THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS

ELECTRONIC™ Servicing & Technology

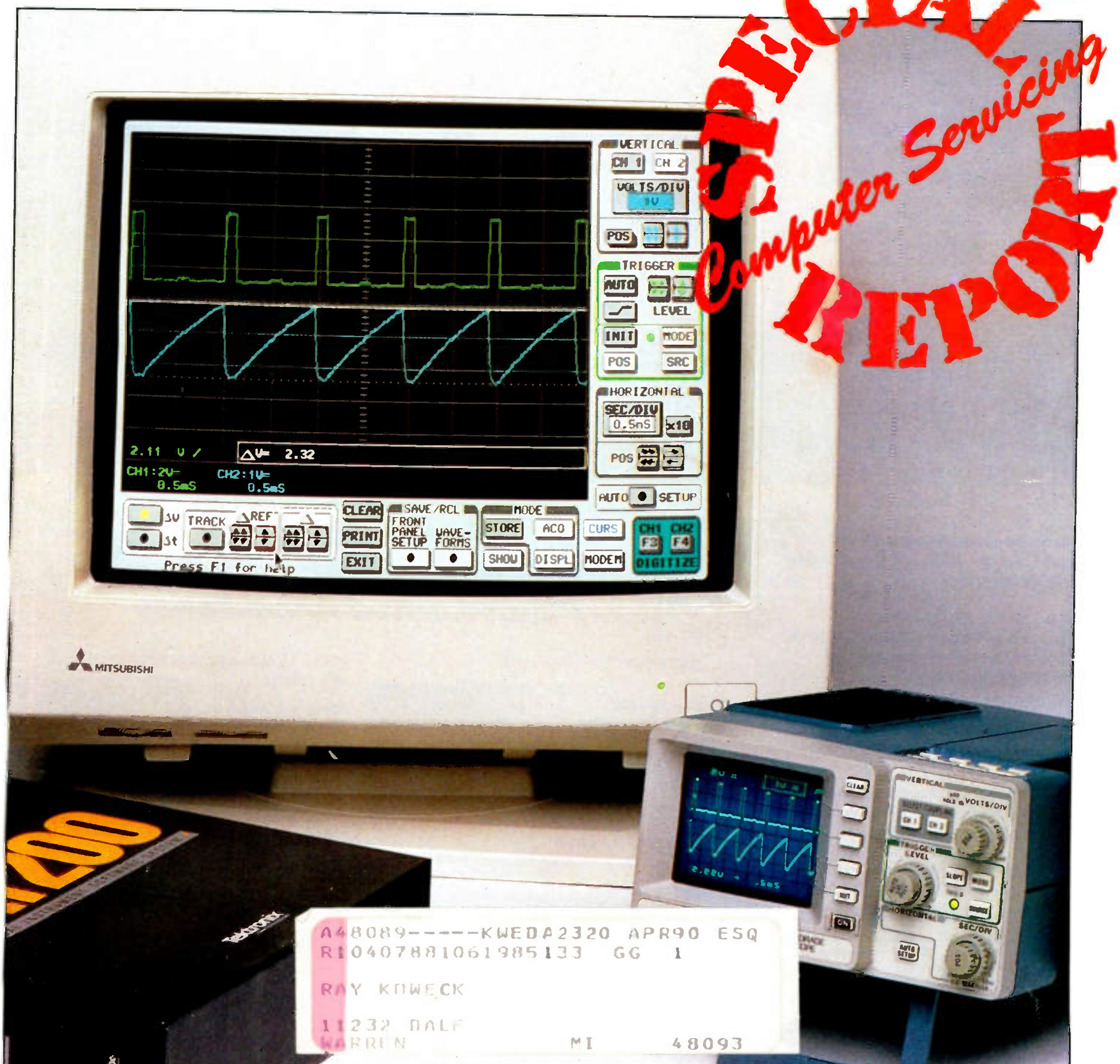
JANUARY 1990/$3.00

Servicing Zenith Microcomputers ● Horizontal Deflection

Teleservicing ● 1989 Article Index

SPECIAL REPORT

Computer Servicing



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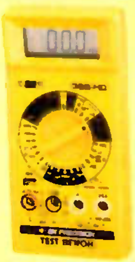

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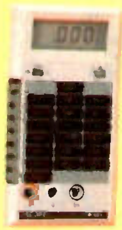

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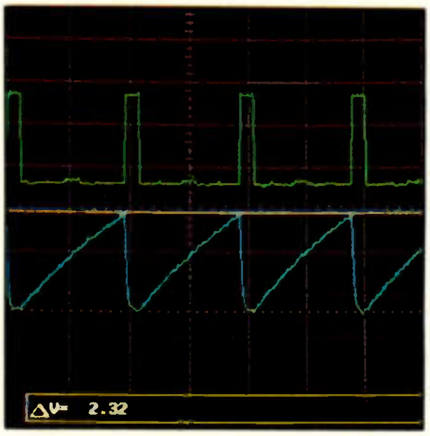
Circle (7) on Reply Card

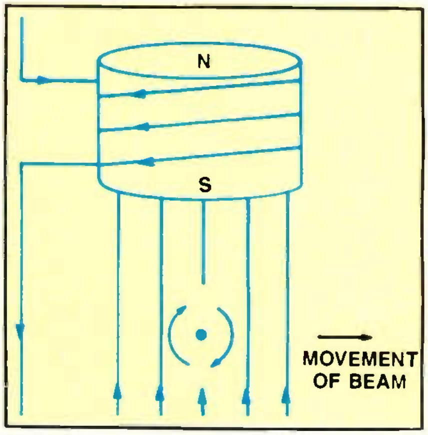
Contents

Volume 10, No. 1 January 1990

Page 6



Page 8



Page 40

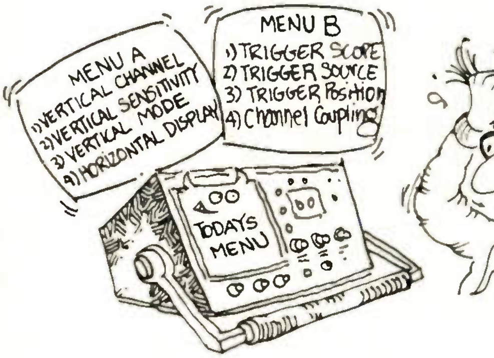
ON THE COVER

Computers continue to make an impact on electronics servicing. Whether they are being serviced or helping the technician service other equipment, this versatile piece of equipment can be a boon for profitability. (Photo courtesy of Tektronix.)

THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS
ELECTRONIC Servicing & Technology

"USER-FRIENDLY" IS THE WATCHWORD FOR TODAY'S OSCILLOSCOPES.

Recent advances in oscilloscope technology have proceeded at a very rapid pace. Almost across the board these advances have been beneficial. In these "high-tech" units, manufacturers have held out the promise of a scope loaded with every feature under the sun. And from auto setup to menu select capabilities, every function is shown to be ac-



cessible at the touch of a button. But a true reading of a scope's user-friendly potential cannot be obtained until the scope is applied to an actual project. Only at that point can it be determined how much time it will take to gain full use of the oscilloscope.

A new unit may allow work to proceed without a hitch. But where things haven't gone smoothly, situations similar to this have been reported. Turn on the new unit and a menu immediately appears. Should horizontal display, triggering, channel coupling, or another of the many alternatives listed be chosen? Triggering is chosen, but then a submenu is displayed. Now a decision has to be made among trigger source, trigger coupling, trigger slope, etc. Okay, trigger source is opted for and set. Now, if information from another menu is needed, trigger source must be exited and the needed menu brought up. With all this going on, the engineer may become distracted from the task at hand — the close observation of waveforms on the screen.

This potential for confusion points up exactly why careful examination has to be made when equipment is advertised as user-friendly. A closer look may reveal that sophisticated, menu-driven scopes are not always the easiest to operate. A new scope that builds and improves on controls that are already being used efficiently may turn out to be the most user-friendly. Toward this end, a number of features have been developed that improve the efficiency and precision of conventional oscilloscopes. Among these features are cursors with digital readouts, auto ranging, and relative hold-off, to name a few.

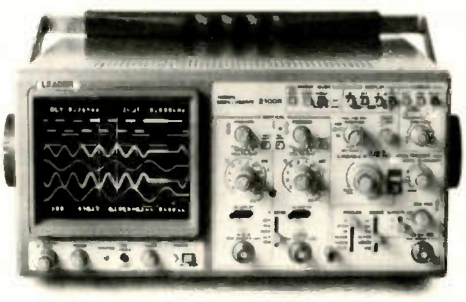
CURSORS WITH DIGITAL READOUTS — A QUANTUM LEAP IN EFFICIENCY

One user-friendly breakthrough, in terms of both speed and accuracy, has been the development of cursors. Whereas older scopes required counting graticule divisions, cursors now allow measurements to be displayed digitally. Cursors supply readouts such as time, voltage, frequency, and phase, plus time and voltage difference ratios. Time difference ratio is ideal for performing phase shift measurement. With voltage difference ratio, the measurements of waveform overshoot can be made. The cursors make measurement of waveform parameters more consistently accurate.

On-screen readouts provide a constant reminder of operating conditions and keep a record of these settings in waveform photographs. Many important settings are displayed, including TV field/line setting, which expands the oscilloscope to video-related applications.

AUTO RANGING AIDS TIME BASE SELECTION

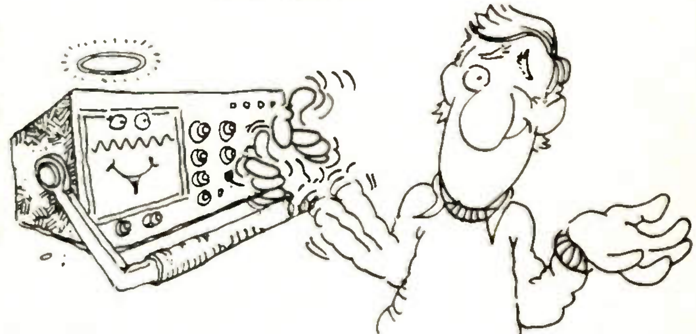
Of great help is a scope that offers both auto ranging and alternate time base. Auto ranging selects from 22 possible time base settings to display an optimum number of cycles. This is another feature that makes an oscilloscope a bit more user-friendly. Alternate time base allows observation of both the main and the delay time base, so that the expanded portion of the waveform can be simultaneously compared with the original.



100 MHz CRT readout Model 2100R from Leader Instruments Corporation.

ANOTHER FEATURE TO CONSIDER CAREFULLY — DOES THE WARRANTY HAVE TEETH?

Another factor that needs to be examined just as closely as those mentioned previously is the warranty. In competing for market share, longer and more extensive warranties are offered every year. Before basing a decision only on warranty, though, consider its true value if the equipment is not reliable. Remember, no warranty can make up the cost of a scope that's out for repairs for 4 to 6 weeks, or more. That's why even more important than the actual wording of a warranty is the reliability that's built into every oscilloscope. Ideally, of course, no piece of equipment should ever break down. But if a unit needs repair, it's important to know who provides the fastest turnaround time in the industry.



Now there is an oscilloscope whose user-friendly format includes all the features discussed earlier, plus many more. This unit, introduced by Leader Instruments Corporation, is the 100 MHz CRT readout with cursors, Model 2100R. The unit is easy to use and also incorporates these additional features: TV full-line selection, alternate triggering, and relative hold-off. This and every other Leader product come with an iron-clad 2-year warranty, which is backed by a return rate of less than 1% during the warranty period and a very rapid turnaround time. In other words, the 2100R offers a complete oscilloscope package.

For more information or Leader's full-line catalog, call toll free: 1 800 645-5104. In NY call 516 231-6900. Or write Mike Hoyer at Leader Instruments Corporation, 380 Oser Avenue, Hauppauge, NY 11788.

For Information Circle (8) on Reply Card
For Demonstration Circle (9) on Reply Card

Editorial

If you *still* haven't diversified...

A lot of servicing technicians are still reluctant to get started in personal computer servicing. There's a mystique about computers: They're complex, they do mysterious things mysteriously, they're expensive, they're delicate.

One of the biggest hangups is that they must be incredibly complex. After all, think of the huge amounts of time it takes to program a computer, and the large amounts of dollars computer programmers receive for their efforts.

Of course, there's something to that line of thinking. Computers are complex, and the people who program them take lots of time and get lots of money to do it. But you don't have to have that kind of skill to service personal computers, although some familiarity with some program functions is definitely recommended.

Here's an analogy: A TV set is capable of reproducing spectacular visuals, beautiful scenery beautifully photographed, song and dance numbers, drama so intense and convincing that it brings tears to your eyes. And a stereo can almost recreate the sound of the concert hall where a Beethoven symphony is being played. But you don't have to be a Beethoven, a dramatist, a director or a cinematographer to service a TV or a stereo. The closest you have to get to that kind of skill in order to service a product is you have to be able to hook up a color bar generator, an audio generator or perhaps even a source of one of these more complex programs.

The situation with computers is similar: You have to be able to understand some simple programs, what they're supposed to do and the possible symptoms if they don't function correctly. However, you do not have to be able to duplicate the skills of a Lotus or MicroSoft programmer.

There are several other factors that further argue in favor of servicing personal computers. One is that PCs are complex enough to present difficulties to the average non-technical person. If you doubt that, think of how many VCRs still have a clock that blinks 12:00, and consider how many people are not able to program their VCRs to record a show in the future. Many of these people will be calling for service even when the problem is one that can be corrected without opening up the computer or picking up a tool. Easy-to-fix operator/software problems make up a large percentage of the computer problems that call for service.

Another advantage of computer servicing is that, to a great extent, personal computers are modular. If a computer is exhibiting problems and you can isolate the problem to a subsystem or a circuit board, in most cases you can remove the offending unit and replace it with a good unit. You can then bring the failed unit back to the shop for refurbishment.

You might send the failed unit out to a depot-level service facility, which will restore it to factory-new condition. Which is the other argument in favor of computer servicing: In many cases, if you run into a problem you just can't resolve, you can send the unit to a depot, let its employees repair it, and still make a profit on the transaction.

Another thought: Computer monitors are similar to TVs, only less complex. If you were reluctant to jump into computer servicing with both feet, one way for a TV servicing technician to get at least one toe in the water would be to start with monitors.

Even if your plans don't currently include computer servicing, it's something you might want to put on the back burner. On the other hand, computers are so helpful that a couple of thousand dollars invested in a computer and some software might pay rich dividends in running your business. A lot of servicing shops now keep track of everything in their businesses — from sets in the shop to inventory to money management — on computer. An attendant benefit, of course, is that, once you learn how to operate a computer in your business, you're probably familiar enough with PCs that you are ready to tackle servicing them. If you are interested in this aspect, keep your eye out for the February issue. We'll be talking about service-shop management software next month.

This issue presents several items that will be of interest to you if you're getting ready to make the plunge into computer servicing. Included is a partial list of servicing depots that you might want to contact.

Nils Conrad Persson

SPECIAL REPORT

Computer Servicing

Another servicing opportunity

By Conrad Persson

Many electronics servicing professionals still see computers as arcane machines operated by highly trained specialists and as inaccessible to ordinary mortals. At one time, that may have been true, but it is not true any longer. In fact, as this special report will demonstrate, many of today's small computers have entered the realm of "consumer electronics products" and are candidates for repair by consumer electronics servicing facilities.

The situation today can be compared to the situation with the automobile as it evolved from the early days to today. In those early days, the automobile was owned by a few well-to-do people, who employed chauffeurs to drive them and who may have found it hard to find a mechanic to keep the cars in operation. The operation of those machines was beyond the average individual. Only a few skilled mechanics and a few brave do-it-yourselfers were servicing them.

Not long ago, computers were in the same category. The promise was great, but if you bought one, who would program it, who would fix it? They were pretty expensive, and the software, if it was available, was even more expensive. Besides, with dozens of manufacturers, there was no standardization.

That situation has changed. In the business computer field, IBM and the clones it has inspired have become a de facto standard. IBM is also the choice of many owners of home personal computers. Apple and the MacIntosh more or less have become the computer of choice in schools and are also a popular choice in homes, especially with people who are involved with graphics. There are a few others, notably the Commodore, Amiga and Atari, but when a servicing technician is called in to service a computer, he will most likely be facing an IBM, clone or Apple product.

The prices of computers have come down dramatically over the past few years. Although it may still require considerable thought on the part of many consumers before they buy one, prices are now low enough that most middle-income families can afford to buy a powerful personal computer. And they are buying them.

In fact, as I was in the process of writing this introduction, my copy of *U.S. News and World Report* arrived. This week's issue contains an 11-page special report on "The Wired Household." The information presented in the issue indicates that there are computers in many U.S. homes: 22% of all households in this country have computers.

A lot of good software programs for both office and home are available off-the-shelf, and more is being added every day. One of the most popular types of software is the word processor. This type of program is useful for basic functions, such as letter writing and preparing school papers. Then there are the financial programs. Some of these can help you keep track of your checkbook, print checks, keep track of whether expenses are taxable, simplify preparing your federal income tax return, and keep track of your stock portfolio.

There are simple database programs that allow the user to keep track of mailing lists, record albums, books, home inventory. There are communications programs that allow you to bank at home, order your own airline tickets, buy and sell stocks, and look up almost anything any time of night or day from one of the on-line databases.

This list does not even begin to scratch the surface. There are scores of off-the-shelf educational, recreational, desktop publishing programs and much more.

In short, the computer has become a tool that is accessible to anyone with between $1,000 and $3,000 to spare. With the increasing availability of useful, low-cost programs, the computer has joined the ranks of the TV, the microwave and the boom box as consumer products. One thing separates the computer from many of the other consumer products: It is expensive enough to be thought of as a serviceable product, not just a throwaway.

Something else to keep in mind is that many of these computers are in the hands of people who have not figured out how to set the clocks on their VCRs or program them to record a program at a later date. Besides the servicing opportunities provided by the potential for electronic or mechanical failure in these units are the servicing opportunities presented by relatively unsophisticated people operating a sophisticated product, and needing help to do so.

That being the case, if you have not at least looked into the possibility of servicing this class of products, you might be missing a good bet.

The tools of the trade

With computers, as with any other of today's consumer electronics products, a servicing technician can dip his toe in to test the water or plunge in with both feet. It all depends on the way an individual goes about things. You can go out and buy all of the sophisticated test equipment needed to troubleshoot and start out repairing down to the component level, or you can start out using little more than the tools and test equipment you already have and gradually add new items as you need them. You can go into it with the determination to solve every knotty problem yourself, or you can fix the ones that are easily within your capability and refer the tough ones to the depots while you increase

Persson is editor of **ES&T**.

your computer-servicing knowledge.

There are two relatively inexpensive pieces of computer-servicing equipment you might want to acquire to go on the bench or in the toolbox along with the DMM and scope: the breakout box and the logic probe. If you have ever taken a look at the connector that goes between the computer and the printer, you will see that there are a lot of wires. Although it looks complex, anyone who can handle a TV wiring harness should have no problem here. The only problem is that computers often are not like TVs. In a given TV, unless the manufacturer messed up, the wires in a harness should go from point to point exactly as it shows on the schematic. With a computer connecting cable, the individual wires may not terminate properly, depending on the kind of printer used.

If a cable has wires that connect to the wrong points at one or both ends, obviously your computer and printer will not communicate properly. The printer may fail to print at all, or it many output some strange stuff. The problem is determining which wires end up where. That's where the breakout box comes in.

In operation, the breakout box is connected to both sides of the interface. For example, if the problem is with a printer interface, one side would be connected to the computer and the other side to the printer. Connected in this manner, all communications lines would flow through the breakout box. LEDs on the box then show whether positive or negative logic signal voltage is present on each pin on each side of the box. Switches and jumpers allow the servicing technician to reroute misrouted connections to restore the system to proper operation.

The logic probe. The logic probe is a simple, inexpensive device that can help track down problems in a computer that is malfunctioning. In its simplest form, it consists of a self-contained probe that contains logic circuitry and LED indicators and can indicate whether a logic signal is present at a given point in the circuit.

A sophisticated probe will have indicators to show whether the test point is high or low or is exhibiting pulses. Some will even have a memory or pulse stretcher, which will show the presence of a single-shot pulse of such a short duration that it lights the indicator too briefly to be recorded by the human eye or doesn't light it at all.

To use the logic probe, you would troubleshoot the computer problem down to a circuit board, then probe suspect components.

Using repair depots

If you are contemplating going into computer servicing, there is plenty of help out there — for a price. If you take in a computer for servicing and find that you are in over your head, you can ship the unit, a circuit board or a disk drive to a depot, which will complete the repair.

If you are thinking about starting in computer servicing, contact one or several servicing depots to determine their terms, conditions and reliability. If you are on the verge of making a decision to service computers, establish some kind of agreement beforehand so you will know how you'll handle depot servicing requirements. Table 1 is a list of computer repair depots that you might contact.

If you do send anything to a depot that will be returned rather than exchanged, always make sure to note the positions of any switches or jumpers, such as DIP switches, before you send the unit off. The depot may have to change their positions to complete the repair, and there is no guarantee they will be reset to the original positions. This could cause a lot of head-scratching if the unit does not operate properly when it is returned.

Table 1
Servicing depots

CRM America Computer Parts
562 Lincoln Blvd.
Middlesex, NJ 08846
201-560-8584

Datatech Depot
2524 E. Fender Ave.
Fullerton, CA 92631
714-680-0383

Distributed Technologies
19823 58th Place S.
Kent, WA 98032
206-395-7800

DMA
611 Development Blvd.
Amery, WI 54001
715-268-8106

Impact Printhead Services
8701 Cross Park, Suite 101
Austin, TX 78754
512-832-9151

PTS
P.O. Box 272
Bloomington, IN 47402
800-333-PTS-1

RepairPro/D.S. Walker
11210 Steeplecrest, Suite 300
Houston, TX 77065
713-890-2257

Victor Computer Services
8125 Westglen Drive
Houston, TX 77063
713-789-1888

The rest of the report

The other articles in this report are designed to bring you important information on the current computer and computer-repair situation. The article "Servicing Zenith Microcomputers, Part VI" is a continuation of the Zenith personal-computer series by John Ross. This part contains some tips on understanding and troubleshooting the memory section of this popular computer. The article "Teleservicing: A Team Approach to Field Service" introduces a new computer/software/oscilloscope combination that essentially makes the probes of an oscilloscope as long as the telephone lines. ■

SPECIAL REPORT
Computer Servicing

Teleservicing:

A team approach to field service

Bench servicing has one major advantage over field servicing: If you run into something you've never seen before, such as an unusual waveform, you can show it to the rest of the techs. Someone else in the shop might have seen the waveform before and could advise you. However, when you're in the field, you might have to make a series of telephone calls to the service center, attempting to describe the questionable waveform or condition. When that fails, you can transport pictures of the scope's display or saved waveforms back to the center in a last-ditch effort to solve the problem. Of course, if you're servicing someone's computer system, the company might be a little upset about not being able to access important information for an extra day.

Teleservicing provides a better way. The combination of a proper oscilloscope, a modem-telephone link and a personal computer is bringing the benefits of teleservicing to field-service applications. Instead of a single person grappling with a difficult problem, the technician can call on the substantial resources of the service center. Field service becomes a team effort that in-

Based on information furnished by Tektronix.

The software

The CAT200 software, developed by National Instruments, Austin, TX, exclusively for Tektronix, is the first product to use DOS-based virtual-instrumentation software technology acquired earlier this year.

A mouse is used to activate any control or to acquire any waveform with this software. No programming experience or formal training is required to use the software.

The combination of the software and the digital capabilities of the scope make for virtually hands-off operation. Front-panel setups can be stored on the PC before going to the field and then called up as needed. The software can display up to six waveforms, which can be stored for later analysis or compared with incoming signals. A permanent library of reference waveforms can be created on a hard disk.

A feature of the software is its built-in support for Hayes-compatible modems. A modem links a PC to an oscilloscope wherever phone lines exist and, in effect, turns the telephone networks into the world's longest probes. Simple controls and menus provide for direct dialing of modems from the software. Once connected, a user can control the oscilloscope as if it were on the benchtop next to the computer. Captured waveforms may be uploaded or downloaded to and from a remote field site and a main station. The waveforms can be displayed on the PC or stored to disk for later analysis.

The software also expands the capabilities of the scope. Delta cursors can be used to automatically measure voltage, time and frequency of acquired signals. The system can output hardcopy to more than 80 popular printers.

In conjunction with developing the software, National Instruments developed a 222 instrument driver for its LabWindows instrumentation software. In addition to controlling the scope, the instrumention software driver will read in waveforms stored to disk with the CAT200 software, where the data may be further analyzed and reduced.

cludes the technician in the field and the often more experienced service-center engineers and staff. In effect, less experienced techs can access the expertise of highly trained technical experts over the world's longest "probe" — the telephone line.

One system that makes teleservicing possible is the Tektronix 222 hand-held digital storage oscilloscope (DSO), placed at a remote site and linked by modem to a service center computer. When the oscilloscope is coupled with a personal computer and the CAT200 Virtual Instrument software, the technician has a graphical user interface that mimics the oscilloscope's front panel on the PC's screen. An engineer or technician who is trained and experienced in scopes will feel immediately at ease with the familiar front-panel controls on the PC's monitor. Because the scope is programmable, the engineer can set up and control the scope from the PC without knowing programming or other computer technology.

Faster troubleshooting

The sooner critical waveforms are interpreted, the faster a problem can be solved. When the technician can send waveforms directly to experienced engineers in the service center, the troubleshooting task becomes faster and easier. In fact, the scope sends waveforms over the modem virtually in real time. Problems that often took days to diagnose can now be solved in a few minutes. In effect, the oscilloscope exceeds its role as a test and measurement tool and becomes a powerful communications tool that links the problem in the field to the solution in the service center.

Reference libraries

Teleservicing also makes it possible to build reference libraries of waveforms at the service center. These waveforms will facilitate troubleshooting and are useful in documenting the performance characteristics of the equipment being serviced. Over time, this documentation becomes a valuable addition to the equipment's service records.

Approved waveforms in the library also can be downloaded for comparisons with waveforms captured at the site, making it easier to solve unusual or unique problems. Service center personnel can also send calibration waveforms to the site, improving calibration time in the process.

Data logging

Oscilloscopes combined with PCs provide valuable data-logging capabilities. The scope acquires waveforms and sends them over the modem for storage and analysis by the PC. The number of waveforms acquired is limited only by the storage capacity of the PC.

Data logging is useful for many purposes. For example, data logging makes it possible to perform trend or degradation analysis on a regular basis to determine the need for equipment adjustment or repair. This is an important ingredient of preventive maintenance procedures. Because a servicer is not required at the site, it is a cost-effective approach.

Remote monitoring and field service

As every service technician knows, service sites are often in less than ideal locations: on a mountaintop, at a remote receiver-transmitter site, or on an oil drilling platform in the middle of the ocean. Worse yet, they are often in hazardous locations, such as an environmental-testing chamber or power-supply test station. In conditions like these, teleservicing capabilities are desirable and can be critically important to the safety of the servicer.

Because the scope probes can be attached and left in place without an operator in attendance, teleservicing is a good solution for hazardous or remote service sites. If the service problem involves intermittent failures, the scope can be set up in a babysitting mode and left to capture the critical signal whenever it occurs.

The Tektronix CAT200 is available for about $350. The Tektronix 222 digital hand-held oscilloscope is available for about $2,350. The RS-232 cable costs about $20. LabWindows and the LabWindows Tek222 instrument driver is available from Tektronix for about $595. The LabWindows Advanced Analysis Library is also available for an additional $895. ■

News

EIA schedules seminars

For the first time the Electronics Industries Association (EIA) has scheduled seminars during the comment period of a standard-setting process. The seminars will provide consumer electronics engineers with technical information about EIA's home automation standard. The seminars are being held during the comment period to allow industry members to preview and critique the standard before it goes into published form.

The seminars will follow the "1990 International Winter Consumer Electronics Show" in Las Vegas and the "1990 National Association of Home Builders Show" in Atlanta. The seminars are scheduled for Jan. 10 and Jan. 23, respectively. A third seminar is under consideration.

The home automation standard will be used with home entertainment (audio and video) products, electronic kitchen appliances, security systems, heating/air conditioning units, water heaters and more. The standard will allow products from different manufacturers to send control signals to one another via existing power and telephone lines, coaxial cable and infrared/RF means.

EIA releases sales figures

Sales figures for TVs equipped with integral MTS stereo sound are showing a continuing upward trend, according to the Electronic Industries Associations' Consumer Electronics Group (EIA/CEG). Approximately 28% of all color TVs sold to dealers in August featured stereo capability. That number was topped again in September, with a record-breaking 31% of color TVs sold to dealers featuring stereo capability — nearly double the number of stereo TVs sold in August. These figures are following a 4-month trend, which could indicate that soon one out of every three color TVs sold in the United States may be equipped with stereo sound.

Another trend is in camcorder sales, up 14.1% in September and 13.2% in October. More than 279,000 units were sold in September, making it the highest sales month of the year. VCR sales continue to lag, down 2.7% in September and 13.9% in October, with a year-to-date figure of −6.9% as compared with 1988. ■

Literature

Catalog and parts reference guide

The *PTS* "Catalog and Parts Reference Guide" contains an extensive in-stock inventory of TV and VCR replacement parts available overnight. VCR parts and VCR camcorder service, disk drive and computer service, all makes of tuners, tuner clusters, modules and motherboards/chassis are listed.

Circle (125) on Reply Card

Tools and test equipment catalog

HMC is offering a buying guide of electronic tools, test equipment and supplies. Test instruments, took kits, soldering/desoldering systems, lamps and magnifiers, anti-static products and precision hand tools are included.

Circle (126) on Reply Card

TV products guide

Tektronix is offering its "Television Products 1989/90" catalog. The 165-page catalog contains information about test and measurement equipment for broadcast, cable, private TV/video facilities and manufacturing environments. The company's line of waveform monitors, vectorscopes, generators, automatic measurement sets, audio monitors, VITS inserters and synchronizers also are included.

Circle (127) on Reply Card

Cable tool catalog

The Eraser Company is offering a 144-page catalog of wire cutting and stripping equipment; dereeling, measuring and coiling units; component lead formers; infrared heat tools and equipment; and FybRglass industrial brushes. New products include automatic, electronic wire and tubing cutters; a workstation fume extractor; temperature controllers for heating applications; a wire stripper for extruded wires; and an air-operated large cable stripper.

Circle (125) on Reply Card

Cross-reference manual

NTE's "1990-91 Technical Guide and Cross Reference" manual lists semiconductor replacement parts for more than 238,000 original devices. All parts are tested and backed by a 2-year warranty. For a copy, contact your local NTE distributor or send a $3.25 check or money order per manual to NTE, 44 Farrand St., Bloomfield, NJ 07003. Call 800-631-1250. ■

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INTERTEC PUBLISHING CORPORATION

Test your electronics knowledge

By Sam Wilson, CET

Level of difficulty: high (50% is a high grade)

1. Which of the symbols in Figure A is used to represent a constant-current diode?
A. the one marked A
B. the one marked B
C. Neither is used for that purpose.
D. Both are used for that purpose.

2. In the ladder diagram shown in Figure B, the neon indicator lamp will light when switch SW is
A. in the open position.
B. in the closed position.
C. Neither choice is correct.

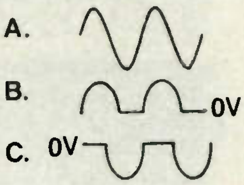
3. A superheterodyne is a basic type of receiver. Name six other types.

4. Name four ways of coupling a signal from one amplifier to another.

5. Which of the following pairs of terms refer to the same kind of circuit?
A. synchronous detector/product detector
B. product detector/heterodyne detector
C. heterodyne detector/synchronous detector
D. All of the choices are correct.

6. Which of the following is an absolute requirement for an AM detector?
A. It must be linear so there is no distortion of the detected signal.
B. It must be non-linear so that the carrier can heterodyne with the sideband signal.

7. Assuming a perfect diode, which of the waveforms shown here is for the circuit in Figure C?



8. Which of the following is an interface between a microprocessor system and the outside world?
A. PIO
B. PIA
C. Both answers are correct.
D. Neither answer is correct.

9. What does the letter I in PIN diode stand for?

10. Two parallel metal plates are immersed in a tank of dielectric liquid as shown in Figure D. A parallel LC circuit is made using the resulting capacitor and an internal inductor. Assume there is no resistance in the circuit. The lowest resonant frequency for the circuit will occur when the liquid level is at the
A. top of the container.
B. bottom of the container.

Answers are on page 19.

Wilson is the electronics theory consultant for ES&T.

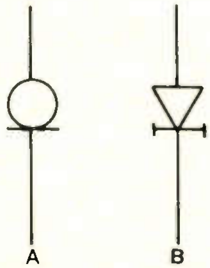


FIGURE A

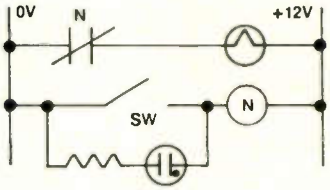


FIGURE B

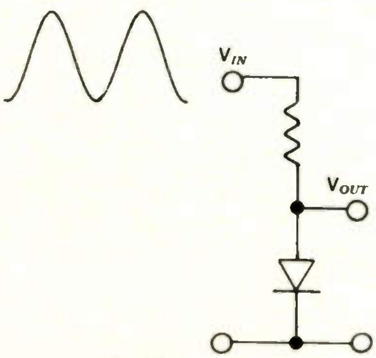


FIGURE C

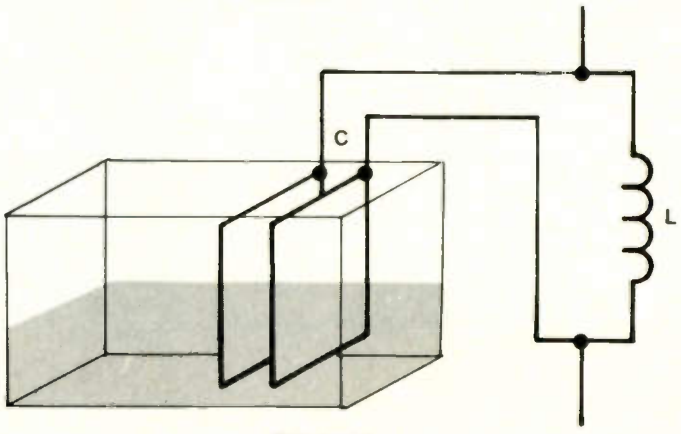


FIGURE D

Servicing Zenith microcomputers

Part VI: Data and parity RAMs

By John A. Ross

Editor's note: Previous articles in this series discussed the evolution of memory devices that led to the configurations currently found in memory cards, as well as the "adjacent" circuitry found on the Zenith memory card — circuitry that provides multiplexing and timing signals. Part VI describes the operation of the computer's memory circuits and some troubleshooting steps you can take when the unit is not working properly.

The Zenith memory card contains five banks of memory ICs. Depending on how much memory the owner purchases, each bank contains either nine integrated circuits or nine sockets that allow the addition of more ICs. Figure 1 shows the pin-out connections of the memory IC and a block diagram of the internal structure of the IC. Figure 2 shows a block representation of the eight data information storage ICs connected without the extra parity IC. The first eight ICs in the bank work sequentially as the actual storage devices; the last chip serves as a parity storage device. When dealing with the operation of the memory circuitry, keep in mind that you will find the same types of signals at the individual pins of each IC in the working bank. Figure 3 shows a sample bank of memory and a byte of information that might typically be stored in it. In this example, the typical Zenith numbering system will show that ICs U412 through U419 serve as the addresses and that U411 serves as a parity storage. U419 gives the least significant bit and U412 supplies the most significant bit for the 8-bit information byte. Any access to the sample bank will cause each chip to contribute either a logic 1 or a logic 0 to the byte.

Ross is a technical writer and a microcomputer consultant for Fort Hays State University, Hays, KS.

Address signals

The row-address and column-address signals start the processes that select the proper row and column for forming a byte. During the actual address, the row-address signal initially causes each multiplexer in the circuit to choose between a logic 1 and a logic 0. This selection places either group of bits on the multiplex bus. Not surprisingly, this operation fulfills the definition of multiplexing — the process of alternately putting different signals on the same bus lines. Through the multiplexing of the row-

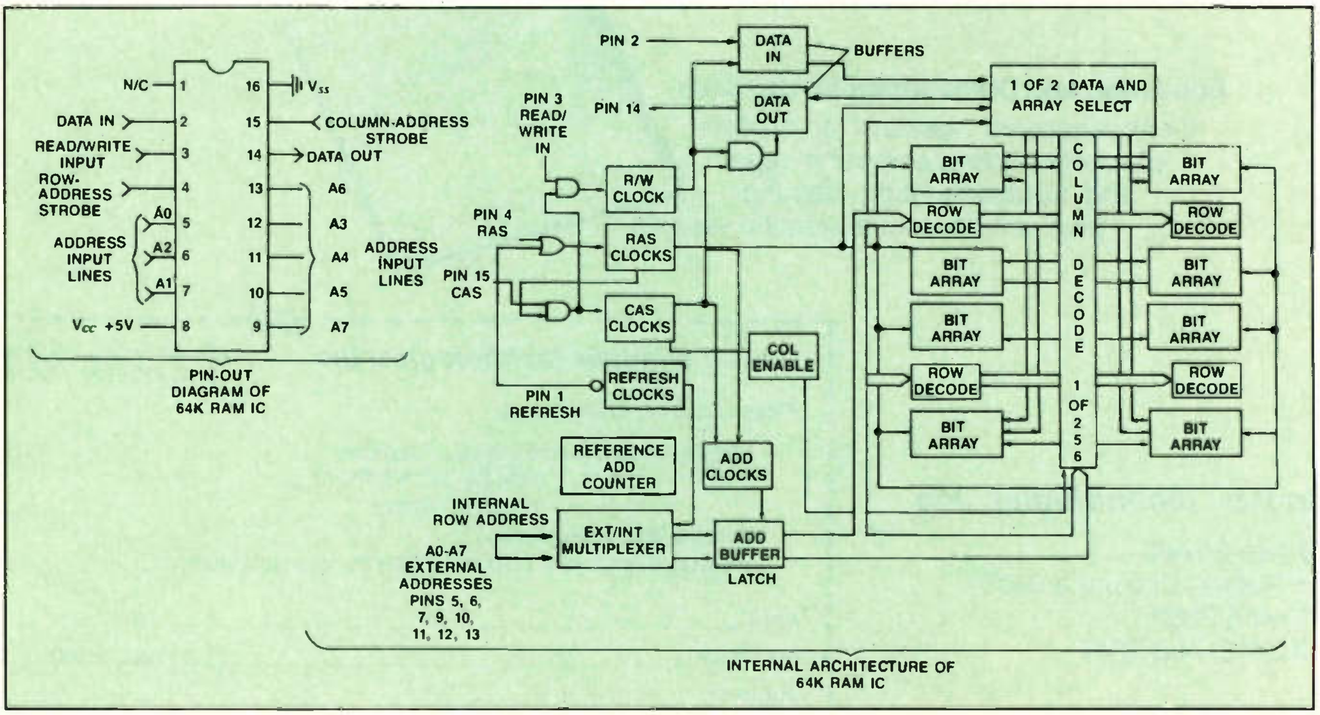


Figure 1. The Zenith memory card contains five banks of memory ICs. Each bank contains either nine ICs or nine sockets that allow the addition of more ICs. Figure 1A shows the pin-out connections of the memory IC. Figure 1B shows a block diagram of the internal structure of the IC.

and column-address signals, the memory device can first latch onto the eight most significant bits and then onto the eight least significant address bits from the input/output address bus. This seemingly simple operation sets up the row and column selection.

To see how this comes into play, we could consider a 64K memory IC as one large 256-by-256 matrix. Remember that each data RAM chip has 256 rows and 256 columns of bits. Multiplying 256 by 256 yields 65,536. One K in the jargon of logic is actually 1,024, not 1,000. Dividing 65,536 by 1,024 yields 64. Thus, a RAM chip that contains a 256-by-256 matrix is a 64K chip. This 64K memory IC stores more than 65,000 single-bit words; the 256K chip (a 512-by-512 matrix) stores almost 280,000 single-bit words.

Row-address strobe, multiplex-timing and row-address signals work together to gate the least significant bits onto the multiplex address bus. Before the signals are applied to a bank, the program address logic (PAL) IC, U455, determines the correct bank for an address. The PAL also acts as a traffic controller for any data information that flows between the address and databuses of the system and the memory circuitry. By latching onto these bits, the selected bank chooses one of the 256 rows.

After the row selection, the column selection begins. Here, column-address strobe timing, column-address strobe and row-address signals team up to latch the most significant bits onto the multiplex bus. The selected bank latches those bits off the bus and uses them to choose one of the 256 columns of the bit matrix. When the gating occurs and the bits from the selected rows and columns of the eight ICs in the bank combine, the data-information byte forms.

If you look at the RAM IC illustrated in Figure 1, the function of each signal

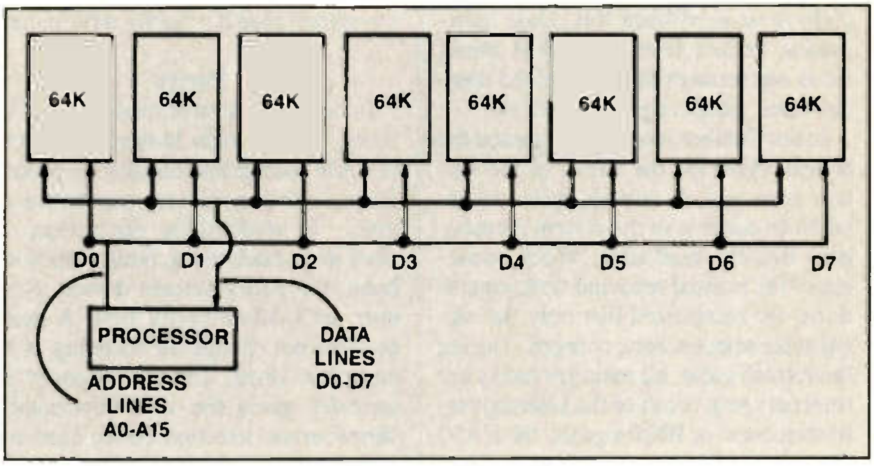


Figure 2. This block representation shows the eight data information storage ICs connected without the extra parity IC. The first eight ICs in the bank work sequentially as the storage devices; the last chip serves as a parity storage device.

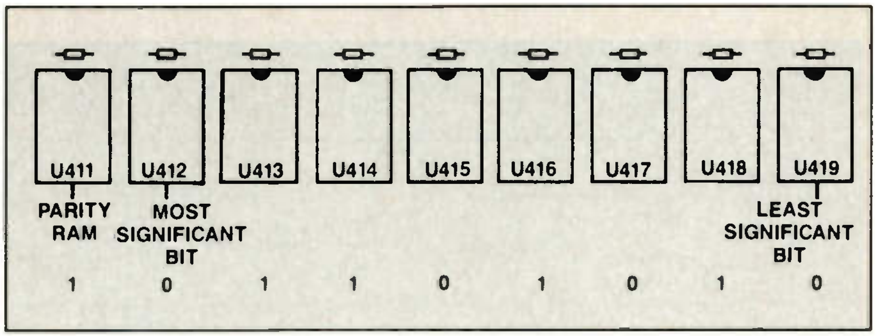


Figure 3. This is a sample bank of memory and a byte of information that might be stored in it. The typical Zenith numbering system will show that ICs U412 through U419 serve as the addresses and that U411 serves as a parity storage. U419 gives the least significant bit and U412 supplies the most significant bit for the 8-bit information byte. Any access to the sample bank will cause each chip to contribute either a logic 1 or a logic 0 to the byte.

and how it affects the operation of the RAM becomes readily apparent. Once again, the example of one IC represents the functions of eight RAM ICs in the bank. After the address decoder IC uses the I/O address bits to decide which row-address strobe line to enable, the column-address strobe signal arrives. Decoding the address bits that arrive at pins 4 through 7 of the memory ICs determines the logic needed for the bank selection. A normal read or write condition will cause the row-address strobe signal found at pin 4 of only the memory ICs in the selected bank to go to a digital active low state. Multiplexed address bytes are applied to pins 5, 7, 12, 11, 10, 13, 9 and 1 of the 256K memory devices. In a computer that uses 64K ICs, no multiplexed signal is needed at pin 1. 256K chips will have a signal at pin 1.

As the user of the microcomputer types information on the keyboard, the information becomes data written into the memory banks. The RAMSEL (RAM-select) signal logic must appear as a digital active low for any data transfer to take place. If the RAMSEL signal reaches an active high, the tri-state data buffer, U470, will go to an off state. An inactive tri-state buffer will block the flow of data from either direction. A digital active low state at pin 3 of the memory devices, the write-enable signal, allows the memory bank to accept written data. In this case, the tri-state buffer gates data from the I/O bus to the system RAM. A digital high state at pin 3 sends the bank into the opposite read state. During the read condition, the tri-state buffer gates the information data from the system RAM to the I/O bus. Figure 4 shows the waveforms displayed during the read-write/read-modify-write cycle.

Illustrated at pin 4 of the ICs, a logic zero row-address strobe signal causes the selected bank to latch onto the eight least significant bits found on the multiplex bus. Seen as a logic 0 at pin 15 of the random-access devices, the column-address signal tells the bank that the RAS* has selected to latch onto the eight most significant bits. Data information to and from the RAM banks feeds out through the data-in and data-out lines found at pins 2 and 14.

In the October issue, we discussed the refresh cycle for the banks of the system memory. A refresh cycle occurs when an address in the system memory goes into the read state. When speaking of the normal read and write operations, we recognized that only the signal at the selected bank changed. During the refresh cycle, all memory banks are selected. As a result of the interrupt refresh request or IRQ0 signals, the RAS0 through RAS4 signal found at pin 4 of every chip in all the banks goes to a digital active low state. Figure 5 depicts the waveforms seen during the refresh cycle.

Parity

In our discussion of memory chip activity, we have only looked at the actual RAM storage and transfer operations. Several other necessary operations remain. To study those operations, we need to go back to the ninth chip in the bank, the parity storage device. However, let's define parity first. A parity bit does not change the meaning of the computer word. The use of parity essentially gives the microprocessor a simple error-detection device used during memory circuit operation. An odd-parity error check detects problems with the 9-bit word consisting of the MD0 through MD7 bits plus the parity bit MD8 at pin 14 of the data storage ICs.

Figure 6 gives a pictorial representation of parity-bit generation and checking. Each byte of data information requires eight bits plus the ninth parity bit.

A parity bit does not change the meaning of the computer word. The use of parity essentially gives the microprocessor a simple error-detection device used during memory circuit operation.

As the microprocessor writes new information to the memory, the parity circuit determines the parity of the eight bits and stores that bit in the ninth location. When the processor begins the read sequence for the byte, the parity circuitry again determines the parity and compares it to the already stored parity bit. In any microcomputer system, the chance exists that one bit may change its logic state during the transfer to and from a memory location. If the "beginning and after" parity bits differ, the parity circuit sends an interrupt to the microprocessor. With the interrupt, error messages appear on the monitor display.

Zenith, like most of the microcomputer manufacturers, employs odd parity as a checking method. Odd parity produces a binary word that has an odd number of ones by adding a one to the data information that has an even number of ones. When a technician uses an oscilloscope or a logic analyzer to check the operation of the memory circuit, naturally he looks for some type of change. When odd parity is used to check the quality of the binary word, a change in signal occurs. If the byte contains all zeros, the signal would resemble a line frozen at zero. Odd parity ensures that at least one bit of the word will exist as a one. Unfortunately, the parity bit, whether odd or even, only detects an odd number of errors. Any detection of errors involving the 2, 4, 6 or 8 bits of the word will require more sophisticated diagnostic tools.

Although the circuitry involved with parity generation and error detection seems similar to other circuitry already discussed, some fundamental differences also appear. Most notably, the parity-storage IC, the same type of circuit as the data-storage IC, has pins 2

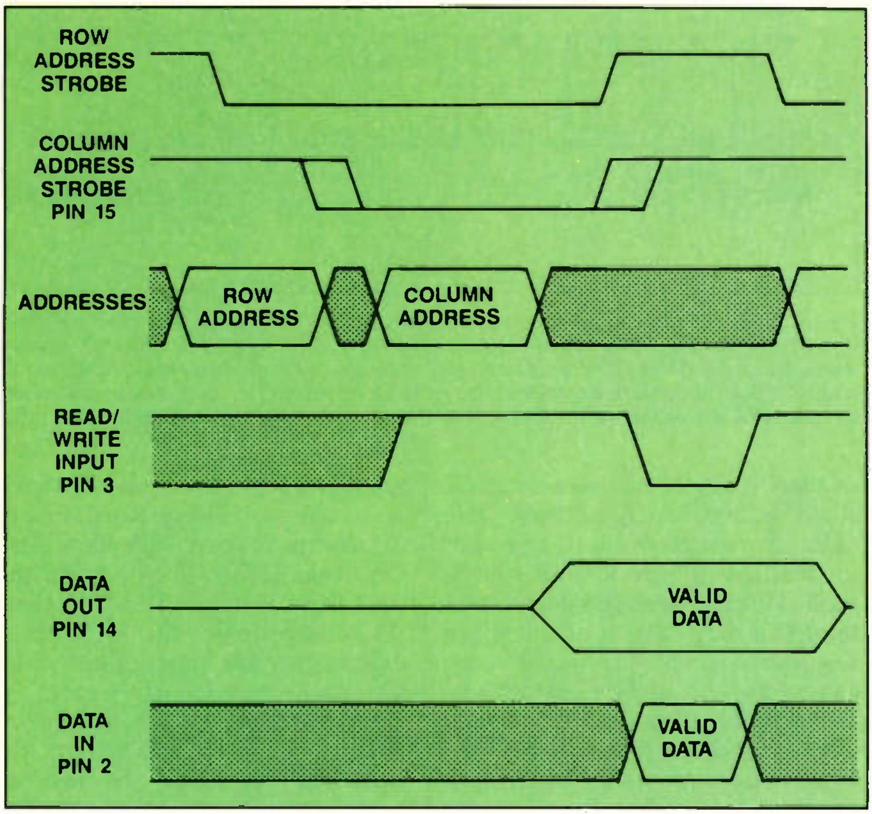


Figure 4. These waveforms are displayed during the read-write/read-modify-write cycle.

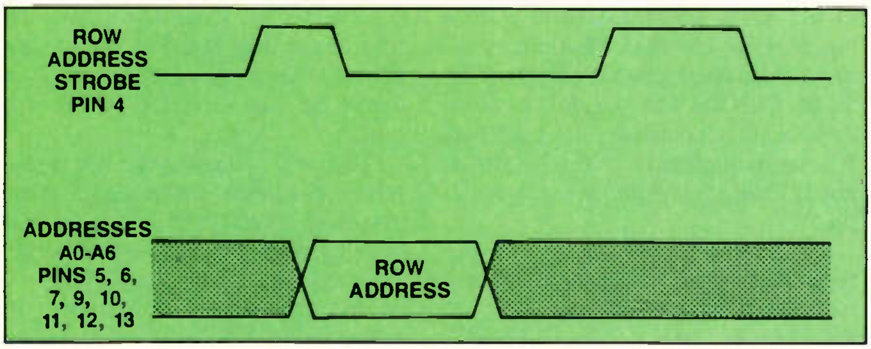


Figure 5. These waveforms are seen during the refresh cycle.

and 14 electrically separated. In the data-storage memory IC, these pins tie together. Pin 2 provides the entry tie point for the parity bits; pin 14 provides the exit tie point for the parity bits. The data word through the memory data bus is applied sequentially to pins 8, 9, 10, 11, 12, 13, 1 and 2 of the parity generator, U451. A digital logic 1 signal appears at pin 4 of the parity generator as the data RAM outputs go to an inactive state and pin 14 of the parity RAM goes to +5V. Here, the parity checking begins. If an even number of ones appear in the data information byte, a logic 0 or *even* signal shows at pin 5 of U451. Figure 7 shows an example of a data word that contains an even number of ones along with the addition of the parity bit. U457, a NAND gate, sees the logic 0 at its pin 4 and inverts the signal to its pin 6. From there, the logic 1 goes to pin 2, the data output, of the all-parity RAMs. If the data string contains an odd number of ones, the opposite digital signals show at the respective pins of U451 and U457. As the selected memory address location stores the 8-bit data word, it also stores the generated parity bit, which guarantees an odd number of ones.

If some condition, such as a power-supply-induced noise spike or an imperfect databit, occurs, U451 senses the mismatch and places a logic 1 signal at pin 5. Remember, the circuitry compares the stored parity bit from the write operation with a recalculated value generated during the read operation. Figure 6 supplies a block diagram of the parity comparison check. This logic 1 causes the NAND gate to reset a dual flip-flop. U464, a hex inverter, inverts the digital active-high output of the flip-flop and applies the signal to the I/O channel check line as an active-low parity error.

Troubleshooting parity errors

If repeated parity errors occur, the parity circuitry provides an easy-to-troubleshoot test point. Not surprisingly, the mention of parity-error detection brings us to circuit diagnosis. When parity errors repeatedly occur, check the data random-access system memory for any possible errors. Connect a logic analyzer to all bits. Then you can manually calculate the correct value of the databit from the data information present and compare the value of the correct parity bit against the value of the generated parity bit. If this step suggests that there are problems in the parity-generation and error-detection circuitry, you can then disable that circuitry with

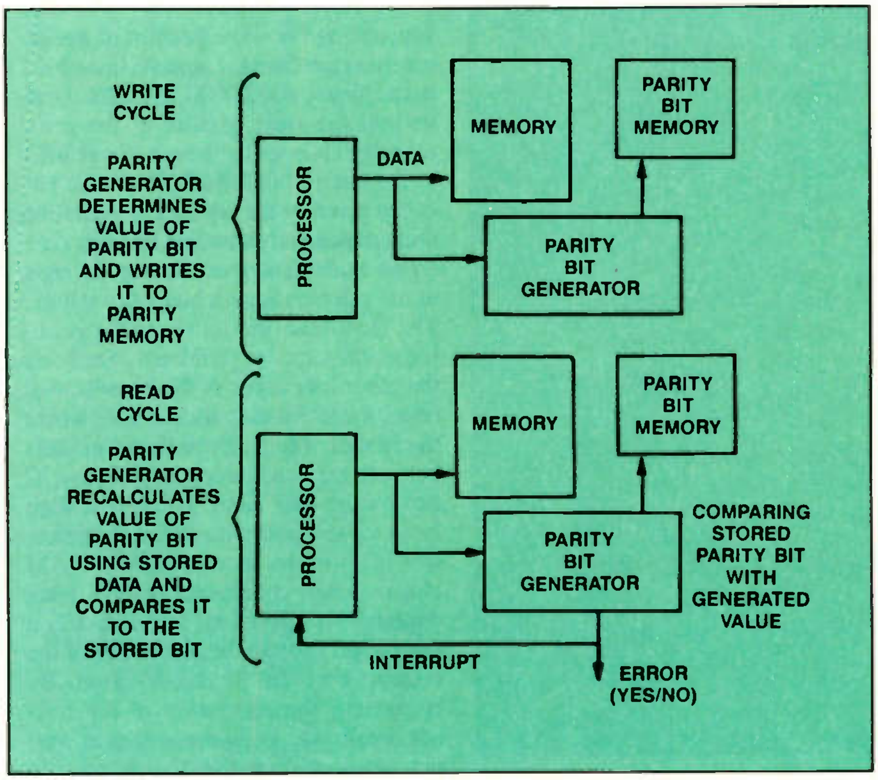


Figure 6. In this representation of parity-bit generation and checking during read/write cycles, each byte of data information requires eight bits plus the ninth parity bit.

I and O debugging commands. Working from the Monitor ROM internal test program, a technician uses the O debugging value to output a value to the location of 100 hex or the parity disable port. A one will disable the parity check circuitry, a two will disable the parity generation circuitry, and a three will disable both areas. With the use of the I debugging command, you can cause a parity read condition to occur, because this command causes the input of data from the port.

The first thing to do is make sure none of the components in the data storage circuitry are defective. Diagnostic software routines can help by writing data to the RAMs, then reading this stored data back out and comparing the read data with the original written data.

A number of diagnostic routines are available. For starters, a built-in set of checks test the memory card. If these initialization tests find an error, they generate an interrupt, a display that gives the defective IC designation (such as U449) and the hexadecimal address.

If repeated RAM errors appear, you can use the unique set of monitor ROM-based tests that Zenith supplies. You can access these tests by simultaneously pressing the Ctrl, Alt and Insert keys. At the prompt, which appears after pressing these keys, type "test," then choose the option for checking the system memory. This test sequence will exercise the system memory, although it is slow.

If the test sequence uncovers a suspected IC, a hexadecimal address will appear at the display. As with the checking of the parity circuitry, you can use debugging commands, such as E for entering a hexadecimal address and F for filling the hexadecimal address at the monitor ROM level. Using these debugging commands, you can force the RAM circuitry to operate as it would if normal operating conditions existed. With an oscilloscope or a logic analyzer, you can monitor activity at a suspected bank or IC.

As the test routine progresses through its checks of the memory circuits, the monitor may display a suspect hexadecimal-based address such as 00E1:20E1. You can convert this hexadecimal code back to its original binary form to find the location of a possible defective memory IC. Each portion of the code helps indicate the location of the address error. The left-hand set represents the segment number; the right-hand set represents the offset. The segment portion of the error message identifies the bank that failed. The offset shows the defective internal address of the defective chip.

If you use the write/read address 00E1 20E1 as an example, a hexadecimal-to-binary conversion follows this format:

0/0000 0/0000 E/1110 1/0001
2/0010 0/0000 E/1110 1/0001

Converting the *write* portion of the error message changes hexadecimal 00E1 to the binary 0000 0000 1110 0001. Converting the *read* portion of the error message changes the hexadecimal 20E1 to the binary 0010 0000 1110 0001. The codes given by the write/read operation don't match and show that an error condition exists. The four zeros to the right of the colon indicate a boundary failure. The technician should check for possible configuration problems. Studying the other four digits of the hexadecimal code, the technician should note where the first digit falls. If the first digit falls between zero and three, the defective IC lies on the first bank. If the first digit has a value higher than three, the defective IC is in the second bank of RAM chips. After concluding which bank contains the possible defective IC, a technician can use the remainder of the code to find the IC slot location. By converting the remainder of the hexadecimal code to binary and then simply counting from the designated zero RAM location, a technician can find and replace the defective IC.

Data word with an even number of ones

Bit	A7	A6	A5	A4	A3	A2	A1
Logic value	0	1	0	1	1	1	0

Figure 7. During parity checking, if an even number of ones appear in the data information byte, a logic 0 or even signal shows at pin 5 of U451. This figure shows an example of a data word that contains an even number of ones.

Problem areas in memory-address logic circuitry

Problem:
Wrong bank selection.

Solution:
Replace U455, the program-address logic IC.

Problem:
Repeated error indication at the same memory address location.

Solution:
Replace U465, U473 and U474 multiplexers.

Problem:
A column-address strobe-gate logic error causes wrong high-order addresses.

Solution:
Replace U467 (OR gate), U468 (dual flip-flop) and U469 (tri-state buffer).

Problem:
Data dropout affects system memory.

Solution:
Replace the U470 tri-state data latch.

Figure 8. The repeated display of the same memory address location generally will point to some area of the memory-address logic circuitry. These are the probable suspect areas in that circuitry.

Commercially available diagnostic test routines also can help service technicians. Available in either 3½-inch or 5¼-inch floppy-disk formats, the diagnostic disks contain tests for each section of the microcomputer. The diagnostic test disks are one of the most valuable tools for the technician. Procedures performed in the other simple test routines, such as the monitor ROM and debug routines, work automatically. Considering the memory section, the diagnostic test routines check the parity-generation and error-trapping circuitry and the data RAM circuitry. Each check of the RAMs fills the IC banks so that an operating condition occurs and then initiates the read and write cycles. Systematically running each bank through a series of tests completely exercises each IC and helps to expose the suspect chip.

After isolating the problem to a defective memory IC location, you can substitute a known-good RAM IC for the suspect IC. If you don't have a memory device in stock, you can switch the suspected IC with any good IC in the random-access banks. (Remember to use the proper anti-static precautions. Semiconductor memory devices have a high sensitivity to static.) If the microcomputer again stalls during start-up and the same memory address appears on the screen, you know it wasn't the RAM chip, so you can look elsewhere. The repeated display of the same memory address location generally will point to some area of the memory address logic circuitry. Figure 8 lists probable suspect areas in that circuitry.

The memory circuits constitute one of the more complex sections of the microcomputer. Because of technological advances, the look and feel of the memory section has begun to change. With the advent of new IC technology, DRAMs have increased in capacity and have diminished in size. Microcomputers with a memory capacity of 4Mbytes have become more common. Today, many microcomputers feature single in-line memory modules (SIMMs). Instead of featuring an entire memory card, the microcomputer chassis features each bank of non-removable ICs on a small removable card that plugs into a motherboard. The same criteria that apply to the older style RAMs apply to the newer memory devices.

In Part VII, we will take a look at the video section of the microcomputer, and we will again see a use for the memory circuits. ■

Answers to the quiz

Questions are on page 12.

1. D — both represent a constant-current diode. You may have seen only one of these symbols, but you should know both.

2. C — neither. A neon lamp requires about 65V to fire. The 12V ladder won't do it. Exchange the neon lamp for an LED.

3. Crystal (also known as crystal input), regenerative, super regenerative, TRF, single conversion (also called homodyne), reflex. All of these types of receivers will be discussed in "What Do You Know About Electronics?" in future issues.

4. Direct coupling, transformer coupling, impedance coupling, R-C coupling.

5. D — all refer to the same kind of circuit.

6. B — it must be non-linear. You cannot heterodyne signals in a linear device.

7. C. On the positive half-cycle of input, the diode conducts and there is 0V across the output terminals. On the negative half-cycle, the diode represents an open circuit.

8. C — both are correct. Motorola calls it a PIA (peripheral interface adapter), but other manufacturers call it a PIO.

9. I stands for intrinsic. In other words, that material has no other material in it. You can call it pure.

10. A — the top of the container. The dielectric constant of air is 1.0, so when the tank is full, the dielectric constant is higher. That makes the capacitance higher and the frequency lower.

Report from the test lab

The PA81 stereo power-amplifier analyzer

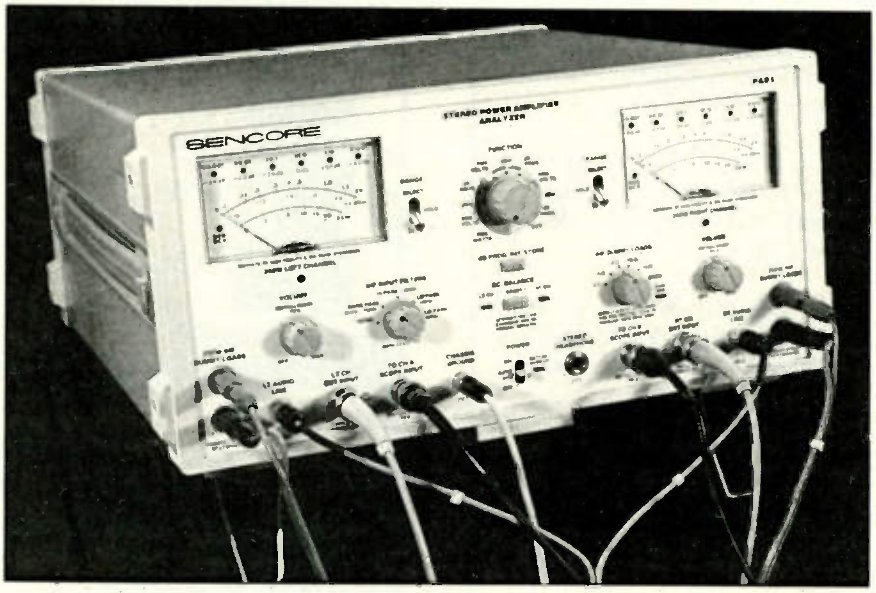
By Carl Babcoke

The model PA81 power-amplifier analyzer from Sencore dynamically tests stereo amplifiers with power outputs up to a total of 500W, measured according to Electronic Industries Association/ Institute of High Fidelity (EIA/IHF) standards. Many unique testing functions and techniques also are included for quick, dependable troubleshooting of hi-fi stereo circuits.

Here is a partial list of features and functions:

- Twin autoranging analog meters (one for each channel) each have six ranges with LED range indicators.
- The user can measure rms audio power to 100W per channel for continuous operation or 500W for intermittent operation.
- The automatic dcV-Balance monitor system has an LED for each channel. The LEDs light red and blink every second if more than ±1V appears at the input to the dummy-load resistors. A relay also disconnects the analyzer's malfunctioning input signal from its dummy resistor within 50ms.
- An open circuit or one of five dummy-load resistances can be selected by the Dummy-Loads switch.
- The user can choose one of four input-frequency filters or no filter.
- For signals entering the left or right audio-lines inputs, the Function switch offers ac measurements of rms acV, dBm or dB Prog (programmed) at 10kΩ input impedance. The purpose is to test standard audio lines.
- For signals entering the external inputs, the Function switch can select rms acV, dBm, dB Prog or dc-voltage measurements. This is the only function having dcV. These functions are for signal tracing and troubleshooting almost anywhere. Input impedances for ac voltages are 1MΩ; dc voltages have 15MΩ.
- For signals from the dummy-load resistors (amplifier's output), the Function switch offers rms watts, rms acV, dBm and dB Prog.
- All types of decibels have the same voltage or power ratios, but those with letters following the dB have specific reference levels. Most decibels in the analyzer are measured by the dBm standard where 0dBm equals 1mW across a 600Ω load (which calculates to 0.775Vrms). Programmed dB readings depart from the zero reference of the dBm standard and, therefore, are given in dB, not in dBm.
- An Over Temp indicator lights when the internal temperature becomes excessive. A fan gives sufficient air circulation to maintain a safe temperature. A total audio power up to 200W is dissipated continuously in the dummy-load resistors. Higher powers require limited operating times.
- Two internal speakers with volume controls, driven by internal amplifiers, are available for each channel. These volume controls are not entirely responsible for controlling the huge span of sound from a whisper to perhaps +35dBm (45Vrms) at 250W per channel that is obtained at maximum power. Sencore has provided a tie-in with the autoranging circuitry so both channel volumes are reduced or increased in 20dB steps.
- Power for the unit can be obtained from one of three sources: a power adapter that operates from 105/130Vac lines and can recharge the optional battery; a fused cigarette lighter plug for 12V operation; or a rechargeable battery pack, which is good for about five hours of operation.
- The analyzer comes with a 13-page instructional pull-out chart.

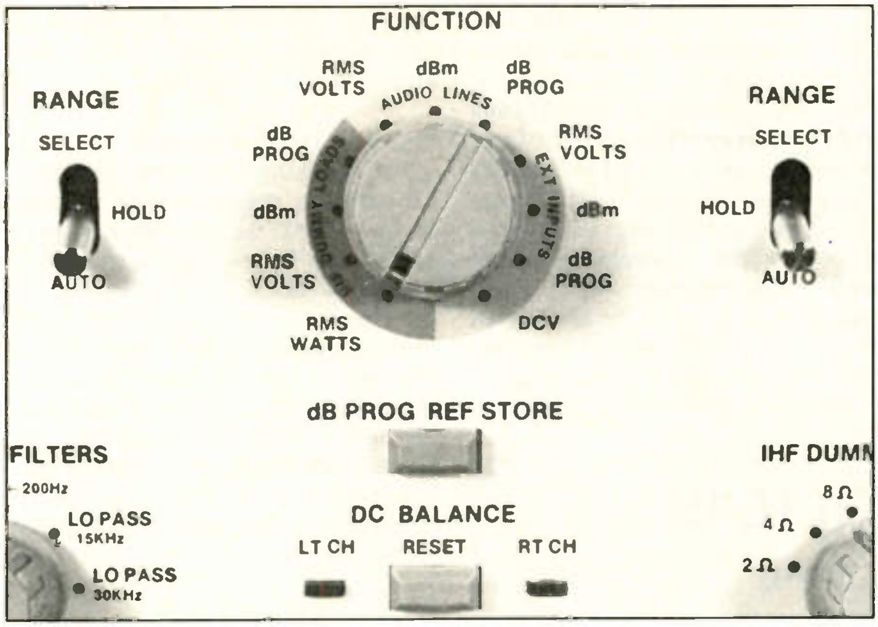
Babcoke is the Consumer Servicing Consultant for ES&T.



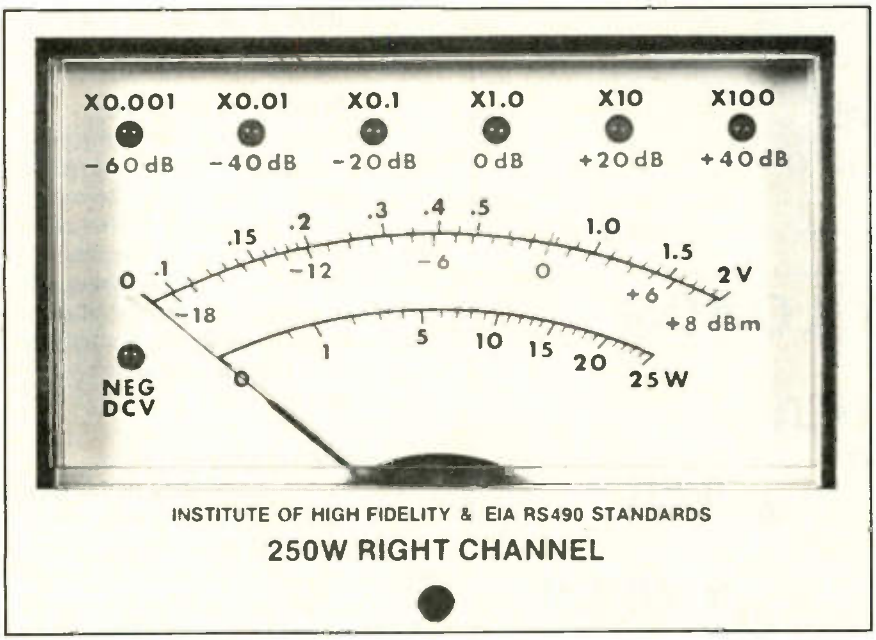
The front-panel layout is both practical and attractive. All operating switches and controls are placed widely apart, leaving plenty of working room. A black dot on each knob plus the large black letters and figures are so legible that you can read all functions and ranges from 5 feet or so.

The dB programming feature

When you want to use a reading from the unit you're testing as a 0dB reference for a measurement at another test point, you use dB Prog. Whatever sig-



All three external components of the dcV-Balance feature are located on the front panel below the Function switch and the dB-Prog-Ref-Store push button. A dc voltage higher than ± 1V from the amplifier that is connected to the dummy-load resistors opens the circuit between amplifier and load resistors. Also, an LED blinks to warn of a defect and show which channel is affected. The two Range switches are between the Function switch and the meters on both sides. Each switch controls the method of range selection for its respective meter.



Analog meters supply all numerical readings. One advantage of the electronics that drive the meters is the need for only three calibration scales on two arcs. Another advantage is the nearly linear dB calibration scale. Also, an overload does not "pin" the pointer.

nal level is being measured when the Store button is pushed becomes the new 0dB reference, and subsequent dB Prog readings are relative to this new 0dB. Both channels undergo programming simultaneously, but they can have different 0dB references.

This feature is useful for troubleshooting, such as checking the gain of a transistor or the gains or losses of cascaded stages.

Remote operation

Tests can be automated by using the model IB72 IEEE 488 bus-interface, which connects between the PA81 and a controller or automated system.

In the basic "talker" mode, a technician selects the desired functions and ranges. The resulting readings are sent to the IEEE interface through an IE233 bus cable.

As a "listener," the PA81 receives

commands from the controller to select certain functions or ranges. In this mode, the panel controls are locked out electronically, and the controller automatically steps the unit through the required tests.

The third mode is a combination "talker/listener." All functions except the dummy-loads resistances and the volume controls can be controlled via the bus interface.

Versatile external inputs

In several important ways, the two external inputs are different from the other two functions from the same switch. First, dc voltages can be measured, along with the usual rms acV, dBm and dB Prog functions. Also, the Ext-Input grounds are not connected to each other or to chassis ground. These independent grounds add flexibility during troubleshooting. For example, one input probe can be connected across a transistor's base resistor and the other across its collector resistor without one reading having any effect on the other.

The isolated grounds also help broaden the areas suitable for dcV testing because both external probes can be used on the same channel.

Isolated grounds

For maximum safety and flexibility, the unit has several sets of isolated grounds. First, the conventional chassis grounds: The two audio lines cables, two scope cables, one stereo jack and the chassis-ground post are connected to the frame and chassis ground. The two sets of binding posts for audio-power input to the dummy-load resistors are not grounded to the chassis, nor to each other. The two external-input grounds are not connected to anything on the panel, the chassis ground or to each other.

Unusual meters

Although the twin analog meters might appear ordinary, they're not. The meter faces are only a small part of each meter's circuitry. IC-based circuitry controls the meters. These ICs are why some functions can have as many as six ranges, although each meter's face has only three scales.

Self-test at power on

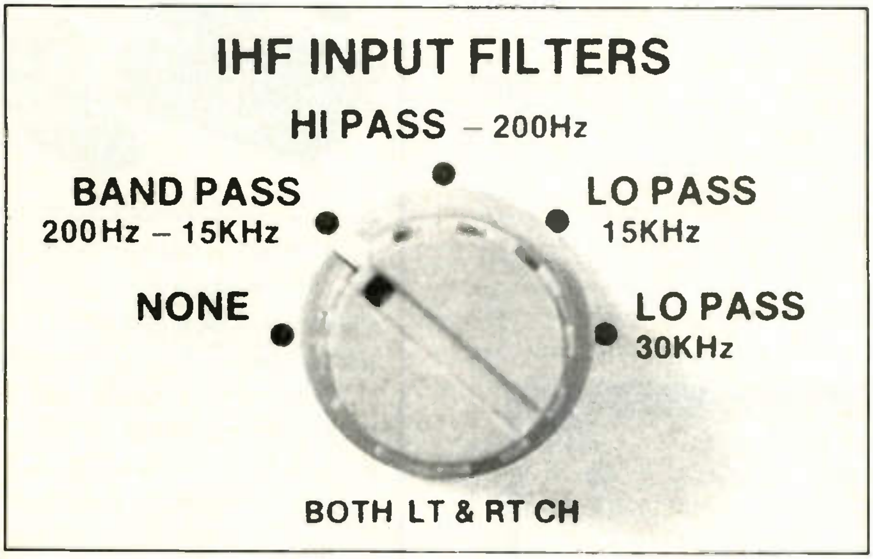
Immediately after power is switched on, the meters produce quite a visual show. The first time I used the meter, I noticed that the display activated all the LEDs, and the meter pointers moved smoothly from zero to maximum and back to zero. I initially thought this was caused by power-on surges, but nothing appeared to happen randomly. I concluded that this was a self test.

Autoranging surprises

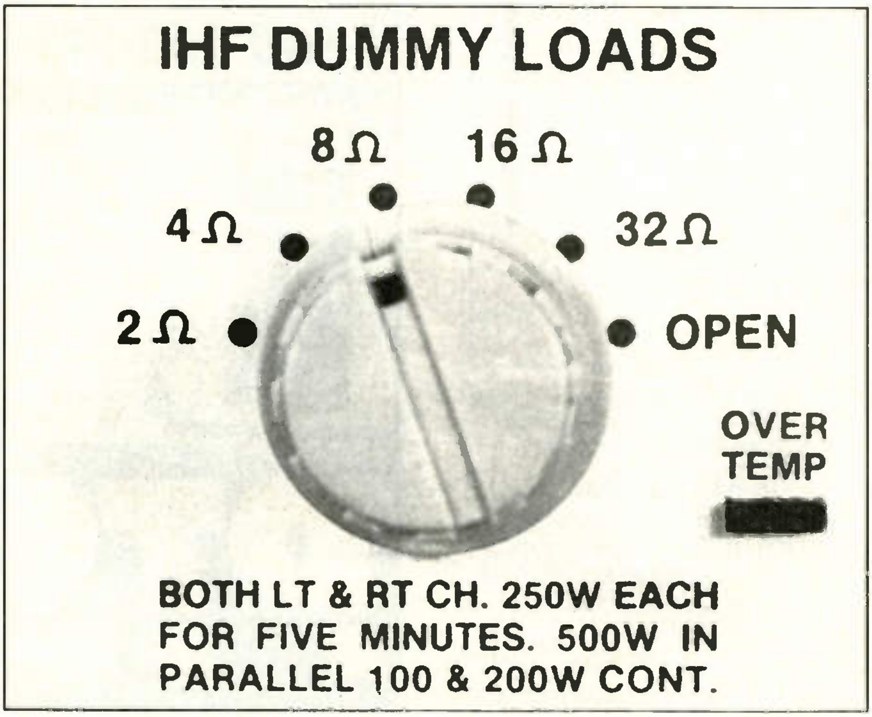
With analog autoranging in this unit, one of the six LEDs shows the range, and the reading is shown by the pointer position vs. the range value. Both digital and analog autoranging are equally easy to use and to obtain a reading. With analog, the pointer can show quick changes of audio, but without the frantic search for a stable reading that is common with digital meters.

The scope's input level and the internal-amplifier sound volume are tied to the steps of the autoranging. This eliminates many adjustments of scope gain controls and the volume controls.

Each meter has a Select/Hold/Auto toggle-type, 3-position range switch. Moving the toggle to the down position, where it locks, activates the autoranging for that channel. With Auto, the



Specifications for the four input filters are in agreement with the IHF standards.



Five load resistors of IHF values are selected by the IHF Dummy Loads switch for both channels. Each resistor can tolerate power dissipation of 100W (per channel) indefinitely, and for gradually reduced times up to a maximum of 250W per channel for five minutes.

analyzer selects the proper range and stops there during a measurement. When the probe is removed from the circuit, the meter downranges to the minimum range and remains there until the next test.

The switch's center position selects the range-hold condition that locks in whatever range is in use, thus overriding the autoranging. When a specific range is needed, use the Select position of the switch to move the range-multiplier LED up one position for each time the momentary-contact switch toggle is moved upward.

Manual ranging by the Select switch operates only for upranging. During Auto fully-automatic operation, however, the internal circuits supply downranging as well as upranging.

Learning about autoranging

Upranging is triggered when an increasing signal reaches the +8dBm calibration line on the dBm scale, regardless of the range in use. This upranging operation ends with the next higher dBm range at the −12dBm line.

Downranging is triggered when the signal level is decreasing and reaches the −15dBm line on the dBm scale, regardless of the range in use. Downranging ends on the next-lower range at the +5dB line.

Coverage from one upranging to the next is 20dBm (12+8=20); the coverage between downrangings also is 20dBm (15+5=20). These ranges give complete decibel coverage. However, the dBm scale has calibrations down to −18dBm, so there are three extra dBms that can be used in manual operation by the Select and Hold switches.

The difference between −12dBm and −15dBm at the low end and +8dBm vs. 5dBm at the high end of each range is the hysteresis that prevents unstable autoranging triggering.

Input IHF filters

Five positions are available from the IHF Input Filters selector switch:

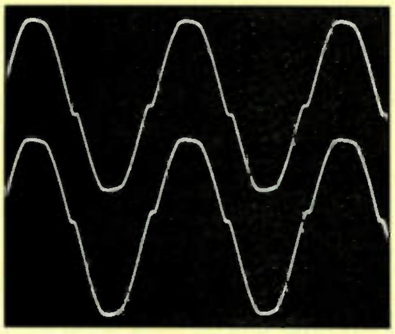
- No filters provides a flat frequency response from 0Hz to 200kHz.
- Bandpass filter circuits pass all frequencies between 200Hz and 15kHz.
- Hi-pass filter circuits pass all frequencies between 200Hz and 200kHz.

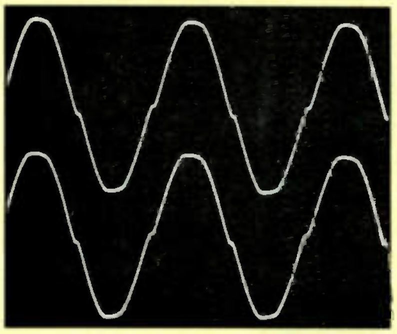

When 120Vac power is not available, a BY234 rechargeable 12V battery can be used to power the unit for up to five hours.

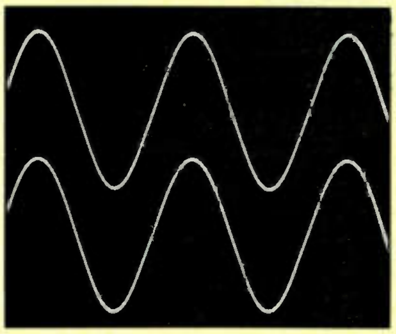
- The lo-pass 15kHz filter passes all frequencies below 15kHz, including the below-200Hz hum area. This filter forms a good pair with the bandpass filter for measuring 120Hz and 60Hz hum in the amplifier's output.
- The lo-pass 30kHz filter passes the audio spectrum below 30kHz. It is useful for removing digital-clock noises above 30kHz without obscuring the CD test material or the music's harmonics.

Repairing a tube-type amp

These waveforms were produced during final repairs of an old tube-type stereo amplifier. In the first photo, both positive and negative tips are rounded. That is typical of mild overload with tubes (whereas transistor amplifiers usually have sharper edges at the clipped tips of the sine waves). In the second photo, notch distortion near the sine waves' vertical centers is excessive. In the third photo, the sine-waves' positive and negative peaks of channel 2 (bottom trace) are not symmetrical, probably indicating one weak 6BQ5 output tube or stage. After the tubes were more nearly matched (no new ones were available). the powers of both channels and the waveforms were nearly identical, as shown in the second photo. Notches near the vertical centers were caused by the overbiased output tubes failing to draw current quickly enough at the beginning of each peak. The notches disappeared and the flat tops filled out as the power was slowly decreased. The third photo shows the undistorted sine waves produced by reducing the output power slightly.







One filter application is removal of the 19kHz pilot carrier from FM-receiver audio signals. Either the 20Hz-15kHz bandpass or the 10Hz-15kHz lo-pass filters will reduce the 19kHz carrier's amplitude by 30dB or more. Another filter (30kHz lo-pass) removes the digital-clock noise from the audio signals of compact discs, providing better accuracy during separation tests. There is no hum filter, but the hum can be calculated easily.

Dummy loads

The dummy-load resistors have the following specifications:

- Values are 2Ω, 4Ω, 8Ω, 16Ω and 32Ω, ±1% (IHF specifications).
- Position six of the Dummy-Loads switch opens the load circuit. This feature helps identify tendencies toward oscillation or other instability, which often is more severe with no load.
- The reactance of any dummy-load resistor is lower than 10% at all frequencies lower than 200kHz.

Lab tests

I decided to test two amplifiers: a 45W per channel, transistorized AM/FM-stereo with digital tuning and readouts; and a 30-year-old tube amp. (For a detailed description, see the sidebar.) I used the analyzer to perform minor repairs on this amp, which gave me an opportunity to use rms watts, the audio input lines and the external inputs, plus functions of rms volts, dBm and dcV during the repairs.

Although the analyzer can perform many tests well, the capability to test stereo-amplifier high-wattage powers easily and accurately is perhaps the most important.

Here is a streamlined method for testing the powers of stereo amplifiers, including the pre-setting of amplifier controls and analyzer adjustments:

- Connect an external audio generator to the amplifier's AUX inputs.
- Connect the amplifier to the dummy-load.
- Adjust the amplifier's tone controls, including subsonic and loudness, for flat bass and treble response.
- Adjust the Dummy-Loads selector to match the amplifier's rated output impedance.
- Adjust the IHF Input-Filters switch to 200Hz-15kHz bandpass.
- Rotate the Function switch to rms watts.
- With shielded cables, connect the PA81's scope outputs to your dual-trace scope's inputs.

The actual amplifier-power measurements usually are performed quickly and easily according to the following steps:

- Slowly increase the signal level of the 400Hz sine waves while you watch the rms-watts range on both meters. These readings should increase slowly and remain approximately equal. Notice the upranging at 25W. Continue slowly increasing the level until the scope shows a small amount of sine-wave peak clipping.
- Reduce the level until the clipping barely disappears. With or without clipping, the sine waves should be free from oscillation, distortion or ringing.

Record the two wattage readings.

PA81 specifications

- The rms watts function for the stereo channels covers 0W to 250W in two ranges: 0W to 25W and 0W to 250W. The accuracy is ±3% of range full-scale at 1kHz with an 8Ω load.
- Dummy loads: 2Ω, 4Ω, 8Ω, 16Ω and 32Ω, ±1%, plus open; reactance lower than 10% below 200kHz; rated for 100W of continuous power or 250W of intermittent power per channel.
- Channel separation is better than 100dB at 1kHz.
- rms volts covers 0.2mVrms to 200Vrms in six ranges for audio line and dummy-load inputs. For external inputs, the 0.2mV range is deleted. The accuracy of these ranges is ±2% of range full-scale; the frequency response is 20Hz-20kHz at ±2%.
- dBm covers −72dBm to +48dBm in six ranges for audio-line and dummy-load inputs. The range from −72dBm to −52dBm is deleted for external inputs. Accuracy is ±0.5dBm at 1kHz; the frequency response is 20Hz to 20kHz with a variation of only ±0.2dBm.
- dc volts covers 0V to ±200Vdc in four ranges for external inputs only. Accuracy is ±3% of range full-scale.
- Impedance of the audio line inputs is 10kΩ paralleled by 100pF.
- External-inputs impedances are 1MΩ for ac tests and 15MΩ for dcV tests.
- Scope levels are 2V ±5% rms when the meters are reading full scale.
- Dimensions are 7″×14″×16.7″ (HWD); weight is 15.8 pounds (17.2 pounds with battery).
- Power drawn from the 12V source is about 4.2W; from the 120Vac source, the power is less than 26W. ■

	Profax Number
RCA KCS B&W AM/FM/clock	2053
Hitachi NP8IX chassis	2054
January 1985	
GE CM chassis	2055
NEC C13-304A chassis	2056
GE XM-E chassis	2057
February 1985	
GE PC-A chassis	2058
Hitachi CT2516 chassis	2059
March 1985	
GE GK chassis	2060
Hitachi CQ4X chassis	2061
April 1985	
RCA CTC117 chassis	2062
NAP UXC chassis	2063
May 1985	
GE EC-A chassis	2064
NEC DJ-60EN(R) chassis	2065
June 1985	
GE EP-B chassis	2066
July 1985	
GE 19PC-F/H chassis	2067
August 1985	
GE PM-B chassis	2068
September 1985	
NAP EC-31-52, -56 & -58 chassis	2069
RCA CTC118 chassis	2070
October 1985	
NAP E-34-18, -32 & -33 chassis	2071
RCA CTC121 chassis	2072
November 1985	
GE BC-N chassis	2073
GE EP chassis	2074
December 1985	
GE PC-J chassis	2075
RCA CTC126 chassis	2076
January 1986	
RCA MMC 100, video monitor	2077
GE PM-A chassis	2078
February 1986	
GE BC-A chassis	2079
RCA 117 chassis	2080
March 1986	
RCA CTC133 chassis	2081
April 1986	
GE 25 PC(J) chassis	2082
RCA CTC120 chassis	2083
May 1986	
GE HP chassis, tuning & control systems	2084A
GE HP chassis, chroma	2084B
June 1986	
RCA CTC125 chassis	2085
RCA 207 series weather clock	2086
July 1986	
GE NF chassis	2087
GE PM-C chassis	2088
August 1986	
RCA CTC136 chassis	2089
September 1986	
RCA CTC130-S1 chassis	2090
October 1986	
GE X110 chassis, B&W TV	2091
GE TV/AM/FM clock radio	2092
November 1986	
RCA B&W TV basic service data, UVM chassis	2093
GE 14-inch portable color TV, RS-A chassis	2094
December 1986	
GE X110 chassis (cont.)	2095
RCA UWJ chassis	2096
January 1987	
GE color TV, MK-2 chassis	2097
February 1987	
RCA color TV supplement, CTC117-S2	2098
GE color TV, MK-1 chassis	2099
April 1987	
Hitachi color TV, CT2250B, CT2250W chassis	3000
May 1987	
RCA color TV, VDM140 chassis	3002
GE color TV, NF chassis update	3003
GE 5-inch B&W TV, 7-7130A chassis	3004
June 1987	
Hitachi color TV, CT1358 chassis	3005
RCA color TV, CTC135 chassis	3006
July 1987	
Zenith color TV, D13085/D1910B chassis	3007
GE color TV, MK-1 chassis, model 8-1938	3008
August 1987	
Zenith color TV, D2500W chassis	3009
Hitachi color TV, CT2020W, CT2020B chassis	3010
September 1987	
Zenith color TV, SD2501W chassis	3011
Hitachi color TV, CT2250B, CT2250W chassis	3012
October 1987	
RCA color TV, CTC134 chassis	3013
November 1987	
GE color TV, CTC140 chassis	3014

	Profax Number
December 1987	
Hitachi color TV, chassis CT0911	3015
Zenith color TV, chassis SD2097S	3016
January 1988	
Zenith PV800 color monitor	3017
Hitachi color TV, CT1358 chassis	3018
February 1988	
GE VCR, 1VCR2018W model	3019
March 1988	
GE 8-4500 projection TV	3020
April 1988	
NAP projection TV, E54-10 chassis	3021
Zenith color TV, C2020H chassis	3022
May 1988	
RCA PVM050 color TV	3023
Hitachi CT2652, CT2653 color TVs	3024
June 1988	
Hitachi color TVs, CT2647/CT2648/CT2649 chassis	3025
NAP projection TV, E54-15 chassis	3026
July 1988	
GE model 1VCR2006W VCR	3027
Zenith color TV, CM-139/B-0 (B) chassis	3028
August 1988	
Hitachi color TV, CT1344 chassis	3029
NAP color TV, E51-56 chassis	3030
September 1988	
RCA color TV, PVM035 chassis	3031
GE color TV, NC-05X3/06X1 chassis	3032
October 1988	
Hitachi CT3020W/CT3020B color TV	3033
Zenith CM-139/B-3 (I) SD2511G/SD2581H color TV	3034
November 1988	
Hitachi VHS VCR, model VT-63A	3035
NAP RD4502SL/RLC312SL color TV monitors	3036
December 1988	
GE projection TV, PW chassis, model 40PW3000KA01	3037
January 1989	
Hitachi color TV, CT1955, NP85XA chassis	3038
NAP color TV, series 19C2 chassis (Magnavox)	3039
February 1989	
RCA/GE color TV, CTC145/146 chassis	3040
Zenith color TV, CM-140/b-2(G) chassis (models SE2503G/SE2505P, SE2507N/SE2509H)	3041
March 1989	
NAP color TV, chassis E34-11	3042
Hitachi color TV, chassis CT1941/CT19A2, NP83X chassis	3043
April 1989	
GE VHS VCR, model 1VCR2002X	3044
Hitachi CT1955 color TV	3045
May 1989	
Zenith CM-14-0/B-3(I) color TV (models SE2721H/SE2725R/SE2727H)	3046
GE color TV, 1987 CTC136	3047
June 1989	
RCA P42000-S1 projection TV (additional models: RVM46700, 46GW700, P46000)	3048
NAP color TV, chassis E54-15 (Magnavox RD8518 and RD8520; Philco model P8190S; Sylvania PSC410 and PSC420)	3049
July 1989	
Hitachi CT2066 color TV	3050
RCA CTC135 color TV	3051
August 1989	
GE CTC135-S1 color TV	3052
Zenith CM-140/B-2(I) color TV	3053
September 1989	
RCA CSM055 color TV/AM/FM/clock radio	3054
October 1989	
Hitachi CT2086 B/W chassis G7NU3 color TV	3055
Zenith PV4661H rear-projector color TV	3056
November 1989	
GE 1987 8-4500 projection color TV	3057
RCA/GE CTC145/146 color TV	3058
December 1989	
Zenith CM-140/DIGITAL(C) chassis color TV (Models SE3135P, SE3191H, SE3535H, ZB2771H, ZB2771H2, ZB2777H, ZB2777H2, ZB2797P, ZB2797P2, ZB2797Y, ZB2797Y2, ZB3193H, ZB3193Y, ZB3539T, ZB3539Y)	3059

Profax number index — 1982-1989

Profax Number	Month	Year
2000-2002	Oct	82
2003-2005	Nov	82
2006-2007	Dec	82
2008-2010	Jan	83
2011-2012	Feb	83
2013-2014	Mar	83
2015-2016	Apr	83
2017-2018	May	83
2019-2020	Jun	83
2021-2022	Jul	83
2023-2024	Aug	83
2025-2026	Sep	83
2027-2028	Oct	83
2029-2030	Nov	83
2031-2032	Dec	83
2033-2034	Jan	84
2035-2036	Feb	84
2037	Mar	84
2038-2040	Apr	84

Profax Number	Month	Year
2041	May	84
2042-2043	Jun	84
2044-2045	Jul	84
2046-2047	Aug	84
2048-2049	Sep	84
2050	Oct	84
2051-2052	Nov	84
2053-2054	Dec	84
2055-2057	Jan	85
2058-2059	Feb	85
2060-2061	Mar	85
2062-2063	Apr	85
2064-2065	May	85
2066	Jun	85
2067	Jul	85
2068	Aug	85
2069-2070	Sep	85
2071-2072	Oct	85
2073-2074	Nov	85
2075-2076	Dec	85
2077-2078	Jan	86
2079-2080	Feb	86
2081	Mar	86
2082-2083	Apr	86
2084A-2084B	May	86
2085-2086	Jun	86
2087-2088	Jul	86
2089	Aug	86
2090	Sep	86
2091-2092	Oct	86
2093-2094	Nov	86
2095-2096	Dec	86
2097	Jan	87
2098-2099	Feb	87
(Note: numbers 2100-2999 were skipped)		
3000	Apr	87
3002-3003	May	87
3005-3006	Jun	87
3007-3008	Jul	87
3009-3010	Aug	87
3011-3012	Sep	87
3013	Oct	87
3014	Nov	87
3015-3016	Dec	87
3017-3018	Jan	88
3019	Feb	88
3020	Mar	88
3021-3022	Apr	88
3023-3024	May	88
3025-3026	Jun	88
3027-3028	Jul	88
3029-3030	Aug	88
3031-3032	Sep	88
3033-3034	Oct	88
3035-3036	Nov	88
3037	Dec	88
3038-3039	Jan	89
3040-3041	Feb	89
3042-3043	Mar	89
3044-3045	Apr	89
3046-3047	May	89
3048-3049	Jun	89
3050-3051	Jul	89
3052-3053	Aug	89
3054	Sep	89
3055-3056	Oct	89
3057-3058	Nov	89
3059	Dec	89

Company index — 1982-1989

	Profax Number	Month and year
GENERAL ELECTRIC		
Color TV, AC-D AC-E	2015	Apr 83
B&W TV, XE chassis	2018	May 83
Color TV, EM chassis	2023	Aug 83
Color TV, PM-A chassis	2028	Oct 83
Color TV, PC-B chassis	2832	Dec 83
AF/C chassis	2037	Mar 84
GL/X chassis	2038	Apr 84
XK B&W chassis	2039	Apr 84
XJ B&W chassis	2042	Jun 84
EC/K chassis	2044	Jul 84
XE B&W chassis	2049	Sep 84
AB/AC chassis	2051	Nov 84
CM chassis	2055	Jan 85
XM-E chassis	2057	Jan 85
PC-A chassis	2058	Feb 85
GK chassis	2060	Mar 85
EC-A chassis	2064	May 85
EP-B chassis	2066	Jun 85
19PC-F/H chassis	2067	Jul 85
PM-B chassis	2068	Aug 85
BC-N chassis	2073	Nov 85
EP chassis	2074	Nov 85
PC-J chassis	2075	Dec 85
PM-A chassis	2078	Jan 86
BC-A chassis	2079	Feb 86
25 PC(J) chassis	2082	Apr 86
HP chassis, tuning and control systems	2084A	May 86
HP chassis, chroma	2084B	May 86
NF chassis	2087	Jul 86
PM-C chassis	2088	Jul 86
X110 chassis, B&W TV	2091	Oct 86
TV/AM/FM clock radio	2092	Oct 86
14-inch portable color TV	2094	Nov 86
X110 chassis (cont.)	2095	Dec 86
CTC140 chassis, color TV	3014	Nov 87
MK-1 chassis, model 8-1938	3008	Jul 87
MK-1 chassis	2099	Feb 87
MK-2 chassis	2097	Jan 87
NF chassis update, color TV	3003	May 87
7-7130A chassis, 5-inch B&W	3004	May 87
1VCR2006W model, VCR	3027	Jul 88
1VCR2018W model, VCR	3019	Feb 88
NC-05X3/06X1 chassis, color TV	3032	Sep 88
Projection TV 8-4500	3020	Mar 88
PW chassis, model 40PW3000KA01 projection TV	3037	Dec 88
VHS VCR, model 1VCR2002X	3044	Apr 89
Color TV, 1987 CTC136	3047	May 89
CTC135-S1 color TV	3052	Aug 89
1987 8-4500 projection color TV	3057	Nov 89
HITACHI		
Color TV, chassis NP80SX	2003	Nov 82
Color TV, GTX chassis No. 615	2008	Jan 83
Color TV, NP9X chassis	2011	Feb 83

1989 Profax directory

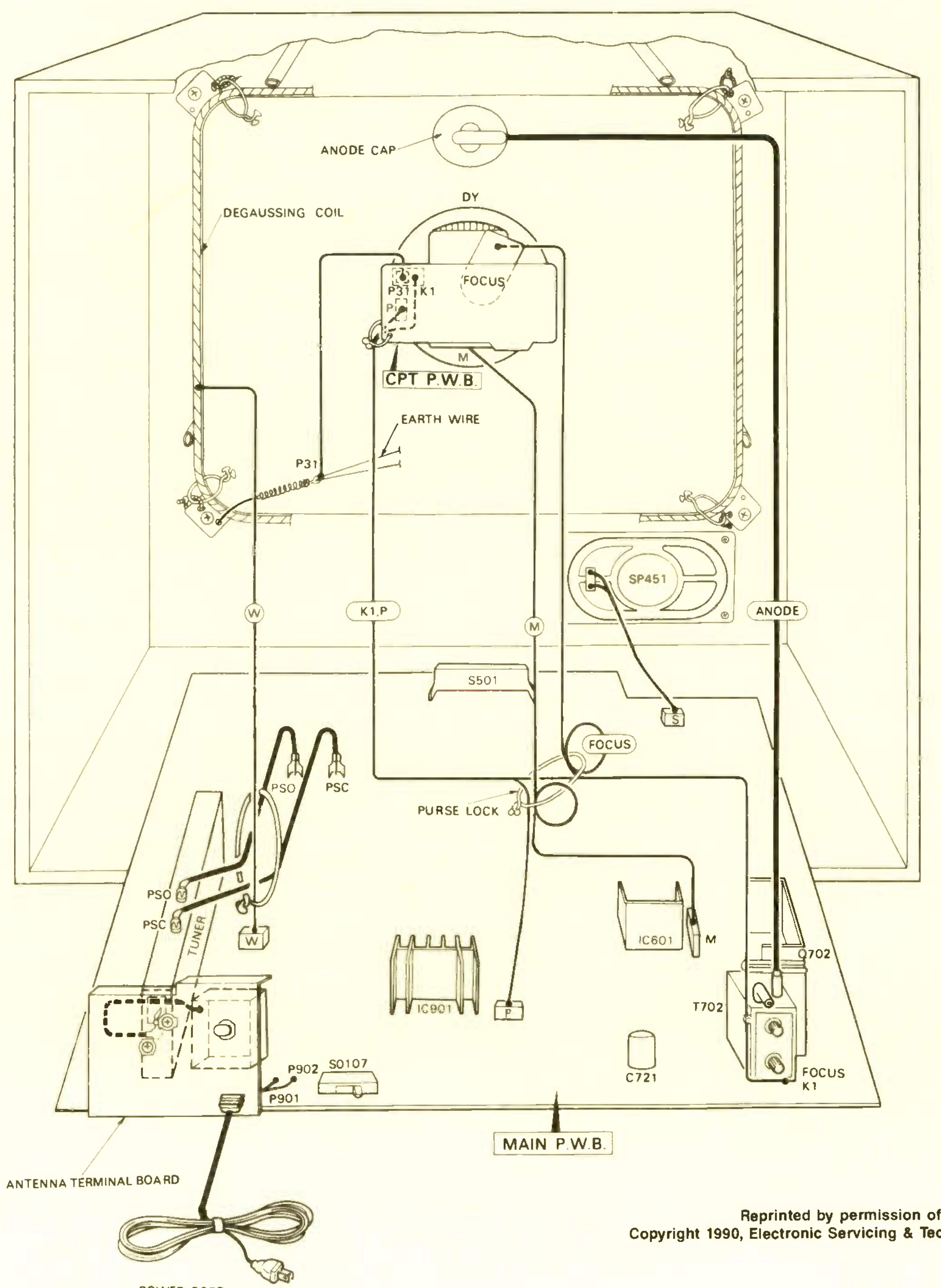
Monthly index — 1982-1989

	Profax Number
October 1982	
NEC color video monitor, chassis Z7A	2000
RCA B&W TV, chassis KCS207B	2001
NAP color TV, chassis 09C201 CQ4X	2002
November 1982	
Hitachi color TV, chassis NP80SX	2003
RCA color TV, chassis CTC115	2004
NEC video projector, chassis W2A-1	2005
December 1982	
NAP B&W TV model MQA014GY (w/radio)	2006
RCA color TV, chassis CTC108	2007
January 1983	
Hitachi color TV GTX, chassis No. 615	2008
RCA projection TV model PGR200/300	2009
Magnavox B&W TV, chassis 09M101	2010
February 1983	
Hitachi color TV, NP9X chassis	2011
RCA color TV, CTC118 series	2012
March 1983	
RCA B&W TV, chassis KCS206C (ac/dc/battery)	2013
Hitachi projection color TV, CT 5011	2014
April 1983	
GE color TV, AC-D AC-E	2015
NAP B&W TV, AM/FM radio UVG-1	2016
May 1983	
NAP color TV, chassis E34-18, -19, -32, -33	2017
GE B&W TV, XE chassis	2018
June 1983	
RCA color TV, CTC117 series	2019
NAP B&W TV, model B386QWA01	2020
July 1983	
Magnavox color TV, chassis E31-38	2021
Philco color TV, chassis K-20	2022
August 1983	
GE color TV, EM chassis	2023
NAP B&W TV, chassis 12M101	2024
September 1983	
RCA color TV, chassis CTC120	2025
NAP B&W TV, chassis 12M101	2026
October 1983	
RCA B&W TV, KCS205 series	2027
GE color TV, PM-A chassis	2028
November 1983	
RCA B&W TV, KCS204 series	2029
NAP color TV, 13C3 series	2030
December 1983	
NAP color TV, 19C3 series	2031
GE color TV, PC-B chassis	2032
January 1984	
RCA KCS206 B&W	2033
NAP E34 chassis	2034
February 1984	
NAP 19C2 chassis	2035
RCA KCS213 B&W	2036
March 1984	
GE AF/C chassis	2037
April 1984	
GE GL/X chassis	2038
GE XK B&W chassis	2039
NAP E32 chassis	2040
May 1984	
RCA CTC111 series	2041
June 1984	
GE XJ B&W chassis	2042
NAP E32-58, -59 chassis	2043
July 1984	
GE EC/K chassis	2044
NAP K10 chassis	2045
August 1984	
RCA CTC123 series	2046
NAP RD425SI & RXC192SL chassis	2047
September 1984	
NAP E53-45, -46 ,-47, -48 chassis	2048
GE XE B&W chassis	2049
October 1984	
RCA CTC132/132 series	2050
November 1984	
GE AB/AC chassis	2051
NAP BD 3911 SL01 B&W chassis	2052
December 1984	

ES&T Manufacturers' schematics **PROFAX**

January 1990

	Profax number
Hitachi	
CT1395W, G7NSU2 CHASSIS color TV	3060



HITACHI CT1395W, G7NSU2 CHASSIS WIRING DIAGRAM

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

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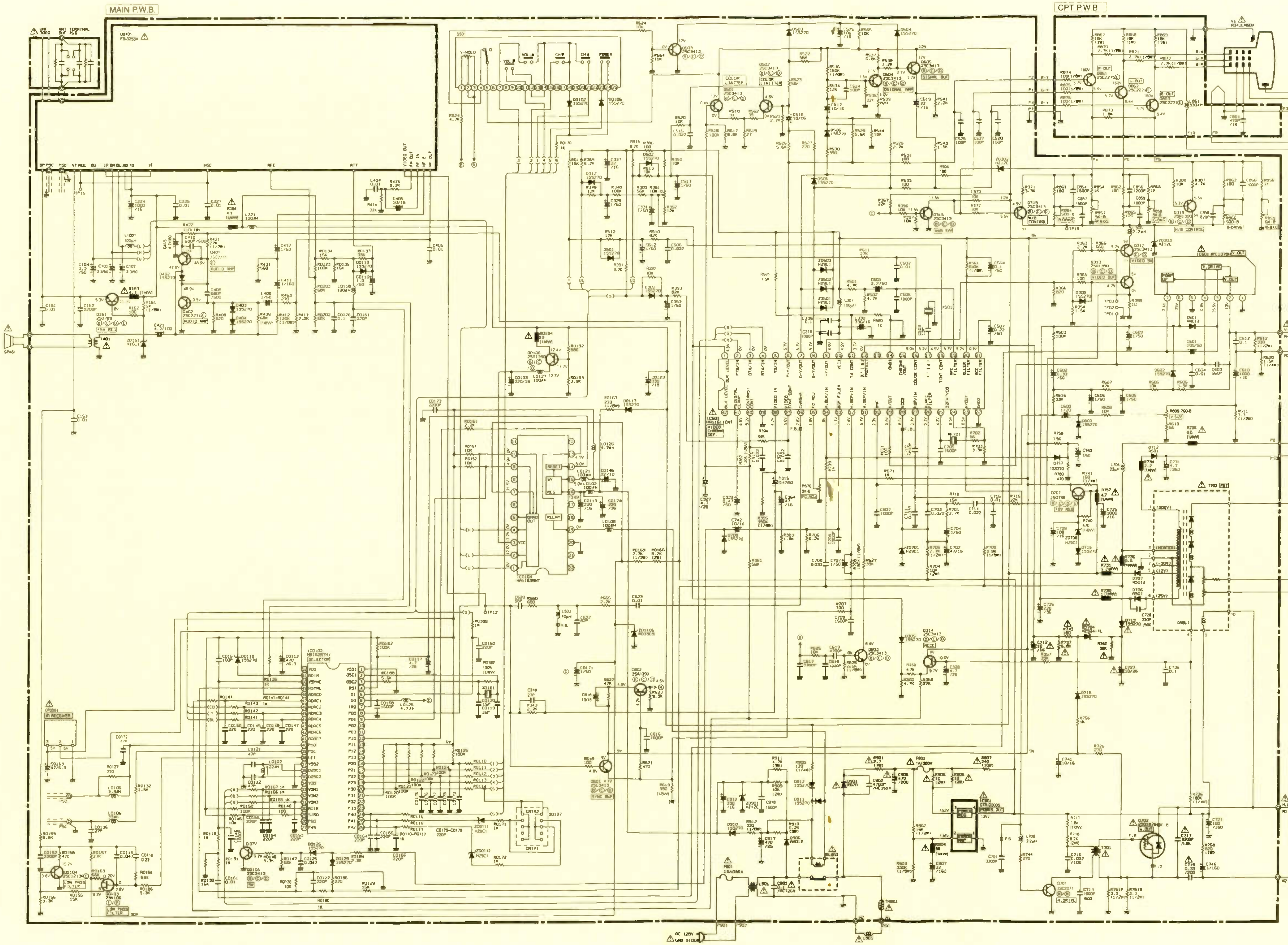
This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

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

	Profax Number	Month and year
Projection color TV, CT5011	2014	Mar 83
NP81X chassis	2054	Dec 84
CT2516 chassis	2059	Feb 85
CQ4X chassis	2061	Mar 85
CT1358 chassis, color TV	3005	Jun 87
CT2020W, CT2020B chassis	3010	Aug 87
CT2250B, CT2250W chassis	3000	Apr 87
CT2250B, CT2250W chassis	3012	Sep 87
CT1344 chassis color TV	3029	Aug 88
CT1358 chassis color TV	3018	Jan 88
CT2647/CT2648/CT2649 chassis color TVs	3025	Jun 88
CT2652, CT2653 color TVs	3024	May 88
CT3020W/CT3020B	3033	Oct 88
VHS VCR, model VT-63A	3035	Nov 88
CT1955 color TV, NP85XA chassis	3038	Jan 89
Color TV, chassis CT1941/CT19A2, NP83X chassis	3043	Mar 89
CT1955 color TV	3045	Apr 89
CT2066 color TV	3050	Jul 89
CT2086 B/W chassis G7NU3 color TV	3055	Oct 89
MAGNAVOX		
B&W TV chassis 09M101	2010	Jan 83
Color TV, chassis E31-38	2021	Jul 83
NAP		
Color TV, chassis 09C201 CQ4X	2002	Oct 82
B&W TV, model MQA014GY (w/radio)	2006	Dec 82
B&W TV, AM/FM radio UVG-1	2016	Apr 83
Color TV, chassis E34-18, -19, -32, -33	2017	May 83
B&W TV, model B386QWA01	2020	Jun 83
B&W TV, chassis 12M101	2024	Aug 83
B&W TV, chassis 12M101 (duplicate)	2026	Sep 83
Color TV, 13C3 series	2030	Nov 83
Color TV, 19C3 series	2031	Dec 83
E34 chassis	2034	Jan 84
19C2 chassis	2035	Feb 84
E32 chassis	2040	Apr 84
E32-58, -59 chassis	2043	Jun 84
K10 chassis	2045	Jul 84
RD 425S1 & RXC 192SL chassis	2047	Aug 84
E53-45, -46, -47, -48 chassis	2048	Sep 84
BD3911 SL01 B&W chassis	2051	Nov 84
UXC chassis	2063	Apr 85
EC-31-52, -56 & -58 chassis	2069	Sep 85
E-34-18, -32 & -33 chassis	2071	Oct 85
E51-56 chassis, color TV	3030	Aug 88
E54-10 chassis, projection TV	3021	Apr 88
E54-15 chassis, projection TV	3026	Jun 88
RD4502SL/RLC312SL color TV monitors	3036	Nov 88
Color TV, series 19C2 chassis Magnavox)	3039	Jan 89
Color TV, chassis E34-11	3042	Mar 89
Color TV, chassis E54-15 (Magnavox RD8518 and RD8520; Philco model P8190S; Sylvania PSC410 and PSC420)	3049	Jun 89
NEC		
Color video monitor, chassis Z7A	2000	Oct 82
Video projector, chassis W2A-1	2005	Nov 82
C13-304A chassis	2056	Jan 85
DJ-60EN(R) chassis	2065	May 85

	Profax Number	Month and year
PHILCO		
Color TV, chassis K-20	2022	Jul 83
RCA		
B&W TV, chassis KCS207B	2001	Oct 82
Color TV, chassis CTC115	2004	Nov 82
Color TV, chassis CTC108	2007	Dec 82
Projection TV, model PGR200/300	2009	Jan 83
Color TV, CTC118 series	2012	Feb 83
B&W TV, chassis KCS 206C	2013	Mar 83
Color TV, CTC117 series	2019	Jun 83
Color TV, chassis CTC120	2025	Sep 83
B&W TV KCS205 series	2027	Oct 83
B&W TV KCS204 series	2029	Nov 83
KCS206 B&W	2033	Jan 84
KCS213 B&W	2036	Feb 84
CTC111 series	2041	Mar 84
CTC123 series	2046	Apr 84
CTC131/132 series	2050	Oct 84
KCS B&W AM/FM clock	2053	Dec 84
CTC117 chassis	2062	Apr 85
CTC118 chassis	2070	Sep 85
CTC121 chassis	2072	Oct 85
CTC126 chassis	2076	Dec 85
MMC100, video monitor	2077	Jan 86
CTC117 chassis	2080	Feb 86
CTC133 chassis	2081	Mar 86
CTC120 chassis	2083	Apr 86
CTC125 chassis	2085	Jun 86
207 series weather clock	2086	Jun 86
CTC136 chassis	2089	Aug 86
CTC130-S1 chassis	2090	Sep 86
B&W TV basic service data	2093	Nov 86
UWJ chassis	2096	Dec 86
CTC117-S2 color TV supplement	2098	Feb 87
CTC134 chassis, color TV	3013	Oct 87
CTC135 chassis, color TV	3006	Jun 87
VDM140 chassis, color TV	3002	May 87
PVM035 chassis color TV	3031	Sep 88
PVM050 color TV	3023	May 88
P42000-S1 projection TV (additional models: RVM46700, 46GW700, P46000)	3048	Jun 89
CTC135 color TV	3051	Jul 89
CSM055 color TV/AM/FM/ clock radio	3054	Sep 89
RCA/GE		
Color TV, CTC145/146 chassis	3040	Feb 89
CTC145/146 color TV	3058	Nov 89
ZENITH		
D2500W chassis, color TV	3009	Aug 87
D13085/D1910B chassis, color TV	3007	Jul 87
SD2501W chassis, color TV	3011	Sep 87
CM-139/B-0 (B) chassis color TV	3028	Jul 88
CM-139/B-3 (I) SD2511G/SD2581H	3034	Oct 88
C2020H chassis color TV	3022	Apr 88
PV800 color monitor	3017	Jan 88
Color TV, CM-140/b-2(G) chassis	3041	Feb 89
CM-14-0/B-3(I) color TV (models SE2721, SE2725R, SE2727H)	3046	May 89
CM-140/B-2(I) color TV	3053	Aug 89
PV4661H rear-projector color TV	3056	Oct 89
CM-140/DIGITAL(C) chassis color TV	3059	Dec 89

HITACHI CT1395W, G7NSU2 CHASSIS BASIC CIRCUIT DIAGRAM



HITACHI CT1395W, G7NSU2 CHASSIS BASIC CIRCUIT DIAGRAM

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Bench power supply

B&K Precision has introduced the model 1646 dc bench power supply, which has an output variable to 16V. The unit has a 10A capacity with low-ripple characteristics, constant-voltage and constant-current operation with automatic mode selection. Coarse and fine voltage controls are provided for voltage settings. Two current ranges are provided for higher resolution.

Circle (84) on Reply Card

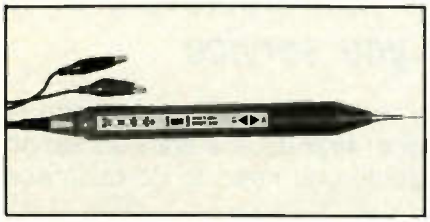
VCR belt kits

PTS Corporation has introduced a line of VCR belt kits. Each kit contains all the belts used in individual models of major manufacturers' VCRs.

Circle (85) on Reply Card

Logic probe/pulser

Extech Instruments has introduced a TTL/CMOS logic probe/logic pulser, which can detect pulses as narrow as 10ns up to 50MHz. Used as a logic pulser, the unit can inject a single pulse, a low-repetition 0.5Hz pulse or a high-repetition 400Hz pulse. Frequency response is 50MHz with an input impedance of 120kΩ. Maximum signal input protection is ±70V ac/dc for up to 15 seconds.



Circle (86) on Reply Card

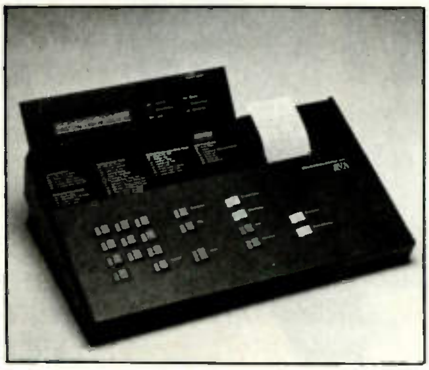
Diagnostic software

The QAPlus/FE diagnostic software package from *Diagsoft* is designed for use with PC/XT/AT/386/PS/2 and compatible systems. The software provides system performance analysis and customization, peripheral calibration, hard disk maintenance utilities, and fault isolation with corrective options. The software reports system data, such as interrupt (IRQ) information, BIOS type, DOS version, DMA channel usage, interrupt usage, LPT and COM assignments to IRQs, active device drivers and environment space. The software also has memory, keyboard and CPU tests.

Circle (87) on Reply Card

Disk drive tester

AVA has introduced the model 409 floppy disk drive tester with version 4.0 firmware, which adds the capability to measure and align all 3½-inch and 5¼-inch floppy disks. The diskettes are available in three versions: 5¼-inch 48 tpi, 5¼-inch 96 tpi and 3½-inch 135 tpi. The diskettes measure hub-clamping accuracy, radial alignment, head azimuth and index-to-burst times. Other tests include window margin, asymmetry, spindle spool and read/write tests.



Circle (88) on Reply Card

Cleaning kit line

The Tech Essentials Cleaning Kit line from *ACL* includes the 8014 fax machine cleaning kit, the 8016 laser printer cleaning kit, the 8004 and 8006 computer cleaning kits for 3½-inch and 5¼-inch disk drives, the 8012 computer mouse cleaning kit, the 8018 keyboard cleaning kit and the 8010 label remover kit.

Circle (89) on Reply Card

True rms multimeter

Extech has introduced a true rms multimeter with built-in RS-232 interface. The meter measures voltage, current, resistance and frequency. Diode and continuity checks give both audible and visual indications. Ranges include dc voltages to 1,000V, accurate to ±0.3%; ac voltage to 750V, accurate to ±0.5%; and ac/dc current ranges to 400mA and 20A.

Circle (90) on Reply Card

Crimp tools

Rostra Tool Company has introduced the Sargent thrift crimp system of tools, which are precision-manufactured and produce crimps to industry standards. The tools have wide cushion grips and straight-line jaw closure to a positive stop.

Circle (91) on Reply Card

Infrared detector pen

Parts Express has introduced the B.I.R.D, a battery-operated infrared detector pen. The device will confirm operation of remote controls, VCR tape-stop circuits, alarm system infrared detectors and other infrared emitting products.

Circle (92) on Reply Card

IC number software

Soft-Trac Publishing has introduced Trac-Gen, an IBM PC-compatible software package that includes a database containing more than 18,000 generic IC device numbers. The database covers microcomputers, microprocessors, peripherals, interface, digital, memory and linear ICs. Users can search by device number, technology, function, description and package outline.

Circle (93) on Reply Card

Data analyzer

The Autofox data analyzer from *DATATRAN* can be used for RS-232 synchronous, asynchronous and parallel transmission problems. The analyzer focuses on the content of transmission problems. It receives and generates data, then tests, exercises, analyzes and converts it. The unit also functions as a fox box and bert/blert tester.

Circle (94) on Reply Card

Digital static locator

Statikil, agent for *Meech Static Elimi-*

nators, is offering the model 980 static locator. The unit allows servicers to find, measure and calibrate static charges. The digital display incorporates a range of ±10V to 100,000V.

Circle (95) on Reply Card

Aerosol chemicals

The Liqui-Tool aerosol chemical product line from *Triangle Tool Group* includes freeze sprays, zero-residue cleaners, flux removers, inert gas dusters, anti-static products, conformal coatings and removers, and a contact cleaner/degreaser. Most of the formulations use a CO_2 propellant instead of CFCs. The products have adjustable spray heads with three spray volumes.

Circle (96) on Reply Card

Rotating cable slitter

The PA 1820 round cable slitter from *Paladin* can slit, split and remove insulation on single or multiple conductor

cable up to 1,000 MCM or 1.50-inch OD. To use the tool, the servicer rotates it 360° around the cable, slits the cable to the end with the blade and peels off the jacket.

Circle (97) on Reply Card

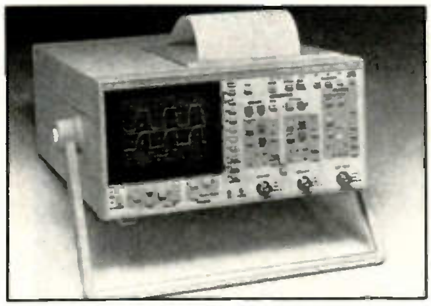
Disk drive exerciser

The Drive Exerciser from *American Educational Services* allows a technician to align 400K and 800K 3½ Macintosh disk drives and Apple 5¼ drives using the Apple IIe. The exerciser allows the servicer to step the heads to see azimuth, radial and track 0, and to read and write 01s and FFs to any given track while checking head amplitude, R/W, write protect, motor speed and eject circuitry.

Circle (98) on Reply Card

DSOs

The model 420 and 450 digital storage oscilloscopes from *Gould Electronics* have a built-in 4-color plotter that documents the date and time of capture. The DSOs offer cursor measurements, trace manipulation, trace arithmetic,



limits testing and a persistence function, which emulates the long-term storage capabilities of a tube storage scope. The 420 has a 100Ms/s digitizing capability with an equivalent real-time bandwidth of 20MHz. The 450 has a 50MHz bandwidth.

Circle (99) on Reply Card

Contact cleaner

Blue Shower cleaner from *Tech Spray* is a proprietary blend of inert solvents that act as an azeotrope for cleaning contacts. It can be used on sensitive components and during equipment operation, and it is "ozone friendly." The cleaner improves wetting and penetration and leaves no residue. The product is active on ionic, non-ionic and particulate contaminants.

Circle (100) on Reply Card

Tool kit

Jensen's JTK-87 professional field engineer's kit is offered in more than 23 case styles and sizes and with a range of options and custom modifications. All styles have two removable pallets. The deep model cases feature a gate-swing style that allows easier access to tools in the bottom of the case. The kit is a combination of the most popular tools, pallet designs and tool cases requested by customers.

Circle (101) on Reply Card

Power source

The *KAPPA/VIZ* model WP-30 Monitor Iso-V-AC II and model WP-32 Monitor Iso-V-AC III provide isolated output ac voltage adjustable 0Vac to 150Vac. Maximum current is 5A 650VA for the WP-30, 10A 1,300VA for the WP-32. Both models include a leakage tester that can measure ac leakage current. An audible alarm warns of hot chassis or shorts to exposed metal on equipment

under test. The units are supplied with two 3½-inch meters. One monitors line or output voltage; the other displays output current or leakage.

Circle (102) on Reply Card

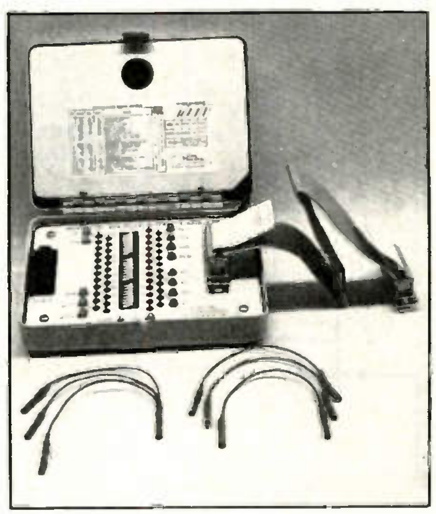
Digital multimeters

Philips ECG has introduced the DM-26 and DM-27 DMMs. The DM-26 features a rotary range switch, diode test and a tilt stand. It has 0.8% basic dc accuracy and a 3½-digit LCD that displays 0.5-inch-high characters. The meter is overload protected, RF shielded and has an overrange indicator. The CM-27 adds an audible continuity test.

Circle (103) on Reply Card

RS-232 interface analyzer

The model 700 EIA RS-232 interface analyzer from *Electro Standards Laboratory* is designed for use at the



standard EIA RS-232 or CCITT V.24 data interface of modems, multiplexers, terminals and computers. Tri-state LEDs display polarity, activity and validity of all key interface signals.

Circle (104) on Reply Card ■

Horizontal Deflection Simplified

By Robert Arso

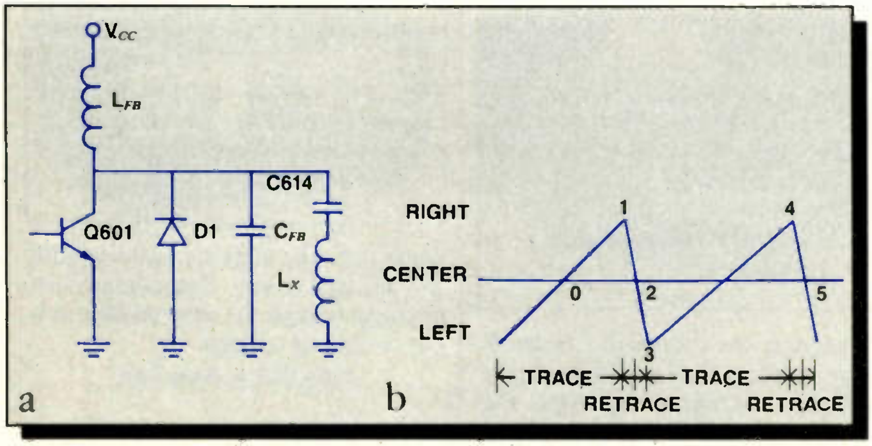


Figure 1. A simplified schematic of the horizontal output circuit is shown in Figure 1A. Figure 1B is a representation of the location of the electron beam on the screen as a function of the horizontal deflection signal. When the horizontal signal is above the horizontal axis, the beam spot will be to the right side of the screen. The lower vertical axis represents the left side of the screen. The horizontal axis represents time. A movement of the beam from left (lower) to right (upper) is the trace time. When the beam moves from right (upper) to left (lower), retrace occurs.

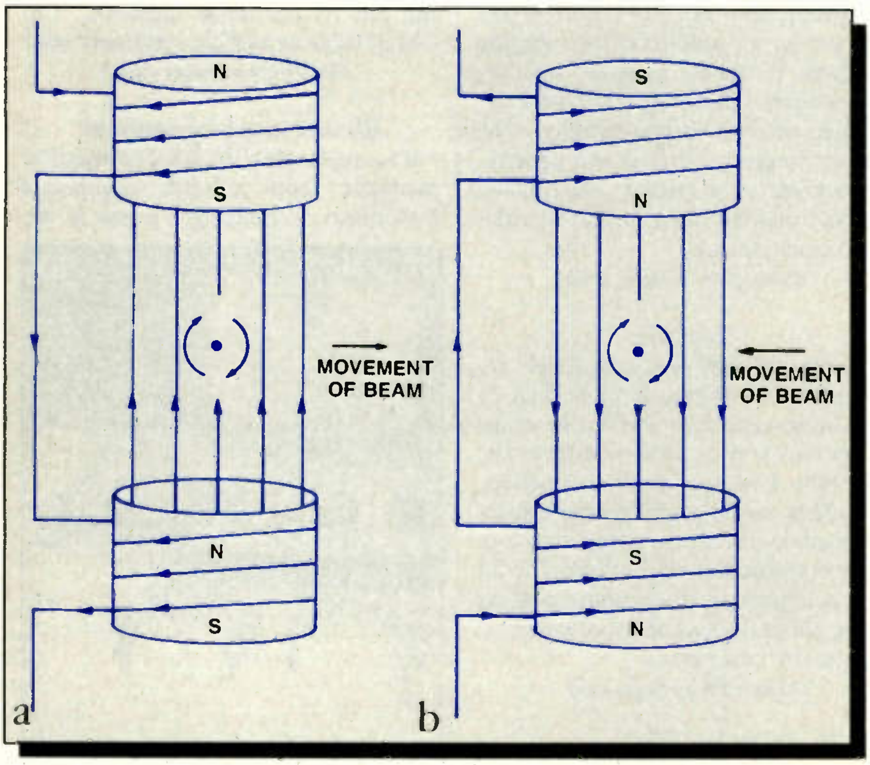


Figure 2. Figure 2A shows the magnetic field of two series aiding coils. The electron beam is represented by the dot and is traveling out of the paper toward the reader. The arrow heads on the coils indicate the direction of electron flow in the wire. This diagram represents like fields, which repel each other. As a result of the interaction of these fields, the electron beam is deflected to the right. In Figure 2B, the current is reversed in the coils, and an opposite action can be observed. The beam is deflected to the left.

The horizontal output circuit sometimes can seem very complicated, but it can be simplified. In this article, we'll discuss the Sears model 564. 50470350/351 TV, Sams photofact 2281-2. However, the explanation can be applied to any transistorized horizontal output circuit.

A simplified schematic is shown in Figure 1A. C_{fb} is the parallel combination of C611, C612 and C613. L_x is the horizontal deflection yoke between terminals WD2 and WD6. D1 is the internal damper diode of Q602. L_{fb} is the primary winding of the flyback transformer between terminals 1 and 6 of T602. V_{cc} is basically the same as circuit trace number 2.

Figure 1B is a representation of the location of the electron beam on the screen as a function of the horizontal deflection signal. When the horizontal signal is above the horizontal axis, the beam spot will be to the right side of the screen. The lower vertical axis represents the left side of the screen. The horizontal axis represents time. A movement of the beam from left (lower) to right (upper) is the trace time. When the beam moves from right (upper) to left (lower), retrace occurs. The trace time is approximately 53.3μs. The retrace time along with blanking takes approximately 10.2μs.

The basics

Let's look at some basic facts about capacitors and inductors:

- The total capacitance of capacitors placed in series is equal to a value that is smaller than the smallest capacitor.
- An inductor will develop a magnetic field around itself as current flows through it. This field tends to oppose the current that produces it. When the source current stops, the magnetic field collapses into the inductor, producing a current flow in the same direction the source flow was in.
- An electron beam will be deflected

Arso is chairman of the electronic technology department at Bismarck State College.

perpendicular (broadside) to a magnetic field. Figure 2A shows the magnetic field of two series aiding coils. The electron beam is represented by the dot and is traveling out of the paper toward the reader. The arrow heads on the coils indicate the direction of electron flow in the wire. All magnetic fields are determined by the left-hand rule.

Notice that the magnetic field is orbiting in a clockwise direction around the electron beam. With the magnetic field of the electron beam traveling in a clockwise direction and the magnetic field of the coils traveling in an upward direction, an attraction in fields is felt on the right side of the diagram because the fields are opposite to each other. The fields are all traveling in the same direction on the left side of the diagram. This diagram represents like fields, which repel each other. As a result of the interaction of these fields, the electron beam is deflected to the right. In Figure 2B, the current is reversed in the coils, and an opposite action can be observed. The beam is deflected to the left.

• A resonant circuit is formed by connecting a capacitor and an inductor together. The resonant frequency occurs when X_c equals X_l. The resonant frequency of the circuit will increase if ei-

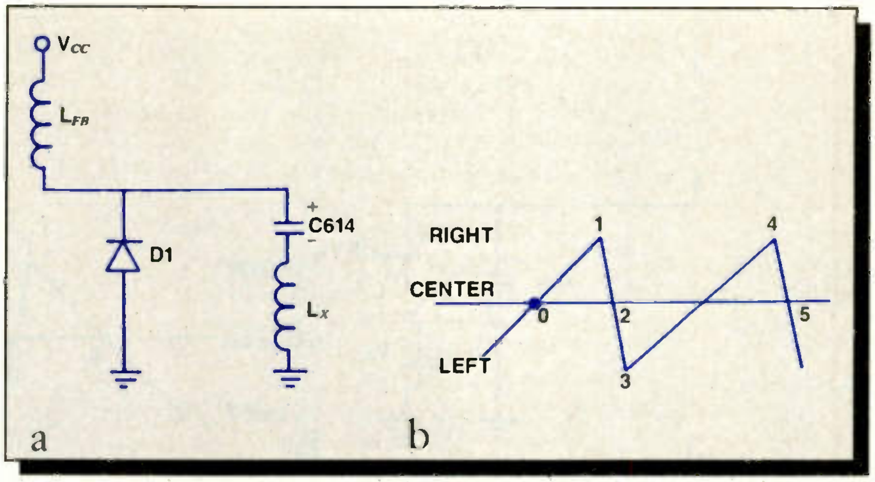


Figure 3. In Figure 3A, C614 has just been fully charged through D1 by the collapsing field of L_x and the charge current has stopped. With no current flowing through the yoke, the electron beam will be positioned at the center of the screen (point 0 in Figure 3B).

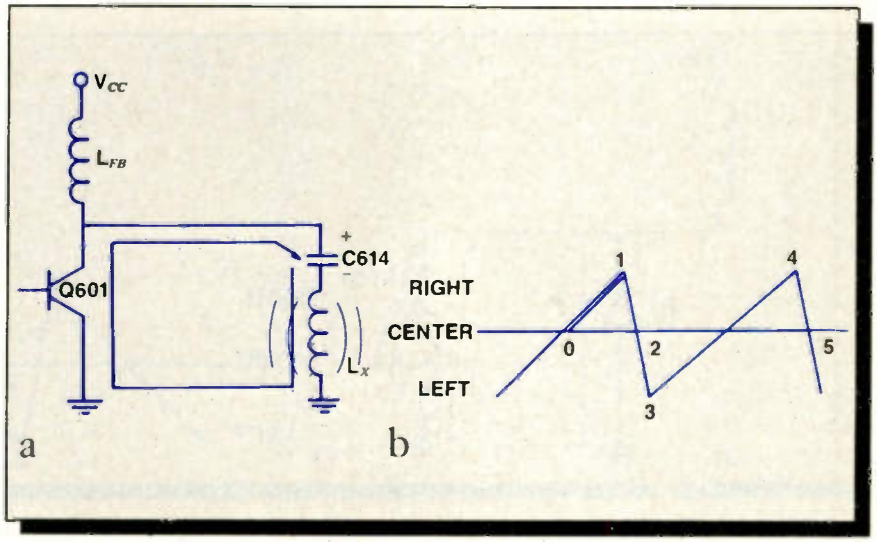


Figure 4. In Figure 4A, Q601 is turned on by the horizontal oscillator signal for approximately 25μs, allowing C614 to discharge through L_x. The magnetic field developed around L_x causes the beam to travel to the right side of the screen (points 0 to 1 in Figure 4B). With Q601 on, C_{fb} is bypassed and D1 is reverse-biased.

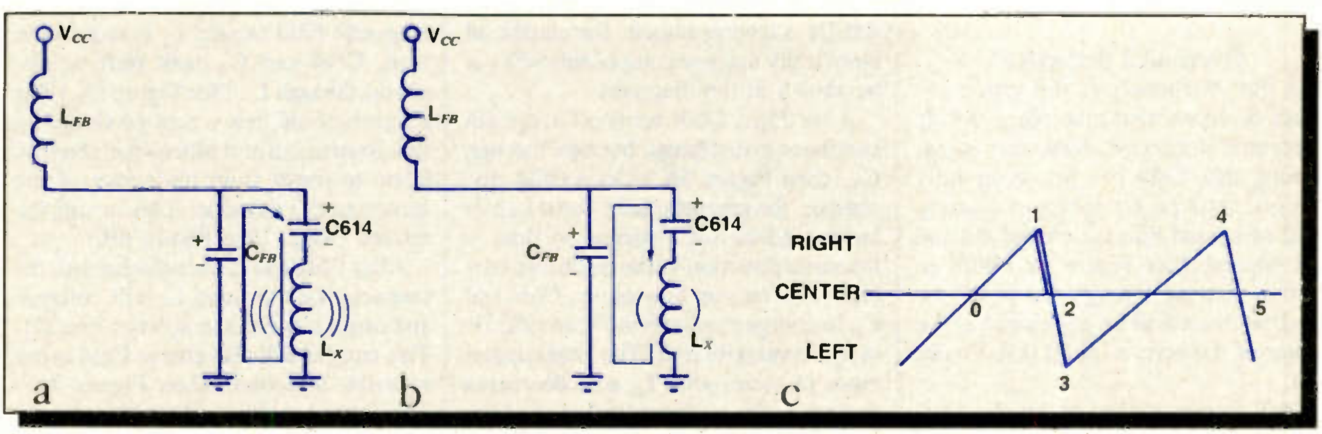


Figure 5. In Figure 5A, Q601 turns off after 25μs and C614 continues to discharge, but through C_{fb}. Once C614 discharges, the magnetic field about L_x collapses and causes a current to flow in the same direction as the discharge current. This current causes C614 and C_{fb} to charge as shown in Figure 5B. D1 is still reverse-biased. The total capacitance in series with L_x decreases and raises the resonant frequency of the circuit, causing the beam to travel at a faster rate. The electron beam is extinguished as it travels at a rapid retrace speed from the right side of the screen to the center. This is the retrace mode (points 1 to 2 in Figure 5C).

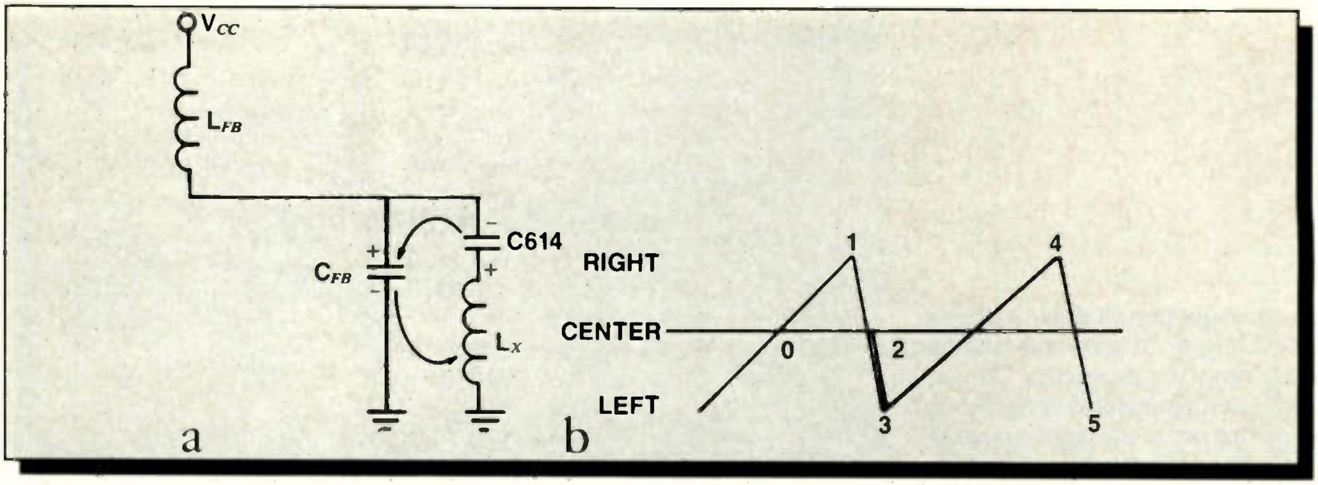


Figure 6. In Figure 6A, the magnetic field around L_x is reduced to zero once C614 and C_{fb} are charged. C614 and C_{fb} start to discharge through L_x. In Figure 6B, the magnetic field produced by this reverse current allows the electron beam to travel from the center of the screen to the left side. This is still the retrace mode.

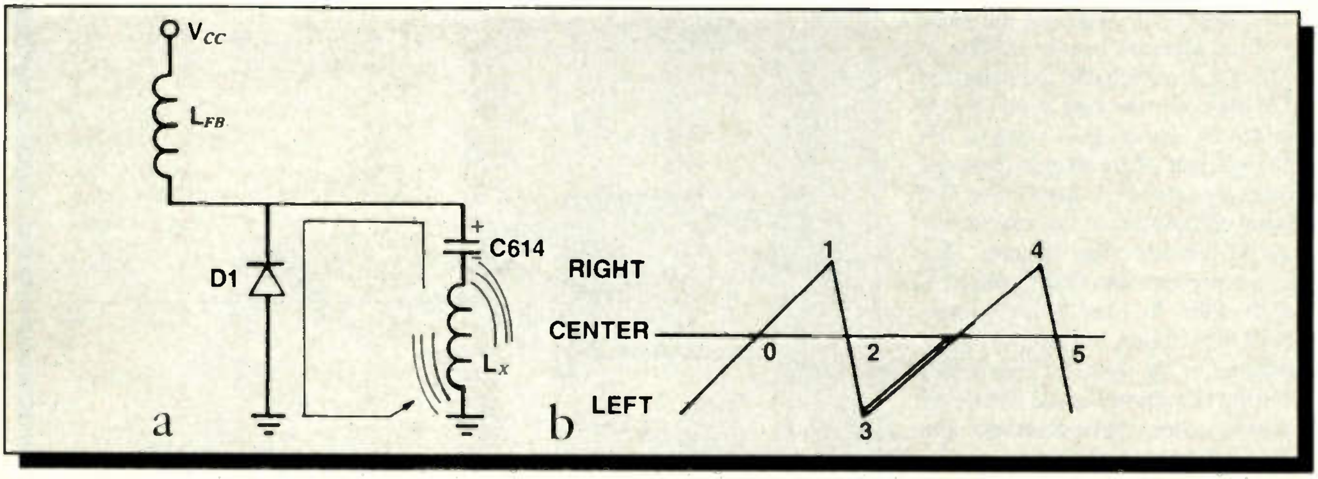


Figure 7. In Figure 7A, C614 and C_{fb} are discharged, which causes the magnetic field around L_x to collapse and cause a current to forward-bias D1. This current will also charge C614 in the opposite direction. This is the beginning of the trace mode, which allows the beam to travel from the left side of the screen to the center of the screen, as shown in Figure 7B.

ther the capacitance or the inductance decreases.

Horizontal deflection

In our discussion of the systematic chain of events that take place during horizontal deflection, let's start by assuming that C614 has just been fully charged through D1 by the collapsing field of L_x and that the charge current has stopped. (See Figure 3A.) With no current flowing through the yoke, the electron beam will be positioned at the center of the screen (point 0 in Figure 3B).

Q601 is now turned on by the horizontal oscillator signal for approximately 25µs, allowing C614 to discharge through L_x. (See Figure 4A.) The magnetic field developed around L_x causes the beam to travel to the right side of the screen (points 0 to 1 in Figure 4B). Note that with Q601 on, C_{fb} is bypassed and D1 is reverse-biased. For clarity, all electrically inactive components will not be shown in the diagrams.

After 25µs, Q601 turns off and C614 continues to discharge, but now through C_{fb}. (See Figure 5A.) Once C614 discharges, the magnetic field about L_x collapses and causes a current to flow in the same direction as the discharge current. This current now causes C614 and C_{fb} to charge as shown in Figure 5B. D1 is still reverse-biased. The total capacitance in series with L_x now decreases and raises the resonant frequency of the circuit, causing the beam to travel at a faster rate. The electron beam is extinguished as it travels at a rapid retrace speed from the right side of the screen to the center. This is the retrace mode (points 1 to 2 in Figure 5C).

Once C614 and C_{fb} are charged, the magnetic field around L_x is reduced to zero. C614 and C_{fb} now start to discharge through L_x. (See Figure 6A.) The magnetic field that is now produced by this reverse current allows the electron beam to travel from the center of the screen to the left side. This is still the retrace mode. (See Figure 6B.)

After C614 and C_{fb} are discharged, the magnetic field around L_x will collapse and cause a current to forward-bias D1. This current will also charge C614 in the opposite direction. (See Figure 7A.) This is the beginning of the trace mode, which allows the beam to travel from the left side of the screen to the center of the screen. (See Figure 7B.)

The sequence repeats itself at step one. ■

1989 Article Index

1989 Department Index

TECHNOLOGY

TROUBLESHOOTING TIPS

VIDEO CORNER

WHAT DO YOU KNOW ABOUT ELECTRONICS?

■

Books/Photofact

Camcorder Maintenance and Repair, by Homer L. Davidson; TAB Books; 292 pages; $16.95, paperback.

This book, which was written for anyone who owns a camcorder, shows the user or servicer how the camcorder works and how to perform simple repairs. The book describes the basic camcorder formats, camera specifications, and how to use the camera. It also describes how the circuits operate. Maintenance sections show how to clean, lubricate and take care of the battery. Repair sections describe how to check the diode, transistor and IC components with a DMM, and how to remove panels and components. The book covers power, battery, recording, playback, viewfinder, video, sound and ac adapter problems.

TAB Books, Blue Ridge Summit, PA 17294-0850; 800-822-8138.

Troubleshooting and Repairing the New Personal Computers, by Art Margolis; TAB Books; 401 pages; $18.95, paperback.

This guide to the new computers covers 8-bit and 16-bit microcomputers, including the IBM PC/XT/AT and compatibles and the Macintosh, Apple II series, Amiga and Commodore 64/128. The book includes new information on the high-pin-count chips and information on the older 12-, 14- and 16-pin chips with static and dynamic RAM. A trouble-symptom guide lists the most common microcomputer problems. The book also includes a chip location guide for the IBM PC and the Apple IIe, plus a manual fault dictionary that shows input and output test techniques. Other sections describe chip-changing techniques, diagnostic software and techniques for troubleshooting and repairing display monitors, disk drives and cassettes.

TAB Books, Blue Ridge Summit, PA 17294-0850; 800-822-8138.

Troubleshooting and Repairing VCRs, by Gordon McComb; TAB Books; 337 pages; $17.95, paperback.

This book offers schematics and details on general up-keep and repair of home VCRs. The book covers cleaning and lubricating, plus troubleshooting from the power supply to logic circuitry problems. Other topics include the basics of video and video cassette operation and installation; preventive maintenance procedures; troubleshooting techniques for the VCR; descriptions of problems not caused by the VCR; and specifications of Beta, VHS and 8mm VCRs and camcorders. Flowcharts are included for common VCR trouble symptoms.

TAB Books, Blue Ridge Summit, PA 17294-0850; 800-822-8138.

PHOTOFACT

GE
2702-1 . . . . 13GP229F01/231F01/430F01/431F01/433C01 (CH. CTC145B/C)

Hitachi
2701-1 . . . . CT2087B, CT2087W

JCPenney
2699-1 . . . . . . 685-4150-00 (855-3554)

JVC
2703-2 . . . . C-2018

Mitsubishi
2698-1 . . . . . . CK-2604R, CK-2605R
2701-2 . . . . CS-2657R, CS-2658R

RCA
2700-1 . . . . F20507WNA01/N01, F20508BHA01/N01, F20509AKA01/N01, F20515EGA01, F20516BHA01/N01, F20517WNA01/N01, F20519AKA01/N01 (CH. CTC146B/C)

Sharp
2700-2 . . . . 20MV77(BK)
2702-2 . . . . 13NV58

Sony
2699-2 . . . . KV-27TR10 (CH. SCC-A05V-A)
2703-1 . . . . KV-8AD10/20 (CH. SCC-B79A-A/B96A-A)

Toshiba
2704-1 . . . . CF1921J/22J, CA20209/19 (CH. TAC8920/25)

Zenith
2698-2 . . . D0920A/D/K/U, DO930S, SD0921A/S
2704-2 . . . . D2020W, SD1933W, SD2023W/X/Y, SD2027W, SD2095W, SD2097W

What do you know about electronics?

Comments on capacitance

By Sam Wilson, CET

A technician friend (who prefers to remain anonymous) sent me an article on capacitors that he believes disproves some of my statements in past issues. He asked for comments, and I thought it might be a good idea to share these with you.

After reading the article carefully, I did not get the feeling that its author and I were sitting at different campfires. In fact, there are a number of places where we are in violent agreement. In the few places where we have a difference of opinion, I will give you experiments that can be performed.

I offer you the capacitor without models. So far, I see no reason to change my discussion on the subject. Having offered experimental evidence of what I say is true, I do not feel that the burden of proof is on me.

Uses for the capacitor

The Leyden jar was the first capacitor. It was named for the University of Leyden, in the Netherlands, where it was invented. It was used to store electrical energy. That was its original use, and that is the *only* use capacitors have today.

Sometimes we talk about types of uses for capacitors: They pass high frequencies but block low frequencies; they produce an ac voltage drop; when used with resistors, they introduce a time delay. As a matter of fact, these are models for the use of capacitors. None of these things can be accomplished without the capacitor storing energy.

I remember one time when I gave a lecture in Denver saying that there were only three uses of resistors (to limit current, to produce a voltage drop when current flows through them, and to dissipate heat). After the lecture, an enterprising technician advanced a fourth possible use. He said they are used as coil forms for peaking coils. If you have ever seen a peaking coil, you know that it is wound on a swamping resistor. Therefore, in his way of thinking, the resistor is a coil form.

In some applications of capacitors, the energy is stored for a short period of time. In fact, the time for storage can be very small. In the case of ac, it may store energy for less than a half-cycle. It may charge and discharge at the ac frequency and thereby give the appearance that it is passing the ac. In reality, it is simply charging and discharging at the ac rate.

dc voltage or current?

What appears to be the most serious difference of opinion between my comments and the article was that the author said a capacitor "blocks dc." It is this statement, which appears to be a contradiction to everything I have said, that the technician most wanted to discuss.

When I say that a capacitor does not block dc, I mean it will not block a dc *voltage*. I have described experiments showing that the voltage is not blocked. But when I read the article closely, I find that the author says that it blocks dc *current*. Barring a breakdown of the dielectric, I agree with that statement completely.

As to whether the capacitor blocks dc voltage, if you wish to take issue with me on that, let me tell you about a meeting I attended in Chicago.

Some well-trained technicians took issue with me on the same subject. They came to the meeting armed with what they considered to be authoritative literature. The argument continued until it began to look as if I would have to take up residence in Chicago.

Finally, I decided to ask for volunteers for a little experiment. It is illustrated in Figure 1. An electrostatic generator was to be used to generate 250,000V. A very large capacitor — greater than 1,000μF — was to be placed in series with that voltage. Then, everyone who assumed that the capacitor could not pass the dc voltage was simply to grab hold of the circuit terminals. They would be quite safe, of course, if there really was no voltage across the output terminals. After all, how could the voltage get there if the capacitor blocks dc voltage?

To all volunteers we offered a free steak dinner. All they had to do was prove me wrong by grabbing hold of the circuit.

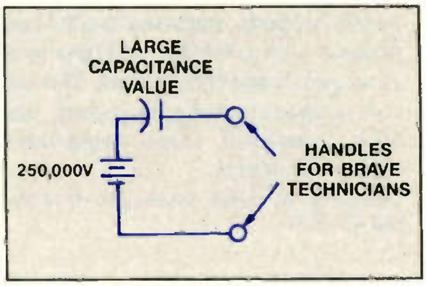


Figure 1. Does a capacitor block dc voltage? In this experiment, an electrostatic generator is used to generate 250,000V. A very large capacitor — greater than 1,000μF — is placed in series with that voltage. If the capacitor could not pass the dc voltage, a technician could grab hold of the circuit terminals. There would be no voltage there if the capacitor blocks dc voltage.

There was a lot of shuffling and mumbling and looking down at shoe laces and no volunteers. "Well," I said, "if a capacitor won't pass a dc voltage, why not grab on to this thing?"

One enterprising technician volunteered the following statement: "There is no voltage there until you touch the circuit."

Statements like that stagger my mind. I am somehow to believe that when the technician touches the circuit, he is instrumental in producing the voltage that is there.

Of course, you and I both know what happens: When he touches the circuit, the capacitor begins to charge. The charging current through the person will be sufficiently high to make him think he is getting an idea.

In reality, no charging current could take place through the body unless there was already a voltage at the point to be touched. I'll repeat — capacitors *do not* block dc. But, in order to stay away from contention with people who are talking about dc current, I want to add this: They won't block a dc voltage.

Wilson is the electronics theory consultant for **ES&T**.

Capacitor charging

The last bone of contention in the article was in the manner of charging the capacitor. The article seemed to imply that there was a difference in the number of electrons on the plate that produced the capacitor charge. The simple experiment in Figure 2 shows that statement is not true.

A capacitor *can* be charged without moving electrons into one plate and sucking them out of the other. In the experiment, you start with a capacitor that is totally discharged. The assumption is that there are an equal number of electrons on the two plates. When the electret is placed between the plates, the capacitor is charged. A voltage appears across the plates.

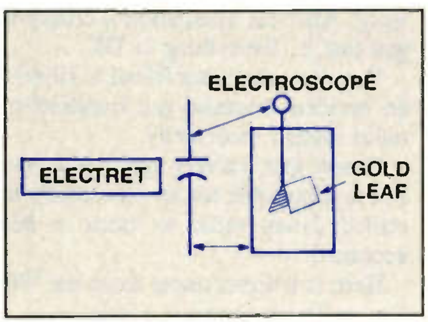


Figure 2. Can a capacitor be charged without moving electrons into and out of the plates? In this experiment, you start with a capacitor that is totally discharged. The assumption is that there are an equal number of electrons on the two plates. When the electret is moved between the plates of the capacitor, the gold leaves move apart, indicating the capacitor is charged.

So, how does the voltage get on the plates of the capacitor if that can only be accomplished by moving electrons into and out of the plates? The answer is quite simple. The voltage is produced by the charged electret. Once it is in place, there is a difference in the number of electrons on the inner surface of the plate. However, if you take the electret away, the electrons quickly redistribute themselves throughout the material. They do not stay on the inside surface of the plates because the force of repulsion between the like charges in the plates is greater than any force exerted over the distance between the plates.

TRUTH TABLE

INPUTS				OUTPUTS									
A3	A2	A1	A0	O0	O1	O2	O3	O4	O5	O6	O7	O8	O9
L	L	L	L	H	L	L	L	L	L	L	L	L	L
L	L	L	H	L	H	L	L	L	L	L	L	L	L
L	L	H	L	L	L	H	L	L	L	L	L	L	L
L	L	H	H	L	L	L	H	L	L	L	L	L	L
L	H	L	L	L	L	L	L	H	L	L	L	L	L
L	H	L	H	L	L	L	L	L	H	L	L	L	L
L	H	H	L	L	L	L	L	L	L	H	L	L	L
L	H	H	H	L	L	L	L	L	L	L	H	L	L
H	L	L	L	L	L	L	L	L	L	L	L	H	L
H	L	L	H	L	L	L	L	L	L	L	L	L	H
H	L	H	L	L	L	L	L	L	L	L	L	L	L
H	L	H	H	L	L	L	L	L	L	L	L	L	L
H	H	L	L	L	L	L	L	L	L	L	L	L	L
H	H	L	H	L	L	L	L	L	L	L	L	L	L
H	H	H	L	L	L	L	L	L	L	L	L	L	L
H	H	H	H	L	L	L	L	L	L	L	L	L	L

H=HIGH STATE (THE MORE POSITIVE VOLTAGE)
L=LOW STATE (THE LESS POSITIVE VOLTAGE)

*EXTRAORDINARY STATES

Figure 3. This elaborate truth table can be found in the Intel specification manual for the 1-of-10 decoder (4028B). Boolean algebra can give you the input and output relationships of a digital circuit, but only the truth table lists all of the possible input conditions and the resulting output condition.

More digital electronics without Boolean algebra

We are in the midst of a continuing discussion on network theorems and laws without mathematics. In the November issue, I listed the laws of Boolean algebra. All of these laws could actually be used to describe the behavior of variations of basic circuits. All of the laws can be demonstrated by the use of the truth-table method.

For the truth-table method, the inputs and outputs of a digital circuit are determined by combining the columns of the truth table. When I reviewed the previous article, it seemed to me that I was being apologetic about using the truth-table method.

This is an important point: Boolean algebra can give you the input and output relationships of a digital circuit, but only the truth table lists *all* of the possible input conditions and the resulting output condition. For that reason, manufacturers sometimes use truth tables in their specifications of digital circuits. As an example, refer to Figure 3. This elaborate truth table can be found in the Intel specification manual for the 1-of-10 decoder (4028B).

If you can find a better way to show all of the inputs and outputs simultaneously, don't tell anybody else. Write to me personally and tell me your secret. I collect ideas like that.

Figure 4 shows the truth-table proofs for most of the Boolean algebra statements given in the November issue. The remaining proofs will be given in a later column. There is nothing profound about demonstrating these laws. They have been known for years — even before there was a subject called electronics. What is unique is the method of demonstrating that the laws are true by using a truth-table approach.

You should study each one of these truth-table methods and get familiar with this method of writing input and output conditions.

Another way to write the inputs and outputs of a logic circuit is shown in Figure 5. Here the inputs and outputs for every gate in the combined logic circuit are written. The inputs are combined according to the type of gate they are entering. Note that the output is a Boolean algebra expression for the circuit. In this sense it is a demonstration of the correctness of the Boolean algebra. However, as mentioned before, you don't have all of the possible inputs and outputs without some additional work.

Summary of the truth-table method

In the truth table, all of the possible inputs to a circuit are listed. A binary count is used to assure that none of the possible inputs are forgotten.

The columns of the truth table are combined in accordance with the gate where the inputs (columns) occur. Eventually, the last column will be the output of the circuit.

At that point, you have to be innovative because the output must be interpreted in terms of the conditions that occur. For example, in the EXCLUSIVE OR, there is an output only when the inputs are different. One or the other can be a logic 1, but not both. Likewise, one or the other can be a logic 0, but not both. This is what makes an output an EXCLUSIVE OR. You can't take that final step unless you know the truth tables for the basic gates and for some of the Boolean algebra laws.

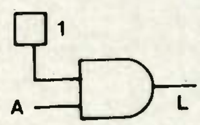
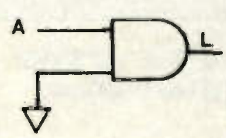
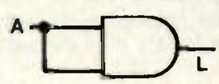
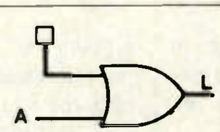
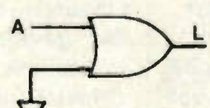
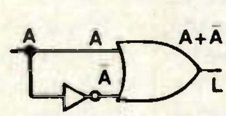
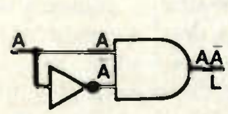
BOOLEAN ALGEBRA LAW	IN SYMBOLS	TRUTH TABLE
A×1=A		A 1 L 0 1 0 1 1 1 AND THESE COLUMNS TO GET L NOTE THAT L=A
A×0=0		A 0 L 0 0 0 1 0 0 AND THESE INPUTS THE OUTPUT IS ALWAYS 0
A×A=A		A A L 0 0 0 1 1 1
A+1=1		A 1 L 0 1 1 1 1 1 OR THESE COLUMNS
A+0=A		A 0 L 0 0 0 1 0 1 OR THESE COLUMNS
A+$\bar{A}$ =1		A $\bar{A}$ L 0 1 1 1 0 1 OR THESE COLUMNS
A$\bar{A}$ =0		A $\bar{A}$ L 0 1 0 1 0 0 AND THESE COLUMNS

Figure 4. You can demonstrate that the laws of Boolean algebra are true with these truth-table proofs.

A note about safety

Consider this possibility: Your friend has just bought a 1989 Dodge truck. He asks you to help him install a 2-way radio in it. Your friend knows nothing about electronics and has no ability with tools, so you end up doing all of the work. After the installation is complete, you test it. Everything is OK.

Two days later your friend is killed in an accident because you installed the radio system incorrectly.

I know, that is a very unpleasant story. But is it possible for an incorrectly installed 2-way radio to cause a fatal accident?

Here is a direct quote from the 1989 Dodge Truck Owner's Manual:

WARNING!

The Anti-Lock Brake System contains sophisticated electronic equipment that may be susceptible to interference caused by improperly installed or high output radio transmitting equipment. The interference can cause possible loss of anti-lock braking capability. Installation of such equipment should be performed by qualified professionals.

I thought I'd pass this along because

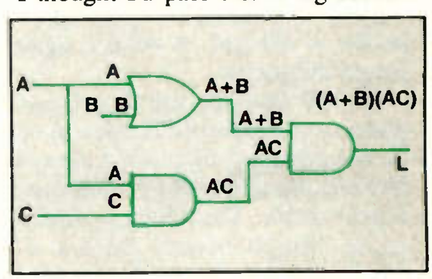


Figure 5. Another way to get the final output of a logic circuit is to write the inputs and outputs for every gate in the combined logic circuit. The inputs are combined according to the type of gate they are entering. Note that the output is a Boolean algebra expression for the circuit.

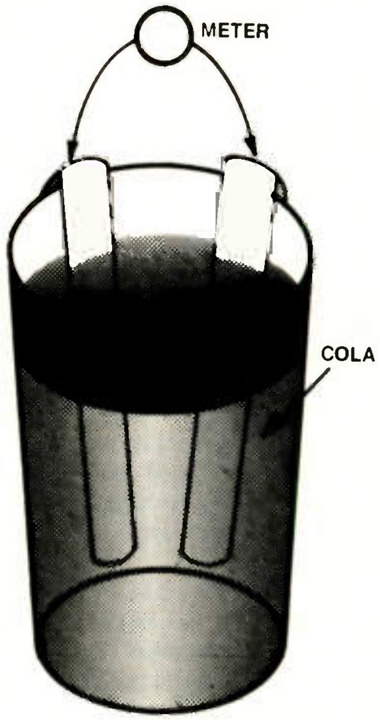


Figure 6. To make a simple battery, scrape the paint off of a piece of iron coathanger wire and place it and a piece of copper wire into a glass of cola. The phosphoric acid in the cola will create a simple cell.

technicians don't always read the owner's manual of a friend's new truck.

So you want to be an inventor...

If you want to be an inventor with your own patent, take my advice: INVENT A BATTERY.

Any time two different kinds of metals are immersed in an acid or alkali solution, a voltage is always produced. When you let your mind roll over the wide range of metals, acids and alkali solutions, you know at least one combination hasn't been tried.

You can start out with an example just to prove to yourself that it works. Scrape the paint off a piece of iron coathanger wire. Stick it and a piece of copper wire into a glass of cola as shown in Figure 6. The phosphoric acid in the cola will go to work and you will have a simple cell.

To measure the output of this cell, use a $0\mu A$ to $50\mu A$ meter. The meter movement on many analog meters can be used. It will serve as a voltmeter in this example.

Wipe off the ends of the wires and start sticking them any place you are allowed to stick them. Try a lemon and other kinds of fruits and vegetables. Keep a record in a bound notebook. A spiral or other type won't do. Date each page. Have two witnesses sign every page. Believe it or not, I have a patent on a booze battery.

Just about anything you try will make a primary (not rechargeable) cell. No need to write and tell me you've been recharging primary dry cells since Hector was a pup. Recharging involves reversing the chemical process. Heating dry cells in an oven — or with a reverse current — rejuvenates them but doesn't recharge them.

Let me tell you about a guy who invented a rechargeable cell and battery. His friend asked him to invent a battery to replace the lead acid type used in cars. Chemistry was his hobby, so he got started right away. It took him about seven years. By the time he got the job done, his friend had gone elsewhere.

Of course, you know he was Thomas Edison. The Edison battery turned out to be one of Edison's most profitable inventions — even though his friend (Henry Ford) couldn't wait for it. ■

Troubleshooting Tips

Symptom: Loss of raster
Set ID: Philco, chassis E25-6
Photofact: 1882-2

This Philco color set was brought in with a complaint of intermittent loss of raster. My first thought was that it might be loss of high voltage. Closer observation showed that the picture dropped to a horizontal line, which then instantly jumped up above the viewing area of the screen. That symptom eliminated the HV as a possible cause of the problem.

I started my probing at the yoke, where I found that there was no vertical sweep at pin 4. Going back to the complementary vertical oscillator/driver, IC302, I discovered that the bottom vertical output at pin 10 distorted slightly whenever the raster disappeared, but stayed fairly constant in level. I noticed the same distortion of the signal at pin 2.

This symptom didn't appear at pin 6 and pin 3, which both dropped to an unreadable level. The dc voltage at pin 3 was normal. From the chip manufacturer's block diagram of the chip, I found that pin 3 is tied internally to the side of the chip feeding pin 6. I used coolant spray to check the solder connections and components (such as L350 and C350) tied to pin 3, but it had no effect.

All of these symptoms seemed to point to IC302, so I changed it out. When I restored power to the set, everything seemed normal for a few minutes, but then the symptom returned.

In my haste to correct what seemed to be a positive indication of IC302 as the problem source, I had failed to check voltages at Q300 and Q302. If IC302 wasn't the problem, that left these two components as the prime suspects. Checking voltages at the leads of these two transistors revealed that the collector voltage of Q300 was only 9V, indicating an open collector. Apparently this condition caused enough of a loss at pin 6 to drop the signal. I replaced Q300, which restored the set to normal operation.

This was a lesson to me: No matter how definitely the readings seem to point to one component as the cause of the problem, something else may be the cause of the problem. When you're absolutely sure which component is faulty, especially when it's an IC, check surrounding components to confirm your diagnosis.

Michael H. Whitco
Wellsburg, WV ■

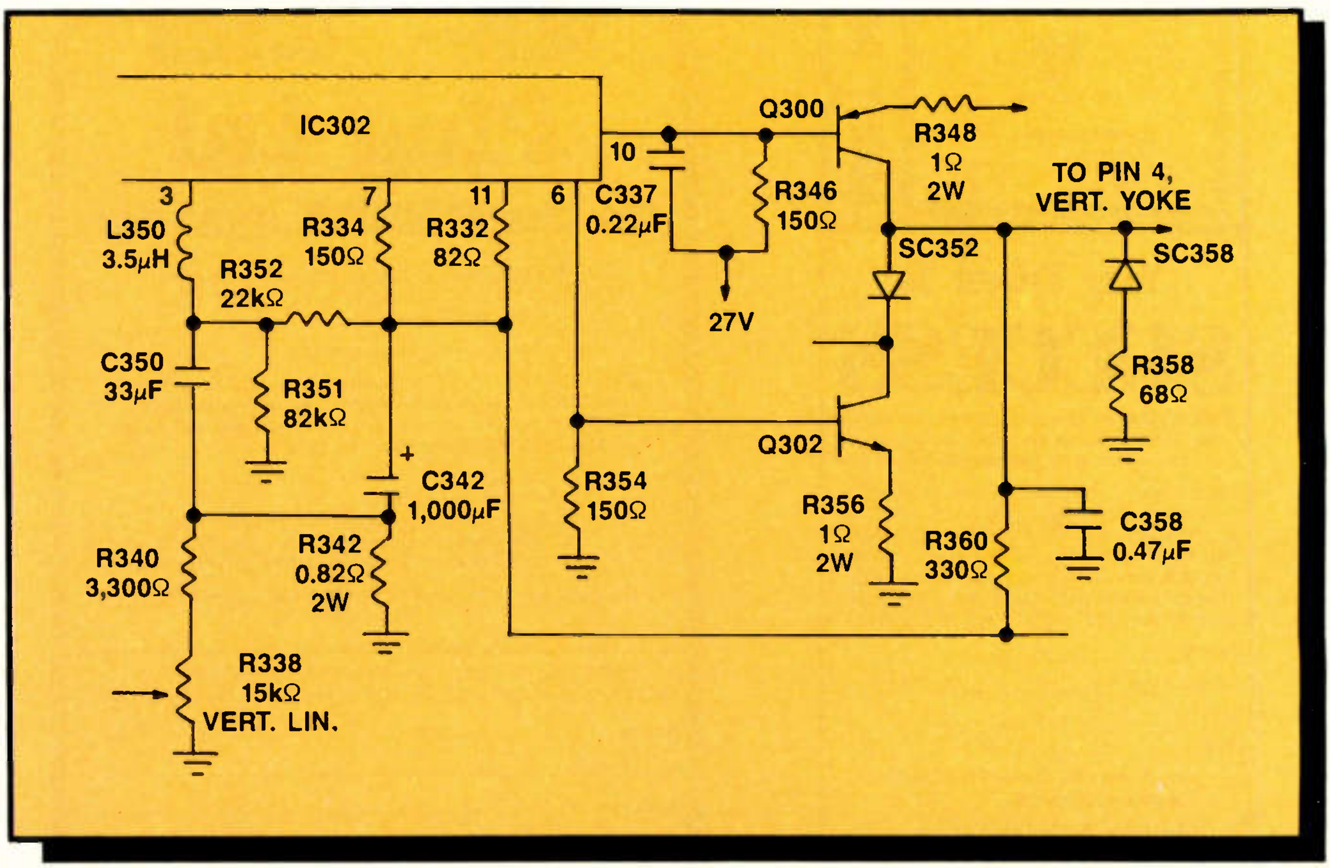


Figure 1. The collector voltage at the lead of transistor Q300 was only 9V, indicating an open collector. This condition caused enough of a loss at pin 6 to drop the signal.

Working with a hard disk system

By Glenn R. Patsch

You may have wondered how the hard disk got its name. *Floppy disks* are flexible and you can actually bend them, although you should not. Hard disks contain rigid, flat surfaces referred to as *platters*. These flat surfaces are coated with a magnetic material to store information. (IBM refers to a hard disk as a *fixed disk*.) Floppy disks are removable; hard disks are fixed in place.

Hard disks are actually quite fragile, and the computer should not be bumped, jarred or moved while it is operating. Otherwise, you could damage the heads or the surface of the hard disk. Before the computer is ever moved, the heads should be parked. This operation may be performed automatically by the hard disk, depending on the computer manufacturer. If not, you should park the heads by using a software utility designed to do that.

Hard disks are not difficult to understand. Before DOS (or any other operating system) can be used by a hard disk, it must be properly set up. A hard disk must be low-level formatted to establish the sector size, interleave and location of the tracks. The sector size is usually 512 bytes, which is the smallest amount of space on the disk. If you need to store 513 bytes of data, you must use two sectors.

The interleave defines the order of the tracks on the disk. A one-to-one interleave places all of the tracks in numerical order. Changing the interleave can speed up or slow down the flow of information from the disk to the processor. All of this depends on how fast the disk rotates, where the sectors are located, and how fast the processor can accept information. By changing the interleave, you are changing the order of the sectors to try to have the next one in the right place to compensate for a slow processor, a slow disk or both.

Patsch is a consultant specializing in the selection, evaluation and installation of IBM personal computer and compatible hardware and software.

Low-level formatting is usually done by the manufacturer of the disk.

Sectors

Once a hard disk has been low-level formatted, it is ready to be divided into one to four sectors referred to as *partitions*. The DOS FDISK command is used to create these partitions. Each partition becomes a different logical drive. The first partition, the C: drive, contains DOS and is used to boot up the PC. The bootable partition is referred to as the *active partition* and can be any one of the four partitions, although it is usually the first one. The second partition would be the D: drive. The third partition would be the E: drive, and the fourth would be the F: drive.

Partitions also can each have a different operating system, which would allow you to have DOS and UNIX on the same disk. Depending on the physical capacity of the disk, each partition can be a maximum of 32Mbytes for DOS 3.3 and older versions of DOS. PC-DOS 4.0 from IBM and MS-DOS 3.31 from Compaq and others allow partitions larger than 32Mbytes, up to a maximum of four trillion bytes. After the disk is divided into partitions, each partition must be formatted with the FORMAT command.

The DOS FORMAT command prepares the disk to accept files by creating a directory and file allocation table (FAT). The directory keeps track of the file names and stores the file size, the time and the date the file was created. The directory also stores the file attributes, which are *read only*, *hidden*, *system* and *archive*.

The FAT keeps track of which clusters are used and which are free. The directory points to the first cluster for the file. Sectors are grouped into clusters. Some disks have one sector per cluster; others use several sectors per cluster. Large-capacity disks have several sectors per cluster to keep the size of the FAT manageable. There are actually two copies of the FAT because it is so important.

Now that the disk is formatted, it should be bootable. The DOS FORMAT command with the /s option or the SYS command will transfer the hidden files IBMBIO.COM and IBMDOS.COM (IO.SYS and MSDOS.SYS for MS-DOS) and the file COMMAND.COM to the hard disk.

Creating directories

Directories should be created on the disk for each application program. The DOS MKDIR or MD (make directory) command will create a new directory. To create a directory for a Lotus 123 spreadsheet program, for example, use MD 123 to create the 123 directory. A path can be set to use the various application programs with the PATH command. PATH c:;c:DOS;c:123; will search the root, DOS and 123 directories for programs to run. Place the PATH command in the AUTOEXEC.BAT files, which will automatically execute when the PC is turned. Your AUTOEXEC.BAT file might look like this:

```
ECHO OFF
ECHO IBM PS/2 MODEL 70 WITH
VGA MONITOR
PATH C:;C:DOS;C:123;
PROMPT $P$G
```

The CONFIG.SYS file contains configuration information for the computer. It might look like this:

```
BUFFERS=15
FILES=20
LASTDRIVE=C
DEVICE=IBMCACHE.SYS 64 /E /P4
BREAK=ON
```

Both the AUTOEXEC.BAT and CONFIG.SYS files should be in the root directory. Load other application programs and files you need. The hard disk should now be ready to use. ■

Electronically tuned radios

By Craig R. Seelig

Audio Corner in December described the circuitry and operation of electronically tuned radios (ETRs). Part II will discuss the control key and mode switch matrix. This part also will describe troubleshooting methods for these circuits.

The switch matrix

Part I of this series described NEC's PD1701C-013, a common electronic tuning system control IC found in both home and car stereo equipment. The control IC, a microprocessor chip, accepts inputs from the tuning controls, AM and FM oscillators, the station detector and the turning controls. It provides control outputs for tuning, mute and the visual display. The control IC also provides user interface functions, including multiplexing signals for the digital display drivers and a 4×7 control and mode switch matrix. Matrix locations designated by a triangle (see Figure 1) allow the circuit designer to "strap" in certain system functions, such as IF frequencies used and AM channel spacing. (European AM channel spacing is 9kHz.) This flexibility allows the device to be used in many markets.

Locations designated by squares are alternate switch locations where, by means of mechanical push-push switches or transistor switches, such functions as bandswitching and display dimming are accomplished. Locations designated by circles are momentary key positions that control such functions as manual up/down tuning, seek/scan and preset address. Conductive-rubber contact switches are often used in these positions.

Troubleshooting

You often can troubleshoot ailing ETRs by carefully analyzing the symptoms. What functions of the control circuit are operating normally? Is it just FM (or AM) that is not working? Is a valid frequency being displayed by the IC? (See the block diagram in Figure 2. For the schematic, refer to Figure 1A in the December issue.)

In the majority of cases where a valid frequency is being displayed, the control IC will be operating properly. If a valid frequency is not visible, check for the presence of 5V on pins 3 and 14. Catastrophic failure of the micro-

Seelig, an electronics servicing consultant, has spent the last 11 years doing circuit-design, prototyping and troubleshooting for a car stereo manufacturing company.

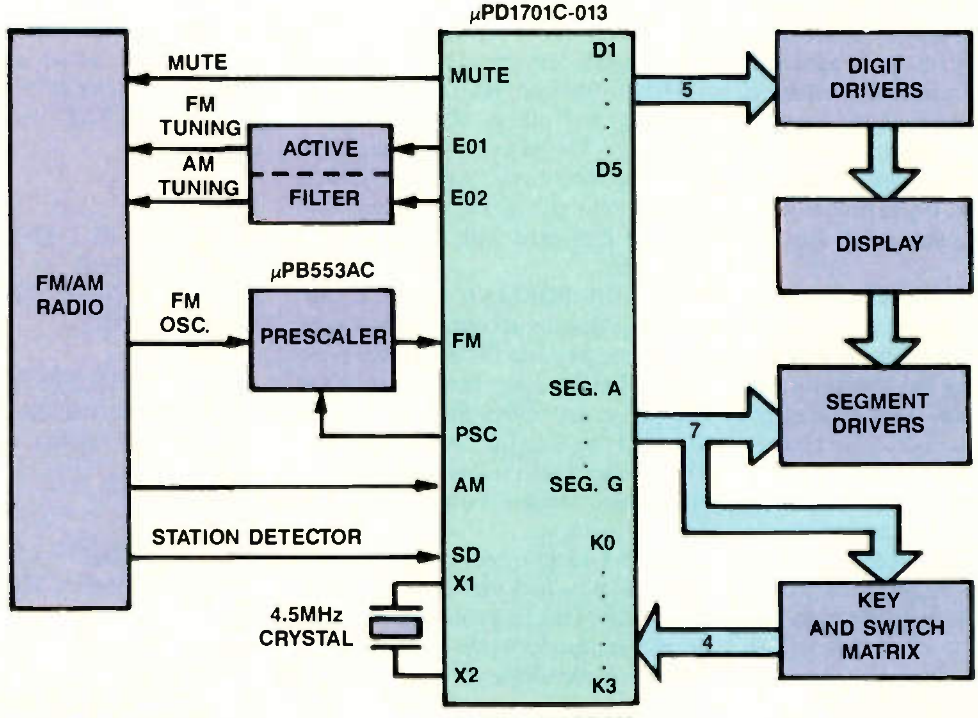


Figure 2. In an electronically tuned radio, a microprocessor selects from a finite number of assigned radio channels. The block diagram of the tuning circuitry of a typical electronically tuned radio is shown here.

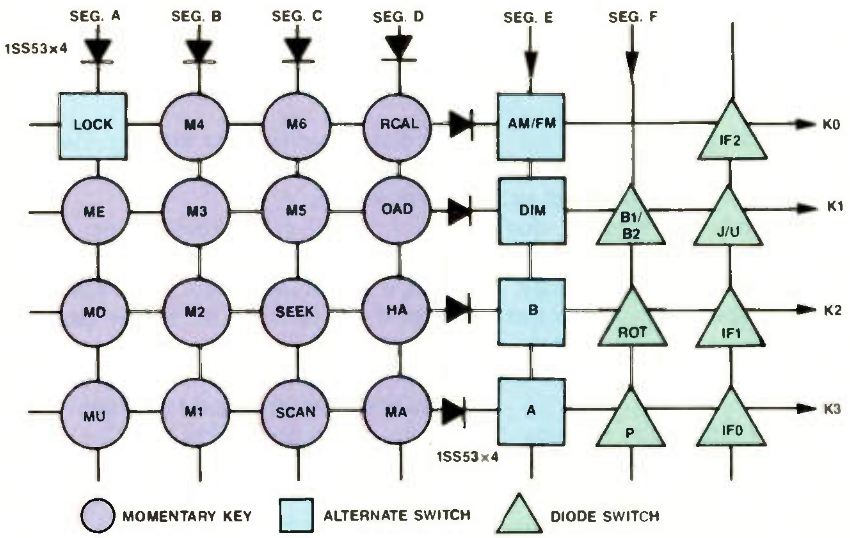


Figure 1. The control key matrix of an electronically tuned radio is shown here. The matrix locations designated by a triangle allow the circuit designer to "strap" in certain system functions such as IF frequencies and AM channel spacing.

processor-control IC may load down the B+ supply to pin 14. If this is the case, opening the solder joint here will return the supply line to 5V and confirm a defective IC. When supply voltages are normal, check for the presence of 4.5MHz at the crystal (use an isolation resistor). If the oscillator is running and the digital display is blank, check for B+ at the segment driver IC.

If a valid display is shown, but the control IC is not responding to any keyboard commands, check for the typical cause: a stuck momentary push-button. If the control IC is initialized with a key stuck in the down position, it will not respond to any key commands.

Proper operation of the ETR's PLL is easily verified. Place the radio in the seek or scan mode with the antenna shorted. Monitor the varactor tuning voltage line while the control IC is scanning. When the PLL is locked, this voltage should be a smooth ramp. The only abrupt voltage change should occur when the displayed frequency changes from one end of the band to the other. Any interruption of any part of the PLL loop, such as loss of sample local oscillator RF, characteristically will cause the tuning voltage line to stay near B+.

It is unlikely that both AM and FM oscillator circuits would become defective at the same time. Therefore, if the PLL tuning voltage does not ramp in either radio mode, the charge-pump/lowpass filter or control IC would be suspect (assuming radio B+ and B+ switching circuits are OK.

Alignment of the PLL is a simple matter of setting the display frequency to the highest channel and adjusting the appropriate local oscillator tank coil or trimmer to achieve the specified tuning voltage as measured at the output of the charge pump.

With an understanding of the various function blocks comprising the electronic tuning system and the influence they each have on overall receiver operation, any technician should be able to quickly isolate the defective subsystem. ■

When the cures become the symptoms

By Wayne Smith, CET

A VCR is a complex device — actually a complex system — consisting of drive mechanisms to move the tape and the video head cylinder; electronics to convert the magnetic signals on the tape to electronic signals that produce a picture on the TV; and control circuitry to make sure everything works together properly.

Because of this complex nature, troubleshooting a VCR can become a complex procedure. You must keep an open mind about symptoms and their possible causes. Perhaps as important, you must make sure you understand what the manufacturer meant by all of the terms in the servicing literature.

One other important item: If the symptoms point to a problem in an area that has already been repaired, don't be blind to the possibility that the repair may not have been made correctly. This article describes the problems that can occur when you lose sight of these suggestions.

Smith is an electronics servicer in Arden, NC.

Don't ignore the obvious

I was repairing a top-loading machine, Panasonic model PV1270/PV1275, for another shop. The original trouble reported was that the tape would load, then unload about 10 seconds later. On my bench, the unit was almost dead. The power-on indicator was illuminated and the clock was working. However, none of the front-panel switches had any effect.

A visual check revealed that there were no obvious troubles and that the tape sensor lamp was illuminated. In most machines, if the sensor lamp or LED is defective, the symptom is shutdown, which is what this unit was exhibiting. System control microprocessor checks revealed that the V_{DD} (B+) power supply, the oscillator and the reset circuit were operating normally. The four scan pulses — C0, C1, C2 and C3 — were present at the microprocessor output pins. (See Figure 1.) When the Play button was pressed, scan pulse C1 appeared at input port B3. The scan pulse proved that the microprocessor was being given the command to load the tape, but something was overriding this command. One of the safety sensors obviously was activated.

The Mode Select switch is coupled to the mechanical portion of the machine. It should have been and was in the stop position as verified by a logic low at P6002, pin 4. The Cassette Compartment Up/Down switch was in the correct position (down) as verified by a logic low at P6003, pin 2. The unload and pause logic levels were verified at their respective connectors.

By this time, I was thinking that the clock could have a problem, although it seemed to be working. The proper logic level was verified at IC6005, pin 24.

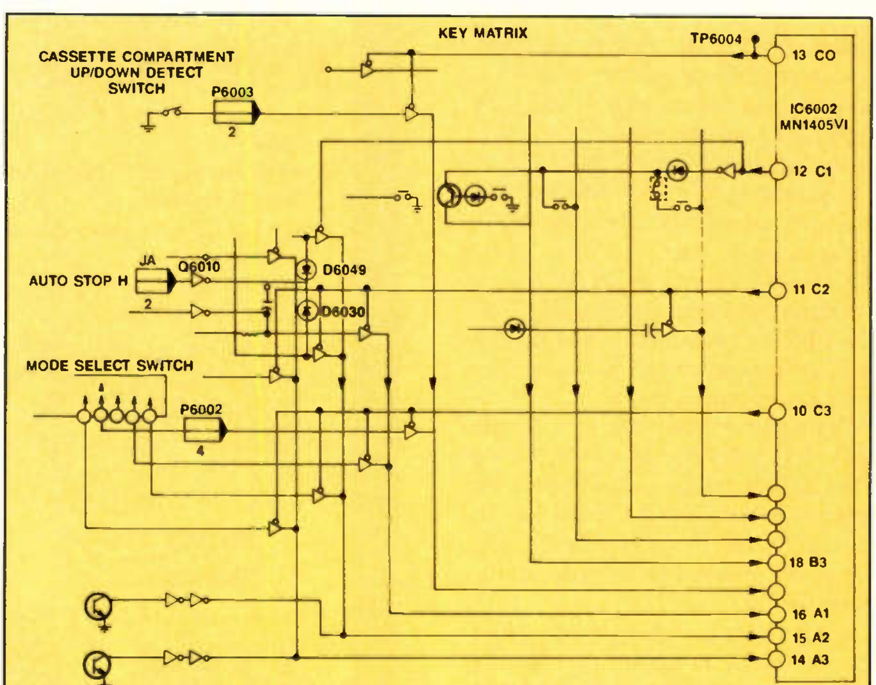


Figure 1. If the scan pulses are present at the microprocessor output pins, the microprocessor is receiving the command to load the tape. Before a servicer delves into the microprocessor, he should first check the end-of-tape sensor lamp.

Know the schematic symbols

The only sensor input that had not been checked was the auto stop at the JA connector, pin 2. I didn't suspect this input because it connects to the sensor lamp circuitry and I knew that the sensor lamp was lit. Just to be on the safe side, I checked the voltage at JA2. It measured 0.6Vdc. The block diagram plainly stated that the condition at this point would be a high if the auto stop was activated.

I knew the microprocessor almost never failed, but what else was left? IC6003 and IC6004 are tri-state buffers. They couple the four scan outputs into the eight data inputs. The program inside the microprocessor knows which switch or sensor has been activated by the scan output pulse (or pulses) that is (are) coupled into the data inputs (A0 through A3 and B0 through B3).

Could a buffer be bad, causing the wrong pulse to be applied to the input ports? One way to check this is with a dual-trace scope. Channel A is connected to TP6004, the C0 pulse. This pulse is used to sync the scope and act as a reference to check the timing of the other scan pulses. Channel B is then used to troubleshoot.

Pins 14, 16 and 17 appeared to have the proper scan pulses present. Pin 15 had scan pulses C1 and C2 present. From the block diagram perspective, the only thing that could turn on both of these buffers would be a logic low at the junction of D6049 and D6030.

If the VCR is not in auto stop, JA2 should be low (and was measured at 0.6Vdc earlier). This low is inverted by Q6010 into a high, which would not allow the C1 and C2 scan pulses to be coupled into pin 15. A voltage measurement at the D6049/D6030 junction confirmed that it was logic low. Could Q6010 be defective?

The collector voltage measured 0.01Vdc, meaning this transistor was either shorted or turned on. The base measured 0.65Vdc, which was just enough to turn it on. I had mistakenly taken the high symbol at JA2 to mean a TTL logic high (2V or above). Before fighting this dog anymore, I wanted to verify that it would work, so I ran a clip lead from JA2 to ground. The machine operated normally.

Check the replacement history

The sensor circuitry connected to JA2 obviously should cause the voltage to be less than what is needed to turn on the transistor switch. In addition to the sensor lamp circuitry, the dew sensor circuitry is connected to JA2. Subsequent checks proved that the dew sensor and its components were good. The resistors and zener diode (D6504) in the sensor lamp circuit checked out OK. The +12Vdc was normal. The only thing left that could be causing the problem was the sensor lamp.

Time for a call to the technician who referred this problem to me. During preliminary checks of the unit, he recalled, he had found that the sensor lamp was broken and had replaced it with a close substitute.

The resistance of the substitute lamp was 31Ω. The original lamp for this machine measures 5Ω. Even though the replacement lamp looked physically the same and had about the same brightness, the higher resistance allowed the voltage at the anode of D6504 to rise to 0.65Vdc. With the exact replacement lamp installed, the voltage was close to zero.

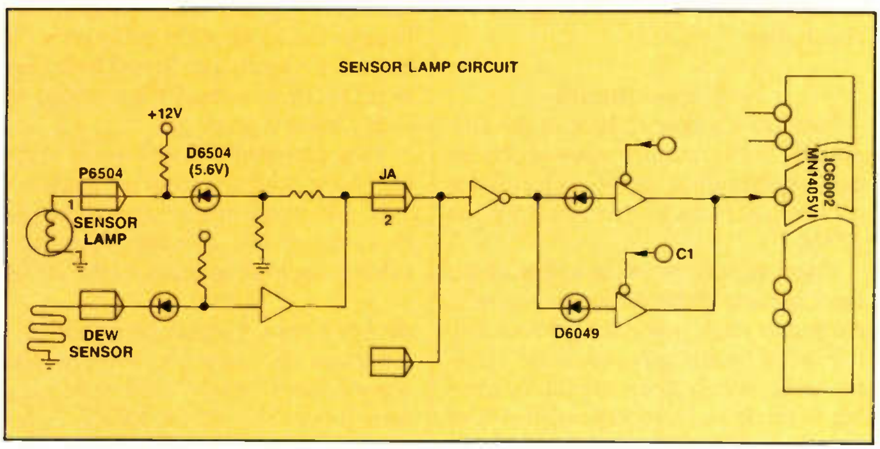


Figure 2. The high symbol at JA2 does not indicate a TTL logic high (2V or above).

Ambiguous schematics

For a final check, I went back to pin 15 of IC6002 and was surprised to find the C1 scan pulse present. The machine was operating satisfactorily, so it was obvious that this pulse was supposed to be present. Nevertheless, how did it get there with diode D6049 biased off?

It's not apparent from the block diagram, but the schematic will reveal that pin 4 of IC6003 is connected to pin 2 of IC6002 by diodes D6014 and D6034. The purpose of this port is not discussed in the service or training manual, but it seems to stay at logic low after an initial high at power-on.

This repair seems to have two morals: Don't assume that something called a high or low is necessarily a *logic* high or low, and always use the correct replacement part. ■

Trends for the '90s

By William J. Lynott

The 1980s were a traumatic time for the electronics servicing industry. For all practical purposes, black-and-white television, like old soldiers, just faded away during the decade. New technology continued to render color TV sets less prone to failure; at the same time, it made possible a host of new and complex electronic products. For example, the desktop computer and its peripheral devices have grown from virtually nothing 10 years ago into one of the world's most important industries.

Another problem servicers face is that, as we enter the 1990s, some manufacturers seem increasingly obstreperous about negotiating fair rates for what little in-warranty work remains.

These and other influences during the past decade have sharply increased the casualty rate among electronics servicers. Precise figures are difficult to come by, but there are certainly thousands fewer small electronics service companies now than there were at the beginning of the 1980s.

The survivors

Does all this signal even tougher times during the decade just beginning? I don't believe so.

For one thing, the long and painful shakeout in the industry has left a group of survivors who are more sophisticated, more energetic, and far more adaptable to change than many of the pioneers who helped to build the industry as we know it.

In my travels around the country, I'm seeing a new breed of service dealer. For the most part, these folks started business during times that were already turning hard. Many of today's electronics servicers cut their teeth long after the plush times marked by fragile vacuum-tube sets and emerging color receivers that seemed to be down as often as they were up. Most never luxuriated in the simple inventory requirements that centered on a few dozen fast-moving tubes and an assortment of standard resistors and capacitors. Most never witnessed a visit by an open-handed manufacturer's rep who was desperate to find a qualified service organization to handle his company's products.

The servicer who learns how to reduce the time between a service call and the completed repair is going to gain a major competitive advantage during the 1990s.

These are the people who have held their businesses together — some even prospered — during a time when others were fading into oblivion. These are the survivors.

If you're reading this, chances are you're one of those survivors. Congratulations! The fact that you have weathered all or part of the toughest decade yet for electronics service dealers says a lot about you.

New opportunities

But now it's time to look at the new decade — to consider what problems and opportunities for the electronics servicer are likely to emerge during the 1990s.

If you've been tuned in to one of the most important changes in the business climate in years, you already know how important time is to people today. Businesses in every industry are finally coming to recognize how important it is to today's consumers that they make the best use of limited time. Waiting for a servicer to show up or for a TV or VCR to be repaired is not on anyone's list of enjoyable pastimes. The servicer who learns how to reduce the time between a service call and the completed repair is going to gain a major competitive advantage during the 1990s. You can't procrastinate on this point. If you have doubts, take a look at your local Yellow Pages and notice the number of service dealers already advertising "service today." I enjoy challenging servicers on these claims as I travel around the country, but I'm finding out that most of them are actually delivering.

Then there is the new emphasis on convenience. Entirely new industries are being built around consumers' needs to have service available at *their* convenience. Just look around your town and you'll see banks, supermarkets, auto dealers and realtors staying open Saturdays, evenings, even Sundays to meet their customers' expectations.

To me, this is perhaps the most important single marketing concept for servicers to embrace during the 1990s: It is the *customer's* expectations that must be met. It is the customer who decides what is or is not "good service."

With more than 35 years in the service industry, I'm no stranger to the fact that many service executives are accustomed to deciding what does and does not constitute good service. That's the way it was in the beginning. I know because I was one of the guilty ones. We had more reasons then for not being able to get out there within 24 hours than you could shake a stick at.

That philosophy won't wash today, and those who are quick to grasp the need for change are the ones most likely to be around 10 years from now, celebrating the beginning of the 2000s.

Author's note: If you have ideas and innovations that help you manage your service business more successfully and more profitably, write to **ES&T**. *Please don't hesitate to let me know if you disagree or have suggestions.* ■

Lynott is president of W.J. Lynott, Associates, a management consulting firm specializing in profitable service management and customer satisfaction research.

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