# ELECTRONIC Servicing & Technology

FEBRUARY 1983/$2.25

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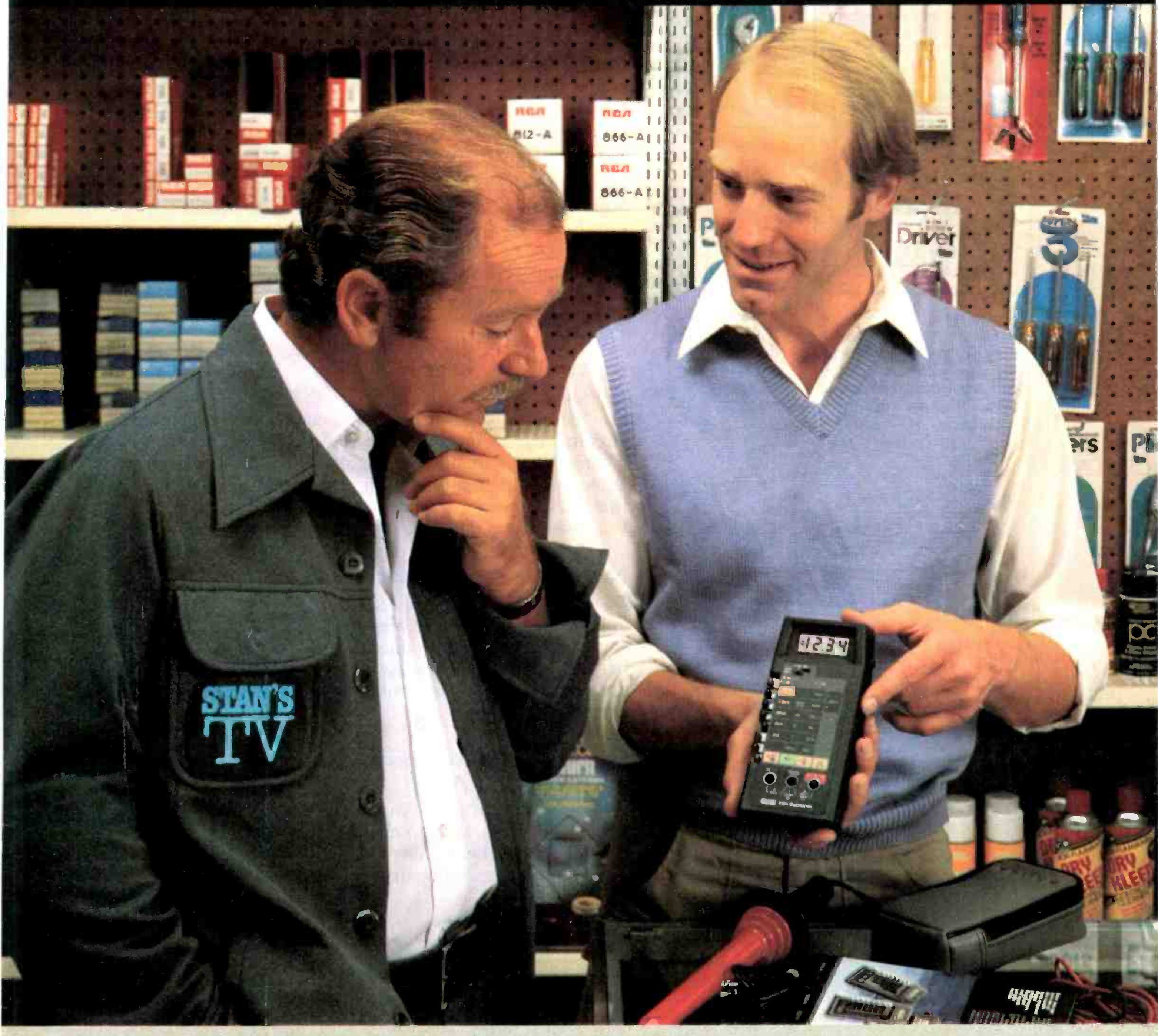


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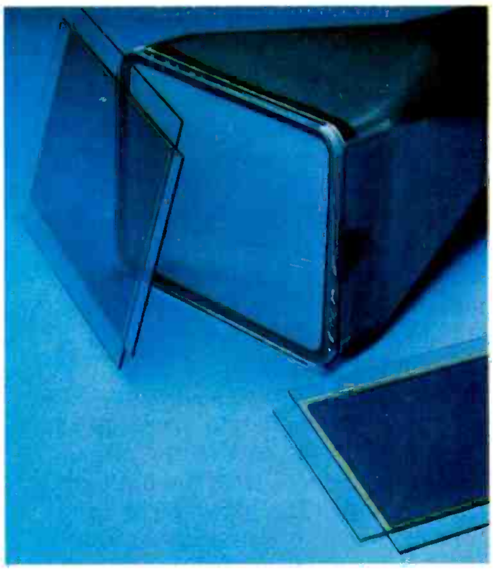
ELECTRONIC
Servicing & Technology

February 1983
Volume 3, No. 2

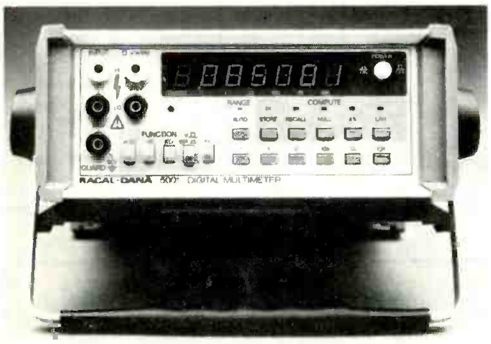

As electronic technology develops, new tools and instruments like these are needed to keep pace with the industry. See related article on page 44. (Photo courtesy of Global Specialties.)

# Departments

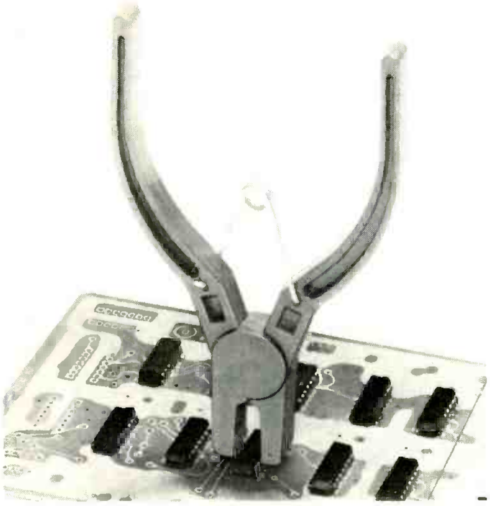




Page 8




Page 12



Page 38

**Next month...**

**How to service arcade video games.** Arcade video games are enjoying unprecedented success today. Although these games employ extensive digital circuitry plus a monitor with analog circuits, they are seldom difficult to repair. This article describes typical circuit operation and offers servicing suggestions.

# Editorial

## Tools evolve in electronic revolution

The history and development of humankind is inextricably intertwined with the history and development of tools. Tools have enabled us to subdue the rages of nature; harness water, wind and fire to the machines of production; and build and repair all manner of devices.

It is a matter for conjecture whether the first tool contrived by a primitive human was a club used in self defense against a larger adversary, a rock thrown to bring down small game from a distance or some other tool. It is, however, a matter of history that that first step in tool use was followed surely, although perhaps slowly, by another and yet another.

A few other animals are occasionally seen to use a stick or a rock as a tool to perform some simple task at hand, but humans are unique in the world in their development and systematic use of tools. To such a degree in fact that some anthropologists have stated that it is this characteristic that most significantly marks the difference between humans and the lower animals. And, furthermore, scientists have suggested that the present state of evolution of the human brain was influenced largely by the discovery and use of tools by early humans.

For the most part, in human history, the introduction of new tools came about slowly. The industrial revolution changed that, forcing a far more rapid evolution of tools to keep up with the rapid changes in production methods.

The electronics revolution of today is, in a similar fashion, forcing the development of new tools to fabricate and service the products of that revolution. Circuits and components are getting smaller and smaller. Electronic circuitry is being incorporated into more and more equipment that it was never used in before. Increasingly, electronic circuits that have historically been analog are yielding to digital techniques. Because of the incredibly low cost of an individual semiconductor component realized in IC technology, circuits are becoming increasingly complex. All of these developments are causing new kinds of problems in the production and servicing of electronic devices that the old tools are ill-equipped to handle. The answer has been the development of a host of new tools to deal with the new technology. There can be no doubt that as the electronics revolution continues to unfold, the development of new tools will keep pace.

Nils Conrad Persson


**ELECTRONIC Servicing & Technology**

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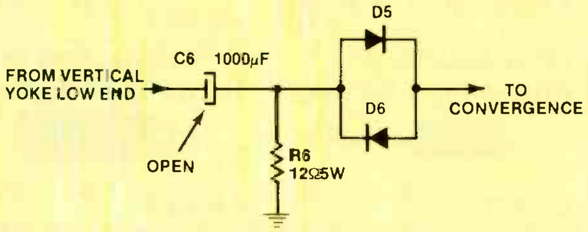
# Symcure

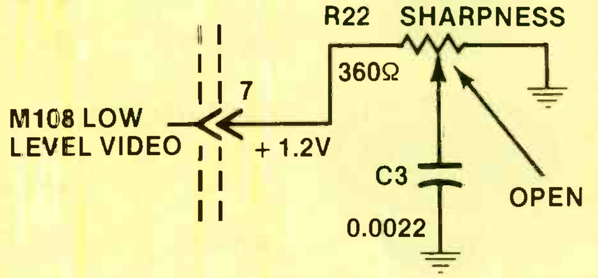
**Symptoms and cures compiled from field reports of recurring troubles**

**Chassis** – Magnavox T995 — 1
**PHOTOFACT** – 1469-1 and 1700-1



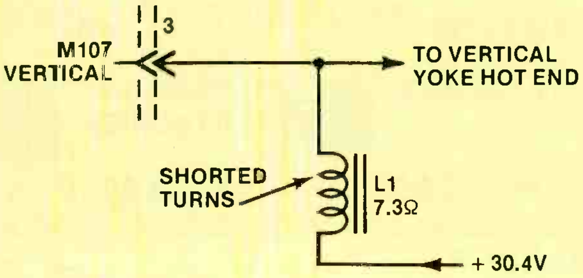

**Symptom** – Insuffient vertical height
**Cure** – Check capacitor C6 (located below vert module) and replace it if open

**Chassis** – Magnavox T995 — 2
**PHOTOFACT** – 1469-1 and 1700-1



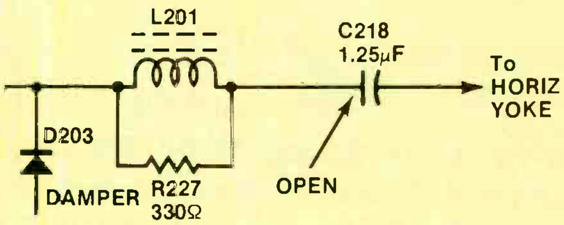

**Symptom** – Appears as AGC trouble, insufficient brightness or a weak CRT
**Cure** – Check R22 sharpness control and replace it if open

**Chassis** – Magnavox T995 — 3
**PHOTOFACT** – 1469-1 and 1700-1



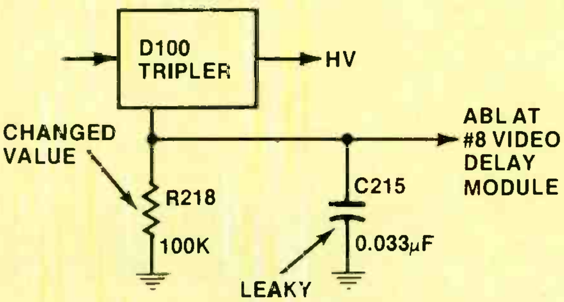

**Symptom** – Vertical foldover, retrace lines or bad linearity
**Cure** – Check L1 vertical inductance and replace it if turns are shorted

**Chassis** – Magnavox T991 — 4
**PHOTOFACT** – 1594-1



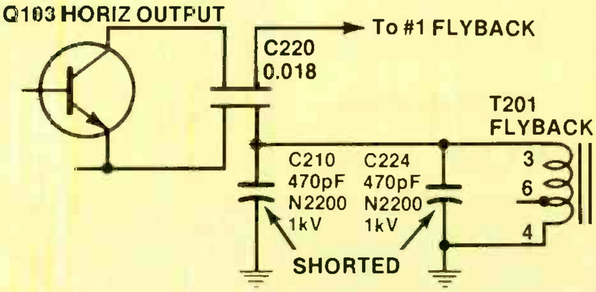

**Symptom** – No horizontal sweep (one single vertical line)
**Cure** – Check C218 and replace or resolder if open or has bad joint

**Chassis** – Magnavox T991 — 5
**PHOTOFACT** – 1594-1




**Symptom** – Excessive brightness with retrace lines, and no control of brightness
**Cure** – Check C215 and R218 and replace them if defective

**Chassis** – Magnavox T991 — 6
**PHOTOFACT** – 1594-1




**Symptom** – No high voltage or raster
**Cure** – Check capacitors C210 and C224 and replace them if shorted (notice the flyback winding parallels them, so disconnect them during tests)

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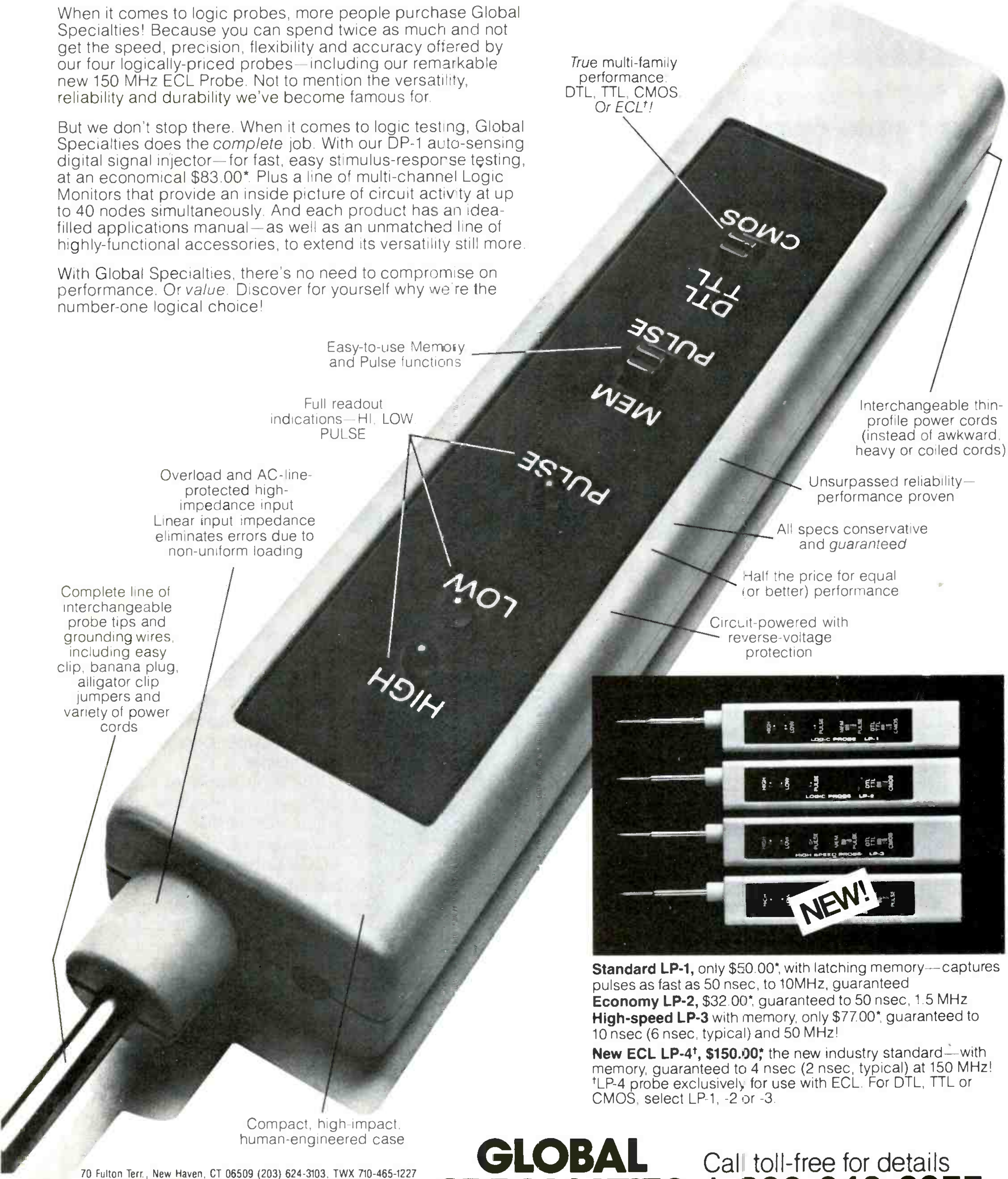


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Technology

# LCD replaces CRT in oscilloscope

Will the next oscilloscope you buy have an LCD readout? Or perhaps, will you, in the not-too-distant future, find yourself troubleshooting a television with a flat LCD screen? The technology for such devices is here and now, as this article shows.

**An LCD** capable of replacing the CRT for oscilloscope applications has been developed by EEV. The display uses dye-phase-change technology, which eliminates viewing angle problems because no polarizers are required.

A major breakthrough has been achieved in the production of an oscilloscope that uses an LCD readout instead of the traditional CRT to present waveform information.

The significance of this development becomes apparent when you consider the differences between an LCD and a CRT. The LCD solution offers low power consumption, low supply voltage, visibility in direct sunlight, compactness and lightness. This development has generated worldwide interest because the techniques involved could be applied to any device needing to display waveforms or trends, such as spectrum analyzers, medical equipment (ECG), analog-type meters and even perhaps radar equipment.

Further developments or refinements of the techniques involved in displaying single-valued functions could lead to the use of large-area LCDs for displaying alphanumeric or graphic information.

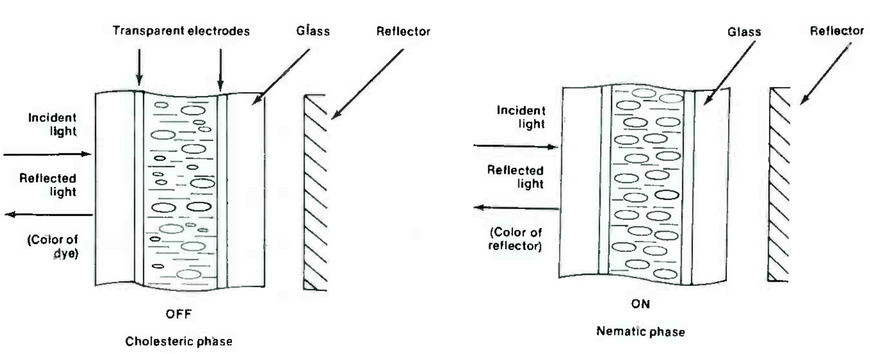



**Figure 1.** Operation of a dyed phase-change display. In the *off* position, the cholesteric molecular planes are approximately at right angles to the glass plates, but the helical axes are randomly oriented. A dye is dissolved in the liquid-crystal material and the dye molecules align themselves with the liquid-crystal molecules. A light-scattering effect causes the display to appear dark.

If an alternating electric field of sufficient strength is applied across the display cell, then liquid-crystal and dye molecules will align themselves perpendicular to the glass plates due to an untwisting of the helical axes of the liquid-crystal material. Pleochroic dye materials have different absorption coefficients parallel and perpendicular to their molecular axes. The result is that the *on* active areas will become transparent. A reflector placed behind the display cell will cause these transparent areas to appear bright.

## Dyed phase change

The Voyager oscilloscope, manufactured in the United Kingdom by Scopex Instruments, uses a dyed phase-change LCD matrix manufactured by the English Electric Valve Company (EEV), Chelmsford, England. EEV's Lucid Displays Department is producing 128-by-256-element displays for the Voyager.

The majority of LCDs today are twisted nematic displays. These displays use polarizers to make the physical changes within liquid-crystal materials visible, but this imposes limitations on brightness, viewing angles and, to some extent, upper operating temperatures. They perform well in watch, calculator and general instrumentation applications, but are not ideal for oscilloscope use. They lack sufficient brightness, and viewing angles are limited to about ±45°.

These problems are overcome by using the dyed phase-change technique, whereby the phase of the liquid-crystal material is changed from the cholesteric to the nematic. Cholesteric and nematic describe the molecular structure of the material.

Figure 1 shows the operation of a dyed phase-change display. In the *off* condition, the cholesteric molecular planes are approximately at right angles to the glass plates, but the helical axes are randomly oriented. A dye has been previously dissolved in the liquid-crystal material, and the dye molecules align themselves with the liquid-crystal molecules as shown. In this situation, a light-scattering effect causes the display to appear dark, and the color is determined by the color of the dye.

If an alternating electric field of sufficient strength is applied across the display cell, then liquid-crystal and dye molecules will align themselves perpendicular to the glass plates, due to an untwisting of the helical axes of the liquid-crystal material. Pleochroic dye materials have different absorption coefficients parallel and perpendicular to their molecular axes. The result is that the *on* active areas will become transparent. A reflector placed behind the display cell will cause these transparent areas to appear bright.

The resultant display has bright, active areas on a dark background. The Voyager uses a black dye materal in the display, and the drive system is reversed such that when energized, the display has black active areas on a bright background.

## Display manufacture

The need for a *clean air* environment is paramount for the manufacture of LCDs, but it becomes even more important for the production of oscilloscope displays. The extremely small interelectrode spacing in high-resolution displays requires extra precautions to avoid short-circuits between adjacent electrodes because of impurities within the

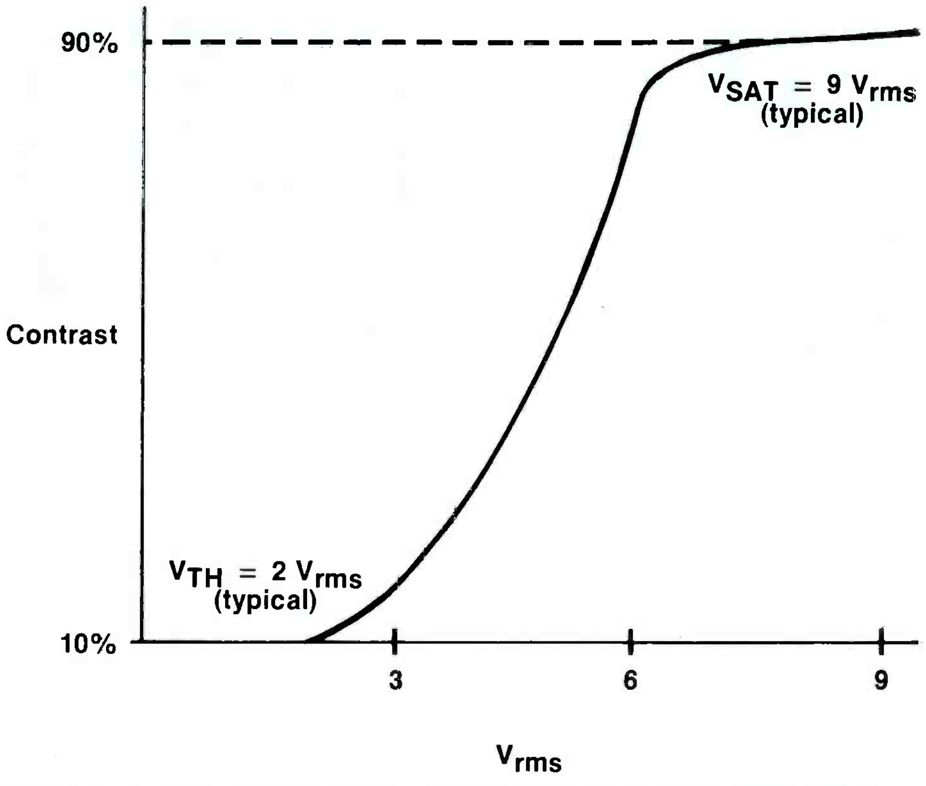



**Figure 2.** Typical voltage/contrast characteristics of a dyed phase-change oscilloscope display.

display cell. Also, unless the cell spacing is kept at a constant value (typically 8$\mu$m) variations in contrast, across the cell, can result.

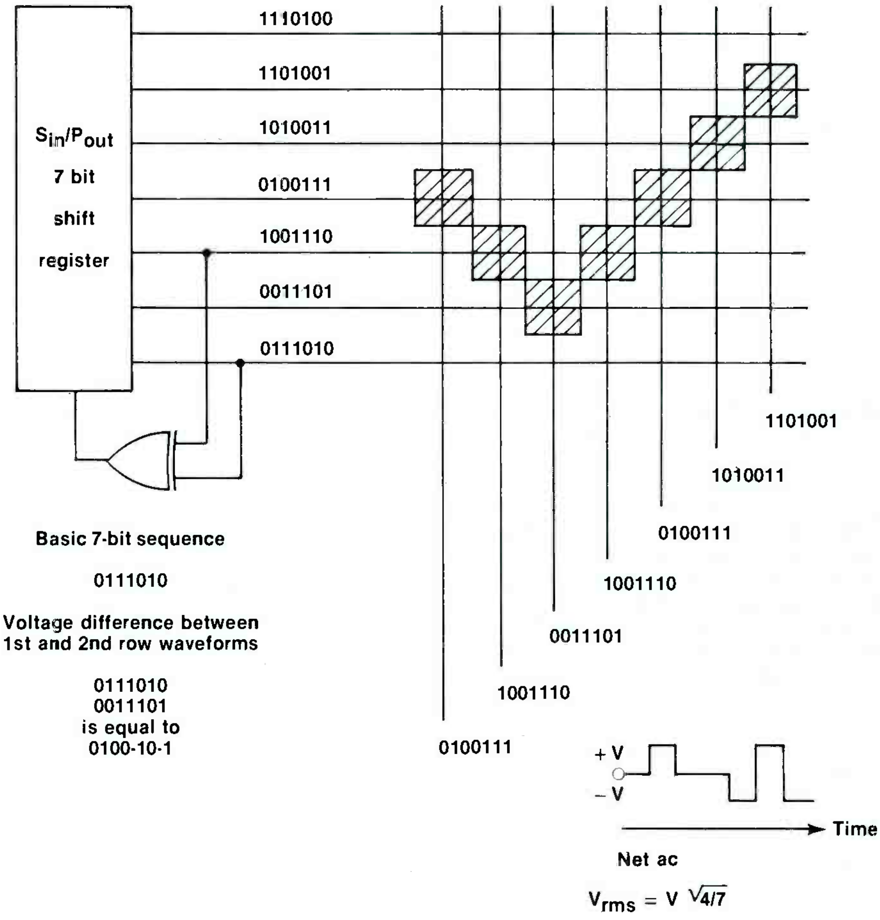
### Driving the displays

Figure 2 illustrates the typical voltage/contrast characteristics of a dyed phase-change oscilloscope display. Alternating voltages are used to drive LCDs in order to avoid electrolytic decomposition effects within the display cell.

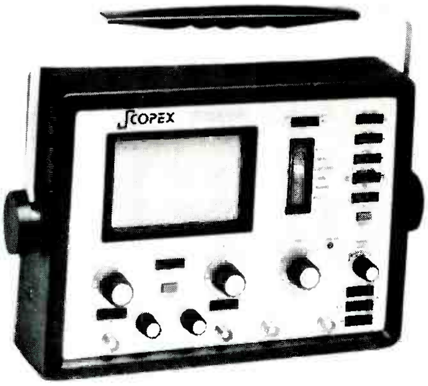
The difficulties of driving large X-Y matrix LCDs are well known, but for the displaying of waveforms, the drive requirements are somewhat easier to achieve than you may first imagine. A single waveform necessitates the addressing of only one Y-coordinate for every X value (i.e., only one element per column needs to be addressed).

The drive method employed in Voyager is based on a novel, patented system developed by the Royal Signals and Radar Establishment (Malvern, England). The system involves the use of binary noise waveforms called Pseudorandom Binary Sequences (PRBS). An advantage of using PRBS waveforms is that the reference waveforms are a phase-shifted version of each other, and hence can be generated simply from a shift register with exclusive OR (or NOR) feedback. Figure 3 illustrates the generation of row waveforms for a 7-row matrix.

For a display of X rows and Y columns, X + Y shift-register outputs are required to drive the display. The PRBS basic shape is contained in ROM, which when addressed by the display controller, serially outputs the required column waveforms to the Y-shift registers. The row waveforms are generated by shift registers with exclusive OR/NOR feedback and are strobed simultaneously with the column waveforms. Each row has a different PRBS waveform, and to address an element in a particular column, the column waveform is made identical to the row waveform. The resultant RMS voltage will be zero, which satisfies the *off* conditions




**The generation** of row waveforms for a 7-row matrix.




**The Voyager** oscilloscope uses a black dye material in the display, and the drive system is reversed so that when energized, the display has black active areas on the bright background.

illustrated in Figure 2. A characteristic of this driving method is that all other combinations of row and column waveforms produce an RMS voltage equal to 0.707 of the supply voltage. For Voyager, which uses a supply of 15Vrms, this value is 10.6Vrms and satisfies the *on* conditions illustrated in Figure 2. This allows a dark trace on a uniformly bright background. An important consequence of this is that the performance of the display is not degraded as the number of rows of the matrix is increased.

### Practical considerations

For large area matrices, the number of connections to the display can be large. Because a relatively high resolution is required from the display, these connections will be close together. In most situations, the display connections will be interlaced, i.e., adjacent rows (or columns) will have contacts at opposite ends of a display. For this reason, EEV's 128-by-256 matrix has contacts on all four sides of the display. Elastomeric connectors can be used for connection to the display. Interlacing of the display contacts will necessitate a minor change to the drive system because column information will

This liquid-crystal, 128-by-256 matrix incorporates the dye-phased change effect to enhance brightness and contrast of a display over a wide variety of ambient light conditions.

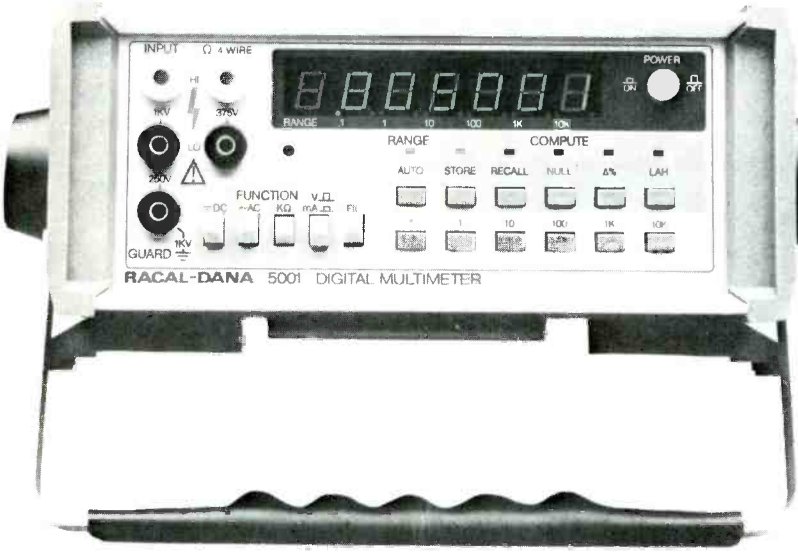
have to be outputted to shift registers at opposite ends of the display.

### Availability

EEV can produce displays of up to 150mm by 140mm in overall size, suitable for oscilloscope applications. A standard device, overall size 140mm by 50mm, containing 256 by 64 elements of size 0.406mm square and pitch 0.5mm is available to enable potential users to evaluate the technology.

The displays are suitable for operation over a temperature range of – 10C to + 70C; typical response times at 20C are less than 100ms. Improvements in contrast ratios, response times and operating temperature ranges are expected as more stable pleochroic dye materials are developed.

# Reports from the test lab: The Racal-Dana model 5001 DMM




**Digital multimeter** model 5001 from Racal-Dana has 5½ digits and sufficient noise reduction and stability to provide stable readings for the extreme accuracy. The dc-voltage accuracy is rated at ±0.007%. A microprocessor is used for several computational functions and the autoranging.

By Carl Babcoke, CET

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*Each report about an item of electronic test equipment is based on examination and operation of the device in the **ES&T** laboratory. New and useful features are discussed, along with tips about using the equipment for best results. Personal observations are given about the performance or other important attributes.*

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The Racal-Dana model 5001 has all the usual features of a good digital multimeter, but it also incorporates several computer-like functions. It has a microprocessor, and it controls five computational functions, the autoranging mode and six error indications.

The five DMM functions have a total of 23 ranges, including five dc-voltage ranges, four ac-voltage ranges, six resistance ranges, four dc-current ranges and four ac-current ranges. Any range can be selected manually or by autoranging. All ac measurements are true RMS with excellent frequency response from 45Hz to 20kHz. RF probes for extending the bandwidth to 500MHz are optional. Resistances to 99MΩ can be measured. A 2-wire or 4-wire resistance mode is selected automatically. Basic dc-voltage accuracy is ±0.007%.

Few DMMs of this high accuracy have current ranges, but model 5001 provides 4½-digit resolution for ac and dc current ranges to 2A full scale.

Noise rejection for voltage and resistance measurements has been improved greatly by these separate functions. The integrating A/D converter has automatic noise rejection at multiples of the power frequency; a single-pole, low-pass filter provides 20dB rejection at 55Hz and 6dB more above 55Hz, and it can be switched on or off from the panel; a guard terminal provides common-mode rejection; a non-recursive filter reduces low-frequency and digitizer noise; digital averaging by the LAH function can minimize sub-Hertz noise and drift; and a metal case shields the circuitry against RF interference.

Another unusual feature promises lower maintenance and calibration expenses. The 5001 has internal digital calibration allowing complete calibration in about 15 minutes, without any manual adjustments. If needed, two signature-analysis routines permit easy debugging of the microprocessor circuits.

### Readout

The readout includes six 7-segment digits, six decimal LEDs, one LED that lights each time the DMM updates a reading, and a minus-symbol LED that

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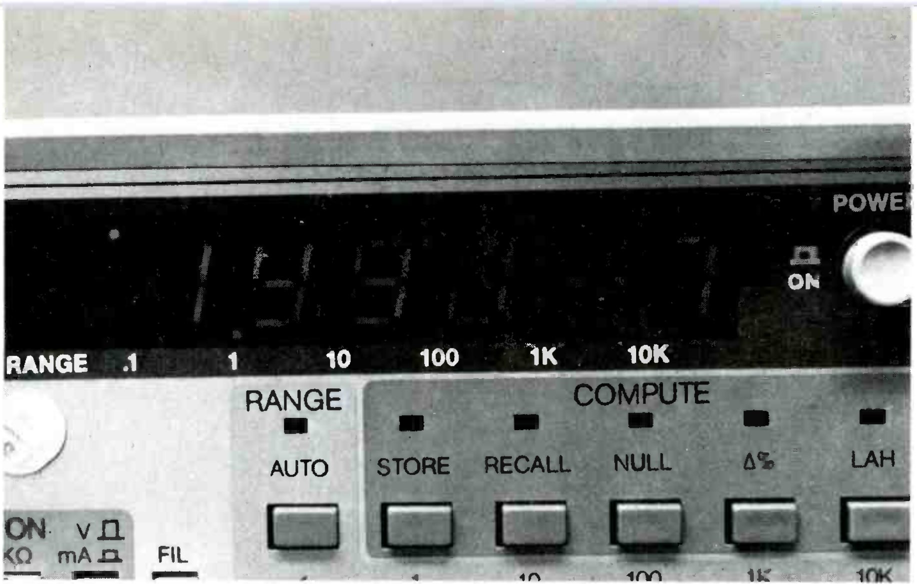
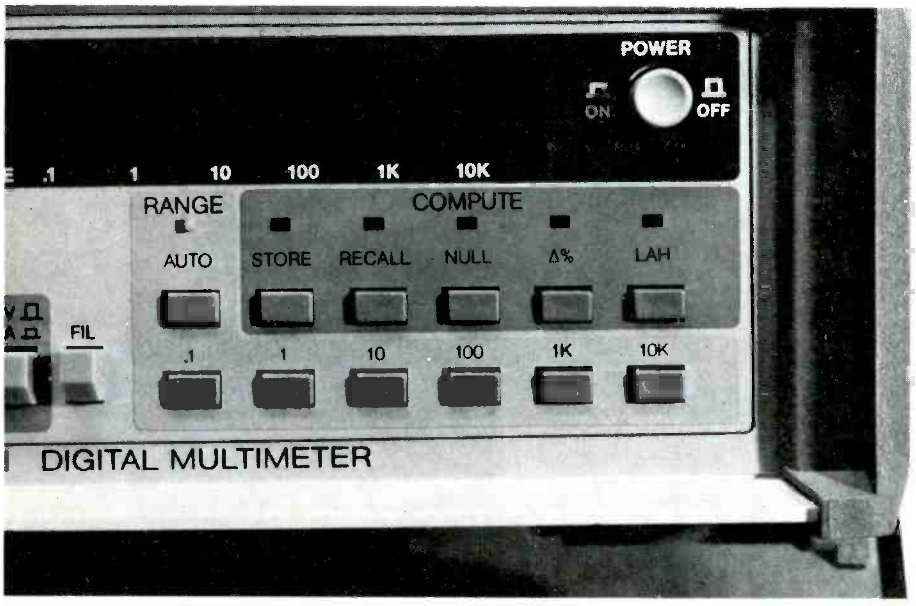
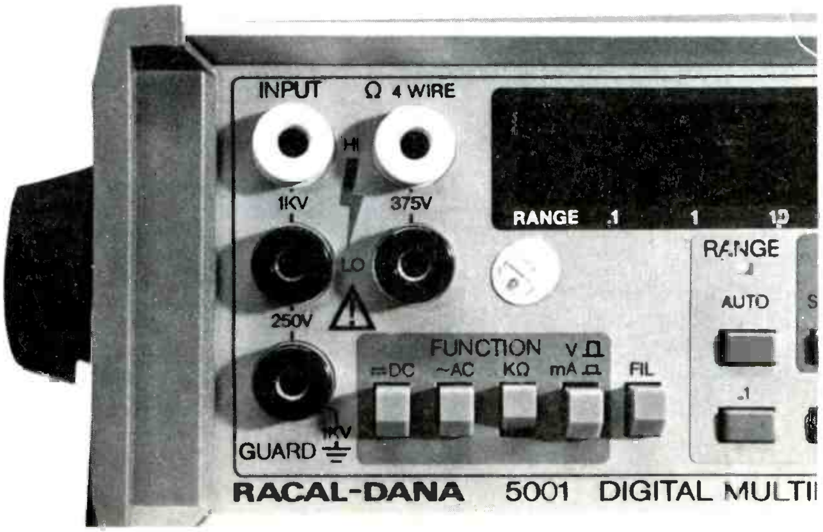



**A D battery** measured +1.49097Vdc, and the display was stable. Notice the added LED segment at the bottom of the *4* digit. The same display shows letters, also.




**The lower row** of push-buttons select the ranges manually, with the decimal positioned automatically. Above these is a row of six buttons for autoranging and five computer-like functions.




**Five banana jacks** accept a *guard* ground and four jacks for 4-wire resistance measurements (when desired). The two *input* jacks are for all five functions.

lights for negative dc readings (positive readings have no symbol).

An interesting feature made possible by the microprocessor is the power-up routine. When power first is applied, the six LED digits (showing 8s) and the minus symbol are turned on, followed rapidly by the six decimal LEDs. These are illuminated for less than 2s before they disappear and the 5001 model number appears for about 3s to 4s. When the model number disappears and the digits become zeros, the DMM is ready for use. This sequence provides a dramatic way of proving that all LED elements can light properly.

### Measurements of dc-voltage

Five decaded dc-voltage ranges cover 0.1V to 1000V full scale. Input impedance of the 0.1V and 1V ranges is 1000 MΩ and the others have 10 MΩ. The short-term accuracy of all ranges is ±0.007% of reading plus three digits, although the 0.1V range requires nulling to achieve this high accuracy.

### Measurement of ac-voltage

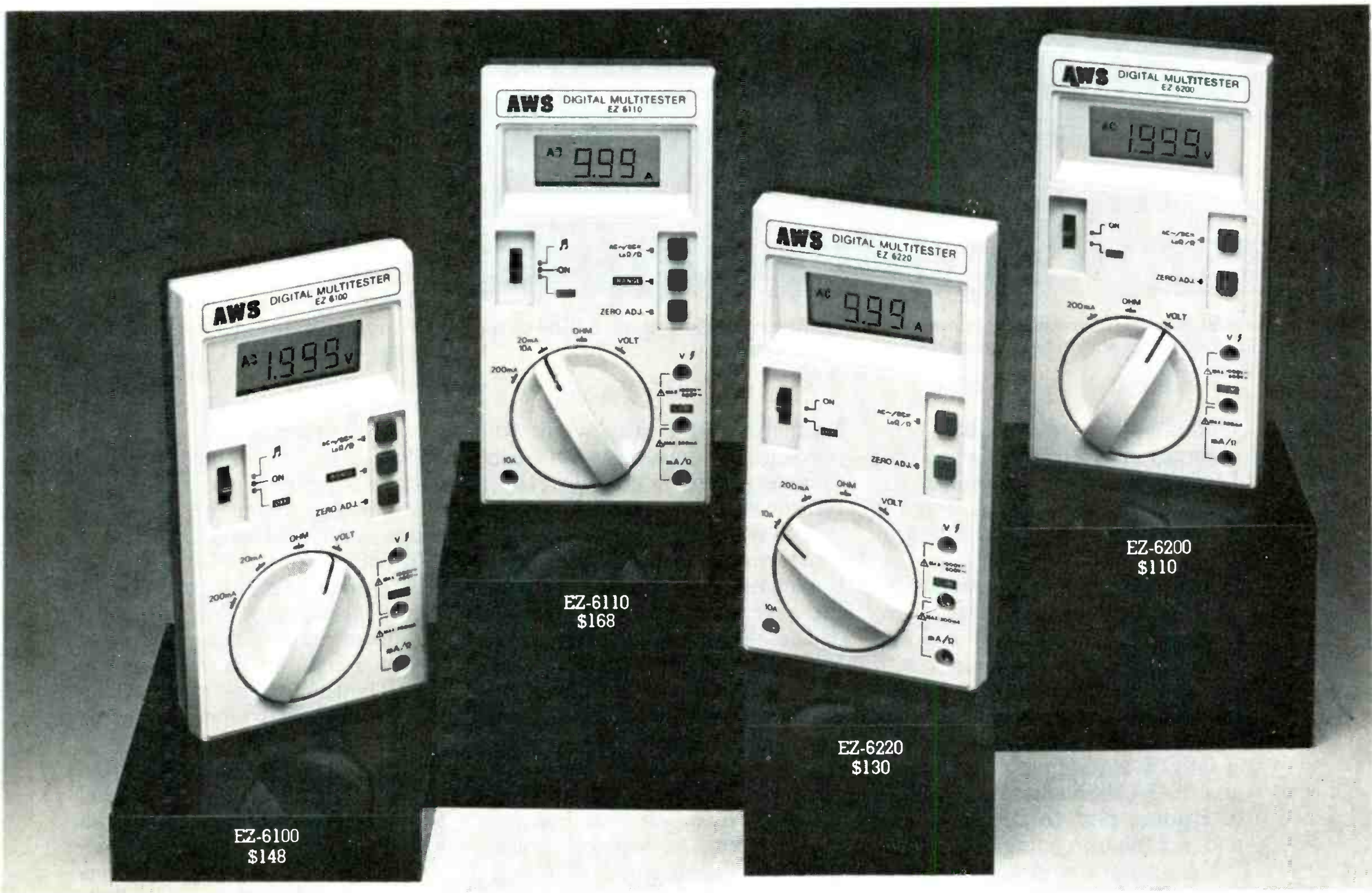
Four ac-voltage ranges provide measurements from 1V to 750V RMS full scale with an input impedance of 1MΩ. These readings are true RMS. True RMS is valuable for measuring non-sinusoidal waveforms, because the reading accuracy is relatively unchanged by different waveforms. Short-term accuracy between 45Hz and 10kHz is rated at ±0.4% of reading +120 digits. Between 10kHz and 20kHz the rated accuracy is ±0.7% of reading +180 digits. Hurried comparisons against three other wideband ac meters showed model 5001 frequency response to be very good from 20Hz to above 20Hz on the 10V range. At about 30kHz, the response was down only 2dB. This is excellent response for all audio measurements.

### Current ranges

The four current ranges (1, 10, 100 and 1000mA) are displayed by four and one-half digits, giving a resolution of 0.01% for any range. Short-term accuracy for dc current is ± 0.1% of reading plus two digits for all but the 1000mA range, which is ±0.25% of reading plus two digits.

All ac current ranges, except the

# When it comes to choosing the right DMM, you really only have four choices...

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| AC/DCMA 0-200 | 2-Ranges | AC/DCMA 0-200 | 1-Range |
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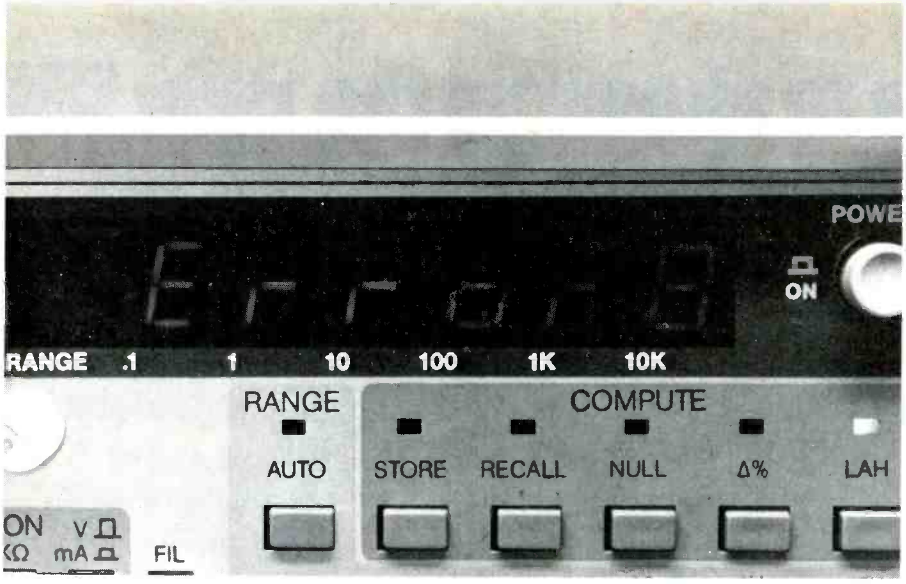


**Several operator mistakes** and internal-circuit malfunctions will activate a code on the LED display, as shown here where the screen reads *Error 8*.

1000mA range, have short-term accuracy of ± 0.5% of reading plus 12 digits between 45Hz and 1kHz. Accuracy of the 1000mA range is ± 0.6% of reading plus 12 digits.

### Resistance measurements

The six resistance ranges are 0.1K, 1K, 10K, 100K, 1000K and 10,000K. Accuracy changes with the ranges. The 0.1K range accuracy is ± 0.4% of reading plus six digits, the next four ranges have ± 0.047% of reading plus six digits and the 10,000K range has ± 0.1% of reading plus six digits to 20M and ± 1.0% of reading above 20M.

Measurements on one sample of the 5001 showed the 0.1K range had an open-probe voltage of −0.376V at the probes. All other ranges had −3.94V with open probes. These voltages indicate that the 0.1K range is *low power,* while the others are *high power.* Therefore, all but the 0.1K range will produce conduction in diodes and transistor junctions. This must be kept in mind during testing.

### Computer functions

Five push-buttons and their indicator LEDs on the front panel can select any of the five digital functions. The *store* button permits the storing of readings or numerical constants. The *recall* push-button is used with other buttons to examine data that is stored in the memory. The *null* button calculates and displays the difference between each measurement value and the null constant. The *percent* button activates the calculation and display of the percentage deviations of each measurement relative to a reference value. And the *LAH* (low-average-high) button displays (or stores and displays on demand) the lowest in a series of readings, the average of all measurements or the highest reading during the LAH operation.

Six types of operator error (such as two buttons pressed at same time) and some DMM malfunctions can be identified by error messages displayed on the LED readout. Also, the readout can show letters, as well as figures, when that is necessary.

### Comments

Operation of model 5001 was excellent, after I studied the manual and learned how to select some of the instrument's unique functions. For example, turning off the LAH function was not accomplished by a simple on/off push-button action. Pressing the LAH button once produces a series of symbols, and the operator must push the button again when the desired function is indicated by the correct symbol. However, if the LAH function is switched off improperly, some wild readings (perhaps a previous reading) and other surprising actions are produced. Therefore, I strongly recommend that you read and follow the instruction manual before you operate the DMM.

A temporary confusion was produced by the power-up mode, because I had not read the manual. As explained before, power-on first lights all digits, then the 5001 model number appears, and finally the readout becomes all zeros, indicating the DMM is ready for use. However, each power-up leaves the machines in autoranging mode, and this can be puzzling to anyone not expecting that. When an operator has selected manual range mode, it is logical to expect a DMM to be in the same mode when used next time. It can be confusing to find it in the autoranging mode. Again, the answer is to read the manual thoroughly.

Overranging in model 5001 is different than in most other DMMs. A 3½-digit DMM, for example, might have a 2Vdc range. As the dc voltage is increased slowly, the reading rises in step to 1.999V. Any further increase of dc voltage triggers the overrange indication. Approximately the same range with the 5001 is called a 1Vdc range with 100% overrange. But with autoranging, up-ranging occurs at about 225% of range, and down-ranging occurs at about 20% of range. There is one exception: The 10MΩ range measures up to 99M without overrange indication.

A pleasant surprise was the stability of readings with model 5001. I expected the extra digits would be in constant motion, because even a 3½-digit DMM has a normal bobble of the last digit. However, the noise-reduction design must be effective because no excessive changes of readouts were noted with stable test signals.

Model 5001 has more features than those needed for daily use on a repair bench; it apparently is intended for applications demanding higher accuracy and those unique functions. The simple recalibration (which does not require opening the machine or turning any adjustments) and the low drift should save considerable maintenance costs over a period of time.

Racal-Dana model 5001 is the first 5½-digit digital multimeter examined in the **Electronic Servicing & Technology** Test Lab, and it was found to have good features and excellent performance. For more information, circle (140) on Reply Card.

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# Exploring solid-

By Bernard Daien

Solid-state memories are now used in consumer electronics equipment such as TV receivers, video games, video recorders, home computers, pocket calculators and more. These memories are indispensable to the operation of such devices, but there are many gray areas concerning their operation, as far as most technicians are concerned. This article covers some of the areas that have not been discussed in most texts devoted to such equipment.

### A review

Before going into the details of solid-state memories, we need to do a little reviewing concerning how the memory fits into the overall system. Since we are considering only solid-state memories, there will be no discussion of floppy discs, tape machines or other magnetic recorders. Although magnetic bubble memories are actually a form of solid-state memory, this article will not include them, but will concentrate on MOS and bipolar transistor memories, which have many similarities.

Such memories fall into two general categories, *static* and *dynamic*. Static memories generally consist of a number of *flip-flop* cells, which can be set and reset. Unless the power supply is turned off, static memories retain their information until erased intentionally. Bipolar memories are static memories. MOS memories can be either static or dynamic. Dynamic memories use electrical charges stored in small capacitors inside the memory IC. Despite the high input impedance of MOS transistors (which are field-effect devices), the charge soon leaks off the small capacitor, which can only hold a small charge, due to the low capacitance. In order to compensate for this, the charge is replenished (refreshed) every millisecond or so. Of course this requires extra circuitry, which increases circuit complexity, but despite this, the MOS manfacturing technique allows more memory to be put on a chip than does bipolar technology. As a result, the large amount of memory needed for most applications requiring several IC chips to form the working memory bank can be made smaller with MOS memories, static or dynamic.

It should be noted that if the refresh circuitry fails for only a few milliseconds, the contents of a dynamic memory are lost. This is called *volatility*. In this respect, bipolar static memories hold an advantage, because it takes a momentary power outage to destroy the memory contents, whereas with dynamic memories, either the loss of the refresh cycle or the loss of power will destroy the memory contents. In order to guard against loss of power to the memory bank, it is common to include a rechargeable battery floating on the power supply line. In the event of outage, the battery is used to maintain power to the memory and preserve the memory contents. This works quite well with static memories, but the battery cannot correct the problem related to loss of refreshing and therefore is only a partial answer in the case of dynamic memories. This is an important point to remember when troubleshooting memories.

This article will be concerned only with static memories, in order to devote more attention to memory addressing, decoding, buffering and other aspects fundamental to both static and dynamic memories.

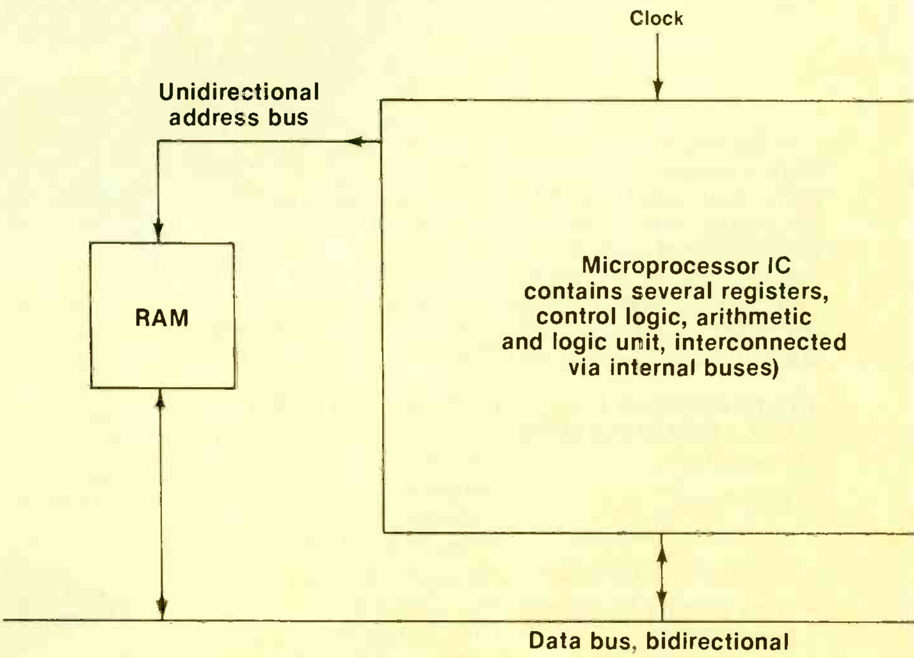



**Figure 1.** The memory (RAM in this case) is connected into the system by means of multiple-wire buses.

# state memories

**Memory as a system element**

Figure 1 illustrates the interconnections between a solid-state memory and a basic system incorporating some of the elements likely to be found in typical equipment. The solid-state memory shown is a read-or-write memory, also known as a *random-access memory* (RAM). *Read-only-memories* (ROM) are also often used for information that must be stored permanently (non-volatile), but the RAM does everything the ROM does and more, and will suffice for the purposes of this article. (If a ROM were being used in Figure 1, rather than a RAM, it would be necessary only to put it in place of the RAM shown, and delete the arrow pointing into the memory from the bi-directional data bus. This would show that data can flow only out of the ROM, not into it.

As we go along, we will expand Figure 1 to show more details of the RAM interconnections, but for now, let's see what Figure 1 tells us as a block diagram.

You will note that there are two buses: a *unidirectional address bus* and a *bi-directional data bus*. The address bus carries information from the microprocessor chip, selecting the location in the memory at which the desired information is stored. There are many bits of information stored in the memory, and it is the job of the address bus to select only the desired information. The above applies in the case of *reading out* data. When writing data, the information to be stored must also be put into a specific location, so that it can be found again when needed. The address bus carries the address information only, from the microprocessor to the RAM, on an 8- or 16-parallel wire bus.

The information stored in the RAM is referred to as *data* and is carried on the data bus. Data can be written into or read out of the RAM, so the data bus must be bi-directional. This is accomplished by means of tristate logic active

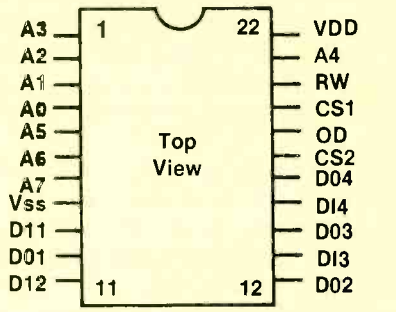
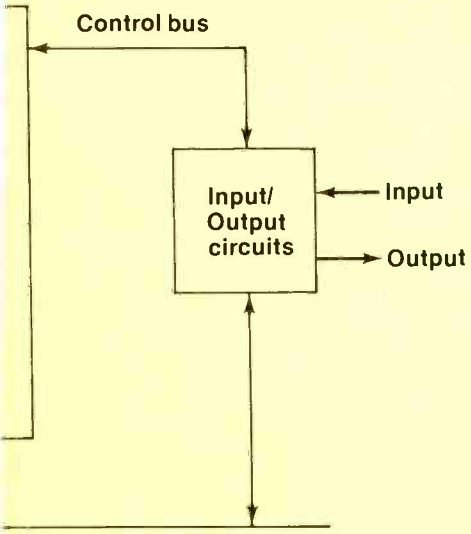



**Figure 2.** The pinouts for RCA CDP 1822 256-word by 4-bit MOS static RAM are shown. A1 through A7 are seven address inputs for a 7-wire address bus. DI1 and DI4 are four data inputs, from a bidirectional data bus. D01 through D04 are four data outputs, to a bidirectional data bus. CS1 and CS2 are chip-select inputs. RW is the Read/Write input. OD is the Output Disable used to control output to bidirectional data bus. $V_{DD}$ is the drain supply voltage. $V_{SS}$ is the source supply voltage.



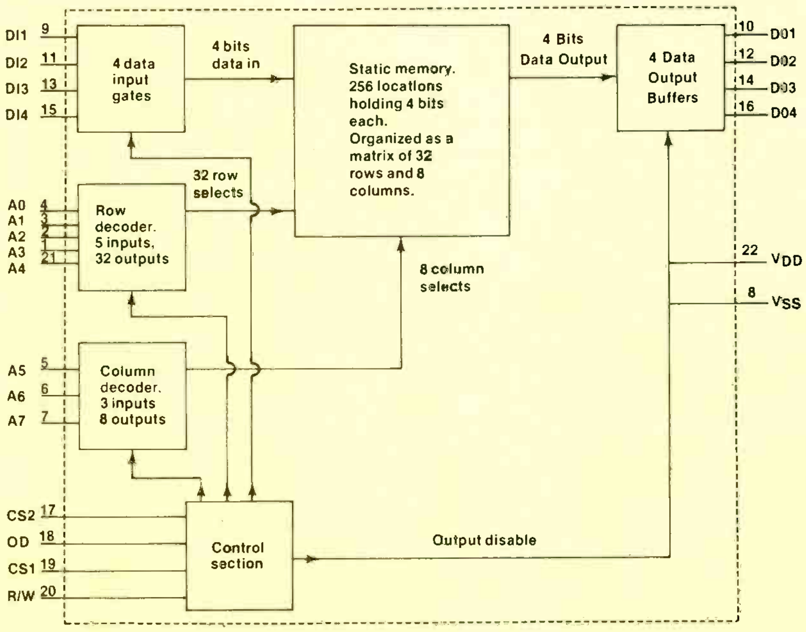




**Figure 3.** A simplified version of the internal organization of a 256 X 4 static RAM.

elements, which act as switches permitting information to flow in either direction, much as a single-track railroad can handle trains in either direction.

The output of the RAM in most microprocessors consists of eight binary bits, carried on eight parallel bi-directional lines simultaneously. This arrangement is called an 8-bit bus. (Some of the newer microprocessors and larger computers have 16-bit, or even larger buses.) It must be noted that the address selected causes an output of eight bits (or more) simultaneously, commonly referred to as a *word.* The individual bits comprising the word cannot be selected. Thus information moves about in 8-bit chunks. The same applies to writing information into the RAM.

In order to get information into the system, it is usual to feed it through an interface or input device, depending upon the source of the information. A teletype keyboard, for example, requires a specific adapter to enable it to "talk" to the microprocessor. Control signals are fed back and forth between the interface or input device and the microprocessor in order to coordinate the flow of information. The microprocessor then manipulates the information, stores it temporarily in internal registers and outputs it, along with a memory address, to the RAM. A "clock" is used for synchronization of information movements and controls the entire system.

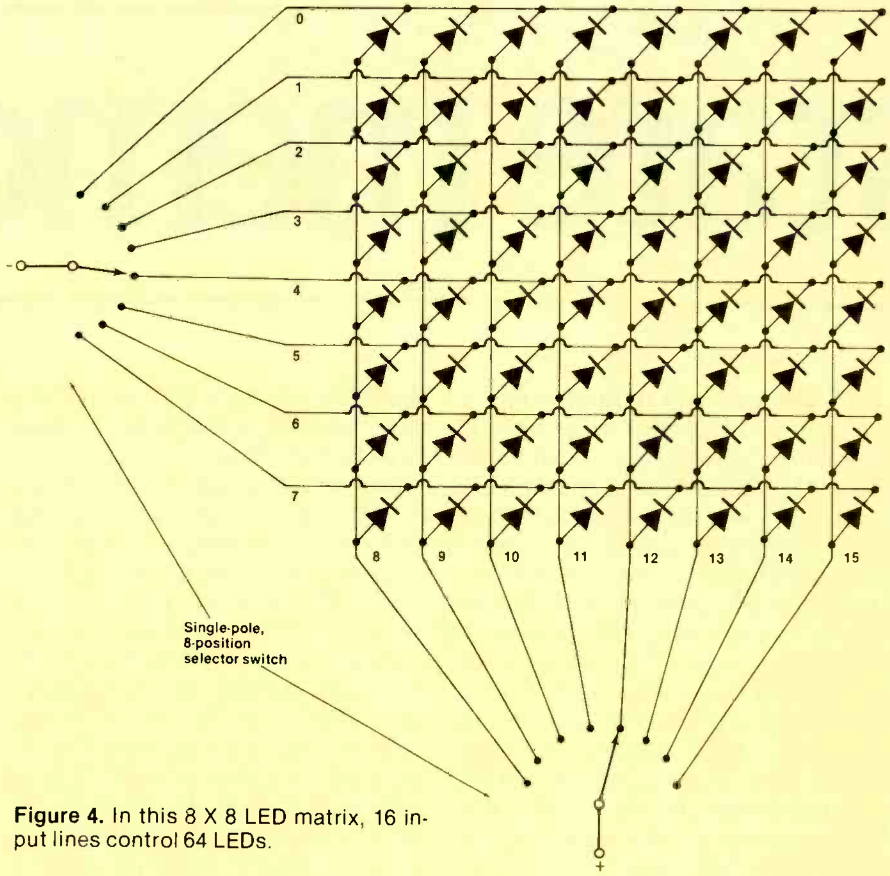



**Figure 4.** In this 8 X 8 LED matrix, 16 input lines control 64 LEDs.

Now that we have seen how the RAM fits into a general system, we can proceed to consider addressing and other such factors. To be more specific, a few terminals were left off the RAM in Figure 1 for the sake of simplicity in introduction. There must be a means of determining whether we are going to read out of or write into the RAM, so a *Read/Write* control input must be added. An *Enable* input, which controls the activation and deactivation of the RAM chip, will also be required. (Some RAMs have two Enable terminals.) In addition, some RAMs also have an *Output Enable* or *Output Disable* terminal, or both.

### Butting heads with the RAM

Figure 2 shows the pin-outs for an RCA CDP1822 RAM with industry-conventional labeling and abbreviations. Figure 3 shows a simplified schematic of the internals of the RAM chip. There are a few facts that need to be noted for Figures 2 and 3. Many RAMs have had more than one terminal for the same function, because, in some cases, one terminal is active when it is in the high state, while the other is active in the low state. In other cases, both terminals must be in a definite required state. In still other cases, one terminal is edge triggered on a rising pulse, while the other terminal is level triggered; the difference is that the edge-triggered input always catches the start of the pulse, while the level-triggered input is less definite about timing but is somewhat delayed as compared to edge-triggered input. These various inputs are in accordance with the timing needs of the particular memory used and the various terminals being driven, in the sequence required by the order of operations within the RAM.

An examination of Figures 2 and 3 reveals that a RAM with 256 different address locations (256x4 RAM) can not physically have 256 different input pins for addressing. As a matter of fact, it was already indicated that the address bus consists of either eight parallel wires (on older microprocessors), or 16 wires (on the latest microprocessors). It's obvious that 16 wires can't directly address a 64K RAM's thousands of different locations without some means of compressing the information tremendously. This is accomplished by encoding the 16 address lines in simple binary number code. Each wire is assigned a value double that of the preceding wire. Ordinary decimal numbers, in contrast, are arranged in columns and have different values with the right column being "ones," the next column "10s," the third column "100s," etc.)

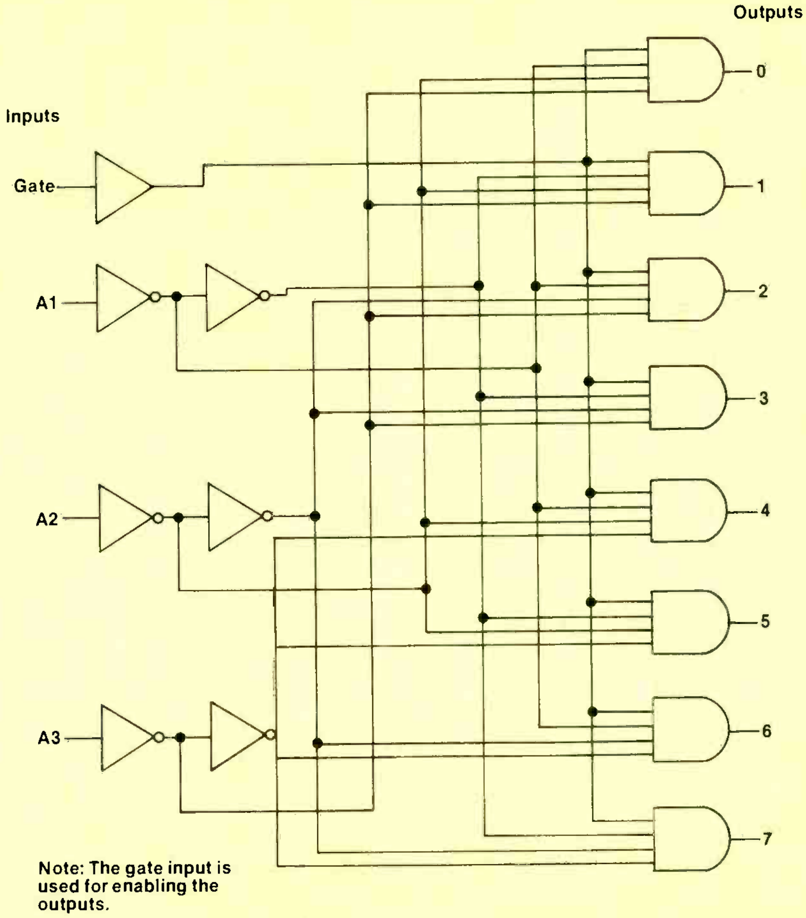
In the case of the 16-wire cable, the first wire is assigned the value "ones," the next "twos," the next "fours," and so on. A 16-wire cable therefore can handle up to nearly 80,000 different numbers (addresses), which is more than adequate to handle a 64K RAM. In order to do this, a *decoder* is needed at the RAM end of the address bus in order to convert the binary information back to decimal. This method reduces the number of address pins on the IC package to just 16 for more than 64,000 different addresses. Of course we must now pay the price for this by including decoders inside the chip in order to make the system work. Also generally included are some registers for the temporary storage of information. Registers hold the desired information until the proper terminals of the IC are activated with the necessary signals and also compensate for the various delay times of the many circuits, thereby avoiding "races."

Let's look at the various pinouts in Figure 2. (They will also be useful in understanding the simplified internal diagram of Figure 3.) Because this particular RAM stores a 4-bit word, it requires a data bus of 4 bits (4 wires), and therefore has 4 Data Inputs (DI) and 4 Data Outputs (DO). In order to handle 256 different addresses we need an 8-bit address bus (A0 through A7). There is also a Read/Write input for control purposes (RW), and two terminals for power supply drain and source voltage ($V_{DD}$ and $V_{SS}$). Further, there are two Chip Select terminals (CS1 and CS2) which are used to enable the chip or (in the case of a large memory bank made up of many such chips) to select one or more chips of many. Finally, there is the Output Disable terminal, which controls the tristate output buffers, controlling them on or off to facilitate the control of information flow in the bidirectional data bus.

With this in mind, we can better understand Figure 3, which is the same RAM but shown in simplified internal structure, illustrating what is tied to the pinouts inside the chip.

The four data inputs go through input gates, which are controlled on or off. Similarly the data output buffers are controlled, both depending upon the signals fed into the control section on the Read/Write, Chip Select and Output Display inputs

The memory itself is organized into a matrix, consisting of 32 horizontal rows and eight vertical columns. The 32 rows are decoded by means of the row decoder,




| Inputs | | | | Outputs | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| G | A1 | A2 | A3 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| H | L | L | L | H | L | L | L | L | L | L | L |
| H | L | L | H | L | H | L | L | L | L | L | L |
| H | L | H | L | L | L | H | L | L | L | L | L |
| H | L | H | H | L | L | L | H | L | L | L | L |
| H | H | L | L | L | L | L | L | H | L | L | L |
| H | H | L | H | L | L | L | L | L | H | L | L |
| H | H | H | L | L | L | L | L | L | L | H | L |
| H | H | H | H | L | L | L | L | L | L | L | H |
| L | X | X | X | L | L | L | L | L | L | L | L |

Notes: H = High = 1
L = Low = 0
X = Doesn't matter.

When Gate is low, all outputs are low, regardless of state of address inputs. When gate is high, address inputs cause output selection. (Gate can be used to "enable," or "clock.")

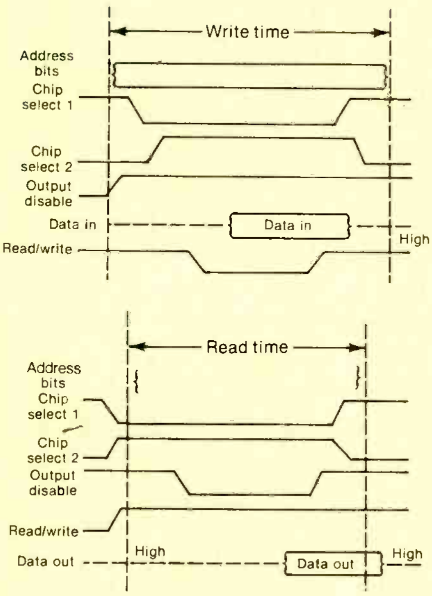
**Figure 5.** A 3-line binary to 8-line decimal decoder provides a means to select one of eight output lines from information on three input lines.

which requires five inputs from the 8-wire address bus. The remaining three wires in the address bus are used as inputs to the vertical column decoder. By this means, the 8-wire address bus used in this case is not required to drive 256 addresses in the memory, but only 40 (32 horizontal and eight vertical). You can readily see that matrixing enables us to greatly reduce the actual number of address interconnections required. To further illustrate this, 100 locations can be accessed by a matrix of 10 by 10 (a total of only 20 connections). The combination of matrixing and decoding enables us to dramatically reduce the number of lines in the address bus, even for a large memory bank.

You can now appreciate that in order to address a RAM or ROM of practical size, we must resort to both matrixing and decoding in order to reduce the address bus to some reasonable number of wires and to reduce the number of pinouts on the chip. A small chip obviously cannot accommodate a large number of terminals. In the case of the 256-by-4 RAM just illustrated, there were 22 pins. Imagine the number of pins needed on a larger RAM!

### Matrixing and decoding

Figure 4 is a simple matrix using light-emitting diodes. There are 64 diodes in the matrix, which is set up on an eight vertical column and eight horizontal line basis. Therefore 16 lines control 64 LEDs. The lines are selected by simple selector switches.




Note: During most of write cycle, the output tri-state buffers are in the high-impedance state.

**Figure 6.** Writing into, or reading out of a RAM requires that several waveforms be present with the proper polarity, amplitude, waveform, and at precisely the correct time.

In order to drive the matrix from solid-state logic, eliminating the mechanical switches, we can use two simple decoders, each as shown in the schematic of Figure 5A, which provides eight output lines, selected by only three binary input lines. Two of these decoders can be driven by only six binary coded address bus lines. Figure 5B shows the truth table for one decoder (the other is identical).

The solid-state decoders also have one or more gate inputs, which can be used to gate the decoder on or off, or provide synchronization or clocking action as desired. (The use of tri-state logic enables decoders to operate efficiently on a bi-directional bus. Tri-state logic was not used in this example, for simplicity.)

Substitute a RAM for the LED matrix, and you will have a good idea of how a RAM is addressed. Remember though, that in the case of the RAM, each address may contain a word of one, four, eight or more bits, all handled simultaneously in one chunk. You do not have access to the individual bits in each word. For example, a 4-bit word can be any combination between 0000 and 1111, but never less than the entire four bits (i.e., no bits can be omitted, they are either zeros or ones). It's as if each address in the LED matrix had four LEDs in series, instead of one. You would be able to turn four LEDs on or off but have no control over the individual LEDs.

Memories are usually made up of several RAM or ROM chips, assembled on a printed-circuit plug-in board. Additional decoding is used to select the RAM chips desired.

### Writing into the RAM

With matrixing and decoding behind us, we can examine some of the finer points: requirements for writing data into the various addresses in the RAM. You can think of the RAM as being a post-office-box setup, with many numbered compartments. Unlike a post-office box, which only requires a key to open it, the RAM requires that several things must happen with proper timing. This business of timing is what causes the major problem in understanding and troubleshooting memory systems. It is not enough that the waveforms be present with proper polarity, amplitude and waveform. They must also be there at the proper time – within fractions of a microsecond. It takes a good scope and some fairly sophisticated test gear to show up these kinds of waveforms, which, unlike TV horizontal and vertical sync, are not always repetitive waveforms. (Although a multi-trace scope is desirable, it is possible with some inconvenience to examine the waveforms in turn, using a common source of external sync and a test program of known content.)

As the waveforms for the CDP 1822, 256-by-4 RAM in Figure 6A show, in order to write into the RAM, CS1 must go low, CS2 must go high, Output Disable must go high and Read/Write must go low. Of course both the address bits input and the data to be stored in the RAM must also be present.

Note that these various signals must have a definite timing relationship. For example, the Output Disable signal must be present during the entire cycle, but the Data Inputs are not. What is indicated is that certain signals must precede others for the proper sequencing of internal logic.

An important thing to remember is that writing information into an address in the RAM erases the previous contents of that address, so be careful in troubleshooting that you do not inadvertently erase needed data by inputting a Write command.

Figure 6B illustrates the Read waveforms and timing for the same RAM. It would be helpful to make up a table showing the states of the various input terminals (CS1, CS2, Read/Write and Output Disable) for three different situations (Read, Write and Standby, which is merely in the Output Disabled state with the outputs in the high impedance state). When you have completed these three truth tables, you will be aware of the functions of these inputs and their effects on the RAM. ES&T

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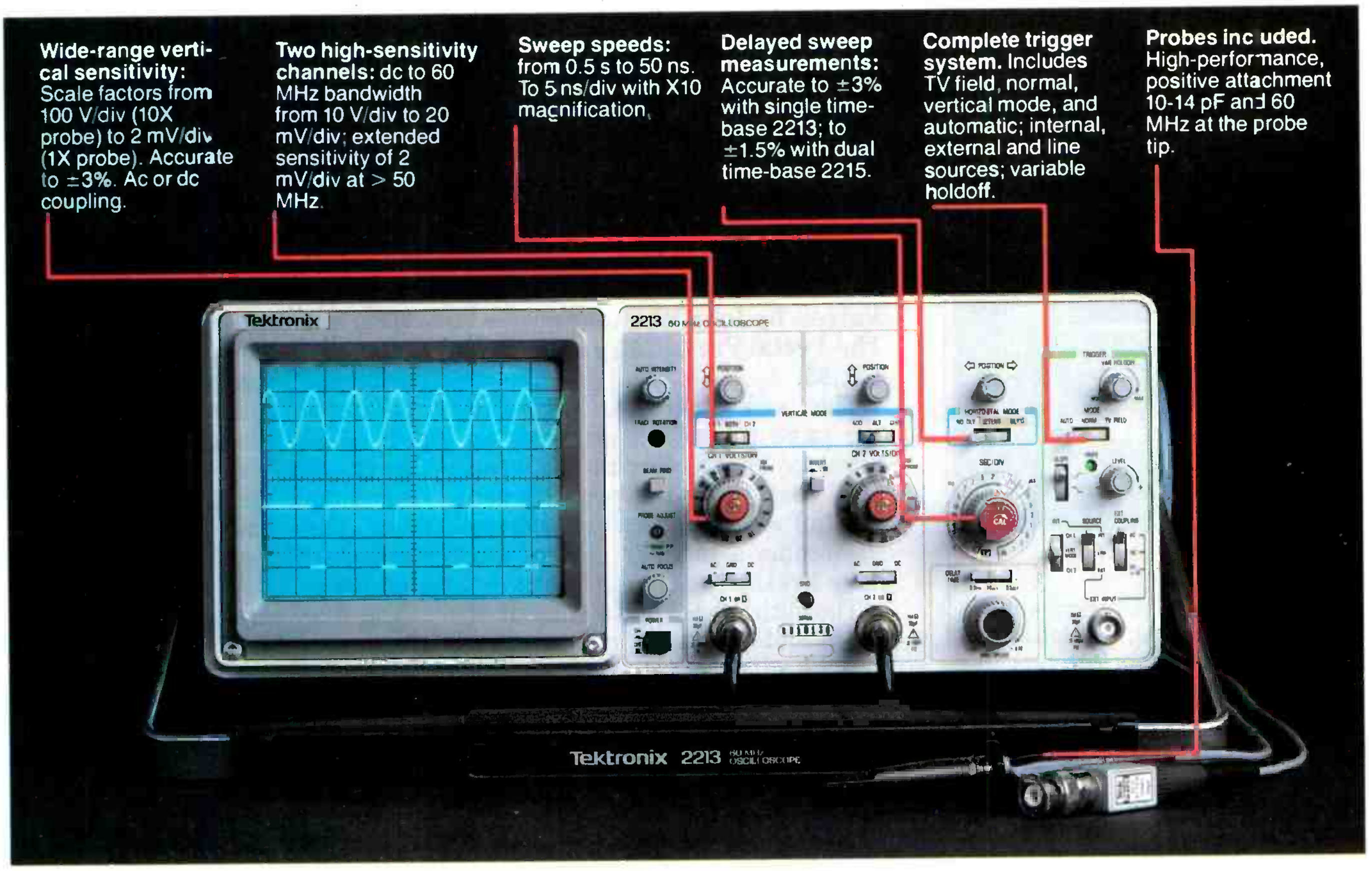


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**Semiconductors & Electronic Communications Made Easy, by Victor F. Veley; Tab Books; 324 pages; $15.94 hardback, $8.95 paperback.**

This practical reference tool is designed for the hobbyist or experimenter, technician, amateur operator or student who wants to get a better handle on textbook theory. The coverage is broad: from simple diodes to MOSFETs; from basic modulation to the elements of radar and broadcast stations.

The first part deals with active circuit devices: diodes, transistors, FETs and vacuum tubes. It describes basic uses of silicon diodes, half- and full-wave rectifiers, bridge rectifiers, voltage-doubler power supplies, 3-phase rectifiers and zener regulators. For bipolar transistors, it includes basic circuits and comparisons between various configurations. Those who want to know something about operational amplifiers or RC-type oscillators will also find it here. There's lots of information on field-effect type semiconductors and practical circuits for FETs, JFETs, MOSFETs and enhancement-only MOSFETs.

The second part of this handy reference manual is devoted to a wide variety of communications applications. All types of modulation are covered, including various forms of AM, FM and phase modulation, plus methods used to measure and calculate operating power and degree of modulation.

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

ES&T

# Events

## May

**4-6**
Electronic Distribution Show, Las Vegas Hilton, Las Vegas. For information, call 1-312-648-1140.

**10-12**
Northcon/83 High Technology Electronics Exhibition and Convention, and Mini/Micro-Northwest, Portland Coliseum, Portland, OR. Contact Electronic Conventions, 999 N. Sepulveda Blvd., El Segundo, CA 90245; 1-800-421-6816 (in California, 1-213-772-2965).

## June

**5-8**
International Summer Consumer Electronics Show, McCormick Place, Chicago. Contact Consumer Electronics Shows, Two Illinois Center, Suite 1607, 233 N. Michigan Ave., Chicago, IL 60601; 1-312-861-1040.

**14-16**
Ohmcon/83 High Technology Electronics Exhibition and Convention, Cobo Hall, Detroit. Contact Electronic Conventions, 999 N. Sepulveda Blvd., El Segundo, CA 90245; 1-800-421-6816 (in California, 1-213-772-2965).

## September

**13-15**
Midcon/83 High Technology Electronics Exhibition and Convention, and Mini/Micro/Midwest, O'Hare Exposition Center and Hyatt Regency O'Hare, Rosemont, IL. Contact Electronic Conventions, 999 N. Sepulveda Blvd., El Segundo, CA 90245; 1-800-421-6816 (in California, 1-213-772-2965).

**26-28**
Maecon/83 High Technology Electronics Exhibition and Convention, Kansas City Convention Center, Kansas City, MO. Contact Electronic Conventions, 999 N. Sepulveda Blvd., El Segundo, CA 90245; 1-800-421-6816 (in California, 1-213-772-2965).

## October

**3-6**
Electronic Industries Association 59th Annual Conference, San Francisco. Contact Electronic Industries Association, 2001 Eye St., N.E., Washington, DC 20006.

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# Readers' Exchange

**Needed:** Service manual and parts list for JVC (NIVICO) console stereo, model #4TR-4U. Will buy or copy and return. *Rick's Stereo Service, 243 N. Marshal, Marshfield, MO 64706, 1-417-468-3198, or 1-417-468-6646.*

**Needed:** A service diagram for an ECA model E1600 TV set, made in Romania, distributed in the United States by Elkrod Corporation. *W.A. Brown, 1608 N. Meade St., S.W., Decatur, AL 35601.*

**Needed:** Schematic and parts list for H.H. Scott Stereomaster 299-C. Will buy or copy and return. *Henry Randall, 4101 S. Federal - 101, Chicago, IL 60609.*

**Needed:** Willing to pay within reason for older issues of **Electronic Servicing & Technology** before August 1982 and other magazines before 1980. Send price and weight. *Steven Barach, Box 54, Pengilly, MN 55775, 1-218-885-2701.*

**Needed:** A schematic and parts list for Scientific Micro Systems +5 and +12Vdc power supply, model MDU1 Assy 1001123-0001B. Will gladly copy and provide you copies. *C.W. Osburn, Schoeller Tech Papers, Box 250, Pulaski, NY 13142.*

**Needed:** Schematic for a Sharp 3K-800, b&w, 13-inch television. Will pay for same or copy and return. *Larry Piurkoski, 9227 Suncourt, Lake Park, FL 33403.*

**Needed:** Switch assembly for Zenith AM/FM AFC table radio. Zenith part #S-71359. It's a slide switch with 12 connections, or a stackpole slide switch will do. State price. *J.A. Gontarz, 14 Rudolph Road, Forestville, CT 06010.*

**Needed:** Schematic for Majestic model 60. Will pay $5 for a good copy. Call collect before 7 p.m. *Lew Wollaston, 1-308-762-3003 (Alliance, NE).*

**Needed:** Sencore PR57 Powerite and Sencore TF46 Super Cricket. *Paul Capito, 637 W. 21 St., Erie, PA 16502.*

**Needed:** Schematic for a Wollensak-3M small-screen, b&w, solid-state television; serial #00239; made in Japan. Will buy or copy and return. *John C.*

*Toms, 708 Spring Bay Road, East Peoria, IL 61611.*

**Needed:** Old tubes, several each: OIAs, 199, 215, WD11 or similar battery set tubes. New or used, good or bad. Please state condition, quantity, price and type. *Dan Steele, 205 High St., San Luis Obispo, CA 93401.*

**Needed:** Information on output transistors (case TO-3) #CZD-7M (RCA). They are in an Emrad guitar amp. I need either a schematic or a cross-reference number for the transistors. *Dave Van Volkinburg, 227 N. Ewing, #9, Dallas, TX 75203.*

**Needed:** Service manual and wiring diagram for Hy-Gain Pro-Scan, model 616 scanner. Will pay all costs plus profit as required. *W. Van Riper, 6916 N. 57 St., Omaha, NE 68152.*

**For sale:** RCA WR514A sweep and market generator, $225; Eico 1030 regulated 0 to 400Vdc power supply, $95. Both like new; plus shipping. *C.W. Hume, 108 Hillcrest Circle, Greenville, SC 29609.*

**For sale:** RCA WR50B signal generator, $75; TV Sams Photofacts, $2.95 each or lot; CB Sams manuals, $5 each or lot. Will ship COD, UPS. *Vic's Electronics, 1024 Studewood, Houston, TX 77008, 1-713-864-6573.*

**Needed:** Symcure, Volume 1, and Tekfax, Volume 1-8. *C.T. Huth, 146 Schonhardt St., Tiffin, OH 44883.*

**For sale:** Geiger counter #CDV 700-6B, $60. Free shipping in United States. Call evenings, *Richard L. Bednarcik, 1-201-694-6374 (Lincoln Park, NJ).*

**For sale:** Dumont model 401-AR scope, $50; RCA model WR-67A test oscillator, $30; Eico model 315 signal generator, $30; and more. Send for list. *Rustan R. Crespo, 440 59th St., West New York, NY 07093.*

**For sale:** Heath IG 5257 post marker sweep generator, $200. Used only once. *Robert Petry, 3739 Dakota, Flint, MI 48506.*

**For sale:** One RCA test jig, model 10J106 with cables, $200, plus freight. *Charles Terry, 505 W. Oak, Lamar, CO 80152, 1-303-336-7304.*

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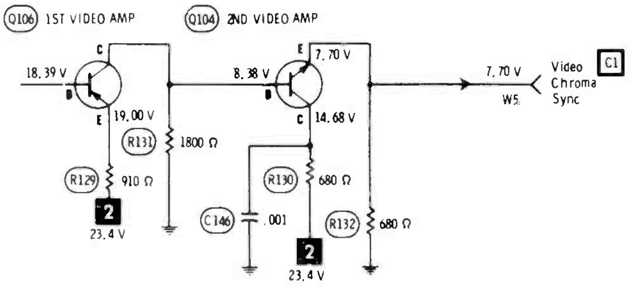
*Readers' Exchange* items are listed for free, but are limited to three items per person for each issue. "For sale" items must consist of used equipment, parts, etc., owned by individuals and not new items for sale by companies or manufacturers. If you can help with a request, please write directly to the reader, not to **ES&T.**

# Troubleshooting Tips

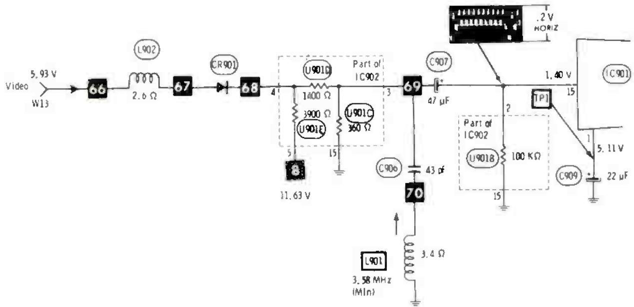
**Intermittent video**
**Zenith 25JC45**
(Photofact 1720-2)

The original complaint against this Zenith color receiver was an intermittent loss of video, which I apparently repaired by replacing the 150-190D IF module. But, later after the chassis was operated for about two hours during a heat run, the picture disappeared, leaving a blank raster with good sound. The loud sound indicated a defect in the luminance channel.




Square waves from a generator were applied to the delay line, but no amplification was produced in IC901. Fortunately, I noticed there was no dc voltage at the delay line. This voltage comes from conduction of Q104, the second video amplifier on the 150-190D video-IF module. Therefore, it seemed likely that Q104 was not conducting.

About that time, the receiver began operating again. Next time it lost video, I was ready with a VTVM, which showed a forward bias of about 5Vdc between base and emitter of Q106, the first video amplifier that is direct coupled to Q104. Obviously, the Q106 transistor had an intermittently open base-to-emitter junction. The open Q106 removes the forward bias from the Q104 and gives zero volts at the emitter. A sample of the emitter dc voltage and video is supposed to be applied to the delay line and through diode CR901 eventually to pin 15 of IC901. Without the Q104 dc voltage, CR901 is reverse biased so it becomes an open circuit and opens the



path between the delay line and the IC. That is why the test square waves would not come through during previous tests.

Replacement of Q106 cured the intermittent video problem.

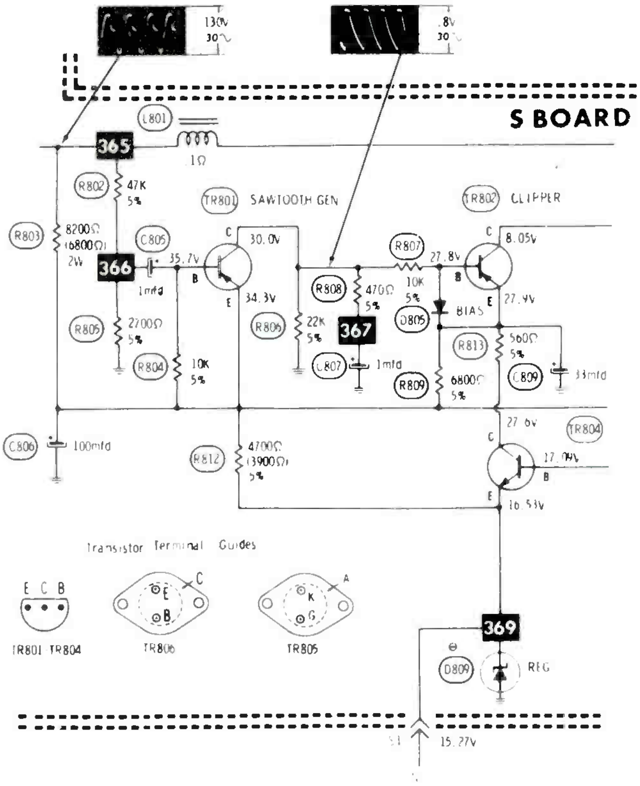
Glen Bryant
La Crosse, KS

**Erratic pulsing picture**
**Panasonic CT-911**
(Photofact 1379-2)

Originally the complaint was about the picture *pulsing* on and off. Without plugging it in, I removed the back and carefully looked at the chassis, finding D811 varistor and resistors R815, R812 and R823 with signs of overheating. These were replaced, although their resistance measured within tolerance.

When power was applied, there was no sound or raster. Measuring for dc voltages at TR805 (the SCR that regulates the +116V supply) revealed input voltage at the anode, but zero at the cathode. Evidently the SCR was not conducting at all. This was verified by paralleling the SCR (as suggested by a technician friend) with a low value resistor (used a 5Ω fusible resistor that was handy). Unregulated voltage was obtained, and the receiver began to operate. Therefore, the SCR was defective, or it was not being triggered on at any time.

With the SCR out of circuit, it tested normal by the technique suggested in the October 1979 **Electronic Servicing** magazine. The next suspect was APF-output transistor Q851. It had been improperly replaced with another brand. In addition, it tested leaky. I replaced it with an original-type 2SC647. Now the SCR was properly triggered, and the problem apparently was cured.



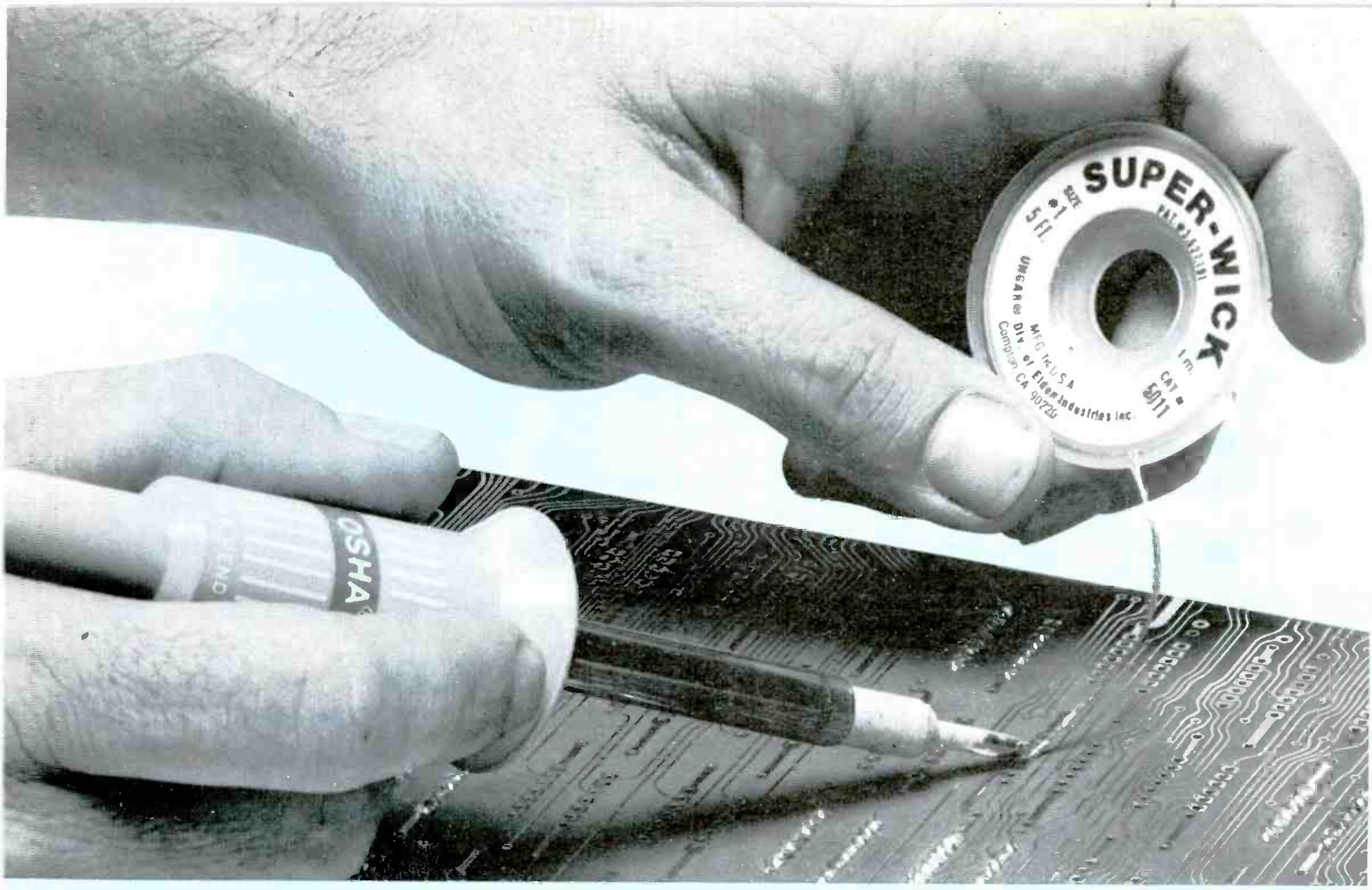

But a few days later, the customer reported it was pulsing again. With the receiver on the test bench, I found it would not operate unless the SCR was paralleled with a low-value resistor. My technician friend suggested that I get out my scope and look at the triggering pulses and other waveforms. He also had a suspicion about C805.

About 20 minutes had passed as I scoped the circuit, when suddenly the receiver came to life. Because I had not operated the chassis before for more than a few minutes, this was a surprise that indicated the problem might be triggered by thermal changes. When I sprayed canned coolant on C805, the receiver stopped operation. And after I warmed C805 with a heat gun, the receiver again operated correctly.

Replacing C805 restored reliable operation.

M. B. Danish
Aberdeen Proving Ground, MD

*Editor's note: Operation of the Panasonic regulator operation was explained on pages 26-28 in the September 1982 issue of* ***Electronic Servicing and Technology.***



**A soldering wick** can be used to remove bits of solder. Apply the soldering iron to the wick while holding it on the solder; the melted solder is drawn to the wick.

*Editor's note: This article on desoldering techniques, tools and materials opens with some material that may seem basic. However, it was deemed advisable to publish it as a review, as well as an appropriate introduction to the more advanced information.*

With the tools and supplies now available, components mounted on circuit boards can be removed and replaced in the field as well as in the shop. Because of the increased sophistication and complexity of printed circuits, however, it is difficult to desolder and remove a component without occasionally damaging a circuit trace or component mounting pad. This article will include information on the repair of common types of damage to the circuit board.

It's very basic information, but it bears repeating that two perils must be avoided in desoldering. First, desoldering tip temperature must be high enough to melt the solder but *not* high enough to damage good components or circuit pads and traces. Second, molten solder must not be allowed to bridge across circuit board traces or short out components.

Because some components are susceptible to damage at temperatures much lower than that necessary to melt solder, regardless of alloy, the desoldering tool must not be allowed to touch a component. The tip must be applied to the solder only long enough for the solder to melt; excess heat will migrate to the component. It may be advisable to clamp a heat sink to the leads of a thermally sensitive component being desoldered to prevent heat damage.

**Avoiding PC board damage**

Damage to the printed circuit from overheating occurs when the copper traces and pads delaminate from the board or are damaged. This may be avoided in most instances by using extreme care in carrying out the following steps.

The solder must be completely removed from the joint. Because molten solder will not flow easily from plated through-holes because of capillary action, extra effort and care are required on such boards. Solder may be extracted by any of three manual methods:

- Applying the soldering iron tip to the solder while the board is upside down. Since the technician must work from the bottom up, the tip can easily be misdirected to a nearby component.
- Using a wick made of braided copper wire, which has greater capillary action to draw up the solder than any solder joint.
- A bulb- or piston-type syringe can suck up the molten solder using a vacuum. Bulbs can be attached to the soldering iron, so that it can be operated by the same hand that holds the iron (leaving the other hand free to remove the component).

# How to avoid damage when repairing PC boards

By Ronald Riccio,
Research & Development Manager,
Ungar Division, Eldon Industries

The newest, piston-type syringes have the advantage of being spring loaded. Solder removal is instantaneous when the spring-loaded piston is released by pushbutton. Such desoldering pumps also give greater assurance of proper vacuum, compared with a hand-operated squeeze bulb.

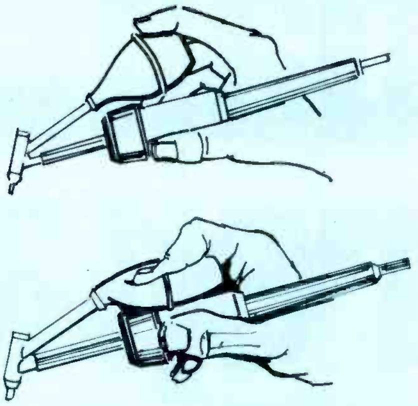
Advanced desoldering systems utilize a remote vacuum source to efficiently effect complete solder removal. The tube that removes the molten solder is built into the heated tip.

If the component is to be salvaged, special care must be taken when removing it to avoid breaking the component or the other lead.

Special tools are available for removing components with a large number of leads, such as ICs. Desoldering tips, which can be used with any modular iron, are shaped to fit over all leads of DIP or round components. Special pliers are available to extract all leads at the same time. A spring-loaded extractor automatically extracts a DIP at the precise moment of solder melt.

Other special tools can make the desoldering job easier and faster. The most common is a stainless steel or chrome-plated pick, to which the solder will not stick. One


**A piston-type** desoldering pump can be operated with one hand. The spring-loaded piston is set with the thumb and released by the push of a button, creating a vacuum that draws molten solder into the chamber.



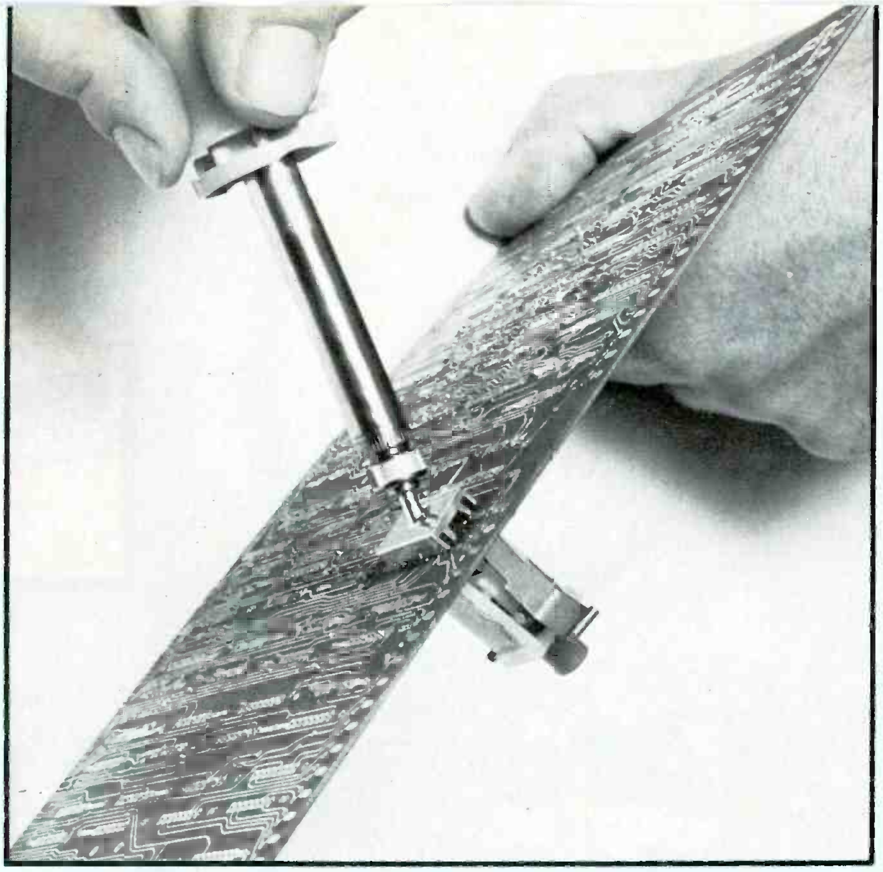
**A combined bulb** and soldering iron frees one hand to remove the desoldered component.

end has a sharp point for removing bits of solder or clearing holes for leads. The other forked end is for removing and bending component leads. Tweezers and brushes also are helpful.

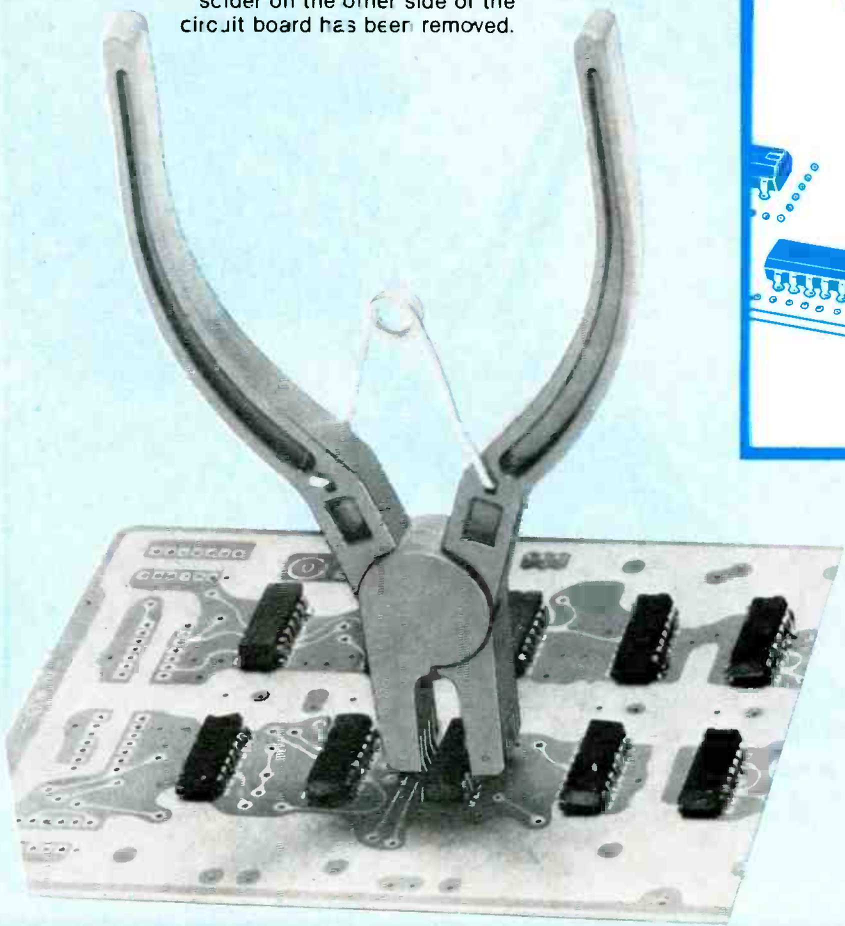
### Circuit board repairs

Check the circuit board traces and pads before soldering new components. The most common faults are broken traces and lifting of the trace or pad from the board. Replacement pads and traces in various widths are available. They have adhesive backs that allow easy positioning on the circuit board.

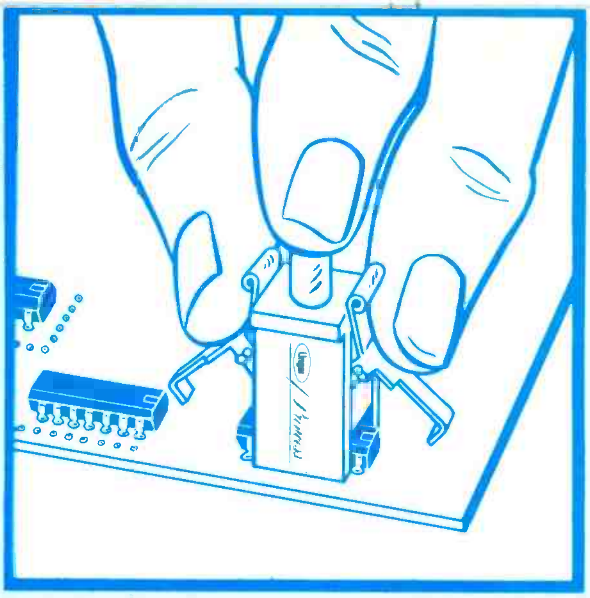
**These common** soldering-iron desoldering tips are used for removing round components (top), for straightening leads (center) and for removing DIP components (bottom).



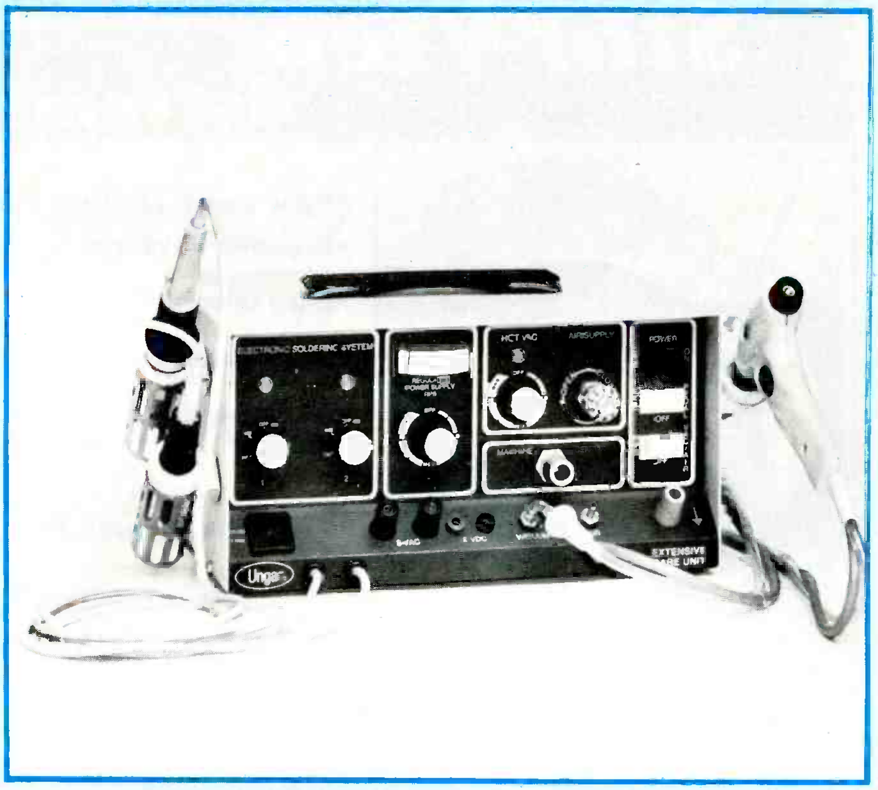
**A special bar** desoldering iron tip melts the solder holding up to 16 DIP pins. A spring-loaded extractor on the other side of the board removes the component when the solder is properly melted.



**Special pliers** are available to extract all the leads of a DIP component after the solder on the other side of the circuit board has been removed.



**This drawing** shows how a DIP extractor is applied. A spring applies the tension that removes the component when the solder has been properly melted on the other side of the board.




**This soldering system** has all the features necessary for desoldering and circuit board repairs in a self-contained, portable unit. The system includes a desoldering system (right), whose vacuum system can be reversed to become an air blower, and both micro- and standard-sized soldering irons (in holders at left).

The coating over the lifted or broken pad or trace may be removed by heating with the soldering iron and scraping it away or by using a sanding wheel in a hand-held motorized tool. Remove enough coating on the remaining ends of the pad or trace to allow the replacement to overlap. Position and solder the new pad or trace to the existing trace.

It is advisable to install eyelets on double-sided circuit boards because the through-hole plating may have been damaged when removing the component. Redrill the hole, using the motorized tool, and install an eyelet. A specialized tool is available for this job.

Remove excess solder. Look carefully for bridges or icicles on the circuit itself. A desoldering wick is easier to use than a syringe when removing tiny bits of solder.

Many companies offer specialized equipment for desoldering. Ungar recently combined all the features necessary for repair and rework of PC boards into the #4900 Extensive Care Unit. The unit includes standard- and micro-sized temperature-controlled soldering irons, a complete desoldering system with an integral vacuum pump (which can be reversed to an air blower for localized heating and cooling), a convenience outlet for a 115Vac motor tool, a 34-piece tool set and replacement pads and traces.

ES&T

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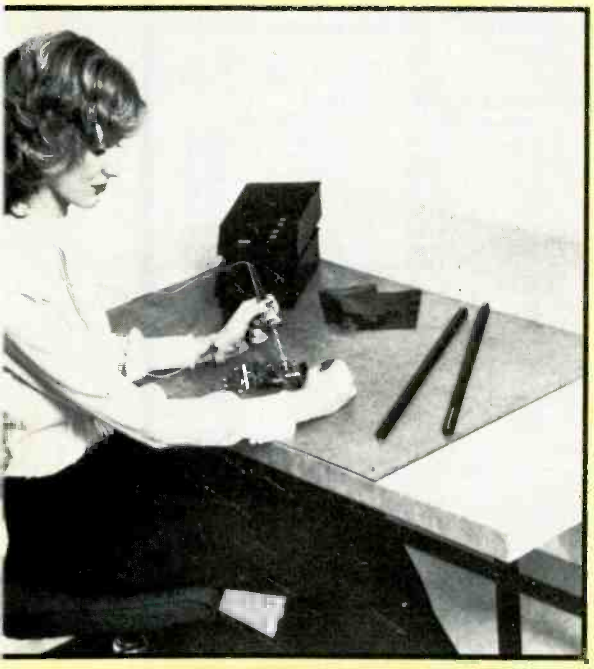
**A printed circuit track** repair kit contains components and tools required to repair a defective PC board.

# New tools for new technologies

By Nils Conrad Persson, editor

As technology continues to constantly change and evolve, the tools and supplies needed to service and repair the products of that technology must change no less dramatically. Although this is true across the entire spectrum of technology, nowhere is it as apparent as in the frenetic world of electronics.

Just a few years ago, it was possible to do a creditable job of servicing most consumer electronic products with a handful of tools: a soldering iron, a few screwdrivers and nutdrivers, a pair of dikes and maybe some long-nose pliers. And of course in the days of tube-type sets, servicing frequently consisted of vacuum-tube testing or substitution, and no tools were needed at all.



**This conductive mat** drains away static electricity before it can build up, preventing damage to sensitive ICs.

### PC boards and semiconductors

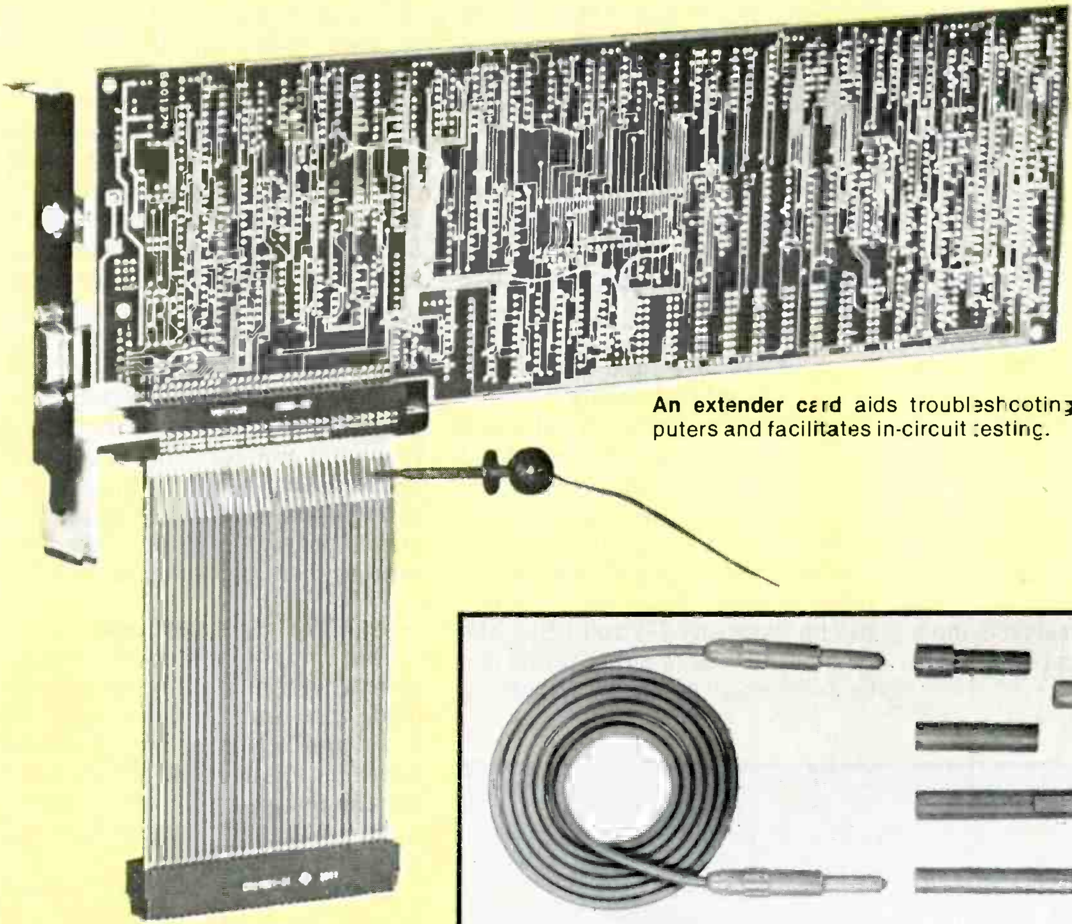
The introduction of PC boards also marked the advent of some new tools and techniques. With hand-wired sets, when a soldered-in part had to be replaced, removal of the defective unit ordinarily consisted of getting out a megawatt soldering gun and pouring the heat to the solder joints to be undone. It soon became apparent to anyone who tried to service PC-board-based equipment in that manner, that they had better add a low-wattage soldering pencil to their toolbox, or stick with working on a wired chassis.

Transistors and semiconductor diodes, of course, compounded the heat problem. A little too much heat applied to a solder joint frequently found its way along a lead into one of these delicate devices, destroying it before it ever saw service. After a few experiences with this kind of problem, servicers found that it was usually wise to clamp a heat sink around each lead as it was being soldered, even though a low-wattage iron was being used.

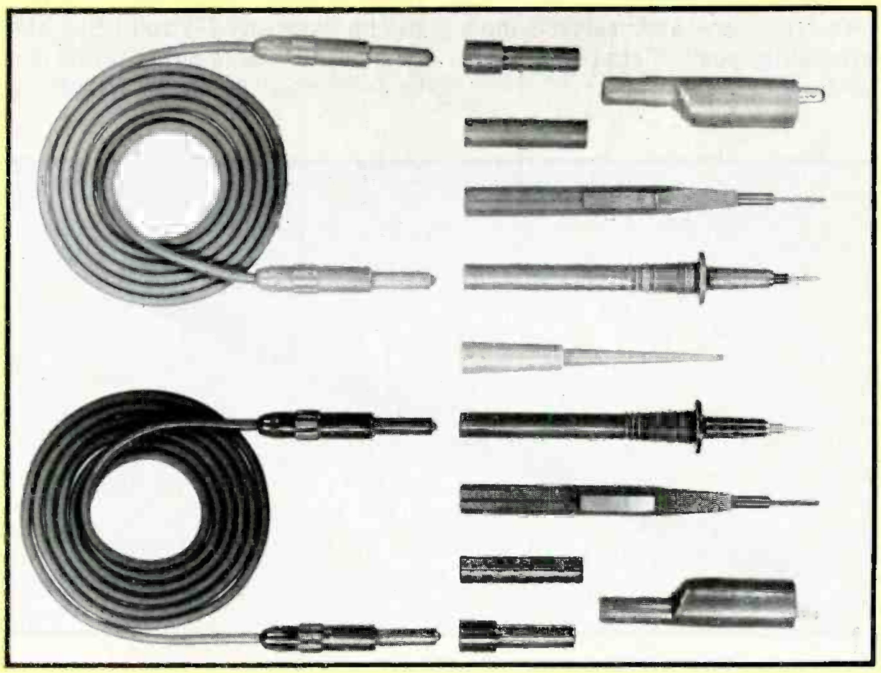
### ICs and MOSFETS

Close upon the heels of the development of PC boards and transistors came the introduction of field-effect devices and ICs, each presenting its own traps and pitfalls for the unwary servicer. Without the proper tools, removing an IC from a PC board could become a major, messy enterprise and could frequently result in damage to the PC board and excessive expenditure of time, to say nothing of extreme frustration for the servicer.

MOS (metallic-oxide semiconductor) devices, of course, present some of the most insidious problems to servicers, especially during the winter months. Static electricity, which is usually only a minor annoyance, becomes a serious problem with these devices. Although they are exceptionally reliable and will operate for years under normal operating conditions, an MOS device can be destroyed by that tiny spark of a few kilovolts that jumps from your fingertip to the water pipe after you've walked across a rug, without leaving any evidence of dam-



**An extender card** aids troubleshooting of IBM personal computers and facilitates in-circuit testing.



**A test lead set** enhances versatility of multimeters.

age. Manufacturers offer a huge arsenal of antistatic tools and supplies to help servicers combat this problem.

### Catalogs are a showcase

Glancing through a few recent catalogs reveals a wealth of tools and supplies that were neither necessary nor available a few scant years ago: IC insertion and extraction tools, anti-static wrist straps, PC-board holding fixtures, IC-pin straightening and alignment tools, IC test chips, miniature meter and oscilloscope probes for IC pins, IC desoldering heads and much more. And while not all of these tools are necessary to all servicers, many are indispensable to someone working on modern electronic equipment, and many others, while not essential, can save time and energy that would have been caused by using the wrong tool.

Space would not permit a comprehensive exposition of modern tools and test equipment here, but the following is a sampling of a few of the many tools and supplies that are available today to make the life of a servicer a little easier.

### Salvaging a PC board

Even if you work very carefully and with the correct tools, mishaps do occur. When you're working on a PC board, the result of such a mishap is often broken conductors or damaged pads.

PC track repair kits are designed to pay for themselves in a production environment if just one PC assembly can be salvaged, but they may also be of great value to servicers.

A kit offered by Automated Production Equipment contains the components and tools required for track repair: master frames with tracks, fingers, pads, elbows and flatpack pads; three sizes of eyelets and funnelets; a set of eyelet setting tools; a consumable replacement kit with red and green bullets, acid brush, red and gray abrasive sticks, epoxy set, mixing pad, spatulas, bottle of flux and bottle of cleaner; a track tool set with two shapes of tweezers, clamp, ball mills and knife set; and a deluxe tool set with temperature-controlled pencil soldering iron, and five shapes of pliers.

### Stop static

The new generation of ICs is incredibly compact, allowing thousands of transistors to be fabricated in a single tiny chip. And they're incredibly reliable. Once installed in a circuit board and operated within design limitations, they will last virtually forever, but a static electric discharge that wouldn't even be noticed by a bipolar device will wipe one of these marvelous devices out in the blink of an eye.

One defense against this vulnerability is provided by conductive work surfaces that drain away static electricity, preventing it from building up. One such device is a conductive table mat offered by Plastic Systems. Manufactured of thermosetting plastic (will not melt), these mats are available in sizes from 24 by 18 inches to 24 by 36 inches and come with snaps to attach it to the work surface and a grounding post to connect it to a ground.

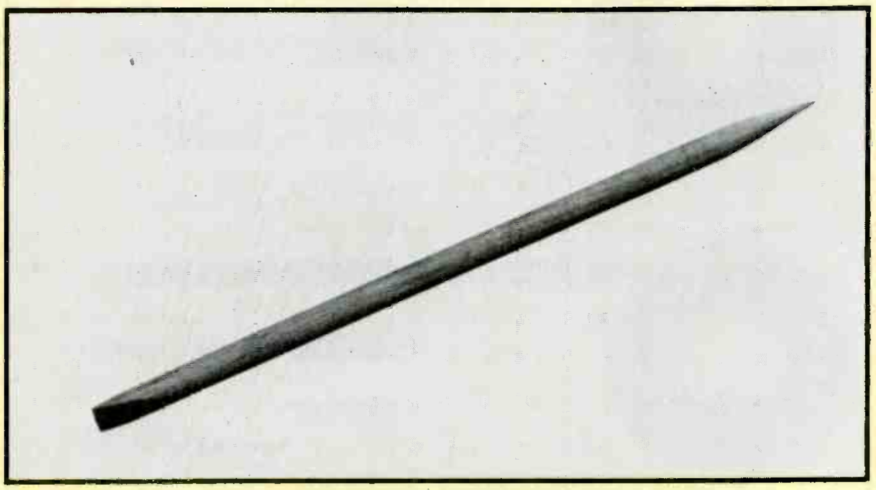
These mats are resistant to acids, alkalis, freon, alcohols and a number of other chemicals, and will withstand soldering temperatures and fluxes.

Besides the conductive mat, the company also offers a selection of other antistatic devices, including built-in benchtop laminate, conductive floormats and conductive wrist straps.

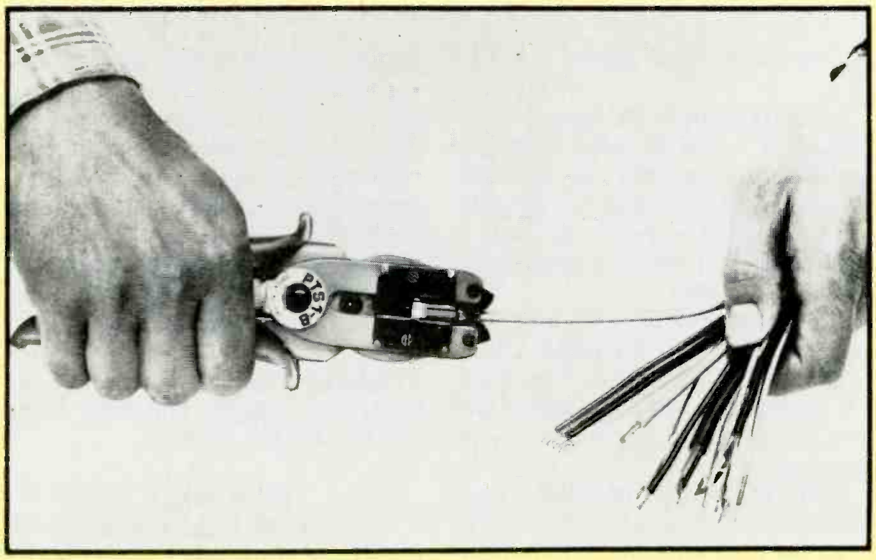
### Extender card aids troubleshooting

In today's crowded chassis, sometimes the most important aid to the servicer is simply a device that facilitates getting the test probes onto the appropriate conductors. There are all manner of these devices. Some are designed to clip over any IC and bring the pins out to where a test probe can be connected to them. Others of this type of device are designed to be used with a specific manufacturer's product.

Designed especially for IBM Personal Computers, a new extender card aids troubleshooting the computer and facilitates in-circuit testing of protytype interface cards. The card, designated the model 3690-22 by Vector Electronic Company, has clearly marked test points for every bus line along the connector, permitting easy probing and signal comparison. An included mounting bracket secures the extender board to the computer to assure a more rigid assembly during testing and to prevent extender card connectors from becoming unjoined.



**Hardwood soldering aids** are disposable and will not scratch.



**This wire stripper** strips flat, ribbon-type cable as well as round wire.

### The right test lead

There might be some discussion as to whether it's appropriate to include test leads in a discussion of tools and supplies, but that's an academic distinction. If you don't get the test point connected to the meter, you don't troubleshoot the defective product.

At any rate, a test-lead system offered by Simpson Electric expands the measuring capabilities of any VOM or DMM with standard or reverse-type banana jacks.

The 16-piece system consists of red and black pairs of 48-inch long test leads, test-lead extenders, probe-type test prods for general-purpose testing, and 6-inch spring-tip, hook-on probes for no-slip connections.

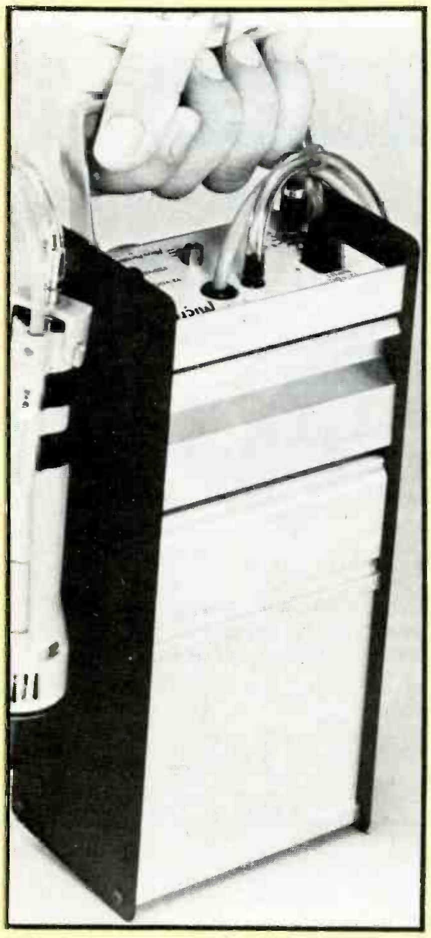
Also, a color-coded pair of alligator clips, a high-density probe tip, probe tip caps and two insulated adapters (reverse banana to standard banana jack) are also included.

The test leads have special safety-guard insulated banana plugs. An insulated sleeve automatically retracts when the plug is connected.

A vinyl pouch holds all components of the system.

### Hardwood tools for electronics?

A line of solid hardwood soldering aids have five different shapes on the ends. The different shapes make the tools very useful for working around delicate components and component leads. The tools come with choices of screwdriver, spade, point, spudger and hoof ends. The tools, offered by Desco Industries, are made from kiln-dried, close-grained, native hardwood. They are precision machined to remove rough edges and particles. Their low cost makes them perfect soldering and assembly aids that can be disposed of and replaced when worn. The model 611 shown in the photo is 7 inches long, ¼-inch diameter and has a point at one end and screwdriver shape at the other.

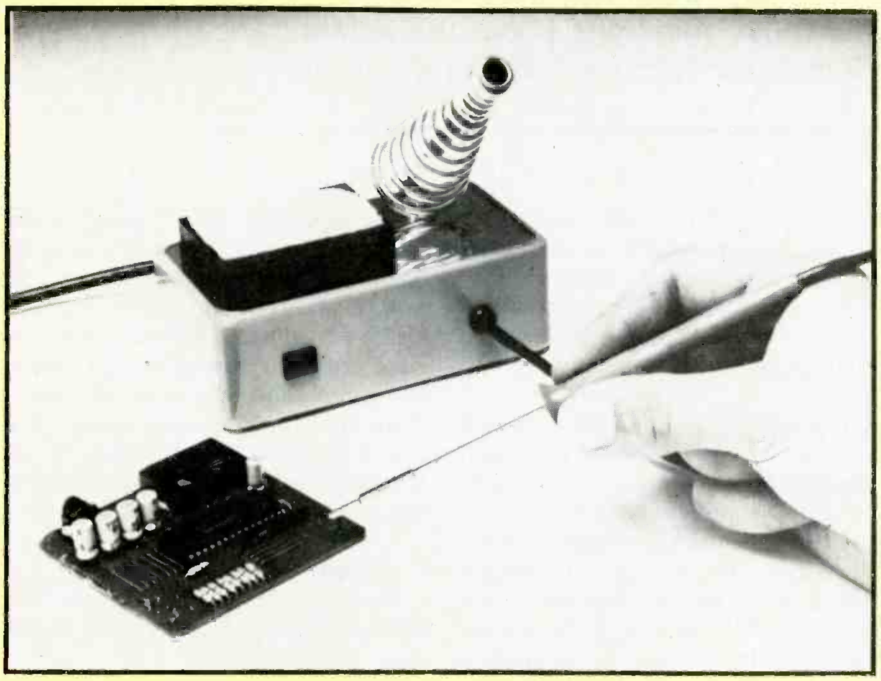


**This portable soldering/desoldering** system operates on ac or 12Vdc.

### Automatic hand wire stripper

Even with PC boards as prevalent as they are, there will be need for wire strippers. The PTS-1B hand wire stripper, by The Eraser Company, will strip a wide variety of insulations from round wires of sizes between 30 AWG 0.010 inch and 1 AWG 0.289 inch. In addition to stripping round wires, this tool will strip flat, ribbon-type cables with a width up to 0.27 inch in a single operation.

The stripper is fully automatic and in addition to severing insulation, the slug is automatically removed. The unit incorporates flat stripping blades 0.5-inch wide, enabling several wires to be stripped in one operation. This feature makes the tool suitable for use both in prototype and production operations. Stranded and solid conductors may be stripped fast and effectively with no damage or nicking to the wire conductors. Incorporated in the stripping head is a pair of cutting blades for cutting wires to length.



**A low-heat soldering** station provides gentle heating of delicate components, PC boards and wire.

### Soldering on the go

Although many tools are carried about and regularly used in the field, a soldering iron is *ordinarily* thought of as a bench tool. A portable unit, the Micro, from Pace, provides a truly self-contained power desoldering and soldering system so portable it can be used anywhere electronic equipment needs to be repaired – in depot, in mobile vans, in remote field-service centers or on-site. The unit operates on ac and 12Vdc sources.

The unit warms up in one minute. Desoldering and soldering are accomplished with a single handpiece, with a finger-activated vacuum. The Micro provides spike-free MOS safe operation and precise tip temperature control for high reliability repair.

### Low-wattage soldering

Heat-sensitive components, leads with diameters the thickness of a human hair, microminiature circuits and components require extreme care and soldering/desoldering equipment that won't deliver too much heat or cover so much area that they cause solder bridges.

A 6W iron is lightweight, small in size, and easy to control. The iron tip operates at 360C, features 14 interchangeable tips (1/25 inch to 5/32 inch) in a variety of materials, finishes and shapes.

In addition to the iron, the station by Wahl Clipper includes a tip-cleaning sponge, sponge well, spring holder for the iron, indicator lamp and internal safety fuse.

### Proper tools, proper methods

All of the above tools and equipment can make the work of the operator easier, faster and more professional, but none of them do the work without the guiding hand of an experienced servicer. Just as the new equipment to be serviced requires new skills on the part of the consumer to operate, servicing of that equipment requires new skills on the part of the servicer. The investment in time to learn those skills, as well as the investment in money to purchase tools can be recouped many times by more efficient, effective servicing procedures.

# How to evaluate cassette tapes

By Carl Babcoke, CET

These are a few of the tapes tested by the methods described in this article. Test results are listed for tapes ranging from unlabeled bulk tapes to the newest premium cassette tapes.

Audiocassette tapes are available in a bewildering variety, ranging from prestige premium brands to cheap private labels sold by discount stores. The facts and opinions given here should answer most questions about these tapes and how to select one type for a specific purpose.

Perhaps you believe all cassette tapes have the same performance, or that the performance varies directly with the price. Neither statement is correct. When I recently became interested in tape recording again (after neglecting it for more than 20 years), I was amazed at the tape improvements and the excellent audio quality formerly possible only with reel-to-reel machines.

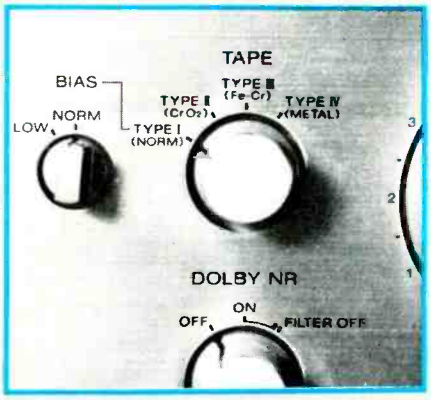
However, my pursuit of hi-fi quality from cassette tapes was not without problems and surprises. About two years ago, I purchased my first good-quality cassette deck and connected it to my hi-fi system. Immediately, I found the playback sound was seriously deficient in high frequencies, although the specifications called for ±3dB response between 30Hz and 17kHz with class-one tape.

After a time of listening and questioning, I tried some premium *chrome* tapes and achieved much better frequency response. This proved the machine wasn't defective, but the question remained about why the normal-bias tape results were so bad. Other questions (about weak playback volume, errors from recording VU meters and unexpected results when boosting high frequencies with a graphic equalizer) required considerable experimentation before they were solved. Before these are detailed, however, it is necessary to describe the basic types of cassette-tape formulations and their specifications. If I had known all this information at the beginning, it would have given me several answers much faster.

### Audiotape classification

Audiocassette tape materials are divided into four categories, from type 1 through type 4.

**Type 1.** Usually type-1 tape is called *normal bias* because its




**One knob** on the panel of this cassette deck selects playback equalization, recording equalization and recording bias level for all four types of cassette tapes.

optimum bias is about the same as the bias used for years with previous ferric-oxide ($Fe_2O_3$) magnetic coatings when only one bias strength was used for all machines and tapes. Normal bias was standard for many years before high-bias tapes were developed. Equalization of 120$\mu$s treble boost is used during recording, as described in Part 3 of this series. If a recording machine has no bias switch, type-1 tape should be used.

Quality and performances of type-1 tape vary tremendously, depending on the manufacturer and model of the tape. Therefore, it is imperative that you know how to intelligently select the type-1 tape that best suits your recording requirements.

**Type-2.** This tape usually is called high-bias or chrome. Originally, a chromium-dioxide ($CrO_2$) formulation invented by DuPont was the magnetic coating.

Many manufacturers now offer high-bias tapes with performance almost identical to the original chromium-dioxide tapes, but the formulation has cobalt-enhanced or cobalt-modified coatings. For instance, Avilyn is the TDK brand name for cobalt-enhanced magnetic particles.

Chromium-dioxide or high-bias tapes require about 50% more bias than the average for type-1 tapes, and recording should be done with 70$\mu$s treble-boost equalization, which can provide up to 5dB better signal-to-noise ratio, relative to normal-bias type-one tapes with 120$\mu$s equalization. These high-bias tapes have better high-frequency response before compression. Therefore, the lower high-frequency boost allows increased headroom and less chance of overload on signals that have loud treble sounds.

Chromium-dioxide tapes often cost more than normal-bias tapes do, which might account for the smaller variations of performance among type-2 tapes.

**Type 3.** Theoretically, type-3 ferrichrome (FeCr) tapes appear to have the best of both type-1 and type-2 tapes, because the coating is in two layers. Applied on the base material is a comparatively thick layer of normal-bias ferric oxide, and on top is a thin coating of chrome particles. This hybrid usually is recorded with normal bias but 70$\mu$s treble boost.

Unfortunately, the combination acts similar to a woofer and a tweeter that are not matched correctly, leaving a valley between their individual coverages. Low-frequency sensitivity is outstanding, producing high amplitudes around the 400Hz test frequency, but high-frequency response is only average. Some field reports indicate the performance varies greatly between individual tapes.

Many machines do not have a switch position for FeCr types.

**Type 4.** The metal on these expensive tapes is pure iron (not a ferrite or ferric compound) and the particles must not be allowed to oxidize in the tape coating. This probably accounts for the high production costs. Metal tapes are recorded with very high bias and 70$\mu$s HF-boost equalization. High erasing power also is needed.

Although metal tapes generally have the best extreme high-frequency responses, some of the newer high-bias tapes that have an *S* or an *X* after the number almost equal the metal tapes' HF response. This improvement of the chrome-type tapes and their lower price eventually might overpower metal-tape sales.

Many machines (particularly older ones) are not designed to *record* metal tapes. However, any machine with 70$\mu$s playback response can *play* them after they are recorded. In fact, metal tapes can be played on a machine designed only for normal-bias tapes, but the high frequencies might be excessive.

### Magnetic properties

Specifications from several tape manufacturers were examined to find what magnetic properties

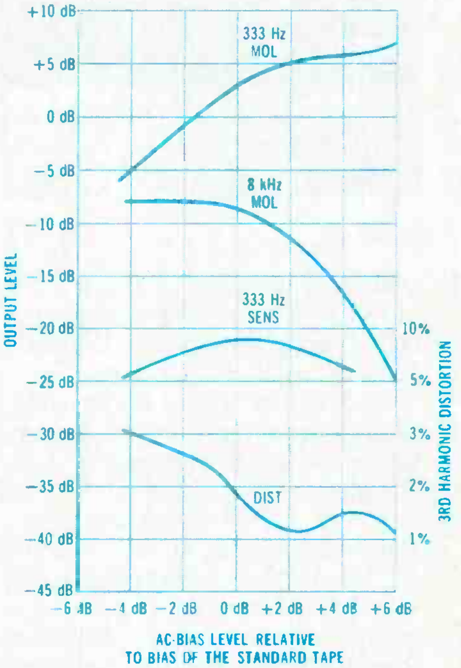



**Figure 1.** Important information can be obtained by studying these curves, which are typical of type-1 cassette tapes. The curves are produced by manufacturers by noting the 333Hz maximum-output level (MOL), 8kHz MOL, 333Hz sensitivity and the 0dB-level distortion at five or six amplitudes of bias. Notice that the bias amplitudes are relative to the standard type-1 tape.

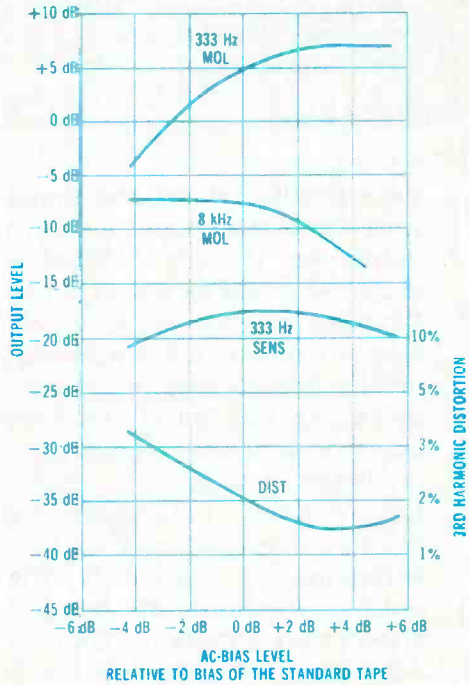
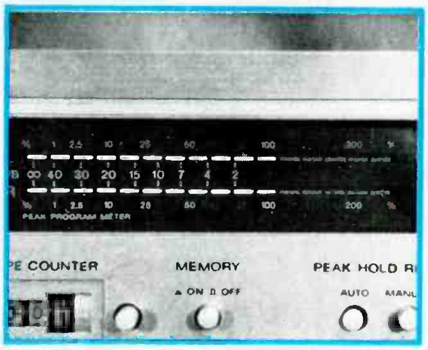



**Figure 2.** The same four curves (of Figure 1) are shown for a typical type-2 high-bias or chromium-dioxide tape. Notice that all figures are improved except for the distortion.




**A 1kHz, 0dB test tape** (LC Engineering Laboratory) was used to establish that the 0dB playback LED of the Sony machine was calibrated correctly. The test tape also showed that the Technics fluorescent bar-graph did not conform to the usual industry standard. The test tape showed where on the bar graph that 0dB should be, and then the variable output-level control was adjusted to produce 0dB on the external dB meter that was used for the various tests. Figure 3 shows the wiring needed during these measurements.

could and should be compared. The ones listed most often were coercivity (HC), retentivity (Br) and squareness (Br/Bm).

In an effort to find the meaning of these terms and how to compare tapes by figures associated with the terms, I checked four technical writings. Unfortunately, there was little written about retentivity, but another term (remanence) was defined from physics and electric standpoints. One statement finally brought the two together: *retentivity* is equivalent to *remanence* except it is expressed in terms of flux density or flux-per-unit of cross-sectional area.

*Remanence* (and retentivity) indicates the magnetic flux that remains after the magnetizing force has been withdrawn. It might be called residual flux density, although the two are not necessarily identical.

*Intrinsic coercivity* is the coercive force corresponding to the saturation flux density of the magnetic material. It is an important factor in determining the amounts of head currents for recording, biasing or erasing a tape. *Coercivity* is the demagnetizing force or field intensity required to reduce a magnetic signal on a tape from saturation level to zero.

High coercivity is essential to prevent unwanted erasure of high-frequency components of the music, but a higher coercivity also demands higher bias power for the erase head and the recording head.

A study of magnetic, almost-square B/H curves for various kinds of tape shows remanence and coercivity at opposite sides of the curve. Therefore, the figures for them usually track together. That is, if the remanence is high, the coercivity also will be high. This is helpful when comparing tapes within one type (high-bias tapes have higher relative coercivity than normal-bias ones do). For example, one Radio Shack tape is rated at 335 Oersteds of coercivity and 1500G of retentivity. Maxell UD-60 tape specs show coercivity of 350 Oersteds and a retentivity of 1450G. The ratios are almost the same. One Sony high-bias tape is rated at 650 Oersteds and 1800G.

Squareness of the B/H curve has been noted at any value from 82% to 93%. Higher percentages of squareness *supposedly* are better. However, the 82% just mentioned was for metal tape (the best type) while the 93% was a high-bias tape. Obviously, this is not going to help us compare tapes.

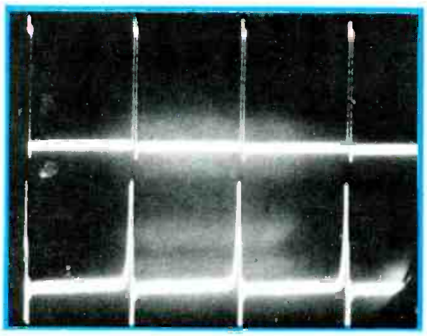
In fact, none of the previous three specifications (coercivity, retentivity or squareness) can be used for error-free evaluations. *None provides more than a vague hint* about how well the tapes will perform in your cassette deck.

**Graphing four characteristics**

Many manufacturers supply graphs showing six or more characteristics plotted against various levels of bias. Two can be eliminated because they show dc-erased and ac-erased noise level, and these noises are *nearly* the same for all tapes.

The four remaining important curves are shown in Figure 1. Definitions of the terms is as

**Experiments were performed** with square waves and pulses to determine if tape frequency response could be displayed by those waveforms. Square waves were not effective, but pulses of certain repetition rate and duty cycle provided waveforms that could be analyzed approximately. Photo 1 shows the 260Hz positive-going pulses at the deck's output jacks before recording (top waveform). The bottom waveform of Photo 1 shows the playback of TDK type AD tape. This can serve as a standard waveform for comparisons. In Photo 2, the top waveform is produced by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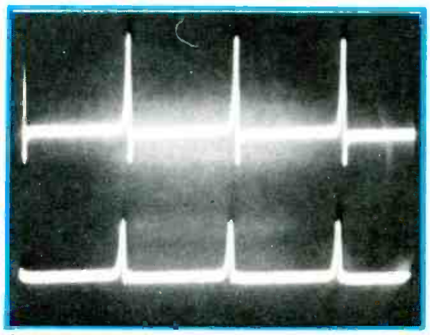
private-label SBC tape. The waveform shows slightly lower amplitude and HF response than for TDK type AD. The lower waveform shows decreased amplitude and poor HF response from a low-priced "white" tape. In Photo 3, the top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waveform shows the sensitivity winner (Maxell XL1S) having the highest amplitude and good HF response. The lower waveform was made by a high-speed duplication tape of good quality; it shows fairly good amplitude and response. The Photo 4 top follows:

- *333Hz MOL* identifies the Maximum Output Level at 333Hz. For each level of bias, the 333Hz recording level is increased until the third-harmonic distortion reaches 5%. Each figure is added to the graph, producing a curve. These 5% distortion points are the beginning of amplitude compression.
- *8kHz MOL* shows the Maximum Output Level at 8kHz. However, the test must be performed differently from the 333Hz-MOL test because the 24kHz third harmonic is outside the tape's bandwidth. Instead, the input level is increased slowly until the recorded output first levels off and cannot be forced to a higher amplitude. Then the input level is reduced until the recorded output drops 0.5dB. The output level at that point is the 8kHz MOL for that bias. Notice that the 8kHz amplitude generally decreases with increasing bias (something that is not desirable).
- *333Hz SENS* is the tape's sensitivity (or the volume remaining after recording) at 333Hz. For each bias level, the tape is recorded with 333Hz sinewaves at −20dB level. Then each playback level is transferred to the graph, forming the curve. High figures are desirable.
- *DIST* is the percentage of third-harmonic distortion at 0dB recording level for the various biases. Low distortion percentages are desirable.

The Figure 1 curves can be used to select an optimum bias level. Of course, compromises are inevitable. If maximum high-frequency response is important, the bias must be reduced from the level giving highest 333Hz MOL.

If your tape deck has the adjustments, the choice is yours. Otherwise, you accept the results locked in by the deck manufacturer, or you can modify the frequency response by external filters or a graphic equalizer.

### Comparing curves

Another advantage of the Figure 1 curves is that tapes can be compared with others. First, you must decide which of the four attributes are important for the contemplated recording. Then, compare all the graphs while looking for a better rating of the important characteristic but without an unacceptable reduction of other attributes. Compromise is inevitable because there is no perfect tape and prices vary.

### Comparing types

These performance-vs.-bias curves also allow comparisons between the four basic types of cassette tape. Comparing the two types in Figure 1 and Figure 2 shows that type 2 is better in three of the four curves. Notice that the 333Hz MOL is higher, the 8kHz MOL is particularly improved in the high biases and the 333Hz sensitivity is much higher (which gives louder volume during playback). However, both distortion figures are nearly the same.

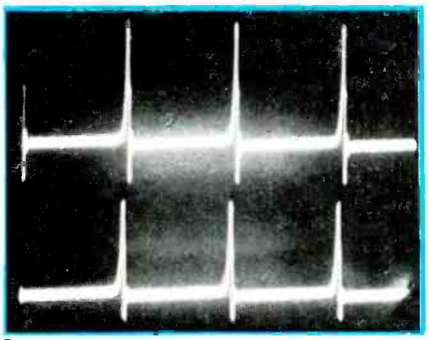
Values in Figure 1 and Figure 2 are fairly typical of the two types, but many tapes depart significantly from these averages, so comparisons should be made on an individual basis.

Type-1 curves can be compared to type-4 curves, just as type-2 values can be compared to type-4 or type-3 curves. However, you should remember the large differences in the various 0-dB biases. Type-2 bias is about 50% higher than type-1 bias, and type-4 bias is approximately double the type-2 bias.

Unfortunately, these graph comparisons give only approximations of the performances. For example, they cannot show the precise frequency response.

Even if some testing laboratory performed accurate frequency-response and sensitivity measurements for all tapes that you might want to use, a problem remains: Your recording and playing machine is different from the one used during those tests.

This is not a minor problem. I have three sets of testing figures



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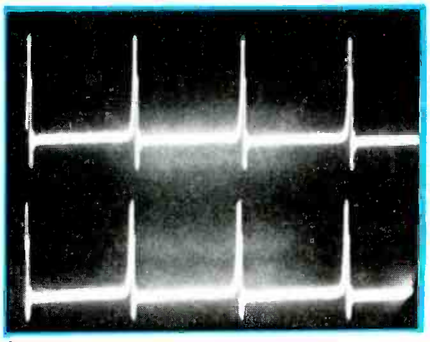

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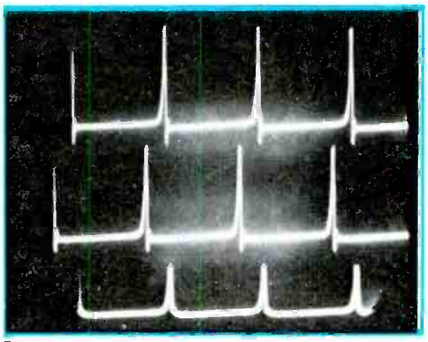

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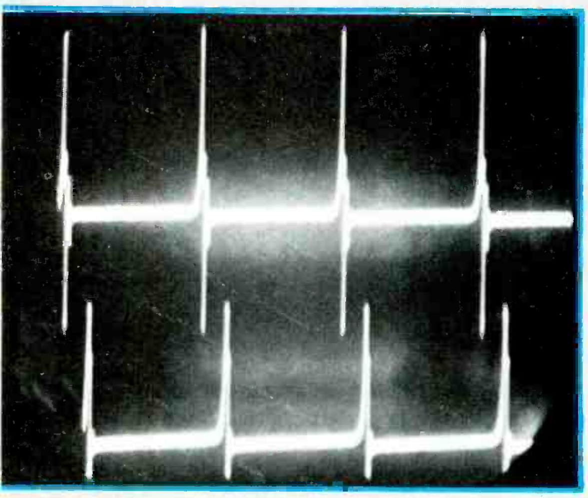
trace shows the good performance of a Fuji metal tape, while the bottom trace shows almost identical results from a Memorex metal tape. In Photo 5, three Radio Shack tapes are compared. The top trace is Supertape Gold, which has good amplitude and fair HF response; the center trace, from Realistic Low Noise, shows moderate amplitude and fairly good HF response; the bottom trace illustrates the weak amplitude and poor HF response of Concertape. These waveforms prove that valid comparisons can be made rapidly (but with only fair accuracy) between the sensitivity and frequency response of various tapes. The best accuracy is obtained when the scope controls are not adjusted (except centering) between tests.

for cassette tapes. They do not cover the same tapes, so they cannot be checked against one another. However, I have made my own tests on many of the same tapes, and my results were vastly different from the ones they reported. Any number of factors might account for these variations. Not all their test conditions were spelled out in detail, and some used Dolby 0dB level while others used another zero level. Even printing errors might have played a part. One list showed 10kHz MOL of type-1 tapes with about the same spread as shown for type-4 tapes. One of the advantages of type-2 and type-4 tapes over normal-bias type-1 tapes is in the much higher 8kHz or 10kHz MOL.

Also, tape characteristics vary significantly from one batch to another of the same brand and tape type. Occasionally, a reputable manufacturer will upgrade a tape without an immediate change of identification. These variations can make previous evaluations almost useless.

All of those national-scope reports were compiled from measurements made on a Nakamichi cassette recorder that has a recording head with a comparatively wide gap and a playback head with an extremely narrow gap. The reviewer's intent in choosing such a superior machine was valid: the machine should not compromise the results of the tape tests. But the inevitable result is that you cannot duplicate their measurements.

The solution, therefore, is for you to make your own tests. Surprisingly, it is not difficult or very time consuming. A few typical results and some excellent and terrible tapes will be revealed after the tests are described.



These waveforms illustrate the effects of recording pulses on a type-2, high-bias tape at correct type-2 bias and equalization vs. recording with the switch changed to type-1 normal-bias position. The top waveform shows *excessive* HF response and excellent amplitude when TDK type SA-X new type-2 switch position. This is one proof that a HF boost could be obtained by recording a type-2 high-bias tape as a type-1 normal-bias tape.

### Which tests?

Although many characteristics can be measured, only two are of paramount importance: *adequate playback amplitude and a wide, flat frequency response.*

You may wonder about tape noise because some tapes are advertised as having low noise. Does this mean some tapes do *not* have low noise? My practical experience shows that tape noise is not a serious problem. In fact, some cheap tapes *appear* to have lower audible hiss than some premium brands have. This is easily explained, however, by the poor high-frqeuency response of the inferior tapes. One report about tapes showed a range of signal-to-noise ratios between 53dB and 60dB for 36 different tapes of all types. If a recording is made correctly, the noise-level differences among various tapes will not be audible.

Distortion with cassette tapes is affected more by the machine's electronics and the precise amount of bias than it is by the brand or type of tape. Therefore, *the only tests needed for most applications are 400Hz sensitivity* (which shows how loud the low-frequency sounds will be) *and frequency response.*

### Test equipment

Only two test instruments are required: an audio generator that emits undistorted sinewaves of the needed frequencies and a meter with a sensitive decibel scale.

Digital meters are not suitable for these tape tests because (even with the best tapes) some amplitude variations occur constantly. Slow amplitude variations of ½ to 1dB are common, and several swings of 4dB to 6dB have been noticed. Digital meters cannot show these variations, which often are more important than the percentage of accuracy.

The most suitable decibel-meter type is called either sensitive, amplified or millivoltmeter. I have an old RCA model WV74A that has nine ranges from 0.01V to 100V RMS full scale. Both ac voltage and decibels are calibrated separately, while the decibel ranges are decaded. A meter of this type is ideal for these tests.

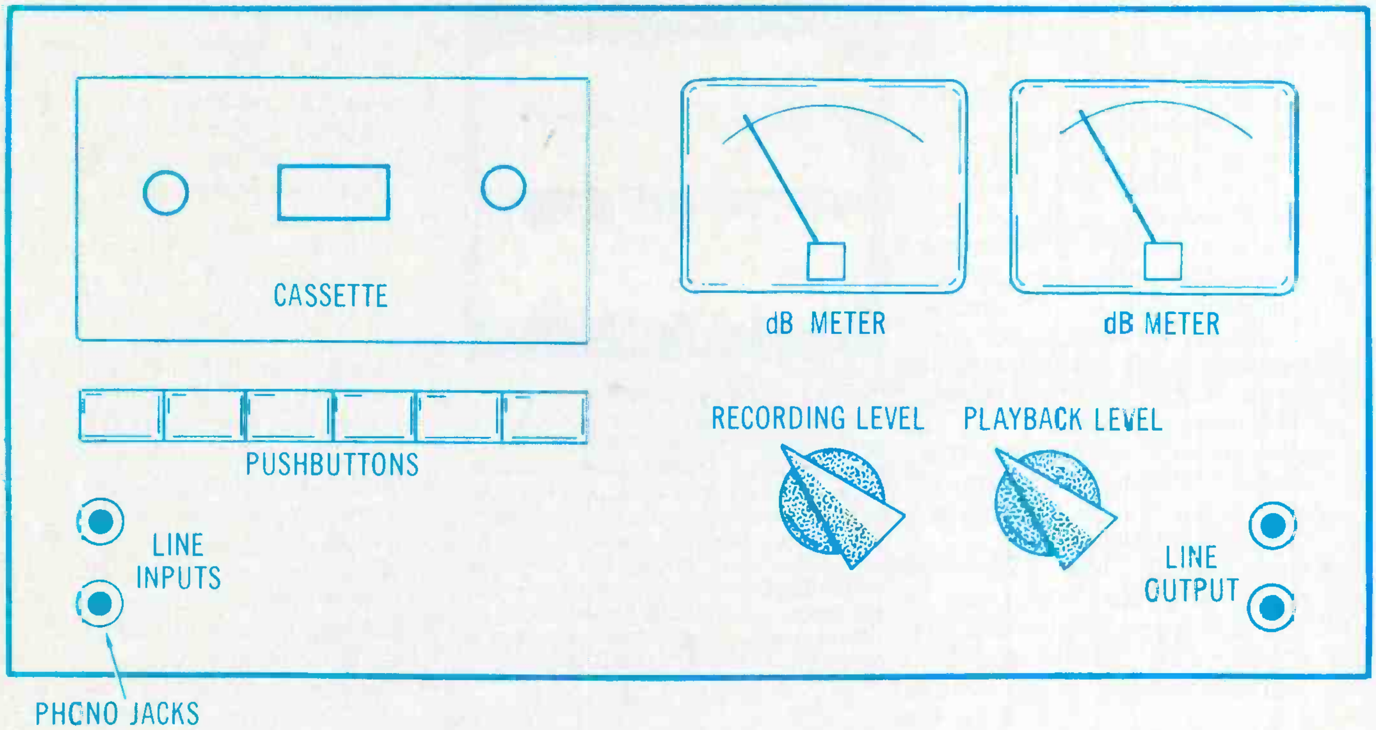
A VTVM is suitable if it has decibel calibrations, or you can use a decibel table. Few VOMs can qualify. The deck outputs are rated at about 50kΩ impedance at a 0dB level of about 0.8V RMS. Even more serious, the 8kHz tests are made at a maximum of about 0.08V, with some readings dropping to about 0.03V. Most VOMs either have insufficient sensitivity or load the circuit excessively.

Ideally, the ac meter should have good accuracy and flat response over the audio range up to 20kHz. Fortunately, the sensitivity and response tests use the same meter for reading both input and output amplitudes, and this cancels most errors and bad frequency response because these shortcomings apply equally to both readings. But don't use any meter that loads down the output signal or has more frequency variation than perhaps 2dB or 3dB over the range of test frequencies. Both shortcomings together might create artificially reduced and even non-linear readings that could make the tests meaningless.

### Testing level and frequency response

Connect the audio generator to the cassette deck's line-input phono jack, using the shielded plug and wire shown in Figure 3. Notice that only one channel of a stereo machine is tested. Connect the sensitive meter to the output-line phono jack, remembering to plug into the right or left as done previously for the input jack. Switching is performed by the tape deck.

The procedure is much easier when the deck has three heads, allowing almost instant recording and playing without rewinding. That system will be described, with the differences explained afterward.

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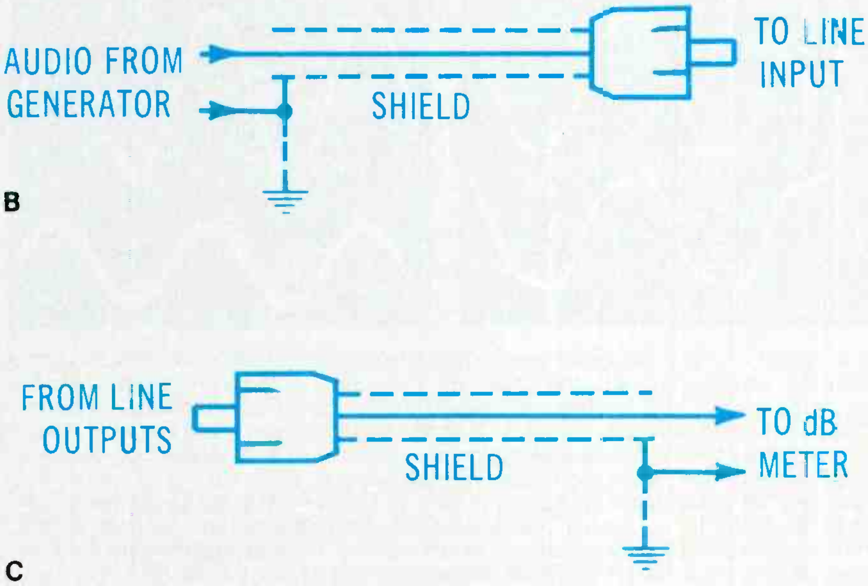



**Figure 3.** Each cassette deck has two phono jacks marked *line input* and *line output* on the rear panel. Usually the impedances are about 50kΩ and the level is between 0.5V and 1.0V RMS for line-level operation. These are the jacks to use when testing tapes. (A) This drawing of a typical cassette stereo deck shows the jacks on the front, but most jacks are on the rear panel. (B) The output from a sinewave generator is sent through a shielded cable and RCA-type phono plug to *one* of the line-input jacks. (Testing both channels together sometimes causes errors and complications.) (C) A sample of the recording or playing audio comes from the line-output jack to a phono plug and shielded wire to the sensitive decibel meter. Switching is accomplished automatically by the deck operation. Therefore, one meter measures both recording and playing levels.

Cassette decks supply a sample of the program material to the output phono jacks during recording. When the deck is changed to playing mode, the internal switching routes the playback signal to the same output phono jacks. In my two decks, the recording and playing signals have the same level. For example, if the signal is recorded at zero dB, the playback signal also will be zero dB *if the tape retained zero-dB level.* (Presumably, the playback signal is adjusted by the factory for zero level when a standard tape is used.) In practice, the playback signal might be either higher or lower according to which tape was recorded. Different tape formulations retain different amounts of flux, which in turn produces various levels of playback amplitude.

Comparative sensitivity of different tapes is tested by recording a constant amplitude (0dB, if possible) and then playing the sample and noting the level in decibels. Frequency response is measured by recording each tone with the same constant amplitude. The playback signal for each frequency is measured in decibels at the output jack. That is the system.

The measurements have been simplified slightly from the manufacturer's methods. Sensitivity is measured at 400Hz, instead of 315Hz or 333Hz; the response is measured next at 4000Hz (one position higher on the generator range switch), and then finally the response is measured at 8000Hz. In accordance with industry standards, the 4kHz signal is recorded at −10dB, and the 8kHz signal is recorded at −20dB. These levels are lower than tape compression at those frequencies.

Follow these steps:

- With the audio generator producing 400Hz sinewaves, record at 0dB level as determined by the meter or other recording readout on the cassette deck when the monitor switch is at the *source* position. Adjust the playback-level control for a convenient 0dB reference point (with my meter, this is 0dB on the 1Vac/0dB range). This calibrates the external meter (as long as the playback level is not changed), which is then used to determine recording and playing levels for *all* subsequent steps. (Thus errors between meters are prevented.)

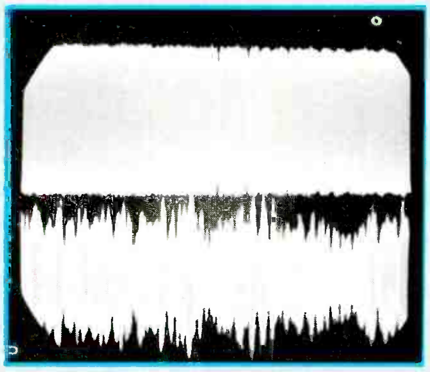
- Change the monitor switch from *source* to *tape*, which directs the playback signal to the external dB meter.
- Read the dB meter, and write down the reading.
- The difference between the recording 0dB reading and the playback reading is the 400Hz sensitivity rating of that tape in *your* machine. An excellent tape might show a +1dB to +2dB reading, but a tape might be acceptable when readings are 0dB to −1dB, if other characteristics are good.
- Switch the generator to 4kHz. With the monitor switch at *source* position, begin recording and adjust for a −10dB level (on external dB meter).
- Change the monitor switch to the *tape* position, read the dB meter, and write down the reading. *This reading compared to the 400Hz sensitivity is the 4kHz frequency response of the tape.*
- Switch the generator to 8kHz. With the monitor switch at *source,* begin recording and adjust rapidly for a −20dB level (on external meter).
- Change the monitor switch to *tape,* read the dB meter, and write down the reading. *A comparison of this reading to the 400Hz sensitivity is the 8kHz frequency response of the tape.*

These figures are sufficient for most practical tape uses because an approximate curve can be extrapolated from them.

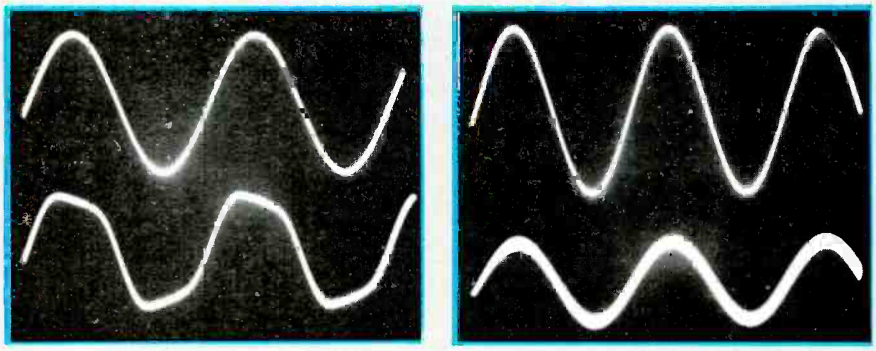
The sequence and figures are the same for decks having only two heads so recording and playing cannot be performed simultaneously. Instead, the recording must be done first for a certain period of time (such as 30s), then the tape is rewound to the same starting point and played as the level is posted.

### Measuring MOLs

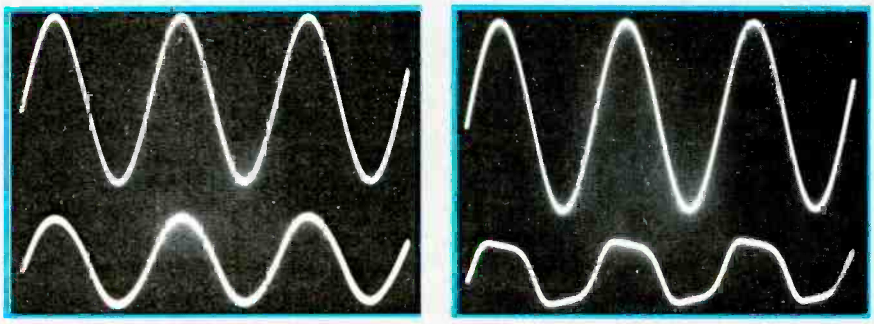
It is not absolutely necessary to know the 4kHz and 8kHz maximum-output levels, but they can help you estimate the high-frequency headroom or how much high-frequency boosting can be applied. Keep in mind that high-frequency boosting already is performed in all cassette decks during recording. If all frequencies are recorded at 0dB level, the 4kHz and 8kHz MOLs often are exceeded, producing unacceptable compression of amplitude. That's why lower levels are used for response tests. When you know each MOL point, you can decide whether or not external high-frequency boosting can be applied to help the overall frequency



**The top waveform** shows a normal incidence of drop-outs (times of low output) when a 8kHz sinewave was recorded and played on a good-quality cassette tape. Compare that waveform with the jagged one below produced by an Avanti brand tape. This was the worst case of drop-outs found during the extensive tests. Excessive drop-puts reduce the HF response and can cause a ragged sound quality. The scope trace was a single sweep that required 0.5s.



**In an effort** to show distortion from tape saturation, recordings were made at the maximum level permitted by the amplifiers. The results were surprising. The Photo-1 top trace shows the undistorted +9dB 400Hz recording sinewave, while the distorted +7.8dB playback waveform is shown by the bottom trace. Part of the peak flattening was caused by tape saturation or compression, and part was produced by amplifier distortion. When the frequency was changed to 8kHz, however, conditions were very different. There was more compression, but it did not cause distortion, since the 24kHz third harmonic was outside the tape's bandwidth. For comparison, the Photo 2 top trace shows the input waveform, and the lower trace shows the maximum 8kHz amplitude (−9dB) that could be obtained (MOL while the input was −3dB). This was 6dB compression, but without distortion as explained earlier. In summary, tape saturation at lower frequencies produces audible distortion, but saturation at high frequencies does not.



**These waveforms** prove the futility of using a low-sensitivity tape and trying to compensate by recording at a much higher level. Photo 1 shows the 0dB, 400Hz recording signal (top trace) and the −6.5dB playback signal (bottom trace). The tape had a weak signal when played, so the recording level was increased to +9dB (top trace of Photo 2) and a 0dB playback level was obtained (lower trace). However, amplifier clipping and tape compression added unacceptable distortion.

response.

In addition, the MOLs give another evaluation of the tape's ability to retain high frequencies.

It is easy to find either MOL. When the 4kHz response is being tested, set the external dB meter to 0dB and increase the recording level until the output amplitude fails to rise with the input. Finally, additional level increases force the output amplitude to decrease. The MOL point has been passed. Go back, slowly rocking the recording-level control to find the maximum dB reading. Write down the maximum reading; it is the 4kHz MOL (although officially, the MOL is 0.5dB below the maximum).

The 8kHz MOL is found just as easily. However, sometimes it is necessary to use a lower dB-meter range, because the MOL is so low at that frequency.

Amplitude compression occurs on an increasing scale when the recording level approaches the MOL point. The only good from this shortcoming is that the compression does not add any audible distortion.

| Brand & type | Type | All figures are in decibels<br>400Hz 0dB | 4kHz −10dB | 8kHz −20dB | 4kHz MOL | 8kHz MOL | Comments |
|---|---|---|---|---|---|---|---|
| TDK AD 90M | 1 | +1.2 | −0.1 | −0.8 | +3dB | −6.5 | Excellent |
| Memorex MRX1 90M | 1 | +1.3 | −1.2 | −1.8 | −1.8 | −9 | |
| Sony SHF 90M | 1 | +1.8 | +0.3 | −0.2 | +3.2 | −6.7 | Good |
| Maxell XL1-S 90M | 1 | +2.6 | +1.0 | +0.6 | +0.6 | −6.5 | Loudest |
| Fuji FX-1 60M | 1 | +1.1 | −0.6 | −0.9 | −0.9 | −7.5 | |
| Unbranded #1 60M | 1 | −6.5 | −5.4 | −7.5 | −1.5 | −12 | Computer tape? |
| Avanti 90M | 1 | −4.0 | −9.0 | −14 | −6 | −19 | HF dropouts |
| Unbranded #2 | 1 | −0.5 | −8.0 | −13 | −5.5 | −12 | |
| Radio Shack Concertape | 1 | −1.6 | −8.4 | −14 | −5.8 | −11.5 | |
| Radio Shack Low Noise | 1 | +0.7 | −1.6 | −3.5 | +1.5 | −10.5 | |
| Radio Shack Gold 46M | 1 | +1.4 | −1.9 | −3.5 | +1.0 | −10.2 | |
| Radio Shack Chrome 90M | 2 | −1.1 | −3.8 | −5.4 | −1.0 | −7.8 | |
| Memorex HB2 90M | 2 | −0.8 | −1.8 | −2.5 | +2.5 | −4.5 | |
| Sony UCX-S 60M | 2 | +0.6 | −1.3 | −1.9 | +2.0 | −4.7 | Good |
| TDK SA 90M | 2 | +0.8 | −1.6 | −2.8 | +2.2 | −5.9 | |
| TDK SA-X 90M | 2 | +1.4 | −0.7 | −1.4 | +3.2 | −3.6 | Excellent |
| Maxell UDXL2 | 2 | 0.9 | −1.9 | −2.9 | +1.7 | −5.5 | |
| Maxell XL2-S | 2 | +0.3 | −1.4 | −2.2 | +2.5 | −4.4 | Excellent |
| Sony FeCr 90M | 3 | +1.7 | −1.6 | −2.7 | −3.0 | −9 | |
| Memorex Metal 4 90M | 4 | +0.8 | −0.8 | −1.4 | +6.6 | +1.0 | |
| TDK MA metal 60M | 4 | +0.2 | −1.8 | −1.7 | +6.0 | +0.4 | |
| Fuji Metal 90M | 4 | +0.6 | −0.6 | −0.9 | +6.3 | +1.0 | |

**Figure 4.** These results were obtained from the five tests for each tape. Actually, the tapes probably have better responses than shown, because the deck previously showed −1.2dB at 4kHz and −2.7dB at 8kHz, according to a standard playback test tape. Remember, the tape response is obtained by comparing the 4kHz and 8kHz figures with the 400Hz sensitivity figures. If both numbers have positive decibels, the higher-frequency number is subtracted from the 400Hz figure to give the relative response. For example, if the 400Hz figure was +1.8dB and the 4kHz figure was +0.3dB, the response was 1.8 minus 0.3 or −1.5dB. Remember, all high-frequency decibels in Figure 4 are lower than the 400Hz decibels. Therefore, all response figures must be minus decibels. If both numbers are negative, just add the two figures and add the minus sign. For example, if the 400Hz figure is +1.2dB and the 4kHz figure is −0.1dB, add them to yield −1.3dB relative frequency response.

## Typical tape measurements

Some typical tape measurements are shown in Figure 4. These figures probably will not correspond to any published previously or to any results you might obtain by similar tests. There are several reasons why this is true, including the following:

- My tests were made using a Technics model M260, a 3-head type. Identical tests were made on my other deck, a Sony 2-head model, and the 4kHz and 8kHz tests were better. But, the Technics was used for all comparison tests because the operation is faster and less complicated. Therefore, the tapes actually have slightly better frequency responses than shown in Figure 4.
- Tape coatings vary considerably. Coating thickness apparently affects the low-frequency response, with a thicker coating giving a higher 400Hz sensitivity. Therefore, 60-minute tapes often have a higher 400Hz sensitivity than do 90-minute tapes made from the same formulation, because the coating is thicker.
- Coating thickness varies on the same individual tape. Therefore, readings can be very different when made at different points on the same tape.
- Readings often change constantly, even with the best of premium tapes, so an average must be reported.

Therefore, if dependable performances are desired, the tests should be repeated with several tapes of each model.

## Mechanical factors

Several mechanical conditions can affect the performance and durability of cassette tapes. Warped plastic cases are an obvious example. A warped case can force the tape pack to become shaped like a convex or concave bowl until the tape jams against the slip sheet and the case, stopping all movement of the tape.

Similarly, any deviation of the rollers and guide pins from true perpendicularity to the tape path can force the tape to wind crookedly and jam.

## Comments

Despite the varying readings obtained, it is worthwhile to test tapes for yourself. If the tests are repeated at scattered points along the total tape length, a fairly accurate evaluation of general characteristics can be obtained with only one tape cassette. However, it is advisable to test more than one of each type.

Many interesting details were omitted from this report, so if you have a question, please write to the editor. The next article in this series will present simple methods for obtaining best-quality recordings and solutions to common problems of high-speed tape duplication.

# At your service

## August survey results

| Electronic equipment serviced (consumer) | Total % | Repair shops % | Retail stores % | Industrial % |
|---|---|---|---|---|
| Televisions | 89.5 | 95.7 | 94.2 | 73.9 |
| Radios | 83.1 | 89.3 | 87.7 | 67.8 |
| Amplifiers, tuners, receivers | 80.7 | 85.4 | 88.1 | 65.7 |
| Audiotape, cartridge cassette recorders | 71.3 | 74.8 | 80.4 | 56.6 |
| Turntables | 70.5 | 77.0 | 85.1 | 46.0 |
| Car radios | 62.3 | 68.0 | 67.7 | 46.9 |
| Speakers | 61.0 | 63.9 | 74.9 | 44.0 |
| Intercoms | 48.3 | 46.8 | 53.1 | 47.0 |
| Portable power supplies | 45.2 | 40.7 | 45.2 | 54.3 |
| Videotape recorders | 44.5 | 42.9 | 56.0 | 38.7 |
| CB radios | 34.3 | 37.3 | 32.8 | 29.8 |
| TV games | 32.4 | 34.0 | 39.0 | 24.2 |
| Security equipment | 26.5 | 23.4 | 24.8 | 34.0 |
| Video cameras | 25.1 | 19.3 | 30.5 | 31.8 |
| Leisure equipment (fish finders, metal detectors, etc.) | 24.6 | 25.9 | 25.8 | 21.2 |
| Telephone equipment | 23.9 | 22.2 | 23.6 | 27.2 |
| Home/personal computers, microcomputers | 23.1 | 18.7 | 18.9 | 35.3 |
| Videodisc players | 22.5 | 20.9 | 38.2 | 12.7 |
| Satellite earth stations/TVRO | 10.7 | 8.7 | 16.3 | 9.8 |
| Radar detectors | 8.5 | 8.6 | 9.2 | 8.0 |
| Other | 14.0 | 16.1 | 17.0 | 7.5 |
| Base | 1272 | 658 | 275 | 339 |

In the August 1982 issue, we incorporated the first of several questionnaires designed to find out a little more about the interests and information needs of our readers.

The response to that questionnaire was overwhelming: Nearly 1300 were returned to us. Because of the way the questionnaire was handled, bound into the issue, rather than mailed to a statistically selected sample, the results that will be discussed here apply to the people who mailed in the questionnaire and do not warrant statistical projection over the entire magazine circulation.

The first question in that questionnaire asked what type of facility the individual works in. Of those who returned the questionnaire, slightly more than half said that they work in a radio, TV or electronics service shop. Slightly more than 20% work in a retail store with service shop, and a little more than 25% are involved with electronics maintenance in a factory, office or institution (school, hospital, etc.).

The variety of equipment serviced by respondents to the questionnaire was amazing. On the consumer side, **ES&T** readers service everything from televisions, radios and stereo equipment to garage door openers and fence chargers. And there's no question that the one single type of equipment serviced by most of those who returned the questionnaires was the television. Just shy of 90% of all of the responses indicated that they service televisions, and that percentage was brought down by the industrial/institutional respondents, only 74% of whom service televisions. Among the respondents who work in independent repair shops, 96% said they service televisions, and slightly more than 94% of those who work in a retail store service shop service televisions.

Radios followed closely behind televisions. More than 83% of respondents service radios (89% by independent repair shops, 88% retail store service shop and 68% industrial/instutional).

Other consumer equipment that more than 50% of respondents service were amplifiers/tuners/receivers, 81%; audiotape/cartridge/cassette recorders, 71%; car radios, 62%; and speakers, 61%.

**Electronic equipment serviced (industrial/commercial/medical)**

| | Total % | Repair shops % | Retail stores % | Industrial % |
|---|---|---|---|---|
| Intercom equipment | 36.9 | 32.8 | 37.2 | 44.8 |
| Video systems | 29.8 | 23.9 | 26.9 | 43.3 |
| Closed-circuit TV | 29.3 | 23.1 | 29.8 | 41.0 |
| Audio-visual equipment | 29.1 | 22.6 | 26.9 | 43.4 |
| Paging systems | 26.3 | 20.4 | 27.0 | 37.6 |
| Industrial test/measuring equipment | 25.4 | 15.2 | 12.1 | 56.0 |
| Alarm signal/security systems | 25.3 | 21.6 | 20.0 | 36.6 |
| Clocks | 24.3 | 22.1 | 18.9 | 32.7 |
| Instrumentation | 23.9 | 14.6 | 13.2 | 50.8 |
| Office electronic equipment | 22.5 | 16.4 | 15.4 | 40.5 |
| Sensing and control | 20.1 | 11.6 | 10.5 | 44.4 |
| CATV | 19.9 | 14.9 | 23.6 | 26.9 |
| Land mobile radios | 19.1 | 18.6 | 13.9 | 24.8 |
| Computers, data processing | 17.9 | 9.3 | 8.4 | 42.5 |
| Other security equipment | 17.4 | 15.6 | 13.5 | 24.1 |
| Telephone equipment | 17.2 | 12.7 | 13.0 | 29.2 |
| Data acquisition | 9.4 | 3.7 | 3.0 | 25.6 |
| Satellite earth stations/TVRO | 9.1 | 6.9 | 13.1 | 9.8 |
| Medical test/measuring equipment | 8.8 | 6.5 | 4.8 | 16.6 |
| Computer-aided design/manufacture | 8.3 | 3.6 | 2.9 | 21.9 |
| X-ray equipment | 3.1 | 1.5 | 0.8 | 8.4 |
| Other | 7.1 | 4.5 | 5.7 | 12.9 |
| Base | 1272 | 658 | 275 | 339 |

**Job title**

| | Total % | Repair shops % | Retail stores % | Industrial % |
|---|---|---|---|---|
| Owner | 44.9 | 64.8 | 48.0 | 3.5 |
| President | 2.4 | 2.6 | 5.1 | ..... |
| Manager, supervisor | 9.1 | 4.6 | 16.0 | 12.4 |
| Engineer | 3.3 | .5 | ..... | 11.5 |
| Electronic technician | 32.3 | 22.2 | 29.0 | 54.6 |
| Service rep | 0.6 | ..... | ..... | 2.1 |
| Instructor (in-plant/school) | 2.7 | ..... | ..... | 10.0 |
| Other | 1.0 | ..... | 0.4 | 3.5 |
| No answer | 3.7 | 5.3 | 1.5 | 2.4 |
| Base | 1272 | 658 | 275 | 339 |

### Industrial/commercial/medical equipment

On the other side of the coin is the non-consumer equipment. There was no single type of equipment that an overwhelming number of respondents serviced. But then that's not surprising, because **ES&T** is primarily aimed at servicing consumer electronic equipment.

It was interesting, though, to note that some significant numbers of respondents indicated that they service some of this equipment. Particularly interesting is the fact that many people who work in either an independent service shop or a retail store service shop from time to time are called upon to service office electronic equipment or security equipment.

A look at the list of non-consumer equipment serviced by respondents reveals that seven items are serviced by more than 25% of respondents to the questionnaire: 37% service intercom equipment, 30% video systems, 29% CCTV, 29% audio-visual equipment, 26% paging systems, 25% industrial test/measuring equipment and 25% alarm signal/security systems.

### Management

One question on the questionnaire asked for job title, and the response was revealing. More owners and managers responded (45%) than did service technicians (32%). There were also a few engineers (3%) and instructors (3%).

To all of you who filled out the questionnaire, we thank you. This information is very valuable to us at **ES&T**, and it will help us determine what kinds of articles and other information to publish. For example, there's little question that we need to continue to concentrate on TV, radio and stereo equipment. Results of some of the other questionnaires have been compiled and others are still being worked up. All this information will certainly help us keep **ES&T** on track.

# Products

### Amperage extender

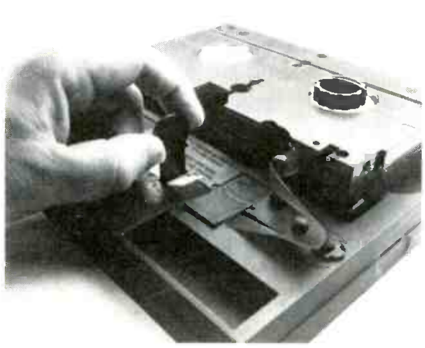
*A. W. Sperry Instruments* has developed the Multi-Tran model MT-1000 amperage extender. The MT-1000 can be used with not only AWS Snap-Around meters, but

also with any make Snap-Around whose jaws fit the sensor coil with an I.D. of $\frac{3}{4}$" x $\frac{15}{16}$". The Multi-Tran extends amperage readings by 10 times, up to 1000A ac, when a maximum of 100A ac is read.

Circle (75) on Reply Card

### Videocassette repair system

*Total Video Supply* announces the creation of a new system for repairing damaged or broken videocassettes. Named the VideoMate Tape-Mender, the M-500 repair system includes



everything necessary to save valuable tape with ease.

At the heart of the system is a work station that will securely hold either a Beta or VHS cassette with the door open. Special pins then guide the tape from the cassette to the repair area, correctly orientating it with the base side up. Tape movement is accomplished with a special hub drive unit that is included.

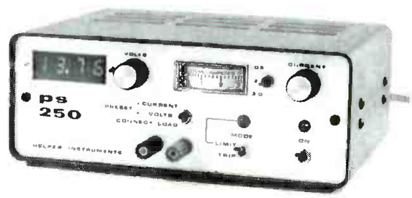
Circle (77) on Reply Card

### Power supply

A new precision power supply, model PS-250 from *Helper Instrument,* has been designed to provide ultimate safety in the testing of pagers and portables.

The supply features a precise digital voltmeter and 3-range ammeter to constantly monitor the fully controllable output of 0.75V to 19V at 0A to 3A.

Current limit or current trip modes are provided with audible and visual over-current alarms. Instant trip circuitry protects deli-

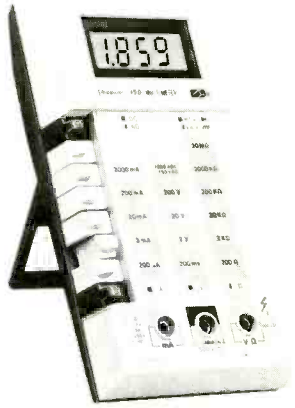



cate portable circuits from the accidental shorts that can occur during service work. No crowbar or high capacitance output circuits are employed.

Circle (78) on Reply Card

### Hand-held multimeter

In addition to providing 26 ranges and accuracy readings to 0.6%, the *Philmetric* model MD 150, 3½-digit, LCD-readout multimeter has side-positioned push-buttons for fast range selection, selected voltages for resistance measurement and extra $200\mu A$ scales for ac/dc readings. It will handle a maximum ac voltage of 750V and is furnished with test leads that have test prod finger guards to deter any accidental shock hazard, an ABS plastic




enclosure, a stand-up easel, portable carrying case and a 9V battery.

Circle (79) on Reply Card

### Emergency solder

A new, tape-like solder strip for quick, on-the-spot soldering repairs has been introduced by *Multicore Solders.* Called Emergency Solder, it can be easily carried in a shirt pocket or stored flat and requires only an ordinary match or candle flame to melt the solder.

Multiple cores of rosin flux are incorporated into the flat strips during the manufacturing process, eliminating any requirement for a

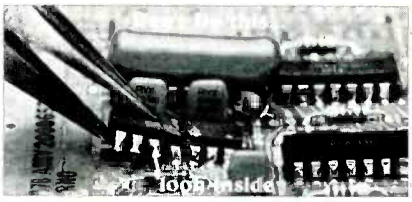

separate fluxing application. The flux is non-corrosive and non-conductive, and need not be removed after soldering.

Circle (80) on Reply Card

ES&T

# Literature

A new 6-page, full-color brochure provides complete product information and capability description for the **Automated Production Equipment** line of desoldering/repair equipment.



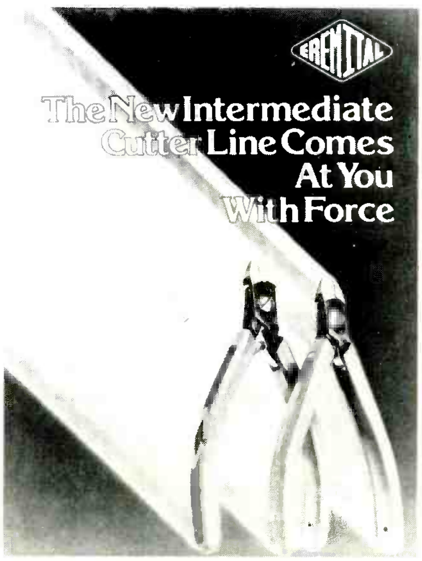
A.P.E.

Highlights of brochure include a focus on new products for solder/component removal.

Circle (100) on Reply Card

The **EREM Corporation** has just introduced a catalog for its new Eremital Intermediate line of wire cutters for the electronic industry.

The catalog lists all the features such as chrome vanadium tool steel, two types of cuts (semi-flush and ultra-fine flush), each distinguished by color-coded




handles, a precision screw joint and an applied 63/65 rockwell hardness for a long-lasting cutting edge.

Circle (105) on Reply Card

The Joint Electron Device Engineering Council (JEDEC) standard no. 100 is now available from the Engineering Department of the **Electronic Industries Association.** This new JEDEC standard is an updated version of what was formerly known as JEDEC Publication no. 100, which is used extensively by the industry to ensure uniformity in the application of terminology among those individuals and corporations involved with the design, development, manufacture, test, sale and use of microcomputers and their ancillary devices.

Copies of the document are available for $12 each.

Circle (101) on Reply Card

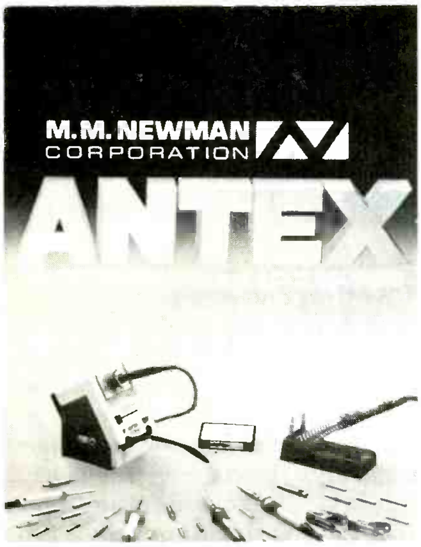
A new brochure from **Fluke** features the company's three 4½-digit low-cost multimeters–two hand-held and one benchtop unit.

The brochure contains product descriptions, full specifications, pricing and ordering information for all three instruments. Included are the two newest members of the 4½-digit family, the 8060A and 8062A hand-held DMMs. These microcomputer-based meters offer full 4½-digit resolution with 200mV, 200mA and 200Ω ranges. Also, the 8060A features frequency measurements to 200kHz, dB measurements and conductance.

Circle (102) on Reply Card

A complete catalog of miniature, precision soldering irons and accessories that features more than 40 interchangeable tip styles for professionals and hobbyists is being offered by **M. M. Newman Corp.**

The *Antex Soldering Irons And Accessories Catalog* features six different models of miniature precision irons, interchangeable tips, and a temperature-controlled




soldering station, stand and sponge tray.
Circle (106) on Reply Card

An expanded ECG Semiconductor Master Replacement Guide lists approximately 3100 individual ECG solid-state replacement devices, used as substitutes for domestic and foreign types in entertainment, commercial and industrial equipment, plus industrial maintenance, repair and operations.

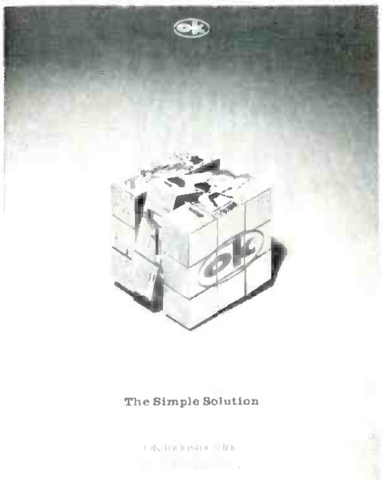
The 545-page guide is from the Distributor & Special Markets Division of **Philips ECG.**
Circle (107) on Reply Card

A new catalog illustrating and describing electronic tool kits, hand tools, test equipment and related products, is now free from **ETCO Electronic Tool.**

The 48-page catalog is pocket size, shows prices for each item, and offers free gifts with selected purchases.
Circle (109) on Reply Card

**Jonard's** new catalog ref. 350, shows many additional tools recently added to the line. The catalog fully illustrates Jonard's complete line of wire-wrapping and unwrapping devices, which include hand wrapping tools, hand unwrapping tools, manual wrapping and unwrapping guns and accessories, and wrap and unwrap tool kits.
Circle (104) on Reply Card

Catalog 82-36P from **OK Machine and Tool** features 108 pages of tools and equipment for



# Marketplace





electronics and telecommunications, manufacturing, field service and labs, as well as schools and hobbyists. The catalog is divided into eight sections covering a complete line of wire-wrapping tools, testing and troubleshooting tools, wire and cable, assembly products and aids of various types, and including N/C wire-wrapping machines and support systems.

Circle (103) on Reply Card

**Vaco Products'** new reversible ratcheting handles with interchangeable driver blades are featured in their new Ratchet Driver Catalog no. SD-272. The



catalog contains complete descriptions and illustrations of Vaco's two new reversible ratcheting handles, no. 90-1R regular-style handle and no. 90-4R T-handle.

Also featured are two new roll-up pouch kits containing the new ratcheting handles.

Circle (108) on Reply Card

A new *A P Products* catalog includes expanded information, detailed specifications and larger photographs of the A P Products line of solderless breadboarding, testing and interconnection devices.

A new, smaller, total product line catalog also will be produced to supplement this new industrial line publication.

Circle (92) on Reply Card

ES&T

# News

## ICS offers computer courses around country

Integrated Computer Systems will be offering a course on computerized robots and one on CAD/CAM technology from now until July. The courses will be held in San Diego, Boston, Los Angeles, Washington, San Francisco and Philadelphia, and cost $845 each.

For more information contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., P.O. Box 5339, Santa Monica, CA 90405; 1-213-450-2060.

## Poor skills keep students from engineering programs

Approximately 75% of today's high-school graduates have an insufficient math and science background to even meet minimum application requirements for engineering programs, regardless of grades or other qualifications, according to a report recently published by the Electronic Industries Association's Human Resources Council.

This report is the first such compilation of data designed to develop a grass-roots awareness of the dangerous shortage of qualified high school graduates entering engineering and certain other technical programs. The document, which is currently available through EIA, reviews key factors affecting industry's anticipated demand for persons with critical technical skills (such as computer professionals and software engineers).

More information and copies of the report may be obtained by contacting the EIA Human Resources Council, 2001 Eye St., N.W., Washington, DC 20006; 1-202-457-4925.

ES&T

# Classified

Advertising rates in the Classified Section are 50 cents per word, each insertion, and must be accompanied by payment to insure publication.

Each initial or abbreviation counts a full word.

Minimum classified charge $10.00.

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Classified columns are not open to advertising of any products regularly produced by manufacturers unless used and no longer owned by the manufacturer or distributor.

## For Sale



**AUTOMOBILE RADIO** and tape replacement parts: Delco, Chrysler, Philco-Ford, Motorola, Panasonic and many others. Large inventory. Laran Electronics, Inc. 3768 Boston Road, Bronx, NY 10469. (212) 881-9600, out of New York State (800) 223-8314. 5-79-tf

**ELECTRONIC SURPLUS: CLOSEOUTS, LIQUIDATIONS!** Parts, equipment stereo, industrial, educational. Amazing values! Fascinating items unavailable in stores or catalogs anywhere. Unusual FREE catalog ETCO-011, Box 762, Plattsburgh, N.Y. 12901. 6-78-tf

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**APPLICATION ENGINEER:** Due to growth, Sencore has immediate openings for 2 Application Engineers in our Sioux Falls, SD facility. Key responsibilities will include: writing application articles for our monthly 24 page technical publication with national circulation of 100,000, working closely with our design team in new product development and testing, as well as creating effective seminar material including reference material and video tape productions. Successful candidates will have a minimum 2 year formal electronics education, or equivalent, with 4 years desired. Knowledge of digital circuits is a must. Past technical writing is a prerequisite. Good communications skills necessary. This position requires a strong background in test instrumentation and video, communications and general maintenance. At least 2 years practical hands-on experience necessary. Sencore offers a competitive salary, full benefit program, profit sharing, and potential for growth. Located in Sioux Falls, SD, one of America's Top Ten Small Cities. If this sounds like your kind of opportunity, send resume to: Doug Bowden, Sencore, 3200 Sencore Drive, Sioux Falls, SD 57107. 1-83-2t

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