The how-to magazine of electronics...

ELECTRONIC™
Servicing & Technology

FEBRUARY 1987/$2.25

Disk drive/printer servicing • MTS: TV sound in stereo, part 2

Troubleshooting horizontal ICs, part 1

Testing serial communications with a break-out box

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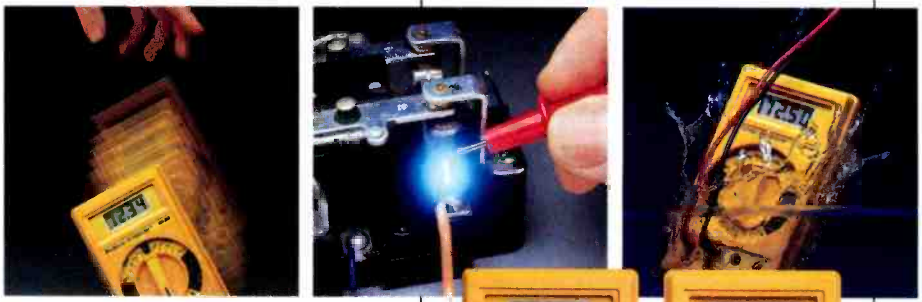

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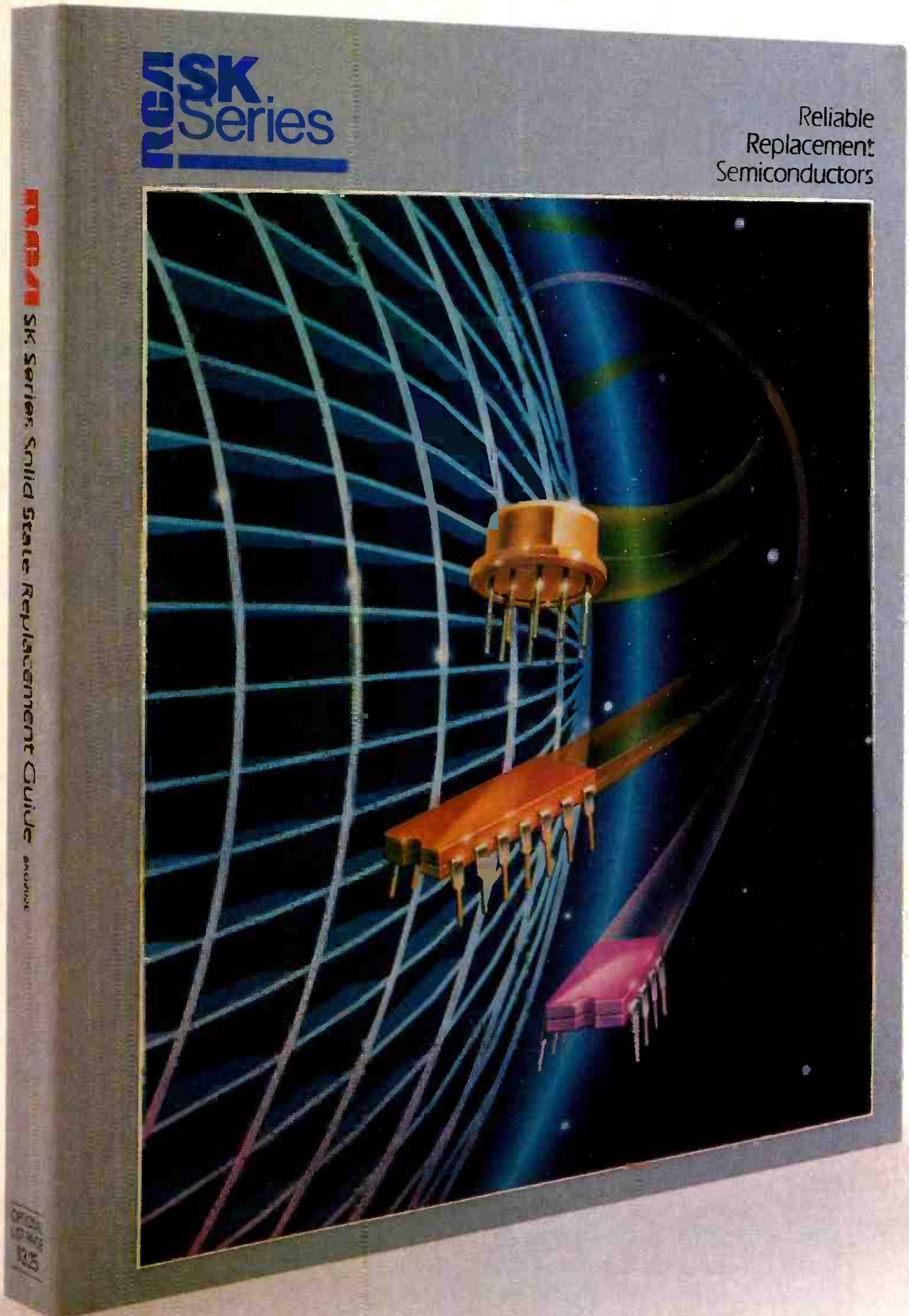

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RCA SK Replacement Solid State

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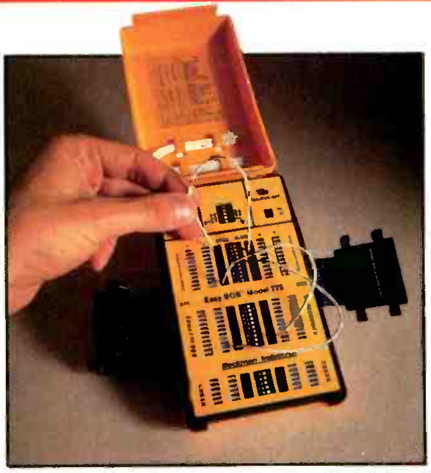
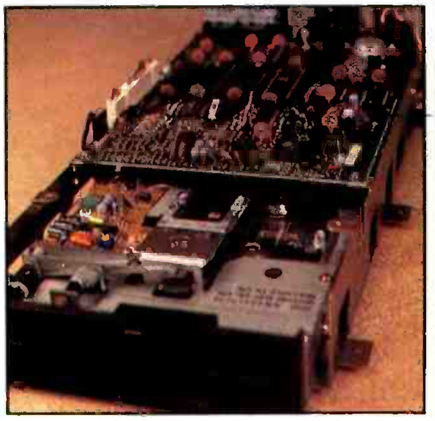
The how-to magazine of electronics...

ELECTRONIC
Servicing & Technology

Volume 7, No. 2 February 1987



page 22
A break-out box is a hand-held, portable test instrument that may use faceplate voltage to simulate missing signals in solving computer communication problems. *(Photo courtesy Beckman Industrial.)*



page 12
According to the author, disk drives *are* delicate, but need not be treated gingerly as if they were cracked eggs.

Departments:

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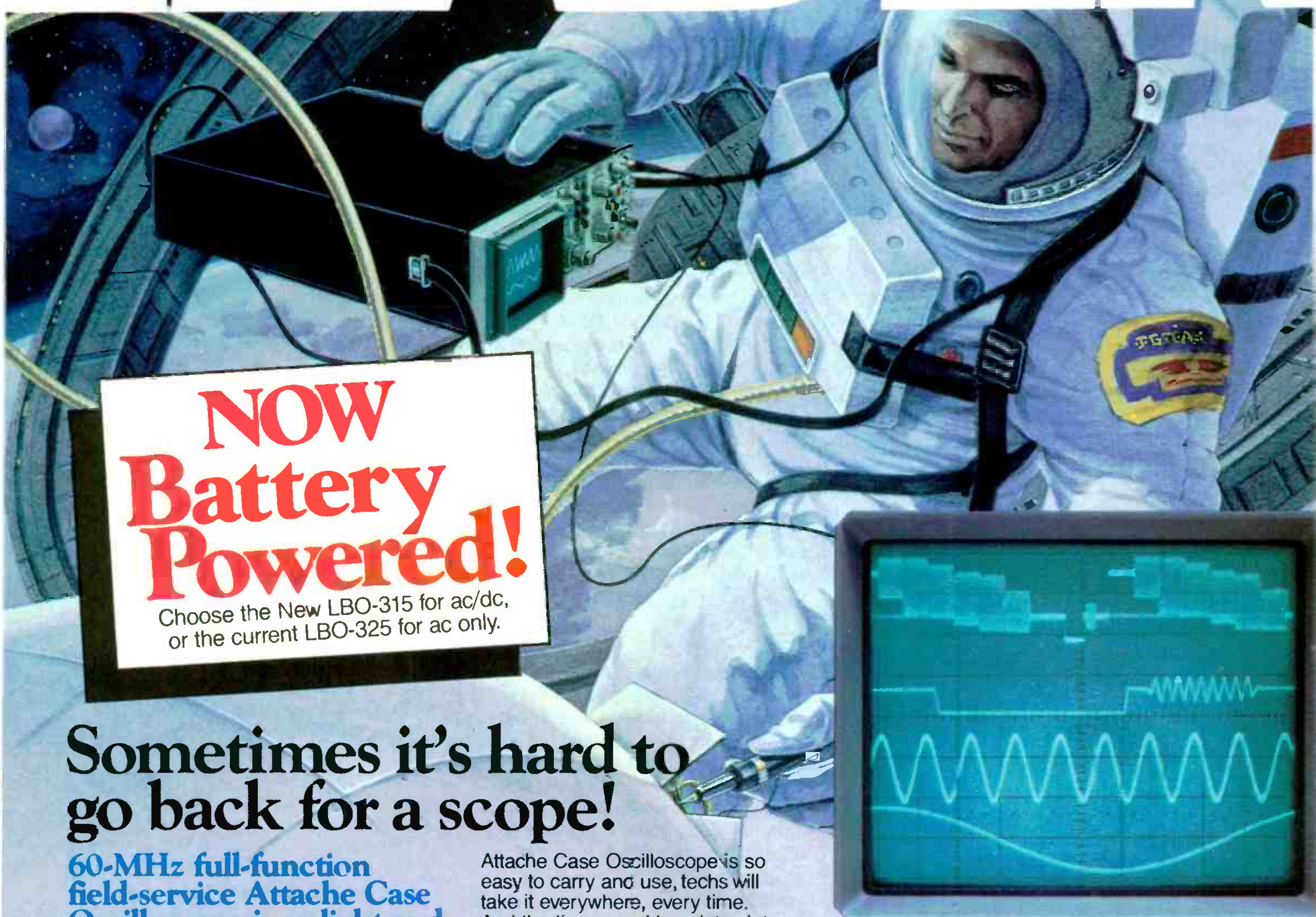

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Mathematics in electronics

A lot of people get bent out of shape when we try to introduce mathematical considerations into discussions of electronic servicing and electronic technology. "Never mind the math," runs the argument, "just give us the facts."

Math does sometimes get difficult and confusing: There's algebra and trigonometry, geometry and even calculus, whatever that is. Unfortunately for those of you who don't care to be exposed to the rigors of mathematics, electronics is a largely mathematical pursuit. You just can't separate electronics and mathematics.

Take a simple case: two parallel resistors. If you want to calculate the equivalent resistance you have to deal with the formula

$$Req = \frac{R_1 R_2}{R_1 + R_2}$$

Here's another simple example, but one where knowing just a little math will help you analyze a problem in a circuit. Let's say you want to find the current flowing in some circuit branch, but you really don't want to break the circuit to insert an ammeter. In many cases you can figure that out using the most rudimentary of mathematical calculations. If there's a resistor in that branch, you can measure the voltage across the resistor, then divide that value by the value of resistance shown by the color bands. To hedge your bets, you might calculate a low value and a high value by figuring in the tolerance marked on the resistor.

Some electronics values don't even have meaning unless the mathematics behind them are understood. Rms is a good example. If you have a regular alternating signal, say a sinewave, and if you try to calculate the average value, you find it's zero. That's because the value of the signal above the zero line is exactly equal to that below the zero line. So what do you do to find the effective value of such a signal? Simple! Square the signal (squaring makes the whole thing positive), find its average value, then take the square root (hence rms: you're finding the *root* of the *mean* of the *square*).

Here's another example: When you put a signal into a series circuit consisting of a resistor and capacitor, say a square wave, and look at the output you'll find that you're looking at that time constant curve in which the voltage is climbing toward the value of the input, but never quite makes it. Such a circuit is said to be an integrator, but just what does that mean?

You'll have to refer to that branch of mathematics developed independently by the Messrs. Newton and Leibnitz, the calculus, to find an answer for that. Basically, though, the circuit produces an output voltage that is proportional in value to the area under the curve of the input signal.

Examples of the mathematical nature of electronics abound: the relationship between frequency and impedance, the relationship between frequency and wavelength. In electronics, mathemetics is everywhere.

"But mathematics is hard." It sure is. "And a lot of electronics theory and servicing will yield without math." Also true. In fact, there's a lot of electronics where it doesn't make any sense to consider a mathematical approach. In such cases, forget the math. But math can be useful both in understanding electronics theory and in servicing electronics products. Don't harden your mind against using math where it can be useful.

Nils Conrad Persson

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News

Electronics design by computer to triple by 1990

The application of computers to help engineer new electronic devices is snowballing at a rate near 30% a year in the United States, says a new study, creating "one of the most exciting technological developments of this century" and what could well be a model that other disciplines will follow.

"Computer-Aided Electronics Engineering (CAEE) in the U.S." (No. 1632), a 312-page report just completed by Frost & Sullivan, says the old distinctions between computer-aided design (CAD) and engineering (CAE) have blurred. CAE in making electronics – integrated circuits or circuit boards – now encompasses the entire design cycle from modeling the behavior (logic) of a system to putting out the complete specifications of a workable design. The fact that today's computers are vastly better than what was available five years ago "has enabled the leap from the drafting room to the engineer's desk," Frost & Sullivan says. It predicts the installed base of CAEE systems will grow some 29% a year between 1985 and 1990 – from an estimated 58,000 seats in 1986 ("seat" being either a computer or workstation terminal) to about 151,000 by 1990.

Improperly repaired computers explode

Three Compaq portable computers have exploded because they were rewired incorrectly, said Jeff Stives, spokesman for the Compaq Computer Corporation, according to a recent Associated Press story. No one was hurt, but the explosions were sufficiently forceful to have caused injuries.

When technicians rewired the systems boards of these Portable II computers, they incorrectly connected to a 5V power supply, each of the 3.6V lithium batteries that run the computers' internal clocks. The batteries are not rechargeable, and became drained when the computers were turned *off*. The spent batteries exploded when operators turned *on* their computers. To forestall the possibility of more blasts, the company is offering free replacement parts.

Stives said that Compaq will replace the systems boards of all models of the Portable II even though there is no danger of explosion unless the computers are improperly repaired. ES&T

PLEASE NOTE

SYMCURES and T.TIPS

Beginning in January, ES&T will pay the following rates for reader-submitted items accepted for publication:

SYMCURE per page – $60

TROUBLESHOOTING TIPS – $25 each

If you have solved one or more difficult servicing problems, share these unusual experiences with other ES&T subscribers.

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INTERTEC PUBLISHING CORPORATION

Technology

New production technique enhances CD quality

An improved production technique introduced by General Electric promises optical variations in compact discs to a uniformly low level, resulting in enhanced disc performance. It's the result of a joint development project involving GE, Engel, and Caco Pacific Corporation, bringing together advances in materials, injection-molding technology and mold design.

The optical quality of a compact disc is essential to its performance. In a CD player, the digitally encoded music stored on a disc is "read" by passing a laser beam through the disc and reflecting it off the metalized back surface. Defects in the disc bend or diffract the laser beam, degrading the sound quality.

Commercial CD plants operate under strict quality-control procedures, yet the reject rate has been high. As a result, a major effort has been mounted to reduce *birefringence*, the technical term for optical defects that can distort the laser beam.

GE tests indicate that CDs created by the new fabrication technique show a factor of three reduction in optical birefringence over discs made by conventional means from the same resin.

A CD is fabricated by injecting molten plastic into a mold. In the conventional approach, the plastic disc – as it cools and solidifies – shrinks slightly away from the mold's edge.

The new CD fabrication technique counteracts the shrinkage problem with an optimized coining mold used in conjunction with novel injection-molding machine control technology. After the molten plastic has been injected, the molding machine employs a patented toggle mechanism to decrease the mold's thickness slightly while the plastic is hardening and shrinking. This keeps the mold's surface in firm contact with the plastic as it cools.

Because of its accuracy in reproducing sound, the CD has revitalized the record industry. A CD stores musical information in digital form, in strings of 1's and 0's represented by up to 15 billion microscopic pits in the disc's surface. They perform the same function as the grooves in a conventional long-playing record.

After the pits are molded into the transparent plastic disc, it is given a reflective coating and covered with a protective sealant. As the completed disc spins in a CD player, a laser beam is reflected off it, reading the encoded data and relaying the information to a computerized sensor for ultimate conversion back to sound. ES&T

Feedback

Letter to Wallace Harrison
Director of Communications
NESDA/ISCET

I am considering going back into the field of electronics, with a strong possibility of my own business. With your experience and up-to-date knowledge of the electronics industry, would it be more feasible to get into VCR servicing, or computer servicing?

I know that the sale price on both of these items has dropped considerably. As with some of the television sets that are now throw-away items, I do not want to start into something that will not pay off after investing in the necessary test equipment for servicing.

Any information you send me on the prospects of VCR servicing, computer servicing, hands-on training schools, or courses to gain experience would be deeply appreciated and very helpful in deciding which servicing to start.

Robert J. Horsley
Buffalo, NY

Your letter poses some very difficult questions.

As you know, electronics is a rapidly changing technology. The businesses that serve the industry must also be fast-changing. Based on the skimpy information you provided about yourself, I'd have to say that, if you're just "thinking" about getting into the electronics service business, you shouldn't.

Not only does this complex technology undergo constant change, the products are also becoming ever-more reliable. And, as you noted, the prices for these better (and more complicated) products keep dropping. This means that they don't need repairs nearly as often and, when they do, the low replacement cost won't justify any kind of major repair. More businesses are vying for fewer repairs on less-expensive products. Radios have been throwaway items for many years. This has become true of many TV sets. It's becoming true for VCRs and, in some cases, even computers. To top it off, virtually no manufacturer will pay profitable rates to do in-warranty service and, by the time the product is out of warranty – and does fail – it's bordering on obsolescense.

That's not to say that you can't make a living in the business. We have a number of members who are doing quite well, thank you. But you are pretty much going to have to decide whether you want to be a technician or an owner/manager. There aren't too many people who can adequately do both jobs anymore; particulary in a small 1- or 2-man operation. If you have to deal with all the pressures of running a business (acquiring capital, generating business, preparing and interpreting profit-and-loss statements, maintaining cash flow, managing employees, dealing with customers, complying with record-keeping, tax and licensing requirements, etc.), you don't have enough time left over to repair the product AND keep up with the technology. By the same token, most people who work the service bench are ill-prepared for business management. Also, as you indicated, expensive test equipment is needed to tend properly to today's complex electronic circuitry.

If you have extensive training in business management – and have access to lots of capital – and can readily employ the number of competent technicians you will need, and have studied the market in your area, then you might well want to start your own business. If you don't have management skills and/or capital but do have a solid background in electronics theory (or can get it), you might want to get your knowledge updated at a good technical school and go to work as an electronics technician. (Good technicians are hard to find and can command a pretty good salary in today's market if they can repair the product fast enough for the company to profit from volume.) Or, you may want to purchase an existing business. That way, you could start with a customer base, some in-place test equipment, probable access to good technicians, and often can work out long-term financing.

For more specific information, you might want to contact the trade association in your area. If so, contact Mr. Paul Totaro of the Western New York Electronics Guild at 490 Grant St., Buffalo, NY 14213.

Wallace S. Harrison
Director of Communications

10-year index available, catalogued according to TV manufacturer

In response to Mr. Jim Watkins letter to you concerning a 10-year index of articles, Symcures, tough dogs, we maintain such a file on all electronic magazines. The index is catalogued by TV manufacturer: Find the TV model number you need information on and you have a 10-year history of the various defects.

If Mr. Watkins would like a copy (or anyone else for that matter) drop us a line for prices.

Larry Gribbin
Farrell Electronics
127 Providence Ave.
South Portland, ME 04106

Editor's Note: *As a service to our readers,* **ES&T** *is publishing Mr. Gribbin's full address, along with a sample from the index he describes in his letter.*

1973 January *This is a portion of one page from the* ***ES*** *Symcure file.*

Pa. 8	Admiral 1K10-1A -	Inter-weak Pix & Sound
	Admiral 3H10 -	Can't Lock Color
	Admiral 1K10-1A -	Excessive Brightness; Weak Video
	Wards GEN-11960A -	No Vert. or Horiz. Lock
	Admiral K10-2A -	Insufficient Ht: Hold at one end
	Wards GEN-11960A -	Pix bending and Horiz Instability
Pa. 12	GE C1/L1 & C2/L2 -	Distorted Sound on CATV
Pa. 12	Magnavox T979 -	Bright Horiz. Line Moving Upward
	Magnavox T936/T956/T957 -	Black Vert. Line in Pix
Pa. 12	Sony KV-1710/1720 -	Black Vert. Line in Pix
	Sony KV-1510 -	Red Smears on B-W
February		
Pa. 8	Silvertone 528;4347 & Similar -	Excessive Color & Reddish Tint
	Silvertone 528;4347 & Similar -	Several Horiz. Bars in Pix

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Features	2230	2220
Analog/Digital Storage BW	100 MHz	60 MHz
Max. Sampling Speed	20 MS/s	20 MS/s
Record Length	4K/1K (selectable)	4K
Save Reference Memory	One, 4K Three, 1K	One, 4K
Vertical Resolution	8 bits 10 bits (AVG mode) 12 bits (AVG mode over bus)	8 bits
CRT Readout	Yes	No
Cursor Measurements	Yes (storage mode)	No
GPIB/RS-232-C Options	Yes ($850)	Yes ($550)
Battery-Backed Memory (save 26 waveform sets)	Yes (inc. with 2230 communications options)	No
Price	$5150	$4150

Both scopes offer optional GPIB or RS-232-C interfaces. With either option the 2230 also includes battery-backed memory that provides 26K of keep-alive CMOS memory—for storing up to 26 waveform sets.

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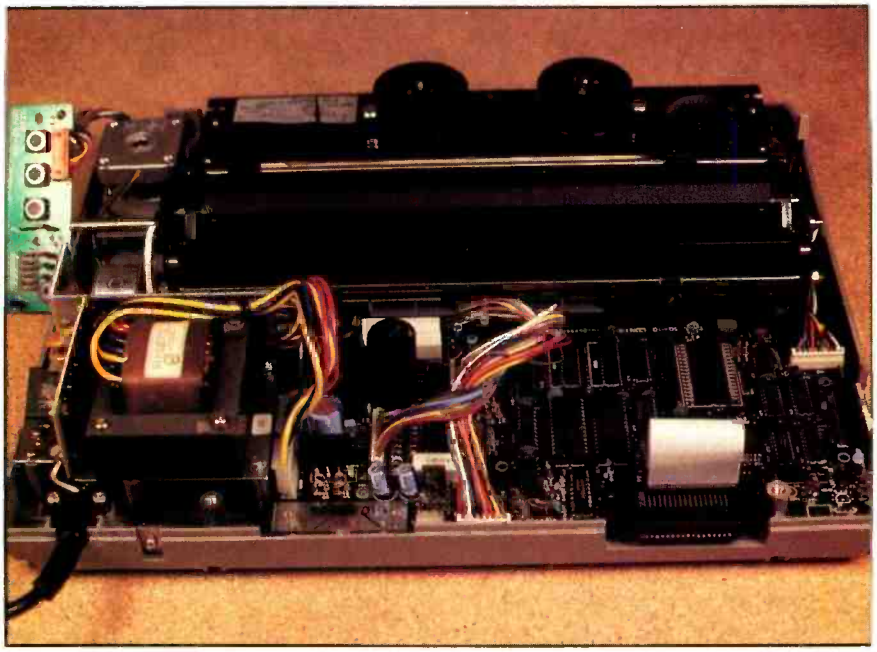
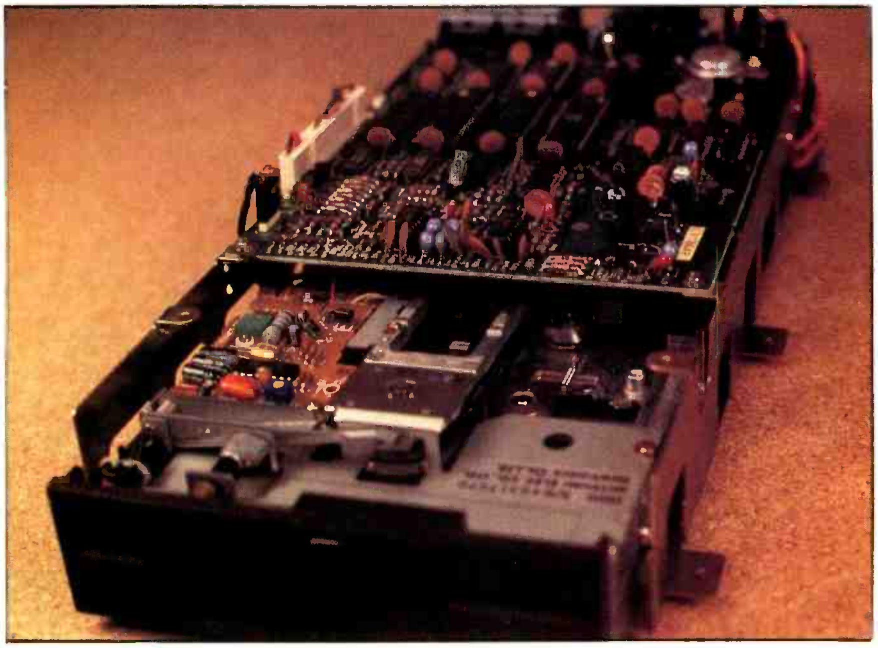
Circle (5) on Reply Card

Disk drive/printer servicing

By Conrad Persson





This article is an introduction to disk drive and printer servicing, to familiarize readers with the physical realities of these devices, how they're constructed, how to get at the operating parts, general trouble symptoms and possible causes. There are so many different types and capabilities that it would not be possible to get into specific symptoms and cures.

Physical characteristics

Printers and disk drives are fragile and must be handled with care both mechanically and electrically. That means that when handling these units, you must be careful not to jar them or drop them. There are mechanical components that might jog out of position, become misaligned or both.

Electrically, these units are fragile, too; always remove power before connecting or disconnecting anything. Connecting or disconnecting peripherals to or from the computer with power applied to the computer, to the peripheral or to both may be harmful or fatal to either unit.

It also is important to follow the correct sequence of operations and observe the correct procedures when operating or servicing a computer system.

On the other hand, these units are rugged enough to withstand normal handling during servicing, and so you needn't handle them as though they were cracked eggs, either. When necessary, you can turn one over to remove screws or otherwise gain access to the underside of the unit; do be gentle and careful.

And don't forget, most of these products contain electronic components such as integrated circuits that are susceptible to damage from electrostatic discharge, so take precautions.

Diagnosing the problem

When a malfunction occurs in a computer peripheral such as a printer or disk drive, the first diagnostic step is to isolate the actual cause of the problem: The problem might be in the peripheral that's exhibiting the problem, or it might be anything else, such as the connecting cable, connectors at either end of the cable, any kind of interface device between the computer and the peripheral, or it could be a computer hardware or software fault.

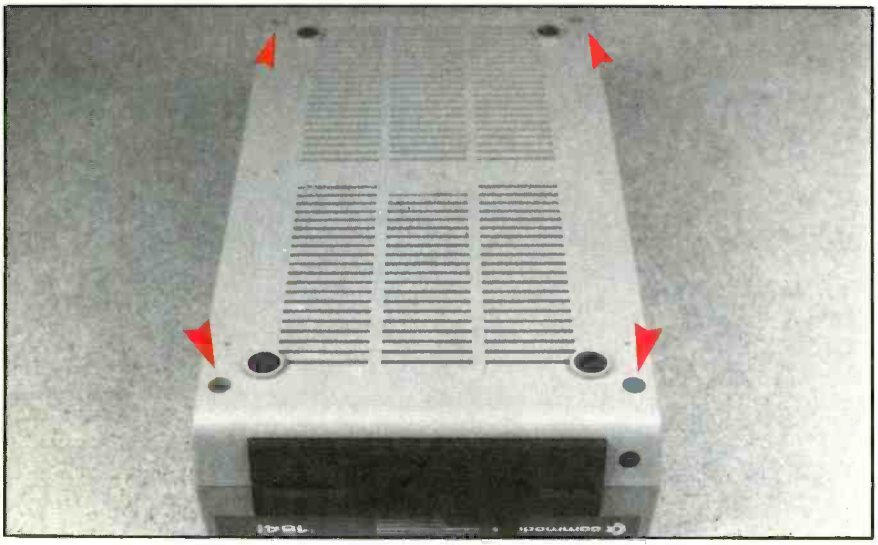
Diagnosing a malfunction in a computer peripheral demands the same logical, step-by-step procedure as troubleshooting any other consumer electronic product. Here's one possible sequence of questions you might ask when a printer or disk drive malfunctions.

- What is the exact nature of the malfunction? Did the input fail to respond to a command, or was it operating normally and then malfunctioned?
- What kind of program was running at the time?
- Has this happened before? Were the circumstances similar? Was the program the same one?
- Is the problem temperature related? (Feel the heat generating areas of the unit and see if the temperature seems excessive.)

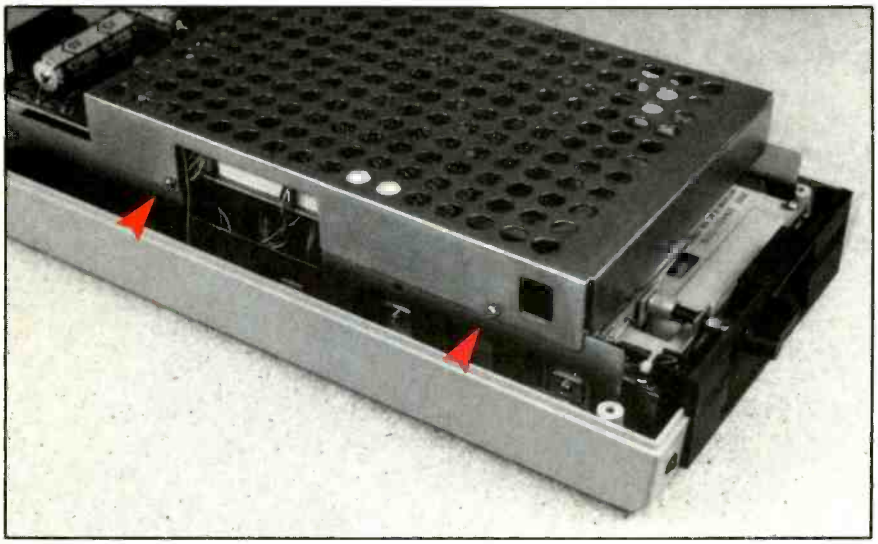
Troubleshooting steps

Here are a few suggested procedures to follow when a peripheral malfunctions. They are not in any particular order, and which ones you perform first depends on the nature of the problem, as well as your own preferences and experience.

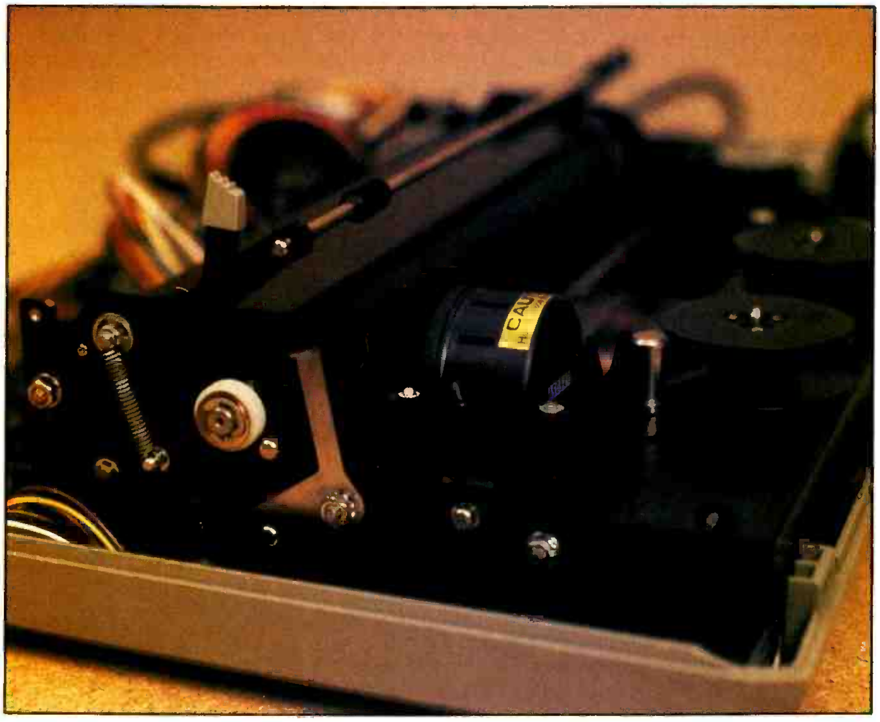
- Reset the system. Shut everything down for a moment then turn it back *on* and reload the program that was running when

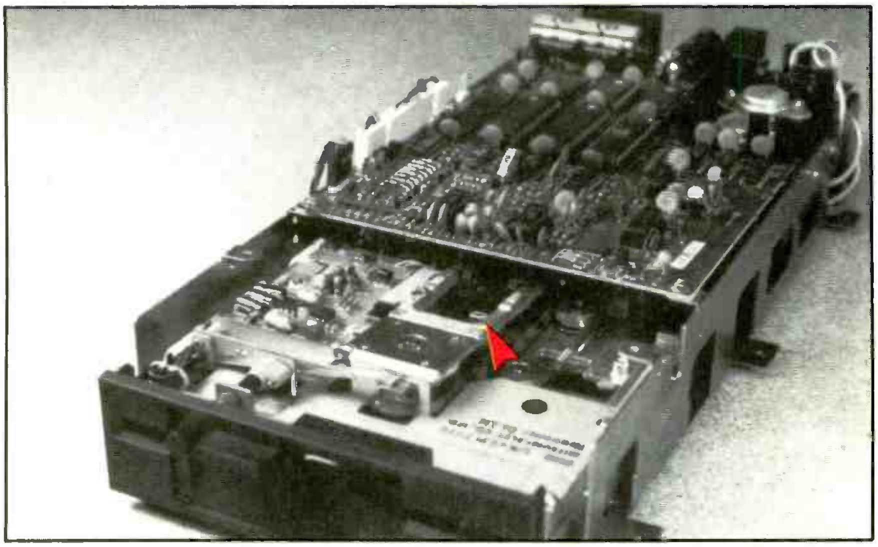


To gain access to the working parts of a Commodore 1541 disk drive, remove four screws (arrows) from the bottom, turn back upright and lift cover off.

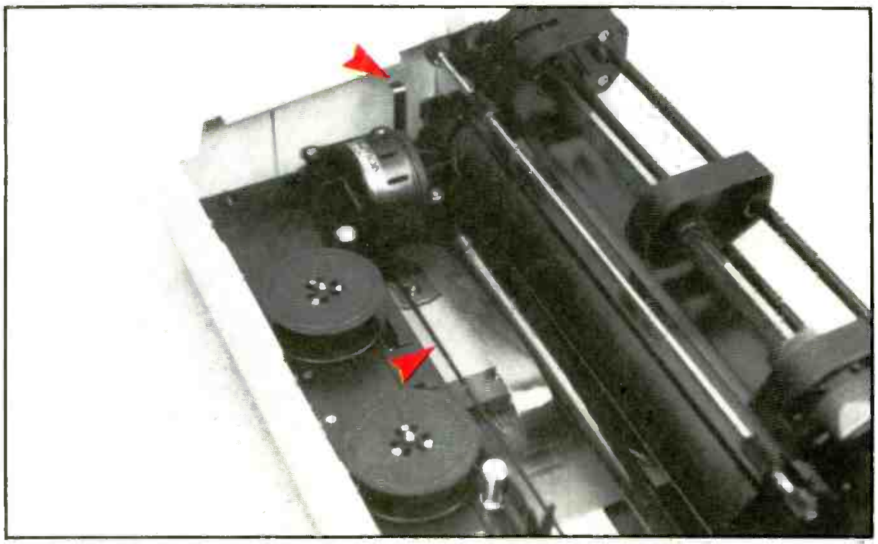


Removing these two screws releases shield and gives you access to the mechanical and electronic components.

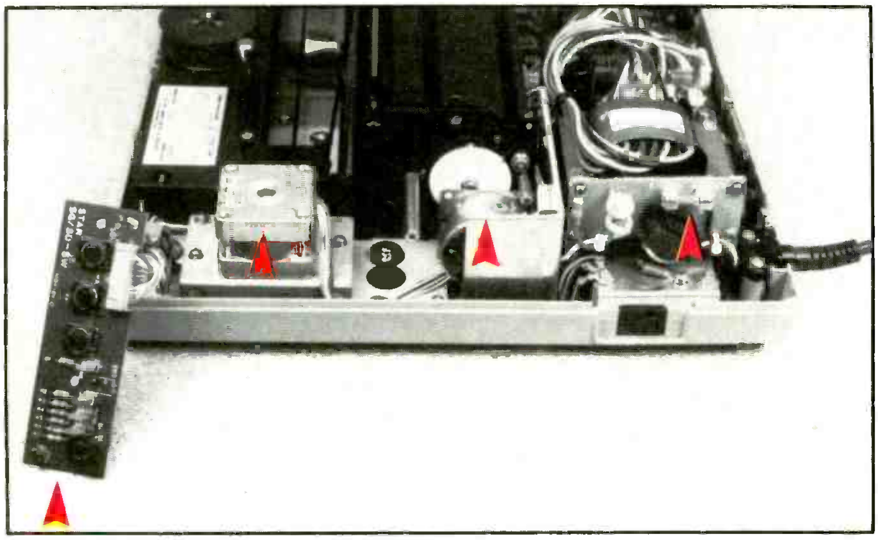




In the foreground, are the drive and read/write components of the disk drive. The arrow points to the read/write head. Above the head is the pressure pad. Removal of the large circuit board will give you access to the rest of the drive's components. Careful, some of the components on this board are susceptible to electrostatic-discharge damage.



This view shows the Star SG-10 printer with the dust cover removed, but with the main cover in place. Two screws at the back are all that secure the cover. Don't forget to remove the tractor feed unit before trying to remove the cover. Top arrow points to the platen adjusting lever, lower arrow to print head drive belt.



View of the Star SG-10 printer from the right hand side. Arrows point to, from left: switch pc board, print head drive motor, platen drive motor, line fuse.

the malfunction occurred. If this solves the problem, the problem might have been caused by some kind of power glitch, some combination of computer operations that only occurs once in millions of operations, or some other entirely mysterious one-time occurrence. If this does not solve the problem go on to to the next step.

• Reset the system and load a know-good program of equal length and run it. If the problem does not occur, it could have been because of a problem in the software, or it may be that the software causes the hardware to operate in some specific sequence that reveals a rarely occurring problem. The only way you'll be able to find out for sure is to get a known-good copy of the software and run it, or run the suspect software on another identical machine.

• If preliminary steps point to a hardware problem in the printer or the disk drive, isolate that unit to test it. Let's say the printer either doesn't operate, or prints a lot of strange looking characters.

The first thought would be to decide that the printer was at fault. Most printers have a self-test function that will let you test the printer separately from the rest of the computer system. In the case of my Star SG-10 dot-matrix printer, for example, in order to test the printer, it is only necessary to turn the printer *off*, then hold down the LF switch (Line Feed) while turning the printer back *on*. If the printer is working properly, it will proceed to print out all of the characters it is capable of providing. If this self-test operates properly, it suggests the problem is somewhere else in the system.

Some simple fixes on a dot-matrix printer

A common problem with dot-matrix printers is poor print quality. There are a number of conditions that can contribute to printing that's too light or otherwise of poor quality:

• Lever is adjusted at wrong setting. Dot-matrix printers have an adjustment system that allows the operator to adjust the position of the print head relative to the paper and platen to accommodate various thicknesses of paper. If this adjustment is incorrect the printer may print too lightly. Another symptom of misadjustment of this lever is poorly formed characters. Most of the letters will be formed properly, but some dots, probably at the top or bottom of the letter, will be too light or not print at all.

- Another possible cause of too-light printing is perhaps more obvious. If adjustment of the adjusting lever does not solve the problem, try replacing the ribbon.
- If the problem seems to consist of a combination of printing too lightly and complete absence of printing of some portions of characters, check the ribbon path. If the operator has inadvertently failed to thread it through all the proper points, it may not always be between the print head and the paper, causing failure to print.

If printer has been used heavily for some time, the problem may be simply that the print head has worn out. In such a case, if all other steps to restore proper print quality have failed, replace the print head. This is really a pretty simple operation. The operator's manual for the Star SG-10 suggests this sequence of operations:

- Turn *off* the switch, unplug the power cord and, if necesssary, wait until the head cools off.
- Remove cover and ribbon.
- Unscrew the two screws securing the print head.
- Disconnect the print head cable.
- Connect the print-head cable to the new print head, put the head in position and fasten it in place with the two screws removed from the old head.
- Apply screw-locking adhesive to the heads of the screws.

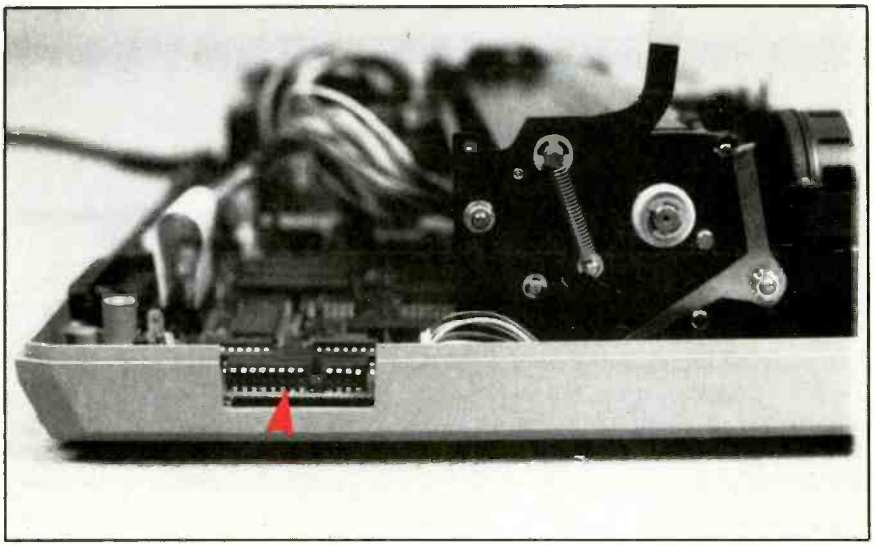
Other mechanical parts

In many dot-matrix printers, there are two motors: one to drive the print head and one to drive the carriage. If the print head malfunctions, for example if it fails to move, examine the belt that connects it to the drive motor during operation. If it is defective, replace it. Check the motor itself for proper operation. If the motor and belt are operating properly, look for evidence of binding or obstruction of the print head.

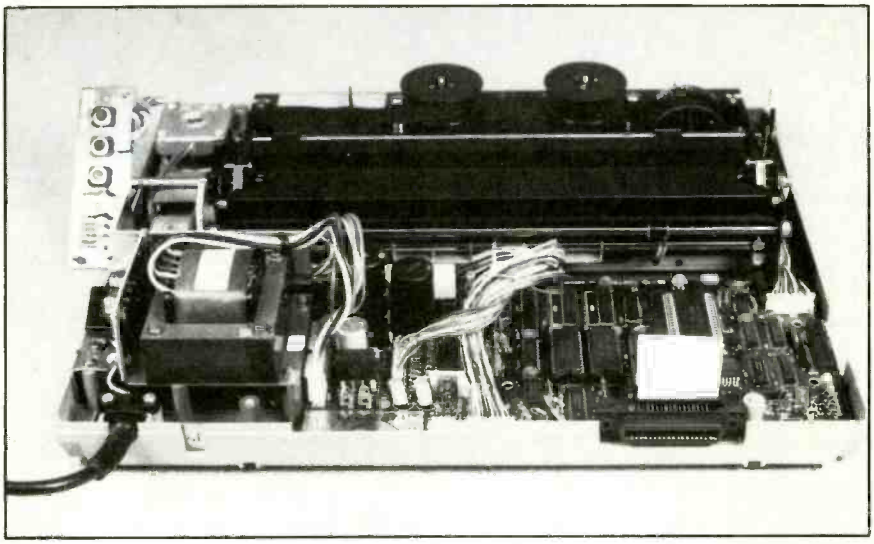
The other motor drives the platen and advances the paper. It is connected to the platen by a set of gears. If the platen fails to feed during printer operation, check for proper operation of its drive motor. Check for correct engagement of the gears.

Disk drive servicing considerations

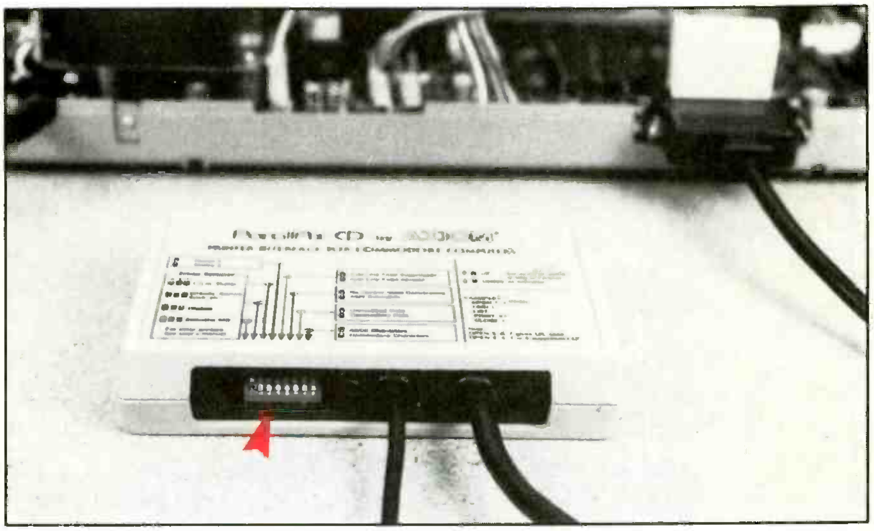
The first thing you need to determine about the disk drive you're servicing is whether it contains its own electronics (this is known as an "intelligent" disk drive), or if it is entirely under the control of the computer. For example, the disk drive for the Commodore 64 contains its own microcomputer, and some memory and so its opera-



Closeup of rear portion of left side of printer shows, from left: selector DIP switches, Tractor/Friction feed selector lever, platen adjusting lever. Switches allow the user to select such things as print quality (draft, real letter quality, condensed, italic) to insert a LINE FEED where the computer does not provide this function. Check the position of these switches if the printer does not seem to be operating correctly.



View from the back of the printer shows the parallel connector (lower right) and the electronics, which provide buffer storage and translate the input from the computer into print head position and character formation.



An interface unit may be necessary between the computer and the printer. If the printer doesn't operate correctly, check to see that the positions of the DIP switches (arrow) are correct. Do not switch any of these switches or the DIP switches on the printer, unless power has been removed from the entire system.

tions are more or less independent of the computer and do not use precious computer memory to direct its operation. Most of the comments in this article about disk drives will concern the Commodore 1541 because that is the one I am most familiar with.

Problems with the disk drive are frequently mechanical in nature. What follows is a listing of disk drive symptoms and the possible problems that may cause them.

- Read/write errors – Read/write errors may be caused by a number of problems. Two of these problems that are not unusual are a worn pressure pad and a slipping drive belt.

Disk drive belts, like any other rubber product, become brittle and slick with age. If the error symptom is predominantly *read* errors when the drive is trying to read outer tracks, the problem may very well be a worn belt. Inspect the drive belt and if it is showing signs of its age, replace it. Then run the disk or disks for which the problem occurred to determine if this has solved the problem.

Another frequent cause of read/write errors in floppy disk drives is a worn pressure pad. The pressure pad presses on the disk, holding it against the read/write head. When the pad becomes worn, the pressure is insufficient and the current put out by the head is too low, causing errors. The solution is to replace the pressure pad.

A personal computer system lends itself to the divide-and-conquer approach to servicing.

One of the advantages of a typical personal computer system is that all of the elements are separable and so can be diagnosed individually. Known-good peripherals can be substituted for suspected problem units. Alternatively, a suspected bad peripheral device can be substituted into a known-good system to isolate the problem beyond question. Once the unit has been determined to be the problem source, a logical approach to troubleshooting and repair will return it to service.

TROUBLESHOOTING Horizontal ICs

By Homer L. Davidson

PART 1

Most solid-state color receivers in the past few years have housed the horizontal oscillator in an integrated circuit, often with other circuits as well. Here are examples of typical circuits and some of the service problems that arise.

Television oscillator circuits have evolved over the years from using tubes to transistors to integrated circuits. However, even the newest IC oscillators make use of the standard basic circuits such as multivibrator, emitter-coupled multivibrator, sine wave with control, blocking or Hartley (the oldest).

Fortunately, it is not essential for technicians to know the name or type of each oscillator circuit in order to make accurate measurements and repairs. Unless the manufacturer accidentally states the type of oscillator, there is no certain method of determining the type. Much of the wiring is inside the integrated circuit where it is not available for visual or electronic tests.

Oscillator minimum requirements

Regardless of the oscillator type, several basic signals are necessary. Any oscillator that is required to be phase-locked (that is, identical in frequency and phase) with a broadcast station *must* have these three signals:

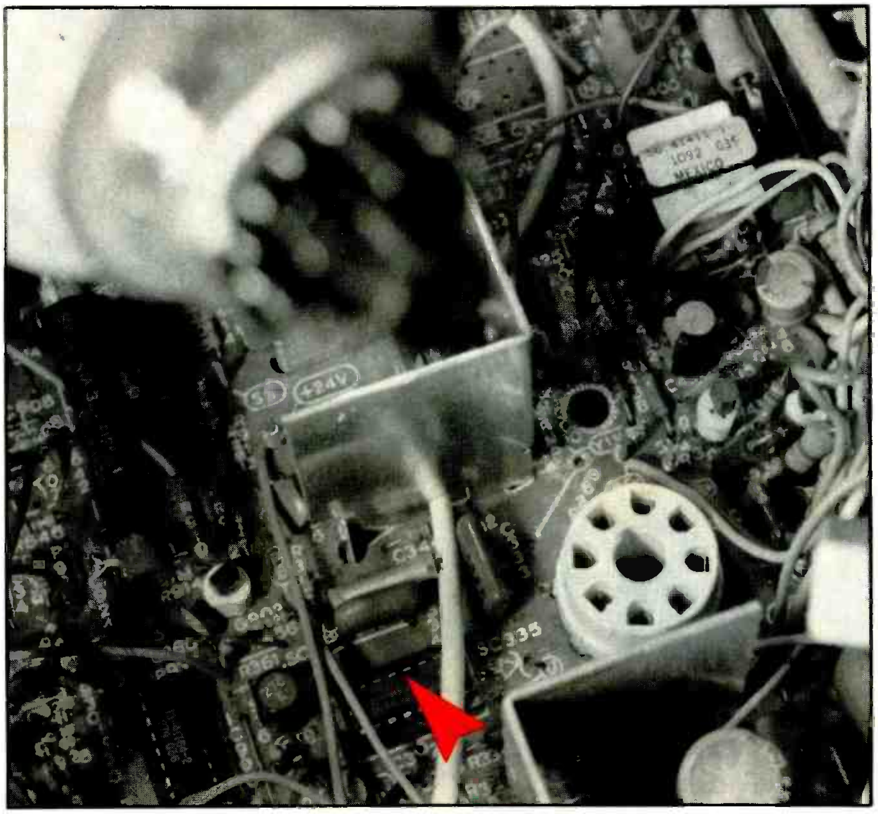
- The output of any horizontal oscillator should be a continuous carrier having the desired amplitude and waveform. In addition, the following two signals are required to control the exact frequency and phase of the oscillator output signal.
- A continuous flow of horizontal synchronizing pulses should be applied to one input of a phase-comparison circuit.
- Pulses from the flyback are integrated into sawteeth and they should be applied to the other input of the phase-comparison circuit.

Therefore, the sync signal is the standard, showing the *desired* frequency and phase, while the sawteeth from flyback pulses indicate how accurately the oscillator frequency and phase actually are being controlled. *Both signals are necessary for correct locking.*

Although the sync and flyback signals were just mentioned as being necessary for correct locking of the horizontal oscillator, the oscillator output itself is the *one* essential signal for operation of the horizontal system. For example, a missing sync or sweep-sample prevents horizontal locking. But if the oscillator is operating and has sufficient output level, deflection with high voltage can be obtained (in most circuits), even if the picture is nothing but lines. However, a loss of oscillation stops the deflection and high voltage, and shows a black screen.

The following steps are recommended when troubleshooting the horizontal oscillator in an IC:

- Measure all B+ supply voltages that affect the horizontal oscillator.
- Scope the oscillator output signal and analyze the waveform, including the amplitude.
- Scope the horizontal sync and



Replacement of an integrated circuit containing the horizontal oscillator is much easier when the IC is plugged into a socket, as shown.

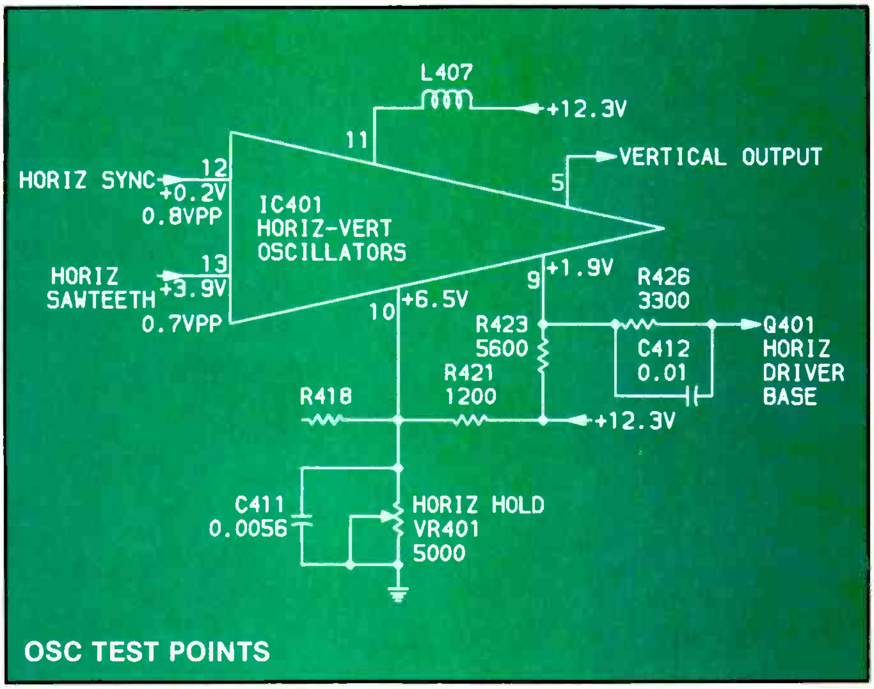


Figure 1. This simplified schematic of a 91C64 Sanyo (Photofact 1929-3) shows the three important test signals (oscillator output, sync input and sawteeth or pulse input) in addition to the B+ supply. R421 and C411 must have superior characteristics, especially stability when heated. Any value changes will vary the horizontal frequency, probably as drift, because they comprise the time constant which is one important factor that determines the horizontal frequency.

check it against the schematic.

- Scope the horizontal pulses, or the sawteeth made from the pulses, and check them against the schematic.

These four items of information usually will provide a wealth of data about the oscillator, and indicate the area where the problem originates, while the tests require only a few minutes. Wherever possible, we will include this type of analysis in the practical examples that follow.

Oscillator troubleshooting

Figure 1 shows a highly simplified schematic of the horizontal oscillator in a Sanyo model 91C64 (Photofact 1929-3). This circuit was chosen because it clearly shows the four essential areas where instrument tests should be made.

First, the horizontal-output or drive signal should be checked. In the Figure 1 schematic, that signal is the one at pin 9 (for the Q401 horizontal-driver base). A waveform that shows approximately the correct amplitude and waveshape at pin 9 *usually* indicates both the oscillator power supply and the oscillator are operating efficiently enough to produce a raster (if the remainder of the horizontal circuit is normal). A loss of all signal at pin 9 indicates a failure of the horizontal-oscillator stage or the horizontal-oscillator power source. The next step should be testing the B+ source (or sources) that supply the oscillator.

At this point, it would be appropriate to examine the power supply schematic and determine whether or not the oscillator B+ source should be constant, or just a pulse of voltage during start-up after which the deflection- or scan-rectified B+ supplies begin operation to maintain oscillation. If the horizontal sweep is dead, the B+ pulse starts the horizontal oscillator, but it dies when the B+ pulse is exhausted. This system requires special testing techniques.

After pin 9 has a stable, strong signal of good waveshape, use the scope to trace through the horizontal-deflection circuit. Perhaps the Q401 collector next, and then the horizontal-output base signal.

If the screen has an unstable picture that rolls or slides, check for adequate horizontal sync at pin 12 and sufficient sawteeth at pin 13. Loss of either signal will make horizontal locking impossible.

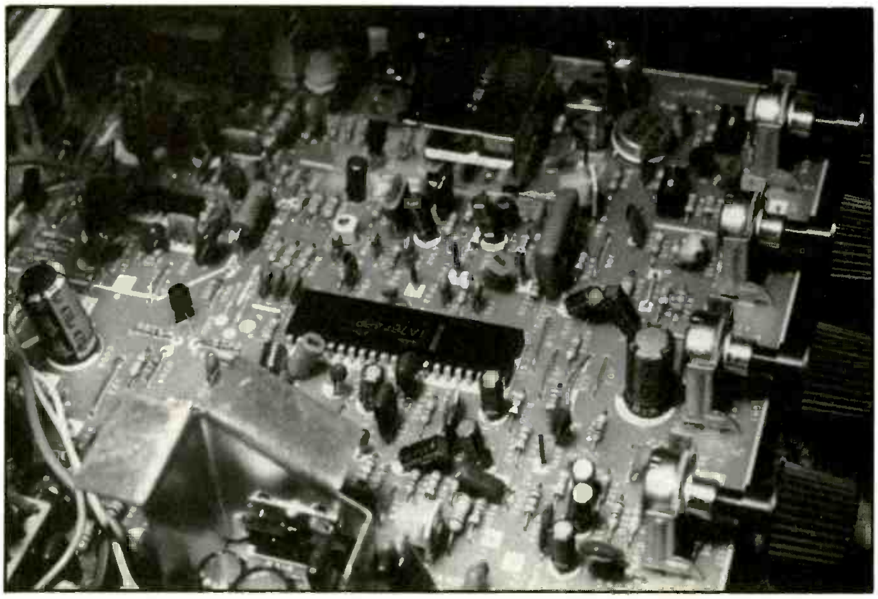
Checking oscillator voltages–Here are a few additional comments about checking dead oscillators of both types: those with a B+ start-up *pulse* and those with a *continuous* oscillator B+ supply.

It usually is impossible to determine from *normal* operation of the receiver (or from monitoring the oscillator B+ supply) which receivers have a B+ pulse to start the oscillator, followed by diode switching to a supply produced by rectification of horizontal-deflection power from the flyback, and which receivers have a continuous B+ supply regardless of the horizontal-deflection operation. It requires the full attention of a technician who is experienced in "reading" schematics to determine the difference between the two types. Occasionally, a few components (such as an SCR, zener, or large resistor) will be labelled "start-up." If so, that is more than a hint to look for the start-up B+ pulse for the horizontal oscillator.

But we are not studying the theory of start-up or shutdown now. Instead, we are concerned about how to troubleshoot the easiest and most accurate way. One tested method is to connect an external power supply (adjusted to the B+ voltage) between the horizontal-oscillator's B+ pin and ground. Notice any major changes of power-supply voltage that might indicate a short or serious leakage. If the voltage is satisfactory, scope the oscillator and horizontal-drive output pins. A lack of both waveforms indicates the oscillator is totally dead. The IC and other components must be tested to find the cause.

However, if the oscillator and drive output signals are almost normal in amplitude and frequency, signal-trace and voltage-trace through the horizontal driver and output stages until the cause of the non-functioning horizontal-sweep circuit is found.

A constant B+ source to the horizontal-oscillator IC calls for a different procedure. Remember, if the receiver has no high voltage or horizontal sweep, no horizontal sync or horizontal sawteeth (needed for locking) are present (the stages that amplify or shape these signals have no B+). A high oscillator supply voltage might indicate the IC is not drawing enough current for proper operation. A low supply voltage might indicate excessive current in the IC, or a problem in the supply source. If the IC is plugged into a socket, it is easy to remove and measure the voltage. If the IC is soldered into place, the problem is more difficult. With solder wick (or vacuum pump) and a small iron, remove enough solder from around pin 11 (Figure 1) that the pin is disconnected from the circuit



Some large ICs contain not only the horizontal and vertical oscillators but also sections of the color, contrast, blanking, sync and X-ray-protection circuits.

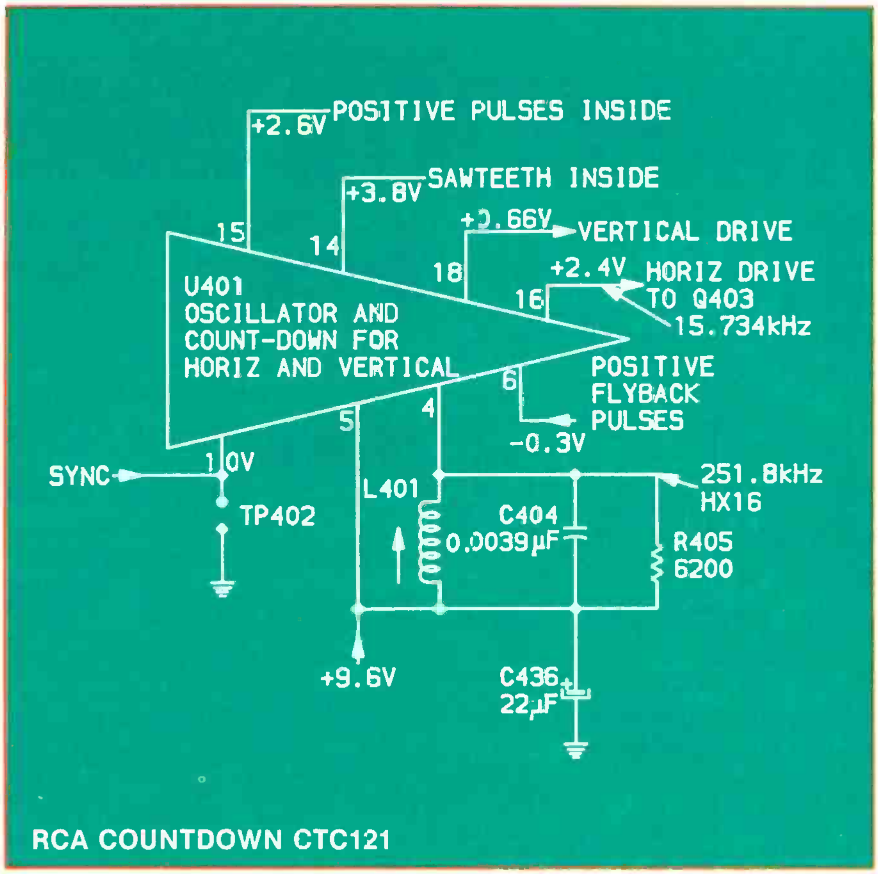


Figure 2. Oscillator frequency of the RCA CTC121 (Photofact 2123-1) is sixteen times (251.8kHz) the standard horizontal frequency. Countdown circuits start with 251.8kHz and produce both 15,734Hz for horizontal and 59.94Hz for vertical deflection. L401 is the only frequency adjustment. And 0.0039µF C404 is a very critical component. Any leakage or capacitance change from moderate heat could cause a frequency drift beyond the ability of the circuit to remain locked.

wiring. Then check the resistance between pin 11 and ground. Suspect a leaky IC, if the reading is lower than 75Ω.

While pin 11 is disconnected from the +12.3V supply, measure the +12.3V supply. A reading higher than the schematic value indicates the IC is leaky. But a continuing low reading might point to a defect in the +12.3V supply source.

Other suggestions for troubleshooting will be given as different models are discussed.

RCA countdown

In many RCA and other brands, these horizontal oscillators, vertical oscillators and phase-comparison circuits are replaced by a high-frequency oscillator followed by frequency dividers that produce 15,734Hz and 59.94Hz deflection frequencies (for color reception). For the television receiver owner, the advantages are extreme stability without any hold controls. Diagonal pictures or rolling pictures that demand periodic adjustment cannot occur with the countdown circuit, unless defects are present. There are no customer-adjustable hold controls anywhere.

In Figure 2, the oscillator operates at 251.8kHz that is divided by 16 to produce the desired 15,734Hz horizontal-deflection frequency. Dividing that frequency by 262.5 would produce 59.94Hz that is needed for vertical scan. But dividers cannot produce a half count, so the horizontal frequency is doubled to 31,468Hz and divided by 525, producing the desired 59.94Hz vertical rate.

L401 is the only frequency adjustment (251.75kHz) in the deflection countdown system. If it needs adjusting, short testpoint TP402 (horizontal sync) to ground and adjust L401 for a picture that drifts sideways and finally pauses with only one upright frame. Then remove the grounding jumper before operating the receiver. No other frequency control or hold control is provided.

A complete explanation of the internal operations of integrated circuit U401 would require several pages but offer no help during servicing. Therefore, we will show that even a sophisticated circuit like this one has the three signals and one voltage that are so valuable for analysis.

Horizontal output comes from pin 16. Horizontal sync enters at pin 1. Horizontal pulses from the flyback enter at pin 6. Evidently, these are clipped and shaped inside U401 because wider horizontal positive-going pulses exit from pin 15. They are integrated into sawteeth (ramp) and are applied to pin 14. The sync and sawteeth from horizontal sweep are not used exactly as they are in most circuits, but sync remains the standard and the sawteeth reveal how closely the receiver is deflecting relative to the sync.

Therefore, these three signals are useful for troubleshooting analysis, just as the comparable three signals are in receivers having less complicated circuitry.

Although the CTC121 has a start-up circuit, the action is not a pulse, but a steady lower voltage that is sufficient for operating or testing the oscillator and the drive signal.

Start-up Q100 receives voltage through resistors from the +164V supply, producing two start-up voltages. One starts the oscillator, and the other powers U401 pin 16 that drives the Q403 base. Some B+ from rectified ac is available for the Q403 collector and the Q404 horizontal-output collector (even before regulation is operational). So when a normal receiver is turned *on*, the entire horizontal-sweep system begins to operate, along with the dc-voltage supplies that are rectified from flyback power. Voltage from one of those scan-rectified B+ supplies has a slightly higher voltage than the oscillator-start-up voltage, forcing CR104 into conduction and allowing the oscillator and pin-16 power to come from scan power rather than from 60Hz rectification.

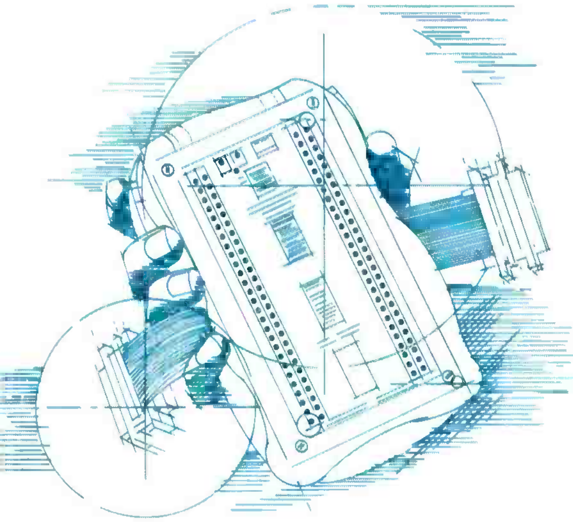
Q100 is reverse biased by the higher scan B+ and thus inactive until the next start-up. Therefore, if the horizontal-sweep system is dead and the oscillator is operating from start-up B+, the measured B+ at U401 pin 5 will be lower than the +9.6V shown on the schematic. Also, one end of R403 in the pin-16 circuit will measure lower than the schematic +24.3V. As a guess, the pin-5 voltage should be around +8V, and the other about +21V.

Although the oscillator can be tested with the start-up voltage, the voltage sources for the sync and pulse/ramp signals are missing when the horizontal-sweep is inoperative. This can be a problem with other receivers also. Follow a common-sense priority: If the horizontal oscillator operates, then concentrate on testing and repairing the horizontal-sweep system. Produce a picture, and perhaps you will not need to be concerned with horizontal locking, or a minor adjustment might be sufficient.

Few components mentioned in the start-up explanation are shown in Figure 2, but all can be found in the 2123-1 Photofact schematic.

Testing serial communications with a break-out box

By Doug Swain



Many computer problems can be traced to faulty communication between processors or control devices and system peripherals, such as printers. A servicing technician can isolate the problem quickly by testing communication lines with a break-out box.

There are many possible problems that can appear suddenly in any computer installation. Problems can occur in all sizes of computers from large mainframes to the personal computer sitting on the desk in the office or home.

Each piece of equipment be it mainframe, PC, or printer expects a certain protocol when communicating with these other devices. A protocol between a personal computer and printer might be:

Step 1 – Complete the input of data and depress the ENTER key to print the information entered.

Step 2 – The computer sends out a signal on pin 4, Request To Send (RTS).

Step 3 – The computer expects a return signal on pin 5, Clear To Send (CTS). In the situation of communicating with a printer, it would signify that there is paper in the printer and that it is not busy doing someone else's job.

Step 4 – Data are sent by the computer or pin 2 to the other device such as printer or modem.

Step 5 – The other device receives data on pin 3 per RS-232 standards.

Doug Swain is product manager with Beckman Industrial Corporation, Brea, CA. Beckman is a subsidiary of Emerson Electric Company.

This is a simple example using 4 of the 25 RS-232C pins. It is probably close to what actually happens in most personal computer systems. In a larger computer system there are other pins that affect the communications between devices. Three of these would be:

Pin 6 – Data Set Ready (DSR): a signal that lets the computer know the modem is ready to accept transmission.

Pin 8 – Data Carrier Detect (DCD): a signal that lets the computer know the telephone lines are ready.

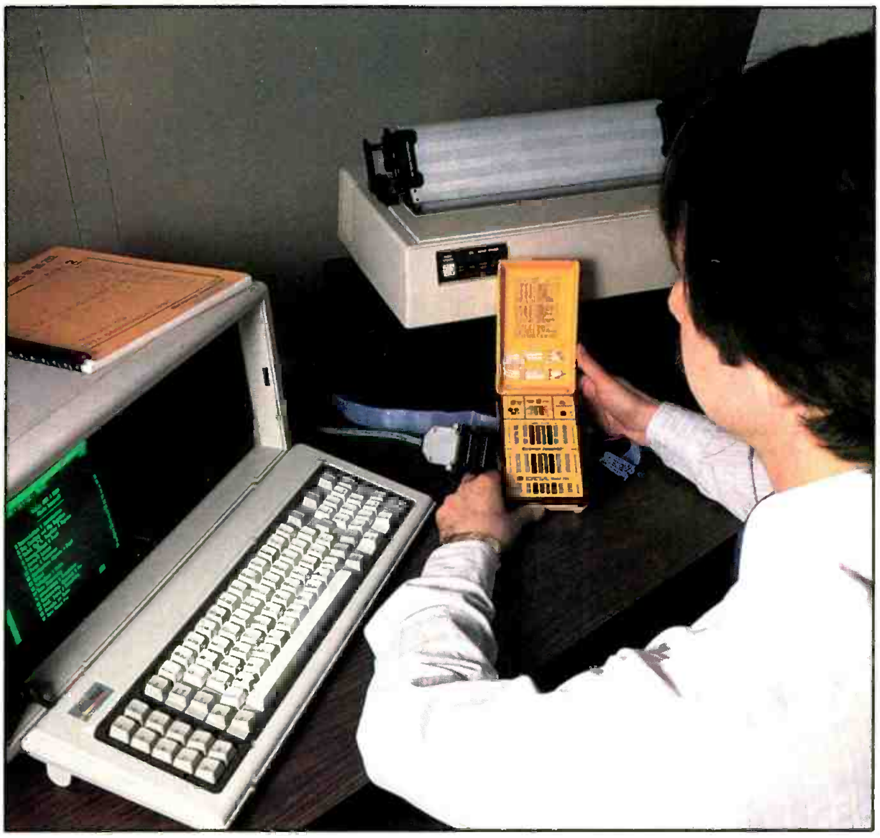
Pin 20 – Data Terminal Ready (DTR): a signal that lets the computer know the device at the other end, such as a terminal, is ready.

The Electronics Industries Association (EIA) originally developed these standards, known as RS-232 (the RS stands for *recommended standard)*, in 1949. Through the years it has made revisions, the most recent of which was revision "C", published in 1969. That is why we see RS-232Cwritten today.

Troubleshooting computer communications problems

What happens when the user enters the data, depresses the ENTER key, and nothing happens? If it is a new installation, it could be a bug in the program, an equipment failure, or some problem in the protocol. A large percentage of such problems involves communications between devices.

In the example, data were transmitted on pin 2 and received on pin



When a computer problem involves an RS-232 interface, a break-out box may expedite troubleshooting.

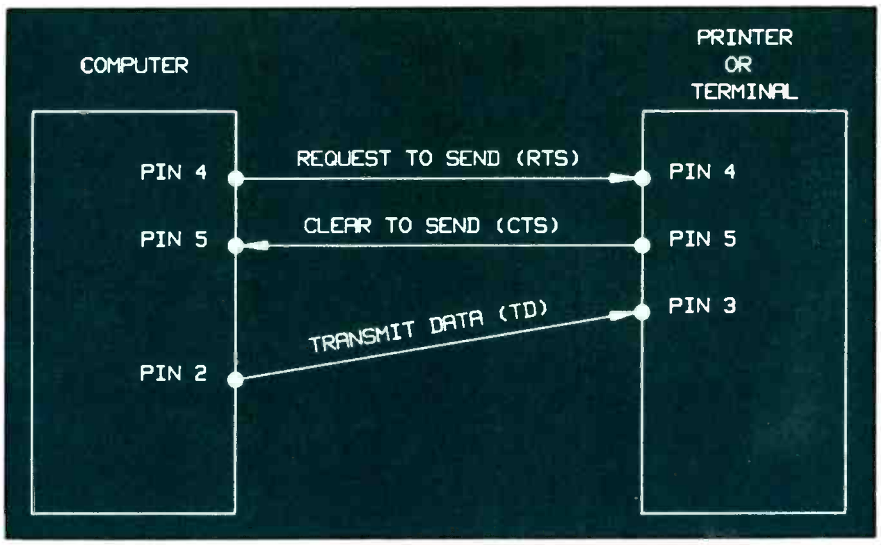


Figure 1. A cable wiring configuration such as this is used in many personal computer-to-printer interfaces.

3. It is easy to forget these RS-232C standards and transmit data on pin 2 and try to receive it on pin 2 as well. Many a service call was made in order to find this problem and reverse the configuration for pin 2 and 3.

Another situation that has caused a tremendous amount of confusion with RS-232C users is that each pin has a specific function according to the standard, but there are no rules as to which pins must be used. One piece of equipment might require the use of four pins, while another needs six of the pins, another eight pins, and yet another 10 pins. This means that there must be a signal on *all* required pins. How does a device that requires only four signals to make it function communicate with a device that requires signals on eight pins? It must be understood that if any one of these required signals doesn't exist, then nothing happens. This usually means the entire system is down.

It is becoming more and more important for the R & D engineer, customer engineer, technician, company service departments and handymen to have an easy-to-use test instrument that shows when signals are being sent from one device to another device. This device is called a *break-out box.* It provides the user many tools but basically it lights an LED when there is a signal on the line.

What is a break-out box?

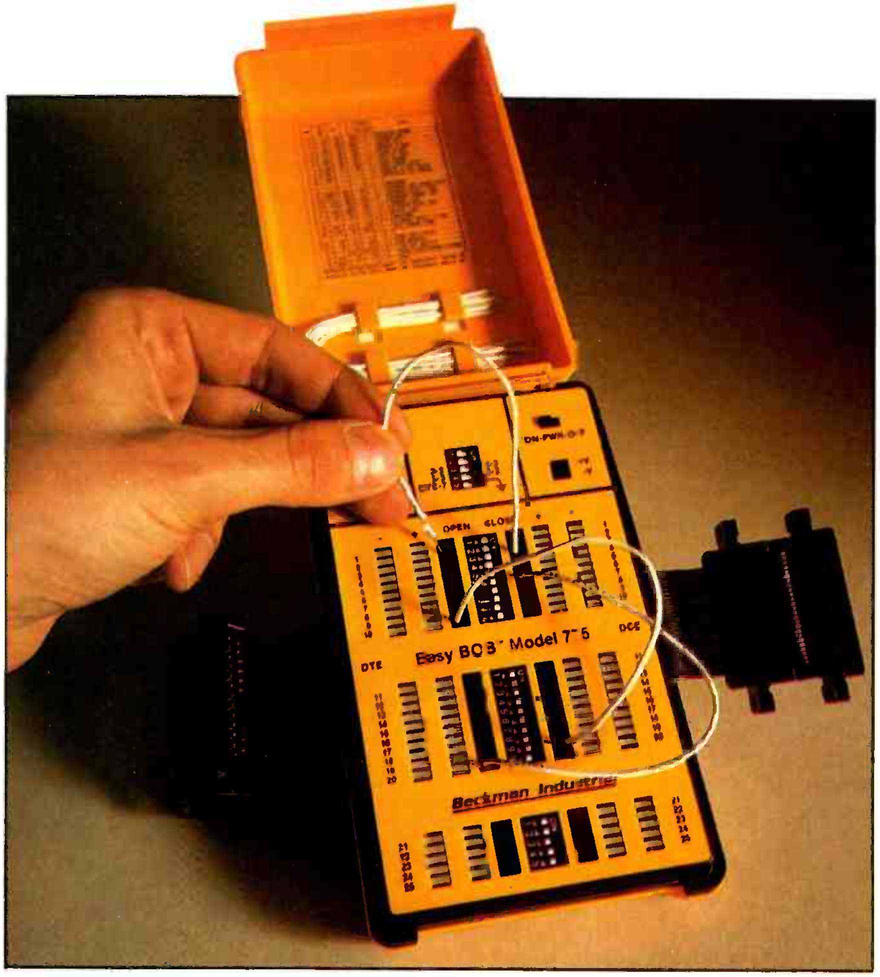
A break-out box (BOB) is a handheld, portable test instrument that is used to monitor RS-232C *serial* communication signals. The break-out box is equipped with connectors and indicators that are configured for the RS-232C communication protocol, a standard of the Electronic Industries Association (EIA). (The equivalent standard in Europe is designated CCITT V.24.) However, standards other than RS-232C might be monitored using a break-out box.

A break-out box is connected to both sides of the interface. For example, one side is connected to the computer, the other side to the printer. So, all communication lines flow through the break-out box. *Red* and *green* LEDs on the box show whether positive or negative signal voltage is present on each pin, on each side.

All RS-232 signals are between 3V and 25Vdc. That applies to pin 4, or pin 2, or pin 20. These signals can be a positive or a negative voltage. Positive voltages are common on most pins except for the data lines that use both mark and space (positive and negative). Of course, this increases confusion. The technician must find out what pins are to be used on each device plus know if there should be a positive dc voltage of 3V to 25V or a negative dc voltage of 3V to 25V.

Think of our earlier 5-step example. The break-out box LED will light when the computer transmits the REQUEST TO SEND signal on pin 4. Did the computer receive a CLEAR TO SEND signal on pin 5 in response? Many times this is the problem. The computer sends out a RTS but does not receive a CTS so data is never transmitted. If you were armed with a break-out box, you would visually see this problem immediately and be able to decide how to correct it.

A servicing technician must understand several sets of rules to play the RS-232C game: what pins are used by the various manufacturers, which pins have a positive voltage signal and which pins have a negative voltage signal, what protocol is needed for each



A break-out box is a hand-held, portable test instrument used to monitor RS-232 serial communication signals. Jumpers (white wires) allow the user to interchange pin functions where necessary to correct the configuration.

The trap is used to detect sudden, momentary voltage drops, sudden shorts, or high-speed data pulses.

PIN	NAME	EIA	CCITT	SOURCE DTE	SOURCE DCE	SIGNAL
1	PG	AA	101	–	–	PROTECTIVE GROUND
2	TD	BA	103	→		TRANSMIT DATA
3	RD	BB	104		←	RECEIVE DATA
4	RTS	CA	105	→		REQUEST TO SEND
5	CTS	CB	106		←	CLEAR TO SEND
6	DSR	CC	107		←	DATA SET READY
7	SG	AB	102	–	–	SIGNAL GROUND
8	DCD	CF	109		←	DATA CARRIER DETECT
9	POS	–	–		←	POSITIVE DC TEST VOLTAGE
10	NEG				←	NEGATIVE DC TEST VOLTAGE
11	–	–	–			UNASSIGNED
12	SDCD	SCF	122		←	SECONDARY DATA CARRIER DETECT
13	SCTS	SCB	121		←	SECONDARY CLEAR TO SEND
14	STD	SBA	112	→		SECONDARY TRANSMIT DATA
15	TC	DB	114		←	TRANSMIT CLOCK
16	SRD	SBB	110		←	SECONDARY RECEIVE DATA
17	RC	DD	115		←	RECEIVE CLOCK
18	–	–	–			UNASSIGNED
19	SRTS	SCA	120	→		SECONDARY REQUEST TO SEND
20	DTP	CD	109.2	→		DATA TERMINAL READY
21	SQ	CG	110		←	SIGNAL QUALITY DETECT
22	RI	CE	125		←	RING INDICATOR
23	–	CH CI	111 112	→	←	DATA RATE SELECTOR
24	SCTE	DA	113	→		SERIAL CLOCK TRANSMIT EXTERNAL
25	BUSY	–	–	→		BUSY

Figure 2. RS-232 defines computer serial interface connections as shown here.

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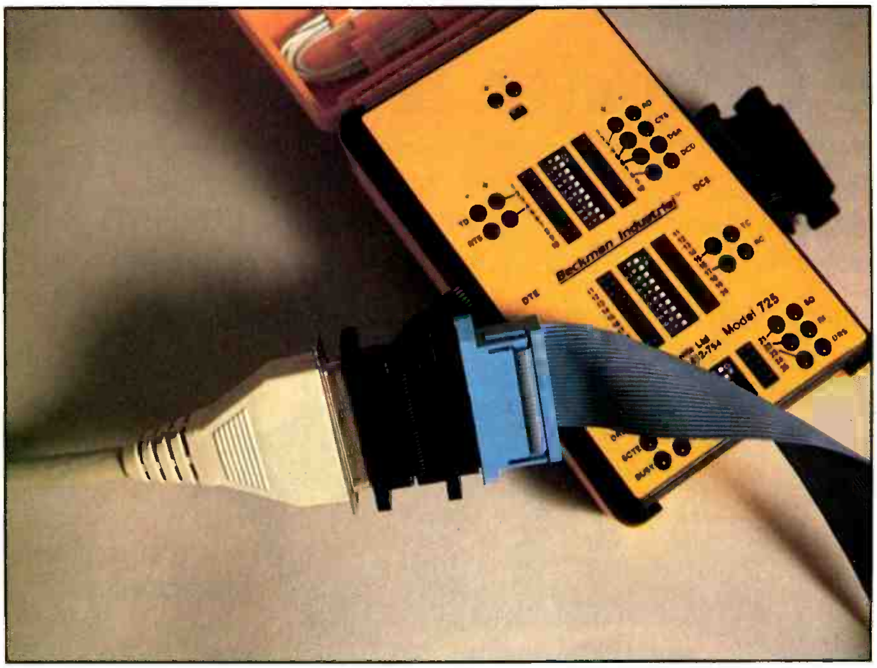


Dual-gender connectors allow male or female connector attachments.

piece of equipment in the system.

As can be seen, RS-232C is a mixed blessing. The standard gets more and more confusing as one gets to know more and more about the standard. This is because signaling schemes, usually pin usage, vary widely among different manufacturers.

A break-out box is basically a passive test device; that is, it detects signals that are present in the circuit under test. An exception is jumpering, by which you can place a positive or negative voltage at a specific pin location to trigger a response from one of the devices.

In test procedures described in this article, specific pin locations can be jumpered so that each device can be tested by itself. For example, if your first test showed a missing CLEAR TO SEND signal on pin 5, you might jumper from pin 4 to pin 5. This will force a positive signal on pin 5 to see whether the device would respond.

Types of break-out boxes

There are three major differences among models of break-out boxes. Combinations of these differences account for the variety of products. The differences are:

- number and types of lines and indicators;
- unpowered/powered display;
- special features.

Lines and indicators

Most break-out boxes, when connected into the interface, give the user some type of access to all 25 lines described in RS-232. These access points are typically some type of pin to which a jumper wire can be connected. This allows the pin-to-pin jumpering of signals such as the pin 2-to-pin 3 crossover. A feature that has a direct impact on the cost of the instrument is the number of lines that have LEDs and the type of LED.

The user will find break-out boxes with the following LEDs:

1. a red LED at eight of the lines. The red LED will only indicate positive voltages.
2. a red LED at 12 of the lines. Again, positive voltages only.
3. a red and a green LED at 12 of the lines. They indicate a positive (red) voltage or a negative (green) voltage is on the line.
4. a red and a green LED at 15 of the lines; indicates positive and negative voltage.
5. a tri-state LED at 12 of the lines. This single LED will illuminate red *or* green depending on the voltage polarity.
6. a tri-state LED at 15 of the lines; indicates plus or minus voltage.
7. a red and a green at all 25 lines on each side of the break-out switches. This will indicate a plus or minus voltage input to any pin and output from any pin location. This type of BOB is known as the 100-LED break-out box.

On BOBs that monitor only some of the lines (such as 15 pins), the LED is connected on the original input side of the center break-out switches. You will have the LED for pin 2 (transmit data) on the data terminal equipment side. The LED for pin 3 (receive data) would be on the data communications equipment side of the switches. This allows the user to see a signal arrive at the BOB even if the signal does not continue through the BOB because the switch may be *off*, probably because the signal is to be jumpered to some other pin.

Unpowered/powered

For many technicians, an important consideration is whether the pin LEDs derive their power from the system being tested, or from an internal battery. If the LEDs are lit by the line signal voltage, the unit is said to be unpowered; a powered unit has an internal battery to light the LEDs.

The main consideration here is the consequences of degradation of the digital signal under test. With an unpowered break-out box, the power consumed by the LED causes a slight voltage drop in the signal. If you are attempting to simulate a long cable run, this is a desirable effect. On the other hand, a powered break-out box will not affect the signal voltage, and so will give more accurate readings of marginal signals.

In general, engineers and technicians who are doing research and development work in the lab prefer unpowered units. Customer engineers and field technicians seem to prefer the powered models.

Special features

Features found on some break-out boxes include *test voltage* and *signal trap.*

On powered break-out boxes, a test voltage may be provided by positive and negative jacks on the faceplate. Through these jacks, nominal power may be drawn from the internal battery for use in applying signal to test points or in forcing a signal positive or negative. For instance, if a pin 5 (CTS) signal is needed but not present, the positive faceplate voltage could be jumpered to pin 5 to simulate that signal.

The trap feature is a special circuit within the break-out box that captures signals of short duration, perhaps so short that you would not see them on the LEDs. The trap is used to detect sudden, momentary voltage drops, sudden shorts, or high speed data pulses. For instance, sometimes the pin 8 (DCD) signal on the telephone line could be dropped momentarily because of lightning during a storm. The trap would detect this drop and illuminate the trap LED.

A handy feature, found on some break-out boxes is dual-gender connectors. This way, you can set up quickly, regardless of whether the interface cables of the computer system being tested have male or female connectors. Normally, if you don't have a gender mender or a patch cable, you're stuck.

The technician faces new challenges with every service call. It is important to have a variety of special features on the break-out box so as a situation exists there is a BOB "tool" to help. A special feature of the Beckman model 785 break-out box is that it is two test instruments in one. With a flip of a switch on the faceplate it changes from a BOB to a cable tester. Plug the cable into the dual-gender connectors and opt whether to step automatically through each pin in sequence, or to depress a button so you can test at your own pace.

It is common to find that pin 2 at one connector of the cable is connected to pin 2 at the other end when it should be pin 3. It can be time-consuming to disconnect the cable, open the connector covers, unsolder pins, resolder them correctly then put everything back together. A convenient feature on some break-out boxes is the pin 2/pin 3 crossover switch. In one switch position, pin 2 at one end goes to pin 2 at the other end. In the other switch position, pin 2 goes to pin 3 at the other end.

The RS-232C standards cover the specifications for each of the 25 pins. Some of these pins are used for slow speed (300BPS to 2,400BPS), asynchronous data transmission. These same pins plus other pins are used for high speed, synchronous data transmission. If you will only need to test slow-speed data transmission, one of the BOBs with 12 or 15 pins with LEDs will serve. If you'll be involved with high-speed transmis-

Symcure rates and guidelines

Beginning with the January 1987 issue, ES&T is paying $60.00 per page for Symcure submissions that are accepted.

The term Symcure is a contraction of the two words: Symptom/Cure. Problems that are published in ***ES&T*** in the Symcure department are those that have occurred more than once.

This is the kind of problem that you can solve without even a second thought because you've already seen so many of that particular brand and model of set with those symptoms and in almost every case it was the same component that had failed, or the same solder joint that had opened.

Because of the manner in which we publish Symcure, TV submissions, if they are to be considered, must follow these rules:

1. It is preferred that each submission must consist of seven individual symptom/cure units on a single brand of television set. Seven are requested so we may chose the most appropriate for publication.
2. We must have the manufacturer's name, the model and chassis number, the Sams Photofact number (if you know it) and a sketch of the schematic area where the fault was found for each of the seven units. Each sketch should contain a major component such as a transformer, a tube or transistor to provide a landmark for the ***ES&T*** staff.
3. Because the very nature of Symcure is based on schematics, if for any reason there is no Sams Photofact on the unit, we cannot accept the submission.

We also will consider Symcure submissions on consumer electronics equipment other than television, such as VCRs, stereos, computers, microwave ovens. Depending upon the nature of the product and the symptom, it may not be necessary to refer to a schematic diagram in all of these cases.

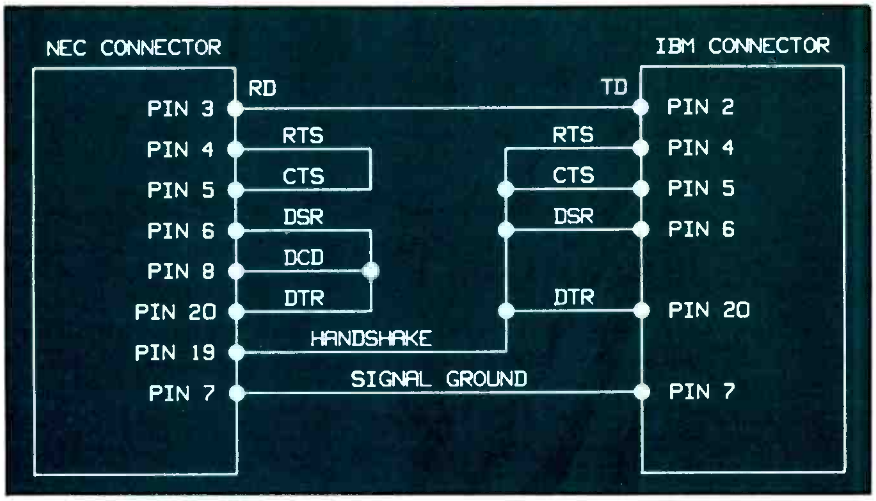


Figure 3. Cable wiring configuration between IBM PC and NEC Spinwriter.

sion, special interfaces or product development, then the 100-LED break-out box would be needed. The 100-LED BOB could be used to monitor the IBM PC, parallel output because it uses the same DB25 pin connector. Please note that RS-232C data signals are always serial and usually ASCII. The RS-232C standards cover both asynchronous and synchronous data transmission. Asynchronous transmission is transmitting one character at a time with a start-and-stop bit for each character. It does not require a separate clock signal for the reception of data. Synchronous will transmit a block (such as 512 characters) at a time, usually at a high baud rate, with a block start sync character and an end of block message sequence.

When would you use a break-out box?

You may save yourself a lot of needless aggravation by using a break-out box as a routine first step whenever a computer-related problem apparently involves a special communication line. For example, you would want to pull out the break-out box right away if the user has noted any operation difficulties between a computer and a serial printer, or between a host/controller and data entry terminals, or between a terminal and a modem.

In such cases, the most common symptom is simply that nothing is happening. Or, the system may have crashed suddenly and can't be brought back up. Sources of these problems usually come down to a missing signal that indicates the "ready" status of one of the devices. So, transmission is halted indefinitely while the other device waits for a signal that never arrives. If you know what the pattern of communication should be on specific pins, and if you can test for a signal on each pin of each device, you can determine quickly if there's a problem anywhere within the interface. That's what a break-out box helps you do. The procedure isn't complicated, and it's amazing how many times the source of trouble becomes obvious.

Again, the RS-232C standard specifies what type of signal should be found at each pin location, but it says nothing about which pins actually will be active within a given configuration. In addition, RS-232C specification limits cable lengths to 50 feet. Longer ones are sometimes used under special conditions. It is possible to link two serial devices with just two lines: transmit data (TD) on pin 2 and signal ground (SG) on pin 7. You will suspect that this was the configuration, for example, if twisted pair wiring were used for the interconnect.

Two twisted pairs and other types of cables can be used for 4-line communication. In such cases, the lines typically used are:

- TRANSMIT DATA (TD), pin 2
- RECEIVE DATA (RD), pin 3
- SIGNAL GROUND (SG), pin 7
- DATA TERMINAL READY (DTR) on pin 20.

A more complex signaling scheme uses eight lines, as follows:

- TRANSMIT DATA (TD), pin 2
- RECEIVE DATA (RD), pin 3
- REQUEST TO SEND (RTS), pin 4
- CLEAR TO SEND (CTS), pin 5
- DATA SET READY (DSR), pin 6
- SIGNAL GROUND (SG), pin 7
- DATA CARRIER DETECT (DCD), pin 8
- DATA TERMINAL READY (DTR), pin 20

DSR and DTR signals often are used in telecommunications. In these applications, the *data set* is the modem, and the *data terminal* is the terminal or workstation. The DCD voltage is provided by the telephone utility to signal that the telephone line is working. The above 8-line configuration is shown in Figure 2.

Still more complicated signaling schemes can use 12 (or even all 25) lines. However, 4- and 8-line configurations are most common for relatively slow-speed data communications. In many configurations, *crossover* is required between transmit (TD) and receive data (RD) pins. For example, the TD signal from pin 2 on the computer must be applied to RD, pin 3, on the printer, and vice versa. So, somewhere along the cable, these wires must be crossed. Note that this crossover normally will not be formed by using ribbon cable with *quick-connect* DB25 connectors. A common problem in new installations is that this *2/3 crossover* has been forgotten.

Bear in mind that these combinations of signal lines are just the most typical configurations. The equipment you will be servicing may have been designed differently. Also, remember that if you're looking at faulty communications with the break-out box, you may see just about anything, including mismatches and incompatibilities that could never work. But, remember, now you have a tool that helps you locate these situations fast and easily where, before, they might have gone undetected.

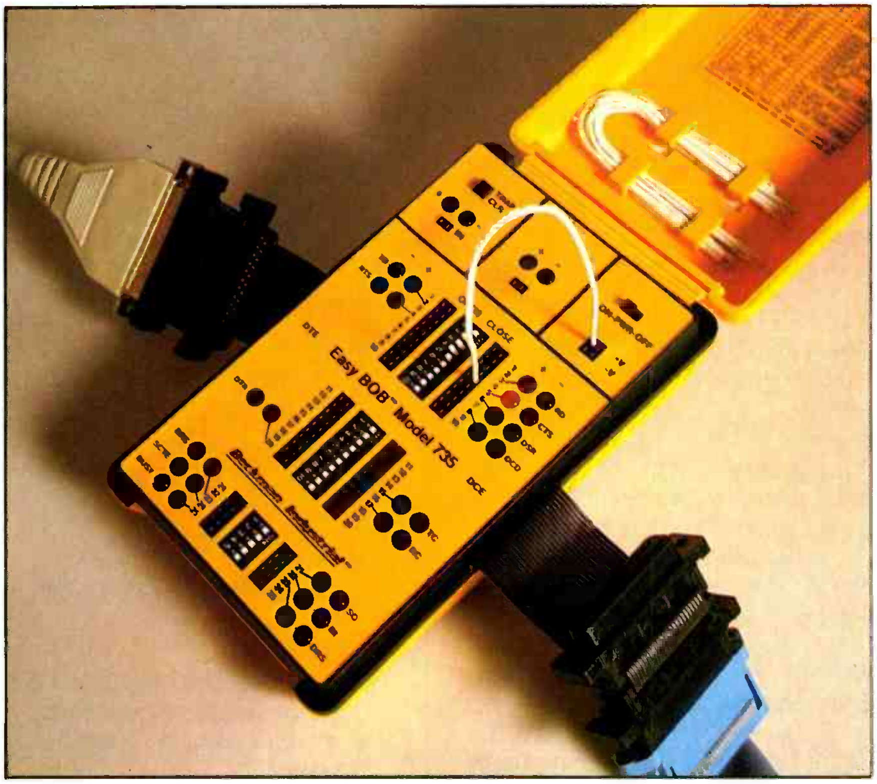
Let's look at a service sequence

Say that a communication problem exists between a new IBM PC and NEC Spinwriter printer: the printer won't work. The first thing to do is check to ensure that everything is plugged together properly and that the cable between the two pieces of equipment is tight in the connectors. Then, check the baud rate. Let's assume that all of these factors seem to be correct. The next area of concern will be the handshaking (protocol) between the two pieces of equipment. This is best done by looking at a service manual to determine which pins are required in the system. (See Table 1 on page 30.)

Next, unplug the cable and insert the BOB into the system. Now, you can watch all signals. Have the BOB break-out switches,

NEC SPINWRITER	IBM PC
Pin 2, TD, neg. signal	Pin 2, TXD, neg. signal
Pin 3, RD	Pin 4, RTS, pos. signal
Pin 4, RTS, pos. signal	Pin 5, CTS
Pin 5, CTS	Pin 6, DSR
Pin 6, DSR	Pin 20, DTR, pos. signal
Pin 8, DCD	
Pin 10, HANDSHAKE, neg. signal	

Table 1. Pin 7 is common to both pieces of equipment, it is signal ground. On pins that show a NEG or POS signal, the signal is constant.



Faceplate voltage is used to simulate missing signals.

except pin 7, in the *OFF* (open) position so signals do not pass through the box. You will see the computer output a signal on pin 2. The service manual indicates a negative signal, so the green LED on the IBM side should be lit. The NEC printer will also output a negative signal on pin 2. Check that all signals match the documentation.

Now, determine how to get the correct signals from the pins with signals to the required pins of the system. Check to see if the required pins, such as pins 5 and 6, need positive or negative signals. You will find that the data lines, pins 2 and 3, usually are negative signals (green LED on BOB) while the other lines require positive signals (red LED on BOB).

With the BOB in the system, you can use it to jumper signals. This will be a temporary situation to confirm that all pin jumpering is correct and that the system will work. Then you must reconfigure the cable so that the PC and printer have the required signals on the proper pins.

Figure 4 shows the correct connector wiring.

With a little study, it can be seen that the IBM PC and the Spinwriter require signals that normally are used only in a data transmission system employing modems. However, there are no modems, thus no signals from data sets, telephone lines or distant terminals, so these signals must be simulated to fool the equipment. This is done by taking a pin with a signal present and jumpering it to the other required pins.

If you have a powered break-out box with faceplate voltage, such as the model 775, the signals for the required lines in the example above also could have been simulated. For instance, to get the negative signal to pin 5 (CTS) of the NEC Spinwriter, a jumper wire from the negative faceplate voltage to pin 5 could be used. Obviously this would only be for a temporary situation. This could have been done while making a new permanent cable for the system.

One of the most common problems in computer systems is that pin 2 of one piece of equipment goes to pin 2 of the other equipment when it should go to pin 3. This crossover, also known as the null modem, would be needed when interfacing with a printer. A straight-through cable, pin number to same pin number, is used when connection is to a modem. So, the type of equipment and the situation are key factors. However, with the BOB pin jumpering can be changed easily until the proper configuration is determined.

If you have an interface involving a terminal and a modem, you might first look to see whether a DSR signal is present on pin 6. If not, you could jumper pin 5 to pin 6. If this produces a data signal on pin 2, the terminal is trying to send data and the problem may be in the modem. To test the modem, you would jumper pin 6 to pin 20 to force a DTR signal at the modem. If pin 2 at the modem glows, the problem is on the terminal side.

Many computer problems are caused by incorrect connections between component units. A knowledge of what the correct connections are, and a means to check them out, such as a breakout box, will solve a great number of these problems. ES&T

Literature

Iwatsu Instruments has issued a short-form catalog covering its complete line of test and measuring instruments.

This 12-page brochure details features and specifications on Iwatsu oscilloscopes that offer a wide range of performance capabilities. A scope calibrator, scope carts and trigger probes also are covered.

Circle (125) on Reply Card

United States Instrument Rentals has published its 1987/1988 Product Guide. This 368-page guide to instrumentation provides information on more than 5,000 different major manufacturer's models of electronic test and measurement and data processing equipment inventoried by USIR.

Circle (126) on Reply Card

Connector Corporation has announced the addition of tube neck retaining clamps as an option for most of its line of sockets for cathode ray tubes. This integral retaining clamp ensures that the socket and tube base remain mated under extreme shock, vibration and rugged environmental conditions.

The tube neck retaining clamp assembly is part of the socket body. The positive clamp is resilient and conforms to the tube neck configuration. Full descriptions are provided in an 8-page brochure.

Circle (127) on Reply Card

Augat/Alcoswitch has released a 90-page New Products Catalog.

Included in the new literature are the Gemini Series subminiature toggle and push-button series and the AS Series sealed and machine insertable slide switch, in a DIP package. Also featured are the Blue Line miniature relays, S-series SIP switch and all new hybrid DIP switches incorporating resistors or diode networks in either conventional DIP or encoded Rotary DIP packages.

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More than 400 precision measuring devices and miniature hand tools are featured in the new **Moody** hand tools catalog No. 867. In addition to the standard line of high quality products, more than 100 Moody and Acu-Min tools for home and industrial use have been added in this 56-page edition.

Circle (129) on Reply Card

Scooter Products Group/Ohm Electronics offers a Computer Accessory Guide that aids computer dealers, resellers, electronic distributors and end users in selecting products that best meet their computer-protection needs. Key features and benefits are listed for each product group. The full color guide details the complementing decor of these products, which are compatible with all popular personal computers, including IBM PC/XT/AT.

Circle (130) on Reply Card ES&T

Test your electronic knowledge

By Sam Wilson

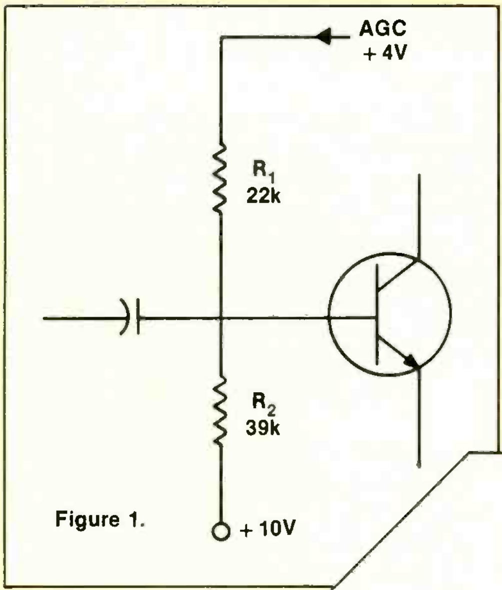


Figure 1.

1. You are measuring the voltage on the base of the transistor in Figure 1. The voltage should be about
 A.) +6V.
 B.) +8V.

2. In Figure 2 the purpose of R1 is to adjust
 A.) the amount of power supply voltage delivered to the op-amp.
 B.) the slewing rate.
 C.) the gain.
 D.) the offset voltage.

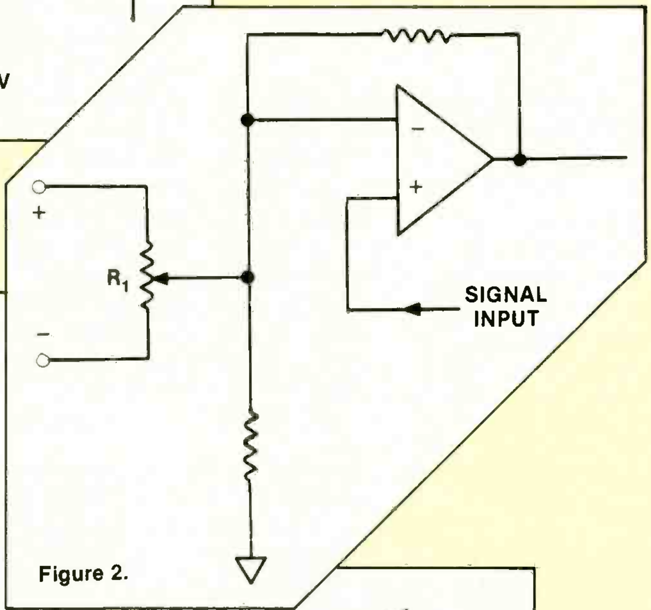


Figure 2.

3. Which of the following is true for the symbol in Figure 3?
 A.) There is no such symbol.
 B.) It is the symbol for a programmable zener diode.
 C.) It is a variation of the symbol for an SCR.
 D.) It is for an avalanche diode.

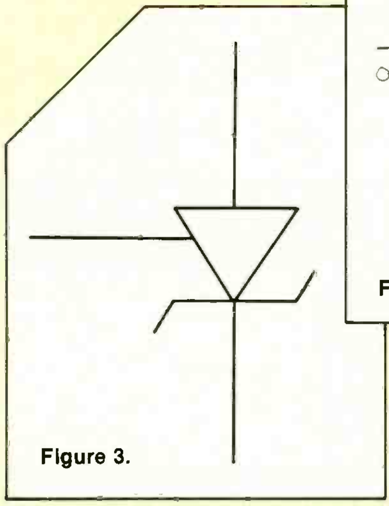


Figure 3.

4. A current-multiplier/buffer circuit whose output "mirrors" the input in a fixed ratio is called
 A.) a Wilson current mirror.
 B.) a reflectometer.
 C.) a slideback current regulator.
 D.) (None of these choices is correct.)

5. Excess noise occurs in amplifiers at frequencies below 1kHz. It is also called
 A.) flicker noise.
 B.) 1/f noise.
 C.) (Both answers are correct.)
 D.) (Neither answer is correct.)

6. The chop mode for a dual-trace oscilloscope should be used for
 A.) low frequencies.
 B.) high frequencies.

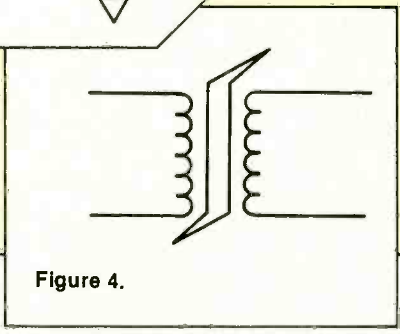


Figure 4.

7. Meter movement X at 50,000Ω/V and meter movement Y require 25μA for full scale deflection. Which is more sensitive?
 A.) Meter movement X
 B.) Meter movement Y

8. You would expect the transformer shown in Figure 4 to have
 A.) no eddy current loss.
 B.) zero hysteresis loss.
 C.) a constant output voltage.
 D.) (None of these choices is correct.)

9. In a compact disc system a sample-and-hold circuit is used in the
 A.) D/A converter.
 B.) A/D converter.

10. A thin air gap may be added to the core of an inductor to make it
 A.) saturate at a lower current.
 B.) almost impossible to saturate.

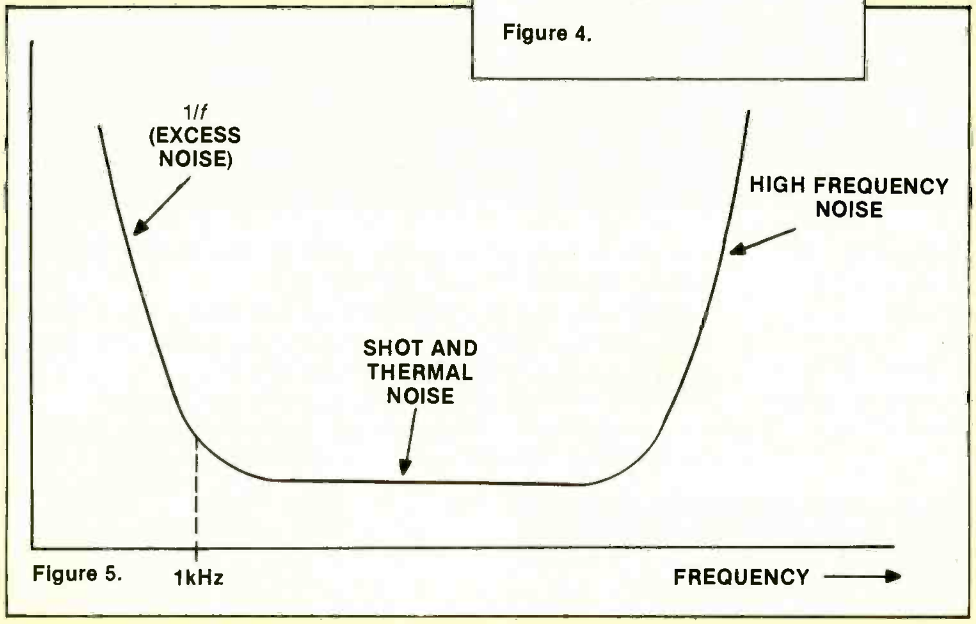


Figure 5.

Answers are on page 57

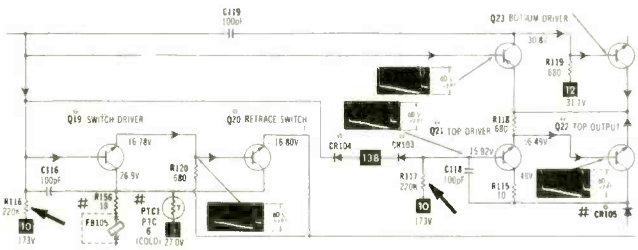
Troubleshooting Tips

Intermittent height
RCA CTC97A
(Photofact 1831-2)

Because the complaint against the RCA CTC97A-chassis color receiver was a total loss of height after about five minutes of operation, the receiver was operated before any tests or adjustments were made. After about six minutes, the vertical deflection collapsed, leaving only a single horizontal line across the picture-tube screen. It was time now for the testing to begin.

With the receiver on the troubleshooting bench, the back was removed and the vertical area made as uncluttered as possible. The receiver was allowed to cool, then was switched *on* and vertical-system dc-voltage readings taken rapidly (and written down) during the five to six minutes before the vertical collapsed. Dc voltage tests were made at the same points as before and the readings compared.

The Q19's +26.9V collector voltage now was about zero, and thermistor PTC1 (between collector and the +27V supply) was very hot. I tried cooling small areas of the vertical system, but the symptoms and voltages did not change. Because I was not familiar with this circuit, I decided to remove the resistors one by one for more accurate out-of-circuit resistance tests. While doing this guessing and boring work, I found that 220kΩ R116 was open. Unfortunately, replacement of R116 did not change the symptom: loss of vertical sweep within minutes.



Not having any better idea at that moment, I continued to remove and test other vertical-circuit resistors, without finding a bad one until I checked 220kΩ R117, which had become very high in resistance. A new 220kΩ resistor was installed to replace the defective R117 and *normal vertical deflection was restored* permanently. Several minor adjustments were made, the back was replaced and the color TV was operated on our time-test bench for several hours without any signs of height or other picture problems.

Since that repair, I have found several model RCAs with similar vertical circuits, and they also had at least one open or increased-value 220kΩ resistor. For those reasons, I automatically replace those two 220kΩ resistors in each of those RCAs that I service. I believe it has reduced call-backs.

Victor Caro
Bronx, New York

Troubleshooting Tips rates and guidelines

Beginning with the January 1987 issue, ES&T is paying $25.00 per item for Troubleshooting Tips that are accepted.

A Troubleshooting Tip is a description of the procedure used by a servicing technician to diagnose, isolate and correct an actual instance of a specific problem in a specific piece of electronic equipment. Its value to readers, however, lies in the general methods described rather than its applicability to the repair of the specific piece of electronic equipment.

A good, useful, Troubleshooting Tip has the following elements:

1. a brief but complete, accurate and concrete description of the problem symptoms;
2. a complete identification of the set, including manufacturer's name, model and chassis number and the Sams Photofact number, if applicable;
3. a hand drawn schematic sketch of the area where the trouble occurred, if applicable. Include some major component such as a transformer, tube or transistor to serve as a landmark to the ***ES&T*** staff;
4. a detailed, step-by-step description of the procedure used to track down the cause of the problem. This should include the thinking process used—for example, "the absence of B+ voltage led me to believe...etc.";
5. a mention of any symptoms that misled you and caused you to follow false trails;
6. a narrative telling why the defect was suspected and how it was determined to be the cause of the problem such as tested open, shorted, etc.;
7. a description of how the repair was performed, including any precautions about possibility of damage to the set or injury to the servicer, if applicable.

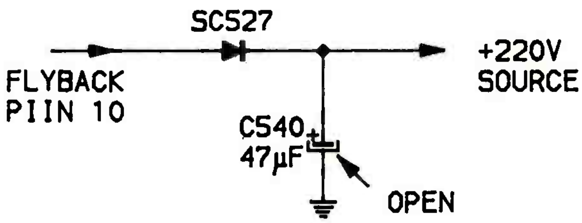
The characteristics of a good candidate for Troubleshooting Tips are as follows:

1. It should be a relatively uncommon problem.
2. The diagnosis and repair should not be obvious, and preferably should present something of a challenge to a competent service technician.

Symcure

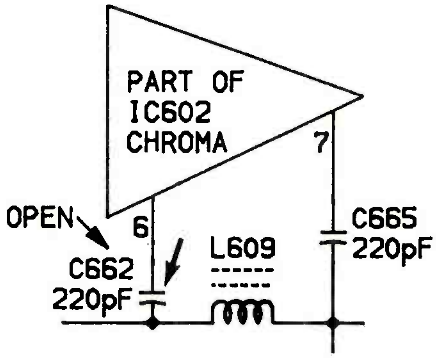
Symptoms and cures compiled from field reports of recurring troubles

Chassis – Sylvania E-32 1
PHOTOFACT – 2034-1



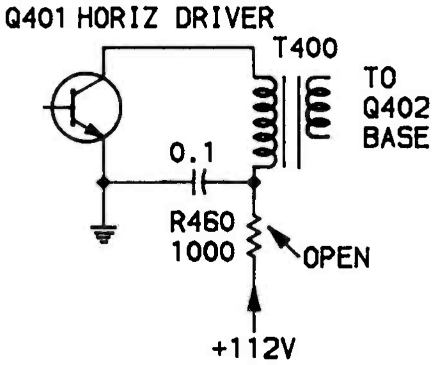
Symptom – Left side of picture is darker; color smears.
Cure – Check capacitor C540, and replace it if open.

Chassis – Sylvania E-32 2
PHOTOFACT – 2034-1



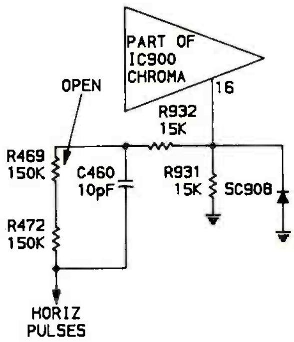
Symptom – Incorrect color hues.
Cure – Check capacitor C662, and replace it if open.

Chassis – Sylvania E32 3
PHOTOFACT – 2034-1



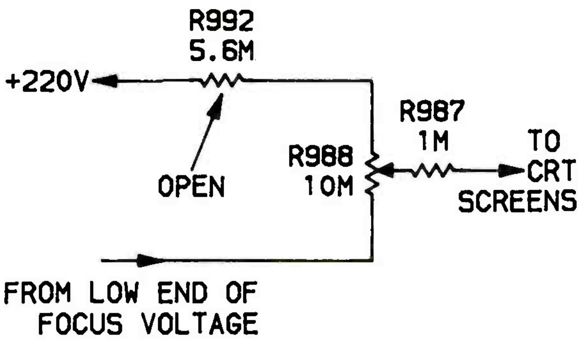
Symptom – The horizontal deflection does not operate.
Cure – Check resistor R460, and replace it if open.

Chassis – Sylvania E32 4
PHOTOFACT – 2034-1



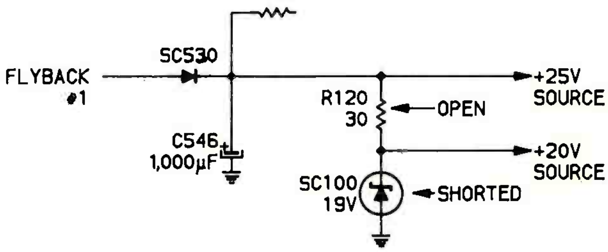
Symptom – All color is missing.
Cure – Check R469 and R472 and replace either if open.

Chassis – Sylvania E32 5
PHOTOFACT – 2034-1



Symptom – Excessive brightness produces retrace lines.
Cure – Check R992, and replace it if open.

Chassis – Sylvania E32 6
PHOTOFACT – 2034-1



SYMPTOM – All sound is missing.
Cure – In the power supply, check for a shorted SC100 diode and an open R120 resistor; replace all defective components.

Books

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

Electric Circuit Analysis, by S.A. Boctor; Prentice-Hall, 839 pages, $30.25 hardbound.

Although this author bases foundation electric circuit analysis primarily on algebra and trigonometry, the emphasis is on the *why* and *how* before involving the reader in the usual albebraic manipulations. New mathematical concepts are treated in conjunction with the corresponding circuit analysis topic. Calculus concepts are clearly introduced, with derivations based on calculus provided in the appendices of relevant chapters. An excellent text for starting or brushing-up math precepts.

Published by Prentice-Hall, Inc., Englewood Cliffs, NJ 07632; 1-800-223-2336.

Digital Logic Circuits: Tests and Analysis, by Robert G. Middleton; Howard W. Sams, 304 pages, $16.95 paperback.

No previous experience with digital circuitry is assumed by the author, who does a good job of anticipating pitfalls that lie in wait for the beginning technician. Stressing the necessity of reasoning back from the symptom, and finding the cause of the problem(s) by systematically eliminating various possibilities, the book introduces readers to basic test equipment and its various applications. Techniques are presented without frills, with the major thrust toward practice instead of theory. With troubleshooting digital logic circuits now an activity of concern to electronic technicians, this is a useful, timely publication.

Published by Howard W. Sams & Company, 4300 W. 62nd St., Indianapolis, IN 46268; 317-298-5409.

ES&T

PART 2

MTS

TV sound in stereo

By Bert Huneault

Part one of this two-part article was published in January 1987 issue of ***ES&T.***

A little MTS history

Through the early 1980s, the Broadcast Television System Committee (BTSC) of the Electronic Industries Association (EIA), on behalf of the TV industry broadcasters and equipment manufacturers, investigated standards for the broadcasting and reception of multichannel television sound that was to include stereophonic sound as well as a simultaneous second audio program–for example, a second language.

The EIA eventually recommended the Zenith transmission system coupled with *dbx* noise reduction, and submitted the combined system, called the BTSC system, to the FCC in January 1984. The following April, in a decision reminiscent of the AM stereo scenario, the FCC informed the industry that the choice of technical standards was left to the marketplace, instead of ruling in favor of a specific system. However, protection was granted to the pilot frequency of the BTSC system; the FCC ruled that if a pilot signal is transmitted at 15.734kHz, the BTSC system must be employed. Thus the way was cleared for TV broadcasters to start transmitting sound in stereo. As a result of the FCC endorsement, the BTSC system rapidly has become the standard TV stereo sound system in North America where the first commercial TV broadcast in stereo occurred during the 1984 Summer Olympics in Los Angeles.

Lambert C. Huneault is coordinator of the Electronics Department, St. Clair College of Applied Arts and Technology, Windsor, Ontario, Canada.

The BTSC system

Just as in FM MPX stereo, the BTSC features an L+R main audio channel, a pilot carrier and a subchannel containing L-R AM sidebands.

One significant difference is the use of 15.734kHz as the pilot signal frequency in the BTSC system, instead of 19kHz. Of course, TV technicians immediately will recognize 15.734kHz as the horizontal scanning frequency in color television. Neat, isn't it? Another important difference is the possible inclusion of a monophonic second audio program (SAP) subchannel, in addition to an optional SCA-like professional subchannel.

Figure 7 shows the composite spectrum of the BTSC system featuring a fully-loaded baseband containing all optional goodies (stereo, SAP and professional subchannels).

The baseband includes the following signals:

1. The *main channel* consists of L+R audio (50Hz-15kHz) with 75μs pre-emphasis. This signal frequency-modulates the TV station's sound carrier in the same way that a conventional

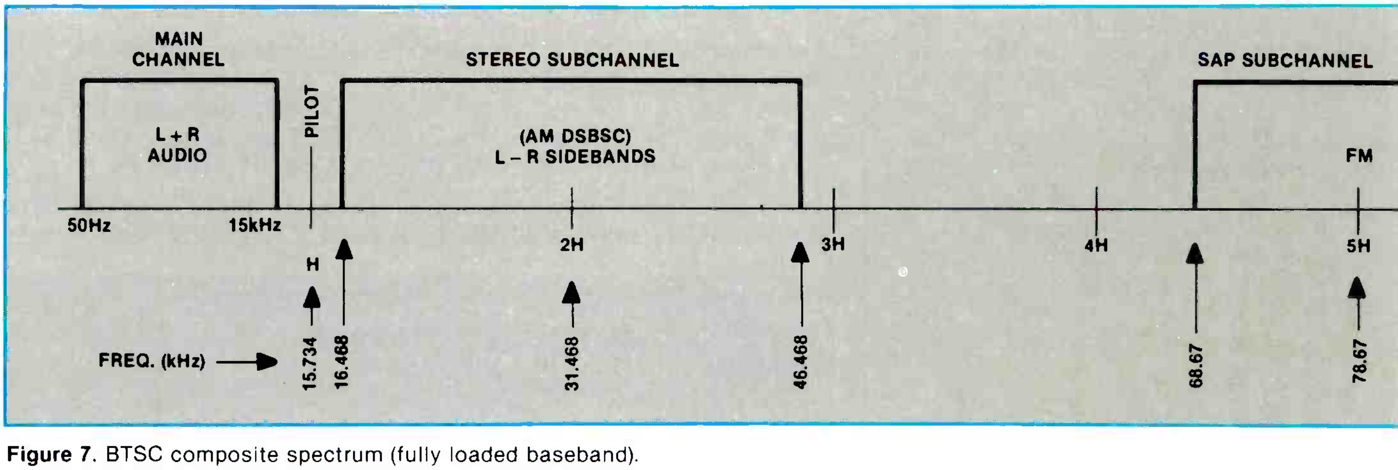


Figure 7. BTSC composite spectrum (fully loaded baseband).

monophonic signal does.

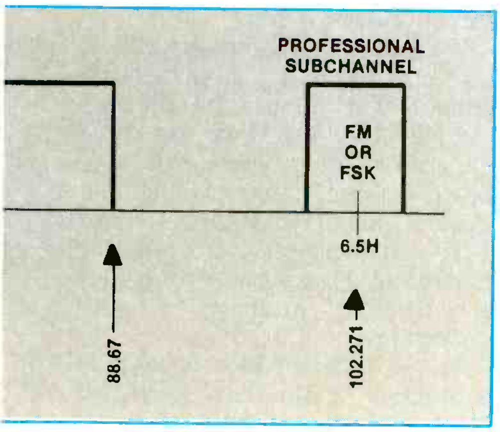
2. The *Pilot Signal* is a 15.734kHz continuous wave. Because this is the same as the TV horizontal sync frequency, we refer to it as *H*. As mentioned earlier, this specific frequency is "protected" under FCC rules; the rest of the audio baseband is virtually unregulated. TV receivers use the pilot signal to:

- recognize that a stereo signal is present and turn on an LED;
- regenerate the subcarrier necessary for decoding of the L-R stereo information – for demodulation of the L-R sidebands.

3. *The stereo subchannel* incorporates the L-R audio signal that first is subjected to level encoding (compression) as part of the dbx companding system. *Companding* means COMpressing (at the transmitter) and complementary exPANDING (at the receiver), in order to achieve better noise reduction. This is somewhat like the Dolby system. The Compressed L-R audio is then used to amplitude-modulate a subcarrier centered at 31.468kHz (frequency = 2H) in a double sideband suppressed carrier modulator (AM DSBSC), producing L-R sidebands on both sides of the 31.468kHz subcarrier frequency. These double sidebands then frequency-modulate the station's sound carrier.

Note that the BTSC multichannel TV sound system is compatible with the existing NTSC standard. A conventional (monophonic sound) TV receiver ignores everything but the main channel, and reproduces the L + R audio just as it would any mono signal.

4. The *SAP subchannel* has no equivalent in the conventional FM



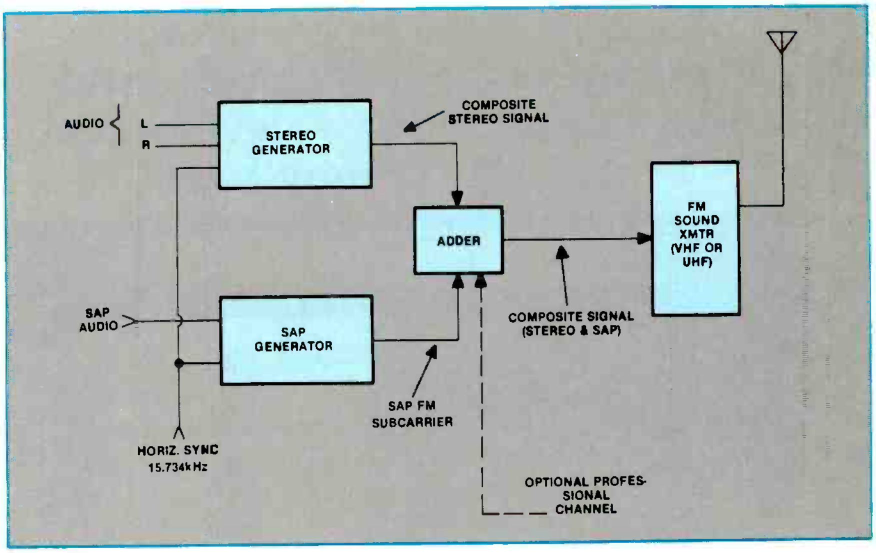


Figure 8. Overall MTS transmission system.

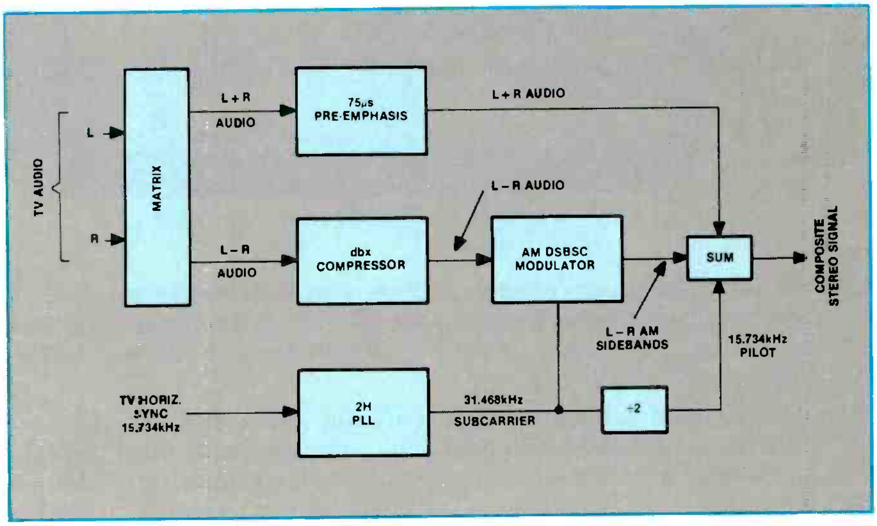


Figure 9. Simplified block diagram of stereo generator.

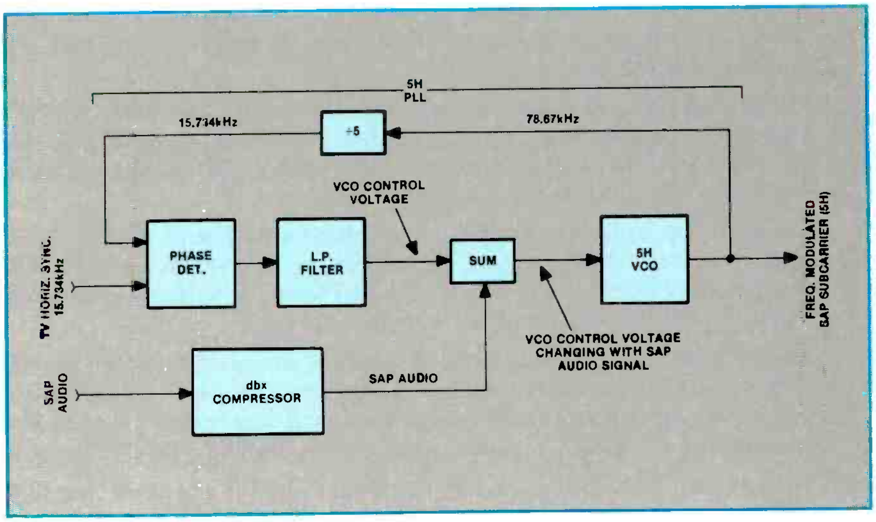


Figure 10. Simplified block diagram of SAP generator.

stereo system. As pointed out earlier, a special feature of the BTSC system is its provision for a monophonic second audio program (SAP) that may be used for a second language in a bilingual broadcast. The SAP audio signal is first subjected to dbx compression identical to that of the L-R audio signal. The compressed SAP audio *frequency-modulates* a 78.67kHz (frequency = *5H)* subcarrier, which then modulates the TV station's FM sound carrier. Maximum frequency deviation of the 5H subcarrier is ±10kHz. Some manufacturers refer to SAP as "secondary" or "separate" audio program.

5. The *professional subchannel* is yet another optional feature of the BTSC system. It can be used for a variety of non-program-related purposes: communicating with remote crews or for non-public subsidiary communication services (much like SCA). Its subcarrier frequency is 102.271kHz (6.5H) and it features either FM modulation for voice transmission or FSK (frequency shift keying) for data transmission.

Other baseband configurations

Because the BTSC baseband is virtually unregulated (with the exception of the pilot frequency), some transmissions may feature different baseband configurations. Instead of the fully loaded multichannel sound baseband illustrated in Figure 7, some transmissions may consist of *monophonic* audio with a second audio program (SAP), with or without a professional channel. Another baseband configuration might consist of the main channel (L+R), pilot and stereophonic subchannel (L-R) with or without a professional channel but with no SAP. Yet another scheme might feature *monophonic* audio with no SAP and with or without a professional channel. This article on MTS is mainly concerned with the main channel and the stereo and SAP subchannels; the professional channel will not be discussed any further because it is used for non-public services.

MTS transmitter

Figure 8 is a highly simplified block diagram of the overall MTS transmission system.

Note that the composite stereo signal at the output of the stereo generator is added to the FM subcarrier emerging from the SAP generator, to produce the *composite signal* that frequency-modulates the TV station's VHF or UHF sound carrier. Also, note the horizontal sync signal (frequency H) that is applied to both generators.

To get a better idea of what is contained in the two *generator* blocks of Figure 8, refer to Figures 9 and 10.

In Figure 9, note that the 31.468kHz subcarrier is produced by a phase-locked loop (PLL) locked to twice the horizontal sync frequency (2H). This subcarrier gets modulated by the dbx-encoded (compressed) L-R audio signal in a balanced modulator featuring AM double sideband suppressed-carrier output. The resulting L-R sidebands (centered on 31.468kHz and ranging between 16.468kHz and 46.468 kHz) are then added to the pre-emphasized L+R audio signal and the 15.734kHz pilot signal, to generate the composite stereo signal.

Just as the L-R audio signal is compressed, so is the SAP audio signal, as seen in Figure 10. Unlike the stereo generator with AM DSBSC modulation of a 31.468kHz subcarrier, however, the SAP generator features frequency modulation of a 78.67kHz subcarrier, which is generated by a PLL whose voltage controlled oscillator (VCO) is locked at a frequency five times that of horizontal sync pulses (5H). Frequency modulation of the SAP subcarrier is achieved in an interesting manner in Figure 10: the SAP audio signal is added to the control voltage in the PLL, forcing the frequency of the VCO to swing (deviate) on either side of 78.67kHz.

Noise reduction

To obtain respectable stereo signal-to-noise ratios, dbx noise reduction is incorporated in the Zenith/dbx (BTSC) system. Just like the Dolby system, this companding reduces noise and hiss even in less-than-ideal reception areas. In order to obtain monophonic compatibility, the main channel (L+R) is not companded. Nevertheless this technique does achieve effective noise reduction because most of the noise is introduced in the subchannels.

Companding reduces noise by using the *masking* principle. Effective masking occurs only if the spectrum of the transmitted signal contains sufficient high-frequency information. Unfortunately, most program material contains very little energy in the high-frequency part of the spectrum. Dbx companding solves that problem by dynamically altering the spectrum of the audio signal in a selective manner that is determined by fre-

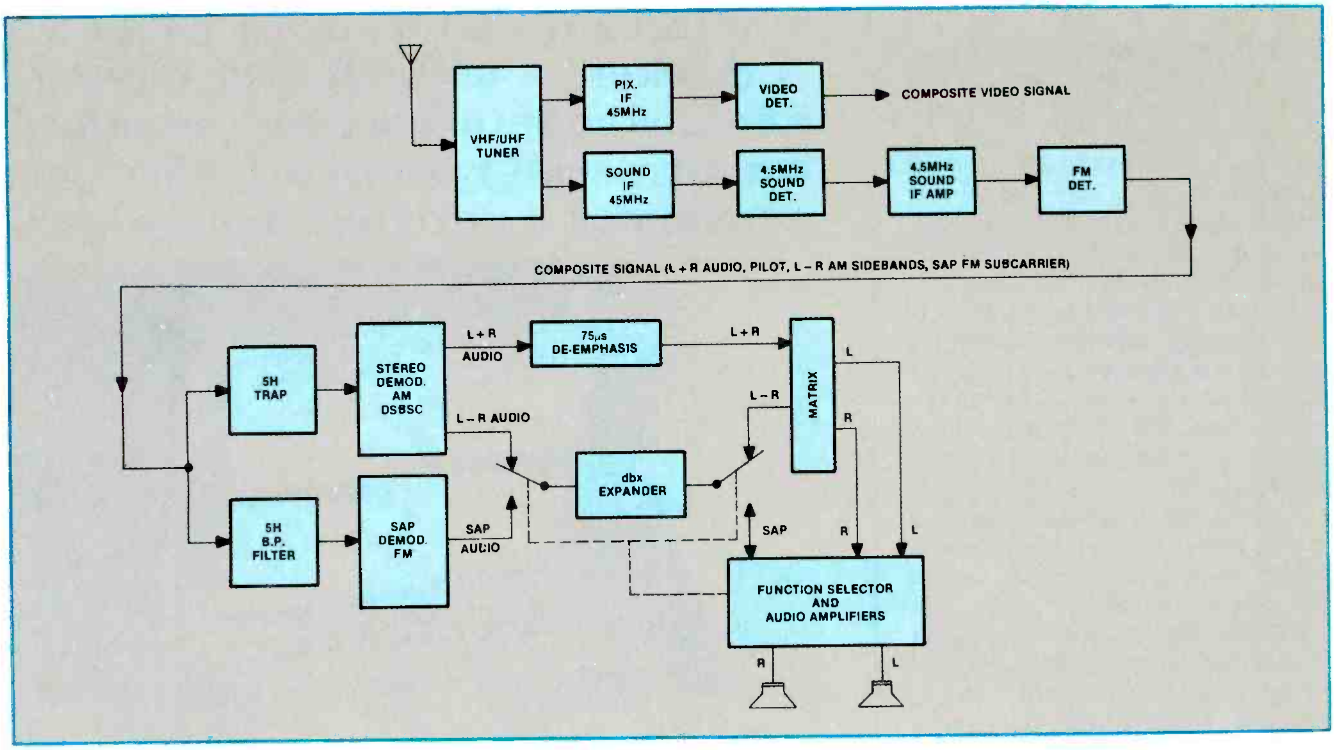


Figure 11. Block diagrams of sound circuits in a BTSC receiver.

quency and amplitude parameters. This is achieved by means of bandpass filters, RMS detectors and op-amps featuring variable gain and variable pre-emphasis circuits. So, when the doctored-up audio signal emerges from the compressor circuitry, it contains a high proportion (but not an excessive amount) of high frequencies.

In the receiver, a frequency selective expander is used to restore the audio signal to its original form, thus restoring the original dynamic range and reducing noise in the process. The expander is virtually a mirror image of the compressor. Although the dbx compander features two compressors at the transmitting end (one for L − R and one for SAP, as seen in Figures 9 and 10, respectively), the TV receiver normally features only one expander, but it is switched to either the stereo mode or the SAP mode.

MTS receiver

Figure 11 is a block diagram of the sound section of a TV receiver suitable for stereo and SAP reception. The front end (tuner) is conventional. Although some MTS receivers feature a single 45MHz IF strip common to both picture and sound, as in conventional monophonic receivers, many TV sets feature two separate 45MHz IF strips: one for the picture and one for the sound, as in Figure 11. The sound IF signal produced at the output of the 4.5MHz intercarrier sound detector must receive special consideration as it passes through the sound IF amplifier and the FM detector because, with the BTSC composite baseband occupying approximately 90kHz, it follows that 180kHz bandwidth is needed in the sound IF and FM detector circuitry. Double-tuned transformers or ceramic filters can provide the required extra bandwidth with adequate selectivity. In monophonic receivers, the 4.5MHz sound section normally has a bandwidth of only 50kHz.

The composite signal at the output of the FM detector contains all the baseband components present at the transmitter: the 50Hz-to-15kHz L + R audio signal (pre-empahsized), the 15.734kHz pilot, the 16.568kHz-to-46.468kHz L-RAM sidebands (compressed), and the 78.67kHz SAP FM carrier that deviates between 68.67 and 88.67kHz.

Stereo reception

The composite signal is fed through an SAP trap to the stereo demodulator, wherein a 31.468kHz subcarrier is regenerated and combined with the L − R sidebands to recover the L − R audio signal; the L + R audio passes through the demodulator, and is de-emphasized before reaching the matrix. The L − R audio signal (which had been compressed at the transmitter) is now fed through the dbx expander circuitry and is then applied to the matrix. The original LEFT and RIGHT audio signals are recovered at the output of the matrix and are fed to the audio system.

SAP reception

The composite signal at the output of the FM detector is fed through an SAP bandpass filter (passband = 68.67 to 88.67 kHz) to the SAP FM demodulator. The output of this FM demodulator is the SAP audio signal. To hear this second audio program, it is only necessary to flip the SAP/STEREO switch to the SAP mode, allowing the SAP audio signal to pass through the dbx expander. It is then fed to the audio system. Although both stereo and SAP signals are received simultaneously, only one program is listened to at a time, as selected by the audio switching arrangement.

A detailed discussion of the complete circuitry of the sound section of actual BTSC receivers is beyond the scope of this article, as it would entail page after page of schematic diagrams and circuit descriptions; but a comment or two are apropos.

So far, manufacturers have seen fit to implement the BTSC decoder block diagram of Figure 11 by means of very elaborate circuitry, which often comprises multiple circuit boards with numerous ICs and a surprisingly large number of discrete transistors. For example, the Toshiba CX484C color TV chassis incorporates two printed circuit boards (PCBs) in the MTS section, in addition to audio circuitry on the main TV circuit board. The two PCBs feature a total of nine ICs and 27 discrete transistors! In the RCA CTC131 monitor/receiver, the complete BTSC sound-processing circuitry comprises three PCBs featuring a total of 17 ICs and 28 discrete transistors. The Canadian Electrohome/Mitsubishi CK-3501C monitor/receiver features one MTS circuit board with six ICs and 24 discrete transistors.

Simpler circuitry to come?

Considering the simplicity of stereo decoder circuits in ordinary FM radios, the complexity of MTS circuitry in TV receivers seems archaic, notwithstanding the fact that dbx expanding and SAP decoding are bound to increase component counts. I think the present complexity represents normal evolution, and anticipate simpler BTSC decoders with fewer discrete components and more circuit functions implemented with ICs in the not-too-distant future, especially in low-cost receivers.

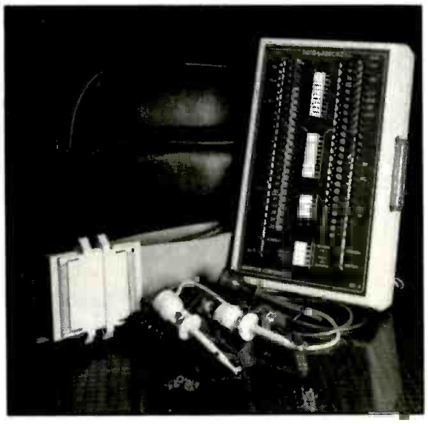
Stereo sound in TV sets undoubtedly is here to stay, and some manufacturers already are offering MTS adapters for existing monophonic TV sets. Keep in mind that due to the BTSC bandwidth considerations discussed earlier, the input signal for such adapters should not be taken from the output of the receiver's FM detector. Instead, it must come from the 4.5MHz intercarrier sound detector or from the tuner output if the adapter has its own 45MHz sound IF circuit. Test equipment manufacturers are also jumping on the MTS bandwagon, offering signal generators dedicated to the alignment and troubleshooting of BTSC circuits; the latest one to come to my attention is the B & K model 2009 MTS TV stereo generator.

Now that we have stereo sound in TV sets, what will come next... stereo (3D) pictures? ES&T

Products

Break-out box

Dataran's RS-232 break-out box, the DataTracker (DT-4) has been designed to monitor 25 lines on both sides, four states (high, low, off and clocking) simultaneously without any special patching. It contains 100 LEDs, 50 red and 50 green, for monitoring activity on all of the 50 lines. According to Datatran, this capability is not found on any other RS-232 device.



The DataTracker is passive, drawing its power from the equipment under test and thereby placing a load on the line being tested, while visually indicating signal strength. There are 25 separate switches for straight-across patching designed in two groups of 10 and one group of five. An added feature allowing pins 2 and 3 to be crossed (a common practice) has been included. Cable testing is an additional capability.

Circle (75) on Reply Card

Silicone elastomer

Dow Corning announces an elastomer, Sylgard Q3-6605 thermally conductive elastomer, with premium thermally conductive properties. This flexible material has been developed for potting and encapsulating electrical and electronic devices that require high thermal conductivity. It is suited for potting transformers, power supplies, general purpose modules, coils and relays where thermal dissipation is crititcal.

Sylgard Q3-6605 elastomer is also effective as an adhesive for bonding hybrid circuit substrates and components to heat sinks and in other bonding applications requiring high strength flexibility and thermal conductivity. It provides primerless adhesion to many substrates. Flexibility and stability are retained through repeated thermal cycling, from a low of −45°C up to 200°C. It has excellent dielectric properties, according to the manufacturer.

Circle (76) on Reply Card

Physical and static protection

Protection for PC boards and subassemblies from both impact and static electricity are combined in a cushioned static shielding bag from the *3M Static Control Systems Division.*

The 3M Model 2120 Cushioned Static Shielding Bag features static protection and a new open-cell cushioning layer to curb the costs involved in 2-part packaging methods while providing optimum protection.

Five-layer construction protects against all three kinds of static threat: direct discharge, triboelectric charge, and static fields. The inside layer of this bag is an anti-static liner of smooth polyethylene to minimize snagging.

Polyester film and open-cell polyethylene cushioning layers provide tensile and dielectric strength and physical protection. A conductive metallic outer layer with an abrasion-resistant coating ensures static shielding ($10^2\Omega$/sq. resistivity).

Circle (77) on Reply Card

Interface analyzer

The model 500 EIA RS-232 interface analyzer has been announced by *Electro Standards Laboratory*. It is a diagnostic tool designed for use at the standard EIA RS-232 or CCITT V.24 data interface of modems, multiplexers, terminals, and computers. The model 500 is simply inserted in series between the data terminal equipment (DTE) and the data communications equipment (DCE) to provide access to and monitoring of all data, timing, and control signals.

High efficiency red LEDs display polarity, activity, and validity of all key interface signals. Miniature rocker switches allow the user to program a *make or break* for each signal at the DCE/DTE interface. Minipatchcords are provided for cross-patching or loopback patching of signals at the front panel test point array.

A complete table of EIA/CCITT standard interface signal description is provided in a reference chart.

Circle (78) on Reply Card

Heat sink compound

GC Electronics has introduced Type 44 Synthetic-Ester based heat sink compound, which transfers 46% more heat than the best of silicone compounds, according to the manufacturer. Type 44 was developed in response to demand for an efficient heat transfer compound that would not contaminate other components. Olefin- and silicone-based compounds evaporate and recondense upon adjacent components, says GC Electronics, but "Type 44's low-bleed and evaporation characteristics eliminate the problem."

Circle (79) on Reply Card

Software link

Pioneer Research has announced the LINK 4000 and 4001 software packages for use on its PM 4000 SMD and 4001 ESDI disk-drive testers. The new packages are written in Basic and compiled to execute on the range of IBM PC/XT/AT computers or associated compatibles.

The menu-driven LINK software provides a variety of capabilities, including automatic and manual updating of the defect map, updating from a specified file, read and save of the media defect map, and full control of the remote function via use of the PC as a dumb video display unit. This gives the user the freedom of direct control without having to exit from the software package.

Circle (80) on Reply Card ES&T

Photofact

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

GOLD STAR
CMT-9202 2464-1

HITACHI
CT1358, CT1358B 2460-1

HITACHI
CT2550/51/52/55/56 2463-1

HITACHI
CT19B4, CT1954, CT1955 2464-2

JC PENNEY
685-2104-00 2462-1

MAGNAVOX
Chassis 25C501/03/04/07/10/14/19/20/21/24/25/26/27/28/30/32/33/34/35/36/37/39/44/45/46/50/51/52/55/56/57/59/61/62 2466-2

PANASONIC
CT-1113, CTF-1011 2461-1

RADIO SHACK
16-236A 2461-2

SEARS
562.42410550 2461-3

SEARS
564.48120550/51/564.48121550 2465-1

SHARP
25J55, 25J105 2465-2

SONY
Chassis SCC-648K-A, SCC-648I-A 2460-2

TOSHIBA
CF305, CF306, CM305C 2464-3

ZENITH
SB2026S, SB2027S 2462-2

ZENITH
B2512G1/12K1/14M1/14N1/16P1/84P1, SB2513G1/SB2513G1/13K1/15M1/15N1/17P1/69K/81P/81Y/85P1 2463-2

MONITOR

HITACHI
CM1406C 2466-1

What do you know about electronics?

Circuits used in digital audio circuits (Continued)

By Sam Wilson

In the previous article, I started a series on the circuits that are used in digital (compact disc) audio circuits. That series is continued here and will be continued in future articles. By way of a short review, the sample-and-hold circuitry previously discussed will be briefly reviewed.

Figure 1 shows the function of the sample-and-hold circuit. A *sample rate* input determines how many samples are taken per second. The input signal in this case is a sine wave. The output of the sample-and-hold circuit consists only of those voltages marked with dots. (The broken line shows the original sine wave input.)

Figure 2 shows a sample-and-hold output signal (again, just the dots) delivered to an encoder. Pulse code modulation is used, so the encoder converts each of the dots to a binary number. In the simple example in the last issue, we used a 3-digit number. The output of that simple encoder will be a string of binary numbers as shown in Figure 2.

There are some inherent problems with pulse code modulation. They were touched on in the last issue and they will be discussed in greater detail here.

The first problem is called quantization error. The basic idea of this error is shown in Figure 3. For the wave shown in Figure 3 (a) the binary output code will be

100 101 100 011 100

The audio waveform in Figure 3 (b) is different. Its code is

100 101 100 011 100

So, the codes are the same but the waveforms are different. If the waveform in Figure 3(a) is reproduced it will look like the one in Figure 3(b). Obviously, the signal has been distorted due to the quantizing error.

The thing that makes this condition worse than any other is that the squared pulses in Figure 3(b) contain high order harmonics. As will be shown shortly, this can produce aliasing and other problems in the compact disc system.

Another situation that can cause a quantizing error is shown in Figure 4. Here the waveform has a constant amplitude for five of the samples taken. The signal amplitude is exactly halfway between Code 100 and Code 101. Which code should be used to represent this part of the signal?

Whichever is used, it is clear that the reproduced wave, which can exist only at 100 or 101, will not be an accurate representation of this part of the audio signal.

Small variations in amplitude in the reproduced signal that are due to quantizing error show up as noise in the loudspeaker.

One obvious solution for reducing these quantizing errors is to use a greater number of codes to represent the signal amplitude. In

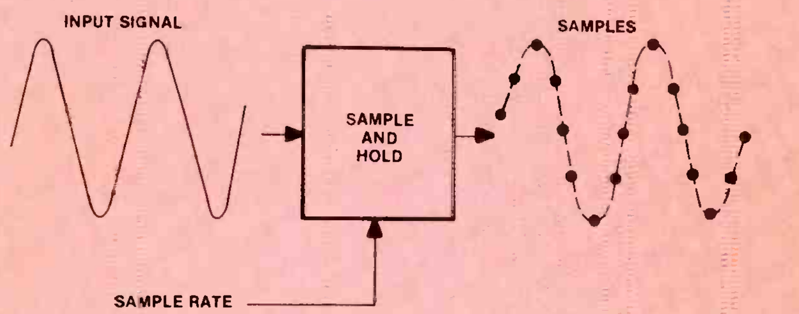


Figure 1.

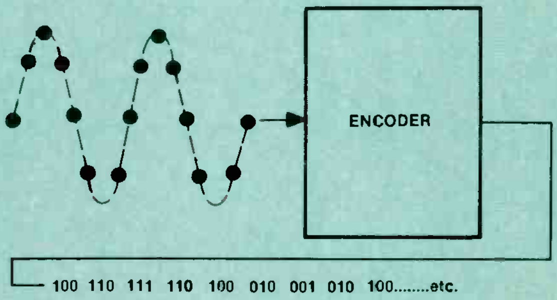


Figure 2.

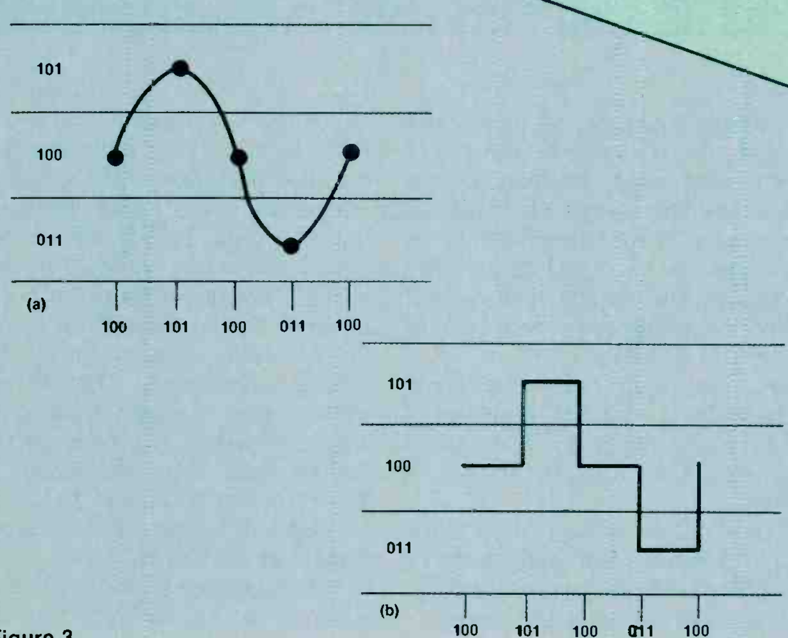


Figure 3.

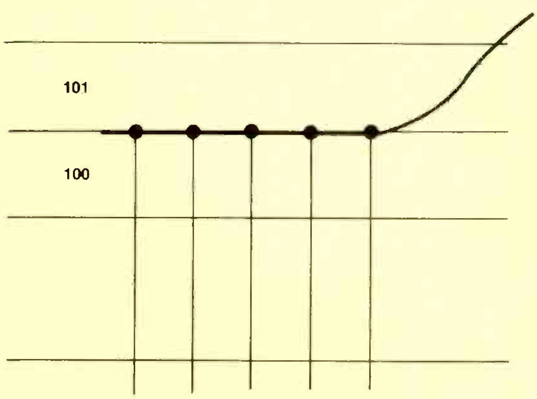


Figure 4.

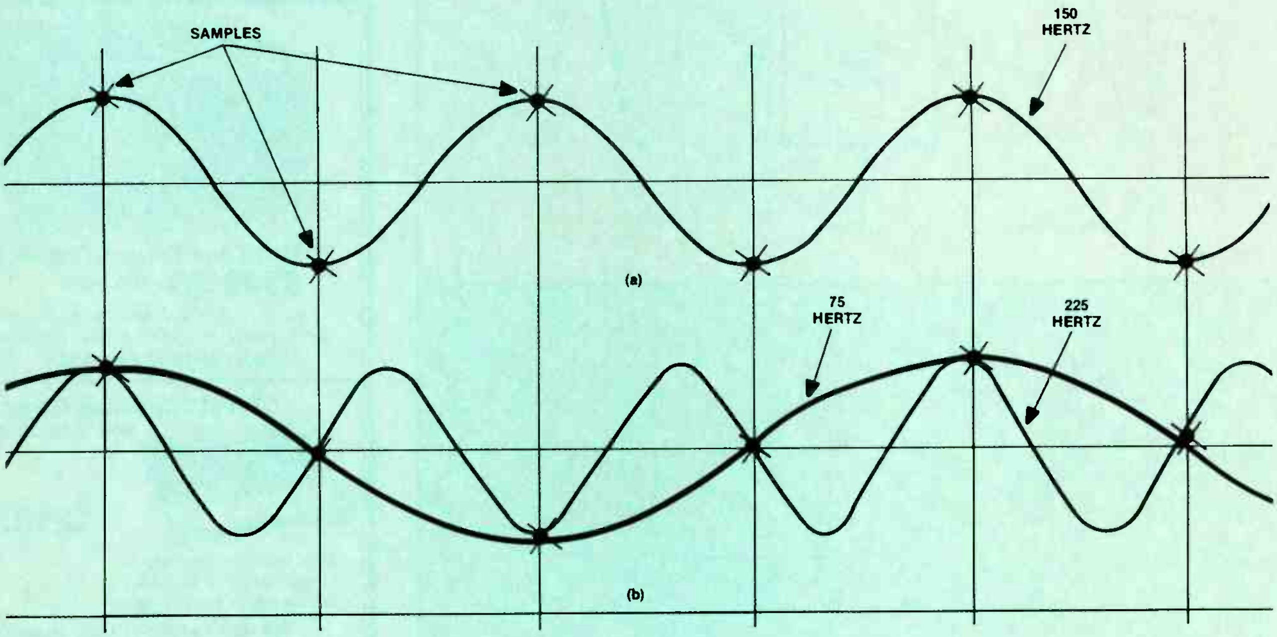
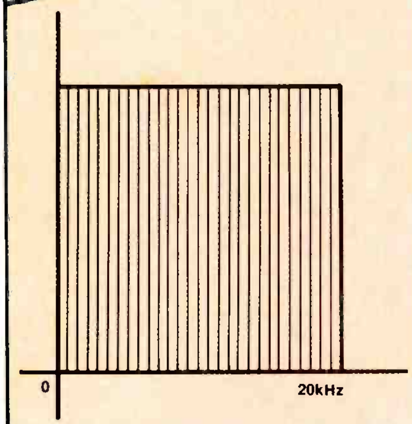


Figure 5.

Figure 6.



our simple example, we used only three digits. If a greater number of digits were used, the problem in Figure 4 could be greatly reduced. The reason is that there would be many levels for 101 and 100. Therefore, the chance of the signal falling between two levels would be greatly reduced.

Another way to reduce the error is to take a greater number of samples per second. That would eliminate the problem shown in Figure 3.

This system developed by Philips (N.A.P.) uses a sampling rate of 44.1kHz. In other words, 44,100 samples are taken every second.

Aliasing

An important mathematical relationship exists between the number of samples that must be taken per second and the maximum frequency that the system can reproduce. In simple terms, there must be at least two samples taken per cycle for the highest frequency that the audio system is designed to reproduce. All this was worked out in detail by a man named Shannon, but when you read about it in books you will find that another person who did a lot of work on this (his name is Nyquist) is given most of the credit.

If the sampling rate is 40,000 samples per second the maximum frequency that could be reproduced would be 20,000Hz. That would allow two samples for each cycle. Using a 44kHz sampling frequency should result in a maximum audio frequency of about 22kHz. However, the filtering system that is used in a typical system makes it necessary to reduce that by a slight amount. Nevertheless, it is safe to say that the system easily can reproduce a 20kHz audio signal.

What happens if you try to shove a signal through a higher frequency so that there is less than one sample per cycle? The result is illustrated in Figure 5.

Figure 5(a) shows a 150Hz signal that is being sampled at a rate of 300Hz. Again, I am using lower frequencies and lower number of digits in order to simplify the discussion.

In (b) of the same illustration the signal frequency has been increased to 225Hz. This is well over the 150Hz maximum. Samples still are taken at the same points. However, the reproduced signal will now be only 75Hz.

Note this very interesting point.

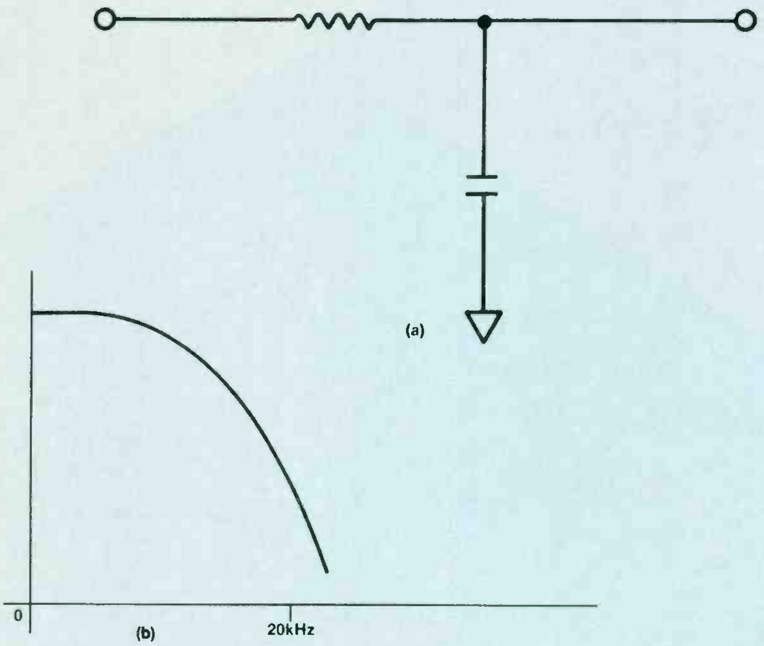


Figure 7.

If you subtract the 225Hz from the 300Hz sampling rate, you get 75Hz, which is the lower frequency that actually is reproduced. That is why this problem is sometimes called foldover.

Once the 75Hz signal is generated (because of the 225Hz frequency being sampled), there is no way to get it back out of the system. It will show up in the final audio as a 75Hz signal. That is a form of frequency distortion.

Having explained the problem of foldover, let's take another example that is more realistic. Remembering that the sample rate is 44.1Hz, what will happen if a 35kHz audio signal finds its way through the system? The result will be a foldover (or, aliasing frequency) as follows:

44.1 − 35 = 9.1kHz.

That 9.1kHz will show up in the reproduced audio as an undesirable signal.

So, you say, what is the chance that a 35kHz audio signal would be in the system anyway? Remember those square waves that were produced by quantizing? They contain a fundamental frequency and a wide range of odd harmonic frequencies. One of those odd harmonic frequencies could easily be in the 35kHz range with a resulting frequency distortion.

This foldover effect is called aliasing because it produces a signal that is not part of the original signal. It is a signal that has taken on a new identity, or alias.

Getting rid of the problems just discussed

OK, so now we know what kinds of problems we are getting into with digital audio. How do we get around these problems?

Obviously, the manufacturers are aware of them and have taken steps to make sure they are not a problem in a new digital audio system. In this issue, I am going to discuss only the method of eliminating aliasing. In the next issue, we will talk about how to get rid of the quantizing effect.

Because of the nature of aliasing, it is obvious that we must eliminate all frequencies above 22kHz if the sampling rate is 44kHz. In practice, we will design a filter that will start dropping off at 20kHz. In other words, we are going to use a low-pass filter.

Figure 6 shows the ideal brick wall filter on a frequency domain display. Unfortunately, a filter

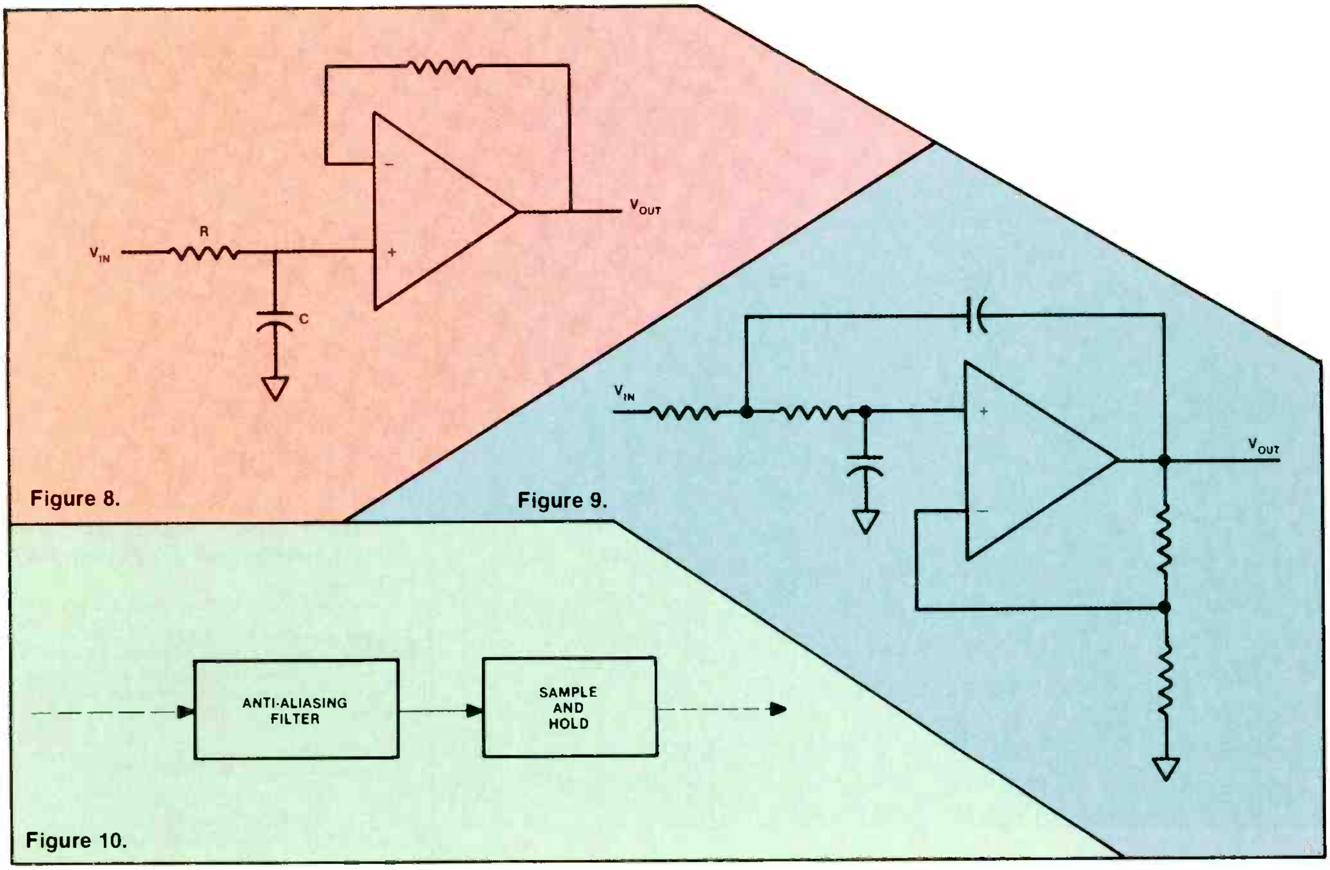


Figure 8.

Figure 9.

Figure 10.

with this type of response cannot be made at any reasonable cost.

Figure 7 shows a simple passive RC filter with its characteristic curve. The circuit is shown in (a) and the frequency domain response curve is shown in Figure 7(b). This is called a passive filter because it does not have any amplification. More specifically, it does not have a source of voltage or amplification.

Note that the response curve must be dropped off at a frequency below 20kHz in order to assure that no aliasing will occur. Engineers are fond of calling this "a filter of the first order." There is a complicated mathematical reason for that terminology but it boils down to this: It's the simplest one you can make for the number of components and the configuration shown. If you put two of these in series, you have a second order filter. A third order filter would require three of these in series.

A better passive filter characteristic is possible with more resistors and capacitors. However, the tendency is to use operational amplifiers in active circuit configurations for the required low-pass filter.

Figure 8 shows an active low-pass filter of the first order. The amplifier serves as a buffer between the input and output circuitry, so it has an advantage over the one shown in Figure 7. However, better results can be obtained with a filter of the second order shown in Figure 9.

As with the passive filter you can get a higher order by connecting the filters in series. So, if two second-order filters are put in series you have a filter of the fourth order. Other combinations also are possible. It is not unusual to have a filter of the 12th order that is made by combining op-amp filters having a lower order. Each additional order produces a sharper cutoff and the frequency ideal of Figure 6.

You will hear terms like Chebyshev filter, Gaussian filter, Butterworth filter and others. Each type has its own special rolloff characteristic.

Figure 10 shows a block diagram of the part of the compact disc system that we have discussed so far. Note that the low-pass filter precedes the sample-and-hold circuitry. Also, note that the low-pass filter in this system is called an anti-aliasing filter. ES&T

ANSWERS to the QUIZ

By Sam Wilson

Questions are on page 40

1\. A. The total voltage across R1 and R2 is 10V − 4V = 6V. Roughly one-third of that voltage is across R1.

$$V1 \approx 6\left(\frac{22}{22 + 39}\right) = 2V$$

Approximately one-third of the total voltage must be added to the AGC voltage (the lower value) to determine the base voltage. That gives a base voltage of 4V + 2V = 6V. Using the values given in Figure A the exact value would be:

$$V1 = \frac{22}{22 + 39} \times 6 = 2.16^{+}$$

Voltage at base

$= \text{AGC voltage} + V1$

$= 4 + 2.16^{+} = 6.16^{+}V$

The small amount of base current is disregarded in this type of calculation.

2\. D. The power supply for op-amps is seldom shown on schematics. In the circuit of Figure B, adjustment of R1 sets the bias on one of the two legs of the differential amplifier at the input of the op-amp. This assures that conduction in the two legs is the same, and therefore, the offset voltage will be 0V.

3\. B. Texas Instruments manufactures these components. They are identified as TL430 and TL431.

4\. A. Really! Texas Instruments makes them. Examples are: TL011, TL012, TL014 and TL021 for fixed input/output ratios. The TL010 can be pin programmed for any of 33 ratios. One example of application is to keep the brightness of series-connected LEDs constant regardless of how many are switched in and out.

5\. C. The mechanism for producing 1/f noise is not completely understood. A graph of this transistor and tube noise intensity, for a range of frequencies, is shown in Figure E. The range of excess noise is marked. This type of noise is important in audio and medical electronic circuits.

6\. A. In the chop mode, the scope switches between the two channels at a fixed rate. In the *alternate* mode, one trace is shown and then the other is shown. Chop is a better way to see both low-frequency waveforms at the same time.

7\. A. The current required for full-scale deflection is determined by taking the reciprocal of the ohms-per-volt rating:

$$1/50{,}000 = 20\mu A$$

Because it takes less current to deflect the meter X pointer to full scale, it is more sensitive than meter Y.

8\. C. The symbol is for a *self-saturating transformer*. It is designed so that the core saturates on each half cycle of input power. That limits the peak voltage on the secondary. So, the output voltage is constant.

9\. B. The circuit samples the amplitude of the audio signal at a given sampling rate. The amplitude of the sampled audio signal is converted to a binary code.

10\. B. It is not possible to saturate air with magnetic flux lines. So, putting an air gap in the core prevents saturation.

Audio Corner

By Kirk Vistain

Calibrating test instruments

If you've been in servicing long, you may have some good stories about getting burned with bad readings on a scope or multimeter. I know I do. That's why the seasoned troubleshooter checks basic calibration nearly every day.

Accuracy and resolution

Let's get some basic terminology straight. *Accuracy* describes how close a measurement is to the true value of a quantity. For example, an ohmmeter with an accuracy of ±0%, which is perfect, should measure exactly 1Ω across a standard 1Ω resistor.

Resolution refers to how small a difference can be detected between two quantities. A meter that can distinguish between 1.5V and 1.55V resolves better than one that can only discriminate between 1.5V and 1.6V. For example, a digital meter usually has good resolution, depending on the number of digits it displays. A 3 1/2-digit unit, set to the 200mV range detects differences of as little as 100μV. An analog instrument would not be so precise, due to the uncertainty that exists between scale marks.

When digital meters first appeared, there was a great deal of controversy and confusion among technicians. The new meters looked more accurate, because the readout was a precise number, so many felt they were superior to analog devices. Actually, accuracy has little to do with resolution or whether circuitry is digital or analog.

To illustrate, assume we measure 1V with an instrument of each type. The analog meter is specified for an accuracy of ±3% of full scale; the digital meter for ±0.5% of reading +1 digit. Set the analog meter for 1V full scale, and the digital for 2V. The reading from the analog device will have an accuracy of 3%.

Assuming 3 1/2-digit display, the other meter will be accurate to 0.5% +0.1% (the value of the last digit), for a total of 0.6%. Now reset the scale to 200V. Leave the analog meter alone. Our new accuracy figure is 0.5% +10%, for a total of 10.5%. (The last digit has a value of 0.1V, which is 10% of the reading.)

Of course, if we measured 1V on the 100V range of an analog meter, we would have poor accuracy, but we'd get a clue from the fact that a D'Arsonval meter is difficult to read when the needle is down at the lower end of the scale. A digital meter, on the other hand, always looks precise.

The lesson to learn is that the accuracy of a measurement depends more upon setting the meter to the correct range than whether the device is analog or digital.

Calibration standards

Calibration standards can be divided into two types: reference and working. Reference standards are generally calibrated against a *transfer* standard, such as WWV for frequency. You use reference standards only for calibrating working standards, never for direct measurement. Maybe you can mount them in a special case, on a bench used only for calibration. Working standards may not be separate components, but rather parts within test gear.

We deal mainly with five quantities in electronics: voltage, frequency, resistance, capacitance and inductance. Fortunately, inexpensive standards are available for the first three.

For voltage, a set of zinc-carbon (not alkaline, Ni-Cd, or other) D cells, wired in series, generates precisely 3.10V. Use them only to calibrate a VTVM or high impedance multimeter. Then store the cells, preferably in a refrigerator, where they won't be used for any other purpose. The multimeter is now your working standard.

Acquiring a resistance standard is as simple as buying a precision resistor or two with the tightest tolerance you can afford, in the range of 0.1% or better. Get several and check them against one another.

Frequency standards are abundant. U.S. power line frequency, averaged over a long period of time is as accurate as WWV, or one ppm, but short term is not nearly that tight, maybe only one ppk. Chroma burst, broadcast by live network shows, is locked to an atomic clock approaching the accuracy of WWV, but with today's "video jungle IC" technology, getting at the signal may be tricky. That leaves our old standby, WWV, at 5, 10, and 15MHz.

Because many counters use a square wave timebase that is a multiple of 1MHz, calibrating them is a simple matter of zero-beating a harmonic of the internal oscillator frequency against WWV, usually at 10MHz. As a rule, all you need to do is set the counter on top of a communications receiver, tune it to WWV, and adjust the counter's oscillator while listening for the beat from the receiver's speaker. If this doesn't provide adequate signal, open the counter and lay a wire across the oscillator circuit. You want the loosest coupling possible, so as not to affect the frequency. Clip the other end to the receiver's antenna terminals.

Precision capacitors are not as easy to find as resistors. All the same, it is possible to get hold of 1% micas, or polystyrene types. I prefer micas because they seem to be more reliable. I suppose that, assuming random tolerance variations, and neglecting stray capacitance, if you paralleled a sufficient number (N) of caps with the same rating, you'd end up with an aggregate value very close to (Nominal) × (N), because the errors would cancel. Something similar might work with inductors. I've not heard of anyone doing this, but it might be worth trying.

For inductance, we usually must rely on indirect methods to get a standard. For example, using a calibrated capacitor and frequency generator, one should be able to calculate the exact value of a coil.

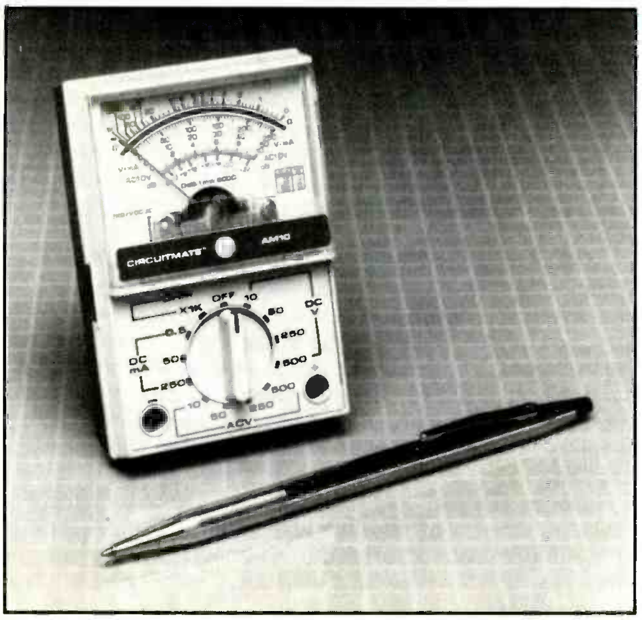
When and where

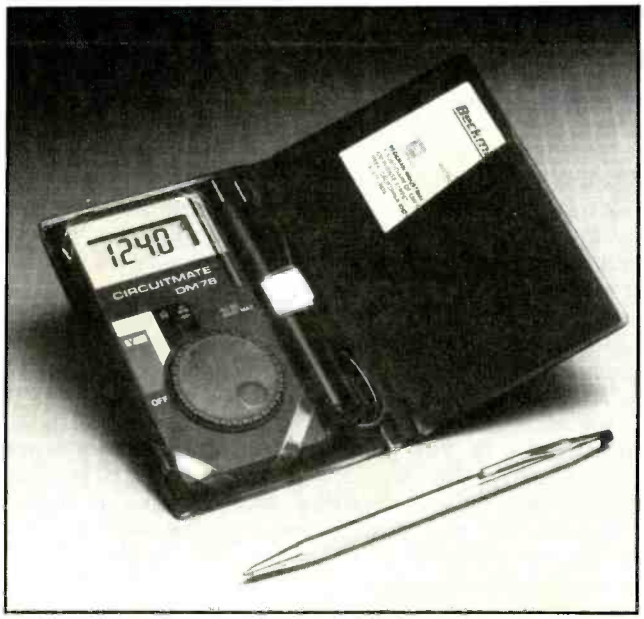
It's difficult to say how often calibration is necessary, but every shop should have the means to test suspected equipment. Many inexpensive service-grade counters need checking nearly every day, but multimeters, on the other hand, are quite stable unless abused.

Scope probes take a beating. I calibrate mine before every session (well, almost) and often discover that the compensation has drifted from last time. Most scopes have a handy calibration signal that is fairly accurate as to amplitude and frequency. It's surprising how many times a person forgets to reset amplitude and timebase controls to the *CAL* position after uncalibrating them in an attempt to lock some complex waveform.

A large shop could afford to have a separate calibration bench. It needn't be anything fancy, just a little clear space, and a collection of standards, mounted in such a way that they can't be scavenged for a repair by an overzealous tech.

Calibration often is taken for granted, but shouldn't be. Many a "dog" repair has been the result of putting faith in an inaccurate measurement.





Digital meters appear to be more accurate because they read out in exact numbers. Actually, accuracy has little to do with resolution or whether the circuitry is digital or analog. *(Photos courtesy Beckman Industrial)*

Understanding computer standards

One of the most nettlesome things about computers is the matter of interfaces among the various components in the system as well as from one computer to another across the room or across the world. It's difficult enough for someone just getting started in computers to understand the operations within the computer well enough to attempt servicing them, but when you begin to study the intricacies of interfacing, it really gets confusing. That's a natural state of affairs in a world as complex as computers, but the complexity shouldn't be confused with difficulty of understanding. Examined from the proper perspective, the business of computer interfacing becomes quite understandable. Not simple – understandable.

Here's one of my favorite analogies. Take a look at a road atlas of the United States. Sure looks complex, doesn't it. It is. How many possible ways are there to get from New York to California? If you count every possible little 2-lane road and city street as well as highways and interstates, the number of ways to get between any two points that are far apart are astronomical. Every time you have a lot of choices you have complexity. But I'll bet you can cut right through all that complexity and find a route that won't take too long to set up. It's a little bit that way with computers. You don't have to evaluate all the choices every time you want to use or service one. But you do have to have some knowledge of what kinds of roads there are to travel and where they lead.

Serial and parallel transmission

One of the first things you learn when you begin working with modern computers is that they handle information in bytes. That is, each character: letter, number, punctuation mark, as well as special characters such as LINE FEED (makes the printer's platen move the paper up one line so it can print the next line below the last) and CARRIAGE RETURN (returns the carriage or print head so that the next line starts printing over at the left hand side of the page), is represented in the world of the computer by eight bits of information. Each of these eight bits is usually signified by a voltage that is either high or low.

Let's say for a moment that we're talking about information in a computer used as a word processor. In that case, we're talking about text. The information is not much use in the computer. It has to be transmitted somewhere: to a printer to be printed out, to a disk to be stored more permanently or perhaps to another computer, or any combination of these.

Here's where the standards come in. In order to transmit and receive data, several things have to happen. The sending device has to let the receiving device know that it's ready to send. The receiving device has to acknowledge that it's ready to receive data. When the data is being sent and received, some scheme has to be available to check that the data received by the receiving device was, in fact, the data that was sent: Bits sometimes get lost. If the equipment of one manufacturer is to communicate with the equipment of other manufacturers (which is not always the case, by any means) it must be manufactured in such a manner that it may do so.

Complicating this already knotty situation is the fact that there are two distinctly different kinds of transmission: *serial* and *parallel*.

When your computer is communicating with its printer or disk drive, or if you're communicating with another computer within the same building, you can communicate over standard data cables using the varying dc levels that make up a data signal. In this case, you might as well transmit all of the bits that make up a byte of data at once over a multiconductor cable – one conductor for each data bit of a byte. You'll also need a few conductors to exchange the ready-to-transmit/ready-to-receive, etc. signals I mentioned a little while ago.

If, on the other hand, you want your computer to communicate with another computer, or data terminal, or other data device in the next building or across the country, you have to modulate the signal: turn the dc levels into an ac signal. The dc signals would attenuate to nothing in a very short distance. And, because putting up poles and stringing your own multiconductor cables would become prohibitively expensive, it makes sense to use lines that already exist at moderate cost: those belonging to the telephone company. In this case, because most telephone systems consist of one line at a time, it makes sense to transmit data one bit after the other and assemble them into bytes at the receiving end. This is known as serial transmission.

RS-232 and all that

Both serial and parallel transmission schemes have given rise to standards for data transmission. One of the most often mentioned of these is the one called RS-232, invoked for serial transmission. To most people, those letters and numbers are just more mysterious jargon. Let's try to make a little sense of it.

The letters RS mean nothing more than Recommended Standard. That's the terminology of the Electronic Industries Association, the group that devised this standard. "Recommended" presumably means that the EIA recommends that its member electronic manufacturing companies follow it in designing interfaces for their computer equipment. The 232 part presumably means that it comes after RS-231 and before RS-233. There, that explains it in a nutshell.

Actually, RS-232 is called "Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange." By the time this issue of ***ES&T*** is published, a new version, D, should be available from EIA should you wish to part with the $20 or so needed to buy a copy. Another standard, CCITT V.24, an international standard recommended by the Consultive Committee International Telegraph and Telephone (a United Nations group that recommends international standards) is equivalent to RS-232.

RS-232 covers four areas:

1. the mechanical characteristics of the interface;
2. the electrical signals that cross the interface;
3. the function of each signal;
4. subsets of signals for certain applications.

The basis of the standard

The article "Testing serial communication with a breakout box" in this issue describes some of the aspects of this standard, so I won't duplicate them here. Rather, here's a brief explanation of the reasons for the standard and some of its peculiarities.

RS-232 applies to a so-called Universal 7-Part Data Circuit (see Figure 1) consisting of:

1. the data terminal equipment (DTE) at point A;

2. the interface between the data terminal equipment and the data communication equipment (DCE – this is a modem) at point A;
3. the DCE at point A;
4. the communication channel between point A and point B;
5. the DEC at point B;
6. the interface between the DCE and the DTE at point B;
7. the DTE at point B.

More later

That's all there's room for at the moment, but we'll talk more about standards in future issues of ***ES&T***. Between this Computer Corner and the break-out box article, the idea of RS-232 has been pretty thoroughly explored.

Oh, by the way, some of the problems described in the BOB article arise because RS-232 is applied where it wasn't originally intended to be applied. Remember the problem of having to cross pins 2 and 3. That's because when you use RS-232 to interconnect a computer with a printer, you're interfacing two pieces of DTE. RS-232 is designed to connect a piece of DTE with DCE.

Of course it works anyway, but you have to be careful about pin assignments.

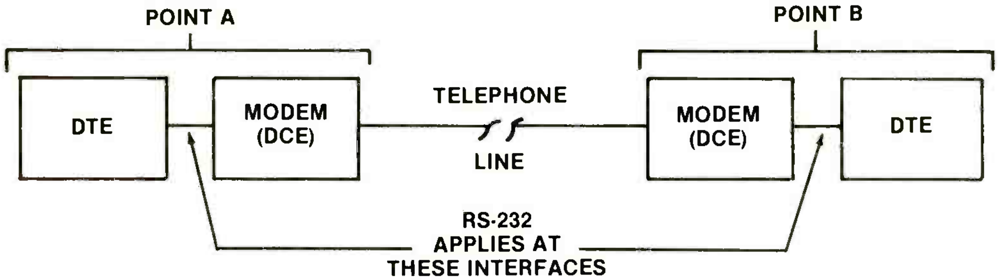


Figure 1. RS-232 was designed to describe the interface between the data terminal equipment and the data communications equipment in a serial data communication system.

ES&T

Video Corner
By Conrad Persson

Diagnostic procedures for system and servo control circuits

General Electric company has developed RECOMMENDED DIAGNOSTIC PROCEDURES FOR VCRs as part of its servicing literature. GE graciously has consented to allow ***ES&T*** to publish this information as a service to readers. This installment of Video Corner will consist of an adaptation of the first part of this document. The second half will be published in Video Corner in a future issue of ***ES&T***.

System and servo control failures account for more than half of all service performed on VCRs. A great deal of time is needlessly spent in determining the defective stage and component(s). All of this coupled with demands for quick service builds pressures on the technician, causing loss of "good old logical thinking."

The purpose of this guide is to reinforce some basic theory, perhaps forgotten, and to suggest some logical steps in troubleshooting and diagnostic procedures. How these circuits process information may differ from model to model. The results however, are the same.

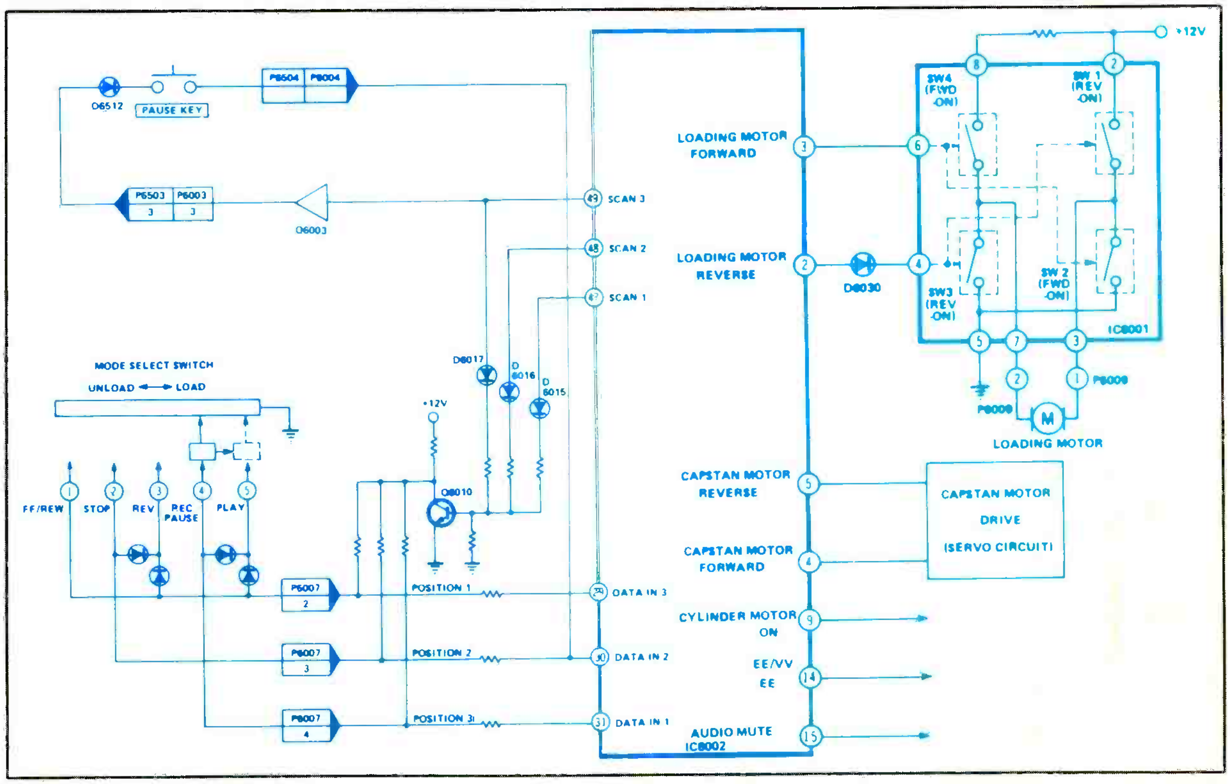
The thought process of linking *inputs* to *outputs* should be used when logically thinking of where to start. Let's briefly discuss the I's (inputs) and the O's (outputs).

The inputs to a device, whether a transistor or microprocessor, are designed to make something happen, usually to an output. Although this is not always the case, let's assume it is for this analysis. Assume that you suspect a transistor whose function is to turn something *on* and *off* (this transistor is basically an electronic switch). You push the Play button and nothing happens. You note that the Loading Motor requires 12Vdc. You also note that the 12Vdc is present in the circuitry. You measure the collector of the transistor and note the 12Vdc is present. Pushing the play button causes no change. Where would you go from here?

- *SUGGESTIONS:*

1. Monitor the base of the transistor when the button is pushed and look for a *change* to occur. (Remember that for a transistor to turn *on*, it must be forward biased. For an NPN, the base must be positive relative to the emitter and for a PNP, the emitter must be more positive relative to the base). A difference of approximately 0.6V between the emitter and base should be considered normal for a silicon transistor; 0.3V for a germanium transistor.
2. If a change does occur at the base, but none at the collector, check the transistor. If no change occurs, work back to the preceding stage.
3. Assuming the transistor is good, you may want to verify the following stage and/or stages by changing the input to transistor (base), by forcing a change of state (base to ground through a low-value resistor, or by applying an external voltage to the base and monitoring the output (collector or emitter).

This procedure is similar to signal injection. In this case by forcing a change of state, you cause the device to respond. This allows you to eliminate much of the circuitry and should lead you to more clearly defined thinking. Leaping before looking, or not thinking logically, are major contributors to incorrect diagnosis. Perfectly good μP's can and have been destroyed by needless desoldering. Always check the discrete components first. Not doing so can be costly, time consuming and result in possible PC board and component damage.



The following are diagnostic hints in troubleshooting the VCR system control circuit. Actual circuitry may differ from model to model, but using the troubleshooting process to logically eliminate circuit components will apply to all units.

Assume that the power supply and mechanical functions are all operating normally.

- *SYMPTOM:*
  1. Nothing happens when play button is pushed.
  2. Cylinder motor starts then stops. (Some models)
- *SUGGESTED DIAGNOSTIC PROCEDURE:*
  1. Check block diagram to determine the proper signal path. (See Figure 1.)
  2. Locate pins 2 and 3 on the system control IC (IC6002) *"Loading Motor Forward":"Loading Motor Reverse"* (control lines).
  3. Check the flow paths on the output ports. In this case, they arrive on pins 4 and 6 of IC6001. These are input ports that turn electronic switches within the IC *on* and *off*. First confirm the Vcc voltage on pins 2 and 8 of IC6001. Next, look for a change to occur on pins 3 through 7 of IC6001 when the play button is pushed. You determine that for the motor to load the tape, pin 7 must be High and pin 3 Low. The reverse is true for unloading. If no change occurs, you recheck pins 4 and 6 while pushing the Play button, remembering that the output of IC6002 will control the loading motor. To load, pin 6 will be High and pin 4 Low. If you confirm the proper change on these pins but none on pins 3 and 7, then the probability is that IC6001 is defective. In most cases, operation of the unit can be accomplished by applying 12Vdc from an external power supply to pin 2 of Plug P6009. The tape should load and the VCR should enter the Play mode. *(Remember to remove the 12Vdc–otherwise the loading motor will continue to run.)*

Now, let's assume there was no change at pins 4 and 6 of IC6001. Using an external dc supply, apply 5Vdc to pin 6 of IC6001. If the tape loads, you've determined that IC6001 is working properly. Work back on this line toward the μP, checking the associated component(s) for defects. If none appear, you might suspect the μP. However, before condemning it, a few more checks should be made. Are there scan pulses on pins 47, 48 and 49? Data IN on pins 29, 30 and 31? Is the Mode Select switch functioning properly? Is Q6010 acting as an "electronic switch"? Is there an open diode (D6015, 6016, 6017)? Ask yourself these questions before you condemn and possibly destroy a perfectly good μP. **ES&T**

Readers' Exchange

Wanted

Operator's & service manuals to be donated to prison vocational electronic school for RCA WR 64A dot bar color generator; Sprague model TO-6 Tel-Omike capacitor analyzer; EICO model 628 tube tester; Accurate Instrument model 257 tube tester; Lectro Tech model V7 transistor tester. *Wm. Mahon, Box 100, Vienna, IL 62995.*

Schematic and service information for Shibaden video monitor model VM111C, and Shibaden TV camera model HV-13. *Wayne Smith, CET/WA4WZP, 224 St. John St., Arden, NC 28704.*

Schematic, arm (part No. KXA-102-0) and dust cover for Pioneer turntable, model PL-61; schematic for Hammerlund HQ-140X general coverage receiver. Will pay for copies and your postage. *David Garrett, 117 S. Mont Valla Ave., Hagerstown, MD 21740; 301-791-6177.*

Service or operation manual for Jerrold No. 747 signal level meter; flyback for Tatung model 13CE3. *Bill, 516-825-5895.*

Original or copied service/operating manuals for Singer tele signal ac voltmeter, model 303-09, and for Norelco video camera type 89006671C, manufactured by Philips (may be same as, or similar to, LDK-15 or PC70). Also need drive/control unit and viewfinder, working or not. *Bill Stegmiller, P.O. Box 2025, Butler, PA 16003; 412-285-1338.*

Sencore VA48 in good working condition, complete with accessories and manual, please quote price. Also want the back issues of *ES&T* from December 1983 to May 1984. *T.A. Naeem, P.O. Box 959, Deep River, Ontario, Canada, KOJ 1PO; 613-584-3022.*

N.R.I. computer, microprocessor course, with or without the Sanyo or ? computer. Also N.R.I. TV, video servicing course. Must be reasonable. *J. Wegner Jr., P.O. Box 262, Glendale, CA 91209.*

For VCR servicing – tape tension gauge, tools, jigs, etc.; Sams TSM 141 manual; Panasonic picture tube No. A26JAS31X. *Ed Herbert, 410 N. Third St., Minersville, PA 17954.*

Schematic diagram or manual for a Conar Instruments oscilloscope, model 255. Will buy or copy and return. *Andy Horeczko, 1600 W. 22nd St., San Pedro, CA 90732.*

Service information, Heathkit – frequency counter No. IB1103, function generator No. IG1271, digital capacitance meter No. IT2250; B&K regulated dc supply No. 1601; Radio Shack digital meter No. 22-198. Please state cost or use fee. *Mike Adams, N4EVS, 6333 Hiway 2321, Deer Point, Panama City, FL 32404.*

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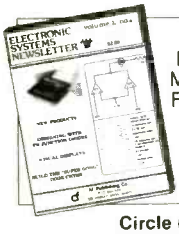

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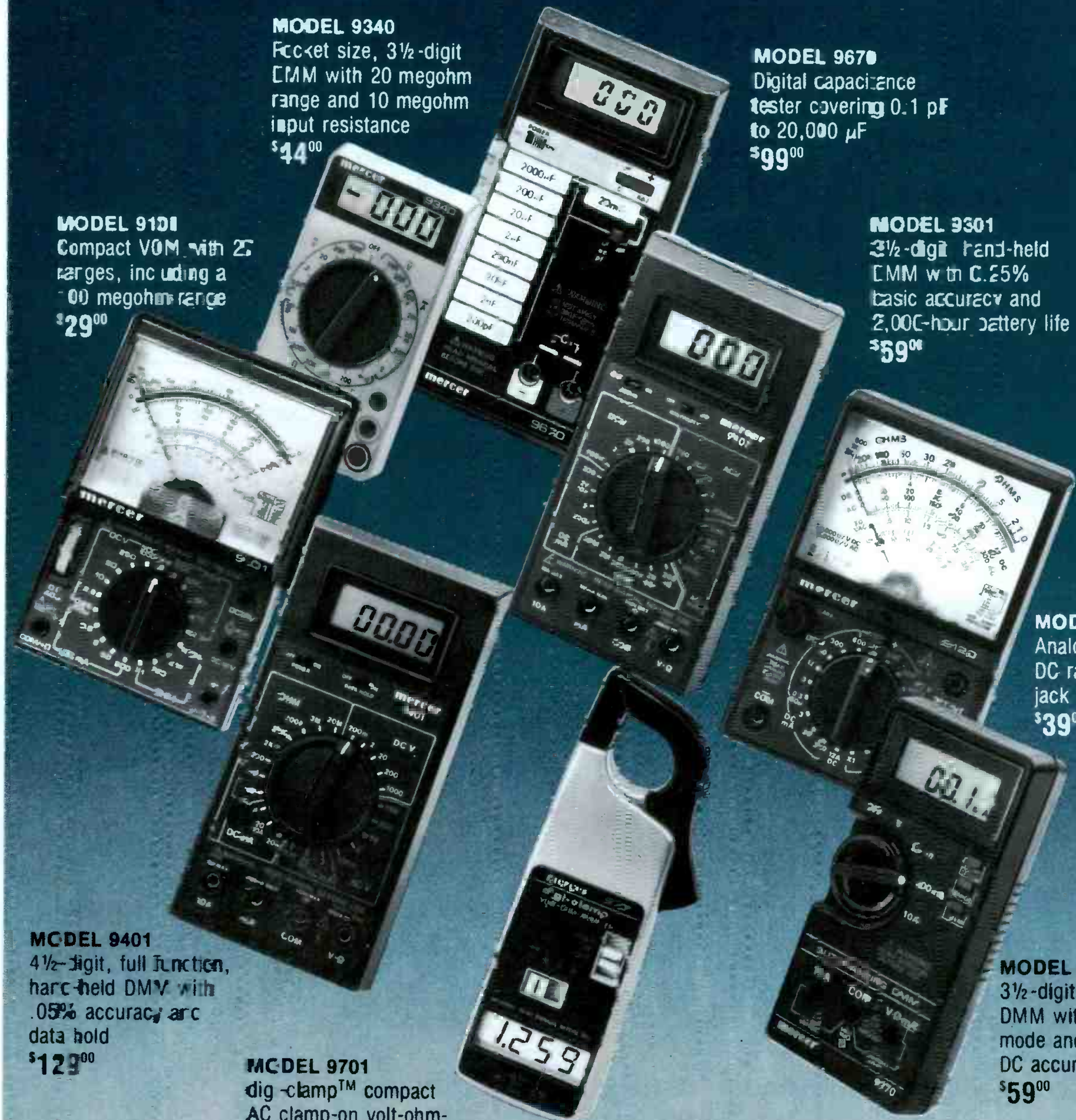

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