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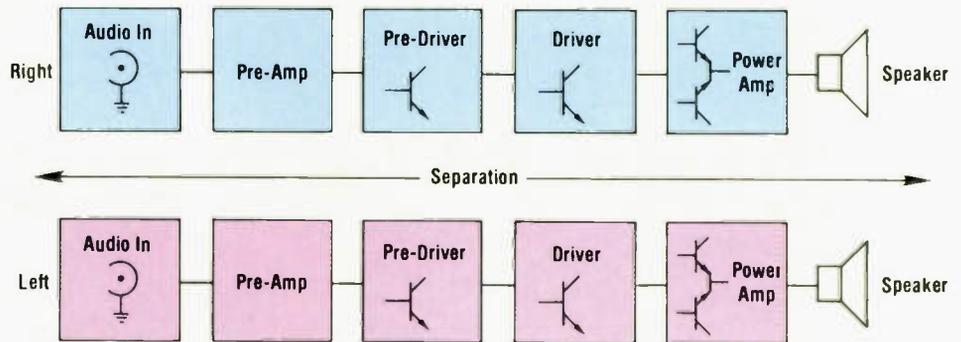
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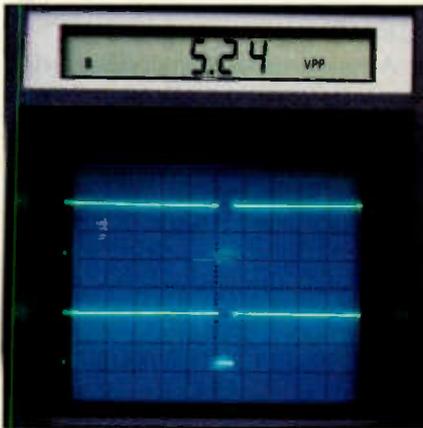


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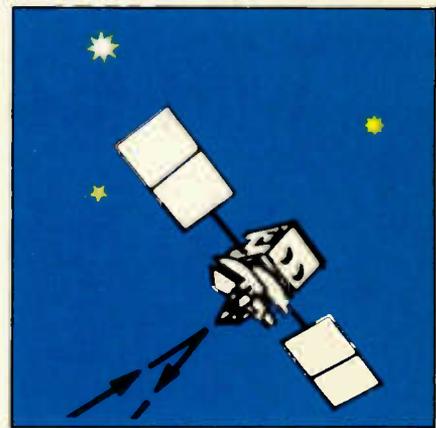
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## SPECIAL REPORT

### VCR servicing

- 6 Isolating VCR system-control problems**  
*By Gregory D. Carey, CET*  
Using a symptom/cure approach can simplify VCR servicing, but it doesn't always work if several problems result in the same symptom. To isolate system-control problems, you have to use a systematic troubleshooting process.
- 18 Measuring VCR tape tension**  
*By Wayne Graham*  
If the symptom on a VCR is intermittent audio or video, you might not automatically measure tape tension, but incorrect tape tension can result in a whole litany of woes.
- 20 The anatomy of videotape**  
*By Victor Meeldijk*  
You know an electronics product is becoming a way of life when even little kids can pop a tape in the VCR and program a cartoon. Here's some information about a part of the VCR you might not think much about — the tape itself.

## FEATURES

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*By Homer L. Davidson*  
Lightning damage might be repairable, but you need to carefully assess the damage before you get started. If it's not a lost cause, check for these common problems.

- 56 Servicing satellite TV systems**  
*By Mike Knight*  
Servicing satellite TV systems involves the same troubleshooting skills as other servicing jobs, but you might need to invest in some new equipment, such as feedhorn servo motors, LNAs and LNBs, pruning shears or wasp killer.
- 60 Understanding sun-transit effects**  
*By James E. Kluge*  
If a dish is pointed at a satellite when the sun passes through the aperture of the satellite antenna, which happens twice a year, the radiant thermal energy can damage the dish. Of course, an unwary electronics servicer might get a bit sizzled too.

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## ON THE COVER

The idea of watching what you want, when you want, without commercial interruption has definitely caught on with consumers, who purchased more than 11 million VCRs in 1988. Because those millions of VCRs are going to need periodic repair, some electronics servicers have carved themselves a nice niche in VCR servicing. (Photo courtesy of Sencore, Sioux Falls, SD.)

# Competing with the big fish

If you've ever felt like a little fish in a big pond, you've probably wished someone could teach you how to keep from being swallowed by the big fish. Last month, we took a step in that direction by starting a new monthly column called Business Corner, written by William J. Lynott. We're not much into a lot of hoopla, so in that issue, we let Mr. Lynott introduce himself and the idea of the column. Now that you're probably hooked (if you'll pardon the pun), we'd like to tell you a little more about it.

As you know, a combination of factors have made consumer-electronics servicing more difficult than ever before. These days it seems that almost every servicing problem is one-of-a-kind. It's also becoming more difficult to diagnose problems. When you find the cause of the problem, as often as not the part needed to correct it turns out to be a special-order part.

The demands of servicing today's sophisticated consumer-electronics products are tough. Continuing education is necessary to understand the ever-changing technology required to service VCRs, camcorders and the like. And you can no longer get by with a DMM, a 60MHz scope and a 25W iron.

Another fundamental change is the business aspect of electronics servicing. It's never been a good idea to be an independent servicer if you aren't well-versed in business principles — but you could get away with it. In today's business climate, if you aren't operating by sound business principles, it will catch up with you. Just take a look at the number of electronic servicing businesses that have gone under in the last ten years.

To help out, we introduced Business Corner. In this column, the author will discuss some of the business aspects of electronic servicing to make servicers aware that they must apply good business principles in the servicing business.

Lynott is uniquely qualified to write this column. He is president of W.J. Lynott, Associates, and has served as consultant to some of the country's largest service companies as well as many small, independent service dealers. In his 35-year career in the service industry, he has been entrepreneur, service manager and cor-

porate executive. For 20 years he was director of service and customer relations for Sears, Roebuck and Co., eastern territory.

A popular speaker at service management seminars, he is also one of the industry's most widely published authors. More than 200 of his articles have appeared in major trade journals and leading business magazines. He is the author of the service industry's best-selling book, *Professional Service Management* (McGraw-Hill, 1983) and founder and publisher of the management journal *Service Dealer's Newsletter*.

We welcome Mr. Lynott to the pages of *ES&T*, and we hope that, with his columns, you can throw yourselves back into that pond better equipped to compete with the big boys.

## Where is satellite TV today?

Satellite TV has been through perhaps one of the most volatile episodes of any consumer-electronic technology. When it was first introduced, a lot of fly-by-night dealers and installers got into the business alongside reputable dealers. A lot of consumers bought good, properly installed systems, but some also bought systems that didn't work properly. Even worse, when they called to complain, they sometimes found that the installer wasn't there any more.

To compound the problem, premium programming services were not scrambled, and both the legality and the morality of watching, for free, programming that other viewers had to pay for was a serious question. When these programs were scrambled, many people predicted the demise of satellite TV, and the business was in fact dealt a serious blow. But it did not fall.

There are a lot of people who do not have access to cable TV or even to much in the way of broadcast TV. Many of them are willing and able to buy a TVRO system in order to keep in touch with what's going on in the world.

Satellite TV is alive and well, although its growth has been retarded somewhat by the gyrations it has gone through. For any of you involved in the servicing of this technology, we present the article "Servicing Satellite TV Systems" in this issue.

*Nile Conrad Pearson*

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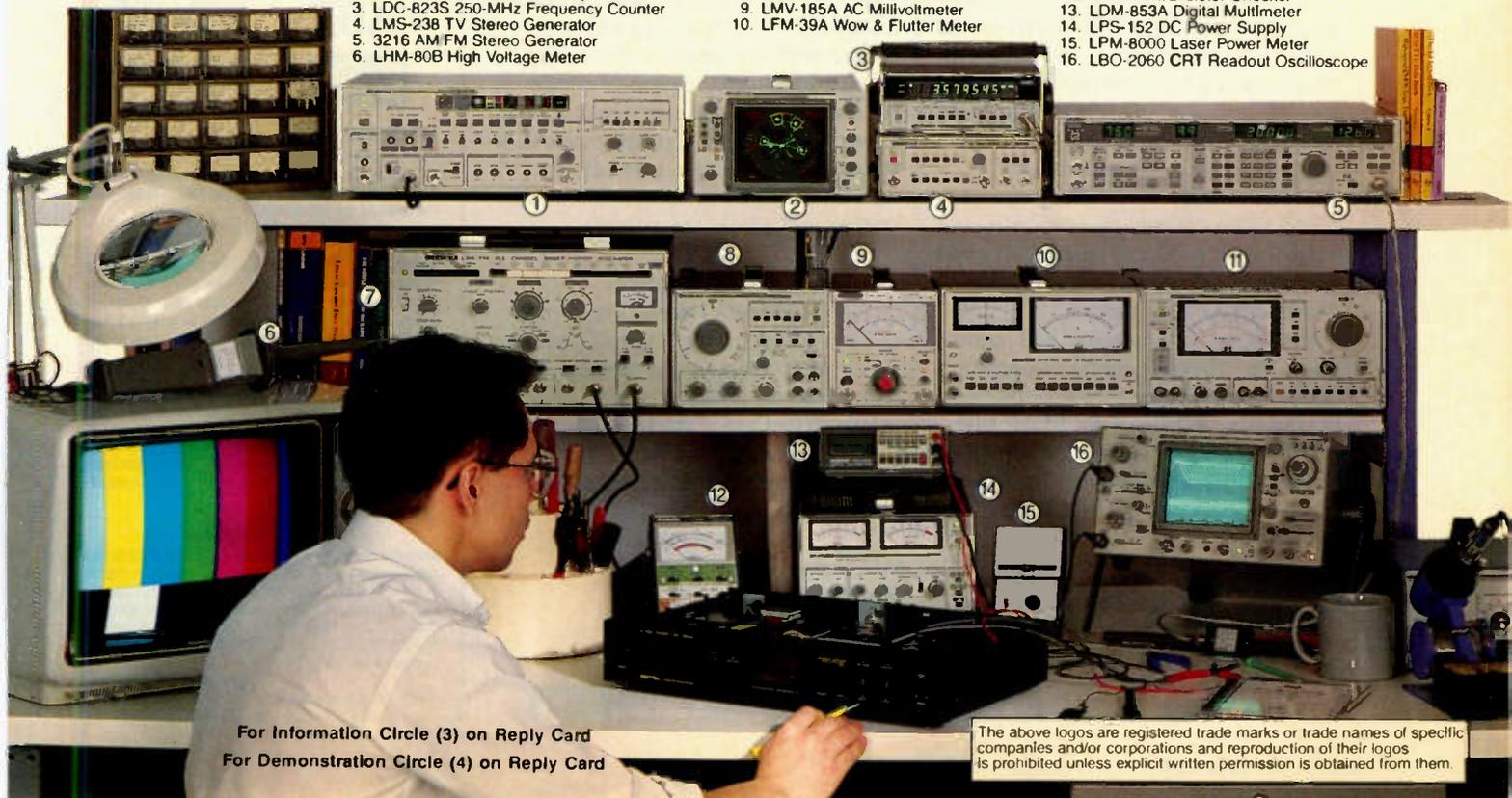
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## New courses from Fluke

General technology workshops and product training application courses have been scheduled by John Fluke Mfg. in 21 cities throughout the United States and Canada, including new workshops in the areas of calibration, microprocessors and the operation of oscilloscopes and logic analyzers.

The new offerings among the general technology workshops include: Cal Lab Management, a course on the establishment and operation of a calibration lab; Principles of Microprocessor Systems, which focuses on fundamental microprocessor junctions and how microprocessors interact with data and address buses, I/O devices and memory devices; Principles of Logic Analyzers, Principles of Analog Scopes, and Principles of Digital Scopes, all of which provide the knowledge and hands-on experience required to enhance the effectiveness of these instruments. The Principles of Metrology workshop will also be offered again in 1989.

New product application training courses in 1989 will be offered on the new Fluke 900 Dynamic Troubleshooter and the 7411B/C/PC calibration system. To be offered again in 1989 are product application training courses on the following products: the 1722A/1752A instrument controller and software; the 2452 measurement control system software; the 9000 and 9100 Series board testers (troubleshooting and programming); and Flexsys software. All courses are offered on a scheduled basis throughout the year. Special on-site course sessions can be arranged.

Also available from Fluke are self-paced video courses on surface-mount technology service and repair and on the use and applications of the Fluke 70 Series digital multimeters.

For more information and course costs on Fluke general technology workshops or product application training courses, contact John Fluke Mfg., P.O. Box C-9090, Everett, WA 98206; or call Customer Support Services at 800-443-5853, ext. 73 (in Canada, call 416-890-7600).

## UL proposes surge suppressor standard

Underwriters Laboratories (UL) is proposing the Standard for Safety for Transient Voltage Surge Suppressors,

UL 1449, for recognition as an American National Standard. UL 1449 covers equipment designed for repeated limiting of transient voltage surges on 50Hz or 60Hz power circuits not exceeding 600V rms. Also covered are hybrid types that contain voltage surge suppression and EMI filtering.

UL is seeking comments from interested individuals to develop a consensus upon which recognition of UL 1449 by the American National Standards Institute (ANSI) can be based.

Contact L.M. Cohen at UL, 333 Pfingsten Road, Northbrook, IL 60062-2096 (312-272-8800, ext. 2692) and request a copy of UL 1449-NR.

## EIA debuts home automation standard

The 1989 International Winter Consumer Electronics Show (CES) marked the debut of a new technology — the Electronic Industries Association Consumer Electronics Group (EIA/CEG) home automation standard. EIA/CEG sponsored a working display of home entertainment products, appliances, security systems, and heating and air conditioning equipment, all working in a safe and comfortable environment. Products featured in the exhibit were supplied by both EIA/CEG member companies and non-members.

The home automation standard allows a number of unrelated products to interface with one another. For example, using a hand-held remote controller in the living room, the user could turn off lights, turn on the TV, program the VCR to record a TV show, turn off the TV, turn on the audio system, select a radio station and adjust the volume.

## Parts supplier address correction

The address for the Philips Consumer Electronics Company's Service Parts Organization, which was printed in the article "The Case of the Missing Diode" in the December 1988 issue, was incorrect. The correct address and telephone number are:

907 Snapp Ferry Road  
Plant 2  
Service Parts Warehouse 1  
Greenville, TN 37743  
800-851-8885  
615-636-5863.

The magazine for consumer electronics servicing professionals

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Electronic Servicing & Technology (ISSN 0278-9922) is published monthly for \$19.49 per year by Intertec Publishing Corp., 9221 Oulvira Road, Overland Park, KS 66215. Second-class postage paid at Shawnee Mission, KS and additional mailing offices. POSTMASTER: Send address changes to ELECTRONIC SERVICING & TECHNOLOGY, P.O. Box 12960, Overland Park, KS 66212.

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# Isolating VCR system-control problems

By Gregory D. Carey, CET

Although many technicians rely on a symptom/cure approach to problems in the system-control circuits of a VCR, there is a major problem with this troubleshooting method—many system-control failures cause identical symptoms. Systematic troubleshooting will allow you to pinpoint the problem, reducing the number of times you replace the wrong parts. Because of the mechanical nature of the system-control circuits, troubleshooting calls for an understanding of the interfacing between the electrical and mechanical components. This information helps you trace troubles to their origin.

## The function of system control

VCR system-control circuits are in charge of the mechanical systems:

Carey, an application engineer at Sencore, has run more than 800 seminars for service dealers.

loading and unloading the cassette, moving tape through the machine and watching for conditions that might damage the tape. All three of these functions interact. For example, detection of a problem usually causes the system-control to stop the tape. Many machines also eject the tape or refuse to let a tape be loaded. (See Figure 1.) The system-control circuits begin their work when you place a tape into a front-loading machine. A small leaf switch behind the tape basket reports the presence of the cassette to the microprocessor, which starts a motor that pulls the cassette into the deck. After the cassette is in place, a second motor controls arms that pull the tape from the cassette and wrap it around the video and audio heads. This process reverses when you press the EJECT button. Whether the tape is moving or standing still, the system-control circuits constantly monitor the

front-panel keys and the signals coming from the remote control. Even the POWER switch is usually an input to the system-control circuits. When you press any function key, the microprocessor controls the motors, solenoids, and other circuits that cause the tape to play, search, rewind or fast-forward. In addition, the system-control circuits exchange signals with the other major tape-deck circuits. They control whether the deck is in the record or the playback mode. They also control the tape speed by controlling the servo circuits. Signals returning from the servo circuits form part of the safety circuits. The system-control also operates the tuner and the automatic timer. When you've set the timer, the system-control fires up the machine at the time you've programmed, selects the desired tuner channel, records the tape and then shuts the deck down at the end of the program. In the meantime, the system-control's clock tells you the time of day. Many system-control functions are for protection. One device senses if moisture has built up inside the machine. Other circuits confirm that the tape and heads are properly moving. If the microprocessor thinks they have stopped, it takes steps to prevent damage to the VCR or to the tape. The protection systems usually *fail safe*, ejecting the tape in some cases or causing a complete shutdown in others. This action often results in a tape stuck inside the machine, although the tape is not damaged or tangled up in the rollers. Now, let's turn our attention to how the system-control circuits can sense the conditions of other VCR circuits.

## Types of sensors

The VCR uses several sensors that convert mechanical motion to electrical signals that the microprocessor can understand. As Figure 2 shows, a

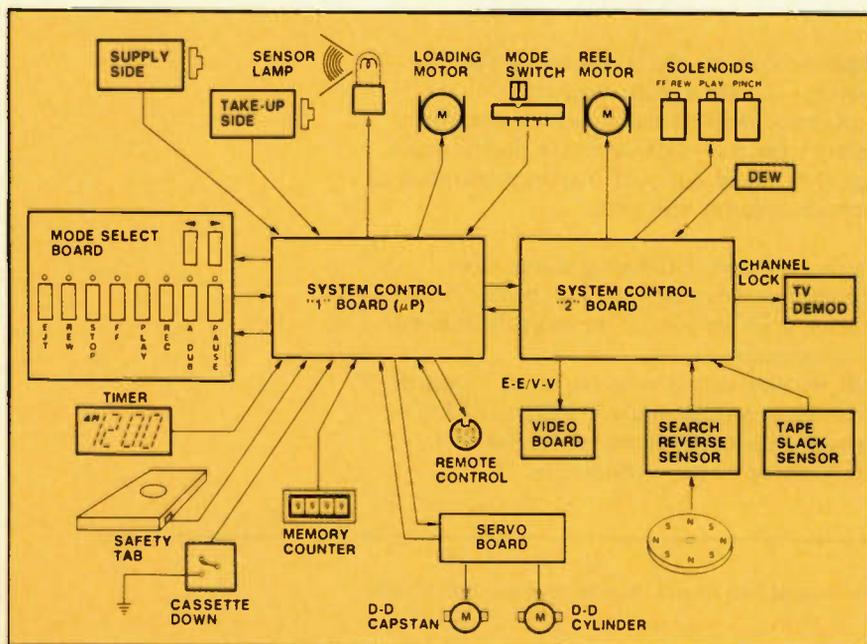


Figure 1. The system-control circuits operate the mechanical functions such as tape loading, tape movement and safety.

microprocessor forms the heart of the system-control circuits. The microprocessor receives signals from many sources and then feeds the other VCR circuits and motors. The microprocessor uses several types of sensors for input.

• **Switches.** Mechanical switches tell the microprocessor if the loading and unloading sequences are proceeding correctly. Small leaf switches sense when you've inserted a cassette and when the cassette loading motor has pulled the cassette into the machine. Another closes when the cassette has been moved down to its operating position. Most VCRs use a multi-pole switch to track the position of the loading ring as it pulls the tape from the cassette. The switch contacts tell the microprocessor how far the loading motor has moved. Using two input pins allows four positions to be encoded. Using four pins allows 16 positions to be noted. Figure 3 shows a scheme for a typical loading switch.

• **Photo sensors.** Some sensors use light sources (either LEDs or incandescent bulbs) and photo pickups (either diodes or transistors) to detect correct operation. The two most commonly used photo sensors detect the end of the tape and whether the takeup reel is turning. The VHS cassette has an opening in the bottom through which a light source shines. Two photo-pickups are positioned near small openings on either side of the cassette. A clear leader is spliced to each end of the videotape. When the tape is being moved in either direction and the end of the reel is reached, the clear leader moves in front of one of the openings, allowing the light to shine through it onto the sensor. This signals the system-control to stop the tape transport before pulling the tape off the supply or the takeup spool. Many VCRs also use photo sensors to confirm that the takeup reel is turning. If the reel

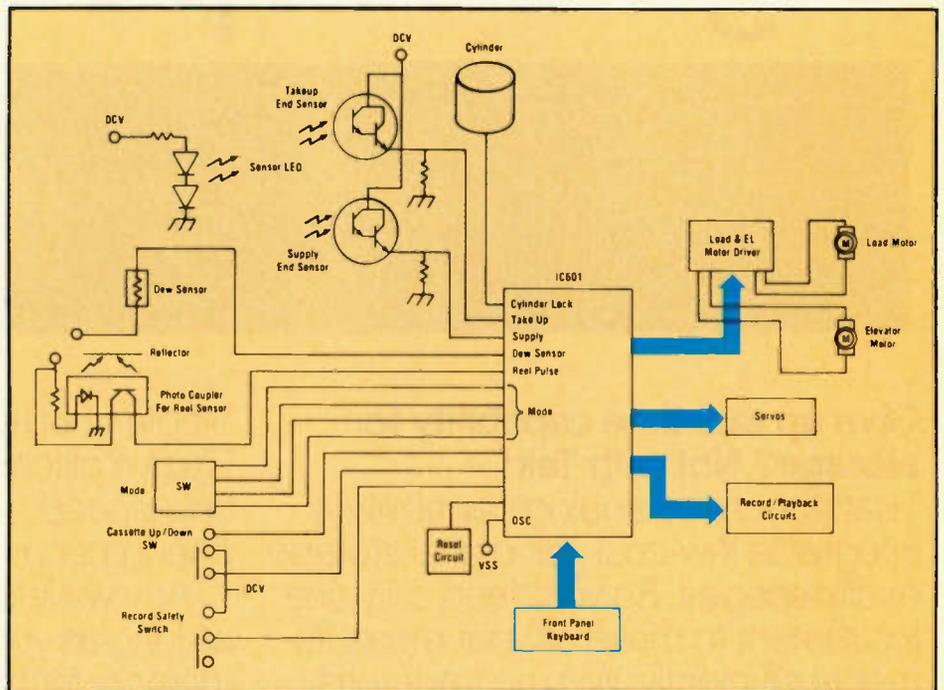


Figure 2. The microprocessor accepts its inputs from various sensor and controls motors, solenoids and digital displays at its output.

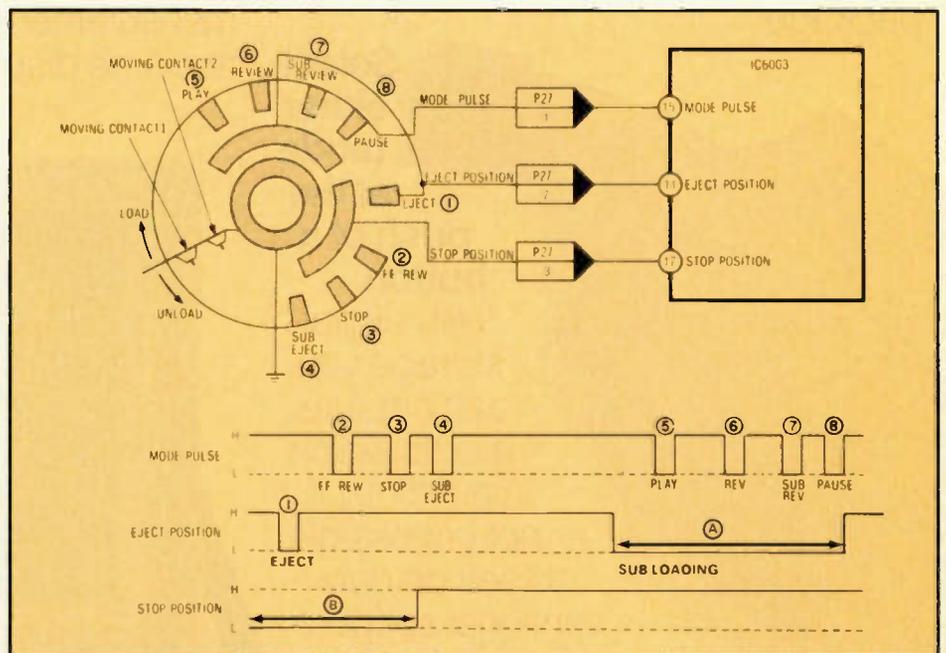
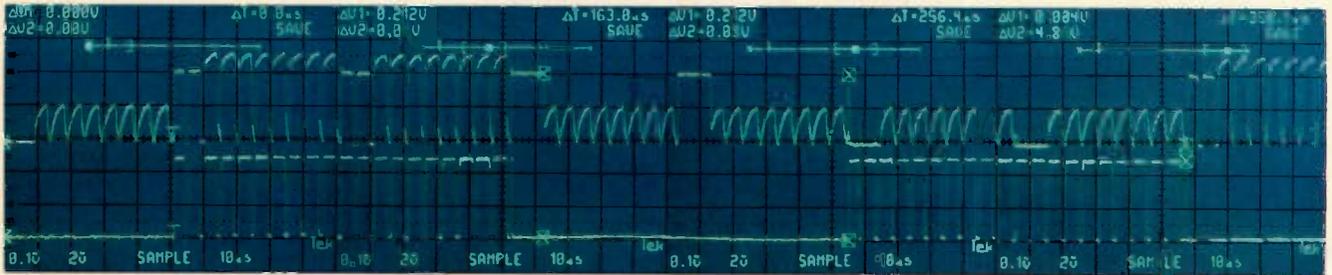


Figure 3. The mode-select switch uses several contacts to tell the microprocessor how far the motor has traveled during loading and unloading sequences.

stops, it indicates a broken tape or a jammed mechanism. The reel sensor is a disk with alternating dark and light stripes. (See Figure 4.) A light shines onto the disk, reflects off the strips and returns to the photo pickup. As the reel

turns, the light is alternately reflected and absorbed, forming a slow square wave at the sensor output. If the reel stops, the output remains high or low, depending on whether the dark or the light colored part of the disk is in front

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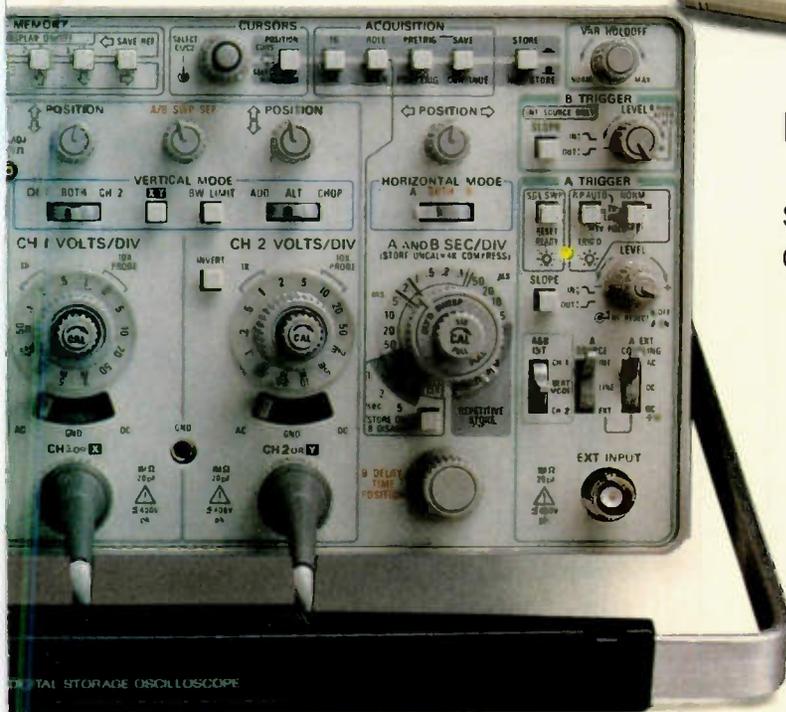
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of the light source. After a few seconds of this condition, the microprocessor stops the deck.

• **Magnetic sensors.** Some sensors use a magnet moving past a coil or a special sensor called a *hall-effect device*. The hall-effect device has better sensitivity than the coil. It also can produce an output when the magnet is stationary; a coil can only produce an induced voltage while the magnet is in motion. Magnetic pickups are commonly used to sense the position of the video heads as they spin at 1,800 revolutions per minute. The magnetic output forms a 30Hz reference signal that feeds to the servo circuits and to the system-control circuits. If the system-control circuits notice that this head-lock signal is missing, they assume the head is not spinning and stop the tape. Some VCRs use magnetic pickups as the reel sensor in place of the photo sensor described earlier. The takeup reel disk has small magnets, which pass a hall-effect pickup as the reel turns to produce the microprocessor signal.

• **Resistive sensors.** Another method of feeding information to the microprocessor is to use a device that changes its electrical resistance as an outside condition changes. The *dew sensor* is the most common example of this type of sensor. This sensor changes resistance if moisture condenses inside the tape deck. If a tape is played while the head cylinder is moist, the tape will stick and jam inside the machine, possibly damaging the delicate video heads. If the output of the dew sensor reveals that

there is moisture inside the VCR, the system-control circuits prevent the video tape from loading or running.

• **Keyboard inputs.** The system-control circuits also sense if any of the front-panel buttons have been pressed. Most microprocessors use a scanning process, so there can be many more keys on the front panel than there are input pins on the microprocessor. Figure 5 shows a typical example. This microprocessor uses six data lines and four scan lines, which allows 24 operating buttons to use only 10 microprocessor pins. The scan pins supply pulses at four different times

relative to each other. When you press a key, the switch feeds one of the scanning pulses to a data pin. The microprocessor determines which is used by comparing the timing of the returned signal to the scanning pulses. Because only one switch matches the combination of scanning signal and data pin, the microprocessor knows which button you've pressed.

• **Remote receiver.** The infrared remote-control transmitter often duplicates all of the VCR's front-panel buttons. It feeds its information to the microprocessor as a series of pulses, which the in-

symptom	circuits
won't accept tape	power supply "cassette in" switch dew sensor
tape won't stay loaded	end sensor dew sensor cassette loading switches mode switch keyboard switch dead head motor
tape won't play	end sensor dew sensor mode switch cylinder signal keyboard switch servo problems
plays a few seconds only	reel sensor

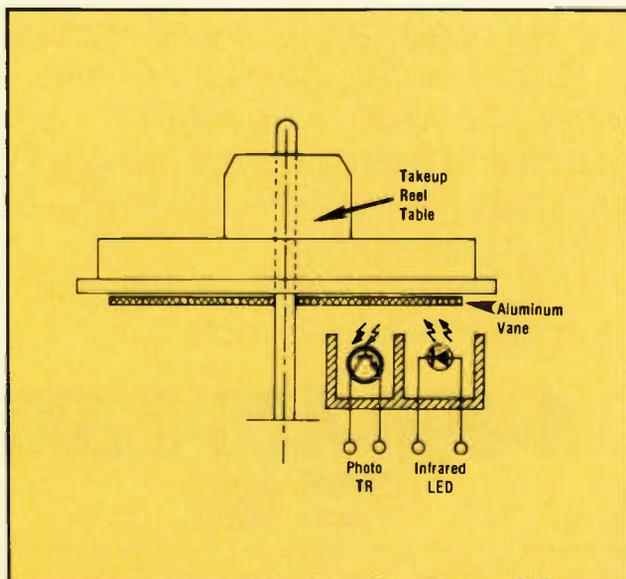


Figure 4. The microprocessor in many VCRs knows the takeup reel is turning because a striped disk alternately interrupts light to the photo pickup transistor.

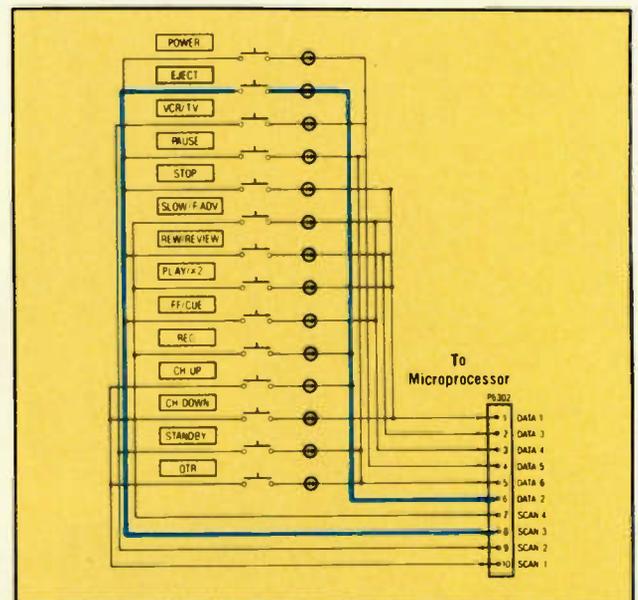


Figure 5. The four scanning pulses and six data pins allow up to 24 external switches with only 10 pins on the microprocessor.

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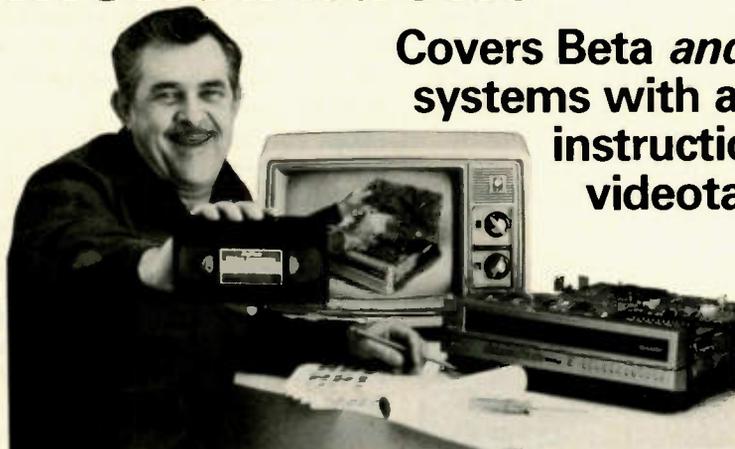
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frared receiver translates to logic signals. The microprocessor decodes the data string to determine which key you've pressed.

### Five steps to microprocessor troubleshooting

These microprocessor signals can help you troubleshoot a system-control problem. "Isolating Microprocessor-related Problems," which appeared in the June 1988 issue, explained how to troubleshoot microprocessor systems. That article gave a five-step process to isolate the problem quickly. To review, here are the five steps:

1. Test the power supplies for dc and ripple.

2. Test the microprocessor clock for frequency and cleanliness.
3. Check for proper input and output signals.
4. Check the reset pulse.
5. Look for bad grounds.

Steps 1, 2, 4 and 5 are the same for any microprocessor-based system, so we won't bother to repeat these steps. Step 3, however, changes with each system. We will spend the remainder of this article giving you some clues on checking the inputs and outputs found in VCR systems.

(Note: For details on the five steps in microprocessor troubleshooting, you can order a free copy of Tech Tip #109 from Sencore by calling 800-843-3338.)

### Testing input/output circuits

Each system-control symptom might be caused by any of several different problems. It's best to test each possible cause one at a time until you find the problem. Table 1 shows common symptoms and the circuits most likely to cause each. In most cases, it's best to

start your tests at the microprocessor and then work back toward the sensor. Trying to start at the sensor or switch gets you into locations buried behind other parts or assemblies. You might need to find a few of these points to isolate the problem, but starting at the microprocessor reduces disassembly. One of the toughest troubles to find is one that causes the VCR to spit the tape back out every time you load it. The deck accepts the tape for a few seconds, and then unloads it. You can't test the circuits after the tape has been ejected because the switches and sensors are no longer in their PLAY positions. To find the source of this problem, connect the two channels of your dual-trace scope or waveform analyzer to the two microprocessor pins that you think are most likely at fault. Monitor the signals while you insert the tape. For example, a leaky phototransistor used as an end sensor may be the problem. To find out, connect your probes to the two end sensors. Confirm that they properly switch to their "dark" mode when you momentarily cover the sensors with a piece of black tape to block room light. If both read the correct level, move to the next pair of pins that may be causing the trouble. As another example, a defective multi-pole loading switch might make the microprocessor think that the tape did not load correctly. The tape might spit out or might simply refuse to play. Monitor two of the switch's microprocessor pins as the tape loads. Con-

Table 2.  
TTL logic levels

Low	0.8
high	2

Table 3.  
CMOS logic levels

	percent of Vcc	power supply (Vcc)			
		5V	10V	12V	15V
low	20%	1	2	2.4	3
high	70%	3.5	7	8.4	10.5



Figure 6. When troubleshooting keyboard problems, use the dual-trace function to compare the timing of the scanning pulse and the data pulse. The keyboard schematic then tells you which switch contact is closed.

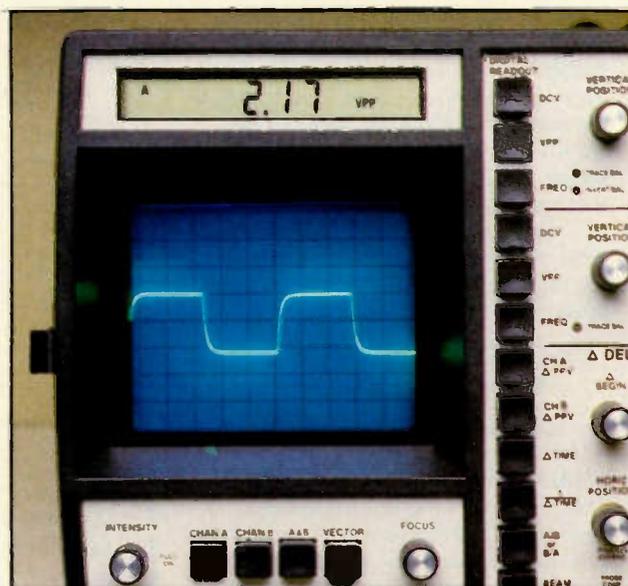


Figure 7. Test the reel sensor if the VCR shuts down after a few seconds or several minutes of operation. If you find a signal, check its amplitude—defective photo pickups often cause the levels to be too low for the microprocessor to detect.

firm that the signals are properly moving from their high to their low states. Don't worry about signal timing. Timing is determined by the mechanical switch position and rarely changes. Confirm that one of the switch contacts is not opening or closing. If the timing is in question, check the service literature. The gears that drive the switch normally have markings that must be properly aligned for the contacts to open and close at the correct time. Resetting the timing marks may correct the problem. Defective front-panel switches sometimes cause a system-control problem. They can become shorted or the spring-return mechanism might prevent the contacts from opening. Confirm these problems by testing each of the microprocessor data pins. (See Figure 6.) There should be no data on a pin unless a switch is closed. If you see data, use the dual-trace function of your scope to see which scanning pulse has the same timing as the data, then use the schematic to find which switch is bad. Bad reel sensors often cause intermittent operation. The deck sometimes only plays for two or three seconds. At other times, the machine might play for several minutes before stopping. Check for a slow square wave at the microprocessor. (See Figure 7.) If you find a signal, measure its high and low levels. A weak sensor often reduces the amplitude. Confirm that the signal moves between logic low and logic high for the type of microprocessor used. If the microprocessor is a TTL type, the LOW must be less than 0.8V and the HIGH must be larger than 2V. If the microprocessor is a CMOS type, the HIGH and LOW signal thresholds depend on the power-supply voltage used. Table 3 shows the logic levels for several common supply voltages. A signal with incorrect amplitudes might be caused by a defective photo sensor or by a buildup of dirt on the transparent window of the photo pickup or on the light-colored areas of the reel sensor disk. If cleaning these surfaces does not correct the problem, a new pickup is needed. Use symptom/cure troubleshooting with care in system-control problems. Many different problems cause the same symptom. Check the input signal at the microprocessor and then work your way back to the signal source. This method will let you confirm which part is bad and keep the unnecessary replacement of parts to a minimum.

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# Troubleshooting Tips

**Symptom:** No picture or sound, tic-tic sound present.  
**Set ID:** Magnavox Model BD4039WA03, 13C3 Chassis  
**Sams Photofact:** 2333-1

This set had no picture or sound, but had a slight tic-tic sound coming from the chassis. I measured a normal 320V from the voltage doubler in the power supply, but the 130V line from pin 5 of T452 measured 30V. Since the horizontal oscillator and the power-supply regulator in this set work in a closed loop, I decided to start by checking the startup voltages. The voltage at pin 16

of IC500 measured 7.3V, and pin 11 showed a horizontal signal of 2.3V<sub>p-p</sub>. The startup voltages seemed normal, but checking in the regulator circuits didn't reveal anything.

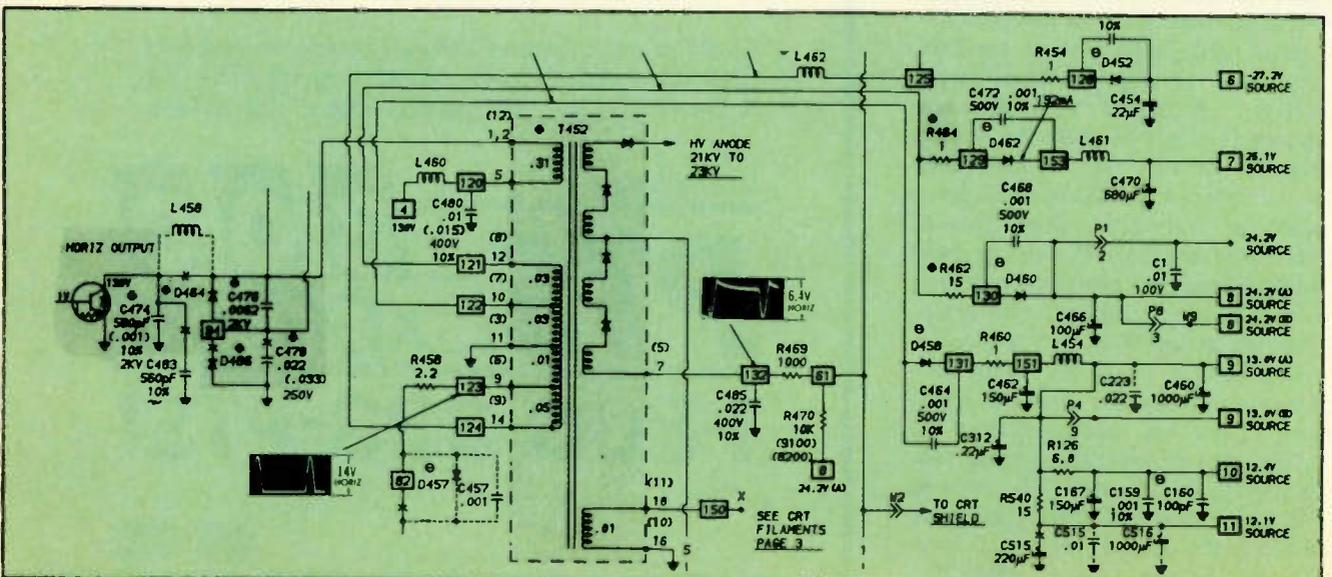
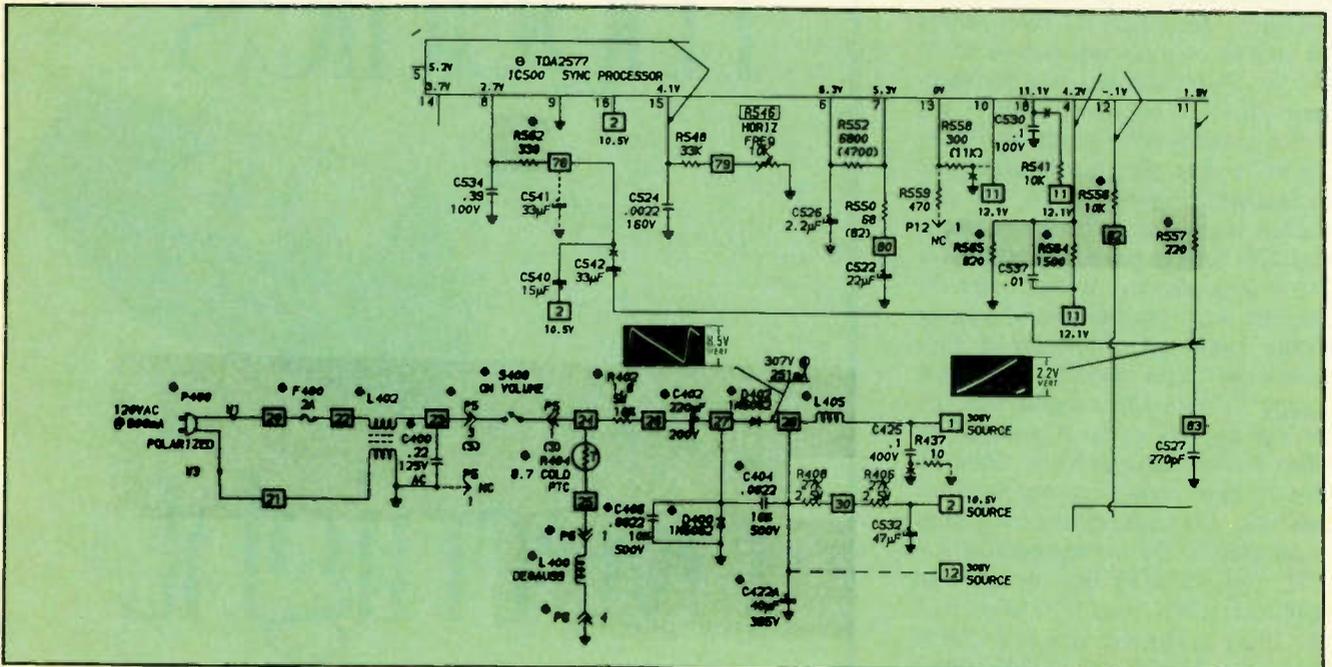
I decided to try to isolate the horizontal circuit from the regulated power supply. I disconnected L<sub>460</sub> and connected a 100Ω, 20W resistor in its place. When I again applied power, the 130V line returned, which suggested that the problem was in the horizontal circuits.

Next, I checked the base drive for the horizontal-output transistor. It looked good. When I checked the collector waveform, however, I noted that there

were extra pulses between the retrace pulses, indicating that there might be a problem in the integrated high-voltage transformer (IHVT).

Rather than replace the IHVT immediately, only to find that the problem was caused by something else, I checked the low-voltage supplies from the IHVT. They were not the same values as specified in the servicing literature, so I went ahead and replaced the IHVT. When I plugged the set in and turned it on, everything was back to normal.

**Paul Campbell**  
 Lake Crystal, MN



# Are you ready to expand?

By William J. Lynott

Should I be happy with this little piece of the action that I've carved out for myself, or should I go for the brass ring and a chance to make it big?

In one form or another, that question is frequently posed to me. It's one that most successful service dealers eventually ask of themselves and their advisers. Unfortunately, there are no easy answers. There are simply too many variables involved, not the least of which are the personality and emotional makeup of the business owner.

I remember an electronics service dealer for whom I had done some consulting work a few years back. He was considering expanding his business by buying out a competitor. As I have done with several others, I advised him against it.

Mark (not his real name) was a world-class worry wart. Conservative to a fault, he was a "Type A" if there ever was one. Over a seven-year period, Mark built his business from nothing to four employees plus himself and his wife. During that time, he never incurred a dime's worth of debt.

Like most electronics service dealers, he was a better-than-average service technician. It didn't take me long to recognize that Mark was happier analyzing a trace on a scope than designing a marketing plan or setting up an operating budget.

Taking over his competitor's business (which was larger than his own), would more than double his work force overnight and necessitate a large bank loan, his first ever.

As I remember them, the specifics of the proposed deal were largely favorable. The price was right and the company in question had a fairly good reputation in the community, but I felt that the change in lifestyle that this move would create would be extremely difficult for Mark to cope with. I felt that his sharply conservative instincts would have prevented him from taking some

of the risks inherent in a successful business expansion. Frankly, I was relieved (he was, too) when he decided to accept my advice.

But when conditions and personalities are right, there is no reason to pass up a chance to go after the pot of gold at the end of the rainbow.

Tom, another small service dealer, is a good example. Tom founded his business about 15 years ago. Following the usual pattern, Tom was himself a good technician and started out doing a full day's workload of service calls. However, Tom is a very different personality from Mark.

Tom has a high energy level and the kind of ambition that allows him to take an occasional business gamble without losing too much sleep. More important, Tom knew from the beginning that building a large business would require different use of his personal time. He knew that he would have to become a true *manager*, not just a tech who happened to have a couple of other techs working for him. Gradually, as his business grew, Tom forced himself to spend more time managing and less time repairing — a progression that many fledgling service dealers simply cannot handle. At some point, a skilled manager's time becomes too valuable to spend it doing anything but managing the business.

Once the commitment to grow has been made, a manager must learn to plan for the development of new business, design newer and more efficient internal systems and records, and put together both short- and long-term budgets and business plans. Once in a while, he must get off by himself just to think.

But those jobs aren't everyone's cup of tea. A lot of small service dealers I know are much more comfortable with a multimeter or needle-nose pliers than with an office calculator. They'd rather read a schematic than a balance sheet.

There's nothing wrong with that, of course. It's just that someone whose basic instincts are not compatible with being a full-time business manager will

do well to come to terms with that fact early on. Better a prosperous and successful one-man business than a bankrupt corporation.

How can you tell if a bigger business is for you? A tough question to answer, but there are a few generalities that may help.

### *Financial instincts*

As a business grows, financial demands grow. Larger payroll and overhead demand an ever-increasing flow of revenue. Do you have a feel for — and enjoy — the challenge of finding new customers? Do you like marketing? Do you have ideas for expanding your customer base?

### *Planning and record keeping*

Can you enjoy "working with your head" instead of your hands? Forget the movie and TV image of the successful executive with rolled-up sleeves "working with the boys." In real life, it rarely happens that way. The business manager who likes to keep his hands dirty often finds his bank account clean.

### *People*

Do you genuinely like people? Do you develop good relationships with most of the people who work around you? The more employees you have, the higher the likelihood that you will find yourself dealing with tough human-relations problems.

### *Physical energy*

Most studies of successful entrepreneurs pinpoint a high physical energy level as an essential ingredient in sustained business success.

And those are just a few of the most important considerations.

If none of this talk scares you, maybe it's time for you to take a flyer. However, if the thought of facing up to these kinds of problems causes your stomach to tighten in little knots, maybe you ought to pause and reflect on how nicely things are going just as they are.

**ES&T**

Lynott is president of W.J. Lynott, Associates, a management consulting firm, and publisher of the Service Dealer's Newsletter.

# Test your electronics knowledge

By Sam Wilson

1. What is the approximate bandwidth (in kilohertz) of an amplifier that passes a 1,500kHz square wave with a rise time of 0.002ms?
2. Amplifier B in Figure A is suspected of being defective. The capacitor is being used to bypass the signal from A to C. Which of the following is true?
  - A. It won't work because the phase of the output signal from A is wrong for the input to C.
  - B. It will work if the capacitor can pass the signal.
3. What is the name for the very small beads that act like inductors?
4. What is the name of the amplifier that uses a varactor diode for the amplifying device?
5. In the Class A circuit of Figure B,  $R_3$  is open. That will cause the voltmeter to read
  - A. 0V.
  - B. a higher-than-normal voltage.
6. What signal waveshape would you expect to scope at the output of the differentiating circuit in Figure C? The input is a pure sine wave.
7. Crystals are identified by their type of cut. An example is the Y-cut. It has a positive temperature coefficient. Which type of crystal cut has a low temperature coefficient?
8. Which type of microphone has an electrostatic material with a permanent static charge?
9. Bandwidth is the range of frequencies between points where voltage is down by 70.7%. It is also the range of frequencies between points where the power is down 50%. Which of these represents  $-3\text{dB}$ ?
10. The silicon diode to be connected across the circuit in Figure D has a maximum value rating of 50mA at 2V. How much current will flow when the diode is connected into the circuit in Figure D?

Wilson is the electronics theory consultant for ES&T.

Answers are on page 47.

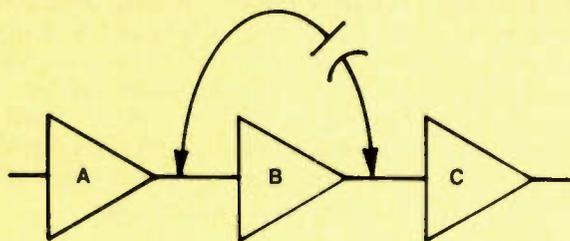


FIGURE A

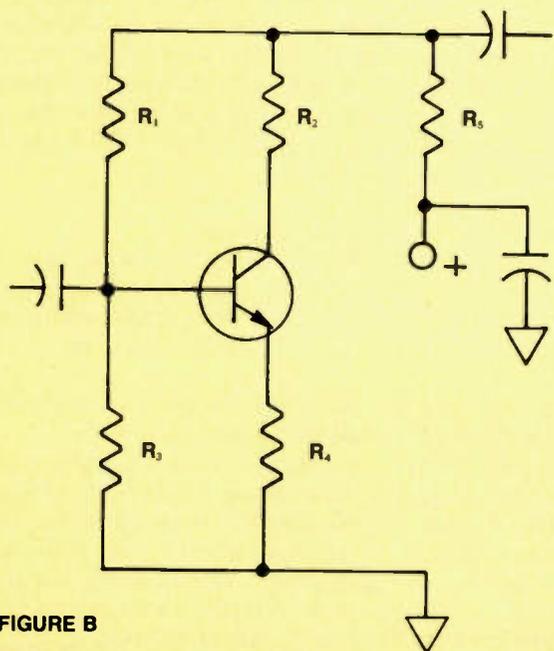


FIGURE B

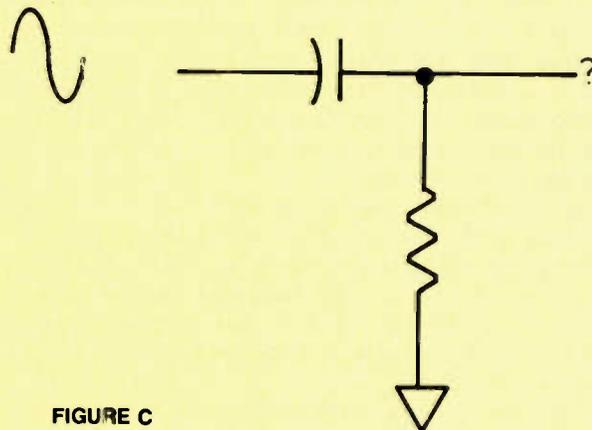


FIGURE C

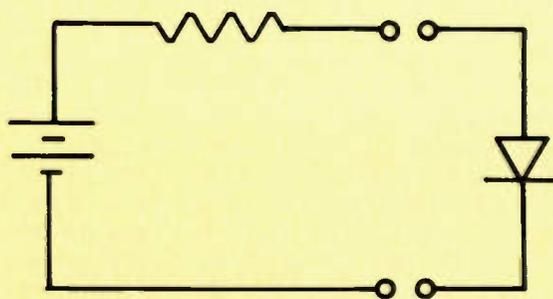


FIGURE D

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# Measuring VCR tape tension

By Wayne Graham

One of the most important parameters for proper, interchangeable video is hold-back tape tension. Improper tape tension has been demonstrated to cause several problems that may be improperly diagnosed as electronic problems.

Low tape tension may cause:

- intermittent video signal.
- increased video dropouts.
- intermittent control track and subsequent intermittent picture break up.
- tape guidance problems and subsequent tape-edge damage.
- skewing errors with video hooking.
- intermittent audio.
- tape destruction due to tape being pulled by the rotating video drum.

High tape tension may cause:

- skewing errors with video hooking.
- premature video-head tip wear.
- tape-edge damage due to high tension at tape guides.
- tape destruction due to stretching at high stall tensions.

Improper tape tension is the most probable cause of distorted and intermittent video. Virtually every experienced service technician knows the importance

of proper hold-back tape tension.

On VHS transports, there are only two accepted methods of measuring this hold-back tension: the back-tension cassette and the in-line tape-tension gauge. Only one of these methods, the in-line tape-tension gauge, may be used with any brand and model of VCR; the other method, if not used carefully, can give misleading readings and may actually cause a good machine to be set up incorrectly.

## Tension cassettes

For checking tension, tension cassettes appear to be the ideal solution. They go into a VCR as easily as a cassette, and they're moderately priced. The drawback is that they aren't a universal test tool. Purchasing one of these tension cassettes from one VCR manufacturer (or supply house) will not provide a gauge that will work on other brands or even different models of the same brand. Tension cassettes can only measure the force exerted at the spindle; they have no way of detecting any tensions beyond the cassette housing. Because they can't measure tensions at or near the entrance to the video drum,

they will provide different readings each time the tape-path design differs in various brands and even different models of the same brand of VCR.

Tension cassettes are actually measuring the hold-back torque exerted on the supply reel by the supply-spindle assembly. There is no standard for this hold-back torque. The tape tension standard is specified at the inlet to the scanning video drum.

Tension cassettes would be a good way to measure tape tension if the number of tape guides, angle of wrap around these guides and angle of wrap around the erase head were the same for all VCR brands and models. If these parameters were standard, a given hold-back torque would always result in the same corresponding tape tension.

Unfortunately, VCRs with properly adjusted tape tension according to the specification can peg a tension cassette from another manufacturer and actually stall during its use. In fact, some manufacturers produce and sell two different tension cassette models—one for their old-style VCRs and one for their new style. It's important not to assume that any tension cassette will work in any particular brand or model of VCR unless that particular version of the tension cassette is referenced in the service manual for the machine.

## In-line tension gauges

The SMPTE (Society of Motion Picture and Television Engineers) and EIAJ (Electronic Industries Association of Japan) standards provide specifications for tape tension entering the video drum, so you can obtain a universal reading by measuring tape tension out in the tape path. The in-line tape tension gauge (for example, the Tentelometer) has three probes that slide directly onto the video tape during the normal play mode. Even the in-line gauge can't be inserted directly at the inlet to the video drum, which is the ideal point at which to measure tape ten-

Graham is general manager of Tentel.



There are two methods for measuring VCR tape tension: the tension-measuring cassette (to the left) and the in-line tape-tension meter (to the right). The cassette pops into the VCR like any other cassette and measures the supply spindle torque, which is then translated into a tape-tension readout. The in-line meter is inserted at the inlet impedance roller location.



sion. It can, however, be inserted at the inlet impedance roller location, which is upstream by a rotating guide (P2) and the final non-rotating slant guide. Because these two guides are virtually the same on all VHS recorders, you can compute the proper tape tension at their entrance.

The correct tension at the inlet impedance roller can be computed from the formula for tape drag around a non-rotating guide post:

$$T_{out}/T_{in} = e^{\mu\Theta}$$

where

$\mu$  = the coefficient of friction of tape against the guide

$\Theta$  = the wrap angle, expressed in radians ( $2\pi$  radians =  $360^\circ$ ; thus,  $45^\circ = \pi/8$  radians = 0.785 radians)

$e$  = natural log 2.72

$T_{out}$  = high tension going away from the guide

$T_{in}$  = low tension going into the guide.

Don't let the formula scare you—all it says is that when the tension at the inlet to the video drum is the proper 31 to 46 grams, the corresponding tension at the inlet impedance roller location is 23 to 35 grams. This specification can be used on all VHS machines that have a rotating guide next to the non-rotating slant guide leading into the video drum.

Another benefit to this method is that, because tension is being measured in the tape path, not within the cassette, it's easy to check the performance of the VCR's tension servo system. The tension servo system has been designed to maintain the back-tension relatively constant throughout the diameter change during the playing of a T120 tape. Without this servo system, the tension would change by more than a 3 to 1 ratio; thus a tension reading of 25 grams at the inlet impedance roller with a full T120 supply reel would have risen to more than 75

grams when it's empty at the end of a 2-hour movie.

This high tension would cause significant video problems or videotape destruction, and could lead to premature head-wear problems. The tension should remain within the 23 to 35 gram range during this supply-reel diameter change. This tension variation can easily be measured with an in-line tape-tension meter. The closer the tension is maintained to a nominal 30 grams, the better the tension servo is designed and is operating.

Although an in-line tape-tension meter can be used on any VCR, do not use a tension cassette on VCRs for which it was not intended. If you do, you will reset some properly operating transports to be outside the correct tension specifications. Consult with the factory service technicians if you are unsure of the application for tension cassettes you already have. **ES&T**

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## **Technology Update--Electronics Servicing Vocabulary**

ES&T will publish a glossary of terms commonly used in ES&T servicing articles, and that are the most misunderstood.

*April*

## **Oscilloscope Update**

This ES&T update discusses the new generation of oscilloscopes: digital storage oscilloscopes (DSOs). ES&T also will compare the specifications of both DSOs and traditional analog oscilloscopes, and make suggestions on how to choose a DSO for specific applications.

## **First Annual Distributor Showcase**

The Distributor Showcase will feature an article on choosing and working with a distributor. This ES&T article will also discuss the kinds of services a distributor offers, and how to take advantage of them.

*Plus ES&T's Regular Monthly Departments*

# The anatomy of videotape

By Victor Meeldijk

**M**ore than a billion blank video tapes have been sold since 1982, and the average VCR owner rents five tapes per month. Great figures, but what do you really know about the tape itself? For example, how do you properly handle or store it? What is it made out of? This article will answer those questions, plus give you a little history about this very popular piece of plastic.

## A little history

In 1957, the first commercial videotape, in open-reel format, was Scotch #179, manufactured by the 3M company. Today, the VCR market is responsible for the sale of almost 400 million blank tapes a year, worth over a billion dollars. Tapes are available from a variety of manufacturers, but JVC (Japan Victor Corporation), the inventor of the VHS format, is the licensor of the VHS logo and does all tests of tapes that display the logo.

Videotape is a wafer-thin polyester base (such as Dupont Mylar) coated with a magnetic layer of oxide particles mixed with a high-density synthetic glue (binder). The coating also contains polymers for strength; lubricants to reduce friction and wear; surfactants to aid in dispersing the particles during manufacturing; and a small, controlled amount of abrasive particles for head-cleaning purposes.

The polyester base layer is coated with an even layer of this mixture on one side and an antistatic backing material

(sometimes called carbon black) on the other side. The magnetic particles are oriented in a specific direction and the tape is polished to a mirror finish. A typical 2-hour VHS tape is 206m (807 feet) long and has been slit to a width of 12.65mm (1/2 inch).

Various oxide material formulations are used for different tape-recording purposes. The first commercial audiotapes in the late 1940s used iron oxide particles. In the mid 1960s, chromium dioxide, which has a higher coercivity level (a higher magnetic strength, enabling denser information recording), was used for digital computer tapes. Today, iron (ferric) oxides, chromium oxide or cobalt-doped ferric oxide (for the new S-VHS tapes) are used for videotapes. These various oxide formulations are sold under such trade names as Epitaxial (Maxell), Super Avilyn (TDK), Dynamicon (Sony), Beridox (Fuji) and Dynarec (JVC).

The tape is housed in a case made of injection-molded polystyrene resin or high-impact ABS resin plastic. The case, which incorporates precision-made tape guides and pins and a tape pad to maintain optimum tape tension (to prevent tape slack), is treated to resist static electrical charges.

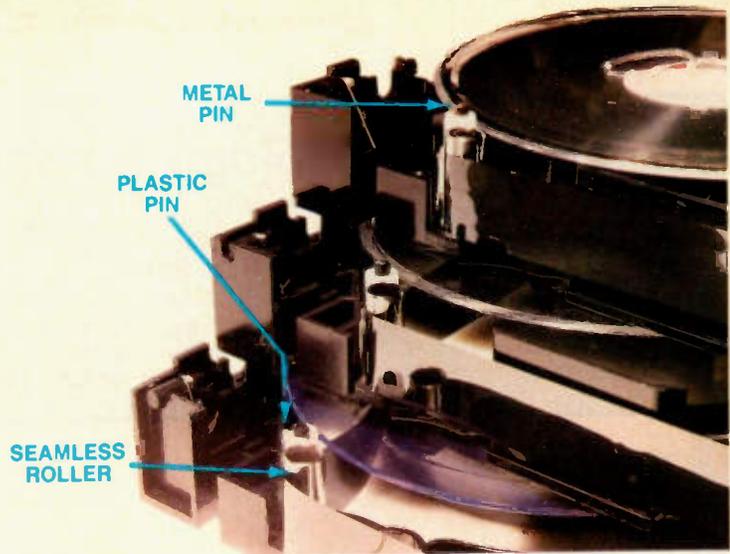
In addition to the tape differences for various tape grades and from different manufacturers, there are differences in the tape-case construction. Photo 1 shows three cases, all with the top removed. The top one is an extra-high-grade tape, the middle is a high-grade tape and the bottom is a standard tape. Note that some rollers have seams, and

pins can be either metal or plastic.

Videotapes come in a variety of grades including standard, high-grade and X-high grade, professional, etc. Numerous video and consumer magazines periodically test and report on various manufacturers' tape performances. These reports indicate that, overall, tape quality has improved over the past several years. In fact, one manufacturer indicates that today's standard tape is better than the high-grade tape of two years ago. Actual differences between tape grades are shown in Table 1, which compares specifications for standard, HGX, HI-FI Gold and professional tape. The dashes indicate no difference from the standard tape specification. Looking at the table, you can see that only the video signal-to-noise ratio (S/N), chroma S/N and dropout rate are different for the various grades. Use Table 2 for the definition of the tape specifications.

Dropouts are specified for different tape sections. No dropout rate is specified for the first half minute or the last one minute of tape. The second minute and the next-to-last minute are rated at twice the dropout rate of the rest of the tape. Stress at the beginning and end of the tape is greater than elsewhere on the tape, and this stress will cause some oxide shedding and stress demagnetization of the magnetic particles in those portions of the tape. These stresses, caused by the tape passing through the tape-transport mechanism, lead to decreasing tape performance after numerous record/play cycles. The dropout figure listed in the table shows the dropouts per minute of

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The tape on the top is extra-high grade. The tapes in the middle and on the bottom are, respectively, high grade and standard.

the main section of the tape (116.5 minutes).

In actual use, most tape dropouts are not visible because a delay line in the VCR uses the previous horizontal scan line to fill in lost information. When dropouts do occur, they can be due to tape imperfections, dirty recorder heads or dirt or loose oxide particles on the tape. Figure 1 shows a severe dropout; Figure 2 shows the videotape. The tape scratches are a result of the tape being subjected to numerous record/play cycles. You can check tape performance with professional tape cleaners and dropout counters. (For example, RTI Video Products, Lincoln, IL, and Asaca/Shibasoku Corporation of America in Los Angeles both offer these devices.)

You may have noticed that a new tape seems to improve after the first use. This improvement occurs because playing the tape removes loose oxide particles, which are caused by the manufacturing process.

### S-VHS tapes

The new S-VHS tape uses a new formulation of ferric oxide that has smaller magnetic particles, which makes it possible to store more information on a given portion of tape. It also has a higher coercivity level (which relates to the energy needed to store and retrieve data on the tape) that enhances the image-retaining capacity of the tape. The greater information storage allows the tape to record more than 400 lines of horizontal resolution for a sharper picture (as compared to broadcast 330

*Main article continued on page 26.*



Figure 1. Most tape dropouts are not visible in actual use because a delay line in the VCR uses the previous horizontal scan line to fill in lost information. However, a severe dropout, such as the one shown here, will be visible.

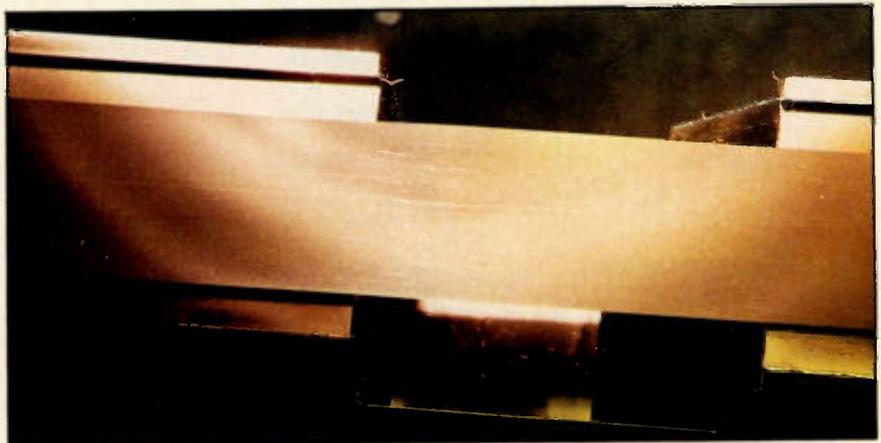


Figure 2. Repeated record/play cycles can cause tape scratches, which can result in dropouts. The scratches on this tape (visible in the center of the tape) caused the severe dropouts shown in Figure 1.

# Videotape storage guidelines

1. At a minimum, the temperature and humidity should be controlled within the limits of 70°F plus or minus 5% and a relative humidity of 50% plus or minus 20%. For archival storage, it is recommended that the relative humidity be kept

at 45% or lower and the temperature below 70°F.

2. Store tapes in their jackets and enclose them in a sealed bag or place the tapes in fully closed boxes or closed drawers to eliminate degradation caused by dust

and dirt and other contaminants (reference Figure 3).

3. Cassettes should be stored on end (to be supported by the hub), not flat, to prevent a section of tape from sagging and possibly damaging the edge of the tape.

4. The air to this area should be filtered. It is recommended that at a minimum, the filtration used must at least meet the efficiency rating of 90% based on the National Bureau of Standards Dust Spot Efficiency Test-Atmospheric Dust.

The airflow system should be designed to maintain a positive pressure. This prevents dust particles from floating into the room from other locations. In addition, the duct work sizes and placement leading to this area should allow the necessary amount of air flow to maintain the proper temperature and humidity control. Air velocities should not be at a level high enough to blow settled dust and debris around the room.

5. When tapes are removed from the storage library, the containers should be inspected for accumulation of dust or debris and wiped clean, if necessary, before being taken to the operations area.

6. The storage environment must be controlled, but it should be pointed out that most tapes are designed to withstand relatively short periods of extreme environments, such as those encountered during shipment (-34°C to +65°C).

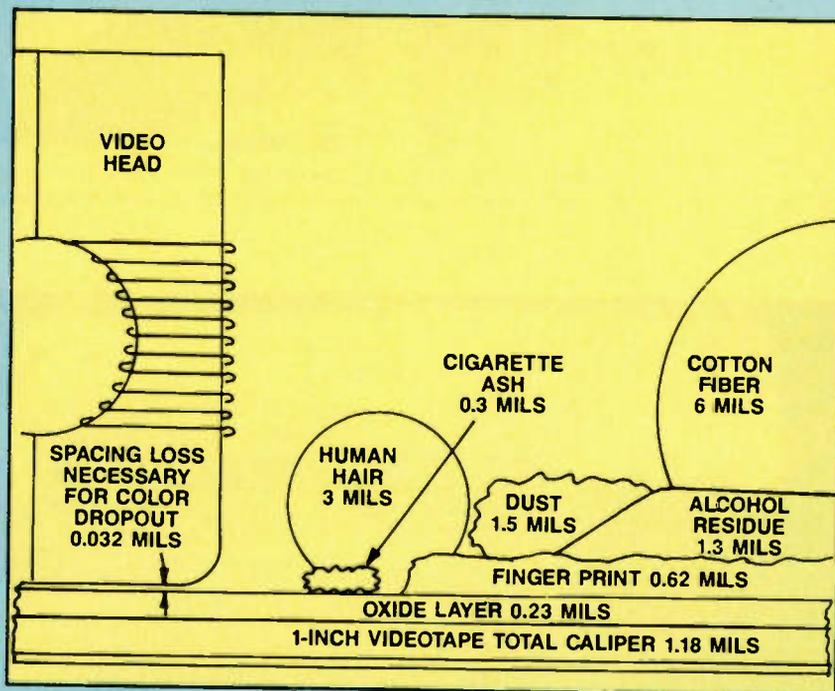


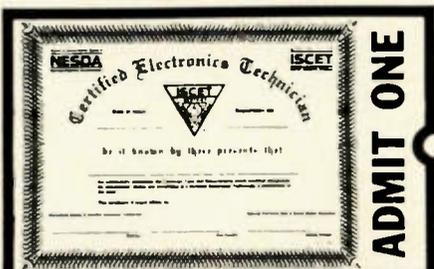
Figure 3. Compared to the size of the videotape itself (1.18 mils), debris, such as a human hair (3 mils), is large enough to cause severe problems. (Courtesy of 3M.)

Table 1  
Comparison of tape-grade specifications

specification	standard	HGX	Hi-Fi Gold	professional
leader/trailer (LT) length	170±20mm	—	—	—
LT tape thickness	40+ 5 -25µm	—	—	—
LT material	polyester film	—	—	—
LT transparency	more than 50%	—	—	—
splicing tape length	12.7mm	—	—	—
splicing tape thickness	less than 33µm	—	—	—
splicing gap	less than 70µm	—	—	—
splicing force	more than 3kg	—	—	—
clamping force on leader (trailer) tape and reel	more than 3kg	—	—	—

Table 1 continued

specification	standard	HGX	HIFI Gold	professional
<b>Tape specifications:</b>				
total thickness	20 (+1/-2) $\mu$ m	—	—	—
width	12.65 $\pm$ .01mm	—	—	—
width fluctuation	less than 6 $\mu$ m	—	—	—
length (T-120)	246 (+3/-0)m	—	—	—
breaking strength	more than 3kg	—	—	—
yield strength (for 5% elongation)	more than 1.8kg	—	—	—
residual elongation	less than 0.2%	—	—	—
electrical resistivity (coating side)	less than 10 <sup>11</sup> $\Omega$ /sq in.	—	—	—
transparency	less than 0.1%	—	—	—
video output	more than -1db	—	—	—
optimum recording current	$\pm$ 10%	—	—	—
video S/N	more than -1db	more than 0db	more than +1db	more than +1db



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Table 1 continued

specification	standard	HGX	HiFi Gold	professional
chroma output	±2db	—	—	—
dropout (times/minute)	less than 50	—	less than 35	less than 35
chroma S/N	more than 0db	more than +1db	more than +0.5db	more than 0db
operating bias	±10%	—	—	—
sensitivity	±2db	—	—	—
frequency response	±2db	—	—	—
output level VARIATION (db VU)	@1kHz within 2 @7kHz within 2	—	—	—
audio S/N	more than -1db	—	—	—
erasibility	more than 65db	—	—	—
print-through	more than 45db	—	—	—
head wear after 50 plays	less than 6µm	—	—	—
playback level reduction	video signal less than 3db chrominance signal less than 3db audio signal less than 3db	—	—	—
pause (after 60 minutes)	no trouble	—	—	—
runnability (check head and video quality after 100 plays)	no trouble	—	—	—
high temperature storage (60°C, 24 hours)	no trouble	—	—	—
high temp. and humidity (40°C, 80% RH, 24 hours)	no trouble	—	—	—
low temperature storage (-10°C, 24 hours)	no trouble	—	—	—
temperature cycling (40°C for 16 hours -10°C for 8 hours)	no trouble	—	—	—
drop test (from 30cm to wooden board) 20mm THICK 3 AXES	no cracks, scratches or case disconnections	—	—	—
vibration 7Hz @ 3mm amplitude 30 minutes all three axes	no mechanical problems or loose screws	—	—	—

## Videotape handling guidelines

1. Never open the cassette, touch the tape or pull the tape from the cartridge.
2. Keep tapes out of direct sunlight and away from heat and high humidity (storage at 25° C is preferred). The case plastic will soften at more than 100°F and will melt at 160°F. Car temperatures in summer easily reach over 100°F.
3. The tapes and cassettes should be kept in their containers when they aren't being used.
4. To avoid inadvertent contamination of both the tapes and machines, smoking, eating and drinking should be restricted to certain areas and preferably out of the recording locations.
5. Avoid abrupt changes in tape temperature, and allow a tape to warm up or cool down to room ambient (25°C) before use.
6. Keep tapes away from magnetic fields



such as amplifiers, TVs and loudspeakers. A magnetic field of 300 to 400 oersteds will erase a tape. These are high levels; for example, the earth's magnetic field is approximately 0.6 oersteds and the field of an electric hand drill under full load is about 10 oersteds at the drill-case surface. Permanent magnets can have a field intensity of 1,500 oersteds at their pole tips, but at a distance of just 3 inches, the field strength will decrease to less than 50 oersteds.

7. Slack tape may jam the VCR. If the tape is slack, wind tape gently until tight. (To tighten slack, hold the cassette with the lid facing up and the bottom of the cassette toward you. Gently rotate the left tape reel counter-clockwise and the right tape reel clockwise.)
8. To prevent tape stretching, before storage fast forward the tape to the end and then rewind it.
9. Most dropouts occur at the beginning of the tape. For optimum recording, wind the tape for 10 to 15 seconds at the beginning before the start of any recording.

10. To prevent erasure of tapes, remove the tab on the back of the cassette. To allow the tape to be recorded again, cover the tab hole with cellophane tape.

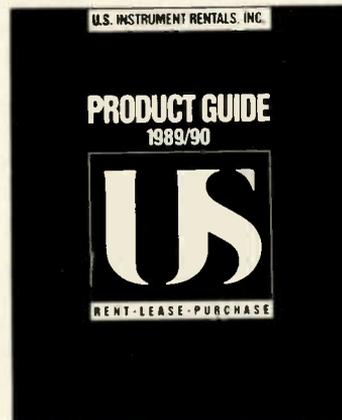
11. Do not cover the tapes with big labels, which may prevent the tape from running properly.

12. Do not wipe the cassette shell with alcohol or benzene, which will melt or distort the cassette case and damage the tape.

13. To ensure that tapes are properly wound and to prevent noise due to magnetic transfer from one layer to another, forward (play mode) and rewind tapes all the way through every six months.

14. The cardboard debris from ripping open the master shipping cartons is a common source of debris. This unpacking should be done outside the VCR operating area.

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## Definitions

**Audio frequency response:** A measure of the range of frequency reproduced by the tape and machine within +3db (output level at 1kHz).

**Audio S/N (signal-to-noise):** Refers to the background hiss in the sound.

**Audio uniformity:** Ability of a tape to reproduce a steady-state tone of 1kHz recorded at a constant amplitude for three minutes on both stereo channels. Right-channel problems may be related to poor tape slitting while left-channel problems may be related to poor magnetic tape coating. This does not apply to hi-fi sound, which is not recorded on outer tape tracks.

**Chroma:** The quality of color that combines hue and saturation.

**Chroma noise:** Splotches and other forms of unevenness in a uniform field of color.

**Chroma S/N ratio:** An accuracy of color measurement. Chroma AM S/N is a measurement of color intensity of a single field. Chroma PM S/N variation is the hue or shade of a single color field.

**Coercivity:** The degree to which a magnetic tape can be magnetized. The greater the tape coercivity, the higher the recording density can be.

**Dropout:** Loss of a portion of audio/video signal, commonly caused by dirt or a lack of oxide particles on a portion of the videotape.

**Dispersion:** The consistency between bat-

ches of tape. This is the difference between the best and worst video S/N measured for each sample of tape and indicates the variation in quality among tapes from different production batches.

**FM loss:** Measure of image dullness/noisiness with a large number of playbacks of the same tape.

**Frequency response:** Picture sharpness.

**Initial dropout count:** Dropouts per minute on a new, unused tape.

**Noise:** Any unwanted signal present in the total signal, one signal interfering with another.

**Oxide:** The metallic compound coated onto the base film that can be magnetized to encode and then reproduce a given electronic signal.

**Print-through:** The information (magnetic field) contained on one layer of tape reacting with other tape layers, causing a weak recording on the adjacent layers.

**Sensitivity:** A measure of how much of the original sound the videotape is capable of reproducing. The higher the sensitivity, the more accurately sounds are reproduced.

**Signal retention:** The ability of the tape to retain signal levels with repeated playback.

**T-120:** Refers to the cartridge style used in a VHS machine with 120 minutes of

record/playback time when used in a 2-hour mode.

**Tape dropouts:** These defects cause brief bursts of video noise on playback. Short-duration dropouts are often mistaken for noise. Dropouts are caused by tape imperfections, which cause an absent or lowered amplitude video signal. Dropouts of 15 $\mu$ s or more show up as horizontal white or black streaks in the picture. Higher dropouts occur near the beginning and end of the tape due to higher mechanical stresses at these points. Tape quality has improved in dropout reduction—in tests done in 1982, nearly half of the tapes evaluated had more than 30 dropouts per minute. Tests in 1987 show that dropouts have been reduced to 10 per minute.

**VCR:** Video cassette recorder.

**VHS:** Video home system. Refers to a 1/2-inch recording format that utilizes an M-wrap method of presenting videotape to the heads.

**Video frequency response:** Relates to picture detail and resolution. The higher the frequency response, the more detail you can expect to see (dependent upon the capability of the VCR being used).

**Video S/N ratio:** The amount of electrical signal produced by the tape compared to the original signal (i.e., picture graininess and snow). A high S/N tape reproduces black and white clearly with lots of shades of gray. A low video S/N results in a picture with blurry outlines appearing flat.

Main article continued from page 21. lines or a standard VCR 230 horizontal lines). A special hole in the S-VHS cartridge allows the S-VHS recorder to sense whether an S-VHS cassette or a standard cassette is used, thus turning on the S-VHS circuitry. S-VHS cassettes can be used in a standard VHS machine, but because the coercivity is higher (900-950 oersteds vs. 700-740 oersteds for a regular tape), a stronger magnetic field is required to put information on the tape. Because a standard recorder is not designed to provide an optimum signal for this coercivity level, actual video performance will be less than if a good, high-grade tape is used. Recorded S-VHS-mode tapes are not playable on a standard recorder because differences exist in the way the S-VHS

machine records data on the tape compared to a standard machine.

### How long will the tapes last?

Videotape will last a long time if it is properly cared for. It is not known at this point, however, whether a tape will last 25, 50, 75 or 100 years. (However, to prevent noise caused by magnetic transfer from one layer to another, tapes should be forwarded in play mode and rewound every six months).

The Museum of Broadcasting, which wants to preserve recordings for 500 to 1,000 years, is using a grant from Sony to transfer their television recordings into a digital tape format. The digital tape uses harder magnetic particles and creates clearer copies, recording a digital signal from which the original

program can be precisely recovered.

Quality name-brand tapes should be good for 1,000 plays or several hundred erase and record cycles. High-grade or premium tapes can be recorded as many as 500 times without showing signs of wear, provided the VCR is in proper condition and has had periodic cleaning.

Tape life and performance is related to the handling and storage of the tape cassette. Tables 3 and 4 are tape-handling and storage guidelines that should be followed to insure the best performance of videotapes.

### ACKNOWLEDGEMENTS

I would like to especially thank the Maxell Corporation and the 3M Company for providing much of the information used in this article. 

## Books/Photofact

*Editor's note: Periodically, ES&T features books dealing with subjects of interest to our readers. Please direct inquiries and orders to the publishers.*

**Principles of Electronics,** by Barry Dowding; Prentice Hall; 509 pages; \$69.

This intermediate-level text requires no previous experience with the material covered, but a familiarity with the basic principles of electricity and electric circuits is recommended. The book develops, from first principles, an understanding of the properties, performance and operating capabilities of an extensive range of modern analog and digital devices, circuits and subsystems.

Prentice Hall, Route 9W, Englewood Cliffs, NJ 07632; 201-767-5937.

**Fiber Optic Communications, 2nd ed.;** by Joseph C. Palais; Prentice Hall; 291 pages.

This book introduces the design, operation and capabilities of fiber communications systems. No previous experience in fiber optics or optic communications is assumed; appropriate background material on optics, electronics and communications is explained as needed. Theoretical and mathematical results are described in physical terms and extensive figures and tables are used to make these results readily useable. Also, block diagrams are presented at the outset of the book, identifying the components of fiber systems.

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**Professional Service Management,** by William Joseph Lynott; Lynco Publications; \$25.95 paperback, \$34.95 hard cover.

This book, previously a best-seller in hard cover, is now available in paperback and can be ordered directly from the publisher. The book covers several management topics, including productivity, marketing, customer relations, contracts and service rates.

Lynco Publications, 614 N. Easton Road, Suite 200, Glenside, PA 19038; 215-886-3646.

**Data Communications Testing and Troubleshooting,** by Gilbert Held; Howard W. Sams; 240 pages; \$29.95.

This comprehensive guide discusses the operation and applications of more

than ten test instruments in a data communications network, including digital and analog instruments, modems and multiplexers. Written as a tutorial for technicians, network analysts, engineers and technical control center personnel, the book offers the foundation for understanding, performing, testing and troubleshooting data communications equipment and transmission facilities.

Howard H. Sams & Company, 4300 W. 62nd St., Indianapolis, Indiana 46268; 800-428-SAMS.

**Complete Guide to RS-232 and Parallel Connections, A Step-By-Step Approach to Connecting Computers, Printers, Terminals, and Modems;** by Martin D. Seyer; Prentice Hall; 617 pages.

This comprehensive guide presents a unique approach to connecting computers and peripherals. Tutorial modules have been designed to illustrate almost any possible connection performed with serial and parallel interface. A review of more than 300 devices has been included in the appendices to assist the reader.

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**Experiments in CMOS Technology;** by Dave Prochnow and D.J. Branning; TAB Books; 256 pages; \$16.60 paperback, \$24.95 hardbound.

Recent advances in Complementary Metal Oxide Semiconductor (CMOS) technology are discussed in this volume, part of TAB's Advanced Technology Series. The book provides several challenging projects, each complete with a schematic diagram, parts list and PCB template, when applicable. Detailed appendices, a glossary, a bibliography and an index are also included.

TAB Books, Blue Ridge Summit, PA 17294-0850; 717-794-2191.

**Linear Circuit Analysis;** by S. Madhu; Prentice Hall; 833 pages.

This text presents a rigorous treatment of the methods of circuit analysis and their applications. Included are an appendix on SPICE; exercises; worked examples; coverage of two ports, magnetic circuits and three phase circuits; and methodical development of all topics.

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Circle (9) on Reply Card

# High-definition tuner/amplifiers

Nakamichi America Corporation and Nakamichi Canada have introduced two high-definition tuner/amplifiers — the TA-3A and TA-2A — that feature STASIS output circuitry and unified system remote control. Both units provide remote operation of a Nakamichi CD player and a Nakamichi cassette deck as well as armchair control of system power, volume and muting, plus station, band and source selection. In addition, the TA-3A will operate a second cassette deck and permit remote control of azimuth on decks with an azimuth-control feature. Both use a motor-driven, audiophile-quality potentiometer to ensure continuous control and avoid noise and distortion.

The 75W/channel TA-3A is designed to be the focal point of a complete audio/video (A-V) home-entertainment system. It accesses three external A-V sources (video 1, video 2 and tape-2/VCR) and three audio-only sources (CD, phono and tape 1), as well as its own AM/FM stereo tuner. Pre-out/main-in jacks enable the user to connect a surround-sound processor, a powered subwoofer or other audio signal-processing equipment at the ideal point in the signal path. A video output is provided to drive a viewing monitor. Independent listen and record-out selectors permit viewing and listening to one source while copying another. The record-out selector is wired to permit A-V recording from either video source to the tape-2/VCR output as well as two-

way audio dubbing between the tape 1 and the tape 2/VCR equipment. Both the video monitor and the VCR record outputs are buffered by discrete three-stage wideband video amplifiers.

The 50W/channel TA-2A high-definition tuner/amplifier accesses three external high-level audio inputs (CD, tape and video) and provides a precisely equalized moving-magnet phono pre-amp with built-in subsonic filter. Independent listen and record-out selectors permit listening to one program while recording another, and pre-out/main-in connectors accommodate external audio-processing equipment at the proper point in the signal path.

Both tuner/amplifiers feature a sensitive, quartz-synthesized AM/FM stereo tuner with 10 station presets and a choice of manual or auto-seek tuning.

The TA-3A and TA-2A use a STASIS output configuration that is radically different from the power stage used in conventional receivers. A STASIS amplifier neither requires nor uses global feedback to reduce distortion. As a result, it is inherently stable with every loudspeaker and its output impedance is uniform with frequency. The result of the STASIS topology is an amplifier that can drive "difficult" loudspeakers and will play louder and cleaner than many amplifiers rated to deliver much more power.

Figures 1 and 2 compare STASIS topology with the circuitry used in a conventional amplifier. The conven-

tional power amplifier uses a global feedback loop (marked NFB) from the final output transistor to the negative terminal of the input amplifier. The NFB loop serves to reduce distortion but causes problems in maintaining amplifier stability. In order to reduce the risk of instability when the amplifier drives a complex load such as a loudspeaker, an output coil must be interposed between the amplifier and the load. The coil causes the output impedance to rise with frequency. This, in turn, affects the amplifier's ability to control the loudspeaker and may cause non-uniform frequency response when a "real-world" speaker is driven. The output impedance of a conventional amplifier is low until about 3,000Hz, when it increases sharply. The uniform output impedance provided by the STASIS design is a key factor in maintaining tonal accuracy and musical clarity.

In the STASIS configuration, two amplifiers drive the speaker. One, the STASIS amplifier, is a low-distortion, low output-impedance amplifier with relatively modest current capability. The other amplifier consists of complementary positive and negative high-impedance, high-current *current-mirror bootstraps*. Because of the impedance difference, the low-impedance amplifier determines the voltage across the load while the high-impedance bootstraps supply the muscle.

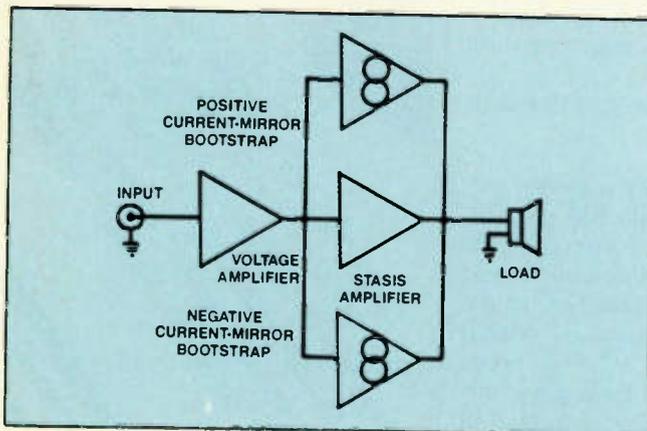


Figure 1. In the STASIS configuration, two amplifiers drive the speaker. The STASIS amplifier is a low-distortion, low output-impedance amplifier with relatively modest current capability.

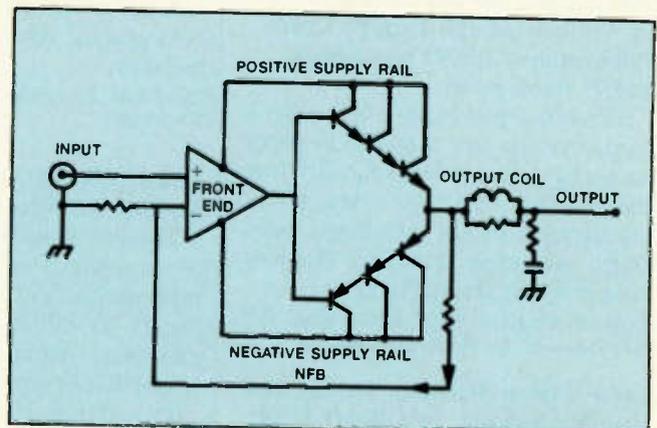
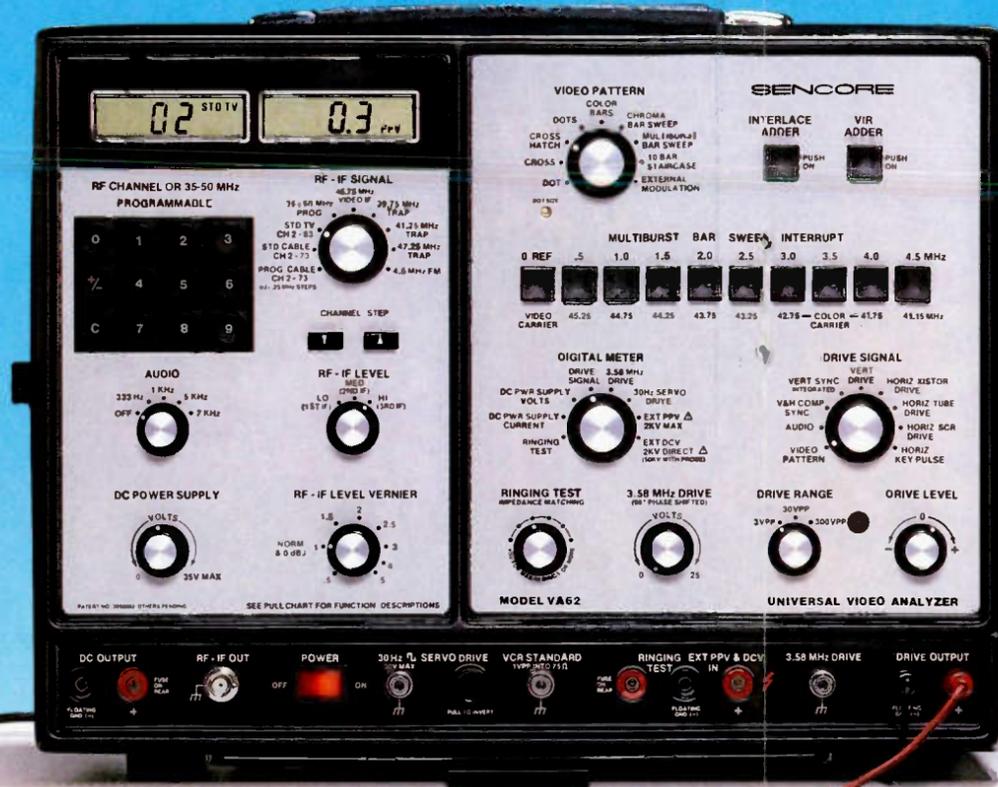


Figure 2. The conventional power amplifier uses a global feedback loop (marked NFB) from the final output transistor to the negative terminal of the input amplifier.

VA62 Universal Video Analyzer

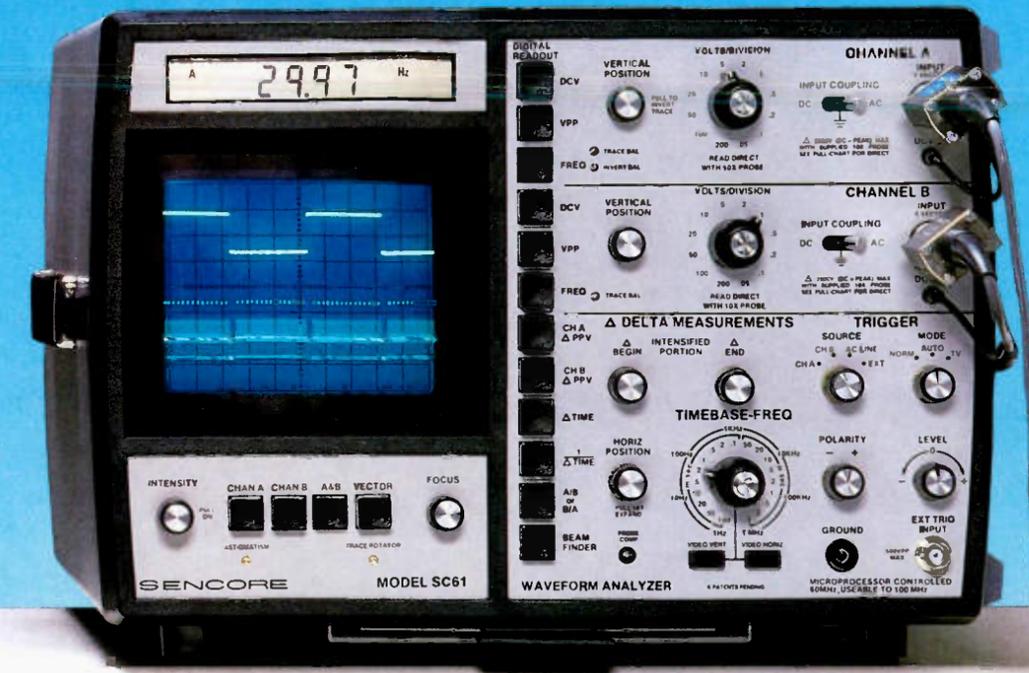


NT64 NTSC Pattern Generator

VC63 VCR Test Accessory



SC61 Waveform Analyzer

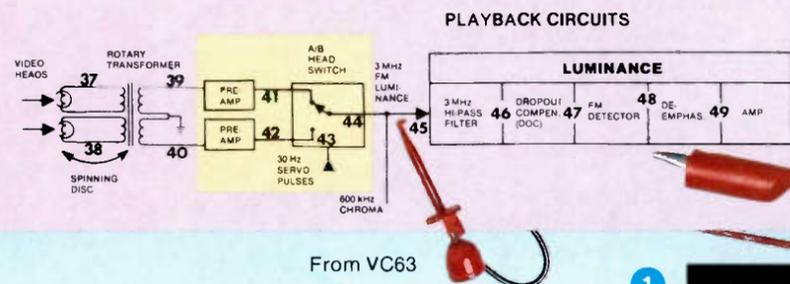


**Turn A 2 Hour Head Circuit Headache Into 20 Minutes Of Easy Profit With The Ultimate Troubleshooting Team.**

**Symptom:** Noisy Picture

**Suspect:** Playback Head Circuits, FM Luminance Circuits, or Composite Video Circuits.

**Solution:** Use the VA62 Universal NTSC Video Analyzing System and the SC61 Waveform Analyzer.



From VA62

From VC63

**Isolate the faulty stage in three easy steps with the VA62 Video Analyzing System and signal injection.**

Load a standard test tape into the VCR and press play. Set the VA62 to generate the CROSS HATCH pattern.

- Inject a 0.3 VPP composite video signal into point 48 from the DRIVE OUTPUT of the VA62.

**Results:** The cross hatch pattern pops onto the screen. This shows you the video circuits following the FM detector function properly and the problem lies toward the heads.

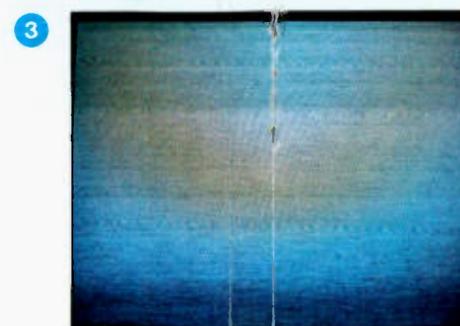
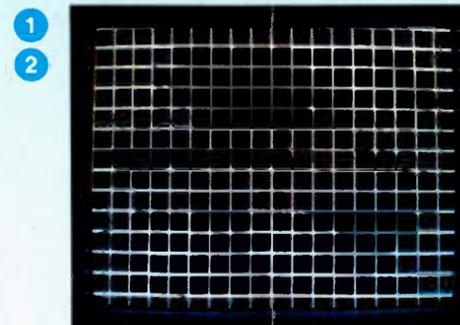
- Inject an FM luminance signal at point 45. This signal is generated from the VC63 Test Accessory.

**Result:** The cross hatch pattern again pops onto the screen. This shows you all of the circuits past point 45 are working including the FM detector.

- Inject the FM luminance signal from the VC63 into points 39 and 40. In a typical IC the preamp and head-switcher are in the same IC.

**Result:** Noisy picture. This shows you are injecting before the fault.

**Analysis:** You've used the VA62 to narrow the problem down to the preamp and head-switcher IC.



**The SC61 Waveform Analyzer isolates the faulty component. Just connect the probe and push the buttons.**

Now use the SC61 to help decide if the IC needs to be replaced or if the problem lies in an outboard circuit.

- Check the B+ supply. Connect the probe to pin 2. Press the DC volts button. Read the DC voltage on the readout.

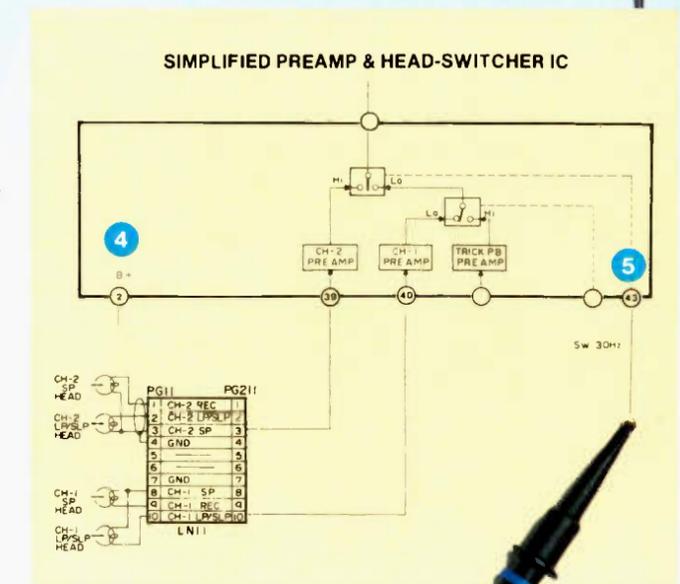
**Result:** The readout shows 12.35 volts DC. The waveform is also clean showing you the supply isn't the problem.

- Check the 30 Hz switching pulse. Connect the probe to pin 43. Press the voltage peak-to-peak (VPP) button. Read VPP on the readout. Press the FREQUENCY button. Read the frequency on the readout.

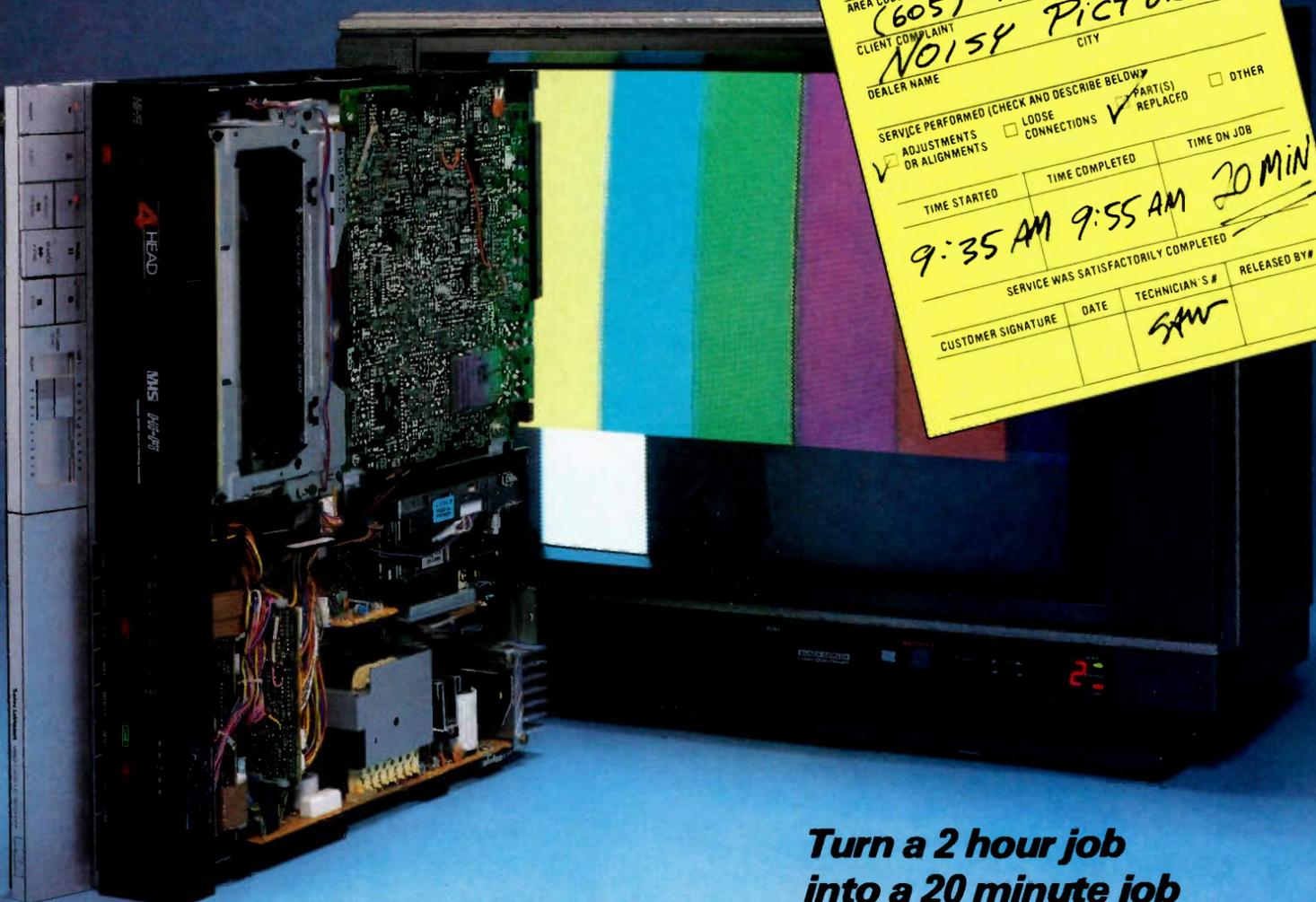
**Result:** The readout shows the VPP of the servo pulse to be 4.9. The readout shows the frequency to be 29.9 Hz. The waveform is within tolerance.

**Analysis:** The SC61 has shown that the IC's outboard circuits are working.

**Conclusion:** Replace the preamp and head-switcher IC.



From SC61



LABOR WARRANTY     PART WARRANTY     NO WARRANTY

BRAND NAME: \_\_\_\_\_  
 CLIENT LAST NAME: **DAVIS**  
 ADDRESS: **3200 STATE ST.**  
 CITY: **SIoux FALLS SD**  
 AREA CODE: **(605)**    PHONE#: **472-1111**  
 CLIENT COMPLAINT: **NOISY PICTURE**  
 DEALER NAME: \_\_\_\_\_

SERVICE PERFORMED (CHECK AND DESCRIBE BELOW)  
 ADJUSTMENTS OR ALIGNMENTS     LOOSE CONNECTIONS     PART(S) REPLACED     OTHER

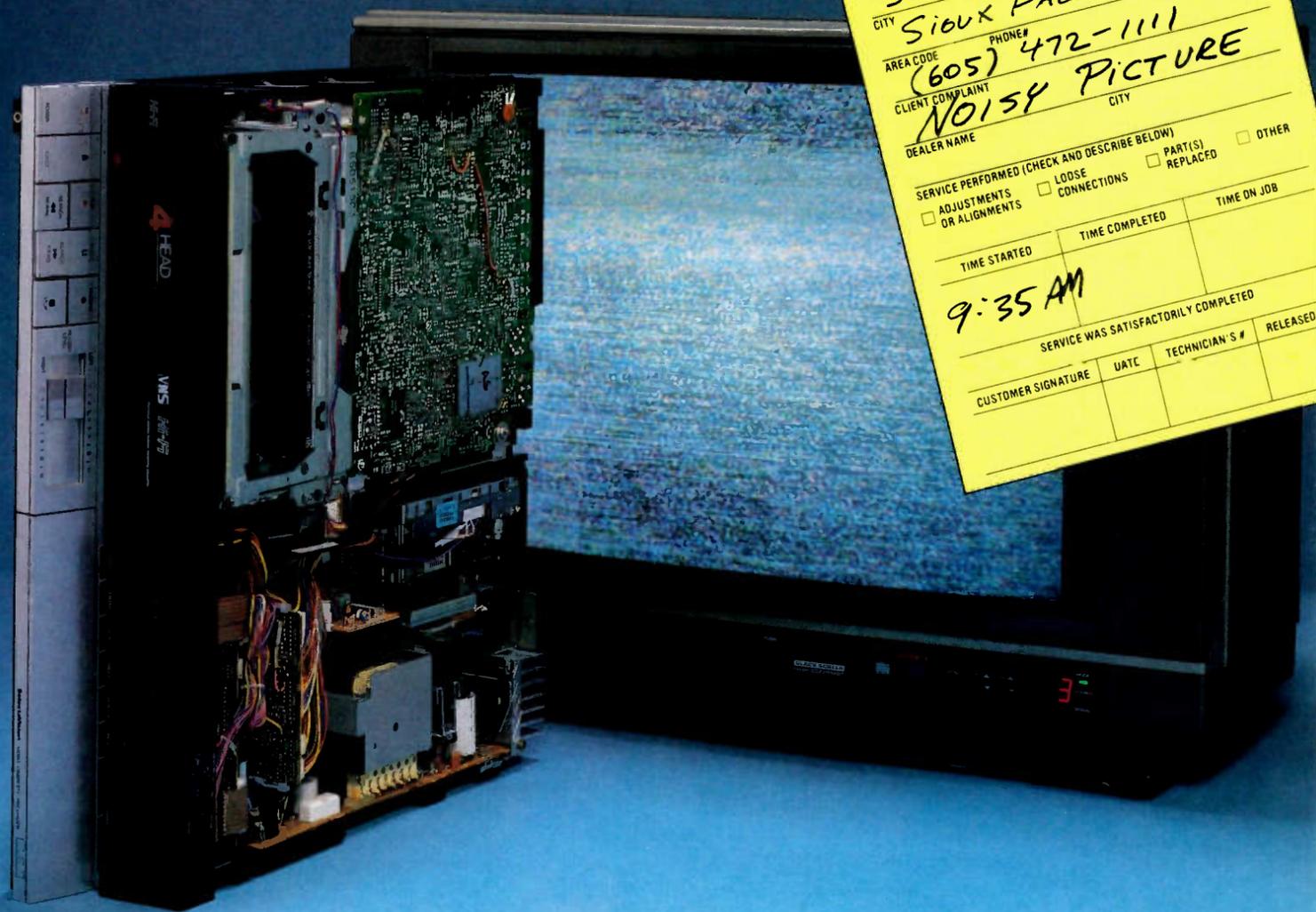
TIME STARTED	TIME COMPLETED	TIME ON JOB
<b>9:35 AM</b>	<b>9:55 AM</b>	<b>20 MIN</b>

SERVICE WAS SATISFACTORILY COMPLETED

CUSTOMER SIGNATURE	DATE	TECHNICIAN'S #	RELEASED BY #
<b>SAW</b>			

**How Long Would It Take You To Locate The Problem In This VCR?**

**1 Hour?  
2 Hours?**



LABOR WARRANTY     PART WARRANTY     NO WARRANTY

BRAND NAME: \_\_\_\_\_  
 CLIENT LAST NAME: **DAVIS**  
 ADDRESS: **3200 STATE ST.**  
 CITY: **SIoux FALLS SD**  
 AREA CODE: **(605)**    PHONE#: **472-1111**  
 CLIENT COMPLAINT: **NOISY PICTURE**  
 DEALER NAME: \_\_\_\_\_

SERVICE PERFORMED (CHECK AND DESCRIBE BELOW)  
 ADJUSTMENTS OR ALIGNMENTS     LOOSE CONNECTIONS     PART(S) REPLACED     OTHER

TIME STARTED	TIME COMPLETED	TIME ON JOB
<b>9:35 AM</b>		

SERVICE WAS SATISFACTORILY COMPLETED

CUSTOMER SIGNATURE	DATE	TECHNICIAN'S #	RELEASED BY #

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Form 3962 Printed in U.S.A.

Product safety should be considered when component replacement is made in any area of a receiver. Components marked with a ! designate sites where safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components. A lightning bolt

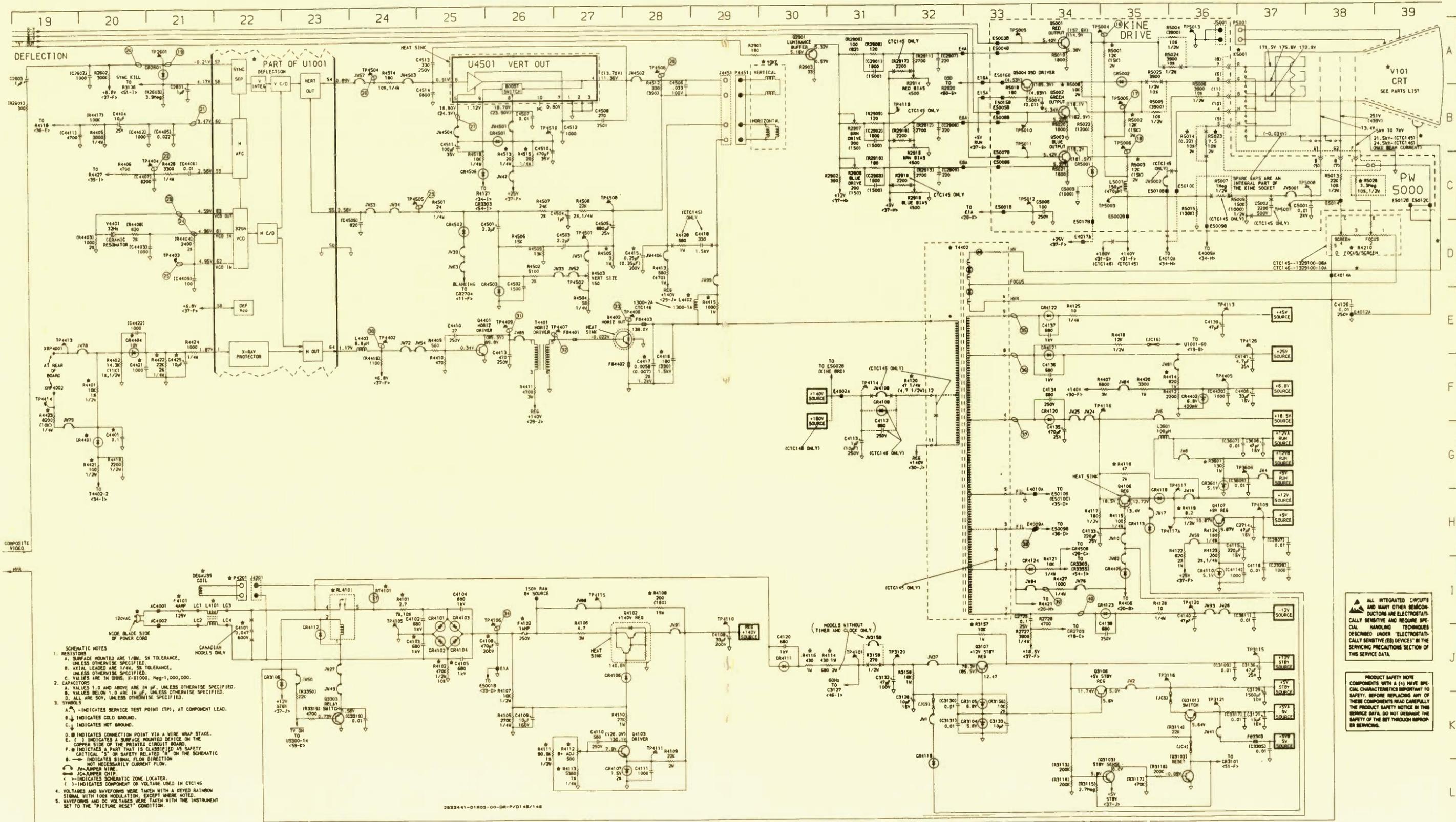
designates the presence of uninsulated, dangerous voltage.

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.

RCA/GE CTC145/146  
DEFLECTION/POWER SUPPLY SCHEMATIC

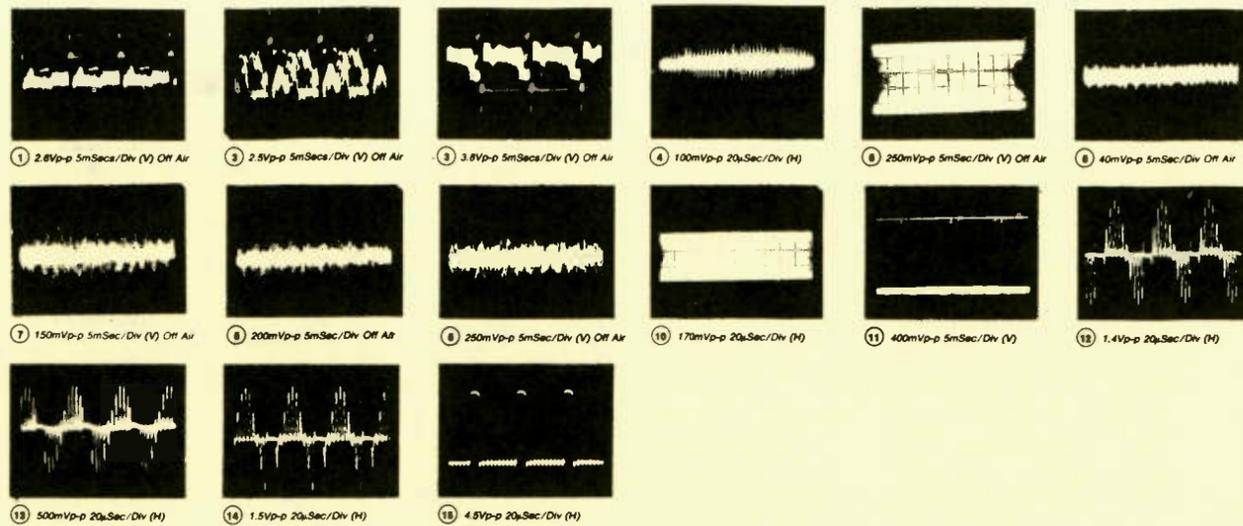


- SCHEMATIC NOTES**
- RESISTORS
    - A. SURFACE MOUNTED ARE 1/8W, 5% TOLERANCE, UNLESS OTHERWISE SPECIFIED.
    - B. AXIAL LEADED ARE 1/4W, 5% TOLERANCE, UNLESS OTHERWISE SPECIFIED.
    - C. VALUES ARE IN OHMS, K=1,000, M=1,000,000.
  - CAPACITORS
    - A. VALUES 1.0 AND ABOVE ARE IN  $\mu$ F, UNLESS OTHERWISE SPECIFIED.
    - B. VALUES BELOW 1.0 ARE IN nF, UNLESS OTHERWISE SPECIFIED.
    - D. ALL ARE 50V, UNLESS OTHERWISE SPECIFIED.
  - SYMBOLS
    - A. - INDICATES SERVICE TEST POINT (TP), AT COMPONENT LEAD.
    - B. - INDICATES COLO GROUND.
    - C. - INDICATES HOT GROUND.
    - D. - INDICATES CONNECTION POINT VIA A WIRE WRAP STAKE.
    - E. ( ) INDICATES A SURFACE MOUNTED DEVICE ON THE COPPER SIDE OF THE PRINTED CIRCUIT BOARD.
    - F. - INDICATES A PART THAT IS CLASSIFIED AS SAFETY CRITICAL. \* ON SAFETY RELATED \* ON THE SCHEMATIC.
    - G. - INDICATES SIGNAL FLOW DIRECTION.
    - H. - INDICATES NECESSARILY CURRENT FLOW.
    - J. - JUMPER WIRE.
    - K. - JUMPER CHIP.
    - L. - INDICATES SCHEMATIC ZONE LOCATOR.
    - M. - INDICATES COMPONENT OR VOLTAGE USED IN CTC146.
  - VOLTAGES AND WAVEFORMS WERE TAKEN WITH A KEYSIGHT SIGNAL WITH 100% MODULATION, EXCEPT WHERE NOTED.
  - WAVEFORMS AND DC VOLTAGES WERE TAKEN WITH THE INSTRUMENT SET TO THE "PICTURE RESET" CONDITION.

ALL INTEGRATED CIRCUITS AND MANY OTHER SEMICONDUCTORS ARE ELECTROSTATICALLY SENSITIVE AND REQUIRE SPECIAL HANDLING TECHNIQUES DESCRIBED UNDER "ELECTROSTATICALLY SENSITIVE DEVICES" IN THE SERVICING PRECAUTIONS SECTION OF THE SERVICE DATA.

PRODUCT SAFETY NOTE COMPONENTS WITH A (!) HAVE SPECIAL CHARACTERISTICS IMPORTANT TO SAFETY. BEFORE REPLACING ANY OF THESE COMPONENTS READ CAREFULLY THE PRODUCT SAFETY NOTICE IN THIS SERVICE DATA. DO NOT DEGRADE THE SAFETY OF THE SET THROUGH IMPROPER SERVICING.

RCA/GE CTC145/146 SIGNAL SCHEMATIC



RCA/GE CTC145/146 SIGNAL SCHEMATIC

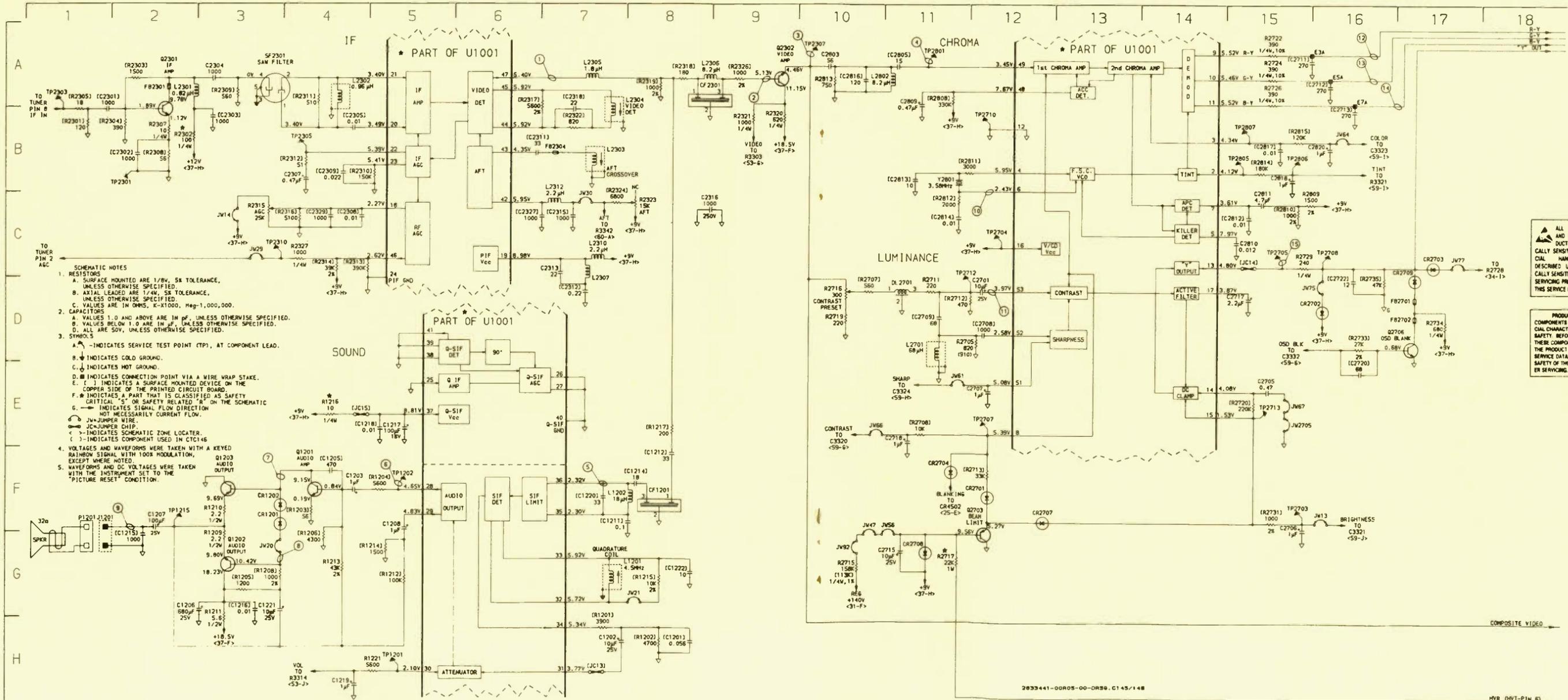
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designates the presence of uninsulated, dangerous voltage.

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

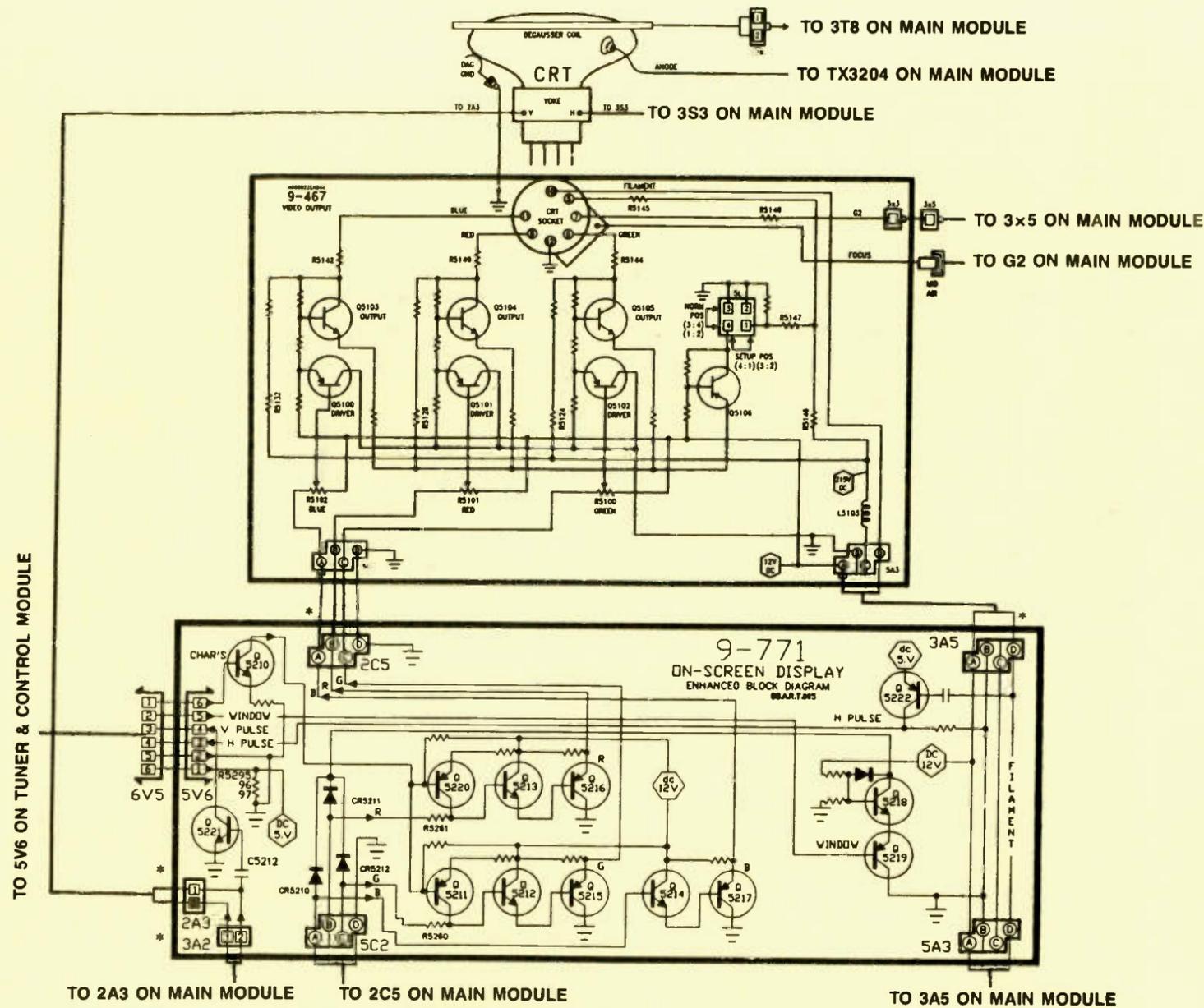


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### ZENITH CM-140/B-2(G) CRT/ON-SCREEN DISPLAY SCHEMATIC DIAGRAM



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February 1989

Schematic RCA/GE Color TV, CTC145/146.....	3040
Zenith Color TV, CM-140/B-2(G) SE2503G/SE2505P, SE2507N/SE2509H.....	3041

### ZENITH CM-140/B-2(G) MAIN SCHEMATIC DIAGRAM

Product safety should be considered when component replacement is made in any area of an electronics product. A star next to a component symbol number designates 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

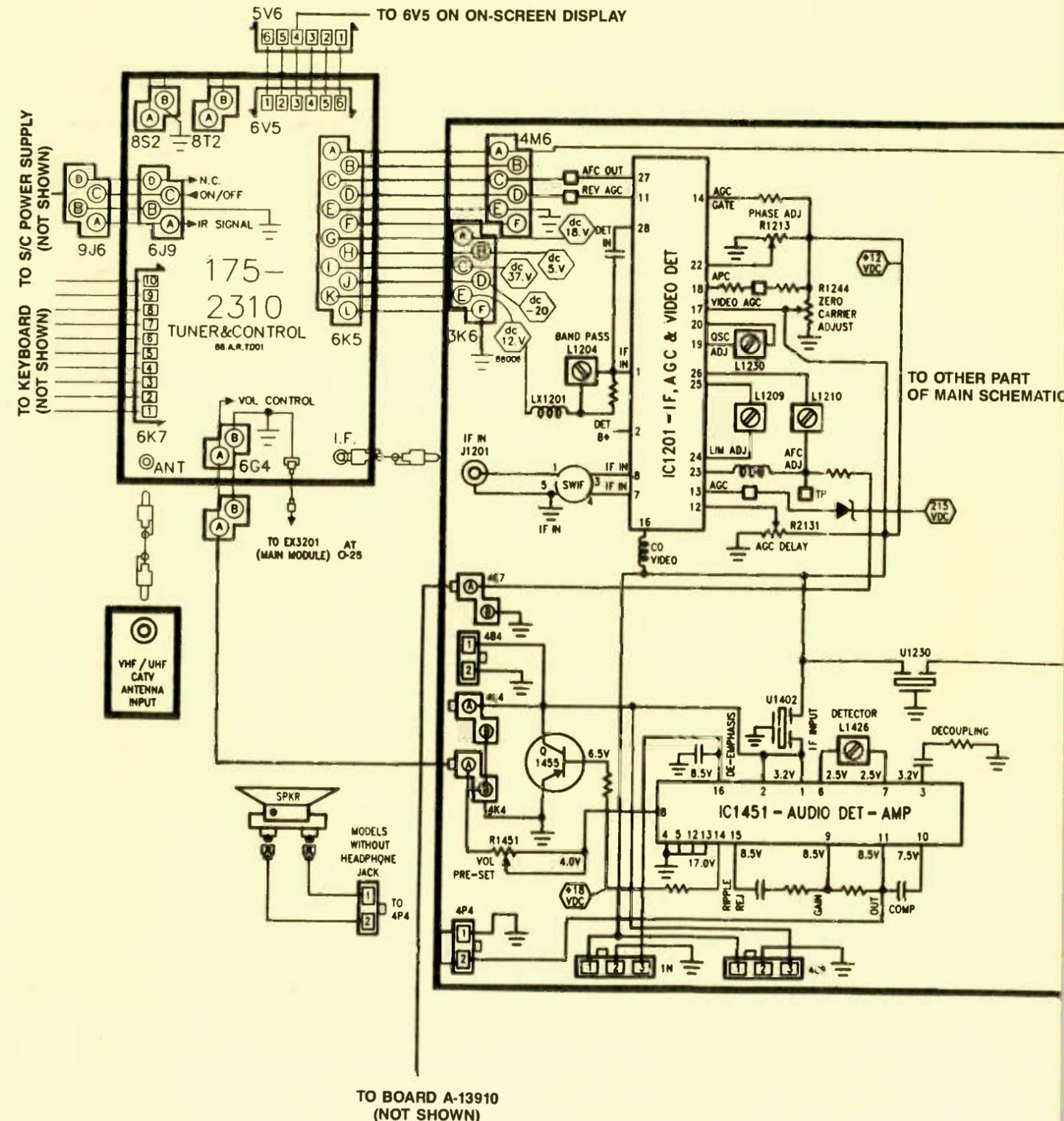
safety characteristics as recommended in factory service information may create shock, fire, excessive x-radiation or other hazards.

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

The other portions of this schematic may be

found on other Profax pages.

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.



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## Literature

### Troubleshooting system brochure

Huntron is offering a brochure on its Tracker 5100DS, a computer-controlled, digital storage troubleshooting system. The system provides signature storage and an easy-to-use user interface.

Circle (130) on Reply Card

### Soldering stations brochure

A brochure available from Hexacon Electric features the company's line of soldering stations, the Therm-O-Trac and Select-O-Trac. The brochure outlines the critical areas of high reliability soldering station performance and describes the features of ten stations.

Circle (131) on Reply Card

### Soldering brochure

Hexacon Electric has published a brochure describing the Soldermaster and Micro-Stedi series soldering stations, irons and tips specially designed for desoldering and reworking surface-mount circuitry. An experimental kit offered by the company is also outlined.

Circle (132) on Reply Card

### Portable oscilloscope guide

"The Tek 2200 Series Affordable Portables: How to choose an oscilloscope," a brochure available from Tektronix, provides strict guidelines for selecting a portable oscilloscope. The 12-page guide discusses bandwidth, vertical channels and sensitivity, sweep speeds, triggering features and more.

Circle (133) on Reply Card

### Product catalog

P.K. Neuses has released its 32-page 1988-89 Product Catalog. The catalog introduces the Interconnect Installation service tool kit and provides information on a product line that ranges from cable tools to relay adjusting to test equipment.

Circle (134) on Reply Card

### Data sheet

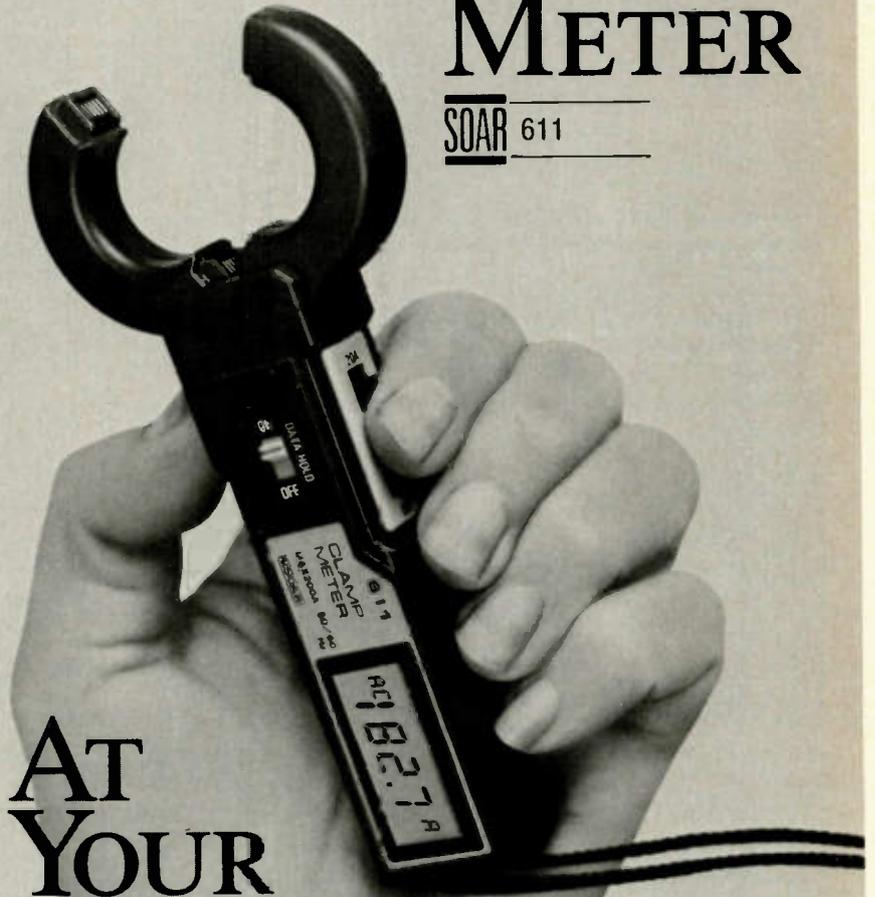
Deltron has released a data sheet that details the Powermedic Transient Voltage surge suppressors. The form includes features and electrical specifications for 4- and 6-outlet versions. The data sheet is ideal for retail and technical purposes.

Circle (135) on Reply Card

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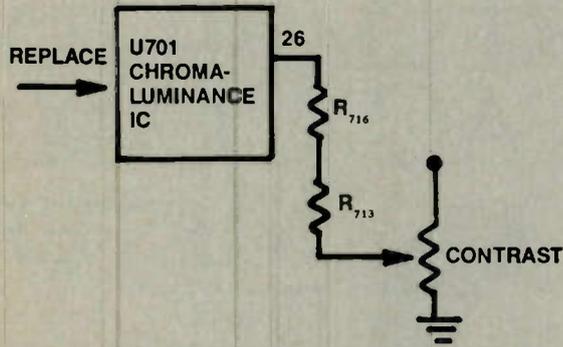
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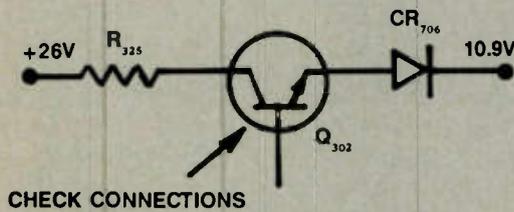
Circle (10) on Reply Card

RCA model GER678S, CTC109 chassis  
Photofact 1952-1



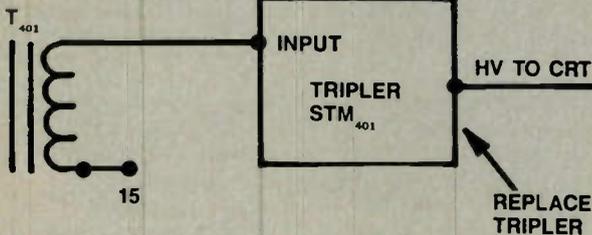
**Symptom:** Excessive contrast, cannot adjust contrast.  
**Cure:** Check contrast control circuit and, if OK, replace chroma-luminance IC (U701).

RCA model EFR333, CTC107 chassis  
Photofact 2032-2



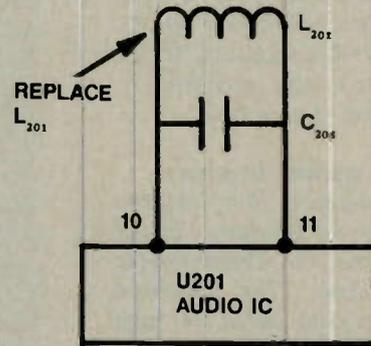
**Symptom:** No color but luminance signal is OK.  
**Cure:** Check 10.9V supply line; if low, check connections on Q302.

RCA model FB441W, CTC85 chassis  
Photofact 1698-2



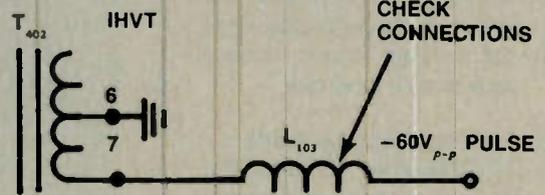
**Symptom:** Set shuts down immediately when turned on.  
**Cure:** Disconnect tripler input lead to see if set stays on; if so, replace tripler.

RCA model FJR457W, CTC120 chassis  
Photofact 2217-1



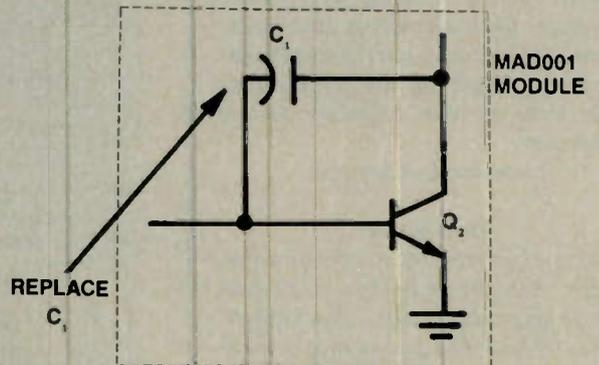
**Symptom:** Distorted sound and lower in volume level.  
**Cure:** Replace L201 and adjust for maximum sound level.

RCA model GER679, CTC109 chassis  
Photofact 1952-1



**Symptom:** Set turns on with just a dark raster, no sound and no LED channel display.  
**Cure:** Check for presence of -60V pulse going from IHVT to tuning system. If it is missing, check connections on L103.

RCA model FX465W, CTC71 chassis  
Photofact 1435-3



**Symptom:** Vertical strip of either red, green or blue on extreme left edge of picture, which is otherwise normal.  
**Cure:** Replace C1 on the appropriate MAD001 module (red, green or blue).

## Answers to the quiz

Questions are on page 16.

1. 175kHz. Use the approximation equation.

$$\begin{aligned} \text{bandwidth (kHz)} &= 0.35/\text{rise time (ms)} \\ &= 0.35/0.002 \\ \text{bandwidth} &= 175\text{kHz} \end{aligned}$$

2. B — It will work if the capacitor can pass the signal. This is a useful troubleshooting tip used to isolate a defective amplifier.

3. Ferrite bead. The conductor is threaded through the center of the donut-shaped bead. The effect is as though an inductor was connected in series.

4. Parametric amplifier. It works by changing the reverse voltage across the varactor diode in synchronization with the signal to be amplified.

5. B — a higher-than-normal voltage. Resistor  $R_3$  is a pull-down resistor. If it is open, the base voltage will float to a higher value. That, in turn, saturates the transistor and increases the voltage across  $R_4$ .

6. The output is a sinusoidal

waveform. You would also be correct to say a cosine wave. It is a sinusoidal waveform displaced  $90^\circ$ .

7. AT-cut. This cut has a low temperature coefficient and a relatively high output.

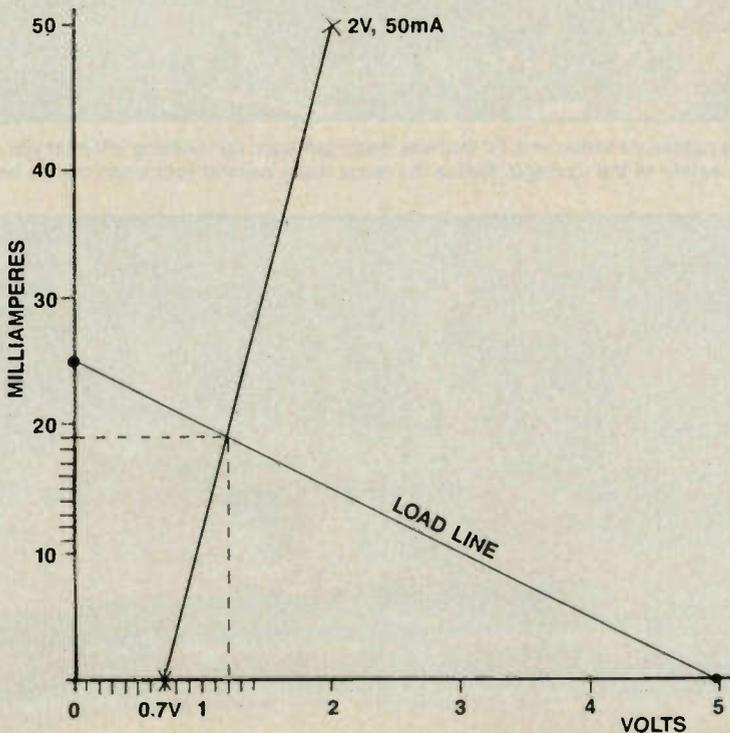
8. Electret microphone. They have an electret that has a permanent electrostatic charge built into it.

9. Both represent 13dB:

$$\begin{aligned} \text{dB} &= 10 \log 0.5 = -3.01 \\ \text{dB} &= 20 \log 0.5 = -3.01 \end{aligned}$$

10. 10.9mA. This problem is easily solved with the piece-wise method. You know two points on the characteristic curve. The breakover point is 0.7V and the maximum value of 2V at 50mA. They are marked with an X and the characteristic curve is drawn as shown in Figure E.

The load line is drawn between the 5V open-circuit voltage and (5/200)mA short-circuit current. The curves cross at the solution, showing that the current with the diode connected is 10.9mA. The voltage will be 1.2V.



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Circle (11) on Reply Card

# Repairing lightning-damaged TVs

By Homer L. Davidson

Lightning can strike anywhere, and its destructive effects may be felt far from where it strikes—lightning that strikes a tree a city block away may create a power surge in the line that will damage your TV. It may destroy motors, blow the circuit breaker from the wall, put a perfect round hole through the rain down spout and knock the TV out of operation.

A spring or summer electrical storm may result in a flurry of calls for the consumer-electronics repair facility. Besides TV antenna and lead-in repair, TV sets, AM-FM stereo receivers, turntables and VCR recorders come in for repairs caused by lightning. Lightning damage may happen to any electronic component tied to any conductor that comes into the house: an outside antenna, power line, cable TV or telephone line.

## Estimating costs

Damage caused by lightning may be covered by a homeowner's insurance or a special lightning-damage policy. Of course, some TVs are not covered at all. It's best for the TV technician to find out whether the damage is covered by insurance before he services the set.

In some cases, an insurance adjuster will call and ask you to prepare an estimate on how much it will cost to service a lightning-damaged TV owned by a client. As any technician knows, giving an accurate estimate is extremely difficult, especially if the low-voltage power and high-voltage circuits aren't operating. If you are asked to make an estimate on a lightning-damaged product, try to make an open-ended or rough estimate that will allow you to add additional charges later in case some damage wasn't evident at the time of the estimate.

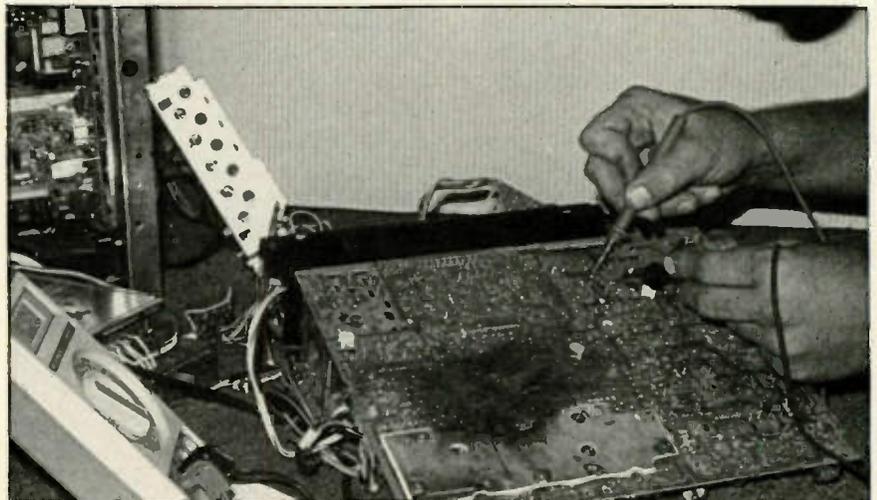
Most insurance companies require estimates from two separate repair

facilities. If this is the case, it should be understood that you expect to be paid for your time for preparing the estimate, whatever decision is made.

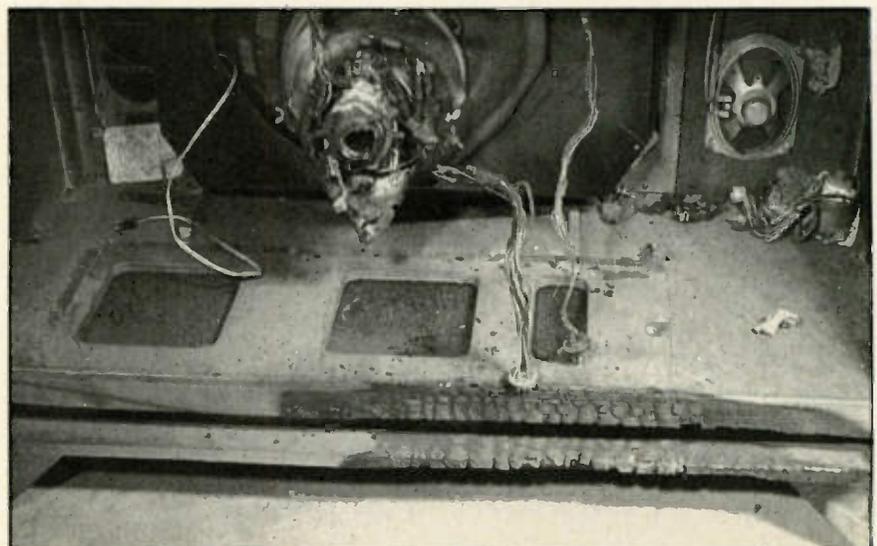
Some technicians give two different estimates, one to just repair obvious damage and return the set to service and another to overhaul the chassis. There are too many variables in giving an

estimate to repair a set that has been damaged by lightning. The picture tube or flyback transformer may fail within a month and the customer will expect you to replace it at no charge to him because it was caused by lightning damage and covered by insurance.

If the damage is beyond reasonable repair, the product should be considered



Checking out the pc wiring in a TV that has been damaged by lightning will help you determine the extent of the damage. Notice the large black burned spot upon the pc board.



You may find that serious lightning damage may result in a fire, even charring the TV cabinet.

Davidson is the TV servicing consultant for ES&T.



This photo shows a tube chassis struck by lightning, which caused fire within the chassis. The curtains behind the TV set also caught on fire, destroying most of the living room area.

a total loss. Extensive burn marks on the chassis or cabinet indicates a direct lightning strike. (See the photo on page 48.) If a TV has a weak or shorted picture tube in addition to chassis damage, it should not be repaired unless there is some compelling reason to fix it. A set with stripped pc wiring in several places on the main chassis board should not be repaired. If the repair bill is expected to exceed the worth of the set, according to the insurance company, total out the TV.

#### The once over

Sometimes it's difficult to pinpoint what circuitry in the unit was damaged by lightning. It helps to keep in mind that the lightning can only be conducted in via the antenna lead-in or power line. Of course, burn marks at the antenna terminal or ac interlock are an obvious indicator of lightning damage. The TV may have a blown fuse caused by leaky diodes in the power supply, or lightning may have opened the fuse and damaged the diode rectifiers. In modular TV sets, a lightning strike a block away might be the cause of damage to the power-supply module. In many cases, more than one module is found to be bad.

A quick visual inspection of the TV chassis may quickly indicate where the lightning damage occurred. Inspect the ac line, interlock, power transformer, ac switch, lead-in wire and tuner for burn or lightning flash-over marks. Check the ac outlet that the unit was plugged into for burned areas. Keep in mind that a lightning strike on cable lines several blocks away might have induced a huge power surge that followed the cable into the home and damaged the TV.

The result of lightning damage may be a blown line fuse with one or two shorted diodes in the power supply. If you find blown coils or an otherwise defective tuner module, they may be caused by lightning. The power transformer that emits smoke may be

caused by lightning damage or leaky diodes in the secondary. Blown transistors or IC regulators in the ac power supply may be caused by lightning. Suspect lightning damage if you find stripped wiring in the power-supply circuits.

A couple of defects that are rarely traced to lightning damage are a leaky

**Before doing any work on a lightning-damaged TV, check the picture tube with a CRT tester. If the TV has a weak or shorted gun in the picture tube in addition to extensive chassis damage, it most likely won't be worth repairing.**

horizontal output transistor and a defective flyback transformer.

#### Assessing the damage

Before doing any work on a lightning-damaged TV, check the picture tube with a CRT tester to see what condition the tube is in. If the TV has a weak or shorted gun in the picture tube in addition to extensive chassis damage, it most likely won't be worth repairing. On the other hand, the fact that a CRT checks good is no guarantee that it will last. I have seen many instances where the

CRT face appeared completely white a few months after the set was hit by lightning. If the insurance company and customer decide to go ahead and repair the TV chassis, you should make it clear, both verbally and in writing on the bill, that the picture tube is specifically excluded from any guarantee.

If you locate damage in the power supply, replacing a blown fuse and inspecting the ac cord and the off/on switch only takes a few minutes. If you replace the line fuse and the new fuse blows immediately, suspect a shorted diode. Check each diode in the rectifier circuit with the diode test of the DMM. (See Figure 1.) Go a step further if the fuse opens after replacement of the defective diodes. Sometimes the isolation resistor (RF201) may open as a result of a leaky diode. A slight lightning charge may cause the fuse and diodes to short out.

If lightning damage is slight, you may find only a little pc foil damage in the low-voltage power supply. If the unit has sustained serious damage, you may find pc foil stripped in several places on the chassis. Look for extensive damage when the chassis is burned over a large section of the pc board. Modules plugged into the chassis are easily replaced, but stripped pc wiring on the main board is a little more difficult and may not warrant TV repairs.

*Main article continued on page 53.*

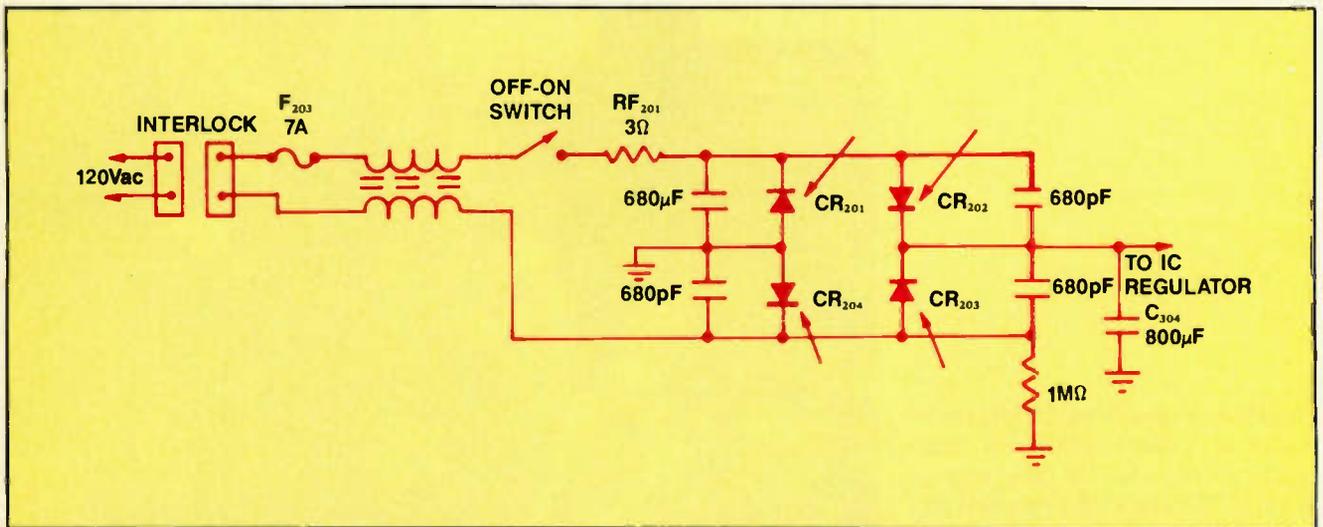


Figure 1. Lightning coming in the power line may destroy the interlock,  $F_{203}$ , on/off switch,  $R_{F201}$ , and some of the silicon diodes in the bridge rectifier circuit.

## Symptom: dead set

When a possibly lightning-damaged set is completely dead, start by checking for an open fuse or problems within the low-voltage power supply. Check for dc voltage at the B+ fuse holder, filter capacitor or collector (metal) of the horizontal output transistor. In some TV chassis, there is a main fuse in the ac line and another B+ fuse feeding to the horizontal output circuits. Inspect each fuse and replace them if they are defec-

tive. If you replace fuses but turning the set on causes them to blow again, check for leaky diodes or voltage regulator components.

Both fuses ( $F_{901}$  and  $F_{902}$ ) were open in a Goldstar VR-800 TV portable.  $CR_{901}$  and  $CR_{903}$  in the bridge rectifier circuits (Figure 2) were leaky. After replacing both diodes and  $F_{901}$ , fuse  $F_{902}$  (2A) would blow. A resistance measurement from  $F_{902}$  to common ground showed a

257Ω leakage, which indicated a leaky component after  $F_{902}$ . Regulator  $TR_{904}$  was found to be leaky and was replaced. Another resistance measurement showed that a 257Ω measurement still existed between the fuse terminal and common ground. Zener diode  $D_{906}$  had a dead short and  $R_{908}$  had changed value. Replacing  $D_{906}$ ,  $R_{908}$ ,  $CR_{903}$  and both fuses solved the dead-set lightning symptom.

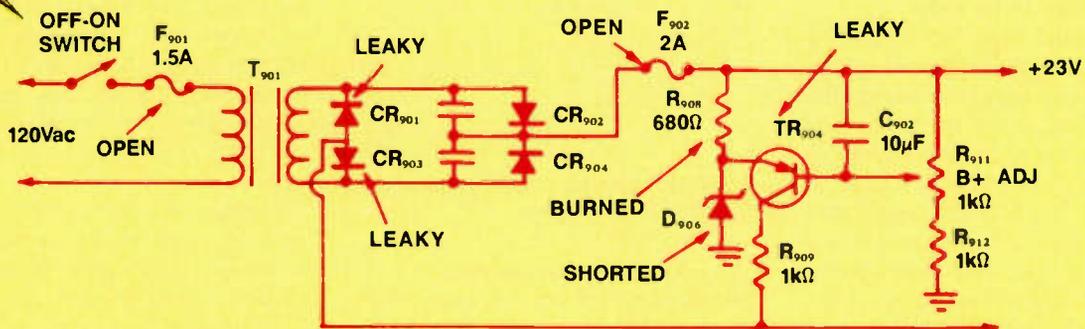


Figure 2. Besides the fuses, several other components had to be replaced in a Goldstar VR-800 portable TV. Damaged components are indicated by arrows.

## Symptom: blown fuse

A customer brought in an RCA CTC109A and reported that it had been damaged by lightning. A cursory inspection revealed no sign of lightning damage, only a blown fuse.

The 5A fuse would pop after a few seconds when connected to the power line. The voltage at the anode of the CRT was only 5kV. A quick resistance measurement between the horizontal output transistor and chassis ground indicated a dead short. (See Figure 3.)  $Q_{412}$  was replaced and another resistance measurement appeared normal.

Before the chassis was fired up, a variable power transformer was used to slowly raise the ac voltage.  $Q_{412}$  started to get quite warm with less than 70V applied to the horizontal circuits. All secondary diodes were removed from the circuit, but the results were the same. The yoke lead was removed from the horizontal circuit and the flyback transformer was deemed defective. The original part number for  $T_{402}$  was 146487. The horizontal output transducer was replaced with a new kit number 154494.

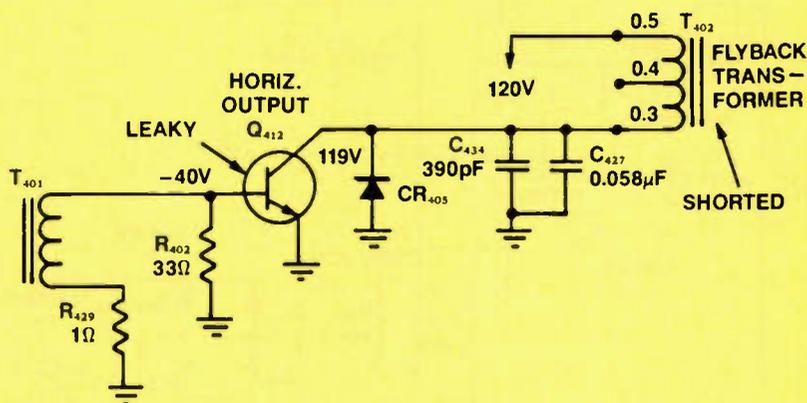


Figure 3. The flyback transformer in an RCACTC92 chassis was shorted, which in turn destroyed the horizontal output transistor ( $Q_{412}$ ). Although the fuse blew, there was no evidence of lightning damage.

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Circle (12) on Reply Card

## Symptom: damaged power supply

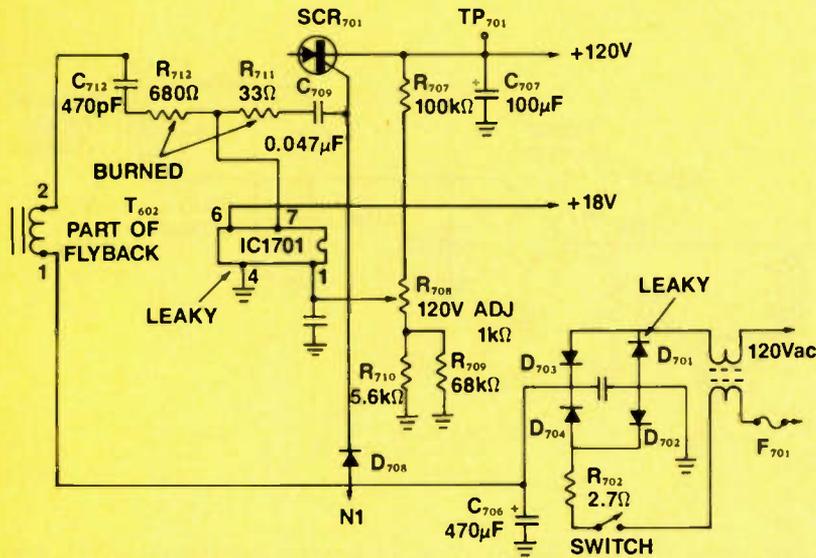


Figure 4. Blackened components and damaged wiring in the low-voltage power supply and regulator circuits indicated lightning damage in a Sharp 13F40 portable.

A Sharp 13F40 portable TV was brought in with a complaint of lightning damage. Around the low voltage power supply there was evidence of burned areas, especially around the power regulator circuits. This chassis (Figure 4) had definitely been hit by lightning or a power-line surge. F<sub>701</sub> (4A) fuse was blown, wiring around line filter (L<sub>701</sub>) was ripped and wiring around the power regulator (IC<sub>701</sub>) was burned.

Two diodes in the bridge rectifier were checked and found to be leaky. They were replaced with 2.5A rectifiers. The wiring around L<sub>701</sub> was restored with hookup wire. The power regulator IC<sub>701</sub> was replaced with the exact part number (RH-1X0137CEZ2). SCR<sub>701</sub> tested normal and was left in the chassis. R<sub>711</sub> and R<sub>712</sub> were burned and were replaced with new resistors. The pc wiring around IC<sub>701</sub> was repaired with hookup wire. A resistance measurement across filter capacitor C<sub>706</sub> (470μF) and at TP<sub>701</sub> seemed normal, so the line voltage was gradually increased to 120V. Everything appeared normal as the line voltage was raised, so R<sub>708</sub> (120V HDJ) was adjusted for 120Vdc at TP<sub>701</sub>, and the repair was considered complete.

## Symptom: blown fuses

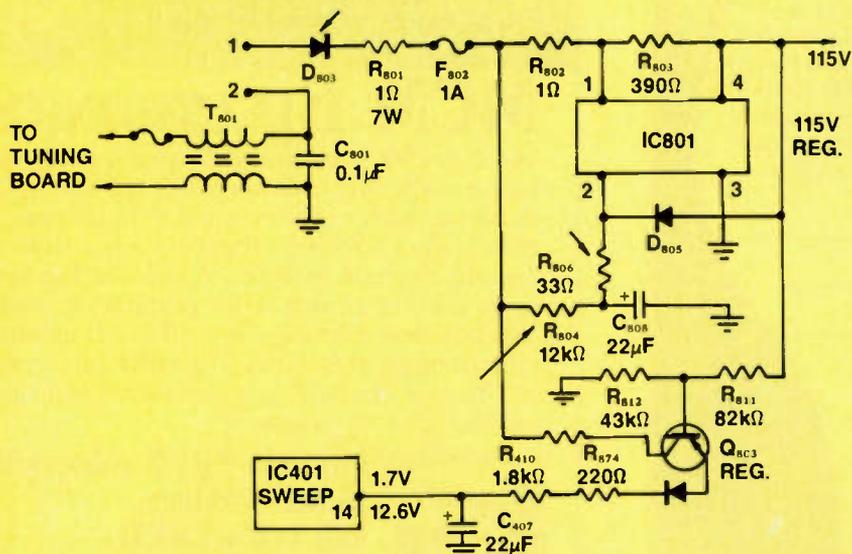


Figure 5. Diode D<sub>803</sub> and the voltage regulator (IC<sub>801</sub>) were blown to pieces in one Goldstar CMT-4442 portable color TV. The sweep IC<sub>401</sub> was also found to be damaged after the low-voltage power supply was repaired.

Both fuses were blown in a portable TV with a no-sound/no-picture/no-raster symptom. Diode D<sub>803</sub> and IC<sub>801</sub> voltage regulator (see Figure 5) were blown in pieces. The 115V power supply output was restored after D<sub>803</sub>, IC<sub>801</sub> and R<sub>806</sub> were replaced. Although voltage was found at the horizontal output resistor, there was still no sound or raster.

Q<sub>404</sub> began to get red hot, so the ac plug was pulled. Even though a replacement horizontal output transistor (2SD1453) was installed, Q<sub>404</sub> still got hot, but there was no horizontal drive pulse at pin 15 of the sweep IC. Only 1.7V was found at the voltage supply pin of IC<sub>401</sub>. Voltage-dropping resistor R<sub>410</sub> (1.8kΩ) was running quite warm. Replacing IC<sub>401</sub> with an SK9194 replacement solved the horizontal sweep problem. In this case, lightning damage required replacement of D<sub>803</sub>, IC<sub>801</sub>, R<sub>806</sub>, Q<sub>404</sub>, IC<sub>401</sub> and fuses F<sub>801</sub>, F<sub>802</sub>.

Main article continued from page 49.

Stripped pc wiring sometimes may be found around fixed diodes and IC components in the low-voltage power supply. First, check out all defective components and replace them. Next, repair the damaged pc wiring with regular hookup wire. Be sure and check both sides of the board if it is a double-sided pc board. If some of the board is burned and charred, you may be able to replace the damaged foil with hookup wire.

It's not unusual to find more than one module in need of repair when a TV chassis has sustained lightning damage. Besides the tuner, the video, luminance and sweep modules may be defective. You may find a burned tuner or power transformer in the older TV chassis. A TV that has several boards and large components damaged at various locations is probably beyond repair.

#### Tuner problems

Although coupling capacitors in series with the balun coils in the antenna lead-in circuits help prevent lightning damage, the power surge may still arc over those capacitors and damage the

manual tuner. Often, the transistors within the tuner are damaged and the tuner should be replaced. If a quick peek at the tuner and balun coils indicates that only a few parts are destroyed, you might try replacing them.

A first diagnostic step is to clip the 75Ω antenna lead to the tuner input jack and notice if stations appear normal. If so, you will probably only have to replace or repair the balun assembly. Today, manual tuners for older TVs are fairly expensive. You should send it in for repair instead of trying to obtain a new one.

The latest TV chassis, especially those with remote control, have either a modular frequency count down or band selector tuner. If one of these tuners is damaged by lightning, the tuner module can be replaced. When you're checking out a lightning-damaged TV and you encounter a normal raster but no sound, picture or snow, suspect the tuner assembly. Inject a signal from a substitute tuner at the IF cable. If this returns the set to normal, check out the tuner assembly. Inject +1V to 12V at the

VHF bandswitching terminal on the VHF tuner and slowly increase the voltage until a local station is tuned in. If the stations are normal with injected voltage, suspect problems within the band selector. Replace the VHF-UHF tuner when poor selection or no stations are picked up when you apply external dc voltage. Check the module and tuner repair depot for servicing either component. You can lose too much time if you aren't equipped for adequate tuner repair.

Whenever a TV has been damaged due to a lightning strike, look for damaged components in the low voltage power supply and tuner assembly, and don't be surprised if more than one module has been damaged. Lightning is rarely the cause of horizontal output and flyback transformer damage. Always look beyond the burned components for damage occurring to transistor and IC components. Do not repair the TV chassis if the repair will cost more than the set is worth. Let the chassis operate on the test bench for three or four days to make sure all defective components are replaced.

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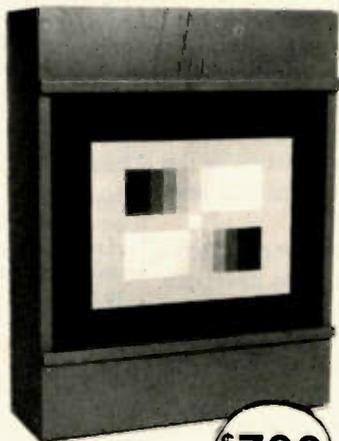
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Circle (15) on Reply Card

# What do you know about electronics?

## Equivalency

By Sam Wilson

Technician friend: "I bet you can't tell me what the biggest problem is with old electrolytic capacitors."

Sam: "Leakage."

Technician friend: "*Wrong!* Leakage is no longer important. The big problem is series resistance."

Sam: "One reason I can't tell you that is because it is NOT TRUE!"

My friend attempted to prove his statement by showing me his new piece of test equipment. It checks the equivalent series resistance (ESR) of an electrolytic capacitor. He didn't put enough thought into the term *equivalent*.

The series/parallel equivalency theorem is seldom talked about in technician courses. One reason is that it is a heavily mathematical relationship that is of no interest to most technicians who work at repairing electronic equipment. However, this theorem has some important applications in modern electronics, so I will review it here without the math. This is a continuation of the series of network theorems and laws without mathematics.

Incidentally, if you are one of those technicians who happen to be interested in a full-blown discussion of the mathematics involved in this theorem, please write to me and I will send you the whole nine yards. If you want to send me two stamps, it would be appreciated.

### Series/parallel equivalency

I will start this theorem by discussing it in relation to series and parallel

resistors. Suppose you have a parallel circuit comprised of  $R_1$  and  $R_2$  (see Figure 1) that has a certain amount of impedance between its terminals (A and

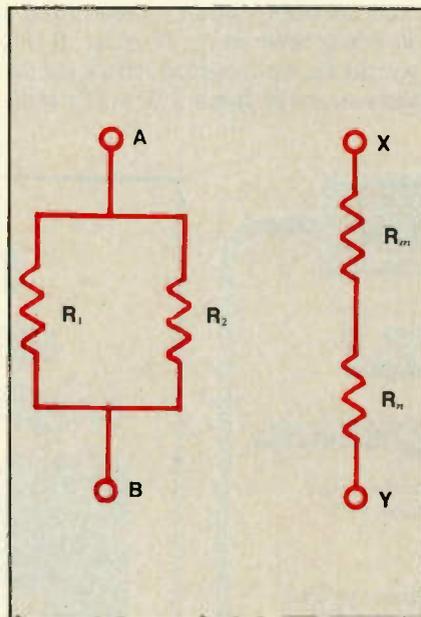


Figure 1. It is not difficult to convert the parallel circuit to the left into the series circuit to the right even if you stipulate that the resistance between the terminals must be the same in both circuits and the voltages across the resistors in the series circuit must be in the same ratio as the currents flowing through the resistors in the parallel circuit.

B). Further suppose that you have the problem of converting this to a series circuit with the following conditions:

- The resistance between the terminals must be the same in both circuits.
- The voltages across the resistors in the series circuit must be in the same ratio as the currents flowing through the

resistors in the parallel circuit.

(Please do not write and ask me for practical applications. This is simply a hypothetical case used to demonstrate a theorem.)

The problem just described is quite simple using some basic algebra. Staying within the rules, the parallel circuit can be converted to the series circuit. Furthermore, the series circuit can be

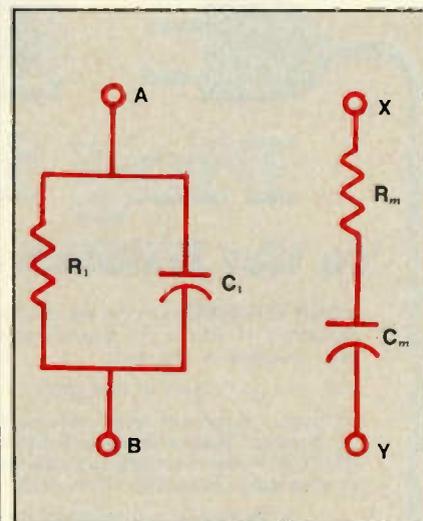


Figure 2. For a little theory exercise, convert the parallel circuit to the left into the series circuit at the right. You must keep the impedances numerically the same and, when an ac generator is connected across either circuit, the generator voltage and current must be the same. Also, the phase angle must be the same for both circuits.

converted back to the parallel circuit.

Now, consider the more practical circuit shown in Figure 2. Again, the problem is to convert the parallel circuit into the series circuit and at the same time be able to convert the series circuit back

Wilson is the electronics theory consultant for ES&T.

to the parallel circuit. The conditions for the conversion are given here:

- The impedances, as seen across their terminals, must be numerically the same.
- When an ac generator is connected across either circuit, the generator

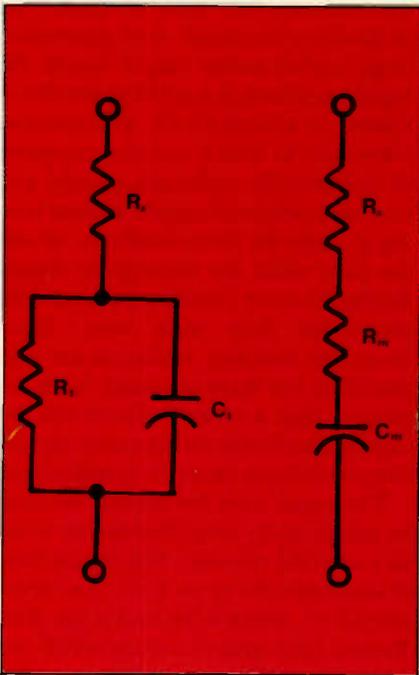


Figure 3. To convert the parallel circuit to the left into the series circuit to the right, convert the capacitor — with its parallel (leakage) resistance — into a series circuit that is represented by  $R_s$  and  $C_m$ .

voltage and current must be the same. Also, the phase angle must be the same for both circuits.

This is a more sophisticated problem, but it can be worked.

Now, consider the equivalent circuit of an electrolytic capacitor as shown in Figure 3.  $R_s$  is the series resistance and  $R_l$  is the leakage resistance for the capacitor. Because this is an electrolytic, it is presumed that the signal applied across the terminals is an ac sine wave with a dc offset. In other words, the ac waveform is never permitted to go to zero or below zero.

Using the same technique as was used for Figure 2, the capacitor can be converted — with its parallel (leakage) resistance — into a series circuit that is represented by  $R_s$  and  $C_m$ . This series equivalent circuit is put in series with the series resistance of the capacitor to obtain the series RC circuit shown in the illustration.

Of course,  $R_s$  and  $R_m$  can be combined as shown in Figure 4. What you get is an equivalent series resistance (ESR).

You can easily build a piece of test

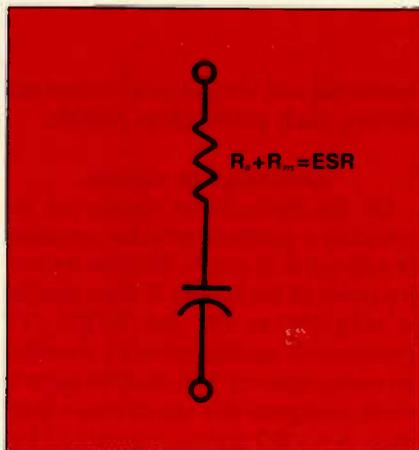


Figure 4.  $R_s$  and  $R_m$  can be combined to form an equivalent series resistance (ESR).

equipment to measure this ESR. All you need is a phase comparator (of the type used in phase-locked loops) and possibly a dc amplifier. Once you have calibrated it, you have a method of measuring the equivalent series resistance for electrolytic capacitors.

I don't recommend that you build this piece of equipment because it is available at a very reasonable cost. It should be noted that the larger the value of ESR, the greater the value of representative parallel leakage resistance. So, ESR meters generally test in such a way that if ESR is greater than a certain predetermined value, the capacitor is rejected.

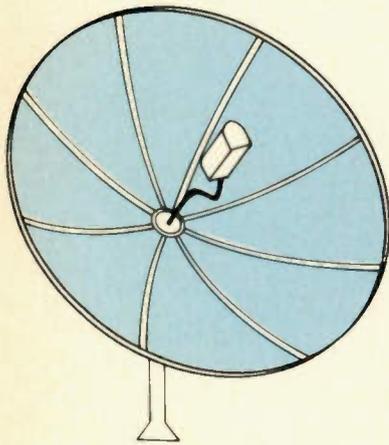
### Popcorn noise?

Have you ever heard the term *popcorn noise*? It is usually assumed that the beta of a transistor is a fixed value. However, it turns out that some transistors switch back and forth rapidly between two beta values. That, it turns out, causes pulsing changes in the output current of the transistor.

This problem can occur in some discrete transistors and in transistors that are part of integrated circuits. A typical time for one beta value is 50ms, and a typical value of a current pulse due to popcorn noise is 200pA.

Transistors can't be repaired — that is, in the usual meaning of the word — so the only way to solve the problem is to carefully test each transistor.

This problem would not bring most systems to a halt. The very low-amplitude pulses are insignificant in most applications. However, it does explain why some transistors may be especially noisy in RF applications. **ES&T**



# Servicing satellite TV systems

By Mike Knight

**S**ervicing satellite TV systems can be a successful addition to an existing electronics service facility. And with the current shortage of adequate satellite TV service facilities across the country, there exists a genuine need for such facilities.

In order to service the complete system, you must understand a little about satellite television and how it works. Above the equator is an imaginary ring of spacecraft called the Clarke Belt, named after Arthur C. Clarke, the British scientist and science fiction writer. In this orbital position at 22,753.8 miles above the earth, a satellite revolves around the earth at exactly the same rate as the planet rotates about its axis, which effectively makes it appear to be standing still above a point on the earth's surface.

A signal is then transmitted to the satellite from an earth station. This signal can be telephony, data or video, but for the purposes of this article, we will assume it to be video. The composite video signal is frequency-modulated onto a 36MHz-wide carrier. This signal is then amplitude-modulated with a 30Hz ramp wave to minimize interference with the terrestrial common carriers, which also use the 3.7GHz-to-4.2GHz C band, the primary band used for satellite TV in North America.

This signal is transmitted to the satellite in the microwave band of 5.925GHz-to-6.425GHz. The satellite receives this signal and retransmits it on

a corresponding transponder in the 3.7GHz-to-4.2GHz band. With appropriate guard bands and an allocated spectrum range of 40MHz per transponder, this method of retransmission would ordinarily allow only 12 transponders per satellite. However, signals at this frequency retain their polarization over long distances, so frequency reuse is possible by alternating

**In the early days of home satellite TV, the actual tuning was done outside, and the signal from one transponder centered on 70MHz was sent to the receiver. This method had significant undesirable side effects.**

horizontal and vertical polarization and shifting each polarization 20MHz.

## Receiving the signals

On the earth, these signals are received by a parabolic reflector commonly referred to as a dish. Because the output power of the average C-band satellite is only 4W to 9W, the TVRO (TV receive only, another name for a satellite receiving system) dish must be large in order to capture this signal over a large area. A TVRO dish is typically 10 feet in diameter. The reflector may be solid metal such as steel or aluminum, per-

forated metal, a wire mesh, or fiberglass embedded with a metallic material. Wire mesh is the most common material for dishes.

The microwave energy that strikes every point on the dish is focused into the feedhorn. The most common type of feedhorn is round, with concentric rings (called *scalar* rings). Inside the typical feedhorn is a small probe that is rotated by a servo motor. This rotation allows you to switch between reception of horizontally polarized signals and vertically polarized signals without having to rotate the entire feedhorn, as was the case when the rectangular funnel feedhorns more common on terrestrial microwave links were used. Electronically switched feedhorns are also available, but these are much more expensive than a servo feedhorn and are usually found only on extremely sophisticated multiple-receiver installations.

The signal from the satellite needs to be substantially amplified before it can be sent to the receiver. This requirement is accomplished by an LNA (low-noise amplifier), which is located at the dish. Typical LNA gain is between 40dB and 50dB. The 3.7GHz-to-4.2GHz signal is then converted to a lower frequency (downconverted), before it is fed into the home, so expensive waveguide or rigid feedline is not needed.

In the early days of home satellite TV, the actual tuning was done outside, and the signal from one transponder centered on 70MHz was sent to the receiver. This method had significant undesirable side effects, and today all new satellite receivers use a technique

Knight is chief technical support representative for the American Home Satellite Association.

called *block conversion*. The 3.7GHz-to-4.2GHz band is simply heterodyned down to a 500MHz-wide band, typically 950MHz to 1,450MHz (although Radio Shack used 450MHz to 950MHz and Scientific Atlanta used 270MHz to 770MHz on some early models of home and commercial units).

#### Equipment in the home

Inside the house is the satellite receiver. The receiver tunes in the signal from the desired transponder, converts the signal down to baseband, clamps out the 30Hz ramp wave, and demodulates the video. Audio is transmitted on a sub-carrier 5MHz to 8MHz above the video, with 6.8MHz being the most common subcarrier. The receiver also controls the position of the probe in the feedhorn and, in most cases, moves the dish as

well. Almost all new receivers have built-in descramblers. These are called IRDs, which stands for *integrated receiver-descrambler*.

The descrambler is necessary if reception of superstations or premium services such as HBO or Showtime is desired. The scrambling method used by almost all services intended for home reception is Videocipher II, developed by M/A-COM. M/A-COM is now a part of General Instrument. The video scrambling is similar to the SSAVI (sup-

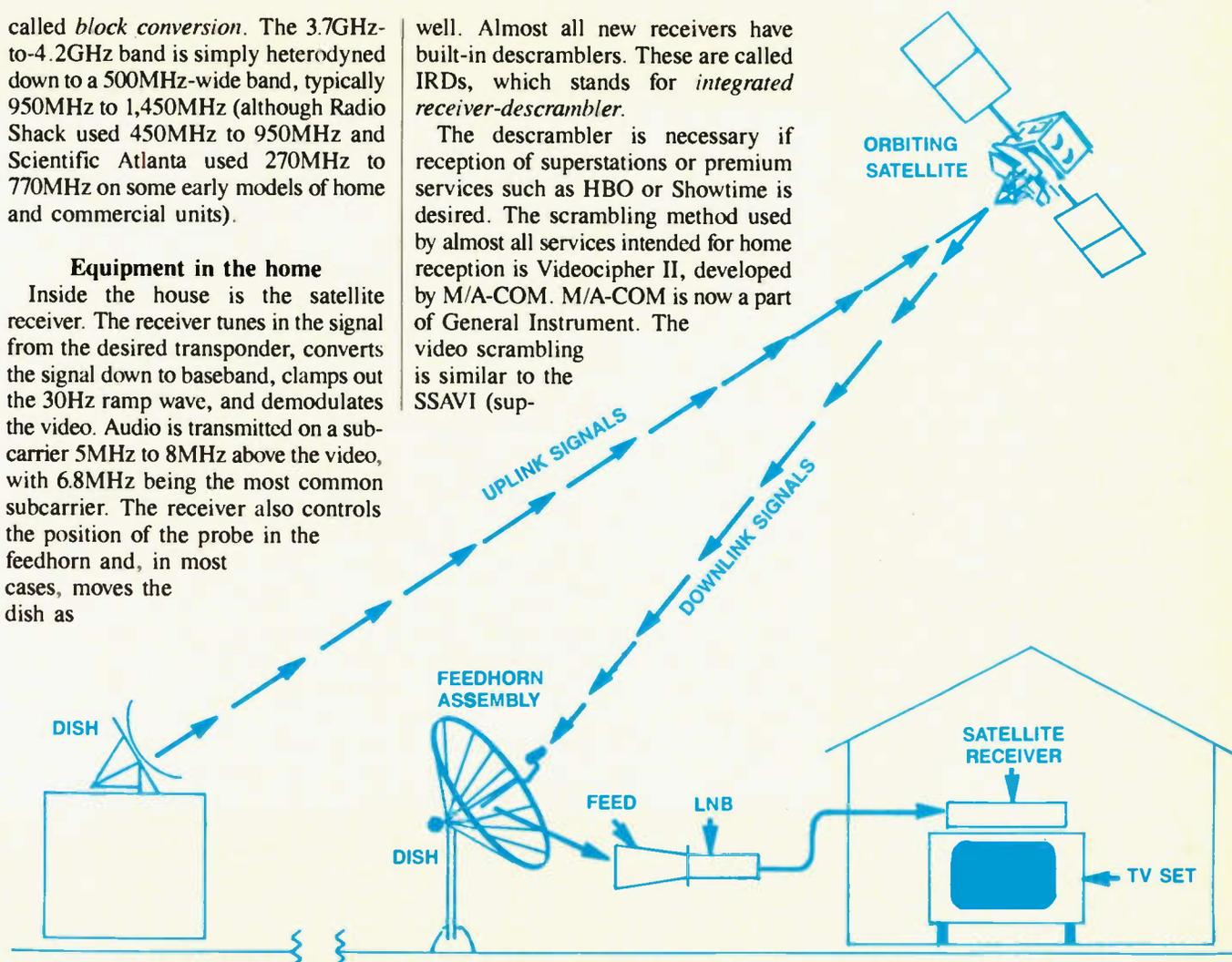


Figure 1. TV signals (picture and sound) are transmitted by a studio to one or more satellites. These satellites orbit the earth at a distance of 22,300 miles above the equator. The orbits of communications satellites are geosynchronous; that is, their locations remain fixed in relation to the earth's surface. The satellites retransmit signals to earth, where they reach a TVRO dish. The dish reflects or focuses the signals to a low-noise block downconverter (LNB), which amplifies them and lowers the frequency. Signals are then brought into the home by coaxial cable to a satellite TV receiver. This receiver processes the signals, permits selection of one of 24 channels transmitted by the satellite, and sends the signal to a TV set where the picture is viewed.

pressed sync and video inversion) common with cable TV systems. The audio is digitally transmitted and encrypted using a method called the NBS DES algorithm. Two channels of high-fidelity audio are available for stereo or a separate audio program (foreign language simulcast).

### Tools and equipment

Armed with this basic understanding of satellite TV system components, we can concentrate on how to service them. One of the important considerations is the tools and test equipment required to properly service the system in the field and on your bench.

In addition to your standard electronic tool kit, some larger wrenches will be needed. Start with two adjustable wrenches, 12 inches or longer. A good socket set with deep sockets will be useful if you have to disassemble the reflector. A good compass and elevation gauge should be in the toolbox as well.

The field service technician should also stock a good assortment of cable. It is a good idea to carry at least 200 feet of one-run satellite cable (two RG-6 coaxes, and polarizer and actuator cables combined in one ribbon-type cable). A 10-foot RG-213 jumper cable with N-connectors on each end is also a necessity for working on older downconverter-LNA systems. A good supply of 6-foot and 12-foot RG-6 jumpers is also a good thing to have handy. The RG6 jumpers should be terminated with F connectors with hex crimps. The old plier-type crimpers are not suitable for use at 1.5GHz.

Some additional system components should be stocked as well. Although feedhorns themselves rarely fail, their servo motors fail quite often. Keep at least two in stock at all times. Actuator arms also wear out over time, or they can be damaged if the controller runs the dish into the ground. It would be advisable to keep a 24-inch stroke actuator arm with a 36V motor and a reed switch sensor in the service vehicle, as well as an assortment of sensors for other popular actuators. Most of the current generation of actuators use magnetic reed switches as sensors. Some of the older systems used hall-effect transistors or special 10-turn potentiometers as sensors. There really is no generic replacement for these sensors, so it may not be feasible to carry every possible sensor, pot assembly or hall-effect board in the kit.

Keep at least two 55°-to-65° C-band LNAs in the kit, as well as two Ku-band LNAs with a 1.5dB-to-1.9dB noise figure (there are no Ku-band LNAs). These should be pretested at your shop to make sure they are good. There is no way to accurately bench test an LNA or LNB without a noise-figure meter, and these cost upward of \$12,000. One way to test them without a noise-figure meter is to install them on a dish and compare them to a working LNB.

Also, keep an inexpensive block conversion receiver in the vehicle, as well as a small portable TV, preferably color.

Special satellite installation test equipment is also available. Portable battery-powered spectrum analyzers are indispensable to test for terrestrial interference, and they are excellent for troubleshooting dead systems and

judge video quality on a 13-inch set.

A stereo amplifier with two magnetically shielded speakers and a good pair of stereo headphones should also be on the bench. A bench-grade spectrum analyzer is not absolutely necessary for most repairs, but it will come in handy for working on receiver front ends. These can run more than \$15,000 new, so you will need to do a lot of satellite receiver repair to justify one of these.

The ideal satellite workbench will have a swept measurement system. These are so expensive that pretty much only receiver design labs will have one, but they do make IF alignment a lot easier. It is possible to do an IF alignment by eye if there is a test pattern on, but keep in mind that there are tradeoffs between IF bandwidth and picture quali-

**You will find that the same troubleshooting principles that apply to servicing of other products also apply to satellite TV servicing: identify the problem, isolate the problem to a specific component and repair or replace that component. You will encounter situations where there may not be a problem with equipment, and your servicing work will consist of realigning the antenna.**

realigning dishes. Antenna tracking can also be done with special satellite signal-strength meters. These are less expensive than a spectrum analyzer, and some have audio feedback so the dish can be aimed without having to look at a display. A company recently came out with a form of spectrum analyzer with an LED bar-graph display. This analyzer is an excellent alternative to the relatively large and bulky CRT display spectrum analyzer.

### Equipment for the shop bench

The shop bench should have some more sophisticated test equipment. Although there are some signal generators that can simulate a satellite signal, they are a poor substitute for an actual live feed. Also, these generators do not simulate a Videocipher signal, so testing a descrambler requires a live feed. An oscilloscope is required, as is a good volt-ohmmeter. Owning a color TV/monitor is advisable as well. Choose one with a 19-inch or larger display—it can be extremely difficult to

ty. Some people with small dishes may tolerate some truncation noise (black spots in bright colors) in order to improve the apparent signal-to-noise ratio, but a videophile with a 6-foot projection screen will definitely not. The only way to know the IF bandwidth is with the proper test equipment.

One other piece of test equipment I can recommend is a waveform monitor. A new waveform monitor can cost several thousand dollars, but these are used in every TV station in the country, so you should be able to find a used one at a more reasonable cost. Because you can also use it on your other video work, it is easier to justify.

Other helpful equipment to have on the bench are polarizer servo motors and an actuator arm. The arm can be mounted on the wall and rigged with pulleys and weights to simulate the load of an actual dish. You will also need your usual assortment of standard bench tools and non-metallic alignment sticks. I suggest that you get a couple of the generic fiberglass sticks that you can file

to the desired shape because some of the slugs have unique shapes. They are also quite brittle and tend to crumble if the wrong shape of tool is used.

### Diagnosing satellite TV problems

The next step in satellite servicing is making your service call. You will find that the same troubleshooting principles that apply to servicing of other products also apply to satellite TV servicing: identify the problem, isolate the problem to a specific component and repair or replace that component. You will encounter situations where there may not be a problem with equipment, and your servicing work will consist of realigning the antenna. In some cases, you may find that whoever worked on the system last didn't weatherproof something properly and moisture got into the cables. One of the easiest problems to rectify is the case of a shrub or a tree that is blocking the dish and only needs judicious application of a pair of pruning shears.

Before you take the feedhorn cover off, you may want to look for signs of occupancy by wasps. If you find evidence of their presence, give it a shot of wasp killer. Yes, those nasty little demons just love to build nests in the feedhorn cover, or even in the throat of the horn. I can tell you that there is no worse surprise than finding an occupied wasp nest while precariously perched on top of a shaky ladder.

### Checking out a dead system

Here's a suggestion on how to proceed if the system is dead: the receiver lights up, but the signal-strength meter is way down and the screen is full of snow. Start with equipment substitution. If you have a portable spectrum analyzer, hook up the coax from the dish to the input of the analyzer and turn it on. If all you see is a flat line, you know the LNB is dead. If you have peaks and dips, then the receiver may be bad.

If you don't have a spectrum analyzer, get the known-good satellite receiver from the service vehicle and hook it up. If you still see only snow, suspect the LNB. If you have picture, the customer's receiver is probably bad.

If the preliminary indication is a bad LNB, before you go out to swap the LNB, check to see if the dish is properly aimed at a satellite. Put your test receiver in scan and move the dish east and west. If you come across any splashes of color or brief glimpses of

video, turn off the channel scan and try to tune in a channel. If you have a picture, hook up the customer's receiver to see if you have anything. Although this is an unlikely eventuality because most dish owners know how to move the dish manually, anything can happen.

Replacing an LNB is a simple matter. Before starting, unplug the satellite receiver because many receivers power the LNB at all times. After you have removed the RG6 coax from the LNB, take a 7/16-inch open-end wrench and a 7/16-inch socket wrench and remove the bolts holding the LNB to the feedhorn. Clean off the feedhorn flange, and bolt on your test LNB. Before you hook up the RG6, inspect the connector to make sure it is not corroded. If it is, cut off a few inches of coax and put on a new F connector. Hook up the connector, plug in and turn on the receiver.

If you now have a picture, you have found the problem. If the customer approves the repair, make sure that you have installed the gasket between the feedhorn and LNB, and weatherproof the F connector before you put the feedhorn cover back on.

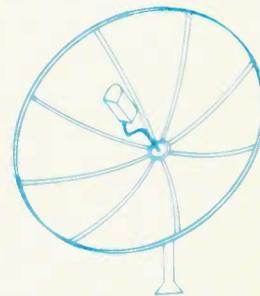
If you still don't have a picture, check for +15V to +20Vdc on the center conductor of the F connector. If there is no voltage, check the receiver. Some receivers have fuses or circuit breakers for the LNB power. If the problem is not simply a blown fuse or a tripped breaker, the receiver needs to go into the shop for service—the voltage regulator is probably in need of replacement. These are usually the standard 3-terminal 78XX family regulators and are usually easy to replace (although I occasionally curse the designer who laid the \$\$\$×& thing out so that you have to remove 87 screws and the transformer, then desolder the entire rear panel just to get to the bottom of the circuit board).

### Receiving half the transponders

Another common problem is that only half of the transponders come in. The usual symptom is that only the even transponders on some satellites come in and only the odd transponders on other satellites come in. This symptom is almost always caused by a bad servo motor on the polarizer.

This problem is pretty easy to diagnose, again by substitution. At the receiver, disconnect the polarizer leads and connect a known-good servo motor

from your tool kit to the receiver terminals. If the motor turns when you switch from odd to even transponders, you know that the receiver is putting out the proper signals, so you probably have a bad servo motor at the feedhorn. Replacement is pretty simple, usually requiring that you unscrew four #0 Phillips screws holding the motor on the feedhorn. It's usually a good idea to put down a thin coat of clear silicon sealant between the replacement motor and the feedhorn so moisture can't get into the probe assembly and freeze up.



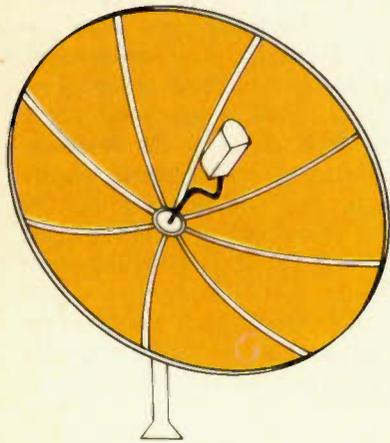
If the test motor doesn't turn when you switch from odd to even transponders, try the skew control. Perhaps the customer accidentally restored both polarities at the same position. I know this is a really rare situation, but I have seen it happen.

The remaining possibility is that the polarity control IC in the receiver has failed. The control chip is almost always a 555 timer. If you have an oscilloscope with you, put the probe on the pulse terminal and look for a continuous pulse train about 5V amplitude and between 0.5ms to 2.5ms in width. A good logic probe will also tell you if your control chip is working. If all you see is a steady-state, the 555 is bad. This is a common problem, but because sockets on the polarizer chip are rare, which means you'll be doing some soldering-iron work, you will probably want to take the receiver in to replace the chip.

### Installing surge suppression

I strongly suggest that if you have to take the unit in to the shop, you also install some surge protection on the pulse terminal and +5V terminal before you reinstall it. TransZorbs work really well for this application, even better than MOVs (metal-oxide varistors). Chaparral found this out and has built them into their servo motor assemblies. Just put the positive lead on the terminal and the negative lead to ground.

**ES&T**



# Understanding sun-transit effects

By James E. Kluge

Twice each year, the sun traverses an arc in the sky that nearly corresponds to the arc of the geostationary satellite orbits. While traversing that arc, the sun passes (or transits) through the aperture of the satellite antenna. This passage is called the *sun transit*.

## The sun-transit effect

If your dish is pointed at one of the geostationary satellites on these days,

Kluge is the satellite TV consultant for ES&T.

the sun will momentarily be positioned directly in line with the satellite. Some of the sun's radiant energy will then be gathered in by the reflector and focused on the feed assembly. Two things will happen when this occurs: the electromagnetic noise energy will completely swamp the desired signal and "wipe out" the picture, and the radiant thermal energy from the sun concentrated on the feed assembly will make it hot enough to melt the plastic and damage the electronics of the LNA/down-

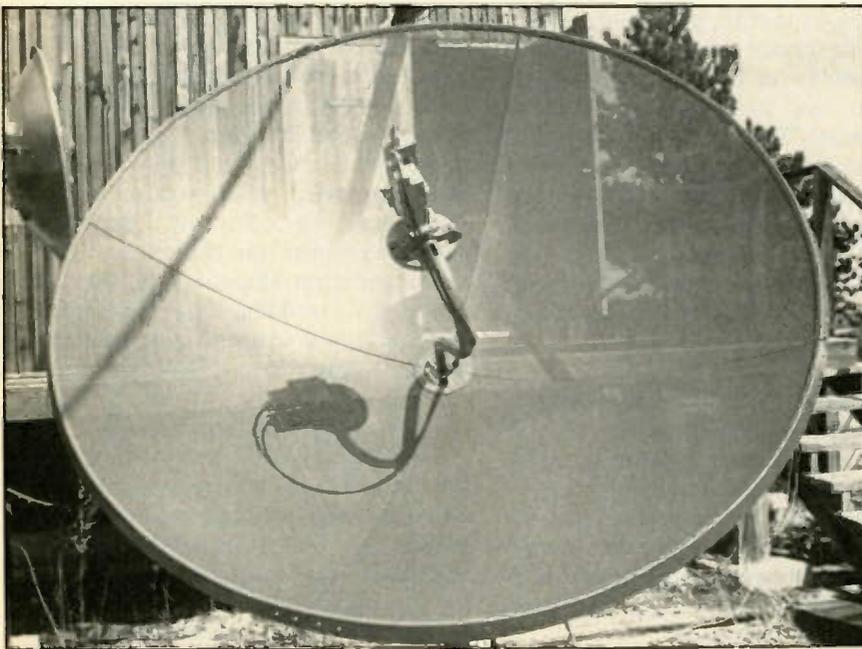
converter. The larger the antenna, the larger the aperture, the greater the energy, and the greater the damage. Especially damaging are bright, shiny (unpainted) aluminum dishes that focus most of the radiant energy on the feed assembly.

If you stop to think about it, the principle is the same as that used by the solar-energy-power community. A field of heliostats focusing the sun's thermal radiant energy on a solar power tower-type heat exchanger (called a *central receiver*) is used to produce high-pressure steam for generating commercial electrical power. In another solar-thermal system, parabolic dishes that track the sun collect and focus the sun's radiant thermal energy onto a heat exchanger located at the focal point. It, in turn, drives a closed-loop reaction engine-generator to produce electricity. In other words, parabolic satellite receiving dishes are efficient collectors of radiant thermal energy as well as electromagnetic energy. When one is pointed directly at the sun, you can expect things to burn up, including your fingers and eyes.

## Safe servicing

If you are working around the dish during these periods of time, exercise extreme care not to point the antenna toward that portion of the sky where the sun is positioned. Instead, point it westerly in the morning and easterly after noon.

For the mid latitudes of the United States, the sun-transit effects occur during the early part of March and October and lasts for about a week. In the north-



The feed-assembly shadow indicates that the sun is east of the satellite to which the dish is pointed. As time of day advances, the shadow will move toward the reflector center.

ern states, the peak day occurs earlier in March and later in October. In the southern states, it is just the opposite because the sun is typically higher in the sky.

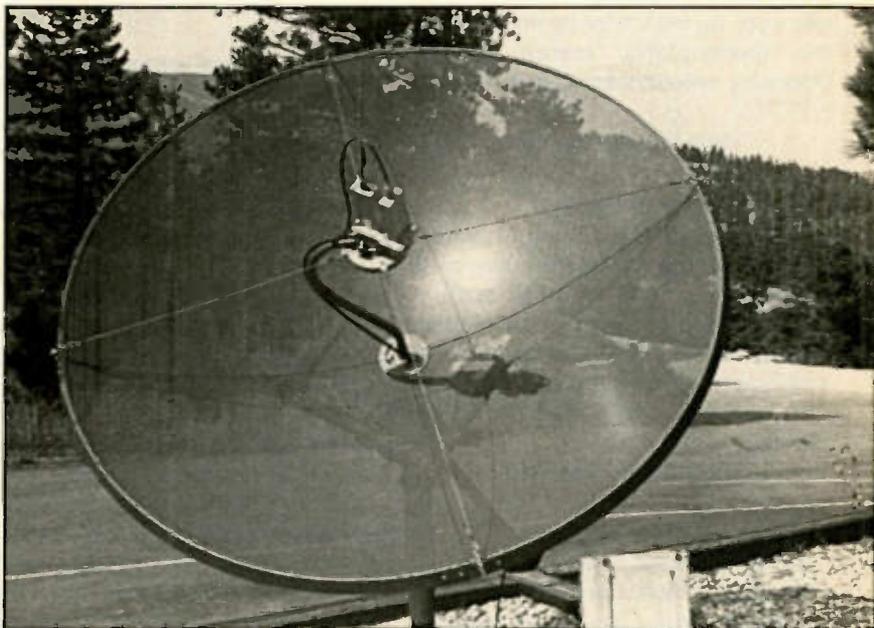
The date on which the peak day occurs depends on the latitude the observer is located at. For example, at 40° north latitude (Boulder, CO), the peak days are March 5 and October 9. At 30° north latitude (Houston), the peak days are March 8 and October 6. At 49° north latitude (western Canada/U.S. border), the peak days are March 2 and October 12. Unless something unforeseen happens to upset the solar system (in which case this discussion becomes moot), the sun-transit effects will occur with regularity on the same dates each year. It can have substantial effects for about three days before and after the peak day.

It also goes without saying that you should keep your face and hands away from the antenna's focal point (feed assembly) during these times. If the shadow cast by the feed assembly falls anywhere near the center of the parabolic reflector, it means the sun's energy is concentrated near the focal point of the parabolic reflector and can do serious harm. Observe the shadow cast by the feed assembly and move the dish any time the shadow falls near the center of the reflector. If it is March, the shadow will fall lower on the reflector after you pass the peak day; in October, the shadow will rise higher as the sun appears lower in the sky. Keep these things in mind and you'll have no serious problems caused by sun transits at your TVRO site.

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If the feed-assembly shadow falls on the center of the parabolic reflector, the solar energy collected by the reflector is concentrated at the focal point, which is where the feed assembly is located.



In this photograph, the feed-assembly shadow indicates that the sun has passed behind the satellite at which the dish is pointed, making it safe to service the feed and downconverter.

## Ozone-safe dust remover

The *Chemtronics* E-series Ultrajet ozone-safe dust remover is an EPA-exempt fluorocarbon that offers high purity, low toxicity, inertness and non-flammability. The unit uses 120 PSI gauge pressure to blast for dust removal and electronic system cleaning, and will not scratch or contaminate delicate surfaces. The system includes a surgical grade chrome trigger valve; a 4-inch nozzle; a final filtration disc; a 36-inch extension hose; and a 12 oz. refill can.

Circle (91) on Reply Card

## Portable oscilloscope

The model 336A portable oscilloscope from *Tektronix* offers improved performance from its predecessor, the model 336 DSO. The improvements include increases of the sample rate to 20MS/s, vertical resolution to 8 bits, and expanded memory to 16kbytes. The model also features auto setup, cursors, on-screen readout, GPIB, and the ability to save waveforms and up to eight front panel setups.

Circle (92) on Reply Card

## Soldering sleeves

*Cole-Flex's* soldering sleeves for silver or tin-plated shield terminations consist of a heat-shrinkable, transparent polyvinylidene fluoride sleeve with an inner pre-fluxed soldering preform and two thermoplastic sealing inserts. Operating temperature range is  $-55^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$ .

Circle (93) on Reply Card

## Repair station

*Pace's* PR-10 tweezer-repair station has a power supply with high duty-cycle temperature control for small surface-mount component repair. The station features a conductive-heating tweezer with several tip-styles and a foot-pedal that activates instantaneous pulse-heating.

Circle (94) on Reply Card

## Soldering tips

*M.M. Newman's* special soldering iron tips include straight and bent needles in various lengths for reaching certain types of leads; iron-plated tips for highly repetitive tasks; hot-knife tips for cutting synthetics; spatula tips for molding and forming; and Teflon-coated

tips for working with special materials.

Circle (95) on Reply Card

## Service kit

The Surface-Mount Technology Service Kit from *John Fluke Mfg.* provides tools, supplies and instruction for component-level repair of surface-mount assemblies. The kit features a hand-held, temperature-regulated hot air solder tool; three nozzles for the



solder tool; a training video and course workbook; a practice circuit board; soldering supplies; and surface-mount components.

Circle (96) on Reply Card

## Surge suppressor

The Electra Guard 3111 surge suppressor from *CPS Electronics* offers telephone/data-line protection as well as power-line protection. The unit responds in less than 1ns and is UL-listed.

Circle (97) on Reply Card

## Soldering station

*Leads Metal Products* has introduced the model 7100 ENDECO temperature-controlled soldering stations, which has push-button thumb-wheel control and a closed-loop thermocouple sensor. The station is designed to solder at 20W ( $450^{\circ}\text{F}$  to  $700^{\circ}\text{F}$ ) and has a 20W/40W switching ability. Features include a 3-wire ground that prevents potential differences greater than 2mV at the soldering tip; a resistance reading of less than  $20\Omega$  from tip-to-ground; and a guaranteed  $\pm 10$  degrees of preselected temperature at idle.

Circle (98) on Reply Card

## Static awareness products

Signs, posters and packaging labels for electrostatic discharge awareness are available from *Desco Industries*. The products feature either the JEDED-14 or the Mil-Std-129J symbols.

Circle (99) on Reply Card

## Interface analyzer

*Electro Standards Laboratory* has introduced the model 700 EIA RS-232 interface analyzer, designed for use at the EIA RS-232 or CCITT V.24 data interface of modems, multiplexers, terminals and computers. Inserted in series between the DTE and the DCE, the battery-powered analyzer allows the user to monitor of all data, timing and control signals. Tri-state LEDs simultaneously display polarity, activity and validity of all key interface signals.

Circle (100) on Reply Card

## Grounding wrist strap

*Davle Tech's* personal grounding wrist strap protects sensitive devices from static charges generated by the operator. The wrist strap features a 6-foot coil cord that swivels 360 degrees. Other features include oxidation prevention and a high-function resistor.

Circle (101) on Reply Card

## Torque screwdriver

An adjustable torque-limiting screwdriver with a calibrated micrometer scale is available from *Klein Tools*. The tool is graduated in 2 inch-pound increments and provides torque accuracy over a range of 2 to 36 inch-pounds. The screwdriver (No. 57035) can also be obtained in a set (No. 57034) that includes five interchangeable bits.

Circle (102) on Reply Card

## Soldering elements

*Wybar Electronics* has introduced improved elements for its model SD-1 desoldering and soldering tweezers. The elements, preformed to fit around the sides of the component, allow very small components, down to 0.12-inches wide, to be processed.

Circle (103) on Reply Card

## Combination case

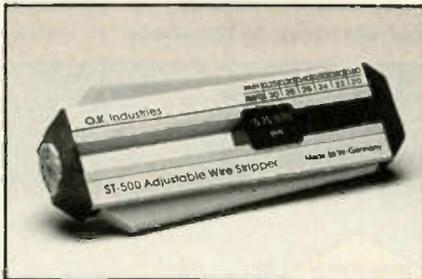
*Jensen Tools* is offering a Rota-Lux case that will carry both a full pallet of

tools and a laptop computer. Molded of rugged polyethylene, the case offers maximum protection for equipment. The lid of the case contains a removable/reversible pallet with pouches for more than 30 tools on one side and for documents on the other.

Circle (104) on Reply Card

### Wire stripper

The model ST-500 adjustable precision wire stripper from *OK Industries* accurately strips 20 to 30AWG wire. The tool has four hardened blades that will



strip all types of wire insulations. An adjustable wire stop that ensures consistent wire strip lengths is also included.

Circle (105) on Reply Card

### Power console

*Kaljo Electronics'* model DPC+, an 8-outlet console surge suppressor/noise filter, features 131V clamping, an outlet wiring integrity checker, and dual-filtered and isolated banks. A fail-safe feature removes the system and con-

nected equipment from the ac circuit if the internal protection components are damaged.

Circle (106) on Reply Card

### Solder feeding system

The model 115 automatic solder feeding system, available from *HMC*, combines a special soldering iron and a solder dispenser that holds a 1-pound spool of wire solder. Solder is fed electronically through the soldering pencil itself when the operator depresses a microswitch on the handle to advance the wire solder.

Circle (107) on Reply Card

### Miniature test connector

The E-Z Micro Double Gripper TM Test Connector series is available from *E-Z Hook*. The series features a dual contact blade assembly, a gripping hook and component leads, and accepts 22AWG test leadwire. Ten color-coded XK double gripper units are also available.

Circle (108) on Reply Card

### Oscilloscope training program

*Bergwall Productions'* 822 Dual Trace Oscilloscope II is an audio/visual training film that provides information and techniques necessary to operate and utilize the Tektronix scope and similar oscilloscopes. The program has four parts, is available in video and filmstrip, and includes a study guide with learn-

ing objectives, pre-tests, post-tests and a glossary.

Circle (109) on Reply Card

### Digital storage adapter

The DSA-250 storage adapter from *Global Specialties* converts analog oscilloscopes into digital storage oscilloscopes. The unit features 8-bit resolution; 1MS/s digitizing rate; selectable 0%, 50% and 100% pre-triggering; and a 1,024-word display capacity.

Circle (110) on Reply Card

### Portable PC tester

*Vu-Data* has introduced its model 8000 portable PC tester for use with all 8086, 8088, 80286 and 80386P-based personal computers. The model provides high-speed troubleshooting of



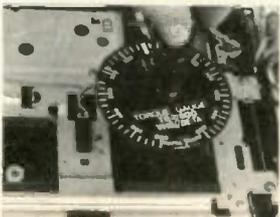
system boards and adapter cards to the component level. No additional computer is necessary for operation.

Circle (111) on Reply Card **BS&T**

# STOP NEGLECTING YOUR VCR's



Tape Tension Gauge



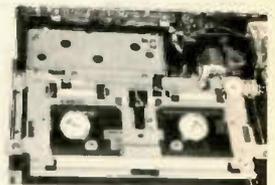
Dial Torque Gauge

Mechanical problems in VCR's cause approximately 75% of VCR malfunctions. Adjustments are necessary to keep your VCR equipment operating properly. Tentel gauges can help! They allow technical measurements to be made, even by non-technical people.

Tentel covers the entire mechanical performance of VCR's with easy to use, universal tools. These gauges are a MUST if your job includes VCR repair, and many non-technical users merely want to set up an effective preventative maintenance program.

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Circle (13) on Reply Card

# Servicing the compact disc player—Part V

By Martin Clifford

This is the fifth part in a series on servicing compact disc players. Part IV covered modification procedures. This part and the continuation next month

Clifford, a freelance writer, has published more than 75 books on electronics.

will discuss how flowcharts can streamline diagnosis.

The value of a flowchart depends on how thoroughly and carefully it is detailed. When a servicing technician uses well-executed flowcharts, no servicing

step is omitted, no servicing step is repeated, and there is no dependence on memory.

## No sound

Because this condition can mean trouble anywhere in the player, an overall

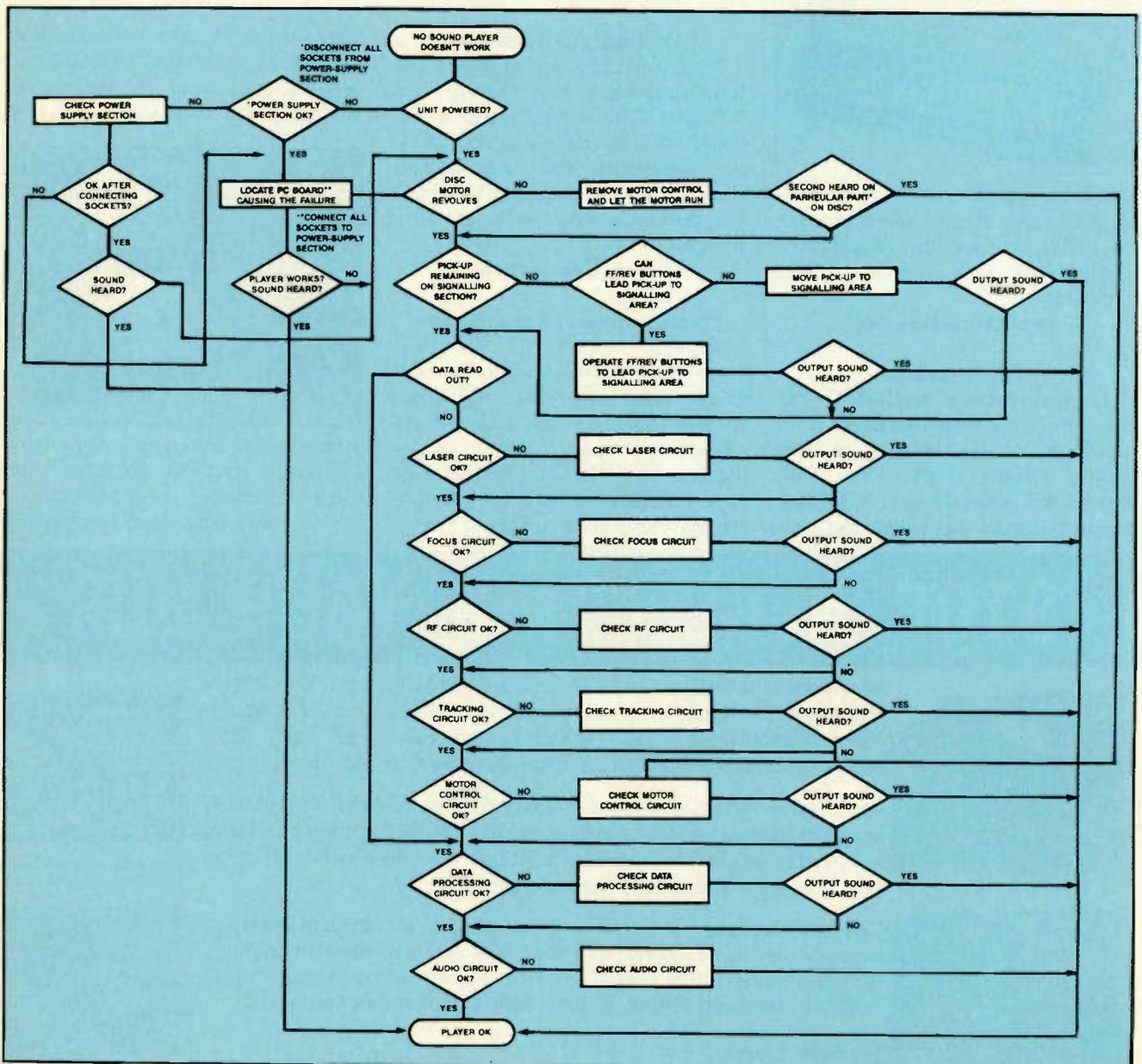


Figure 1. A no-sound condition can mean trouble anywhere in the player, so an overall flowchart is required. Finding the fault is a process of elimination, so a large number of decision symbols are used. (Courtesy of Kyocera International.)

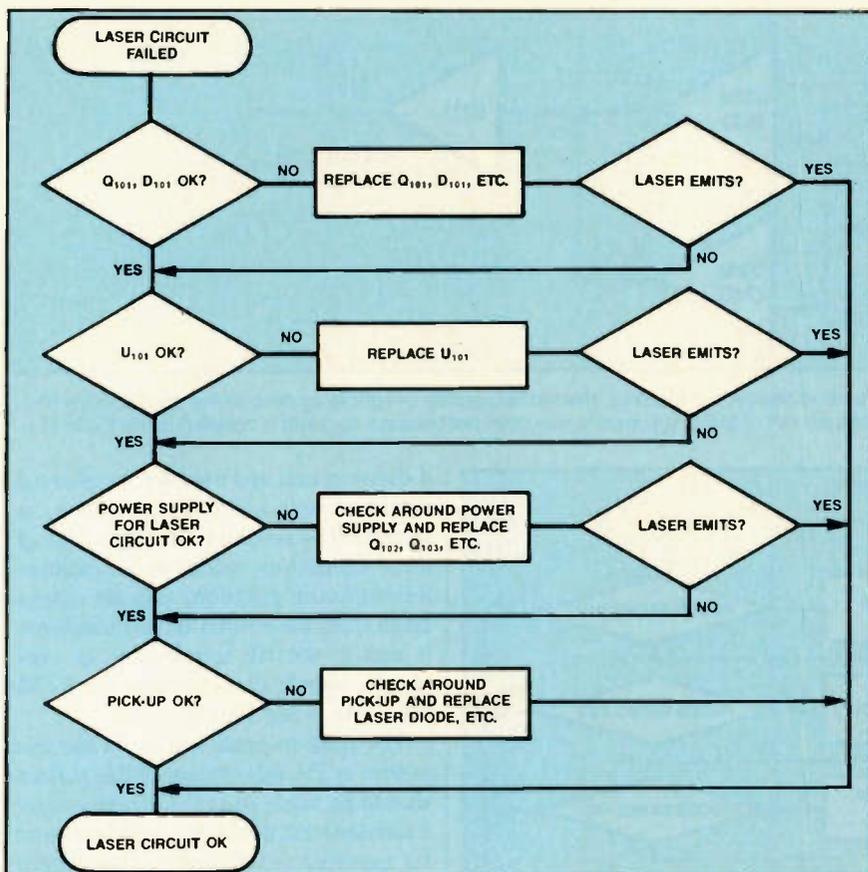


Figure 2. The abbreviations in this flowchart for laser circuit failure are Q (for transistors), U (for ICs) and D (for diodes). To be able to identify these components, you will need a circuit diagram or you must be familiar with the transistors, ICs and diodes that are used. (Courtesy of Kyocera International.)

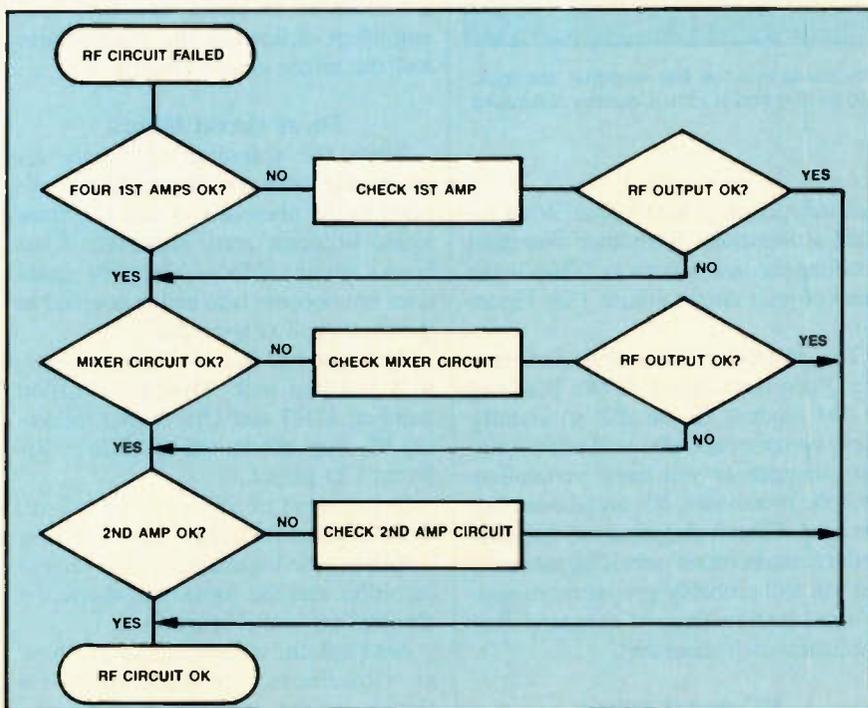


Figure 4. The procedure in this flowchart for RF circuit failure is to check the first four amplifiers following the photodiodes and the mixer circuit. (Courtesy of Kyocera International.)

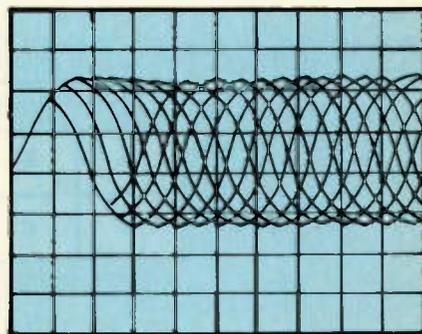


Figure 3. In the RF circuit, the signal picked up by the photodiodes is amplified by several transistors. One of these transistors works in an emitter-follower configuration, and the output taken from the emitter of this transistor is sent to the HF terminal as an eye-pattern signal. (Courtesy of Kyocera International.)

flowchart (Figure 1) is required. Finding the fault is a process of elimination, so a large number of decision symbols are used. By following the YES and NO connections on these symbols, it should be possible to narrow the search in a logical and orderly manner.

If the player does not function, do not assume the fault is in the player. It may seem obvious, but check to make sure there is power available at the outlet and, if there is, that the power switch is turned on. Failure of the compact disc player to work is possibly one of the most common complaints.

Although the flowchart shows the testing steps to follow, no chart can cover every possible contingency. For example, a player won't work if no disc has been inserted, or if it has been inserted upside down, or if two discs are in the loading tray, or if the loading tray is mechanically operated and has not been fully closed. None of these are covered in the flowchart and, therefore, a physical examination of the player is the first step.

Open the CD player only after you have made some preliminary tests of your own: Is line power available? Is the operating switch turned on? Is the loading tray clear? Has a disc been inserted into the loading tray, and has the disc been inserted with the label side up? Are there any foreign objects in the loading tray? Has anyone tampered with the loading tray? Has the player been dropped, or has it become water-damaged or affected by high humidity? Does the player work when operated

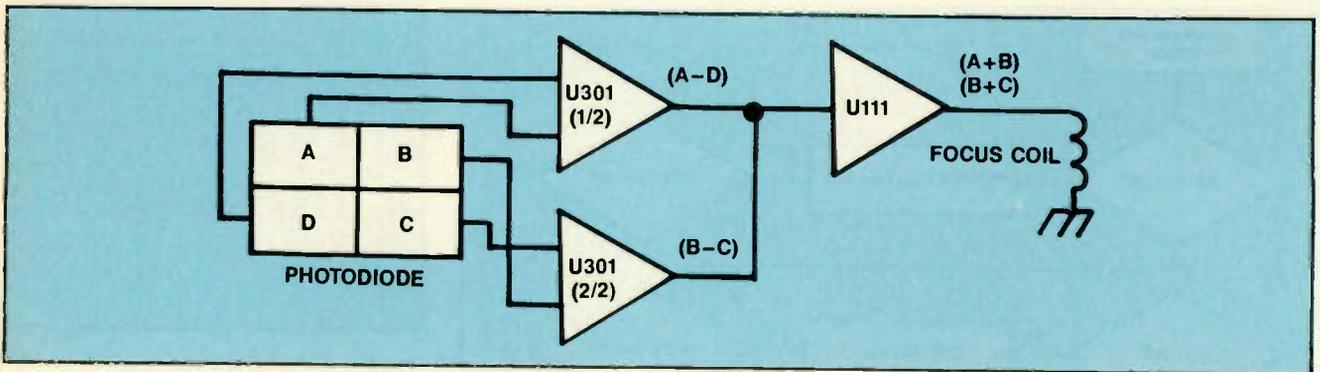


Figure 5. In this focus servo circuit, when the scanning beams are focused, the same quantity of light is applied to the photodiodes and the error signal becomes zero. However, if the beams are out of focus, the error signal does not become zero and is coupled to the focus coil.

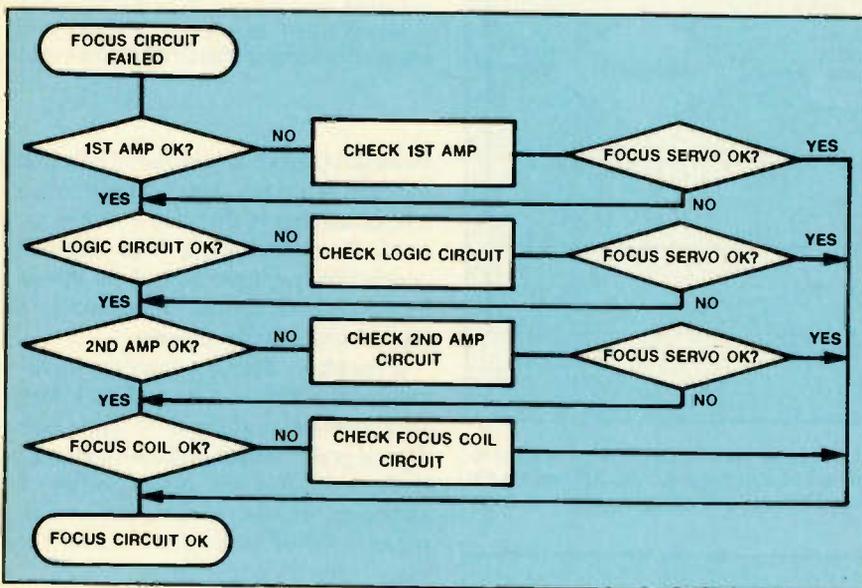


Figure 6. This flowchart for focus circuit failure indicates that the first amplifier, the logic circuit, the second amplifier and the focus coil should be checked in turn. (Courtesy of Kyocera International.)

manually but not with remote control? If the player will not deliver sound to an external amplifier, will it still operate headphones? Is the connecting cable from the player to the hi-fi system satisfactory, and will operation be restored if a new cable is used? Are the plugs on the connecting cable corroded?

You can answer some of these questions, but if you have been asked to repair the player, do not expect to get all the answers honestly from the user.

**Laser circuit failure**

Assume you have followed the overall block diagram in Figure 1, and when you reach the block marked "laser circuit OK," you have a "no" answer. In this case, you must move to the block reading "check laser circuit." By itself,

that instruction is inadequate. What we need at this point is another flowchart detailing the instructions to follow in the event of laser circuit failure. (See Figure 2.)

The abbreviations in this flowchart are Q (for transistors), U (for ICs) and D (for diodes). To be able to identify these components, you will need a circuit diagram or you must be familiar with the transistors, ICs and diodes that are used. Circuit diagrams are available in the manufacturers' servicing manuals, but you will probably get one more easily and quickly from a company that publishes such diagrams.

**RF circuit failure**

In this circuit, the signal picked up by the photodiodes, arranged as a

4-division unit and used for focus-error detection and main signal-pickup, is amplified by several transistors. One of these transistors works in an emitter-follower configuration, and the output taken from the emitter of this transistor is sent to the HF terminal as an eye-pattern signal, also known as the EFM waveform. (See Figure 3.)

The peak-to-peak voltage of the eye pattern is 2V. Adjustment of this pattern should be made near the center area of a standard test disc with the adjustment for maximum clarity of the eye-pattern signal. The adjustment is done by a potentiometer that has a range limited to  $\pm 45^\circ$  from the mechanical center of this control. The procedure in the flowchart is to check the first four amplifiers following the photodiodes and the mixer circuit (Figure 4).

**Focus circuit failure**

When the scanning beams are focused, the same quantity of light is applied to the photodiodes and the error signal becomes zero. However, if the beams are out of focus, the error signal does not become zero and is coupled to the focus coil (Figure 5).

Although two ICs are indicated here, it is just one unit. The identification number, U301 and U111 in the following IC, may not be the same in a different CD player.

In the event of focus circuit failure, the flowchart indicates that the first amplifier, the logic circuit, the second amplifier and the focus coil should be checked in turn (Figure 6).

Next month, we'll continue our look at flowcharts, concentrating on flowcharts for tracking circuits, the motor control system and the data processor.



# Troubleshooting floppy disk drives

By Conrad Persson

Floppy disk drives are pretty reliable devices, but because of their nature, they are susceptible to problems caused by dust and dirt, excess heat, and other environmental problems. Floppy disks themselves are also highly reliable media for mass storage of computer files, but they too are susceptible to damage if they aren't handled properly.

When a disk-drive operation gives you a strange message, it may be a hardware problem, a problem with the disk itself, a software problem, an operator problem, or no problem at all. When you're called on to solve a disk-drive related problem, before you dive right in and start taking things apart, question the operator carefully, take notes, and make some checks yourself.

For example, for someone not familiar with the IBM personal computer disk-operating system (DOS), the error message "GENERAL FAILURE" might cause heart failure. It really sounds bad. But it doesn't mean that the disk drive needs to be replaced or anything like that. A quick look at the DOS operating manual tells you that the problem is probably caused by one of three minor problems:

- The diskette type and drive type don't match. For example, the operator may be trying to use a 1.2MB high-capacity diskette in a 360KB drive.
- It may be that the diskette is not completely inserted into the drive, or that the drive door is not closed.
- The operator may be trying to use a diskette that isn't properly formatted.

Another disk drive-related message is "ERROR WRITING TO DISK." This is another message that may not actually be a problem, or it could be an indicator of a potential problem. One case that I became aware of turned out to be no problem at all. The operator asked me to take a look at her monitor screen as it was giving her that message. In this case, I simply called up the directory of the disk and took a look at the number of files she had on it. It turned out that

she had recorded a large number of short files on the disk and had simply used up all of the available file space on the disk directory track.

Just to verify that this was the problem, I had her erase one of the files on the disk and then save the file on the screen. She had no problem saving the file once room was made in the directory.

Another operator got the same message and asked me to have a look at her computer screen. This was a different situation, as she knew that she had very few files on the disk and they were all relatively short as well. A look at the directory of the disk didn't tell us much, so we did a CHKDSK. This told us a great deal. More of the space on the disk was unusable than was usable. Apparently some kind of a manufacturing defect had occurred that left a great deal of the oxide unable to accept magnetization.

This information fit in with some of the other things she had been experiencing. Out of one box of disks, something on the order of three or four disks were bad. Some were so bad they couldn't even be formatted at all. That's something to keep in mind when dealing with floppy disks. If one or more disks are found to be bad, there's a distinct possibility that you'll find still more bad disks in the same batch. These were first quality disks, guaranteed for a lifetime to be free from defects, not some no-name bargain-basement disks.

In the case of disks that have been used to store valuable data and are found to be grossly defective, it might be a good idea to make copies on known-good disks. Otherwise, two potential problems might crop up. One is that the portion of the disk on which the data are stored might turn out to be incipiently defective and you might lose some of the data on that disk. Another potential disaster is that, if some of the oxide is bad, it might flake off, become embedded in the read/write head and damage other disks.

Intermittent disk problems, like many

other intermittent computer-related problems, may be caused by bad connections. If you encounter a disk problem that doesn't yield to the first level of troubleshooting — questioning the operator and delving into software effects — the next step is to make sure all connections are clean and tight. As you probably know, anywhere there are connections that are not soldered, mechanical stresses and oxidation may interrupt the electrical continuity and cause data to be lost, resulting in improper operation.

After you've made the obvious checks, such as CHKDSK, and the problem continues, turn the system off and check all connections. Carefully unplug any connectors to the offending disk, and make sure that card-edge connectors are clean and bright. If there's any doubt, take an eraser and rub on each of the connectors to remove any oxidation. A wipe with a cloth moistened with isopropyl alcohol followed with a wipe with a dry cloth will finish the job. Disconnect any cables, clean the contacts if they look like they need it, and reconnect them.

In many cases, this will be all that is necessary to restore the disk drive to operation.

### Making notes

One of the things alluded to in this article is the usefulness of keeping notes. If you will be responsible for specific computers, it might help immensely to keep a log on each computer. Ask the operator to make a note of anything strange that occurs. If a strange message occurs on the screen, ask the operator to do a "Print Screen," and keep the printout. It would be a good idea to make a note of the time and date of any occurrence.

A malfunction log such as this, along with a log of any servicing/maintenance procedures, will help you keep track of a deteriorating situation. It will also give you a record that you can refer to for future malfunctions.

**ES&T**

# Troubleshooting VCR front loading systems—Part II

*This series of Video Corner describes procedures for servicing the front loading system on a specific brand and specific models of VCR. However, the methods discussed, the operation of the device and the precautions mentioned should have applications to almost any brand or model of VCR. Last month's installment gave an overview of the circuitry and its operation. This part will describe the actions that take place when a cassette is loading and the troubleshooting procedures to use when loading doesn't occur properly.*

### Cassette loading

To aid in isolating a defect in the capstan drive circuitry, the sequence of events occurring during a normal cassette-loading operation are described here:

1. As the cassette is manually inserted, the FL status switch assembly rotates.

This information was adapted with permission from the article "VCR Front Loading Troubleshooting," which appeared in Volume I of The Best of the Expander, published by Mitsubishi.

2. Rotation of the FL switch generates a low in the FL-1 status line, which has no significance at this point—it is merely a presetting action.

3. Continued rotation of the FL switch causes the FL-2 status line to go low, and the microprocessor responds by generating a low on the CP-REV line.

4. The low on the CP-REV line turns off  $Q_{4N1}$ , allowing forward drive at pin 7 of IC5A4 from the 12V supply via  $R_{4P1}$ .

5. The positive voltage at pin 7 generates an output at pin 3, driving the capstan motor in a forward direction.

6. The rotation of the capstan motor drives the front loading mechanism and the cassette is drawn into the VCR.

7. Because an FG signal is generated when the capstan motor rotates, the microprocessor does not remove the low on the CP-REV line and the motor drive continues.

8. The FL switch continues to rotate as the cassette is drawn into the VCR.

9. When the cassette is resting on the reel hubs, the FL switch generates a high on the FL-1 status line.

10. The microprocessor responds by driving the CP-REV line high, removing drive to the capstan motor. Remember that if the capstan motor does not rotate, the drive commands will only be generated once. To reproduce the drive commands, the VCR must be disconnected from the power source, then reconnected to reset the microprocessor. This process makes tracing the capstan drive somewhat more time consuming, but it is necessary to determine where the drive command is lost.

### Troubleshooting

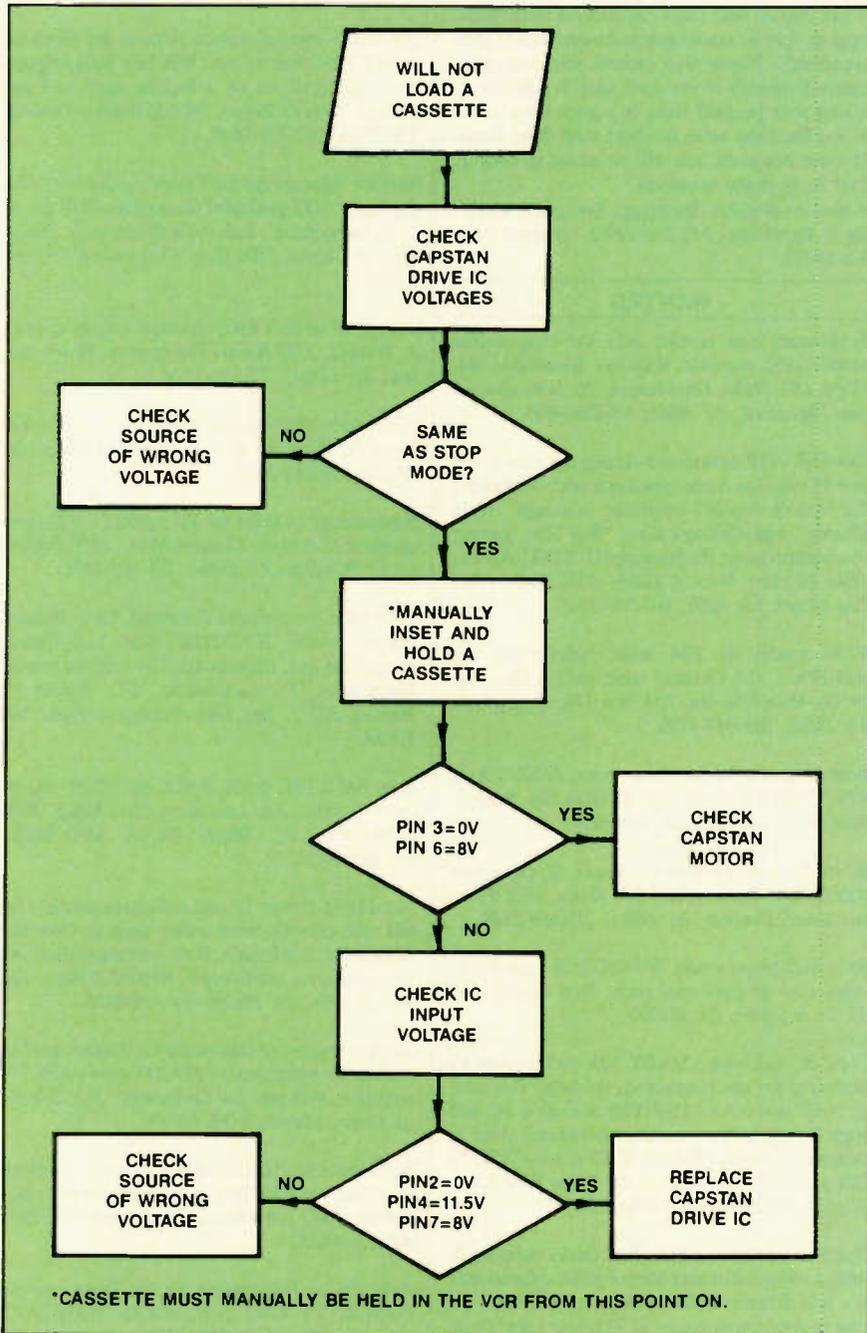
As an aid to isolating the cause for a loading or unloading problem, Table 1 lists the normal voltage at the inputs and outputs of the capstan drive IC for each mode of operation. Remember that drive voltages given during load or unload are only momentary under normal operation.

If a defect renders the capstan motor inoperative, the VCR will simply refuse to accept a cassette. Although the same symptom can be caused by other sections of the VCR such as defective status switch assemblies or mechanical control circuitry, the flow chart illustrated in Figure 1 should be useful in determining whether the problem is in the capstan motor or the capstan drive circuitry.

Although the HS-710UR is a vertical-loading VCR and does not rely upon the capstan motor for the cassette-loading

**Table 1**  
Momentary voltages

mode	capstan drive IC				
	pin 2	inputs pin 4	pin 7	outputs pin 3	pin 6
stop	0	11.5V	0	0	0
load	0	11.5V	8V	0	8V
unload	8V	11.5V	0	8V	0
pb	0	11.5V	5V	0.1V	3.5V
ff	0	11.3V	9.5V	0	8.5V
rew	9.5V	11.3V	0	8.2V	0
fs	0	17.2V	10V	0	9V
rs	10V	17.2V	0	8.5V	0



**Figure 1.** If the capstan motor is inoperative, the VCR will simply refuse to accept a cassette. Although the same symptom can be caused by other sections of the VCR, this flow chart should be useful in determining whether the problem is in the capstan motor or the capstan drive circuitry.

process, the capstan motor is used to remove tape slack during the loading procedure and is an integral part of the eject cycle. Because the HS-710UR uses the same capstan motor and drive IC as the horizontal-format front loading

machines, the voltage in Table 1 should be useful in checking the capstan drive circuit even though the symptom may vary somewhat on this model.

Next month, we'll discuss how to replace the mode switch. **ES&T**

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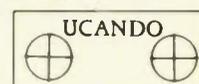
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- a sketch of the schematic area where the fault was found. (Include a major component such as a transformer or transistor to provide a landmark.)

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