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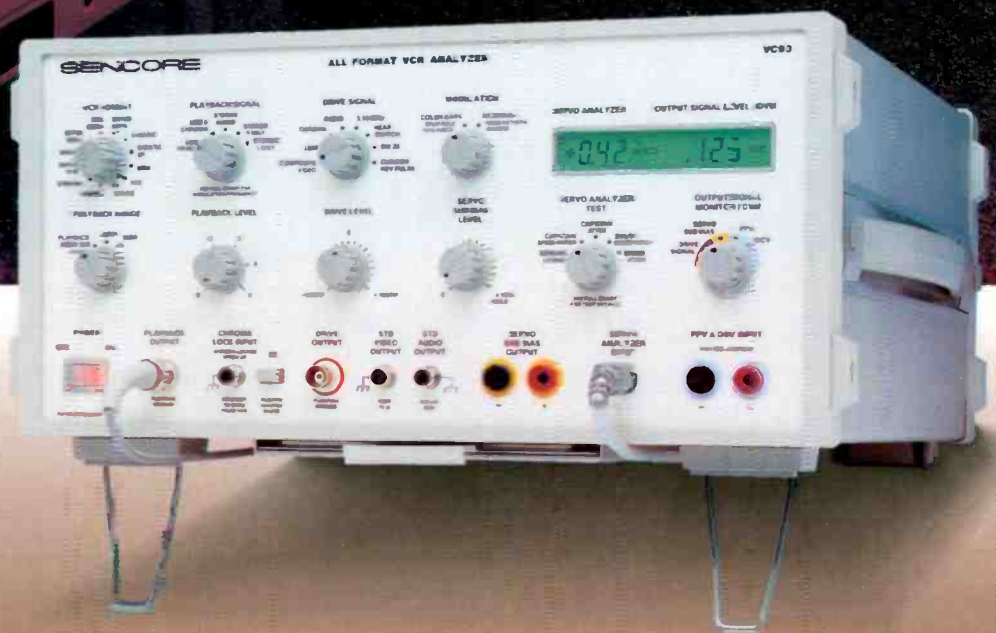

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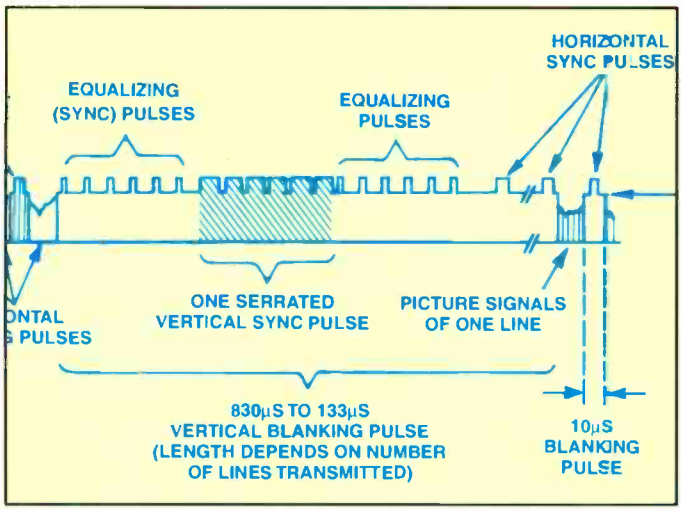

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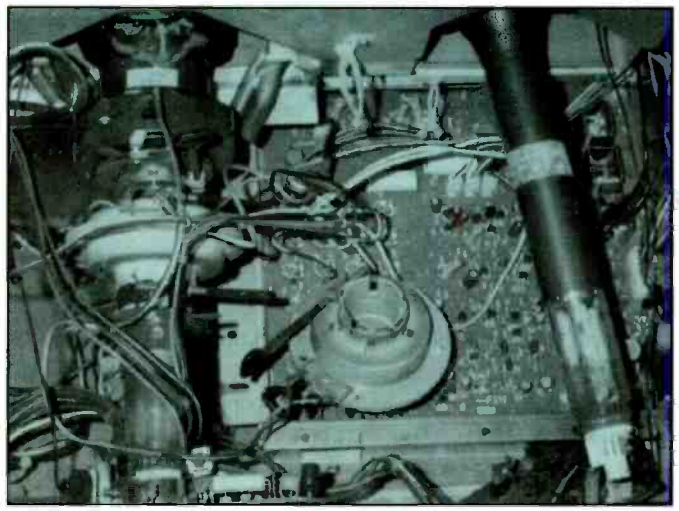

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FEATURES

DEPARTMENTS

ON THE COVER

Much of consumer electronics servicing involves disassembling, testing, identifing and replacing faulty parts that cause problems. However, there are some cases where dust, dirt, corrosion and other contaminants interfere with the proper operation of the product. In such cases, a dose of the right chemical therapy can quickly end the problem. (Photo courtesy of Caig Laboratories)

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING
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An update on ES&T on the Internet

Back in March we reported in this editorial space that **ES&T** had entered the age of digital communication. Here's an update. Now users of the internet can contact the editor of **ES&T** directly via the net. If you have anything you'd like to say to the **ES&T** staff, or if you have an article idea, a completed article, or any other correspondence, you can send it to me at this internet address: cpersedit@aol.com. I'll try to reply promptly to any internet messages.

For any readers who might have missed it the first time, here's some other information about ES&T and the internet that we published in March.

If you have a computer and modem, you can talk back to us or get an advance look at what's coming up in future issues by checking into the **ES&T** feedback area on the GEnie information service. If you're a GEnie member, look for us in the RADIO & ELECTRONICS ROUNDTABLE (Pg. 345), under "Commercial Vendors—Books, Magazines, Videos, etc." (Category 16; Topic 5). If you're using a Windows or Mac based program to access GEnie, just go to Keyword RADIO, click on "Radio/Electronics Bulletin Board," then open folder 16 and go to topic 5, **ES&T**. It's even easier with a text-based program: just type "M345;16;5" (without the quotes) and press "enter." If you're not a GEnie member, you can take care of that by calling them at 1-800-638-9636. And if you're on another online service, or have direct Internet access, you can send us mail addressed to "CQ@genie.geis.com."

If you'd like to gain access to ESIG, the Electronic Servicers Information Group, the on-line address to which you can send e-mail to is, esig-list-request@frick.com. If you'd like to get more information about ESIG, you can call Susan Frick at 816-461-6230.

Currently, the primary focus of ESIG seems to be checking on the availability of older, out of stock parts and general industry communication, something many of the servicers would like to see their industry groups do better. Sending out information on the internet allows for the transfer of information on industry trends, news bulletins, or other sorts of customer service information with tremendous time savings.

ESIG is administered by NESDA (the National Electronic Servicing Dealers Association), and is not a free service. It is offered at an annual cost of $25.00 to members and $50.00 to non-members. At the moment, if you sign on you will be allowed to use it at no cost for around 30 days to see if it is of use to you, and asked to send a check to NESDA if you wish to continue to have access. After that trial period, if your check has not been received, you will be denied access.

ES&T readers and computer service

In the January issue, we included a survey questionnaire that asked a few questions about the experience that readers have had with computer service. Here are the results of that survey.

1. What percentage of products serviced at your service center are computers or peripherals?

0	1 - 10	10 - 25	26 - 50	Greater than 50	Total
38	51	14	8	24	135

2. What computer products do you serve?

Computer/CPU	Monitor	Disk Drive	Printer	Other
61	78	40	50	13

3. Do you use diagnostic tools in servicing computer products?

NO: 24
POST (power on self test reader cards): 20
Diagnostic software: 54
Fixed drive utilities: 39
Floppy drive utilities: 37
Virus utilities: 40
Windows utilities: 28
Other: 11

It is important to keep in mind that the results of this survey are not statistically significant and cannot be projected over the **ES&T** readership. However, what this does tell us is that of all of the 135 readers who returned the survey cards, 97, or over 70 percent, reported that they perform some computer service. Of that number, 24, or almost 18 percent spend over 50 percent of their time servicing computers.

It is also interesting to note that large numbers of these individuals are pretty well equipped to get the job done. Many of them have POST reader cards, diagnostic software, and a selection of other utility programs.

It is safe to conclude that consumer electronics service centers are turning in significant numbers to personal computer servicing as a way to broaden their business base. We will be continuing to provide articles on that subject. We will also continue, however, to publish articles on all of the other aspects of consumer service as well.

Nils Conrad Persson

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Electronic Servicing & Technology is edited for servicing professionals who service consumer electronics equipment. This includes service technicians, field service personnel and avid servicing enthusiasts who repair and maintain audio, video, computer and other consumer electronics equipment.

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News

Home theater components post strong growth in 1994

Factory sales of home theater products rose 12 percent in 1994 to $7.7 billion compared with $6.8 billion in 1993, according to the Consumer Electronics Group of the Electronic Industries Association (EIA/CEG). Large screen direct-view televisions, the primary component of most home theater systems, led the increase with sales of $4.4 billion in 1994.

"These very strong sales figures indicate that consumer interest in home theater is on the rise," said Gary J. Shapiro, EIA/CEG group vice president. "Research conducted by EIA/CEG concludes that the number of home theater households is expected to increase more than 150 percent in 1995."

Home Theater, Shapiro explained, brings together the latest advancements in both audio and video technology. The components necessary for a complete home theater include a large screen color television, an audio-video receiver with surround sound capability, a hi-fi stereo VCR, a laser disc player, and four or more speakers.

"Strong sales in these component areas confirm that the consumer electronics industry is responding with an array of affordable systems that allow families to recreate the movie theater experience in their own homes," said Peter Tribeman, president of Atlantic Technology International Corporation and Chair of the EIA/CEG Home Theater Subdivision.

One of the key findings of the research is that audio and video components of the home theater market shared equal increases in sales, with each rising roughly 12 percent in dollar volume.

Industry group expects another record year for color television

Despite increased sales of projection televisions and camcorders, video hardware products posted mixed results in January, the Electronic Industries Association's Consumer Electronics Group (EIA/CEG) reported today.

"The home theater boom continues to drive sales of big-screen TVs, a marketplace trend that may explain why projection models are selling at a brisk pace," explained Gary J. Shapiro, group vice president of the industry association. Some 650,000 projection TVs were sold to dealers in 1994, and the January figure rose nearly 25 percent as compared with the same month a year ago.

Camcorders also fared well in January, EIA/CEG said. Some 193,000 camcorders were sold to dealers, a solid 5.2 percent improvement over January 1994. Sales of compact models, increasingly the formats of choice for family moviemaking, rose 20 percent in January, while sales of full-size camcorders dropped 36 percent.

Coming off the hottest year in their four-decade history, sales of color TV receivers cooled during January. Sales of color TVs to U.S. dealers, which last year totaled a record shattering 24.8 million units, slipped 9.9 percent in January to approximately 1.28 million units from 1.42 million a year ago. Large-screen models today account for more sales, in units and dollar volume, than those in the traditional most popular 19-and 20-inch categories.

"After buying at a torrid pace during the second half of 1994, it appears that color TV dealers are taking a breather and bringing inventories into balance," Shapiro said. "Given the trend line, however, these numbers are unlikely to be more than a blip in the steady growth of color TV in general and the large-screen categories in particular."

EIA/CEG recently predicted, based on an expanding economy, a high degree of consumer confidence, and upbeat results from intent-to-buy surveys, that color TV sales for 1995 will set new records. Among the hottest categories will be direct-view models measuring 30-inches and above, which during 1994 jumped a spectacular 33 percent.

Sales of VCR decks, which totaled 13 million last year, declined 11.4 percent in January, from approximately 775,000 to 686,000 although within the VCR category sales of stereo models jumped an impressive 19 percent. Like color TVs, VCR sales had previously enjoyed five months of uninterrupted growth.

Also reporting slippage were color TV/VCR combinations and laserdisc players. TV/VCR combos, more than 2.2 million of which were sold during 1994, contracted 18 percent in January to some 91,000 units. Sales of laserdisc players, still the preferred video source among cinemaphiles, for example, fell 28 percent in January to slightly more than 13,000 units.

Consumers find accessories enhance basic consumer electronic products

Consumers buy accessories to enhance and expand the use of and prolong the life of their consumer electronic products, according to the Electronic Industries Association/Consumer Electronics Group's (EIA/CEG) sampling of 1,000 households across the United States. Survey questions explored the ownership and intent-to-buy of accessories for TVs, VCRs, camcorders, telephone products, PCs and audio equipment.

"With accessories, consumers can extend the lives of, and add new functionality to their consumer electronic products, and our survey shows consumers are doing just that," said Gary J Shapiro, group vice president of EIA/CEG. "With the new accessories on the market today, owners can make sure video tapes run more smoothly in their VCRs, can operate several consumer electronic products more quickly and easily via a universal remote, can preserve the battery life of their cellular phones and can protect their computer equipment."

Steve Trice, CEO of JASCO Products Co. Inc., affirmed the survey results. "Accessory sales are up 19 percent over the last year, according to the latest EIA statistics. Consumers obviously are seeing the value accesories can add to their TVs, VCRs, stereos, telephones and computers. At JASCO, we recognize the booming industry accessories have become and are helping our customers to find new uses for their hardware by creating accessory innovations and meeting extremely high quality standards."

The survey was consucted through the CEG Consumer Research Service by the CEG Accessories Division, in cooperation with the EIA Market Research Department. The Verity Group Inc. conducted the survey via telephone. Results are based on completed surveys from 1,000 randomly selected U.S. heads of households. Telephone calls were made using industry standard random-digit-dialing techniques from a nationally representative random sample supplied by Survey Sampling Inc. ■

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Circle (93) on Reply Card

PC floppy, printer and mouse problems

By Jurgen Ewert

Computers are very reliable office products, but anything can break down. On one Gateway 2000 486SX/25 the screen went blank while the operator was working with a word-processing software program. The computer was about two years old. That is not very old for a computer.

This particular computer had just been upgraded to a 486DX/50 with an overdrive processor. The upgrade was performed two weeks before the malfunction occurred. In addition to the new processor, 4MB of RAM were also added.

When I got the emergency service call I told my customer to leave the computer on. When I arrived, my first step was to try a different monitor because there was no sign of life on the screen. The new monitor showed a blank screen. The problem was obviously not with the monitor.

Running setup

After switching the computer off and turning it on again I noticed that floppy drive A did not react. In all IBM PCs drive A goes on looking for a boot diskette (this can be changed in the setup program, so that the computer first looks at the hard drive, so this may not always be true). An error message appeared (Figure 1).

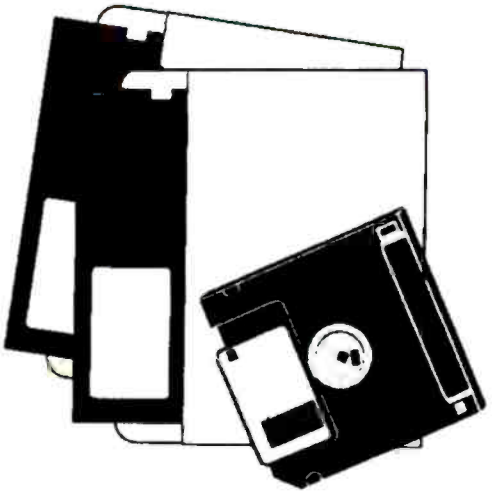
I pressed the F2 key to run the setup program. The setup program enables the user of this computer to modify certain settings: e.g. time and date, the floppy drives, the hard drive and the display. The first setup screen is shown in Figure 2. After examining the first setup screen, I went on to the second (Figure 3).

None of this setup information showed anything wrong, and there was no sign as to why floppy drive A did not work, but sometimes an error message did appear during the setup process (Figure 4). When I hit a key as instructed by the screen of Figure 4, the computer locked up. I shut the computer down and started again. The trouble was with drive A, so I was unable to use another boot diskette to determine if there was something wrong with the boot up process.

Ewert is an independent consumer electronics servicing technician.

```
* Diskette drive 0 seek failure
* Diskette drive 1 seek failure
Invalid configuration information—
please run setup program
Strike the F1 key to continue, F2 to
run the setup utility
```

Figure 1. I switched the computer off then turned it on again. This error message appeared on the screen.



Troubleshooting without a boot disk

After restarting the computer the message of Figure 1 again appeared on the screen. This time I pressed F1 to see if the computer operation would continue. I got a big surprise—the Windows screen appeared but there was no mouse cursor visible (Figure 5).

I had worked on this computer before, so I knew that there was a diagnostic program on the hard disk, but without the mouse it was difficult to start this program from Windows. By pressing [Alt] and [Esc] simultaneously I got out of the start-up screen (calendar and clock). Now I was able to access MS-DOS and start the diagnostic software by pressing [F10] and using the cursor keys.

The diagnostic program showed the

```
Phoenix Technologies Ltd.                    Version
System Configuration Setup                   4.03 00

Time    08:33:33
Date    Fri Feb 03, 1995
Diskette A:  5.25 inch, 1.2 MB
Diskette B:  3.5 inch, 1.44MB   Cyl  Hd  Pre  LZ  Sec  Size
Hard Disk 1:  Auto Config       989  12  0    0   35   202
Hard Disk 2:  Not installed
HD1 Block Mode:  Disabled
HD2 Block Mode:  Disabled
Base Memory:  640kB
Extended Memory:  7168kB
Display:  VGA/EGA
Keyboard:  Installed
Coprocessor:  Installed
Reserved Memory:  384kB
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Figure 2. After I pressed F2 to run the setup utility, this setup screen appeared.

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Internal Cache    : Enabled
External Cache    : Enabled
0c0000-0c7fff     : Cacheable
0c8000-0cffff     : Noncacheable
0d8000-0dffff     : Noncacheable
0e8000-0effff     : Noncacheable
0f8000-0fffff     : Noncacheable
```

Figure 3. This is the second setup screen.

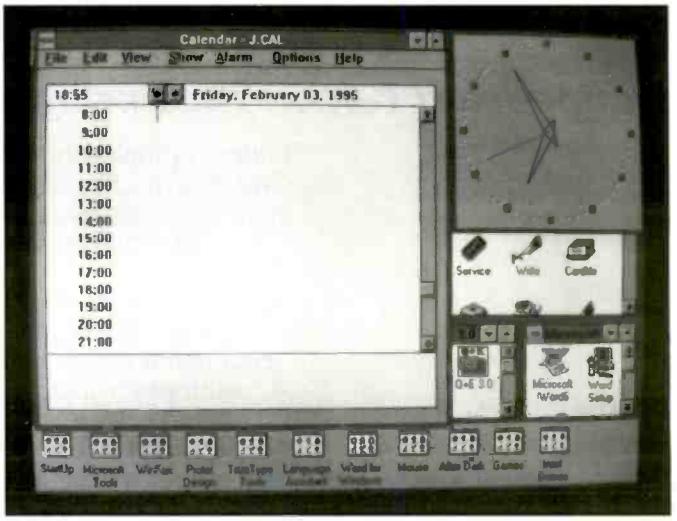


Figure 5. When the computer was allowed to go through its startup routine, this Windows start up screen with no mouse cursor appeared.

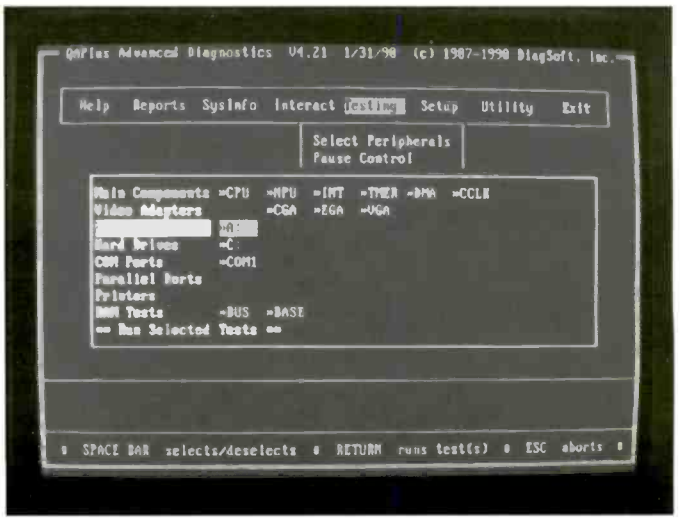


Figure 7. Floppy drive B and Parallel Port were not detected for testing.

system configuration first (Figure 6). It detected only Floppy Drive A and no printer ports, but I knew that there was Floppy Drive B and a printer installed.

Next, I tried to test Floppy Drive A. There was no reaction

Errors have been found during the power on self test in your computer. The errors were:

Incorrect configuration data in CMOS

SETUP will attempt to correct these errors through auto-configuration.

Hit any key to continue;

Figure 4. This error message appeared on the screen on occasion during setup.

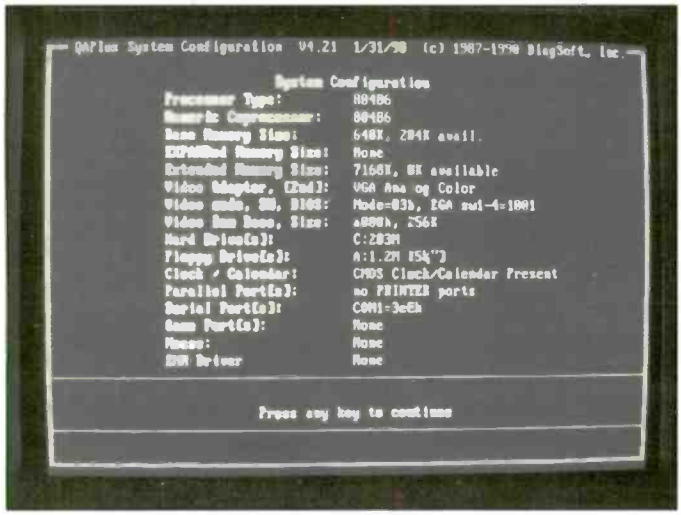


Figure 6. Once I was able to run the diagnostic program, I proceeded to this system configuration screen.

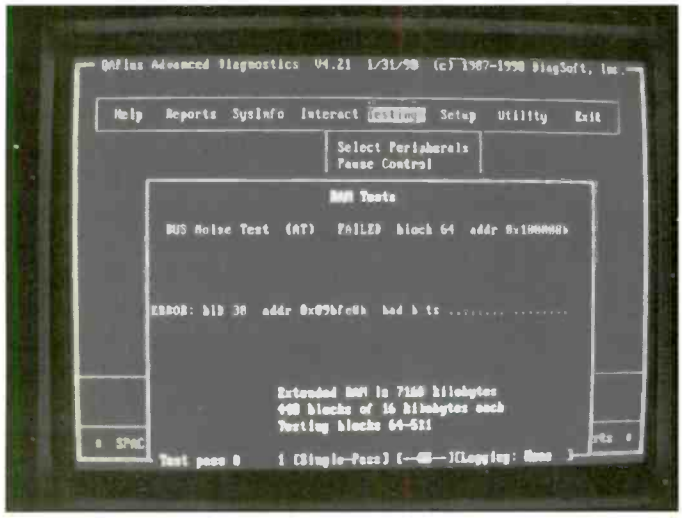


Figure 8. The RAM test failed.

(Figure 7). After this attempt I started testing the RAM and got the error message shown in Figure 8. Because I had upgraded the computer recently, I reconfigured it to the old setup with 486SX/25 CPU and 4MB of RAM. That did not change the error status.

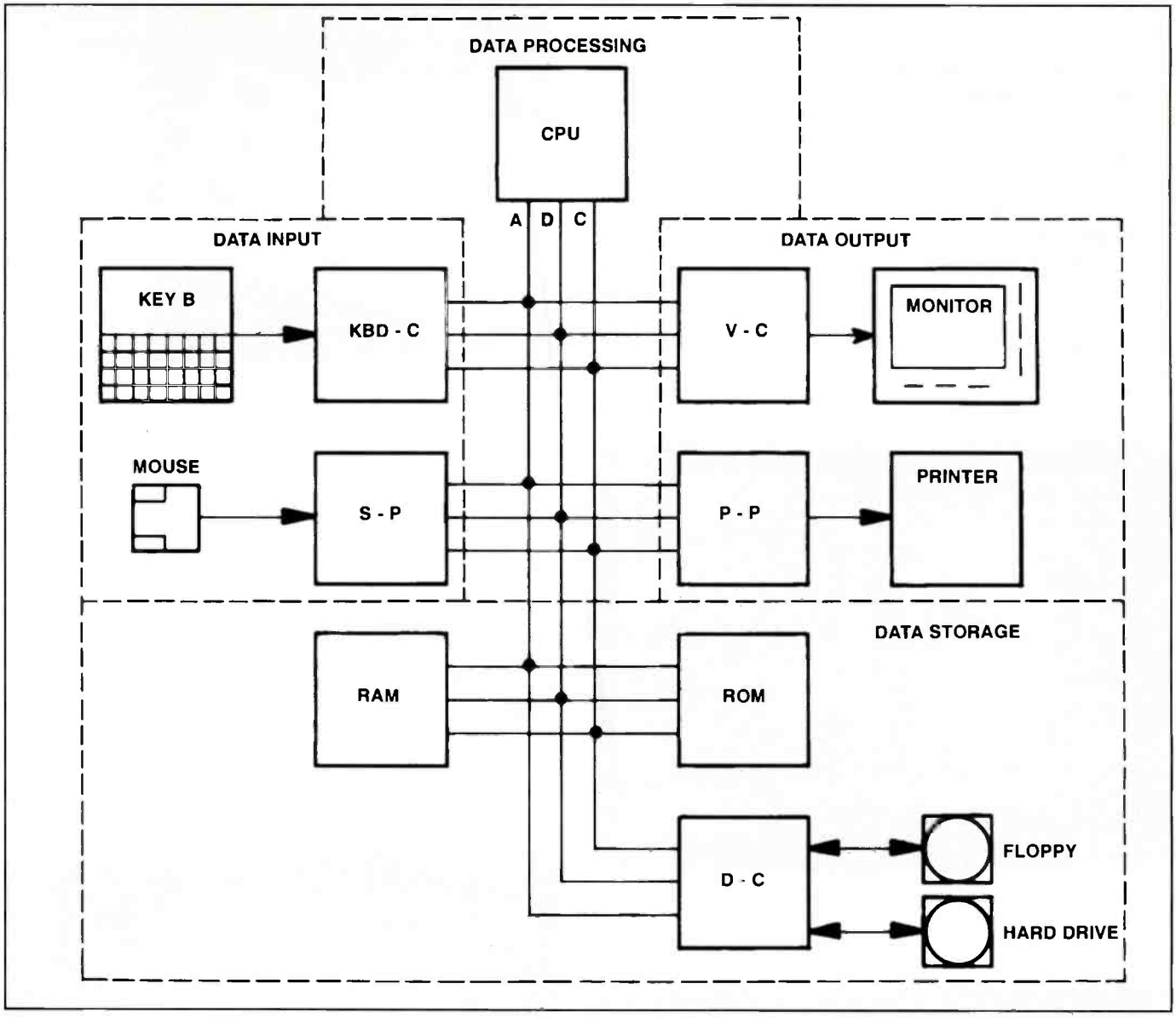


Figure 9. Block diagram of a PC.

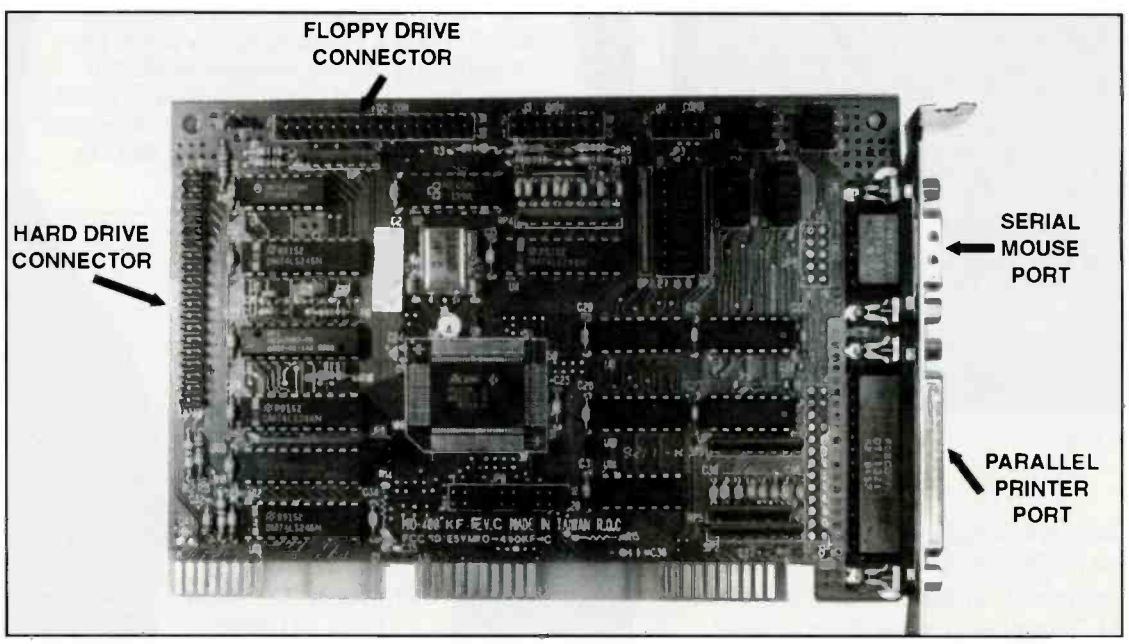


Figure 10. DFI-IDE controller card

Figure 9 shows a block diagram of a Personal Computer. The Central Processing Unit (CPU) is connected via Address, Data and Control Bus to all other function blocks. There are three different functional groups, Data Input, Data Output and Data Storage.

In the faulty computer, I found problems in all three sections. That is unusual because in most computers separate controllers are used for each function block. This computer uses a DFI-IDE controller to control hard disk, floppy disks, mouse and printer.(Figure 10) That means disk controller (D-C), parallel printer port (P-P) and serial port (S-P) is on the DFI-IDE card. Because the floppy disks, printer and mouse all failed I decided to replace the DFI-IDE controller.

ESD precautions

When replacing any components in a computer or any other electronic device there is always the danger that something can get damaged by static electricity. As a reminder, here are some basic rules:

- Before handling or touching static sensitive components, discharge your body by touching a grounded surface.
- Wear a grounded wrist strap. (It should be a part of your tool box.)
- Do not remove parts from their antistatic bags before using or installing them.
- Do not lay parts on antistatic bags! The bags are only antistatic on the inside.
- When handling printed circuit boards, hold them by their edges and their metal mounting brackets.
- Don't touch components or on PC board edge connectors.
- Avoid plastic, styrofoam, vinyl, and other materials that produce static electricity in your work area.

Testing the repair

After I replaced the controller the computer worked fine. To make sure all functions were correct I ran the diagnostic software. No error messages appeared on the screen. This computer failure looked very complex when I started troubleshooting it, but that was only because the problem was caused by a controller board with multiple functions. Perhaps this article will help you to solve your next problem involving multiple failures.

Coming Next Month

In August, **ES&T** will present several features that will help service technicians get the job done:

Technical training/literature

Servicing consumer electronics products is an extremely involved, complex, and challenging task. It requires an understanding of basic electronics circuit theory, a grasp of how today's complex consumer products work, and specific information about the specific product being serviced. To make matters worse, trying to keep current with consumer electronics servicing is a lot like trying to hit a moving target: things are changing so fast that it's hard to track the changes. There are, however, a number of resources that a technician can turn to, to help him remain abreast of this constantly changing field: books, courses, videos, manufacturers' service literature, even CD-ROM. This article will present information on a selection of these resources.

Troubleshooting techniques

The methods employed by a consumer electronics technician will have a great deal to do with how successful he is in getting the job done. Given the complexity of today's products, and the wide variety of product types, manufacturers and brands, it becomes ever more important to be methodical and thoughtful about servicing. This article will present a number of suggestions on how servicing technicians can become more efficient and productive.

Replacement Parts Showcase

This showcase gives companies that manufacture or distribute replacement parts, and who advertise in the magazine, a chance to tell you a little more about themselves, their products and their way of doing business. This showcase will help you make a more informed choice the next time you need to buy replacement parts.

Servicing RF distribution systems

By Arthur Flavell

RF distribution systems represent a large potential service market. They are used in hotels, convention centers, hospitals, schools and apartment complexes. RF distribution systems require periodic maintenance, upgrades and modifications, just as do any other electronics products or systems.

Early RF distribution systems used one or more antennas, an amplifier and a distribution network which provided service to several receive sites. This method of using a "master" antenna allowed quality reception in weak signal areas and gave rise to the term "Master Antenna Television" or "MATV" system. Today's systems may include broadcast, cable, satellite, local origination and closed circuit signals.

System basics

Effective servicing of MATV systems requires an understanding of system function and the role of individual components in its operation. Let's begin by looking at a modest MATV system, such as might be found in a small motel.

The block diagram of Figure 1 illustrates the system design and signal flow. Individual program sources are received and converted to a system channel. If any of these received signals is weak, an antenna preamplifier may be necessary for each of them.

The system channels are then combined into a single cable feed for distribution. The signal processors, channel modulators, local origination equipment and combiner are typically located together and referred to as the "head end."

Most MATV systems are uni-directional. That is, the signal flows from the source (antenna, satellite, etc.), through the head end to a destination (guest room, conference room, etc.). When describing components or analyzing system performance, it is useful to know where a given point is relative to other points. The terms "upstream" (toward the signal source) and "downstream" (toward the signal destination) are used to describe specific areas. For example, the satellite receiver is upstream of the head end and the cable termination in the motel lobby is downstream of the head end.

Antennas

Professional antennas for MATV service are available with a variety of performance characteristics. These include single-channel and broadband configurations. The type used depends on signal conditions at the MATV site.

Each antenna type has specific operating parameters that affect its performance. The descriptions of these parameters follow.

Gain

Antennas are rated in signal focusing capability. Performance is compared to an isotropic antenna, a theoretical single-point radiator in free space. The unit used to express the difference in performance between a given antenna and an isotropic antenna is the dBi(the ratio of the gain of a given antenna to the gain of an isotropic antenna expressed in decibels).

Beamwidth

Antennas that exhibit gain also exhib-

Flavell is owner of an independent consumer electronics service center in Alaska.

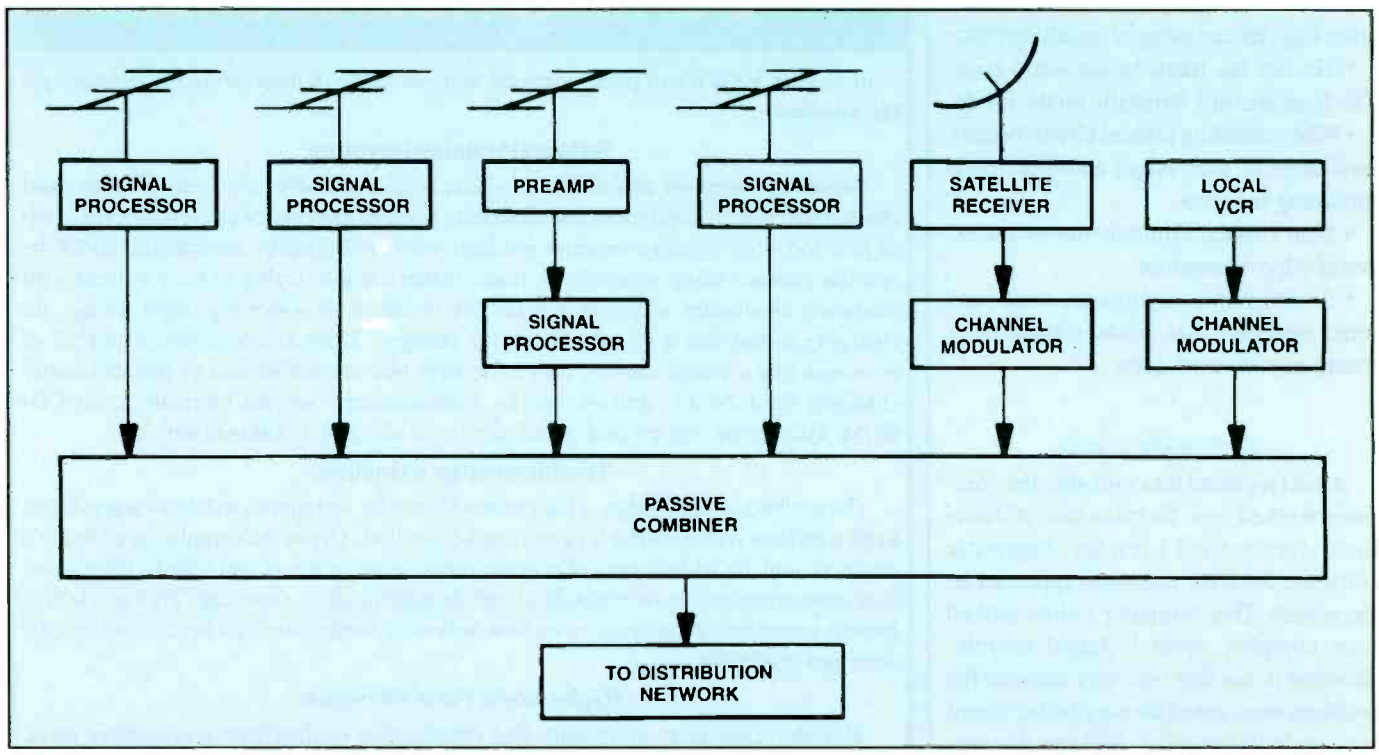


Figure 1. In a typical MATV system, individual program sources are received and converted to a system channel. If the received signal is weak, an antenna preamplifier may be necessary. The system channels are then combined into a single cable feed for distribution. The signal processors, channel modulators, local origination equipment and combiner are typically located together and referred to as the "head end."

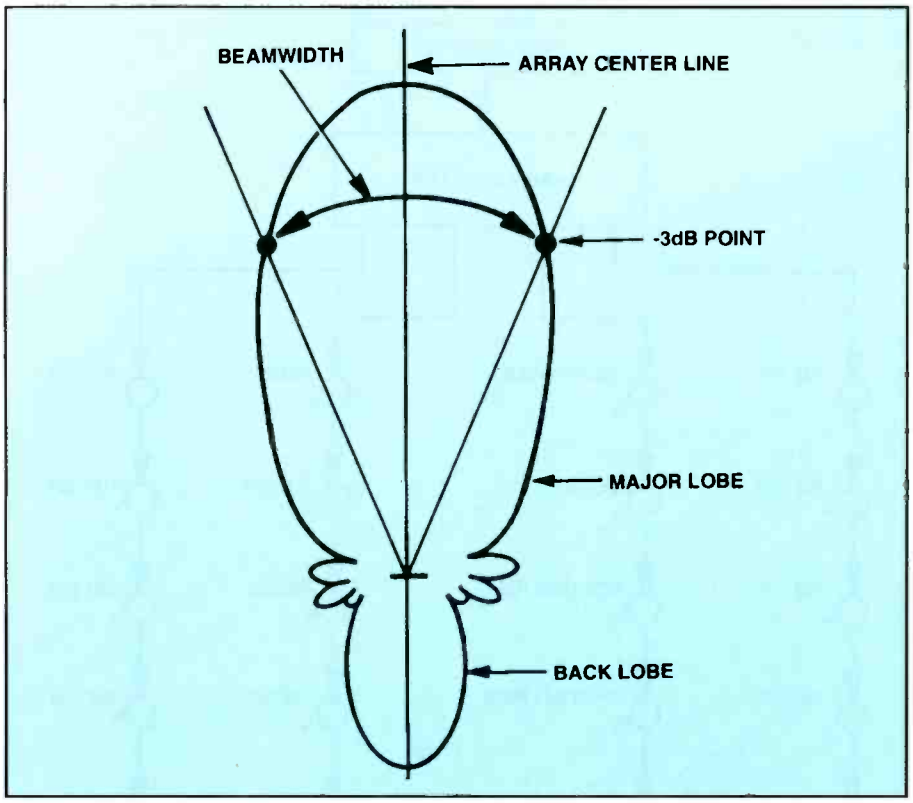


Figure 2. A typical antenna directional pattern. Beamwidth is the angle formed by the -3dB points of the plot and is specified in degrees. Beamwidth is a measure of an antenna's ability to reject signals from the sides.

it directional characteristics. That is, they operate better in some directions than in others. Ideally, a receiving antenna would pick up signals only from the direction of the transmitting antenna.

In practice, an antenna will receive signals from other directions at reduced signal strength. Figure 2 shows a typical antenna directional pattern. Beamwidth is the angle formed by the -3dB points of the plot and is specified in degrees. Beamwidth is a measure of an antenna's ability to reject signals from the sides.

Bandwidth

Bandwidth is a measure of the frequency range over which an antenna is responsive. Maximum response is realized at the resonant frequency of the antenna. As the signal frequency is moved away from resonance, the response of the antenna decreases.

Bandwidth is specified as the frequency difference between the -3dB response points. As the gain and directivity of an antenna increases, the bandwidth decreases.

Front to back ratio

Front to back ratio is a measure of an antenna's ability to reject signals from the rear of the array. The ratio is expressed in dB. Table 1 is a comparison of various MATV antenna types. Single channel models are of Yagi design, broadband models are log-periodic, and satellite models are parabolic.

Antenna preamplifiers

In fringe areas, the signal level from the antenna may not be sufficient to provide the desired picture quality. A Grade 1 (excellent) picture is achieved with a 46dB signal-to-noise ratio. A preamplifier may be needed to boost the signal level from the antenna.

Preamp specifications include a minimum input level to achieve a Grade 1 output, typically around -10dBmV. If this level is not present at the antenna terminals, it may be necessary to use a higher gain antenna or to stack two or more antennas in an array.

Consideration must also be given to preamplifier output levels. Modern signal processing equipment will accept input levels ranging from -15dBmV to +30dBmV. For good signal-to-noise performance, +10dBmV to +25dBmV is desirable. Levels in excess of +30dBmV may cause overloading of the processor and picture degradation.

Preamps may be mounted at the antenna or in the head end. Because cable runs contribute additional noise, it is preferable to install the preamp on the mast or tower near the antenna. Weather or physical access conditions may make it difficult to service a tower-mounted preamp. In this case it may be necessary to install the preamp at the head end to minimize channel down time in the event of problems. Professional model preamps are powered from a remote power supply located in the head end. The power is diplexed on the coaxial cable so separate power leads are not needed.

Antenna preamplifiers are available in single channel and broadband configurations. Single channel units exhibit bandpass characteristics which may be useful in reducing interference from other strong signal sources in the band. The selectivity of a good quality single channel preamp is in the neighborhood of -12dB at 9MHz from the center of the channel.

Signal processors

Signal processors receive the off-air signal, filter and process it and produce an output signal. The output signal may be on-channel (same as the input channel) or off-channel. Output levels range from +40dBmV to +65dBmV, depending on the model used.

In the signal processing circuits, access is provided in the IF stage for further processing, such as scrambling. Alternate signal sources may also be used, such as a "Stand By" trouble message or all-call audio.

Adjustments are provided to vary the overall output level as well as the video and audio carrier ratio. An accurate signal level meter is needed to perform these adjustments. Test points are provided at both input and output for use in setup.

An important feature of the signal processor is the standby carrier. This internally generated signal provides an output to the system in the event of a loss to the input signal.

When an input signal is lost, such as when a broadcast station goes off the air, the AGC circuits detect a decrease in signal level and gain is adjusted to maximum. The only signal that remains to be amplified, however, is noise. This sudden increase in noise is fed through the combiner into the distribution system. If amplifiers are used downstream of the head end, distortion may result as well as interference to other channels.

If loss of signal is detected, the stand-

by carrier automatically turns on after a delay of 15 seconds. This produces a blank, dark screen on the affected channel. An internal video generator with a trouble message may be added. When setting up the signal processor, the standby carrier should be adjusted to the same level as the normal carrier.

Channel modulator

Local origination equipment produces baseband audio and video signals. This equipment might include a character generator, music programming, video tapes or in-house video production. These signals must be converted to an RF signal for inclusion in the distribution system. The channel modulator performs this function.

Input signal levels to the channel modulator are $1V_{PP}$ NTSC video and 140mV to 500mV rms for audio, depending on the model. The output level is typically +55dBmV. If the channel modulator is used with a signal processor, an attenuator must be placed on the input of the processor to prevent overloading.

Combiners

The combiner accepts inputs from each signal processor or channel modulator and combines them into a single output. The combiner may be passive or amplified.

Passive combiners are available with 8 or 12 inputs. Each input feeds an isolated transformer to match impedance. Some reduction of signal level, known as insertion loss, occurs at each port. The amount of insertion loss increases with the total number of ports, with typical values of -12dB for 8 input combiners and -16dB for 12 input combiners.

Active combiners contain an amplifier stage after passive combination. The overall gain ranges from 16db to 22dB. The combiner amplifier is designed to amplify higher frequencies more than the lower ones to compensate for non-linearity in the distribution network. This characteristic is known as "slope" and is typically 1.5dB.

Distribution

Distribution consists of taking the signal from the combiner and routing it to various destinations. Components such as coaxial cable, connectors, splitters, directional couplers and taps, and distribution amplifiers may be used. Figure 3 illustrates a flow diagram of a small distribution network.

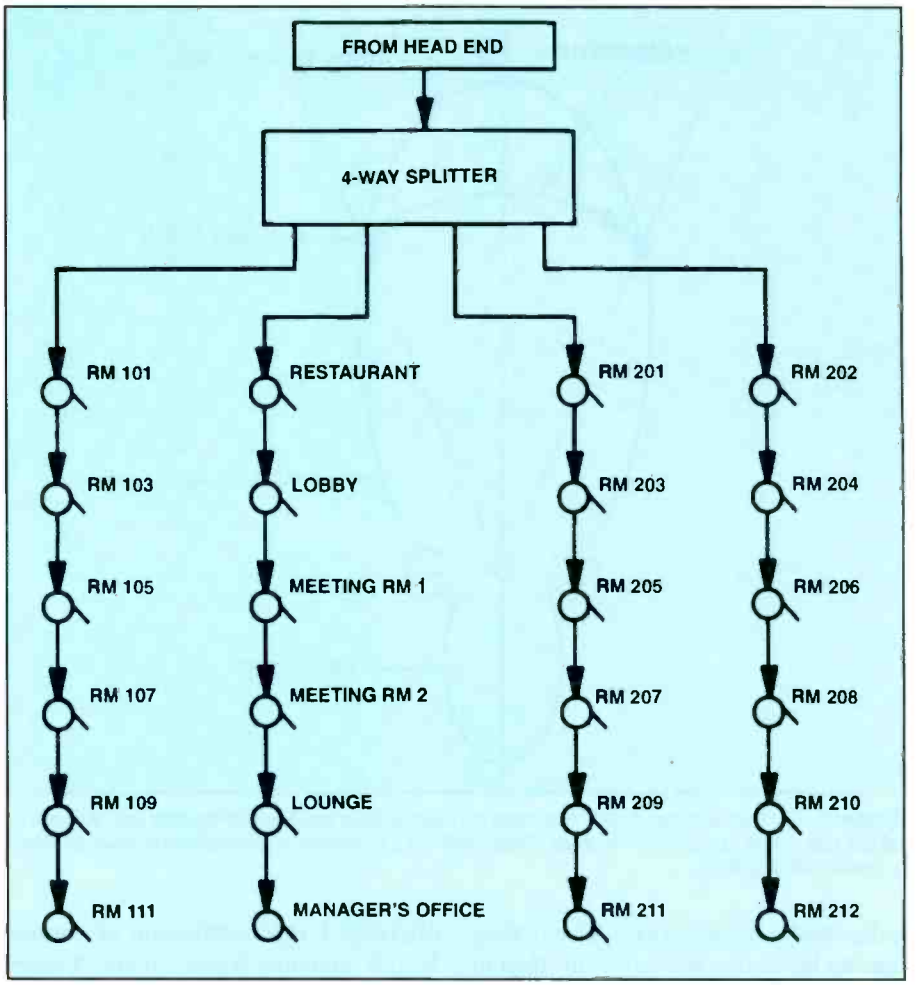


Figure 3. Flow diagram of a small distribution network.

Coaxial cable is available in a variety of grades and specifications. Cable used in TV RF distribution should have a characteristic impedance of 75Ω. RG-6 type cable is commonly used for interior distribution. It offers a reasonable compromise between cost, signal loss and ease of handling.

Splitters are used to divide the main feed from the combiner for distribution to various areas. Each leg from the splitter may serve several destinations. Splitters are available with two to eight outputs.

Directional couplers and taps provide a method of routing a portion of the signal from the main distribution leg to an individual destination. They are available with one to four outputs, and varying amounts of signal reduction at the tap. Some models of directional couplers may be wall-mounted in a standard electrical box, where others may be mounted in an equipment panel or cable race with a cable running from the tap to a wall outlet plate. The desired signal level at each termination point is +10dBmV (+/-5).

System troubleshooting

When you're called on to troubleshoot an MATV system, the best place to begin is with the system operator. Ask questions. Find out which areas of the system exhibit problems. Does the problem include all system channels or just one. The answers to these questions can help you to pinpoint the problem.

Ask for system documentation that shows the locations of head end equipment and distribution components. It should also show signal flow and levels. If no documentation exists, make notes as the system is checked and develop your own.

Invest in a cable numbering kit and document as you go through the system. Having proper documentation can save many hours of frustrating work, particularly on large or complex systems.

Start at the head end

If you have no other information to go on, start at the head end, at the output of the combiner. Check each channel for signal strength, program content and picture qual-

	VHF 1 CHANNEL 5 ELEMENT	VHF 1 CHANNEL 10 ELEMENT	VHF CH 2-6 8 ELEMENT	VHF CH 7-13 10 ELEMENT	VHF CH 2-13 12 ELEMENT	UHF 1 CHANNEL 10 ELEMENT	UHF BROADBAND 11 ELEMENT	FM NON-DIR 2 ELEMENT	FM 5 ELEMENT	SATELLITE 3 METER C BAND
GAIN	9.2dBi	13.2dBi	9.0dBi	13.2dBi	8.2dBi	12.6dBi	10.2dBi	2.2dBi	9.2dBi	40.6dBi
BEAMWIDTH	63 DEGREES	51 DEGREES	57 DEGREES	51 DEGREES	70 DEGREES	46 DEGREES	62 DEGREES	360 DEGREES	63 DEGREES	1.7 DEGREES
BANDWIDTH	8MHZ	8MHZ	34MHZ	42MHZ	162MHZ	8MHZ	420MHZ	20MHZ	23MHZ	N/A
F/B RATIO	17dB	17dB	22dB	20dB	18dB	17.2dB	18dB	N/A	17dB	N/A

Table 1. Comparison of various MATV antenna types. Single channel models are of Yagi design, broadband models are log-periodic and satellite models are parabolic.

ity. Signal levels may be measured with a signal strength meter.

Typical signal levels at the output of a passive combiner may range up to +45-dBmV. The output of an active combiner may run as high as +60dBmV. Most head end equipment includes a -20dB test point so signal checks may be made without interrupting system service.

Program content and picture quality may be checked with a portable receiver. Connect the receiver to the -20dB test point, using additional attenuators to provide approximately +10dBmV to the test unit.

Some head end equipment, such as character generators, VCRs, satellite receivers, etc. may need to be reprogrammed after power outages. It is important to check the program content on these channels to be sure it is correct.

Problems that are evident in one or more individual channels are most likely to be caused by a malfunction in the head end or individual signal sources. Check for the proper signal level at the input of the channel signal processor.

If the signal level is correct at the input of the channel signal processor, the signal processor may be bad or the input port of the combiner may be defective. If the processor input is low or missing, check upstream toward the signal source. You may find corroded or broken cables or damage to an antenna.

Distribution problems

If the signal is correct at the combiner output, but problems exist elsewhere in the system, distribution is the most likely culprit. Use the system diagram to check signal levels at various points.

Where splitters are used to feed several distribution legs, check the output of each port to isolate problem areas. Pay particular attention to in-line distribution amplifiers. These are often tucked into cable ducts or distribution panels and may be difficult to locate.

Common sense and logical troubleshooting

Servicing RF distribution systems requires the same common sense and logical troubleshooting techniques applied to other systems. A modest investment in training, tools and test equipment allows you to expand into this relatively overlooked area of servicing. A profitable, long-term market exists for those willing to make the investment.

A special thanks is in order for the folks at Blonder Tongue Laboratories, Inc. for providing technical information used in preparing this article.

Electronics servicing chemicals

By The ES&T Staff

Along with all of the tools and test equipment that a technician uses: the DMM, oscilloscope, soldering iron, screwdrivers, etc., chemicals are extremely useful to consumer electronics service. Often a chemical is the tool of choice when servicing a unit.

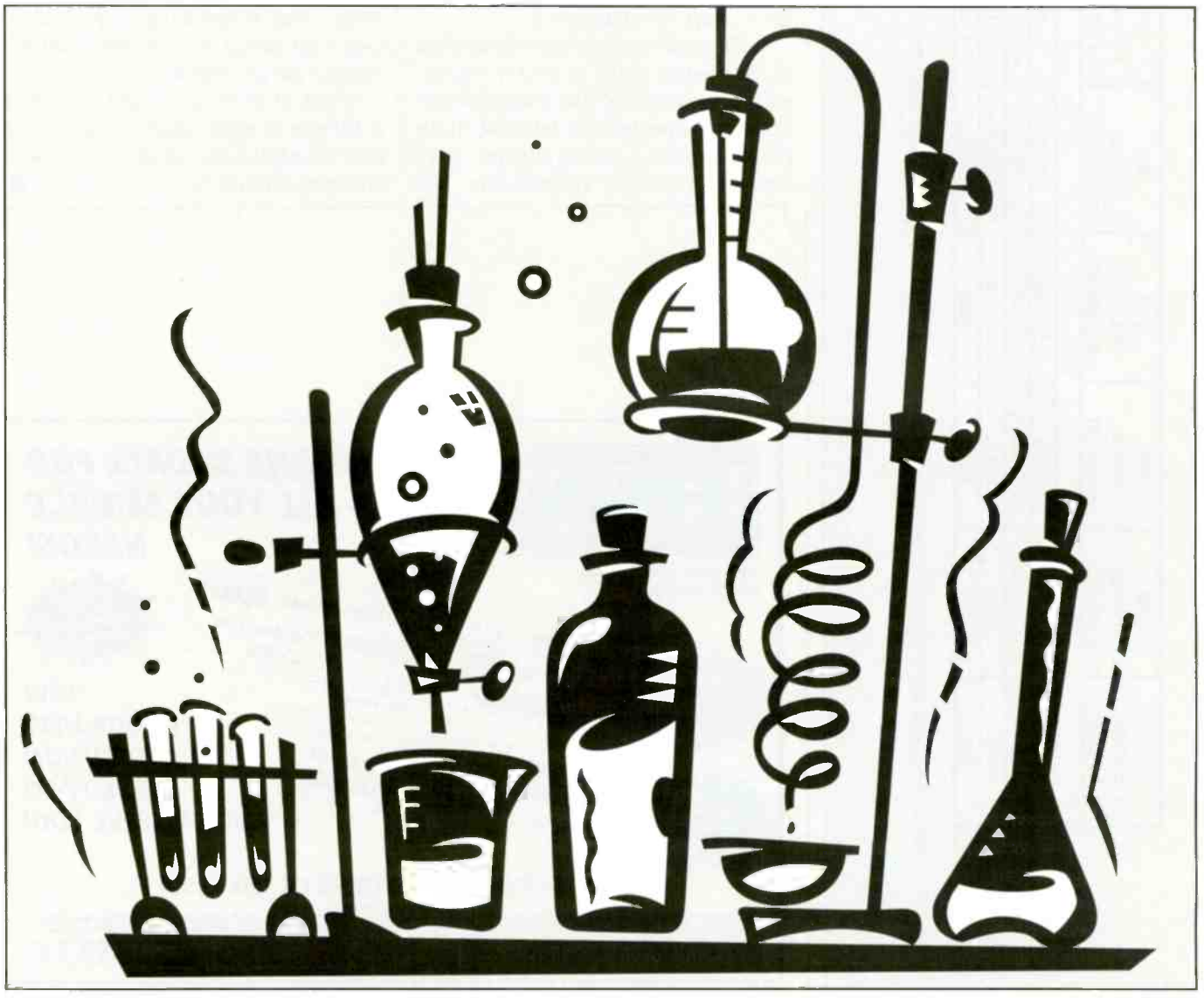
For example, when someone brings in a VCR and claims that the picture is showing problems, such as noise or dropouts, the first thing a technician does is to inspect the head drum and tape path, and perform a good general cleaning and lube. Then he plays a tape to see what the results are. Often this chemical treatment is all that is needed to restore the unit to proper operation.

Another common problem (although less and less common as electronic controls become more prevalent) in consumer electronics products, is a noisy control, such as a mechanical tuner or a potentiometer. In many cases there's not much to do except to replace the control. In other cases, however, the situation can be remedied simply by spraying a little cleaner/lube and turning the control knob back and forth a few times.

Problems with chemicals

Unfortunately the chemicals used in consumer electronics servicing are not without undesirable side effects. For one thing, many of them are toxic to humans to some extent. Another unfortunate side effect is that while they dissolve grease and dirt, they may also attack materials such as plastics, out of which components, circuit boards, controls and even the cabinet are made.

Perhaps the most widely known undesirable side effect of some chemicals is that they are harmful to the environment. Of particular note in this regard are some of the chlorinated chemicals: chlorinated solvents like 1,1,1-trichloroethane and CFC-113. The chlorine from these chemicals is very stable in the atmosphere and remains intact for many days, rising in the atmosphere until it reaches the ozone layer. Here the chlorine combines with



TYPE OF CLEANER	CHLORINATED SOLVENT (1,1,1 BASED)	HYDROCARBON SOLVENT ALCOHOL	CHLORINATED SOLVENT	PETROLEUM DISTILLATE/	TERPENE BASED	WATER
Evaporation Rate	Fast	Moderate	Fast	Fast	Moderate	Slow
Rinsing Required	No	Wiping Recommended	No	No	Wiping Recommended	Wiping Recommended
Residue	None	None	None	None	Slight	Slight
Stains Fabric	No	No	No	No	No	No
Dielectric Strength	28,000V	29,000V	26,000V	20,800V	29,500V	N/A
Safe on Plastics	No	May Be Harmful To Some Plastic	No	May Be Harmful To Some Plastics	May Be Harmful To Some Plastics	Yes, If Surface Is Rinsed
CFC, Trichlor Free	No	Yes	Yes	Yes	Yes	Yes

Table 1.

the ozone, thus removing ozone from the upper reaches of the atmosphere.

This is a serious environmental problem. The ozone layer absorbs ultraviolet radiation, the region of the spectrum of sunlight that causes suntans and sunburns, and can cause damage to the eyes. According to current medical knowledge,

TYPE OF CLEANER	CFC SOLVENT	HCFC SOLVENT	PETROLEUM DISTILLATE/ ALCOHOL	PETROLEUM DISTILLATE/
Evaporation Rate	Very Fast	Very Fast	Fast	Moderate
Rinsing Required	No	No	No	Wiping Recommended
Residue	None	None	None	None
Stains Fabric	No	No	No	No
Dielectric Strength	32,000V	21,000V	22,600V	43,600V
Safe on Plastics	Yes	May Be Harmful To Some Plastics	Yes	Yes
CFC, Trichlor Free	No	Yes	Yes	Yes

Table 2.

there is no such thing as a "safe" suntan. Any reddening or tanning of the skin is in fact evidence of damage, and could in time lead to skin cancer.

In areas where the ozone layer has been depleted, the intensity of ultraviolet light at the earth's surface is considerably higher than elsewhere. Thus the potential for skin damage is greater.

But that is only part of the problem, the part that is of direct significance to humans. There are other potential damaging effects to other species that could cause ecological problems in the future. These problems are not as well understood.

CFCs and trichloroethane banned

The environmental impact of CFCs and trichloroethane are so serious that as of the end of 1995, that's this year, these chemicals will be banned by law in the United States. The most effective and least chemically reactive cleaning and degreasing products will no longer be available because they have been proven to be harmful to the environment, and, more specifically, to humans.

There are substitutes for these chemicals, but none, at least not yet, that have all of the desirable characteristics of the chlorinated solvents. Some of the other chemicals clean as well but may attack certain plastics. Other substitute cleaning chemicals may not evaporate as rapidly and so leave behind traces of liquid that must be wiped up.

Choose carefully

The fact that chlorinated solvents are being phased out because of their adverse environmental impact does not mean the end of the world for the cleaning of electronics products during service. It does mean, however, that service technicians and managers will have to become better informed so that they can find chemicals that will clean effectively without damaging or destroying the plastic portions of consumer products. Tables 1 and 2 provide some general information about some of the environmentally safe alternatives to chlorinated cleaners. ■

Books

***Electronic Circuit Design Ideas*, By Venkataraman Lakshminarayanan, Butterworth-Heinemann, 288 pages, $29.95 Paperback**

Butterworth-Heinemann proudly announces the publication of *Electronic Circuit Design Ideas* by Venkataraman Lakshminarayanan.

With 14 chapters, using over 170 circuits, this book contains a wide range of circuit design ideas. Each idea consists of a circuit diagram, waveforms (where applicable), and a simple explanation of how each circuit works. Relevant design equations and formulas are also shown, so that the full lesson offered by each can be appreciated.

This collection provides a reference for design engineers, consisting of many circuits that provide the building blocks of larger system design. Each component used is fully described, and data sheets are provided.

Butterworth-Heinemann, 313 Washington Street, Newton, MA 02158-1626

***The Internet Passport: The NorthwestNet's Guide to Our World Online*, Fifth Edition, NorthWestNet, Prentice Hall, 704 pages, $29.95 Paperback**

Now in its Fifth Edition, *The Internet Passport* has been updated and verified by Internet experts at NorthWestNet to reflect the latest Internet tools and resources.

The Internet Passport is both a "how-to" manual and a complete reference to the electronic superhighway. It is helpful to novices as well as experts.

The Internet Passport starts with explanations of all the Internet's essential tools. These include global e-mail, Telnet, FTP, Usenet, archie, Gopher, WAIS, and World Wide Web, and directory services-all presented with examples and instructions.

The book features chapters devoted to K-12 education and health care resources on the Net, Newsgroups, a guide to the Internet's growing library of electronic books, journals, newsletters, and information about the Internet's databases, catalogs and other resources.

For experienced Internet users, *The Internet Passport* also offers these and other new areas of coverage: discussions on security and Internet communications, a new guide to becoming an information provider, and special coverage of the internet's resources for supercomputing.

Prentice Hall, PO Box 11073, Des Moines, IA 50381-1073

***The Power Supply Cookbook*, By Marty Brown, Butterworth-Heinemann, 248 Pages, $39.95 Hardcover**

The Power Supply Cookbook provides procedures for every phase of power supply design. Using this book, any technician or engineer will be able to complete a complicated power supply schematic in less than one day.

Marty Brown's latest book covers linear, PWM switching, and resonant-mode switching power supplies, both DC-to-DC and off-line types. It presents each section of the power supply, organized into functional subcircuits, along with explanations of each function and typical design approaches.

This volume addresses every phase of power supply design, from magnetics and feedback loop compensation to RFI/EMI control, in an easy-to-follow, step-by-step fashion. Many easily modified design examples are provided as design templates to help the reader.

Butterworth-Heinemann, 313 Washington Street, Newton, MA 02158-1626

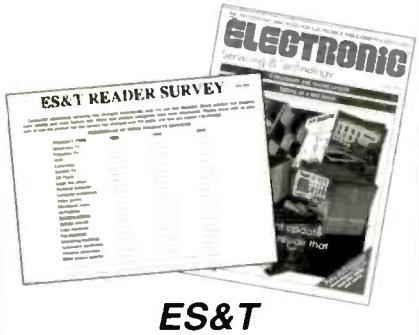
***Handbook of Batteries*, By David Linden, McGraw-Hill Inc., 1,216 Pages, $125.00**

The new second edition of the *Handbook of Batteries*, has been revised and updated to reflect the advances in electronics in recent years-and the corresponding growth of the battery market.

More than 60 specialists in the field have contributed material on their areas of expertise. They examine the entire spectrum of battery technology. The second edition of The Handbook of Batteries features the latest data, tables, and figures on battery performance.

The handbook tells how to determine the performance characteristics of different types of batteries under all conditions of use. It explains how to establish proper operating procedures and conditions for the optimum effectiveness of each bat-

(Continued on page 68)



ES&T READER SURVEY

Bound into this issue is the ES&T Reader Survey card. It's located on page 31.

It's a mini survey about ***you.*** We would like to hear about the problems you face, the opportunities you see and the equipment you use during the course of your work day.

The postage is paid. All you have to do is fill it out and mail it.

What could be easier?

Please fill yours out and mail it today.

Products

Color LCD DSO

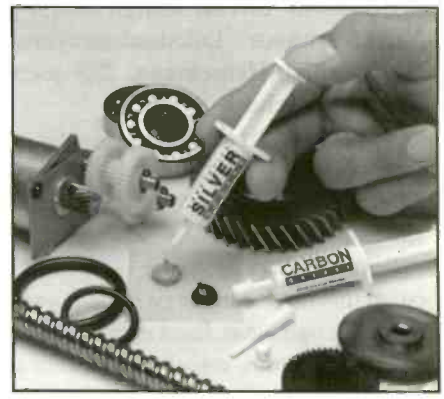
Hitachi Denshi America Ltd. introduces the VC-5410 Color LCD Digital Oscilloscope. The unit has a bandwidth of 20MHz, and two separate A/D's operating at 15Ms/S, features a "scope-like" interface for ease of use. Along with this familiar user interface are a number of advanced function keys to allow the user to "autoset", make a printout, save and recall front panel set ups and waveforms. The instrument has a 2KW record length, and features 10 waveform and 10 front panel memories.

The product's performance and price, make it appropriate for industrial control applications, mechanical applications, and those technologies involving the physical sciences. Its analysis capability includes both waveform parameter measurements and cursor measurements, and it features both RS-232 and Centronics ports as standard, for interfacing to a computer and direct connection to most supported printers. Waveform transfer to a PC is easy with a number of Windows compatible S/W programs.

Circle (70) on Reply Card

Conductive grease

Planned Products introduces two new greases developed for applications requiring electrical conductivity, lubrication and protection. Available in silver and carbon formulations, the new Circuit Works Conductive Greases protect assemblies from wear and environmental hazards while providing electrical and thermal conductivity. When used at low to medium loads and speeds, the 7100 silver grease, and 7200 carbon grease lubricate and protect assemblies while forming conductive pathways, contacts, connections, static drains and grounding. Based on advanced silicone lubricants the new greases are chemically inert, thermally stable and nonflammable. Assemblies are protected from moisture, oxidation, radiation and corrosion, with a single grease application.



Compatible with metal, rubber and plastic assemblies, the greases can be applied directly to a variety of seals, o-rings, gears, bearings, splines an lead screws. The lubricants cling aggressively to assemblies even at high temperatures.

Circle (71) on Reply Card

Service dispatch and scheduling software

Sirius Software, Inc. announces the release of an additional application to their business accounting program, service dispatch and scheduling. This software centers on the technician status screen. Management and dispatch can tell at a glance which technicians are available, and where each technician is located.

When work orders are entered, they can be scheduled for a date and time, assigned a priority, and assigned up to three technicians. As each work order is called in complete, the dispatcher can update the start and end times, and assign a new work order to the technician. Open work orders, with scheduled date, time, and priority, are available with a single keystroke in a pop-up window. Additional pop-up functions include, pre-assign technicians to a work order, list all work orders, and show technician scheduled time-off.

Reports are available to print all work orders in various sorting sequences, and to print a daily schedule for each techni-

[Continued from page 19]

cian. Technician time-off for vacation, holiday, sick, or other can be scheduled. And, the on-screen graph shows the next 45 days with the time-off marked.

Circle (72) on Reply Card

Synthesized signal generator

Leader Instruments Corporation announces the release of Model 3222. It covers 100khz to 2.7GHz, and offers 10-Hz resolution to 1.35GHz and thereafter, 20Hz, resolution to 2.7GHz. Frequency accuracy is better than 0.05ppm standard, but an 0.002ppm time base is offered as an option. A standby mode maintains reference timebase oven stability to eliminate warm-up time when powering up.

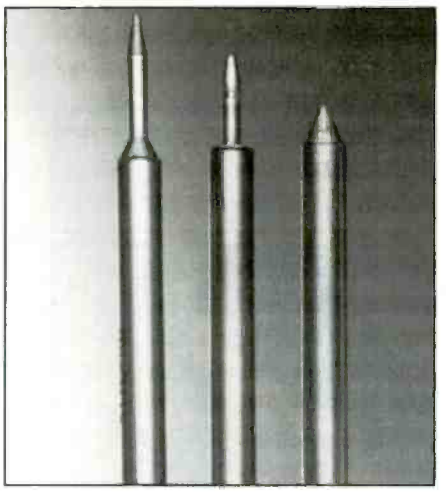
Operating choices include up to 100 setup programs in which carrier frequency, modulation modes and parameters, and output attenuation are easily present. The precision output attenuator controls output from +13 to -133 dBm with 0.1 dBm setability. Readout in dB is an operating choice. The output attenuator is equipped with mercury-wetted relay contacts to eliminate switching transients, and to ensure long-term reliability (rated for more than a 100 million operations.)

Extensive modulation capabilities include 7 modes with 14 simultaneous combinations to choose from. Included are pulse (GaAs FET), logic DC FM and internal or external AM and FM. GPIB control is standard. Reverse power protection of 50W is provided to avoid accidental damage when working with transceivers.

Circle (73) on Reply Card

Soldering tip cartridges

Metcal's 600 series soldering tip cartridges are applicable for most soldering and SMT rework applications where soldering at lower temperatures is desirable. Because these tip cartridges use Smart-Heat technology, users can solder the same applications that they normally would with comparable conventional soldering irons, but at temperatures approx-

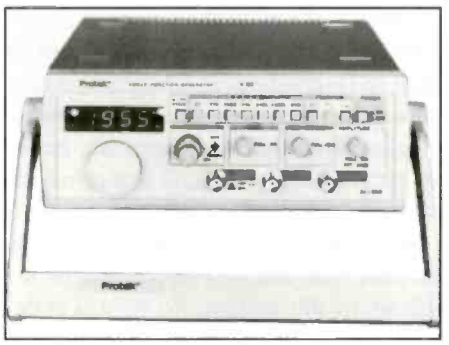


imately 100F. cooler overall, according to the company. The tips sense the thermal load on contact to deliver precisely controlled heat directly to the solder joint.

Circle (74) on Reply Card

Function generator/frequency counter

The Model B-803, 0.02Hz to 2MHz function generator from *HC Protek*, features a 4-digit LED readout for continuous display of generator output frequency and can now be used as a frequency counter to measure an external signal.



The combination function generator/frequency counter produces square, triangle or sin waves. It has plus or minus dc offset, 20dB attenuation and sweep output of 0.5Hz to 50Hz continuously variable. Output frequency is controlled via push button switches from 1X to X1-MHz and a frequency dial.

Circle (75) on Reply Card

Soldering system for SMT rework

Metcal's STSS-002E Soldering System is a flexible way to accomplish SMT rework, from the heavy heat-sink jobs to delicate components and flex circuits.

(Continued on page 68)

Television theory

By Lamar Ritchie

For the benefit of readers who have never been exposed to television theory, and for those who haven't reviewed any theory in a while, here's a primer and refresher on TV theory. This article will cover black and white (monochrome) TV (we'll discuss the color aspects of TV in a future issue of this magazine).

Black and white images were the first to be used for commercial television. With the advent of color TV, colors had to be transmitted in such a way that compatibility could be maintained. That is, existing black and white receivers must still be able to reproduce the color images as black and white images.

This meant that the basic black and white portion of the color system must be nearly the same as their counterparts in the old monochrome broadcast system, and the color signal was added to the monochrome signals to be used to generate color in the color receiver.

Creating the picture

In the present television system the picture must be reproduced in the receiver using a beam of electrons fired at a phosphorescent screen in the CRT (picture tube). The only practical way of achieving this is to focus the beam in such a way that it strikes only a tiny spot on the CRT. This spot will produce a visible glow where the beam strikes. The beam can be made to vary in intensity to produce a lighter or darker glow from this spot.

To create the image, the picture must then be placed on the screen one dot at a time by moving the beam across the entire screen while varying the intensity of the beam to "color in" each small area with the correct shade of gray. To create all of the corresponding shaded areas, the beam can be started at the top left corner and made to move from left to right.

As the beam moves, a video signal voltage applied to the CRT varies the intensity of the beam. After "scanning" one horizontal line, the beam is moved down slightly and the process is repeated. After scanning a number of lines, the beam reaches the bottom of the screen and has covered the entire picture area.

Ritchie is an electronics instructor at Kentucky Tech, Hazard campus.

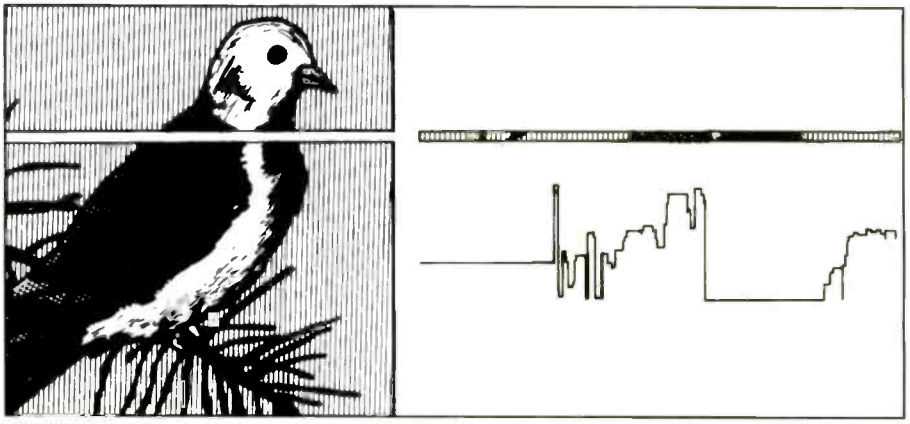


Figure 1. This image was created with fifty horizontal scanning lines. A single scanning line is shown to indicate how the video signal varies in level as the brightness of the image varies during this line.

Scanning

The process of moving the beam from left to right is called *horizontal scanning* and the process of moving the beam from top to bottom is called *vertical scanning*. The picture image is not transmitted or reproduced in complete form, but is created one small dot on the screen at a time as the scanning beam moves from left to right and top to bottom. This process also allows the image to be transmitted with a single system with a reasonable bandwidth. It would be difficult to transmit all of these "dots" at the same time!

Each tiny dot in the image is the smallest area that can be reproduced, or resolved, by this system. No objects in the scene that are smaller than this can possibly be seen. These tiny dots that compose the picture are called *picture elements*, or *pixels*.

Brightness

In order to reproduce a picture in an electronic system, a voltage must be used to represent information concerning the brightness of each small area. The voltage level will correspond to the brightness level for each area. Thus white areas will be produced by the highest level of voltage of the video signal while black areas will be produced by a low voltage level. Varying shades of gray will produce varying intermediate voltage levels.

Figure 1 shows an image created with fifty horizontal scanning lines. The video waveform for a single scanning line is shown to indicate how the video signal varies in level as the brightness of the image varies during this line. As you can see, the video signal has an ac component to it because the voltage varies as the brightness of the image varies. It must also have a dc component since the precise level of the voltage at any point will determine the brightness of the pixel at that point.

What we have discussed so far is the mechanisms by which a single still image can be created and reproduced electronically. To reproduce moving pictures, techniques were copied from the motion picture industry.

Moving picture images

Just about everyone knows that moving images can be conveyed by showing a series of still images. This allows movies to be filmed one picture, or frame, at a time. Cartoonists can create a series of drawings, each frame only slightly different from the previous one, and film these in succession to make motion picture cartoons.

Motion pictures rely on the *persistence of vision* characteristic of the eye. The eye retains images for a short time, approximately 1/40 second. This means that events occurring faster than this would be perceived as being continuous. Fluorescent lamps for example, actually blink on and off 120 times per second, but because

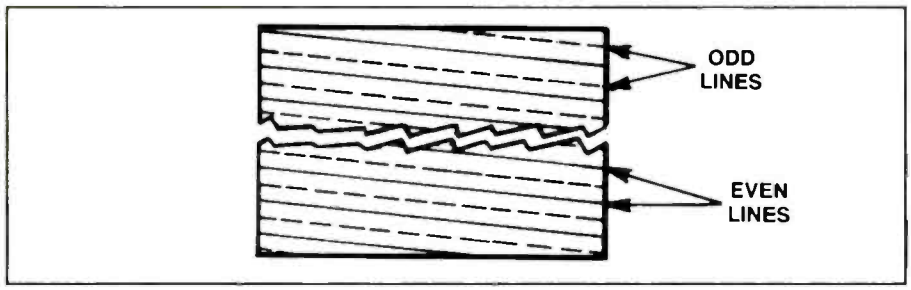


Figure 2. There are two fields of video for each frame. The scanning lines for each field are not the same, but must interlace with each other to form the complete picture. The first field of each frame is called an odd field and the second is called an even field.

of this persistence of vision, they appear to be on continuously.

All that is necessary to produce moving pictures, is to produce a series of still pictures as described earlier, with at least 40 images produced per second. There were some problems with this approach, however. Notice that I said "were". Electronics has advanced considerably since the 1940's, and we could do things much better if we were not confined to the present TV broadcast system, but there are so many TV receivers using this system it can't be abruptly changed.

One problem is the amount of bandwidth needed to convey the image. As we have seen, the video signal contains an ac component that corresponds to the variations of brightness from the images. For smaller objects in the image, the voltage must change in level quickly. This represents a higher frequency. So, to reproduce the different shapes and sizes of objects in the image therefore requires a large range of frequencies.

The exact bandwidth required depends mainly upon two factors; the resolution and scanning speed. Resolution refers to the ability to discern small, detailed objects. The smaller the object to be televised, the faster the video signal must change to represent this object. This generates higher frequencies. For slower scanning speeds, these frequencies can be lower.

If we had all day to scan a complete image the video would be able to change rather slowly and still have time to place a large number of pixels on the screen. This wouldn't be very useful in creating moving pictures since we must place at least 40 images on the screen per second.

Fewer images

TV borrows another "trick" from motion pictures. In order to reduce the amount of film needed, each frame of the picture is shown twice before a new image on a different piece of film is moved behind the lens. A shutter arrangement in the projector flashes the image on the screen, then flashes the same image on the screen again. A sprocket mechanism then pulls the film down so that a new image is placed behind the lens. This image is then shown twice, and so forth.

With this system, an image is flashed on the screen 48 times per second, although there are only 24 different frames of film per second. The eye does not know that each image was used twice. To reduce the bandwidth and increase resolution, a similar scheme is used for television pictures. The frame rate used, however is 30Hz. This frequency was easier to obtain because it allowed use of the 60Hz power line as a reference.

TV picture fields

The TV picture is scanned as two fields, (each being the same image). Each of these fields has only half of the horizontal scan lines and therefore pixels, that the entire frame will have. This procedure is a way to further reduce the needed bandwidth. For this to work, the image must be scanned, as we have shown, but a blank line (a line that is not scanned) is left after each horizontal scan line. This creates one field of the image.

On the next field, the same image is scanned again. This time, the lines that are scanned are the ones that were left blank in the previous field. They are placed on the screen in between the scan lines of the previous field and thus "fill out" the image to give the full number of

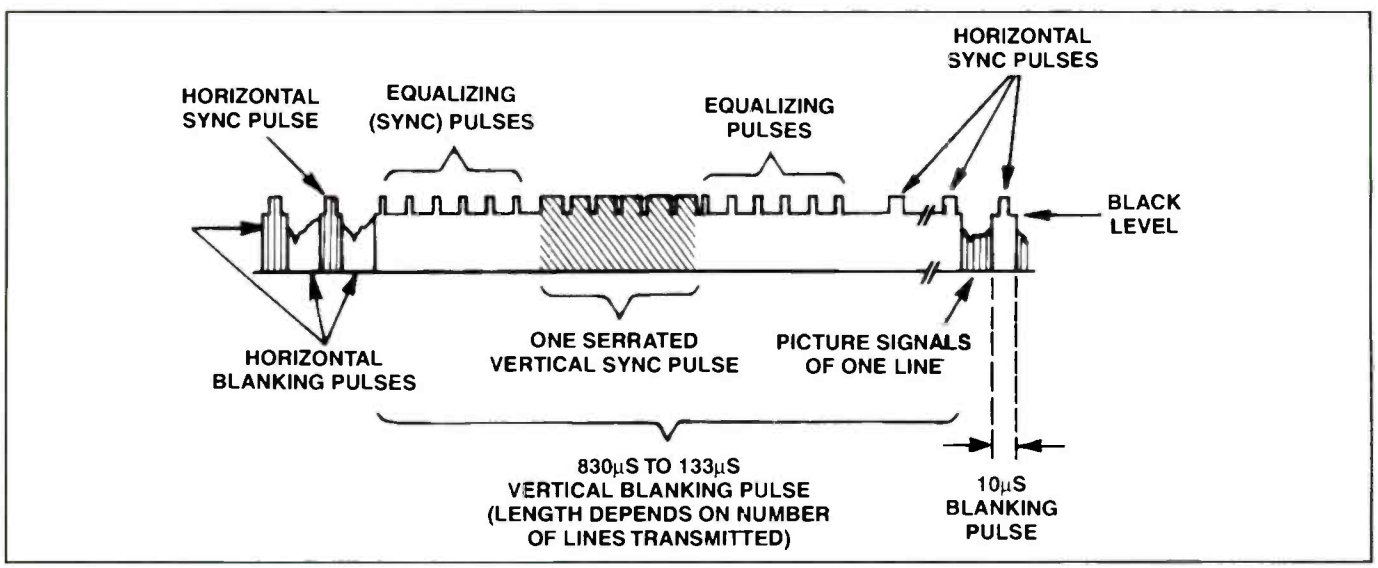


Figure 3. The standard adopted for the TV system used in the U.S. is called the NTSC system, shown here. NTSC, which stands for National Television Standards Commission, calls for a complete frame to consist of 525 horizontal scanning lines. Each field, therefore, will consist of 262.5 lines.

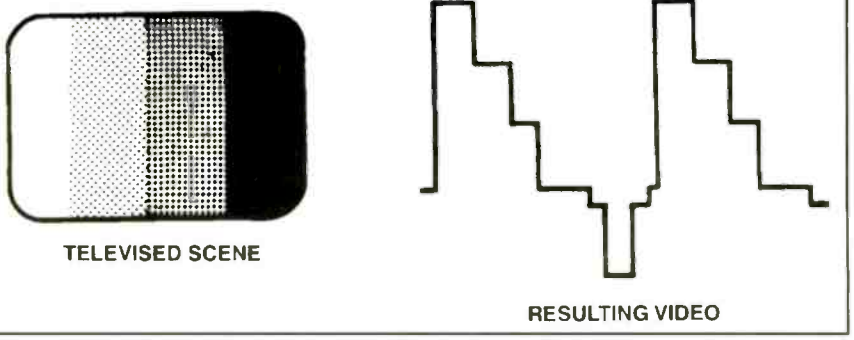


Figure 4. The video signal generated by the televised scene on the left would look like the signal shown at the right. Note that the video information for the two horizontal lines shown in the waveform are identical, as they would be for this type of image. The video information for all horizontal lines would be identical if vertical bars were televised.

pixels and resolution. This process is called *interlaced scanning*.

If interlaced scanning were not used in this system, the top of the picture would have noticeably dimmed by the time the bottom of the picture is scanned, causing an annoying flicker. Interlaced scanning eliminates this flicker.

There are two fields of video for each frame. The scanning lines for each field are not the same, but must interlace with each other to form the complete picture. The first field of each frame is called an odd field and the second is called an even field (Figure 2).

The NTSC system

The standard adopted for the TV system used in the U.S. is called the NTSC system (Figure 3). NTSC, which stands for National Television Standards Commission, calls for a complete frame to consist of 525 horizontal scanning lines. Each field, therefore, will consist of 262.5 horizontal scanning lines.

It is obvious, of course, that the same standards must be applied when the image is created and when it is reproduced by the receiver. Another standard that was adopted was the shape of the image. It was decided that the image area would be scanned with an aspect ratio of 4:3 (the ratio of the width to the height of the image). This gives a more pleasing image because most points of interest are spaced horizontally around the observer.

Now, since we have determined that the frame rate, or frequency, is 30Hz and there are two fields per frame, it is easy to see that the field rate is 60Hz. This must be the rate at which the electron beam scans the image from top to bottom, so it is also the *vertical scanning frequency*.

During one field there are 262.5 horizontal scanning lines, so there must be 62.5 X 60, or 15,750 horizontal lines scanned each second. The *horizontal scanning frequency* is therefore 15.75Khz.

At this horizontal scanning rate, if twenty pixels were used in each horizontal line, this would generate ac video frequencies of 157.5Khz. That would be ten ac cycles per scanning line. Ten ac cycles per scanning line would have a frequency ten times that of the scanning itself. Since each ac cycle has a positive and a negative half, this would correspond to a light colored pixel and a dark colored pixel, or two pixels per cycle. This would give 20 pixels per scanning line. Twenty pixels per line is not nearly enough for an acceptable picture, therefore video frequencies must go higher than this. For broadcasting of pictures, it was decided to use frequencies up to about 4MHz. This allows approximately 500 pixels per horizontal scan line.

Picture resolution

It takes at least two pixels to create the image of an object, since two adjacent pixels must be different in order to see the edge of a single object. A better way of giving the *resolution* of a video system is the *number of lines* that could be resolved, or seen, with the system.

This is usually given for the horizontal scan rate and referred to as the *horizontal lines of resolution*. This is a measure of how many vertical stripes could be distinctly seen on the screen at one time. Any more than this would blur together into a smooth screen. This will vary somewhat from system to system but is normally between 300 and 350 lines for a broadcast TV signal.

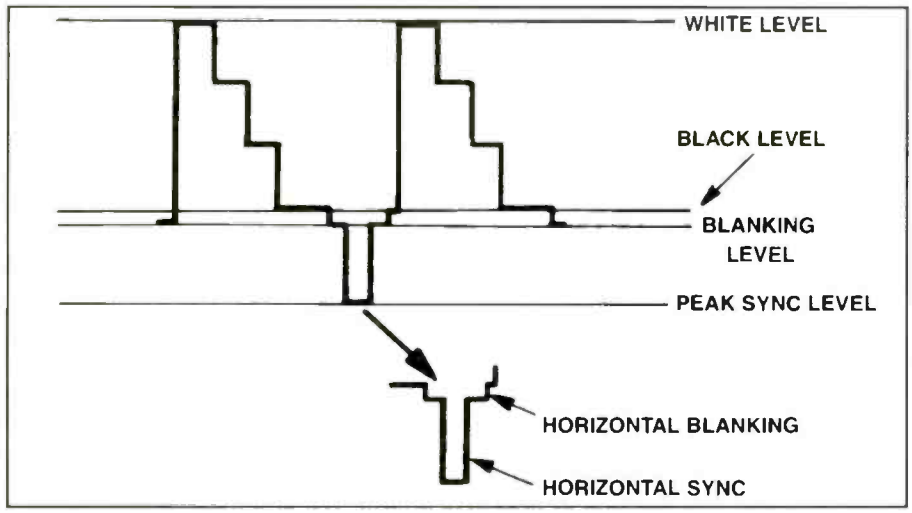


Figure 5. The two lines of video shown in the illustration in Figure 4 would have these levels and signal components.

Modulating the video signal

Now back to the video signal. The signal we are referring to is the *baseband* video signal. This is not the signal as it is transmitted by a TV station. This video is to the picture what audio is to the sound. An audio signal has to be used to modulate an RF carrier before it can be transmitted. The same is true of the video signal. In the receiver, the baseband audio signal must be recovered to drive the speaker, and the baseband video must be recovered to drive the CRT. Sometimes TV engineers use the terms *video* and *audio* for the baseband signals, and the terms *visual* and *aural* to refer to the modulated RF signals.

Synchronization

As we have seen, part of the video signal consists of a voltage that varies in level as the brightness varies at any particular point on the image. There is more to it than this however. For this system to work, the receiver must be scanning the correct place on the CRT screen when the bright and dark variations are applied to it. The source of the video and the receiver must therefore be synchronized as to where the horizontal scanning for each line starts, and as to when the scanning of each field begins.

If we can get the scanning of the electron beam started at the same time as the received video signal is beginning, the circuitry of the receiver can be made to stay close enough in step for the duration of one horizontal scanning line. To synchronize the receiver to the video signal requires the addition of *synchronizing pulses*, sync pulses, for short, to the video signal. These pulses can be recovered by the receiver and used to "tell it" when to begin scanning. There must be two sets of sync pulses, one for the horizontal scanning circuitry and one for the vertical scanning circuitry.

Retrace

Another part of the signal that has to be added has to do with what happens at the end of the scanning of one line or field. After the beam in the CRT reaches the right of the screen (as seen by the viewer) after a horizontal scan line, it must be brought back to the left for the start of the next line. The horizontal sync pulse will tell the receiver when to do this.

To keep from producing a line on the screen during this *retrace* of the beam, the beam must be lowered in intensity to the point where it cannot produce a glow on the screen. The intensity of the electron beam must also be reduced to near zero after the beam reaches the bottom of the screen and vertical retrace begins. To achieve this reduced intensity, *blanking pulses* are added to the video. There are two sets of blanking pulses, the vertical blanking and horizontal blanking.

Another set of pulses has to be added in order to achieve interlacing. Note that in Figure 2, one horizontal scan line must start in the middle of the screen. This requires precise control of the horizontal scanning circuits in the receiver. There is a problem with the time it takes for vertical retrace. The vertical circuitry operates at much lower frequencies than the horizontal circuitry and vertical retrace is

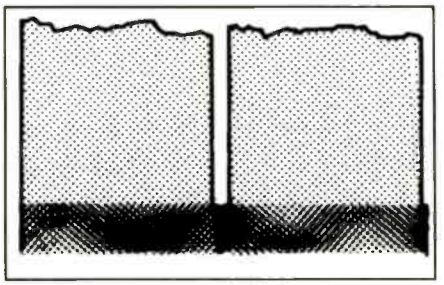


Figure 6. A two-field video display would look like this. Notice that the sync region has a blurry appearance because of the horizontal sync pulses. There are 262.5 of them in the displayed area for each field. Also, there are no distinct pulses displayed for the vertical sync and equalizing pulses. These 18 pulses will be too small to be discerned on this waveform.

much slower than the horizontal trace. This means that the horizontal circuit will go through several scan cycles while the beam is retraced vertically.

The vertical blanking signal will blank out the beam during this retrace, of course, but if no synchronization is provided for the horizontal circuit during this time, it will drift and be at the incorrect place for the start of the first scan line of the next field. It would quickly synchronize with the horizontal sync pulses, of course, but the first few lines may be displaced to the left or right, at random, before this takes place.

Moreover, because the beam did not start at the correct place, even after synchronization occurs, the scanned lines would not exactly fall between those of the lines of the previous field. To get the full amount of picture resolution by interlaced scanning, it is necessary that the beam begin scanning at the correct place.

Maintaining horizontal sync

To provide a horizontal sync signal during vertical retrace, *equalizing pulses* are added during the vertical blanking. Because every other horizontal scan line will begin at the middle of the screen, synchronization requires that these pulses have a frequency at twice the horizontal scanning frequency, or 31.5KHz. To provide sync during the entire vertical retrace time requires that 18 pulses be added. Within this time there must also be a vertical sync pulse. To help provide vertical sync and horizontal sync at the same time, the vertical sync pulse is serrated (chopped up) at a 31.5KHz rate.

This entire series of pulses consists of 6 equalizing pulses followed by 6 serrations of the vertical pulse followed by 6 more equalizing pulses. A horizontal line that ends in the middle of the screen will then find the first equalizing pulse there. The horizontal circuitry will synchronize to this pulse and every other pulse will be at the correct place to act as a horizontal sync pulse. The vertical circuitry in the receiver will be able to see the wider serrations of the vertical pulses and merge them into one pulse to provide a single vertical sync pulse.

Viewing the signal

With all of these signals combined to form the composite video signal, how this signal appears on an oscilloscope depends greatly upon the oscilloscope settings. There are two preferred ways to observe the overall video signal. One way to view the composite signal is to adjust the oscilloscope time base such that only a few horizontal scan lines of video can be seen. Another way to view the signal is to use a much slower time base setting, such that one or more complete fields of video can be seen. The preferred ways to view the video signal to obtain maximum information about the signal is the two-line display or the two-field display.

For the two-line display, adjust the oscilloscope time base so that exactly two horizontal scanning lines of video can be seen. In between the two lines would be the horizontal blanking and horizontal sync pulses. The vertical sync and blanking would not be seen because these do not occur until 262.5 horizontal scanning lines have been completed.

In the two-field display, the time base of the scope is adjusted until two fields of video are displayed on the graticule. In between these, in the middle of the graticule, would be the vertical sync, blanking, and equalizing pulses. During the video of the two fields, there would be a hazy area displayed at the sync level. This is caused by the blurring together of all 262.5 horizontal lines of video during this time. The individual vertical serrations and equalizing pulses would appear too small at this time base setting to make out individual pulses. The sweep magnify function of the oscilloscope can be used to "stretch out" the display to make these signal features visible.

The clearest display of the video is obtained when the scope is adjusted to provide the two-line display, and this one is

used the most to evaluate the video signal. Figure 4 shows what the video signal would look like on the oscilloscope for the shown televised scene.

Note that the video information for the two horizontal lines shown in the waveform are identical, as they would be for this type of image. The video information for all horizontal lines would be identical if vertical bars were televised. As a matter of fact, most successive horizontal lines are very nearly the same in all images. Because they are so close together, there is very little difference in the picture between two adjacent scan lines. VCRs have a circuit called a dropout compensator that stores each line for a little while. If the video drops out because of defects in the tape, the circuit inserts the previous line for the missing line. There is no noticeable difference if this is only done for one line.

Black and white signal levels

As mentioned previously, the video signal must have a distinct level that represents black, and another distinct level that represents white. The sync and blanking must also appear at distinct voltage levels. Various shades of gray, of course, do not appear at a definite voltage level but will be at various levels between black and white. For consumer electronic equipment, the standard value of the composite video signal (including sync and blanking) is $1V_{pp}$ for the part of the signal that causes the screen to be white. Commercial broadcasting uses a higher voltage, ($1.4V_{pp}$) for their standard. For the video output of a consumer VCR, the video information of the signal would be a maximum of $0.7V_{pp}$ for a scene with the full range of brightness, and the sync level would be approximately $0.3V_{pp}$. Figure 5 shows the two lines of video previously shown with the levels and signal components identified.

Measuring voltage levels of the composite video signal

In order to make easy measurements of these levels, broadcasters use a measurement system developed by the IEEE (Institute of Electrical and Electronics Engineers). TV stations use special oscilloscopes called waveform monitors to view the video signal. Signal levels on waveform monitors are expressed in IEEE units.

Each IEEE unit represents 0.01V. The blanking level is used as the reference line for measurements and a line on the waveform monitor marked as 0 units is where this signal is placed. The peak white level is at 100 units, the blanking level is 7.5 units, and the sync tip is at -40 units for a proper video signal.

Since these levels are marked on the monitor the engineers can quickly spot defects in the signal or adjust controls to give a proper video signal. The signal would appear somewhat different, as mentioned earlier, if the time base of the scope were adjusted so that complete video fields could be observed. Figure 6 shows how a two-field video display would look on a waveform monitor.

Notice that the sync region has a blurry appearance because of the horizontal sync pulses. There are 262.5 of them in the displayed area for each field. There are no distinct pulses displayed for the vertical sync and equalizing pulses. These 18 pulses will be too small to be discerned on this waveform.

The following diagram shows some of the pulses and signal parameters. Note that this is the waveform display of the vertical pulses. Note also that the polarity of the video is reversed and shown as negative phase. At some points within video circuits the video would appear this way, but for standard video output and input connections between devices, positive phase video is always used.

This display can be difficult to obtain on an oscilloscope. It requires an oscilloscope with delayed sweep, and the sweep magnify function must be used. Even with a very good oscilloscope it requires very careful adjustment to obtain this waveform for display.

The waveforms that have been presented in these figures are idealized waveforms; actual video waveforms encountered in consumer equipment will not look exactly like these. There will always be some distortions of the waveforms. The sync and blanking pulses will usually not appear perfectly square. There may also be some 60Hz hum and other noise present in the signal that will distort its shape to varying degrees. Good consumer electronics technicians see these signals often and know what they should look like if the circuits are operating correctly.

Almost all video equipment today uses color signals. The color signals have not been discussed or shown yet and will change slightly the way these waveforms look. Also, the frequencies discussed here had to be changed slightly to accommodate a colorized video signal.

For example, the color signal's vertical scanning frequency is 59.94 Hz, not 60 Hz., and the horizontal scanning frequency is actually 15734.26 Hz., not 15750 Hz. These are very near to the black and white video standards but nevertheless had to be changed to these values for the color system to work properly.

An understanding of these principles can aid troubleshooting

It isn't absolutely necessary to be familiar with the theory of TV operation and the NTSC composite video signal to service a TV set. Moreover, many problems in TV sets will not require a technician to use his knowledge of this theory even if he does possess it. In many cases, however, especially when a technician is trying to tame one of those "tough dogs," a sharp understanding of the theory may be just what it takes to get the job done. ■

Servicing projection TV sets

By Jurgen Ewert

Increasing the size of the TV screen has always been a goal of TV manufacturers. The first CRTs were small and round, but their size gradually increased and the shape gradually became rectangular. New technologies have made rectangular CRT- screens in sizes from 5" to 35" possible. The smallest screens are usually LCD screens and the largest ones are projection types that use separate CRTs for each primary color. Some older designs used one very bright color picture tube as a source for the picture to project on a screen. These TVs give a very dim picture.

A new technology for projection TV is the LCD video projector. The disadvantage of these projectors is the slow speed of the LCD, so changing scenes look a little blurry.

The most popular type of big screen set is the projection TV, which uses an extremely bright CRT for each of the primary colors red, green and blue. This article will show the parts and the *problems* that are peculiar to projection sets, and will conclude with two repair histories.

Ewert is an independent consumer electronics servicing technician.

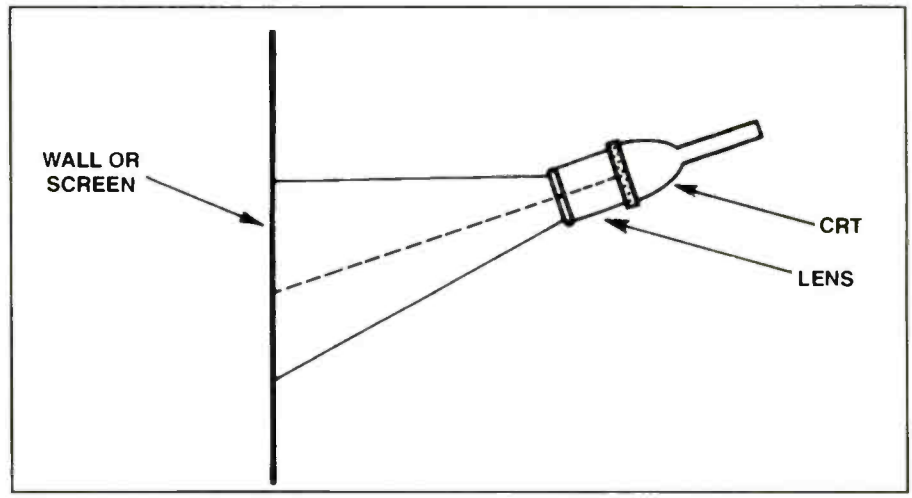


Figure 1. Basic construction of a projection TV.

The projection TV system

Projection TVs are designed in two different ways. In one type, the picture is projected on a screen or a wall. In this design (Figure 1), the size of the picture is determined by the focal length of the optics and by the distance between the CRTs and the screen. This design is space-consuming and not suitable for the average living room.

Rear projection TVs (Figure 2) require less space and are easier to install because they are self-contained. The distance that the light travels from the CRTs to the screen is increased by using a mirror to

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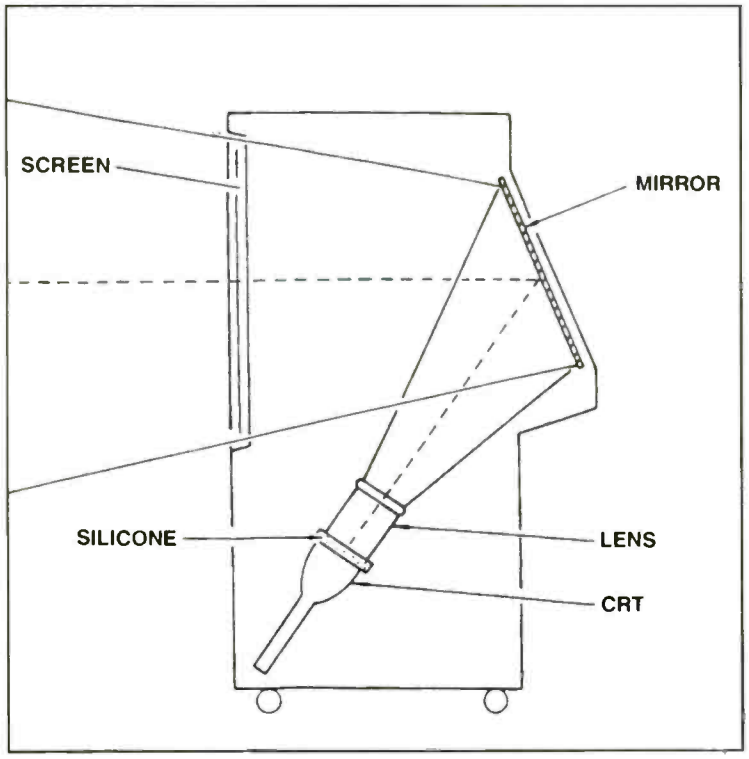
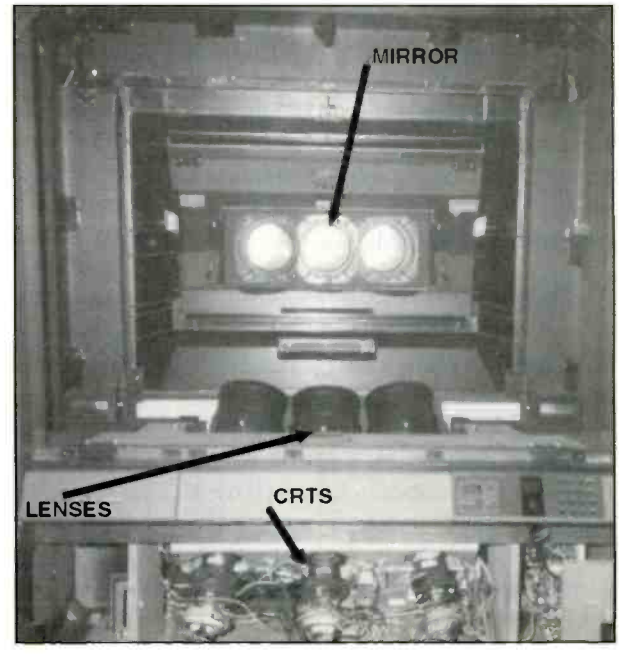


Figure 2. Basic construction of a rear projection TV.

Figure 3. Inside of a rear projection TV.



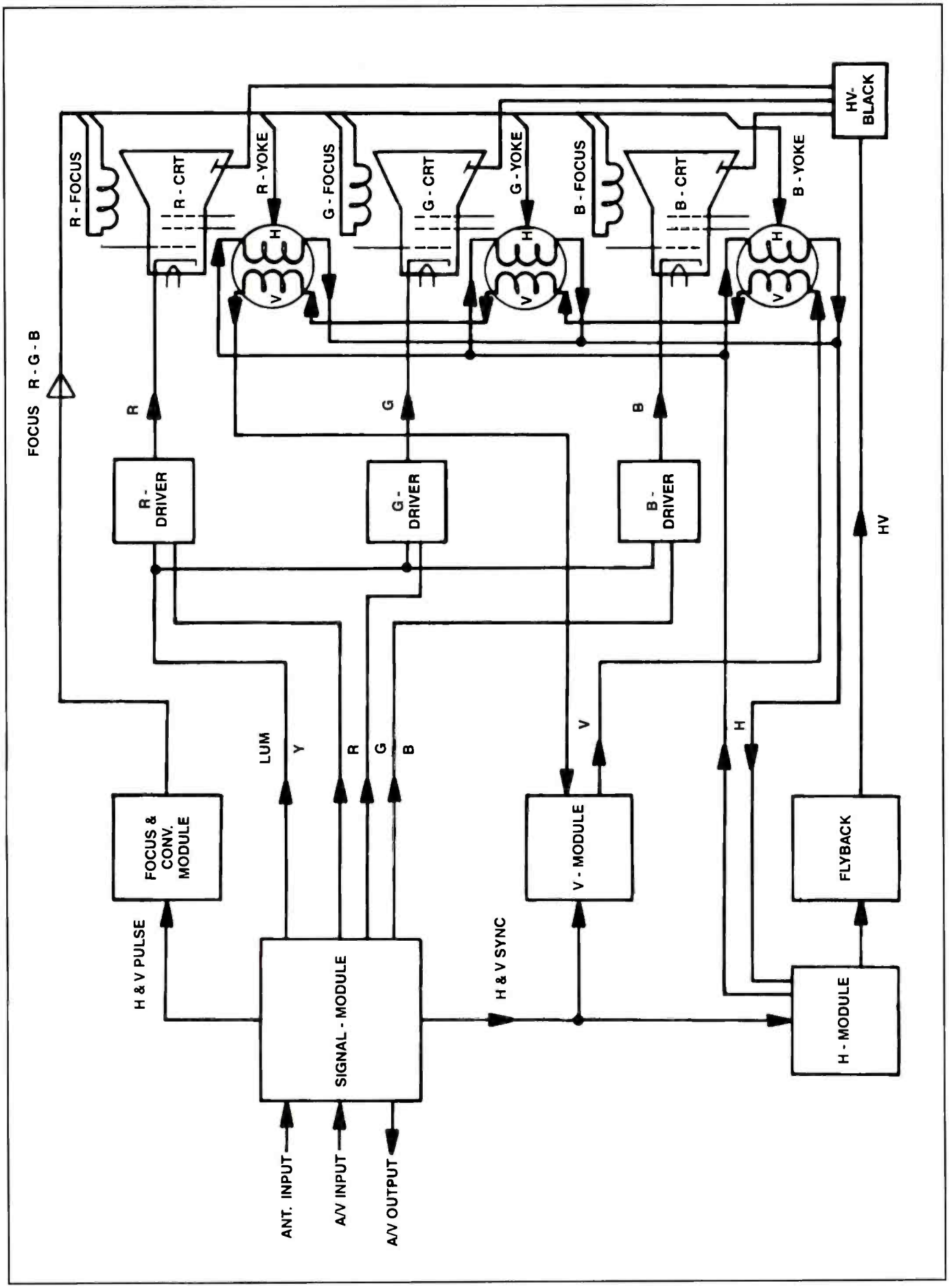


Figure 4. Block diagram of a projection TV with electromagnetic focus.

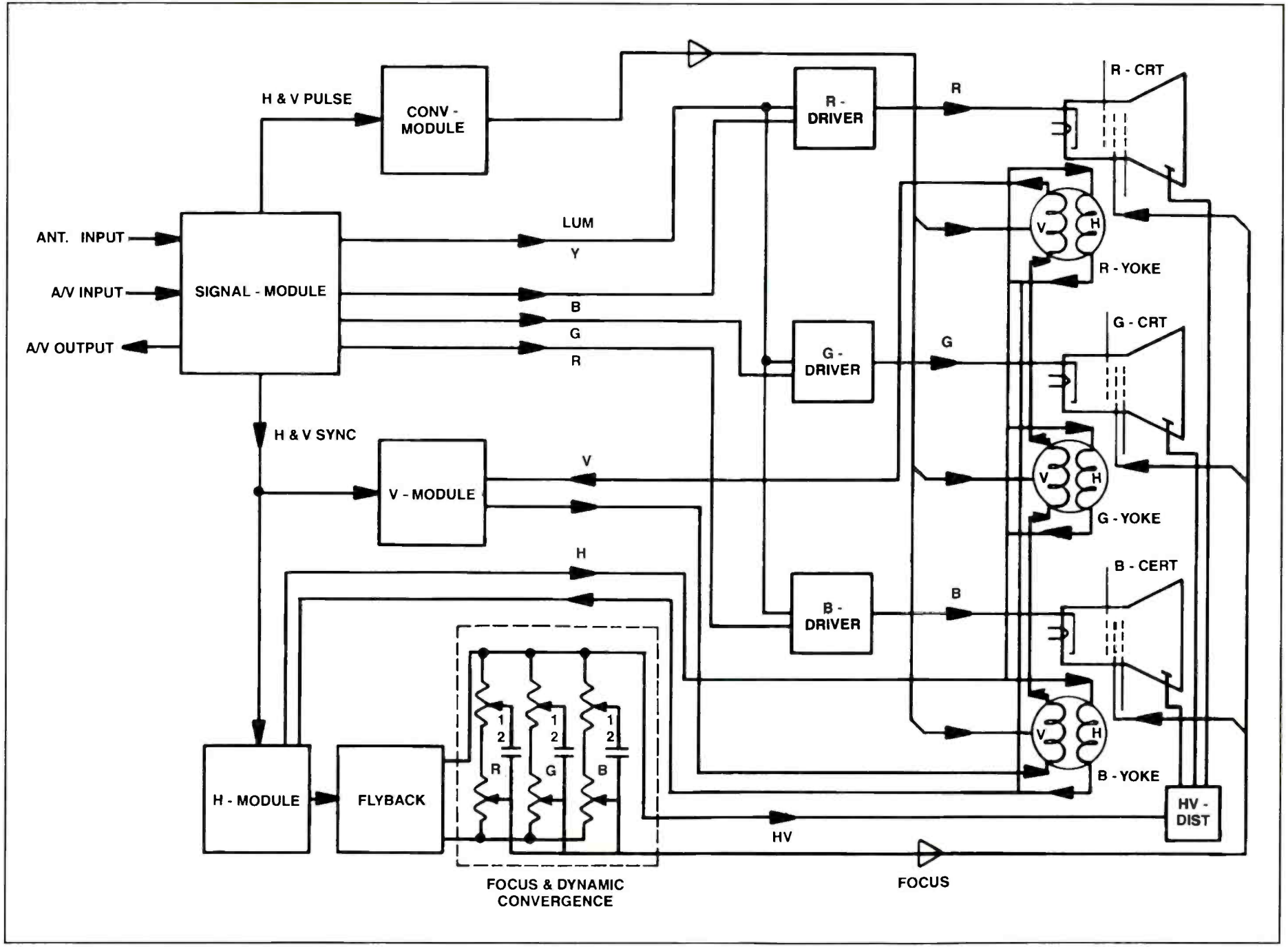


Figure 5. Block diagram of a projection TV with electric focus.

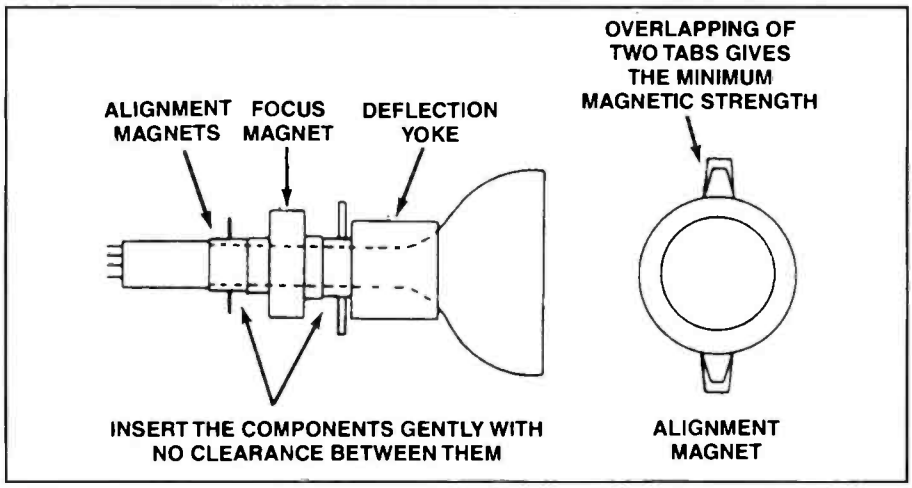


Figure 6. CRT with electromagnetic focus.

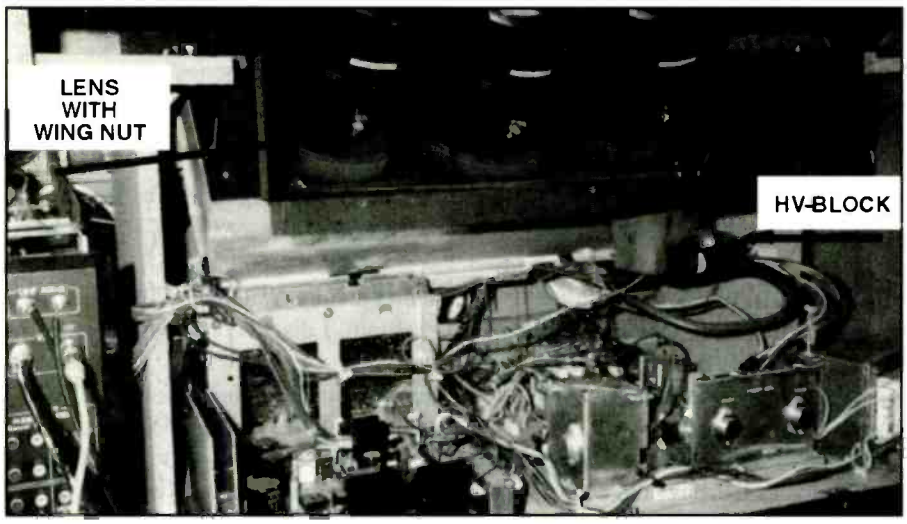


Figure 7. The lens assemblies in a rear projection TV.

direct the light beams, which consists of a plastic fresnel lens. Figure 3 provides a view of the insides of a rear projection TV set. The block diagram in Figure 4 gives an overview of the functions in a projection TV with magnetic focus. The block diagram in Figure 5 gives an overview of the functions in a projection TV with electric focus.

Similar yet different

In a projection set, the television signal from the antenna or video input is processed in the same way as in any other TV. The block diagrams of Figures 4 and 5 show the signal module with the output signals: luminance, R, G, B, V-SYNC and H-SYNC.

The differences are found in the CRT and the HV sections. A significant number of parts in the circuitry around the CRTs is used to correct the convergence of the three light beams. The yokes, which deflect the electron beams in each tube, are complex as are the driving circuits. However, there are vertical and horizon tal deflection coils as there are in any other TV. In all projection sets the vertical coils are connected in series and the horizontal coils are connected in parallel. It is important to know this when troubleshooting around the yokes and deflection circuits.

Some manufacturers use yokes with four coils. One set of coils is connected to the convergence module. In addition there are focus magnets on the CRTs in projection sets with electromagnetic focus (Figures 4 and 6). There are also alignment magnets to center the beams and to make the static convergence adjustment.

Some projection sets use electric convergence circuits and trailer yokes to make the corrections (Figure 5). The high voltage for the three CRTs is obtained from one flyback transformer and connected to each tube through a HV-distributor or HV-Block. This part may be the cause of trouble if only one of the three tubes is not operating.

CRTs in projection TVs operate at anode voltages of 30kV to 32kV. For this reason, it is absolutely necessary to measure the high voltage after working on the flyback section or making adjustments related to the high voltage (e.g., horizontal width) to avoid excessive X-radiation.

Precautions when servicing projection sets

It is always a good idea to read the section "Safety Precautions" in the service manual before starting to service any consumer electronics product. In addition to the directions for performing the leakage current check, there is an X-radiation warning in the service manuals of projection sets. One manufacturer even advises technicians to use a lead apron when servicing the TV.

It is usually not possible for a service technician to measure X-radiation directly. Physics books, however, state that the higher the anode voltage, the higher the intensity of the X-radiation when an electron beam hits matter such as a screen of a CRT. So the high voltage should never exceed the maximum value given in the service manual.

When servicing a rear projection TV set it is often necessary to remove the fresnel lens. There are some important precautions to observe when handling the fresnel lens.

- Always handle the fresnel lens carefully to prevent scratches and other damage. You should wear gloves when handling it to avoid fingerprints and scratches.
- Do not handle the fresnel lens in direct sunlight. Also, do not leave the lens unattended because it can cause a fire or burns by focusing the light around it.
- Never lean the fresnel lens it against anything. This might warp or bend the lens changing the optical properties.

After the fresnel lens is removed, the mirror is exposed. It is important not to touch the mirror to avoid leaving fingerprints. If the mirror looks clean, it is best to leave it alone. If the mirror is dusty you may use a glass cleaner. But take care not to leave any streaks; they will be seen in the picture later.

Focus and convergence adjustments

Each of the three CRTs is attached to a

lens system that focuses the light beam on the screen. The optical focus of the lenses is adjustable after loosening the wing nuts on the lenses (Figure 7). Before attempting to perform any focus adjustments to the lenses, consult the service manual. Manufacturers of projection sets provide different procedures on how, and in which order, to adjust the optical focus and the electrical and/or the magnetic focus. Usually the optical focus needs to be readjusted only if the lens or the CRT has been replaced.

Before making the adjustment, you will have to loosen the wing nut at the lens (Figure 7). Use the crosshatch pattern to adjust the optical focus of each lens separately. The other two lenses must be covered during the adjustment, or the signal to two of the CRTs has to be removed so that only one color is present.

Convergence adjustment

Two difficult and time-consuming adjustments on projection TVs are the static and dynamic convergence. All projection TVs contain a module that is strictly for the adjustment of convergence and focus. This module can contain 27 to 65 different controls (Figure 8). The controls on this board are usually well-marked. In most cases it is not necessary to alter all of the adjustments.

An adjustment is necessary if a CRT, a yoke, a focus magnet or the convergence module was replaced. Usually it is only necessary to adjust focus and convergence at the CRT (including the lens) where the work was done.

Table 1.

	H-COIL (BLUE & RED)			V-COIL(BROWN & YEL WIRE)		
YOKE	R [Ω]	L[mH]	D	R [Ω]	L [mH]	D
R	4.8	3.00	0.12	9.00	8.44	0.18
G	4.8	3.00	0.12	9.00	8.44	0.18
B	4.2	2.18	0.50	9.00	8.44	0.20

Table 1. Resistances, inductances and dissipation factors of the three yokes on the Mitsubishi projection set that had no picture and no sound.

To perform these adjustments properly, a crosshair, a crosshatch, and a monoscope test pattern should be available. In addition to these patterns, a color bar signal should be used for a general performance test. These test patterns can be played from video tape if a test pattern generator is not available.

Because most large-screen service is performed on-site, a tape with test patterns is preferable to a pattern generator because it is easier to carry. It is a good idea, however, to ask the customer if he owns a VCR before leaving for the site. The signal quality from a VCR is not comparable to a generator signal, but it is good enough for most service work.

The crosshair pattern is used to place each color in the physical center of the screen and to adjust the yoke if it is tilted. Some projection sets have a built-in crosshair generator. This generator should not be used to make the center adjustment because the test patterns it creates are usually not accurate enough.

For convergence adjustments, the crosshatch pattern is the best choice. To adjust the focus, the monoscope pattern works very well, especially for fine tuning in the corners of the screen. Moreover, there is a gray scale in the monoscope test pattern that makes it easy to adjust brightness and contrast for the tests.

A convergence problem

The owner of a Mitsubishi projection set, Model VS-648, complained about a blurry picture. Watching a black and white program, I discovered that there was no convergence. The fuse on the convergence focus PC board was blown. After I replaced the fuse, the convergence was fine for about 30 minutes. The fuse did not blow again, but the blue beam drifted far out of convergence. Touching the convergence focus PC board brought the convergence back to normal (sometimes).

Because the convergence responded to

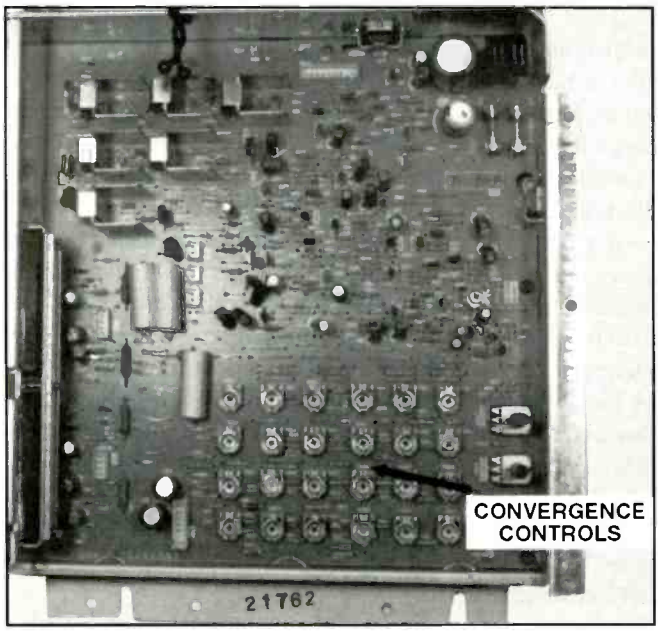


Figure 8. Convergence and focus module.

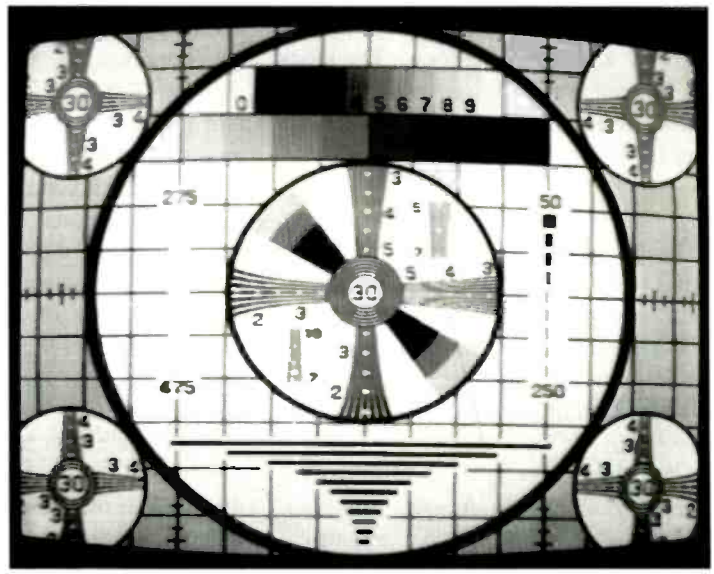


Figure 9. Monoscope test pattern.

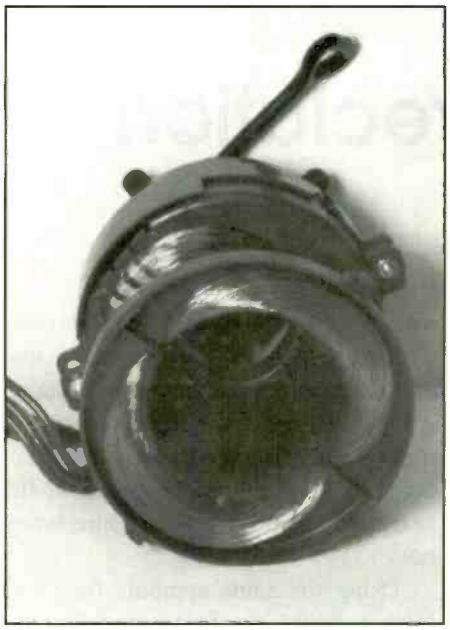


Figure 10. B-yoke of the projection TV.

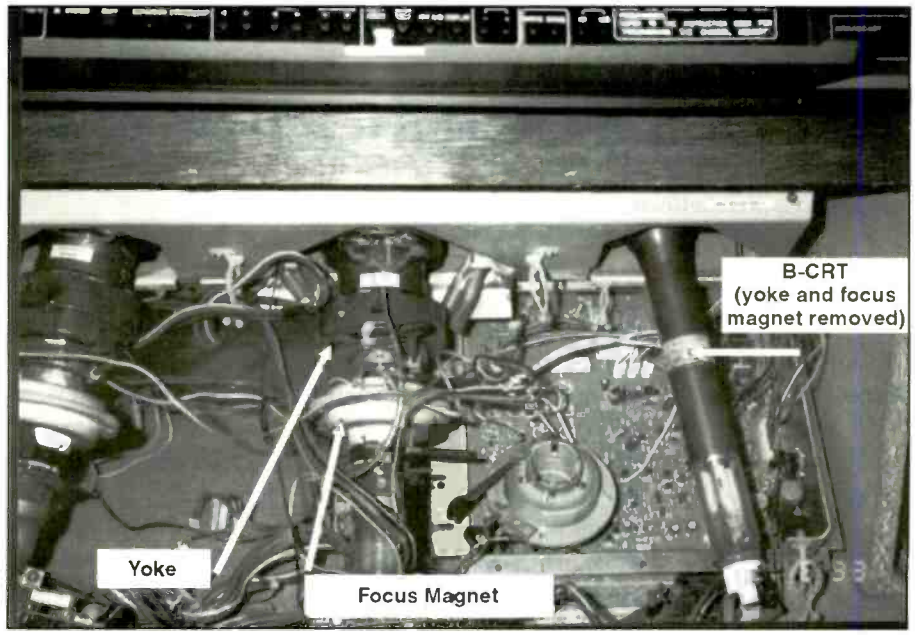


Figure 11. CRTs with yokes and focus magnets.

physical pressure, I thought the problem might be caused by a loose solder connection, so I resoldered the sensitive section on the board. The problem remained. Troubleshooting and solving this problem was beginning to take a good amount of my time with no success. Ultimately I had to give up trying to repair the convergence PC board. I called for the service manual as well as the price and availability on the board. The owner of the TV agreed to pay the relatively high price on the repair. After I replaced the convergence board (Figure 8), the TV worked fine.

Before I started the convergence adjustments on the new board, I demagnetized the metal parts around the CRTs and turned on the set for about 10 minutes to warm it up. The replacement board was preadjusted so I only had to perform minor touch-up adjustments.

No picture and sound

One dealer in our area must have sold a lot of Mitsubishi Rear Projection sets. I was called to service another Mitsubishi large screen TV, Model VS-648. The customer told me that the screen suddenly went blank and the sound stopped. First I looked at the fuses. The fuse on the main board was blown and, of course, the replacement fuse blew immediately after I installed it. My first guess was a trouble spot in the power supply or the HV-section. I checked the diodes and the switching transistor in the power supply and the horizontal output transistor, but the components were fine. The flyback transformer looked good as well.

My next step was to check the yokes with an LCR meter that gives a reading of the dissipation factor (D) of inductors. The dissipation factor is the reciprocal value of Q (quality). The quality decreases and the dissipation factor increases if there are shorted turns in a coil. The results of the measurements on the three yokes are shown in Table 1.

Since I checked all three yokes, I had reference values for the dissipation factor. The D values of the R and G yoke were the same, but the value of the B yoke was much higher (Figure 10). A common method of finding a bad yoke or flyback is the ringing test, but I find that using an LCR meter is much easier.

To replace the yoke, I had to remove the focus magnet. In this set the focus magnet is mounted flush to the yoke (Figure 11). That makes it easy to put it back at the right location. The TV worked after I replaced the B-yoke but I had to adjust center and convergence. Performing the center and convergence adjustment was not difficult because I was able to use the red and green beams as references.

These examples show that you can troubleshoot projection sets with procedures similar to those you use for direct-view color sets, keeping the differences of the design in mind. Perhaps this article will help you with your next large-screen TV set repair. ■

An appreciation of depreciation

By Dale C. Shackelford

As an electronic servicing technician, you know how important established formulas (such as Ohm's Law) can be when it comes to saving time and effort during the servicing of an electronic device. When tax time rolls around, there are a few other formulas that could save you hundreds of dollars annually when applied to shop equipment, tools and other assets.

One of the most basic tax deductions that a business can take is depreciation. Unlike a fine wine, equipment on your work bench, the tools in your box, or the building within which you labor many hours per day will not improve with age. Virtually every device you own has depreciated over the past year, and this depreciation rate can often be considered a deduction on your taxes.

Why would you pay taxes on a device which is valued at $5,000, when the actual worth is only $1,000? To see how much you could save this year, and in the years to come, let's take a look at how depreciation of assets works.

Calculating depreciation

Let's assume that you have purchased a piece of test equipment within the past month (we'll assume it was an oscilloscope). This scope, which you purchased brand new, cost $6,500, and has a life expectancy of five years. If you were to sell the scope after five years, you would receive $500 as the scrap value.

For practical purposes, we will abbreviate Cost as (C), Life as (L) and Scrap as (S). With these abbreviations in mind, we can now discuss the three most popular methods of depreciation as calculated by accountants across the country.

Straight line depreciation

The Straight Line method of depreciation is without a doubt the easiest, most common method of depreciating an asset. Unfortunately however, the amount of depreciation is by far the lowest of all methods, meaning more taxes at the end of the year (or quarter, depending upon how you file your taxes).

To calculate depreciation using the straight line method, we can use the formula (C-S)/L. As we have determined the Cost, Life and Scrap value of our scope (above), we can determine the first year depreciation of this unit as:

(C)$6,500 - (S)$500 = $6,000

$6,000/(L)5 = $1,200

Thus, the first year depreciation for this scope is $1,200. At the beginning of the second year, the actual worth of the scope will only be $5,300 (Cost - Depreciation). This is the amount upon which your taxes will be figured, not the new cost of $6,500, as the depreciation will be considered deductible.

With the straight line method, you can simply depreciate the scope at the same rate ($1,200) every year of its life (5 years). This means that the amount of depreciation can never mathematically fall below the scrap value.

As an example, we have determined that the first year's depreciation for the scope is $1,200, and that the adjusted value for the beginning of the second year is $5,300. When depreciating the scope for the second year, we simply subtract $1,200 from the adjusted value (second year cost) to determine the value for the third year ($4,100). After 5 years of depreciation at the $1,200 rate, the scope will only be worth $500, the original scrap value of the unit.

While the straight line method is by far the easiest method for depreciating equipment, it is also the method that allows the least amount of annual depreciation.

Declining balance depreciation

The Declining Balance method of depreciation, while more complex than the straight line method, can often save quite a bit more money for the service center owner/taxpayer than any other method. Another benefit of the declining balance method is that the scrap value of the unit being depreciated can change over the years without affecting past depreciation rates.

Using the same symbols for Cost, Scrap and Life, we can use the following formula to determine the depreciation of our scope using the declining balance method: 2/L x C. Note that this particular formula does not factor in the scrap value. This allows the scrap value to change over the years due to market, technological or other factors which may be beyond the owner's control.

It should be mentioned once again that the Cost must be adjusted after each calculation of depreciation, and that in the case of declining balance, as the name implies, the amount of depreciation will be less every year. Thus, if your calculations indicate that the depreciation for the first year is less than for a subsequent year, you have made an error.

With our hypothetical scope, we can determine the first year's depreciation by calculating as follows:

2/5 (L) = 0.4

0.4 x $6,500 (C) = $2,600

$6,500 - $2,600 = $3,900

Thus the depreciation for the first year, using the declining balance method is $2,600, giving an adjusted value for the second year of $3,900. For the second year, we figure (C) = $3,900, and apply the same formula for depreciation.

Note that the rate (2/L = 0.4) will remain constant as long as the life expectancy of the device never changes. Therefore, the declining balance depreciation for the second year will be $1,560 ($3,900 x 0.4 = $1,560). We can now determine the (C) for the beginning of the third year as: Cost - Depreciation = C for third year.

As mentioned previously, the depreci-

Shakelford is an independent electronic servicing technician

ation for the second year will always be less than the depreciation in the first year when using the declining balance method, quite different than when using the straight line method where the rate stays the same throughout the life of the device. This is extremely useful when you purchase a device, and plan to sell it before the end of its useful life.

Avoid pitfalls

One of the dangers of using the declining balance method is that it is mathematically possible, though improper, to devalue a device through depreciation to the point where it is worth less than its scrap value. For example, if we were to have a device with a scrap value of $500, and the adjusted cost for the beginning of the year was $850, we could not depreciate the device more than $350, even if the formula indicated that we would normally do so, as this would give us an adjusted value lower than the scrap value. This rule applies not only to the declining balance method of depreciation, but to other methods of depreciation where it is mathematically possible to depreciate below scrap value, such as in the Sum of the Years Digits method.

Sum of the years digits

In the Sum of the Years Digits (SYD) method of depreciation, the scrap value of a device is factored into the formula. This means that any change in the scrap value of the device will have some impact upon past/future depreciation rate. The SYD method, while not as simple to calculate as the straight line method, will allow for more depreciation early in the life of the unit, similar to that provided by the declining balance method.

Unlike the declining balance or straight line methods, however, the SYD allows one to determine the depreciation for any single year in the life of the unit, with a single calculation, without beginning at the first year, and working down. This is especially useful in determining the depreciation rate of a device with a relatively long life expectancy.

YEARS	DIGITS
1	6
2	5
3	4
4	3
5	2
6	1
21	

Figure 1. In the sum of the years digits method of calculating depreciation, you can lay the years and digits out in columns like this and use the digit for the year in question in the depreciation formula.

To use the SYD method, we must first understand what Sum of the Years Digits means in this context. Let's go back to our scope. We know that it has a life (L) of 5 years. If we add all of the digits of the years which make up the life (1, 2, 3, 4, 5), we have a sum of 15. This is the Sum of the Years Digits.

If we were discussing a device with a relatively long life, say 50 years, it would be impractical to spend an afternoon add-

YEARS	DIGITS
1	5
2	4
3	3
4	2
5	1
15	

(C) $6,500 - (S) $500 = $6,000
DIGIT (5) / SYD (15) = 0.33333
$6,000 X 0.33333 = $2,000
(DEPRECIATION)

Figure 2. Using the method of Figure 1 to the calculate the first year depreciation on the oscilloscope mentioned in the text, the calculation is performed like this.

ing up all of the digits (1 through 50). As an alternative, we can use a simple formula to determine the SYD, as SYD = N x (N+1)/2 where N equals the life (in this case, 50). Thus, 50 + 1 = 52; 52 + 2 = 25.5; and 50 x 25.5 = 1,275 (SYD).

Next, we must determine the Digit which will become a part of our formula for calculating depreciation. The Digit in this instance is nothing more than the number which is opposite the number of the year you wish to calculate. Suppose for example, that you plan to purchase a two year old device that has an overall life expectancy of 6 years. Obviously, you will need to know the depreciation for the third year in order to determine a fair price. You might set your years and digits out in columns as shown in Figure 1.

As we now know the sum of the years (21), and the proper digit (4) for the third year, we can use the following formula:

(C - S) x Digit / SYD = Depreciation.

The same method, when applied to our hypothetical scope, would be figured as shown in Figure 2. Obviously, as in each of the previously discussed methods, the cost will be adjusted after the depreciation from the previous year has been subtracted, though the SYD method allows the depreciation rate of any year to be determined, without regard to adjusted cost for previous years.

While there are other methods of depreciation (Unit of Production, etc.), the three we have discussed are probably of the most use to the average electronics repair shop or independent repairman. There are also many ways in which one can determine the official life expectancy of a particular device, the most reliable being a call to the manufacturer.

Check with an authority

This article has presented the basics of calculating depreciation as may be used for tax purposes. It is not intended to give you tax advice, as that advice should come directly from your accountant, your attorney or the Internal Revenue Service.

By determining the method(s) of depreciation that your accountant recommends for your particular situation however, you can calculate the depreciation of your own equipment and other assets yourself, saving your accountant hours of painstaking paperwork which, during the busy tax season, translates into higher billing rates for you or your company. Once you see how much you can save by doing the math for yourself, you may well develop an appreciation for depreciation.

Photofacts

CROSLEY
CC2760A101 3502
27E502-00AA 3502

EMERSON
TC0916 3505
TC1379 (Suffix A, B, C) 3508
TC1379TG (Suffix A, B, C) 3508

FISHER
G3M-45250 3497
G4L-46200 3497
PC-4525 3497
PC-4620 3497

GE
CTC148A 3507
CTC187BD 3500
20GT610F01 3507
20GT610N01 3507
27GT618FE1 3500
27GT618JX1 3500

HITACHI
CY32 3501
CY34 3501
M1CLXU 3501
31DX22B 3501
31KX41K 3501

MAGNAVOX
TS2760C207 3504
VR9062AT01 ..... VCR-265
VR9065AT01 ..... VCR-265
27E508 3504

PHILIPS
VR6065AT01 ..... sim to VCR-265

RCA
CTC177BH2 3499
CTC187CL 3496
F27251WNFE1 3499
F27632SEFE1 3499
F27632SEJX1 3499
F31672ETFM1 3496
F35672MBFM1 3496
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G31681ATLX1 3496
G35772ATLM1 3496

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CKA50HM 3509
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CT-5072XVC 3509
CT-5315XVC 3509
TTB2012 3509
TTC1940 3509
TXB1920 3509
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Service literature on CD-ROM

By Maggie Cummings

Service manuals and other types of paper documentation contain the vital information that a service center needs in order to properly restore its customers' products to proper operation.

Unfortunately, there are many problems with paper documentation: they take up a great deal of space, wrinkle and get dirty, and are easily misplaced. Finding the right page in a paper manual can be time consuming. Moreover, the manner in which the information is presented is limited to ink on paper.

Putting manuals on CD-ROM

Even though the technology is in its infancy, CD-ROM has already begun to revolutionize publishing. Entire encyclopedias have been put on a single CD-ROM, for example. But in addition to the words and pictures that are found in a printed encyclopedia, CD-ROM- based reference works often include full-motion video and sound to enhance the value of the information.

CD-ROM interactive technology is already well established in some areas of the service industry and will likely revolutionize the way consumer electronics service centers operate. If multimedia interactive manuals do replace even some paper manuals, the speed and accuracy of service technicians could increase greatly. Interactive training on CD-ROM could also lessen the need for live field training seminars, saving manufacturers and servicers both time and money.

Cummings is a freelance writer

Advantages of CD-ROM

A brief demonstration of CD-ROM technology applied to consumer electronics service literature will convince most technicians that this technology belongs on the bench. For starters, CD-ROM manuals allow for instantaneous access to information (including part numbers, replacements, and specs).

Moreover, while improving speed of access, CD-ROM also vastly enhances the amount and type of information that can be included. Not only can the servicing process be accomplished in less time, it can be done more accurately because the CD can hold multimedia information that paper manuals can't: troubleshooting methods, shortcuts, how to avoid common pitfalls, or just about anything else a manufacturer deems useful. The repair process itself can become a kind of field training for the technician.

Another advantage of CD-ROM is that the multimedia formats that provide video can be as useful as any in-person demonstration. This feature of CD-ROM disks involves full-motion video with narration and high speed graphics. The video can be stopped and started at will, and in addition, provides interactive access at indexed points. With such a system, abstract diagrams of component locations will no longer cloud the technician's mind. Video (and high resolution electronic still photography) show exact parts locations, alignment methods, etc.

Being truly interactive means that procedures and parts can be highlighted or enlarged in diagrams, photographs, and video, and interlinked so a technician need only click and he has navigated from a symbol of a transistor on the schematic, to the image of a physical transistor on the PC board.

TekDisc

TekDisc is one CD-ROM-based system of consumer electronics service manuals being developed by Vicom Multimedia Inc., a video production company based in Canada, which recently expanded into the field of interactive workplace products. Alan Wilensky, General Man-

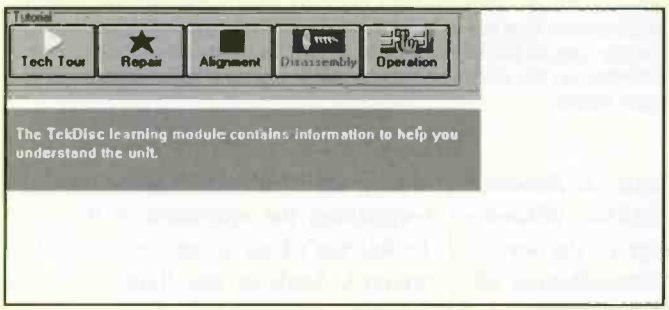


Figure 1. The learning Module includes the Operation Guide (explaining the operation of the unit), Technician's Tour (a concise theory of operation), Analysis and Repair (troubleshooting, symptoms, and methods), Alignments, and Disassembly.

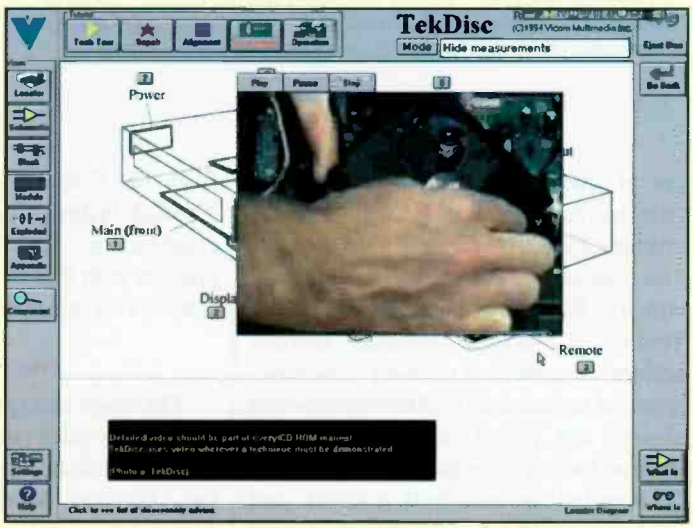


Figure 2. Disassembly, part of the Learning Module, shows the technician how to gain access to the inner workings of the product in order to perform service.

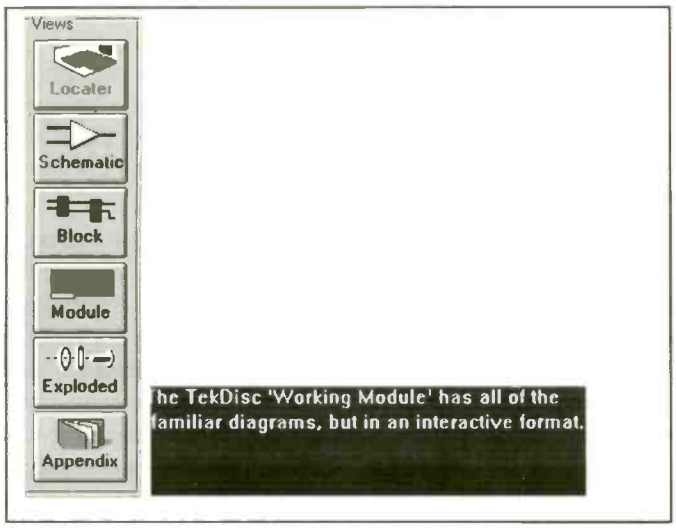


Figure 3. The Working Module consists of a series of views, following the organization of most traditional manuals.

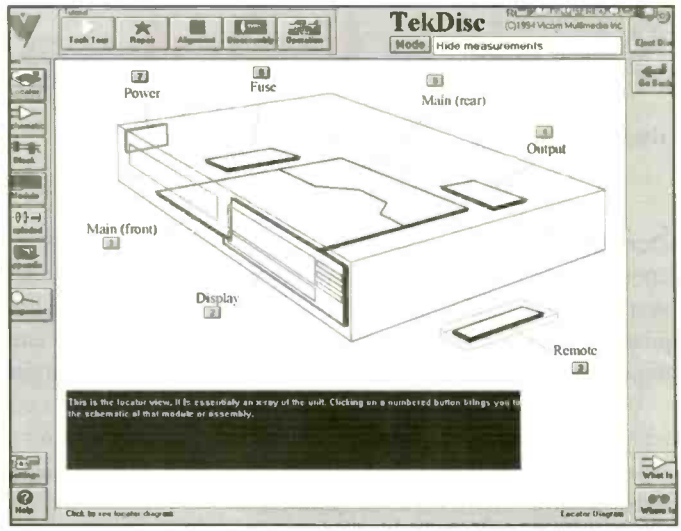


Figure 4. The Locator View is an x-ray view, with clickable buttons to bring you to the schematic.

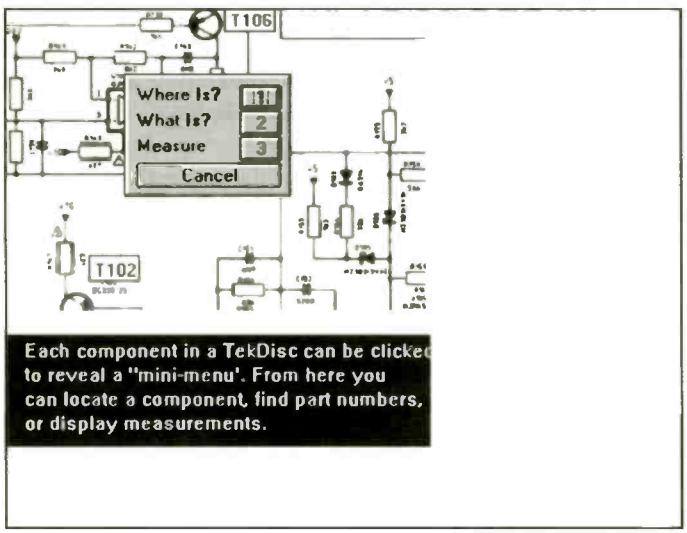


Figure 5. Clicking on a component on the schematic brings up a sub-menu that says, "Where is?, What is?, Measure?, Clicking on "Where is?," allows the technician to bring up a high resolution photograph of the location of the component on the PC board.

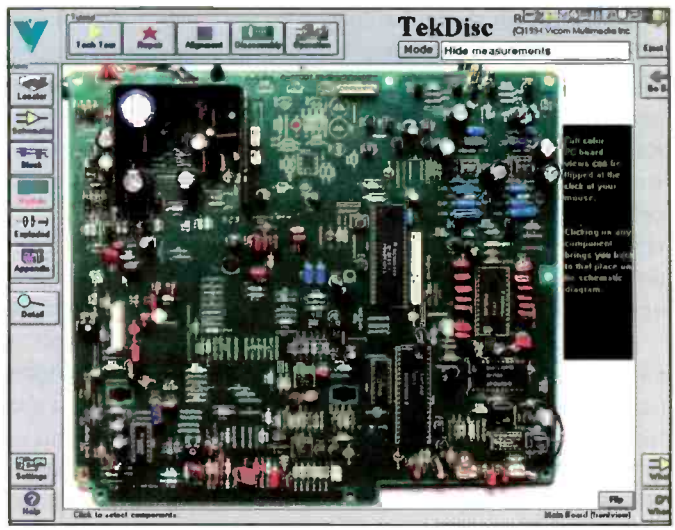


Figure 6. When the technician wants to test the unit and see if it's working, he can click on the Operation icon in the learning module, which shows how the technician can enter the diagnostic search mode. Joe can pause the video, and go try it. If he notices that there is some anomaly on the circuit board, he can bring up a full color view of the main board.

ger in charge of interactive workplace aids, as recently as 1993 worked in the consumer electronics service field as service manager and technical training instructor. Wilensky, the originator of the TekDisc CD-ROM technical manual architecture, teamed up with Vicom because of the natural fit of talents between himself and Vicom, an established production facility. This product was recently awarded an industrial research and applications (IRAAP) development grant from the Canadian National Research Council. In designing TekDisc, Wilensky combined his knowledge of the service process with that of a consortium of fellow service industry professionals.

Two menus

The discs incorporate a user-friendly system, divided into two multimedia menus called the "Learning Module" and the "Working Module". The Learning Module (Figure 1) is arranged as the following set of subjects: Operation Guide (explaining the operation of the unit), Technician's Tour (a concise theory of operation), Analysis and Repair (troubleshooting, symptoms, and methods), Alignments, and Disassembly (Figure 2).

The Working Module (Figure 3) consists of a series of views, following the organization of most traditional manuals, in the following categories: Locator View (Figure 4; an x-ray view, with clickable buttons to bring you to the schematic),

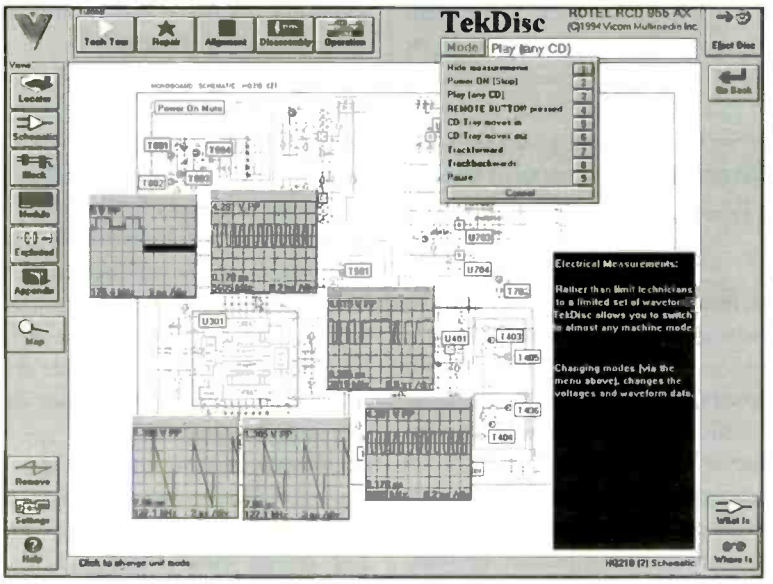


Figure 7. The Measurements featured provide electrical specifications captured in far more modes than could be presented in a paper manual.

Block Diagrams (a macro view of the schematic diagram), Schematic Diagrams, Modules, Exploded Views (mechanical parts exploded out), Technical Contact Information, and the Appendix (the paper manual as originally scanned). All views are scaleable and draggable on screen, just like a piece of paper. A "Smart Linking" feature links entities shown on a diagram to other important information (stored in different menus), which may be easily accessed by clicking on diagram entities (like transistors or IC's) or icons shown in the diagrams.

CD-ROM-based manuals in use

Here's how a technician, call him Joe, might use a CD-ROM-based technical manual. Joe pulls a ticket on a CD audio player that exhibits several problems: it skips tracks, and it sometimes doesn't load discs. Joe loads the CD-ROM disc for that product into his computer, and is greeted by a locator view, which shows him a graphical layout of the inside of the unit. He sees where the main circuit board is, and clicks on the icon for the main front PC board, getting a schematic diagram, zoomed to full screen view. He then clicks on the laser circuit. He goes to the zoom control, punching the number two zoom, which is the circuit level zoom. As the diagram is enlarged, it also brings the point of interest closer to the center of the screen, and now he can look at the circuitry surrounding it.

On the top of the screen in the learning module, Joe has access to the Technicians Tour menu, but since he sees a Smart Link icon, right on top of U101, he clicks on it, which brings up a multimedia presentation of how that circuit works. Thinking that the laser might be

part of the problem, he wants to touch up the laser current. He goes to the alignment icon in the Learning Module Menu, and sees a video on how to align the circuit. Previously he might have had to go to a seminar for this kind of information.

Locating a circuit

Hmm, alignment didn't help with the loading problem! Now the question is, how to get to the tray loading circuit? Joe looks at the locator view again, and bangs through a few digital schematics and block diagrams till he finds the right driver IC for the tray. A click on the IC pops up a sub-menu that says, "Where is?, What is?, Measure? (Figure 5). So, clicking on "Where is?," Joe brings up a high resolution photograph of the IC's location on the PC board. He can even flip the image of the board around.

When he wants to test the unit and see if it's working, he can click on the Operation icon in the learning module, which shows how the technician can enter the diagnostic search mode. Joe can pause the video, and go try it. If he notices that there is some anomaly on the circuit board, he can bring up a full color view of the main board(Figure 6). He can click on a piece of the board and get the schematic, too. If it wasn't just an adjustment he wanted to do, but more in depth troubleshooting, the CD-ROM can supply the required knowledge on the spot.

Other features

Other features of note include the Go Back Feature (which retraces the last several steps visited), Measurements (Figure 7; captured in far more modes than a paper manual could), and Print (which can print out whatever is on screen).

Manufacturers work with Vicom to create TekDiscs for their particular products, and have several distribution options. Wilensky, who is working very closely with the manufacturers, says, "Partnership is the key; some manufacturer's service departments do not have large budgets, so we arrange co-distribution in a way that makes it easy for them to get the full advantage of CD-ROM for their authorized network, while we can make our profit later on the non-warranty service centers."

Advantages for manufacturers, in addition to reduced field training, include reduced technical support requirements, better quality final repairs, fewer units returned to the manufacturer, and avoidance of common errors during service.

Wilensky reports that so far, the response has been very favorable. Contracts are under consideration with a number of manufacturers. The product should be surfacing on the market soon. Sony disks will be ready at the NPEC show in Arlington, VA. That will be it's worldwide debut accompanied by a press conference and manufacturers' reception.

What's next for CD-ROM service manuals? Maybe new kinds of data such as failure statistics, failure probability, and failure cases. Integration of test equipment with the computer and the CD-ROM manual is another possibility, in addition to connecting the manual to online services such as parts distributors. And within not too many years, the entire technical manual will likely be available via high speed-dial up lines.

Further information and demonstrations of TekDisk are available by calling (800)548-7411. ■

IBM and compatible basic cleaning and maintenance

By James A. Williams

A properly conducted preventive maintenance program is one of the most important things you can offer your customers to help them obtain years of trouble free service from their IBM and compatible computer systems. Data loss and component failures are two of the problems that preventive maintenance helps prevent. A regularly maintained computer system will also have a higher resale value because it will look and perform better.

Maintenance frequency

The frequency of basic maintenance depends on the environment in which the computer system is used. A computer system used in a smoke and chemical free environment will need to be serviced less often than a system used in a more industrial environment such as an auto repair or maintenance shop.

For the normal office environment, a once a year maintenance program is about right. In a more industrial environment or a system routinely exposed to dust, smoke or chemical fumes, every four months or less should be the service timetable.

Contamination comes in with cooling air

Components in a computer can generate enormous amounts of heat that must be removed by the computer's cooling system(s) or these components can fail. All IBM and compatible type systems, use a form of forced air cooling. A fan in the power supply draws outside air into the system through openings in the computer case and expels it through the power supply, where it passes over the computer systems components, cooling them.

On some systems you will also find a secondary fan at the front of the case, near the ventilation holes. A small fan is sometimes mounted on a heat sink attached to the computer's CPU chip, such is the case for the 486DX and Pentium, to provide additional cooling to this critical component. When air is drawn into the computer for cooling, it also carries with it outside contaminants, such as smoke, dust, hair and other types of solid and chemical contaminants.

Floppy disk drives are a major contributor to this problem area. They act as a large hole within the system, drawing in large amounts of air, along with dust and other contaminant. This allows for a quick build-up on internal system components. This kind of contamination can also lead to floppy drive failure and cause damage to floppy disks that are put into dirty drives.

These contaminants, which act as a thermal insulation, prevent proper cooling, and should be cleaned off during routine cleaning/maintenance.

Problems caused by thermal expansion

In the high-temperature environment within personal computers, thermal expansion can cause IC chips to become unseated. This is known as "chip creep." Thermal expansion is also a natural occurrence in all electronic devices, because

Williams is a computer engineer

of the heating/cooling down processes that occur when the computer is used and then turned off.

Another problem that can affect personal computers is dust and chemical contaminants, that may contain conductive elements. When this type of contamination gets inside a computer, the result may be a high-resistance short circuit, resulting in costly damage to the system.

Tools and chemicals

To properly clean and maintain an IBM or compatible computer system you will need a selection of tools and chemicals :

- a small and a medium Phillips head screwdriver
- a small and a medium flat screwdriver
- 3/16 and 1/4 inch nut drivers
- T10 and T15 Torx drivers
- an anti-static strap
- a vacuum cleaner
- canned air
- contact cleaning solution
- 5.25 and 3.5 dry or wet floppy cleaning disks

Cleaning procedure

When you're preparing to perform routine maintenance and cleaning of a personal computer, start by grounding yourself with the anti-static strap. Open the computer case. Write down and diagram any special cabling and/or wiring you find. Remove all expansion cards, SIMM memory modules, cables, floppy drive(s) and hard drive(s), and CD-ROM drive and tape back-up if there is one. I generally remove the motherboard and the power supply from the system case, as well. This allows me to gain access to all parts of the computer system.

Using the canned air, blow the loose accumulated dust, dirt, cobwebs and anything else you may find, off the motherboard and all expansion cards. Clean inside of the empty case with a vacuum cleaner and brush. Clean the power supply fan by blowing canned air into the power supply opening opposite the fan.

Using the brush, gently brush and loosen any remaining dust and dirt on the expansion cards, motherboard and the power supply fan and grill. Remove the loosened dust and dirt with a blast of canned air.

Next, clean all electrical contacts and connectors, using the contact cleaning solution. Clean all expansion card and SIMM memory edge connectors. Clean the motherboard expansion sockets and SIMM memory sockets. You will also want to clean the ribbon, power supply and other connectors.

Also, clean all small connectors for the various switches and buttons (on/off switch, turbo LED/switch, HD LED, etc.). Follow manufacturers' directions for use of the contact cleaning solution.

Don't be afraid to use large amounts of cleaner, really soak the connectors. Do not use a pencil eraser on the card edge contacts, as it could cause damage. Clean the ribbon and power connections on the floppy drive(s) and hard drive(s), as well as the CD-ROM and/or tape back-up if there is one in the system. Make sure all socketed chips are seated firmly in place.

As mentioned earlier, one of the effects of overheating and the day- to-day cycle of heating and cooling of the system is thermal expansion, which causes an effect called "chip creep." Chip creep causes the socketed chips to loosen and work their way out of their sockets.

All socketed chips should be checked and reseated. Perform the following procedure carefully. With the motherboard removed from the system, place your supporting hand behind the socketed chip. Using your thumb press down hard on the chip (press hard, but this is not the place to prove how strong you are). You will hear a crunching noise as the chip reseats.

Do this with all socketed chips on the motherboard, and then do the same with the expansion cards. Make sure you place your hand behind the chip you are reseating for support or you could crack the circuit board and damage it beyond repair.

Cleaning the keyboard

It is not necessary to disassemble the keyboard in order to clean it. First use a vacuum cleaner to vacuum the keyboard. This will remove most of the accumulated dirt and dust. Then, turn the keyboard upside down and blast it with canned air. Vacuum the keyboard again to remove any loosened dirt and dust. Then, clean the connector(s) with contact cleaner.

Before you reassemble the system, visually check each circuit board for any burned components, lifting foil or any other type of damage. Replace or repair parts as necessary. Also, inspect all cables and wiring. Then, replace any wire or cable that shows worn spots, cracks or cuts. If everything looks good reassemble the system, making sure all connections are made correctly.

Check your work

If you did everything right, when you boot the system everything will work fine. Now, clean the floppy drives by using the wet or dry cleaning disks according to manufacturers' directions. Finally, you're finished.

Cleaning IBM and compatible computer systems, should only take about an hour. This type of maintenance will protect and enhance the investment your customer has put into their computer system, while also enhancing your business. ■

What Do You Know About Electronics?

Color codes and Thevenin's theorem

By Sam Wilson WA8RMS

Here's something I ran across while looking up something else. It happened while I was sitting in my favorite easy chair in front of a picture of a fireplace (we don't need the real thing in Florida). I was looking up some material and I ran across the word "paradigm" three times in the space of a few pages.

I guess I must have known what it meant at one time, but I had to look it up again: paradigm: a model that is generally accepted and used as the basis for discussing or solving a scientific or technical problem. For example, an expanding universe is a model (paradigm) used by astronomers in formulating a theory. Well, now we all know (again).

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

I.Q. and vocabulary

And that reminds me—did you know you can raise your I.Q. score as much as 10 points by increasing your vocabulary? That is one reason why people who know a lot about such things say that the I.Q. test is slanted against children who are raised in certain communities.

If the parents are not academically inclined the child is not exposed to much vocabulary at home during the formative years. Since vocabulary is such an important part of the I.Q. scores it is apparent-

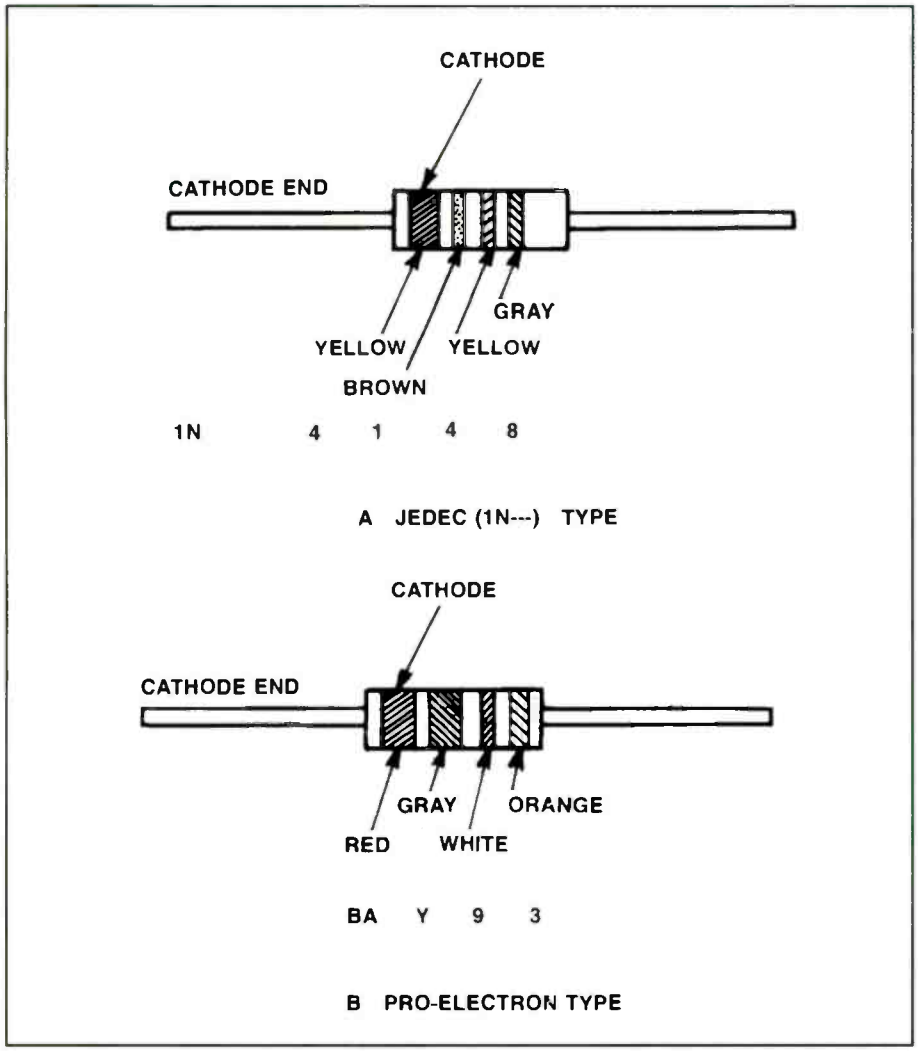


Figure 1. Some diodes are color coded, similar to the color codes on resistors. Here are two diode color codes you may run across. See tables at right for a description.

Table 1

Color	Number
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Color code for diodes with JEDEC (1N) type numbers The JEDEC type number consists of "1N" followed by a sequence of four digits. These four digits are indicated by four color bands. The first digit is indicated by a broad band, which also indicates the cathode end.
The color code is shown above.

Table 2

Broad Bands		Small Bands
First Band	Second Band	Serial Number
AA - brown	Z - white	0 - black
BA - red	Y - gray	1 - brown
	X - black	2 - red
	W - blue	3 - orange
	V - green	4 - yellow
	T - yellow	5 - green
	S - orange	6 - blue
		7 - violet
		8 - gray
		9 - white

Color code for diodes with Pro Electron type numbers.
The Pro Electron type number consists of three letters and a sequence number of two digits. The letters are indicated by two broad bands which indicate the cathode. The digits are indicated by small bands.
The color code is shown above.

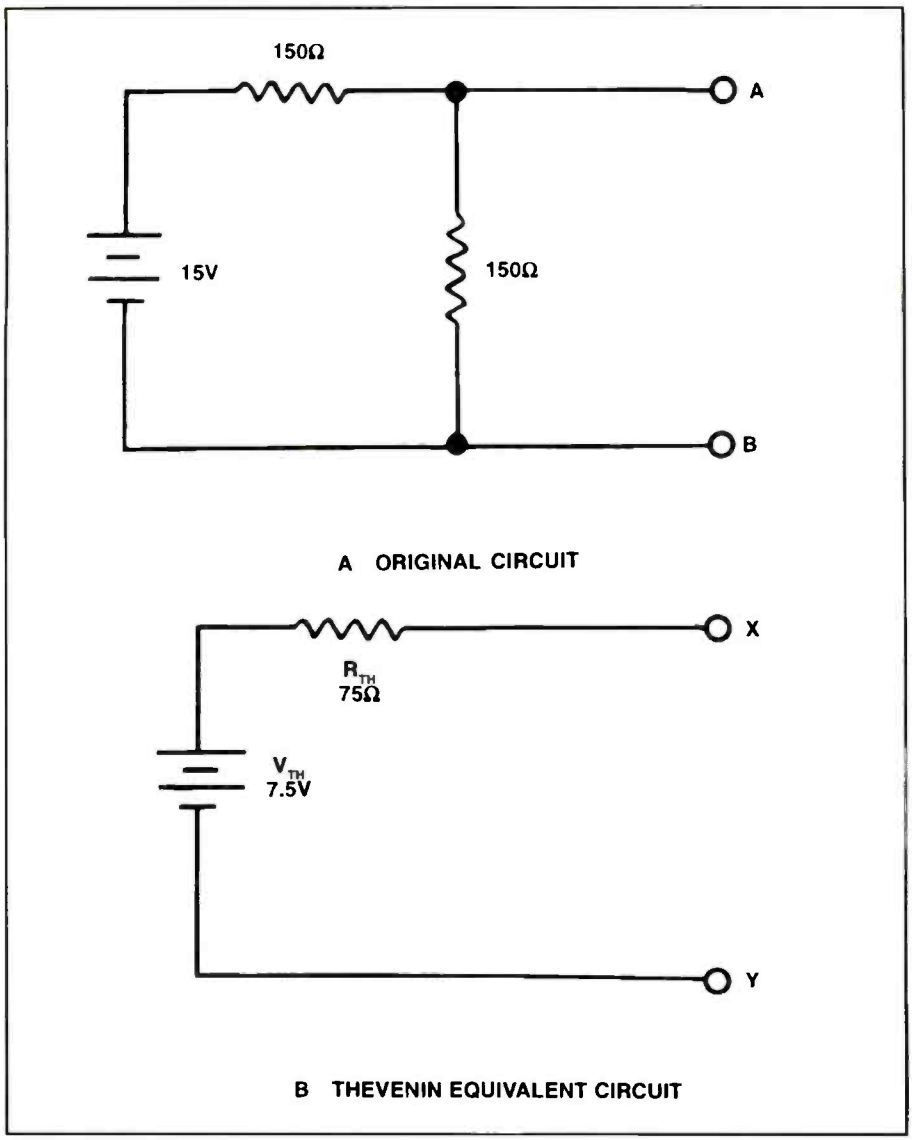


Figure 2. Thevenin's theorem for dc circuits states: any two-terminal network with one or more sources of dc voltage and linear, bilateral circuit elements (resistors again) can be emulated with one battery having no internal resistance, and one resistor. That theorem is illustrated here.

ly not possible for some children to compete in I.Q. scoring.

Those who try to defend the importance of vocabulary in I.Q. scoring say that you are better able to express ideas if you have an extensive vocabulary. (However, if you don't have the wide vocabulary it doesn't mean you can't have ideas.) I personally think they ought to throw the whole idea out.

I know what you're thinking: "Sam Wilson has a low I.Q." Well, when I was 22 years old I was tested by a psychology services company and earned a high I.Q. score. *That* is probably why I don't have much confidence in the test.

Diode color codes

Another thing I found while looking up something else was diode color codes. I know, from the mail I got requesting color codes, that there is much interest in that subject.

Figure 1 shows the color codes I found. Probably the most significant one is for the 1N _ _ _ _ type, but I could be wrong about that. I pawed through a box of diodes that I keep handy and none of them have color codes. They are new diodes, so, what do you do in a case like that?

One thing you can do is sort them according to physical size. The smallest are for low current and the largest for high current. Also, you can display the diode characteristic curve on your scope. Calibrate the horizontal sweep on your oscilloscope in volts and measure the breakover points.

How do you calibrate the horizontal sweep in volts? Use a staircase generator for the external horizontal sweep. If each step is adjusted to equal one volt you have a good calibration. Use logic circuitry to generate a blip at each step and feed it to the Z axis to get markers on the sweep.

Conversion factors for temperature

Most of the catalogs in my library express temperature values in degrees Celsius. At one time that temperature scale was called "centigrade," which meant "divided into 100 parts". That was too logical, however, so the temperature scale is now named after its inventor: Anders Celsius (a Swedish astronomer).

Here is how Celsius came up with the temperature scale: he called the freezing point of water 0 degrees and the boiling point of water 100 degrees, then he divided the scale between those numbers into 100 equal parts.

That makes sense, but how did Gabriel Fahrenheit come up with the numbers 32 and 212? Well, he arbitrarily called the freezing point 32 degrees (?). Nobody seems to know where he got that number. Then he divided the space between zero degrees and the boiling point into 180 equal parts and ended up with 212 degrees as the boiling point of water.

Anyway, that is what my book says. I'll never understand why he didn't call the freezing point 23.7 degrees and the boiling point 203.7 degrees. That's the way I would have done it. Maybe he was just having a bad day. To get an approximate conversion from degrees C to degrees F, double the temperature in degrees C and add 30 (close enough).

For example, to change 20C to F.

20C X 2 = 40.

Then 40 + 30 = 70F. To change degrees F to degrees C subtract 30 and divide by 2. For example, to change 90F to C.

90F - 30 = 60.

Then, 60/2 = 30C.

Actually, if you want to get an exact conversion from Celsius to Fahrenheit, instead of doubling the temperature and adding 30, multiply by 9/5 and add 32. Similarly, if you want to get an exact conversion from Fahrenheit to Celsius, subtract 32 and multiply by 5/9.

Get your checkbook ready

You wanted to teach your nephew the value of saving money. So, you gave him a penny bank for his tenth birthday. To start him off right you put a penny in the

bank and tell him you will double that deposit every day for the next 30 days. How much money will you need to put in for the last deposit?

Answer: take the bank away from the kid and give him a new Buick. Your last deposit will be over 10 million dollars. To be exact it will be: $10,737,418.24

Thevenin's theorem without heavy math

When you work problems in college related to Thevenin's theorem the usual approach is to solve very complicated circuits using a lot of math. The math is so heavy it would stagger a moose down to his knees. Those problems are designed to give the student extensive practice in mathematics, with a little bit of theory thrown in.

If you are a working person and you just want answers you can do the whole thing with a few choice measurements. A four-function calculator will help.

A review of definitions

It will be a good idea to start by reviewing some basic definitions.

• A *linear component* is one that complies with Ohm's law. If you double the voltage across a linear component the current through it will also double.

• A *two-terminal, bilateral component* conducts current equally well in either direction (we're talking about a resistor).

• An *active component* generates a voltage, and, an active circuit contains one or more sources of voltage.

• A *passive component* doesn't generate a voltage. A passive circuit does not contain any source of voltage.

Thevenin's theorem for dc circuits states: Any two-terminal network with one or more sources of dc voltage and linear, bilateral circuit elements can be emulated with one battery having no internal resistance, and one resistor.

The battery is called a Thevenin source (V_{TH}) and the resistor is called the Thev-

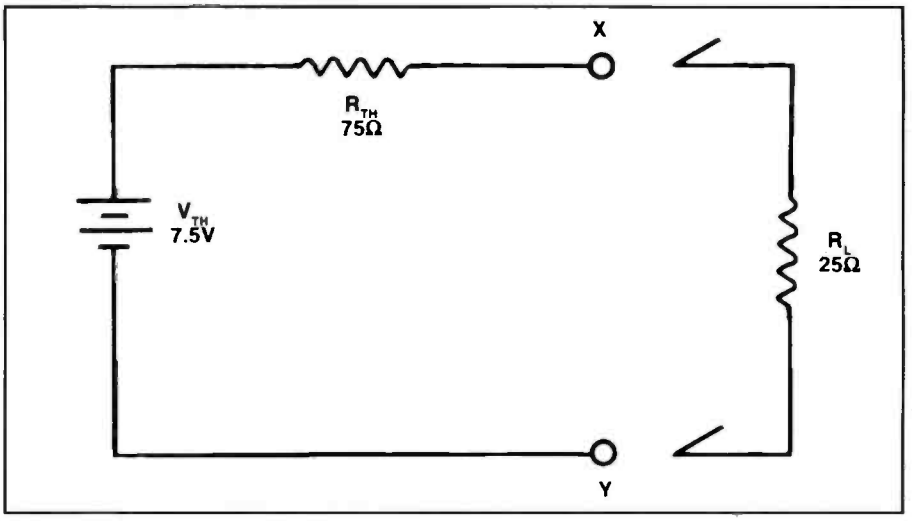


Figure 3. The Thevenin equivalent circuit can be determined by measuring the open circuit voltage and the closed circuit current, and then calculating the Thevenin resistance.

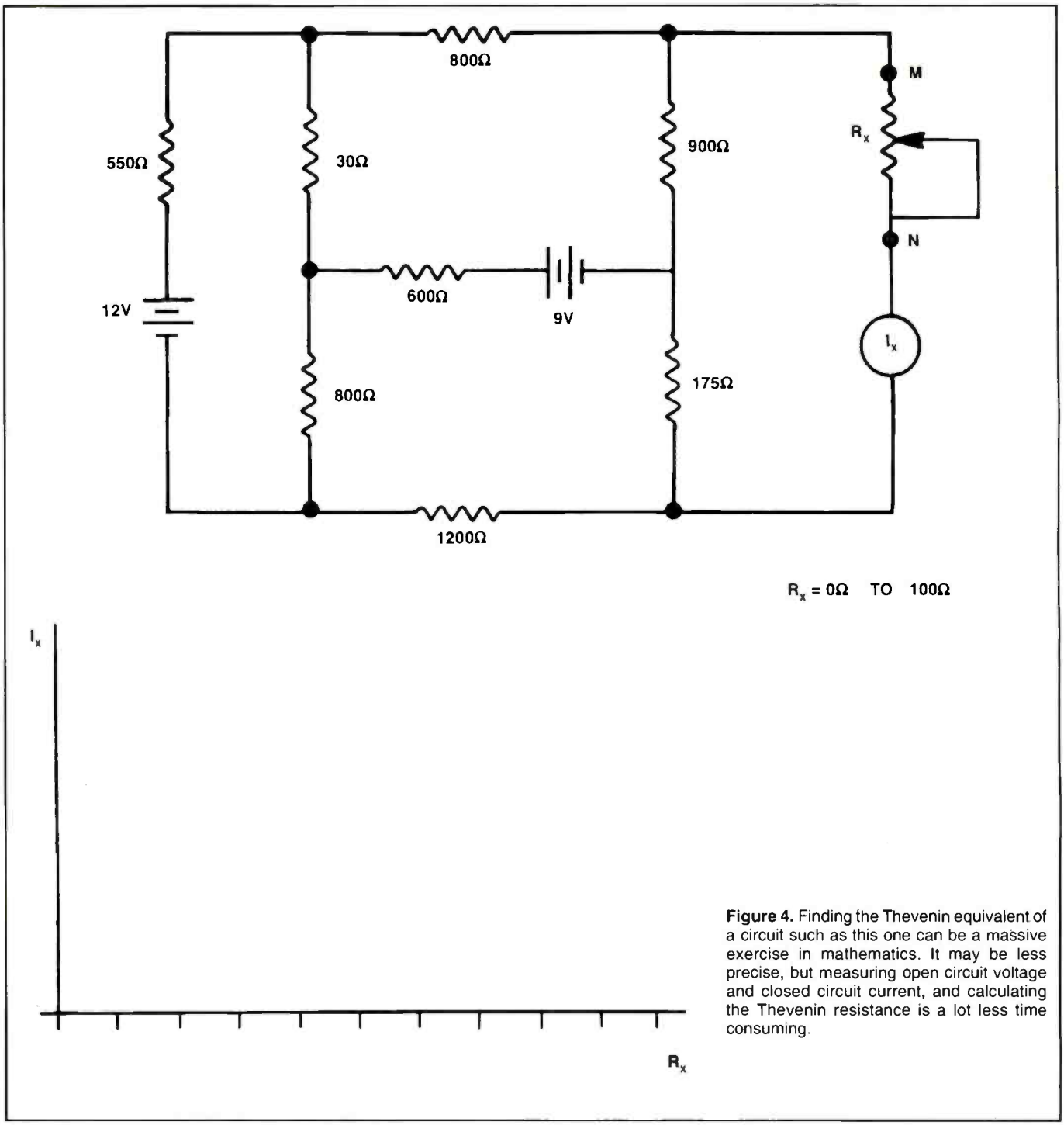


Figure 4. Finding the Thevenin equivalent of a circuit such as this one can be a massive exercise in mathematics. It may be less precise, but measuring open circuit voltage and closed circuit current, and calculating the Thevenin resistance is a lot less time consuming.

enin resistance (R_{TH}). Figure 2 shows the concept. We will use it as a simple example of how Thevenin's theorem works. In order for the Thevenin generator to emulate the more complicated circuit it must be true that identical resistors across both sets of terminals will draw identical amounts of current.

The Thevenin equivalent circuit

We will use the circuit of Figure 2(a) as the "complicated' circuit. You won't have to perform the actual measurements because the circuit is so simple you can easily determine the values that would be measured. We will proceed as if you couldn't do the calculations.

To convert the circuit of Figure 2(a) into the Thevenin equivalent circuit of Figure 2(b), the first step is to measure the open circuit voltage across terminals A and B with a high-impedance digital voltmeter having 10MΩ input impedance. What you are measuring is V_{TH}. In this circuit you will measure about 7.5V. That is obvious because you are looking across half the total circuit resistance.

The second step is to connect an ammeter or millimeter across terminals A and B. Obviously, you will start with the current set to the maximum dc meter scale and work down to the point at which your reading is between half-scale and full scale. The current you measure is I_N (more about that next time).

Use your calculator to determine the Thevenin resistance as follows:

$R_{TH} = V_{TH}/I_N$

You should measure 75mA for I_N and

your calculation for R_{TH} should give you 75Ω. The values for V_{TH} and R_{TH} are shown in Figure 3.

Checking the equivalence of the circuit

To prove that the circuits are equivalent we will connect 25Ω across terminals A an B and also across terminals X and Y. We should get the same current flow through the resistor in each case (by calculation you will find the current through the 25Ω resistor for each set of terminals to be 75mA.).

Phronsie Picknit raises his hand in my class to ask the following question: What's the big deal? I could solve that problem in my head. (There is always a Phronsie type in every class.) I always have a second problem ready.

For my answer I give Phronsie the schematic of the circuit shown in Figure 4. Then, I say "For your lab assignment today you are to remove R_X and calculate the Thevenin equivalent circuit for terminals M and N. To prove that your Thevenin circuit is equivalent to the original circuit, connect a variable 0Ω to 100Ω resistor across each circuit and calculate the current ten times for each circuit. Then plot graphs of your results"

"For the rest of the class I have made up the circuit of Figure 4 for each lab group. I enclosed the circuits in black boxes. Thevenize the circuit by making measurements. Then, connect a 0Ω to 100Ω variable resistor across the original circuit and across your Thevenin equivalent circuit. Draw graphs of your results in 10Ω steps".

In those days students were more interested in learning than they were in just getting grades. Phronsie could Thevenize the circuit in Figure 4 by using network analysis techniques he had already learned. However, it always took him longer than the students who used the measurement technique.

Phronsie could argue that his answer was correct to five decimal places and he would be right about that. If he had to construct the Thevenin circuit, however, he would be hard pressed to obtain the Thevenin components to ten decimal places.

My point is this: students should be taught to make decisions about the correct techniques for solving problems depending upon the accuracy and time allotted. However, they should also be taught how to use the different techniques.

Test Your Electronics Knowledge

By Sam Wilson WA8RMS

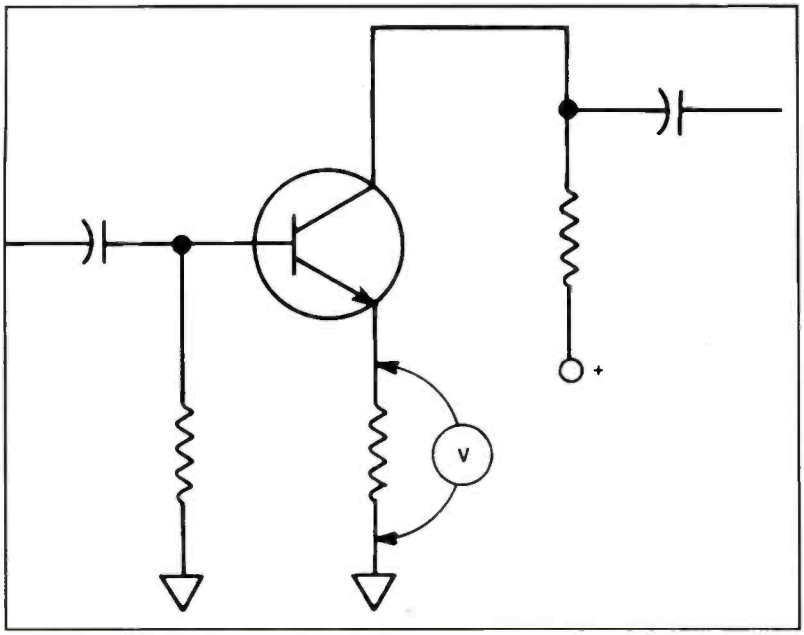
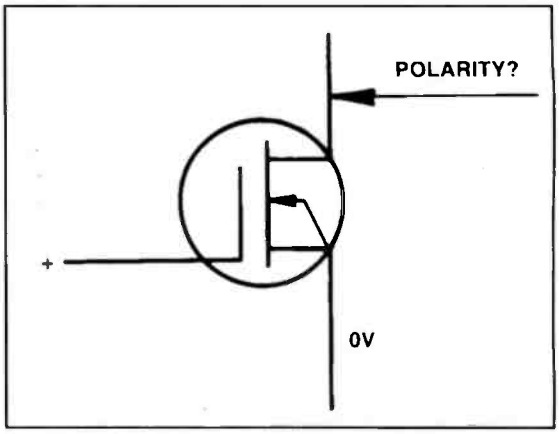


Figure 1. Voltage V is 0V, and there is no signal voltage. Is this normal, or is there a problem?

Figure 2. What is the polarity at the drain of this device?



1. There is no input signal to the transistor in Figure 1. A technician measures the voltage across the emitter resistor and finds it to be zero volts. The technician should conclude

A. that it is a normal reading.

B. that there is something wrong and further tests should be made.

2. The voltage polarity on the drain lead in Figure 2 should be

A. negative.

B. positive.

3. In order for the transistor in the circuit in Figure 3 to operate properly the battery should be connected with

A. its negative pole connected to the emitter, and, its positive pole connected to common.

B. its positive pole connected to the emitter, and, its negative pole connected to common.

4. Which of the following diodes has a characteristic curve similar to the one for neon lamps.

A. noise diode.

B. diac.

C. constant current diode.

D. tunnel diode.

5. Which of the following diodes does not belong in the same category as the others?

A. pin diode.

B. rectifier diode.

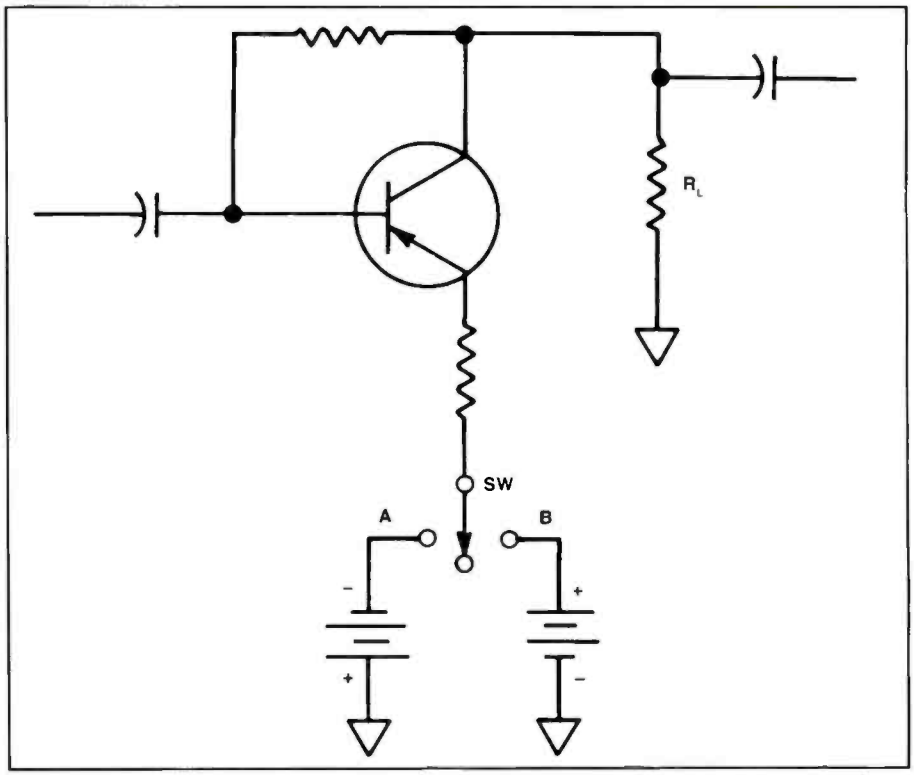


Figure 3. Should the switch be connected to A or B for proper operation of this circuit?

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

C. zener diode.
D. varactor diode.

6. In a bipolar transistor amplifier, the stability factor depends upon (among other things) the resistance of the resistor in the emitter circuit. It is desirable to have
A. a stability factor with a high number.
B. a stability factor with a low number.

7. Another name for a hot carrier diode is
A. shockley diode.
B. schottky diode.

8. Write the equation for the base current (I_B) in a bipolar transistor.

_____

9. Regarding the UJT, the symbol eta (η) is used to represent

_____.

10. Here is an IEEE dictionary definition: For certain transparent conducting films separated by semiconductor materials, electromagnetic radiation on one or more of the films can create a no-load potential difference. That is a definition of a _____.

(Answers on page 68)

ES&T Calendar

July 31–August 5, 1995
National Professional Electronics Conference
Arlington, VA
National Electronics Service Dealers Association
817-921-9062

CTIA Breakaway '95
Computing Technology Industry Association (Formerly ABCD)
August 27-29, 1995
New Orleans, LA
708-268-1818 Ext 310

10th Annual Networks Expo-Dallas
Networking and Interoperability
September 12-14, 1995
Blenheim Group
800-829-3976

NASM 40th Annual Meeting
National Association of Service Managers
September 16-19, 1995
Oak Brook Hills Hotel and Resort
Oak Brook, IL
708-310-9930

PC Expo Home
Technology for Small or Home Offices and Home Computing
September 28- October 1, 1995
Jacob Javits Convention Center
New York, NY
Blenheim Group
800-829-3976

10th Annual PC Expo-Chicago
October 3-5, 1995
McCormick Place East
Chicago, IL
800-829-3976

October 10-12, 1995
CES Mexico
Mexico City, Mexico
703-329-1380
Personal Computer and Electronics Expo

October 19-22
Nassau Veterans Memorial Coliseum
Uniondale, NY
Expo, Inc.
800-886-8000
516-889-6000

October 26–27, 1995
Systems Support Expo
Moscone Center
San Francisco, CA
10:00 am to 5:00 pm daily
Fax: 207-846-0657

Literature

Expanded PCMCIA products catalog

Envoy Data Corporation offers its latest edition of PCMCIA products catalog. PCMCIA (Personal Computer Memory Card International Association) is the new industry standard for 68 pin memory cards and I/O cards. New products include multi-media PC Cards like the Digital PC Card Camera, Video and Audio capture cards, and CD ROM cards. Other products are: RAM, FLASH, and Hard-rive memory cards; Fax/Modem, LAN, Serial, GPS, sound, IEEE 488.2 I/O cards; Reader/writer card drives for serial, parallel, ISA, or SCSI ports; Palmtop and Tablet computers that use the PCMCIA cards; PCMCIA card engineering accessories. Technical support and data sheets are also available.

Owners of the Apple MessagePad, Fujitsu Stylistic 500, HP Omnibook or 200-LX, Motorola or Casio PDAs, and other PCMCIA notebooks will find this a valuable source for PCMCIA accessories. Engineers and scientists working with this technology can use this catalog as their source for present and new PCMCIA products.

Circle (50) on Reply Card

Fiber optic catalog

Metrotek Industries has a new 33 page catalog that gives technical specifications as well as prices from major manufacturers of just about everything related to Fiber Optics.

The company maintains a complete inventory of fiber optic cable, cable assemblies, connectors, adapters, attenuators, splices, tools, tool kits, links, accessories, test equipment, supplies, active components, books, training videos, couplers/splitters, termination equipment, multiplexers, and more.

Circle (51) on Reply Card

Tools and test equipment catalog

Jensen Tools' Spring 1995 Catalog Supplement D presents 72 pages of service products for the support of telecom/broadband communications equipment and systems. New products include Chesilvale Electronics' DSTS2 Dual Standard Test Set, the Fluke 860 Series Graphical Multimeters with combination digital/ graphical display, and several new Jensen brand tool kits. Many other instruments from Fluke, Chesilvale, Tektronix, Wavetek, Harris Dracon, Microtest and other leading test manufacturers are also offered.

The catalog presents two new crimp tool kits containing ratchet-style crimp tool frame and dies (for Coax, or RG-53/59/62, PVC and plenum cable). It also features the JTK-44 Telecom Installer's kit-a handy complement of 14 quality tools and optional test accessories in a handsome Cordura Plus nylon case suitable for work in an office environment, plus the JTK-4400 Deluxe Telecom Kit.

Other major sections of the catalog offer wire/cable, connectors and connector kits, PC diagnostics, soldering equipment, benches and bench accessories, cleaning supplies, cases, shipping containers and more.

The diskette is packaged in an attractive four-color, 12-page brochure which discusses the four stages of product development—concept, design, prototype and production—and how 3M's design guide can maximize productivity and efficiency.

Circle (52) on Reply Card

CD-ROM

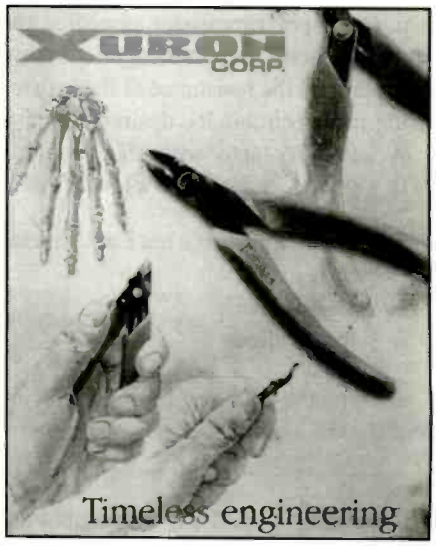
Kalamazoo Technical Furniture (a.k.a. Teclab), announces the availability of a multi-media CD-ROM product catalog. The CD-ROM presentation is a comprehensive look at the full line-up of the company's workbenches and furniture systems.

This interactive multi-media presentation, designed exclusively for Windows, features product specifications. Hundreds of benches and configurations are featured. Also included is information on ESD benches, a free planning and design module, and more. Meeting the Challenge, an introductory 13-minute video presentation is used throughout the catalog to completely illustrate the story and provide the viewer with a detail-by-detail review of the features built into these benches.

Circle (53) on Reply Card

Tool Catalog

A new catalog that includes a full line of specialty hand shears, flush cutters, wire cutters, pliers, crimpers and compact pneumatic cutters for industrial or electronic assembly and field service use is being offered by Xuron Corporation of Saco, Maine.



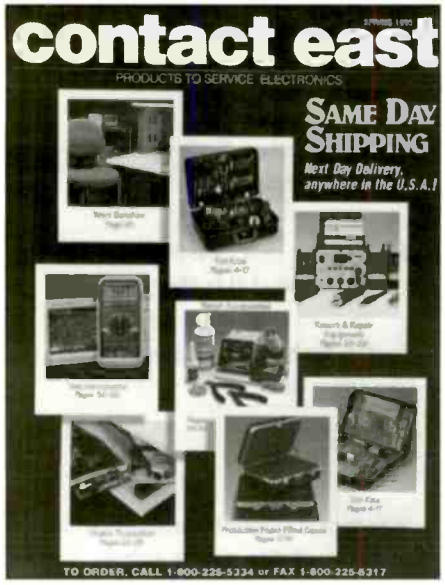
The "Timeless Engineering" catalog describes over 100 variations of ergonomically designed special purpose shears and flush cutters that feature their patented Micro-Shear bypass technology which provides a clean square cut using less force than conventional compression cutters. Pliers, crimpers, wire cutters, pneumatic flush cutters and other electronic assembly aids are included.

Featuring product descriptions, dimensional drawings and full-color photographs, the 24-page catalog has a section which explains the ergonomic enhancements designed into the tools such as cushioned rubber hand grips. Other products include solder resists, desoldering braid dispensers, tweezers and dispensing bottles.

Circle (54) on Reply Card

Catalog of test equipment, tools, & supplies

This 48-page supplement catalog comes packed with hundreds of new test instruments and tools for engineers, managers, technicians, and hobbyists. Featured are quality products from brand-name manufacturers for testing, repairing, and assembling electronic equipment. Product highlights include new DMMs and accessories, certification for Fluke multimeters, soldering tools, custom tool kits, EPROM programmers, power supplies, ELF meters, helpful reference books,

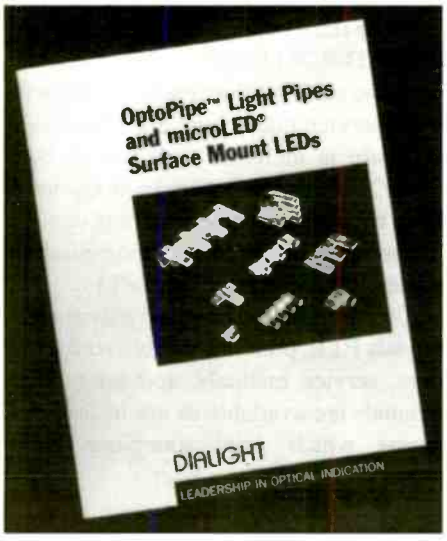


breadboards, heat guns, scope meters, datcom tools and testers, adhesives, measuring tools, precision hand tools, portable and bench top digital storage scopes. Also included are Contact East's popular lines of: communication test equipment, soldering/desoldering systems, static protection products, ozone safe cleaners, magnifiers, inspection equipment, workbenches, cases and more.

Circle (55) on Reply Card

Brochure on light pipes, packaged SMT LEDS

Dialight Corporation has issued a 16-page brochure on its new line of standard OptoPipe light pipes. The brochure covers mounting requirements and compatible LEDs for optimum light output. Also covered are the company's full line of surface mount LEDs, both single-and-bi-color, on tape and reel compatible with automatic placement equipment and various soldering processes.



Circle (56) on Reply Card

Digital storage oscilloscope brochure

LeCroy Corporation, announces the release of a new brochure featuring the 9300AZ Series of Digital Storage Oscilloscopes.

The brochure focuses on the product's primary features, optional PCMCIA portable hard drive and built-in floppy drive for mass storage solutions, built-in printer which produces high-resolution screen dumps in less than 10 seconds, new triggers that catch data bit dropouts, timing interval jitter, microprocessor crashes or network collisions, long record length, up to 8 Mbytes, to zoom in on details, the ability to calculate any of 32 measurements on any part of a waveform, and display the result as a bar chart characterizing circuit performance.

The brochure also includes a number of bright, clear color screen photographs which showcase the unique capabilities of the oscilloscopes.

Circle (57) on Reply Card

EIA Trade Directory and Membership List

The Electronic Industries Association (EIA) has released the newest edition of its annual Trade Directory and Membership List. The current listing of more than 1,000 member companies represents the full spectrum of the $340 billion U.S. electronics manufacturing industry. This publication lists EIA members' corporate and division locations, telephone numbers, executive level personnel, trade names, number of employees, as well as specific company products and services.

The directory and membership list includes a valuable section on company facilities by geographical location, a convenient "cross-reference" of companies by product category and now also includes company logos. The EIA Trade Directory also features a section on the Association's Board of Governors, group, divison and departmental officers, committees, councils, and panels with a description of their activities, as well as an EIA staff listing.

Circle (58) on Reply Card

Free assembly design guide diskette

Electronic design engineers can now streamline the cable assembly design process with a free design guide brochure and diskette from the 3M Electronic Products Division. The brochure, which includes a diskette-based customer specifications worksheet, eliminates the need for napkin sketches, incomplete specifications and numerous fax transmissions.

The Assembly Design Guide, which gathers and sorts critical design information in an organized format, saves customers time on the input stage of the project, shortens the production cycle and brings products to market faster. The completed worksheet portion of the program can be sent to the company electronically via modem or fax.

Circle (59) on Reply Card

Hardware training catalog update

Computer Maintenance Training Company, Inc. has updated its course catalog to reflect the latest changes to their curriculum. The catalog offers course descriptions, prerequisites, and course goals for more than 40 courses, covering the maintenance and repair of virtually all hardware products manufactured by Digital Equipment Corporation. The catalog is conveniently indexed into chapters corresponding to product lines including; PDP-11, MicroVAX/VAX, Alpha/AXP, Disk, Tape, Cluster/Network, and a new addition in this issue, Desktop Products.

Circle (60) on Reply Card

Books *(from page 19)*

tery system, and how to select the most suitable battery for a given application.

Detailed discussions are devoted to a wide range of important aspects, including electrochemical principles and reactions, battery standardization, battery design, and the selection and application of batteries.

McGraw-Hill, Inc., 11 West 19th Street, New York, NY 10011

***Simplified Design of Switching Power Supplies*, By John D. Lenk, Butterworth Heinemann, 248 pages, $39.95 Hardcover**

Simplified Design of Switching Power Supplies is an all-inclusive guide to switching power-supply design. The book concentrates on the use of IC regulators. All popular forms of switching supplies, including DC-DC converters, inverters, buck, boost, buck-boost, pulse frequency modulation, pulse width modulation, current-mode control and pulse skipping, are described in detail. The design examples may be put to immediate use or may be modified to meet a specific design goal. As an instructional text for those unfamiliar with switching supplies, or as a reference for those in need of a refresher, this book is essential for those involved in switching power-supply design.

Butterworth-Heinemann, 313 Washington Street, Newton, MA 02158-1626

***Start Your Own Computer Repair Business*, By Linda Rohrbough and Michael F. Hordeski, McGraw-Hill Inc., 304 pages, 50 illus., $32.95 Paperback**

Start Your Own Computer Repair Business is the first complete reference on setting up a home-based PC repair enterprise. The authors Linda Rohrbough and Michael Hordeski share invaluable insights and information on subjects such as, launching the business, what tools to buy and tricks for using them, how to maximize profits by choosing a specialty such as data recovery or network services, and boosting income by offering auxiliary services such as hardware and software upgrades and system tuning. There are also appendices listing helpful resources.

McGraw-Hill, Inc., Blue Ridge Summit, PA 17294-0850

Test Your Electronics Knowledge

Answers to test *(from page 64)*

1. (A) The transistor is operating with no forward bias so there is no conduction through the transistor or through the emitter resistor.

2. (A) It is a P-channel MOSFET and it requires a negative voltage on its drain with respect to its source voltage.

3. (B) It is a PNP transistor. It requires a negative collector voltage with respect to the emitter. If the emitter is positive with respect to common, and the collector is connected through RL to common, then it follows that the collector is negative with respect to the emitter.

4. (B) The diac and the neon lamp both have forward and reverse breakover voltages.

5. (B) All other diodes listed are operated with reverse bias.

6. (B) The best possible stability factor is zero, and, 1.0 is the worst.

7. (B) A shockley diode is also called a four layer diode.

8. $I_B = I_E - I_C$.

9. Intrinsic standoff ratio—it is the percent value of the power supply voltage needed on the emitter for conduction.

10. Photovoltaic device—when light strikes the device a voltage is generated. In this definition light is considered to consist of electromagnetic waves. ■

Products *(from page 20)*

Over 120 tip styles, including the company's multi-lead "hoof" and blade tips for multi-lead soldering and over 85 SMT rework tips, are available for the system. Tips are offered in four temperature series (ranges) for all requirements, from low-temperature applications to heavy loads.

The system features SmartHeat technology with self-regulating temperature, rapid response, and high power. The self-regulating tip cartridges sense the load on contact to deliver controlled heat directly to the solder joint.

Circle (76) on Reply Card

Consumer electronics products database on CD-ROM

Casio, Inc., has released Version 4.0 of it's "Production Information Environment" CD-ROM. Nicknamed "Casio P.I.E.," this massive database answers the information needs of Casio's service and sales affiliates.

According to Ted Grier, Casio's Service Director, over 25,000 new data items have been added bringing the total amount of factual information available to over 420,000.

Keyed by only a product's name, almost every significant piece of useful product information can be retrieved including: product specifications, parts lists, clip art, schematics, a vast problem/solution library, user manuals and more. Also included are file transfer utilities, corporate policies and a glossary of Casio corporate lingo.

The P.I.E. 4.0 version works with Microsoft Windows 3.1 or IBM OS/2 2.1. P.I.E. requires 3MB RAM, but 8MB is recommended. Other requirements are: 1MByte Hard Drive, VGA monitor, ISO-9660 CD-ROM Drive.

Casio said that the new SA3000 hardware service documents and diagnostic software is included and that all SA-2000/2100 hardware service documents have been added. (There is a beta version of the new SA3000 sales configuration advisor utility program as well.)

Utility programs to export lists of what models P.I.E. presently covers with parts data, service manuals, and instruction manuals are available as are utility programs which print timepiece parts spreadsheets data to a laser.

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NEW! ES&T BOOK SHOP

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By Alvis J. Evans and Eric J. Evans

This book will show you how to plan your car stereo system, choose components and speakers and install and interconnect them to achieve the best sound quality possible. **Order# 61046 ····· $16.95.**

IC Cross Reference Book

By Howard W. Sams & Company

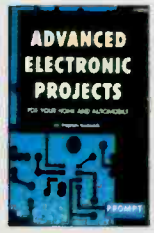
The IC Cross Reference Book, compiled from manufacturers' data and from the analysis of consumer electronics devices for Photofact service data, will help you find replacements or substitutions for more than 35,000 ICs or modules. **Order# 61049 ····· $19.95.**

Industrial Electronics for Technicians

By J.A. Sam Wilson and Joseph Risse

Industrial Electronics for Technicians provides an overview of the topics covered in the Industrial Electronics for Technicians CET test, and is also a valuable reference on industrial electronics in general. **Order# IET ····· $16.95.**

Advanced Electronic Projects for Your Home and Automobile



By Stephen Kamichik

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By J.A. Sam Wilson and Joseph Risse

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By Gordon McComb

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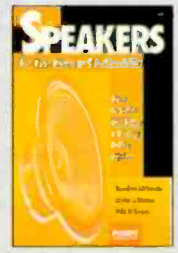
Speakers for Your Home and Automobile

How to Build a Quality Audio System

By Gordon McComb, Alvis J. Evans and Eric J. Evans



Build quality home speaker systems that will complement the sound available from your other components using the instructions in this book. **Order# 61025 ····· $14.95.**

Basic Principles of Semiconductors

By Irving M. Gottlieb

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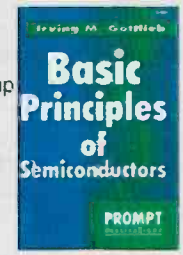


Semiconductor Cross Reference Book

By Howard W. Sams & Company

From the makers of Photofact service documentation, the Semiconductor Cross Reference Book is the most comprehensive guide to replacement data for all major types of semiconductors. This volume contains over 475,000 part numbers and other identifying numbers. **Order# 61050 ····· $24.95.**

Tube Substitution Guide

Complete Guide to Replacements for Vacuum Tubes and Picture Tubes

By William Smith and Barry Buchanan

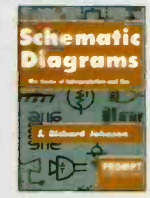
The Tube Substitution Handbook will help antique radio buffs, consumer electronics technicians and other interested individuals find the right replacement tube when servicing older electronics products. **Order# 61036 ····· $16.95.**

Electronic Control Projects for the Hobbyist and Technician

By Henry C. Smith and Craig B. Foster

Electronic Control Projects for the Hobbyist and Technician helps the reader know how and why an electronic circuit works, then applies that knowledge to building practical and dependable projects that solve real, everyday problems. **Order# 61044 ····· $16.95.**

Schematic Diagrams



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Hitachi Video disc player, model VIP 9550. Need remote control. *Contact: Grant Gough, 5107 Harbourview Road, Burnaby, B.C. Canada, V5B 1C9.*

Curtis Mathis 13 inch color TV model #K1332MW flyback transformer. Original transformer part # 47105196 is no longer available from the manufacturer. Brand new or slightly used. *Contact: Steve Harris, 2166 South Shore Drive, Erie, PA 16505, (814) 459-0591 after 11:00 AM EST.*

Magnavox VR8416SL01 VCR, part #483552237137, need right wiper gear for cassette up assembly. *Contact: Chris, Anchor VCR&TV Repair, 4044 Shasta Way, Klamath Falls, OR 97603, (503) 884-5985.*

B&K 801 capacitor analyst, Sencore MU150 tube tester, and Supremes TV-1, 17, and 27 manuals. *Contact: Charles T. Huth, 229 Melmore Street, Tiffin, OH 44883, (419) 448-0007.*

Sencore PR-57 in good condition. *Contact: Walt, (616) 599-3220.*

Hitachi flyback 2432091 and, the location of the nearest CRT rebuilding shop to SE Alabama (or nearby states). *Contact: W. Worley, 305 Hickory Bend, Enterprise, AL 36330, (334) 347-5281.*

Panasonic CT9023 CTV, Sears 5G4-4035375 CTV, KTV KT1210A B/W TV need schematics or Photofacts. *Contact: E. Cardona, 633 Apeninos Street, Pto. Nuevo, San Juan, Pto. Rico, 00920-5306.*

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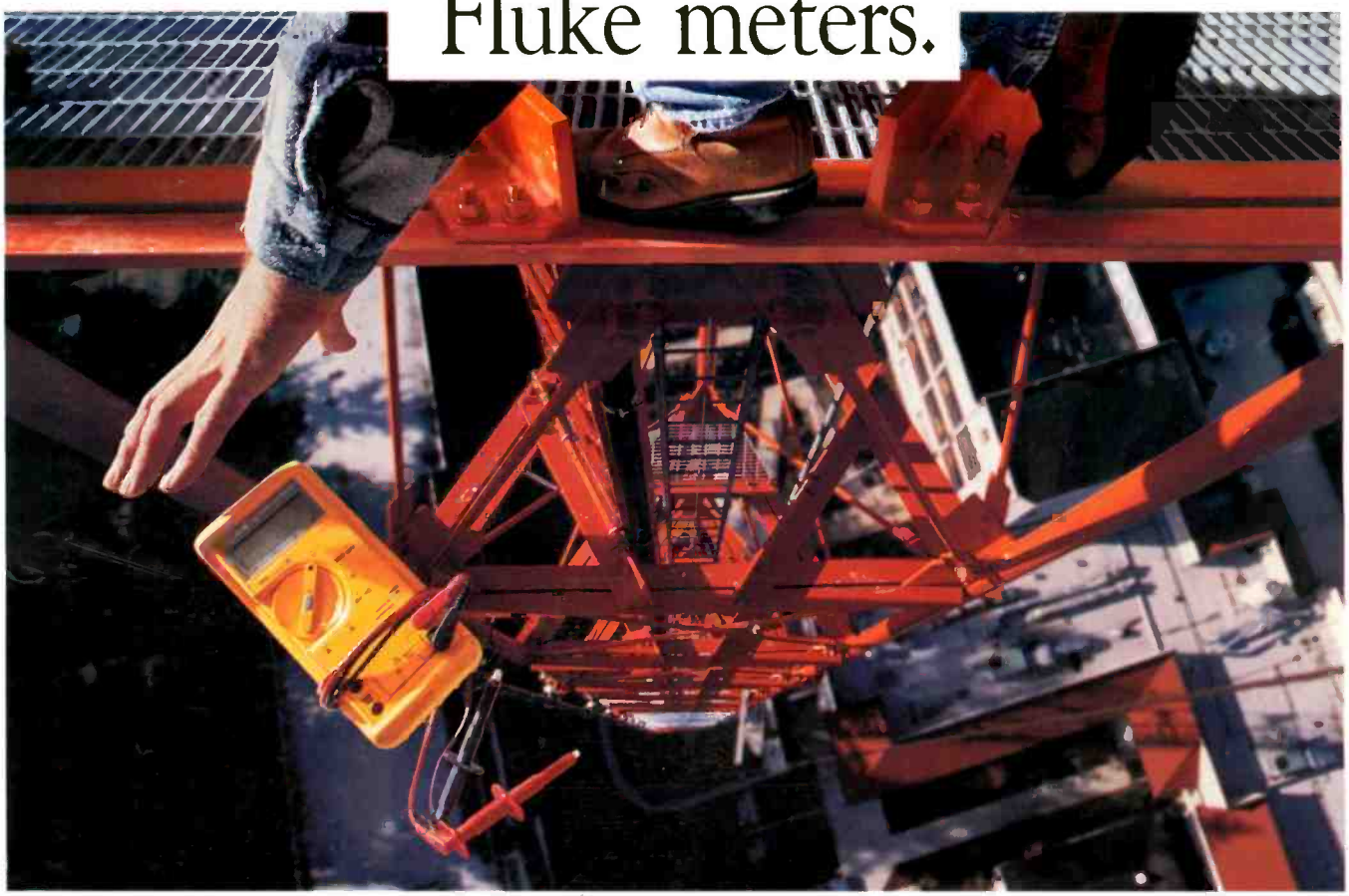
A crash course in why you can *always* count on Fluke meters.



Professionals know Fluke never lets you down. Every day, you're asked to rise to new challenges. You need a test tool as tough as your job. True story: a tech working atop a 170-foot tower accidentally knocks his Fluke 23 meter and an industrial-grade screwdriver over the edge. Straight down they fall, crashing to the asphalt below. He goes down. His screwdriver's handle is shattered. Expecting the worst, he gingerly picks up his Fluke meter and smiles. All that's broken is a fuse. He snaps in another, goes right back up and continues testing with the *same* Fluke 23. No harm to the meter — or the pocketbook. Unbelievable? Not when you consider every rotary knob, keypad, and switch on every Fluke meter must pass strict testing for drops, intense heat or cold, electrical overloads, and years of harsh wear and tear. What's more, Fluke meters are built in an ISO 9001 certified factory. So you know you can always meet your quality goals. People depend on you, so depend on Fluke. See your Fluke distributor today, or call 1-800-59-FLUKE for a catalog and a direct connection to a distributor near you and ask for a catalog.

For technical or application support call 1-800-44-FLUKE.

Send us your "Fluke survival story" and get a *free* meter case.

Serious Tools for Serious Work

FLUKE®

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