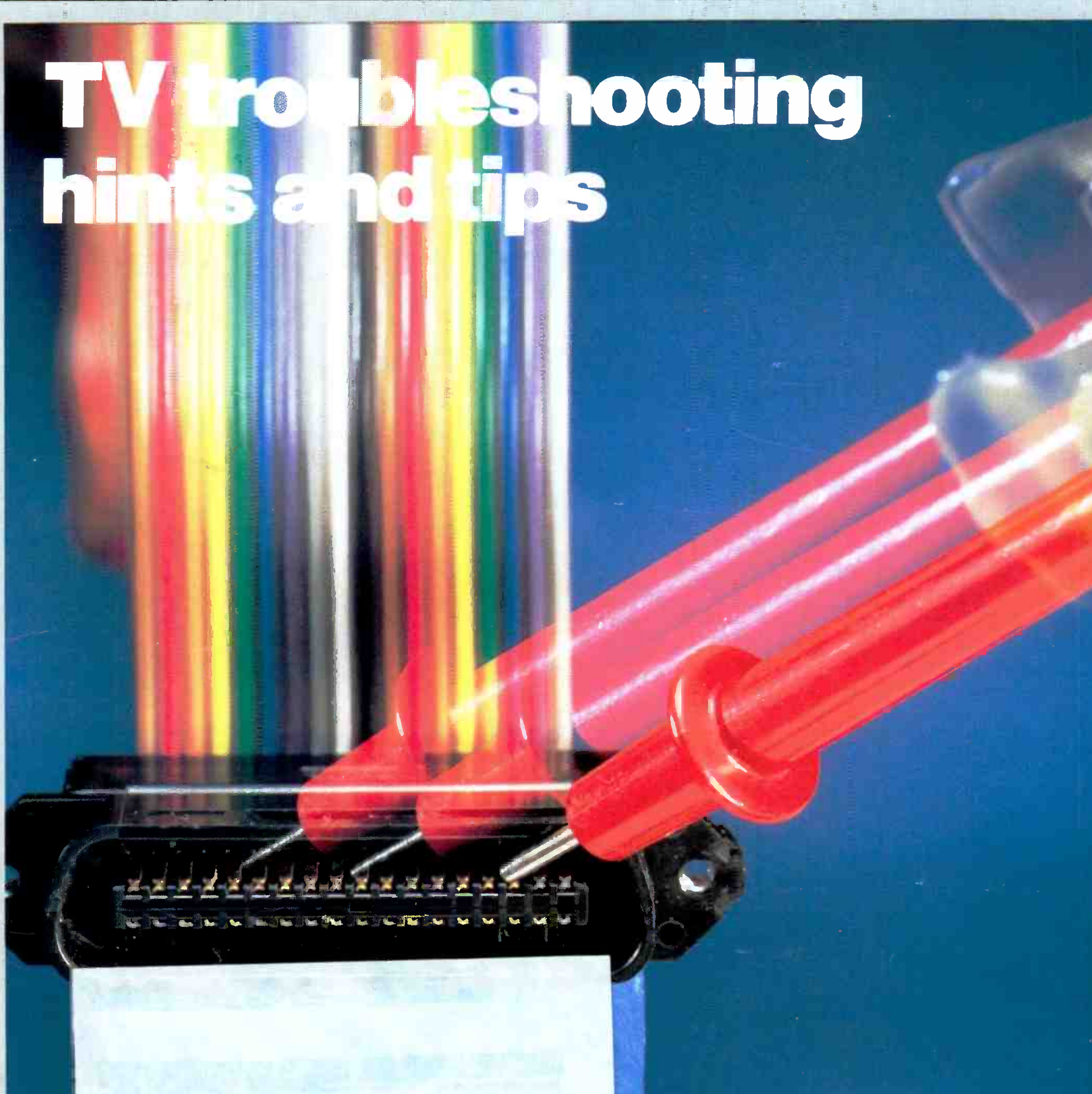
The how-to magazine of electronics...

ELECTRONIC™ Servicing & Technology

DECEMBER 1986/$2.25

Index of 1986 articles • 51-month Profax index

Troubleshooting audio equipment Supertech style



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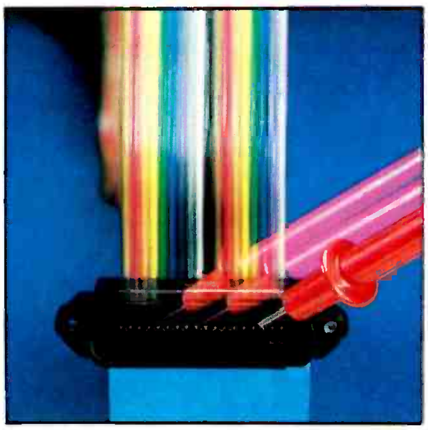
ELECTRONIC Servicing & Technology

Volume 6, No. 12 December 1986



Page 14
Good test tools plus the functional-block approach facilitate TV troubleshooting. *Photo courtesy John Fluke Manufacturing.*

Page 39
Super techs simplify servicing with proper maintenance. *Photo courtesy Chemtronix.*

Departments:

It was so obvious...

Troubleshooting a piece of malfunctioning electronics equipment, especially one as complex as today's television and video equipment, is a challenge. There are so many things that can go wrong, and in many modern direct-coupled sets, a problem that appears to originate in one circuit frequently originates somewhere downstream, reflecting back to the circuit that appears to be the cause of the trouble.

But, as most of you know, that's only the beginning of the problem. In modern sets with start-up and shutdown circuits, the possibilities of the problem source multiply in proportion to about the square of the number of protective circuits. That makes the agony of the problem that much more exquisite.

In spite of this increasing complexity, and its attendant difficulties in troubleshooting, many servicers confess that they feel inadequate if they don't proceed in a straight line direct to the cause of the malfunction. It's a common statement in Troubleshooting Tips and other correspondence that we receive for a servicing technician to conclude, after reciting his approach to a problem, "It was so obvious, I don't know why I didn't think of it first thing."

That's a natural and normal reaction to locating an "obvious" problem cause after spending a lot of time following false trails and turning the problem over and over in your mind. Anyone who has ever spent much time troubleshooting and repairing products has had the same feeling.

But you're being unfair to yourself. Instead of the unalloyed feeling of triumph that you deserve, you feel that you're less than adequate: that you've wasted time and energy following those dead-end leads.

Troubleshooting is a creative process, and like most other creative processes frequently proceeds in a non-linear fashion. A problem in one of today's sophisticated consumer electronic products could be caused by any one of dozens of problems. So you start by saying to yourself "The combination of symptoms consists of A and B and C and D. One cause of that combination of symptoms might be X." When you check out X and that turns out not to be the problem source you think it over a little and you come up with another possibility, and you check that one.

Let's say that you check that out and it turns out not to be the problem, but an anomaly you discover in checking out that circuit gives you a clue that leads you to suspect another area of the circuit, which you proceed to explore.

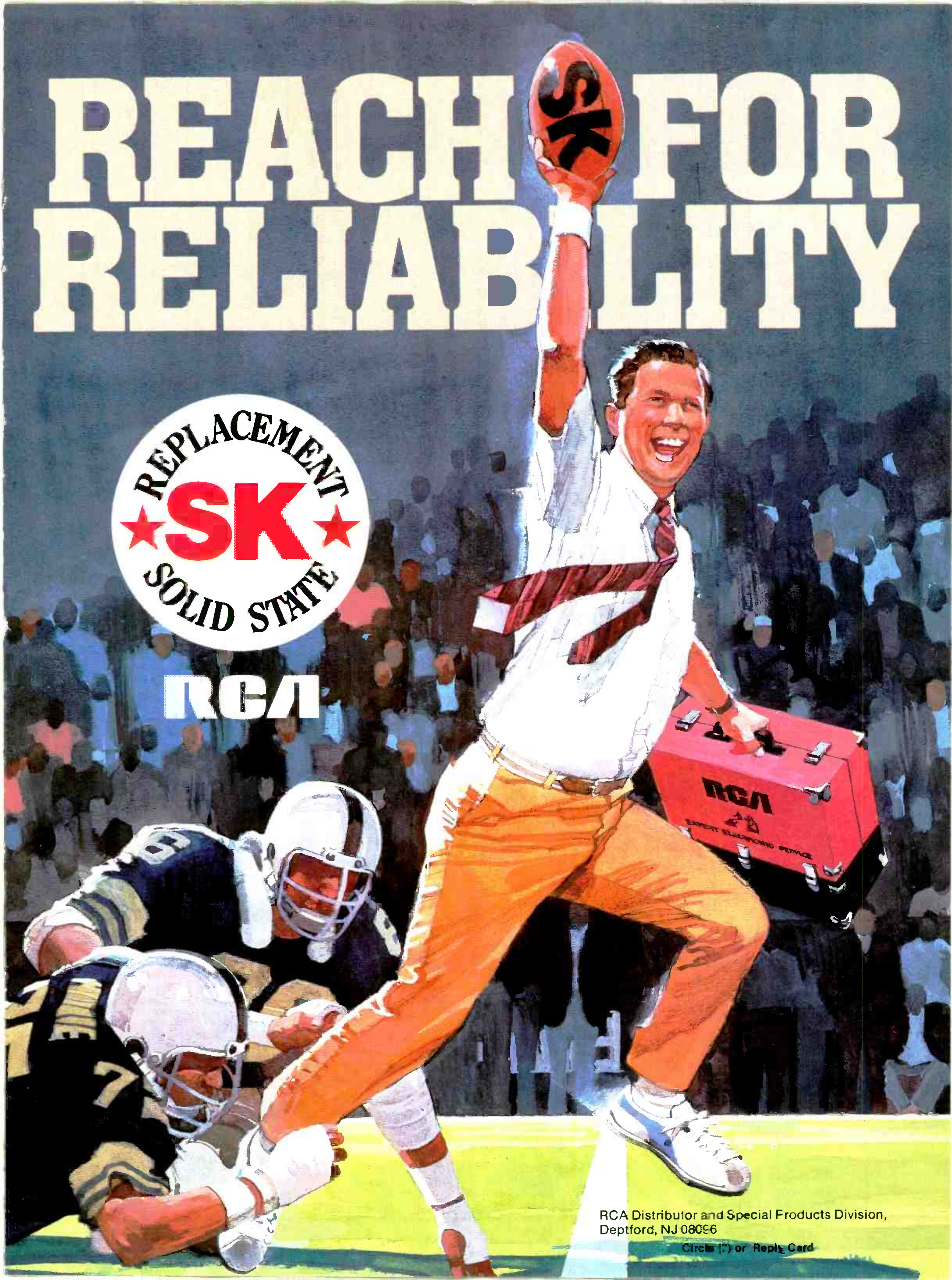
Sometimes you get lucky and your first stab at the problem (hypothesis is a more elegant sounding word, by the way) turns out to be the source of the problem. Sometimes you check every possible avenue you can think of and still don't get to the root of the problem. Those are the ones that servicing technicians call *dogs.* Most often, the solution to the problem yields in some reasonable number of steps.

Take a look at a manufacturer's diagnostic chart (if you don't have one handy, there's a partial one in Computer Corner in this issue). Notice that these charts ordinarily have many branches with many steps on each branch. The only way to find the problem source (sometimes sources) is to follow first one branch and then another until you come to the step that points to the solution. And you thought that the answer should have been obvious?

Most people involved in creative work, whether it's engineers, artists or writers, begin the process with some kind of statement of a problem or desired direction, then sit down and proceed to explore all of the possible ways to get to a solution, then choose one or a combination of the possibilities that came to mind. Almost invariably the reaction is the same one that besets the servicing technician when he finds the answer. "It was so obvious." It just *seemed* so after you've spent hours looking at the problem from every angle.

Think about this the next time you diagnose a problem after a lengthy battle and think to yourself, "It's so obvious. I should have been able to go right to the source of the problem. I followed so many false trails." The problem probably wasn't obvious at all. And you weren't following false trails at all, but testing hypotheses. And you probably deserve a pat on the back and that feeling of triumph for solving a tough problem.

Nils Conrad Persson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News

Study predicts $985 million 1986 accessories business

It's the optional extras that count in today's VCR and consumer video camera sales, according to an RCA study of video accessory buying trends. The hardware products themselves will account for an estimated $8.4 billion in this year's retail sales.

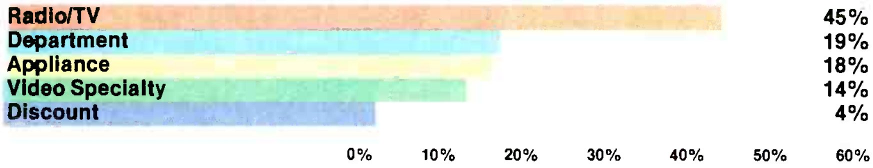
The $985 million figure represents an anticipated 18% increase over 1985 sales of extras that are bought to enhance VCRs, video cameras and camcorders; it does not include blank tape, which is a separate $1 billion plus business.

RCA Distributor and Special Products Division

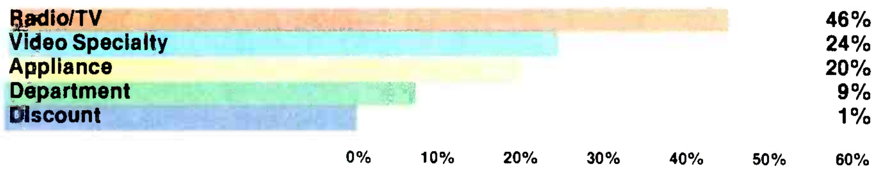
SHARE OF TOTAL DOLLAR SALES BY PRODUCT TYPE

VCR Installation and Maintenance Products	65%
Carrying Cases	10%
Universal LP Batteries	9%
On-Board Batteries	7%
Camera Tripods	6%
Camera Accessories	3%

**VCR-RELATED ACCESSORIES
SHARE OF DOLLAR VOLUME — BY STORE TYPE**

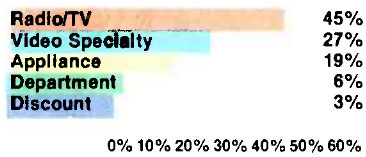


**VIDEO CAMERA-RELATED ACCESSORIES
SHARE OF DOLLAR VOLUME — BY STORE TYPE**

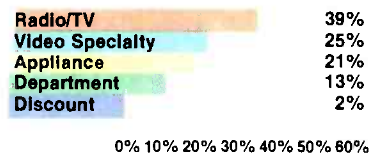


**PRODUCT-BY-PRODUCT ANALYSIS
SHARE OF DOLLAR VOLUME
BY STORE TYPE**

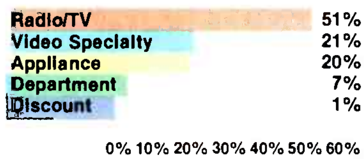
VIDEO CARRYING CASES



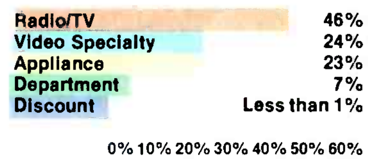
CAMERA TRIPODS



UNIVERSAL LP BATTERIES



ON-BOARD BATTERIES



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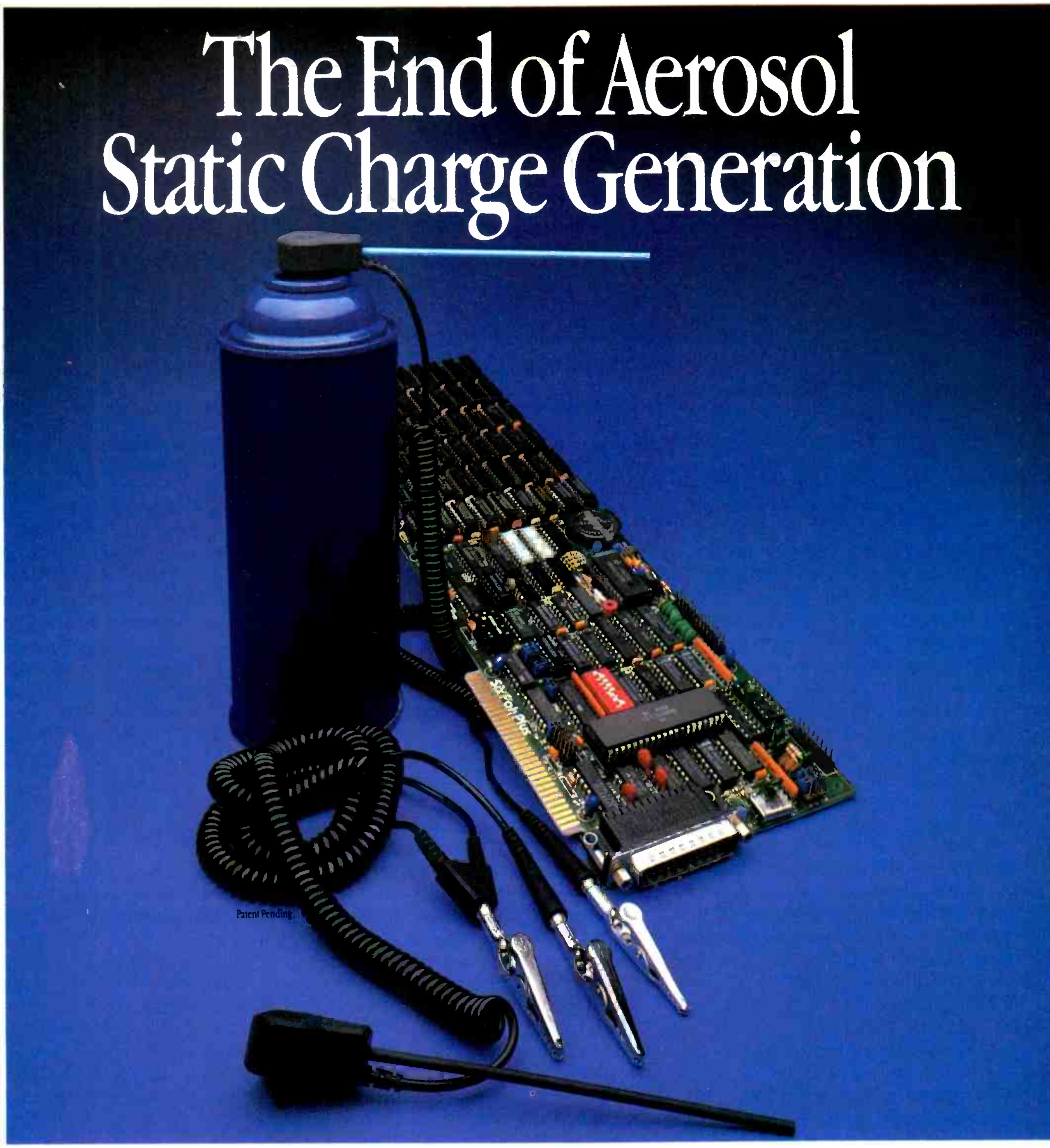

Static damage from aerosols has become so serious that aerosols are being banned in an increasing number of facilities. Tests in many facilities show that quick chill sprays and cleaning solvents can generate static charges from 50 to 12,600 volts depending on humidity, spraying time, orifice size and distance between orifice and surface being sprayed.

While adding anti-static compounds to quick chill sprays reduces the charge, they leave minute residues that must be removed or malfunctions may occur. Decreasing orifice size may help but will not end the problem. (Obviously, cleaning solutions for electronic components cannot include anti-static compounds since all anti-static compounds leave residues.)

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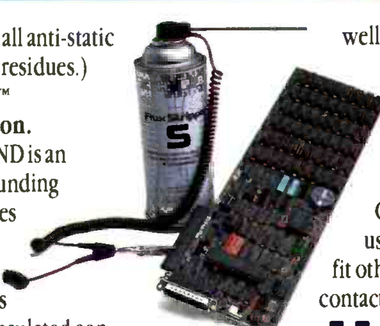

AEROGROUND is an equipotential grounding device that replaces the ordinary aerosol delivery system. It includes a concentrically insulated conductive spray nozzle, special sprayhead and appropriate leads that ground the aerosol nozzle/extension to the unit being sprayed. The completed ground loop protects all surfaces as well as the operator from static charge build-up during and following the spraying operation. When properly connected, AEROGROUND specifically controls static charge generation and dissipation from aerosols. (AEROGROUND is designed for the fitments used on Tech Spray aerosols and may not fit other aerosols.) For complete information, contact Don Schrowagen at TECH SPRAY.

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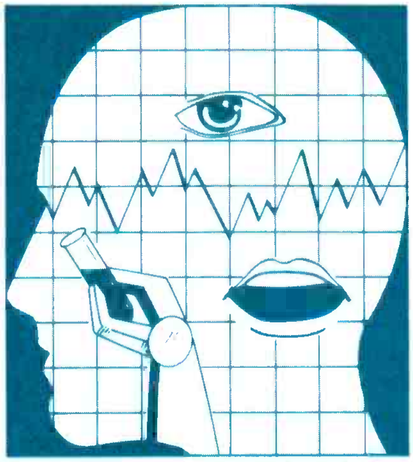


Artificial intelligence: debunking the myths

Machines that think! Artificial intelligence—defined as a machine's ability to mimic intelligent human behavior.is a new technology with tremendous potential usefulness. AI's scope encompasses vision, speech, robotics, expert systems (computer programs that incorporate the knowledge of human experts), and natural language.

By Joseph J. Kroger

Science writers love terms that connote mystery. *Artificial intelligence* is one of their favorites. It has a futuristic, Flash Gordon-ish ring to it. And, like most things with an aura of the unknown, it's fun to speculate about.

But now it's time to put some of the more fanciful misconceptions surrounding the topic to rest. Because AI, which can be defined simply as the capability of a machine to mimic intelligent human behavior, is really neither far off nor far out. It's here. And it's beginning to change the way we live.

Case in point—Artificial intelligence technology is making possible a sophisticated type of problem-solving activity called rapid prototyping. This involves simulation that is based so closely on reality that users can visualize real-life implementation. One example of this solution at work: NASA scientists, who had spent eight years trying to eradicate carbon dioxide from space shuttles, turned to AI applications and solved the problem in four weeks.

Case in point—A major U.S. airline has developed an AI application that optimizes seat revenue by analyzing such factors as capacity vs. tickets sold, allocation of full fares and discounted ones, number of days until departure, competitive airlines' seats available, and so forth. For the airline, the benefits are significant, including increased profit, more efficient use of personnel and facilities, and a competitive advantage.

Case in point—An artificial intelligence system called *Just In Time Manufacturing* aims at reducing costs and improving quality on factory production lines by virtually eliminating the need for inventory and storage.

The Just In Time system simulates a factory's entire production flow via representations of various workstations and tools that appear in windows on a video screen. It shows not only the functions and relative speed of each tool, but also how much lead time is needed to order parts for each step along the way. And it can suggest ways to correct bottlenecks by moving people and machines around to change the product flow, thus indicating which manufacturing configuration is most productive.

Another AI system being developed takes aim at automating the diagnosis of printed-circuit board failures. The system has already demonstrated its ability to pinpoint faulty devices with a minimal number of probes, while it frees up valuable human resources. The potential dollar savings are dramatic: Conventional testing uses hardware that costs \$1.5 million and is operated by a highly skilled technician, while the AI approach uses a program that costs less than \$100,000 and can be run by someone with two weeks of training.

Still other artificial intelligence systems already in use diagnose diseases, uncover subterranean oil deposits and design computer chips. More such practical applications—many more—are just over the horizon.

Programs like the ones just described are called *expert systems*, so named because they contain the collected, computer-stored knowledge of specialists in a given field; an expert system, when provided with specific information about a task, can draw on mountains of data to make a decision based on the stored knowledge about that task. AI's scope also encompasses natural language processing, robotics and vision and speech recognition. At least for the moment, the most promising advances are in the expert systems area.

Essentially, artificial intelligence is viewed as both a basic *technology* (it's a complex software technology, not a *product*) and an exciting *business* with enormous potential.

AI is a new way of using computer technology to solve problems in business and science, boost productivity and improve a company's market position. Those in the forefront of AI technology are poised to offer business and industry a vast array of new tools. Manufacturing, especially, is one area in which AI has many applications, including the technology needed to achieve true computer integrated manufacturing (CIM).

Obviously, any company serious about participating in the AI revolution must commit vast amounts of R&D dollars. But money alone isn't enough. Leadership also requires a willingness to initiate extensive training programs, to increase support for university research projects and to team up with other companies and undertake joint ventures so that products can be delivered in a smooth, timely fashion.

In fact, as AI moves out of the laboratory and into the market-

Joseph J. Kroger is president of Sperry Corporation, Blue Bell, PA, manufacturer and supplier of electronics-based, high technology systems and services. Sperry now has the second-largest installed computer base in the world.

Continued from page 10
place, its true nature becomes increasingly apparent. Basically, it's nothing more than sophisticated electronic circuitry rigged up to manipulate symbols in the same way that people do when they reason through problems and come up with feasible solutions.

Solving problems that until now were beyond the computer's grasp: *That's* the name of the game. And we're starting to win it.

World's fastest transistor

Toshiba researchers have developed a hetero-junction bipolar transistor (HBT)–a new generation transistor–with the world's fastest switching time per gate of 35ps (a trillionth of a second).

An HBT is a high-speed transistor of the future that uses compound semiconductor materials of aluminum gallium arsenide (AlGaAs) and gallium arsenide (GaAs). Numerous applications are expected in such fields as central processing units (CPUs) for next-generation supercomputers, and transceivers designed for optical communications.

In order to fabricate an integrated circuit using HBTs, research focuses on the miniaturization of each transistor. The key to making each transistor smaller is to shrink the gap between the electrodes of the emitter and the base while retaining sufficient insulation.

However, in the conventional method, the emitter and the base (key elements forming a transistor are formed respectively by using different masks, which means extra space is needed to ensure enough isolation between each electrode. This increases the overall size of the transistor.

Toshiba researchers have overcome this problem by developing a completely new process technology called the *self-alignment* method. In the new method (see Figure 1), the emitter is first formed and then a new thin layer of silicon dioxide (SiO_2) is introduced as an insulator to cover the emitter region completely. Then the base electrodes are formed next to this SiO_2 layer, which means that no extra idle space is required to complete the new transistor.

In other words, experimental results show that the width of the emitter thus has been halved from 4μ to 2μ, and the gap between the emitter and the base electrode reduced to one-fourth: from 1 down to 0.25μ. As a result, the size of the whole transistor has been reduced significantly.

At the same time, the ion implantation technology has been improved for making the external base region. In the conventional method, only magnesium is implanted. Toshiba researchers have found that adding some phosphor along with magnesium virtually will suppress lateral diffusion, or erosion of magnesium into the emitter region.

By using these two key technologies, Toshiba has test-manufactured a CML (current mode logic) ring oscillator–a typical device for measuring the speed of a transistor–integrating 97 pieces of HBTs. The oscillator recorded the world's fastest switching time of 35ps per gate, more than 5ps faster than any other kind of bipolar transistor device.

Several new types of transistors are now being developed, including MESFET (metal-semiconductor field effect transistor), HEMT (high electron mobility transistor), Josephson Junction devices and HBTs.

HBTs have the advantage that, unlike Josephson devices, they are capable of operating under normal environmental conditions. Further, unlike MESFET and HEMT, HBT is a kind of bipolar transistor whose current capability is superior to FETs and that is more suitable for very high speed ICs. ES&T

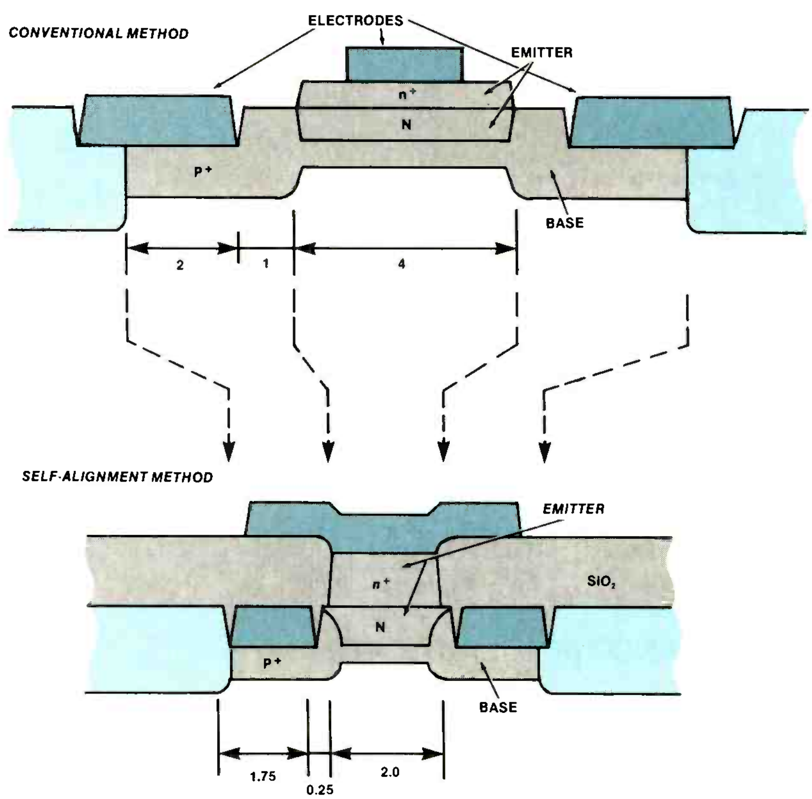


Figure 1. The self-alignment method of transistor fabrication eliminates wasted space, resulting in a smaller device.

Feedback

Letter to Sam Wilson

I would first like to congratulate you on your fine articles for ***Electronic Servicing and Technology.*** As chief engineer for the University of Massachusetts, Video Instructional Program, I keep myself up with almost all the video/electronic technology magazines and periodicals. I find ***Electronic Servicing and Technology*** to be the finest among a very large group.

The Video Instructional Program transmits electronic engineering classes via Ku-band satellite to industry to allow engineers in the field to access graduate studies, and earn graduation degrees while in their own work place. As an integral part of the university's College of Engineering, I spend a lot of time among prospective engineers just learning their trade, and feel that it is very important that they get off on the right foot. I appreciate your continual discussions and observance of proper safety procedures, and want to express some thoughts on that subject.

I recently found myself in our vast library searching through various technical materials when I came across a book in which the author is discussing the correct use of meters. A quote reads *The two-hand method is a dangerous practice which should be avoided religiously.* Obviously this is marvelous advice, but ironically the protective jacket of this very book shows a photograph of a technician using the *two-hand method* while testing an electronic device! This seems to be a dramatic oversight considering the author spends a great deal of time concentrating on proper safety procedures.

I have known many technicians who have held solder in their mouths while soldering, and have used other improper or unsafe methods of testing or repair. Many periodicals focus on new equipment, software or practices in our field. I'm as enthusiastic as anyone about new information such as this, but I feel that I should applaud you in taking the time to remind everyone that safety is first, and should never be taken for granted. If there is anything I would like to share with the new engineers graduating from the University of Massachusetts, or anywhere else, it's the concerned reminder to always observe careful and safe technical procedures. Thanks for doing your share of the same.

Andrew R. Casiello, MT
University of Massachusetts at Amherst

*I want to thank you very much for your letter regarding safety practices and also for your comments on my material in **ES&T** magazine.*

You are quite right to be concerned about the safety aspects of electronics. It is very often overlooked in our haste to keep up with the technology. In the near future I expect to discuss some dangerous chemicals–such as tantalum–that are being used in manufacturing today. In addition to the safety of technicians, there is the problem of discarding these chemicals into the environment. (I guess you could say that is an indirect safety problem.)

Sam Wilson

Letter to Sam Wilson

I wish to apply for one of your rare and valuable certificates as described in your article in the September issue of ***Electronic Servicing and Technology.*** I take some exception to the answer to question 3 on page 71. Because Black, Nyquist and Bode, who invented and formulated negative feedback, were all friends and associates of mine, I feel some responsibility to respond. Also, of my 59 issued U.S. patents, several apply to negative feedback.

Black's patents in 1925 and 1932 and Bode's 1940 article in the Bell System Technical Journal, "Relations Between Attenuation and Phase in Feedback Amplifier Design," together with Nyquist's stability criteria, paraphrased *"Thou shalt not enclose the point on the complex plane, 1 + J0,"* are the authorities I cite.

The *amplifier gain* is not what a Bode plot presents nor is it what Nyquist described in his stability criteria. Bode and Nyquist were talking about the loop gain of feedback amplifiers. Further, the Bode plot is not a simple graph but is a plot on the complex plane. The X axis is real numbers and the Y axis is imaginary numbers. Mu beta is plotted, not *amplifier gain.* A feedback amplifier with a forward gain of mu and a feedback gain (loss) of beta will have an external gain, *amplifier gain,* of mu divided by 1 plus mu beta. This external gain is generally far different from the loop gain. The measurement of external gain is of little value in determining feedback stability or distortion reduction by feedback, which were major concerns of all three gentlemen cited.

If I do earn one of your rare and valuable certificates, or perhaps even the first one, I promise to hang it on the wall of my laboratory. Although retired, I keep busy. Habits from over 40 years at Bell Labs are hard to break.

Ray Ketchledge
Englewood, FL

Thank you for your interesting and informative letter regarding the origins of the Bode plot.

Regardless of the original intent of the authors, the term Bode Plot has now come to mean a plot of gain and phase angle against frequency. I now quote directly from the IEEE Standard Dictionary of Electrical and Electronics Terms (IEE Standard 100):

Bode Diagram

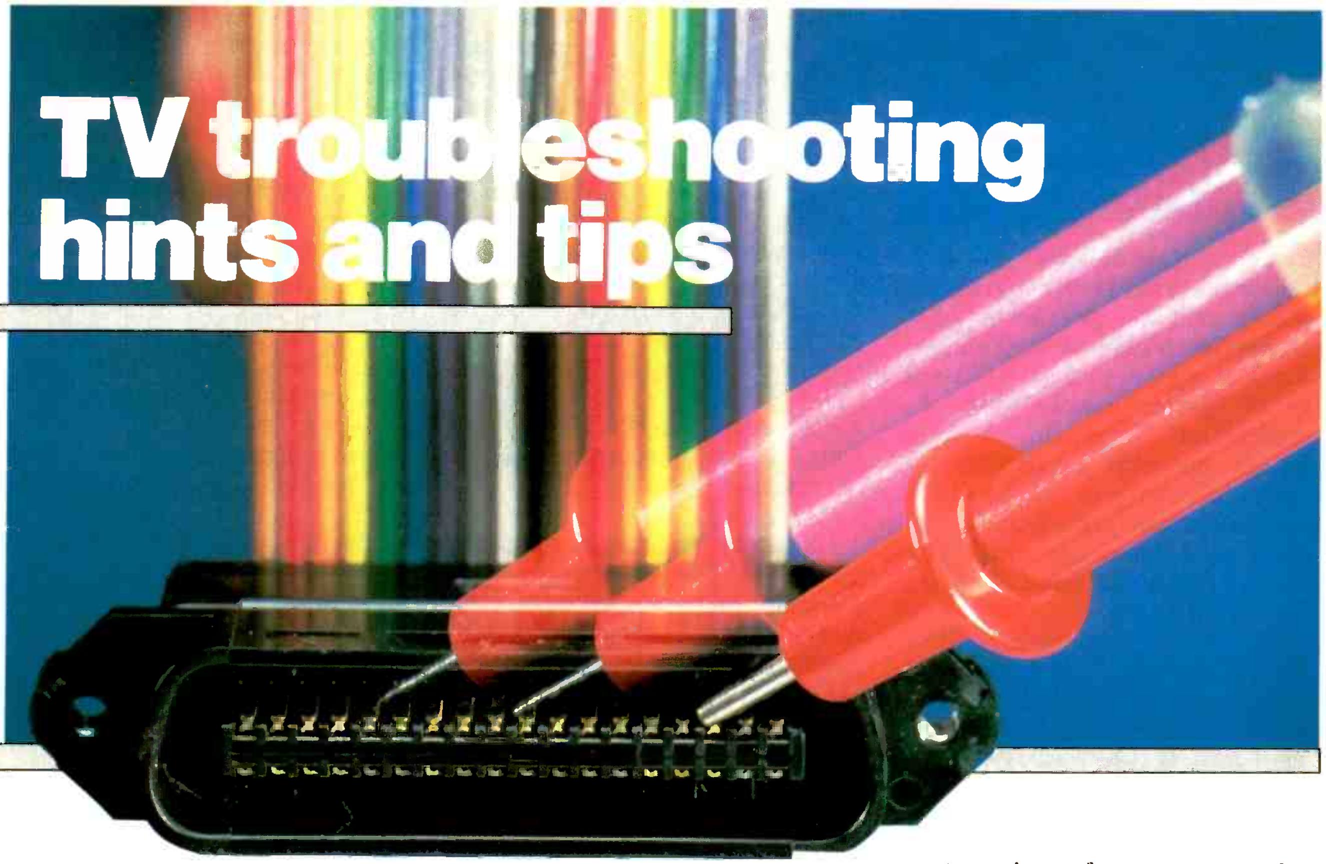
A plot of log-grain and phase-angle values on a log-frequency base for an element transfer function, a loop transfer function, or an output transfer function....The ordinate may be expressed as a gain, a log gain, or in decibels as 20 times log-gain; the abscissa as cycles per unit time, radians per unit time, or as the ratio of frequency to an arbitrary reference frequency.

So, regardless of the original intent, Bode plot has come to mean a plot of gain and phase angle values against frequency.

Keep trying. I am sure the highly coveted certificate is well within your grasp judging by your letter of August 28. Maybe next time!

Sam Wilson

TV troubleshooting hints and tips



By Conrad Persson

Troubleshooting a television is one of the hardest things in the world to do. OK, there are probably a few things that are harder: housebreaking a grizzly bear, going over Niagara falls in a teacup, winning the Indianapolis 500 on a skateboard. But a malfunctioning television does present strenuous challenge to someone bent on diagnosing and repairing the problem.

There are several things that the service technician can do, however, that will help to reduce the difficulties of servicing a television to manageable proportions:

- Observe symptoms carefully, in detail, and make a note of them.
- Keep in mind the television's functional blocks.
- Know and apply some of the long-established TV troubleshooting hints and tips.

Ask questions

Have you ever observed carefully what your doctor does when he's examining you? He goes through a set routine of tests and measurements: temperature, blood pressure, pulse rate, heart and lung sounds, reflex, and more, and carefully notes them down. At the same time he's asking you if it hurts anywhere or if you're experiencing any other symptoms, and noting that down as well. It all becomes part of your record.

This orderly approach to noting symptoms is no less valuable in treating sick televisions than it is in treating sick people, and even in the most obvious cases should be followed. When you're planning to work on a television, you should ask the principal viewer questions that will help pinpoint where the trouble lies. Ask questions such as:

- Describe the exact nature of the problem.
- Was this a gradual decline in performance or did it occur suddenly?
- How long has the problem existed?
- Are there any other symptoms?
- Have you moved the set recently, or made any other changes in the viewing room?
- Have you had problems with any other electronic devices?
- Has there been an electrical storm in the area recently?

The answers to questions like these may not by themselves lead to a diagnosis of the problem, but can help point to the answer. Gradual onset of a problem suggests aging of components, but sudden failure points to something catastrophic that might be observable as a burned component or some other visible problem. If the problem had a sudden start and occurred at about the time of a thunderstorm, your subsequent investigation might include close scrutiny of the television's circuits for evidence of lightning damage.

Observe symptoms

As soon as you get the malfunctioning set on the bench, the next step is to turn it *on* and observe symptoms for yourself. Again, don't forget to make note of anything unusual. If the set operates normally, and your earlier investigations led you to suspect heat related problems, you might use a heat lamp, or cover the set with a blanket or something similar to accelerate warming the set to the point where it malfunctions.

Look. Listen. Smell. When you first turn the set *on*, you should hear the rushing sound of the high voltage coming up. Note the picture: Is the size correct, brightness, color? How's the sound from the speaker? Are there any unusual smells, such as might be caused by an excessively hot component? If this television does exhibit intermittent problems, if you don't write notes about proper operation and problems noted, by the time it does malfunction, you'll have forgotten what you've observed. Take notes.

When you have the set opened up, again use all your senses and make notes of your observations. Use your eyes: Check for loose wires, blackened components that are evidence of excessive temperatures caused by overloading. Examine components for signs of cracking; of other problems, such as leakage of electrolyte from capacitors. If a component doesn't look right, there's a high likelihood that it's bad. Check it carefully and replace it if it's bad.

Component temperature is another indicator of whether the circuits are operating properly or not. If you suspect a certain component, sometimes a finger care-

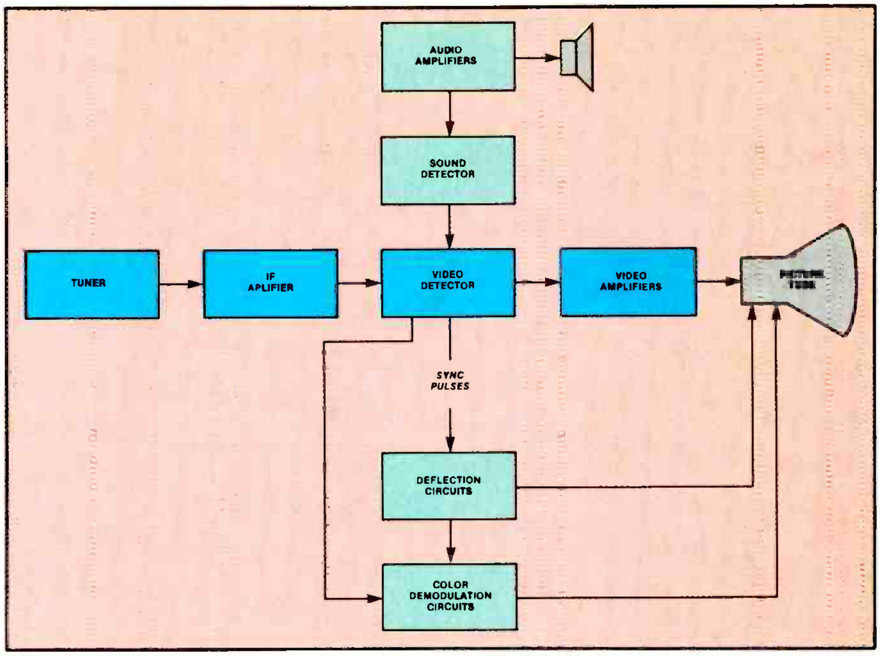


Figure 1. Thinking of a television or other consumer electronics device in terms of its functional blocks, and evaluating the trouble symptoms in those terms, can help isolate the source of the problem.

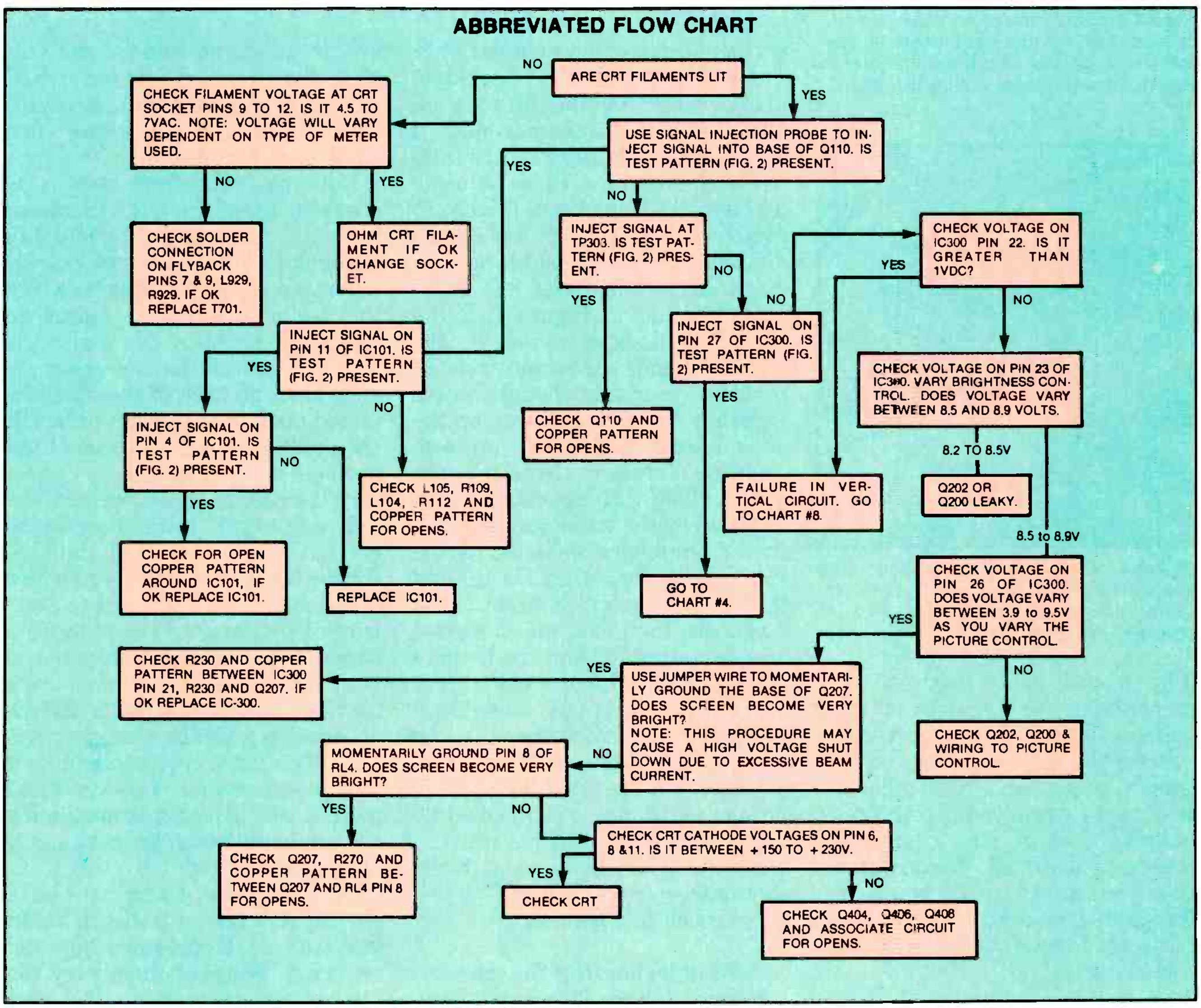


Figure 2. Manufacturers' troubleshooting flowcharts, such as this one from GE, are an aid in logical, step-by-step, fault diagnosis. A technician who is familiar with the functional block description of television can, with the aid of the schematic diagram (Figure 3, page 16), establish a similar troubleshooting approach. *(Drawing and chart courtesy of GE Company.)*

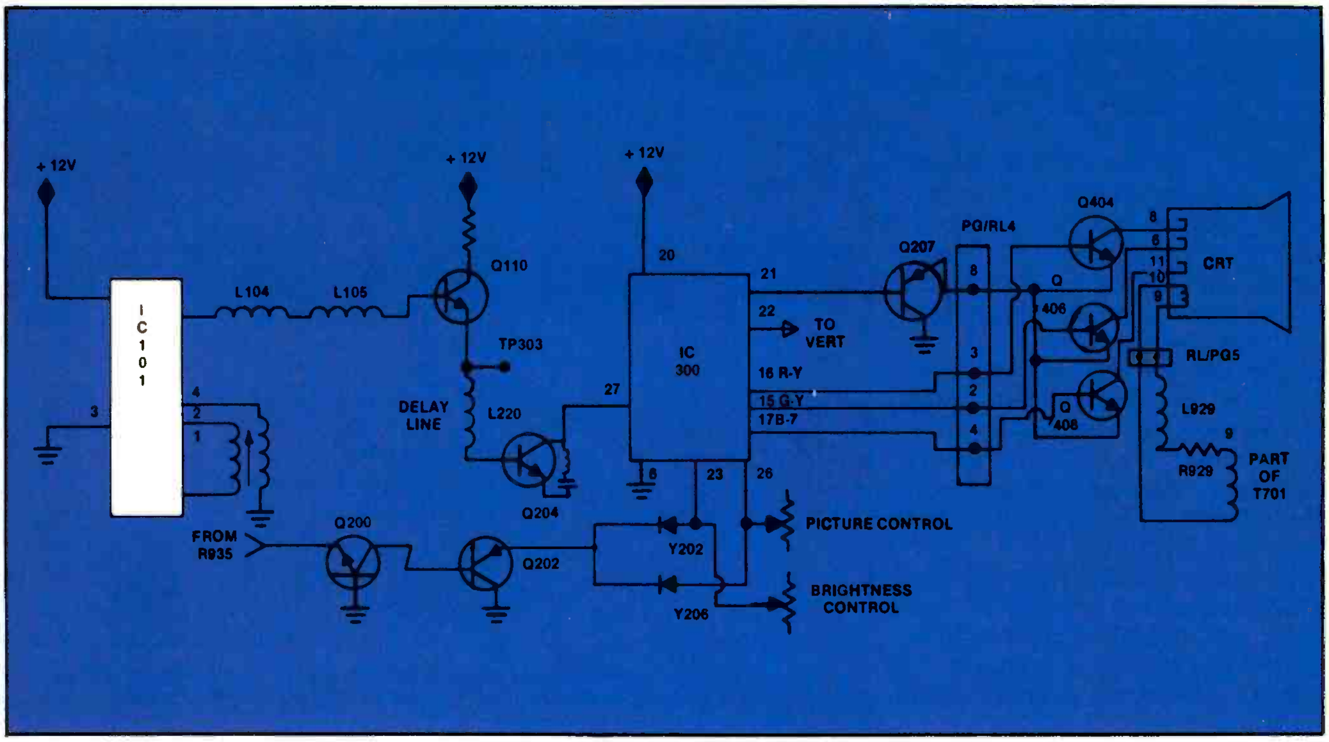


Figure 3. Symptoms of *no video, no color, audio ok,* narrow troubleshooting effort to this portion of television. Refer to Figure 2 for troubleshooting flowchart.

Figure 4. Alternately heating and cooling suspected components can help to pinpoint the cause of failure. *(Photo courtesy of Chemtronics)*

fully placed on it (with all due precautions for hazards of high voltage, burns, etc., observed, of course) will tell a great deal about what's going on. A component that's very warm to the touch may indicate a short circuit or other source of overload. A component that you expect to be warm but that is cold, on the other hand, suggests that there's an open circuit somewhere.

Remember functional blocks

A glance at the schematic of a modern, sophisticated TV set reveals an extremely complex unit. There are hundreds of components, wired together in very intricate fashion. Sometimes it seems as though any of those little devils could be the cause of some problem. At those times it helps to remember that any TV set can be divided into functional blocks and diagnosed on that basis. For example, referring to Figure 1, if the problem is lack of sound, or distorted sound, or some related problem, your first thought would naturally be to concentrate on the audio circuits. But the problem could be elsewhere. Note that the sound, along with the video, has to be tuned by the tuner, amplified by the IF amplifiers, detected by the video detector, then is routed through the sound circuits. Your diagnosis, then, becomes a matter of considering likelihoods. If there is a problem with the sound, but everything else is OK, most likely the problem is somewhere on the audio circuit side of the video detector. On the other hand, if the problem is audio, accompanied by some degeneration in the video as well, the problem is most likely somewhere from the video detector on back to the tuner.

A troubleshooting flowchart

Figure 2 is a flowchart taken from GE's troubleshooting guide for the PC chassis. It suggests a course of action if the symptoms are no video, no color, audio OK. Note that it doesn't go beyond IC 101. If the audio is OK, it means that everything's working fine right up to that point.

Note that the first step is to check to see if the CRT filaments are lit. The troubleshooting thought process has very quickly narrowed down the area in which the technician has to search to locate the problem. Note also the continuation of the flowchart. In each case, an area of the circuit is tested, and if it turns out to be OK the next most likely source of the problem is considered.

In the case of this flowchart, the GE engineers have been kind enough to do most of the thinking for the technician, but if you take a functional block approach to servicing televisions, or any other consumer electronic product, you can, with the aid of the manufacturer's service literature or Sams material, develop a similar thought process: "If *only* A is malfunctioning, it must be somewhere between x and y. If A *and* B are malfunctioning the problem *must* be between y and z," and so on.

Over the years, technicians have developed a bag of tricks to aid in the task of troubleshooting and servicing. Some of them vary the voltage or current to the unit under test, some of them change the temperature of the devices that are suspected, but they *all* im-

Continued on page 18

★ RESEARCH
★ DEVELOPMENT
★ PROTOTYPING
★ PRODUCTION

Diehl Industries of Amarillo, Texas proudly announces the opening of a new and unique research, development, and proto typing division, for use by the nation's electronic industry.

WHAT MAKES IT SO UNIQUE

Traditionally, when a company or an individual has a new idea, mass confusion sets in, - - - and promptly takes control of the project.

The "electronics" for the original idea goes one direction (to R & D), while another "team" scrambles to develop the mechanicals for the case that will house the final product.

From "R & D" the artwork for PC boards must be generated, then sent to a PC board manufacturer, the mechanicals for the case must then be sent to a plastics manufacturer, once they are finished, the PC boards must then be sent to a "board stuffing" company, someone must then find the best price on component parts and hardware, someone else must coordinate the receiving of same, while yet another team s frantically trying to develop an operations manual for the final product (which must then be sent to a printer, who will ultimately have to send it out to a bindery to be bound, and turned into an actual book).

You guessed it! By the time all of the above comes back to home base, - - - nothing fits ★!✓$*
(just ask anyone who has tried it).

Diehl's new division has a unique advantage over tradition, in that all of the above is done under one roof.

Diehl's R&D Department can take a preliminary schematic (or just an idea without the schematic), design it, or refine it, bread board it, test it, turn it into working artwork for printed circuit production, then, using their own proto typing system, produce the original "trial" PC boards. Our R&D staff has immediate access to four, totally separate individual, full time, "in house" CAD systems (computer assisted design). In a "total design" project all four will become necessary.

"Auto CAD 86" will be used to generate shop drawings which will then be used by Diehl's Plastic Division.

Winteks "Hi-wire" will be used to generate the necessary schematics for use by Diehl's own in-house printing and bindery department along with the necessary text for same, which will be provided by Diehl's in-house technical writing staff.

Winteks "smart-work" will be used to generate artwork to produce PC boards. This same artwork is then given to Diehl's in-house camera and stripping dept. where it will be photographically reduced, and turned into working transparent positives, which will then be given to Diehl's in-house PC manufacturing division (once the R&D proto type boards have been approved).

Meanwhile, Winteks "drill" CAD System is used to generate the necessary "drilling" information for our Excellon "Mark III", four spindle, computerized drill which is just part of Diehls in-house PC board manfacturing division. Once our Excellon drill (which is based on an 8,000 lb. granite slab for accuracy) has completed the drilling operation (at 10,000 holes per hour × 12 boards at a time), the boards will go through our own in-house chemistry, then into one or more of our fourteen in-house electro platers for copper, tin-lead, nickel, or gold.

After being properly sized, the PC boards will then go to our in-house "board stuffing" department (which employs 20 full time stuffers). There it will be "stuffed", wave soldered, inspected, tested, then given to quality control for final inspection.

Meanwhile: Our purchasing dept. has been on the phone with every major supplier in the country fighting for the best possible price on the highest quality components. Our in-house printing and bindery division has produced the operation manuals from artwork that was provided by our own technical staff. Our in-house plastics division (which does some of the most sophisticated vacuum forming in the nation) has produced the cases into which the final product will be assembled. Our own in-house silk screening department has produced all necessary escutcheon plates and panels.

All of the necessary components are now ready for mass production by our own final assembly division. Because everything was done under one roof, and monitored by one project supervisor, - - - everything fits!

In adddition to the above, we also have our own in-house advertising agency and international marketing facilities.

The next time you have a "project" think about us,
- - - **we can make it happen!**

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6661 Canyon Dr.
Amarillo Texas 79110
Phone (806) 359-0329

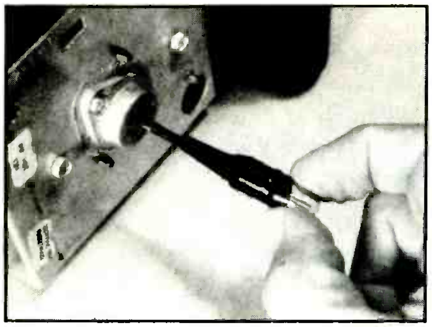


Figure 5. A neon bulb can verify the presence or absence of horizontal sweep pulses.

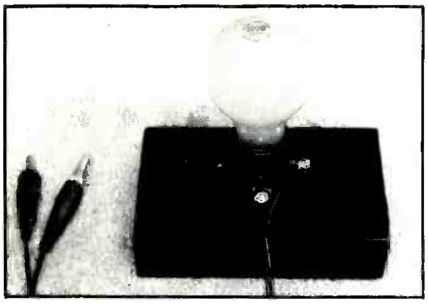


Figure 6. A 100W light bulb placed in series with a portion of a TV circuit that's drawing excessive current and blowing fuses or popping the breaker will limit the current to give you time to troubleshoot the set. The degree of brightness of the bulb will give you an indication of the severity of the overload.

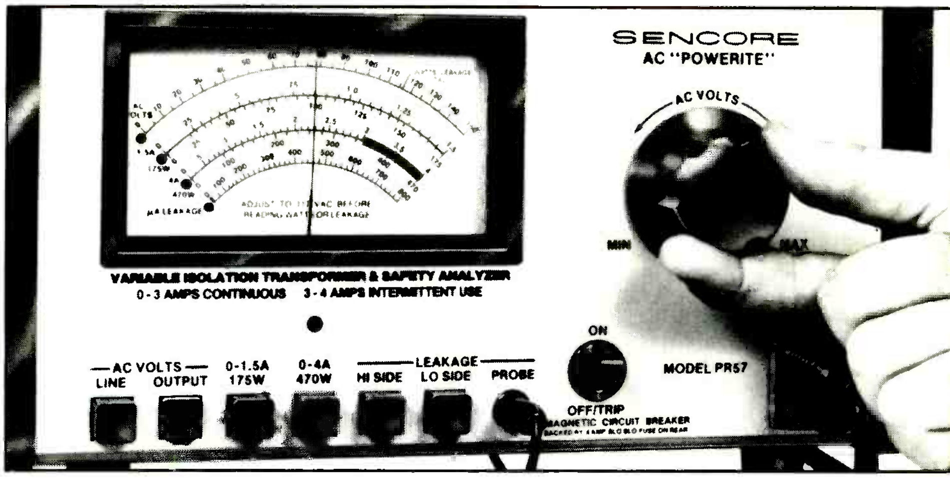


Figure 7. A variable voltage power supply is another way to limit the current to a faulty television. A unit such as this model PR-57 Powerite by Sencore has the additional advantages of measuring wattage, performing leakage safety checks and providing isolated power.

prove your chances of determining what the problem is.

Heating and cooling components

One way to pinpoint which device in a circuit is causing problems is to alternately heat and cool each device in the circuit in turn. Frequently, a heat rise causes a defective transistor, IC or diode to stop operating. If a circuit in a set on the bench no longer operates properly after warmup even though the set behaved properly while it was comparatively cool, a short blast of canned coolant spray on the suspect component might restore operation (see Figure 3). If so, you can be fairly confident that replacing the component will solve the problem. To double check, you might add heat with a hair dryer or other heating device to see if the problem comes back.

Checking for sweep with a neon bulb

A neon bulb will glow when brought into close proximity to a source of high voltage. You can use this fact to check to see if there is sweep. Solder a well-insulated piece of short heavy wire to one terminal of a neon bulb, then tape the connection, the wire and the metal part of the bulb with plenty of electrical tape.

To test for the presence of horizontal output pulses, hold the bulb in your fingers and bring the wire near the flyback or touch it to the horizontal output transistor's collector. Touch only the glass part of the bulb. Do not touch the wire to the high-voltage pulse output from the flyback; the danger of arcs and shock are too high to try this.

Limiting the current with a light bulb

If you're faced with a set that has such a serious short or other overload producing fault that the fuse blows every time you turn it *on,* or it goes into shutdown, you need some way to limit the current. A very inexpensive way to limit the current into such a set is to replace the line fuse with a 100W light bulb, the same kind you put into your living-room lamp. One way to go about this is to use a socket like the one shown in Figure 5, and just clip the alligator clips onto the fuse clips. With the light bulb in circuit, the current will be limited and allow the set to operate while you proceed with your diagnosis. An added advantage is that the brightness of the bulb will give you an indication of the severity of the overload. A dim bulb means only a slight overload, while a bright bulb might mean almost a dead short. The bulb also can be used to limit the current in any high-current circuit that is exhibiting a near short circuit. For example, if a color television has a fuse protecting the horizontal-output transistor and that fuse blows instantaneously each time the set is turned *on,* the bulb should be connected across that fuse holder in place to the fuse. If the bulb lights up to nearly full brightness, you know that there is excessive current. You then disconnect the tripler, damper, horizontal-output transistor and other prime suspects one at a time until the bulb becomes significantly less bright. That part is the prime suspect.

Varying the line voltage

Another way to keep a television with a probable overload from blowing fuses while you're trying to troubleshoot it is to use a variable-voltage power supply. The reduced voltage may allow you to operate the set long enough to isolate the problem.

It's as easy as one, two, three

Locating and correcting a malfunction in one of today's sophisticated color televisions is a challenge; but an orderly, logical approach to the problem can prevail. Gather as much information as you can, from the set's primary viewer as well as your own observations, apply that information to the set, looking at it in terms of its functional blocks, and apply some of the tricks. You probably will find that these steps, along with judicious use of instruments like a DMM, oscilloscope, signal generator, etc., will lead to solving most TV problems.

Watch Your Language

By Conrad Persson

Every major advancement in electronics entails new materials, new manufacturing techniques and new packaging. All of this introduces new concepts to be learned and new terms for the vocabulary.

Many of us got involved in electronics during the era of the vacuum tube, and terms like plate, cathode and grid are an integral part of the language we command (even if we rarely use those terms any more).

The transition to transistors reduced the size and power consumption of consumer electronic products, ushered in the era of truly portable radios, and swelled the vocabulary with terms like emitter, collector, base, bias, TO-5 and other solid-state terms.

More recently, integrated circuits were introduced, and a flood of new terms came into the language: DIP, SIP, thin film, thick film, hybrid IC, monolithic IC, and more. Unfortunately, much of this new terminology was thrown about by those in the know with little or no explanation. Many of the terms are still poorly understood or not generally understood at all.

From time to time when room permits, beginning with this issue, we'll feature a few detailed explanations of some of the less well understood terms.

Thick vs. thin films

When someone first showed me a hybrid integrated circuit that featured *thick-film* resistors and conductors, I thought they must be mistaken; the films I saw looked thin enough to me. And they were thin. But in the crazy subminiature world of integrated circuits, anything thicker than 0.001mm (yes, one thousandth of a millimeter) is a thick film.

Besides this gross thickness, two other features generally characterize thick films: They are ordinarily deposited as inks or pastes (some kind of liquid vehicle containing either a highly conductive metal or a resistive material like carbon) using a silk screen process, then baked to set the material and trimmed using a sandblasting type process. They are generally used in hybrid integrated circuits and are laid down on the same substrate with the components that they interconnect.

Thin film circuits, on the other hand, consist of material less than 0.001mm thick, deposited on a ceramic or silicon substrate via evaporation or sputtering through a mask (a kind of stencil for IC work). Thin films are ordinarily of metal or metal compound. One typical thin film fabrication process consists of placing the masked substrate into a chamber filled with nitrogen. Tantalum, a hard metal, is bombarded with an electron beam (sputtered), enters the nitrogen atmosphere, combines to form tantalum nitride that is deposited onto the substrate through the mask, defining the pattern.

What's a substrate?

The foregoing definitions included the term *substrate*, which is frequently not defined and may not be well understood. The substrate is merely the material on which a circuit or a portion of a circuit is fabricated. Its purpose is mainly to provide mechanical support for the circuit components. There may in fact be more than one substrate mounted one on the other. For example, the silicon or other material on which a thin-film resistor network is sputtered or evaporated is the substrate for that network. If the resistor network is going to become part of an integrated circuit, it may be mounted onto the integrated-circuit substrate. I suppose a case could be made that the PC board is the substrate of the completed circuit.

Sheet resistivity

Sometimes when you see discussions of thin-film devices or material, you may see the term P_s, *sheet resistivity*, and see it given as so many ohms per square. The

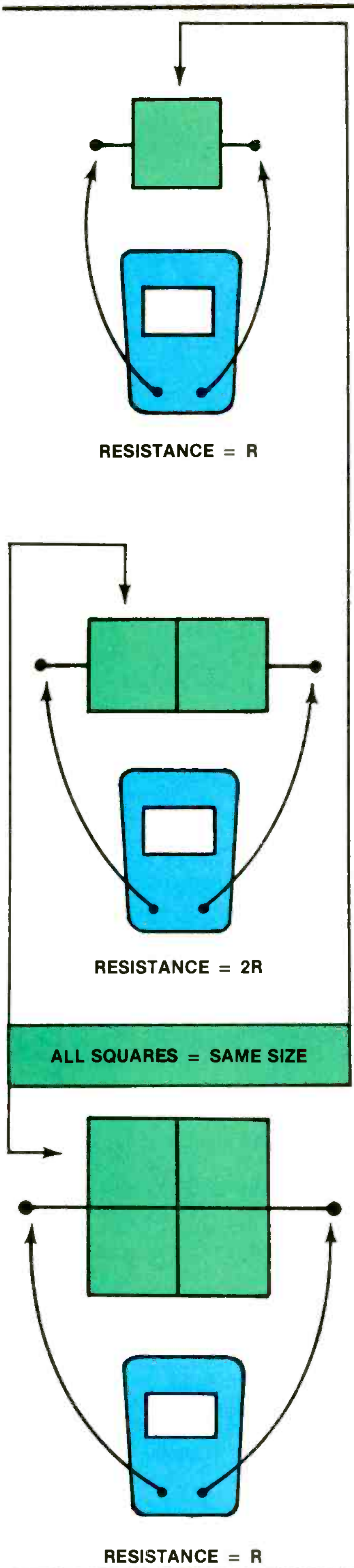


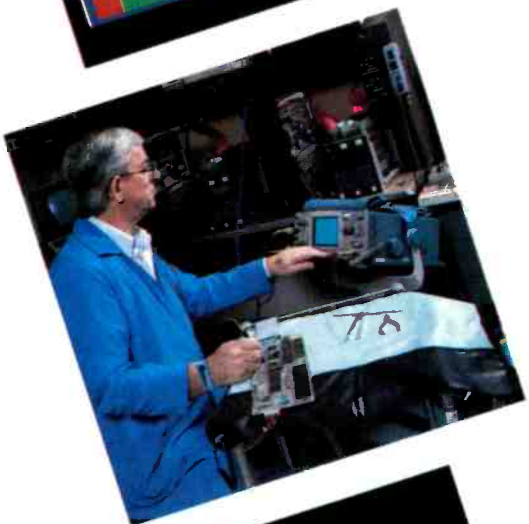
Figure 1. Sheet resistivity of thin films is measured in ohms per square. A square of a given material of a specified thickness will exhibit the same resistance as any other size square of the same thickness of the same material. That's because when you create a larger square, the greater resistance resulting from the greater distance across the square is exactly compensated for by the addition of resistance of the same magnitude in parallel.

reaction of a lot of people is to ask the question, "Per square what?" Sheet resistivity is measured simply in ohms per square.

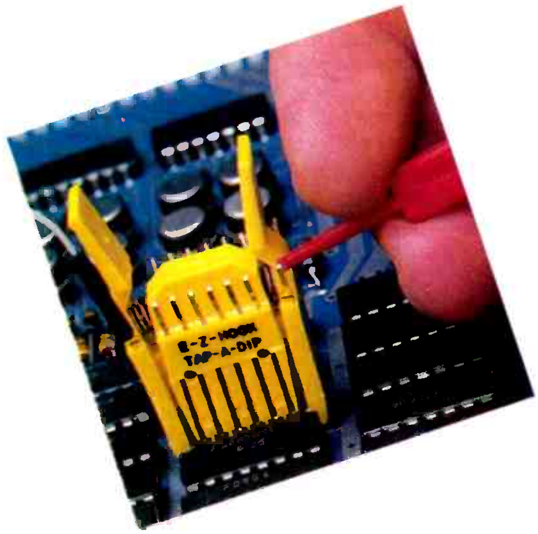
This strange-seeming value comes about because of some interesting characteristics of thin films. If you deposit a specific material, say tantalum nitride, in a specified thickness, in a square pattern, no matter how large the square, the resistance measured across the square will be the same. A glance at Figure 1 will show why this is so. **ES&T**

Index of 1986 Articles

Compiled By Warren G. Parker, Metairie, LA



ARTICLES


E-Z-HOOK
TAP-A-DIP

PROFAX

Profax schematics date from the October 1982 issue of ES&T. The 51-month directory of these schematics begins on page 27.

SYMCURE

GENERAL ELECTRIC

Month Page

MAGNAVOX

PHILCO

RCA

SYLVANIA

VIDEOCASSETTES

Manufactured by Matsushita, distributed by RCA, Panasonic, others.

Month Page

TECHNOLOGY

TROUBLESHOOTING TIPS

BOHSEI

GENERAL ELECTRIC

PANASONIC

QUASAR

RCA

SHARP

SYLVANIA

PROFAX

Compiled by Alisa Carter

	Profax number
OCTOBER 1982	
NEC color video monitor chassis Z7A	2000
RCA B&W TV chassis KCS 207B	2001
NAP color TV chassis 09C201 CQ4X	2002
NOVEMBER 1982	
Hitachi color TV chassis NP80SX	2003
RCA color TV chassis CTC 115	2004
NEC video projector chassis W2A-1	2005
DECEMBER 1982	
NAP B&W TV model MQA014GY (w/radio)	2006
RCA color TV chassis CTC 108	2007
JANUARY 1983	
Hitachi color TV GTX chassis No. 615	2008
RCA projection TV model PGR 200/300	2009
Magnavox B&W TV chassis 09M101	2010
FEBRUARY 1983	
Hitachi color TV, NP9X chassis	2011
RCA color TV, CTC 118 series	2012
MARCH 1983	
RCA B&W TV, chassis KCS 206C (ac/dc/battery)	2013
Hitachi projection color TV, CT 5011	2014
APRIL 1983	
General Electric color TV, AC-D AC-E	2015
NAP B&W TV, AM/FM radio UVG-1	2016
MAY 1983	
NAP color TV, chassis E34-18, -19, -32, -33	2017
GE B&W TV, XE chassis	2018
JUNE 1983	
RCA color TV, CTC 117 series	2019
NAP B&W TV, model B386QWA01	2020
JULY 1983	
Magnavox color TV, chassis E31-38	2021
Philco color TV, chassis K-20	2022
AUGUST 1983	
GE color TV, EM chassis	2023
NAP B&W TV, chassis 12M101	2024
SEPTEMBER 1983	
RCA color TV, chassis CTC 120	2025
NAP B&W TV, chassis 12M101	2026
OCTOBER 1983	
RCA B&W TV KCS205 series	2027
GE color TV, PM-A chassis	2028
NOVEMBER 1983	
RCA B&W TV KCS 204 series	2029
NAP color TV, 13C3 series	2030
DECEMBER 1983	
NAP color TV, 19C3 series	2031
GE color TV, PC-B chassis	2032

	Profax number
JANUARY 1984	
RCA KCS 206 B&W	2033
NAP E 34 chassis	2034
FEBRUARY 1984	
NAP 19 C 2 chassis	2035
RCA KCS 213 B&W	2036
MARCH 1984	
GE AF/C chassis	2037
APRIL 1984	
GE GL/X chassis	2038
GE XK B&W chassis	2039
NAP E 32 chassis	2040
MAY 1984	
RCA CTC 111 series	2041
JUNE 1984	
GE XJ B&W chassis	2042
NAP E 32-58, -59 chassis	2043
JULY 1984	
GE EC/K chassis	2044
NAP K 10 chassis	2045
AUGUST 1984	
RCA CTC 123 series	2046
NAP RD 425SI & RXC 192SL chassis	2047
SEPTEMBER 1984	
NAP E53-45, -46, -47, -48 chassis	2049
GE XE B&W chassis	2049
OCTOBER 1984	
RCA CTC 131/132 series	2050
NOVEMBER 1984	
GE AB/AC chassis	2051
NAP BD 3911 SL01 B&W chassis	2052
DECEMBER 1984	
RCA KCS B&W AM/FM/clock	2053
Hitachi NP 81 X chassis	2054
JANUARY 1985	
GE CM chassis	2055
NEC C13-304A chassis	2056
GE XM-E chassis	2057
FEBRUARY 1985	
GE PC-A chassis	2058
Hitachi CT2516 chassis	2059
MARCH 1985	
GE GK chassis	2060
Hitachi CQ4X chassis	2061
APRIL 1985	
RCA CTC 117 chassis	2062
NAP UXC chassis	2063
MAY 1985	
GE EC-A chassis	2064
NEC DJ-60EN(R) chassis	2065

	Profax number
JUNE 1985	
GE EP-B chassis	2066
JULY 1985	
GE 19PC-F/H chassis	2067
AUGUST 1985	
GE PM-B chassis	2068
SEPTEMBER 1985	
NAP EC-31-52, -56, & -58 chassis	2069
RCA CTC 118 chassis	2070
OCTOBER 1985	
NAP E-34-18, -32, & -33 chassis	2071
RCA CTC 121 chassis	2072
NOVEMBER 1985	
GE BC-N chassis	2073
GE EP chassis	2074
DECEMBER 1985	
GE PC-J chassis	2075
RCA CTC 126 chassis	2076
JANUARY 1986	
RCA MMC 100, video monitor	2077
GE PM-A chassis	2078
FEBRUARY 1986	
GE BC-A chassis	2079
RCA 117 chassis	2080
MARCH 1986	
RCA CTC 133 chassis	2081
APRIL 1986	
GE 25 PC(J) chassis	2082
RCA CTC 120 chassis	2083
MAY 1986	
GE HP chassis, tuning & control systems	2084A
GE HP chassis, chroma	2084B
JUNE 1986	
RCA CTC 125 chassis	2085
RCA 207 series, weather clock	2086
JULY 1986	
GE NF chassis	2087
GE PM-C chassis	2088
AUGUST 1986	
RCA CTC 136 chassis	2089
SEPTEMBER 1986	
RCA CTC 130-S1 chassis	2090
OCTOBER 1986	
GE X110 chassis, B&W TV	2091
GE TV/AM/FM clock radio	2092
NOVEMBER 1986	
RCA B&W TV basic service data, UVM chassis	2093
GE 14" portable color TV, RS-A chassis	2094
DECEMBER 1986	
GE X110 chassis (cont.)	2095
RCA UWJ chassis	2096

Profax Directory—by number

Profax Number	Month	Year
2000—2002	Oct	82
2003—2005	Nov	82
2006—2007	Dec	82
2008—2010	Jan	83
2011—2012	Feb	83
2013—2014	Mar	83
2015—2016	Apr	83
2017—2018	May	83
2019—2020	Jun	83
2021—2022	Jul	83
2023—2024	Aug	83
2025—2026	Sep	83
2027—2028	Oct	83
2029—2030	Nov	83
2031—2032	Dec	83
2033—2034	Jan	84
2035—2036	Feb	84
2037	Mar	84
2038—2040	Apr	84
2041	May	84
2042—2043	Jun	84
2044—2045	Jul	84
2046—2047	Aug	84
2048—2049	Sep	84
2050	Oct	84
2051—2052	Nov	84
2053—2054	Dec	84
2055—2057	Jan	85
2058—2059	Feb	85
2060—2061	Mar	85
2062—2063	Apr	85
2064—2065	May	85
2066	Jun	85
2067	Jul	85
2068	Aug	85
2069—2070	Sep	85
2071—2072	Oct	85
2073—2074	Nov	85
2075—2076	Dec	85
2077—2078	Jan	86
2079—2080	Feb	86
2081	Mar	86
2082—2083	Apr	86
2084A-2084B	May	86
2085—2086	Jun	86
2087—2088	Jul	86
2089	Aug	86
2090	Sep	86
2091—2092	Oct	86
2093—2094	Nov	86
2095—2096	Dec	86

Profax Directory — by company

	Profax Number	Month Year
GENERAL ELECTRIC		
Color TV, AC-D AC-E	2015	Apr 83
B&W TV XE chassis	2018	May 83
Color TV, EM chassis	2023	Aug 83
Color TV, PM-A chassis	2028	Oct 83
Color TV, PC-B chassis	2032	Dec 83
AF/C chassis	2037	Mar 84
GL/X chassis	2038	Apr 84
XK B&W chassis	2039	Apr 84
XJ B&W chassis	2042	Jun 84
EC/K chassis	2044	Jul 84
XE B&W chassis	2049	Sep 84
AB/AC chassis	2051	Nov 84
CM chassis	2055	Jan 85
XM-E chassis	2057	Jan 85
PC-A chassis	2058	Feb 85
GK chassis	2060	Mar 85
EC-A chassis	2064	May 85
EP-B chassis	2066	Jun 85
19PC-F/H chassis	2067	Jul 85
PM-B chassis	2068	Aug 85
BC-N chassis	2073	Nov 85
EP chassis	2074	Nov 85
PC-J chassis	2075	Dec 85
PM-A chassis	2078	Jan 86
BC-A chassis	2079	Feb 86
25 PC(J) chassis	2082	Apr 86
HP chassis, tuning and control systems	2084A	May 86
HP chassis, chroma	2084B	May 86
NF chassis	2087	Jul 86
PM-C chassis	2088	Jul 86
X110 chassis, B&W TV	2091	Oct 86
TV/AM/FM clock radio	2092	Oct 86
14" portable color TV	2094	Nov 86
X110 chassis (cont.)	2095	Dec 86
HITACHI		
Color TV chassis NP80SX	2003	Nov 82
Color TV GTX chassis No. 615	2008	Jan 83
Color TV, NP9X chassis	2011	Feb 83
Projection color TV, CT5011	2014	Mar 83
NP 81 X chassis	2054	Dec 84
CT2516 chassis	2059	Feb 85
CQ4X chassis	2061	Mar 85
MAGNAVOX		
B&W TV chassis 09M101	2010	Jan 83
Color TV, chassis E31-38	2021	Jul 83
NAP		
Color TV chassis 09C201 CQ4X	2002	Oct 82
B&W TV model MQA014GY (w/radio)	2006	Dec 82
B&W TV, AM/FM radio UVG-1	2016	Apr 83
Color TV, chassis E34-18, -19, -32, -33	2017	May 83
B&W TV, model B386QWA01	2020	Jun 83
B&W TV, chassis 12M101	2024	Aug 83
B&W TV, chassis 12M101 (duplicate)	2026	Sep 83
Color TV, 13C3 series	2030	Nov 83
Color TV, 19C3 series	2031	Dec 83
E34 chassis	2034	Jan 84
19C2 chassis	2035	Feb 84
E 32 chassis	2040	Apr 84
E 32-58, 59 chassis	2043	Jun 84
K10 chassis	2045	Jul 84
RD 425S1 & RXC 192SL chassis	2047	Aug 84
E53-45, 46, 47, 48 chassis	2048	Sep 84
BD 3911 SL01 B&W chassis	2051	Nov 84
UXC chassis	2063	Apr 85
EC-31-52, 56 & 58 chassis	2069	Sep 85
E 34-18, 32, & 33 chassis	2071	Oct 85
NEC		
Color video monitor chassis Z7A	2000	Oct 82
Video projector chassis W2A-1	2005	Nov 82
C13-304 A chassis	2056	Jan 85
DJ-60EN(R) chassis	2065	May 85
PHILCO		
Color TV, chassis K-20	2022	Jul 83
RCA		
B&W TV chassis KCS 207B	2001	Oct 82
Color TV chassis CTC 115	2004	Nov 82
Color TV chassis CTC 108	2007	Dec 82
Projection TV model PGR 200/300	2009	Jan 83
Color TV, CTC 118 series	2012	Feb 83
B&W TV, chassis KCS 206C	2013	Mar 83
Color TV, CTC 117 series	2019	Jun 83
Color TV, chassis CTC 120	2025	Sep 83
B&W TV KCS 205 series	2027	Oct 83
B&W TV KCS 204 series	2029	Nov 83
KCS 206 B&W	2033	Jan 84
KCS 213 B&W	2036	Feb 84
CTC 111 series	2041	Mar 84
CTC 123 series	2046	Apr 84
CTC 131/132 series	2050	Oct 84
KCS B&W AM/FM clock	2053	Dec 84
CTC 117 chassis	2062	Apr 85
CTC 118 chassis	2070	Sep 85
CTC 121 chassis	2072	Oct 85
CTC 126 chassis	2076	Dec 85
MMC 100, video monitor	2077	Jan 86
CTC 117 chassis	2080	Feb 86
CTC 133 chassis	2081	Mar 86
CTC 120 chassis	2083	Apr 86
CTC 125 chassis	2085	Jun 86
207 series, weather clock	2086	Jun 86
CTC 136 chassis	2089	Aug 86
CTC 130-S1 chassis	2090	Sep 86
B/W TV basic service data	2093	Nov 86
UWJ chassis	2096	Dec 86

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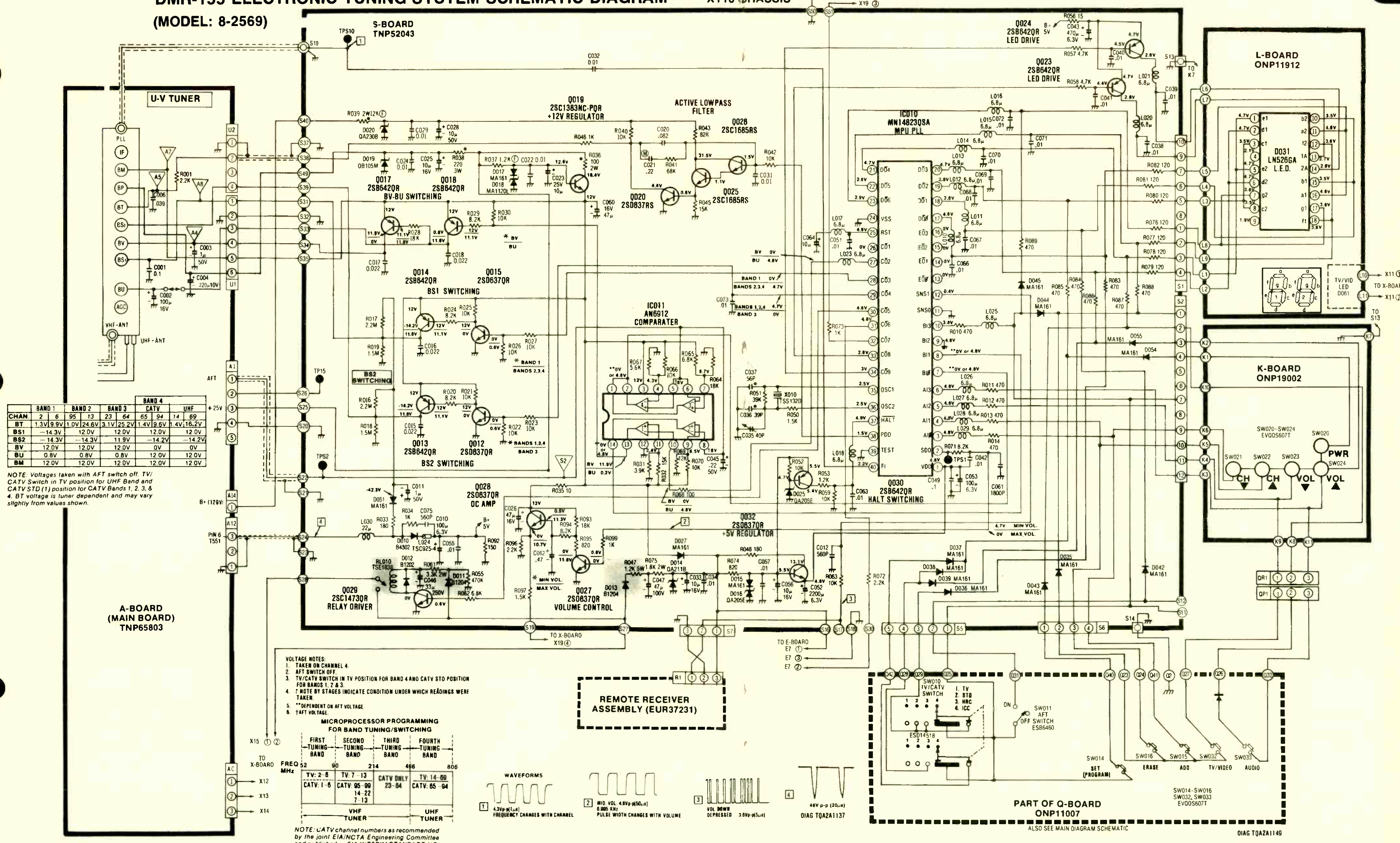
The other portions of this schematic may be found on other Profax pages.

DMR-155 ELECTRONIC TUNING SYSTEM SCHEMATIC DIAGRAM

X110 CHASSIS

(MODEL: 8-2569)



	BAND 1		BAND 2		BAND 3		BAND 4 CATV		BAND 4 UHF	
CHAN.	2	6	95	13	23	64	65	94	14	69
BT	1.3V	9.9V	1.0V	24.6V	3.1V	25.2V	1.4V	9.6V	1.4V	16.2V
BS1	−14.3V		12.0V		12.0V		12.0V		12.0V	
BS2	−14.3V		−14.3V		11.9V		−14.2V		−14.2V	
BV	12.0V		12.0V		12.0V		0V		0V	
BU	0.8V		0.8V		0.8V		12.0V		12.0V	
BM	12.0V		12.0V		12.0V		12.0V		12.0V	

NOTE: Voltages taken with AFT switch off. TV/CATV Switch in TV position for UHF Band and CATV STD (1) position for CATV Bands 1, 2, 3, & 4. BT voltage is tuner dependent and may vary slightly from values shown.

VOLTAGE NOTES:
1. TAKEN ON CHANNEL 4.
2. AFT SWITCH OFF.
3. TV/CATV SWITCH IN TV POSITION FOR BAND 4 AND CATV STD POSITION FOR BANDS 1, 2 & 3.
4. ? NOTE BY STAGES INDICATE CONDITION UNDER WHICH READINGS WERE TAKEN.
5. **DEPENDENT ON AFT VOLTAGE
6. †AFT VOLTAGE

MICROPROCESSOR PROGRAMMING FOR BAND TUNING/SWITCHING

FREQ MHz	52–90	90–214	214–466	466–806
	FIRST TUNING BAND	SECOND TUNING BAND	THIRD TUNING BAND	FOURTH TUNING BAND
	TV: 2–6 CATV: 1–6	TV: 7–13 CATV: 95–99, 14–22, 7–13	CATV ONLY 23–64	TV: 14–69 CATV: 65–94
	VHF TUNER	VHF TUNER	VHF TUNER	UHF TUNER

NOTE: CATV channel numbers as recommended by the joint EIA/NCTA Engineering Committee and published as EIA INTERIM STANDARD NO 6 — CABLE TELEVISION CHANNEL IDENTIFICATION PLAN — MAY 1983.

PROFAX 2096

Manufacturers' schematics

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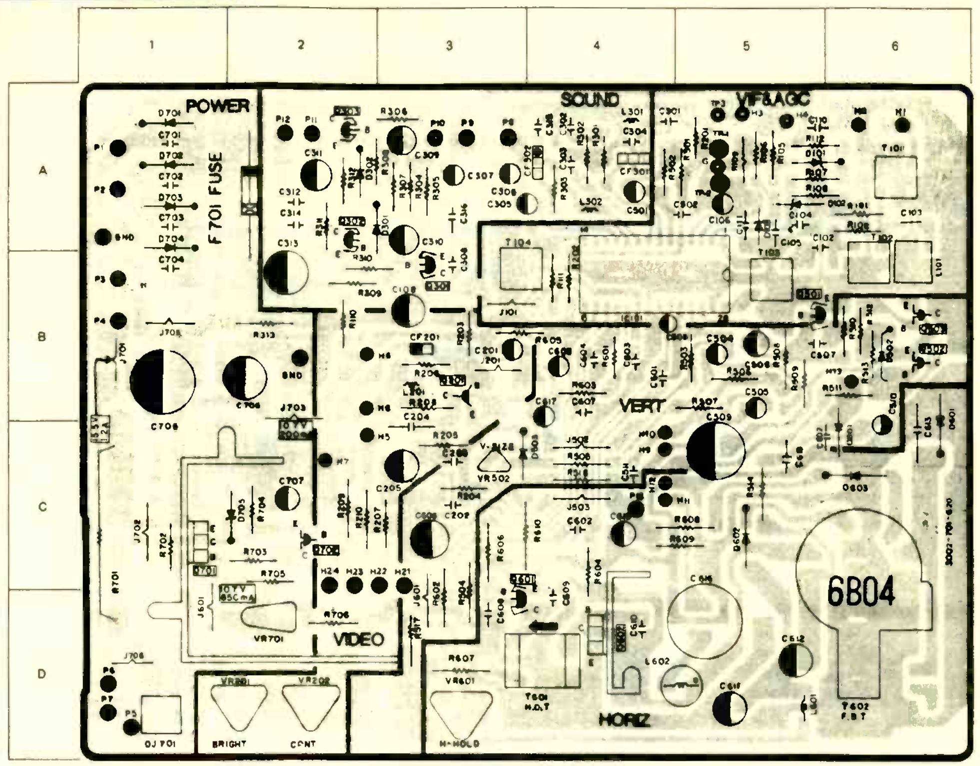
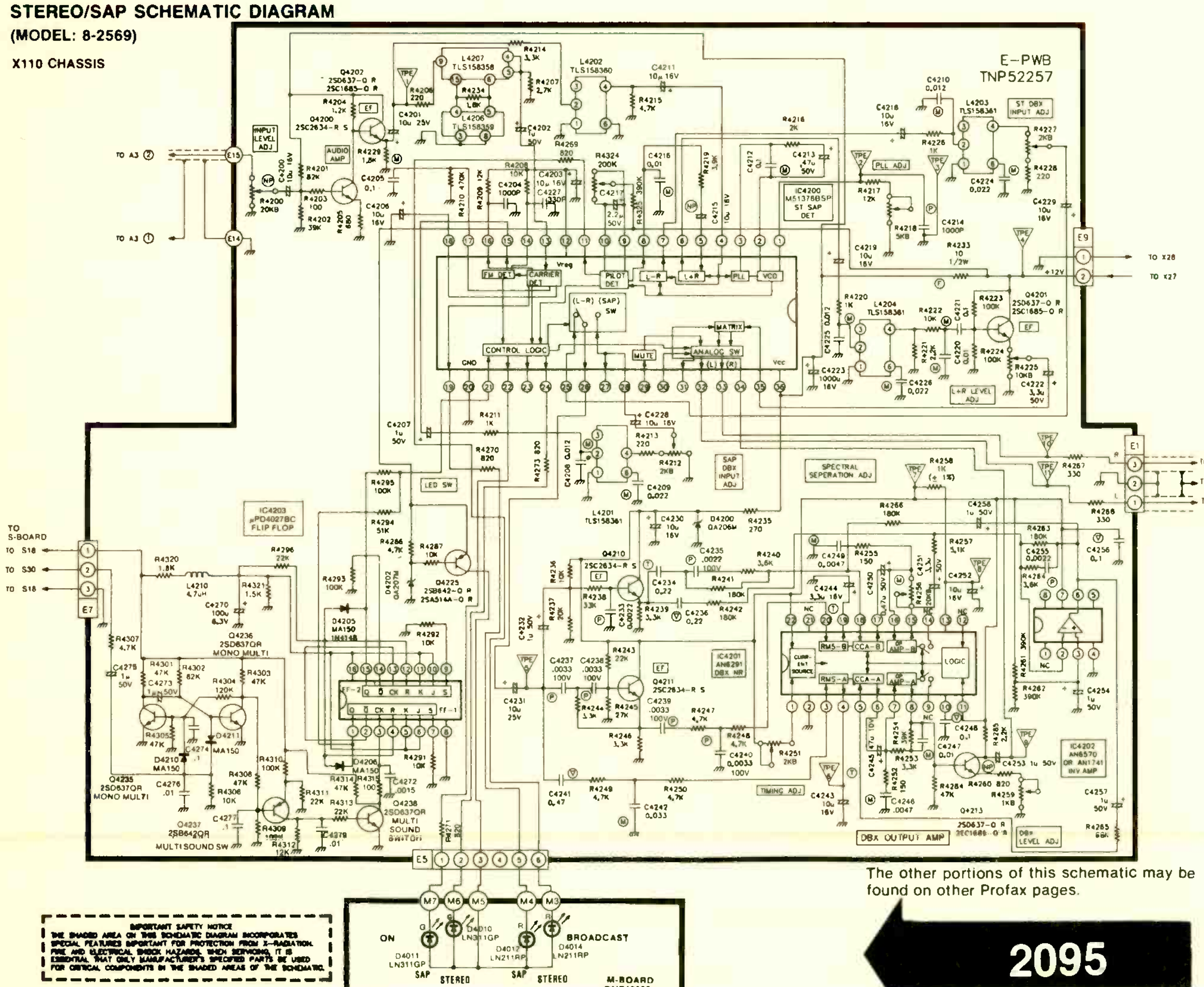
The other portions of this schematic may be found on other Profax pages.



STEREO/SAP SCHEMATIC DIAGRAM

(MODEL: 8-2569)

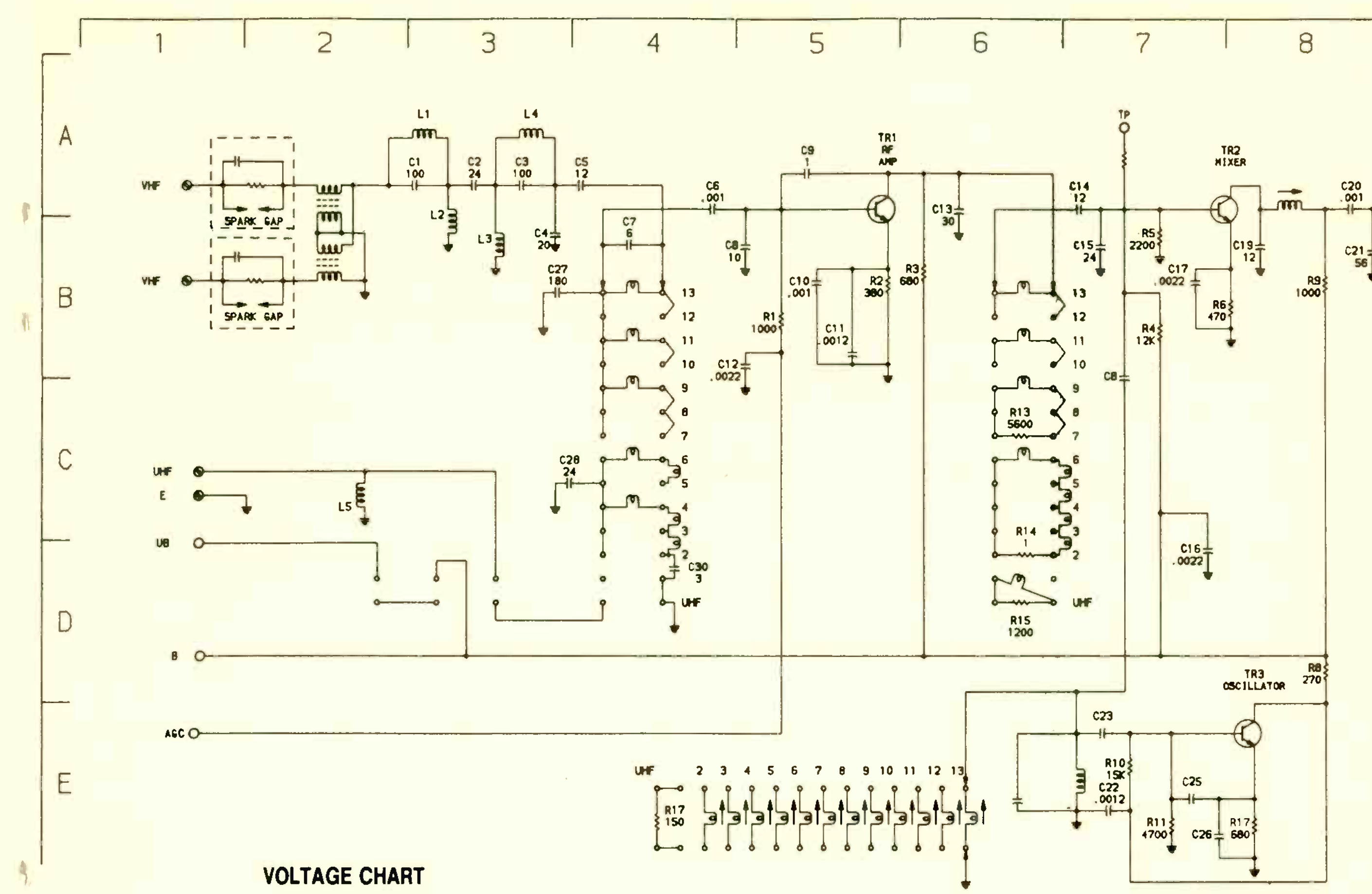
X110 CHASSIS



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

2095

VHF TUNER SCHEMATIC



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

VOLTAGE CHART

Measured with high impedance V.T.V.M. or circuit tester under line voltage 120V
Voltage reading may vary ±10%

Tr. No.	Tr. Type	Function	Operating Condition	Base	Emitter	Collecter
Q201	KSC2310 (O)/(Y)	VIDEO	No Signal	5.7V	5.3V	70.2V
		OUTPUT	1000u V B&W Signal	5.6V	5.5V	67.5V
Q301	KSC945 (O)/(Y)	AUDIO	No Signal	0.72V	0.04V	6.8V
		DRIVE	1000u V B&W Signal	0.72V	0.05V	6.8V
Q302	KSD261 (O)/(Y)	AUDIO	No Signal	8.2V	7.6V	16.6V
		OUTPUT	1000u V B&W Signal	8.2V	7.6V	16.5V
Q303	KSA643 (O)/(Y)	AUDIO	No Signal	6.8V	7.4V	0V
		OUTPUT	1000u V B&W Signal	6.8V	7.4V	0V
Q501	KSC945 (O)/(Y)	VERT.	No Signal	0.6V	0V	6.2V
		DRIVE	1000u V B&W Signal	0.5V	0V	6.2V
Q502	KSC2331 (O)/(Y)	VERT.	No Signal	7.3V	6.7V	16V
		OUTPUT	1000u V B&W Signal	7.2V	6.7V	16.2V
Q503	KSA931 (O)/(Y)	VERT.	No Signal	6.2V	6.7V	0V
		OUTPUT	1000u V B&W Signal	6.2V	6.7V	0V
Q601	KSC815 (O)/(Y)	HORIZ.	No Signal	0.5V	0V	10.3V
		DRIVE	1000u V B&W Signal	0.5V	0V	10.2V
Q602	KSD362 (N)/(R)	HORIZ.	No Signal	0V	0V	17.2V
		OUTPUT	1000u V B&W Signal	0V	0V	17.2V
Q701	KSA614 (O)/(Y)	VOLTAGE	No Signal	15.8V	16.8V	10.7V
		REGULATOR	1000u V B&W Signal	16.5V	17V	10.7V
Q702	KSD261 (O)/(Y)	ERROR	No Signal	3.7V	3V	15V
		AMP.	1000u V B&W Signal	3.7V	3V	15V

IC VOLTAGE CHART

Unit: Volt

IC101 AN5151. VIF Amp. & DET. SIF Amp. & DET, AGC, Vertical OSC. & Drive Horizontal OSC. & Drive, sync. Sep.

Pin No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
No Signal	4.8	5.9	2.5	8.1	4.4	6.4	3	3	4.7	4.7	2.5	6.5	3.6	6.9
1000u V Signal	4.7	5.9	8.3	5.1	3.5	7.4	3	3	4.7	4.7	2.2	0.6	3.6	6.9

Pin No.	15	16	17	18	19	20	21	22	23	24	25	26	27	28
No Signal	7	9.7	0.8	5.4	5.4	10.3	0	3.5	0.4	5.2	1.04	6	0	4.8
1000u V Signal	6.9	9.7	0.7	5.4	5.5	10.3	0	3.4	0.9	5	0.9	5.8	0	4.8

COMPONENT LOCATION GUIDE

C102	5A	C607	4B	R307	3A	D302	2A
C103	6A	C608	3D	R308	2A	D502	6B
C104	5A	C609	4D	R309	2B	D503	3C
C105	5A	C610	4D	R310	2B	D601	6C
C106	5A	C611	5D	R311	2A	D602	5C
C108	3B	C612	5D	R312	2A	O603	6C
C110	5A	C613	6C	R313	2B	D701	1A
C111	5A	C615	4C	R501	5A	D702	1A
C201	3B	C616	5D	R502	4A	D703	1A
C202	3C	C617	4B	R503	5B	D704	1A
C203	3C	C619	5C	R504	3D	D705	1C
C204	3C	C701	1A	R505	4C	D801	6C
C205	3C	C702	1A	R506	5B	Q201	3B
C301	4A	C703	1A	R507	5B	Q301	3B
C302	4A	C704	1B	R508	5B	Q302	2A
C303	4A	C705	1B	R509	5B	Q303	2A
C304	4A	C706	2B	R510	6B	Q501	5B
C305	3A	C707	2C	R511	6B	Q502	6B
C306	3A	C802	5C	R512	6B	Q503	6B
C307	3A	R101	6A	R513	6B	Q601	3D
C308	3B	R102	6A	R514	5C	Q602	4D
C309	3A	R105	5A	R516	4C	Q701	1C
C310	3A	R106	5A	R517	3D	Q702	2C
C311	2A	R107	5A	R601	4B	CF201	3B
C312	2A	R108	5A	R602	3D	CF301	4A
C313	2B	R109	5A	R603	4B	CF302	4A
C314	2A	R110	2B	R604	4C	T101	6A
C315	4A	R111	4B	R605	3B	T102	6B
C316	3A	R112	5A	R606	3C	T103	5B
C501	4A	R201	5A	R607	3D	T104	3B
C502	5A	R202	4B	R608	5C	T601	4D
C503	4B	R203	3B	R609	5C	T602	6D
C504	5B	R204	3C	R610	3C	L101	6B
C505	5B	R205	3C	R701	1C	L201	3B
C506	5B	R206	3B	R702	1C	L301	4A
C507	5B	R207	2C	R703	2C	L302	4A
C509	5C	R208	3B	R704	2C	L601	5D
C510	6C	R209	2C	R705	2C	L602	5D
C511	4C	R210	2C	R706	2D	VR202	2D
C601	4B	R301	4A	IC101	4B	VR502	3C
C602	4C	R302	4A	D101	5A	VR601	3D
C603	4B	R303	4A	D102	5A	VR701	2D
C604	4B	R304	3A	D103	5A	DJ701	1D
C605	4B	R305	3A	D301	2A	F701	2A
C606	3C	R306	3A				

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DECEMBER 1986

RCA
UWJ chassis
B&W TV
Model BWT128E

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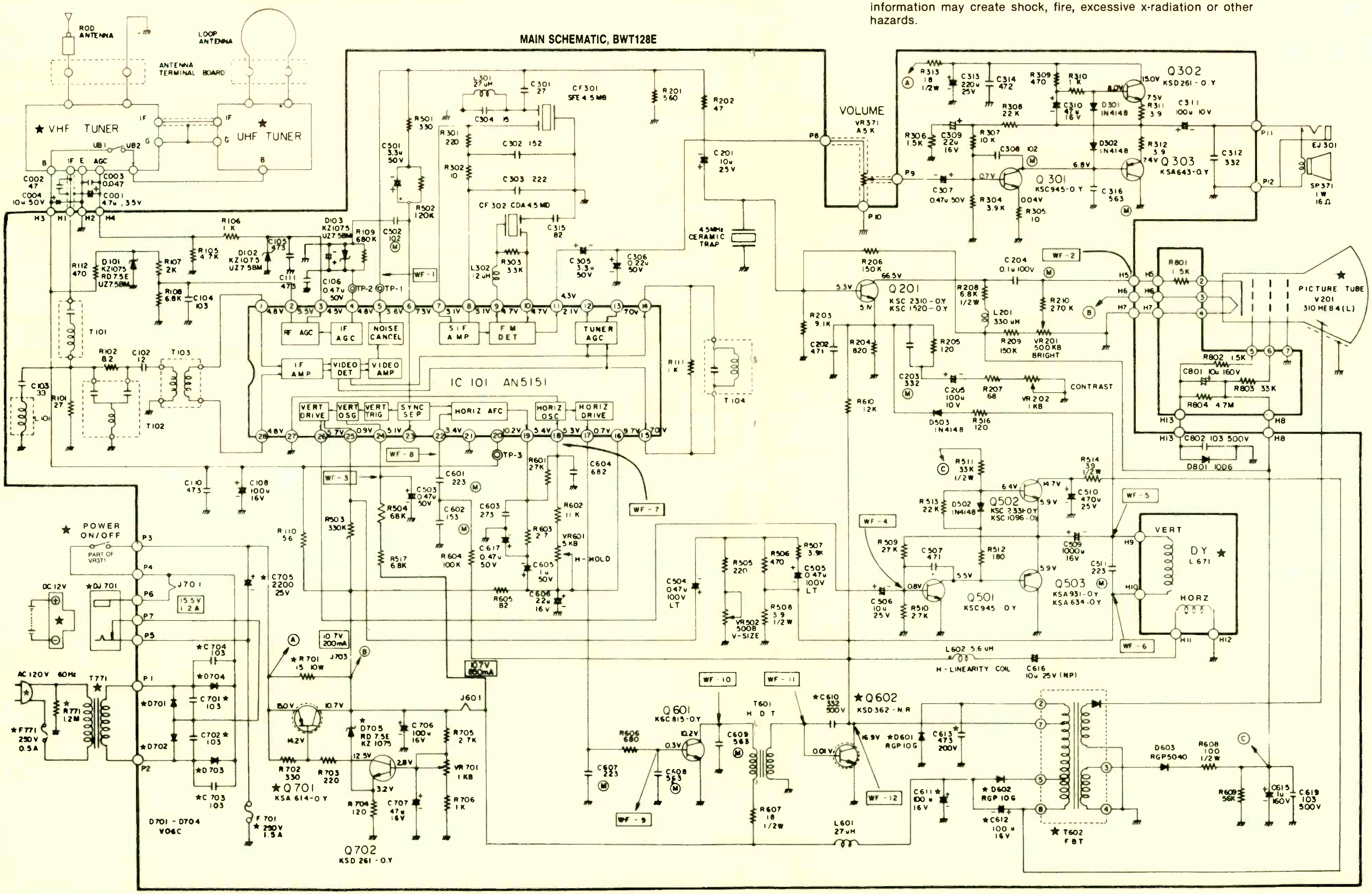
MAIN SCHEMATIC, BWT128E



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ES&T Manufacturers' schematics PROFAX

DECEMBER 1986

Schematic No.	
GE	
B&W TV, X110 chassis (continued)	2095
RCA	
B&W TV, UWJ chassis, model BWT128E	2096

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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.

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.

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.

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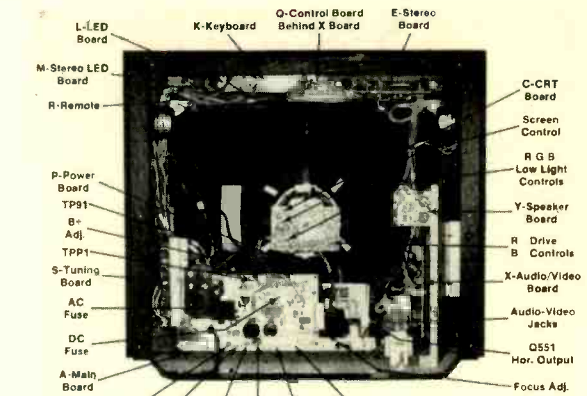
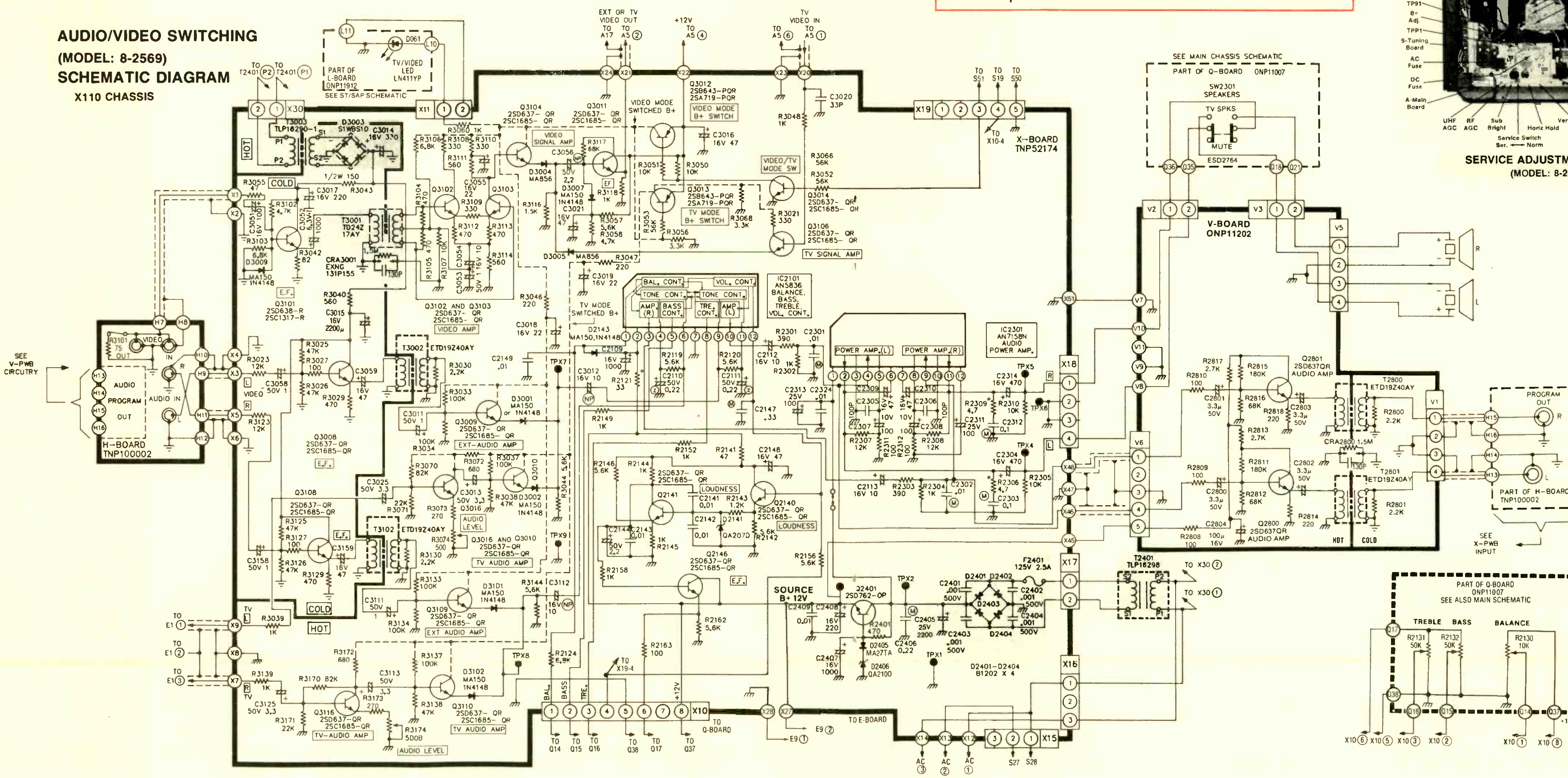


SERVICE ADJUSTMENTS (Cont.)
(MODEL: 8-2569)

The main diagram schematic for GEX110 chassis B&W television was published inthe October 1986 ES&T Profax section.

AUDIO/VIDEO SWITCHING
(MODEL: 8-2569)
SCHEMATIC DIAGRAM
X110 CHASSIS



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Audio servicing step by step

By David Miga, CET

Visual observation, troubleshooting, repair and maintenance are the four steps to the successful repair of electronic audio equipment.

There are four steps to the successful repair of electronic audio equipment: visual observation, troubleshooting, repair and maintenance, although not necessarily in that order, as we shall see. We will look at some common complaints and remedies of problems with amplifiers and receivers (both older units and the new microprocessor-controlled units) and tape decks (reel-to-reel and cassette.)

Receivers and amplifiers

The most common complaints of these units are "one channel out," "both channels out," "one channel lower than the other," "intermittent cuts in and out," etc. Many technicians make the mistake of spending too much time troubleshooting instead of looking for the most obvious clues. Five minutes of *thorough* visual observation can save you many hours of troubleshooting. The technician who spends two hours with a protection circuit problem on a Pioneer SX-950 only to trace it to a loose fuse holder will remember these two steps: static observation and dynamic observation.

Static observation: Check all fuses with an ohmmeter and be sure the fuse holders are holding the fuses tight enough. Also, be sure the fuses are of the correct value. Look for obvious burnt PC foils, discolored resistors or recent soldering. If the outside of the cabinet looks damaged, look for cracked PC boards inside.

Dynamic observation: Plug the unit into a "safety socket" (this is nothing more than an extension cord with one wire cut and a 100W bulb in series with the load). The bulb should light briefly and dim down as the power supply capacitors charge, and if the unit has a speaker relay, it should click in after a few seconds. Assuming this happens and you can tune in a station or run a signal into the auxiliary input, operate *all* the switches and controls one by one. You might find that the "intermittent left channel" or "one channel dead" is just a dirty tape monitor switch or input selector.

If the bulb stays bright, you have something shorted in the unit (and you just saved yourself a fuse). The only way to find the shorted components is statically. Unplug the unit and with your ohmmeter or the diode test function of your

DMM, measure the most obvious: shorted power supply diodes and audio output transistors reign supreme. If you find the audio outputs shorted in one channel, remove them from the circuit, plug the unit back into the safety socket and check the other channel and all other functions.

When repairing a direct-coupled amplifier with shorted output transistors, it is *very* important to statically check the driver and predriver transistors and all low value (under 5k) metal oxide fireproof resistors in the circuit. It is a very rare amplifier that blows only the outputs, and the unwary technician who simply replaces the output transistors and turns the unit *on*, hoping for the best, will soon find that another set of outputs has just been blown. When soldering output transistors or any other components that must be mounted to a heat sink, always solder the leads *after* the component is mounted. Otherwise, premature failure could occur.

When you are reasonably sure that you have replaced all of the defective components, plug the unit into the safety socket, and with no speakers hooked up, turn the unit *on* and measure the dc voltage at the amplifier output before the speaker relay. If you have more than a volt, you missed something (did you check the bias diode or transistor on the heatsink?). Don't make the mistake of trying to troubleshoot the unit dynamically with voltage comparisons from the schematic; with dc-coupled amplifiers using negative feedback, you're just wasting time. Checking semiconductors statically with a semiconductor analyzer and resistors with the *low ohms* position of your DMM is the best method.

> It is a very rare amplifier that blows only the outputs

Amplifiers with intermittent problems have been known to make some technicians turn to drink and others to become believers in the supernatural. Here again, if certain steps had been taken, those technicians would have been working on the next customer's unit instead of dying on this one.

Solder one end of a grain of wheat bulb at the amplifier's output before the speaker relay, and the other end to ground (do this to both channels). The voltage of the bulbs is dependant on the amplifier's size, so use the rail voltage as a guide. Turn the amplifier *on* with the speakers hooked up and listen to some music while you're working on something else. When you hear the amplifier act up, look at the bulbs. If the bulbs show that both channels are experiencing the same problem, the chances are that the amplifiers are OK and the problem is in the power supply or protection circuit. If just one channel acts up, look for thermally noisy differential transistors (a common Pioneer trait) or a noisy dc offset or bias trimmer (a common Sansui trait), or a leaky electrolytic capacitor at the last stage of the tone circuit before the amplifier. Incidentally, noisy transistors and leaky capacitors sound different; low frequency thumping is usually a leaky electrolytic, while sharp snapping is usually a noisy semiconductor.

Electronics servicing chemicals provide an arsenal of products for use in audio servicing. Freeze sprays simplify component cooling for troubleshooting purposes, solvents provide cleaning for both mechanical and electrical/electronic components.

If the problem seems to be common to both channels, suspect the power supply first. Regulators of the TO-220 case style will become intermittent if they are mounted to a too-small heat sink (Pioneer again). Simply compare all regulator output voltages with the schematic when the unit acts up; sometimes you can find the defective component in a jiffy with a can of Freon freeze spray. Look for oxidized PC board solder connections at the regulators and their support components (Yamaha and Pioneer).

In some cases, the protection circuits themselves can cause the intermittent problem; this is almost always caused by leaky transistors in the early stages of the protection circuit (Sony and Kenwood). Heating the transistors with a common hair dryer and then freeze-spraying them one at a time will usually find the defective component quickly.

More amplifier problems difficult to find are such complaints as "one channel lower/louder than the other" and "output pops when low filter switch is activated." This is usually associated with older units and is always (well, almost) a leaky or open electrolytic capacitor. Rather than spend time troubleshooting to the component itself, it is usually quicker to replace all the electrolytics in the offending stage (Pioneer, Fisher). Also, keep in mind that the older units will have enough wear on the balance and volume controls that they may not vary both channels equally (but you would have found that when you did the "dynamic observations" step...right?).

After you have repaired the unit, it's time to do maintenance; if nothing else, it will lessen the chances of a "call-back" because you have overlooked something. An amplifier that comes in with a channel blown that you have repaired may blow up again because you didn't clean and adjust the bias trimpot, so spray a good Freon/silicon-based cleaner on the dc offset and bias trimmers before adjusting them to the manufacturer's specifications. Also spray all the switches and controls on the front panel and burnish the speaker relay contacts and any PC board edge connectors. If the unit is a receiver, align the FM tuner; the correct method is to adjust the discriminator coil first, then adjust the front end trimmer caps while tuned to the upper ranges of the FM band.

Microprocessor-controlled units

The reason you'll find that most technicians are scared to death to work on the newer digitally controlled equipment is because they overcomplicate a problem that could be easy to find if they only followed certain steps.

If the unit turns *on* but ignores all functions, first check power supply voltages; if the 6-V supply in the Pioneer SX-5 is 6½V, the MPU will not function! If voltages appear to be normal, check to see that the *clock* (i.e., crystal, ceramic resonator, etc.) is operating. Remember that all an MPU does is execute certain functions step by step. Without an oscillator to run it, it will stay stuck on one step until it grows hair. The most common failure with MPU-based units is the ceramic resonator; like a crystal, but lower in frequency, they often become intermittent. Substitution is the best method.

The third most common problem to look for is a stuck switch (Akai, Kenwood). The MPU is constantly scanning all its input switches, and if just one is pressed, the MPU will ignore all commands from the others. Incidentally, the switches don't have to be front-panel buttons; on cassette decks, microswitches tell the MPU what position the mechanism is in, and the unit will not operate properly if these switches are intermittent.

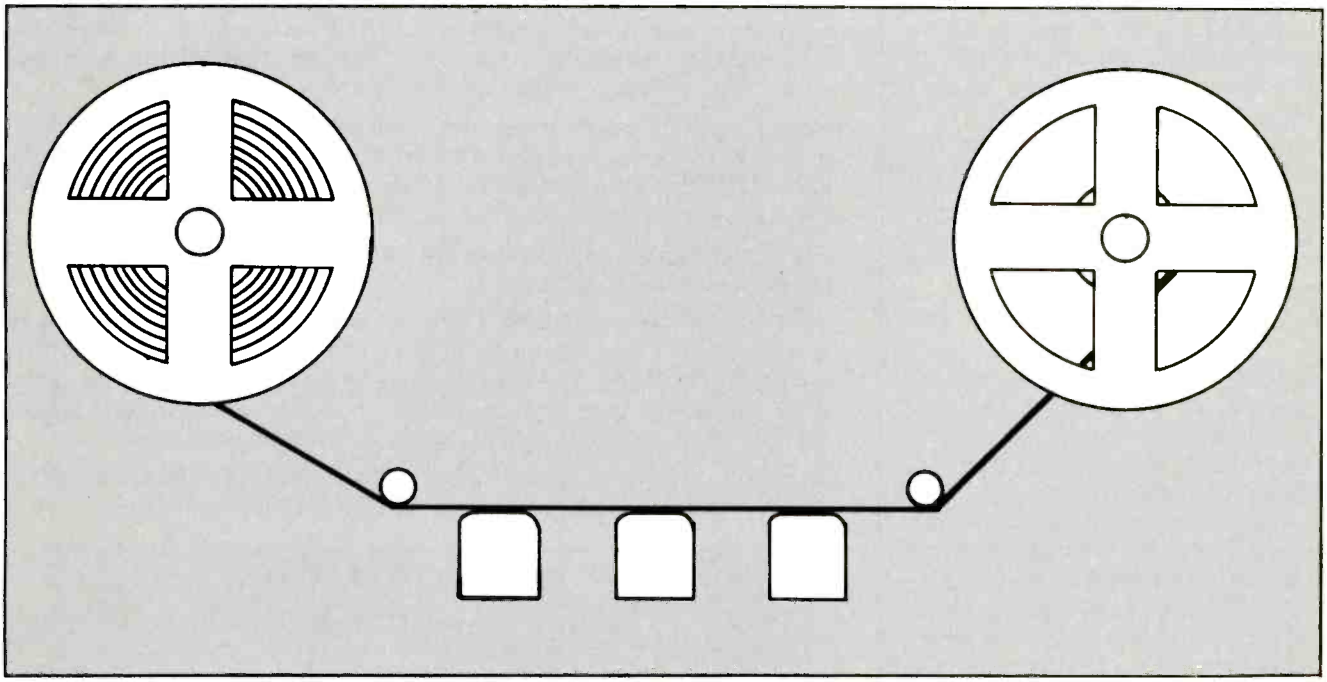
If the MPU is operating and accepting commands, but it is doing some pretty strange things such as adjusting bass when the treble button is depressed, it has received a glitch in its program; find the reset pin and reset the MPU with an alligator clip (some receivers have a reset button on the rear panel). Most MPUs are designed to be reset at turn-on through a small electrolytic capacitor to ground, and some of them use batteries to keep the MPU's memory.

Unfortunately, a close lightning strike can reprogram the RAM inside the MPU and the customer will think that the unit is defective. Just short the reset pin to ground for a second and see if it corrects the problem. Replace the MPU only when you have determined that the supply, oscillator, switches and reset capacitor are OK. After soldering, it is mandatory that the PC board be strip cleaned, as some MPUs have high impedance inputs that can be affected by contaminated rosin flux.

Tape decks

Remember when I said that the four steps to successfully repair a unit were visual observation, troubleshooting, repair and maintenance, but not necessarily in that order? Whenever you are dealing with anything mechanical, suspect a mechanical failure before an electronic one. To spend time troubleshooting a "low record" problem to a dirty tape head is SHAMEFUL. As usual, go through the visual observation, but instead of troubleshooting next, do maintenance instead. You'll find that 90% of most complaints with tape recording equipment will vanish once maintenance has been done.

Clean the heads, capstan and pinch roller with toluene (GC Electronics *Service Solvent*). This removes the dead rubber and, frankly, does a better job of revitalizing old rubber than most of the solvents sold only for that purpose. Also clean the pulleys that the belts and idlers come in



Cleaning the tape path, heads, capstan, pinch roller and pulleys will clear up most complaints about tape recording/playing equipment.

contact with, as well as the tape guide path.

After cleaning the belts, hold the flywheel immobile and turn the motor *on*. If the motor spins, the belt is stretched and must be replaced. On most units, the length of the belt actually will change the tape speed, so be sure you replace the belt with the size recommended by the manufacturer. If the customer complained of a speed problem with a cassette deck, find the switch that activates the motor when the mechanism is activated and burnish it (Pioneer, JVC).

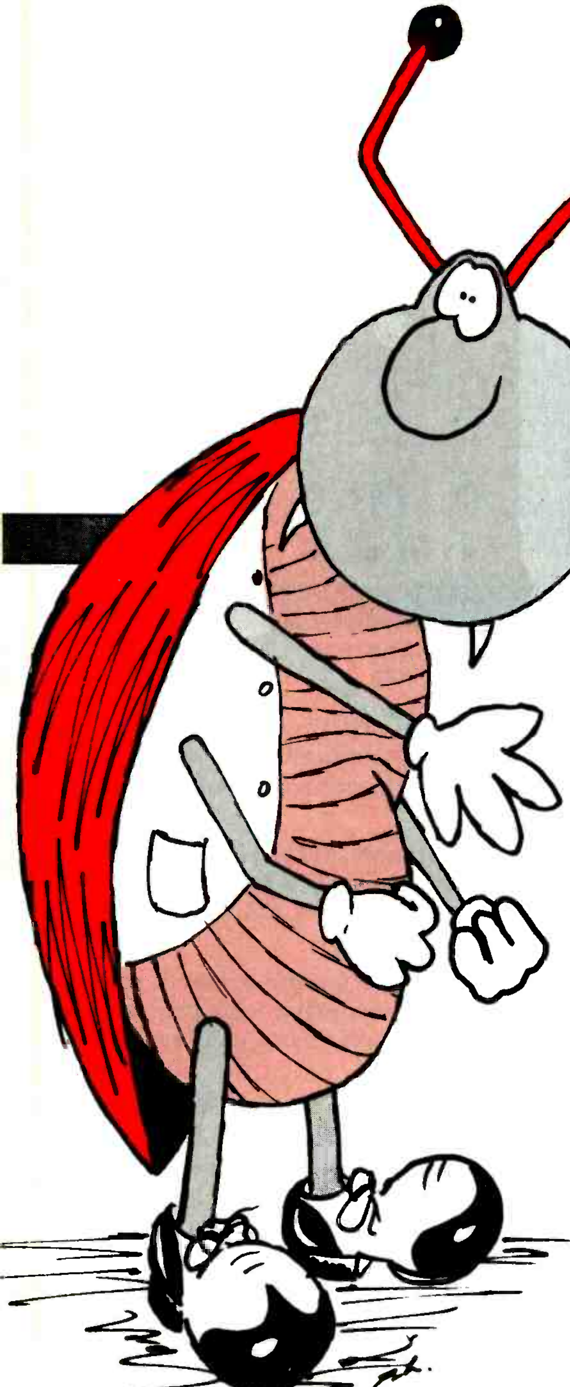
After all maintenance has been done, check the speed, wow and flutter, rewind, fast forward and take-up torque. Research has shown that most people hear slow music more readily than fast, so set the motor speed (if adjustable) to between 0.0% and 3% fast.

Now that maintenance has been done, you'll probably have a working unit. But in case you don't, here are some pointers to look for: Worn motors will vary their speed if tapped on with a small screwdriver handle; replace them. A cassette deck with no play or record in one channel is almost always a defective Dolby chip. Recording levels lower in the right channel in comparison to the left channel signifies a worn head; replace and align it. Intermittent motor operation in cassette decks is usually the motor microswitch buried in the mechanism (did you burnish it while doing maintenance?). Reel-to-reel decks that intermittently stop for no reason usually have thermally defective supply regulators of the TO-220 case style (Akai, Dokorder). Cassette decks that do the same thing usually have loose tape counter/motion detector belts. Some newer units use a mechanical system for measuring tape motion; be sure that they are not binding.

The steps outlined in this article could turn an average technician into a good one, and a good technician into a "Supertech."

David T. Miga is an FCC licensed, Certified Electronic Technician (ISCET) with 16 years of experience in repairing consumer electronic equipment. Now as an engineering technician with Electronic Design Specialists, he has designed many test equipment, alarm, audio and digital circuits.

BUG OUT!



There are electronic bugs, and there are bugs that bug electronics. Technicians are trained to cope with the electronic type, but, according to a national pest control consultant, the insect-type bugs have put the electronic equipment community between the well-known rock and the hard place.

"The dilemma stems from the threat of insect invasion of computers, cash registers, security alarms and other high-tech instruments," says Russell E. Jones, president of Rainbow Manufacturing Corporation, a firm that specializes in pest control research and products.

On the rock side: Electronics equipment is vulnerable to various insect-caused malfunctions. Hard place? Conventional insecticides are unsuitable for application inside electronic housings. Many aerosol insecticides, in fact, carry the cautionary statement: Do not use on plastics, painted or varnished surfaces; do not spray directly into any electronic equipment . . .

Consider that manufacturers' warranties and dealer service contracts do not cover damage due to insects. Because of this, insect invasion, although not epidemic, may be a problem to the owner of infested equipment even if the "infestation" is limited to a single roving roach. Perhaps the most devastating incident of this type occurred in a New York hospital.

According to Jones, a roach got into an $800,000 computer system and crossed a high-voltage contact. This caused a short that was accompanied by a huge puff of smoke which, in turn, activated an automatic sprinkler system. The computer quite literally was washed up.

Far less costly, though annoying and disruptive, was a spider's invasion of a personal computer in a Maryland school superintendent's office. The critter's web shorted out the twin-diskette model's B-drive. Service and parts cost about $250. Had the operator not had a back-up disk, her recording time would have been wasted and valuable information lost.

Automatic smoke and heat detectors have been a favorite attraction for flying and crawling insects for many years. On Nantucket Island, off Massachusetts, insects were the primary cause of the hotel-motel industry's disconcerting false alarm wave in 1984. Monthly "falsings" numbered as high as 60.

In New Mexico, insects set up housekeeping in a small-town high school's new $100,000 fire alarm system. One measurement of their destruction is the $15,000 they cost the community in false alarm fines in a single year.

Electronic cash registers are frequent prey, too. Roaches are the primary marauders, causing circuit board shorting by gnawing the

[redacted]

plastic-coated wiring and depositing their highly acidic feces. In Alabama recently, a food service operator paid $600 to replace a roach-destroyed board in his $1,600 cash register.

In California, ants have had a field day in the Department of Transportation's traffic control boxes and other critical cable and wire terminals. Wiring in some boxes had to be replaced twice in three months.

One effective deterrent to insect invasion of electronic equipment is a product called Rainbow Insec-Tape. It is described by Jones as being totally safe for use in electronic equipment because it is non-toxic, non-conductive and non-corrosive. It has been used for more than a decade by Bell Systems and independent telephone companies to keep their outdoor cable closures insect-free. The product has an effective life of up to three years.

InsecTape resembles a BandAid. It comes in 1" x 4" strips of multi-layered plastic compressed to 1/32-inch thick. It contains a sealed-in reservoir of high-strength propoxur (Baygon), which continually migrates *to* and crystallizes *on* the tape surface. The peel-and-stick strips are easy to apply.

Additional information, safety data and allied laboratory reports are available...

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Circle (19) on Reply Card

Test your electronic knowledge

By Sam Wilson

The wide variety of subjects in this quiz makes it very difficult to get a passing grade. Only a super tech will get better than 70% on this one.

1. For a highly stable transistor oscillator, a high
   A.) L-C ratio is desired in the tuned circuit. In other words, the higher the value of L/C, the less likely the oscillator is to drift off-frequency when the temperature changes.
   B.) C-L ratio is desired in the tuned circuit. In other words, the higher the value of L/C, the less likely the oscillator is to drift off-frequency when the temperature changes.
2. The symbol in Figure A is for
   A.) a programmable UJT (PUT).
   B.) an adjustable shunt regulator.
   C.) an SCR.
   D.) a light suppression diode.
3. Figure B shows a vertical antenna in series with a loading coil. Replacing the coil with a short circuit will cause the antenna to have
   A.) higher resonant frequency.
   B.) lower resonant frequency.
4. The circuit in Figure C is best described as a
   A.) follower.
   B.) low-pass filter.
   C.) integrator.
   D.) differential amplifier.
5. When you are dealing with fast TTL logic, the rule is that unused pins should be
   A.) connected to a logic high.
   B.) floating.
   C.) connected to a logic low.
   D.) connected to either high or low.
6. Which of the following statements is correct regarding op-amp filters?
   A.) A unity-gain active filter must be a low-pass filter.
   B.) Unity-gain filters can be either low-pass or high-pass types.
   C.) A unity-gain filter must be a high-pass filter.
7. The maximum rate of change of the output voltage for a step voltage applied at the input is the definition of
   A.) roll off.
   B.) pitch rate.
   C.) slew rate.
   D.) differential margin.
8. Which of the following is a non-inductive winding?
   A.) Fixed Q
   B.) Bifilar
   C.) Shorted-end
   D.) Surge-limiting
9. Which of the following could be used to measure the voltage of a battery without drawing current from that battery?
   A.) An oscilloscope
   B.) A digital voltmeter
   C.) A potentiometer
   D.) A slide wire bridge
10. In the binary addition problem shown in Figure D, the mistake is in the column marked
   A.) W.
   B.) X.
   C.) Y.
   D.) Z.
   E.) (There is no error.)

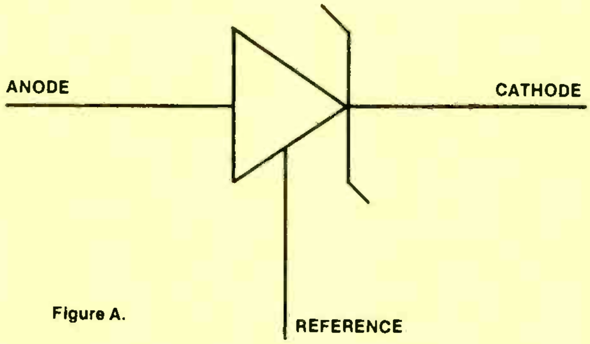


Figure A.


Figure B.

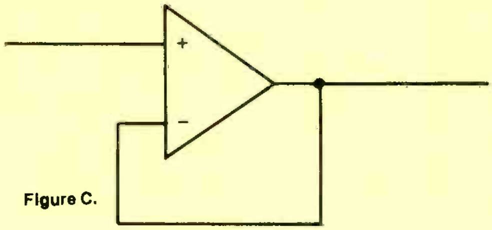


Figure C.

				z	y	x	w
1	1	0	0	1	1	0	0
1	0	1	0	1	0	1	0
1	0	1	1	1	1	1	0

Figure D.

Answers are on page 59

Books

Electronic Servicing Data & Procedures, by Robert C. Genn, Jr.; Prentice-Hall, 373 pages, $24.95, hardbound.

Today's service technician must analyze and repair an incredible variety of display and solid-state circuits from optoisolators to phototransistors. This up-to-date, fully illustrated service manual provides nearly 200 tests and measurements for troubleshooting, analyzing and repairing a wide range of electronic equipment.

Published by Prentice-Hall, Inc., Englewood Cliffs, NJ 07632; 800-223-2336.

Understanding Solid-State Electronics, by Don Cannon; Howard W. Sams, a division of Macmillan, Inc., 272 pages, $14.95 softbound.

This is an addition to the Sams/Texas Instruments Understanding Series. It is an easily understood, fully illustrated text that provides self-paced instruction beginning with a review of IC technology and logic circuits. Other topics covered include: logic cells and arrays, microprocessors, digital signal processing, graphics processors, communications processors, bit-slice systems, linear integrated circuits and interface integrated circuits.

Published by Howard W. Sams & Company, 4300 W. 62nd St., Indianapolis, IN 46268; 317-298-5409.

Channel Master Satellite Reception Equipment Service Manual; Channel Master, division of Avnet, 180 pages, $15, hardbound loose-leaf.

The manual contains information on problem solving, including schematics and a troubleshooting guide. It also has information on adjustments and alignments for best performance. There is a reference for parts that are field-replaceable and should not require special equipment to replace or retune.

Published by Channel Master, P.O. Box 1416, Industrial Park Drive, Smithfield, NC 27577; 919-934-9711.

Troubleshooting Tips

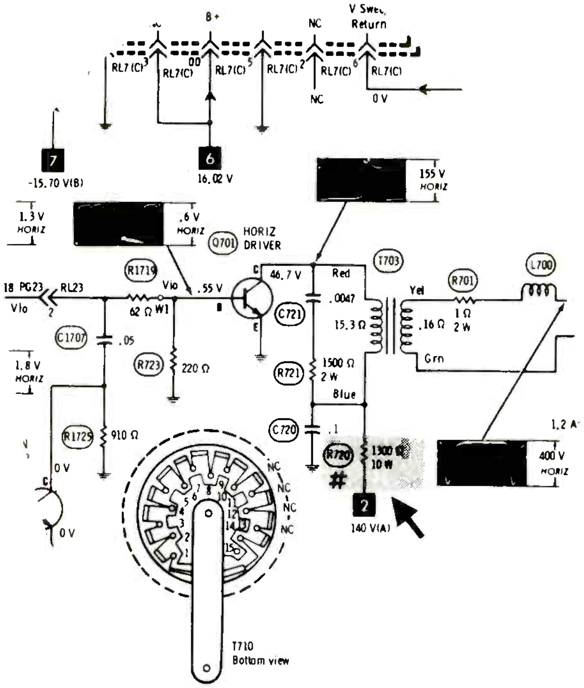


Figure 1.

Sound but no raster
General Electric 25YM
(Photofact 1672-1)

When first switched *on*, this color receiver produced normal sound but no raster or picture. A visual inspection of the horizontal area showed R720 (1300Ω 10W) was charred and cracked from internal heat. After I replaced R720, the high voltage measured only about 10kV. After a few seconds, R720 began to smoke from heat.

At first, I assumed there must be a partial short or some excessive Q701 driver-transistor collector current. However, each part in the driver circuit was tested and much time wasted without finding any defective components.

Finally, I started scoping the various power supplies and intended to scope the driver stage, but when the +140V power source was scoped, it had excessive ac ripple. A few more tests proved filter capacitor C705B was open; I had been looking at the wrong end of R720!

Replacement of C705A&B and another R720 restored normal operation and stopped R720 from overheating. The +140V supply also is connected to the flyback for use by the horizontal-output transistor. So, the open 400µF capacitor reduced the high voltage (finally enough to black out the screen) by developing some of the pulses across the flyback primary and some across L701 in the power supply. R720 began as 1300Ω and was bypassed at the driver side by a 0.1µF capacitor. Therefore, the 0.1µF capacitor tried to pass the horizontal pulses to the ground *through* R720, thus heating R720 and eventually ruining it.

The new C705A/B filter and resistor R720 produced normal operation in this General Electric.

Steve's Radio & TV Service
Bassett, Virginia

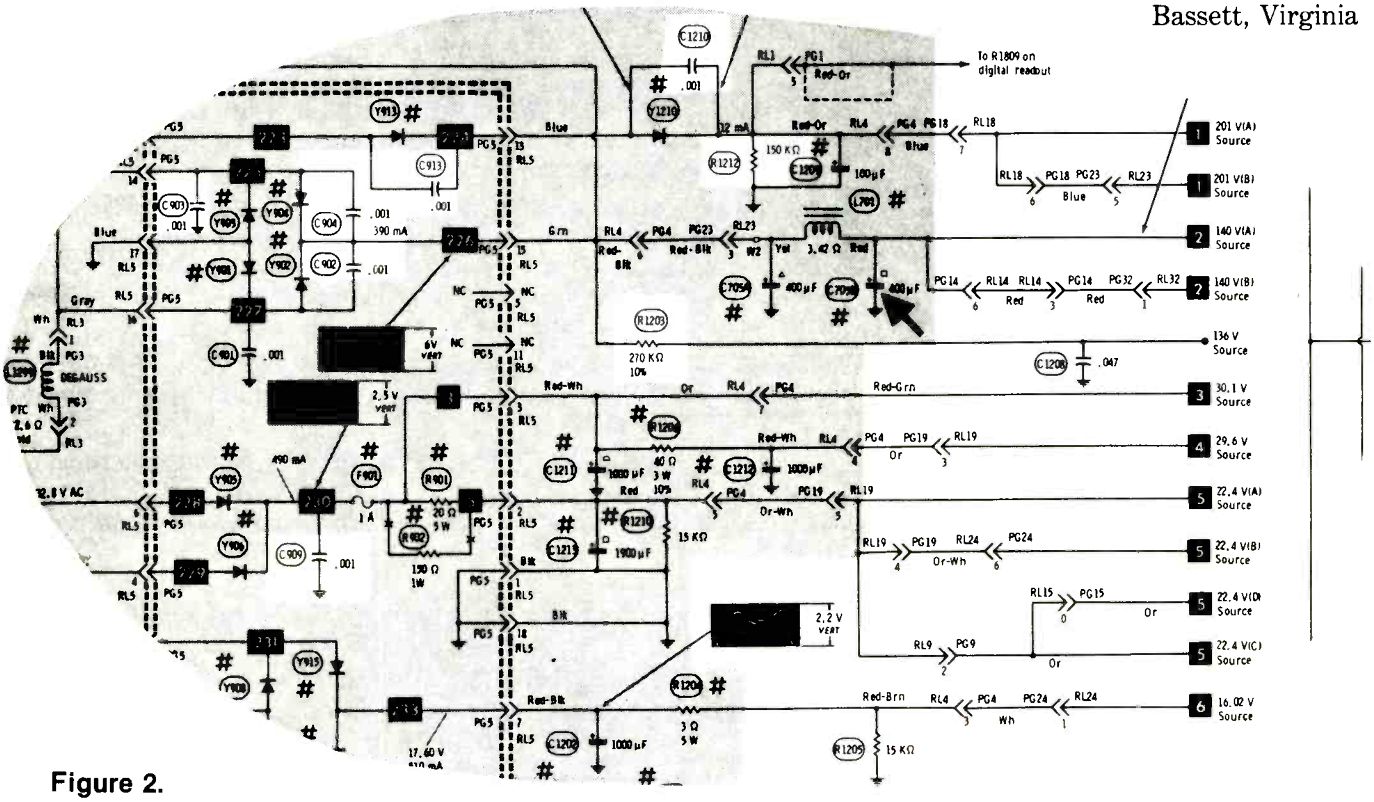


Figure 2.

Are you ready for multistandard TV?

There currently are 11 major TV transmission standards in use around the world (each country selects its own). A conventional color TV set (CTV) is compatible with only one standard, and can't receive the broadcasts of other standards.

Color TV sets that can receive signals of more than one standard have been needed, especially in Europe and the Middle East, where different transmission standards (PAL and SECAM) operate in close proximity. Moreover, the increasing availability of video cassette recorders (VCRs) and videodisc players, as well as video software (prerecorded programs), has spurred demand for multistandard CTVs.

...some 10 million CTV sets...will soon be multistandard models.

Using these multistandard CTVs, viewers can enjoy video software recorded in other countries under different transmission standards. (Many of them are in NTSC or modified NTSC standard.) For this reason, some 10 million CTV sets out of the 60 million (estimated annual worldwide demand for 1986) will soon be multistandard models.

A current multistandard CTV set may use seven integrated circuits (ICs) for automatic detection of transmission standards and signal processing, with about 500 peripheral component pieces.

Two advanced LSI (large-scale integration) chips recently developed by Toshiba can reduce the number of components to 250, simplify the CTV production process, and improve the flexibility of chassis design. Moreover, the chips can perform a variety of functions, such as teletext, for the higher-end CTVs.

According to Toshiba, the TA8616N is the world's first achievement of a one chip multistandard video-chroma-deflection combination. It integrates 3,800 elements on a 5.2mm x 5.4mm chip – the world's largest integration for a bipolar device – with a DIP shrink 64-pin package.

The second chip (TA8615N) is used in conjunction with the TA8616N. It integrates 550 elements on a 2.4mm x 2.5mm chip in a DIP shrink 30-pin package.

This article was based on information provided by the Toshiba Corporation.

What do you know about electronics?

A letter about sawtooth waveforms

By Sam Wilson

Dear Sam:

I am an electronics technician with many years in the field. I have managed to keep pace with the ever-growing field of electronics.

As I was reading the recent issue of ***Electronic Servicing & Technology*** (August 1986), I came across an article on "Tests for Low-Frequency Amplifiers." In it you requested an answer as to why technicians seldom use the sawtooth waveform test. I am pretty sure that many technicians will agree with what I am about to say.

First, out of all the service station facilities, how many have a spectrum analyzer? A few, if any at all. This is an elaborate piece of equipment with an expensive price tag. If a facility has such an item the supervisor stresses that no one is to touch it except supervisory personnel – that is, if it is touched at all. The spectrum analyzer might be sitting in some location gathering dust.

If technicians *were* allowed to use this piece of equipment, how many know *how* to use it and would instruct other technicians accordingly?

Secondly, while servicing a piece of audio equipment, the technician's objective is to repair it as quickly as possible so that sound comes out of it. He is not allotted the time to sit around and read the odd numbers of harmonics present, except in his spare time.

I read the issues of ***Electronic Servicing & Technology*** and I find it informative. This tip on tests for low-frequency amplifiers has given me a new piece of information that makes me more aware of a new problem that can exist in amplifiers.

Thomas Velez

My answer:

Dear Mr. Velez:

Thank you very much for taking the time to write. Somehow, we got on different wavelengths regarding the sawtooth test. If you look at the article, you will notice that I compared the sawtooth test with the square wave test. They both have the same test set-up and *no spectrum analyzer is needed.*

Figure 1 shows this simple test set-up. The sawtooth generator takes the place of the square wave generator. It applies the sawtooth waveform to the amplifier input terminals. The oscilloscope is connected to the amplifier output terminals. If the amplifier has a broad frequency response, there will be no change in the observed output sawtooth waveform.

You can look at the sawtooth waveform in two different parts as shown in Figure 2. Part A represents a relatively gradual change in voltage from the minimum to the maximum value. The low-frequency response of the amplifier is being tested by this gradual change in voltage.

The second part of the sawtooth is a very rapid change from maximum to minimum. This is marked (B) on the drawing and it tests the amplifier high-frequency response. As was stated in the article, the sawtooth is made up of a number of harmonic waveforms. A poor high-frequency response will cause this line to be a curve rather than a straight drop to minimum value.

Figure 3 shows four of the basic sawtooth outputs in an amplifier test. As with the square wave test, this is just a quick method of checking an amplifier's overall response. It is a *qualitative* test and requires the technician's experience to interpret the output waveforms.

The test is more useful if the sawtooth goes above and below 0V

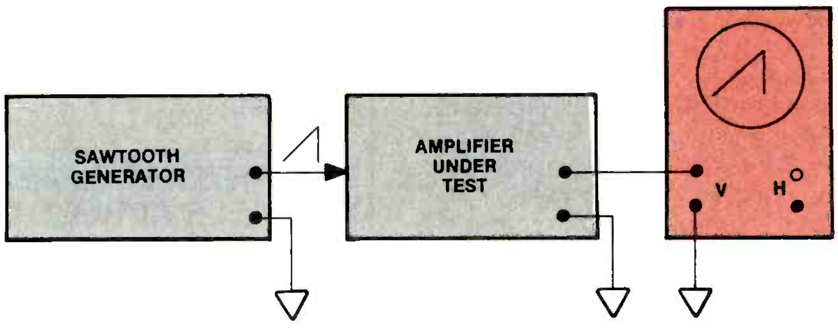


Figure 1. Frequency response of an amplifier can be tested by connecting it to a sawtooth generator and an oscilloscope as shown here.

by equal amounts as shown in Figure 4. That permits both cut-off and saturation observations.

As in the case of the square wave test, it would be a good idea to check the scope first to see if it is able to handle the sawtooth before the amplifier gets involved in the analysis.

Again, thank you for writing.

Applications of the Hall Effect

As technicians, you should be familiar with the Hall Effect and some applications of this effect.

Figure 5 shows the basic principle involved. This is a model showing the relationship among current, voltage and magnetic flux in the Hall device.

In the absence of any external flux, the current flowing through the semiconductor slab would be equally distributed and there would be no difference in voltage between the two edges. When a flux is introduced, the charge carriers in the semiconductor slab

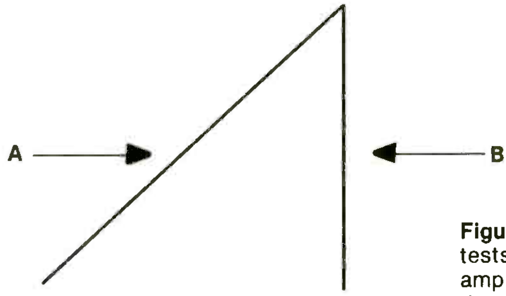


Figure 2. The leading edge of a sawtooth tests the low-frequency response of the amplifier under test. The trailing edge of the waveform tests the high-frequency response.

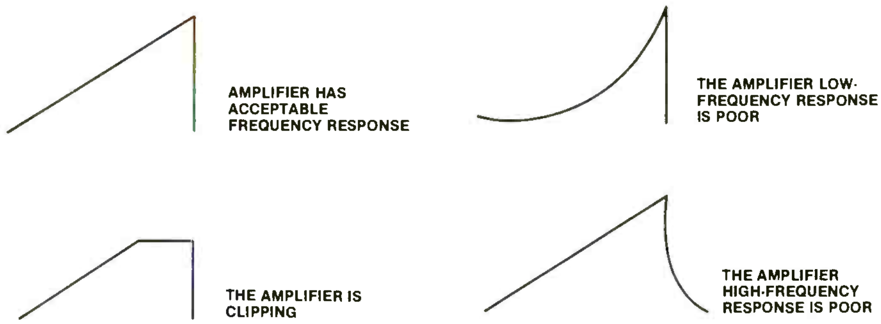


Figure 3. The scope trace of the amplifier's output will be a good indication of the frequency response.

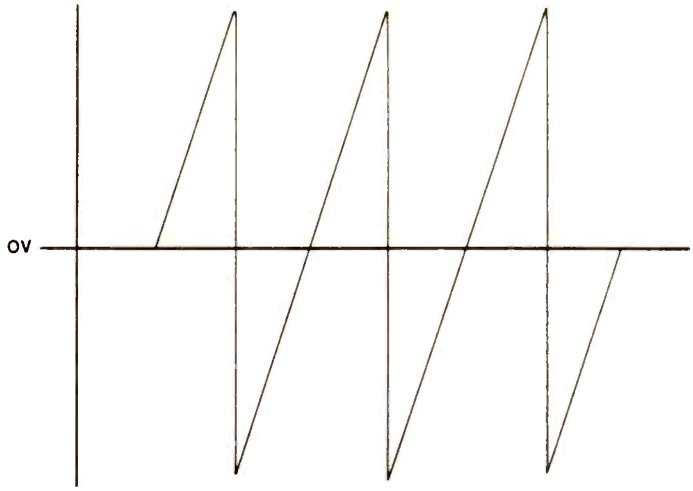


Figure 4. The sawtooth waveform test is more useful if the sawtooth goes above and below 0V by equal amounts, permitting both cut-off and saturation observations.

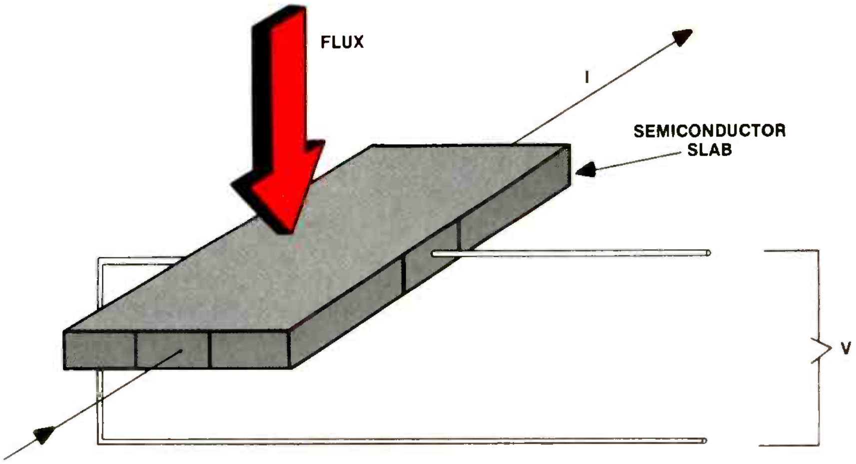


Figure 5. In a Hall effect device, when there is no magnetic flux present, the voltage across the two edges is zero.

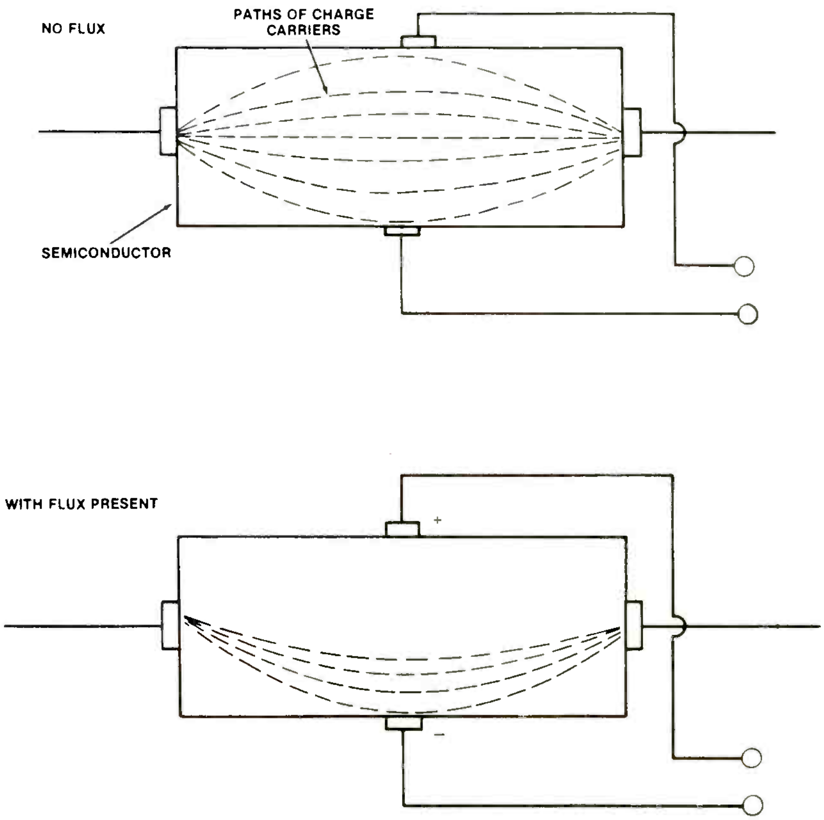


Figure 6. Introduction of a magnetic flux causes a redistribution of charge carriers in the Hall effect material that results in a voltage difference across the device.

tend to move around the magnetic field. (See Figure 6.) That produces a greater concentration of flux on one side than on the other.

The greater concentration of charge carriers on one side means that there is a voltage difference between the edges. This is the output voltage of the Hall device. Increasing the flux produces an increase in the output voltage for a given amount of current flow.

One obvious application of this device is in the measurement of magnetic field strength. The output voltage can be calibrated to indicate the exact amount of flux when the current is held to a constant value.

It also is possible to determine the current with this device. This application is shown in Figure 7. The soft iron material around the current-carrying conductor concentrates the flux on the Hall device. The voltage output is dependent upon the amount of flux that, in turn, is dependent upon the amount of current. Therefore,

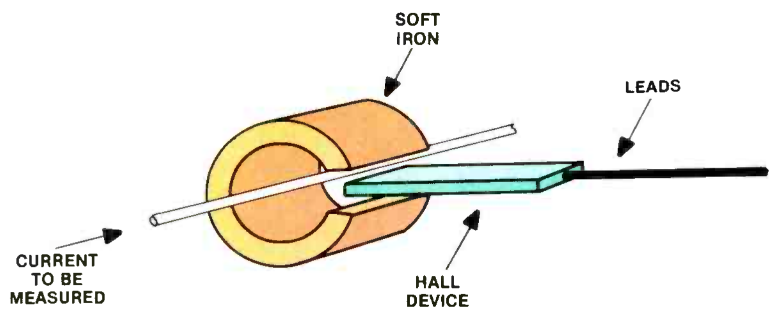


Figure 7. A Hall effect device can be used to measure the current in a conductor by measuring the magnetic flux induced by the current.

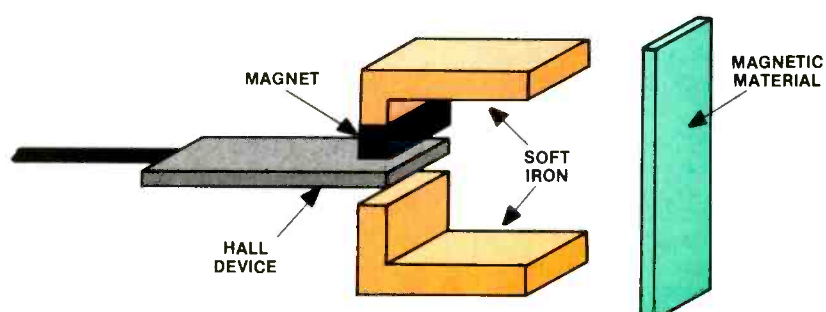


Figure 8.

Figure 8. Through use of a permanent magnet, a Hall effect device can be used as a motion detector.

the current can be determined by measuring its accompanying magnetic field. There is no need for breaking the current line.

Figure 8 shows the use of a Hall device for sensing position and motion. It requires a strip of magnetic material. This material can be attached to a moving or stationary surface. Magnetic flux is supplied by a permanent magnet. As the magnetic material approaches the Hall measuring device, there is an increase in flux through the semiconductor material. That increase in flux produces an increase in voltage.

The output voltage can be sensed and used to control the motion or position. With this system, it is possible to measure movements and positions within 0.001 inch.

I am grateful to F.W. Bell Inc., Columbus, OH, for supplying the information on the Hall Effect and its application.

The technology required to produce a compact disc

In the next issue, there will be a discussion on some of the circuits involved in making a compact disc. I decided it would be a good idea to reflect on the problem of making the compact disc work before we get into the circuitry.

Think first about the disc itself. It is about 4¾ inches in diameter, and it can play up to 60 minutes. On the recorded side of the disc there are approximately 2½ miles of spiral track. Just getting tracks that are so closely spaced is, by itself, a technological marvel.

In order to get such a long groove, it is necessary to keep the distance between the spiral tracks a constant at 1.6μm.

It is necessary for the disc to be very flat. A long-playing record can have a warp of as much as 1½mm and still be playable, but the disc must be flat to within 0.4mm. (This is not as hard as might be thought since the disc is much smaller and more rigid than the large LP records.) The information stored in the disc is in the form of pits and lands. The width of a pit is about 0.4μm and its depth is about 0.1μm. These very small bumps in the track of the disc represent logic ones and zeros for stored information.

A laser beam is used to retrieve the information from the disc. During playback, the laser beam starts at the inside track and works outward.

If that disc is turning at a constant speed, it would mean the rate of input information would be greater near the outer edge. However, in practice, the disc is scanned at a constant linear rate of about 1.3m per second. To accomplish this, the disc has to be turned faster at the inside and slower at the outside track. At the start-up, the disc turns at about 500RPM. Toward the outside rim, the speed is automatically slowed to about 200RPM. The overall result is that the laser disc moves at a constant linear speed on the track.

By linear speed, I mean the speed of the stylus on the surface of the disc. Keeping the laser beam focused in the track requires some very sophisticated technology.

The beam must be focused precisely. Also, some provision must be made so that if the laser starts to get off the track, an immediate correction will be made.

The necessary circuitry for laser tracking involves the use of four light-sensing diodes. The physical position of these diodes depends upon the company making the compact disc player. The overall result is that the diodes and associated circuitry can refocus the beam if it gets out of focus, and it can recenter the beam if it starts to get off the track.

During the recording process, the sound is converted into a series of digital numbers. During playback over 44,000 numbers, each 16 bits wide per channel, are retrieved per second. The technology used to do this produces *4 million switching operations each second.*

The pits and flats that represent the sound are not on the surface of the disc, but rather, are about 1.1mm below. A transparent covering protects the surface.

The present technique is to read the disc upside down. In other words, the grooves are read from the bottom of the spinning disc.

More next month. ES&T

Circle (25) on Reply Card

Computer Corner

By Conrad Persson

Back in October when I turned *on* the heating system in my home for the first time during this heating season, it immediately became apparent that something was wrong. The blower came *on* at high speed as soon as the COOL-OFF-HEAT switch was placed in the HEAT position. The AUTO-ON switch was in the AUTO position. The correct behavior of the system is to pause for a minute or two once the system has been activated while the gas flame heats the air in the heat exchanger to some predetermined temperature. Once that temperature is reached, the blower comes *on* at low speed and gently distributes warmed air throughout the house. What was in fact happening was the blower came *on* at high speed immediately when the system was turned *on*.

I'm not a gas furnace expert, but when the heating company wasn't able to come out for a week because of a rash of service calls, I decided to take a crack at the problem.

Fortunately there's an electrical block diagram glued to the furnace door. Armed with that and my multimeter, I decided to try to track down the source of the problem. I found the trouble to be associated with a relay. The normally closed contacts in the relay connect the blower motor's low speed windings through the heat exchanger thermostat. When the relay is energized, the normally closed contacts open and the normally open contacts close. In this configuration, normally occurring when the thermostat is placed in the *ON* position, the blower motor's high-speed windings are continuously connected and the blower blows at high speed regardless of the condition of the heat exchanger thermostat.

After I had studied the circuit diagram for a while it became clear that either the thermostat ON-AUTO switch when placed in the AUTO position was sending a spurious signal to the relay, or the relay was stuck in its energized position. It turned out to be a problem at the thermostat.

Troubleshooting a microcomputer-based control system proceeds in a manner similar to troubleshooting this relay-based control system. The microcomputer circuit may be viewed as a complex relay circuit. In the relay, an input signal causes an output, which in turn initiates some action. In the microcomputer circuit, an input signal, or a combination of input signals, causes an output at another terminal of the microcomputer, which in turn causes some action.

That fact should strip away some of the mystery surrounding microcomputers in consumer electronic products. They're tiny and contain a lot of circuitry that only the designers understand, but the thing a servicing technician is concerned with is the *inputs and outputs.*

A VCR microcomputer control system

Take a look at Figure 1, a microcomputer control diagram from a GE VCR. Notice that some of the terminals of the microcomputer are inputs and some are outputs.

Let's take a specific sequence of events and consider how to troubleshoot if it doesn't occur as it should. When you insert a cassette into the front of the machine, it should be automatically loaded by the front-loading motor, then it should stop once it's in position and await a signal from the control panel. If the cassette doesn't load, what's the problem?

Take a look at the upper left of the diagram. When you insert the cassette, the CASSETTE IN switch should close bringing PIN 7 low. This input to the microcomputer should result in outputs that drive the front-loading motor, which in turn moves the cassette into the down position. Once the motor is loaded, the CASSETTE UP/DOWN switch closes, sending a signal to the front-loading motor to halt.

If this sequence of events doesn't occur, the problem could be anywhere in the chain that connects the CASSETTE IN switch with the F. LOADING motor. It could be the switch itself, or a poor connection from the switch to ground, or from the switch to the microcomputer. On the output side, (look as the lower right side of the diagram), the problem could be a burned out motor, a faulty plug, problems in IC 6002 (the motor driver) or any of the interconnections between any of these elements.

Notice that no mention was made of the microcomputer itself. It could have been that, of course, but conventional wisdom, for the time being at least, is that the microcomputer is highly reliable and is the least likely to be the cause of the problem. Check the microcomputer last. The troubleshooting flowchart (Figure 2) shows how you should proceed.

Table model VCRs

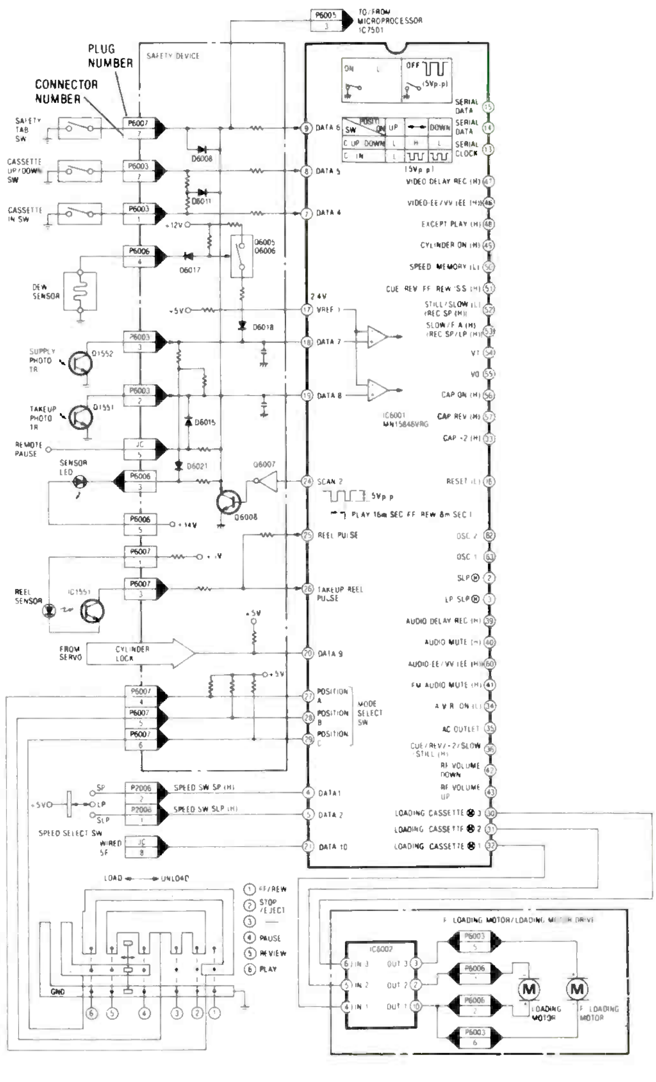


Figure 1.

TROUBLESHOOTING SYSTEM CONTROL

↓

CHECK THE OUTPUT LOGIC STATES FROM THE SYSTEM CONTROL MICROPROCESSOR. DO THEY RESPOND CORRECTLY TO OPERATIONAL INPUT COMMANDS?

NO — YES

YES ↓ CHECK THE CIRCUITRY THAT TRANSFORMS THESE OUTPUT COMMANDS INTO DRIVE VOLTAGES (FOR MOTOR) AND LOGIC LEVELS (FOR ELECTRICAL CIRCUIT SWITCHING).

CHECK THE TROUBLE LINE INPUTS AND MECHANICAL STATE SWITCH INPUTS AT THEIR SOURCE (AS FAR AWAY FROM THE MICROPROCESSOR INPUT PINS AS POSSIBLE). ARE THESE CIRCUITS OPERATING CORRECTLY?

YES — NO

NO ↓ TROUBLESHOOT THE DEFECTIVE CIRCUIT.

YES ↓ USE THE OSCILLOSCOPE TO CHECK THE OPERATIONAL INPUT KEY MATRIX. ARE OPERATIONAL INPUT PULSES BEING RETURNED TO THE MICROPROCESSOR WHEN COMMAND BUTTONS (PLAY, RECORD, FF, ETC.) ARE PUSHED?

YES — NO

NO ↓ TROUBLESHOOT THE OPERATIONAL INPUT KEY MATRIX STAGE.

YES ↓ USE THE OSCILLOSCOPE TO CHECK THE TROUBLE LINE, MECHANICAL STATE, AND OTHER "TIME SHARED" INPUTS TO THE MICROPROCESSOR, ARE THESE INPUTS CORRECT?

YES — NO

NO ↓ TROUBLESHOOT THE DEFECTIVE CIRCUIT.

YES ↓ SUSPECT A DEFECTIVE MICROPROCESSOR.

Figure 2.

Follow a similar procedure for other trouble symptoms, keeping in mind that in many cases you have to consider multiple inputs. For example, if the cassette loads correctly but pushing the PLAY button doesn't result in a picture on the screen, it could be one of many things: the loading motor might not have operated properly, or IC 6002 might be faulty, or the switch that monitors the state of the mechanical components might be faulty.

The microcomputer(s) in any of today's sophisticated consumer electronic products are busy little units, and they make the product seem complicated and difficult to service. But if you just keep in mind that the microcomputer is similar in function to a relay system in that an input or combination of inputs is designed to result in an output, troubleshooting a microcomputer-based control system becomes a logical exercise in tracking where the system broke down. ES&T

Readers' Exchange

For Sale: CRT recovery/tester/short remover, model 201-REM (Torrence, CA), has four meters, built-in timer, adapters, good condition, $125 or best offer; tube and CRT tester, EICO model 635, used six times, new condition, all information included, $60 or best offer. Will UPS or c.o.d. *Cecil F. Mott III. 221 Mobil Land Court, Bloomington, IL 61701.*

For Sale: Sencore PS163 scope, $150; Sencore VA48, $750; Sencore CB41 tester, $100; EICO 667 tube tester, $100; Sencore DVM56, $400. *Bill Bechtold, 7429 Frederick, Omaha, NE 68124; 402-397-2461.*

For Sale: Sencore VA48 with all cables, adapters, manuals and instructional tape, excellent condition, $650 includes shipping. *John B. Schneider, 856 Pedro Ave., No. B, Orlando, FL 32807; 305-281-1293.*

Wanted: Old Leader, B&K transistorized oscilloscopes, any condition. Please send model number and asking price. *M. Shelton, 2708 May Drive, Burlington, NC 27215.*

Wanted: For electronics classes – any type of circuit boards for students to practice with. All are tax-deductible. *Walter Williams High School, c/o Mike Shelton, 1307 S. Church St., Burlington, NC 27215.*

Wanted: Precision EV10 VTVM, working/non-working; CK300 test jig. State price and condition. *Cleo Zarella, 937 Center St., Brockton, MA 02402; 617-583-3667.*

For Sale: B&K 1655 ac power supply (isolated variable), $175; B&K 1801 autoranging frequency counter with PR-25 10:1 probe, $175; Heathkit IT-5235 yoke/flyback tester with IMA-100-10 100:1 probe, $40; Heathkit IT-3120 FET/transistor tester, $25. All equipment includes manuals and leads, all in excellent condition. *Tom Finnegan, 2709 S. 18th St., Grand Forks, ND 58201; 701-746-0136.*

Wanted: Sams CB Radio volumes: CB28, 56, 57, 67, 68, 74, 75, 79, 80, 81, 82, 85, 86, 87, 88, 89, 91, 92, 93, 94, 95, 96, 101, 102, 104, 105, 106, 108, 110, 118, 120, 124, 128, 131, 132, 133, 135, 137, 147, 159, 160, 236, 240, 243, 244, 245, 246, 247, 248, 252, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 265, 266, 267, 268, 272, 273, 274, 275, 276, 278, 279, 281, 282, 283, 284, 285, 287, 288, 289, 291, 292, 293, 294. *Paul Garner, P.O. Box 636, Millbrook, AL 36054; 205-285-5839.*

Wanted: April 1978 *Electronic Technical Dealer* article that begins on page 20, "Sony and the GCS." *McEwen, 4125 Heather St., Vancouver, British Columbia, Canada V5Z 4H1.*

Needed: Schematic for Leader oscilloscope, model LB0505; transistor K3491D; schematic and manual for Leader LSW333 sweep/marker generator (or address in New York area where they may be purchased). *Joe Varas, 449 Torry Ave., Bronx, NY.*

Needed: Transformer part for 1966 or 1967 model Magnavox stereo No. PT3901, serial No. 763649, transformer No. 320310-1. *Reginald Huey, 7300 State Ave., Kansas City, KS 66112; 913-334-6391.*

For Sale: Picture tube monitor with telematic adaptors, excellent condition, $35. *William J. Maida, 274 W. Sabal Palm Place, Longwood, FL 32779.*

For Sale: Sams Photofacts, one each of 1000-3, 1122-2, 1126-3, 1211-3, 1240-1 and 1325-2. Also other complete Sams sets from 10 to 500. Make offer. **Needed:** Sams 908-2, 1070-1, 1166-3, 1283-1 and 1306-2. Will trade for others or will pay for copies. *Dan's TV, 316 E. Ave. "E," Hutchinson, KS 67501.*

For Sale: Industrial dc-drive service inventory, 25 years of schematics and test jigs. S.a.s.e. for price list and inventory listing. *M. Shelton, Box 234, Alamance, NC 27201.*

For Sale: Sams Photofact folders No. 822 to 1955, new with nothing missing, 1134 complete folders, $2 each, not sold separately. Or will sell 822 to 1500 as unit at $2 each, and 1500 to 1955 as unit at $3 per folder. Also will sell Ar 19 to 78 sets, 60 issues at $2 per issue, T.R. 15 to 64 sets, 50 issues at $2 per issue as complete unit, none sold separately. Test equipment – Sencore FS 135 field meter, $150; B&K 1076 analyst, $100; Sencore SM152 sweep and marker, $200; EICO flyback transformer, yoke tester, $25; EICO 368 sweep generator and marker, $25. Prices do not include shipping. **Wanted:** any good short-wave radios and digital frequency counters, Lectrotec scopes such as TO55-TO60, scanners such as Bearcat, working or not. S.a.s.e. for quick reply. *Stanley R. Chalker, 1176 Smithsonian Ave., Youngstown, OH 44505.*

For Sale: The following Heath items – IG-42 Lab RF generator, 100kHz to 30MHz, $75; IG-102 RF generator, 100kHz to 110MHz, $50; IM-18 VTVM, $50; IR-5204, strip chart recorder, $100; IO-4235 dual trace, 35MHz scope, $400; GD-1162 telephone dialer/speaker phone, $25; IT-2250 autoranger digital capacitance meter, $75; HD-1250 dip meter, $50; IM-2215 portable DMM, $60. Linear-5 sinadder meter, new, $150; Lampkin-109 service monitor, 20 to 42MHz, 150 to 172MHz, 450 to 472MHz, $500. Simpson – 464 DMM, $75; 7016 frequency counter, $75. All guaranteed in working order. *Northwoods Electronics, P.O. Box 159, Lac du Flambeau, WI 54538; 715-588-3674.*

For Sale: Sencore LC53 Z meter, excellent condition, $600; Telematic test jig with 30 adapters plus transverter and low voltage focus supply, $175. *Nate Lilienthal, 29515 Quailwood Drive, Palos Verdes, CA 90274; 213-377-9913.*

For Sale: EICO model 369 sweep marker generator, complete, $250; B&K model 467 tube-tester rejuvenator, complete plus extra adapters, $350. **Wanted:** Schematic or service manual for Emerson model M3070 solid-state AM-FM stereo 8-track cassette tape player. Will copy and return. Information unavailable from Emerson or Sams. *D.R. Electronic, David A. Roa, 64 Brown St., P.O. Box 641, Pawtucket, RI 02862-0641; 401-728-0634.*

Wanted: Sony TC-770, TC-355 service manuals. Will buy or copy or trade. **Needed:** TC-770 drive motor or complete unit in any condition. **For Sale:** VCR service manuals and tools, send s.a.s.e. HP427A, $200; HP5381A, $200. *Richard Sereda, 1872 Lexington Ave., San Mateo, CA 94402.*

Wanted: Complete kit No. 22T for NRI Master TV Course model 315 25" color television. *David M. Kinchlow, 1515 Walnut St., New Albany, IN 47150; 812-944-4097.*

For Sale: Sencore SG165, excellent condition, $750; Sencore PR57, $300; Diehl Engineering Mark IV Supertech computer, $300. Prices do not include shipping. *Mark Vuozzo, 4592 Lockhaven, Irvine, CA 92715; 714-733-0372.*

Wanted: For VCR repair – tape tension gauge and any tools needed for mechanical adjustments. Panasonic color picture tube No. A26JAS31X. *Edward Herbert, 410 N. Third St., Minersville, PA 17954.*

Wanted: Schematic and service information for RCA table radio, model 1058, chassis No. B274. Any charges will be paid by return mail. *John G. Lefko, P.O. Box 782, Fairfield, CA 94533; 707-425-4578.*

Wanted: Manual or schematic for Lambda LH130FM power supply. Will buy or copy. Also want plug-in PC boards for Sorensen QRC40-8A power supply, or does someone want the power supply and manual without the PC boards? *Warren Kernaghan, 901 E. 108th St., Kansas City, MO 64131; 816-942-3615.*

Needed: Video, sound, ACG/AFT module for Panasonic model CTA-314, chassis No. ETA-12, part No. TNP 65111. *R.B. Wetherell, Wetherell Electronics, 14 West St., Wakefield, RI 02879.*

Wanted: Information – How many connectors, cables or jumpers are used, or come with the B&K1076 TV analyst? I have one 6-foot (approximately) gray shielded cable with mic connector that goes to the front panel of this analyst; it also has two short red and black leads. What other wires come with the outfit? I will answer you and pay for your trouble. *Jags Radio & TV, 14 Rudolph Road, Forestville, CT 06010.*

Wanted: Panasonic main PC board assembly No. YFVPKB5470PA, new or rebuilt, for Monitor model WV5470. *S.O. Sellers, TV Grouting, 1290 Oak Grove Road, Birmingham, AL 35209.*

Wanted: Sams Photofacts CB Radio series Nos. 158, 170, 180, 187, 190, 207, 219, 221 and 251. **For Sale:** Sams Photofacts CB Radio series Nos. 35, 59, 72, 74 to 78 and 87. All are new, in original condition. $6 each. *S.H. Zagar, Swan Lake Enterprises, Box 384, Pengilly, MN 55775; 218-885-3710.*

For Sale: Sams CB manuals from 1 to 280, best offer for entire lot; Hickok model 266 CB signal generator, $125 firm, plus shipping; DSE teletex decoder to use on satellite or cable, used very little, $200, plus shipping. *Bill Coleman Jr., Coleman Electronics, 114 Circle Drive, Rocky Mount, NC 27804; 919-443-7870, after 5:00 p.m. EST.*

Needed: Sams photofacts Nos. 1508 to 1682, 1858 to 1920, 1991 to 2004. *Willy's Electronics, P.O. Box 56595, North Pole, AK 99705; 907-488-1307.*

For Sale: Sencore model CG141 color generator, $40; Sencore model TF166 transistor-FET tester, $60. Both include manuals and leads. Heathkit model IP-17 power supply with manual, $100. No reasonable offers refused. *Dennis Dillon, 1616 S. 94th St., West Allis, WI 53214; 414-774-2255.*

For Sale: Tektronix 535 oscilloscope with CA dual-trace plug-in, $150; Tektronix 545A oscilloscope with CA plug-in and scope mobile, $250. *Anthony Luppino, 73 Selden Blvd., Centereach, NY 11720; 516-732-9440.*

ES&T

ANSWERS to the QUIZ

Questions are on page 46

1. B. When there is a higher capacity in the tuned circuit, the lower capacity of the transistor and its associated circuitry has practically no influence on the frequency of the output signal.

2. B. You could answer this question even though you had never seen the symbol. You *know* it is not choice A or C because you know the symbols for those devices. Choice D is ridiculous.

Figure E shows the basic operational circuit for the adjustable shunt regulator, and the comparison of this device with a typical zener diode.

Texas Instruments makes these adjustable shunt regulators in (at least) two versions: TL430 and TL 431.

3. A. The purpose of the coil is to make the antenna act as if it is physically longer, so it can resonate at a lower frequency. When the coil is removed (by a short circuit), the extra "length" is no longer provided, raising the frequency.

4. A. Of the definitions given, choice A is best. The circuit also is known as a buffer. It has unity voltage gain (voltage gain = 1). The output signal is the same shape as the input signal with no phase inversion. This op-amp connection is used to isolate two circuits from each other.

5. D. According to Texas Instruments: *Proper digital design rules dictate that all unused inputs on TTL devices be tied either HIGH or LOW. This is especially important with FAST logic.*

Electrically open inputs can degrade ac noise immunity as well as the switching speed of the device. Small geometries make FAST more susceptible to damage by electrostatic discharge than other TTL families. Tying inputs to V_{cc} or GND, directly or through a resistor, protects the device from in-circuit electrostatic damage. Additionally, while most unconnected TTL inputs float HIGH, FAST devices with NPN inputs float LOW.

FAST devices do not require an input resistor to tie the input HIGH. Inputs can be connected directly to V_{cc} as well as ground.

6. B. The two filters are both shown in Figure E. Note the zero-gain (voltage-follower) amplifier configuration.

7. C. The term *slew rate* is used in several different ways. The one in this question refers to the slew rate of an operational amplifier.

8. B. None of the other terms have meaning related to inductance. Non-inductive windings are used in wire-wound resistors.

9. C. A potentiometer is an instrument that balances an unknown potential difference against an adjustable measurable difference.

A potentiometer is also a variable resistor used to divide a voltage, but that is not applicable to this question.

10. D. One plus one equals zero with a one carry.

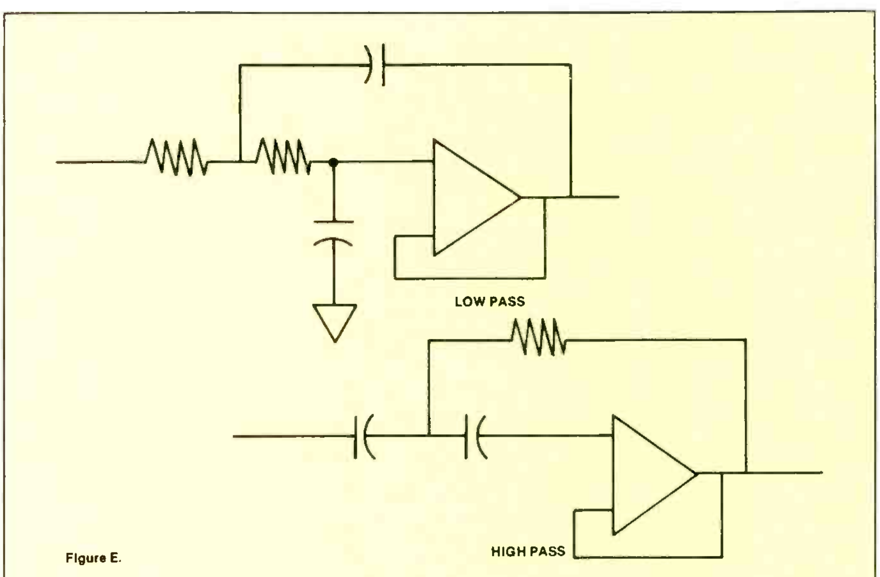


Figure E.

Products

Desoldering tips for SMDs

Weller CSF chip desoldering tips for surface-mounted devices desolder flat or quad packs without damaging circuit board leads, according to the manufacturer. The new desoldering accessory features a temperature control frame that spontaneously melts the solder of all connected leads. An adjustable suction cup, activated by a vacuum switch, lifts the component. The tips are available in seven threaded and seven tapered mounts.

Circle (75) on Reply Card

Smallest hand-held DMM

A.W. Sperry Instruments announces the digital multimeter, model DM-6593.

The AWS DM-6593 Electro-Probe is the smallest hand-held DMM, says the Sperry company. Its features include autoranging, an interchangeable probe tip, electronic overload protection on all ranges, instant continuity buzzer, data hold button, and one-hand operation. It is designed especially for taking readings easily and accurately in hard-to-reach areas.

Circle (76) on Reply Card

An expanded line

Kikusui International, is featuring its DSS5040 oscilloscope, a 40MHz dual-channel, portable, digital storage/analog scope that delivers a 10MHz single-occurrence capture rate (25 megasample/second).

Another recently introduced addition to the digital storage scope line is the dual-channel, portable 20MHz DSS5020A, with easy-to-use function selection controls, similar to those on an analog scope.

KIK also has introduced the PAR 80A and PAR 160A regulated dc power supplies. Both products offer a range of voltage and current outputs for maximum control and regulation of precision test. The Model PAR 80A has an 80W output in four voltage ranges, up to 80V. The 160W model PAR 160A has three ranges up to 80V.

Circle (77) on Reply Card

Hand-size digital testers

Models 3350 and 3360 autoranging digital multimeters, introduced by *Triplett Corporation*, a *Penril Company*, provide 19 ranges and seven functions for versatile equipment testing. (Model 3360 provides two additional dc/ac current ranges.)

Both units have 3.5 digit LCD displays, auto polarity with diode test and continuity check. Data hold and range hold are included on the model 3360.

Ranges include: 0-1,000Vdc in five ranges; 0-750Vac in four ranges; 0-10A ac/dc current in two ranges, model 3350 (model 3360 in four ranges); 0-20MΩ resistance in six ranges; 200Ω continuity check; 2V diode test.

Circle (78) on Reply Card

Hand-held DMM has D factor

American Reliance announces the Reliance AR-460D. According to the manufacturer, this is the industry's first hand-held DMM featuring LCR (inductance, capacitance and resistance) with D dissipation factor, an essential tool for use in engineering laboratories, incoming quality control, and by radio amatuers.

The device features seven ranges for capacitance testing; five ranges for inductance testing; six ranges for resistance testing. The dissipation factor range is from 0 to 19.99.

Circle (79) on Reply Card

Test probe replacements

E.F. Johnson Components Products has introduced test instrument probes designed to replace Triplett 310 probes.

Available in red or black, the test probes include unshrouded banana plug instrument-end terminations. They feature a solderless crimp connection to provide postive electrical contact and integral strain relief that withstands 15 pounds or more of pull.

As original equipment replacements, these test probe sets meet all manufacturer specifications for safety, electrical and mechanical performance. They also follow the recommendations of proposed American National Standards Institute standards.

Circle (80) on Reply Card

Semiconductor general-purpose replacements

Howard W. Sams & Co., a division of *Macmillan,* has published the 6th edition of "Semiconductor General-Purpose Replacements," a 418-page volume.

This guide is designed to use various bits of available information to select the proper semiconductor replacement, such as a number stamped on the part or listed in a parts list.

U.S., European and Far Eastern type numbers and manufacturers' part numbers are included. The universal general-purpose replacement semiconductors of five suppliers: NTE Electronics, Philips ECG, Radio Shack, RCA, and Zenith are given for the over 281,000 devices listed. This comprehensive listing is updated regularly by the Sams Photofact analysis department.

Circle (81) on Reply Card

Hand tools tested at 10,000V

CemenTex Products manufactures hand tools that, according to the manufacturer, are dielectrically safe. By applying layers of a proprietary plastic formulation onto a special base bonded to and covering tool-gripping surfaces (and sometimes the whole instrument), an extremely high level of user safety is achieved without adding excessive bulk to the tool. Each hand tool is dielectrically tested and visually inspected prior to shipment. The company has offered to coat individual workers' hand tools as a personal safety gesture. Insulation to 10,000Vac can be provided.

Circle (82) on Reply Card

Audio Corner

By Kirk Vistain

The past several years have been fertile ones for audio. Coming out of the malaise of the late '70s, design engineers began to fundamentally rethink audio reproduction. New tools derived from video technology produce previously impossible levels of performance that affect the most critical component of the reproduction chain, the signal source. From the videodisc, we get compact disc (CD), from the VCR, VCR hi-fi, and from nascent 8mm, we have PCM (pulse-code modulated) audio.

Actually, PCM audio has been around for nearly as long as VCRs. Add-on units were available that changed incoming audio into a digital format compatible with the recording characteristics of NTSC video. The sampling rate and performance of these units is virtually identical to that of the CD. But the new 8mm video format has made high quality audio available from a cassette not much larger than a standard Philips musicassette. Some units even can record up to 24 hours of audio on a single 8mm tape. Performance is similar to VCR hi-fi, an analog format. The constraints imposed on the 31kHz sampling rate limit high frequency response to 15kHz. The 8-bit word size yields a theoretical S/N (signal to noise) ratio of 48dB, but a little electronic massage boosts this to around 80dB. As a comparison, the CD has an inherent 96dB S/N ratio, and a 41kHz sample rate, resulting in a flat response to 20kHz.

Analog into digital

Analog signals vary smoothly over a given amplitude range. Within this range there are an infinite number of possible values. But digital signals only have two, high or low, *on* or *off*. A similar distinction exists between a potentiometer and a switch.

In order to change analog voltages into a train of digital pulses, engineers developed a technique called sampling. By taking a discrete measurement of the analog voltage at an instant of time, and converting this reading into a digital code, the voltage level for that moment is converted. If we sample quickly enough, we can do a good job of accurately converting the analog signal into a series of pulses without the loss of much information. Theoretically, and empirically, it has been confirmed that the required sampling rate is at least twice the highest frequency to be digitized. For 8mm PCM, this comes out to 31.5kHz, which, not coincidentally, is twice the NTSC horizontal scan rate. This gives us a maximum high end of 15kHz, about the same as a good audiocassette deck. Compare this to CD and ½-inch PCM, with a sampling rate of 44.1kHz and a top end of 20kHz.

The Achilles heel of digital audio is a phenomenon called *aliasing*. By examining the products of the sampling process in the *frequency domain*, that is, with a spectrum analyzer, we can see that, in addition to the desired information, the sampling frequency and two sidebands, whose maximum bandwidth is equal to the highest sampled frequency, are present. As you can see from the diagram, if the sampled frequency is greater than one-half of the sample rate, the lower sideband and the top end of the audio band will overlap, producing some of the most annoying distortion you're likely to experience. For this reason an anti-aliasing filter is used to eliminate any signals greater than one-half the sampling frequency. Designing a sharp-cut filter that doesn't perturb the desired audio band is the stuff dreams are made of. Frequency response irregularities noted among 8mm PCM machines are often due to this filter. Seldom does the top end look as smooth as that of a VCR hi-fi or even a top-notch audiocassette machine.

First the information is filtered, sampled, and converted to a string of discrete pulses with varying amplitude, a technique termed pulse amplitude modulation (PAM). Next, an analog-to-digital (A/D) converter changes these pulses into digital *words,* in this case 8 bits long. The raw dynamic range (S/N ratio), theoretically, is 6 x number of bits, or 48dB, which is less than breathtaking. (Compare this to a CD, which uses 16-bit words, yielding a 96dB S/N ratio.) A trick called "10-to-8 bit non-linear quantization" extends the dynamic range at low signal amplitudes, where it is most noticeable, at the expense of S/N ratio at

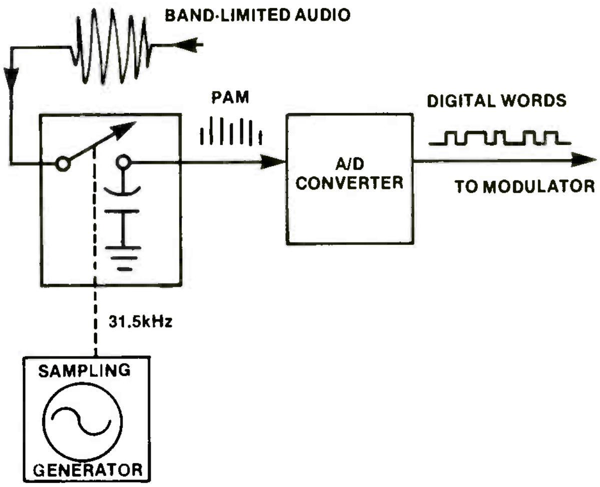
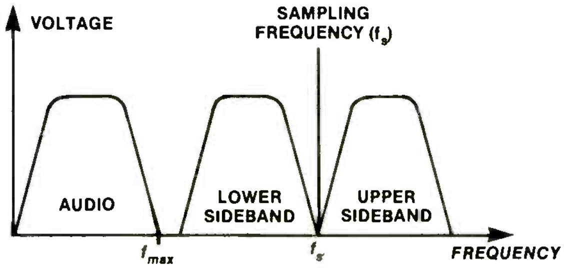
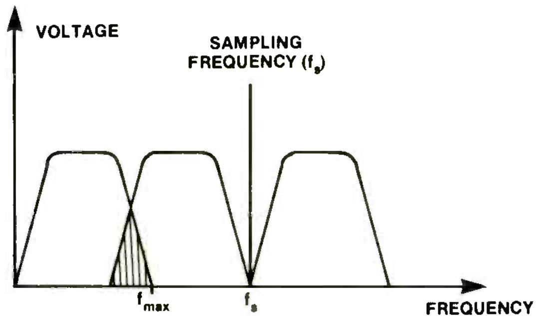


Figure 1. SAMPLING AND ANALOG-TO-DIGITAL CONVERSION



f_s is greater than $2f_{max}$. No aliasing problem.



f_s is less than $2f_{max}$. Distortion is produced as shown in shaded area.

Figure 2. ALIAS EFFECT

the upper end. Fortunately, at higher volume, the musical material masks noise, so the decrease is not noticeable. Additionally, the analog signal is compressed before sampling, and expanded after D/A conversion, roughly doubling the overall dynamic range of the system. The result of all this number crunching and signal massaging is a respectable frequency response, good distortion characteristics, excellent dynamic range, and 24 hours of audio on a single cassette.

Recording the digital data

An 8mm uses a rotary head, helical-scan system, similar to Beta or VHS, to record both audio and video information. The 8mm format specifies one channel of AFM, recorded in the video track, as with Beta hi-fi. A special, stereo PCM section also is specified. Normally it is recorded during the first 31° of head rotation, then video in the remaining 180°. But, in the multi-PCM (audio-only) mode, the entire width of the tape is devoted to PCM. The extra space is derived by dividing up the video section of the tape, producing a total of six separate stereo audio tracks. Some very sophisticated (read that *complicated*) switching is done to keep everything straight.

The signal is laid down on the tape by recording a carrier, which is shifted between about 2.9MHz and 5.8MHz, depending on whether a digital high or low is present. This process is called *bi-phase* modulation. A sync signal marks the beginning of a block of data words. Being at a lower frequency than the other data, it is easily distinguishable.

The extremely high information density requires great attention to timing. A master clock, phase locked to a servo reference pulse, controls nearly all the switching necessary to separate the correct PCM track from the six that coexist on the ⅓-inchwide tape. After working on an 8mm timing problem, troubleshooting CD servos seems like a vacation. On the plus side, ATF (automatic track finding) eliminates the need for a control head, and greatly improves tracking. In general, 8mm machines seem a good deal more reliable than their internal complexity would lead you to believe.

The troubling aspect of all these new audio formats is that customers are getting confused, shades of the 4-channel fiasco of the mid-'70s. So far, the '80s have produced CD, VCR hi-fi, 8mm PCM, and soon, recording CDs and direct digital audiocassettes. Add these to previous analog audiocassettes and phonograph records. What you've got is more formats than the market can support. A shakeout is inevitable. The only question is the identity of the survivors. The wild card in all this is video. Many of the audio systems are integrated with video, or are video-upgradable (such as still pictures on CD). Whoever finally wins, one thing is certain, audio performance will have been significantly upgraded, both in terms of signal quality and information density (playing time). ES&T

Literature

Now available is the 8-page Selection Guide #206 describing **Connector Corporation's** expanding line of CRT sockets for Cathode Ray Tubes. The catalog details CRT socket families that are available for most JEDEC base configurations and those not so designated. All sockets are made to order utilizing a wide range of materials and finishes to suit the exact requirements of the application.

Circle (125) on Reply Card

A booklet from **Microwave Filter Company,** "TVRO Service Dealer's Master Receiver List and Filter Connection Guide," describes filtering terrestrial interference (TI) in more than 500 different receivers.

The booklet discusses how to identify whether a receiver is standard or block conversion, its IF frequency, connector type and whether it's synthesized or automatic frequency control driven. Based on characteristics identified, the best filter to solve the interference problem is recommended. Two other filters are also listed: a second best and one for weak signal. Diagrams show where the filters should be installed in the system. Descriptions of the filters also are included.

The data were compiled by MFC staff who have helped dealers with 10,000-plus cases of TI.

Circle (126) on Reply Card

The Eraser Company announces the availability of a new 12-page Short Form Catalog, presenting most of its electrical and electronic production equipment, in a shortened, comprehensive brochure. Included is a selection of equipment used to solve many production problems in industry. Applications such as wire cutting and stripping, printed circuit board assembly, wire and cable dereeling, and cleaning and burnishing operations are featured.

Circle (127) on Reply Card

Jensen Tools offers a full color, 160-page catalog containing more than 1,000 items. Two new sections feature supplies and equipment in support of fiber-optics and wire/cable systems. The line of circuit board equipment has been expanded. Other major categories cover lighting and optical aids, metric, power and metalworking tools, work-holding devices, drafting supplies and more than 50 dedicated tool kits.

Circle (128) on Reply Card

Comprehensive home study courses in video technology and TV/radio servicing with digital electronics are featured in a new catalog issued by **National Technical Schools/Independent Training Group** (division of **United Education & Software**). Also included are independent study programs in electronics, industrial technology and microprocessors, robotics technology, personal computer technology and servicing, transportation technology and climate control technology.

Circle (129) on Reply Card

ES&T

Photofact

These Photofact folders for TV receivers have been released by Howard W. Sams since ES&T's last report.

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FOR SALE: Radar Range Scope, early 1940's. DuPont, weighs about 90 lbs., several G's shock resistant. ALSO Webcor High Fidelity, reel-to-reel, tube type Tape Recorder Mod. TP2718-1, weighs about 40 lbs. Make offer on each. SHANNON O. SELLERS, 7308 Franklin Dr., Bessemer, AL 35023. 12-86-1t

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CAMERA-VIDEO Technicians needed. Top pay and benefits for well trained and experienced technicians who are expert with consumer and/or industrial cameras and VCR's. Training by manufacturers such as Sony, Hitachi, Panasonic, etc., are necessary for job experience. Come to sunny Florida and enjoy your work & leisure time. Write or call ATLANTIC ELECTRONICS INC., 1881 NE 26 St., Ft. Lauderdale, FL 33305. (305) 564-8274 10 AM to 6:30 PM. Ask for Dave or Joe. 8-85-tfn

ELECTRONIC TECHNICIAN/SERVICE SHOP MANAGER needed for small busy repair shop. Send resume to Whittington's Electronics, 501 Broadway, Truth or Consequences, New Mexico 87901. 10-86-2t

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

WANTED – Part-time television-tech. benchman. Experienced only – seasonal only. Paul's T.V., 6564 S. Federal Hwy., Stuart, FL 33497. 12-86-1t

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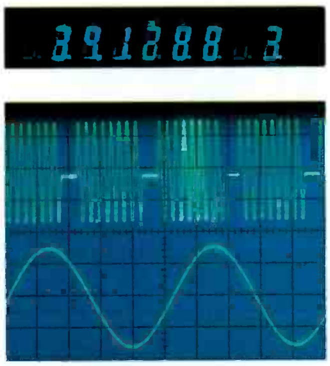
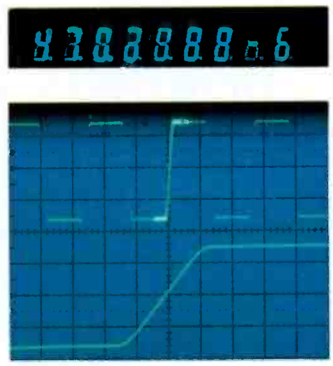
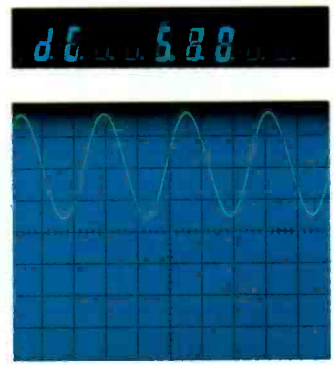


Gated frequency measurement. B sweep triggering during the intensified portion of the A sweep. Intensified portion frequency is measured with the counter/timer/DMM.



Delay time measurement. Delay time from the start of A sweep to the start of the B sweep is measured with *crystal accuracy.*



Channel 1 dc volts measurement. The average dc component of a waveform is measured directly through channel 1 with direct digital fluorescent readout.

The Tek 2236 combines 100 MHz, dual timebase scope capability with counter/timer/DMM functions integrated into its vertical, horizontal and trigger systems. For the same effort it takes to display a waveform you can obtain digital readout of frequency, period, width, totalized events, delay time and Δ-time to accuracies of 0.001%.

The same probe is used to provide input for the CRT display and the digital measurement system, resulting in easy set-up, greater measurement confidence and reduced circuit loading. Probe tip volts can also be measured through the Ch 1 input.

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1-800-426-2200 for application assistance or ordering information.

In Oregon, call collect:
1-627-2200

Bandwidth	100 MHz
No of Channels	2 + Trig. View
Max. Sweep Speed	5 ns/div
Digital Readout Features	Direct Ch 1 Voltage Meas. 0.5% DC; 2.0% AC RMS Resistance: .01Ω to 200 MegΩ Continuity/Temp: Audible/C° or F° Totalizing Counter: —1 counts to 8,000,000 Direct Freq. Meas: 100 MHz to 0.001% acc. Period, Width Meas: 10 ns with 10 ps max. resolution
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