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the Commodore 64 • Power protection, electronic equipment

Efficient troubleshooting: write it down

Protecting against static electricity damage

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Circle (3) on Reply Card

ELECTRONIC

Servicing & Technology

Volume 6, No. 3 March 1986

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Servicing the Commodore 64

By Tom Strong

Blank screen, snow screen, garbage screen...these are common problems of the personal computer that are analyzed, with remedial action detailed, in this article that prepares all of us for an impending servicing demand.

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Protecting against static electricity damage

By Jess Kanarek

On the horizon are 1-megabit chips that are five times as sensitive to static electricity damage as are devices used today; a heightened awareness of ESD peril can result in upgrading anti-static procedures.

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Power protection for electronic equipment

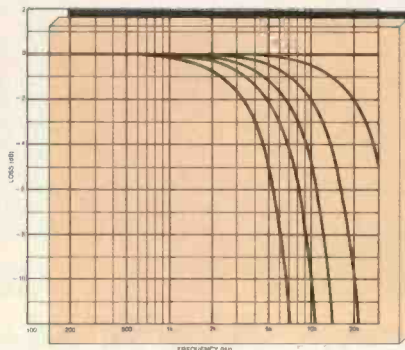
By Gary Mager

When equipment malfunctions, first focus on voltage irregularities instead of blaming a theoretical hardware breakdown or software inconsistency. Clean power is valuable.



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Anti-static devices of a portable work station protect an electronics technician and his equipment as he test probes for waveform aberrations. (Photo courtesy of Wescorp, Mountain View, CA.)



Page 7

With the self-calibrating tape deck that adjusts to the characteristics of each tape, azimuth-misalignment loss, as graphed above, is not critical. (Calculations courtesy of Nakamichi USA, Torrance, CA.)

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Efficient troubleshooting: write it down

By Bud Izen, CET/CSM

Consigning pertinent facts to paper relieves pressures on technicians' minds, freeing them for improved on-the-job concentration. The forms included here may be reproduced, or adapted to the needs of your servicing situations.

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What do you know about electronics? Capacitors and triggers

By Sam Wilson

Dust off your receptivity to electronics equations, then review how questions of voltage capacitance and current relationships are resolved mathematically, with your comments invited. Schmitt Triggers also are discussed.

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Test your electronic knowledge

By Sam Wilson

Questions this month range from A (analog regulator) to the final z in Hz (correct ripple frequency for a ??); it's a real potpourri requiring extensive background information.

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Static electricity has many faces

Static electricity manifests itself in many ways. It's the annoying force that makes your synthetic fabrics cling to you when you're wearing them, or to other items of laundry when you take them out of the dryer. It's the annoying and sometimes painful snap when you've just walked across a rug and reach for the light switch.

Static electricity has been observed and studied for centuries. The ancient Greeks noted that if a piece of fur was rubbed across the surface of amber that the amber would attract small bits of other materials. In fact, the Greek word for amber, *elektron*, became the root word in most languages used to describe all electrical and electronic phenomena.

Static electricity is so fascinating that it's frequently used in science demonstrations. Who can resist a show where the demonstrator rubs a glass rod with a piece of cloth then brings it near some bits of paper, which twitch a little, then leap at the rod, only to leap away again upon touching the rod and becoming charged with the same polarity of static electricity as possessed by the rod.

The static electricity part of the show usually proceeds with fun experiments such as this, then concludes with the grand finale: the Van de Graff generator. With this little toy, the demonstrator builds up static electric charges of thousands of volts in order to discharge them with sparks several inches long. It's awesome. Usually, members of the audience are invited to become part of the demonstration, and when they come under the influence of the static electric field, their hair literally stands on end.

Static electricity has another face, a destructive one. On a grand scale, the lightning of a spring thunderstorm

easily can fell a tree, fire a home or kill a person or animal. In hospitals or other environments where pure oxygen is used, a single spark of static electricity has been known to start horrendous fires. Static electricity is a suspect in explosions and fires where fine particles are mixed with air, as in grain elevators.

Until recently, static electricity was of little concern to electronics manufacturers, users and servicers, unless it was on the scale of a lightning discharge. This has changed. The introduction of metal-oxide semiconductors (MOS) resulted in smaller devices with impedance characteristics that were more advantageous for circuit designers in many applications. It also resulted in devices that failed mysteriously. After some investigation it was determined that the mysterious cause of failure was simply electrostatic discharge (ESD).

Imagine if you can, a person who is wearing synthetics, and sitting and working at a service bench. The static electric charge generated in this situation, if discharged through a MOS device, is several times the potential needed to destroy the device. This is especially true during the winter, when humidity is low and there is no moisture in the air to help drain off the charge as it builds.

An entire industry segment has been built to counter this serious, costly problem. There are techniques that a manufacturer or servicer can employ to reduce the danger of ESD damage. There is a huge array of devices designed to prevent static electricity build-up or to drain it away as it builds up. The servicer or hobbyist, or anyone else involved in handling these ESD-sensitive devices, should become aware of the problem and take steps to prevent ESD damage.

Nils Conrad Pearson

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Circle (5) on Reply Card

News

FCC advisory given

If you know anyone planning to do localized area broadcasting, you may wish to pass this information on. It could save them from possible violation of FCC regulations and federal law. Manufacturers, retailers and consumers using low-power video transmitters may find themselves subject to monetary fines (to \$10,000), jail terms (to one year) and seizure of the equipment by federal authorities.

The transmitting devices in question are designed to be connected to the VCR, TV camera, computer or other video source for transmission throughout the house to TV receivers. Operating without interconnecting coaxial cable to reduce undesirable RF radiation, the units generate field strengths that may produce interference to licensed broadcast services. Because signal bandwidths of these devices are not well controlled, they may cause interference to adjacent channel services as well. The problem is compounded if linear amplifiers with outputs up to 20W are used with the transmitters.

The FCC realizes that some will

see this action as an invasion of privacy of the user. Of greater concern, is the problem of interference with broadcast signals, to say nothing of invasion of privacy of their neighbors, whose children might be subjected to video material that is not to their taste of standards of decency.

Anyone contemplating the use of such a video transmitter that does not connect to the television through coax should check the unit for appropriate FCC identification and type acceptance labels, plaques or certification stickers. Devices packaged with computers and integral to VCRs already have received FCC certification and are not included in this advisory. If there are questions of legality of an RF generating device, contact the FCC field office in your area for assistance.

Will optical memory technology replace magnetic storage?

In 1990, the market for optical data storage is predicted to reach \$9 billion, growing from \$200 million in 1985.

The development of this new technology is the subject of a report by *Electronic Trend Publications* titled, "Optical Memory's Impact on Magnetic Storage and Computer Systems Architecture." The report examines trends in CD ROM, write-once, read-many optical disk players and systems, and the

various types of erasable optical disk products.

The study advises that the United States is far behind the rest of the world in optical disk technology, with only 3M Company and Verbatim making recent announcements in media and drives, and few large computer manufacturers aggressively pursuing optical technology.

Editor's note: In a similar study, *Frost and Sullivan* makes an identical prediction. The *Frost and Sullivan* report also includes certain descriptive information that we believe will be of interest to our readers.

Optical disk technology moving from lab to marketplace

Optical technology is finally moving from the laboratory to the commercial marketplace.

There are three broad market segments for optical systems for computer storage—large, medium, and small capacity disks for mainframe, mini, and microcomputers. In addition, there are two optical disk formats currently available and one under development.

The format in development is the erasable optical disk. In erasable technology, the recording layer of the disk is not permanently altered when data is written—the "used" areas can be returned to their original "clean" states.

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Tape deck automatically adjusts itself...



Every audiocassette is unique, differing even from other cassettes of the same type and from the same manufacturer. To achieve optimum performance from any cassette, therefore, the bias and Dolby calibration of the recorder must be specifically adjusted to match the characteristics of that particular tape.

The azimuth alignment problem

Unless the effective gap in the playback head is perfectly aligned with the recording tape, treble response is diminished. The problem is especially severe in the cassette format because slow tape speed means that each cycle of high-frequency signal occupies an extremely short length of tape, that is, it has a very tiny wavelength.

Figure 1 graphs the azimuth-misalignment loss as a function of frequency for various azimuth errors. Even with a tiny 5-min. error ($1\frac{1}{2}^\circ$), there is a 2dB loss at 20kHz. With a more typical error, 10-min. or $1/6^\circ$, there is a 2dB loss at 10kHz and almost a 10dB reduction in output at 20kHz. Companding noise-reduction systems make the problem worse. The more effective the noise-reduction system, the more it increases treble loss.

Azimuth error can occur for a variety of reasons. Either the recording or the playback heads, or both, may have been improperly aligned at the factory. It may not be possible to align them to each other. Or the tape in one cassette may track differently from that in another, causing the actual record-

ing azimuth to vary from cassette to cassette.

The azimuth-misalignment problem is bad enough on an ordinary cassette deck. When azimuth alignment is ignored on an *auto-calibration* deck, serious problems ensue. When the deck *auto-calibrates*, it attempts to achieve flat frequency response by recording and reproducing a high-frequency test tone. The playback level is either compared with a reference voltage or with the output level when recording a low-frequency tone. Then one of two things happens, depending upon

the design of the deck. Either bias is adjusted until the high-frequency output matches the low-frequency output or the recording equalization (high-frequency pre-emphasis) is adjusted for a match. A combination of the two procedures also is possible.

In principle, this procedure is fine; in practice, it results in *miscalibrating bias unless the playback head is perfectly aligned with the recording head.*

Automatic head alignment

A new tape deck from Nakamichi, the CR-7A, avoids this prob-

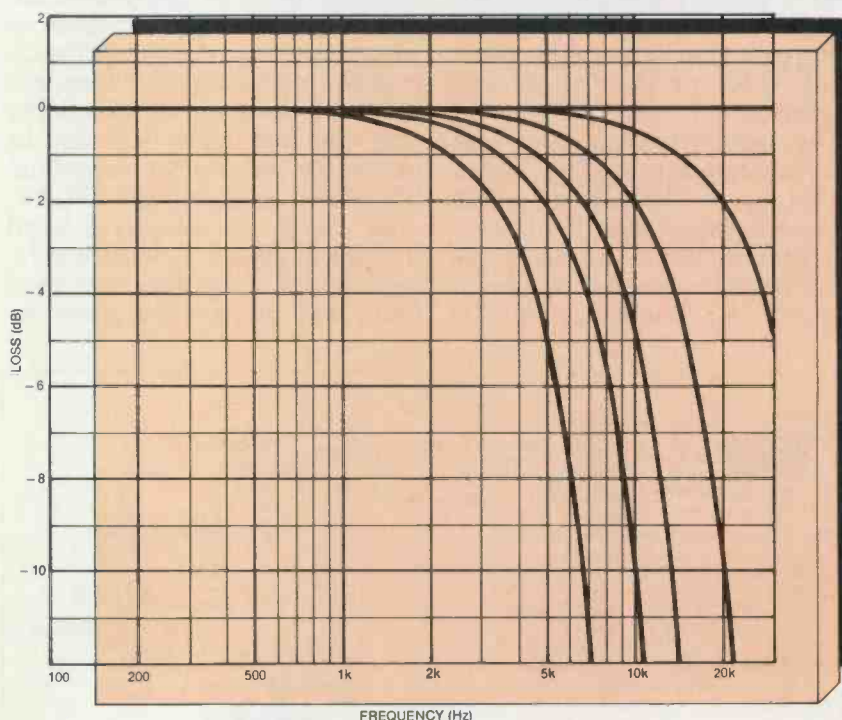
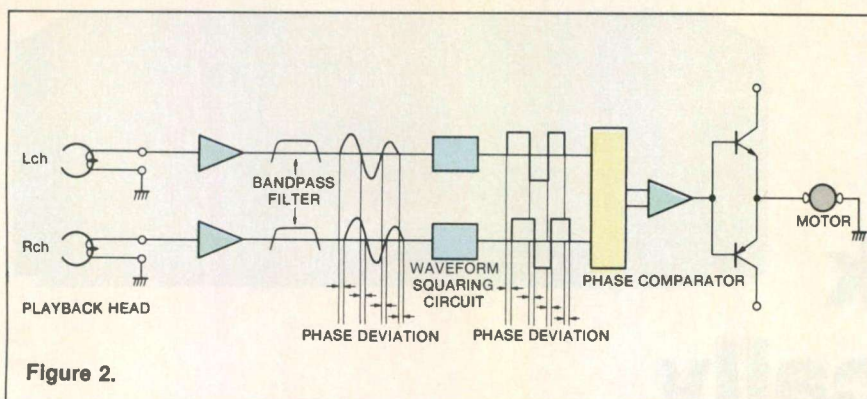


Figure 1.



lem by automatically aligning the playback head with the recording head as the first step in the auto-calibration procedure. The auto azimuth-correction system uses the "phase-comparison" method shown in Figure 2. A 400Hz tone is recorded in phase on the left and right channels. It is immediately reproduced by the two tracks of the playback head. Any azimuth misalignment shows up as a phase (time) difference between the left and right outputs. After amplification and bandpass filtering, the signals are passed through squaring circuits to eliminate amplitude variations and sharpen the axis crossings. The phase difference between the square waves is measured by a phase comparator. The difference is amplified and used to power a servo motor that, through a series of gears and linkages, manipulates the playback head into proper alignment (Figure 3).

The azimuth-alignment and auto-calibration procedure is controlled by a 6-bit/64-step microprocessor. On average, it takes approximately 15s to complete the sequence of operations shown in Figure 4. Pressing AUTO

CALIBRATION passes control of the deck to the microprocessor. During setup, the microprocessor mutes the output to protect the loudspeakers, then resets the tape counter so that, at the conclusion of the procedure, the tape will be returned to the point at which the procedure started. The Manual Tape/Equalizer switch is checked. If it is *on*, tape equalization is set in accordance with the Manual Tape Selector switch settings; if it is *off*, the equalization is determined by the Auto Tape Selector.

The Monitor is switched to TAPE (overriding the manual setting) so the system will read the playback signal and the Dolby NR system is switched *off* (again overriding the manual selection) to prevent it from affecting calibration accuracy prior to Dolby level adjustment. The playback head is returned to its reference azimuth position and the tape fast forwards for 1s to eliminate any possibility that the test tones will not be erased by subsequent recording. Then the deck enters REC/PLAY.

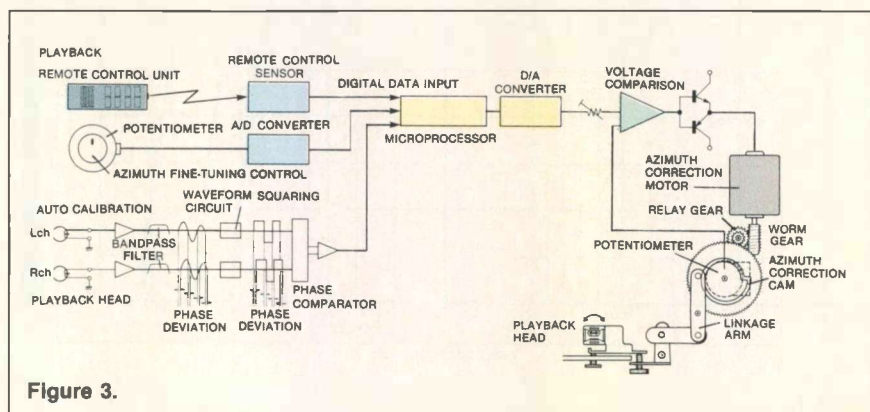
In Step 2, playback-head azimuth is aligned. A 400Hz tone is recorded at Dolby-reference level (0dB) and the relative phase be-

tween left and right channels is measured every 100ms (10 times per second). If an interchannel phase error is detected, the playback-head azimuth is adjusted (in steps of approximately 1.3 min.) until the phase error is corrected and the correction is confirmed 10 times. If the tape is so bad that the azimuth cannot be corrected within 5s, the auto-calibration procedure is then suspended and the AZIMUTH, LEVEL and BIAS indicators flash as a warning.

If the azimuth alignment is achieved, the microprocessor proceeds to the third step—level calibration. In this step, the recording level is adjusted to compensate for differences in tape sensitivity and ensure that the Dolby tracking will be perfect. A 0dB 400Hz tone is recorded and the playback level is sampled at 15 points, independently in the left and right channels. The highest value in each channel is digitized by an A/D (analog-to-digital) converter and sent to the microprocessor. The microprocessor compares the values with the digitized value of the input level and the difference, if any, is converted to an analog voltage by a D/A (digital-to-analog) converter. This analog voltage is used to adjust the gain of the recording amplifier and, by so doing, correct for differences in tape sensitivity.

Bias is calibrated in Step 4. A 15kHz tone is recorded on both tracks and the playback level again is sampled at 15 points, independently in the left and right channels. The highest sample in each channel is digitized and sent to the microprocessor for comparison with the proper value for that test tone. If a difference is found, the bias is adjusted in the appropriate channel and the process is repeated (up to six times) until the difference (in analog terms) is within $\pm 0.3\text{dB}$. Then, since even a slight change in bias can affect tape sensitivity, Steps 3 and 4 are repeated.

In Step 5, the accuracy of the calibration is checked. If, after repeating Steps 3 and 4 twice, the $\pm 0.3\text{dB}$ criterion for output on bias cannot be attained, or if the bias value is beyond the deck's



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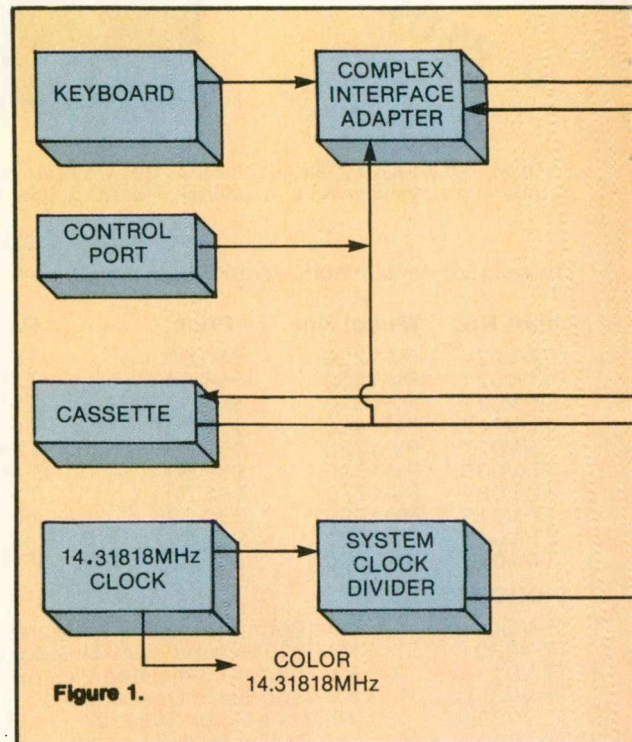
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Servicing the

The functions of computer circuits and subsystems are clear-cut; when they fail, the symptoms are usually unambiguous. An understanding of what these devices are supposed to do will help you troubleshoot them when they require service.

By Tom Strong



The largest selling full-power personal computer in America is the Commodore 64. With 64K of memory, the machine offers flexibility in programming. The manufacturer provides a selection of peripheral devices including the video display, disk drive, printer and modem. The popularity of the Commodore 64 can be attributed to its good performance, a reasonable price and abundance of user-friendly software.

Figure 1 illustrates the design of the Commodore 64. Whether a computer is a desk top personal type or a room size mainframe, every system contains the following basic components:

- Central processor unit (CPU)
- Memory (RAM and ROM)
- Interface
- Input and output devices (peripherals)

Tom Strong is director of education, Electronic Servicing Institute, Cleveland, OH.

It is in the memory that the instructions and data are stored. In the case of a small computer, the microprocessor (MPU) is the central processor unit that controls the operation of the computer in carrying out the instructions of the program.

Computer peripherals

Figure 2 illustrates common accessories connected to the Commodore 64. Notice the keyboard and joystick are input devices only. The printer and video monitor can only receive data from the computer. Whereas, the modem, tape cassette recorder and disk drive are *both* input and output devices.

Circuit description

The 6510 microprocessor connects to the memory circuits and interface chips via the bus lines: groups of conductors that interconnect devices for the inter-

change of information. Physically on the circuit board, the bus lines consist of thin foil circuit traces connecting one IC to another. Three bus lines are used:

Address—there are 16 address bits that can access certain memory locations as directed by the computer's program.

Data—after the information (data) is located in memory, it is transferred to as MPU where it is processed. The result could be the start of a program, answer to a question or a command to a peripheral device. The data bus contains eight bits.

Control—under the direction of the MPU, special signals are placed on the control bus, including *clock*, *Read/Write* and *interrupts*. The clock controls timing all computer operations in orderly fashion. The MPU receives the 1.02MHz clock signal from the video chip U19. The R/W signal controls direction

Commodore 64

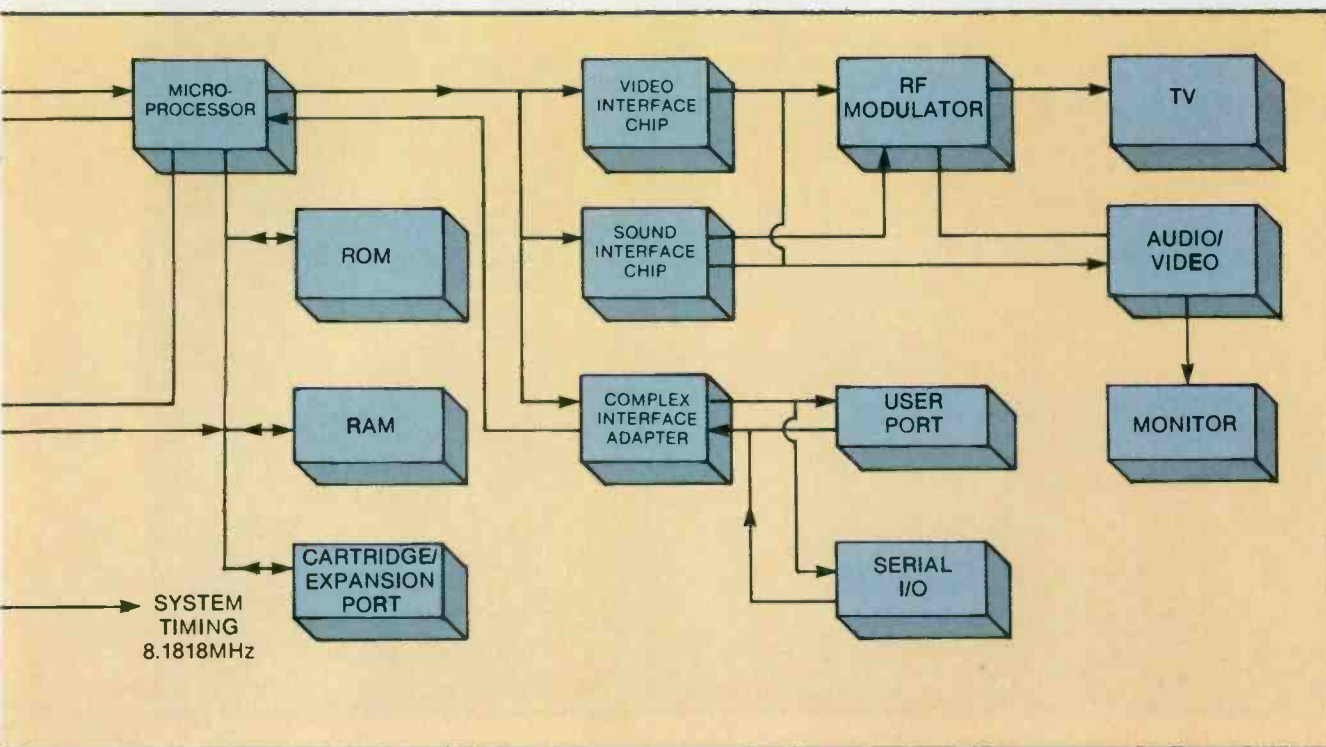


Figure 1. You can get a good feel for the design of a personal computer by studying its block diagram, such as shown here for the Commodore 64. A sense of what's going on in the unit makes troubleshooting easier.

of data movement on the D0 to D7 data bus.

The 6510 MPU has the capability of handling two interrupt signals (IRQ and NMI), which can stop the processor to let other actions occur. A signal from the disk drive can disable the MPU and allow the

disk system to communicate directly with the computer's memory in loading its program.

RAM chips

There are eight 4164 random access memory (RAM) chips in the Commodore 64. Four of these 16

pin ICs, U9 thru U12, are located in one row on the circuit board. The other four, U21 through U24, are located on another row. See Figure 3. Each RAM contains 64,000 memory locations, but outputs only one bit of data for each byte (eight bits) representing a

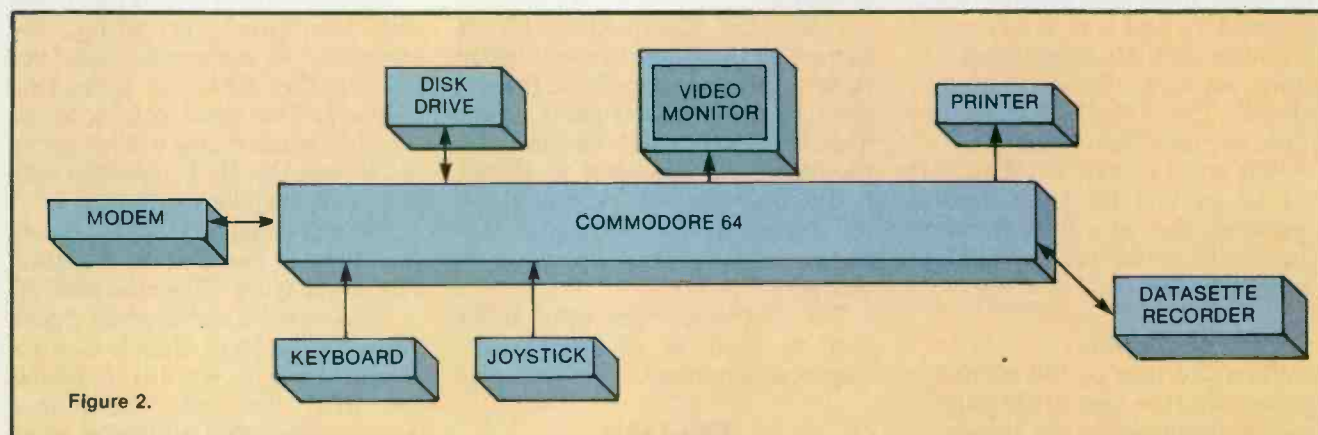


Figure 2.

Figure 2. A number of peripherals can be connected to the Commodore 64, as shown here. When you're troubleshooting the computer, don't forget that the problem could be in one of them.

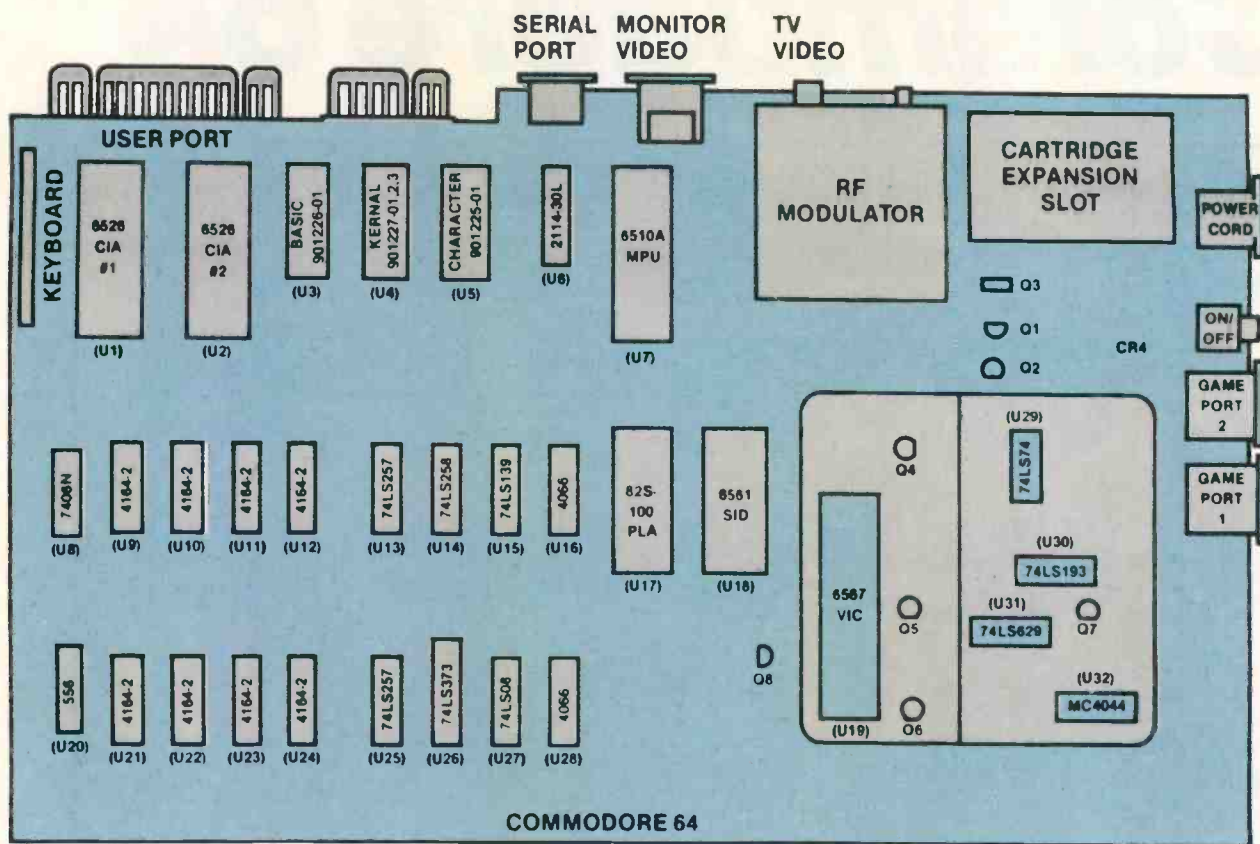


Figure 3. Viewed from the top front of the computer, the ICs and other components are laid out on the printed circuit board as shown here.

character or instruction (Pin 2 or 14). The eight chips are connected in parallel, so that each of the 64,000 8-bit data bytes stored in the memory bank is made up of one bit from each chip. These outputs are labeled D0 through D7 and are directly coupled to the MPU. Because the RAMs present their 16 high and low addresses on the eight lines alternately, multiplexers U13 and U25 are required to convert the 16 address lines into eight address lines and two selects. The 74LS257 chips are 2-line to 1-line data selectors.

U6 is a 2114 Color RAM chip. It is a 1K by 4-bit IC. U6 is used to represent the 16 different colors that can be generated by the Commodore 64.

ROMs

When you turn *on* the computer (power up), the same title page is always displayed on the screen.

Power-up resets the computer to a beginning point. This start-up

program is stored in a read only memory (ROM) called the Kernal (U4). The following are important actions that the Kernal initiates:

It's the Kernal that lets you communicate with the computer through the keyboard. The Kernal program interrupts the MPU operation every 1/60th of a second to scan the keyboard for any key closure.

When the Commodore bit is turned on, it is immediately ready to be programmed in Basic (beginner's all-purpose instruction code). This is only possible because the programming language is stored in the computer in ROM. The Basic ROM chip is U3. The basic language interpreter is contained in this IC.

The Character Generator ROM (U5) is used to create all 512 displayed symbols.

Video chip

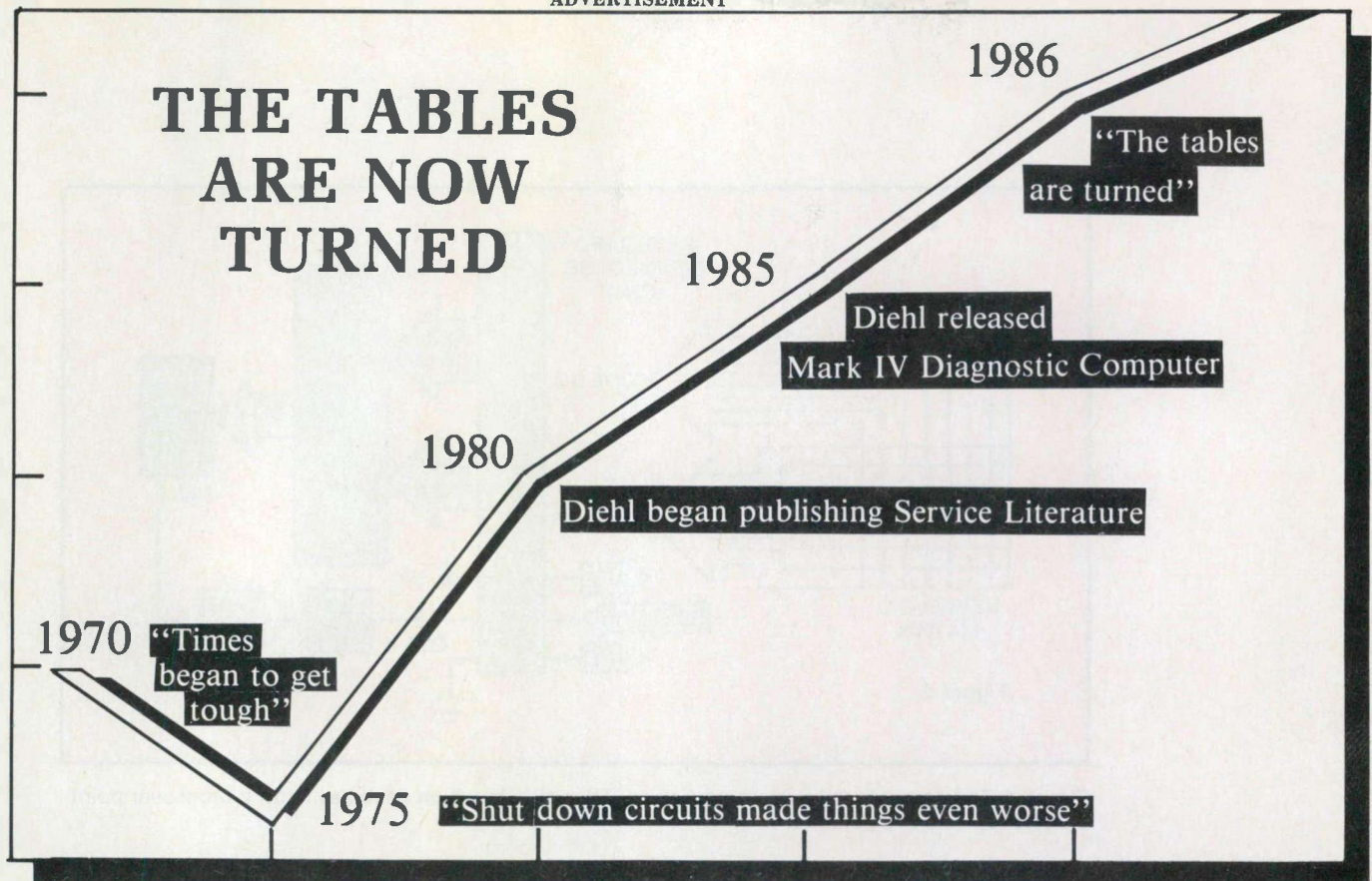
The output of the video IC (U19) contains the sync and luminance

signal at pin 15. The color signal exits pin 14. These signals are connected to the RF modulator, which produces the channel 3 or 4 RF carrier. Also, connected to the modulator is the audio signal from the sound chip U18. The output of the modulator uses a standard RCA phono connector to the TV set.

The 6567 video chip is like a second microprocessor within the computer. It shares the same bus line as the MPU in addressing memory. The video chip accesses memory when Phase 0 clock signal is low and the MPU uses the data bus when the clock is high.

The video chip provides the control signals required to maintain this bus sharing. When the 6567 IC is accessing the address bus, it provides the Address Enable Control signal (AEC on pin 16) to *disable* the MPU. The AEC signal is a square wave with alternate *on/off* times.

The video IC can access 16K of



1986

**PROMISES
TO BE
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YEAR YET**

—FOR TECHNICIANS—

IN THE PAST:

We've all seen it happen. A piece of equipment comes in for repair (dead on arrival). In the process of trying to get it to power up, some half dozen or so components "self destruct", and the customer no longer wants it repaired. Furthermore, they don't even want it back. Nor do they want to pay for the time it took you to prepare the estimate.

A few days later, you see this same customer at the local discount chain store buying a replacement unit for less than your wholesale price.

Well, unless that chain store is

prepared to give everyone a 60% discount (off their advertised price), things are about to change - - -

Particularly, the labor costs of repairing electronic equipment that frequently develops low voltage power supply problems. Or problems in other circuits that ultimately show up as symptoms that would normally lead even a good technician to "suspect" low voltage power supply problems.

The main problem has been pure and simple. The bench time required to complete repairs on most electronic equipment has made today's service shops totally non-competitive with the replacement cost of the same piece of equipment at the local discount chain. And, non-competitive with the continually lower costs of purchasing a brand new unit.

The main culprit is, that it takes more and more time to **isolate** the stage or circuit that has failed, than it does to actually complete repairs once isolation has been achieved. In the meantime, today's technology offers more and more "opportunities" that cause additional components to self destruct **while** you are attempting to isolate the actual stage or circuit that has failed. If you're not really

careful, its pretty easy to make a major service problem out of what started out as a very minor repair job, with regards to the number of new parts that will be required, and the amount of time that will be required to replace them.

INSTEAD OF THE ABOVE, IMAGINE THIS:

A home stereo amp or similar piece of equipment shows up at your bench for repair. Without even taking the back off, you plug it into a computer. The computer tells you (1) if any shorts exist in the unit; (2) if so, what **type** of a short exists. (i.e. is it a shorted LV rectifier, a shorted output transistor, a shorted driver transistor, a shorted pre-amp, etc., etc.). The computer has such an effective current limiting feature that it will virtually not permit a chain of components to self destruct. If on the other hand, the circuit under test is open, the computer lights an "open" light and tells you so. If the current consumption is **normal**, it also tells you that, with a "normal" light. If the current consumption is **low**, the bar graph on the computer lets you know.

This new concept of troubleshooting all but eliminates the possibility of spending tedious

Continued on Page 15

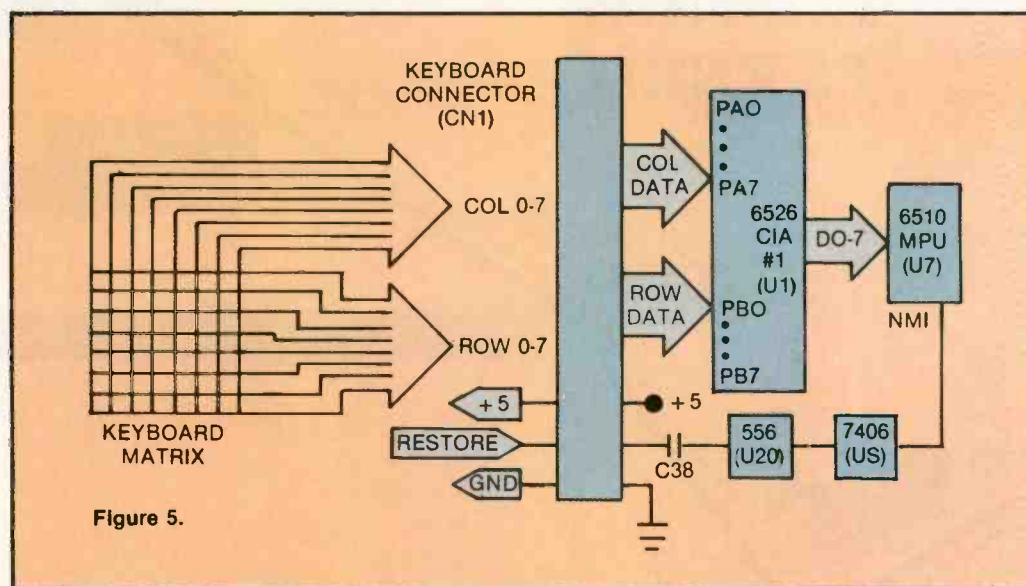


Figure 4. The computer's keys are part of an X-Y matrix in which each key is on a crossover point of an X row and a Y column.

display memory. The Commodore 64 displays up to 25 lines of 40 characters each.

Clock timing

A crystal oscillator produces a 14.3MHz master oscillator signal from U31. Frequency counters divide down the master oscillator frequency to produce the color carrier (3.58MHz) and the clock signal (1.02MHz).

Interface chips

There are two 40-pin interface ICs in the C64, U1 and U2, located near the keyboard connector. Commodore calls these chips Complex Interface Adapters, or CIAs. U1 interfaces the keyboard and both joystick ports. U2 is the serial port connector for a disk drive or printer, and also connects where a modem could be connected.

Notice both CIA chips use the same part number, 6526. When you're troubleshooting I/O problems, conceivably, you could swap these ICs to determine if one is the cause of the problem.

Keyboard operation

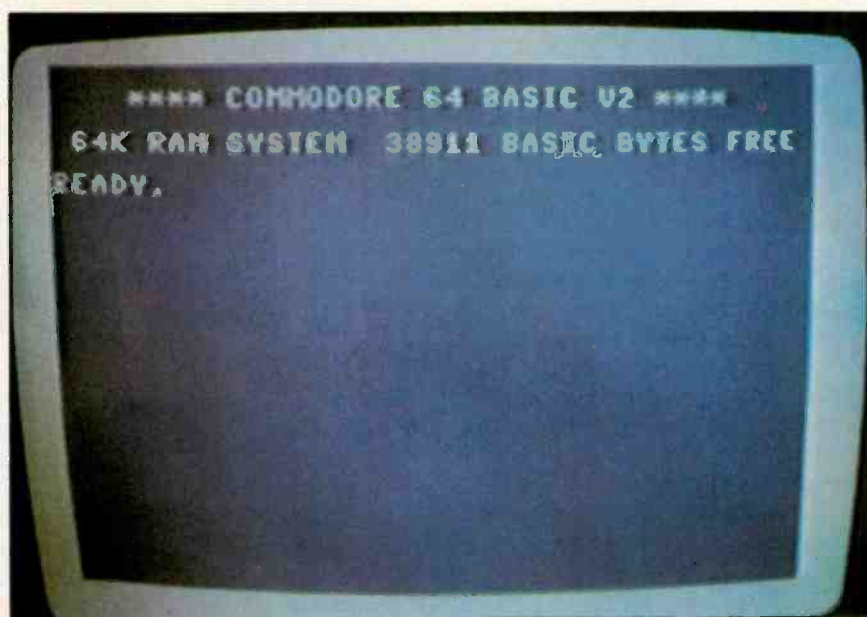
The keyboard is connected to a matrix 8 rows high by 8 columns wide, which plugs into a socket

just to the left of U1. Keystrokes are interpreted by the circuitry (shown in Figure 4) that then produces the correct characters.

The keys are part of an X-Y matrix where each key is on a crossover point of an X row and a Y column. Each time a character key is pressed, the circuitry con-

verts this action into a column and row code that is stored in U1's registers. A scan key routine in ROM causes the row/column data of U1 to be output as an 8-bit code to the MPU.

Except when there are keyboard problems, the keyboard can be disconnected when trouble-



When the Commodore 64 computer is turned on, if all the circuits are in working order, you may expect that this title screen will be displayed on the monitor, as shown above.

Continued from Page 13

hours, chasing potential problems that ultimately never existed in the first place. We now manufacture such a device. It's called our Mark VI Diagnostic Computer.

If you work on a lot of equipment that employs any type of a transformer, (i.e. the horiz sweep transformer in a TV set), you will no doubt want to consider one of our slightly more sophisticated computers. Take TV service as an example, our Mark VII Computer provides you with two separate twelve unit bar graphs. The first bar graph gives you a read out on **resistive** load power consumption. The second bar graph gives you a read out on **inductive** load power consumption. Both graphs provide you with an open and a normal read out, both employ current limiting control.

WHAT DO THESE BAR GRAPHS TELL YOU ABOUT TV SERVICE?

First off, just a few examples:

If the red "nine" or "ten" light is lit in the **resistive** bar graph, it's time to start changing the LV rectifiers. With these lights lit, the short is positively located on the B+ side of the primary winding of the (horiz sweep) transformer. It cannot be anywhere else. If the red "six" or "seven" lights are lit, either the horiz output transistor is shorted, or something on its collector line is shorted, (i.e. damper diode, safety capacitor, pin cushion transformer, discharge capacitor for the horiz yoke circuit, etc.). A short that produces a red light in the **resistive** bar graph will not be, and cannot **possibly** be located on the secondary side of the sweep transformer, it **has to be** on the collector line of the horiz output.

A red "nine" light in the **inductive** bar graph and the TV set either has a shorted CRT, or a shorted HV tripler. A red "eight" light means a shorted scan derived B+ rectifier, or its associated filter capacitor, and so on. Each light, in each of the bar graphs has a very specific meaning. The best part is, thus far, you haven't so much as taken the back off the TV set so long as the horiz osc / driver, and the LV regulator is functional. If one or the other is not functional, you will naturally have to substitute it with horiz drive injection to the base of the set's horiz output transistor, or in the

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case of an in-op LV regulator, restore primary low voltages.

Aside from looking at the power consumption label on the equipment under test, then, setting the computer's range control to that setting, absolutely no programming is ever required to operate either of the above computers. Just turn the equipment on, turn the computer on, plug the repair job into the computer, push one **single** button and look at the bar graph(s).

If you do not do TV work, the Mark VI will do everything you will ever want done. If you work **primarily** on TV sets, plus any other equipment that comes in, you will most definitely want the Mark VII unit. (You will not need both).

You might say that the Mark VI is somewhat like a variac that permits you select the amount of **wattage** (instead of voltage) that you wish to apply to a circuit, with a built-in computer that tells you if a resistive short exists in the equipment under test, and if so, what type of a short exists, and just how severe it is.

The Mark VII does all of the above, except that it has an additional computer that tells you whether the short is resistive or inductive (on the secondary side of a transformer), and again, just how severe the short is.

The watts output range of both units is 25, 50, 75, 100, 125, 150 thru 250 watts in 25 watt increments. The greatest part is, if a short exists, you can't tear anything else up (such as additional components). In the event of a short, the computer simply lights one of the "short" lights in it's bar graph. Based on which light is lit, you now know essentially where the short is.

Once a short light comes on, the computer immediately reduces it's output to whatever level is "comfortable".

As you are about to see, the Mark VII unit is expandable (the Mark VI is not expandable).

IF YOU PREFER NOT TO WORK AT ALL:

Then you will want to purchase a Mark VII computer, and consider the following self contained "add on" computer which we have appropriately named the "**Eliminator**" (for obvious reasons). Since it is a plug in expansion system

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for the Mark VII, you can add an "**Eliminator**" package to your Mark VII at a later date.

The "**Eliminator**" expands the features that are found in the Mark VII units. It's main frame is built around an eighty square inch gaseous display panel which provides you with a generic block diagram of the entire lv, lv regulator, horiz output, horiz sweep circuits, scan derived B+ sources, horiz oscillator and driver circuits, horiz yoke & P.C. circuits, vertical, color output, start up, shut down and B+ run circuits (to name just a few).

With the "**Eliminator**", all you do is set the same power consumption switch, plug the TV set into the computer, turn it on, then, press just one single button. The gaseous display will now light up the stage, circuit, or in many instances, the actual component that has failed. In instances where the TV set's horiz oscillator, driver or output is not operational, the "**Eliminator**" will light an instruction telling you to interface to the set's horiz output device. When this happens, remove the TV set's horiz output device (transistor or SCR), and plug in the computer's interface plug (which looks like a horiz output transistor). Then, press the test button again. A similar instruction is given for instances where the TV set's LV regulator must be analyzed. In some eighty percent of all cases, neither instructions will be given because neither will be required for the "**Eliminator**" to analyze the entire overall circuit.

Yes, this means that you can virtually analyze most TV sets right down to circuit level in **every** instance. And, right down to **very specific** component level in **most** cases without ever taking the back off!

In fact, the only instances that will require you to remove the back in order to do so with virtually 100% accuracy, are cases where the TV set's horiz osc / driver, or output stages are in-op. Or, in cases where the LV regulator circuit is not cooperative. Virtually no other types of circuit failures will require the removal of the TV set's back for an accurate diagnosis to circuit level!

In fact, the "**Eliminator**" will spot any type of a shorted condition and many types of open conditions without removing the back, **and** without you're even so much as looking at the set's CRT.

Under the above conditions, the
Continued on Page 17

shooting the motherboard. In other words, the keyboard is not required for the computer to display its *title page*.

Joystick operation

The joystick circuitry is connected to U1, using 10 of the ports to which the keyboard interfaces. This explains why you can play some games using either the joystick or keyboard. Referring to Figure 3, notice two ports are available for joysticks. The joystick operations are read by the game program and the resulting signals are interpreted by the MPU.

Disk operating system

The disk drive is plugged into the serial port connector on the back of the computer. The DOS signals interface with U2 and are buffered by U8. (Figure 3.)

Sound

U18 is the SID chip (Sound Interface Device). This IC has the capability of generating signals that produce arcade-type sounds from your television or monitor's speaker. Inside the SID are tone oscillators generating different audio signals with a combination of frequency filters passing various sound effects.

The frequency generated depends on the computer program. The audio output from U18 exits pin 27 to the RF modulator. Of course, troubleshooting any sound problem begins by checking U18.

Power supply

Power to the Commodore 64 is supplied by a sealed power pack. This external power adapter provides both ac and dc voltages. The ac voltage is 9V, which is changed to dc by a bridge rectifier located on the computer circuit board. This dc voltage is used for the video chip (U19) and the clock generating ICs.

The dc voltage output is high current and regulated. This 4.9V is used to power the logic chips on the computer board.

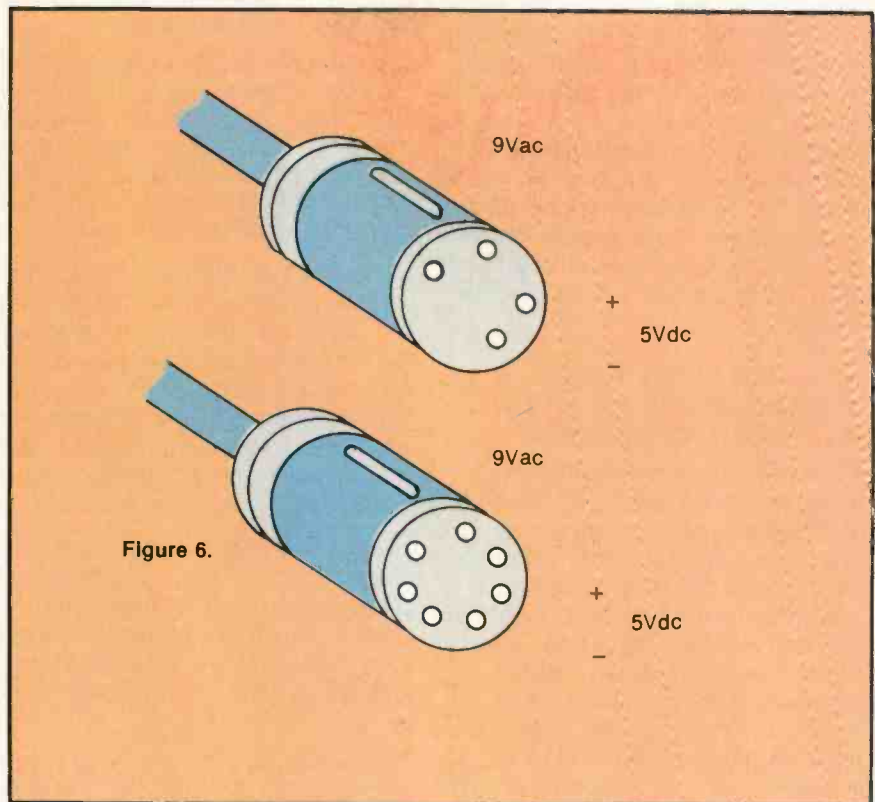


Figure 5. Two types of power-supply connectors are used with the C64. These diagrams show you which pins are which on both types.

Referring to Figure 5, you can verify the condition of the two types of power adapter connectors. Because of their high current output, power adapter failures are quite common. The sealed units cannot be repaired and have to be replaced when defective. Sometimes the regulator breaks down after warmup and produces excessive dc voltage that will damage some of the 4164 RAMs. CAUTION: When replacing overheated RAM chips, you should keep in mind that the power pack might have been the cause and its replacement also may be required.

Since the power adapter produces two separate voltages, it is possible for one voltage to be normal and the other voltage to be missing. For example: The com-

puter's LED power indicator light uses dc voltage for illumination. The 9V ac side of the supply can be dead and the LED will still be on.

Troubleshooting steps

Although the following troubleshooting procedures apply specifically to the Commodore 64, these steps can be adapted to repair any microcomputer.

ICs will cause about 90% of the breakdowns on the computer board. Failures generally occur in the circuits that are used or stressed the most, including the RAMs, CIA, PLA and video chips. Less common defects are caused by the MPU and ROMs.

I/O chips—U1 interfaces with user devices such as joysticks and the keyboard, making this IC vulner-

"Eliminator" will spot such things as open fuses, surge resistors, bad filter capacitors, shorted LV rectifiers, open LV regulator devices, defective LV regulator drive circuits, shorted or open horiz output devices, bad damper diodes and safety capacitors, shorted pin cushion transformers, yokes, discharge capacitors in the horiz yoke circuit, centering diodes, shorted horiz driver transistors, shorted oscillator stages, open horiz osc / driver stages, defective start up circuits, shut down circuits, and scan derived B+ circuits, (with regards to shorted rectifiers and associated filters in scan derived B+ circuits, the "Eliminator" will tell you **specifically** which circuit(s) are connected to the shorted scan B+ winding).

If the resistor is open that couples the secondary of the horiz driver transformer to the base of the horiz output, the "Eliminator" will tell you so.

If the scan derived B+ circuit is open that feeds the horiz osc and driver stages, the "Eliminator" will tell you so.

If the vertical output circuit is either open or shorted the "Eliminator" will tell you so. The same goes for shorted red, green, and blue, video output transistors.

If the CRT is developing a second anode short when it gets hot, the "Eliminator" will likewise tell you so.

Nothing, - - - absolutely nothing, no amount of other test equipment, no quantity of technicians, and no possible combination of the above can compete with just one "Eliminator". It can't be done!

If you so desired, you could no doubt cut you present labor rates in half, work only a fraction of your present hours, simultaneously double your production output, and at least **triple** your present net profit, with just one "Eliminator".

You could place an ad in the paper or on TV that states "Bring your color TV repair job in for a genuine computer diagnosis, and an accurate estimate, for a total cost of only ten dollars. With our new computer, we can repair your color TV set for about half of the normal labor rates". (We are not recommending this).

In the race between discount chain stores and their ever decreasing cost of replacement equipment, you (not them) will now be able to compete for the purchasing power of today's consumer. The best part is, **Y O U** can make some really big money while **T H E Y** try (for a change), to find some way to compete with **Y O U**!! Unless the TV set has a bad CRT, flyback or yoke, they won't be likely to find such a way, short of passing their new TV sets out a significant loss!

It should come as no surprise why we have chosen to name our new computer the "Eliminator"!

The "Eliminator" is a full fledged, bonified, total logic, decision making computer that carries a 100% two year parts and labor warranty (except for physically obvious abuse, and cosmetics). If you can find a way to tear it up, we will repair it free of charge. You pay only for transportation.

IMAGINE THIS:

A TV set shows up in your shop. You plug it into your computer, press one button and a red light comes on in back of the vertical output circuit in the block diagram of the computer's display panel. In just one second, without so much as removing the back of the TV set, you know where the problem is.

Generally speaking, red lights indicate shorts, yellow lights mean that an open circuit exists.

Another set shows up. You plug it in and the surge resistor in the LV supply of the block diagram is lit up yellow. You replace the surge resistor and push the test button again. This time the LV rectifier in the scan derived B+ supply for the R, B, G video outputs is lit up red. You replace the LV rectifier, push the test button, and presto! The set now has a picture on it! It's fixed and ready for the cookout bench.

After pushing the test button for the next set, a red light comes on behind the LV rectifiers. In another the HV multiplier is lit up red.

Later in the same day, the start up circuit is red for one set, another TV set comes in with a color picture but, the shut down stage in the block diagram is red.

In fact, any problems in **any** of the previously mentioned long list of circuit failures will be displayed in either yellow or red on the screen of your "Eliminator" when and if they

fail. In many instances, if your computer sees two or more problems at the same time, it will simultaneously display both.

It may sound like the "pipe dream" of some technician turned "mad inventor", but, we are already manufacturing them, and they do exactly what we have stated. If you would like to own either a Mark VI, Mark VII or the "Eliminator" (which is an add on, plug in computer for the Mark VII unit), you can bet your socks that we have a dealer in your area who would like to show you one in operation. If we don't have, we very soon will! Without actually seeing one in use, it's impossible to imagine everything it will do. We used to sell via direct mail, but, when we decided to release the "Eliminator" we realized the necessity of local dealers who could demonstrate it "hands on".

For this reason, we have chosen TV service shops or technically qualified parts wholesalers to sell our products.

Yes, we still manufacture our Mark III and Mark V computers for analyzing horiz / hi-voltage circuits. For those who already have a Mark III or V unit, the Mark VI or Mark VII will certainly compliment the operation of either unit. A member of our design team recently stated, "Owning a Mark III is like being released from a set of life long shackles. Getting a Mark V was like having the same shackles removed and being permitted to use hand tools for the first time. Buying an "Eliminator" is just like having the world's greatest technician come to work for you. Then, realizing that he also owned a magic wand."

If you would like a "hands on" demonstration, and are willing to drive fifty or so miles to get one, call (806) 359-0329, or write to the above address asking for same. We will be pleased to give you the name, address and phone number of your nearest sales dealer.

Your local dealer will do "hand stands" for a chance to show you our test equipment in action. But be aware that in most cases, you will have to go to his shop for a "hands on" demonstration. Please keep in mind that he is not only your sales dealer, he also has a TV repair business to run. Even so, who could better demonstrate test equipment than the people who are using it on a day to day basis! The drive to his shop will be more than worth the time.

able to static electricity discharge. If certain joystick movements fail (like moving right or left) while using a known-good joystick, the defect is likely U1.

With any keyboard problems, a known-good keyboard can be substituted to determine if the defect is in the keyboard of U1. Dirty key contacts can be cleaned. U1 is the *only* chip that can cause keyboard and joystick problems.

U2 is the second port chip. A defect here could cause disk drive or printer failure.

Blank white screen and garbage screen symptoms—Assuming the power supply is good, two common symptoms with Commodore 64 breakdowns are:

- 1.) Blank white screen (no video and no snow).
- 2.) Garbage screen—random characters displayed or sometimes

a screen full of C's. (Photo 2.)

When the problem is a blank screen, turn the power switch *off* and *on* about five times to determine if any random pattern is displayed on the screen. If the screen remains blank and no garbage pattern is viewed, the following troubleshooting steps are suggested, using a high-frequency oscilloscope. (Note: Most computer waveforms will look strange. Fortunately, you're only concerned with whether there are signals present. If signals are present you can feel confident the system is working at these stages.)

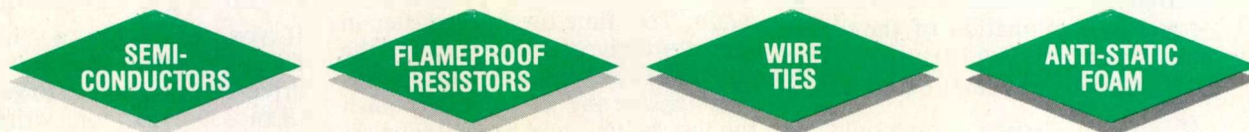
1.) Measure both clock signals on the MPU (Pins 1 and 39). If these square wave signals are missing, the cause will be the video chip U19 or its associated clock frequency generating circuits.

2.) If clock signals are present, continue to measure all the

waveforms and voltages on the MPU. With a blank screen, many of the waveforms and voltages will be abnormal or missing. *This does not mean the microprocessor is defective.* Actually, the MPU is not likely to cause this symptom, but a faulty chip is loading it down.

With a blank screen symptom, expect waveforms at address lines A8, A9 and A12 thru A15 to be missing. RDY pin 2, IRQ pin 3 and R/W pin 38 also will show no waveforms. Pin 24 reads low.

The remaining 10 address lines (A0 thru A7 and A10, A11) and all eight data lines (D0 thru D7) should display waveforms of 5V amplitude. If any data lines show lower than 5V, the RAM chip (there are eight 4164 RAMs) connected to that particular data line is shorted, draining the signal voltage. A shorted RAM also can be detected by touch: It will be hot-



ter than the other seven.

The NMI (non-maskable interrupt) pin 4 and RESET pin 40 should read HIGH. A LOW on either of these pins will disable the MPU and cause a blank screen.

A missing waveform at pin 5, AEC, indicates a faulty video chip, because U19 generates the Address Enable Control signal.

3.) If everything checks out during step 2 with the MPU, proceed to measure voltages and waveforms at U17, the Program Logic Array IC (PLA). Experience has shown the PLA to be one of the most common IC failures in the Commodore 64. The PLA is addressed by the microprocessor, and controls and selects many computer functions. The following include common PLA functions with their resulting failure:

a.) Symptom: blank screen—Pin 15 CHAROM or Pin

16 Kernal have no waveform. These outputs are used to select the Character ROM and Kernal (starter) ROM chips respectively.

b.) Symptom: flashing garbage on screen, or letters and numbers are pulsing on screen—pin 12 I/O or pin 13 GR/W read low, 1V instead of a high. These pins enable IC's U15 decoder and U16 Color ROM respectively.

c.) Symptom: blank screen only with game cartridge inserted, Pin 22 Game and Pin 23 Ex ROM read low instead of a high.

Garbage screen—When the screen is filled with random characters, technicians call this symptom "garbage display." A symptom like this means the computer is *lost*. The computer cannot execute one of the instructions in its program and began executing instructions at *random*. This process continued

until the computer filled the screen with garbage, then stopped. When one or more memory locations in a RAM fail, the computer may *garble* the lines in a program. Also, if the computer title screen displays fewer than the normal 38,911 bytes free, or "out of memory" on the screen, this is an indication of a RAM problem.

Troubleshooting garbage screen—With the garbage display, expect to find the upper four address lines on the MPU (A12 thru A15) missing. The MPU is not the cause. As previously mentioned, a 4164 RAM is at fault. It is difficult to diagnose which RAM is defective because normal voltages and waveforms will be measured. A RAM with some faulty memory locations will still output data. Substituting one chip at a time is the best procedure.

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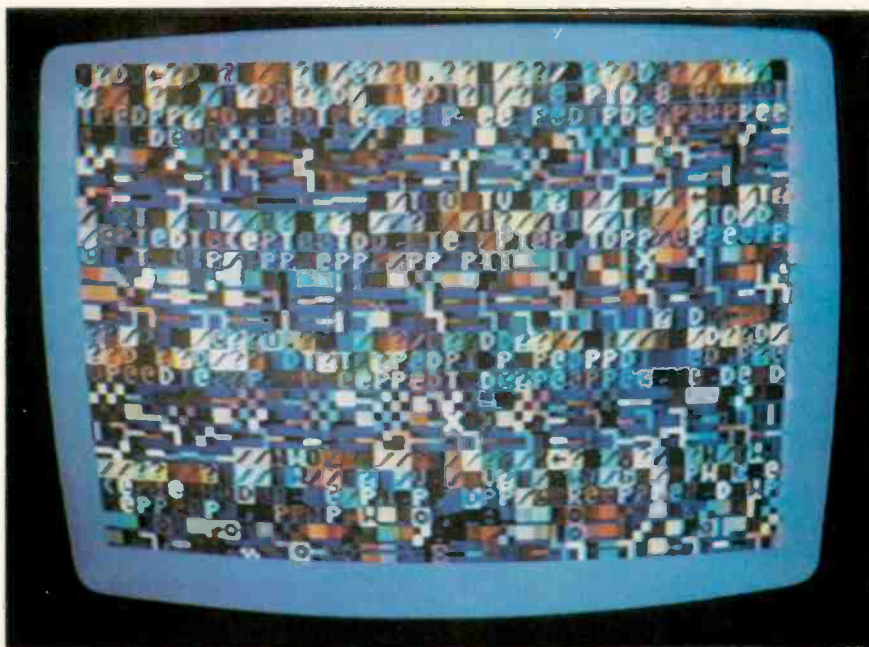
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Circle (8) on Reply Card



Some conditions will cause the screen to fill with random characters. This is sometimes referred to as a "garbage screen."

More blank screen problems

U4 is the Kernal ROM, which contains the starter program for the computer system. Failure of the Kernal ROM will cause a blank screen.

- One dilemma a technician encounters in troubleshooting a blank screen manifests when one or more address or data lines are low in amplitude (or it could be any line low), and these lines are



A number of programming errors will cause an OUT OF MEMORY ERROR message on the screen, but when you get this message at power-on you know that there's a defective RAM somewhere.

connected to many chips. You know there "is a short somewhere" draining these aforementioned lines. But where? Sometimes you get lucky and you touch a hot IC that is causing the problem. Like the 4164 RAM.

Otherwise, you have to check the schematic and locate all the chips connected to the *low lines* in question. Then, remove one IC at a time until the lines go high.

In one actual case, five of the eight data lines on MPU were low, and all the RAM ICs were cool with this blank screen symptom. The diagram showed seven chips directly connected to the MPU's data lines. When U3, the Basic ROM IC, was unsoldered, all eight data line waveforms were restored.

- A defective video IC (U19) can cause various symptoms. Because the video chip generates the clock signals for computer operation and other control signals, a loss of these signals would cause a *blank screen*. One faulty chip failed to generate the AEC signal (pin 16).

Also, the video IC addresses memory and displays the screen text and graphics. A defect here could cause irregular patterns on the screen. One faulty U19 displayed tiny checkerboard squares on the screen. All pins read correct voltages and waveforms. The only way to solve this problem was to substitute a new IC.

Symptoms and results with certain chips removed

The following information can be useful in analyzing symptoms in the Commodore 64 computer. Certain important ICs have been removed, one at a time, from the circuit board and the following symptoms and results have been recorded:

- 1.) U19, video chip
Screen blank, no clock signal or waveforms on all logic chips.
- 2.) U7, microprocessor
Screen blank, data waveforms present, some address lines present.
- 3.) U4, Kernal ROM
Screen blank, data waveforms present, some address lines present.
- 4.) U17, PLA
Screen blank, data waveforms present, some address lines present.
- 5.) U3, Basic ROM
Screen background present, but no letters or images on screen.
- 6.) U5, Character ROM
Normal screen background, but Commodore title page shows garbage for 2¼ lines—instead of normal characters (letters and numbers).
- 7.) U1, interface chip
Display normal, but no cursor
- 8.) U2, interface chip
Display normal
- 9.) U18, SID (sound chip)
Display normal
- 10.) Any one of the eight RAMs removed results in a blank screen.

Snow on screen—assuming the power supply is good, this symptom suggests little or no modulated video signal is being received at the television's antenna input.

Troubleshooting snow on screen

- 1.) Substitute another antenna switch box.
- 2.) Substitute antenna coax cable.
- 3.) Check if computer's RF modulator output jack is loose.
- 4.) Check computer's channel selector switch.

Comments

In all the Commodore repairs, we've never found a faulty 7400 series TTL chip.

A complete schematic of the Commodore 64 is available by Sams Computerfacts, folder CC4. Also, the diagram is printed in the

back of the Commodore 64 Reference Manual, *also* published by Howard W. Sams & Company.

Parts can be purchased at local authorized Commodore outlets. And, you will find that many standard devices in personal computers have equivalents that you can find in parts catalogues such

as those published by Philips ECG and RCA SK, available at your local distributor.

One mail order company selling parts is:

Electronics Warehouse Corporation

1910 Coney Island Ave.

Brooklyn, NY 11230

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Circle (9) on Reply Card

Protecting against static electricity damage

By Jess Kanarek

Service technicians have known for a long time that static electricity has been a threat to microprocessors. Those who service products using microprocessors have learned basic procedures for protecting against damage caused by electrostatic discharge (ESD).

However, through the years more functions have been compressed into small microprocessor chips. This increased efficiency has come at the cost of two tradeoffs:

1.) The built-in switches that equalize static electricity potentials have been reduced in relation to the total size of the circuit, while the speeds of the circuits have increased. As a result, the "protective" switches are no longer able to provide adequate protection.

2.) In order to access all the added functions, lead diameters and spacing between leads have been reduced. These circuits cannot handle static transients as high as before.

Leads have been reduced from 5μ of a few years ago to today's 1.5μ and less. Spacing between leads has been reduced by a factor of three or four. While in the past the ESD peril was to semiconductor "substrates," in today's devices the metallization itself is subject to damage.

The coming 1-megabit chips are

called *submicron devices* because the conductor widths will be only 0.9μ in diameter in order to provide access to all functions, with a similar reduction in spacing between leads.

These circuits will be more than five times as sensitive to static electricity damage as the devices in use today.

Minimizing ESD damage

Easy-to-use, relatively low-cost anti-static materials and products are being developed to meet the needs of this new generation of devices. If ESD damage is to be avoided, however, service technicians must upgrade their anti-static procedures. To establish a reference point to begin from, here are some basic anti-static precautions commonly used:

- Don't touch an individual lead, pin or trace while handling a static-sensitive semiconductor device. Hold the chips only by the plastic body.

- Keep static-sensitive parts in their original containers until ready for use. Bags, tubes or boxes provide anti-static protection.

- Drain static electricity from your body by touching a conductive, grounded surface such as a metal rack before handling or working on a chip.

- Do not slide static-sensitive devices over any surface.

- Practice good housekeeping in the work area. Remove all nonconductors such as cardboard boxes, paper work orders, blueprints, and cigarette and candy packages.

- Wear a smock of cotton, which generates considerably less static electricity than manmade fabrics. Gloves, if used, should also be cotton. Anti-static smocks are now available.

- Keep visitors away from static-sensitive devices, unless they are grounded.

- Have a portable conductive surface on the work surface, which is grounded. Never use carpeting.

Basic improvements are necessary on four levels to meet the static-electricity challenges of the "submicron" era.

Eliminating static electricity generated by the technician

Normal movements can generate up to 50,000V, and less than 100V can ruin some devices. A conductive wrist strap is a standard anti-static device. It drains electricity from the wrist—the last feasible point between the body and the work before it can build up to harmful levels.

One new wrist strap, which was designed to meet the needs of the submicron era, is of conductive elastic polyester fabric with an adjustable buckle to assure a snug fit even after long use. Stainless steel

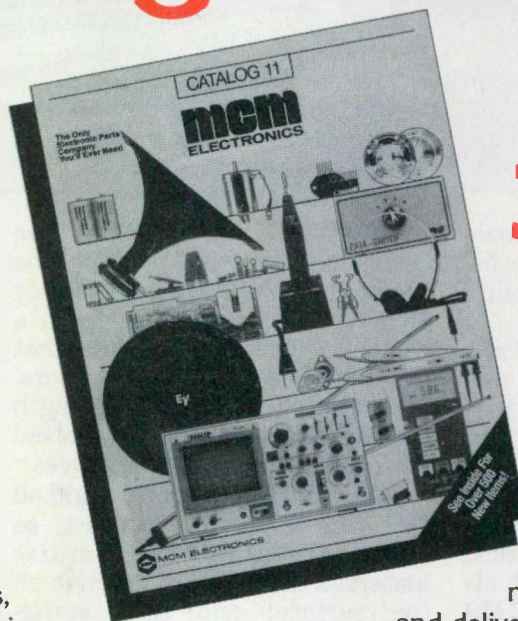
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SOURCE NO. ES&T-7



threads woven into the elastic fabric assure positive, low-resistance conductivity, corrosion resistance and cleanliness.

A 10-foot conductive cord links the wearer's wrist to a grounded surface. Any static electricity is conducted to ground before it can accumulate to harmful levels.

To meet OSHA and other requirements for safety in case the cord crosses an open electrical line, the outside of the wrist attachment is insulated and a 1M Ω resistor is molded into the cord at the wrist end.

Other personal items are static-safe smocks and conductive shoe grounders to drain static electricity generated from walking on anti-static floors.

Eliminating static electricity generated in the work area

The most common anti-static safeguard in the work area is the covering for the worker's workbench and floor. Other items include non-nuclear ionizing air guns and fans.

Since the 1970s, suppliers have been able to extrude polyethylene compounded with approximately 30% carbon granules to obtain a rigid conductive material that could be used on tables and floors. The material had great strength and abrasion resistance and solved the need for conductive surfaces.

Some manufacturers claimed that this conducted too fast, so they introduced *anti-static* materials that were conductive on the surface; and then *static-dissipative*, which dispersed the same conductive surface throughout the material, making it faster than anti-static but slower than *conductive*.

Subsequently, suppliers introduced rigid anti-static materials that could be permanently laminated onto bench and table tops. They came in decorator colors, which greatly improved the decor compared with the black conductive and blue dissipative and pink anti-static materials that proliferated, but are slower to dissipate static.

Problems began to arise when faster microcircuits were developed. First, the effectiveness of these bench tops was difficult to confirm. A test probe five pounds in weight and three inches in diameter is the standard test of surface conductivity. The devices that actually will come in contact with the surface weigh only a few milligrams. The material could pass the test and might blow out the very next microcircuit that comes into contact with it.

In addition, faster switching speeds of newer microcircuits left doubt that these materials dissipated ESD fast enough.

Surface covering materials of the future must have these characteristics:

- Conductive throughout, rather than on the surface. This eliminates degradation of anti-static performance from abrasions, and shortens the path to the grounded tabletop for faster ESD decay.
- Non-sloughing, for use in clean rooms.

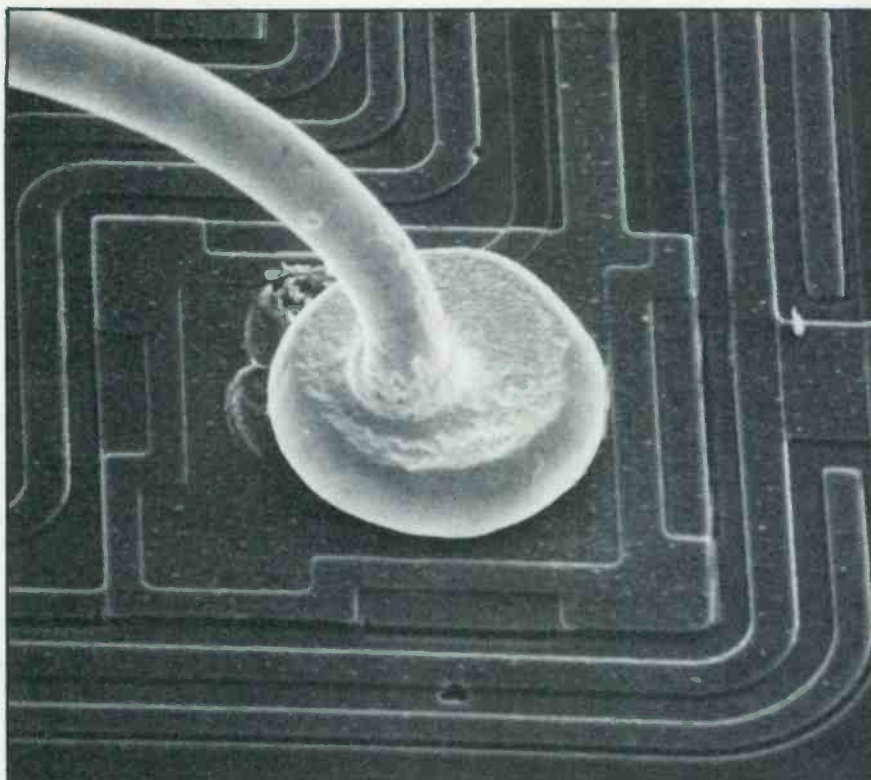


Photo courtesy Jet Propulsion Laboratory.

This scanning electron microscope photo illustrates ESD damage to the metallization of a metal-oxide semiconductor field-effect transistor (MOSFET). Please note the places where damage occurred. The objects in this photo that look like bent nails are actually gold lead wires with a diameter of one mil (by contrast, a typical human hair is 3 mils in diameter). The photo was originally shot at 200x magnification.

- Testable with standard ohm-meters.
- Cannot be punctured by hot soldering irons. This rules out the 3-layer and homogeneous soft mats introduced in the early 1980s.
- Fireproof.
- Lay flat on the surface without curling.
- Resistance in the range from 500,000Ω to 10MΩ per square, which is the optimum range needed by users.
- Retain their anti-static qualities for long periods without deteriorating.

Non-nuclear *deionizers*, which generate alternate flows of positively and negatively charged ions to keep them in balance, can reduce the static electricity buildup in all work areas.

Protection while returning serviced items

Clearly, a tote tray sliding across the bed of a pickup truck when it goes around corners will generate enough static electricity to undo careful shop work. In fact, friction of conveyor rollers or dollies in the shop can ruin microprocessors in electronic subassemblies.

Static-safe shipping boxes and trays are now available. Some service shops have plans to encourage return of these containers, which cost much more than ordinary corrugated boxes, and others write them off as the cost of assuring that the product is returned safely without static electricity damage.

Anti-static cushioning also is available to protect products from shock when they are traveling in static-safe containers, and to protect against static electricity damage when they are not. The most common packaging material is coated polyurethane foam made conductive by formulating carbon granules or other conductive additives to the plastic. The material is soft enough to be cut by scissors.

Knowing the static electricity potential

Both the shop and the sensitivity of devices in the products being serviced have static-electricity potential of which you must be aware. Static-electricity meters are much more economical and easier to use than they were a few



Photo courtesy Jet Propulsion Laboratory.

At 5,000 times magnification, the character of the damage can be observed. Some of the aluminum metallization has melted and can be seen along the bottom edge of the hole.

Table 1. Sample series

Positive +	Air Human Hands Asbestos Rabbit Fur Glass Mica Human Hair Nylon Wool Fur Lead Silk Aluminum Paper Cotton Steel Wood Amber Sealing Wax Hard Rubber Nickel, Copper Brass, Silver Gold, Platinum Sulfur Acetate Rayon Polyester Celluloid Orlon Polyurethane Polyethylene Polypropylene PVC (Vinyl) KEL F Silicon Teflon
Negative -	

Table 1. This is a sample triboelectric series. The term "triboelectric" describes the tendency of a material to acquire a static charge when brought in contact with and then separated from a different kind of material. (The root of the word, "tribo-" comes from the Latin, to rub.) The farther apart any two materials are on the table, the greater the static voltage generated.

years ago. You can quantify the static-electricity potential of every operation and location—work station, storage shelves, service counter and shipping area—by isolating them from ground one at a time.

You should balance this information with the static sensitivity of the chips being used. The Department of Defense has classified devices in three ranges of sensitivity and an appropriate grade of conductivity for each class. The most sensitive devices, such as MOS without protective circuitry, have a sensitivity range of 0V to 1,000V. These require conductive materials. Surface resistivity is $10^5\Omega$ ps or less. Static decay rate is 5,000V to 0V in 200ns or less.

Class 2 devices have a sensitivity range of 1,000V to 4,000V, such as MOS devices with protective circuitry. Static-dissipative materials can be used for protection. These have a surface resistivity of $10^6\Omega$ ps to $10^9\Omega$ ps.

Class 3 products, such as resistor chips, have a sensitivity of 4,000V to 15,000V. Anti-static products, which have resistive values of 10^9 to 10^{12} , are suitable for these devices.

However, there is another problem with anti-static products, which generally come in pink. Since the conductivity is on the

Table 2

Object or Process	Material or Activity
Work surfaces	<ul style="list-style-type: none"> Waxed, painted or varnished surfaces Common vinyl or plastics
Floors	<ul style="list-style-type: none"> Sealed concrete Waxed, finished wood Common vinyl tile or sheeting
Clothes	<ul style="list-style-type: none"> Common clean room smocks Common synthetic personnel garments Virgin cotton Non-conductive shoes
Chairs	<ul style="list-style-type: none"> Finished wood Vinyl Fiberglass
Packaging and Handling	<ul style="list-style-type: none"> Common plastic-bags, wraps, envelopes Common bubble pack, foam Common plastic trays, plastic tote boxes, vials, parts bins
Assembly, Cleaning, Test and Repair Areas	<ul style="list-style-type: none"> Spray cleaners Common plastic solder suckers Solder irons with undergrounded tips Solvent brushes (synthetic bristles) Cleaning or drying fluid or evaporation Cryogenic sprays Heat guns and blowers Sand blasting Electrostatic copiers Temperature chambers

Table 2. These materials are considered to be typical prime sources of static electricity.

¹Virgin cotton can be a static source at low relative humidities such as below 30%.

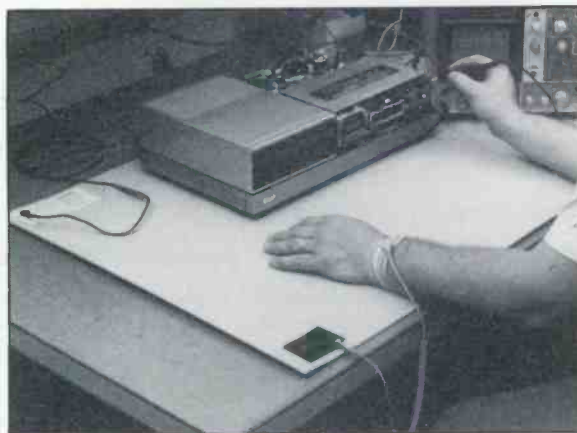
Be Sure... with RCA's Antistatic Kit.

Protect static sensitive devices from costly damage.

Electrostatic charges build up all around the work environment, posing a constant threat to static sensitive devices.

RCA's Antistatic Kit (Stock No. 162351) protects these devices from the damaging effects of static buildup. The kit consists of a static dissipative mat, a lightweight wrist strap and coil cord, and a six-foot grounding cable that safely drains electrostatic charges to ground.

No matter what kind of static sensitive



devices you test, repair, or work with, you need RCA's Antistatic Kit working for you. See your RCA Parts Distributor; or for more information write RCA Distributor and Special Products Division, 2000 Clements Bridge Road, Deptford, NJ 08096-2088. Attention: Sales Promotion Services.

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Table 3		
Means of Static Generation	Electrostatic Voltages	
	10 to 20 Percent Relative Humidity	65 to 90 Percent Relative Humidity
Walking across carpet	35,000	1,500
Walking over vinyl floor	12,000	250
Worker at bench	6,000	100
Vinyl envelopes for work instructions	7,000	600
Common poly bag picked up from bench	20,000	1,200
Work chair padded with polyurethane foam	18,000	1,500

Table 3. Everyday activities are capable of generating high static electric voltages. The higher the relative humidity, the lower the voltage generated. This is why static charge is so annoying in winter when the air is dry.

surface of the soft plastic material, it can be rubbed off in areas large enough to generate static charges that can ruin the chip which the material is meant to protect. Also, it has a short shelf life.

The sensitivity level of devices is available from the manufacturers. In addition, the level of conductivity selected by the chip manufacturer for shipping is generally a guide to the sensitivity of the contents: black indicates the addition of carbon, making it most conductive; blue generally indicates it is static-dissipative and pink, or anti-static, is least protective, because it offers less Faraday shielding.

See page 28 for Table 4.

Jess J. Kanarek is considered a pioneer and technical leader in controlling static electricity. In 1967, he recognized the problems that static electricity was causing to semiconductors being designed in Silicon Valley. Accordingly, he developed a conductive foam by saturating and thermosetting polyurethane with a paint made conductive by the addition of carbon filaments. This was the basis for the first static-safe shipping and storage containers. From this, he has expanded into development and production of anti-static, personal-use items, and is president of Wescorp, Mountain View, CA.

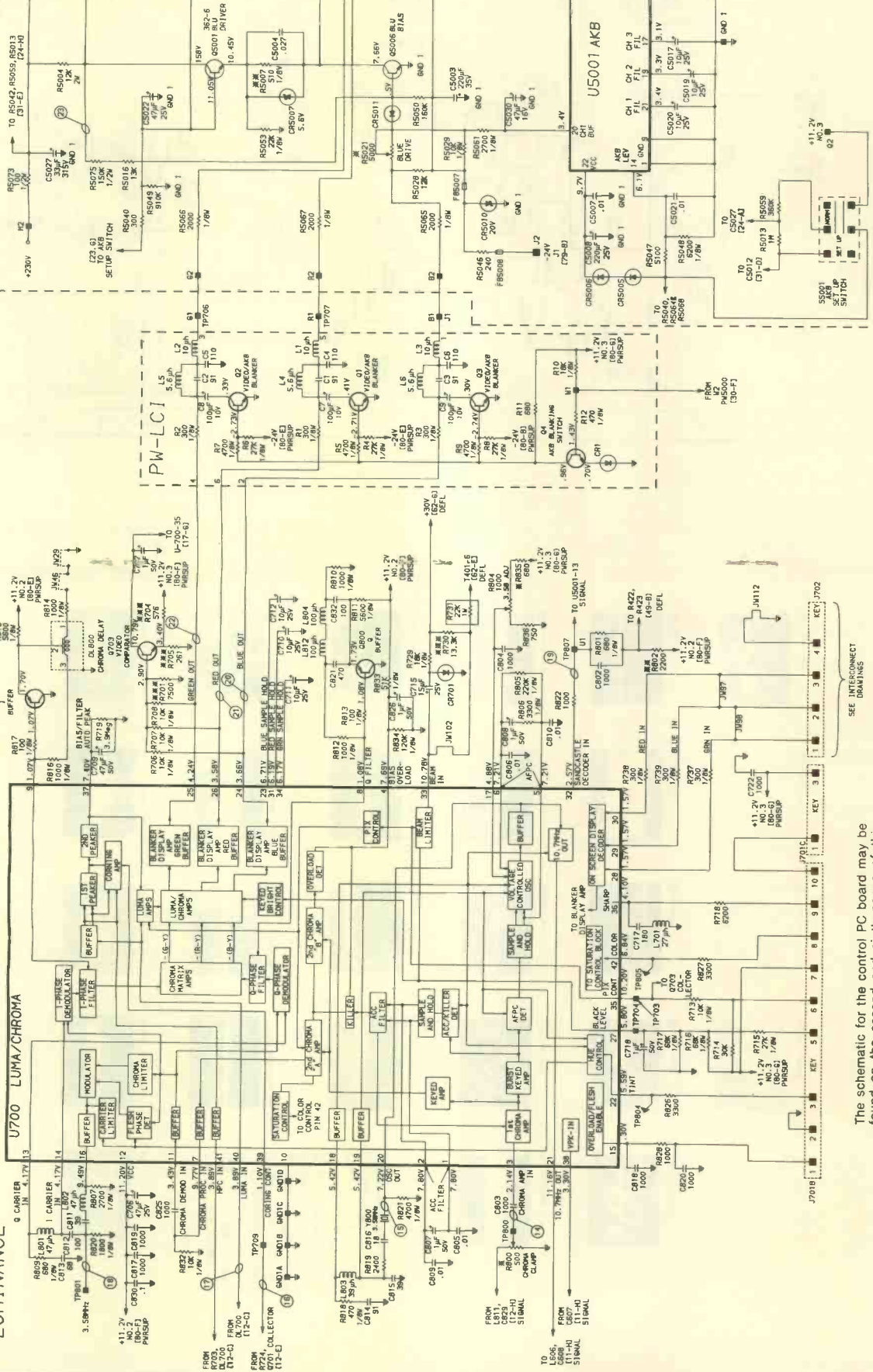
In 1976, Kanarek won the annual "Materials Handling Leadership Award" from the Society of Packaging and Handling Engineers for "exceptional leadership" and "innovations for practical utilization of advances in electronic technology."

Table 4

CLASS 1: SENSITIVITY RANGE 0 TO $\leq 1,000$ VOLTS	
•	Metal Oxide Semiconductor (MOS) devices including C, D, N, P, V and other MOS technology without protective circuitry, or protective circuitry having Class 1 sensitivity
•	Surface Acoustic Wave (SAW) devices
•	Operational Amplifiers (OP AMP) with unprotected MOS capacitors
•	Junction Field Effect Transistors (JFETs) (Ref.: Similarity to MIL-STD-701: Junction field effect, transistors and junction field effect transistors, dual unitized)
•	Silicon Controlled Rectifiers (SCRs) with $I_o < 0.175$ amperes at 100° Celsius ($^\circ\text{C}$) ambient temperature (Ref.: Similarity to MIL-STD-701: Thyristors (silicon controlled rectifiers))
•	Precision Voltage Regulator Microcircuits: Line or Load Voltage Regulation < 0.5 percent
•	Microwave and Ultra-High Frequency Semiconductors and Microcircuits: Frequency > 1 gigahertz
•	Thin Film Resistors (Type RN) with tolerance of ≤ 0.1 percent; power > 0.05 watt
•	Thin Film Resistors (Type RN) with tolerance of > 0.1 percent; power ≤ 0.05 watt
•	Large Scale Integrated (LSI) Microcircuits including microprocessors and memories without protective circuitry, or protective circuitry having Class 1 sensitivity (Note: LSI devices usually have two to three layers of circuitry with metallization crossovers and small geometry active elements)
•	Hybrids utilizing Class 1 parts
CLASS 2: SENSITIVITY RANGE $> 1,000$ TO $\leq 4,000$ VOLTS	
•	MOS devices or devices containing MOS constituents including C, D, N, P, V, or other MOS technology with protective circuitry having Class 2 sensitivity
•	Schottky diodes (Ref.: Similarity to MIL-STD-701; Silicon switching diodes (listed in order of increasing trr))
•	Precision Resistor Networks (Type RZ)
•	High Speed Emitter Coupled Logic (ECL) Microcircuits with propagation delay ≤ 1 nanosecond
•	Transistor-Transistor Logic (TTL) Microcircuits (Schottky, low power, high speed, and standard)
•	Operational Amplifiers (OP AMP) with MOS capacitors with protective circuitry having Class 2 sensitivity
•	LSI with input protection having Class 2 sensitivity
•	Hybrids utilizing Class 2 parts
CLASS 3: SENSITIVITY RANGE $> 4,000$ TO $\leq 15,000$ VOLTS	
•	Lower Power Chopper Resistors (Ref.: Similarity to MIL-STD-701: Silicon Low Power Chopper Transistors)
•	Resistor Chips
•	Small Signal Diodes with power ≤ 1 watt excluding Zeners (Ref.: Similarity to MIL-STD-701: Silicon Switching Diodes (listed in order of increasing trr))
•	General Purpose Silicon Rectifier Diodes and Fast Recovery Diodes (Ref.: Similarity to MIL-STD-701: Silicon Axial Lead Power Rectifiers, Silicon Powder Diodes (listed in order of maximum dc output current), Fast Recovery Diodes (listed in order of trr))
•	Low Power Silicon Transistors with power ≤ 5 watts at 25°C (Ref.: Similarity to MIL-STD-701: Silicon Switching Diodes (listed in order of increasing trr), Thyristors (bi-directional triodes), Silicon PNP Low-Power Transistors ($P_c \leq 5$ watts @ $T_A = 25^\circ\text{C}$), Silicon RF Transistors))
•	All other Microcircuits not included in Class 1 or Class 2
•	Piezoelectric Crystals
•	Hybrids utilizing Class 3 parts

Table 4. The Department of Defense classifies electronic components in terms of their susceptibility to ESD damage. Many components will be destroyed if they sustain a discharge of 1,000V or less. The least sensitive components in this table, Class 3, will be damaged if they are exposed to ESD potentials of 15,000V or less. If you compare this chart with Table 3, it immediately will become clear why precautions are recommended.

LUMINANCE



The schematic for the control PC board may be found on the second and sixth pages of this month's Profax.

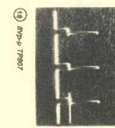
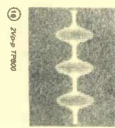
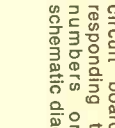
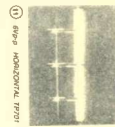
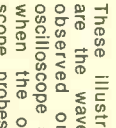
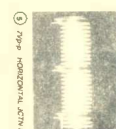
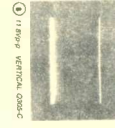
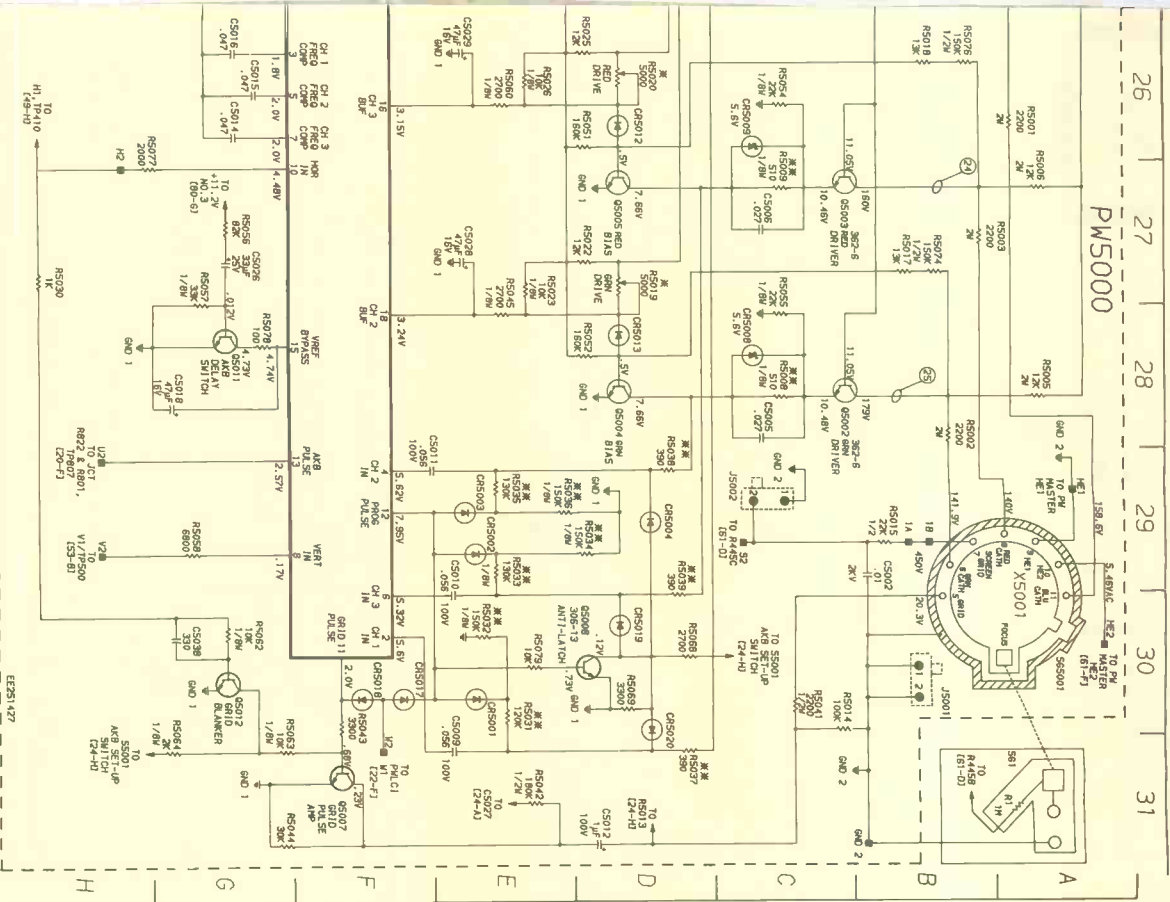
Product safety should be considered when substituting parts in the chassis of a receiver. The shaded areas of the schematic diagram designate the components in which safety is of special significance. It is recommended that only experienced technicians use this schematic for replacement of these components.

Use of substitute replacement parts that do not have the same safety characteristics as the original parts may create shock, fire, excessive radiation or other hazards.

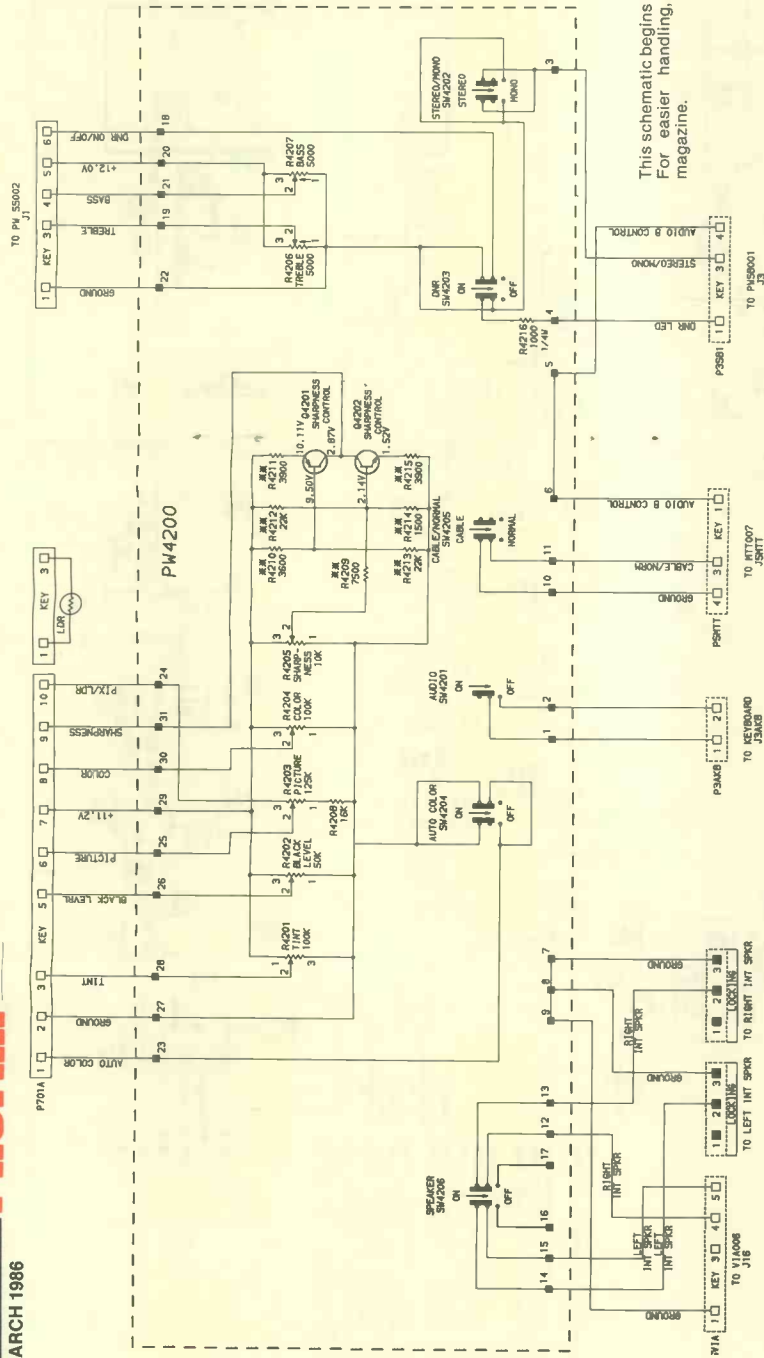
This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

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

PW5000



These illustrations are the waveforms observed on the oscilloscope screen when the oscilloscope probes were connected to the test points on the signal circuit board corresponding to the numbers on the schematic diagram.



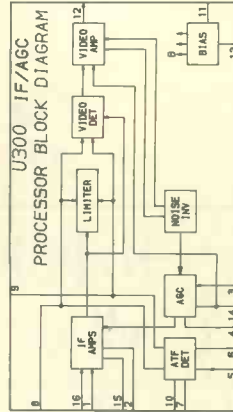
Control PC board

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

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

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

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



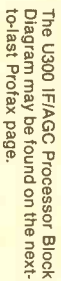
This schematic begins on the second Profax page. For easier handling, pull these pages from magazine.

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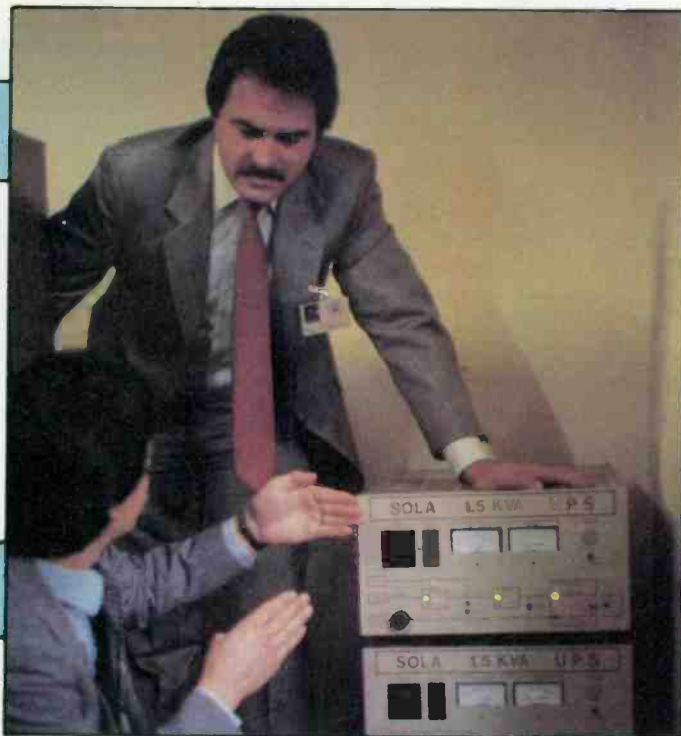
The other portions of this schematic may be found on other Profax pages.



ES&T
Manufacturers' schematics

PROFAX

RCA	Schematic No.
CTC 133 Color TV	2081



These two 1.6kVA uninterruptible power systems (UPS) with battery packs provide power conditioning when ac power is present and, because they always are on-line, continue to supply no-break power.

Power protection for equipment electronic

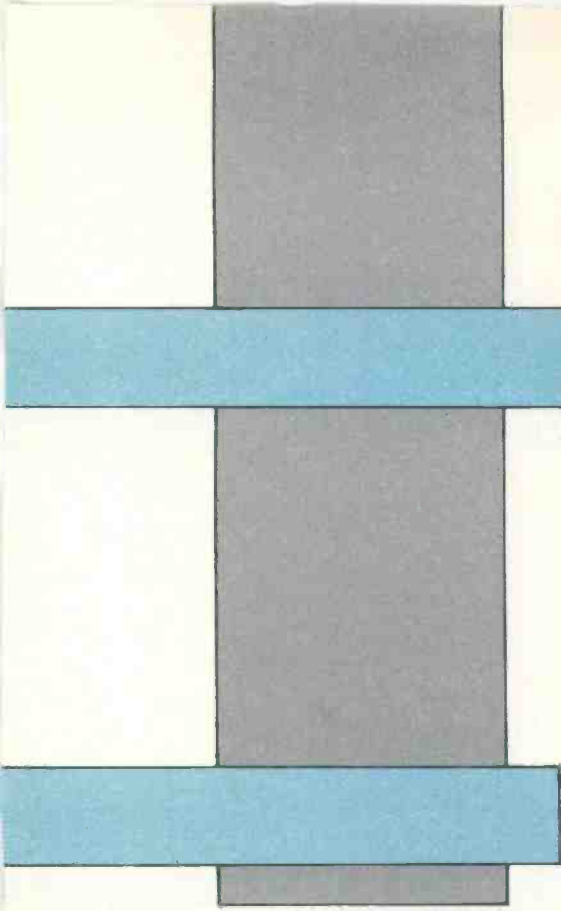
By Gary Mager

As the use of sensitive micro-processor-based electronics such as small home and business computers, word processors, data storage systems and digitally controlled audio systems continues to proliferate, there are likely to be more and more complaints that the hardware or software does not work properly. In many cases, there is an easily overlooked and sometimes less costly alternative to major examination and repairs.

Because clean ac power is becoming a rarity in some areas, voltage irregularities may cause sensitive electronics to malfunction or components to deteriorate gradually. These power line fluctuations may actually be the cause of the complaint, rather than the hardware or software. Installation of power protection equipment can solve the problem of irregular voltage and reduce the number of service calls.



Standby power sources (SPS) provide clean, regulated ac power to critical loads when ac power fails or drops 15% below nominal. SPS units are available with outputs from 1,200VA down to 300VA.



Complicating the situation is the fact that power fluctuations which caused the problem where the equipment is used may not be present at the service center. Because of this a piece of equipment might be repaired at the shop and then returned to its workplace only to prove defective again. The result is wasted time and money, and frustration at the equipment's failure to operate correctly.

Similarly, the shop itself might experience power problems that could affect the accuracy of diagnostic test procedures. Power protection equipment at the service center can safeguard against power problems, improving test accuracy and minimizing the amount of time spent on the job.

To combat the wide variety of ac power disruptions, an assortment of power protection equipment is available. Each of these devices promises to provide *clean* power, but choosing among the alternatives is not always easy. It is important to remember when comparing different types of power protection equipment that some designs provide more protection than others. Generally, the higher degree of protection they offer, the more money they cost.

A basic understanding of the nature of common ac power-line ir-

regularities is important when selecting power protection equipment. This information, combined with a look at the kinds of power protection devices available and the applications for which they are designed (discussed later in the article), can aid in diagnosing the cause of system failure or complete shutdown and implement corrective action.

Common ac power problems

Electrical noise—Probably the most common ac-line problem affecting microprocessor-based systems is electrical noise. This is high-voltage, high-frequency interference on the power line. There are two basic types of noise: *common-mode* (interference between hot line and ground) and *transverse-mode* (interference between hot line and neutral). Noise generally results either from radio frequency interference (RFI), electromagnetic interference (EMI) or both of these.

Sources of RFI can include radio, TV and microwave transmission, radar, arc welding, even distant lightning. Common EMI producers include heaters, coffee makers, air conditioners, copiers, electric pencil sharpeners, electric typewriters and other thermostat-controlled or motor-operated devices. In fact, it is difficult to find an electrical system that does not produce some type of noise. Noise at a very high frequency can cause erratic operation of sensitive electronics as well as component deterioration and catastrophic failure.

Voltage transients—Line transients (ranging from momentary spikes or faults, to longer surges or dips) occur routinely on power lines whenever electrical equipment is turned on or off. Any motor-driven or electrically heated device will generate a brief voltage

fault on start-up and a corresponding surge in voltage on shutdown. The magnitude of duration of these transients will vary.

However, transient spikes can cause voltage to exceed normal levels by 10 times or more. Lightning strikes can place extremely powerful spikes on the line, capable of burning up electronic hardware. Spikes also can wipe out stored data and alter data in progress. Such transients can occur as many as 10,000 times a year on an incoming ac power line.

Brownouts—Brownouts are temporary reductions in voltage of 5% to 15% that occur when demand on the utility system exceeds the utility's ability to supply power. Voluntarily created by utilities in times of extra energy demand or short supply, brownouts are necessary to enable utilities to maintain service. However, since most electronic equipment is designed with only a $\pm 10\%$ tolerance to voltage variations, even a moderate brownout will bring line voltage dangerously close to system tolerance level, allowing other power problems to have an even greater effect. Also, during brownouts, motors run hotter and slower, which can affect motorized parts of electronic systems.

Blackouts—A total power outage, whether due to downed power lines, tripped circuit breakers or other causes, probably needs no explanation. Fifty percent of all blackouts are corrected within six seconds or less. But this is more than enough time to affect sensitive electronics. When power is lost, computers can experience a complete loss of memory. If power is allowed to surge back automatically, it can severely stress hardware components. At the least, computer users are inconvenienced by shutdowns, which inter-

rupt normal operations in mid-stream, forcing re-entry of data and/or rerunning of programs.

Alternatives in power protectors

When selecting power protection equipment, it is wise first to determine the nature of the power problems that will be encountered. Power line monitors are available through local electrical or electronics distributors to help diagnose power disturbances at existing or potential electronics installation sites. Often, these devices can be temporarily rented and installed.

Not only can a power line monitor pinpoint power problems, it also can note the time, date, cause and suggested solution.

Types of protection devices

Once you've determined which of the previously discussed types of power problems prevail at the intended location, you're ready to consider the types of power protection devices available:

Surge suppressor—This device clips high-voltage transients, but does not regulate voltage to limit surges and sags, or attenuate noise. It only provides protection

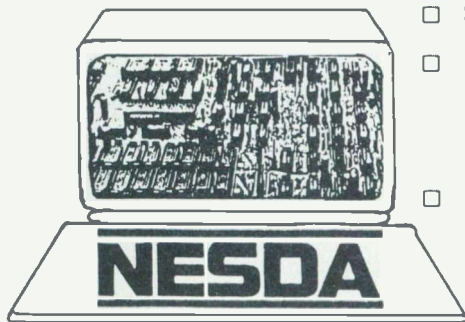
against the transients it is designed to clip.

Passive filter—A passive filter is an economical, easily installed device. Rarely used by itself in critical electronics installations, the action of the passive filter is limited to noise attenuation over a certain band of frequencies to which the filter is tuned. It does not regulate voltage or clip transients.

Ultra-isolation transformer—This device is a simple transformer with added electrical insulation and electrostatic shielding between its windings. Its function is

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to protect against line-to-ground leakage, one form of which is common-mode noise. It is not a true line conditioner since it offers no line voltage regulation to protect against sags and surges, and has little transverse-mode noise attenuation.

Electronic tap changer—The electronic tap changer essentially is a transformer with multiple taps on the secondary side. Electronic control circuitry senses fluctuations in input voltage and responds by firing Triacs to switch transformer taps and adjust output voltage. With a tap changer, line voltage regulation is not smooth and continuous, but in steps ranging from $\pm 3\%$ to $\pm 7\%$.

Tap changers offer good operating efficiencies (in excess of 90%) and provide good common-mode noise attenuation up to 120dB. However, due to the switching process inherent in the design, they are considered less reliable and more susceptible to

failure. They provide little transverse-mode noise suppression and no protection from line frequency variation.

Constant voltage transformer—The constant voltage transformer is a ferroresonant device that comes closer to being a true line conditioner in that it furnishes tight line voltage regulation ($\pm 0.50\%$) with a fair amount of noise attenuation. It inherently limits current, to protect itself and its electrical service from overloads and short circuits. It performs its voltage regulation automatically, with no need for sensing circuitry. Output voltage adjustment is done instantaneously, continuously and steplessly. Because of its built-in storage capacitors, it also can maintain full, regulated output through severe faults ranging up to three milliseconds of total line loss.

Line conditioner—Sometimes called a micro/minicomputer regulator, this basically is a constant

voltage transformer modified to provide the extra high noise rejection required by microprocessor-based equipment. Available either in portable plug-in or hard-wired form, line conditioners offer state-of-the-art noise rejection levels of 60dB for transverse-mode noise and up to 120dB for common-mode noise. Regulation is somewhat relaxed, but still holds output voltage within $\pm 3\%$ of nominal levels during line voltage swings as wide as 15%.

Even in severe brownouts, with voltage drops to as low as 65% of rated voltage, the micro/minicomputer regulator still holds output to within $\pm 5\%$ of nominal. This is within the tolerance range of most types of electronic equipment. The unit does not provide frequency regulation, but does offer the protection of holding harmonic distortion at its output to less than 3%.

Backup power systems—If protection is needed against blackout (total power failure), a battery-

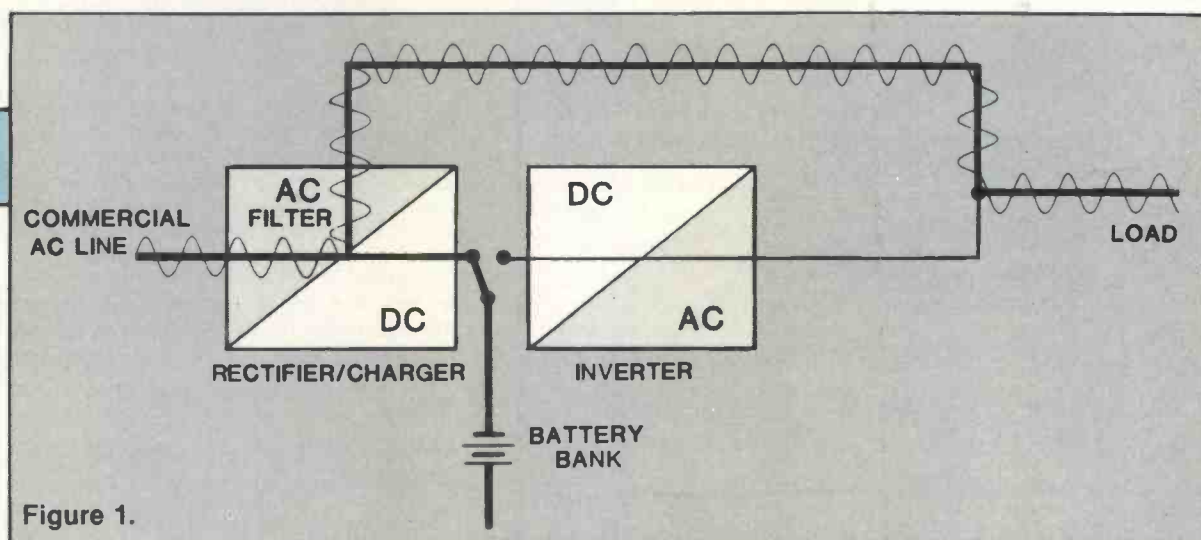


Figure 1.

Figure 1. In a standby power system (SPS) commercial ac line power input is split into two circuits. One passes through an ac filter and becomes ac output to the load. The other drives a rectifier/charger that supplies dc to maintain battery charge.

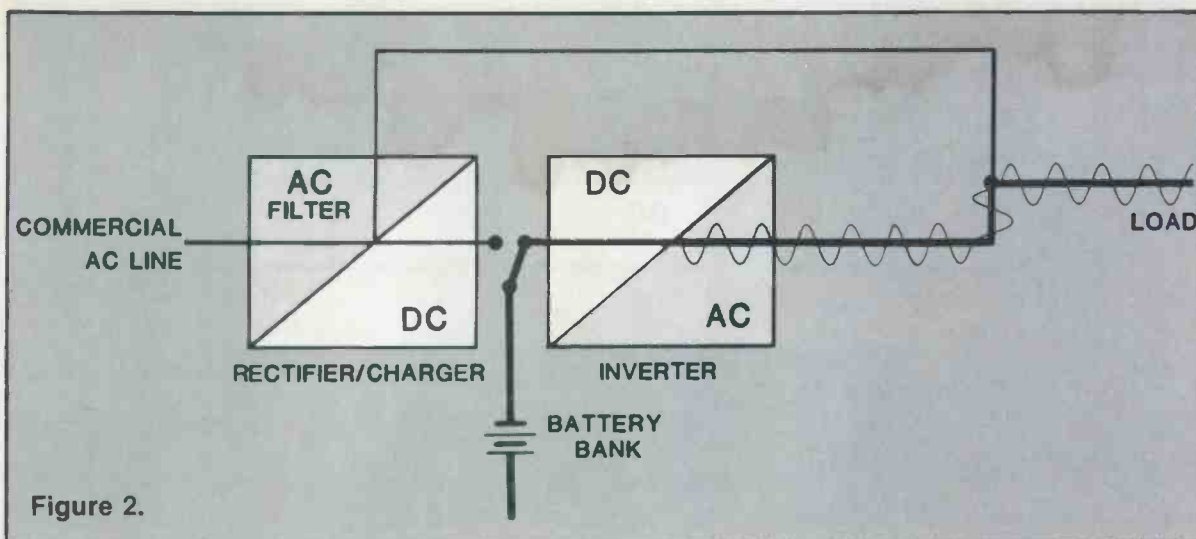


Figure 2.


Figure 2. If the commercial ac line power falls or droops more than 15%, an electronic transfer switch in the SPS automatically shifts the load onto battery-powered inverter output, typically within 4ms to 10ms. When line power returns to within 10% of nominal, retransfer to commercial ac typically occurs within 2ms to 4ms.

supported backup power system is the only answer. But that answer offers two alternatives: the standby power source (SPS) and the uninterruptible power system (UPS).

Both SPS and UPS designs con-

tain an inverter that converts the battery's dc voltage into ac output. Note, however, that the SPS is an off-line system. Its battery is kept in a charged condition by the ac line, but battery power is not switched into service unless a

power failure occurs. This switching time may or may not be fast enough to be tolerated by the microprocessor, so the performance specs of both the SPS and the system it's supposed to protect should be carefully compared.



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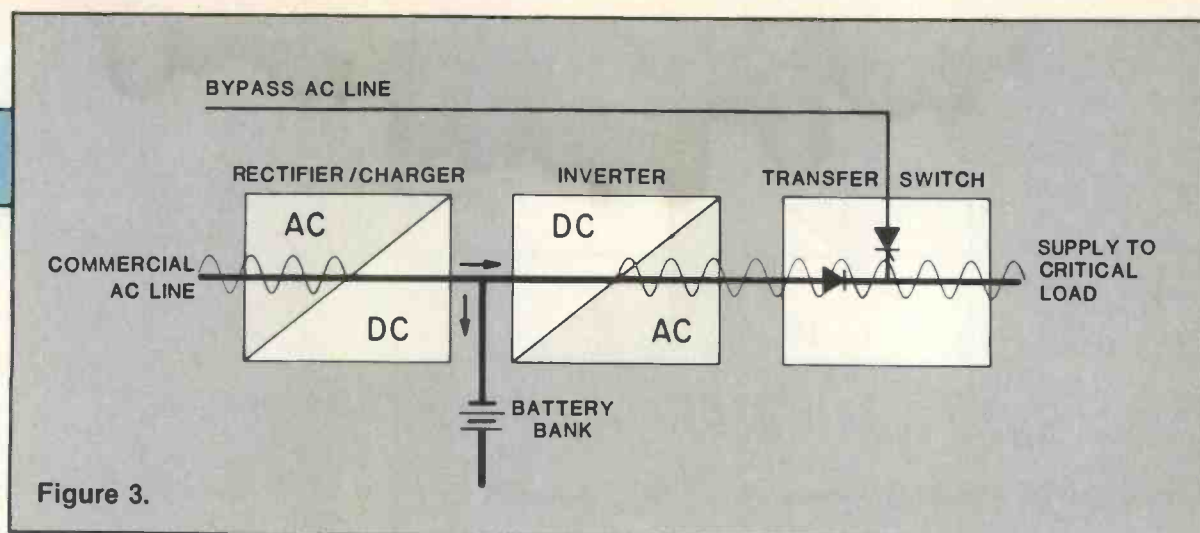


Figure 3. Under normal conditions, the commercial ac line delivers power to the rectifier/battery charger (ac to dc conversion) section of the UPS. The rectifier/battery charger will deliver dc power to the battery bank, to ensure a fully charged (float) condition, as well as to the inverter (dc to ac conversion) section of the UPS. The ac output of the inverter, via a constant voltage transformer (CVT), is connected through the automatic transfer switch to the critical load.

If the SPS switching time is not fast enough to satisfy the electronic equipment's tolerance, and true *no-break* uninterrupted power is required, an on-line UPS is mandatory. In this system, the commercial ac powers a rectifier-charger, which not only keeps the batteries charged but also drives the inverter that supplies output to the load. Whenever any drop in the ac line voltage causes the rectifier-charger output to decrease, the batteries automatically compensate. With battery power always on line, UPS output continues and the load sees no break in power.

The UPS generally is considered the ultimate in power protection because it does much more than

provide backup power in event of an outage. During normal conditions, when commercial ac power is present, the UPS remains on line, serving as a power conditioner to protect the load from noise, transients, voltage fluctuations and brownouts.

The SPS, as an off-line device, will cost less than a UPS but will not provide continuous power conditioning.

It should be obvious from this summary that a wide variety of power protection solutions exists to cure the commercial ac power problems most disruptive to sensitive electronics. Selecting, purchasing and utilizing protective equipment is a matter of degree;

units are available to provide a range of functions from simple filtering to total protection. The actual selection of power protection equipment depends as much on the importance of the electronic system as on the user's budget. If the electronic system is performing a critical function, then the cost of providing maximum protection with an on-line UPS should be weighed against the expenses incurred if the system is completely shut down or damaged by power problems.

In cases where a backup power supply is not required but broad-range line conditioning is imperative, the micro/minicomputer regulator is recommended for pro-

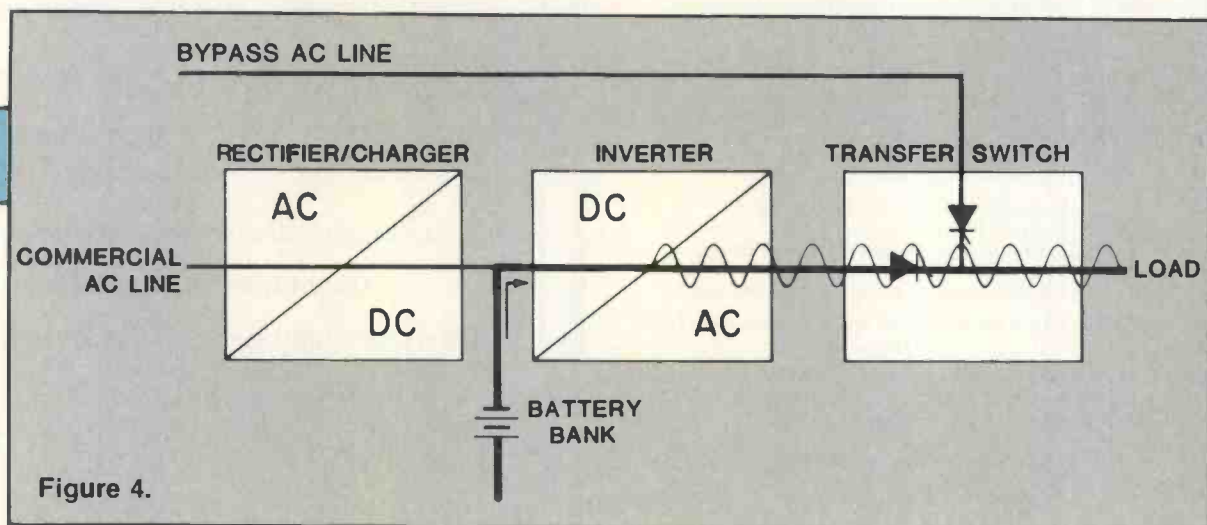


Figure 4. If the ac line falls or droops more than 20% below normal, dc power will continue to be supplied to the inverter section by the battery bank. Since the dc voltage of the battery bank is always present, there is no time delay involved in the transition. The ac output to the critical load is therefore uninterrupted and unaffected by the commercial ac line variation or failure.

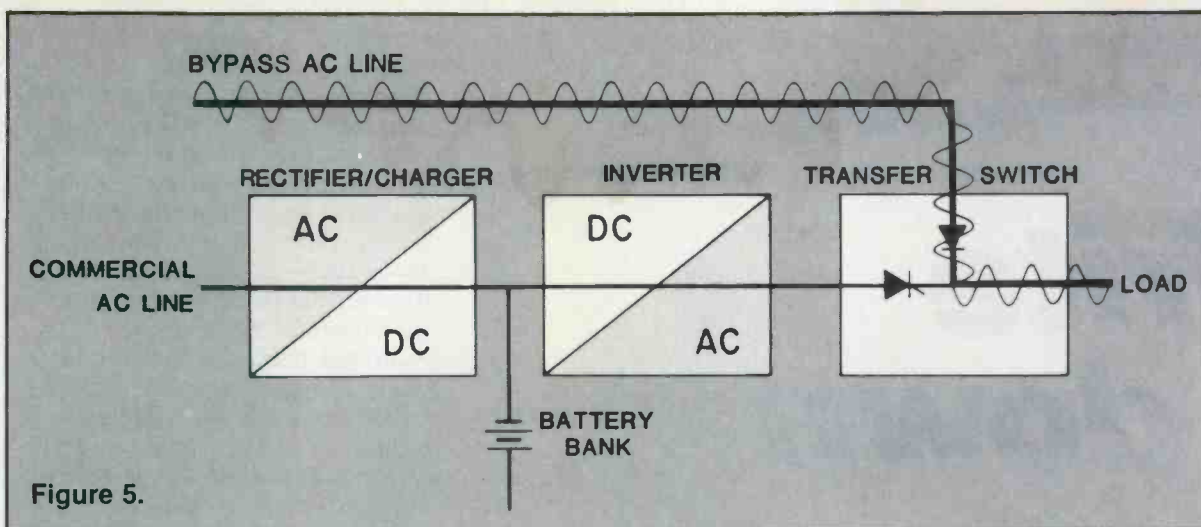


Figure 5.

Figure 5. If the system is overloaded or malfunctions during availability of the commercial ac line, an automatic transfer switch will bypass the UPS and connect directly to the commercial ac source. An automatic transfer is prevented if the bypass line is not acceptable (voltage, frequency and synchronization) or available. Upon restoration of acceptable inverter output, the transfer switch will return the load to the UPS.

viding both regulation and isolation. This combination of protective functions is designed specifically for digital electronics where noise and transients cause errors, or low voltage and short-term disruptions can result in loss

of memory or damaged components.

In all its forms, power protection equipment is becoming essential to service today's electronic equipment. These devices help assure smooth operation of sophisticated

electronics and eliminate costly power-related disturbances. Properly selected, they are indeed a worthwhile investment. **ES&T**

Gary Mager is line conditioning product manager for Sola, a unit of General Signal, Elk Grove, Village, IL.



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Efficient Troubleshooting

Write it down

By Bud Izen, CET/CSM

Have you ever started to troubleshoot a piece of electronic equipment, checking a voltage here, a resistor value there, then been interrupted? And have you discovered when you return that you have forgotten which components you've checked and what readings you got? It happens to everyone, and it's easy to do.

There's a way, though, to make sure that this doesn't happen. To make sure that the precious time you spend taking measurements isn't wasted, *write it down*.

The key to this process is to develop the ability to do the work and then write down what was done without losing concentration. The ability to do this is a *skill* that is distinct from either the ability to do the work or the ability to write it down. For maximum servicing efficiency coupled with minimum errors, both must be accomplished at the same time.

The best place to learn how to do this is in school. Even so, it's not too late for you to apply something to your job that was originally developed for use as a training aid. Many years ago, the Standard Diagnosis Sheet was developed by the EIA for use as part of its Service Technician Development Program. In the two training programs I have run, I have extensively modified this form and use it to good effect teaching students how to be more efficient troubleshooters. I have developed several of these forms, one for B&W sets and one for each major type of color set. I'm working now on similar forms for color cameras, videodisc players and VCRs. See accompanying examples.

If you start to use this or some similar form correctly, it will help you to do several tasks well. First, it is a tremendous aid in the development of logical troubleshooting. Also, it will help you focus on the actual symptoms that product is exhibiting. It allows you to describe what you have done in the process of making a repair. Most important, it allows you to improve your concentration so that you can maintain your troubleshooting ability while writing down what you do as *you do it*. This has a side benefit: If you write it down, you need not clutter up your mind trying to remember what you did, but instead can give your entire concentration to what you must do next.

If you take the time to do it, you will be more than glad you adopted this method. For one thing, if you perform a test or take a measurement and write down the results, you will never accidentally and unnecessarily repeat the same action. This will save a lot of time and aggravation. Then, too, if you get stuck on something, all it takes is a few minutes for someone else to see what you have done, and possibly make further suggestions as to what to do next. Finally, if for some reason you cannot finish the repair, by having written down everything you have done, it makes it easier for you to pick it up later, or for someone else to take up where you left off, rather than having to start all over.

Also, as I mentioned before, if you write it down, you need not remember it. This statement is not as obvious as it may seem. Concentration is what troubleshooting is

all about. If you are trying to recall the results of a test or measurement you performed, or else trying to remember whether you even made the test or took the measurement, you cannot possibly concentrate 100% on the problem itself. This means you are more likely to make mental mistakes.

Mental mistakes lead to inefficiency, aggravation and ultimately to confusion. Such a situation is avoidable. The best troubleshooters are able to focus 100% of their attention on the problem at hand and are not easily distracted. Invariably, these people are always writing things down. Don't just take my word for it; try it, and see if it doesn't help.

One of the biggest advantages of writing down everything is that if you are interrupted for any reason, you can look at your notes and go right back to where you were without having to remember anything at all. This alone will improve your efficiency.

When I operated my own service shop, I used the blank side of our service agreement form for writing these things down. This proved to be successful. One shop owner thought the Standard Diagnosis Sheet was such a good idea that he had it copied onto the technician's copy of the service invoice that accompanied the product on its trip through the shop. This, he said, did much to accomplish exactly the things I have indicated above.

Here's one way to use the sheet effectively. If you start by filling in all the blanks at the top, then it will be clear which product is being diagnosed, who was doing the work, and when the work was started and completed. Then, the symptom can be described by making the appropriate notations in the raster, picture, color and sound blocks. After close examination of the symptoms, the (relevant) user and technician controls should be turned, and their effects on the symptoms noted on the sheet. After that, it should be easier to tell which blocks of the receiver are most likely to blame as the source of the symptoms. These *likely blocks* should be circled on the block diagram.

Next, in the first large block

labeled Tests and Measurements Performed, you should write down the conclusive tests you made and the results. If the block does not have enough room, continue on the back of the sheet. When you are finished with that, the source of the problem should be localized to a particular functional block. In

the next block, write down all the tests, measurements performed, and results as you troubleshoot within the defective block until the circuit and finally the defective component causing the symptoms has been localized. In the space below the block diagram, you can put what you did to remedy the

problem, or can indicate what parts need to be ordered, and where they should be installed when received. This eliminates your having to remember all those details.

Examples of these diagnosis sheets are provided in the following illustrations.

BLACK AND WHITE TELEVISION STANDARD DIAGNOSIS SHEET

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Technician _____

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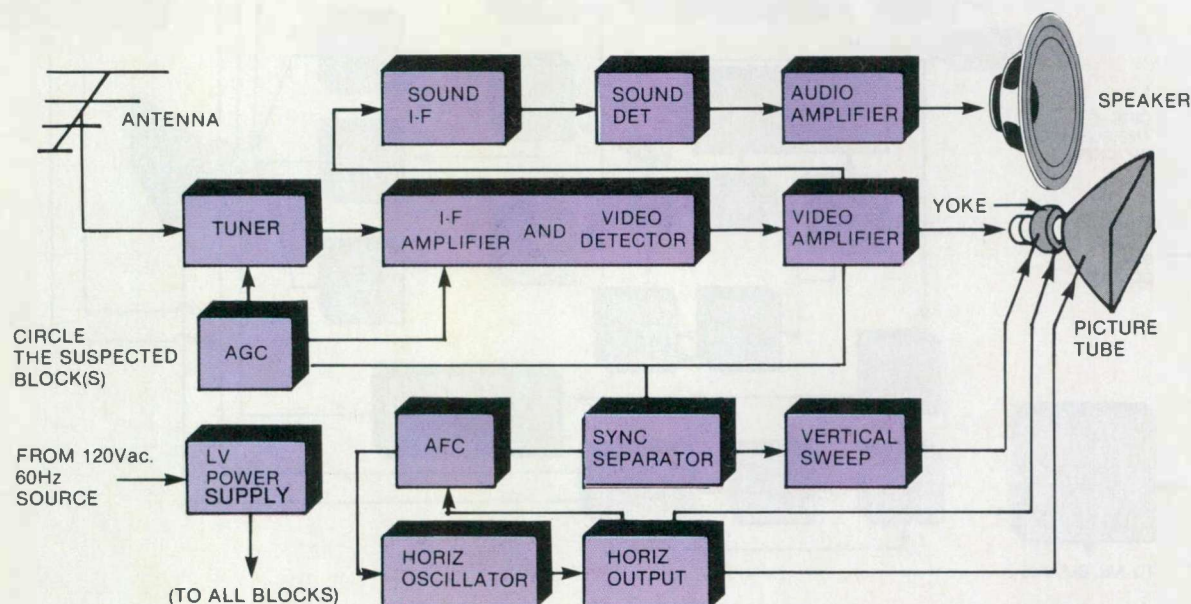
OBSERVED SYMPTOMS

RASTER	PICTURE	COLOR	SOUND
Normal _____	Normal _____	Normal _____	Normal _____
Other: _____	Can't tell due to lack of raster _____	Other: _____	Other: _____
	Other: _____		

Indicate suspected functional block(s) on diagram, based upon above symptom(s) and effect of controls.

Tests/Measurements performed:

If problem can be isolated further, list all tests/measurements performed, results and conclusions:



Further action suggested or performed to remedy the problem:

Main B+ spec. _____ meas. _____
HV spec. _____ meas. _____

Ac leakage test results: _____
Set returned to proper operation: _____

X-Z SYSTEM COLOR TELEVISION DIAGNOSIS SHEET

Brand/model _____

Technician _____

Date _____

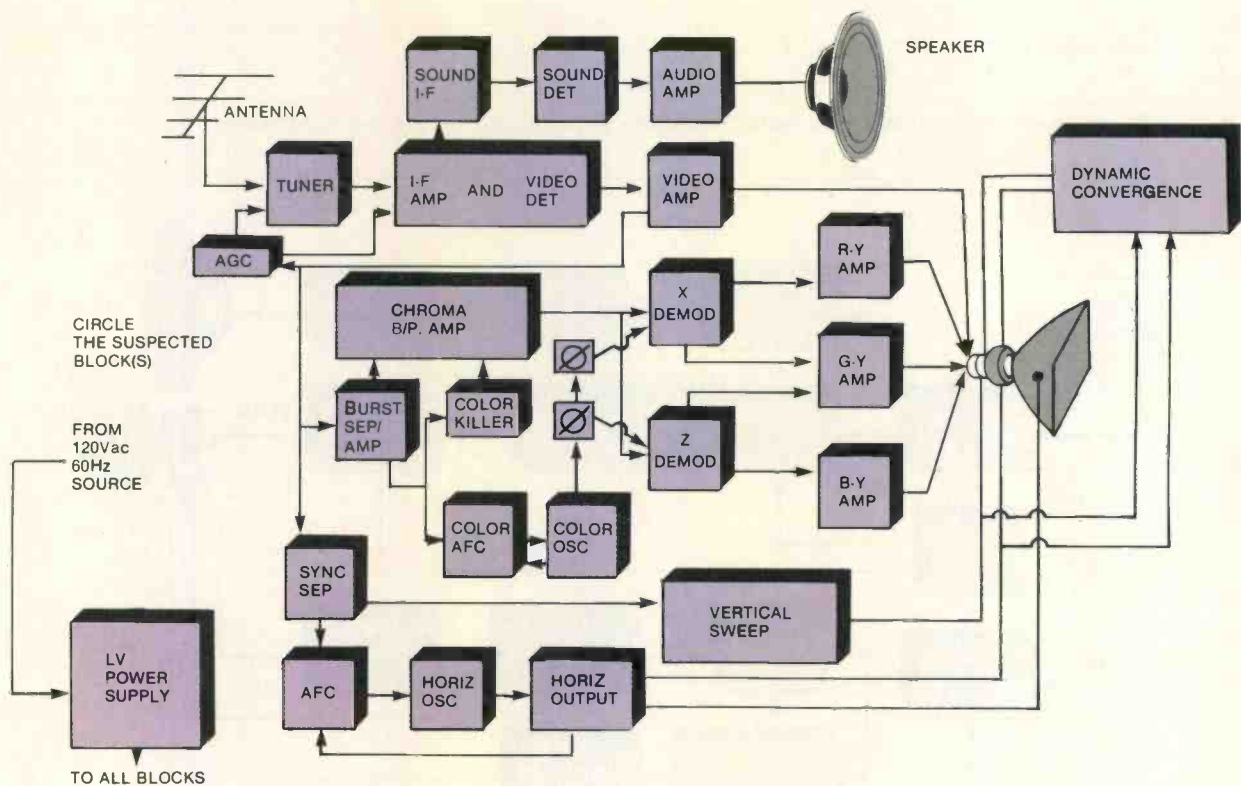
OBSERVED SYMPTOMS

RASTER	PICTURE	COLOR	SOUND
Normal _____	Normal _____	Normal _____	Normal _____
Other: _____	Can't tell due to lack of raster _____	Other: _____	Other: _____
	Other: _____		

Indicate suspected functional block(s) on diagram, based upon above symptom(s) and effect of controls.

Tests/Measurements performed:

If problem can be isolated further, list all tests/measurements performed, results and conclusions:



Further action suggested or performed to remedy the problem:

Date _____

SOUND

Normal _____

Other:

If problem can be isolated further, list all tests/measurements performed, results and conclusions:



GENERAL R-G-B COLOR TELEVISION DIAGNOSIS SHEET

Brand/model _____

Technician _____

Date _____

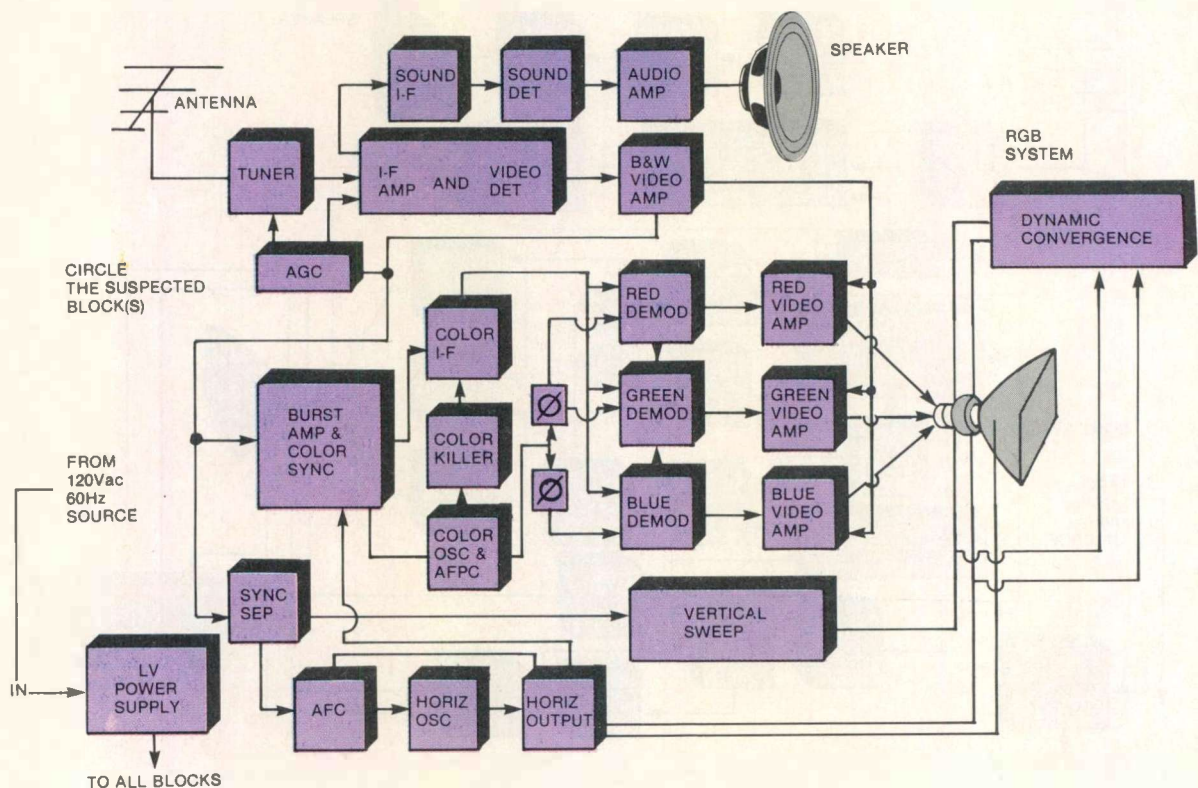
OBSERVED SYMPTOMS

RASTER	PICTURE	COLOR	SOUND
Normal _____	Normal _____	Normal _____	Normal _____
Other: _____	Can't tell due to lack of raster _____ Other: _____	Other: _____	Other: _____

Indicate suspected functional block(s) on diagram, based upon above symptom(s) and effect of controls.

Tests/Measurements performed:

If problem can be isolated further, list all tests/measurements performed, results and conclusions:



Further action suggested or performed to remedy the problem:

CRYSTAL RINGING SYSTEM COLOR TELEVISION DIAGNOSIS SHEET

Brand/model _____

Technician _____

Date _____

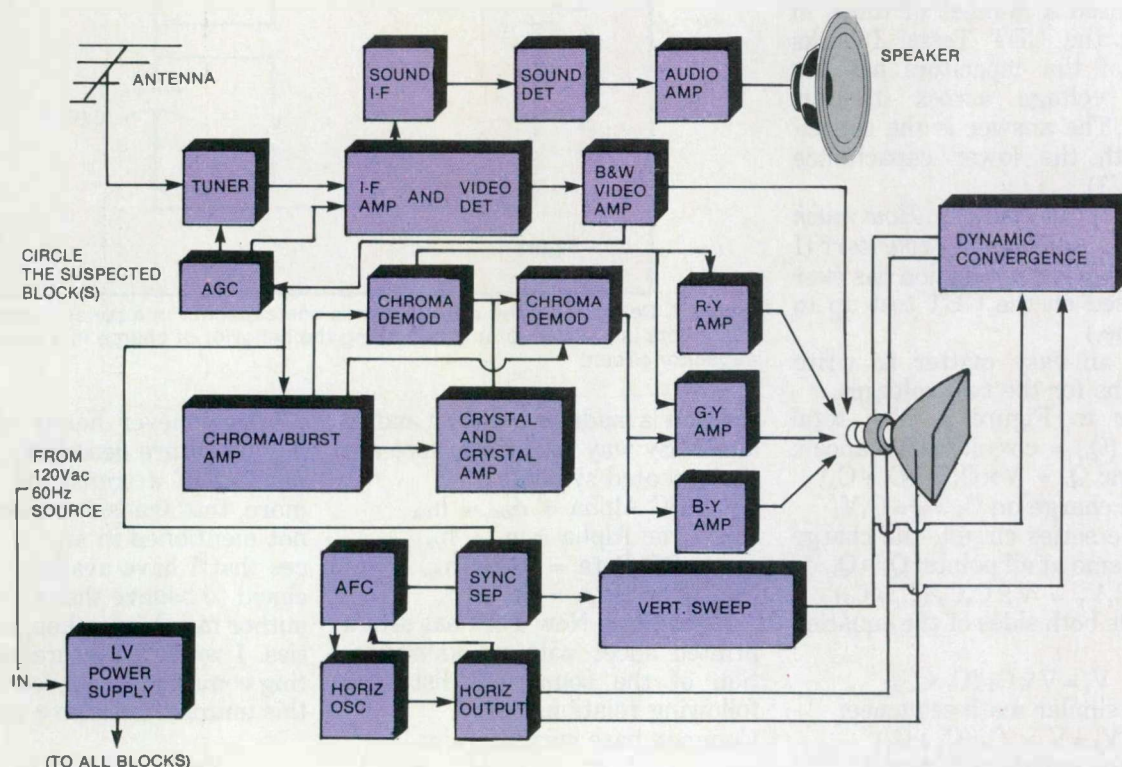
OBSERVED SYMPTOMS

RASTER	PICTURE	COLOR	SOUND
Normal _____	Normal _____	Normal _____	Normal _____
Other: _____	Can't tell due to lack of raster _____	Other: _____	Other: _____
	Other: _____		

Indicate suspected functional block(s) on diagram, based upon above symptom(s) and effect of controls.

Tests/Measurements performed:

If problem can be isolated further, list all tests/measurements performed, results and conclusions:



Further action suggested or performed to remedy the problem:

What do you know about electronics?

Capacitors and triggers

By Sam Wilson

Figure 1 illustrates a question that I used a number of times in writing the CET Tests. It asks which of the capacitors has the higher voltage across its terminals. The answer is the capacitor with the lower capacitance value (C_1).

The next question is: *How much voltage is across each capacitor?* (I don't believe this question has ever been used on the CET test up to this time.)

It is an easy matter to write equations for the two voltages.

Refer to Figure 1. The total charge (Q_t) = circuit capacitance \times voltage: $Q_t = V \times C_1 C_2 / (C_1 + C_2)$

The charge on $C_1 = Q = C_1 V_1$

In the series circuit, the charge is the same at all points: $Q_1 = Q_t$, or

$$C_1 V_1 = V \times C_1 C_2 / (C_1 + C_2)$$

Divide both sides of the equation by C_1 :

$$V_1 = V \times C_2 / (C_1 + C_2)$$

By a similar math sequence:

$$V_2 = V \times C_1 / (C_1 + C_2)$$

For the circuit of Figure 1:

$$V_1 = 100 \times 0.05 / (0.01 + 0.05) = 83.33V$$

$$V_2 = 100 \times 0.01 / (0.01 + 0.05) = 16.66V$$

Alpha, Beta, ... and Gamma?

I also used test questions about the alpha and beta of transistors. They may be designated by h (hybrid) parameter symbols. A distinction is made between ac and dc

alpha. By way of review, here are the accepted symbols:

$$\text{DC Alpha} = \alpha_{DC} = h_{FB}$$

$$\text{ac Alpha} = \alpha_{ac} = h_{fb}$$

$$\text{DC Beta} = \beta_{DC} = h_{FE}$$

$$\text{ac Beta} = \beta_{ac} = h_{fe}$$

A reader in New York has sent a printed sheet with no identification of the source. It lists the following relationships:

Common base current gain:

$$\alpha = \frac{\beta}{1 + \beta} = \frac{\gamma - 1}{\gamma}$$

Common emitter current gain:

$$\frac{1}{1 - \alpha} = \gamma - 1$$

Common collector current gain:

$$\frac{1 + \beta}{1 - \alpha} = 1$$

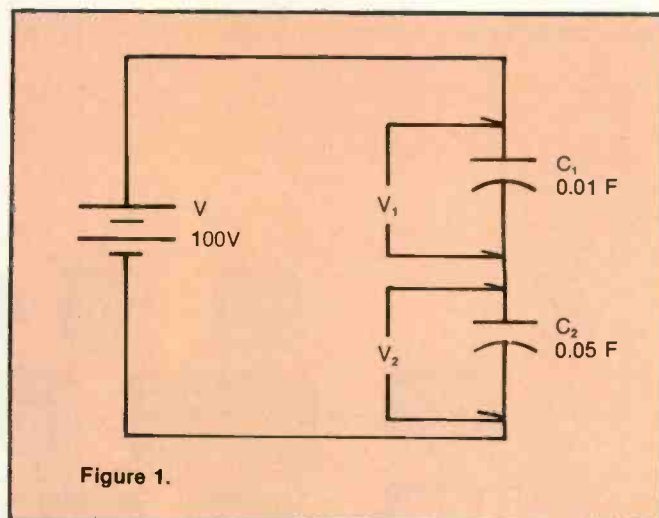


Figure 1.

Figure 1. Determining the voltage across one capacitor in a series combination of capacitors is a matter of understanding the behavior of charge in a series capacitor circuit.

I have never heard of or seen any literature describing the *gamma* (\sim) of a transistor. Furthermore, that transistor parameter is not mentioned in any of the sources that I have available. I am inclined to believe that an ambitious author may have taken a few liberties. I would be interested in getting comments from readers about this unusual transistor parameter.

Some comments on Schmitt Triggers

The name Schmitt Trigger usually brings to mind two important characteristics of that circuit: They switch very rapidly and they have a switching hysteresis.

Figure 2 shows a basic circuit for representing the Schmitt Trigger. There are many other versions, but this one is easy to understand.

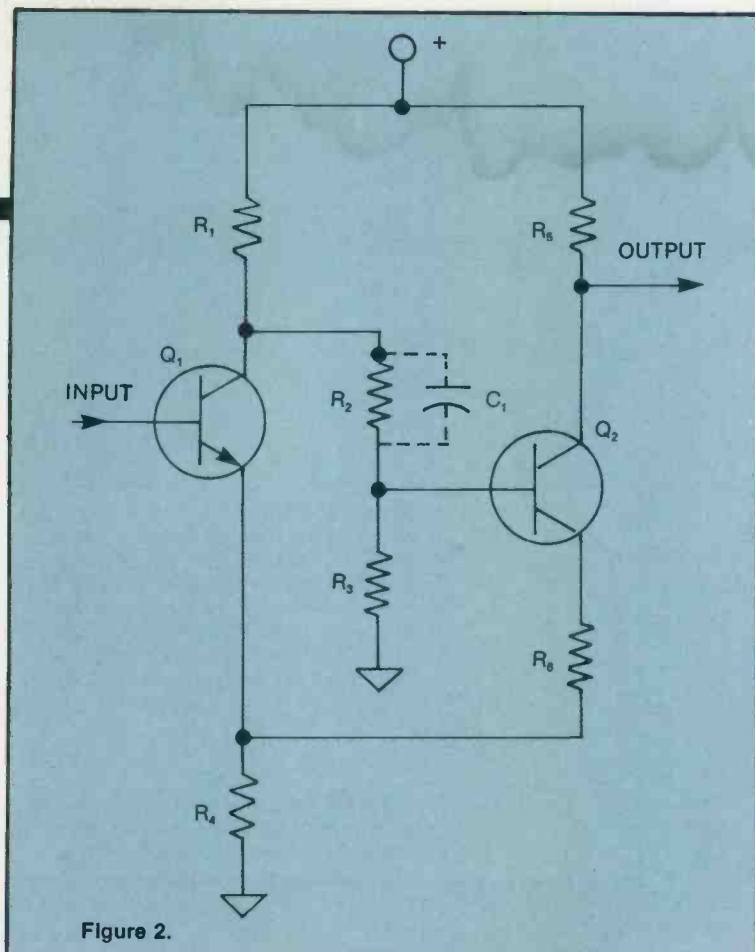


Figure 2.

Figure 2. A Schmitt Trigger switches very rapidly between its two possible states. Hysteresis makes this a stable circuit.

There is a common emitter resistor (R_4) for the two transistors. This is a bistable circuit, so one transistor is conducting and the other is shut off. For example, if Q_1 is conducting at saturation, the drop across R_4 will be high enough to assure that the emitter of Q_2 is more positive than its base. So, Q_2 is cut off.

Likewise, if Q_2 is conducting at saturation, the drop across R_4 will assure that Q_1 is cut off.

Note that Q_2 is biased with a voltage divider that is connected between the collector of Q_1 and common. Capacitor C_1 is called a *speedup capacitor*. It assures that a change in voltage on the collector of Q_1 will be rapidly transferred to the base of Q_2 .

In the initial condition, transistor Q_2 is saturated and Q_1 is cut off. Because there is no collector current flowing through R_1 , the voltage divider for supplying bias to Q_2 (R_2 and R_3) has the full supply voltage applied at the junction of R_1 and R_2 .

A positive voltage supplied to the base of Q_1 will start it into conduction. The resulting drop across R_1 quickly lowers the bias at Q_2 . That transistor goes out of saturation. At the same time, Q_1 goes into saturation.

The lower base voltage on Q_2 and the high voltage at its emitter holds that transistor at cutoff. This condition will remain until a negative pulse at the base of Q_1 brings it out of saturation. Now the more positive voltage on the base of Q_2 drives it into saturation and Q_1 is quickly cut off.

Hysteresis

Figure 3 shows the relationship between the input and output signals for a typical Schmitt Trigger. Whenever the input signal rises above voltage A, the output goes positive; and, when the input signal level is below voltage B, the output voltage is about 0V.

The fact that the triggering points are at two different levels accounts for the *hysteresis* of the

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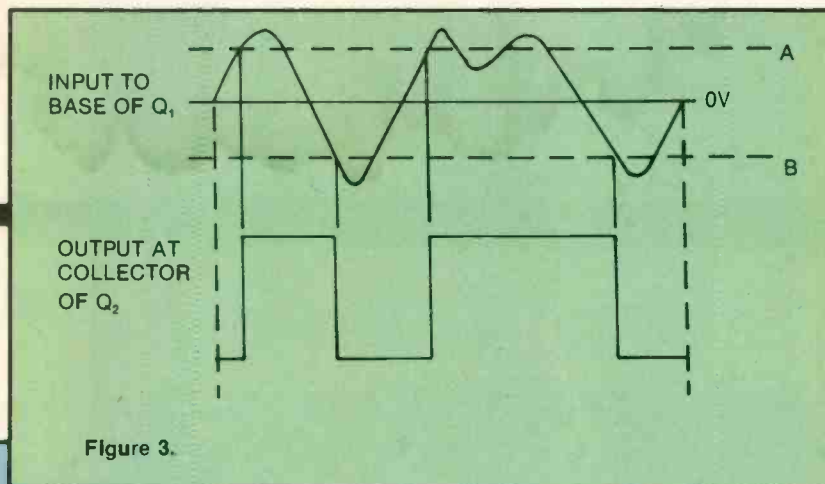


Figure 3.

Figure 3. The characteristic operation of a Schmitt Trigger is such that an increase in the input voltage above a threshold voltage causes it to switch states, resulting in an abrupt rise in its output voltage. When the input drops below a lower threshold voltage, the circuit output drops abruptly to its original value.

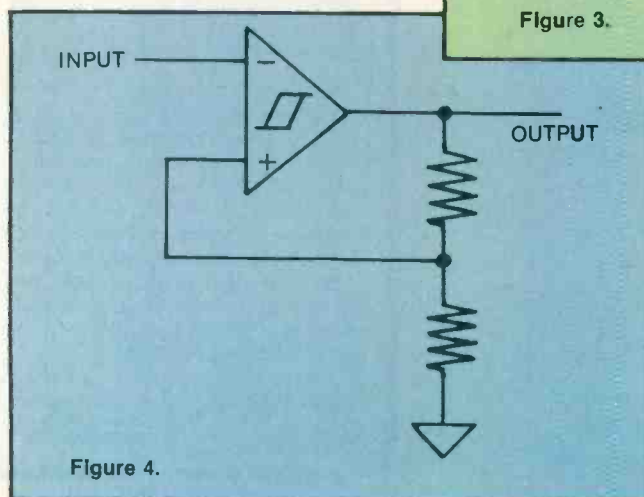


Figure 4.

Figure 4. Another version of the Schmitt Trigger.

circuit. This is an important feature of the Schmitt Trigger. If the *on* and *off* points occurred at the same voltage, the circuit would be very unstable at that point. Also, as the circuit components aged, the operation would change completely.

The output waveform has a very steep rise time, so it is ideal for triggering. That is why this multivibrator circuit is called a Schmitt trigger.

Figures 4 and 5 show other versions of the Schmitt Trigger.

Obtaining the hysteresis curve

The hysteresis curve in the symbol of the Schmitt Trigger shows that it switches *on* and *off* at two different points. It can be obtained on an oscilloscope as a lissajous pattern. Figure 6 shows the test setup.

The sine wave generator delivers a signal to the Schmitt Trigger and to the external sweep input of the scope. The scope must be switched to external sweep operation.

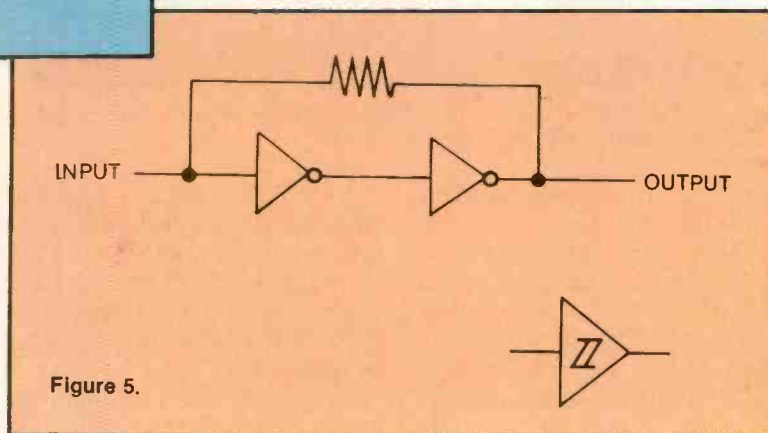


Figure 5.

The output of the Schmitt Trigger goes to the vertical input terminals. So, the lissajous pattern compares the trigger output with a sine wave sweep.

Figure 6 shows the scope display for the first half-cycle of sweep. During this half-cycle, the sweep input signal moves the scope beam from left to right on the screen. The solid line on the sweep input signal shows the voltage delivered to the scope during this period.

During the same time period, the Schmitt Trigger switches from low to high. The dotted sine wave shows the input to the vertical amplifier of the scope. The solid line shows the voltage that the

trigger delivers to the scope during the first half cycle of sweep.

On the next half cycle, the input to the sweep input moves the beam from the right side of the scope to the left side. See Figure 7. Now the Schmitt Trigger switches from its high to low voltage. The screen display shows only the right-to-left part of the display. If you compare this display with the one in Figure 6, you will note that switching occurs at two different places on the screen.

Figure 8 shows the two halves of the display to be a hysteresis curve. Knowing how this curve is obtained makes it easier to understand its meaning.

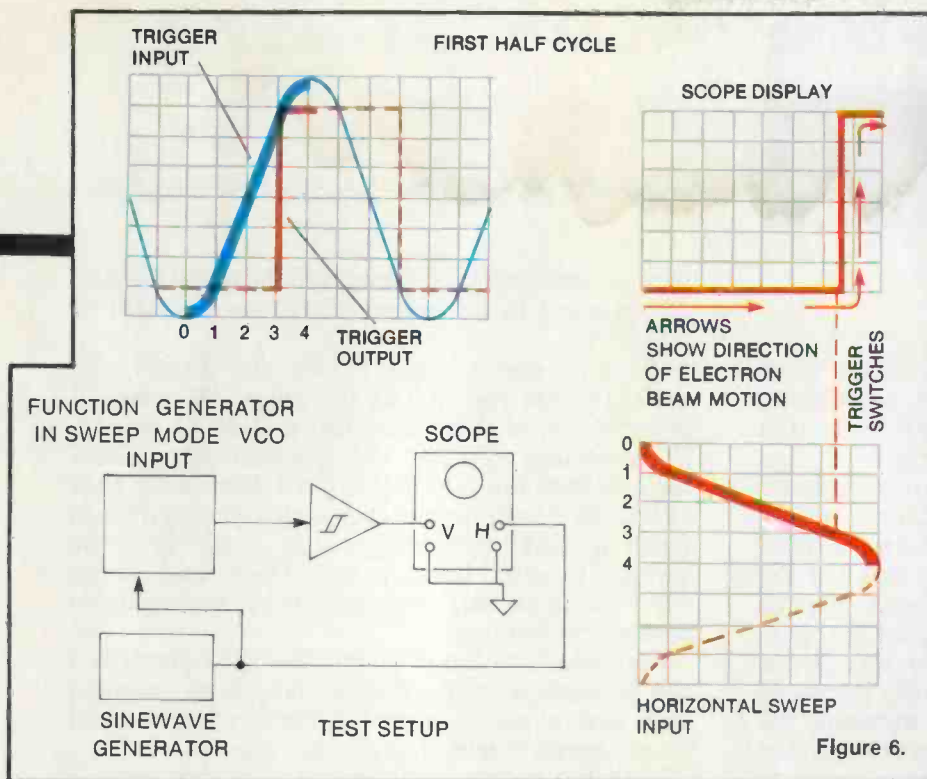


Figure 6. The hysteresis, characteristic of the Schmitt Trigger, may be examined with the use of an oscilloscope, as shown here (see text for details).

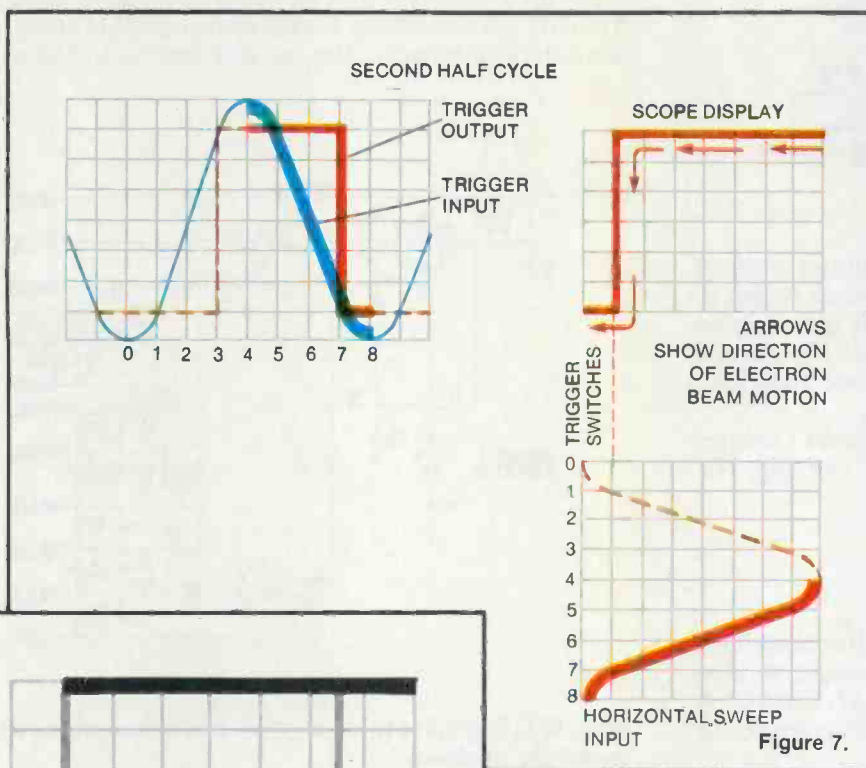


Figure 7. An oscilloscope trace resembling this results when the Schmitt Trigger output returns to its lower value.

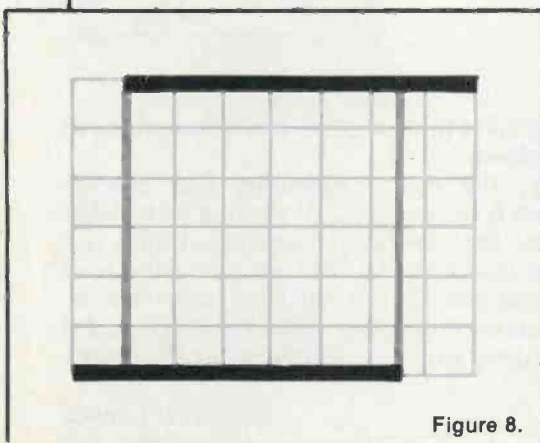


Figure 8. The composite of the two oscilloscope traces is the classic hysteresis loop.

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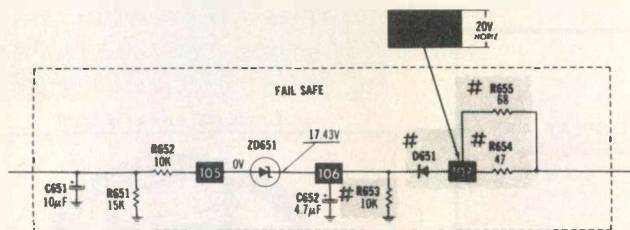
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Troubleshooting Tips

No sound and no raster Sharp model 19D72 (Photofact 1922-2)

When I applied ac power to the Sharp color receiver on the test bench, there was a tic-tic sound from the region of the regulator. Otherwise, the receiver was dead, without sound or raster.

After I examined the complete schematic, I decided the chassis must be in shutdown mode. Therefore, I disconnected the wire between T602 flyback pin 10 and R654/R655 at the input of the shutdown fail-safe circuit. Ac power was supplied from a variable-voltage power supply as the high-voltage probe was touched firmly to the second anode of the picture tube. Then I slowly increased the power-supply ac voltage, while watching the high-voltage meter, starting at a low voltage (say 70Vac) and increasing it as the receiver began to play.



However, before the variable ac voltage reached 120V or the HV attained 24kV, the flyback began to smoke. Of course, I quickly backed off the variable voltage to prevent any damage. *After the flyback was replaced* (and the wire on pin 10 re-connected), *the receiver operated perfectly.*

David Luckner
Corning, NY

No sound or picture General Electric EC-A (Photofact 1918-1)

All *tough dogs* seem tame enough after they have been repaired. Sometimes the technician is chagrined that the testing required so much time. So it was with this EC-A/chassis General Electric color receiver.

A varying *snow* noise could be heard, but there was no high voltage and no raster or picture. During the troubleshooting procedure of measuring all major supply voltages, it was discovered that the +15.21V supply was missing at RL-35 pin 6.

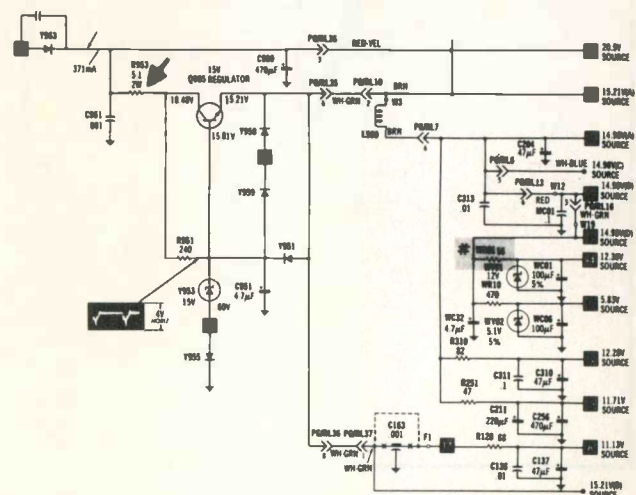
In this particular chassis, the first suspects always are the griplets that connect top to bottom wiring. So, without making any further tests, I removed the power-supply board, soldered the griplets, checked all diodes and the Q905 15V regulator transistor

with an ohmmeter and reinstalled the board because all appeared to be normal. But there was still no +15.21V.

When I disconnected PG-35 and PG-36, the +15.21V was restored at the plugs. Of course, I thought one of those lines had a short to ground. Reconnecting PG-35 and disconnecting PG-7 brought back the +15.21V to pin 6. Resistance tests of the 15V line in the sweep module and signal board failed to find any leakages that should drop the voltage to zero. Reconnecting PG-36 and leaving PG-7 disconnected, dropped the voltage again to zero at PG-36 pin 8.

Going back to the pulses at the Y963 anode and the dc voltage at its cathode showed no variation with both plugs connected. Therefore, there could be no shorts; *it had to be an open somewhere.*

With the power-supply board removed again, I checked visually around regulator Q905 and resistor R953 that brings B+ to the transistor. Finally, I discovered that one end of R953 had pulled loose from the foil and solder, barely showing a thin crack. Mechanically securing the resistor lead to the adja-

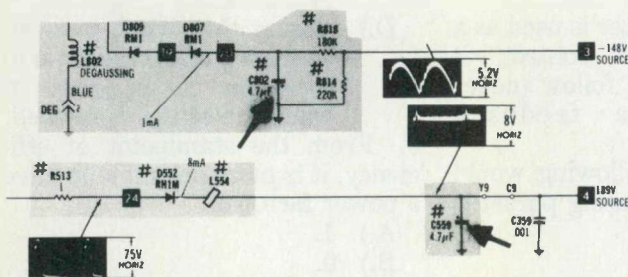




Hum bar of noise Quasar ALDTS-989 (Photofact 2045-1)

When this color receiver first was examined, it showed a single *noise* bar across the screen riding slowly upward when video was present. With only a raster, there was no bar. Experience with a similar trouble in a Sony prompted me to scope the +189V source (for the three color-output transistors). The ripple voltage was excessive, so I bridged another 4.7 μ F across C559. Evidently, the original capacitor was open because the former +120V voltage rose to +189V and the ripple decreased to normal. Also, the picture became slightly darker from the higher supply voltage, but the noise bar continued to move upward through the picture.

Because the waveform proved the C559 capacitor was open, I began to scope other dc-voltage supplies, hoping to find one with excessive ripple. No waveform was shown for the -148V source, so I



checked the dc voltage and was surprised to find the voltage was only -90Vdc. Could this 4.7 μ F filter be open as well? It could, and it was. A new C802 capacitor gave a normal picture without a moving hum bar.

It is strange that both capacitors were identical in ratings and physical appearances. Probably many more of these will fail in other Quasar's.

One thing should have given me a clue much earlier: The +189V source is produced by rectification of *horizontal* power from the T551 flyback. Therefore, the ripple could not produce a bar traveling upward through the picture. Only 60Hz line frequency can do that. And where could that come from? An open C802 in the -148V source will provide 60Hz ripple, since D807 is rectifying the 120V line voltage. Therefore, the -148V source excessive ripple will cause a single broad horizontal line to move *upward* through the picture. Excessive ripple of the +189V supply cannot produce such a horizontal line.

Anyway, be on the lookout for those 4.7 μ F capacitors.

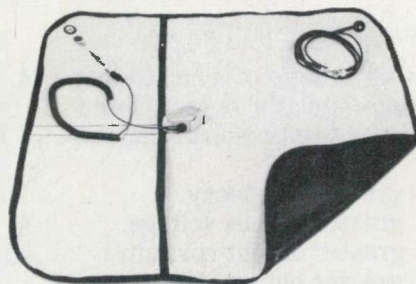
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Test your electronic knowledge

By Sam Wilson

1. An advantage of a closed-loop *switching* regulator over a closed-loop *analog* (continuous) regulator is

- A.) greater efficiency.
- B.) greater output voltage.
- C.) greater output current.
- D.) greater output power.

2. Which of the truth tables in Figure 1 is correct for the circuit in Figure 2?

- A.) Table A
- B.) Table B

Table A				Table B			
A	B	C	L	A	B	C	L
0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	1
0	1	0	1	0	1	0	0
0	1	1	1	0	1	1	1
1	0	0	0	1	0	0	0
1	0	1	0	1	0	1	1
1	1	0	1	1	1	0	1
1	1	1	1	1	1	1	1

Figure 1.

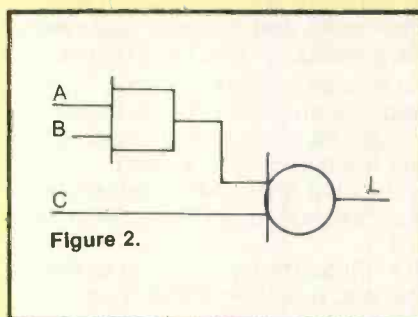


Figure 2.

3. A ferroresonant transformer in a power supply circuit is used for

- A.) closed-loop power supply regulation.
- B.) open-loop power supply regulation.
- C.) oscillator feedback.
- D.) amplifier coupling.

4. The circuit of Figure 3 is

- A.) an OR.
- B.) a NAND.
- C.) a NOR.
- D.) an AND.

5. Which of the following statements is true?

- A.) A tachometer must be an active transducer because of the very nature of its job.
- B.) A tachometer is used for direct torque measurements.
- C.) A tachometer may be a passive transducer or it may be an active transducer.
- D.) If a tachometer is used as a motor speed control, it always must follow (never precede) a feedback amplifier.

6. Which of the following would be useful for eliminating parasitic oscillations?

- A.) An LDR
- B.) A ferrite bead
- C.) A diac
- D.) An LAD

7. An advantage of placing a transducer in a bridge circuit is that

- A.) its output is not affected by small changes in power

supply voltage.

- B.) the output impedance is reduced.
- C.) the output voltage will not drop to zero.
- D.) it produces a greater change in output signal.

8. In the circuit of Figure 4,

- A.) closing the switch momentarily will cause the lamp to come on and stay on.
- B.) closing the switch momentarily will destroy the SCR.
- C.) the lamp will be on at all times regardless of whether the switch is open or closed.
- D.) closing the switch momentarily will cause the lamp to come on but it goes off when the switch is opened.

9. From the standpoint of efficiency, it is more desirable to have a power factor of

- A.) 1.
- B.) 0.

10. Assuming a power line frequency of 60Hz, the ripple frequency of a 3-phase full-wave bridge rectifier should be

- A.) 60Hz.
- B.) 120Hz.
- C.) 180Hz.
- D.) 360Hz.

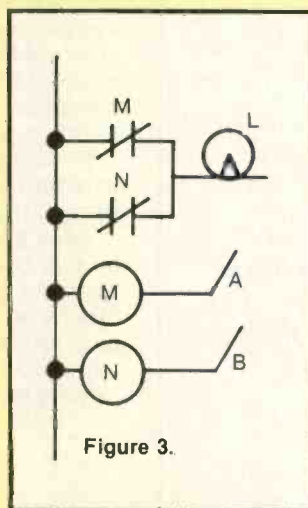


Figure 3.

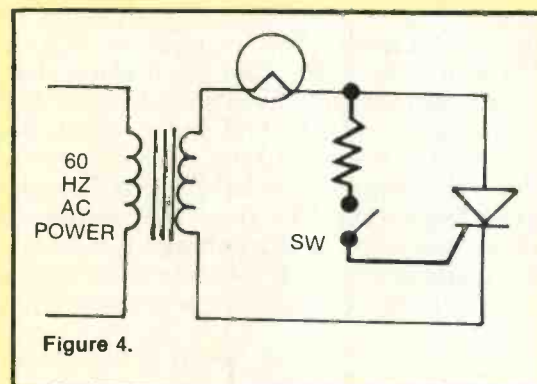


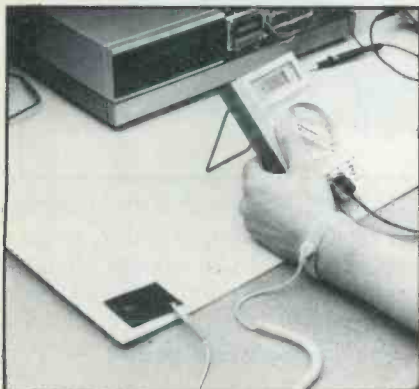
Figure 4.

The answers are on page 57.

Products

Anti-static kit protects solid-state devices

An antistatic kit introduced by *RCA Distributor and Special Products Division* provides protection for anyone handling or working with static-sensitive devices in production, testing or servicing.



The kit consists of a static-dissipative workbench mat, a wrist strap and coil cord, for the worker, and a grounding cable that safely drains electrostatic charges to ground. Most of the components are also available separately as spares or replacements. This enables each operator to use his own wrist strap that snaps off the coil cord for ease in leaving the work station.

Circle (75) on Reply Card

Computer care kit

This comprehensive Computer Care Kit, intended for cleaning and maintenance of personal and business computers and sensitive electronic instruments, is available



from *Philips ECG*, a North American Philips company.

The new kit is part of the company's line of high technology chemicals used as cleaning, lubricating, shielding and testing agents in electronic servicing and hi-tech maintenance applications.

Circle (76) on Reply Card

Wire strippers

GC Electronics announces two product additions: The Coax Automatic Wire Stripper and the GC Automatic Wire Stripper Kit.

The Coax Automatic Wire Stripper features a fully automatic delayed action mechanism that prevents the wire from being crushed. In addition, this model can handle the three most popular sizes of coax cable: RG58, RG59, and RG62.



The GC Automatic Wire Stripper Kit comes complete with the multiwire automatic stripper, which can handle 8- through 22-gauge wire, along with two replacement blades for use with telephone line cord, station wire and coax cable.

Circle (77) on Reply Card

Portable static control work station

The Plastistat FS-7020 field service kit serves to prevent unnecessary static-caused damage to ESD sensitive devices and printed circuit boards under field repair conditions. The unique feature of the *Plastic Systems* field service kit is the conductive fabric work surface. This material is tear resistant, flame retardant, and meets all conductivity and static decay specifications of MIL B-81705B, NFPA No. 56A and DOD-HDKB No. 263. Included with the kit are all necessary grounding cords to allow PC boards and devices to be handled safely.

Circle (78) on Reply Card

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tape tension gauge is the world standard for tape tension measurements to prevent skewing and interchange problems. The TSH gauge series finds problems causing edge damage and binding cassettes, the two biggest causes of tape destruction. The New HPG-1 head protrusion gauge represents a breakthrough for an accurate, easy to use method of determining head life; takes the guesswork out of video head replacement. The HPG-1 for Beta, VHS, and U-matic VCR's measures head tip protrusion and drum eccentricity in both microns and ten thousandths of an inch.

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Answers to the Quiz

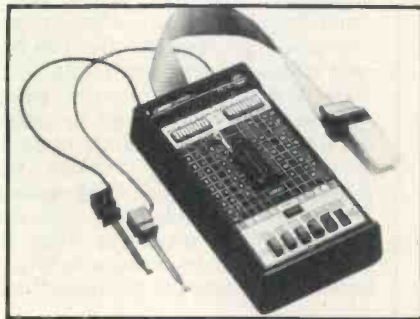
By Sam Wilson

1. A
2. B
3. B
4. B
5. C
6. B
7. A
8. D
9. A
10. D

The questions are on page 56.

TTL IC comparator tester/ logic monitor

A compact, hand-held instrument that can be used as either an IC comparator tester for most 54 and 74 series, 14, 16, 18 and 20 pin TTL devices or as logic monitor for 14, 16, 18 and 20 pin, 5V ICs has been introduced by *B&K-Precision Industrial Electronic Products Group, Dynascan Corporation*.



Designated Model 550, the instrument provides in-circuit testing of most standard TTL, Schottky (S), low power Schottky (LS), advanced Schottky (AS), advanced low power Schottky (ALS), high speed (H), and fast (F) families.

When used as a logic monitor, model 550 indicates the logic state of each IC pin for TTL ICs with up to 20 pins. This function continuously monitors each pin to show changing as well as constant logic states, which avoids using a logic probe that can only check one IC pin at a time. Power is drawn from the equipment under test. Both overvoltage and reverse polarity protection are provided.

Circle (79) on Reply Card

Anti-static mat products

A variety of anti-static mat products are available from *Peak Products*, to protect computers and



electronic equipment. A layer of carbon particles embedded in a vinyl mat material safely draws off static electricity. These mats are not harmed by spills of most liquids, including solvents, and dirt

wipes off easily. The mats may be ordered in several sizes. Anti-static material useful for protecting electronic equipment as well as for electronic assembly operations also is available in rolls. Grounding cords and wrist straps are also available.

Circle (80) on Reply Card

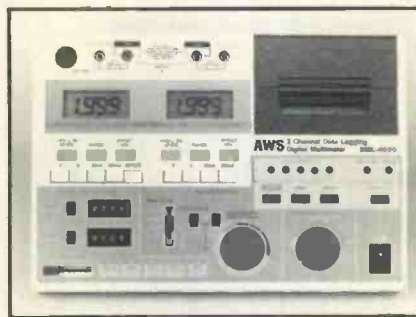
Test jig adapter

Telematic, a division of UXL Corporation has introduced test jig adapters for projection televisions, enabling technicians to remove only the chassis/modules and service them in the shop where proper tools and instruments are available. This eliminates costly damage to cabinets, and saves on manpower when furniture is left with the customer. Although there is a variety, the adapters are not available for all brands and models.

Circle (81) on Reply Card

DMM with built-in printer

Model DML-4020 2-channel data logging digital multimeter is a microprocessor controlled unit, containing two 3½-digit autoranging DMMs and a data logging dot matrix printer. The *A.W. Sperry Instruments* multimeters can be used individually or simultaneously to display similar or dissimilar functions. With the DML-4020's built-in comparator, high and low limits can be set. An array of five LEDs will indicate readings as



compared to the limits. Started by pushing a button, the built-in dot matrix printer will show both a numerical and graph printout of the values being measured: (highest and lowest), number of times the samples were taken and the average reading of the function. Readings can be taken over an extended period of time (up to 30 days).

Circle (82) on Reply Card

Power supply line

Global Specialties has announced a series of triple power supplies, models 1300, 1301 and 1302. Each model provides one fixed and two continuously variable dc outputs, and each offers a different output range. All three perform with laboratory precision, while delivering low ripple, exceptional line and load regulation, and short circuit protection, according to the manufacturer.

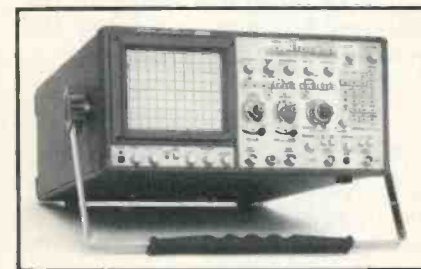


Outputs of all the 1300 models can be used independently, or interconnected, to accommodate different voltage and current requirements.

Circle (83) on Reply Card

Oscilloscope/microprocessor

The test and measurement division of *Hitachi Denshi America* has introduced two oscilloscopes: the V-1150 and the V-680. These oscilloscopes feature microprocessors in their design, allowing for a substantial number of new functions and applications.



The V-1150 is a 150MHz bandwidth, 4-channel (Quad), 8-trace instrument featuring an "on screen" writing capability (character generator) and cursor measurements with selected readings automatically displayed on the CRT.

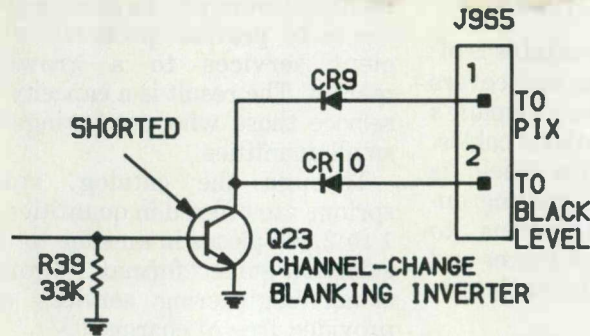
The Hitachi V-680 is a 60MHz bandwidth, 3-channel, 6-trace oscilloscope that features cursor measurements (V, ΔV , ΔT , $1/\Delta T$) with the measured values displayed on-screen.

Circle (84) on Reply Card

ES&T

Chassis—RCA CTC131
Photofact—Not available yet

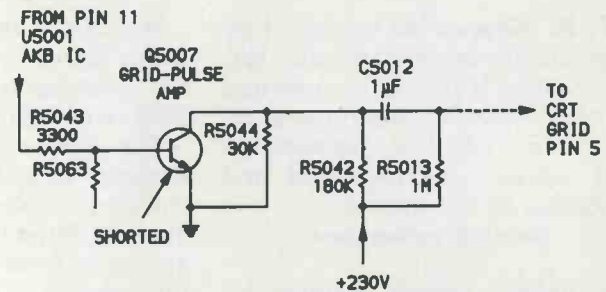
1



Symptom—Dark raster with HV but without picture.
Cure—If the picture is restored by unplugging P9 cable from PWSS002 board, check channel-change-blanking Q23 (on this board) for an E/C short. Replace Q23.

Chassis—RCA CTC131
Photofact—Not available

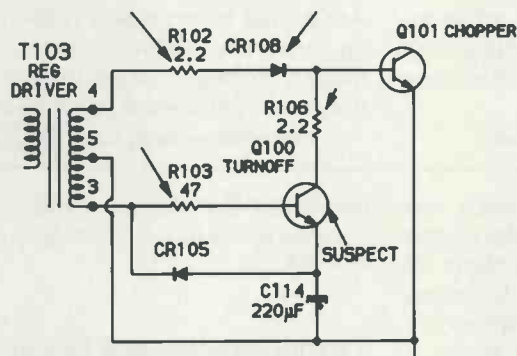
2



Symptom—No picture, but increasing screen control gives a white raster with retrace lines.
Cure—Check Q5007 (on kine socket board) for C/E short, and replace if it is shorted.

Chassis—RCA CTC131
Photofact—Not available

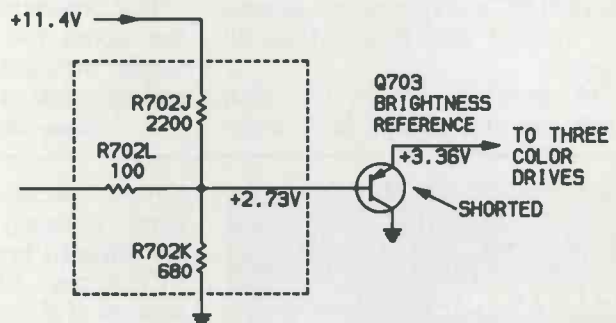
3



Symptom—No voltages; fuse blown. Q101 chopper is shorted.
Cure—Check chopper-turn-off components, especially those shown with arrows. Replace all defective ones and all suspected ones.

Chassis—RCA CTC121
Photofact—2123-1

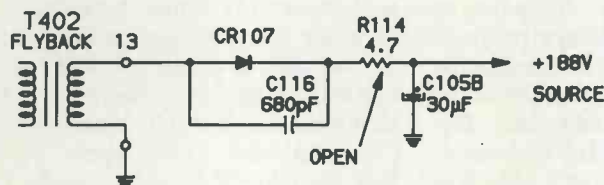
4



Symptom—Picture too bright without control, but without retrace lines.
Cure—Check Q703 for a C/E short, and replace it if defective.

Chassis—RCA CTC120
Photofact—2135-1

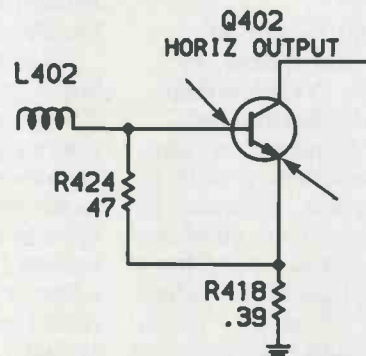
5



Symptom—When switched on, a bright white screen is followed by shutdown.
Cure—Check R114 (4.7Ω) in the +188V source, and replace it with a flameproof carbon-film type.

Chassis—RCA CTC120
Photofact—2135-1

6



Symptom—No sound or picture; SCR is in the tic-tic mode.
Cure—Carefully check the base and emitter connections on Q402's socket. Repair or replace the socket.

Literature

P. K. Neuses has published its 1986 full-line catalog and price list. The catalog is fully illustrated and contains detailed descriptions on all of the tools, kits, instruments and supplies manufactured and marketed by the company.

Circle (125) on Reply Card

A unique system designed to troubleshoot and repair IBM PCs to the component level is featured in the **Fluke** brochure "PC Tester."

The 4-page, full-color brochure provides a detailed description of PC Tester, a combination of Fluke hardware and Techpro software that typically can trace faults in the IBM PC's major circuit boards to a specific chip in less than 30 minutes.

The package allows for both functional and guided fault isola-

tion test techniques for quick, yet comprehensive testing. PC Tester allows testing of IBM PCs whether they can boot or not; all that is required is a functional power supply, system clock and microprocessor socket.

Circle (126) on Reply Card

W.L. Gore and Associates is offering a free brochure that covers the advantages of the company's Fold-Over Shield for ribbon cables.

The copper adhesive shield is designed to attach to existing unshielded cable installations to hinder electrical interferences and emissions from altering cable performance.

The preinstalled drain wires in Gore's Fold-Over Shield provide convenient folding lines and they eliminate most of the tooling required to install and terminate other shields.

Part numbers, sizes and features for both 2- and 3-drain wire construction are covered.

The brochure includes information about the copper insulation's tensile strength, flame resistance and chemical resistance.

Circle (127) on Reply Card

Spring Industries has a catalog of stock springs that is complete, easy to use, and easy to understand (even for those not familiar with spring design).

Spring Industries is the joint efforts of more than a dozen spring manufacturers who have combined forces to provide quick and efficient services to a growing market. The result is a capacity to service those who use springs in small quantities.

Through the catalog, stock springs are offered in quantities of 1 to 2,000 pieces in an easy to use selection-guide format. Professional engineering services are provided free of charge.

Circle (128) on Reply Card

A battery-operated electrostatic charge locator, **ACL's** model 300, is described in an available 2-page bulletin. The free bulletin indicates specifications of the unit and what it can measure, and also explains how to conduct meaningful tests. Additional information is included on accuracy enhancement techniques, voltage range interpretation and operational guidelines.

Circle (129) on Reply Card

ES&T

Books

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

Maintenance and Repair of Video Cassette Recorders, by **Matthew Mandl**; Prentice-Hall; 244 pages; \$27.95 hardbound.

Whether for beginner or electronics expert broadening skills to include VCR repair, Chapter 11 alone could be worth the purchase price. This one chapter provides a master index alphabetically listing the symptoms of ailing VCRs, probable causes and references to relevant servicing instruction in the book. Testing and repair of video and audio imbroglis (including the need for realignment and color circuit adjustments),

signal tracing procedures, and parts isolation and replacement are covered broadly to include all VCR types. Elemental, technical aspects of circuits and systems are described, as are various types of test equipment.

Published by Prentice-Hall, Englewood Cliffs, NJ 07632.

55 Easy-to-Build Electronic Projects, by the editors of *Elementary Electronics*; Tab Books; \$14.45 paperback, \$21.95 hardbound.

Selected from the best that have been published in *Elementary Electronics* magazine are projects that range from simple circuits for the novice to challenging ideas for more experienced hobbyists. Devices to measure rainfall and temperature, experimenter's electro-scope or electrostatic battery, electronic games, safety and security systems for home and auto....all are presented and illustrated in readable style. There is generalized guidance via construction tips and techniques, encouraging readers to modify and thereby

customize the various projects.

Published by Tab Books, Blue Ridge Summit, PA 17214.

Troubleshooting and Repairing Satellite TV Systems, by **Richard Maddox**; Tab Books; \$18.45 paperback, \$26.95 hardbound.

TVRO servicing information and complete schematics for most popular receivers are included in this troubleshooting and repair manual that deals with trends and technologies influencing the satellite receiver industry. The author, who is senior technical instructor for Amplica, advises how to set up a proper TVRO test bench, how to identify and minimize terrestrial interference (TI) and how to interpret video test signals. With other useful information, there is a quick-reference guide for routine installations and repairs, a list of mail-order parts suppliers, a satellite information guide and a glossary of TVRO terms.

Published by Tab Books, Blue Ridge Summit, PA 17214.

ES&T

Readers' Exchange

For Sale: Jerrold model 3880 broadband amplifier, like new, \$100; Advent Videobeam, 1,000A, installation and service manual, \$20. *Mackenzie TV, 1800 N. Scottsdale Road, Scottsdale, AZ 85257; 602-946-7270.*

Wanted: Complete service and parts manual for Motorola model T-1131A FM station monitor. Will copy and return, and pay reasonable fee. *David Cudd, 3101 Wilkinson Blvd., Charlotte, NC 28208.*

For Sale: Heathkit model IG-5257 post marker/sweep generator, \$100. *Leo Bienenstock, 200 Banff Springs Way, San Jose, CA 95139; 408-227-5264.*

Wanted: Zenith all-transistor Radio Royal or equivalent (model 750 Royal, I believe). It runs on six 1½V C-size batteries, 9V altogether. Must be in working order. Please state price. *JAG's Radio & TV, Joseph A. Gontarz, 14 Rudolph Road, Forestville, CT 06010; 203-583-7532.*

Needed: Supremes TV-15, 16, 27 and R-1 manuals. *C.T. Huth, 229 Melmore St., Tiffin, OH 44883.*

Wanted: Sams Photofacts folders 1507 to 2095. *Willy's Electronics, P.O. Box 56595, North Pole, AK 99705; 907-488-1307.*

Needed: Color-bar generator, Hickok model 661. Also, Channel Master field strength meter. *J.G. Shoemaker, Color TV Sales and Service, 600 First St., Leechburg, PA 15656.*

Wanted: Heathkit oscilloscope model 10-18, in good condition and complete with manual and leads. *Stevens Radio Service, P.O. Box 168, Wickes, AR 71973.*

Wanted: Sencore SG165 stereo analyzer with manual, must be in good electrical and mechanical condition. Will pay \$330, including prepaid UPS. Also want Sencore CR70 CRT analyzer. Will pay \$300, same conditions as above. *Walt Sattler, 512 S. Lynch St., Flint, MI 48503; 313-238-9538.*

Needed: Service information or schematic for old Zenith 3-band unit covering 0.55MHz to 25MHz. Chassis No. S366148, perhaps previously identified as S807 or 5807, used in model 8S-359. Have been advised information may be found in original Zenith publication, page 521, volume 1. Please help. *David W. Mulks, 366 Sheffield Road, Ithaca, NY 14850.*

For Sale: Stark model 9-66 tube tester with tube chart (works) \$75; VTVMs, various makes and models, \$5 to \$35, write for list; Speco signal-tracer amplifier, \$50. Payable in U.S. funds plus postage by money order only. No checks please. *Ed Barlow, P.O. Box 29, Tweed, Ontario, Canada K0K 3J0.*

For Sale: Soundtech 1000A, 1700B, all cables, manuals, perfect condition in original boxes. Will ship. Partnership liquidation, best offer takes the pair. *Alan Shapiro, 201 Ojo de la Vaca, Santa Fe, NM 87505; 505-988-7434.*

Wanted: Schematic or service manual for Sony receiver, model STR6060F. Will copy and return or pay for copy. *Joe Gray, Route 6, Box 264A1, Logansport, IN 46947.*

For Sale: B&K telephone product tester, model 1045, \$200; Keithley DMM, model 130A, and accessories, \$75; Keithley HVP 40kV, model 1600A, \$30; digital logic probe (OK), \$10; more than 40 complete sets of Sams Photofacts, \$75. *Gregory A. Ward, 512 Lafayette Blvd., Wilmington, DE 19801; 302-652-1117.*

For Sale: Sams AR, MHF, TR, TSM and HTP manuals, s.a.s.e. for complete list; Sencore TR139B transistor checker, best offer. *Marty Rosenzweig, P.O. Box 1045, Steamboat Springs, CO 80477; 203-879-7063.*

Needed: Chroma board part No. 35-41201-1 for Sears color television, model 528-40910200. Please state price. *George Saylor, 2319 Parrish St., Philadelphia, PA 19130.*

For Sale: Tubes, transistors, Sams Photofacts, magazines, diagrams, parts. *Florian A. Rogowski, 25103 Cunningham, Warren, MI 48091.*

For Sale: Bell and Howell TV/Electronics Course, includes 10 3-ring binders, \$50. *Roger Stigney, 8400 Eastwood Road, Minneapolis, MN 55432.*

For Sale: B&K dual trace No. 1474 oscilloscope; telematic test rig, complete with all accessories; B&K capacitor analyzer No. 801; Hickok Cardmatic tube tester with full set of cards; B&K model 1077B TV analyzer; Sencore VA48 TV analyzer; much more. *John Sannino, 609-653-1500.*

For Sale: Beitman TV manuals, 1947 through 1970 (31 books), \$50 for all, postage paid. Wanted: Sams AR243, 262, 266, 293, 170. Will buy or trade. *Jim Farago, P.O. Box 65701, St. Paul, MN 55165.*

Needed: Sams SD-13 for Bear Cat scanner, model BC-210. Will pay for any copying cost and shipping. *G. Garcia, 1213 Sanchez Ave., Burlingame, CA 94010.*

Wanted: Service manual or Sams CB-13 (out of print) for Tram Titan CB. *Bob Newberg, 937 N.W. 6th Ave., Homestead, FL 33030.*

For Sale: Approximately 50 TV tubes for old tube-type sets, 25 cents each. *Al Crispo, 3225 Chipmunk Drive, New Port Richey, FL 33552.*

For Sale: B&K color bar generator, model 1245, \$25; Heathkit RF signal generator, \$20; Simpson white-dot generator, \$20; EICO 369 sweep-marker generator, \$40; RCA W088A oscilloscope, \$35; SEI PS36 regulated power supply, \$10; Panasonic NV3160 reel-to-reel video recorder, \$200; Quasar VR1000 VCR with seven tapes, \$100. All in working order. *Sony AV5000A reel-to-reel video recorder, not working, \$20. Northern Technical Services, Box 347, Woodruff, WI 54583; 715-356-6004.*

Wanted: B&K 1248 color bar generator; 550MHz frequency counter. *Paul Crouch, 1823 Queen Palm Drive, Edgewater, FL 32032.*

For Sale: B&K 707 tube checker, choice condition, with chart, \$100; B&K 415, like new, all manuals, leads, probes...\$300. In original cartons. Will ship UPS, c.o.d. Send certified check. *George W. Crouch, Ace TV and Electronics, 4018 Lillian Drive, Concord, CA 94521; 415-682-8841.*

For Sale: Simpson 260 series-3 volt ohmmeter and Micronta LCD autoranging DMM, catalog No. 22-192, (used four times), both \$100 plus shipping. Both, excellent condition. *T. Walton, 8209 Lynnhaven Ave., Lubbock, TX 79423.*

For Sale: Sencore VA48, very good condition, all cables and manuals included, \$750; Heathkit color bar generator, \$50. *Dave Wright, 615-376-6690.*

Wanted: Sams Photofacts folders from 500 to 2300 (or close to these numbers). Reasonable price. *210 E. Anderson, Round Rock, TX 78664; 512-255-0843.*

Wanted: NRI TV, Video Servicing Course and equipment, and NRI Computer, Microprocessor Course and equipment. Reasonably priced. *Joseph Wegner Jr., P.O. Box 262, Glendale, CA 91209.*

For Sale: B&K 1040 CB Servicemaster, \$150; Heath IG-5237 FM stereo generator, \$100; Heath IT-12 visual-audio signal tracer, \$40; Heath IG-102 RF signal generator, \$30. *Henry E. Ruther, 3701 Surrey Lane, Colorado Springs, CO 80918; 303-599-9582.*

For sale: Motorola Mobile Training Institute (MTI) FM 2-way professional radio communication course, complete and in excellent condition, \$100. *Clarence G. McKee, 9516 Zion Road, Rives Junction, MI 49277; 517-569-3139.*

For Trade: Kruse Electronic/Systron Donner 5000A sweep oscillator E/W 5014 dual band plug-in (3.6GHz to 4.2GHz and 5.9GHz to 6.5GHz) and directional coupler, all 100% functional according to manufacturer's specifications. Trade for Diehl Engineering Mark V high voltage analyst. *TV and Hi-Fi Services, 170 St. Andrews Road, Columbia, SC 29210; 803-772-3915.*

For Sale: Sencore CB analyzer, model CB42, all test probes and manuals, mint condition and in original packing, first and best reasonable offer: B&W professional audio oscillator, model 210, very good condition, manual included, \$60; Heathkit audio analyzer, model IM-48, very good condition, \$75. Prices include shipping. *Derry Electronics, 511 W. Fourth Ave., Derry, PA 15627; 412-694-8822.*

Wanted: For VCR repairs—tape tension and spindle gauge, video test tape, VCR service manuals. Also, Panasonic 12-inch picture tube No. A26JAS31X. *Ed Herbert, 410 N. Third, Minersville, PA 17954.*

Wanted: Manual and setup data for Hickok 539 tube tester (unavailable from manufacturer). Also, 123A series Cardmatic cards. **For Sale:** old test gear and TV parts, s.a.s.e. for list. *Jim Corliss, 2446 Vista Drive, Upland, CA 91786; 914-985-9967.*

Wanted: RCA service manual/copy for chassis CTC 39 XAD. Please quote price. *L. Wenrich, 1014 S. Mansion Drive, Silver Spring, MD 20910; 301-589-5316.*

For Sale: Paco model 20 resistor and condenser checker, excellent condition, make offer. **Needed:** Dual volume control and switch part No. EVFK-12L50A53, new or used, for Panasonic AM/FM stereo tuner-amplifier, model 7671 (Sams 960-7). *William J. Maida, 274 W. Sabal Palm Place, Longwood, FL 32779.*

For Sale: 12FQ8 and many other vintage tubes, s.a.s.e. for quote. *Ted Youngman, 2225 Vigo St., Lake Station, IN 46405; 219-962-1241.*

Wanted: Magnavox function switch 160395-2 for R21205AA; power transformer 1-442-036-11 or a substitute for Sony; schematic or wiring diagram on a Sony SQA-100 decoder-amplifier. Send prices. *Dan's TV, 316 East Ave. E., Hutchinson, KS 67501.*

For Sale: Sams Photofacts folders 601 to 999, and 12 other full folders, \$400 for all; hand-held capacitance meter LCD with power transformer, good working condition, \$50; VTVM, good condition, \$40. Prices do not include postage and shipping. *David Muratore, 27 Clarkview Road, New Windsor, NY 12550; 914-562-2805.*

For Sale: B&K sweep marker generator, model 415, \$100; B&K curve tracer, model 501, \$100; Supertech Mark IV HV circuit analyst, \$575; EICO flyback and yoke tester, \$25; Sencore SS137 sweep circuit analyzer, \$25; Sencore CR161 auto tracker CRT tester and rejuvenator, \$40; Sams AR 10-200, best offer; Sams CB 10-69, best offer. *Bob Cahill, P.O. Box 568, Kingston, NH 03848; 603-642-4292, days.*

For Sale: Approximately 420 Sams Photofacts folders (in drawers, some in series), including RCA and Zenith factory-service manuals, loose Tekfax and manuals and TLGs No. 1 to No. 12. Make offer; New York City area only, cannot deliver. *E. Schwartz, 1119 Foster Ave., Brooklyn, NY 11230; 718-434-9011.*

To Exchange: Sencore VA48, excellent condition, for Z meter, same condition. Will demonstrate in the tri-state area. *Frank Yurgan, 7800 Shore Front Parkway, Rockaway Beach, NY 11693; 718-474-0827.*

Wanted: Power transformer No. 120-0594-00 or complete scope for parts, for telequipment model D67 scope. *Duane Loeffler, P.O. Box 1955, Seneca, SC 29679; 803-882-9089 or 803-638-6029.*

For Sale: MS-230 Non-Linear Systems dual trace, triggered miniscope, with charger and carrying case \$425. Like new (cost \$800-plus, Jensen Tools), haven't needed, so used very little. **Wanted:** Radio Shack's little SA-102 stereo amplifier (1984 catalog). Also, Rider's Radio Manuals, volumes 17 and 19 to 23. *Harry Sisson, 1763 Zuni Drive, Sheridan, WY 82801.*

For Sale: 3M 209 automatic copier, complete; electronic parts for SBM 1100 electrostatic copier; precision Geiger counter, model 107B, in original box. Make offer on all. *Donald J. Ajjala, 50 Fir Circle, Babbitt, MN 55706.*

For Sale: Hewlett-Packard 200C, AF generator, with manual, \$45; Ballantine 300 electronic voltmeter, true RMS, 5 ranges, 10mV full scale to 100V full scale, with manual, \$45; RCA WR-67A, RF signal generator, probe and manual, new capacitors and resistors, \$35; Heath IT-18 Xistor test set, upgraded, with manual, \$30; Heath ID-22, electronic switch dual trace, with manual, \$35; precision 1kHz tuning fork, electronic excited, complete, \$40. Also, fathometer chart paper close-outs: No. 285-7235P4 or M95-P4, \$3 per roll; No. 1856-1039P3, \$6 per roll; No. 7208-1031G2, \$6 per roll. Prices do not include shipping. *Ed Pitsinger, P.O. Box 247, Galveston, TX 77553; 409-763-2207.*

Wanted: Schematic diagram for Harris series 450 car telephone. Will buy or copy and return. *A. Horeczko, 1600 W. 22nd St., San Pedro, CA 90732.*

For Sale: Heathkit IO-104 oscilloscope, \$200; B&K 467 CRT restorer, \$200; B&K 1077 analyst, \$250; B&K 1246 color-bar generator, \$50; Telematic test jig, \$100. All in excellent condition. *B. Carter, 33578 Stonewood, Sterling Heights, MI 48007; 313-268-5963.*

Editor's note: Reader's Exchange items are published in the order they are received. We are happy to offer this service at no charge to you, our readers, but ask that:

- Items are legibly written or typed.
- Your name and address are included on the same page as your item (envelopes and contents often become separated). Phone numbers also may be included. Using your peel-off label is a good idea.
- You limit any item to no more than three units.

Please understand that **ES&T** is in production six weeks to two months ahead of publication date.

ES&T

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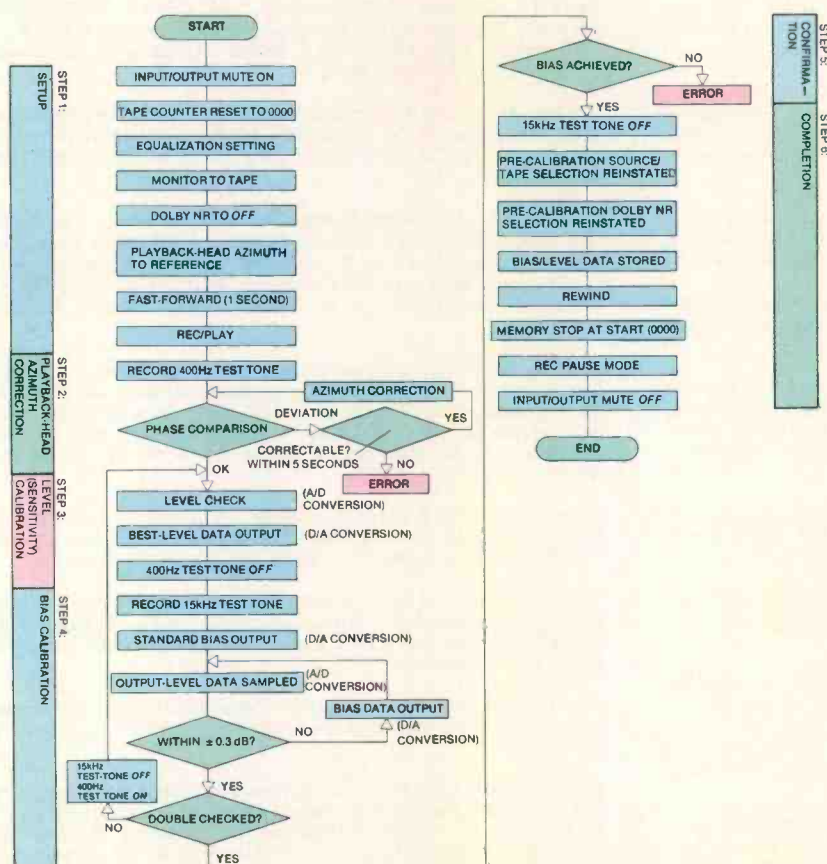


Figure 4.

range of adjustment (for example, if the user has manually set the wrong tape position), auto-calibration is suspended and the error message is displayed. If this occurs, the entire auto-calibration process can be reinitiated by pressing RESET and starting over.

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ES&T

Photofact

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

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8-85-tfn

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03-86-1t

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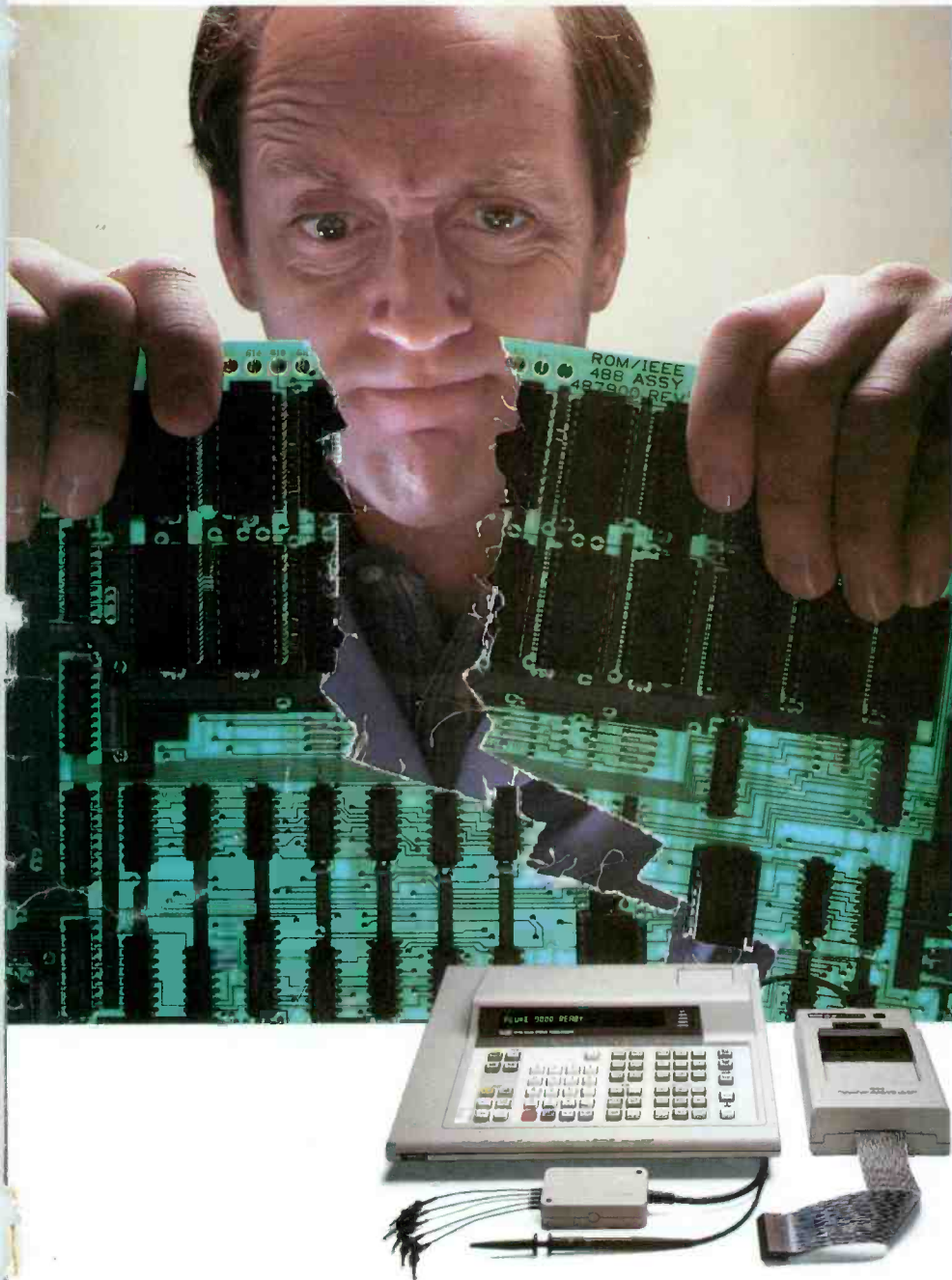
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Introducing a new dimension of test capabilities for the Fluke 9000 Series Micro-System Troubleshooter line.

Finally there's a way to conquer some of the most difficult board testing problems imaginable. Take control of the situation with Fluke's 9000 Series and new **Asynchronous Signature Probe option**. You'll be able to pinpoint virtually every digital hardware fault on the entire board. Even those frustrating faults in circuits that operate independently of the microprocessor bus cycle.

Begin testing boards with the 9000 Series' built-in, preprogrammed test routines. In a single keystroke, you can automatically check the entire microprocessor kernel—Bus, ROM, RAM and I/O.

For testing beyond the bus, Fluke's new probe option eliminates the need for a logic analyzer or scope to test asynchronous circuits. One complete package, easily installed into either new or existing 9000 Series units, offers signature analysis, waveform capture and event counting. These three vital troubleshooting functions give any 9000 Series the power to diagnose:

- DMA Controllers
- Disk Controllers
- Video Controllers
- Video-Generation Circuits
- Communication Circuits
- Peripheral Controllers
- Dynamic RAM timing relationships

Not only does the 9000 Series test more of the board, it also supports more 8-bit and 16-bit processors than any other tester on the market.

Call Fluke toll-free **1-800-426-0361** or contact your local representative, and put your most challenging board to the 9000 Series test. If it can't be fixed with the enhanced 9000, it's probably beyond repair.



Circle (2) on Reply Card

ON THE ONE HAND,
A SMARTLY-STYLED,
PERSONAL-SIZE, CARRY-OUT KIT.



IN THE OTHER, THE CONTENTS
NEATLY ORGANIZED FOR
DESK-DRAWER STORAGE

INTRODUCING! STAT-ATTACK™

THE HI-TECH CLEANING SYSTEM FOR YOUR USE AND PROFITABLE OVER-THE-COUNTER SALES

Here's a triple-threat computer cleaning system from Zenith! Perfect for 1) on-the-job and in-the-shop use...2) tie in sales with your computer service contracts and 3) for over-the-counter sales.

It's the Zenith STAT-ATTACK Computer Cleaning System! Scientifically formulated and designed for cleaning and protecting hi-tech electronic products!

GREAT AT FIGHTING COMPUTER DATA DISRUPTION CAUSED BY STATIC AND DIRT

There's no system better, easier and more convenient to use wherever static electricity is a threat to CMOS devices and other electronic products.

SPRAY AWAY STATIC AND DUST WIPE AWAY SMUDGES AND DIRT

The Zenith STAT-ATTACK System consists of seven antistatic aids and cleaning agents scientifically formulated for cleaning and discharging static from computer terminals, CRTs, keyboards, printers, computer enclosures, disk drives, video games, word processors and other hi-tech electronic products and sophisticated office equipment.

SMARTLY-STYLED AND PACKAGED FOR OVER-THE-COUNTER SALES

With its down-sized units packaged in a colorful, personal-size carry-out kit, the entire Zenith STAT-ATTACK Computer Cleaning System comes with a built-in tray for handy desk-drawer storage by computer operators. Also available in larger, more economical sizes.



HERE THEY ARE! THE 7 KEY ELEMENTS IN A PREVENTIVE MAINTENANCE PROGRAM FOR ELECTRONIC PRODUCTS!

Inert Dusting Gas — sprays to remove dust, lint, and other loose particles from printers, keyboards and other hi-tech electronic products. **Antistatic Spray** — helps neutralize static from carpets, cloth, general work areas, and electronic components. **Monitor Screen and Keyboard Cleaner** — aids in removing oily film, smudges, and dust to provide maximum clarity. **Antistatic Cabinet Cleaner** — a double-duty cleaner and static-fighter. Works on glass, plastic and metal surfaces. **Antistatic Hand Lotion** — helps dissipate static charges from the body and/or electronic products. **Lint-Free Wipers** — for computer, peripherals, and in clean rooms. Safe for use on relays and electrical contacts. **Lint-Free Swabs** — for use with or without solvents in hard-to-reach places of keyboards, disk drives, printed circuit boards, etc.

STAT-ATTACK SYSTEM AVAILABLE FOR SERVICE TECHNICIANS' USE... AND OVER-THE-COUNTER SALES

Starting now, the Zenith STAT-ATTACK Computer Cleaning System is available for in-the-shop and on-the-job use by Service Technicians...and over-the-counter sales by Service Technicians and retailers of computer systems, peripherals, software, supplies and electronic products and accessories.

Service Technicians and retailers of electronic and hi-tech products interested in the Zenith STAT-ATTACK System for their own use and/or for re-sale, should get in touch with their Zenith distributor immediately.

Call your Zenith distributor now and take full advantage of the STAT-ATTACK system for on-the-job and in-the-shop use...for tie in sales with your computer service contracts...and profitable over-the-counter sales!



The quality goes in before the name goes on.®

Zenith Service, Parts & Accessories
11000 Seymour Avenue, Franklin Park, Illinois 60131
A Division of Zenith Electronics Corporation