For Industrial Maintenance and Consumer Servicing Professionals

February 1981 □ $2.25

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Service shop management

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UNIVOLT'S DT-810 DIGITAL MULTIMETER

The unique space age digital multimeter with transistor gain (hFE) measurement capability should be the only multimeter you own.

Ora Electronics has offered in the past many fine Digital Multimeters (D.M.M.'S). We still sell the famous D.M.M.'S such as Beckman, Fluke, Hickok, and others. We have always followed the advance in technology used in D.M.M.'S, and we always wanted to supply our many good customers with the most Ideal Multimeter, at a price they can afford. In the past we had to sell good, but expensive Multimeters, expensive but "fair" Multimeters, and plain "cheap" Multimeters.

WE FOUND IT!

Several months ago, a famous Test Equipment Manufacturer, walked in to our headquarters with a Prototype of a Digital Multimeter. We were very impressed it had almost everything we wanted plus a bonus, the only question remaining was "how expensive is it?" When we heard the answer, a big smile appeared on our faces. After several improvements we are proud to offer it. After you read the features (and price) I am sure you are going to order one or more, of these fine D.M.M.'S that we call the "UniVolt".

LCD DISPLAY.

The unit has a 3.5 Digit liquid crystal display. The sharp digits are 14mm high and have a viewing angle of 140°.

HIGH ACCURACY.

The basic D.C. accuracy of the UniVolt is 0.5% of reading +1 digit, which makes it one of the more accurate instruments in its class. The input impedance is very high, 10 mega- Ohms (10,000,000) Ohms, which helps in measurements of low voltage and high frequency signals.

MEASUREMENT RANGES.

The UniVolt has D.C. voltage range of 100uv to 1000V in five steps, A.C. voltage range of 100mV to 1000V, current measurement range of 100mA to 10A (DC) and resistance range of 1 to 2,000,000 Ohms.

CONTINUITY & DIODE TEST.

A fast and accurate continuity test mode utilizes a built-in buzzer to indicate continuity. The same mode is used to check diodes and their approximate forward voltage.

EASE OF OPERATION.

The UniVolt is small, it measures 6½" x 3⅜" x 1¼". It's light weight, only 9.87 oz. including battery! It utilizes push buttons, for easy one-hand operation and the front panel has a unique color coding for reduced errors.

OVERLOAD PROTECTION

The unit has an extensive overload protection on all ranges. On D.C. current ranges it uses a .5A GMA type fuse. A spare fuse is supplied with the unit at no extra cost.

MAINTENANCE FREE

The heart of the UniVolt Multimeter is a 40 pin L.S.I. chip; the Intersil ICL710G. This space ages chip has proven to be one of the most sophisticated and reliable micro-electronic circuit in use, it is supported by minimum amount of external parts, which are over specified to insure failure safe instrument. Of course, Ora Electronics stands by this instrument and guarantees it for one year (See specific warranty information).

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OTHER FEATURES

It uses one 9 volt carbon battery (included), which last approximately 200 hours of continuous use. Its sampling time is 0.4 seconds, operating temperatures of 30°F to 104°F, and operating humidity of less than 80% R.H.

BONUS!!

We left the best to the end. The UniVolt DT-810 has something unique. It has a **transistor gain (hFE) measurement mode!** This unique feature enables you to measure hFE values of 0-1000 of either P.N.P. or N.P.N. transitors.

SPECIAL PRICE

We had originally decided to sell the unit for $119.95, but in order to promote the new advancement in D.M.M. design, represented by the UniVolt, for a limited time only you can buy this incredible unit for only $99.95 including: standard red & black test leads, a fresh 9v carbon battery, a spare 0.5A GMA type fuse and an instruction manual.

FREE CASE

We have worked long on the UniVolt project and we hate to see scratches or bad looking units. So we decided to go all the way, when you buy the UniVolt DT-810 Multimeter (and for a limited time only!) we will give you absolutely free a hard vinyl leatherette, carrying case, with felt padding and a compartment for your test leads. The regular selling price for this case mode CC-01 is $8.00.

ACCESSORIES AVAILABLE.

The only two accessories available are: UP-11, hFE probe with special plug and 3 color codes alligator clip, and the UP-12 I.C. clip adaptor, which will help you hook your multimeter to any I.C. pins. (You can buy both probes for only $6.00, but only when you purchase the UniVolt DT-810 now.)

ORDER NOW!

It's very easy to order your UniVolt DT-810 multimeter. Send $99.95 (California residents add 6% sales tax) plus $2.50 delivery charge to the address below, if you want the optional accessories, please add $6.00 (California residents add 6% sales tax). A cashier check or money order will help speed your order. Credit card holders (master card or visa) can call our toll free number **(800) 423-5336**, in California it's **(800) 382-3663**. C.O.D. orders will be accepted, but you must pay by cash or money order and a C.O.D. charge of $1.40 will be added. If you decided to buy another brand of Multimeter, please call us too, we carry many other types of multimeters and test equipment at low prices.

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Electronic Servicing

About the cover

Shown is the AIM-65 microcomputer manufactured by Rockwell International, which is featured in *Industrial applications of the AIM-65 microcomputer*, page 6.

Photograph courtesy of Robert L. Nuckolls III, Electro-Mech Inc.

electronic scanner

news of the industry

Thordarson adds five Admiral replacements

In response to numerous requests from service technicians, Thordarson Meissner has added five exact replacement flybacks for Admiral TV sets to its line. This action is the direct result of customer comment reply cards packed with Thordarson flybacks and yokes. The new Thordarson numbers and corresponding Admiral number are:

Thordarson Number	Admiral Number
Fly 684	79( )199-1
Fly 685	79( )197-1
Fly 686	79( )166-1
Fly 687	79( )166-10
Fly 688	79( )166-14

Flybacks 684 and 685 are now available from Thordarson distributors. Numbers 686, 687, and 688 will be stock items in February.

Economist presents 1981 forecast at EIA DPD meeting

"The Economic Outlook—1981" was the featured topic at the January 20 meeting of the Electronic Industries Association, distributor products division, central region, according to William G. Little, Quam-Nichols Company, central region chairman.

W. David Woolford, vice president, business & economics, research department, First National Bank of Chicago, analyzed the general state of the nation's economic health, including predicted growth in the electronics industry—industrial and consumer, as well as other areas: the percentage of gross national product attributable to the various segments of the economy; unemployment; inflation; interest rates; and government manipulation or stabilization of the economy.

Woolford's afternoon presentation was preceded by concurrent morning meetings of the three central region special interest sections: marketing & distribution, advertising & sales promotion, and executive management.

Leonard Cravath, president, Classic Components Supply, Northbrook, IL, and Michael Omansky, sales manager, OHM Electronics, Palatine, IL, discussed what they wanted to hear at distributor sales meetings, and how the meetings should be conducted. Jim Kimball, vice president, sales, Sola Electric, explained how he conducts successful distributor sales meetings.

The advertising and sales promotion section viewed and discussed the film, "How Not to Exhibit at a Trade Show." The film portrayed proved and effective methods for participating in trade shows, including how to plan for a trade show; pre-show training for booth personnel; manning a booth; and post-show critique.

"Financial Strategies for Rapid Growth" was discussed by the executive management section. Carl Korn, president, Dynascan Corporation, examined "Public Financing"; Gene R. Hill, president, Grayhill Inc., discussed "Private and Internal Financing"; and Jim Liautaud, president, Capsonic Group, Inc., discussed "Venture Borrowing."

Zenith announces merchandising programs

Zenith Radio Corporation's service, parts and accessories division has recently announced new merchandising programs highlighted by the company's first television commercials promoting parts and accessories.

"Most people think of quality color TV when they think of Zenith," William G. Frick, vice president, Zenith Sales Company Division, said. "We want to be remembered for our quality TV parts and accessories.

The four new commercials, produced for local television station spots, advertise Zenith's 1981 exact replacement parts; Chromatenna indoor and outdoor TV antennas; and audio accessories, including stereo headphones and blank recording tape.

In addition, Zenith's service, parts and accessories division is conducting a traveling "Road Show" throughout 1981 to familiarize retail dealers across the country with both current and new products. Zenith distributors are providing

Scanner

sponsorship cooperation of the program in 24 major markets.

Other Zenith parts and accessories product lines for 1981 include semiconductors; color picture tubes; electronic test equipment; receiving tubes; chemical contact cleaners; and audio needles and cartridges.

EDS announces ladies program

Women planning to attend the 1981 EDS show in Atlanta are invited to participate in a ladies program. Programs will be held during the three exhibit days of the show, May 5-7. The Ladies Hospitality Headquarters in the Cherokee Room of the Atlanta Hilton will serve Continental Breakfast each morning, followed by tours of Atlanta. The final day's program includes a half-day trip to Stone Mountain historical park.

The cost of the program is $21 for Tuesday, $24 for Wednesday, and $11 for Thursday, which covers tour bus transportation, all admission charges, one attraction at Stone Mountain, and the Tuesday brunch and Wednesday lunch.

Space on the tour buses is limited, so early reservations are advised. For more information, contact: Electronic Industry Show Corporation, 222 S. Riverside Plaza, Suite 1601, Chicago, IL 60606; telephone (312) 648-1140.

Los Angeles TV station first with digitally recorded simulcast

The first television program simulcast with digitally recorded audio occurred December 25, 1980. The musical program "All That Brass" originated from KCET-TV, the Los Angeles PBS affiliate, with stereo audio broadcast on radio station KPFK (90.7 FM).

Jerry Zellinger, sound mixer and engineer at the Los Angeles TV station, said, "Since the Sony digital system utilizes videotape recorders, we thought it might be an interesting way of not only getting good quality audio, but also of integrating it into our video editing system." Zellinger also said there was no generation loss with digital audio, a factor which preserves the quality of the sound in the step-by-step production process.

Recording for the program was done using the Sony PCM-100 Digital Audio Processor. The Sony digital system can handle approximately 50 percent more dynamic range than conventional analog recorders.

Tronics 2000 sells development rights

Tronics 2000, a franchise organization for TV, audio and appliance repair shops, has announced tha development of three territories is underway.

Development rights to a three county area north of Chicago have been purchased by Opportunity Unlimited Corp.

Jim Cardnell & Associates, Inc., purchased the development rights to a 21 county area in Central Florida.

Development rights to a one county area in Louisville have been purchased by Jim Reeves and Joe Schulz, two Louisville area businessmen. □

letters to the editor

To the Editor:

In servicing, what is B-?

Clarence Rolkosky
Milwaukee, WI

The other end of any positive-voltage supply is the negative terminal; both a positive and a negative terminal are necessary. In older television (and other electronics) circuits, ground was the B- terminal of the B+ supply.

Many of the newer circuits have two grounds for separate power circuits. A new color TV can have a "hot" ground that is connected to one side of the ac-power line and a "hot" B+ supply that powers the horizontal-sweep circuit. In this case, the "hot" ground is B- of the isolated (nongrounded) dcV supply. Other power sources are created by rectification of horizontal-sweep signals. Each dcV is a B+ supply; chassis ground is the B- for all.

Granted, it is difficult to keep the various grounds and B- points properly labeled in articles. The "B-" label usually is applied only to "hot" grounds.

To the Editor:

What causes the "Venetian-blind" effect of 20 or more horizontal dark bars in a TV picture? These bars are very prominent during fade-to-black between scenes of a picture, and are less noticeable with very weak or very strong signals. Is this "silicon radiation?"

Virgil Priddy
Louisville, KY

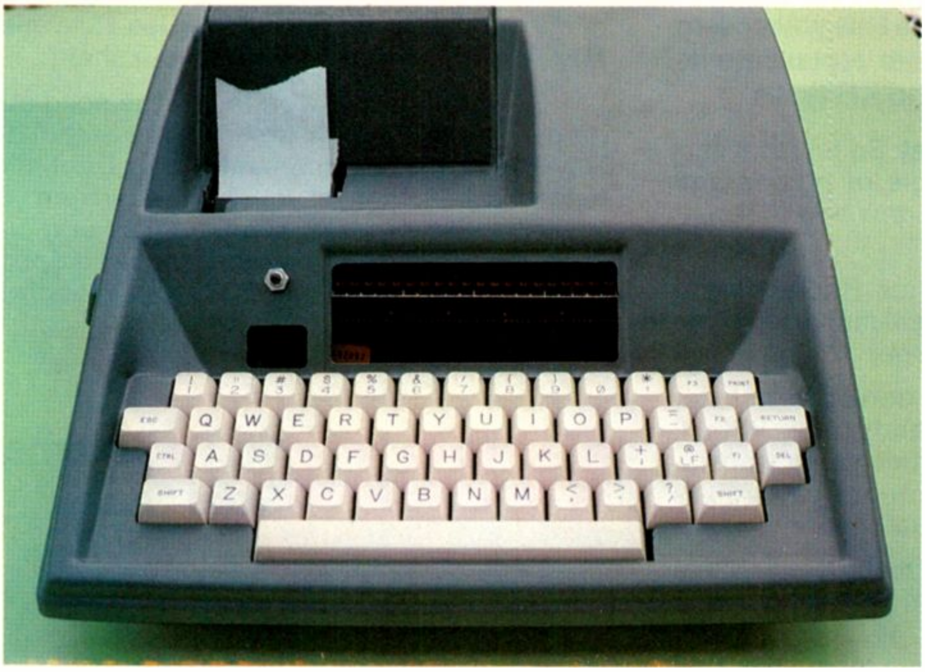
It is not clear from your letter what conditions produce these bars. Silicon-diode radiation bars are two broad (tall) bars that *always* move slowly up the screen. Sometimes only the edges can be seen, as though there are four narrow lines. These edges are very sharp.

Radiation from fluorescent lamps often (but not always) has about six lines together and then a space without any lines. However, these are triggered by the 60Hz line and move slowly upward (never downward).

Venetian-blind effect does have perhaps 20 bars that can be stationary or roll up or down. The bars are caused by a beat between the TV-signal carrier and another fixed carrier, usually another TV station on the same channel. When TV stations are less than about 200 miles apart, and are assigned the same TV channel, one is required by FCC rules to offset the carrier frequency by a certain value. A frequency difference of 600Hz between the two carriers produces about 10 bars on the picture. A difference of 1200Hz causes about 20 bars, etc.

It is rare for any location to have more than one channel with Venetian blinds. And it is almost impossible with rabbit-ear antennas (no distance reception). An alignment generator accidently left operating might cause a similar effect. Or radiation from a cable TV system could be the cause.

If these suggestions do not answer your questions, write again and we will ask other readers for advice. □



Industrial applications of the AIM-65 microcomputer

By Robert L. Nuckolls III, *Electro-Mech Inc., Wichita, KS*

Today's microprocessor / microcomputer** market is flooded with products. Marketing departments for each claim virtues and features they hope will improve its position in the marketplace. Nearly all the offerings cater to the consumer market of the computer hobbyist with machines that run the range from single board "trainer" devices to very elaborate systems with a lot of memory, multiple floppy disc drives and one or more higher language programming capabilities.

The emphasis in most marketing schemes is to entice the prospective buyer with the excitement of video games or to justify the purchase by offering a better way to keep the household budget straight. This article introduces a unique product in the microcomputer field. Of all the features for which microcomputers are usually purchased, the AIM-65* does none of them very well. It has no CRT; playing "Star Trek" is out. Because the printer is only 20 columns wide, running the household budget is difficult, if not impossible.

However, the AIM's unique combination of ROM resident editor, assembler, interactive monitor and 8K of BASIC along with uncommonly complete and lucid documentation make it an excellent choice for many industrial training, control and data gathering applications. In several instances, the AIM will perform these tasks better than any other machine in its price class, making its cost/performance ratio unequaled in the industry.

First impressions of the AIM might border on the ludicrous. The fully arrayed AIM sells for a price equal to some of the popular CRT-equipped entry level machines. The AIM, shown in Figure 1, looks a bit naked with no case, a flimsy looking sheet metal printer and a one line display all sitting on an etched circuit board to which a keyboard is loosely attached with a short ribbon cable.

One is reminded of the numerous student trainer, single-board computers with their hex keypads and 6-digit displays that sell for considerably less. But, at least the AIM's keyboard is full ASCII.

Before starting the machine, check the documentation. Here is where the first indication comes of something unique. The AIM's documentation probably tells more than the user ever wanted to know about the AIM and about microprocessors in general. First, Rockwell put the AIM's schematic on one sheet of paper. It makes a good wall-sized poster but tracing the AIM's circuit is a breeze. This schematic alone tells a lot about how microprocessor systems are assembled. Second, the AIM-65's User's Guide is a complete and often updated text on the AIM's operation. Third, a 6500 family software manual provides details on how the CPU does its job. Fourth, a couple of pocket reference cards

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*AIM is an acronym for Advanced Interactive Microcomputer. It is manufactured by Rockwell International, Richardson, TX.

**Paper presented at the MAECON—'80 conference held October 14-15, 1980, in the Kansas City Convention Center, Kansas City, MO. Published with permission of the IEEE.

place often-used information in easy reach for writing programs. And fifth, but very important, a complete detailed listing of the AIM's monitor program is provided with cross references for the symbols and assembly labels and comments.

There is a BASIC manual but it is brief and covers only the instruction set. The AIM was not created to teach BASIC. The combination of documentation along with a knowledgeable and cooperative staff at Rockwell proves that there are no secrets about any part of the AIM's construction or operation. This machine was created to fill a need in an industrial market for a complete microprocessor educational system.

Operator I/O for the AIM starts with a full sized ASCII keyboard. This keyboard is constructed of individual cross-point matrix keyswitches brought out to a dual in-line connector in the corner. Encoding of the keyboard is handled by the AIM's monitor software rather than by the usual keyboard encoder chip. This reduces the costs in the keyboard and provides an unexpected bonus in industrial applications (to be discussed later).

The printer is a thermal device that uses a common, inexpensive paper. It is only 20 columns wide but unless the programmer likes to put lengthy comments after source code entries, the 20 columns are adequate. Likewise, the 20-digit fully alphanumeric display leaves little to be desired in usual applications and proves useful in industrial control situations. The printer and display are independently addressable under software control and individual characters on the display may be addressed directly.

Standard interconnection to the outside world is through the AIM's applications connector, which provides two 8-bit parallel ports and four control lines. Any of the 16 parallel port bits may be an input or an output under software control. The AIM also has a serial output and input port normally used to interconnect the AIM to a remote terminal via 20mA loops. The monitor makes these two ports active when the KB/TTY switch is in the TTY position on the AIM. This would disable the AIM's local keyboard, display and printer. However, the subroutines that use these ports may be called at any time by user's software for the input or output of serial data without disabling the keyboard or printer/display.

The AIM has two audio ports. One is an input and the other an output normally used to dump or retrieve data from a tape recorder. These two ports are also available under software control for sending and receiving AFSK serial data. Two control lines are brought out to operate the motors in two tape decks, but these may be turned on and off under software control as well. These are the usual hardware I/O ports provided on the AIM along with their usual and unusual applications.

Now for the not-so-obvious I/O. The AIM's thermal printer is interfaced to the AIM with some ULN2003 high current open collector buffers. If the printer is not needed in a control application, it may be removed from the etched circuit board (its electrical connections just unplug from a single inline jack) at the open collectors of the buffers, which may be used to operate up to 10 24-volt relays. The same connector has a strobed source that was used to operate the printer's motor.

It was mentioned earlier that the keyboard was not encoded. It is interconnected to the AIM via a 16-pin dual inline connector that is connected to the parallel ports of an interface adapter. The keyboard can be unplugged and the resulting open socket used for additional I/O. Note that all of the "unusual" I/O is made available by simple unplugging. This is important where the machine might be shuttled from one job to another with different requirements. If more I/O is needed, it may be plugged into AIM's expansion connector where all the lines necessary for complete utilization of AIM's unused addressing space are available.

Now that the way the AIM can be hooked up to the whole world has been covered, let's look at an industrial control/data gathering application that it can handle. Suppose that a series of tests are to be performed on a dc motor. One set of tests would be to gather data at various speeds, torques and voltages to determine motor performance in any expected service requirement. This normally involves the time and effort of several people standing at a test stand, setting up the various conditions and then trying to record various parameters. After the data is gathered it must be reduced and plotted to produce the family of performance curves. A second kind of test is the life test in which the motor is operated continuously for some period of time to determine its brush life, bearing wear rates, etc. During this kind of test, data is gathered but at less frequent intervals and the parameters monitored

Figure 1. The bare AIM system.

so that the test can be terminated if something starts to get out of hand.

Additional hardware

First look at the additional hardware requirements for this task. Voltages up to 30V dc, current to 100A, torque, rpm and temperatures need to be monitored. Some form of A/D converter is needed. If it is to read thermocouples for temperature, it must have a full-scale sensitivity in the 10mV range. All of the larger voltages can be scaled down to this range with precision resistors.

The AIM's 6522 VIA (Versatile Interface Adapter) has a 16-bit counter that can be used to measure the period of an external signal so that rpm may be easily measured. This application will not require the use of the "keyboard port" for hardware I/O so we can leave the keyboard attached. However, for simplicity of operation by persons not versed in computers, the keyboard might be replaced with a few push-buttons. They might be "Reset," "Life Test," and "Data Point" buttons.

The AIM's monitor provides for no less than six jumps to programs with single keystrokes. Three are in monitor firmware and three more may be initialized by one of the firmware jumps to provide some more entry points to running programs. Because the normal AIM's keystrokes consist of a single contact closure on its non-encoded keyboard, a simple push-button control panel may be plugged into the AIM's keyboard port socket.

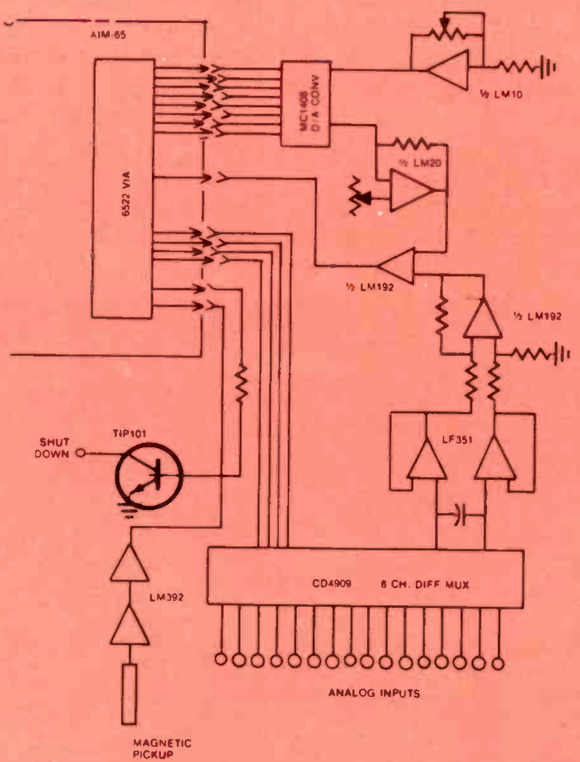


Fig. 2. The AIM with an A/D converter.

The A/D converter would not be too hard to build, as shown in Figure 2. The AIM can be programmed to run a successive approximation routine in software and output the appropriate words to an eight-bit D/A chip. Another line could be used to look at the output of the comparator that is looking at the difference between the D/A's output and the output of the instrumentation amplifier. A CMOS, eight-channel, differential multiplexer chip can be used both as the selector switch for the data point to be read and as the sample-and-hold switch to ensure that the AIM is not trying to do a conversion on a signal that is moving around.

Conditioning of the rpm signal requires an amplifier and comparator to square up the sinusoidal output from a magnetic pickup on the motor's output shaft. It should be noted at this time that slicing up a 10mV signal into 256 pieces presents some special problems in construction technique and in wiring the system so that thermal differences in joints of the wiring do not introduce errors of their own. Also, all of the signals must be ground-referenced to within a couple of volts of ground because this particular multiplexing A/D scheme does not have a large common mode rejection or handling capability.

This technique for gathering data will yield a binary number between 0 and 255 for each of the recorded values for the analog data and a number between 0 and 65,535 for the period of time in microseconds for one cycle of the incoming rpm signal. These numbers are converted to their real world values in the software.

Programming the AIM for an application such as this is aided by the fact that assembly source code may reside in editor text, assembled object code may reside in RAM or ROM, and BASIC may reside in RAM or ROM all together with a symbols table for assembly of source code. It is possible to set aside RAM space for all four uses so that one can jump from the writing, debugging and running of either BASIC or machine code

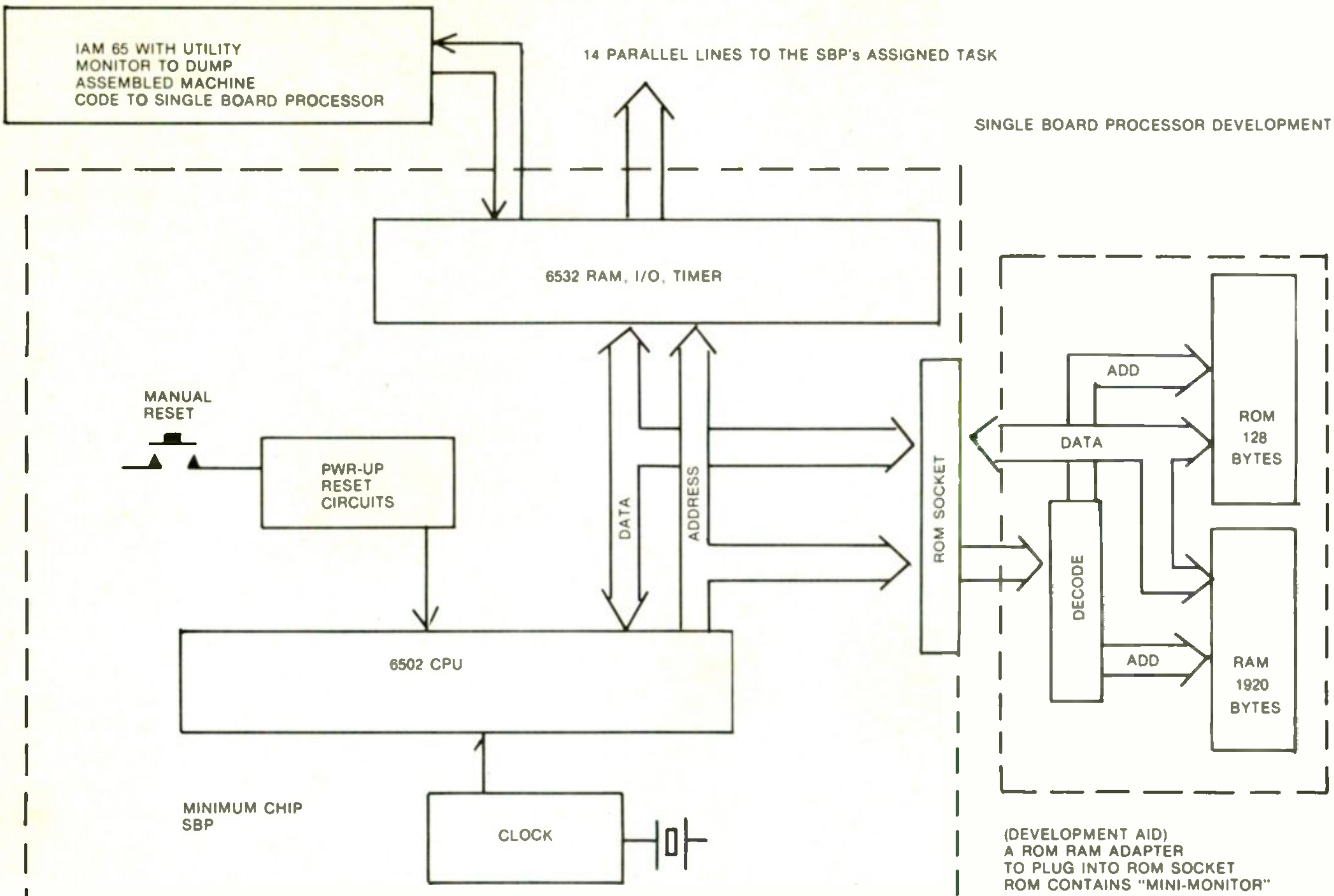


Fig. 3. Example of a small single board machine with 16 I/O lines.

programs without disturbing the other areas of the RAM space.

In this application, the data is gathered by a machine code program that evaluates each of the eight inputs in turn and places its binary number into some assigned space in RAM and then jumps to a little routine that measures and stores the period of the incoming rpm signal. AIM's BASIC includes a USR(x) function that allows BASIC to call up a machine code subroutine. The entry addresses for the subroutine can be initialized by a statement in BASIC or by part of some other initialization routine. But, if desired, statements in BASIC can call up different addresses if more than one machine code program is installed for use by BASIC.

By using a machine code program to gather the data, it happens so quickly that the data points obtained are essentially coincident in time. The main body of the program can be written in BASIC for the conversion of the binary data values to real world numbers and for doing the math and output operations.

In operation, the operator would have to set the operating points on the motor under test and then press the Data Point button. AIM would then gather the data and print something like this:

Voltage:	28.5
Current:	75.3
Speed:	9455
Torque:	16.7
Input watts:	2145
Output H.P.:	2.50
Efficiency:	86.8%
F bearing temp:	225
R bearing temp:	285
Brush temp:	321
Field temp:	297
Air temp:	83
Time:	14:05:43

After a series of such operations, the user might proceed directly to the plotting of the data on the graphs.

During the life test operation, the operator needs only set up the parameters under which the motor is to be run and then press the Life Test program button. In this mode, the AIM would provide the same kind of printout as before on, say, 10 minute intervals. Between printouts, AIM would be continuously taking data readings and watching to see that they all fall within preset limits. Should some parameter fall out of limits, AIM would shut down the test and print out the values measured just before the shutdown.

In more routine tasks for which one might be inclined to fabricate a single board processor (SBF), the AIM might well fill the bill better. At about $400 for the stripped down AIM, the little computer might be stripped of its keyboard, printer and display and installed in an application that might require only a minimum hardware system. By the time one were to lay out and debug an etched circuit board and then write software that might not run the first time on a board that cannot debug programs, $400 is a real bargain.

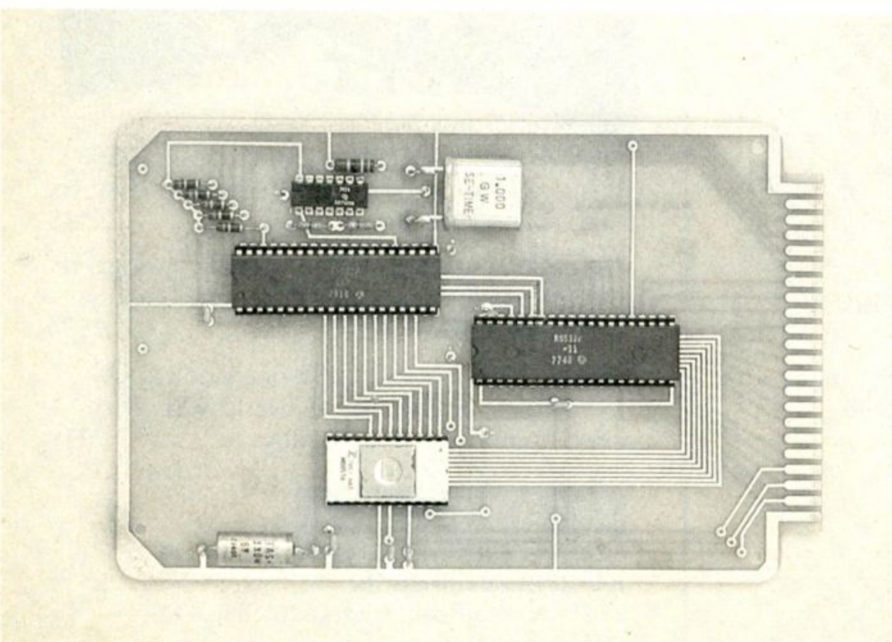


Fig. 4. A model of the system shown in Fig. 3.

For cases in which the home-grown, single-board processor is a practical option, the AIM-65 can be helpful. The 6500 series microcomputing devices give the designer considerable latitude in tailoring the system to the task. An example of a small single board machine with up to 16 I/O lines is illustrated in Figure 3 and shown in real life in Figure 4. This processor uses only four chips to make a useful dedicated precessor. Normally, writing and debugging machine code software for such a device is difficult, if not impossible, without a costly development system. A logic analyzer is also often needed.

In Figure 3, an adapter is shown that plugs into the single board machine's ROM socket. The adapter holds enough ROM to contain a mini-monitor that enables it to talk back and forth with the AIM-65. The remaining memory space normally assigned to ROM is mapped in RAM. This lets a programmer *write* into ROM space so programs that will later run there in ROM can be easily modified during the debugging process. The single board machine can be connected to its assigned task in the finished system. Should tweeking of the program be required, the software can be dumped back to the AIM-65 for editing. Once the software is proved, it can then be *blown* into an EPROM and plugged into the single board processor's ROM socket to complete the development task.

The AIM fits well into many slots, especially those for training and for system controlling. It appears to be the only single board microcomputer on the market today that has enough firmware on board to be both an effective programming tool and low enough in cost to do the job for which the program was written. □

Strategic issues confronting today's service organization*

Both industrial and consumer service shops may be looking at ways of expanding their customer service base in the '80s. The author suggests some approaches.

By Ken Scott, *marketing manager, Data Communication Analyzers, Tektronix Inc., Beaverton, OR*

As maintenance income continues its climb in corporate importance, the strategic issues surrounding the service organization's success and profitability have become a common item on the agenda for meetings involving senior management.

In most cases these same managers will have developed or approved specific objectives designed to ensure customer satisfaction while maintaining or improving service productivity. In light of these objectives, a set of strategic policies and business practices will have emerged. Surrounding these policies and practices will be some perception of the current and future environments that service organizations are expected to be involved with.

Environmental factors

Although the use of digital electronics is growing in many market areas, including automotive, industrial, medical and consumer, the information processing and transfer sector is the most mature and best illustrates the problems and opportunities associated with product maintenance. Similar problems and opportunities will emerge in these other sectors during the 1980s, and many of today's service operations will be required to grow to accommodate this expanded customer base.

The information processing and transfer sector is made up of conventional electronic data processing products, data communications networks, and "intelligent" office products, a market which is forecast as the fastest growing for computer-based products in the '80s. Representative products and services include computers, contract software and service, peripherals, modems, data communications front ends, telecommunication carriers/networks, word processing equipment, PBXs and facsimile machines.

Demand for these products is being driven by the potential for productivity improvements as the US economy continues its shift to service industries and white collar employment. By 1985, 55.1% of the 104.3 million persons in the United States workforce will be employed by service industries, vs. 52.4% of the 87.5 million employed in 1976.

During these shifts in employment, growth in worker productivity in the United States has been declining. Productivity in the United States grew at 3% per year during the 1947 to 1973 period but slipped to under 2.4% for 1973 to 1980. Productivity growth rates in service industries and white collar employment have traditionally been less than half of those in manufac-

The Proliferation of End Devices Installed in Base Units

DEVICES	1979	1984
Computer terminals	3,300,000	7,600,000
Desktop computers	400,000	3,600,000
Computers	500,000	1,200,000
TELEX/TWX teleprinters	480,000	740,000
Communicating word processors	25,000	500,000
Private branch exchanges (PBX)	235,000	400,000
Facsimile units	180,000	380,000
TOTAL	5,120,000	14,420,000

Source: SRI International

Figure 1 The proliferation of end devices in installed base units in the United States.

*Paper presented at the American Field Service Management meeting in Phoenix, AZ.

Figure 4 The maintenance environment depicted as a matrix of the problems to be solved and the place where the actual repair takes place. Observable industry trends are denoted by arrows.

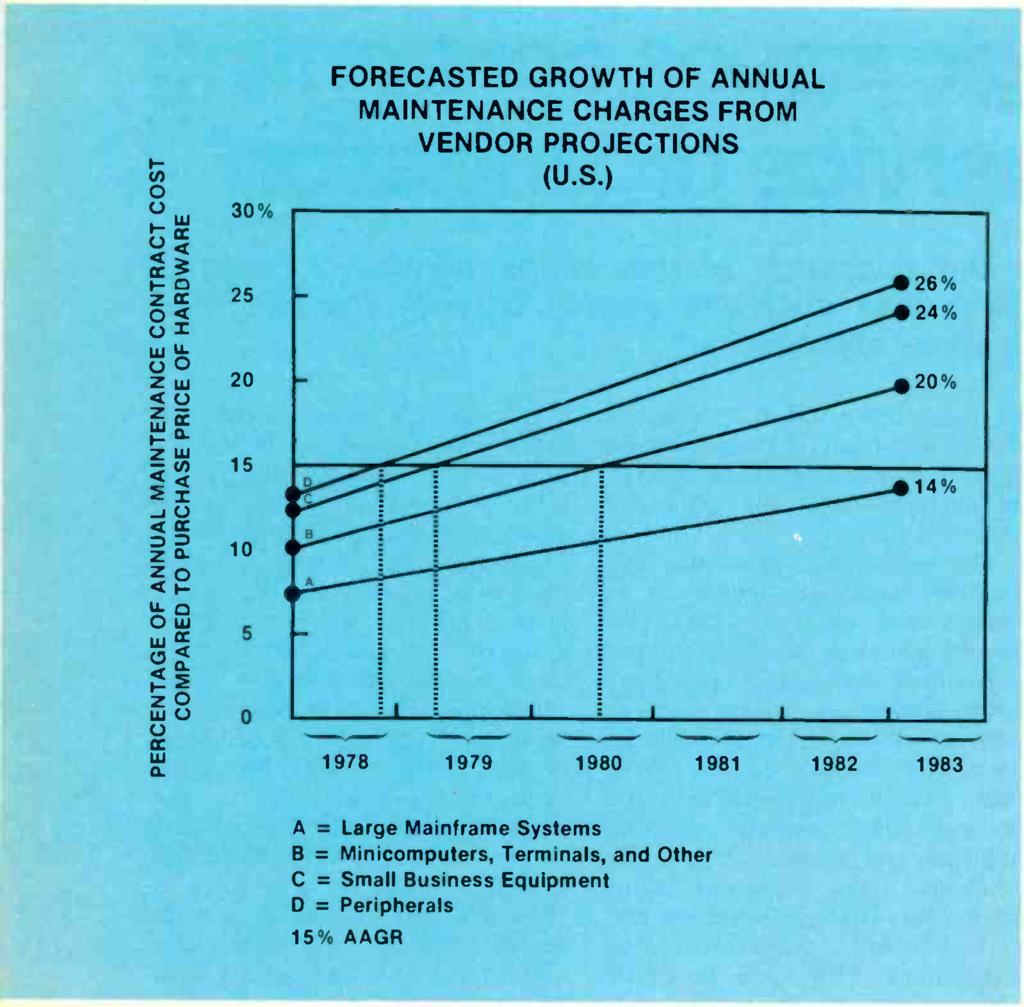


Figure 2

Figure 3 The Tektronix 834 Programmable Data Communications Tester.

turing and one-third of those in agriculture.

The major source of United States productivity gains during the past 20 years has been technological innovation, and a sizeable portion of this innovation stems from the use of computing power. Supporting the development of computing products to meet future needs will be advances in semiconductor technology, paralleled by remarkable achievements in magnetic technologies (disc and tape drives), printers, data compression techniques (facsimile), and low-cost readily available data transmission networks.

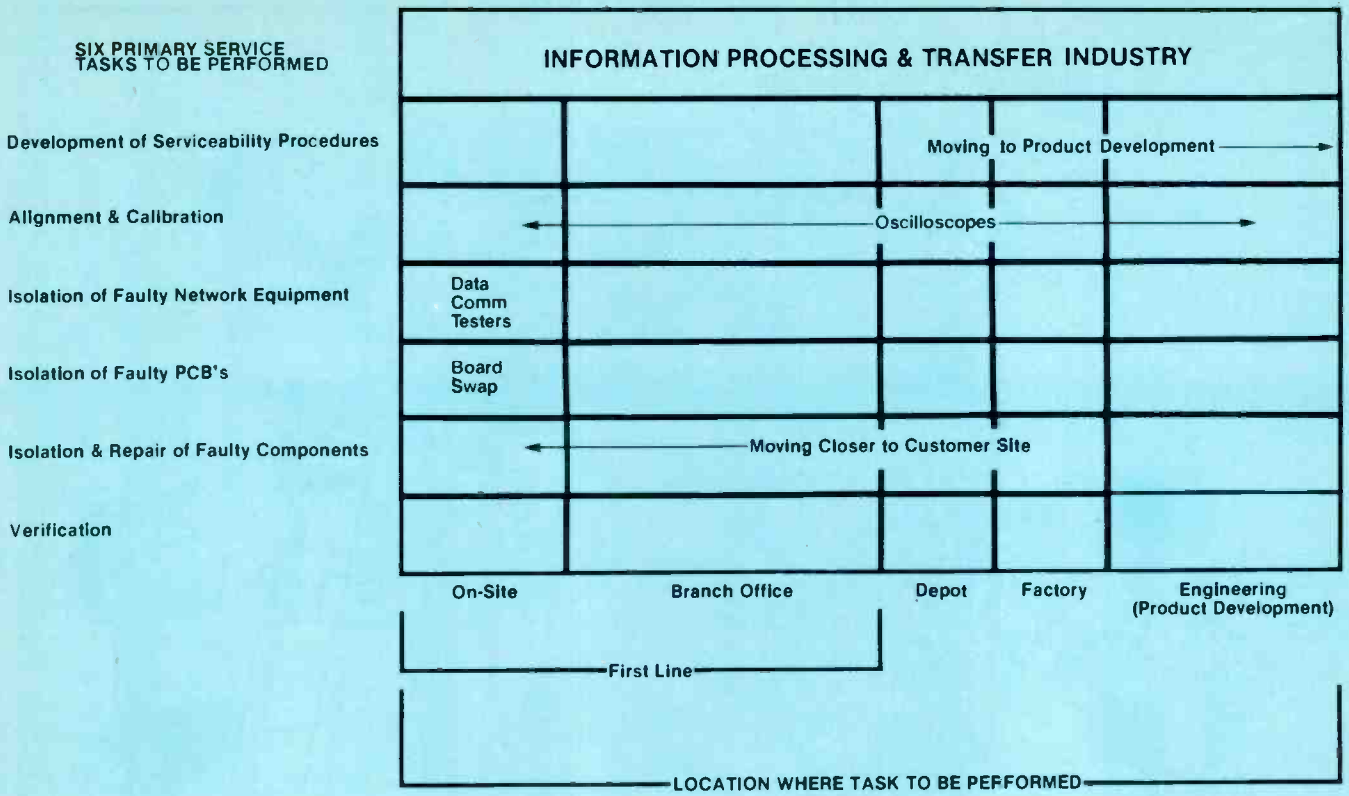
Arthur D. Little projects this will lead to a 1990 office environment that includes multinational teleconferencing and facsimile, electronic mail and telephone, computerized word processing and in-house publishing, and intelligent copiers and printers.

This movement toward the office of the future is one of the big factors expected to cause the installed base of data communications equipment (modems, multiplexers and communications processors) to double by 1983 to 4.2 million units worldwide.

Within the United States, the growth in the number of units involved may jump to 14 million by 1984 (Figure 1). Assuming this number would double when taking into account the total worldwide population of data communications equipment and devices, the total number of possible devices climbs to more than 30 million units (more than three times the 1979 installed base).

This dramatic increase in an installed base made up of more complex products, geographically dispersed, and linked by data communications networks, presents an unsettling problem for the service manager and suggests the need for change.

Product maintenance was historically viewed as an expense drain on profits and a customer obligation



incurred at the time of a sale. Today, corporate officers are considering it a sound business opportunity. Sources at the Digital Equipment Corp. have stated, "Service has always grown faster than the company, and it has always been profitable. It's one of the few businesses that we can control."

Regardless of how any vendor looks at the maintenance business, it is billions of dollars in size and growing rapidly. By 1983, worldwide information processing maintenance revenue is expected to reach $17 billion. Major suppliers of computing equipment are deriving in excess of 20% of total revenues from service. According to a recent study of information processing service operations, it was discovered that pre-tax service profits averaged 19% in 1979.

These profit margins are under pressure. Because the service business is labor intensive, reduction in expenses is difficult without improving labor productivity, shifting more of the service burden to the customer, or improving product reliability. And there is evidence of building resistance, on the part of customers, to increase in the price of maintenance.

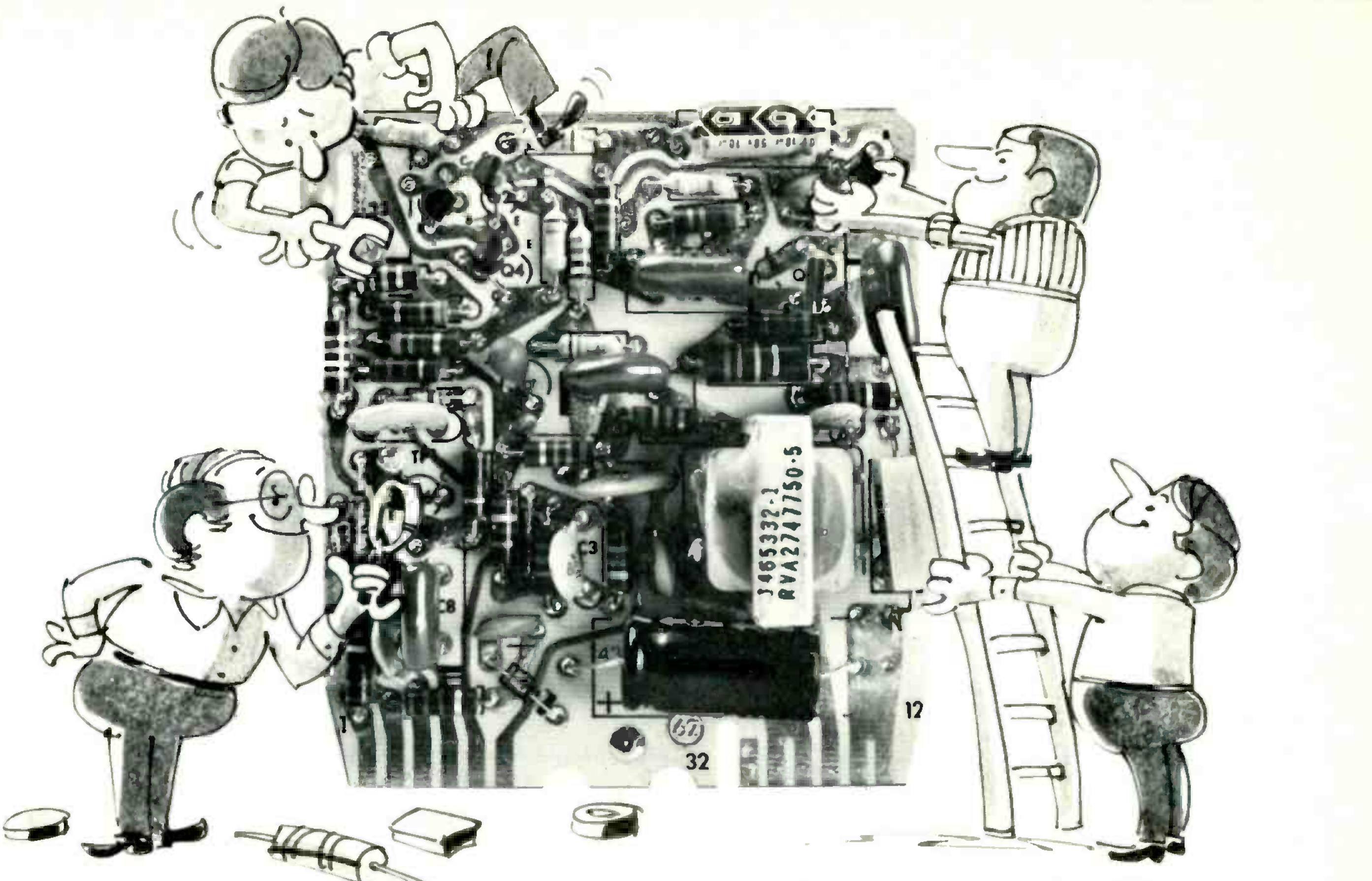
Of the 215,000 worldwide information processing maintenance personnel employed in 1979, 150,000 were first-line service engineers. On the average, each first-line service engineer made about 25 to 30 trouble calls each month or a total of 45 to 55 million trouble calls during the year. Approximately 10 million calls were "repeat" or "no fault found."

Compounding the problem of labor intensiveness in product maintenance is the lack of labor availability. Traditional sources of qualified technicians (such as the DOD) have, in the past several years, reduced the number of people trained in electronics. In 1983, the industry is forecast to need more than 300,000 service engineers and specialists making more than 100 million service calls. These people are not expected to be available. Not only will the number of people be unavailable, the rate of turnover is not expected to decline—considering that some companies experience a 50% turnover rate. Personnel issues alone during the 80's will occupy a significant portion of management time.

Product maintenance, as a labor intensive business facing a forecast of fewer qualified technicians, is also affected by issues such as advances in product technology, higher operating costs resulting from the geographic separation of sites to be serviced, and increasing labor rates. And don't forget the issue of PCB inventory stemming from the service philosophy of board swap. Estimates of the board float inventory ranged from $2 billion to $5 billion in 1980, with no decline in sight.

A final factor, price resistance, is also influencing the complex information processing service environment. Customers using information processing products demand immediate (measured in hours) repair of faulty equipment. But as Figure 2 illustrates, service contract prices are beginning to exceed the acceptable annual maintenance limit (as perceived by the customer) of 15% of the system purchase price.

As Figure 2 also illustrates, the cost of an annual service contract for many product families will exceed acceptable limits as perceived by the customer. The impact on profit margins is obvious, although the number of viable alternatives may not be. Alternatives can be classed as: shifting the burden



Shown here: XL100 Horizontal Color TV Module

Issues

to someone else—the customer for example; improving service technicians' productivity; and improving MTBF/MTTR.

Longer term trends in service policy are related to the desire to have customers shoulder a larger share of the burden. Approximately 45% of the information processing vendors recently surveyed think their customers would bring disabled products to a repair site and 70% think their customers would be willing to diagnose faults. Some vendors are beginning to implement this strategy. For instance, IBM now sells the 3101 terminal by phone and the installation and service can be provided by the customer (a possible harbinger of the future service environment). However, it may turn out to be a short-term solution for personnel problems because customers will simply become another source of demand for qualified service personnel.

One way of improving service technician productivity is through the use of low-cost, highly automated and portable test equipment like the Tektronix 834 Programmable Data Comm Tester.

This type of equipment has been designed taking into consideration all of the issues surrounding current and future service environments. It can be used in almost any data communications network by low-skilled service technicians with just a few hours training.

And, ultimately, increases in the reliability of products in the installed base will have the greatest impact on margins. Implementation of internal diagnostics and self-test, as well as tighter specifications on Mean Time Before Failure (MTBF) and Mean Time To Repair (MTTR), are steps in that direction.

Product maintenance

Figure 4 depicts the maintenance environment as a matrix made up of the problems to be solved and the place the actual repair takes place. Observable industry trends in service strategic direction are denoted by arrows. On-site repair is primarily done by first line service engineers with occasional support from specialists and factory engineers.

• *Development of serviceability procedures* occurs mostly at product design and can involve internal diagnostics, external diagnostics and service procedures, all of which require documentation. Internal diagnostics is a complex, poorly understood task requiring rigorous definition of service tasks and philosophy; a cooperative effort between the design function, service function and test equipment makers; and good documentation and technician training. Internal diagnostics can increase manufacturing costs 5%-10% and are thought by some to be anticompetitive and prohibitively expensive because they take up space that could have been used to add features to make the product more saleable or could be stripped out to reduce cost and thereby improve profit or reduce sales price. With external diagnostics and service, the training of the service personnel must change to include software, and the design of the product must lend itself to remote test routines (fault trees). For external service, product design must include provision for programmability and redundant components, or both. Interactive/programmable test equipment is required.

- **Alignment/Calibration** relates primarily to electromechanical and/or peripheral equipment. However, newer high-speed technology with faster clock times requires more precise adjustments and measurements. These measurements are made using oscilloscopes and DVMs.
- **Isolation of faulty network equipment** is a new testing requirement which stems from a need to pinpoint the faulty element within a multi-vendor environment. This, the most costly problem set, occurs predominantly in data communications networks and, although there is some evidence that carriers are building network diagnostic capability, test equipment is a necessity.
- **Isolation of faulty PCBs** or modules are the traditional service activities—the source of board float inventories. The isolation must be done quickly (to positively affect mean time to repair) and at the user site. Many alternative solutions are available, including internal diagnostics, external diagnostics, random board swap, "maintenance panels," system exercisers and test equipment. Isolation and repair of faulty components has traditionally been done at the factory or repair depot. This task involves heavy utilization of ATE, and has been moving to the branch office (with some on-site work being done).
- **Verification** has been traditionally carried out with diagnostic software or system exercisers.

The future

If the maintenance problems associated with the increasing installed base of information processing and transfer products is disheartening, consider 50 million households requiring maintenance for electronically controlled appliances, communications devices and other electronic gadgetry. And, one of the basics we have all come to recognize about this business is that the company with the best service organization has a much higher probability for success than those who are playing catch-up.

Conclusion

Service management has arrived in terms of corporate recognition and importance. In fact there are likely to be several companies emerging from the '80s with revenues from service exceeding that from hardware sales and leases. Service revenue is the preferred kind; it rarely shrinks during a recession. In the near future there will be some companies whose primary purpose in building hardware will be to establish a base for software and service revenue.

The only catch is this: The problems appear to be almost insurmountable. The path to success will require unusually good management skills and complete corporate backing. □

Reports from the test lab

Each report about an item of electronic test equipment is based on examination and operation of the device in the ELECTRONIC SERVICING laboratory. Personal observations about the performance, and details of new and useful features are spotlighted along with tips about using the equipment for best results.

By Carl Babcoke, CET

Hickok MX-333 DMM

Hickok model MX-333 is a digital multitester with more useful features than previous Hickok hand-held portable DMMs. Model MX-333 is a 3½-digit LCD instrument of 0.1% dcV accuracy in a low-profile rectangular case (Figure 1). The function and range-selector push-buttons, readout and other components are on the front panel. Finger holds in the top add stability while a thumb presses a push-button. Two banana jacks on the right (Figure 2) are used for all measurements except 20Ω resistance and all current ranges, which require two additional jacks.

In addition to the usual five functions (ac and dc voltage and current plus resistance measurements), a special-function button and three of the range buttons provide diode voltage-drop readings, a logic-probe function and the 20Ω resistance range. These tests will be described in detail.

Another valuable feature is the *Vari-Pitch*, which sounds a tone varying in pitch according to the reading. This is helpful with resistance readings of erratic continuity and for all tests in which it is advantageous to not watch the readout. Model MX-333 can be used for bench operation or for digital or computer servicing.

Dc-voltage specifications

Five dc-voltage ranges provide full-scale readings from 0-200mV, 2V, 20V, 200V and 1000V with an accuracy of ±0.1% of reading plus 1 least-significant digit (LSD). These full-scale readings end one LSD below the marked voltage. For example, the 20V range ends at 19.99V. Above that reading, overrange occurs. The overrange indication on the readout is an unblinking 1 and a decimal without any other digits.

Input impedance is 10MΩ for each range, and overload protection extends to 1000Vdc/peak-ac and to 6kV of transients.

Ac-voltage specifications

The five acV ranges of 200mV, 2V, 20V, 200V and 1000V RMS are the same as the dcV. However, the accuracy depends on the frequency. Specifications call for ±1% of reading plus 2 digits from 45Hz to 1000Hz and ±5% of reading plus 5 LSD from 1kHz to 5kHz on the 200mV to 20V ranges.

Frequency response tests of the MX-333 revealed performance better than the specs. With sinewaves of 1.6V RMS, the 2V range showed slightly falling high-frequency response with -1dB at about 136kHz and -6dB at about 350kHz. With 6.4V applied to the 20V range, the response was -4% at 20kHz, +31% at 300kHz, -1dB at 360kHz and -6dB at about 4000kHz. With 6.4V measured on the 200V range, the response was +45% (almost +6dB) at about 20kHz, rising to +2100% (143V) at about 285kHz, decreasing to 0dB at about 980kHz, down to -1dB at about 1.05MHz and increasing slightly to 2MHz, the generator's top limit.

Ac-voltage response of the MX-333 was one of the best recorded in our Test Lab. The 2V and 20V ranges should be usable over the 20Hz to 20kHz audio band, except for response tests of extreme accuracy. However, the 200V (and probably the 1000V range) should not be used for accurate audio measurements unless a graph is made of the meter's individual response because of the sharp peak at 285kHz.

This variation of frequency response between the various ranges (and at widely separated points in the same range) is typical of acV measurements in most digital multitesters. Another MX-333 meter might have different response curves from those of the sample meter. Therefore, these measurements are disclosed to point out possible problems in using DMMs to measure frequencies above the 20kHz top of the audio range, and they do not indicate any deficiency in model MX-333 (some DMMs do not have flat response even to 1000Hz).

Input impedance of all acV ranges is 10MΩ, with overload protection of 1000Vdc/750VRMS (all ranges except 200mV) for 15 seconds. The input blocking capacitor is rated at 1000Vdc plus peak acV.

Current-range specifications

The five current ranges (2mA, 20mA, 200mA, 2A and 10A) have the same specifications except for accuracy and frequency response. Most of the dc-current ranges have rated accuracies of ±1% plus 1 digit (slightly less accuracy for the 2A and 10A ranges). Four of the ac-current ranges are rated at 1.5% plus 2 digits (the 2MA accuracy is ±2.5%) up to 400Hz.

All current ranges except 10A are protected to 250V at 2A. The 10A range has a replaceable 10A slow-blow fuse that will withstand 15A for one minute before blowing.

Resistance-range specifications

Seven resistance ranges extend from 20Ω—20MΩ full scale. Rated accuracy of the 20Ω range is ±3%,

Figure 1 Hickok model MX-333 has all standard DMM features and 0.1% basic dcV accuracy, Vari-Pitch audio indication of the reading, Logi-Track indications of pulses and supply voltages, a 20Ω low-resistance range and an effective diode test.

Figure 2 Test probes plug into side-mounted jacks.

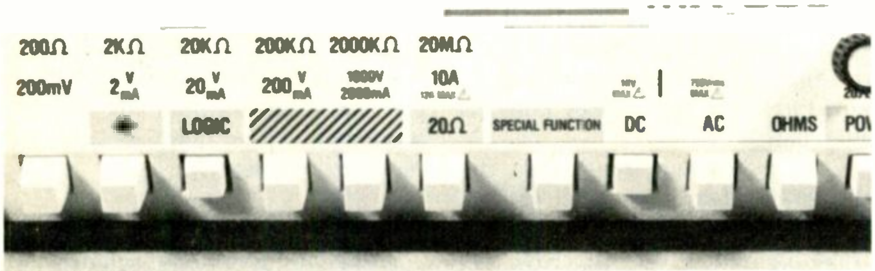


Figure 3 Words and symbols inside blue rectangles identify those buttons used for three special functions.

Figure 4 A scope-type low-capacitance probe (such as this SP-7 Hickok probe) is required for proper operation of the Logi-Track function.

for the 200Ω range it is ±0.2% plus 1 digit, and the other five ranges are rated at ±0.1% plus 1 digit.

Overload protection extends to 500Vdc/RMS-ac for all ranges, plus a 2A fuse for the 20Ω range.

All resistance ranges are of the low-power type. Maximum voltage with open test leads measured 0.26V (with a 22M DMM) on 20K, 200K, 2000K and 20MΩ ranges, the 2KΩ range measured 1.29 V, and the 200Ω range measured 2.71V. The 20Ω range had 0.66V. When used to check a silicon diode, all ranges showed overrange except the 20MΩ range, which had 15MΩ (leakage resistance, not forward conduction).

To select the 20Ω range, move the red test-lead plug to the mA/20Ω banana jack, push the 20M/10A/20Ω button and the *special-function* button. A 20Ω-null control is provided above the power button to null the test-lead resistance. (The control operates only on the 20Ω range.) Touch the test probes together and adjust the null control for 0.00 on the readout. The control adjusts from about -0.22Ω to 0.25Ω with the supplied test leads.

The special-function button and the other front panel buttons associated with it have black identifying letters or symbols in blue rectangles above each button (Figure 3). This clarifies the proper combination needed for: diode test, Logi-Trak (logic-probe function) or the 20Ω resistance range.

Diode tests

Low-power resistance tests, as provided in the MX-333, are excellent for all measurements except semiconductor junction tests. The diode test is good because it forces a constant current through each diode or transistor junction and measures the voltage drop resulting from the current. Each nondefective junction shows a voltage reading that is typical for the type. Germanium junctions test about 0.25V; silicons range between 0.6V and 0.8V.

To select the diode test, press the 2KΩ/2V/diode-symbol button and the special-function button. It is not necessary to move the test-lead plugs.

With the MX-333 test leads shorted together, 3.2mA flowed. When a diode and milliammeter were connected, the current was 2.5mA. The diode-voltage readings were slightly lower than those from another meter that used a constant current of 5mA. The MX-333 readings were consistent and satisfactory.

Another advantage of the diode voltage-drop test is that the accuracy is good in most circuits, without disconnecting any wires.

Vari-Pitch

Several DMMs have an audio tone that indicates continuity or a certain voltage level. Few have the flexibility of the Vari-Pitch feature.

When selected by the audio push-on switch, the tone varies in pitch according to the reading displayed, and it operates on all ranges and functions.

When measuring positive-dc voltages on the 20V range, for example, zero voltage did not produce any sound. Increasing the voltage to +0.25V started the tone at a pitch (repetition rate) so low that each pulse could be heard separately. Gradual voltage increases produced corresponding increases of pitch up past overrange. The pitch was increasing when the test source reached its maximum +35V. No tone was produced by any negative voltage. When negative voltages must be evaluated by Vari-Pitch, the test probes must be interchanged.

For resistance readings, the change of pitch is reversed. Infinite resistances produce no tone. Decreasing resistances increase the frequency of the audio. There is one exception. The 20Ω range has reversed pitch. Open test leads cause a high tone. Shorted test leads produce a growl or silence.

The audio response during diode tests is similar to that of the 20Ω range. Open test probes produce a high tone, a shorted diode silences the tone or gives a low-pitched buzz, and a normal diode sounds an intermediate pitch. The change from open test lead to a normal diode gives a distinct "wee-ooh" sound.

Selection of increasing-frequency or decreasing-frequency slope was made by the design engineers to place the most sensitive area where most measurements will be made.

Vari-Pitch audio tones are also a part of the Logi-Trak function.

Logi-Trak

The Logi-Trak function is activated by pressing the *special-function* and *logic* buttons, and applying an appropriate signal through a 10:1 scope-type low-capacitance probe to the logic jack on the front panel. Optional Hickok SP-7 scope probes (Figure 4) are available for use with MX-333.

Several parameters are measured or indicated by a combination of the Logi-Trak and Vari-Pitch functions. Dc voltages up to +19.99 or -19.99 can be read on the LCD display. The tone indicates the voltage. This allows meter measurement or tone indication of logic highs, logic lows, opens, floating inputs, shorts to ground or shorts to positive supply, and measurements of supply voltages.

A pulse or a voltage-level change lights a colon above the decimal in the display. A single level change causes the colon to blink for 0.1s. Fast changes or rapid pulses also light the colon, but it does not blink. The differences between these various signals can be heard in the Vari-Pitch tone. Continuous pulses produce a chirping sound.

The Logi-Trak and Vari-Pitch can be used together to provide more indications than are possible for a logic probe.

General features

Automatic functions include auto zero, auto polarity and auto decimal. A *lo-bat* signal appears above the minus symbol when approximately 20% of the battery life remains. The 3½-digit LCD readout has 0.5-inch digits.

A 9V battery powers the DMM. An alkaline battery averages 140 operating hours. An optional ac-power adapter is available.

A belt clip is included with the safety-type test probes, battery and instruction manual. When the clip is installed on the bottom of the meter, the instrument can hang from a belt during use. This feature is convenient when large equipment is being tested, particularly during checks using the Vari-Pitch tone.

Comments

Hickok model MX-333 universal digital multimeter performed all functions perfectly. Accuracy of the standard five functions appeared to be high in comparison with other meters of similar ratings. The special features (diode test, Logi-Trak, 20Ω low resistance, and Vari-Pitch indication) are practical and valuable additions to a good instrument. The volume of the Vari-Pitch tone is high and can be easily heard in the normal noise of shop or office. ☐

Equipment highlights: Logic probe switcher

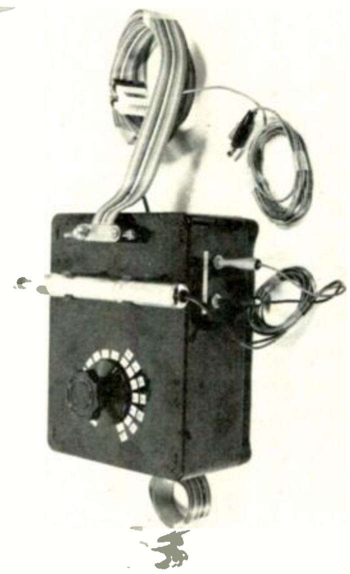
By Cliff Graff, *chief engineer, WSGW-AM/WIOG-FM, Saginaw, MI*

Because of the increasing use of ICs in today's solid state circuits, the problem of servicing these circuits requires all the servicing aids possible. In cases such as logic memory circuit servicing, it is time consuming and frustrating to be testing each IC pin with a logic probe. In some cases it is difficult to see the particular pin desired, and there is always the chance of the probe slipping to the adjacent pin. The test aid described here was made so that a Quik-Clip can be put on the IC to be tested. Then the accompanying switch and logic probe can be used to test each pin, and its condition can be determined immediately with the aid of a logic probe. The other advantage is that this logic probe-switcher can be located away from the extension board. (For example, a phone with connection to a factory technical consultant.)

Constructing the box is quite easy. The only problem is making a longer cable than the manufactured length. The unit is housed in a phenolic instrument case No. 2257 measuring 6-13/16 x 5-9/32 x 2-5/16 inches with cover No. 2260. The switch is a Centralab PA 3001, 2-17 position, 1-pole with stop adjusted for 16-position action. The parts are mounted on the bottom of the box so that all parts can be wired without disconnecting for servicing. This also makes available 6/32-inch taps for mounting small rubber feet when mounting cover bottom. The connection for the test clip extension cable is made by installing a 16 pin female socket near the top of the box. This socket is the type with long wire wrap pins so it is easier to solder or wire wrap.

To mark holes, press IC pins through a blank piece of paper. Use these holes for pencil-marking the location. A small hole is drilled in each mark so pocket pins will go through each hole. The socket is then glued in place. Two 6/32-inch bolts, three 6/32-inch nuts, one wing nut and a small flat bar make a retainer to keep the cable plug in its socket.

The probe is mounted between the switch and 16 pin socket using two capacitor clips. The probes



used were Mallory TH17, 5/8-inch clips for use with the Kurz-Kasch LP-520 logic probe. If the probe used is a different size or shape, another appropriate clip can be used. On the left, near the test point of the probe, a short wire with small clip is put through a small hole in the box and soldered to a common switch connection on PA3001 rotary switch. The clip of this wire is connected to the probe test pin after the probe is in place. On the right, two 1-inch x 3/16-inch bolts are installed. To the inside of these bolts a 6-foot pair of speaker wires is connected through a hole in the top. On the other end of this wire, two small clips are soldered with red and black plastic sleeves for polarity identification. The positive and ground connections from the probe are clipped to the exposed terminals and the extended pair is clipped to the logic card to make voltage connection to the probe.

A VOM can be used instead of the probe by connecting the positive lead of the VOM to the common lead on the switch or the lead that went to the probe tip. The negative lead of the VOM goes to the equipment ground and then the exact voltage of each terminal can be read on the appropriate dc scale to determine whether the voltage is correct, if there is leakage in that diode section of the IC.

Numbering on switches was made using single-wire markers from the Gardner 42-029 Pocket Pack with numbers 1 to 16 in white. Numbers 8 to 14 were colored red with marking pencil and put beside numbers 10 to 16. This makes them easier to identify when using a 16-pin clip on 14-pin ICs. Switch positions were soldered to corresponding numbers on the female IC socket.

For the socket to Quik-Clip, the AP Company has had a short one made up that is 18 inches long and can be used for bench work. The male socket is an Alpha No. FCC-130-16 DIP connector. The test clip is an AP type 923700. To make connection to this clip, two AP type 923625, 8 pin connectors were used. When soldering is completed, the connectors slip over the exposed pins on the test clip. Pin connections correspond to the switch positions. □

Good customer relations are a key to business profits

By Kirk Vistain,
West Chicago, IL

Many factors contribute to the success of an electronic service business. However, these cannot produce a stable and profitable operation unless the relationships between company employees and customers are harmonious.

A service company will prosper by repeat business from satisfied customers. Satisfied customers will recommend your company to others. However, a mutual feeling of distrust or animosity either stunts the growth of an electronic service business or contributes to an early failure.

Customer relations is the term used to describe those reactions and feelings that customers have about a business.

Technicians and shop managers often think customers begin the cycle of bad faith. Customers do not have electronics training, yet they are in a repair situation that might cost them much money. They seldom expect a breakdown of their equipment, and perhaps have no cash to spare. They have read and heard stories about excessive charges for work. It is common for a customer to fear a service company and its representatives before the first phone call is made. Anyone answering a shop phone may automatically receive the blame from a frustrated customer, although the service company has nothing to do with manufacturing the equipment or causing it to malfunction. This is a human reaction that can trigger a similar reaction in anyone it is used against. After talking to two or three irate customers, an employee might snap back without even noticing. Therefore, the first irritation (in words or tone of voice) is the trigger for a positive-feedback reaction that worsens with each cycle. Unless one of the cycles is eliminated, the results can be serious. A potential argument can be avoided if one person stops irritating another. Part of the solution is realizing that irritations can be transferred to other people. Proof of this can be obtained easily by recording all calls to a shop phone for one day. The playback will reveal many hidden traces of anger or irritation.

It is easy to blame customers for disagreements. Even if they are guilty, nothing is solved. Customers cannot be forced to be friendly. Arguing about the situation only causes more problems. Identifying the source of disagreements has no value. Instead, service-shop employees must take the initiative toward appeasement.

If customer relations are not good, don't blame the customers. They can find another shop easier than you can find other customers. It is your business and you should control the situation, not allowing it to control you and your employees.

There are methods of satisfying the most irate customers. They can be changed to loyal boosters after realizing that you can be trusted. But, improper tactics can change even a reasonable customer with a slight problem into one ready to sue.

The best method depends on the facts of each case and the people involved. However, a better solution is to prevent disagreements before they occur. This can be accomplished through a proper attitude.

If customer relations are not good, don't blame the customers

Attitude

Although specific rules can be formulated for avoiding complaints or settling them fairly, the complicated procedure can be condensed to having the proper attitude toward others.

It is helpful in achieving a good attitude to view each situation from the customer's standpoint. The employee thinks the customer should be grateful that a moderate charge can transform a non-operating machine into the equivalent of

Cassette Management Course

To help improve management skills in service shop operations, Zenith offers a set of three audiocassettes with a 48-page workbook as a self-training workshop. Proved in classroom use, the workshop is geared to teaching you how to be as good a businessman as you are a service technician.

Topics covered in the course include selection of location, setting and revising service rates, organizing and maintaining customer records, techniques for speeding up collections, inventory control of parts, preparing a balance sheet, preparing a profit and loss statement, accounts receivable and payable, purchasing, insurance, taxes, analyzing income and expenses, equipment depreciation and telephone usage. The course covers 19 essential factors of service shop management that directly address shop operations and profitability.

This self-training cassette course is available for $39.95 (dealer net cost) from the Zenith Radio Corp., Technical Subscription Service, 11000 Seymour Ave., Franklin Park, IL 60131. □

a new unit. But the customer might not think this way. The customer is probably fearful of the possibility of an excessive charge. Look at the situation from the customer's side, and do everything possible to reassure him.

A few tips for maintaining better relations with customers:

- A friendly tone of voice without annoyance or condescension.
- When a phone customer begins with anger, insults and rudeness, do not reply in the same way. Don't let pride tempt you to fight back. Realize that the customer believes he or she has been wronged.
- Internal anger, resentment and fear is certain to produce physical, mental and emotional damage. Do not habitually respond with these harmful negative emotions. Don't allow customers to damage you by these reactions.

Replying with irritation, resentment or anger is destructive to the business and to the individuals who operate it. Use every available method to instill a good attitude in all company employees.

Self-image

When a person likes a job, a desire to become more proficient arises. Higher proficiency helps complete jobs in less time and increases profit. In turn, desire for higher profit (or salary) inspires a search for additional knowledge. This becomes another positive-feedback loop that helps produce one ingredient of correct attitude: a feeling of personal value.

Technicians should be proud of their profession. This helps them overlook problems arising from opinionated and sometimes uninformed customers.

Valuable symptoms

Obtaining correct symptoms before an estimate or repair is second only to technical expertise in eliminating wasted time. Obtaining useful symptoms from customers is called symptom-retrieval. It should be performed by a skilled technician. Only someone who understands both circuit theory and practical servicing methods can ask relevant questions and evaluate the answers.

Always obtain symptoms, not diagnoses

Customers do not understand technical jargon and sometimes give a diagnosis, not valid symptoms.

It is impractical for a technician on commission to spend much time at the front counter writing symptoms. If the shop has several bench technicians, the task of writing counter tickets can be shared equally.

One chain of audio/video sales and service shops has an effective method. A minimum of two technicians is provided for each shop, while a central location maintains the parts and has the accounting department. One technician is the service manager who is responsible for smooth operation of the shop, overseeing the shop parts inventory, waiting on customers and doing as much technical service as possible in the remaining time. This service manager receives a salary, and his earnings are not tied directly to his personal production. Bonuses are arranged according to total shop production, customer satisfaction (partially judged by lack of complaints) and adherence to company policy. The manager is given incentives to provide professional and efficient services without being penalized by loss of his labor commission.

When properly administered, this system provides excellent service and good customer relations.

A different method can be used when technicians are paid by the hour. Allowances are made in production quotas, and the counter duty is rotated among the technical personnel. There are several minor advantages. Each technician has a break from bench work, while learning first-hand the customer's needs and wants.

Symptom retrieval—After answering the question of who does the interviewing for legitimate trouble symptoms, the next step is the system for doing it. The following are general principles for symptom retrieval:

- *Always obtain symptoms, not diagnoses.* A complaint of "Short in the FM" is a diagnosis, but "One channel cuts out on FM only" is a valid symptom. "Picture rolls downward after 15 minutes" is an accurate symptom, but "Defective vertical-hold control" is a diagnosis (and probably an incorrect one). A common complaint is "Short in ______" because many people believe a short is the only possible defect. Most such "shorts" are opens.

• Ask whether the problem is intermittent, and if it is, under what conditions. Many machines have left the shop unrepaired because no one informed the technician that the problem occurred only after the unit was operated for two to three hours, or only with a certain type of sound tape. Five minutes spent at the counter can prevent the waste of 50 minutes on the bench and provides customer satisfaction.

• Always ask these questions in a friendly manner, but do not encourage rambling narratives that give no useful information. Make the customer think you actually need his help in doing the best job, because it is true. Speak in terms and descriptions that customers can understand. Compliment them on the acuteness of observation whenever possible.

Warranty repairs

Warranty repairs are disliked by most service shop technicians. However, warranty repairs are a part of business and should be made as painless as possible.

Precautions should start when the repair order is written. No equipment should be examined or repaired before it is certain who will pay. If the customer calls, remind him to bring the bill of sale. When the warranty information is not immediately available, the service order should be placed in a "pending" file, and no work should be performed until all required information is received. This simple rule prevents misunderstandings, changes of billings, arguments and serious problems.

Another type of warranty is given to customers who have paid previously for repairs. To prevent misunderstandings, the repair-warranty terms and conditions should be printed on all invoices and posted prominently.

A high-volume shop should expect the customer to bring an invoice of the last repair with the unit. This rule can be relaxed if the manager or technician remembers the former repair or has complete and up-to-date files for easy reference.

Complaints and recalls should have top priority. It ruins customer relations to place recalls in the regular routing and make the owners wait again. If it is brought to the shop, whenever possible repair it while the customer waits, or at least test the unit to be sure the problem is not a simple misunderstanding or wrong connection.

The way recalls are handled is one hallmark of professionalism. Unfortunately, some technicians and managers regard a recall as a personal insult against them, and retaliate by arguing with the customer. View the recall as an opportunity to prove that the shop stands solidly behind its work. No warranty is worth anything until it is tested, and customers remember the shops that passed the test.

Complaints and recalls should have top priority

The best complaint handling begins with an apology. Even if a technical mistake was made, the customer has a problem that will be easier to solve when he is treated fairly. Any shop that practices treating customers with respect during recalls will have a loyal clientele.

Follow these steps during a recall:

• Apologize for the inconvenience, whether or not there was a technical mistake.

• Repair the unit immediately.

• Apologize again when the unit is picked up.

Estimates

Customers generally want a precise estimate, or at least a ceiling figure, before leaving a unit for repair. With the one-step flat rate system, this is easy. Quote the flat labor rate and list a reasonable parts price, with the understanding that these figures will not be exceeded unless the customer is contacted and gives approval. Then write the quoted labor and parts prices on the invoice and obtain the customer's signature.

Billing hourly or by the Sperry-Tech method requires experience to quote a combined labor/parts estimate.

In some areas, these are called "free estimates." However, some states and localities have laws describing estimate methods. For those who have the right to determine their business policies, limit "detailed estimates." In electronic service, finding the defective part requires up to 90% of repair time. Giving a detailed estimate (telling what is wrong and listing the parts needed) is almost equivalent to repair. If a customer insists on a detailed estimate and then rejects it, the full labor rate should be charged.

Conclusion

Other facets of service-shop management include a good accounting system, pricing based on known costs, rapid inventory turnover, attendance at service-management seminars, technical-update training, and proper tools and equipment required to save time. All these are vital for continuing profitable operation of the business.

These valuable aids are useless unless customers are satisfied with the way they are treated and the quality of repairs.

Customer relations are improved by these factors: helpful and non-antagonistic employee attitude; a good technician self-image; efficient symptom-retrieval to minimize recalls; informing customers of warranty and recall rules before problems arise; and giving estimates that are not increased unless approved by the customers.

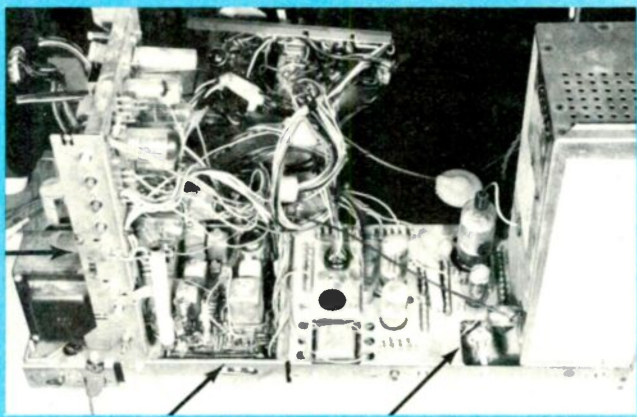
The improved customer relations that result from following these practical suggestions will result in more income with less irritation to everyone. □

PACKARD BELL CASE STUDY

Repairing an older color TV

By Gill Grieshaber, CET, Gill's Color TV, St. Joseph, MO

Repairs of older color-TV receivers can be profitable, but only if the diagnosis and parts replacements can be accomplished in a reasonable time, and when the total performance of the repaired machine is satisfactory to the customer. This article demonstrates some techniques for tube TVs.



The left-side arrow shows where broken resistor R67 was on the 98C19 Packard Bell chassis. The arrow at lower center points to the rear of the IF circuit board that includes the AGC circuitry, while the hold/stabilizing coil (L41) is pointed out by the right-side arrow.

Nothing about the appearance or the preliminary diagnosis of this color TV receiver gave any hint of the problems it would cause for the technicians. Soon it would become an electronic "dog," requiring many hours and a return to comprehensive troubleshooting methods to find all the defects.

According to the outside technician's notation on the service order, the suspected problem with the Packard Bell model 98C19 (Photofact 1019-1) was AGC overload. Although the exact symptoms varied erratically according to how long the TV ac power had been applied and which channels were selected, the principal visual clue was a blank raster (Figure 1).

A loss of signal always is the cause of a blank raster, but the symptom can be classified in two basic ways. A loss of signal in the IF's, for example, produces very little AGC gain reduction. With tubes, the negative AGC voltages are near zero. An overactive AGC system can produce a blank raster

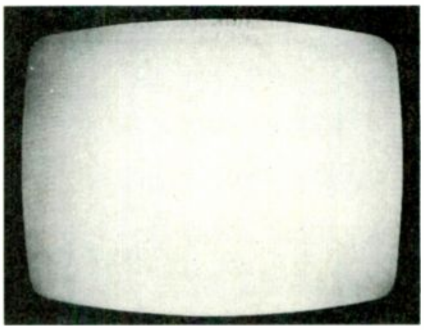


Figure 1 A blank raster was the symptom on all channels.

by reducing RF and IF gains excessively. This condition causes the AGC voltages to RF and IF tubes to become highly negative so the controlled tubes are cut off. A few quick tests of the AGC voltages usually reveal which condition is present.

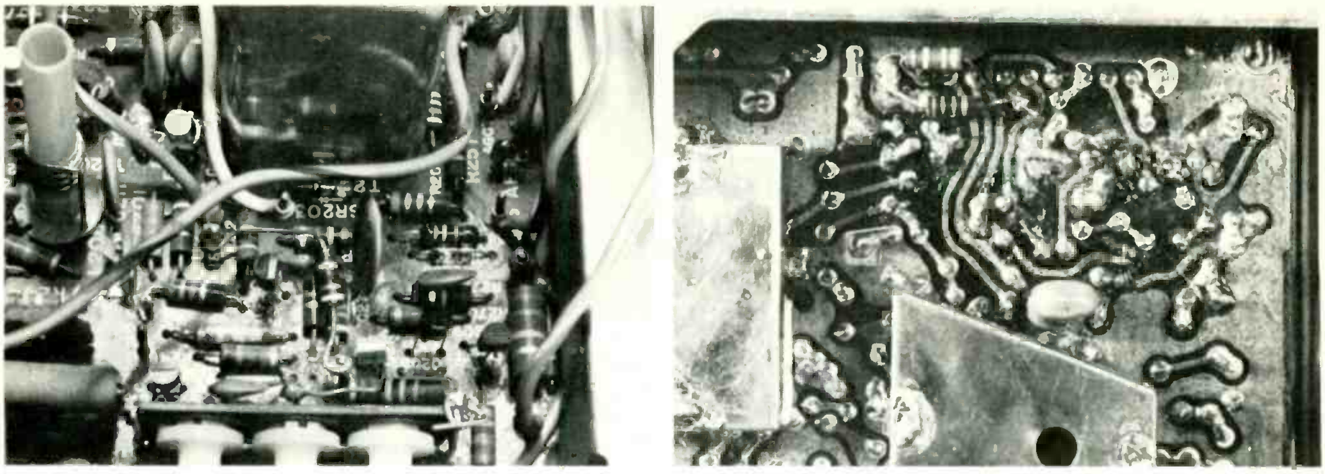
Many cases of overactive AGC can be diagnosed by rotating the tuner to a channel without a signal. Normal heavy snow on an unused channel and a blank raster on a channel having a strong signal prove the AGC circuit is at fault. However, this helpful shortcut is not infallible. Other defects produce excessive AGC, regardless of signal strength. Measure the dc AGC voltages; don't guess.

The snow-without-signal test was not conclusive in this case because the performance was erratic.

AGC circuitry of chassis 98C19 is at the rear end of the IF circuit board (Figure 2).

Testing the AGC keyer

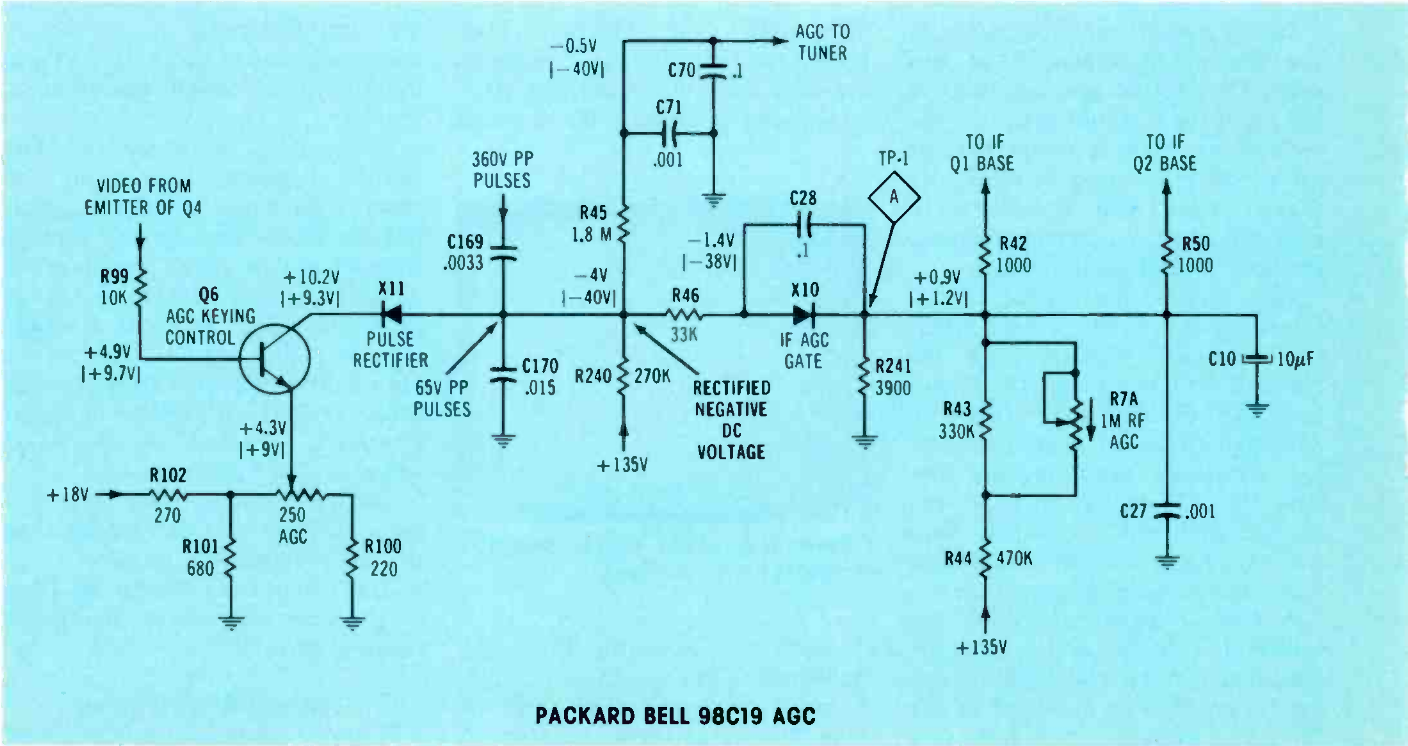
Figure 3 contains a schematic of



A B

Figure 2 Transistors and other components of the AGC circuit are in this section of the board (photo A), while photograph B shows the wiring side of the same area.

Figure 3 (A) This is the Packard Bell 98C19 AGC-keying and AGC circuits. (B) These are correct waveforms for the AGC circuit. Waveform A is the 9VPP video signal at the R99 input. Waveform B is the 8VPP video signal at the Q6 base. Waveform C is the 65VPP horizontal signal at the X11 anode, and waveform D is the 42VPP signal at the Q6 collector. There is a large similarity between the Q6 AGC-keying operation and a triode-tube AGC keyer action. Conduction is determined by the instantaneous difference between the emitter (or cathode) dc voltage and the combined base (or grid) positive voltage and video waveform. Both tube and transistor circuits require the same arrival time of sync tips at the input element and the positive horizontal pulses at the output (plate with a tube, but diode with a transistor). In a tube circuit, the instantaneous grid/cathode voltage determines the plate/cathode resistance, which in turn determines the efficiency with which the plate pulses are rectified. In other words, zero voltage between grid and cathode allows full rectification with production of a high negative plate voltage. Negative grid bias reduces the negative plate voltage. Q6 operation would be the same except for one solid-state quirk: any negative voltage formed by C/E rectification at the collector would instantly flow through the forward-biased C/B junction and be lost. (Short across X11 and measure the Q6 collector voltage.) Therefore, a fast-switching diode (X11) is added in series with the collector. Pulse rectification forms a negative voltage at the X11 anode (not at the Q6 collector—a positive voltage is there). In other words, X11 *rectifies* and Q6 C/E resistance *controls* the amount of rectified negative voltage which varies according to the video amplitude at the base and the dc voltage at the emitter. Operation of the X10 gating transistor is explained in the text. Dc voltages before repair are shown in parenthesis; other voltages were measured after repairs during operation with a TV signal of moderate level.



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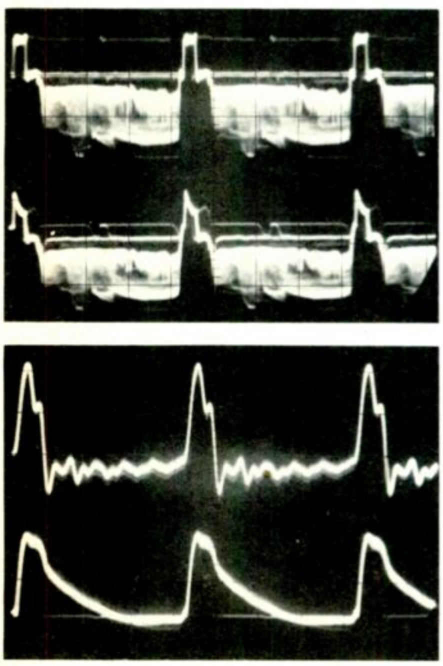
the Packard Bell AGC-keying circuit and a detailed explanation of its operation. The explanation should be studied because it disagrees with some points of theory that originated with tube circuits. Correct waveforms and strong-signal dc voltages are shown with the incorrect original dc voltages.

AGC keying transistor Q6 controls the rectification efficiency of diode X11, which rectifies the horizontal pulses. The rectification produces a negative dc voltage at the X11 anode that varies according to signal level at the video detector. A stronger IF signal calls for a larger negative voltage at the X11 anode. The negative voltage is filtered and used as gain-reduction voltages for the RF tube and two IF transistors.

A rectified voltage of approximately -40V was measured at the X11 anode, with nearly as much at the tuner AGC and the anode of AGC-gate diode X10. In a properly operating chassis, the excessive negative voltage indicates a huge signal at the video detector. A quick scope test at the video detector and a look at the TV screen proved the detector signal level was zero. These facts and measurements strongly indicated an overactive AGC system. The reason


A
B
C
D

for the excessive AGC operation must be located next.

According to the -40V reading, the collector-emitter path in Q6 must be a near short. A C/E short in the transistor is a strong possibility. When removed from the circuit board, transistor Q6 tested normal during ohmmeter and transistor-checker tests. While Q6 was removed, there was no negative voltage at X11's anode. Installation of a suitable substitute gave no improvement of voltages or symptoms.

The next logical suspicion was that Q6 had excessive forward bias. More than 0.7V of forward bias was measured between base and emitter. As the emitter voltage was varied with the AGC control, the base voltage tracked the emitter voltage, still maintaining about 0.7V. This proved the saturation bias came from the video through R99.

Although finding the source of the excessive Q6 bias should have been the next step, a combination of mistakes caused a time-consuming detour.

IF AGC operation

While the dc voltages of the AGC and IF circuits were being measured and written for analysis, a question arose about how the keyer dc-output voltage reached the two IF-transistor bases.

Each transistor has a certain critical forward-bias voltage that produces maximum gain. Increasing or decreasing the forward bias reduces the gain. In other IF circuits, some transistors have had their gains reduced by decreasing the forward bias when the signal level increased (cut-off AGC). Others have the bias increased when the signal level is increased (saturation AGC). None of the schematics indicate which type of gain reduction is used.

There is a method of determining cut-off vs. saturation gain-reduction by analzying the positive-going and negative-going signals beginning with the video detector and following the noninverted or inverted signals through the AGC keyer and then to the dc AGC voltages applied to RF and IF devices. In this chassis, the video-detector output was positive-going (from the cathode). The Q4 video-amplifier

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output from the emitter is not inverted. Therefore, the Q6 base signal is positive-going (becomes more positive with a stronger station signal), which in turn causes increased negative voltage from the X11 anode.

This would indicate cut-off biasing for AGC control of the IF transistors if the negative voltage went directly to their bases. It does not. Diode X10 is in series, and it functions either as an on/off switch or a variable resistor (depending on the voltage across it).

Another unknown is whether X10 is supposed to pass the negative voltage. If the voltage is used directly to reduce the base voltages, the answer to that question is *yes*. But, if the negative voltage is used indirectly to modify the IF bias, the diode does not pass the negative voltage, and the answer is *no*. With a properly operating receiver, it would be simple to measure the voltage across X10 without a signal and again with a strong signal. A short analysis would give the answer. Unfortunately, the receiver and the schematic were both defective.

Photofact schematics show dc voltages typical for a normal receiver operated without any external signal (the antenna is removed and the antenna terminals are shorted together). Photofact 1019-1 showed the X10 anode voltage as -1.4V, and the cathode voltage as +0.9V (this is the IF transistor's base dcV supply). According to those voltages, diode X10 would have reverse bias and function as an open circuit when the receiver has no input signal that is incorrect, because any increase of input signal strength would increase the X10 anode negative voltage, maintaining the diode open effect. *The diode could not conduct with signal or without it.*

Something was incorrect. Perhaps X11 or X10 were shown with reversed polarity on the schematic. Each was reversed separately and then both were reversed at the same time. None of the three tests solved the problem.

The next suspicion was that the schematic showed an incorrect voltage. Schematics for similar Packard Bell models were examined. One schematic showed a positive voltage at the X10 anode (presumably without an input signal). The anode was approximately 0.7V more positive than its cathode, indicating diode conduction.

Assuming a X10 anode positive voltage, the IF AGC action now was clear: With no signal (eliminating any rectified negative voltage), the X11 anode should be several volts positive (from +135V through R240 in Figure 3), and this positive voltage travels through R46 through forward-biased X10 and to R241 and C10 where it increases the Q1

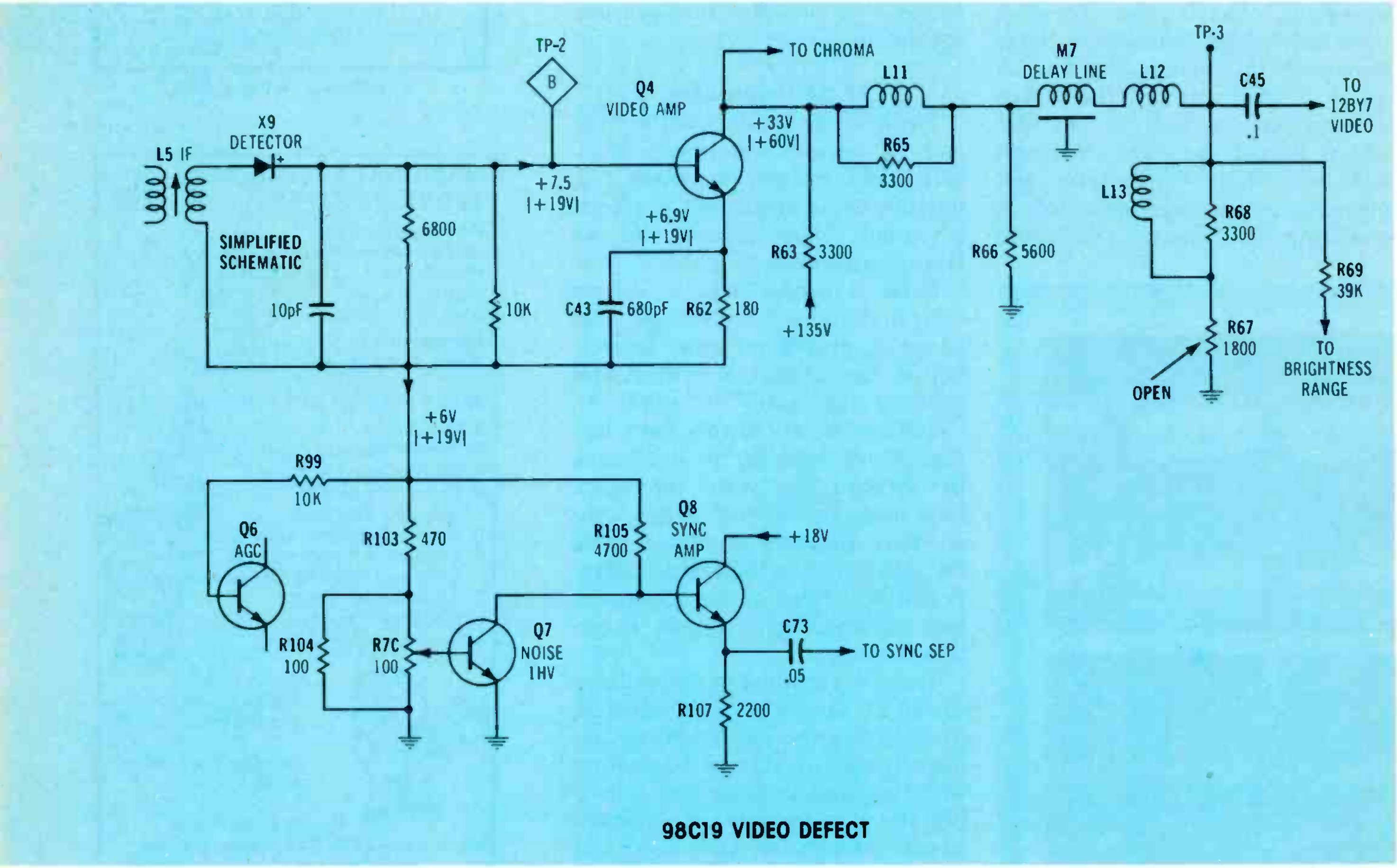

Figure 4 Q6, Q7, Q8 and video-detector wirings are simplified; the Q4 schematic is complete. The only B/E forward bias for Q4 comes from rectification of the IF signal by X9. Dc voltages were measured after repairs and adjustments when the TV signal had a medium level. Voltages in parenthesis were measured before any repairs were made. The collector signal goes through the delay line to the video-output tube. Noninverted signals from the emitter are sent to the AGC-keyer, the noise-inverter and the sync-amplifier transistors.

and Q2 base voltage to the level giving maximum transistor gains. This base voltage also is adjustable (for lowest tuner noise) by R44 and R43/R7A.

If the tuner input signal level is raised gradually, X11 negative voltage from pulse rectification increases and partially cancels the positive voltage at the X10 anode. This decreases the forward bias across X10, and its internal resistance increases, slightly decreasing the X10 cathode positive voltage that feeds bias to Q1 and Q2, decreasing their gains slightly.

Additional increases of input signal amplitude produce more of the actions described, until the X10 anode is about +0.4 and the cathode measures about +0.9V. Beyond that approximate point, X10 is an open circuit and no longer can affect the IF transistors biases. Any value of *negative* voltage at X10 anode opens the path through X10 and stops the IF gain reduction.

Notice that the AGC sent through R45 to the 6HQ5 RF tube has no switching diode. All increases of negative voltage at the X10 anode act to decrease gain of the RF tube.

A mystery of correct IF AGC theory and operation was solved, and it was time to use this knowledge to the Q6 AGC keyer transistor, answering why the C/E path was almost a short.

Q6 base drive

According to the partial schematic in Figure 4, the Q4 video-amplifier transistor has no forward bias except for that provided by X9 (video detector) rectifying the IF signal. Off-channel snow produces a small forward bias for Q4, and stronger station signals increase the forward bias in proportion. Some of the +135V supply current flows through collector resistor R63, through Q4 and emitter resistor R62 to the cold side of the video-detector circuit that feeds R99, R103 and R105. This video signal is similar in nature to one coming from the emitter of an emitter-follower: the phase is identical to that of the base signal.

R99 feeds part of this combined video signal and positive dc voltage to the Q6 base. The Q4 end of R99 has the higher dc voltage, so it was clear the excessive forward bias at Q6 came from Q4 video amplifier.

Voltages shown in parenthesis were measured at those points before repairs were made. Other voltages were recorded after repairs when a moderate-level TV signal was tuned in. The same excessive +19V appeared at the detector common line and at Q4's base and emitter.

Although the Q4 emitter voltage was very high (as it would be if the video detector were producing a large signal), the same dc voltage at base and emitter proved the detector had no output voltage. Further evidence that excessive Q4 emitter current was not to blame was obtained by shorting together Q4's base and emitter. There was no reduction of the wrong +19V.

Voltage leakage from some higher-potential point to the detector's cold side could account for all symptoms. The Q7 and Q8 bases have lower voltages, so a shorted transistor there could not be the source of the voltage. A detailed search of the circuit board failed to find any unauthorized components or points of leakage.

Although Q4 current had been disproved as the source of the excessive voltage, the situation was becoming critical, so Q4 was removed for out-of-circuit tests. Unfortunately, Q4 checked perfect in several tests. While Q4 was out of the chassis, power was turned on, and the Q4 base and emitter wiring points measured almost zero voltage. The conclusion was clear: whatever the problem, Q4 was involved.

For the first time, attention became focused on the +60V reading at Q4's collector. Several Ohm's Law calculations involving R63 and the sum of R66 and R67 (Figure 4) showed the collector voltage should not rise above about +40V with Q4 removed from the circuit (zero current).

An ohmmeter measurement from Q4's collector to ground showed a reading of about 5600Ω instead of the expected 1400Ω. Evidently R67 was not paralleled across R66. Perhaps an open had developed in M7 delay line, L12 peaking coil or L13 peaking coil. The wiring or R67 could be open. Each component and connecting wire was tested in sequence until R67 was located.

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R67 was hidden under other components, but the slightest pressure of a test probe separated the previously broken resistor into two parts.

R67 is the output load for the delay line, and the value is critical because incorrect values generate reflections that appear as ghosts in the picture. (These ghosts might have been a good symptom of an open resistor, but there was no picture.) A precision resistor was not available, so several smaller values were connected in series to provide exactly 1800Ω (see Figure 5).

After this resistor was installed and power turned on, the screen showed a picture requiring only adjustment of the AGC control to obtain normal contrast.

Avalanche effect

It is not obvious why an obscure video-stage resistor could paralyze a video stage and an AGC keyer stage. Higher collector-circuit resistance increases transistor gain, and a higher collector voltage changes gain very little. There appears to be no logical reason why an open R67 affected the video operation, and even less chance of it destroying AGC action.

The answer is the breakdown or avalanche effect. If the collector-to-emitter voltage is increased steadily, a point will be reached at which leakage current rises rapidly. The transistor will be destroyed unless current-limiting (even a series resistor) is built into the system. Curve tracers can demonstrate this breakdown effect spectacularly. When the collector sweep voltage rises above a critical point, the curves become vertical (indicating excessive current).

Breakdown effect in Q4 caused excessive C/E current although the B/E forward bias was zero. When

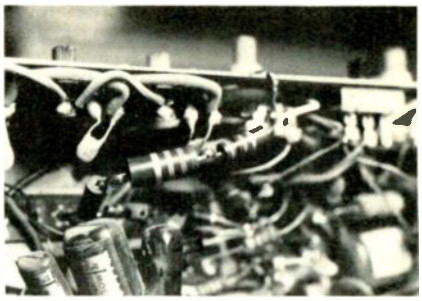
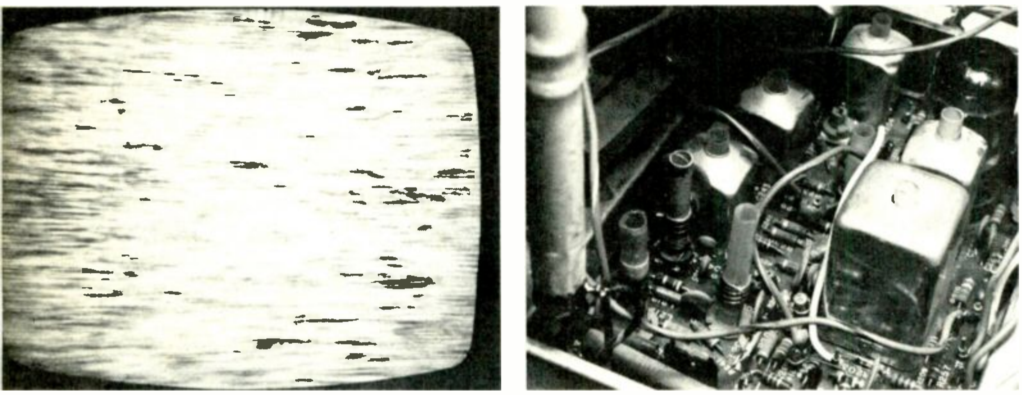


Figure 5 Selected resistors were connected in series to produce the required precision for 1800Ω R67. The original cracked R67 had been located on the terminal strip under several other components.

R67 was replaced (reducing the maximum collector voltage), the breakdown could not occur in that particular transistor, and normal amplification was restored. In turn, the AGC keyer again functioned as designed.

Some transistors will avalanche at much lower collector voltages. During tests of transistor curve tracers several years ago, several transistors had breakdowns at as low as 10V. Diodes also have this characteristic. That is the reason for high reverse-voltage ratings when lower ratings appear to be sufficient.



A B

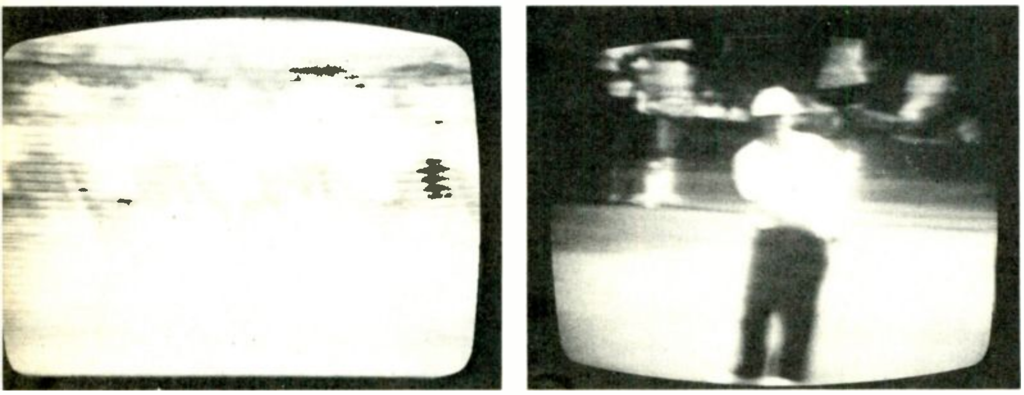
Figure 6 Snow in horizontal streaks (photograph A) proves the IF's are near self-oscillation. Missing coil shields (photograph B) or cracked board grounds often are responsible, although poor alignment also can cause the effect.

Alignment problems

Although the picture now had normal contrast, the picture quality was not good. Ghosts moved back and forth when the fine tuning was adjusted. The snow seen on channels with no TV signal appeared to form into horizontal streaks (Figure 6). These two symptoms usually indicate poor alignment or an IF section that is on the verge of self-oscillation.

These snowy streaks and tunable ghost were minimized by addition of an improvised shield (to replace a missing one) around the IF input coils, and also relocating the wires near the IF components.

The b&w sharpness and color quality now were satisfactory, considering the usual smear caused by the test-jig harness.



A B

Figure 7 When the Packard Bell picture first appeared, the screen showed dozens of out-of-lock lines (photograph A). After R202 was tailored, a solidly locked picture was obtained shortly after the picture appeared (photograph B).

Horizontal-oscillator drift

As the TV-receiver power was turned on and off during heat cycles and time tests, it became obvious that the horizontal-oscillator frequency drifted excessively, especially during warm-up. As shown in Figure 7, the picture had dozens of out-of-lock stripes when power was first turned on. Approximately two minutes were sometimes required for the horizontal to lock. Stability can often be improved by a careful change of component values.

Packard Bell 98C19 has no horizontal-oscillator coil (Figure 8 schematic). The oscillator is a cathode-coupled multivibrator, and tuning of the L41 core varies the frequency for locking.

Unfortunately, L41 is wired as a ringing coil. Ringing coils reduce frequency drift and minimize the effects of noise in the signal when they are correctly tuned. This tuning for best stability is critical. As a secondary effect, adjustments of a ringing-coil's resonant point also changes the oscillator frequency. There is a danger in using a stabilizing coil to control the frequency. If unsuitable parts values in the oscillator produce an incorrect frequency that requires a misadjustment (from the point of best stability) of the ringing coil to accomplish stable locking, then the stability suffers. The most noticeable result is excessive drift, especially during warm-up.

Although the precise values of many oscillator components affect the frequency, the most effective control of frequency is in the time-constant value of C109 and R202 at the pin-7 grid of the oscillator tube. Tailoring this time constant can improve the stability greatly. Unless C109 has internal leakage, it should not be replaced during any tailoring, because its stability is excellent. The R202 value should be chosen for optimum performance. *The horizontal-oscillator frequency is the same with a short across the L41 ringing coil as it is when L41/C108 tuned circuit is adjusted correctly.* The oscillator works fine without the L41 coil. The following method depends on those previous principles:

• After the TV receiver is warmed up and operating correctly, place a *short* test lead across L41. The

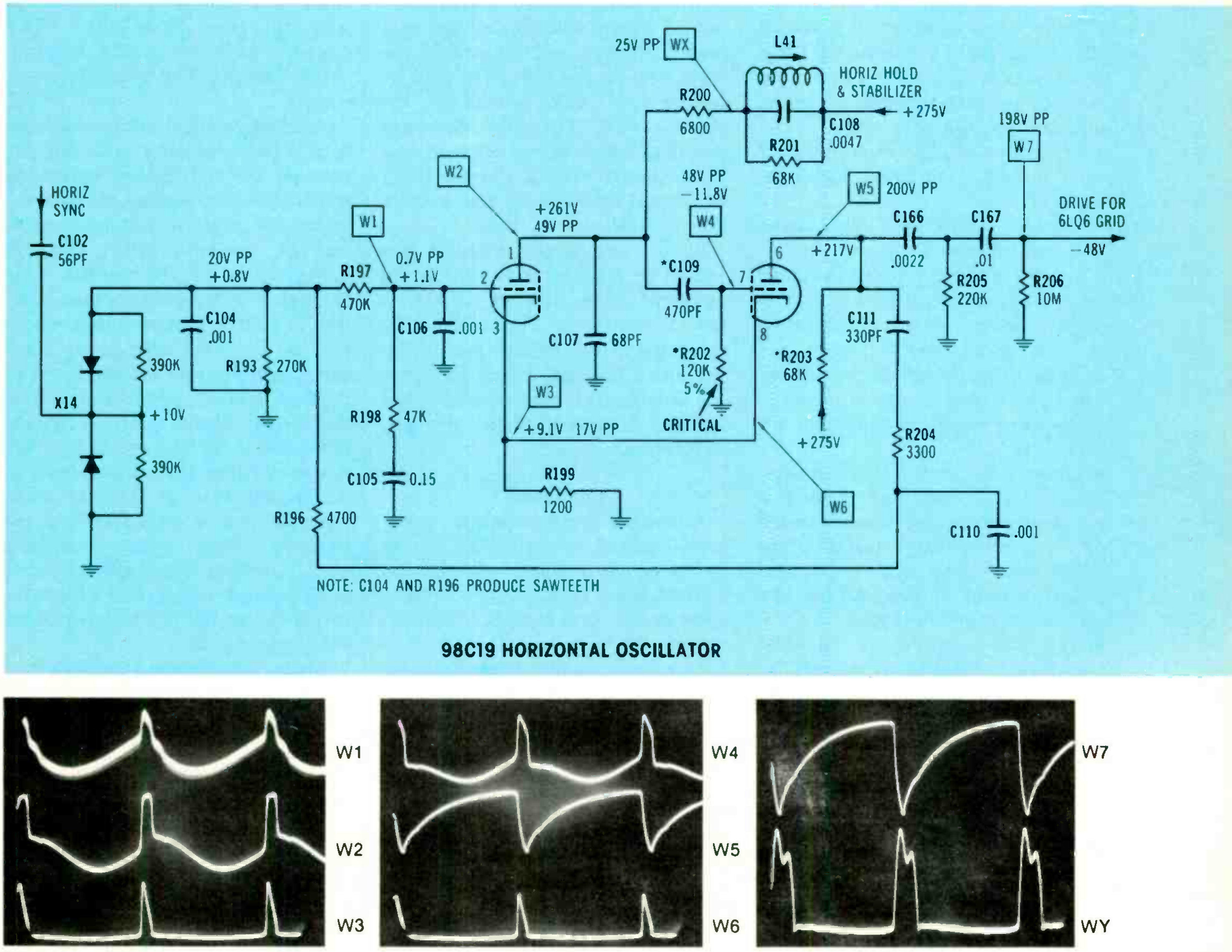
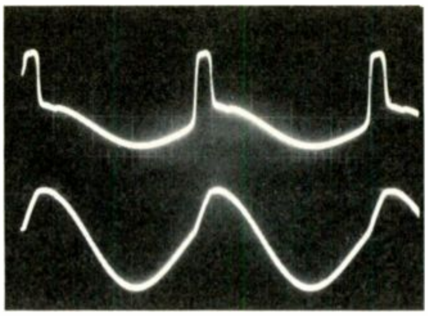


Figure 8 The 98C19 horizontal oscillator is a cathode-coupled multivibrator type using a ringing coil (L41) as a horizontal-hold adjustment. Values of C109 and R202 (at the pin-7 grid of the 6CG7 tube) primarily determine the frequency of oscillation. Changed values of R203 account for many cases of excessive or insufficient drive to the 6LQ6 horizontal-output tube. The W1 through W7 waveforms represent normal operation, while the last one shows horizontal flyback pulses for phase comparisons.

A



B

Figure 9 L41 hold-control/ringing coil is mounted on the chassis rear panel near the 6CG7 horizontal oscillator tube. The three series resistors used to produce a precision R202 can be seen at the socket's left (photograph A). The top scope trace in photograph B is the normal waveform from the pin-1 plate to ground. The lower trace is the near-sinewave scoped *across* L41.

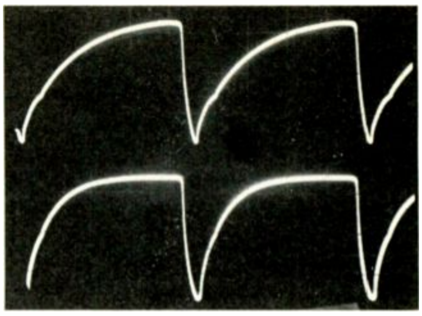


Figure 10 Top trace is the normal waveform at the horizontal-output grid. It produced -48V. The lower trace shows the flattened drive waveform (when R203 was 18K) that produced -42V at the output grid.

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picture will probably go out of lock.

- Count the number of diagonal stripes on the TV screen. If there are three or less, no repairs are needed. If there are four or more, proceed with the next steps.
- With power off, replace R202 with a 500KΩ or 1MΩ potentiometer.
- Connect a short test lead across L41 and turn on TV power.
- Adjust the test potentiometer until the receiver locks to the station signal (adjust in the direction that gives fewer stripes).
- Turn off ac power, disconnect the test control and measure its resistance using a digital ohmmeter for accuracy.
- Obtain (or construct by connecting several in series or parallel) a resistor of the value just measured in the previous step. Install it for R202, remove the L41 jumper and apply receiver power. Adjust the L41 core for best locking.
- Test the stability by alternate power-on and power-off periods.

Figure 9 shows the position of the L41 hold/stabilizer coil and the three resistors connected in series to obtain the critical value for R202.

After this tailoring, the horizontal oscillator was locked when the picture first appeared, at worst only a few seconds elapsed before locking occurred. Improvement of such magnitude is worthwhile.

Drive problems

Many complaints and call-backs can be prevented by a few dc-voltage tests in the horizontal-sweep circuit of televisions using tubes. The Packard Bell proved the wisdom of this procedure. Most of the measurements showed normal conditions except the dc voltage and drive waveshape at the grid of the horizontal-output tube. The grid dc voltage was -42V instead of the correct -48V. The grid waveform was flattened (but not clipped) and a crosshatch pattern showed slight horizontal nonlinearity and a small lack of width on the right.

These symptoms usually are caused by reduced resistance of the oscillator plate resistor (R203, a 68KΩ resistor in Figure 8). R203 measured about 18KΩ, and installation of a new 68KΩ value improved the horizontal performance and voltages. Figure 10 shows the grid waveforms.

Comments

Although these separate problems occurred in one chassis during the same shop repair, the lessons learned from them apply to many other brands and models of approximately the same age.

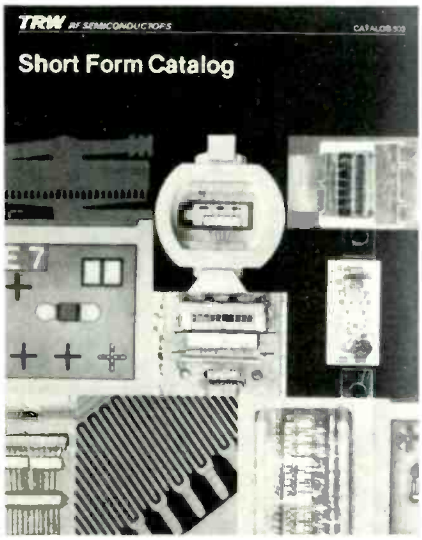
One lesson is that transistors can simulate zener operation (large leakage current flows above a specific voltage, but almost none below that voltage) when their ratings are exceeded. Finding the open R67 resistor by any other method might have been impossible. After all, R67 was hidden underneath other components on another chassis from the AGC circuitry; the chances of solving the problem by hit-or-miss component replacements were nearly zero. A technician might have replaced Q4 with one having a much higher voltage rating, but it's not likely. Or another technician could have discovered that the circuit operated fairly well (but with ghosts) if Q4 was operated from the +18V supply rather than the original +135V supply. The possibilities are remote.

Another problem not encountered here is how transistor junctions can conduct dc voltages in surprising ways. One is explained in Figure 3 where any negative voltage (regardless of its source) at the Q6 collector is passed to the base through the collector-to-base junction. There are many other examples of incorrect voltage or resistance readings that are produced by diode or transistor-junction conduction. Any silicon junction having more than 0.5V of forward bias will have resistance that draws current. A forward bias of 0.7V or more reduces junction resistance to a few hundred ohms. These resistances and currents can affect many voltage and resistance measurements unless the technician realizes the implications.

Most experienced technicians agree that modern electronic circuits are more difficult to troubleshoot. Therefore, technicians should have these qualifications: (1) a good understanding of the natures and specs of all components; (2) a knowledge of the purpose and operation of basic circuits; (3) ability to interpret symptoms and instrument readings; and (4) ability to troubleshoot quickly and accurately. These troubleshooting abilities should include the talent for improvising methods and techniques when new or unique ones are needed. □

catalogs literature

TRW RF Semiconductors has published a 12-page short-form catalog, No. 503A, that lists basic specifications for 156 components. Ten



catagories of products are described with photographs and engineering drawings of each package type. An alphanumeric index and a cross-reference table are included.

Circle (15) on Reply Card

Application note 222-3 from **Hewlett-Packard** presents a detailed economic model developed for determining the cost and feasibility of using signature analysis for the testing and servicing of microprocessor-based products. Signature analysis is for those involved in product design, manufacturing, field service, cost control, or in managing any combination of these functions.

Circle (16) on Reply Card

The **Sprague** Q-Line Component Catalog, No. C-652, features the newest addition to the component line, Pinch 'N' Seal heat shrink tubing. The tubing is available in assortments of 24 pieces for frequently used sizes.

Circle (17) on Reply Card

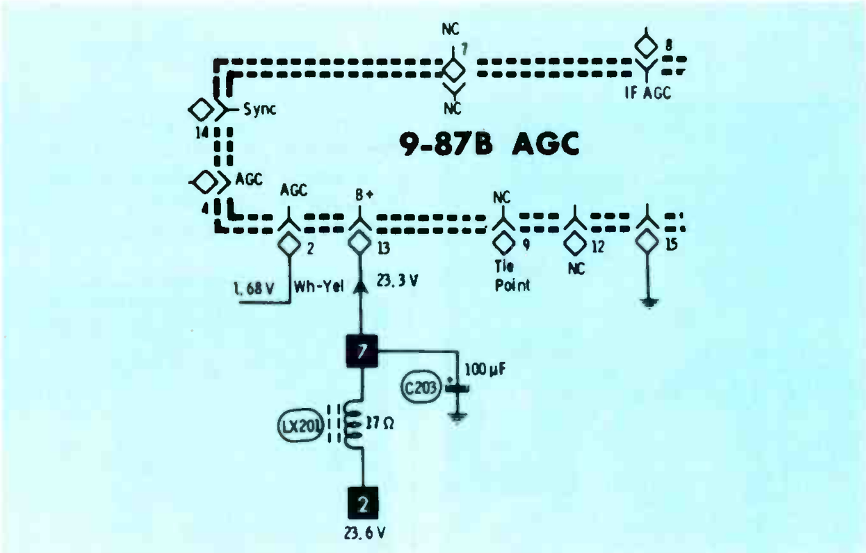
The **Westinghouse** Power Semiconductor Cross Reference Guide covers all rectifiers, transistors, SCRs and assemblies available from Westinghouse, and includes 10,000 part numbers from JEDEC, Westinghouse and other suppliers. All are cross-referenced to Westinghouse part numbers.

Circle (18) on Reply Card

A new product supplement to the off-the-shelf indicator light catalog is available from **Industrial Devices.** The catalog supplement, form FSG, covers new panel-mounted LED assemblies, leaded LEDs, bare LEDs and LED lenses. Also included are a new Omni-Glow neon flasher indicator and a relampable Mini-Slide indicator assembly for incandescent lamps. Photographs, dimension drawings, mounting information and technical specifications and ratings are included.

Circle (19) on Reply Card

troubleshooting tips



White raster without sound
Zenith 14B387
(Photofact 1156-3)

A white raster with no sound often is caused by an overactive AGC, so the first test was a series of dc-voltage readings in the AGC circuit. About -70V was measured at the AGC keyer plate. A fair-quality picture and sound were obtained when the AGC control was rotated completely clockwise.

A sample of negative voltage from the grid of the horizontal-output tube is used to provide part of the AGC-keyer grid bias, and this voltage at the keyer was too positive. The output-tube grid measured -30V instead of the correct -39V. Additional tests of the horizontal oscillator proved the plate voltage was low. This was traced to a leaky C65 (0.0033µf) coupling capacitor.

Installation of a new capacitor increased the oscillator plate voltage, gave a normal -39V at the output grid and allowed normal AGC operation near the rotational center of the control.

Remember that a gassy output tube also can cause a gradual change from correct AGC operation to excessive AGC with loss of contrast.

J. M. Thurston
Thurston Electronic Service
Fort Wayne, IN

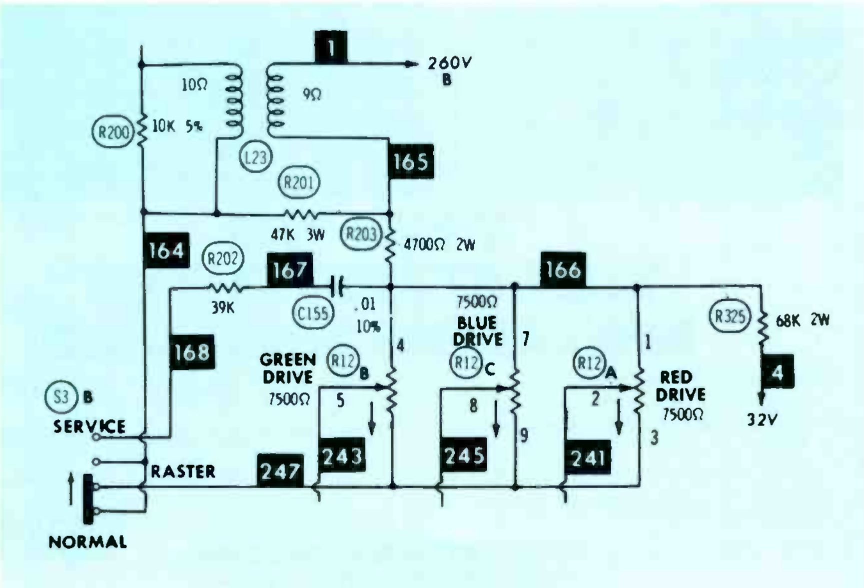
Intermittent sync failure
Zenith 19GC45
(Photofact 1546-2)

This Zenith was brought to our shop because horizontal and vertical sync were intermittent. After horizontal module 9-90 and video processor 9-87 module were replaced, the television was set aside for a heat run. After about two hours, the sync problem began, but it was too erratic for use to pinpoint the source.

To monitor one aspect of the operation, we connected a voltmeter to pin W13 of the 9-87 sync module. This is the supply point that should always have +24V. After about an hour, the voltage dropped to about zero, and the sync was gone. Tracing back from pin W13, it ws found choke LX201 was open.

Replacement of LX201 cured the intermittent sync and locking. The same trouble can occur in other Zenith chassis using the 9-87 module.

Mac Kellman
Video Master TV
Brooklyn, NY



Intermittent excessive brightness
RCA CTC40 (Photofact 1111-3)

According to the customer, the color receiver would play for hours without a problem and then the picture would become very bright and washed out. There was no pattern to the malfunction. Apparently, it was not caused by operating heat. Therefore, the chassis was taken to the shop for operation on our test jig.

After the chassis was operated for some time on the test jig, the excessive brightness occurred. This proved the picture tube was not responsible, although a bad picture tube had been the first suspect.

All video transistors were tested, but all checked normal. A decision was made to monitor the Q9 video-output collector dc voltage. When next the picture became too bright, the collector voltage dropped from the normal +213V to about +30V. Of course, a lower voltage here always increases the brightness, so the voltage change was a valuable clue.

While the defect was continuing, the power was turned off and an ohmmeter test found an open primary in L23, the peaking transformer that feeds video to the picture-tube cathodes via the drive controls.

A new L23 was installed, and the intermittent brightness problem was cured.

Mac Kellman
Video Master TV
Brooklyn, NY

Sound distortion Magnavox T979

(Photofact 1329-1)

Over a period of several years, we have found one defect that can produce several symptoms in the Magnavox T979 sound circuit. The audio driver and output transistors are on a small circuit board (M1B) that is plugged into the main chassis. (Late production replaced the transistors with one IC.) The socket has several pins, but only four are used. There is one each for: input signal; output signal; ground; and supply voltage. An open in any pin connection will eliminate all sound, of course. But the ground circuit is the critical one.

Because the same ground serves both input and output signals, any resistance between M1B and ground produces positive feedback that sounds like an open output transistor or a badly adjusted discriminator transformer. The distortion is severe and cannot be ignored.

To verify the bad ground, rock the M1B module in the socket while the sound is heard. Crackling noises and a momentary clearing of the distortion proves the ground circuit is at fault.

Cleaning the socket contacts might prevent the distortion for a time, but a permanent fix calls for an alternate ground wire added between the M1B common ground and chassis ground. In fact, this extra ground path should be added to any new module that is installed (because bad connections can ruin it also).

A convenient chassis ground can be made to the metal shield that partially covers the M1B module.

None of the modified color sets have had a recurrence of the distortion or noise following this repair, to our knowledge.

Ken Barton, CET
Columbus, OH

Low brightness and contrast RCA CTC72C

(Photofact 1518-2)

As the customer explained, the picture had poor contrast and low brightness, particularly for the first half hour of operation. I suspected a weak picture tube, but it checked normal on a tube tester.

When transferred to the test jig, the chassis operated better. That still pointed to a picture tube problem. A bad connection in the heater supply can produce the same symptoms, so I traced the picture-tube heater wires back to a winding of the T402 transformer that also furnishes drive to the trace SCR (in this case, a combination SCR and diode called intrinsic rectifier).

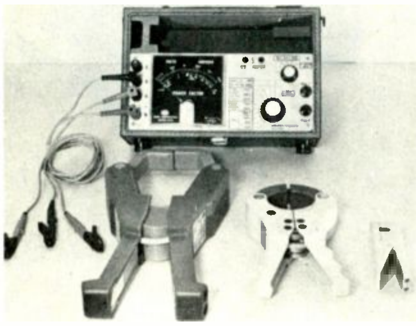
The foil was hot around the T402 lugs, indicating excessive voltage drop (probably from poor soldering). I soldered all of these lugs, using a hot soldering iron, and the low brightness and poor contrast problems were solved.

Erratic contacts at the T402 lugs have been responsible for many intermittent troubles. They should be checked during each chassis repair.

Mac Kellman
Video Master TV
Brooklyn, NY □

Power factor meter

The **AEMC** Power Factor Meter offers flexibility to the electrical maintenance engineer conducting power factor surveys. Three clamp-on current transformers are availa-



ble. The unit includes the voltmeter (0-150-300-600V; 60 Hz); the ammeter (0-15-60-300-1000A, maximum 3000 A with large clamp-on CT); and the direction of phase rotation indicator. Accuracy is 2.5%.

Circle (20) on Reply Card

20MHz scope

Kikusui has introduced its model 5519 portable scope for production line, test and service applications. The 5519 has a vertical bandwidth of dc (ac 2Hz) to 20MHz (-3dB) and a sensitivity of 5mV to 10mV per division in 11 ranges. The horizontal axis (sweep time) is 0.5 seconds to 0.2 seconds per division in 20 ranges with an external input sensitivity of less than 200mV per division. Frequency is dc to 500KHz. A 5X sweep magnification accelerates sweep time for detailed studies of waveform components.

The base price for the 5519 is $595.

Circle (21) on Reply Card

Digital multimeter

The **Triplett** model 4200 Digital Multimeter features true RMS conversion for improved measurement of complex ac signals, fuse overload protection to 1000V on all ranges, an easy-view 3½-digit .43-inch LED display, typical accuracy of ± 0.2% 32 ranges, push-button function selectors, single range selection switch with only two input jacks, auto-zero and auto-polarity in the

voltage and current modes, and RF shielding. Safety test leads, combo carrying handle/bench stand, line cord and instruction manual are included.

The 4200 is priced at $270.

Circle (22) on Reply Card

product report

Hot melt gun

Adhesive Machinery has introduced the Supermatic I, a portable hot melt gun designed for industrial use. It loads with either 4-inch or 15-inch Supersticks, and will dispense glue at a rate of 24 ounces per hour. More than 2 feet of glue line can be dispensed with a single

trigger depression. Its valved nozzle provides instant adhesive cut-off when trigger pressure is removed. Interchangeable nozles are available. The unit is supplied complete with a one-hole valved nozzle, 5-foot, 3-inch grounded electric cord, 150W heater, 375° pre-set thermostat and flip-up gun stand.

Circle (23) on Reply Card

Power line monitor

The BMI Glitch Sentry monitors 120 Vac power lines feeding minicomputers, test equipment and other sensitive electronic equipment. It plugs into an accessory outlet and

will sound an alarm at power failure, low line voltage, high line voltage, voltage spike, voltage drop and high frequency noise. A card describing possible causes and solutions for each of these power disturbances is included. Intended for both in-house use and field service applications, the unit sells for $300 (single quantity).

Circle (24) on Reply Card

Instrument enclosures

Stock and custom designed instrument enclosures from **Foxy Box** feature furniture grade materials

and are furnished in all available grades and styles of Formica. Five hundred stock sizes are available. Estimates on custom enclosures are given from drawings or sketches.

Circle (25) on Reply Card

Dip socket

The **GC Electronics** GTC DIP socket is UL rated and resists high temperatures, moisture, vibration and mechanical shock to maintain a high consistency of performance. It requires no special tooling for installation and may be used with conventional gold, tin or solder—plated compounds. The socket is available with 8, 14, 16, 18, 20, 22, 24, 28 or 40 contacts.

Circle (26) on Reply Card

reader's exchange

Needed: Operating manual and schematic for B&K-Precision color generator model 1245. *Rev. F. C. Lewis, 5728 Hemmingway, El Paso, TX 79924.*

Needed: Operating manual and/or schematic for B&K-Precision model E-400 sweep generator. Will buy original, or copy and return. *William A. Jackson, 109-32 172nd St., Jamaica, NY 11433.*

Needed: High voltage rectifier (1AD2) socket for GE model M213CWD, chassis HC. GE part No. ET34X167. *M. B. Danish, P.O. Box 217, Aberdeen Proving Ground, MD 21005.*

Needed: Service manual for Coleco Telstar Combat game model 6065. Will buy original, or copy and return. *Bob Burley, 9007-129B Ave., T5E OP4, Edmonton, Alberta, Canada.*

Needed: Schematics, operating manuals, parts lists and chassis photos for Grundig/Majestic AM/FM/SW receivers model 2066-PX and 4085. Will buy original, or copy and return. *B. R. Orwig, 800 Sussex Terr., Crete, IL 60417.*

Needed: Power transformer for Heath model 0-10 scope. Original No. 54-26. *Bob Kramer, 919 Grove St., Aurora, IL 60505.*

Needed: Photofact or copy for Emerson twin speaker model G1703. Will pay for copying and postage. *Philip Butler, Box 581, West Brookfield, MA 01585.*

Needed: Sencore SC-165 AM/FM stereo analyzer; Sencore portable color bar generator; Sencore TF46 and Sencore UPS 164 PS. *C. M. Johnson, 510 4th St., Kenyon, MN 55946.*

Needed: Heathkit 1G-5218 sine-square wave audio generator; and repair parts for Watchmaster model G-11 watch testing and timing machine. *Steve's Radio Service, P.O. Box 168, Wickes, AR 71973.*

Needed: VHF tuner for Sylvania model CX2174W television, chassis No. D19-05. *Harvey Rousseau, 6 Longview Rd., Milford, MA 01757.*

Needed: Flyback for Sears model 562-51040300 portable b&w television. *David A. Clark, 1635 Navajo Dr., Owensboro, KY 42301.*

Needed: Schematic for Philco radio model 42-1008 code 121; and schematic for Brawn model No. RC6217 AM/FM/Phono set. Will pay for original, or copy and return. *Angelo Strazzante, 27 Boxwood Ln., Willingboro, NJ 08046.*

Needed: Wattmeter transformer No. 101202 for Knight signal tracer; and service alignment data for ICP 8TP-716/736 stereo. *C. T. Hugh, 146 Schonhardt St., Tiffin, OH 44883.*

Needed: Service data, alignment instructions and schematic for Wards Airline radio model 14BR-911A. *Harold W. Smith, CET, Rt. 2, Box 531, Eugene, OR 97401.*

Needed: Instruction manual for Triplett tube analyzer model 344. *Jack Gillette, P.O. Box 1923, Costa Mesa, CA 92626.*

Needed: Schematic of 6C5, transformer, audio oscillator in B&K-Precision E-200-C signal generator. *Daniel Vivona, 3253 N. Kraft Circle, Lake Elmo, MN 55042.* □

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A19-23 1968-1

RCA
Chassis CTC107A 1969-2

TOSHIBA
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Remote Control Receiver CR313,
Remote Control Transmitter CT313 1966-2

TRUETONE
GEC4003A-18, GEC4006A-18 1964-1
GEC2000A-18 (24-2000-8) 1967-2
GEC4009A-18 (24-4009-7) 1968-2

WARDS
GEN-11240A 1963-3
GGV-12910B/940C/979B 1964-2
GGY-12950A 1965-1

ZENITH
Chassis 19MB1X 1964-3
M1312/318WXS/320W 1965-2
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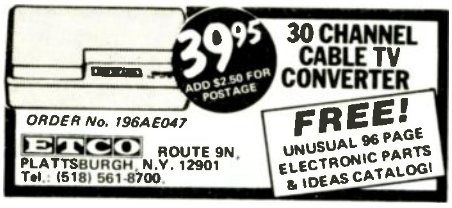

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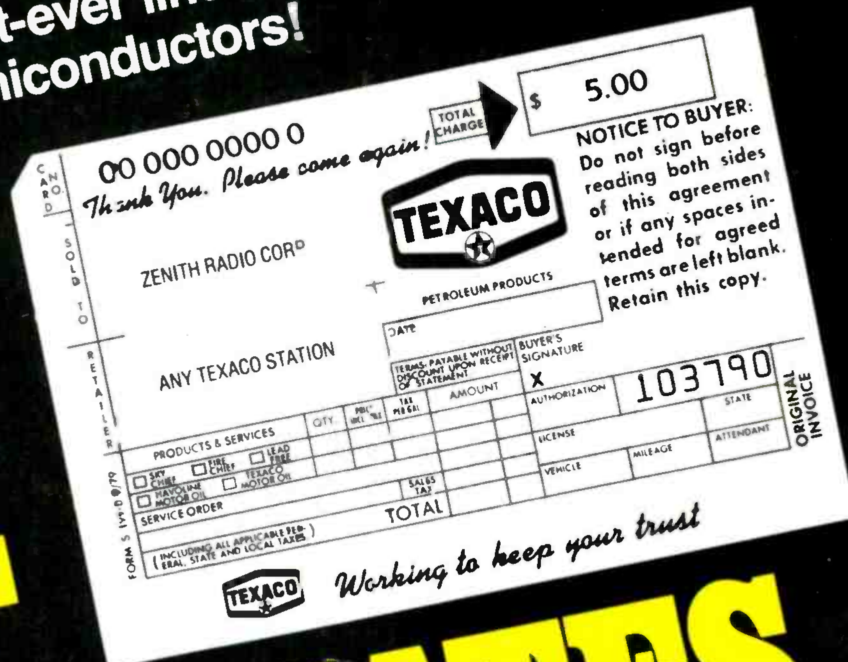

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