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August 1998

Troubleshooting microprocessors

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The joy of troubleshooting

An article by Bob Rose in this issue, "Troubleshooting microprocessors," describes in general how to troubleshoot microprocessors in television sets, and then provides some detailed troubleshooting procedures that he followed in servicing some specific microprocessor-controlled sets. One thing comes through loud and clear as you read the article: while microprocessor control changes somewhat the way in which electronics products operate, for the most part, the tried-and-true troubleshooting techniques used by service technicians apply just as well to microprocessor-controlled circuits as they did to products in the past.

For example, the first rule of thumb that Rose recommends if you suspect the microprocessor and/or surrounding circuits is to check B+ and ground to the processor. Isn't that pretty much the first step that a technician would take in servicing just about any circuit? After all, if a circuit doesn't have B+ or ground, it won't operate.

The article goes on to suggest that the technician check the standby voltage, reset voltage, the oscillator, and data-in and data-out lines. Again, these procedures don't differ much from the procedure that a good technician would follow in servicing a set that was not microprocessor controlled.

A good troubleshooter must possess certain qualities. For starters, an in-depth knowledge of the design and operation of a product is essential. If a technician is going to be able to determine why a product is not operating correctly and restore it to proper operation, it helps immensely to know what is involved in making it work properly in the first place.

Another quality of a good troubleshooter is the drive to solve problems. This includes the ability to ask questions and record and sift data. For example, if a technician is presented with a dead set, the first thing he does is look to see if it's receiving power. A check at the output of the power supply determines whether or not the power line is providing power and the supply is providing the correct output voltage(s). Armed with that basic knowledge, the technician can then step through the rest of the set gathering information

on which to base a sound determination of the cause of the problem.

In fact, most competent technicians really enjoy their work. It's a joy and a challenge. Determining the cause of a problem in a TV set or VCR is much like working some kind of puzzle in terms of the intellectual challenge that it presents. It's an exercise in logic. You might say that in a way troubleshooting is a little like building a truth table: this condition exists, and this condition exists, but this condition does not exist. What type of fault could cause this set of conditions?

In some cases, the answers recorded in the initial information-gathering steps is enough to make a determination. In other cases, the first troubleshooting steps provide some valuable information, but not enough. Then the technician begins to ask questions about the data he has already gathered. Why was the voltage at point x a few volts different from that specified? Or is that within tolerance? Why was there no signal at point y? Questions like these allow the technician to gather more information and to refine the information he already has.

Unfortunately, troubleshooting is not all fun and games. Perhaps if it were a leisure pursuit it would be more fun, but reality has a way of rearing its ugly head. The expectation of having to repair so many sets in a day or a week puts a great deal of pressure on the technician. But then, I guess that's why they call it work. And that's why it's so important that a technician be constantly honing his skills. One incorrect conclusion based on the information gathered can lead the technician down a long series of dead ends from which it may be difficult to return. The wrong idea, once implanted, can confuse the technician's thinking to a degree that it makes it difficult to return to the proper frame of reference.

When this situation occurs and the technician just can't seem to make any progress on the repair, the best approach is to put the product aside and let it sit for a while. Such an approach sometimes allows the technician to forget the blind alleys he's gotten into and to bring a fresh mind to the problem.

It can't be overemphasized that troubleshooting is far easier when the

required test equipment and service literature is available. The ability to refer to a schematic diagram helps immensely in determining the nature of the problem. For example, if the technician is trying to trace a signal to see where it disappears, it will be difficult in the extreme if the schematic diagram is not available. Moreover, the function of many circuits in today's consumer electronics products is not obvious. The explanation of circuit operation that the technician finds in a service manual or in a manufacturer's seminar may be just the tidbit of information he needs to pinpoint the problem and complete the product repair.

But the enjoyment of troubleshooting and repairing the product doesn't end when the cause of the problem has been identified. In a way, the next step is the best part. Once the faulty components or circuits that are causing the problem have been identified, the technician gets to replace them. Then comes the moment of truth when the technician turns on the set and observes the effects of his troubleshooting and repair. What could be more satisfying than to turn on a set that had just a horizontal white line across the center of the screen and see a picture at full height and in glorious color, or to repair a set that had no volume and that now puts out ample sound in high fidelity stereo, and to realize that it was his skills that had caused the transformation.

Fortunately, it doesn't matter whether the product to be serviced is controlled by a microprocessor or not. Most of the functions are the same, in general, as they were before the application of microprocessor control in television. However, as Bob Rose says in the conclusion to his article: "microprocessors are a fact of life, and they are not going to disappear. As a matter of fact, they and their associated circuitry are getting more complicated as time goes on. It, therefore, behooves people in our business to learn to work with them. After all, this business is our livelihood. Learning how systematically to evaluate their performance is one way to work with them."

Nile Conrad Penam

Seminars to be featured at National Professional Service Convention

Service managers who attend the 1998 National Professional Service Convention (NPSC) Will find an Intel information processor inside. The name of this processor is Dan Russell, Director of Platform Marketing for Intel Corp.; who will be the keynote speaker. Mr. Russell will relate his company's thoughts on the marriage of the computer with the television set. Of interest to consumer electronics servicing professionals is how this merger will affect the consumer, and thus, what it will demand from the manufacturer, retailer, and servicer. Also to be covered is its effect on the Universal Serial Bus, IEEE 1394 (Firewire), Digital Video Disk, and more.

The keynote session by Mr. Russell will be held on the first day of the six-day service industry event. NPSC '98 will be held August 10 through 15, 1998 at the Hyatt-Orlando Hotel, in Kissimmee, FL.

On the convention's final two days, business guru Mike Stoll will share abundant information about profitable service management. In his seminar titled, "If You Sell Below Cost, You Can't Make it Up With Volume," he will discuss pricing strategies for service dealers. His two other seminars will focus on "Team Power and Performance," and "27 Ways to Increase Profits."

Other sessions at NPSC '98 to help service managers improve their bottom lines will be the famous annual Best Business Ideas Contest, a study session for the Certified Service Manager exam, and seminars on "Discovering Diversity," and "Tax Changes That Affect the Small Service Business."

Forums intended for all convention participants will include a panel on standardizing electronic service data, and information about the progress of High-Definition Television.

Another highlight of the week will be the two-day Professional Service Trade Show, August 12 through 13. This will feature products, services, and equipment for professionals in the product service industry.

Servicers will also have the opportunity to meet privately with the top service executives from dozens of major manufacturers. These information-sharing "Service Information Symposiums" will occur preceding the trade show on Wednesday and Thursday.

More than a dozen technical seminars will help prepare technicians to cope with the newest technology. The featured presentations will cover Windows 95 troubleshooting and network setup, and computer monitor, and PC servicing schools. Also included will be: sessions on DVD concepts, and MPEG Compression, as well as how to service FAX, copiers, scanners, printers, big-screen monitors, LCD projectors, progressive-scan TV, and power supplies.

Registrations are available for the full week, for any three consecutive days, or on a daily basis. Early registrants can save up to \$70 over the \$300 at-the-door price. For registration information, contact NPSC '98, 2708 West Berry, Fort Worth, TX 76109, (817)921-9061, FAX (817) 921-3741, or e-mail: isctfFW@aol.com.

First graduating class for C.N.S.T.

ETA, The Electronics Technicians Association, International, Inc., (Green-castle, IN) recently announced the addition to its array of certification programs for electronics technicians, the C.N.S.T., Certified Network Systems Technician, program.

Since that announcement, the C.N.S.T. initiative, developed

by Texas A & M University System's, Engineering Extension Service, has completed beta testing of the 100-question written examination and has gone ahead to certify through ETA, an initial group of computer networking professionals.

Each successful C.N.S.T. receives a wall certificate and wallet card and is entered in ETA's international certification data base at Greencastle, IN. In addition, those who qualify for Senior C.N.S.T. status, receive a walnut and brass wall plaque attesting to their accomplishment and status. C.N.S.T. lapel pins are also part of the recognition items.

On June 9, Texas A & M's Engineering Extension Service in San Antonio, graduated the first class of C.N.S.T. technician aspirants at its HemisFair Park campus. The rigorous 144-hour program is designed to prepare the students who pursue it to pass the C.N.S.T. exam.

The C.N.S.T.'s role in the telecommunications industry is between that of a Computer Desk Top Service Technician, and a Network Systems Engineer. The C.N.S.T. assists the Network Systems Engineer in designing, installing, and maintaining computer networks. Prerequisite for applying for the C.N.S.T. through ETA is an ETA C.E.T. in Computers, or the A+ certification through CompTIA. Two years of experience and/or schooling are required for the Journeyman C.N.S.T. status in ETA.

Dick Glass, President of ETA, stated that the C.N.S.T. certification program has generated more initial interest in its first 3 months, than any other of the association's 15 skills and knowledge certification categories, since 1986.

While additional classroom courses are not a requirement of the C.N.S.T. program, ETA advises that, unless the networking technician is already an expert, an in-depth class such as that conducted by Texas A & M, (and being implemented by several other proprietary schools around the country), can bring the computer technician up to the level of C.N.S.T. and its current higher financial rewards.

For more information and the competencies listing for C.N.S.T. certification, contact ETA at: 602 N Jackson, Greencastle, IN 46135, Fax 765-653-8262, e-mail: eta@indy.tdsnet.com

CEMA applauds FCC decision on consumer cable devices

The Consumer Electronics Manufacturers Association (CEMA) applauds today's decision by the Federal Communications Commission (FCC) to adopt pro-competitive, pro-consumer rules allowing consumer cable devices to be sold at retail.

"This decision will benefit consumers because it will foster innovation and competition. Consumer electronics manufacturers now can move forward to develop a wide range of products and features, increasing consumer choice and driving down consumer costs," said CEMA President Gary Shapiro.

The Telecommunications Act required the FCC to enact rules that provided for a competitive market for cable services equipment. As a result of today's decision, consumers will be able to purchase set-top cable boxes at retail like any other consumer electronics product.

CEMA is a sector of the Electronic Industries Alliance (EIA), the 74-year-old Arlington, Virginia-based trade organization representing all facets of electronics manufacturing. CEMA represents U.S. manufacturers of audio, video, accessories, mobile electronics, communication, information and multimedia products which are sold through consumer channels. ■

Electronic Servicing & Technology is edited for servicing professionals who service consumer electronics equipment. This includes service technicians, field service personnel and avid servicing enthusiasts who repair and maintain audio, video, computer and other consumer electronics equipment.

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LITERATURE



Transformer information website

Signal Transformer Company, an operating unit of the Insilco Technologies Group, has unveiled a website that makes it easier for engineers to obtain information about the company's off-the-shelf and custom power transformers, as well as valuable educational material on transformer design and applications.

The website, located at <http://www.signaltransformer.com>, features a home page that offers functionality and the ability to easily link to other sections of the website. Product information on Signal's comprehensive line of printed-circuit (PC) and chassis-mount transformers, as well as supplemental magnetics, can be easily accessed directly from the home page. Detailed specifications and part numbers are available by downloading Adobe Acrobat portable document files (PDFs) for various products. Visitors can also download the Custom Magnetics Design Data Sheet to find information on the company's custom design capability.

Users looking for technical information on transformers can find it by accessing the Technical Library section, which posts application notes on various transformer technology products.

Circle (86) on Reply Card

Tool, tool kit, tool case and test equipment catalog

Specialized Products has released its new comprehensive Spring '98 Catalog. The new 384-page publication features a wide assortment of products for virtually every service application in telecom, LAN, fiber optic, wireless, medical electronic and computer industries.

Technicians, field service managers and engineers can choose from a complete assortment of electronic test equip-



ment featuring component testers, digital multimeters, frequency counters, function generators, oscilloscopes, power supplies and more.

The computer testing selection includes benchtop test equipment, EPROM testers and SIMM testers. LAN test equipment choices include analyzers, category 5 testers, continuity testers and fiber optic test equipment. The telecom selection features bit error rate testers, digit grabbers, digital butt sets and transmission test sets. For fiber optic test equipment, the technician can choose from cleavers, light sources, optical time domain reflectometers, power meters, strippers and more.

Circle (87) on Reply Card

Electrostatic discharge control catalog

Desco's new catalog of electrostatic discharge control products has 68 pages of products in sections of personnel grounding, neutralization, shielding and test equipment. Products include wrist straps, foot grounders, floor and table mats, ground cords, shielding bags, floor finish ionizers, test equipment and more. A separate section on the basics of ESD control is also included.

Circle (88) on Reply Card

Component data book

Alps has released the all-new 1998 Data Book. Completely redesigned and expanded, the data book features a new page format and a new compact size in a book

binding. Several new additions include more detail drawings, product reference guide for each section and an all-inclusive index, and Alps ISO certifications.

Circle (89) on Reply Card

Test equipment catalog

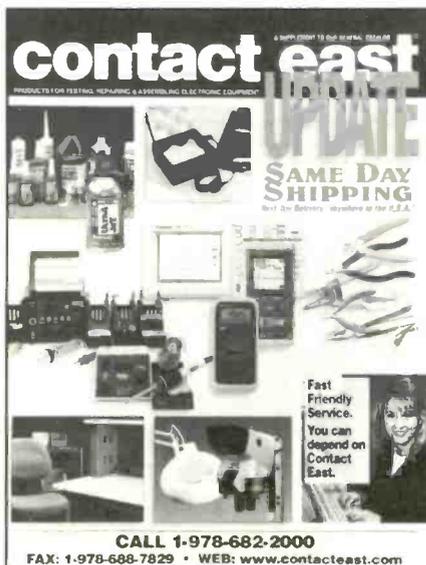
Amprobe announces its Golden Anniversary Catalog, covering the entire product range and including a host of new products. The catalog has extensive cross-reference charts and product in-use photographs enabling customers to quickly find the tool that provides the best solution for their needs.

Circle (90) on Reply Card

Catalog update

This 64-page update from Contact East lists the latest in test instruments and tools for engineers and technicians. Featured are quality products from brand name manufacturers for testing, repairing, and assembling electrical and electronic equipment. New product highlights include Fluke's T5 Electrical Testers, Tektronix' Huntron Tracker TR210, and the CEK-74 complete electronics tool kit. Other products displayed are DMMs, oscilloscopes, soldering/desoldering tools, clamp meters, power supplies, ESD protection products, aerosol cleaners, adhesives, and precision hand tools. Choose from quality brand names like Fluke, Tektronix, Hewlett Packard, Xcellite, Xuron, Ideal and Weller.

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Power products guide and catalog

Hewlett-Packard Company announces the availability of the 1998/1999 editions of its System Power Products Selection Guide and Power Products Catalog. The 16-page guide (Literature No. 5966-1707) contains a succinct overview of the company's power product line, highlighting key features and specifications.

The 65-page catalog (Literature No. 5966-1706) provides R&D and production engineers complete technical information on more than 125 models of dynamic measurement dc sources, ac power source/analyzers, harmonic/flicker test systems, dc power supplies, dc electronic loads, solar array simulators and modular power systems.

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Troubleshooting microprocessors

by Bob Rose

Virtually every modern television consists of five basic systems. Whether it's a nine-inch fellow

Rose is an independent consumer electronics business owner and technician.

that is kept in the kitchen or a 60-inch job that dominates a room in the house, it will still have five systems: power supply, system control, deflection, video, and audio. Each system presents a special challenge

to the technician because each system is different.

System control

This article will explore the TV's system control, the "brains" of which is the

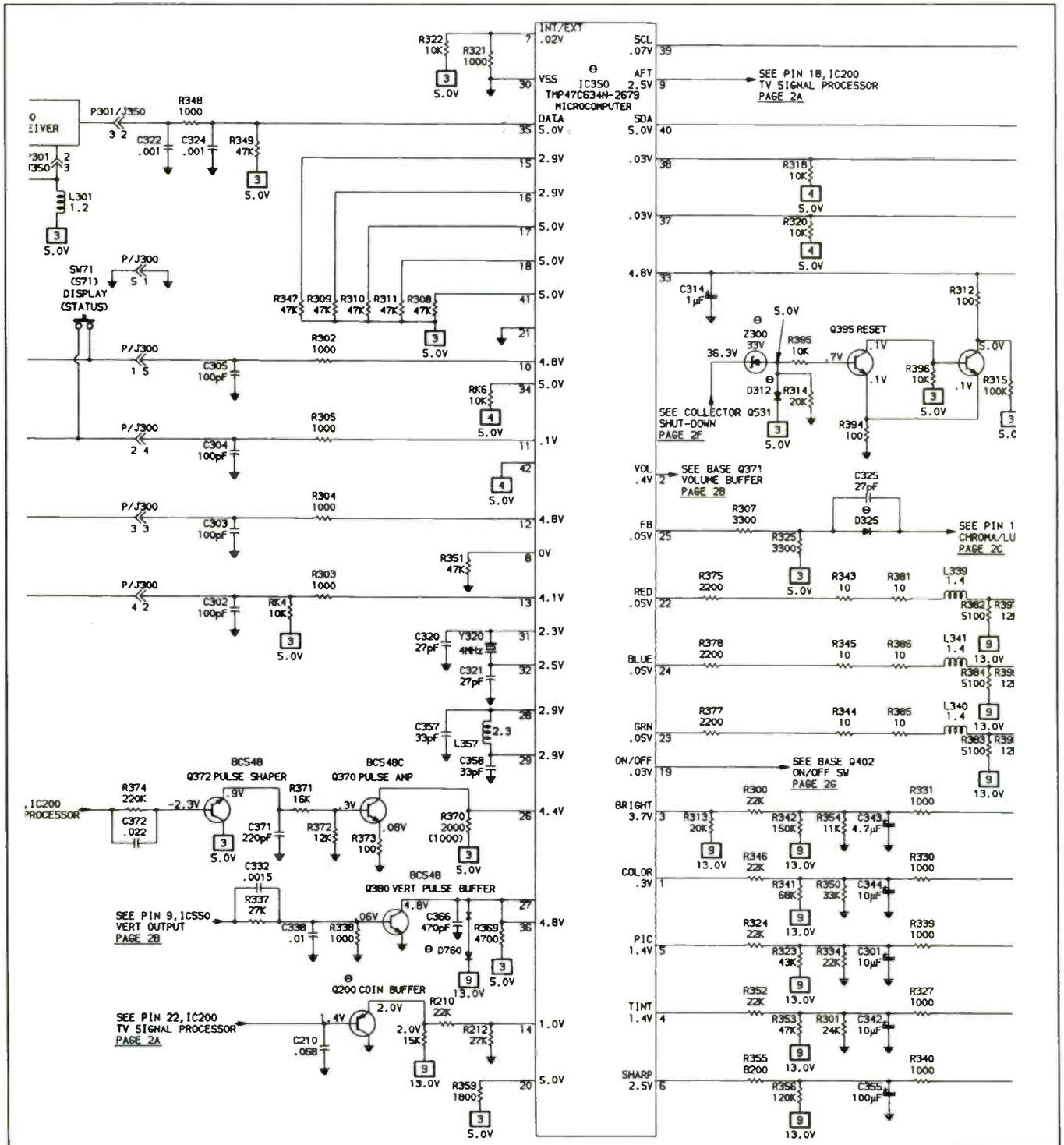


Figure 1. The CPU for a Magnavox 25N1 chassis.

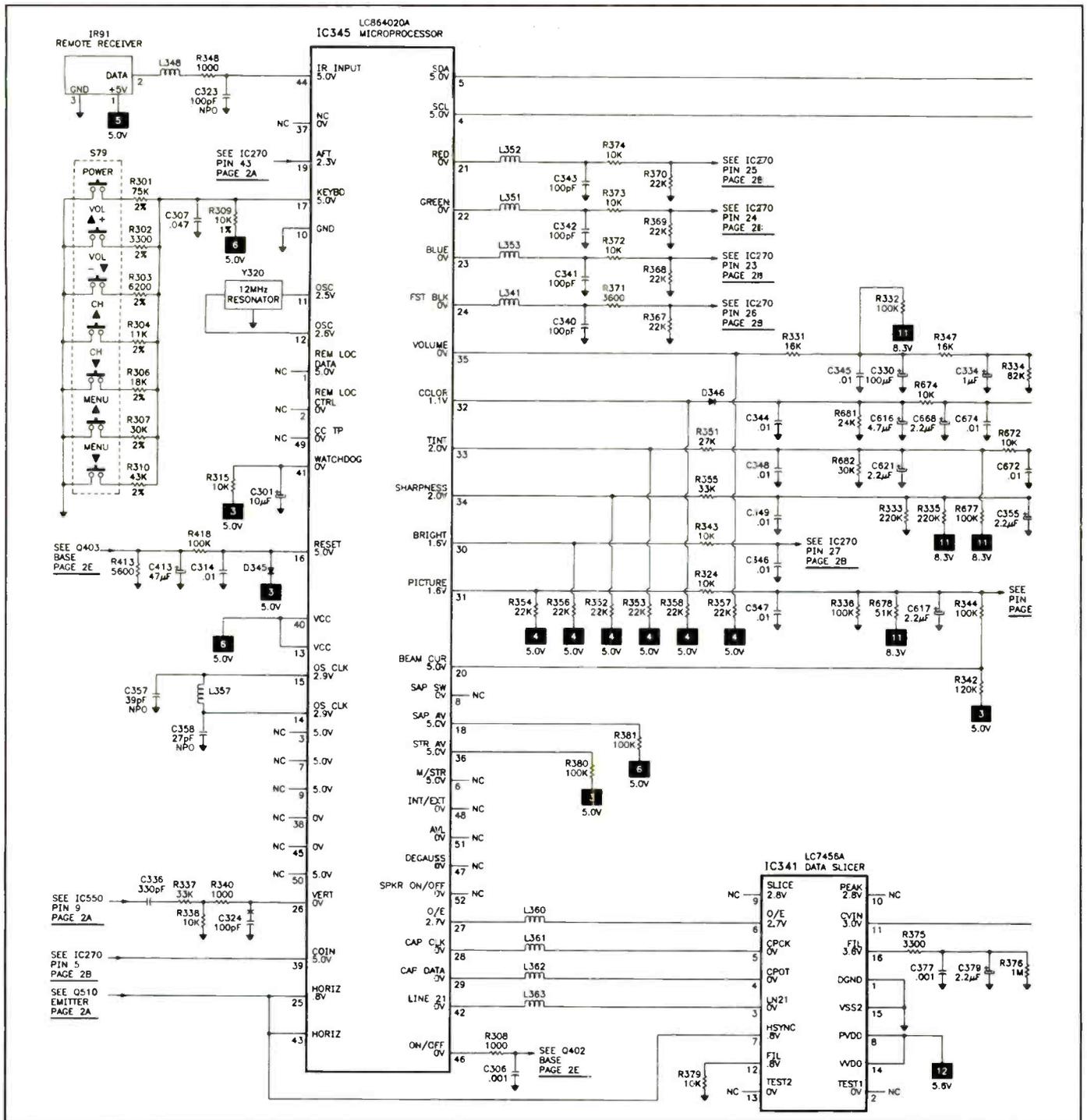


Figure 2. The microprocessor for a Philips' G-6 chassis.

microprocessor. Perhaps this is as good a place as any to note that microprocessor technology is not going to go away. It is in fact getting more and more complex. For example, if you service RCA TV's you know that the microprocessor uses data and bus lines to communicate with the EEPROM, video IC, tuner, and audio circuits. Consider the operation of the horizontal oscillator. The CPU receives information about horizontal frequency and phase from the EEPROM and sends

the information via clock and data lines to the video processing IC where the horizontal drive signal is generated.

I just recently received Panasonic Services Company's training manual for its new VCR (the UZ mechanism) and TV/VCR combination. These units feature the "I-Squared-C" bus which consists of a data line and a clock line. It employs a "master" (system control microprocessor), a "slave" (EEPROM), and several other "slaves" (the TV jungle

IC, the HI-FI IC, and the Y/C/normal audio IC). This system replaces many of the mechanical controls to which we have grown accustomed with an on-screen display (OSD: as in "service menu") and adjustments via remote control.

Is it a system control problem?

Given the complexity of these new circuits, how do you determine if the problem you are trying to solve is a system control problem? Once you have determined

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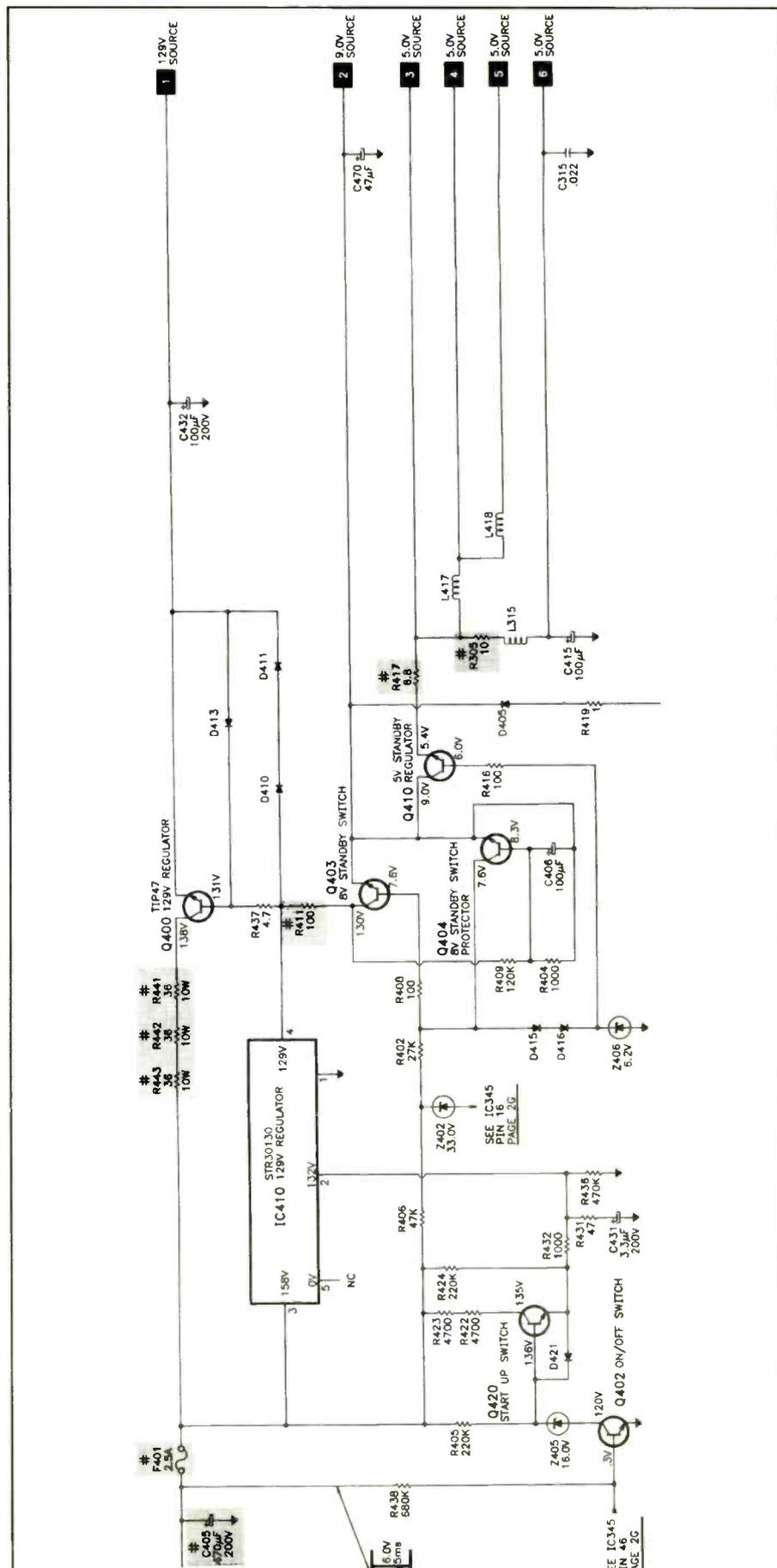


Figure 3. In the Philips G-6 chassis, the stand-by voltage is developed by IC410 at pin 4. In stand-by mode this voltage should be about 15.7V.

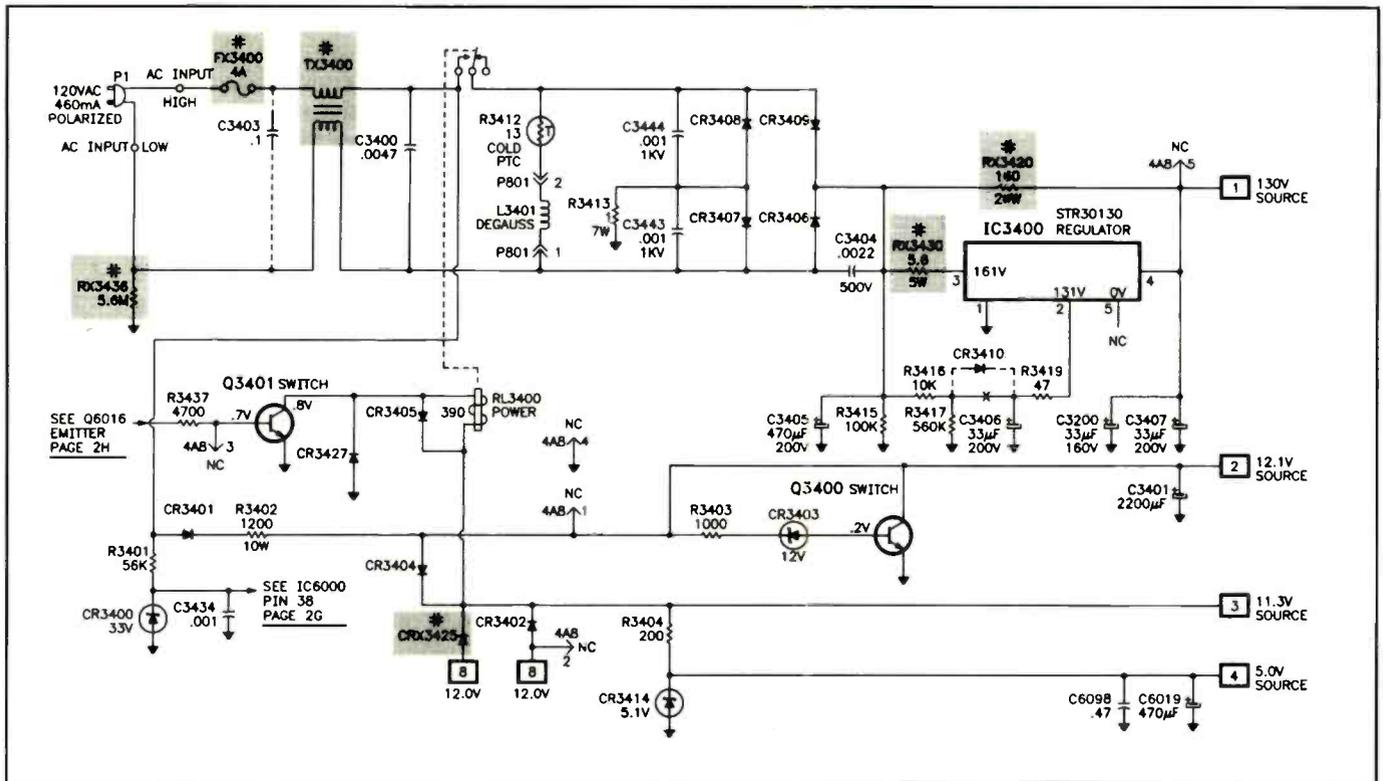


Figure 4. When all else fails, check the standby 5V. In this set, this voltage measured about 4V, and had a lot of noise on it.

that you have a system control problem, how do you pinpoint the exact cause?

I am going to suggest a five-step approach to help you answer these questions. First, locate the microprocessor and then check the following: B+ and ground, reset, oscillator, input data lines, and output data lines. These few measurements

will give you a picture of the health of the microprocessor and should point you to the source of your problem.

Troubleshooting tools

Now a word about some necessary troubleshooting tools. You will need good literature. The literature will give you pin-

outs and voltages, and it will also provide you with waveforms. You will need a good DMM, and I recommend a good oscilloscope. There are some problems you will not find if you don't use an oscilloscope. For example, you might condemn a tuner when the tuner is good. If you had checked clock and data inputs to

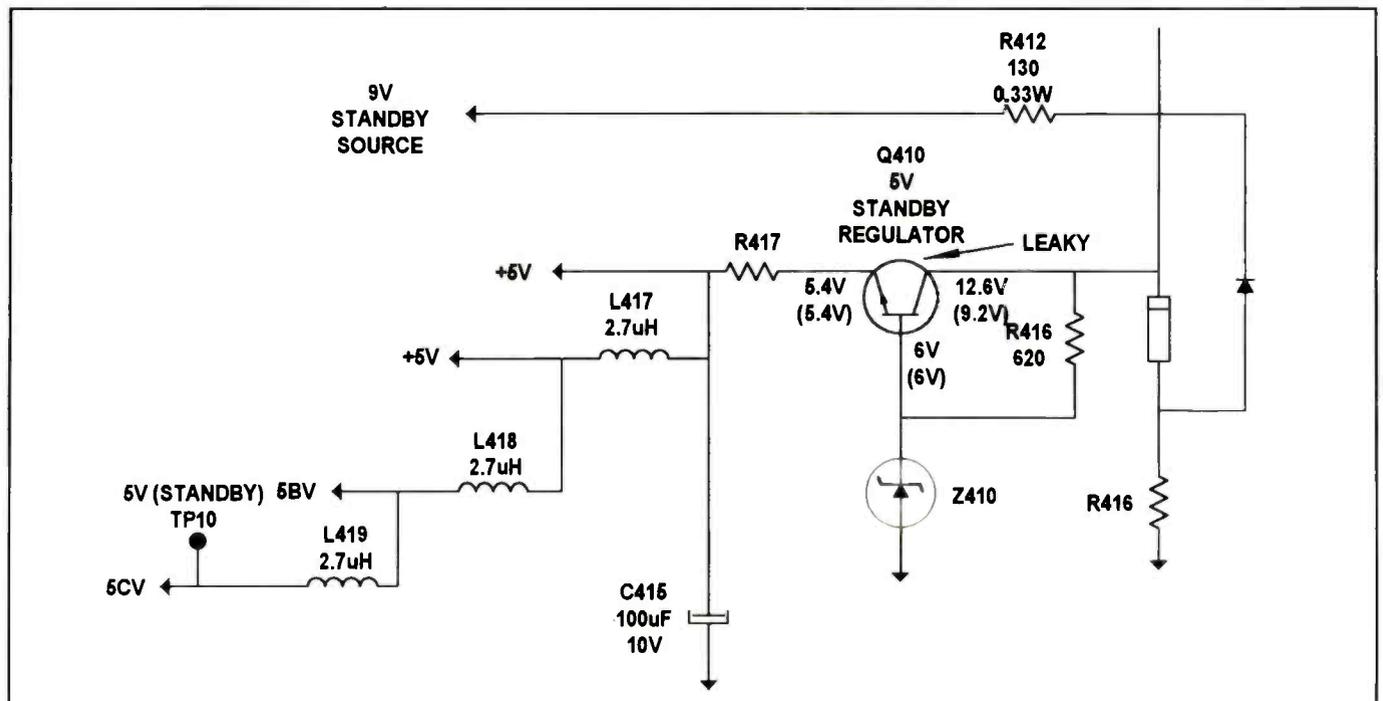


Figure 5. In one set, the picture looked washed out, as if there were a problem with the contrast. Transistor Q410 at the 5V regulator, was leaky and permitting 6V to get to the microprocessor.

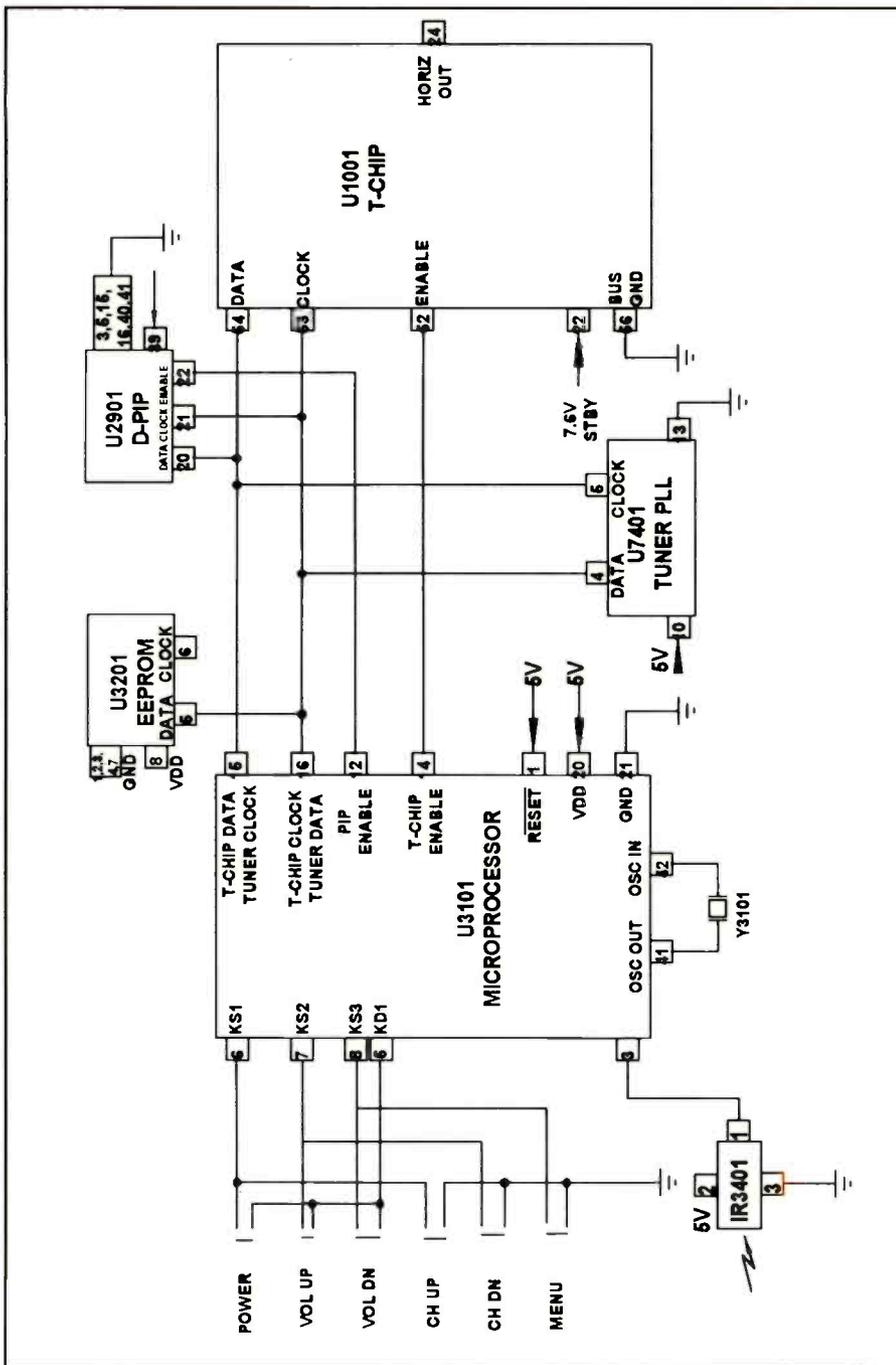


Figure 7. A load on an input data line can mimic a defective CPU.

When all else fails, check the standby 5V. This voltage measured about 4V (Figure 4), and had a lot of noise on it. We replaced a leaky diode and filter capacitor to restore this voltage to the correct 5V (CR 3414 and C6019 in Figure 4). A good DMM would have revealed the low voltage, but it took a good oscilloscope to show the "hash" riding on the supply voltage.

What would be the situation if this voltage exceeded 5V? We serviced a set that had such a problem earlier this year. The picture looked washed out, as if there was a problem with the contrast. The color

was also very poor. But the really odd symptom was a very dark, almost black, OSD. None of the customer controls had an effect on the quality of the picture. I have a rule-of-thumb. When you have an oddball problem, check the power supply. In this instance the 5V regulator was leaky and permitting 6V to get to the microprocessor (Q410 in Figure 5).

Check reset voltage

Suppose you have good B+ and the ground connection is also good, but the set still will not come on. What next?

Don't forget the reset voltage. Look again at Figure 1. Pin 33 (reset) should be an active high after ac has been applied. This high signals IC350 to initialize its program. If the voltage is missing, IC350 does not initialize its program, and the result is a dead set. According to Figure 6, the reset voltage is developed via R417, a 100kΩ, 1W resistor. For some reason, these N-1 chassis are tough on R417. Rarely does a month go by that I don't have to replace an open R417. If your service center is like mine, it will not see many reset problems. Nevertheless, when you encounter a dead set and suspect a system control failure, be sure to verify the reset voltage. The reset may be an active high or active low (a condition when the reset will go high for a specified time when ac is applied and then low).

Check the oscillator

If a television set is to operate properly, the oscillator should be on frequency, and the waveform should have the specified peak-to-peak value. The latter is usually around 5V. The former will vary from chassis-to-chassis. For example, the N-1 chassis runs at 4MHz while the G-6 runs at 12MHz. Always consult the manufacturer's literature for voltage and frequency. If the oscillator is not running, or if the waveform is not close to the stated value, the microprocessor will not operate. The most common cause of a faulty oscillator in my area is lightning damage. When the oscillator is not running, I usually replace both the IC and the crystal.

Oscillators can cause problems. For example, I remember one N-1 chassis that would be playing fine and suddenly go off, as if the set had been unplugged. Well, a lot of things can cause the problem, but in this instance Y320 at pin 31 of IC350 was failing. I don't think we would have found the problem if we hadn't consulted the engineers at Philips who were kind enough to point us in the right direction.

Be certain to confirm these parameters before moving on to the next level. If the oscillator is running, is it on frequency, and is the waveform the correct value?

Incidentally, a microprocessor needs more than B+, reset, and oscillator to perform its functions. For example, if it generates on-screen display information, it will also need inputs from the horizontal

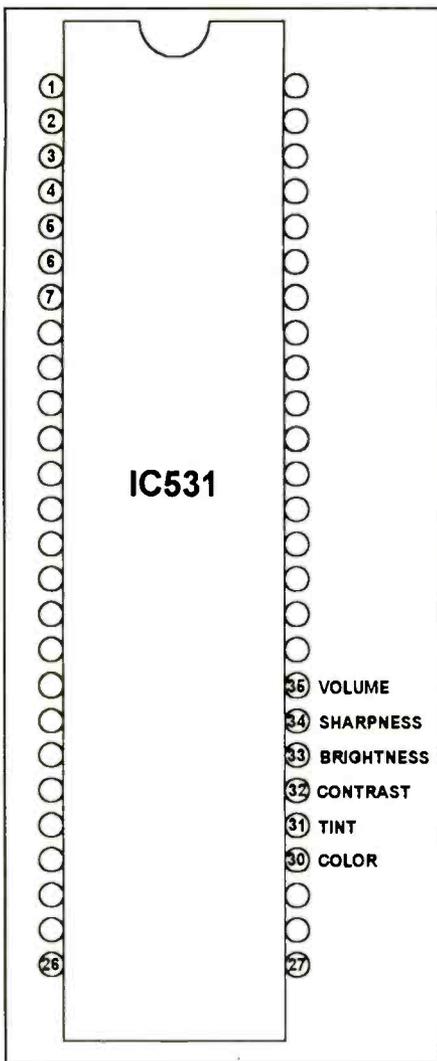


Figure 8. A partial schematic for a Sanyo DS 31450. One of these sets that we serviced had been damaged by lightning and was completely dead.

and vertical output circuits. So, if the OSD is missing, you would naturally check these inputs to the microprocessor.

Check input data lines

A load on an input data line can mimic a defective CPU. Take a look at Figure 7, a partial schematic for an RCA CTC 177. We just recently received such a unit for service. The customer said it began to channel up by itself and then turned itself off and would not come back on. A peculiar set of symptoms! I immediately suspected a system control problem. Following the procedure I am outlining, I began with U3101. B+ voltage was about 4.8V, and the ground was good. The oscillator was working, and the reset voltage was the correct value, but there was no communication between the CPU and the EEPROM. Was, therefore, the EEPROM or the microprocessor defective? Let's not change either just yet. The next check will then be the input data lines (pins 5, 6, 7, and 8) which should be at 0V. Sure enough, one of the pins was high, which pointed to a defective front control switch. Replacing the switch (Channel up. Remember the customer's complaint.) restored this CTC 177 to proper operation.

What about the loss of a single function? Philips has had several chassis that would intermittently lose remote control function. Every function worked except the remote control. The G-6 chassis in Figure 2 was one of the affected TV's. If you scoped pin 44 of IC345, you would

find the IR signal present. The problem almost had to be the IC itself, which in fact it was. Philips came out with a service bulletin confirming the diagnosis. It seems that random noise would lock up the IR port. The problem could be cured by removing ac for a couple of minutes. When power was reapplied, IC345 reset and the remote functioned fine. But the only permanent cure was to replace the chip. If one function does not work, you must check the appropriate data input to see if the input changes. The change may be a voltage change, or it may be a change that appears on the oscilloscope as a series of pulses. If there is data input, then you will have to check the appropriate data output port. Which brings me to step five.

Check data output.

Always make this final check before you condemn the microprocessor. Remember if a data output line appears "hung up," some component tied to the line may be hanging it up. I once checked a Goldstar TV that had a system control problem. All checks were good except when I got the data output lines. It turned out some "glue" left from the manufacturing process had shorted out two of the output lines.

Figure 8 is a partial schematic for a Sanyo DS 31450. The TV had been damaged by lightning and was completely dead when we began to work on it. We began by getting the power supply up and

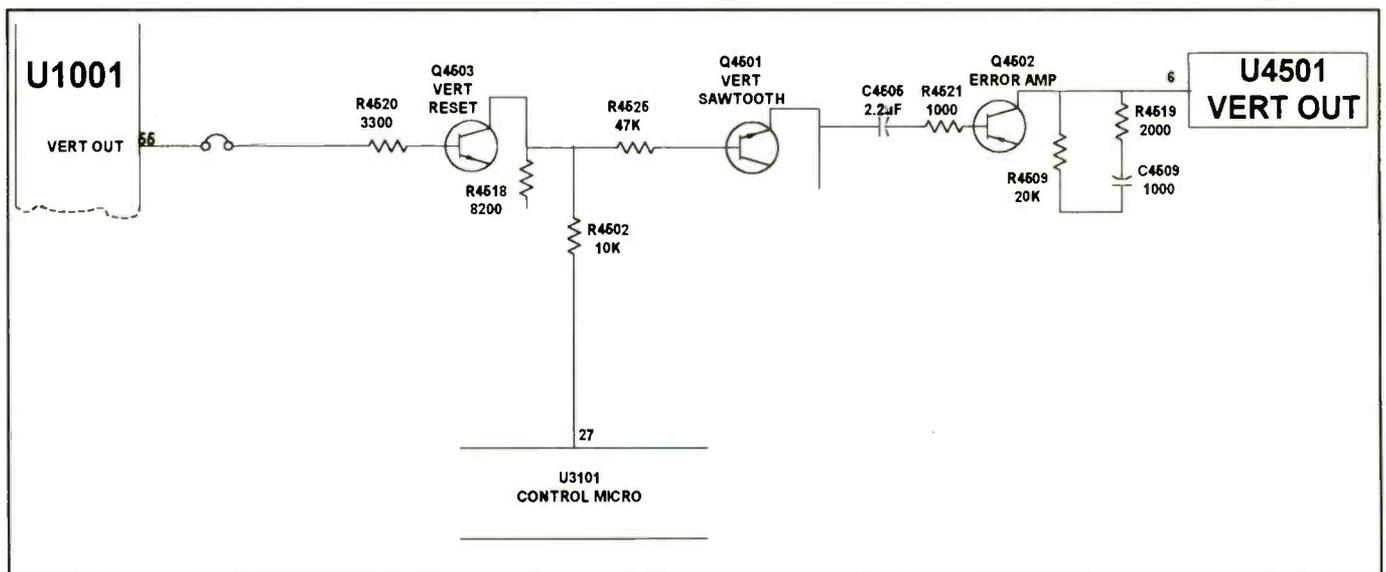


Figure 9. In one RCA CTC167 that exhibited a horizontal white line in the middle of the screen, the most obvious place to begin troubleshooting was the vertical circuits. I quickly determined that all voltages were present, but there was no vertical drive at pin 6 of U4501.

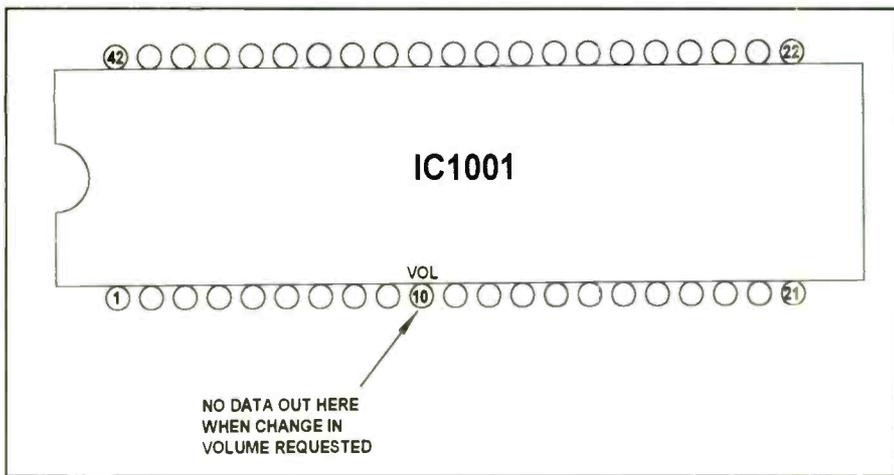


Figure 10. A partial schematic for a Sharp 25A-M050. The complaint was "cannot raise or lower the audio." In this case, IC1001 was defective.

running. Then we repaired vertical deflection. When deflection had been restored, the TV came on with no raster and no audio. The OSD worked, and the channel numbers changed. But that was all. We couldn't even force a video signal through the set. What was going on?

Some of the voltages on the video processor were substantially off, but these voltages were controlled by IC531, the microprocessor. Voltages on pins 30 through 35 of IC531 were substantially off. When the pins were wicked out, the voltages were still off. We replaced the IC, and the TV began to work as it should.

A strange problem

Let's look at another "slightly weird" problem caused by a defective microcomputer. I accepted an RCA CTC 167 for repair. The customer's complaint was "a line in the middle of the screen," in other words no vertical deflection. When I assessed the TV I noted that there was indeed no vertical deflection. There was also no audio and, as far as I could tell, there was no video. In fact the only function that worked on the remote or the front controls was power on/off.

Where to begin? The most obvious place was the vertical problem. I quickly determined that all voltages were present, but there was no vertical drive at pin 6 of U4501 (Figure 9). Drive exited pin 55 of U1001, but it almost disappeared at the base of Q4501. A waveform that should have been about 20V_{pp} had dropped to almost nothing! This chassis takes verti-

cal drive at the collector of Q4503 and sends it to U3101 to develop OSD information. I wicked out pin 27 of U3101, which restored vertical deflection. However, the other problems had not gone away. A new microcomputer put this CTC 167 in good working order!

No volume control

Let's use one more example. Figure 10 is a partial schematic for a Sharp 25A-M050. The complaint was "cannot raise or lower the audio." I checked B+, reset, and oscillator of IC1001 even though all other functions worked. I hope I have learned not to ignore the obvious. These were within acceptable parameters. Data was present when I requested a change in volume, but there was no data out on pin 10. I wicked out pin 10 and checked it again. Still no change when data input changed. IC1001 was indeed defective.

Microprocessors have become a fact of life

Microprocessors are a fact of life, and they are not going to disappear. As a matter of fact, they and their associated circuitry are getting more complicated as time goes on. It, therefore, behooves people in our business to learn to work with them. After all, this business is our livelihood. Learning how to systematically evaluate their performance is one way to work with them. Use my system if you like it; if not, work up one you do like. ■

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Troubleshooting tube circuits

by Alvin C. Sydnor

Every vacuum tube you encounter has been designed to be operated within certain predetermined limitations that are called "characteristics." When dealing with tube operating characteristics you will encounter the term "amplification factor."

One of the most important features of a tube is the fact that a very small variation or change in grid voltage will produce a large change in plate current. This is possible due to the ability of the tube to *amplify*. We can also cause a change in plate current by varying the plate voltage, but we can get a greater change in plate current by a smaller change in grid voltage.

Amplification

Let's assume that we have a tube operating in a circuit and we measure an increase of 5mA when the grid voltage is driven 10V more positive, but that an increase of 30V on the plate was needed to produce the same 5mA increase in the plate current. From this we can see that it takes a three times greater increase in plate voltage than the increase in grid voltage to produce the same 5mA change in the plate current. From this simple test we can say that this tube has an amplification factor of three. When looking at tube characteristic data it is common practice to call the amplification factor the "MU" (μ) of a tube.

The amplification factor or μ of any vacuum tube is the ratio of the change in plate voltage to the change in grid voltage that would be required to produce the same change in plate current.

Troubleshooting vacuum tube circuits can become very easy once you are familiar with the Eg-*I*p and Ep-*I*p curves. Looking at the curve shown in Figure 1 you will notice that if -3V were applied to the grid of this tube, 25mA of plate current would be flowing. With -6V on the grid, the plate current will be reduced to

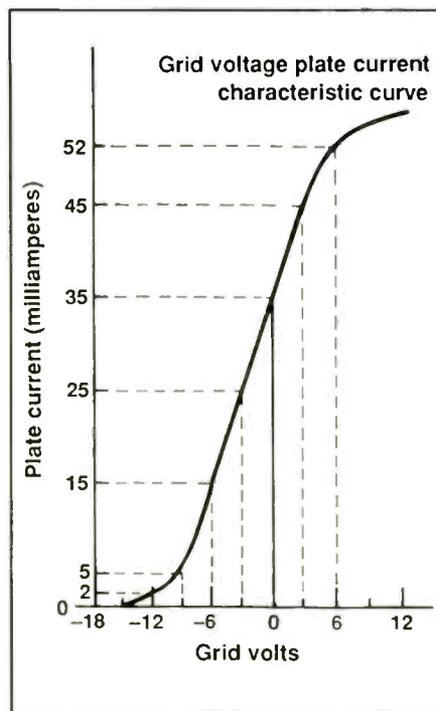


Figure 1. Characteristic curve of a typical vacuum tube.

15mA. With -9V on the grid the plate current drops down to 5mA. When the grid voltage is -15V the plate current drops down to zero. This point at which the plate current drops to zero is called *cutoff*.

The characteristic curve shown in Figure 1 also shows us that by making the grid more negative we can reduce plate current, and by making the grid more positive we will be increasing plate current. Also notice that as the grid gradually becomes more positive the change in plate current is not as great as for values located on the straight portion of the curve, which indicates that we are approaching this particular tube's *saturation* point at higher grid voltages.

Tube characteristics

The particular characteristic curve shown in Figure 1 acquires its specific slope only when a certain positive voltage is maintained on the plate. If a different voltage were applied to the plate, the slope of the curve would be altered,

and the plate current values for a given grid voltage would be different from that shown. An important point to remember is that a higher plate voltage will result in a steeper grid-voltage/plate-current curve, whereas a lower plate voltage will result in the curve having a more gradual slope. When you look in any tube manual you'll see different slope curves for different tubes, so we can see that each tube type has its own particular Ep-*I*p curves.

Every tube and its associated circuit is designed to operate within certain limitations, and by conforming to these limitations and specifications, a tube's life can be prolonged considerably. There are many factors that contribute to a tube's life span and in many cases little can be done to control them. There are, however, some things that you should be aware of that can help in controlling tube life.

Factors that determine the lifetime of a tube

Whenever a low filament emission occurs, the filament or the cathode is unable to supply the necessary electrons to the plate or grid. This deficiency of electrons manifests itself as weak signals within the circuits associated with a weak tube. The external factors that affect emission life are filament temperature which in turn depends upon filament voltage, plate current, plate voltage and overall temperature of the tube.

Whenever a vacuum tube becomes gassy, ionization takes place and the plate or grid current no longer responds to any variations in electrode voltages as required in the circuit design. Filament emission is destroyed very rapidly by the presence of gas. A gassy tube in some cases is caused by deficiencies in manufacturing techniques.

Severe overloads, either prolonged or momentary, can cause an appreciable release of gas within a tube. Only limited provisions are made in the fundamental design of the tube to limit this gas release. Some tubes use the metal tantalum, which has the ability to quickly absorb gases that

Sydnor is a retired consumer electronics servicing technician.

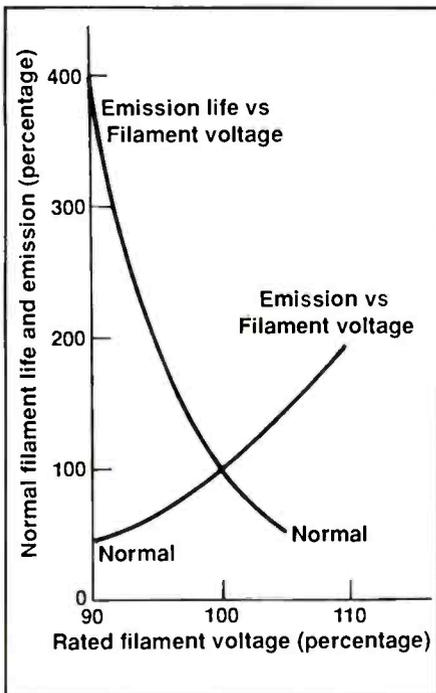


Figure 2. This graphic shows the effects of emission and emission life versus filament voltage for tungsten filaments.

are liberated by momentary overloads, within their structure.

A cracked seal, as distinguished from a broken bulb, usually permits a small amount of air to enter the bulb. If the process of admitting air takes place very slowly over a long time period, the tube will possibly behave as though it was gassy. Once enough air enters the tube, the filament will burn out immediately.

In some cases a cracked seal can be attributed to a weakness in the manufacturing process or careless handling during the manufacturing process. Severe vibrations, sudden shock, overheating, voltage arc-overs, and corona are other possible abuses that could cause problems for the technician.

Tubes react to abuse

Abusive handling of tubes in the form of shock and vibration can result in broken or possible shifting of internal elements. For example, the control grid could sag toward the cathode. This type of failure can render a tube useless because of internal shorts, broken filament, sagging grid, broken leads and misaligned elements. Tapping and hitting tubes while in operation can be classified as abusive handling.

Overheating elements can cause the liberation of excessive gas and can also cause warping or melting of electrodes within the bulb. All these failures combined can cause localized heating. I have seen tubes that had developed localized heating so great that the bulb became deformed and melted the glass at the point of excessive heat. Localized heating is usually caused by inadequate cooling, which occurs when the tube is covered with dust and dirt. Keep the tubes clean.

Tube life vs. emission

The effects of emission and emission life versus filament voltage for tungsten filaments are shown in Figure 2. The life of a tungsten filament depends on the rate of evaporation or reduction of the tungsten wire. This rate depends on the temperature at which the tungsten wire is being operated.

As shown in Figure 2, a three percent decrease below normal filament voltage will result in an approximately 50 percent increase in emission life with only a 20 percent decrease in filament emission. Also note that a three percent increase above normal filament voltage will result in about a 30 percent decrease in emission life with an increase of 25 percent in emission. This illustration points out the need to be aware of the filament voltages.

Since most filaments draw very high currents at relatively low voltages, it is

important to be aware of filament voltages. Extreme care must be taken when checking the filament circuits looking for and eliminating contact resistance where appreciable voltage drops may develop. Examine and clean the filament tube pins to eliminate corrosion and any other high resistance substance. Examine all filament wiring and always measure filament voltages at the tube pins.

Parasitic oscillation

Parasitic oscillation is a condition in which undesired oscillations occur due to feedback. These undesired oscillations can be caused by long leads, unshielded leads, large interelectrode capacitance, and relatively high values of transconductance, all of which are common to power-output tubes. Besides subjecting a tube to excessive voltages and currents, parasitic oscillations can reduce power output and cause distortion. These phenomena can usually be observed by monitoring the grid and plate currents which will most likely be fluctuating.

References:

- *RCA Receiving Tube Manual RC-34 (or later edition)*
- *Radiotron Designers Handbook 3rd Edition*
- *Principles of Electron Tubes By H. Reich*
- *Saga Of The Vacuum Tube By Tyne* ■

ES&T Calendar

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PCS 98
September 23-25, 1998
Orlando, FL
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Personal Computer & Electronics Expo
October 15-18, 1998
Uniondale L.I., NY
800-886-8000

PCS 99
September 22-24, 1999
New Orleans, LA
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Do you remember that old bit of doggerel that goes: “For want of a nail the show was lost, for want of a show the horse was lost?” If so, you might remember that the last lines read “For want of a ...the kingdom was lost. All for want of a nail”

Doesn't that pretty much express an idea along the same lines as what happens when a service center can't find a replacement part for a television set, VCR, camcorder or stereo. Although I suppose you'd conclude “For want of a part, the sale was lost.”

Unfortunately, that kind of problem crops up much more often than most service centers care to think about. As an example, there was the case of a certain brand of consumer electronics product manufactured off-shore. It was sold in the U.S. for a year or two, then the company went out of business in the U.S. and it was all but impossible to locate replacement parts. A lot of customers were unhappy about the products they owned, and a lot of service centers spent a lot of time researching, only to find that it was futile. The parts didn't exist.

That's an extreme example, but lack of parts availability is a pervasive problem in consumer electronics service. Another problem that sometimes faces service centers is early obsolescence of product. Many consumers are very happy with the electronics products they buy. They use them for a number of years, pleased with the sound and picture, and when the product fails, they want to get them serviced. However, in many cases if the product is

more than about seven years old, they may not be able to get it fixed.

Oh, if the problem is caused by a standard resistor, capacitor, inductor, transistor, the service center will probably be able to track down a replacement and restore the product to working order. But if the faulty part is a horizontal-output transformer, or a yoke, or a proprietary IC, the customer, and the service center that has a great deal of diagnostic and parts research time sunk into the unit, are both probably out of luck.

From time to time, however, it happens that although the product is obsolete and many suppliers have no replacement parts for the product, one or two resourceful distributors might just know how to get their hands on that part. And that's one of the differences between a good distributor and an excellent distributor. There are many other qualities that differentiate the best parts suppliers from the good and very good suppliers. Sometimes it's hard to tell which is which. The list below provides some guidelines.

Evaluating a distributor

Here's a list of questions you might ask yourself when you're evaluating a distributor.

- ☛ How many locations do they have?
- ☛ How often are they able to fill orders from stock?
- ☛ What payment options do they offer – open order account, credit card, etc.?
- ☛ How soon after receipt of an order do they ship?
- ☛ Do they add a shipping surcharge?

- ☛ Do they have a toll free number?
- ☛ What ordering options do they offer?
- ☛ What is their return policy?
- ☛ Do they offer a warranty?
- ☛ Is there a minimum order amount?
- ☛ What shipping options do they offer?
- ☛ What special services do they offer?
- ☛ Do they have a research department to help technicians find a specific part?

“You want to find someone you can count on for reliability, convenience and service.”

Food for thought

Keep some of these questions in mind when you're looking for a supplier of replacement components. You want to find someone you can count on for reliability, convenience and service. Merely locating someone who stocks the part isn't the only consideration. For example, if you have to wait until you fill a large minimum order amount before you can order, or if you have to wait weeks for the part to arrive, you'll have that defective product sitting around the service center for a long time without earning you any profit, and the customer will not be pleased with the wait.

It might be tempting to order from the first distributor that comes to mind, but if you will take the time to ask a few questions, it might save time, money and aggravation. The following section will give you a head start in answering some of those questions. ■



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Customer Contact

Generally, the first line of customer support is provided by our order offices located in Kent, Washington. This office handles a wide variety of customer calls ranging from simple parts orders to requests to do research on unique model numbers. Currently, the order office handles an average of 1,800 calls a day just for taking orders, as well as take an average of 250 calls from customers requesting such things as estimated shipping time, return authorizations, processing credits, and special orders. Also, the office receives over 1,000 faxes daily. In addition to all this, we offer retail customers toll-free phone and fax numbers to call and order literature, parts, or any of our comprehensive line of accessories.

In order to further improve our level of service, we've made significant investments in phone management systems to improve our efficiency. Data gathered from these systems graphically depict work load volume, peak times, and average call length on a daily basis, and give management a true picture of where additional improvements are needed.

Our staff includes representatives which reach out to the field as well. Regional parts accessory representatives call on distributors, independent servicers, dealers, and even end users, to assess their needs. With a comprehensive portfolio of sales programs and promotional items, they are able to offer profitable opportunities to small and large businesses alike. Along the way, they are able to keep in touch with the ever changing needs of all, and make the necessary recommendations to our market development personnel.

Our commitment doesn't stop with our internal efforts. We also maintain a network of over 40 authorized independent parts and accessory distributors who are well positioned to support our wide range of customers in various markets throughout the country.

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Once we've established what our customer needs, we have to get it to them. That's the job of over 125 employees that staff our parts and service literature warehouse in Kent. The building is a quarter mile long, and encompasses 228,000 square feet, which houses over 110,000 line items and 2.8 million pieces.

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We have recently completed our investment in the modernization of our warehouse operations. This includes the expanded use of RF and bar codes throughout the facility, conveyors, carousels and a new software system. Designed to create a paperless environment, this comprehensive, state of the art installation enables us to provide faster, error free service to our customers as well as positioning Matsushita for the next decade.

Finally, in our effort to be earth friendly, the warehouse has been a leader in the effort to recycle. It all started four years ago when we began to use biodegradable packing material. Today, we have a comprehensive program to recycle all paper, cardboard, aluminum cans, and pallets. We make an effort to purchase recycled product when it is available. In recognition of our efforts, we were designated a "Distinguished Business in the Green" by King County.

The Future

There will be a continued emphasis on expansion of our customers' ability to go "on line" with PASC, not just for order entry and order inquiry, but also for credit and return procedures.

Internally, with systems that our customers don't directly see, we move further into the information age. Not only do our purchasing agents continue to employ CD-ROM information systems, we are now on line with our factories in Japan for inquiry purposes, a capability we plan to expand to selected aspects of our market. The use of bar coding will continue to expand.

Our goal for the future is customer satisfaction, not just for our direct customer, but anyone who comes in contact with Panasonic, Technics, or Quasar.

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The Software Development department grew out of an effort to create the best electronic service manual program possible. From this effort, we have embraced the goal to "Develop the most user friendly software products for the service industry".

The criteria we used in developing our electronic service manual program:

1. An electronic service manual program has to be FAST to allow a technician to make the most of their time. Access to diagrams and other information needs to be simple and fast.

2. It had to be COMPATIBLE with all other manufacturers. In order to prevent servicers from having to have multiple systems, our program is designed to be flexible to accommodate any manufacturers service manual data.

3. The most challenging and important is that our program had to OVERCOME EVERY COMPLAINT we could imagine concerning the use of paper manuals.

Overcoming every complaint was most difficult. There are so many problems to using paper manuals. This is a short list of problems we worked to overcome:

- Manuals get lost on one bench, under other manuals and do not get refilled.
- Tracing signals through a manual is time consuming and difficult.
- Finding any information in a manual takes too long.
- The diagrams are printed too small for most people.
- It takes too long to order and receive a manual when it is needed.
- Storing paper manuals takes up too much floor space in the shop.
- Paper manuals take up too much bench space when opened to view the diagram.
- Keeping paper manuals updated in a timely manner is difficult.
- Paper manuals lack an up to date history of known fixes and troubleshooting techniques.
- Paper manuals cost too much.
- Every company makes their manual in a different style.

We considered every one of these complaints and designed FORCE, our service manual program, to overcome these and many more complaints. FORCE makes every manual available to every technician at the same time. It includes Hot Spot signal tracing that quickly jump from one diagram to another. Location information for components circuits, diagram name, and all Known Faults are included. We can deliver our manuals via the Internet as well as update it at any time. We allow you to make notes about any fix that you find. In addition, we are soliciting consumer electronics company wishing to make manuals in this style to join us.

FORCE is user friendly and can improve productivity so much that every technician will soon have his or her own

computer. We see productivity improving by 10% to 30%, depending on the technician's use and the kind of products worked on. It costs only 1% of that productivity improvement to put a computer in the hands of every technician.

How to distribute and use electronics manuals

CD-ROMS can be used to distribute manuals but to use manuals while on a ROM has problems. ROMs slow the manual down, eliminate your ability to make notes on diagrams, limit usage to one technician at a time, and if you don't file them, they can get lost.p

We want to update your manuals daily with new fix information, corrections to part numbers, and make sure your diagrams are accurate. We can do this through the Internet most effectively.

What are the main features of FORCE?

- Diagram zooming and panning is very fast.
- Part numbers can be linked to pricing to allow orders or fast estimates.
- Our manuals are small, 500k for a regular TV to 3meg for a large VCR.
- We allow distribution via CD-ROM or over the Internet.
- Instant access to all parts of a service manual insures a speedy repair.
- Signal flow from circuit to circuit is as fast as a tag and a jump.
- Keep a fix history of all repairs.
- Draw a box on a diagram, type a note, and from then on its viewability by everyone using the manual.
- Force was designed from the beginning to be used by all manufacturers.

The FUTURE of FORCE is growth and expansion. We are adding many more features:

- Cause voltage measurements to appear on-screen and remain there while you diagnose a problem.
- Draw or write on a diagram, save it and FAX it to a help line.
- Link via modem to any compatible help line to exchange ideas on a repair.
- Allow NARDA claims to be generated and electronically filed right from the job.

There are more features being planned and we expect technicians to make suggestions that turn into even more new features.

The Software Development Department is ready to help any company make manuals that work with Force. We want to overcome the last complaint about paper manuals and finally produce manuals that are easy and *intuitive* to use. FORCE is designed to do just that. ■

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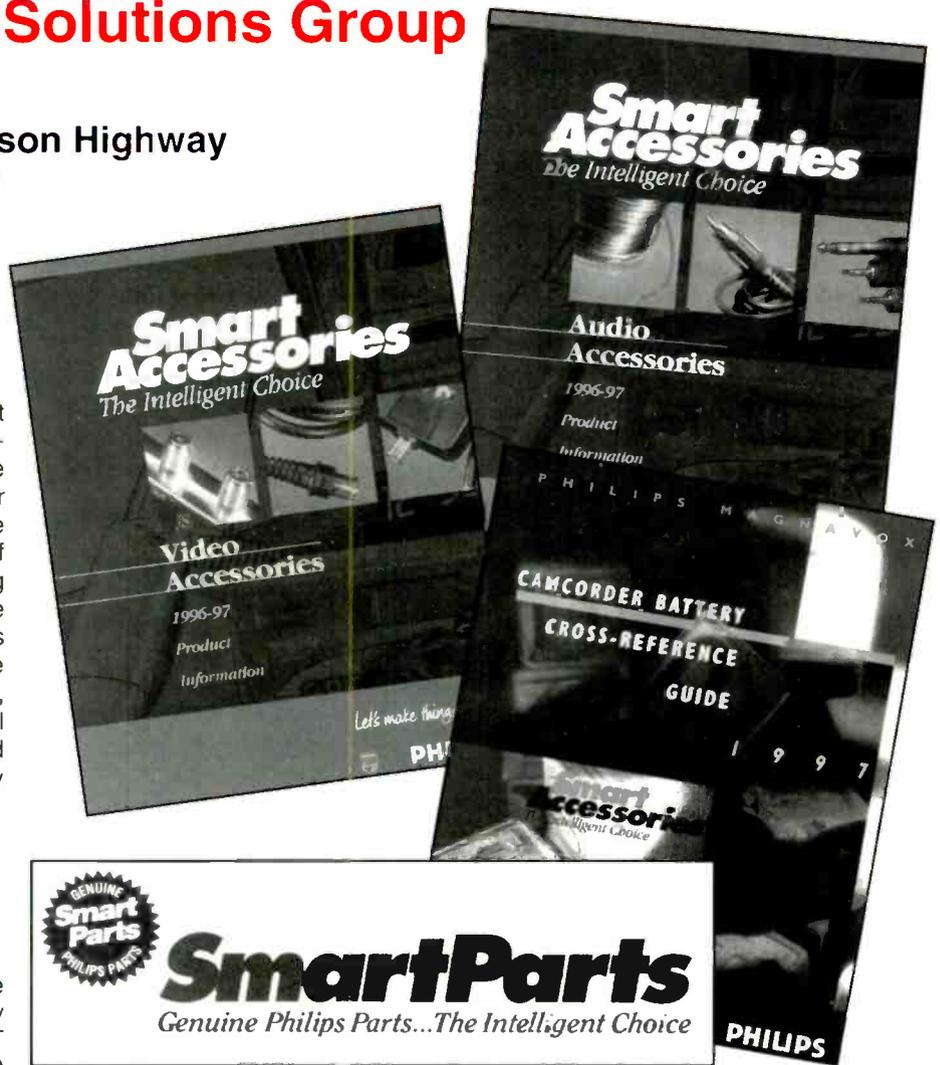
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In our effort to continually *make things better*, Philips Service Solutions Group reduced its parts pricing in late 1996 representing a reduction in price from 2% - 23% for many of our most popular items such as tuners, remotes, and transformers. There have been no significant changes since that time to increase pricing and we continue to review to ensure we remain competitive in our pricing. We believe in offering the highest quality products as the best possible price. ■

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Leading The Way in the USA

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There is no time like the future...

... And the future is now. The convergence of the home electronics and personal computer marketplace is no longer a discussion or theory. It is now a fact. The only question left is how much time remains before these two industries consolidate into one. With Bill Gates investing over \$1 billion dollars into cable providers, and other hardware / software competitors pledging allegiance, it would appear that the business plan is already in place. Business models are being adjusted. Marketing and distribution efforts are being modified to comply. Support systems will have to be created. Distributors and manufacturers are scrambling to understand, and to manage, this new emerging marketplace.

What is the Crossover Convergence?

As the communications and entertainment marketplace embrace the new digital era, information distribution vehicles will convert to full digital technology. Simply, put this means that the television and VCR that you use on a daily basis will soon utilize the same components as your personal computer. Belts and idlers will be replaced by flash memory and micro-controllers. Information will be transmitted as binary code not as an analog signal. What were two succinctly different markets, are now one.

How will it affect our industry?

The replacement parts distribution companies that have prepared for this convergence of technologies will be the ones ready to meet the needs of their customers. Those that have not properly prepared will not be able to provide the proper services.

EDI is Ready

Information is the commodity of the new digital era. Information is the key to any service center's future. To prepare for this new commodity EDI has

formed alliances with service companies that consolidate and supply pertinent, valid, and concise information to service centers globally.

We have engaged in marketing and distribution efforts that will bring this information to the service centers cheaper and quicker than ever before. We have invested in the development of this information for future technologies and for future delivery platforms.

We're not looking towards tomorrow—we've brought tomorrow to our customers today.

"...TV is now on a collision course with the PC - a modest little \$125 billion industry. Companies on both sides of the fence are jumping into the convergence game, bidding up the stakes to dizzying levels."

Robert H. Reid, 'The Real Revolution', WIRED, page 122, October 1997

Company evolution

For more than 14 years, Electro Dynamics has been importing and distributing television, VCR, computer monitors and other peripheral electronic replacement components. As the growth of the computer service and maintenance marketplace became apparent, EDI crossed over into this market in 1989. EDI's customer base reaches from local and family owned repair service centers to global corporations in the United States, Canada, Europe and South America.

Our current penetration level into the marketplace allows for power purchasing. Our active customer base will con-

tinue to aid and develop that penetration level for years to come. We have insured that position by extending our customer base and by expanding our product line. Through this growth and planning, EDI has created a niche for itself into other growing marketplaces such as government installations, major educational institutions and medical research facilities.

Why do we want to help advance our customers' success?

The core philosophy of our company is based on three concepts; service, service and service. If our customer's do not succeed in making this crossover we will not succeed. At EDI we know that it is our customers that make our success and we never stop improving our service to our customers. This is our number one concern.

EDI is a highly engineered, product specific, future involved company. Its business model has been constructed of the right materials, formulated, tested and refined over the course of 14 years. Its corporate culture and structure has been constantly adapted and designed for the future and the immediate needs of the marketplace. This has been accomplished by an ongoing dedication to planning and forecasting. These kinds of accomplishments have taken personal as well as financial commitment.

EDI realized the future was upon us, and prepared for the day when the consumer electronics and computer service marketplace would crossover and become one. We embraced this emerging marketplace, and are prepared to provide the next generation of service and parts for the new niche created by this convergence.

Our vision and dedication make us successful, our leadership, capabilities and commitment make our customers successful too.

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Is your replacement parts distributor ready for the Crossover Convergence?

The Future is Here, and It's Name is Convergence.

ED1 realized the future was upon us, and prepared for the day when the consumer electronics and computer service marketplace would crossover and become one. We embraced this emerging marketplace, and are prepared to provide the next generation of service and parts for the new niche created by this convergence. Our vision and dedication make us successful, our leadership, capabilities and commitment make our customers successful too.

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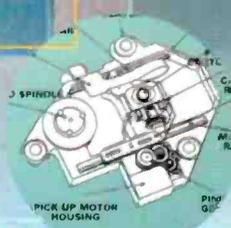
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Herman Electronics is one of the largest original replacement parts and accessory distributors in the country and is factory authorized for most of the major brands. In addition, Herman Electronics is the source for everything in service accessories. Their new catalog, published three times a year, includes everything in technicians' aids, tools, sol-

der & de-soldering equipment, test equipment, audio/video accessories, chemicals and much more, all from the industry's leading manufacturers. Stocking one of the largest and most comprehensive inventories in the country enables the company to fill over 80% of their orders from inventory and guarantees SAME DAY shipment of all in-stock orders placed before 5:30 PM (EST).

Herman Electronics provides a variety of customer support services as a result of their commitment to customer service excellence. They have several professional customer service representatives to serve all your needs from 8:30 am to 6:00 pm, (EST) Monday through Friday. The company prides itself on being accommodating to its customers in order to provide complete customer satisfaction. "We realize there are many good distributors throughout the country," says Jeffrey A. Wolf, President and son of one of the company's founders. "It is our job to EXCEED customers' expectations by taking that extra step in providing the highest level of professional, personalized service. This industry has quickly become service driven and therefore it is our focus and dedication to



maintain a standard of excellence in customer service. As the year 2000 rapidly approaches we must continue to develop innovative ideas and fresh approaches to meet and exceed the demands that lie ahead." And the company is doing just that. On-line computer services, a 24-hour electronic telephone ordering system, EDI, the world wide web and on-line parts research, just to name a few.

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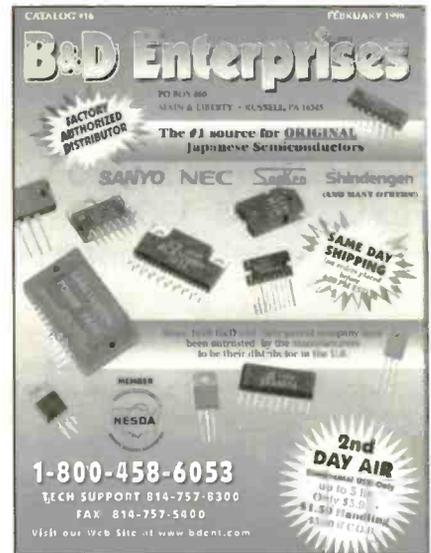
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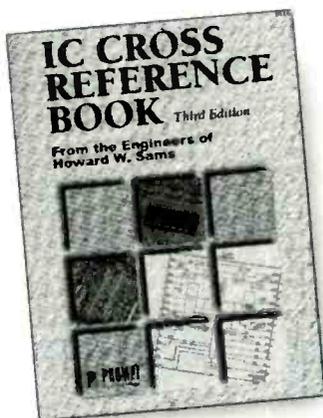
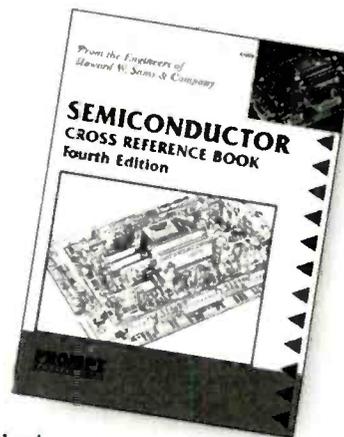
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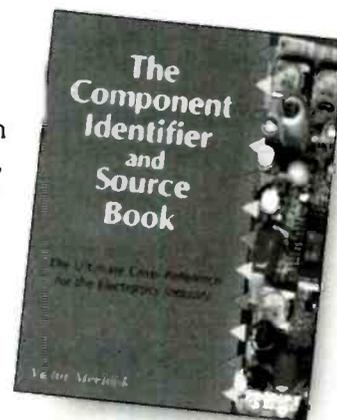
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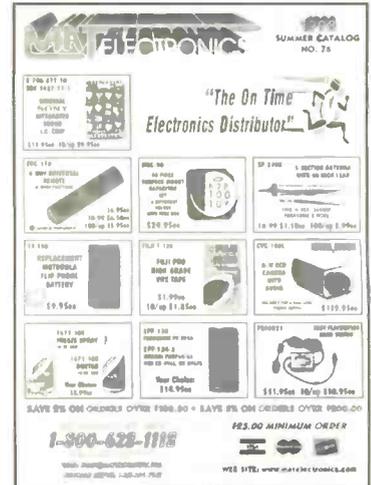
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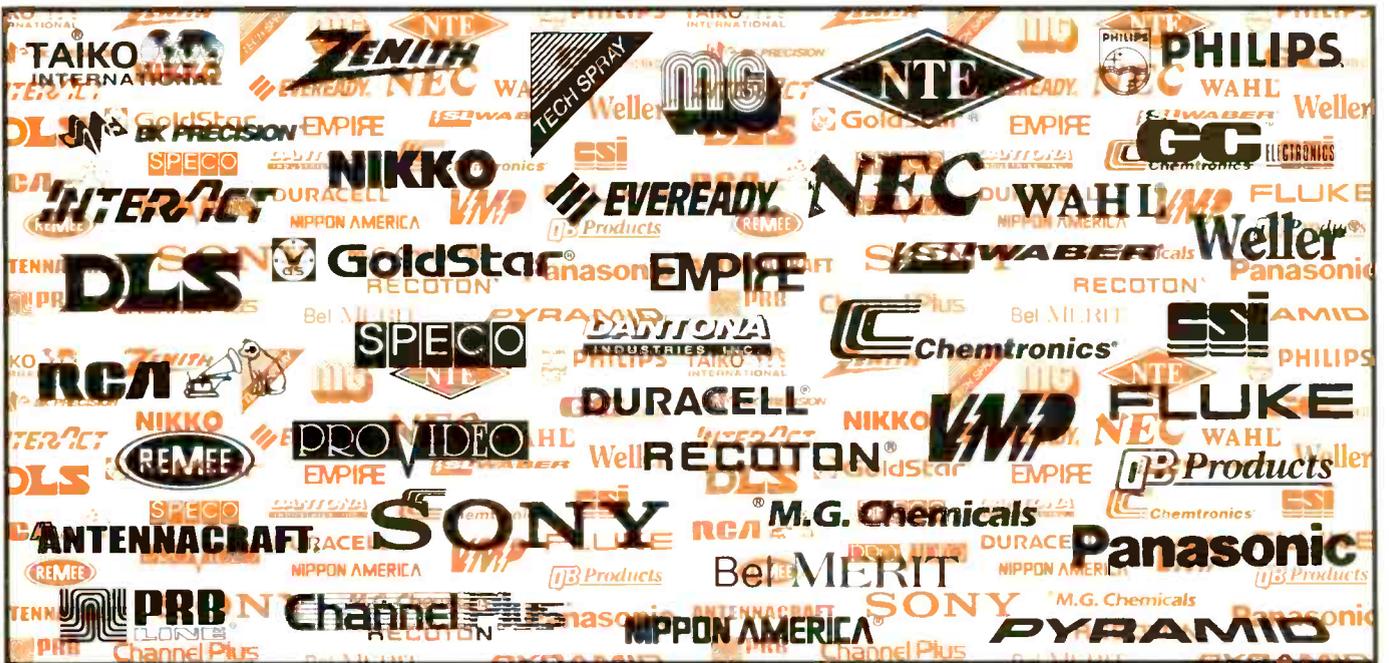
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Basic Digital Electronics, by Alvis J. Evans, Prompt Publications, 192 pages, paperback \$19.95

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Learn about circuits, flip-flops, registers, multivibrators, counters, 3-state bus drivers, bi-directional line drivers and receivers, analog-to-digital (ADC) and digital-to-analog (DAC) converters using easy-to-read, easy-to-understand explanations coupled with detailed illustrations that bring "seeing" and "doing" together for a very meaningful experience.

This book contains worked-out examples within the text and quizzes and problem sets at the end of each chapter to complete and reinforce the learning cycle.

PROMPT Publications, 2647 Waterfront Parkway E. Drive, Indianapolis, IN 46214

Build Your Own Home Theater, by Robert Wolenik, Butterworth Heinemann, 200 pages, paperback, \$16.95

Champagne on a beer budget - the ultimate audio/video experience. *Build Your Own Home Theater* is for the do-it-yourselfer who is looking for bargains but is still interested in quality. Readers will learn how to create a dream system for a fraction of the cost of having it done for them. This book also includes information on home theater that is not found anywhere else, as well as how-to instructions.

PROMPT Publications, 2647 Waterfront Parkway E. Drive, Indianapolis, IN 46214

Troubleshooting Analog Circuits, by Robert A. Pease, Butterworth Heinemann, 217 pages, hardcover \$28.95

Whether you are primarily an analog or digital engineer/technician, experienced or neophyte, this book has something for you. Now available in paperback, this guide by one of the legends of electronic designs walks the reader through tried and true methods for debugging and trou-

bleshooting analog circuits.

The text includes generous helpings of Pease's unique insights, humor, and philosophy regarding analog circuits and their operation. Armed with Bob's clear explanations and proven techniques, you will be prepared to get your analog designs up and running for the ever-increasing tasks demanded of today's electronic devices.

Butterworth Heinemann, 313 Washington Street, Newton, MA 02158

VCR Troubleshooting & Repair, Second Edition, by Gregory Capello & Robert Brenner, Butterworth Heinemann, 286 pages, paperback \$19.95

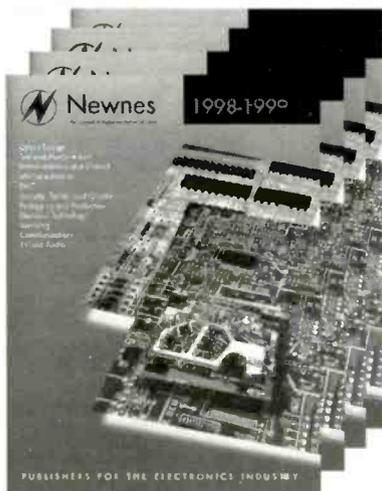
This book focuses on VCR preventative maintenance, and does an excellent job covering basic electronics principles and how they relate to VCR performance, and gives suggestions on how to avoid breakdowns. The second edition also covers stereo, Super-VHS, H-VHS, and bar code programming.

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Continuing education in servicing

by the ES&T Staff

Education and training have always been constants for every consumer electronics service technician. There are a number of reasons that this is true. For starters, the subject matter, whether we're talking about vacuum tubes, transistors, or integrated circuits, or whether we're talking about analog or digital, is difficult. A television set, for example, is a complex device, and operates on principles that are not readily apprehended. To know enough about a TV set, or a VCR or personal computer, to be able to actually troubleshoot and repair a problem based on an analysis of the symptoms, and not on tips provided by another agency, takes a great deal of education and training.

Most technicians get a pretty good education at some kind of formal school: a technical school, a junior college, or some other kind of school that they attend for two years or more. And that's a good start. If it's a well-done course, it gives the entry level technician a good grounding in the fundamentals of electronics. Unfortunately, given the scope of electronics today, and the pace at which it's being developed, that two-year is only the beginning of the technician's education.

As I understand it from talking to a number of service managers, most graduates from technical schools these days have a thorough grounding in the basics, with emphasis on digital circuits. Most have had little or no exposure to consumer electronics circuitry, however, so continuing education for technicians of today should start the minute they've left school with that diploma. And given the dizzying pace at which engineers and manufacturers are expanding and changing the world of consumer electronics, it will become a way of life for most technicians, until they retire. Interestingly, however, most retired technicians I have met are so interested in the subject that their curiosity, and their efforts to learn about new developments in electronics continue long after retirement.

And here's another interesting item: Occasionally a subject area that is no longer at the forefront of technology is

discontinued in some schools so that other more recent material can take its place. This has to be done, of course: it isn't possible to teach everything. Unfortunately, sometimes the discontinued subject matter still exists and may be encountered by someone who is not prepared for it. As an example, vacuum tubes have been deemphasized in electronics in favor of solid-state devices. And this makes sense, since there are so many more solid state devices in use. However, many older products, and some newer high-end stereo systems use vacuum tubes. If a technician who becomes interested in servicing one of these products has never studied tubes in school, he'll have to continue his education in order to provide that type of service.

Skills and attributes of an effective technician

For what it's worth, here's our idea of the set of skills and attributes that technicians must possess in order to get the job done. If any readers have any other ideas, or suggestions about technicians' qualifications, we'd love to hear from you.

- Basic language skills in order to be able to communicate with customers, other people in the service center, manufacturers, distributors, etc.

- Good reading skills in order to be able to gain information from textbooks, service manuals, service bulletins, etc.

- An even temper, tact and diplomacy as needed to handle difficult customers, difficult service jobs, etc.

- Good math skills. A technician should be able to perform all of the calculations necessary to interpret readings from meters, oscilloscopes, etc. He should have at least a passing familiarity with electronics math, such as Ohm's Law, Kirchhoff's Law, etc. He should be able to perform all of the financial math in order to be able to prepare an invoice.

- A technician should have a reasonably broad background in electronics circuit theory. He should have some kind of picture in his mind of how the basic electronics components work, and how they interact in a circuit.

- A technician needs to have a basic background in the use of test instruments such as DMMs, oscilloscopes, signal generators, signal analyzers and more, including how to use them safely.

- A technician needs to be reasonably skilled in the use of small hand tools and soldering/desoldering equipment in order to be able to disassemble a product to the extent necessary to identify and replace a defective component and to reassemble the product once it has been repaired without causing any damage to the product.

The need for continuing education

A good two-year or four-year technical education provides many of the skills that a technician needs in order to be adept at the duties of a service technician. But two years, or even four years, is a relatively short space of time in which to absorb all of the knowledge and hone all of the skills needed to develop a skilled technician. Moreover, as time goes on, we tend to lose some of the knowledge we gained while going to school, sometimes quite a great deal. For those reasons, it is important for a technician to continue his or her education for life.

Another, very important, reason for continuing education for technicians is the difficult, demanding nature of the subject matter. Because it is so abstruse, students, and, yes, instructors and writers as well, sometimes don't really understand what's going on entirely, and end up with misconceptions, or sometimes just fuzzily understood ideas. The more study a technician does, the more likely he will encounter material that will help him clear up misconceptions, or sharpen ideas that were fuzzy in his mind.

Here's an example from this fuzzy mind. A lot of us learned that electromagnetic induction takes place when magnetic "lines of force" "cut" a conductor, thereby inducing a current in the conductor. There is a simpler explanation, that doesn't require the idea of any kind of lines cutting anything. It's this: when the magnetic field in the vicinity of a conductor changes — increases or decreases — a current is induced in that conductor

that is proportional to the strength of the magnetic field and its rate of change.

Keeping up with developments in the field

But the greatest reason for continuing education is to keep up with developments in the field. This is especially true in a pursuit such as consumer electronics servicing which seems to be undergoing a continuous revolution.

Take, for example, someone who became a technician in the 1950s. Now, 40 some years later, and maybe getting ready to retire, how useful would a technician be if he hadn't updated his skills several times. Most electronics servicing in the '50s still emphasized vacuum tubes. Transistors were just being introduced and ICs hadn't been heard of yet. Everything was still entirely analog. All TV signals were received via a broadcast antenna; there was no cable TV, no VCRs, laser disks, etc. A technician who allowed himself/herself to stagnate at that period would be helpless with today's technology.

Interestingly, the paradigm shift from analog to digital has caused some educational problems on the other side of the coin. Most technicians graduating from technical schools today have specialized in digital electronics, because that's what industry wants, and besides, it's much more glamorous than analog. So technicians today who want to work in consumer electronics servicing must continue their educations beyond technical school simply to learn some of the "old" stuff in electronics.

Every profession has to keep up

Sometimes people in the consumer electronics service business feel picked on. They complain that those engineers and manufacturers keep advancing the technology, so the poor technicians have to continue running to keep up. No one can blame a technician for feeling that way. It is frustrating to constantly watch the state of the art in electronics technology advance faster than any individual technician can possibly keep up.

If it's any consolation, many professions have similar problems. Take medicine for example. Of course, when it comes to humans, there are still only the two basic models, male and female, and they haven't really changed in thousands

of years. But the practice of medicine has changed incredibly and continues to change. Doctors have to study constantly to keep up or they'll be in danger of providing less than the best care.

As another example, in recent years automotive technology has been changing rapidly, and automotive technicians have to work hard to keep up.

In the final analysis, any kind of knowledge worker has to be prepared for change, and work to cope with the demands of keeping up.

There is help

Fortunately for service centers and technicians, everyone from the manufacturers and the manufacturers' associations, to service associations and technical schools, as well as publishers, have recognized that technicians need a lot of training for this new technology, and are making that training available.

And depending on the amount of money available to the technician, the amount of time he has for school, and the travel budget, the technician has a choice of resident schools, hands-on schools, self-study courses, videotapes, books, test equipment manuals and user instructions, association meetings and seminars.

The **ES&T** staff continually remains tuned in to the educational opportunities available to technicians. We like to think that we're a valuable source of technical/servicing information, but we recognize that a 70-or-so-page magazine once a month can't begin to fulfill the information needs of consumer electronics servicing technicians, so we try to make you aware of every other avenue of education that we can find.

Training from EIA/CEMA

One of the best, and least expensive, sources of training for servicing of consumer electronics products is the Electronics Industries Association/Consumer Electronics Group (EIA/CEMA) Product Services Department. This organization, in conjunction with state and national service organizations, offers three-day and five-day on-site workshops for technicians who are actively working in consumer electronics servicing (Table 1). There is a nominal fee for these classes.

EIA/CEMA is the association to which manufacturers of TVs, VCRs, stereo

equipment, etc. belong. They recognize that it is in their best interests to attract and train technicians to service all of the products that they manufacture and sell. Every service center that can do so should take advantage of this superb training.

In addition to the workshops, EIA/CEMA also offers video cassettes, manuals and the like on a wide range of subjects from "Troubleshooting with modern electronic test equipment" to high-tech soldering and microprocessor troubleshooting, and more. These tapes are priced very inexpensively, just enough to offset the cost of producing them.

If you or someone in your service facility is in need of training, you should at least explore what EIA has to offer. See their name and address in the listing in this article.

Currently available from EIA

For example, the EIA currently offers several courses in servicing of color TV, VCR, personal computer, microprocessor/pc, and monitors. These courses will be presented in cities throughout the United States, throughout the current year.

Workshops for electronics instructors in vocational education are also available.

Interested in attending? Contact:

Consumer Electronics Manufacturers Association
2500 Wilson Blvd
Arlington VA 22201
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You can also learn more about CEMA by visiting their website at <http://www.cemacity.org>.

Considering the high quality and timeliness of these programs and the materials the attendees retain, EIA believes that the practical nature of these workshops will provide the attendees with new skills of immediate benefit.

These courses have an estimated value of several hundred dollars, but EIA/CEMA offers them at minimal cost to qualified technicians. Attendees must provide their own transportation and lodgings while at the workshops.

Identifying the need for education

For the technician, identifying the need to further his education usually isn't difficult. One day a customer brings in a TV set for service and, when the technician opens up the set to perform a technical

evaluation of the nature of the problem, he finds components and circuitry he's never seen before. Or one day a customer brings in a digital compact cassette or a DVD, a product that the technician has only seen in photographs before.

Once the need to get further education has been established, it's important to pin down exactly what education is needed. There are usually two questions that the technician must answer: "What training do I need?" and "How do I get that training?"

It's important to examine these questions in detail to determine beforehand exactly what it is you need to study. It's not enough to just say "I need to learn about DVD servicing," and then to look for a correspondence school or a local school that might offer a course on DVD.

It's important to examine the situation precisely, and determine what aspects of the subject that need to be covered. Do you just want an overview on DVD technology? Or do you really have a pretty good idea of how DVD works and really need a course in nuts and bolts DVD servicing?

Once the specific goals are set, the question becomes how to achieve them. One simple but effective method might be to contact other technicians in your area. If you have a skill that they lack and vice versa, you might be able to arrange for a session, or a series of sessions, in which you educate each other.

Technical books

Technical books provide a good way to fill in the gaps in your service education. Many technicians are able to learn enough through reading books to enter into a whole new area of servicing. If the book is well written, and the technician has a lot of self discipline, he just might be able to add a whole new product to the scope of his technical education. If the book is poorly researched or written (there are probably a lot more of these than there should be), or if the technician doesn't have the self-discipline to study on his own, the whole thing might turn out to be a waste of time.

Home study courses

Home-study courses are a step up from simply studying from a book on one's own, and they generally make learning easier and lead to better results. In a home study course, the material is divided into logical study units, an instructor tells the student

what is expected, and there is feedback through regular tests. Some schools also assign an instructor to the student with whom he can correspond by telephone and mail when there is a problem.

Schools and seminars

If the technician or service center can afford the time and money, structured class and lab courses provide a more effective way to learn. There are many options available for a technician who can attend such classes. Technical schools throughout the country offer anything from the most elementary introductory courses to detailed theory, design and servicing courses.

For anyone who has the time and the budget to travel, consumer electronics equipment manufacturers offer seminars on the operation and servicing of specific products to servicing technicians.

There are also many organizations, especially in the computer area, that offer seminars of a few days to a week or so, usually in a number of locations throughout the country.

Other good sources of technical education are manufacturers of test equipment and tools such as multimeters, oscil-

losopes, soldering tools, etc. Many of them offer instruction in using their products. Some offer books and pamphlets, and some even have videotaped instructions, that help the technicians understand how to most effectively use their products. Some companies offer formal courses for home study, and others offer courses and seminars that travel to different areas of the country so you can take a formal course taught by the experts near home. Some of the instruction is free, and some will cost a substantial amount, so check before you proceed.

Finding the knowledge

We wish we could provide a complete list of all of the technical educational resources available to technicians today, but such a list would no doubt fill several thick volumes. Some of the educational resources, in no particular order, are: local vocational technical schools, both public and private, a large handful of national technical correspondence schools, associations such as ETA, NESDA/ISCET, PSA, manufacturers' training, thousands of technical books. Any service technician who wishes to stay abreast of modern electronics technology, would do well to sim-

Modern Soldering Techniques

Today's smaller surface mount components can be difficult and often seem impossible to remove and install. Because of their small size, today's technicians need new and improved methods for dealing with these components.



Sony introduces the Modern Soldering Techniques Video. In this tape, you'll learn the recommended techniques for removing and installing today's smaller components. Techniques covered are: the hot air method; the Chip Quik® method; the cut-out method; the pick method; and the soldering iron method.

YES, please send me Modern Soldering Techniques (T-MODSOL-9) in VHS for \$40.00 including shipping & handling. Please include applicable sales tax.

Please send me more information about Sony's videotape library.

Please charge my purchase to:

Mastercard _____ Visa _____ Discover _____ .. or ..
 Card # _____ Exp. Date _____
 Signature _____
 Phone # _____

Make check or money order payable to Sony World Repair Parts Center and mail completed form to:

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 Company _____
 Street _____
 City _____ State _____ Zip Code _____

Sony World Repair Parts Center
 ATTN: Publications Dept.
 P.O. Box 20407
 Kansas City, MO 64195- 0407

Sorry, no C.O.D.'s. Allow two weeks for delivery.
 Price and availability subject to change.

SONY

ply maintain an awareness of what the educational resources are and how to take advantage of them.

Along with this article, we present several lists of companies and other organizations that offer some kind of training and/or training materials. Unfortunately, space doesn't permit a comprehensive list. There are a number of detailed lists available that will provide someone who is serious about training many avenues to explore. One such list is the *ES&T March Buyers' Guide*. That issue contains a large list of consumer electronics manufacturers, tool and test equipment manufacturers and associations with addresses and phone numbers.

Try the product manufacturers

Many of the manufacturers of consumer electronics equipment provide training in a number of ways. Some of the manufacturers restrict the training they provide to technicians from their own authorized servicing facilities. Others not only offer courses to anyone who is both qualified and interested, they make it a point to make their courses universally applicable.

Test equipment manufacturers

Test equipment manufacturers not only know a great deal about the test equipment they sell, they are also familiar with applications of their products. They talk to the engineers and technicians who buy and use their products and learn what their problems and needs are.

They also recognize that the more their customer knows about how to apply their products, the more likely they will be to buy their product in the first place, to be happy with it once they've bought it, to recommend the company's products to a friend, and to buy that same brand the next time they need a piece of test equipment. In order to enhance the customer's or potential customer's understanding of the testing/diagnosing function in general and the company's product in particular, many manufacturers of test equipment offer courses, manuals, videotape courses, and other training opportunities.

For example, B&K Precision offers booklets such as a "Guidebook to Function Generators," a "Guidebook to Test Instruments," and a "Guidebook to Oscilloscopes." Sencore offers seminars throughout the country as well as their "Tech Tips" binder, the periodical "Sencore News" and other training materials.

Tektronix Oscilloscope Division puts out booklets such as "The XYZs of using a scope" and "Basic Oscilloscope Operation." They even sell a training kit that allows a scope user who needs to learn more about use of an oscilloscope to practice on circuitry for which the scope traces are known. The Tektronix Television Business Division offers application notes such as "Basic NTSC Video Testing" and "Checking VCR Performance."

Hewlett-Packard offers manuals such as "The fundamentals of signal analysis" and "Feeling comfortable with digitizing oscilloscopes," that provide in depth information about the state of the art in circuits and signals, and the test equipment and techniques needed to study and understand it.

You should also check with any of the other well-known manufacturers of test equipment to determine what kinds of training materials they have, or that they may recommend.

Office equipment

Personal computers now constitute a large segment of what is considered consumer electronics products. The increasing availability of useful, user-friendly, low-cost software such as word processing, spread sheet, data base, desk-top publishing, accounting, on-line data bases, and the huge information sources available on the Internet are making personal computers more and more attractive to more and more people.

More people are establishing offices at home. Along with fax machines and answering machines, personal computers are essential tools for the home office.

One result of this increasing population of personal computers in homes is that personal computers have become consumer products, and consumers are looking to their traditional service centers to service their computers. And while making the transition from servicing TVs and VCRs to servicing computers does take something of a mental adjustment, it's usually far easier than it first seems, especially for someone who has made a lifetime study and a business of understanding and servicing electronics circuits.

Trade associations

Organizations such as ETA, NARDA/NASD and NESDA/ISCET (see the "Associations" listing below for the

meaning of these abbreviations, and the addresses and telephone numbers of these associations) and their state and local affiliates offer many opportunities for education, both technical and management oriented.

For example, state and local chapters of these associations frequently invite a technical training instructor from a consumer electronics manufacturer to their monthly meetings to lead seminars on servicing the company's new products.

Some of the most successful service center owners and managers belong to these trade associations, and attend the meetings, seminars and annual conventions religiously. Most, if not all, of them attribute a great deal of their success to their membership in the organization and their participation in these training activities. If you don't belong to such an association, you should at least look into it.

Just do it

If a technician hasn't taken a course, read a technical book, or otherwise made an attempt at learning about some of the new technology in some time, he may be in danger of joining the dinosaurs in extinction. The resources to develop new skills to catch up with the new technology may be as near as the local library, the local association meeting place, the mailbox, or the nearest computer with Internet access. The information is there. The listings that accompany this article will help you get started in finding it.

Let us know

As always, if any readers are aware of any good training resources that we have not mentioned in this article, please let us know about it. The more thorough and comprehensive we can make this list of training resources, the more useful it will be for readers.

Some of the sources

Table 1 lists a number of correspondence schools, book publishers, associations, and test equipment manufacturers whom you might want to contact for information on what educational opportunities they have to offer.

CEMA Product Services conducts workshops around the U.S. as part of their on-going project to improve the training of Consumer Electronics technicians. CEMA offers hands-on workshops on:

Windows 95 Troubleshooting & Network Setup (3 Days).

"CEMA's technical training puts the experience in your hands. We don't just talk about methods or demonstrate solutions, we give you real hands-on experience." The workshop features:

- Damage Control
- Installing new hardware
- Registry Editing
- Network trouble shooting
- File & print services
- Peer-to-Peer Networking
- Ethernet
- TCP/IP
- Internet
- Network Topologies

PC servicing w/Windows 95 (3 Days) Updated for 98

"The focus of the workshop is on practical aspects of PC servicing. Every discussion is illustrated with a lab exercise

or demonstration. Hands-on activities account for more than 50% of the workshop time. The exercises provide the opportunity to observe signals, make adjustments, and troubleshoot defects. (An understanding of basic electronics is needed for this workshop.) The workshop features:

- Microprocessor overview
- Address/data/control bus signals
- PC bus signals
- PC bus buffering
- Address decoding and decoders
- Power control interfaces
- Keyboard interface
- Communications interfaces
- System configuration & expansion
- POST and software diagnostics
- Hardware diagnostics
- Operating systems
- Config problems
- Serial and parallel I/O problems
- Troubleshooting,

adjustments and repair • Preventive Maintenance

Basic Color Television Servicing (3 Days)

After an overview of a TV receiver and a review of test equipment usage, each functional block of a typical current model TV is examined. (A general background in analog electronics is needed for this workshop.) The workshop features:

- The NTSC system
- Receiver familiarization
- Test equipment
- Oscilloscope calibration
- Microprocessor
- RF signals
- Tuning system
- Video Signals
- Audio processing
- Power supplies
- High voltage
- Deflection
- Scanning
- Convergence
- Adjustments. On the last day all participants gain essential skills, hands-on trou-

Trade Associations

Consumer Electronics Manufacturers Association
2500 Wilson Blvd
Arlington, VA 22201
703-907-7656
Fax: 703-907-7968

Electronics Representatives Association
444 N Michigan Ave Suite 1960
Chicago, IL 60611
312-527-3050
800-776-7377
Fax: 312-527-3783

Electronic Technicians Association
604 North Jackson St.
Greencastle, IN 46135
317-653-3849

International Society of Certified Electronics Technicians
2708 W. Berry Street
Ft. Worth, TX 76109
817-921-9062

Musical Instrument Technicians Association, International (MITA)
MITA, Inc.
12425 Parkwood Lane
Florissant, MO 63033-4662
314-355-2339

NARDA (National Association of Retail Dealers of America)
NASD (National Association of Service Dealers)
10 East 22nd Street
Lombard, IL 60148
630-953-8950

National Association of Service Managers (NASM)
PO Box 712500
Santee, CA 92072-2500
619-562-7004
Fax: 619-562-7153

National Electronic Distributors Association
35 East Wacker Drive
Suite 3202
Chicago, IL 60601
312-558-9114

National Electronic Servicing Dealers Association
2708 W. Berry Street
Ft. Worth, TX 76109
817-921-9062

Professional Service Association
71 Columbia Street
Cohoes, NY 12047
518-237-2953

United Servicers Association, Inc. (USA)
PO Box 626
Westmont, IL 60559
5630 Harmarc Place
Downers Grove, IL 60516
708-968-6752
800-432-0972

Technical Book Publishers

CRC Press, Inc.
2000 Corporate Blvd., N.W.
Boca Raton, FL 33431
407-994-0555

Hayden Book Company
Rochelle Park, NJ 07662

McGraw-Hill Book Company
1221 Avenue of the Americas
New York, NY 10020

MacMillan Publishing
Front and Brown Streets
Riverside, NJ 08075
800-257-5755

PCS Publications
PO Box 10492
Clearwater, FL 34617-8492
800-741-DATA
Fax: 813-446-3157

Prentice-Hall, Inc.
Rte. 9W
Englewood Cliffs, NJ 07632
201-592-2455

Howard W. Sams & Company
2647 Waterfront Parkway,
East Drive
Suite 300
Indianapolis, IN 46214-2041
800-428-7267

Tab Books
PO Box 40
Blue Ridge Summit, PA 17214
717-794-2191

Van Nostrand Reinhold Company
135 W. 50th St.
New York, NY 10020

Publishers of Schematic Diagrams (other than manufacturers)

Eagan Technical Services, Inc.
1408 Northland Drive
St Paul MN 55120
612-688-0098
800-285-1873
Fax: 612-688-7829

MI Technologies
3310 E. Peterson Rd
Troy, OH 45373
937-335-4560
Fax: 937-339-6344

Howard W. Sams & Company
2647 Waterfront Parkway
East Drive
Indianapolis, IN 46214
317-298-5400

Software Sources

Service tips programs

AnaTek Corporation
(Computer monitor tips)
PO Box 1200
100 Merrimack Rd
Amherst, NH 03031
603-673-4342

Electronic Software Developers
826 South Main Street
South Farmingdale, NY 11735

FixFinder
TCE Publications
10003 Bunsen Way
Louisville, KY 40299

High Tech Electronics
1623 Aviation Blvd.
Redondo Beach, CA 90278
213-379-2026

Higher Intelligence Software
60 Farmington Lane
Melville, NY 11747
516-643-7740

Technical Information Procurement Service (TIPS)
PO Box 1681
Forest Park, GA 30051-1681
770-968-3715
Fax: 770-968-3715 →

Home Study

Cleveland Institute of Electronics

1776 E. 17th St.
Cleveland, OH 44114
216-781-9400
Fax: 216-781-0331

Cook's Institute of Electronics Engineering

4251 Cypress Drive
Jackson, MS 39212
Fax: 601-371-2619

Heath/Zenith

PO Box 167
Hilltop Rd.
St. Joseph, MI 49085
616-982-3411

National Institute of Technology

1701 W. Euless Blvd.
Euless, TX 76039

National Technical Schools

456 W. Santa Barbara Ave
Los Angeles, CA 90037

NRI Training for Professionals

McGraw-Hill Continuing
Education Center
3939 Wisconsin Ave.
Washington, DC 20016

Private Trade Schools

Accrediting Commission of Career Schools and Colleges of Technology ACCSCCT (Formerly NATTS)

2101 Wilson Blvd Suite 302
Arlington, VA 22201
703-247-4142
Fax: 703-247-4533
e-mail: info@accst.org
website: <http://www.accst.org/>

Other Training Programs

Computer training

American Institute Institute for International Research

437 Madison Ave., 23rd Floor
New York, NY 10022
212-826-3340

Learning Tree international

6053 West Century Boulevard
PO Box 45028
Los Angeles, CA 90045-0028
213-417-8888
Fax: 410-2952

National Advancement Corp.

2730-J South Harbor
Santa Ana, CA 92704
714-754-7110

Test Equipment Manufacturers

B&K Precision

1031 Segovia Circle
Placentia, CA Status 92870
714-237-9220
Fax: 714-237-9214

Fluke Corporation

PO Box 9090
Everett, WA 98206
206-347-6100
206-356-5116

Sencore

3200 Sencore Drive
Sioux Falls, SD 57107
605-339-0100

Tektronix

Oscilloscope Division
PO Box 500, MS 39710
Beaverton, OR 97077
503-627-2010
Fax: 503-627-5593

Tentel

4475 Golden Foothill Parkway
El Dorado Hills, CA 95630
916-939-4005
800-538-6894

Table 1.

bleshooting with faulty equipment guided by an experienced instructor.

VHS Video Cassette Recorder Servicing (5 Days)

"This workshop focuses on basic VCR operation and servicing. After an overview of a VCR system and a review of the NTSC television system, each functional block of a typical current model VHS VCR is examined. (A general background in analog electronics is needed for this workshop and familiarity with TV systems is highly recommended.) The workshop features:

- The VHS system • Television signal
- Audio REC / PB • Video REC / PB • Drum servo • Capstan servo • Microprocessors • Display circuits • Mode switch logic • Tape transport • Power supplies • Adjustments. On the last day all participants gain essential skills, hands-on troubleshooting with faulty equipment guided by as experienced instructor.

Computer Monitor Servicing (3 Days) Updated for 98

Three day electronics servicing workshop that covers current technologies

using a hands-on, service-oriented approach. (A general background in analog electronics is needed for this workshop.) The workshop features:

- Test equipment usage • Oscilloscope calibration • Monitor familiarization • Multi-sync systems • VGA/SVGA/XGA Signals • Video signal processing • Switching power supply • High voltage power supply • Deflection and scanning • Microprocessor control • Manual adjustments • PC-controlled alignments • Convergence • Troubleshooting and repair. On the last day all participants gain essential skills, hands-on troubleshooting with faulty equipment guided by as experienced.

Windows 95 Unleash the Power. Troubleshoot Hardware and Software, Setup Networking and TCP/IP.

"Attend this professional workshop and CEMA will make you an expert at Windows 95 in only three days. CEMA's technical training puts the experience in your hands. We don't just talk about methods or demonstrate solutions, we give you real hands-on experience. In four days,

we "walk," configuring Windows 95, including both software and hardware upgrades. We will show you how to connect multiple PCs to form a peer-to-peer network system. This workshop gives you the tools necessary for fully utilizing the power of Windows 95 in your day-to-day business." The workshop features:

- Skill Improvement in differentiating hardware and software problems • Diagnose and Solve System Problems • Gain Hands-on Experience with Windows 95 • Avoid Potential Hardware/Software Conflicts • Learn to Support Peer-to-Peer Networking Configurations • Maximize Performance for Windows 95 • Select the Best Equipment for Your Needs

This workshop provides essential skills to those who:

- Provide Support for PC Hardware and Software • Make Software/System recommendations • Develop PC Support Policies • Teach Computer Technology • Install Windows 95 on PCs • Train Windows 95 Users • Troubleshoot PC Hardware/Software Issues • Plan to Upgrade to Windows 95

To Register Call (703)907-7656

Training aids on the Internet

The Internet is a virtual treasure trove of information for individuals and companies with access to the Internet. For example, if you access the Advanced Television System Committee website listed below, you can download hundreds of pages of technical specifications and other information having to do with HDTV. The ITT Internmetall website, also listed below offers information on the chipset that that company has engineered for HDTV sets.

Other websites listed offer information on the subjects noted.

Introduction to the oscilloscope

<http://www.ee.su.oz.au/teaching/topics/labintro/cro.html>

Cathode Ray Oscilloscope

<http://www.richardson.k12.tx.us/schools/phys/Academics/Physics/APPhysics/OscopeWeb/OscopeLab.html>

ATSC

<http://www.atsc.org/>

<http://www.intermetall.de>

Hewlett Packard Educators Corner

This is a website that displays information about learning and teaching resources for educators. In the month of June it carried a Spectrum Analyzer segment that helps users visualize modulation of radio frequency signals with audio frequency signals.

<http://www.tmo.hp.com/tmo/ia/edcorner/English/index.html>

In addition, Hewlett Packard offers an Educator's Corner CD-ROM; containing pre-written and interactive lab experiments from HP's Educator's Corner website, for those who don't want the long wait required to download them. This free CD-ROM, available by ordering from this website, contains all of the content found on the website. It's packed full of learning and teaching resources for engineering educators. It includes search tools, live links to the World Wide Web, and more.

This is Version 2.0 in an on-going series of CD-ROMs for engineering educators. The labs and experiments in this series are submitted by professors and educators from around the world. To use this CD-ROM, the user will need a Windows or Mac PC with a CD-ROM drive. The CD-ROM has a familiar web browser interface, and all required software and drivers are included on the CD-ROM.

EIA/CEMA will be offering (optionally) 2.0 CEUs for this workshop. A nominal registration fee will be charged for the CEUs.

Another CEMA resource is *Raising the Standard—Electronics Technician Skills for Today and Tomorrow*.

This manual covers skills standards for work-ready, entry-level electronics technicians. The Electronic Industries Association and the Electronic Industries Foundation developed the national skill standards under funding from the U.S. Department of Education. More than 200 representatives from the electronics industry, business, labor, and education, worked side by side in this industry-led effort to develop workable and mutually agreed upon standards. An additional 300 individuals helped assure their validity.

The manual includes guidelines on how employers, employees, trainers, educational administrators, educators, school counselors, and students can use the detailed lists of skills required of work-

ready, entry-level electronics technicians in any of a broad range of occupational areas. Service centers can use this valuable resource in a variety of ways:

- Clarify the competencies workers need
- Improve workers' capabilities and productivity
- Enhance a company's ability to convert to a high performance workplace
- Evaluate prospective employees and new hires
- Plan internal training programs
- Develop performance-based curricula preparing graduates to leave school with work-ready skills, qualified to obtain jobs
- Encourage excellence in voc-ed to improve the American workforce

The spiral-bound manual is divided into tabbed categories for easy reference. Each describes and lists the skills identified as necessary for competent work in five general categories:

- Desirable behavior and work habits
- Technical skills
- Test equipment and tools
- Basic and practical skills
- Additional skills needed in three advanced specialty areas.

The cost of this document and the disc is \$25.00, including S/H. ■



Are You Servicing Computers?

Do you know that major computer hardware and software vendors, distributors, resellers and publications, back the A+ Certification program as a means to verify the competencies of computer service technicians.

Do you know that many hardware manufacturers will not reimburse warranty work unless the technician or service center is A+ certified.

If you're servicing computers, now is the time to consider A+ Certification. Our computer-based, self-study course offers you the most comprehensive way to pass the A+ Certification exams.

Unlike the competition, our exclusive course features allow you to:

- Review hundreds of sample questions and isolate the exact areas you must learn to pass the exams.
- Study only those areas where you need work. The program assesses your knowledge and pinpoints you to the exact page in our *Heathkit® reference library* for further study.
- Evaluate your competency level and practice your test-taking skills with our *invaluable timed practice tests*.

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email: heathkit@heathkit.com • <http://www.heathkit.com>

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98-100

Circle (66) on Reply Card

Test Your Electronics Knowledge

by J.A. Sam Wilson

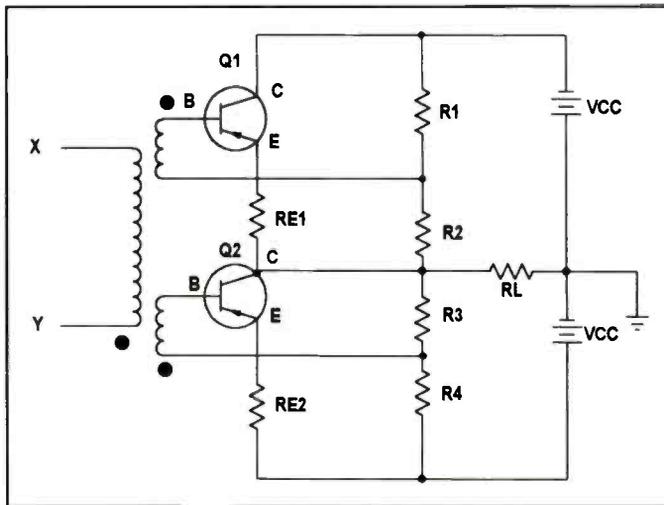


Figure 1. What does the dot notation on the transformer indicate?

1. In the circuit of Figure 1, the dot notation on the transformer indicates

- A. which end of the transformer should be grounded.
- B. that the dc voltage value at those points is the same.
- C. that the ac voltage value at those points is the same.
- D. None of these answers is correct.

2. Which of the following amplifier configurations has a gain related to β ?

- A. Common collector
- B. Common base
- C. Common emitter
- D. Starved amplifier

3. Which of the following is a linear, bilateral circuit element?

- A. Thermistor
- B. Resistor
- C. Transistor
- D. Nuvistor

4. Which of the following statements is correct?

- A. Bipolar transistors have the problem of partition noise, tubes do not.
- B. Tubes have the problem of partition noise, bipolar transistors do not.
- C. There is no such thing as "partition noise" as related to tubes and bipolar transistors.

D. Both tubes and bipolar transistors have the problem of partition noise.

5. Which of the following symbols means the same as alpha in reference to transistors?

- A. h_{FE}
- B. h_{FB}
- C. β
- D. A

6. Which of the following amplifying components is primarily controlled by current?

- A. Pentode tube
- B. JFET
- C. MOSFET
- D. PNP transistor

7. Which of the following is correct?

- A. Thermal agitation noise is more of a problem with tubes than with transistors.
- B. Thermal agitation noise is more of a problem with transistors than with tubes.

8. Which of the following is NOT correct?

- A. Removing the speaker from a transistor power amplifier circuit can destroy the transistor when the circuit is operated.
- B. Since $P = I^2R$ it follows that increasing the load resistance of a tran-

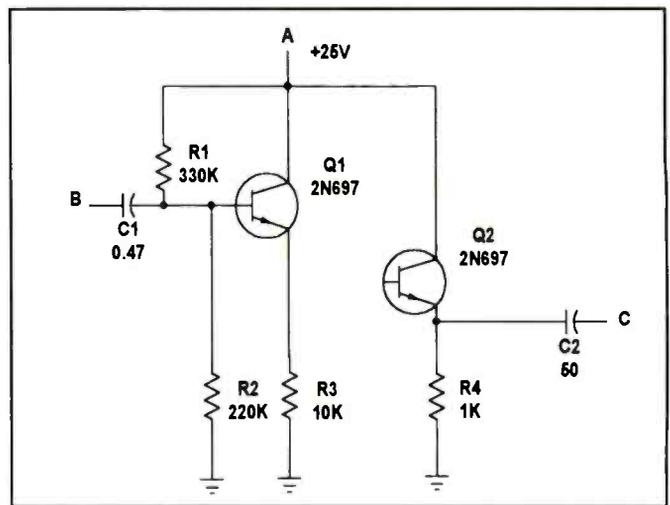


Figure 2. If you create a short between the emitter of transistor Q_1 and to the base of Q_1 , what will happen to the collector voltage?

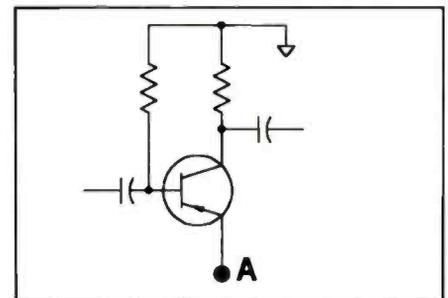


Figure 3. In this amplifier circuit, what should the voltage at point 'A' be?

sistor amplifier will always increase the output power of the circuit.

C. There is no vacuum-tube equivalent circuit for complementary bipolar transistor amplifiers.

D. It is not necessary to make a good mechanical connection before making a solder connection.

9. In the circuit of Figure 2, shorting the emitter of Q_1 to the base of Q_1 will cause its collector voltage to

- A. become more positive.
- B. become more negative.
- C. remain unchanged.
- D. become zero volts.

10. In the amplifier circuit of Figure 3, the voltage at point 'A' should be

- A. positive.
- B. negative.
- C. zero (ground) potential.

(Answers on page 60)

Wilson is the electronics theory consultant for ES&T.

What Do You Know About Electronics?

by Sam Wilson

Sam's opinions expressed here on emerging technology do not necessarily reflect the official position of ES&T.

In a technology as dynamic as electronics, new developments are constantly taking place. Every time something new is developed, someone comes up with abbreviations for it. As it's important to keep up with these abbreviations, we bring you these:

SMTP - Simple Mail Protocol Transfer (It governs the transmission of E-Mail through the Internet.)

WWW - World Wide Web (also, World Wide Wait)

It is an information network.

This and that

There is a glut of information on the World Wide Web and, it is not all important information. No person could possibly use all of the information available.

An example is news information. There are more people writing news stories than are needed. How many different ways can you write a story about Monica Lewinski?

Many broadcasters are taking a "wait and see" attitude toward HDTV. They are not even sure the public wants it. Broadcasters favor the 1080i format. That's 1080 interlaced scanning lines. Computer people favor a 720p (programmable scan) format. That's 720 lines a frame at a time - no interlacing.

Most broadcasters are reluctant to commit to HDTV until they can be sure that they can profit from it.

Here is a problem that has raised its ugly head. Broadcasters don't have enough material to support the channels available. How many times can you run and re-run Kukla, Fran and Ollie?

Also, do you really want to invest up to \$10,000 in a high-definition receiver so you can see the pores on the newscaster's nose? Some broadcasters claim that DTV (Digital TV) and HDTV (High-Definition TV) is not just about getting a clearer picture on the screen. It's also about the other things you can do with them.

Let me translate that for you. Its also about many other things you will have to pay for and may not want. An example is interactive video games. An 80-year old widow who relies heavily on TV for her entertainment need interactive TV games like a moose needs a bathing cap.

Cable TV - which services 60% of the TV viewers - has threatened to supply a "set-top box" to convert digital programs to analog format so customers can use their present TV sets. There is a lot of behind-the-scenes fighting with broadcasters over that one.

The FCC has been one of the stumbling blocks in the DTV and HDTV mess. Up until the middle of May they failed to issue standards that are needed by equipment manufacturers. Now that the standards have been provided do you think technicians will get to loaf at them? I'm trying to get them for you.

When color TV first hit the market we were quickly advised about that signal. As a result, we knew much about the requirements of the receivers. Have you seen a block diagram of an HDTV set?

The U.S.A. in technical competition

Here I go again! I know that this subject is going to bring at least five letters telling me: "That isn't electronics" and "Stick to the subject." But, if I don't pass this along, who is going to tell you?

I got the following information from James C. Dobson, Ph.D. in his Family Newsletter - Focus on the Family. If it doesn't boggle your mind, your mind just isn't boggable.

In 1990, President George Bush and all 50 governors announced their goal for U.S. students to be "first in the world in mathematics and science and achievement by the year 2000." It sounded good at the time. But, almost a decade later America's high school seniors still compare poorly with young men and women in most other industrialized nations.

That was the conclusion of the most comprehensive and rigorous international comparison ever conducted of academic achievement. The results of the study

were released in February, 1998. The final report should be of concern to every parent and grandparent in the nation (and every technician, technologist, engineer and scientist.)

What it revealed is that fourth-grade students in this country scored above average internationally, but by the middle school years, scores were below average. And by the time they were seniors in high school they ranked near the bottom when compared to other nations. The conclusion is unmistakable: The longer students stay in American schools, the farther they fall behind their age-mates in most industrialized nations.

Tables I and II show the mean (average) achievement test scores in various categories of science and math for the nations that participated in this comparison study at the secondary level.

As dismal as the U.S. position in these rankings was, it easily could have been worse. Asian countries which typically excel in math and science did not partic-

TABLE I
MATHEMATICS LITERACY

<u>Country</u>	<u>Mean Achievement</u>
Netherlands	560
Sweden	552
Denmark	547
Switzerland	540
Iceland	534
Norway	528
France	523
New Zealand	522
Australia	522
Canada	519
Austria	518
Slovenia	512
Germany	495
Hungary	483
Italy	476
Russian Federation	471
Lithuania	469
Czech Republic	466
UNITED STATES	461
Cyprus	446
South Africa	356

Wilson is the electronics theory consultant for ES&T.

**TABLE II
SCIENCE LITERACY**

Country	Mean Achievement
Sweden	559
Netherlands	558
Iceland	549
Norway	544
Canada	532
New Zealand	529
Australia	527
Switzerland	523
Austria	520
Slovenia	517
Denmark	509
Germany	497
Czech Republic	487
France	487
Russian Federation	481
UNITED STATES	480
Italy	475
Hungary	471
Lithuania	461
Cyprus	448
South Africa	349

I am thankful for this information from Dr. Dobson. I believe it to be very important to everyone who reads this magazine.

Toroidal transformers

As I have said before, some of the most useful technical information available to technicians and technologists comes from advertisements for technical products. The following information comes to us from a company named Ulveco, Inc. in Houston, TX. It spells out the advantages of toroidal transformer design.

Low Weight - Because they are more efficient, toroids can be up to 50% lighter (depending on power rating) than traditional transformers. Low weight simplifies end product design by reducing mounting hardware and supporting enclosure requirements.

Small Size - Most toroids are smaller than their conventional transformer counterparts. Electrical and mechanical designers, when "painted into a corner" by a minuscule space allotment for power supplies, appreciate a toroidal transformers compact dimensions.

Flexible Dimensions - Compounding the benefits of low weight and small size is the flexibility to vary dimensions. As long as the core cross section is held constant, the height and diameter for the toroid may be economically varied to accommodate equipment design requirements, a great help when designing low profile, slim-line equipment.

Easy to Mount - A single center screw easily and quickly mounts the toroid, avoiding costly mechanical design and practical problems associated with traditional laminated transformers, and three screws are eliminated at assembly!

Low Stray Magnetic Field - Toroids have no airgaps: primaries and secondaries are wound uniformly around the entire core. As a result, toroids emit very low radiated magnetic fields. This makes the toroid ideal for application in CRT dis-

**TABLE III
ADVANCED MATHEMATICS**

Country	Mean Achievement
France	557
Russian Federation	542
Switzerland	533
Australia	525
Denmark	522
Cyprus	518
Lithuania	516
Greece	513
Sweden	512
Canada	509
Slovenia	475
Italy	474
Czech Republic	469
Germany	465
UNITED STATES	442
Austria	436

**TABLE IV
ADVANCED PHYSICS**

Country	Mean Achievement
Norway	581
Sweden	573
Russian Federation	545
Denmark	534
Slovenia	523
Germany	522
Australia	518
Cyprus	494
Latvia	488
Switzerland	488
Greece	486
Canada	485
France	466
Czech Republic	451
Austria	435
UNITED STATES	423

ipate in the study. "Otherwise," wrote columnist John Leo, "American might have been fighting for 39th or 40th place in a 41 nation field."

What is even more shocking is how our most gifted students compared with high achievers in secondary schools from other participating countries. For many years, Americans have consoled themselves with the believe that their most-talented youngsters were on a par with the best-educated students on earth. Not so, according to these findings. When compared with gifted students elsewhere, our smartest kids tested even worse.

Tables III and IV are the results for students enrolled in the most advanced math and science courses.

Think about this: ↓

Funding	School Days Per Year
United States \$3,843	Japan 240
Canada 3,508	Korea 222
Italy 2,683	Taiwan 222
West Germany 2,470	Israel 215
France 2,446	Scotland 191
United Kingdom 2,438	Canada 188
Japan 1,978	United States 178

plays, high-quality amplifiers, and medical equipment.

Low Mechanical Hum - The core of a toroid is formed from a single strip of grain-oriented electrical grade silicon steel tightly wound in the form of a clock spring with the ends spot-welded in place. The copper wire is wound over polyester film, forming a silent, stable unit without glue or varnish coating.

Reduced No-Load Losses - Compared to traditional transformers, toroids exhibit extremely low no-load losses. In applications where a circuit is in a "stand-by" mode for long periods, the potential cost reduction for power can be significant. ■

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VR4250 VCR-300
VR4450 VCR-300

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CT-20G13W 4019

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e-mail: eta@indy.tdsnet.com

Circle (77) on Reply Card

Test Your Electronics Knowledge

Answers to test (from page 54)

1. D - The dots indicate the points that have the same polarity.
2. C - The common base amplifier has a gain related to alpha.
3. B - By definition.
4. D - Partition noise occurs when the charge carriers can go either of two ways.
5. B - By definition.
6. D - Bipolar transistors are current-operated devices.
7. B - Thermal agitation noise occurs when charge carriers move through semiconductor materials.
8. B - Excessive load resistance can reduce the collector voltage and lower the gain of the transistor stage.
9. C - The collector voltage is locked to +25V.
10. A - Making point 'A' positive makes the collector negative in the PNP transistor circuit.

DSS installation and setup videotape

Electronix Corp offers "DSS Satellite Installation," a video tape that describes how to quickly and professionally install a DSS type satellite system. Says the manufacturer, whether you are setting up your own system, or want to become a professional DSS installer, this instructional video will guide you step-by-step through the entire process. The detailed instruction covers the most important issues for a proper installation: The site survey, dish assembly, dish installation, complete alignment procedures, as well as many handy tips to make the job easier.

Circle (101) on Reply Card



full evaluation of the digital data stream.

Other features include full EDH facilities with readout of the time of detected errors, and the status of ANC, embedded audio, TRS, EAV, SAV, APCRC, FFCRC and EDH flags. The operator may assign internal and external alarms to any or all of the status readouts. A rating of serial data quality is given in terms of equivalent length of coax from an ideal source. Also featured is a direct readout of signal data in hex form for all 1716 data points of a user-selected raster line. The line may also be selected automatically as triggered by a TRS error.

Monitor modes include waveform (overlay and parade), component vector, picture (from the Y or G signal and including the line-select strobe), and a stereo audio phase/amplitude display with an electronic scale. Extensive menu controls select YChCr or GBR for waveform and monitor output, setup operating choices, line-select, cursors, calibration, preset/remote, dc restorer operating parameters, clock/calendar settings and more. A rear-panel jack provides an active serial feed of the selected A or B input.

Circle (103) on Reply Card

DMM with data port

Wavetek introduces the new 235, a DMM with an RS232C serial data output port. The meter features 11 functions in 45 ranges, and a bright display backlight. The meter's "T" design allows for an oversized display area and larger characters. The unit also features a bargraph providing analog and digital displays.

An RS232C data output port allows the meter to interface directly with laptops and PCs. Included software, including driver and application that add features including alarm trips, datalogging, graph-

ing and output to spreadsheet. Output is optically isolated, and the meter comes complete with I/O cable.

Using simple front panel buttons, the user can quickly select from features including Probe-Hold, Max/Min, reading hold, Relative (Δ) reading mode and Range locking. Display and audible annunciators warn the user when measuring potentially hazardous ranges, and fully fused current inputs add to measuring safety. Test leads, rubber holster and spare fuses are also included.



Circle (102) on Reply Card



Computer monitor pattern generator

Computer & Monitor Maintenance Inc. announces the newest member of the Checker family of monitor test equipment, the "Checker Pro," an ac or battery operated computer color monitor pattern generator, designed for the sophisticated user. Sweep rates to 64kHz, various patterns, and gray scale, allow the user to check-out a wide variety of monitors.

The technician can quickly switch modes using the push buttons, add Sync on green, turn off any of the colors, and turn off either horizontal or vertical sync. The unit provides various test patterns for VGA monitors. Its color bar/8 step gray scale pattern allows color balance and tracking to be quickly evaluated.

Circle (100) on Reply Card

Digital/analog waveform monitor

Leader Instruments announces an improved version of the LV 5100D, the combination digital-analog waveform, vector, picture and stereo monitor. This latest version is Model LV5100DE and includes the "EYE" pattern display with both level and time cursors to facilitate

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TV CASE HISTORIES: Booklet with 2,825+ histories. Satisfaction assured. Only \$56 (plus \$3.00 for priority mail). **Mike's Repair Service**, P.O. Box 217, Aberdeen Proving Ground, MD 21005. Same mailing address 34 years. Send SASE for samples. 410-272-4984, 1-800-2-FIX TVS 11am-9pm. (or at <http://www.netgsi.com/~mikesrs>).

Factory service data, used-Sams, books, vintage parts. AG Tannenbaum, Box 386, Ambler, PA 19002. 215-540-8055, fax 215-540-8327, **On-line catalog: www.agtannenbaum.com**.

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Hickok model 615 sweep marker generator, with manual and cables, good condition. \$50.00. B&K 1827 frequency counter with manuals and leads. New in box, \$25.00. All plus shipping. Contact: Kermit Shetley, 2031 Woodland Hills Drive, Cape Girardeau, MO 63701, 573-334-2055.

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Sams Photofact and service repair manuals. Some pretty old. Contact: David M. Kinchlow, 1515 Walnut Street, New Albany, IN 47150, 812-944-4097.

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Howard Sams tube substitution handbooks, Vol 2-19 Photofact - cheap. Contact: Ann Bichanich, 15 W. Lake Street, Chisholm, MN 55719.

Sencore SC3100 oscilloscope (mint), LC-53 capacitor inductor analyzer, TF46 transistor-FET checker, SCR-250 accessory tester, Protek 506 multimeter. Contact: 612-869-4963.

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Samsung flyback, FCC 1215AL, used in Sears 13 inch TV. No longer available from Sears, either new or good. Used one is fine. Contact: Gordon Hard Electronics, 1005 E. Grand Avenue, Tonkawa, OK 74653, 580-628-4234 after 3PM.

Emerson horizontal output transformer, part no. 4221051014 (HFT 683) for model EC12PA TV. Contact: Dudley Overton, 843-406-9942.

Sony 1040 series projector tubes part number SD-187G, B or R. Contact: D. McNggly, 562-924-2666.

Dell color monitor display GPD-16C schematic. Northern transceiver model N550. Contact: Joe Szczytle, 208-865-2216.

Sears TV model number 564.48900651, error detector board part number 409-015-3301. Will pay money. Contact: Randy Sanders, 317-859-8567, fax 317-899-6977. Leave message.

Zenith model 953508 or 953512R SYSIII, working with IC's included. Contact: George Schierer, 2125 NE 63 Court, Ft. Lauderdale, FL 33308. 954-771-0406.

Panasonic volume control 5K with switch for an AM/FM portable radio. Manufacturer is Matsushita Electric Co. Ltd., Japan. Contact: Joe Quinn, 717-642-6883, e-mail: jojoq@cvn.net.

Emerson radio model 5-38, music cone and 90V B+ battery and 16 to 45V B+ batteries. Contact: Apple Electronics, 3428 E. Bankhead Highway, Lithia Springs, GA 30122, 770-948-9895.

Hitachi schematic for SR2004 stereo receiver. Sony KV-137OR VIF IC module. Motorola MRF309 RF power transistors. Contact: C. Ellis, 9419 Wallre Rd. E., Tacoma, WA 98446. 253-531-8142. e-mail: rnine@wolfenet.com.

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If you repair these ...

Belts and Tires

When you need belts or tires, it's important that you get the right ones. SK Series has added a full line of replacement rubber products in all the popular sizes. Ordering is easy and accuracy is assured.

SK Series belts or tires are available in bulk or a convenient 6-pack.

SK Series, the right parts for the job!

For more information, contact your Thomson Distributor.

We can supply you with these ...

Ask Your TCE Distributor About The Latest SK Specials!

SK6FR21.6	SK6FR7X7	SK6FR9M0	SK6FR22X4
SK6SC3Q2	SK6SC4Q3	SK6SC5Q7	SK6SC3Q6
SK0333	SKBK0533	SKBT.988	SKBK0335
0011	SKPR0023	SKPR230	SKPR0012
4X3	SK5SC6A1	SK5SC8A9	SK5SC4X6
2X4	SK6FR7X8	SK6FR9M2	SK6FR23.6
Q6	SK6SC4Q6	SK6SC5X1	SK6SC3X2
5	SKBK0534	SKBT1.014	SKBK0336
2	SKPR0024	SKPR231	SKPR0013
6	SK5SC6A7	SK5SC8B4	SK5SC5A4
6	SK6FR8.2	SK6FR9M6	SK6FR23X6
6	SK6SC4A	SK6SC5Y0	SK6SC3X5
SKBK0536	SKBT1.116	SKBK0337	
SKPRCC25	SKPR232	SKPR0014	
6	SK5SC6Q0	SK5SC8Q2	SK5SC5Q3
6	SK6FR8M0	SK6FR9W6	SK6FR25X0
6	SK6SC4X3	SK6SC5Y2	SK6SC3Y5
47	SKBT.46	SKBK0367	
016	SKPR0016	SKPR0017	
5Q3	SK5SC5Q6	SK5SC5Q6	
R25X0	SK6FR25Y0	SK6FR25Y0	
SC3Y5	SK6SC4A0	SK6SC4A0	
SK0367	SKBT.515	SKBK0372	
PR0017	SKPR0031	SKPR0018	
SK5SC5Q6	SK5SC6Q7	SK5SC8X4	SK5SC5Q7
SK6FR25Y0	SK6FR8W0	SK6FR9X2	SK6FR25Z0
SK6SC4A0	SK6SC4X9	SK6SC6A1	SK6SC4A2
SKBK0372	SKBT.599	SKBT1.152	SKBK0501
SKPR0018	SKPR216	SKPR236	SKPR0019
SK5SC5Q7	SK5SC6X2	SK5SC8X6	SK5SC5X1
SK6FR25Z0	SK6FR8X0	SK6FR9X7	SK6FR7M5
SK6SC4A2	SK6SC4Y0	SK6SC6A7	SK6SC4A5
SKBK0501	SKBT.670	SKBT1.156	SKBK0530
SKPR0019	SKPR225	SKPR237	SKPR0020
SK5SC5X1	SK5SC6Y0	SK5SC8X9	SK5SC5X5
SK6FR7M5	SK6FR8X4	SK6FR9Y7	SK6FR7W1
SK6SC4A5	SK6SC4Y2	SK6SC6B6	SK6SC4B2
SKBK0530	SKBT.948	SKBK0095	SKBK0531
SKPR0020	SKPR227	SKPR0009	SKPR0021
SK5SC5X5	SK5SC6Y	SK5SC5Y0	
SK6FR7W1	SK6FR9M7	SK6FR23Y6	
SK6SC4B2	SK6SC5Y0	SK6SC3Y2	
SKBK0531	SKBT.113	SKBK0347	
SKPR0021	SKPR233	SKPR0016	
R0010	SK5SC6Q0	SK5SC8Q2	
SK5SC5Y2	SK6FR8M0	SK6FR9W6	
SK6FR7X5	SK6SC4X3	SK6SC5Y2	
SK6SC4Q0	SKBT.46	SKBK0367	
SKBK0532	SKPR0017	SKPR0017	
SKPR0022	SK5SC5Q6	SK5SC5Q6	
SK5SC5Y2	SK6FR25Y0	SK6FR25Y0	
SK6FR7X7	SK6SC4A0	SK6SC4A0	
SK6FR9.7	SKBT.515	SKBK0372	
SK6FR21.6	PR0018	SKPR0018	
	SK5SC5Q7	SK5SC5Q7	

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