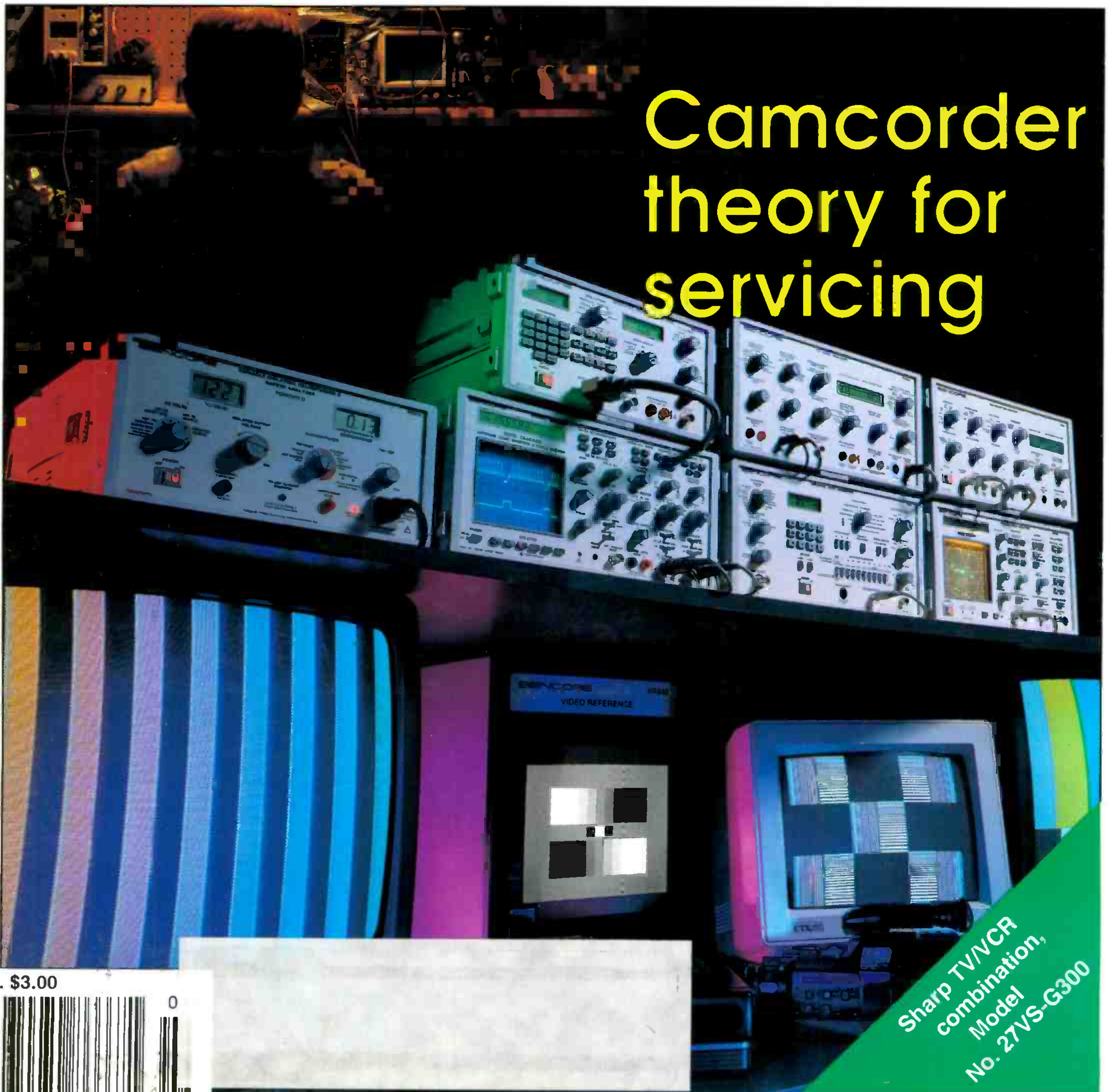
THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC Servicing & Technology

June 1996

Setting up a service bench

Test equipment update



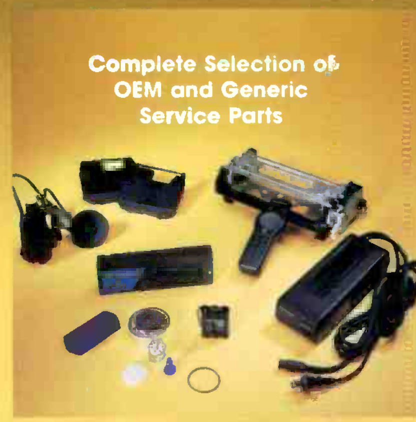
U.S. $3.00

0 74470 86667 1

MCM Electronics®

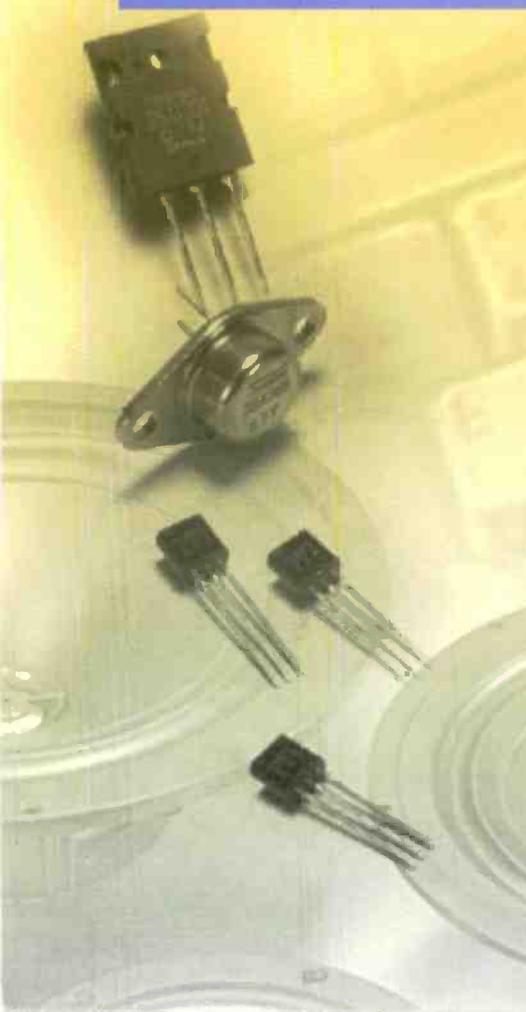
LEADING THE WAY

For 20 Years!



RCA / GE
Premier Distributor

Panasonic
Quasar / Technics
Authorized Original
Parts Distributor



- Over 25,000 Products Stocked and Ready to Ship Within 24 Hours
- Replacement Parts for Most Brand Name Consumer Electronic Equipment
- Over 11,000 Original Japanese and American Semiconductors
- ERH Exact Replacement Video Heads
- Test Equipment From Tenma, B+K, Fluke, Hitachi and Leader

For two decades, MCM has been THE comprehensive source for all of your electronics needs. Repair parts including belts, idler tires, video and audio heads, semiconductors, test equipment, tools and more, are stocked and ready to ship. If you service electronics, MCM has what you need.

Discover for yourself the MCM difference, call for your FREE CATALOG today!

20th Anniversary 1996

1-800-543-4330

FREE CATALOG

MCM ELECTRONICS®
650 CONGRESS PARK DR.
CENTERVILLE, OH 45459-4072
A PREMIER Company

Hours: M–F 7 a.m.– 9 p.m., Sat. 9 a.m.– 6 p.m. EST.

Circle (111) on Reply Card

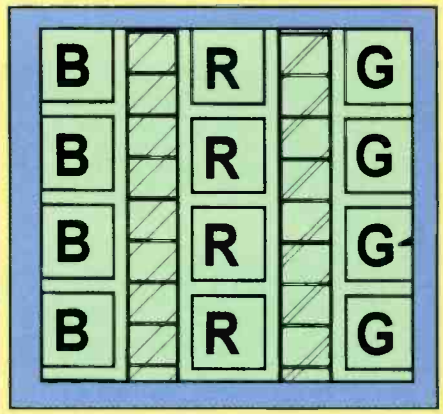
CODE: ES88

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

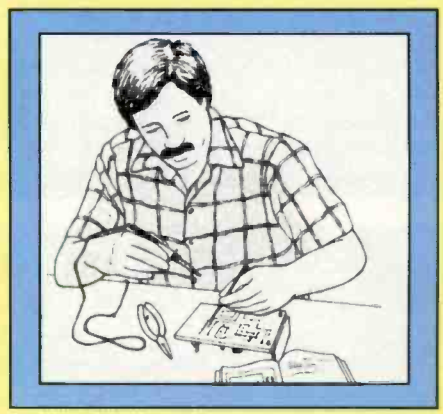
ELECTRONIC Servicing & Technology

Volume 16, No. 6 June 1996

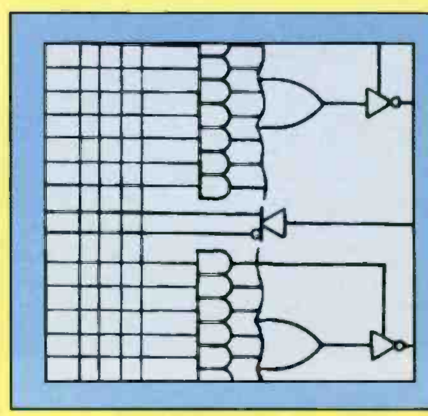
Contents



page 10



page 20



page 50

ON THE COVER

Camcorders contain electromechanical and optical assemblies as well as electronics circuits. Servicing of these miniature marvels requires an understanding of all of these elements. (Photo courtesy Sencore)

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC
Servicing & Technology

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.

EDITORIAL
Nils Conrad Persson, *Editor*
(Internet e-mail: cpersedit@aol.com)
Kirstie A. Wickham, *Associate Editor*
(Internet e-mail: kirstieest@aol.com)
Richard S. Moseson, NW2L, *On-Line Coordinator*

CONSULTING EDITORS
Homer L.Davidson, *TV Servicing Consultant*
Victor Meeldijk, *Components Consultant*
John E. Shepler, *Audio Consultant*
Sam Wilson, *Electronics Theory Consultant*

PRODUCTION
Elizabeth Ryan, *Art Director*
Barbara McGowan, *Associate Art Director*
Susan Oliveri, *Assistant Art Director*
Edmond Pesonen, *Electronic Composition Mgr.*
Dorothy Kehrwieder, *Production Manager*
Emily Kreutz, *Assistant Production Manager*
Pat Le Blanc, *Phototypographer*

BUSINESS
Richard A. Ross, *Publisher*
Diane G. Klusner, *Associate Publisher*
(Internet e-mail: dianekest@aol.com)
John Dorr, *General Manager*
Frank V. Fuzia, *Controller*
Simon Schatzmann, *Circulation Director*
Catherine Ross, *Circulation Manager*
Melissa Nitschke, *Operations Manager*
Carol Licata, *Data Processing*
Denise Pyne, *Customer Service*

SALES OFFICE
Electronic Servicing & Technology
76 N. Broadway, Hicksville, NY 11801
516-681-2922; FAX 516-681-2926

Diane G. Klusner, *Director of Advertising*
Emily Kreutz, *Sales Assistant*

EDITORIAL CORRESPONDENCE:
P.O. Box 12487
Overland Park, KS 66212
913-492-4857

National Electronics Service Dealers Association, Inc.
NESDA
Member, Electronic Servicing Dealers Association

ELECTRONICS TECHNICIANS ASSOCIATION
ETA

Electronic Servicing & Technology (ISSN 0278-9922) is published 13 times a year by CQ Communications, Inc. 76 N. Broadway, Hicksville, NY 11801. Telephone (516) 681-2922. Second class postage paid at Hicksville, NY and additional offices. Subscription prices (payable in US dollars only): Domestic—one year $24.75, two years $45. Foreign countries—one year $30.75, two years $57. Entire contents copyright 1996 by CQ Communications, Inc. Electronic Servicing & Technology or CQ Communications, Inc. assumes no responsibility for unsolicited manuscripts. Allow six weeks for delivery of first issue and for change of address. Printed in the United States of America.

Postmaster: Please send change of address notice to Electronic Servicing & Technology, 76 N. Broadway, Hicksville, NY 11801.

CQ Communications, Inc. is publisher of CQ The Radio Amateur's Journal, Popular Communications, CQ Radio Amateur (Spanish CQ), CQ VHF, CQ Contest, CQ Amateur Radio Equipment Buyer's Guide, CQ Amateur Radio Beginner's Buyer's Guide, Popular Communications Communications Guide, and Electronic Servicing & Technology.

Continuing education

Consumer electronics servicing is a difficult intellectual task. The electronics circuitry in the products is extremely complex, and operates on principles that are frequently difficult to grasp. Moreover, the teaching of these principles in colleges, technical schools and trade schools varies.

Some instructors seem to be able to provide their students with not only an understanding of the principles, but a kind of insight that allows them to have a good feel for what's going on. Other courses and other instructors seem to leave a lot untaught.

We thought that it would be interesting to ask our readers some questions about their electronics training, so we did, in a survey that was included in the magazine in March. These were the questions we asked. The numbers represent the numbers of respondents who checked that answer.

The responses

1. What type of formal electronics education/training have you had?

None	5
Military/Navy Tech School	62
Vocational/Technical School	95
Junior College	24
Other (please specify)	36

2. Did your education, or lack of education, leave you with electronics concepts that you still have difficulty grasping?

Not at all	40
Somewhat	89
A great deal	36

3. Do you find that your grasp of electronics concepts helps you to diagnose/service problems in consumer electronics products?

Not at all	1
Somewhat	35
To a great extent	106

4. Do you find the discussion of basic electronics concepts and terms in **ES&T** helpful?

Not at all helpful	2
Somewhat helpful	45
Very helpful	99

5. Are there any specific concepts/terms that you would like to see discussed in **ES&T**? Please tell us what they are.

The answers to these questions surprised us somewhat, but the information they provided was very useful to us in planning future editorial coverage on basic electronics concepts in **ES&T**, and we thought that readers might be interested in the views of some of their colleagues on the subject of education.

What do the numbers mean?

A total of 145 readers filled out these cards and sent them back. Thanks to all of you who did so. Keep in mind that this is a self-selected group of readers, and it's a small sample, so we can't project the numbers over the entire readership, but as you read the results, you can compare the responses of the respondents to your own experience and see to what degree you agree or disagree with the responses of this group of people.

Also keep in mind that the numbers in many cases add to more than the total number of respondents. That's because there were multiple responses. For example, the answers of some respondents to the first question said that they had training in all of the categories mentioned.

Some surprises

The thing that we found somewhat surprising was that 40 respondents said that their education did not leave them with electronics concepts that they still have difficulty grasping. Considering the breadth of electronics, and the many abstruse concepts involved, it was surprising to us that so many checked this box. It leaves us wondering if we asked the wrong question, or if we asked the question wrong, or if perhaps some readers have forgotten how difficult some of those concepts are to really understand, or if there are simply a lot of smart technicians reading **ES&T.**

We found a couple of things very heartening: only two respondents said that they didn't find the discussion of basic concepts in **ES&T** helpful, and that 99 found them very helpful. Furthermore, many respondents provided detailed descriptions of some of the subjects on which they want more discussion. We'll be sifting through that list in the future to try to address some or all of the concepts that were mentioned by the respondents.

Subjects requested

Here are some of the subjects that the respondents mentioned in particular that they'd like to see some discussion of:

- basic troubleshooting,
- more VCR servicing,
- discussion of component spec sheets,
- computer A/D and I/O concepts,
- CPU communications; specifically clock pulse, strobe, reset,
- surround sound, ProLogic sound, HDTV, DSS,
- scan velocity modulation,
- math, including the "j" operator.

We'll be trying to come up with editorial on some of these subjects. In the meantime, if any readers have any other specific subjects that they'd like to see covered, please let us know and we'll try to oblige.

And thanks again to all of you who fill out those survey cards.

Nils Conrad Persson

VCR sales grab video spotlight in February

VCRs saw double-digit sales growth last month compared to February 1995, according to the Consumer Electronics Manufacturers Association (CEMA). However, sales of all other video equipment categories were down leading to a two percent decline in February after rising the same amount in January.

"The strong showing by VCRs this year is very encouraging, especially with the public demonstrations of the digital disc format, DVD, earlier this year," said Joseph P. Clayton, executive vice president of marketing and sales for Thomson Consumer Electronics. "VCRs play an important part in America's home entertainment. As consumers continue to look to high-quality consumer electronics video products for their families' entertainment options, VCRs, and later DVDs, will be consistent market winners."

The strength in the VCR market continued unabated in February. Total sales were up 13 percent as shipments of both monaural and stereo models rose. In the year-to-date, VCR sales rose 16 percent to a new record high of 1.66 million units.

Color TV sales continued to suffer from weakness in the mid- to low-end of the screen size range. Sales of sets 20 inches and smaller fell 20 percent in February compared to last year, while sets 27 inches and larger were up almost nine percent. Overall sales were down nine percent in the month and year-to-date.

Sales of larger screen TV/VCR combinations (14 inches and larger) jumped 68 percent in February, not quite offsetting a 38 percent decline in smaller models ofTV/VCR combinations. Overall combination sales fell two percent in February but were up a combined 12 percent in the first two months of the year.

Sales of projection TVs declined for the first time in 30 months, dropping seven percent in February. The primary reason for the decline was a 25 percent drop in sales of models 49 inches and smaller. However, projection TV sales are still up 11 percent in the year-to-date and are expected to rise by 15 percent in 1996, according to CEMA.

Camcorder sales were down slightly in February, falling five percent, while laserdisc players were off 54 percent.

Cyberspace shopping predicted to have impact on retail industry

Cyberspace shopping isn't mainstream —yet. however, a recent study conducted by MasterCard International for the National Retail Federation (NRF) revealed that there is a growing interest in on-line shopping among consumers that may have implications for the retail industry. The research showed that 84 percent of the people currently "surfing" the World Wide Web believe they are at least somewhat likely to purchase items over the Internet this year.

"Internet commerce is clearly in its infancy since only 1 percent of US consumers are currently purchasing items on-line," said Watts Wacker, noted futurist with SRI International. "However, with approximately one-third of American consumers planning to access the Internet over the next year, on-line shopping is likely to grow significantly and have a major impact on the retail industry."

The current market for shopping on-line

According to the study, 19 percent of US consumers have accessed the Internet; another 12 percent of consumers say they plan to access the Internet for the first time in the next year. Of those currently using the Internet, 60 percent "surf" the World Wide Web—where shopping is conducted. Twenty-seven percent of Web users surveyed have purchased something over the Internet.

Who are Internet users/buyers?

The on-line and telephone surveys revealed the following demographic profile of Internet users:

• Approximately 75 percent who have accessed the Internet are male.

• 55 percent of Internet users have a college degree or some higher education.

• Nearly 40 percent have a household income of more than $50,000.

• The median age of Internet users is 34.

• 60 percent of Internet users are married; one-third have children.

• Entrepreneurs and students account for close to half of frequent Internet users.

What are consumers purchasing?/ How much are they spending?

Consumers are clear about what they do and do not want to purchase over the Internet. According to the survey, consumers are most interested in purchasing items they "already know" or items for which they can "define exactly what they want." The most popular item bought over the Web is computer software, followed by information, entertainment and computer hardware. Flower delivery services and travel agencies—both of which have traditionally offered their services via telephone—show the beginnings of successful selling over the Internet.

Most on-line buyers described their expenditure over the last 30 days in either the $20 to $50 range or the $100 to $200 range. Also, a significant group (20 percent) of Internet buyers spent more than $500 on the Internet in the last month.

Consumers views—benefits and barriers to shopping on-line

According to the study, consumers view the Internet less as a venue for obtaining discount pricing and more as a tool of convenience. More than 70 percent of frequent Internet users (and over 70 percent of PC users interested in shopping on the Internet) perceive on-line shopping as delivering the following benefits:

• 24-hour shopping
• Ability to shop from any PC
• Purchasing from retailers anywhere in the world
• Shopping at home
• Time savings
• Privacy
• Easy comparison shopping

Credit card fraud is a concern to large segments of the population. This concern is much more prevalent among non-buyers than buyers. Even though consumers know they are only partially liable (usually for up to $50) if their card number is used fraudulently, they want to be guaranteed that the Internet is secure.

The legitimacy of merchants is also a security concern of consumers. Anyone can get on the Internet; anyone can be a merchant. This concern may cause consumers to limit their purchases to retailers with local stores or regional/national name recognition.

The future of shopping on-line

As comfort levels grow, so does the potential for shopping over the Web. The survey found that increased use of the Internet leads to increased buying tendencies. Nearly half of those users who spend 30 hours or more on he Internet have purchased items on-line.

"The Internet should be seen by retailers as an opportunity to expand their reach into the consumer market rather than a threat," said Wacker. "It offers retailers the opportunity to interact with a large segment of consumers in their homes."

Despite the growth potential of commerce on-line, the study concluded that two things must happen before an explosion of Web commerce occurs:

1) The Web must be marketed by retailers and financial institutions as a safe, effective means for purchasing.

2) A broader base of US consumers must become more experienced in using the Internet. This experience will likely translate directly into increased buying habits—as shown by the survey of users, the more consumers use the Internet, the more likely they are to shop on-line.

Challenges and opportunities facing retailers

Many consumers still see the Internet as a way to gather information or to contact colleagues or friends rather than to shop for goods and services. While the convenience of shopping on-line is appealing to many consumers, they are not willing to give up customer service. Retailers that stand to benefit the most from on-line shopping are those that offer both Internet service and local retail locations.

"Consumers still view local retail locations as an easy and convenient means to obtain customer service," said Charles Spatola, vice president, Retail Markets, MasterCard International. "They want the option of taking their problems directly to the retailer and receiving help face-to-face. Convenience coupled with traditional retail service will be strong selling points for retailers on-line."

Retailers most likely to be affected by shopping over the Internet include those that sell standardized, commodity products; products requiring little customer service; very expansive products that might be discounted heavily over the Internet; and items by phone or mail order. Examples include CDs and records, stereo equipment, kitchen appliances, automobile parts and travel reservations.

Today, traditional retail is not being cannibalized to any great extent by online shopping. However, this finding points less to the lack of immediate threat the Internet poses to traditional retailers and more to the opportunity it suggests for them.

(Continued on page 56)

1996 catalog

Tritronics, Inc. announces the publication of its sixth catalog.

The catalog has more pages and now includes test and soldering equipment, optical pick-ups and many new products.

The catalog contains up-dated and expanded cross-references and products that are competitively priced in the industry.

Circle (14) on Reply Card

Data acquisition and serial control demo

National Instruments announces a free multimedia software demonstration package that shows users how to set up and use Measure for Windows, the new direct data acquisition and instrument control software for Microsoft Excel. Also available is a new four-page, full-color brochure, which highlights sample screens of the easy-to-use, interactive menus for controlling plug-in data acquisition (DAQ) boards and serial measurement devices and describes how spreadsheet users can use the software to improve productivity and even automate experiments with Excel macros.

The multimedia demonstration shows how users can employ interactive menus and intuitive dialog boxes to quickly and easily configure and execute acquisition operations directly into Excel worksheets. The demo highlights the ease of use and flexibility of the software as users define how data is input and output from the worksheet by going through pop-up dialog boxes. The demo includes various examples of the fast data acquisition capabilities of the software for analysis, report generation, and online documentation.

Circle (15) on Reply Card

Spring '96 catalog

The new Spring 1996 Catalog from Jensen Tools introduces a line of modular electronic test/assembly workbenches from BenchMark, two new DMM service kits by Fluke, and the latest additions to the company's full line of tools and tool kits for test, installation and repair.

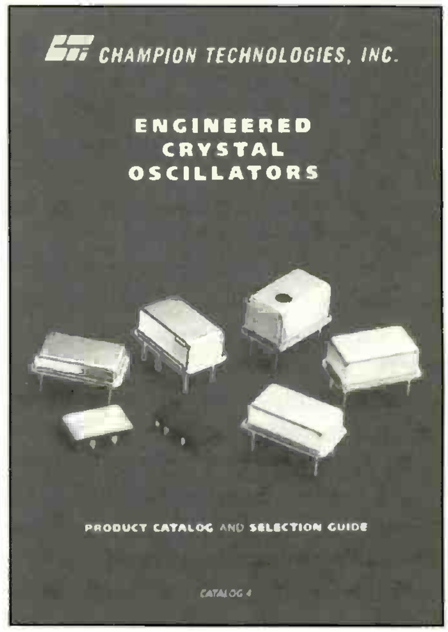
The catalog features 96 pages of electronic service products. Included are inch and metric tools, test equipment, SMT soldering and rework stations, static control products, cable and connectors/adapters, computer diagnostics, telecom/LAN accessories, technical literature, cases and shipping containers.

The selection includes some new bench and field service accessories, quality ergonomic and insulated tools, and many new state-of-the-art test instruments from leading manufacturers.

Circle (16) on Reply Card

Crystal oscillator catalog and selection guide

Champion Technologies, Inc. recently released a new Product Catalog and Selection Guide for their full line of crystal oscillators. Technical information, specifications and mechanicals are featured in this catalog for over 60 of Champion's VCXOs, TCXOs, VCTCXOs, data clocks and related products. This wide line of products offers frequency ranges up to 155.52 MHz for general purpose to high frequency or tight stability applications.



Additionally, this catalog offers a detailed selection guide, phase noise definition, custom product definition guide and an extensive definition of terms section.

Circle (17) on Reply Card

Electronic components catalog

Mouser Electronics announces the publication of their newest electronic components catalog. This 324 -page catalog is newly updated and contains over 61,000 products from more than 120 of today's leading electronics manufacturers. Featured in the catalog are products from Mouser's newest vendors including Clarostat, Bud Industries and Mill-Max.

These products are in addition to Mouser's continually growing line of electronic components from current industry leaders such as AMP, Keystone, the 1996 IC Master, NEC, SGS Thomson, Belden, Swtchcraft, QT Optoelectronics, Littlefuse and dozens more. This catalog serves as a guide for buyers as well as engineers because it provides both complete specification drawings and up-to-date, guaranteed prices for all products, allowing for immediate, real-time decision making.

Circle (18) on Reply Card

Components catalog

Jameco Electronics has just released their latest catalog. The Winter '96 edition features over 185 new products, including: ICs from Comlinear and Microchip, BNC connectors, stranded hookup wire, wall transformers, cordless soldering equipment, Windows '95 keyboards and more! The company's product line now includes over 5,000 electronic and computer products.

They now also offer Internet access to friends and customers. The *info@jameco.com* e-mailbox is always open to comments, suggestions, requests for quotes and literature or complaints.

Circle (19) on Reply Card

UPS catalog

A new catalog SP795 from Superior Electric describes SP Series Stabiline Standby Uninterruptible Power Supplies that provide a power quality solution for PCs, workstations, POS systems, cash registers and other electronic devices by instantly switching to battery power in the event of an ac power outage.

SP Series units are available in UL1778 listed and CSA certified 250VA, 400VA and 600VA, 120Vac, 60Hz types and VDE certified 220 Vac, 230 Vac and 240 Vac 50/60Hz types. They utilize economical synthesized sine wave (step wave) output technology and come complete with audible and visual alarms. Optional computer interface software for Novell, UNIX and other platforms is available on 400 and 600VA models.

Circle (20) on Reply Card

LED databook

Dialight Corporation has issued a new 200-plus-page databook that provides specifications for more than 1,000 LED products, including circuit board indicators, surface mount indicators, light pipes, discrete LEDs, and panel mount indicators. Also contained in the databook are an easy-to-use product selector guide, glossary of terms, part number index, and application notes.

cial information, searchable product listings, and access to the manufacturer's family of companies. Not only will individuals anywhere in the world be able to browse through a virtual tour of the company's manufacturing facilities via video clips and ask questions of product experts, but they'll be able to see new products the moment they're released and in some cases have direct input into new product designs.

Circle (21) on Reply Card

Product specific accessory kit catalog

Outfitted with a complete set of test accessories specifically designed for use with either Fluke, Hewlett-Packard or Tektronix digital multimeters, graphical multimeters and oscilloscopes, ITT Pomona's new Test Companion accessory kits feature rugged, lightweight Cordura carrying cases for easy portability and accessibility when servicing in office, plant or field locations. Cases hold and protect instruments, test leads, probes, and tools and provide a variety of zippered and Velcro-sealed pockets for manuals, service forms and miscellaneous items.

Also available among the company's all-new line of the brand- and model-specific accessory kits are smaller, shoulder-pack kits and tri-fold pouch styles. Most accessories in the accessory kits are IEC1010-compliant.

An easy-to-read chart in ITT Pomona's new 1996 Short Form Catalog enables easy kit selection according to instrument and coded by specific model number.

Circle (22) on Reply Card

Brochure about all-weather antenna positioning

Thomson Saginaw announces the availability of a new brochure featuring the dimensions and specifications of their Performance Pak Actuators.

Designed for either C band or KU band systems, each actuator can be operated with either a 36Vdc or 24Vdc power supply regardless of the positioning sensing option chosen. All standard commercial and TVRO models feature a protective vented shaft boot, enhanced corrosion resistance, a heavy steel ball clevis end, and a water-tight wiring connector. The actuators are available in cost-effective models designed for TVRO applications, standard commercial models for medium to large receiving dishes and heavy-duty models for large commercial installations.

Circle (23) on Reply Card

Solvent guide update

An all-new, solvent guide update is now available from Dynaloy, Inc., a manufacturer of specialty chemicals and solvents serving such industries as telecommunications, computers, electronics, plastics processing/molding, automotive, avionics/aerospace, medical, audio/video, converting and laminating.

The one-page flyer is an update to the main Solvent Selection Guide, and describes a new line of safety solvents for solving industries' concerns of health, safety, disposal, and the environment.

Applications for these solvents include general cleaning and degreasing; cleaning of urethane and isocyanate residues from equipment and molds; the removal of mold release residue from plastic molded parts; cleaning of silicone oils and uncured silicone polymers from molds and equipment; and the cleaning and defluxing of printed circuit boards.

Circle (24) on Reply Card

CCD video camera theory for servicing

By Tom Schulte, CET

If you're considering servicing camcorders, or are just starting to service the camera section of camcorders, you're probably looking for some basic information on how video cameras operate. The information in this article will help you do a better job of checking the camera section for problems, troubleshoot to the defective circuit or component, and check the camera's final performance before you send it back to your customer. Even if you repair only mechanical camcorder problems, a basic understanding of what the camera does to produce a video record signal will help you understand the significance of simple camera tests you'll want to perform before you send the unit back to your customer.

Whether the camcorder includes a full size VHS, VHS-C, or 8MM VCR transport, the camera section operates pretty much the same electrically. Security video cameras operate similarly. The block diagram in Figure 1 shows the major camera circuits and a typical flow of signal through those circuits. The following sections will discuss what the camera has to do in each circuit to create a final NTSC composite video signal, starting with just reflected light energy from a scene.

Sync generator

A video camera's composite output signal needs to contain luminance, sync, 3.58MHz subcarrier chrominance signals, and chroma burst, all combined in an organized manner according to NTSC specs. The sync generator provides horizontal and vertical drive signals for the pick-up device (or sync signals to a separate drive signal generator), composite sync and burst for the video output, 3.58MHz subcarrier reference signals for the color modulators, and timing signals for all the other camera circuits to insure that the camera output signals are properly synchronized to each other.

These synchronizing signals are developed by dividing the signal from a master sync oscillator, which typically runs at 7MHz to 25MHz, down to each needed frequency. An adjustment in this circuit directly sets the frequency of the master sync oscillator, which affects the frequency of all the camera output signals. Alternately, this adjustment is set for proper burst frequency at 3.579545 MHz.

Lens assembly/control circuits

A video camera's signal development begins at the lens assembly, where the lens focuses reflected light from the scene onto the light sensitive surface of the CCD pick-up device (Figure 2). A mechanical service adjustment of the distance between the lens assembly and the CCD pick-up affects how well the image remains in focus as the lens zoom ratio is varied from wide angle to telephoto. This is called the "flange back" or "back focus" adjustment, although some think that a more descriptive name might be the "focus/zoom tracking adjustment."

A small motor in the lens assembly positions internal focus lenses for proper focus at a particular distance. The focus motor is controlled by a servo control circuit to provide automatic focus. The auto-focus control circuit maximizes high frequency information in the pre-video signal for optimum focus, or responds to an infrared or LED distance ranging sensor. An adjustment of the auto-focus circuit sets the optics for best distant focus at the maximum zoom (telephoto) setting. Another motor in the lens assembly responds to input from the user-operated camera zoom switches to position the internal zoom lenses.

The auto-iris circuit controls the amount of light that passes through the lens by operating a small motor to open and close the iris diaphragm. The iris motor is controlled by a servo control circuit for automatic iris operation. The iris control circuit samples the camera CCD output signal (prevideo) to determine the amount of light falling on the pick-up device (more light, more signal amplitude).

Under normal to bright lighting conditions, the iris control circuit limits the amount of light falling on the pick-up by partially closing the iris, thus controlling the amplitude of the prevideo output signal. An adjustment of the iris control circuit sets the level of the CCD output signal for normal to bright lighting.

Proper operation of the auto-iris circuit is crucial for video output, since the iris diaphragm is spring-loaded closed, and a failure in the iris control circuit often results in no light reaching the pick-up device. This failure results in absence of camera video output, although sync would still be present.

CCD pick-up/drive

The CCD pick-up device converts light energy passed through the lens into an initial electrical signal (pre-video), which is then processed by the remainder of the camera circuits into an NTSC standard composite video signal. CCDs are solid state pick-up devices made up of a large number of photodiodes, arranged horizontally and vertically in rows and columns under the IC's transparent window.

Conversion of light energy to electrical energy takes place at the individual photodiodes, each of which produces a small electrical charge corresponding to the light energy level falling on that photodiode from a single point in the scene. These small sampled points in the scene are called picture elements or pixels.

CCD pick-up devices use vertical and horizontal frequency drive pulses, synchronized to the master sync generator, to control their raster scanning process.

Schulte is an application engineer for Sencore

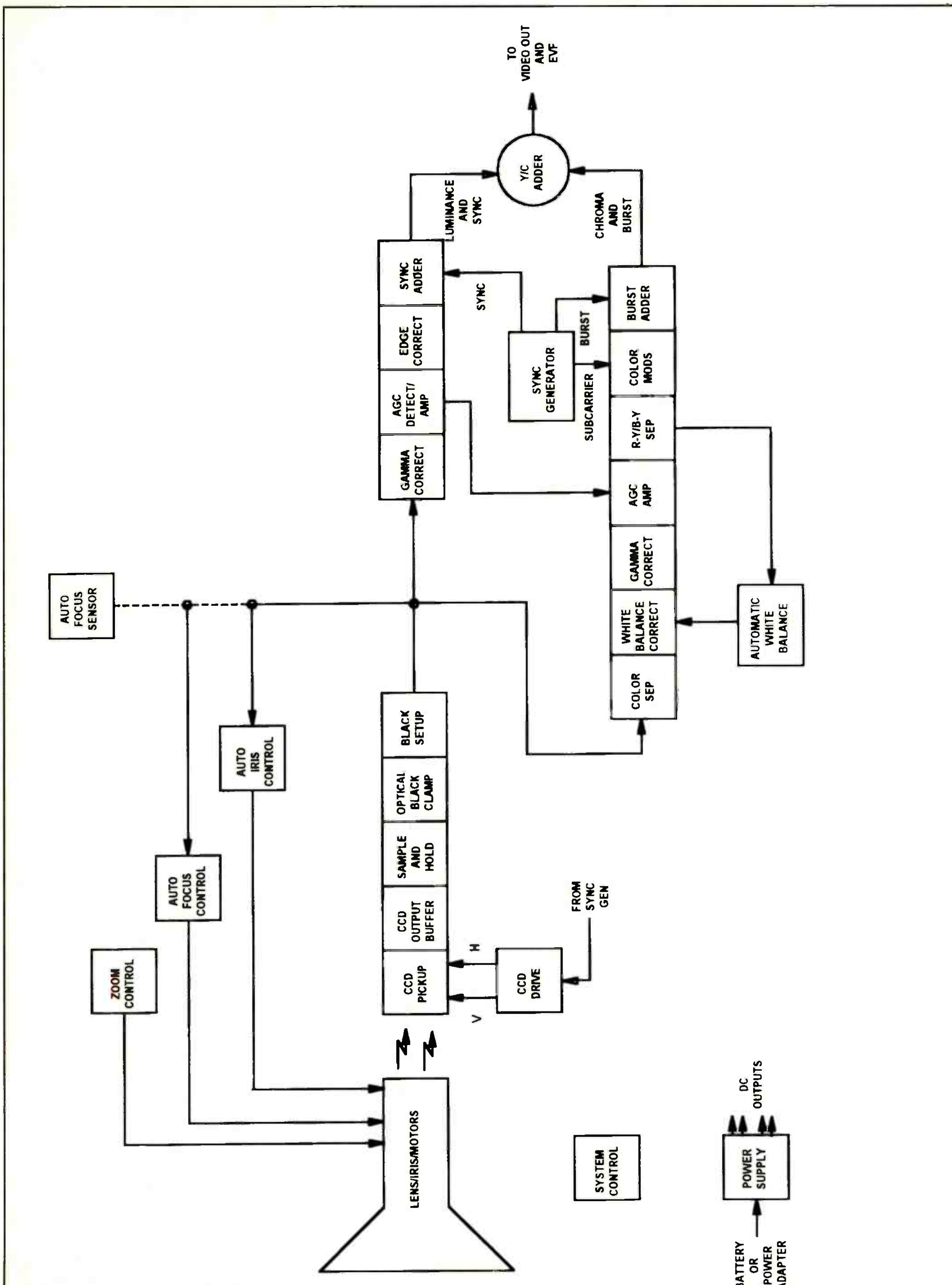


Figure 1. This typical video camera block diagram shows circuit blocks and signal flow through the camera.

These drive pulses control the orderly collection of charges from the pick-up device photodiodes through electronic column and row signal pipelines (shift registers) (Figure 3).

During vertical blanking, a vertical pulse from the CCD drive circuit causes all of the individual pixel charges developed during the preceeding vertical field to be coupled to the adjacent vertical shift registers. Then, during each horizontal blanking period of the following field, a horizontal drive pulse causes a complete horizontal scan line of charges to be shifted to the common horizontal register. Finally, during each horizontal active scan time period, the charges are shifted out of the horizontal register, one pixel charge at a time.

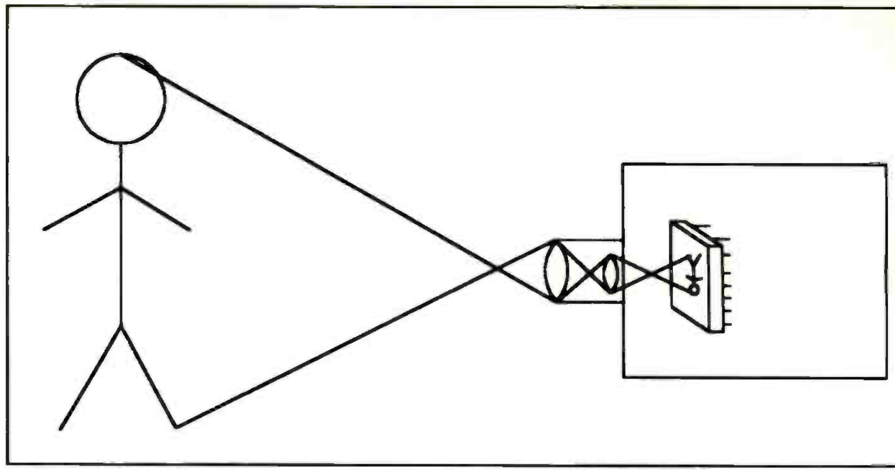


Figure 2. The lens focuses a small amount of light from the scene onto the CCD pick-up.

As this process is repeated, field-by-field and line-by-line, a semi-continuous luminance signal is created. An output buffer amplifier, typically a bipolar emitter follower or FET amp, provides output isolation for the CCD as the signal is passed to the following luma, chroma and control stages. This signal contains all the necessary luminance picture information needed to generate a monochrome NTSC composite video signal. The CCD (charge-coupled device) is named for this method of collecting and coupling individual charges to the IC output pin through vertical and horizontal shift registers.

An adjustment often included in the CCD circuit affects the ability of excessive bright light charges from one photodiode to spill over to adjacent photodiodes. This adjustment is called the overflow, substrate, sub, or blooming adjustment, and is set to minimize bright light smear in the picture. Overadjustment of this control causes loss of color and/or washed out picture.

Pre-video process

The semi-continuous CCD video output signal is a digitally sampled signal made up of charges assembled from the individual, slightly separated photodiodes. The process of scanning the photodiodes to collect the individual pixel charges creates a choppy video signal (Figure 4). To smooth out the video sig-

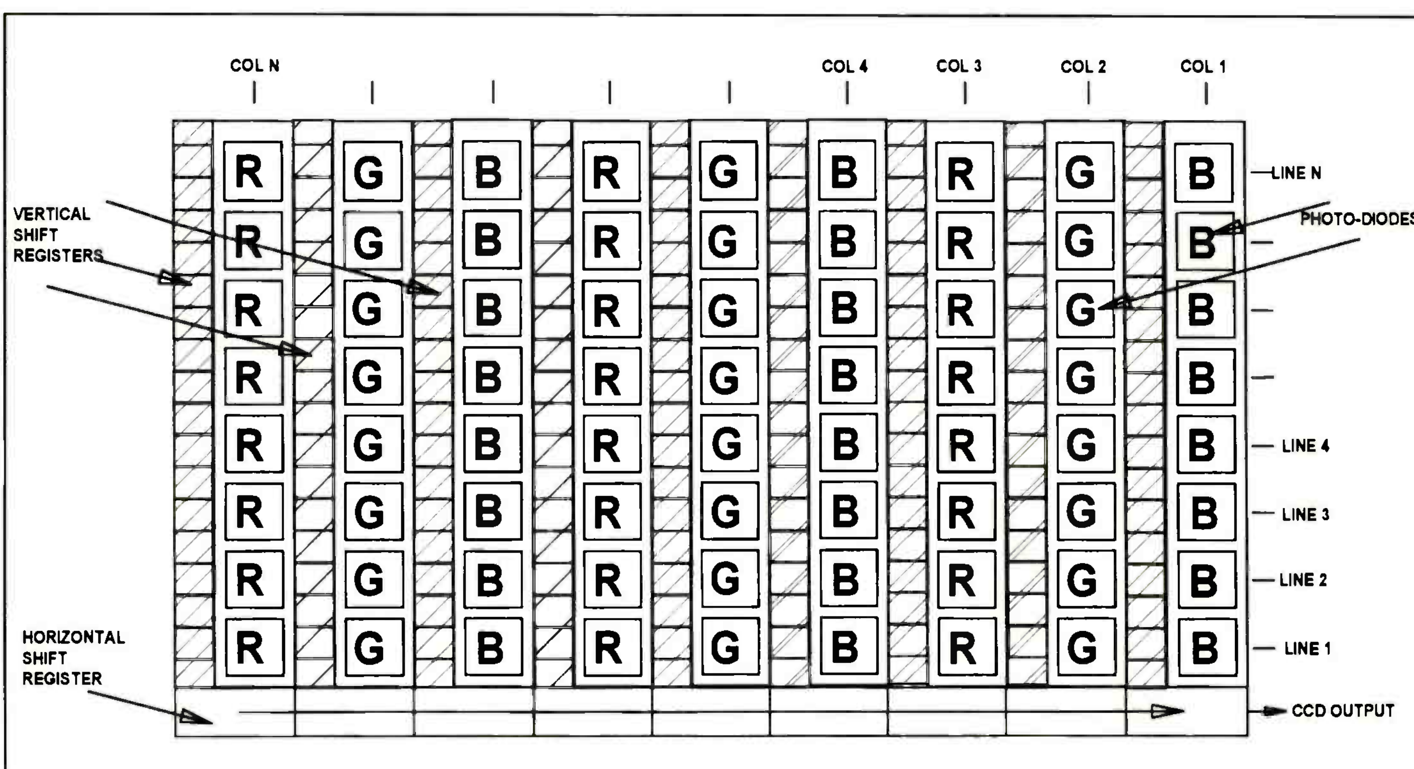


Figure 3. The vertical shift registers collect charges from the photodiodes and feed them to the common horizontal shift register to be delivered to the CCD output.

Share Your Vision! 1996 Technical Survey

(must be received before July 31, 1996)

We'd like to know how you feel about the electronic servicing industry and where you are headed in the future. Your valuable input will help shape our plans for future analyzing products which in turn helps you and the electronic servicing industry.

Please take a minute to complete and return this survey. In return, we'll place your name in a drawing for the Camcorder Servicing Package (worth $10,180). Thanks for your input!

Here's what the Camcorder Servicing Package includes:

- SC3100 "AUTO TRACKER" Automatic 100 MHz Waveform & Circuit Analyzer
- VR940 Video Reference Light Source
- CVA94 "Video Tracker" Camera Video Analyzer
- VC93 All Format VCR Analyzer

Drawing will be held July 31, 1996*

(All questions must be answered to qualify)

Are you presently servicing camcorders?
❑ Yes ❑ No

Do you advertise that you do camcorder service?
❑ Yes ❑ No

Do you service the camcorder in-house or send them to a repair drop-off spot?
❑ in-house
❑ repair drop-off
Business name: ____________
Location: ____________

How many camcorders do you repair each week?
❑ 0-1 ❑ 2-5
❑ 6-10 ❑ 11 or more

What is your average invoice per camcorder?
$ ________

What types of camcorders do you service?
❑ VHS ❑ VHS-C
❑ Super VHS ❑ 8mm
❑ BETA ❑ Hi-8

What is your biggest challenge in camcorder servicing?
❑ service literature
❑ assembly/disassembly
❑ troubleshooting techniques
❑ other____________

What are the typical defects you run into?
❑ mechanical ❑ lens/CCD
❑ luminance ❑ physical damage
❑ color

What training have you had to learn camcorder servicing?
____
____

What training would help make you more profitable?
____
____

What test equipment do you have on your camcorder service bench?
❑ scope ❑ waveform monitor
❑ DVM ❑ vectorscope
❑ light box ❑ other____________

What's the future trend in the area of camcorder?
____
____

*Void where prohibited and to government employees

To discuss this survey, call toll-free at 1-800-SENCORE or FAX back to (605)339-0317

Name ____________
Company ____________
Title ____________
Address ____________
City ____________
State ________ Zip ________
Phone (________) ________
Best time to call ________ ❑ A.M. ❑ P.M.

SENCORE
3200 Sencore Drive, Sioux Falls, SD 57107

Please tear here, fold, tape, and mail to Sencore.

Form 6343a

Fold Here

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL
FIRST-CLASS MAIL PERMIT NO. 1667 SIOUX FALLS, SD

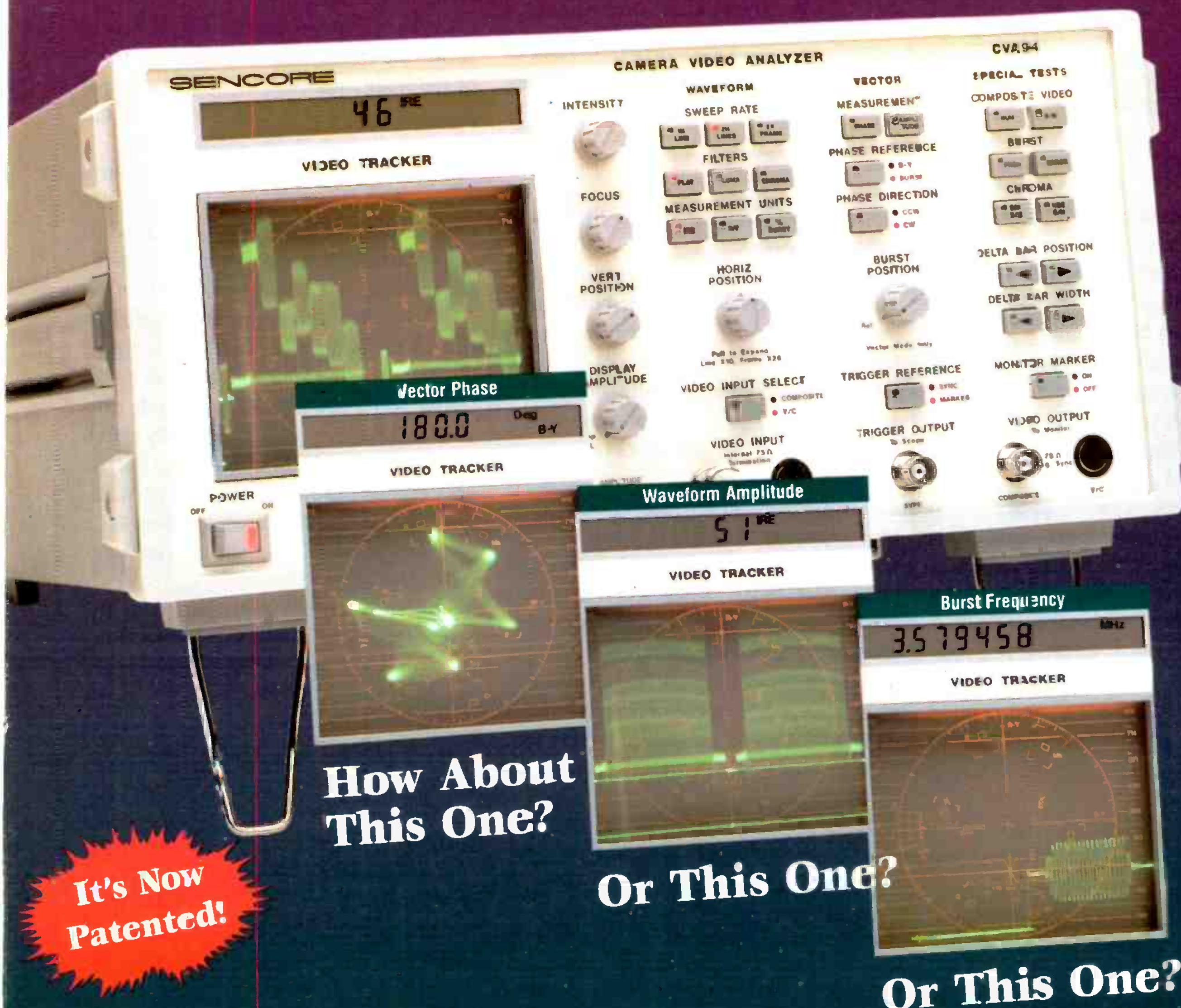
POSTAGE WILL BE PAID BY ADDRESSEE

SENCORE
3200 Sencore Drive
P.O. Box 5062
Sioux Falls, SD 57117-9949

Fold Here

Tape Here

If You Don't Like This Camcorder Answer...



CVA94 "Video Tracker"

Camera Video Analyzer Patented

TECH CHOICE SYSTEM

When you need another opinion on a camcorder signal, now all you have to do is push a button. The CVA94 "Video Tracker" provides a complete vectorscope and waveform monitor, plus digital waveform measurements for fast signal troubleshooting. It is the only instrument designed specifically for camera analyzing, saving time, and building customer trust. The confidence you gain is what makes the "Video Tracker" such a powerful tool. From the first time you use it, you'll positively identify and localize camcorder problems for fast service and alignment. Need another opinion? Ask the CVA94 "Video Tracker."

But don't take our word for it. See it for yourself on your bench with our no-obligation trial. Call 1-800-SENCORE (736-2673) ext. #518 for details!

Circle (5) on Reply Card

SENCORE
3200 Sencore Drive, Sioux Falls, SD 57107
Direct (605)339-0100 Fax (605)339-0317

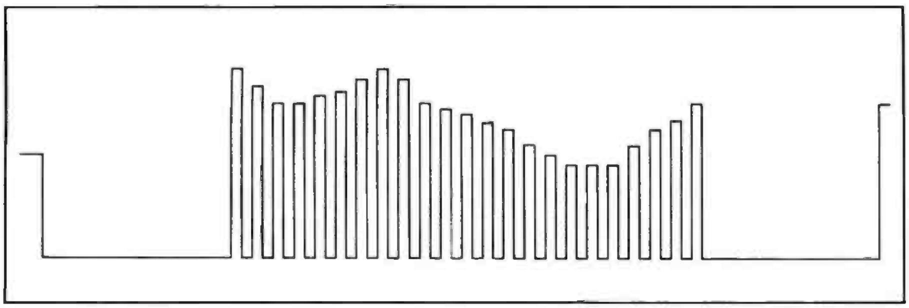


Figure 4. Since there are spaces between the CCD photodiodes, and the charges are digitally sampled, the CCD output signal is "choppy."

nal, it is sent to a sample-and-hold circuit or a low pass filter.

An optical black clamp circuit clamps the signal to a black reference level at the very end of each horizontal and vertical scan, while the pick-up device is sampling a blacked-out area of the pick-up surface. A blanking clamp, or black setup circuit then clamps the entire blanking period to a fixed level with respect to the black level. These blanking levels, which the camera adds to the video signal during retrace time, serve as the measurement reference level for voltages in the rest of the signal.

Black areas of the scene produce a voltage level which should be 54mV more positive than the blanking level (Figure 5). This "black setup" level is adjustable with a setup circuit control. If black setup is misadjusted, unstable sync or washed out video results.

White areas of the scene produce a voltage level which should be 714mV more positive than the blanking level. Gray areas of the scene which produce voltage levels between the black and white levels. Thus, when a scene which contains both black and white is scanned, the camera's video output voltage level varies between 54mV and 714mV more positive than the blanking level.

The output signal of this section is called "pre-video" since it contains picture information, but not sync or burst reference signals which are normally part of a composite video signal. Also, color signals produced from colored light reflected from the scene are still in a form that can't be used by standard NTSC video devices without further chroma processing.

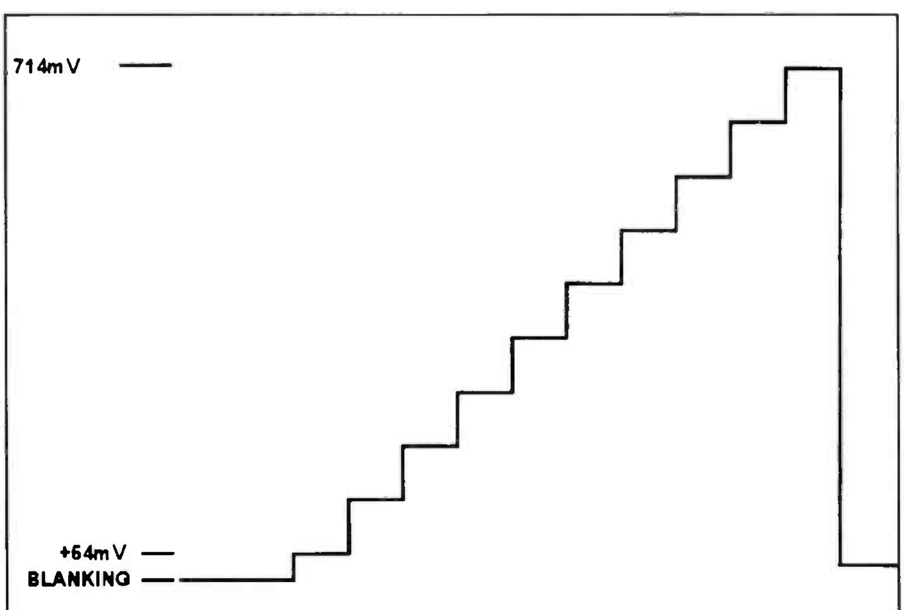


Figure 5. During active video time, the signal level ranges between 54mV (black) and 714mV (white).

Luminance process

The luminance process circuits are fairly simple. Gamma correction provides additional gain for darker portions of the video signal to correct for the normal black compression that occurs in the CRTs of all televisions and monitors. This correction causes the brightness of even dark portions of the image on the TV screen to correspond directly to the light intensity of the image picked up by the video camera.

At very low light levels, when the iris is already fully open, signal white levels tend to drop below 714mV because of insufficient light input. The AGC amplifier responds to a control voltage from the AGC detector with additional amplification to maintain a constant white signal level at the amplifier output. This additional AGC amplification, which also adds noise to the signal, is normally active only during low light levels when the iris has reached the end of its range and cannot open any further to compensate for a drop in input light level and previdco signal output level.

An AGC circuit adjustment sets the level of the video output signal under low lighting conditions. A master luminance level adjustment is also included in the luminance process circuit to set the level of the luminance signal at the camera video output connector.

The edge (aperture) correct circuit senses transitions from black to white and vice versa in both horizontal and vertical picture directions. Fast spikes are then added to these signal transition points to speed up the signal transitions and sharpen the edges of objects in the picture.

Finally, horizontal and vertical sync from the sync generator are added to the video signal in the sync adder stage to form a composite luminance and sync (Y) signal, which is sent to the Y/C adder stage. An adjustment in the camera's sync generator circuit sets the level of the sync signals to 286mV more negative than the blanking level. The overall amplitude of the composite video signal, with maximum white in the picture, is 1V from the negative peaks of the sync pulses to the positive peaks of the white signals.

Rather than always referring to composite video signal levels in terms of mV, a more convenient video measurement

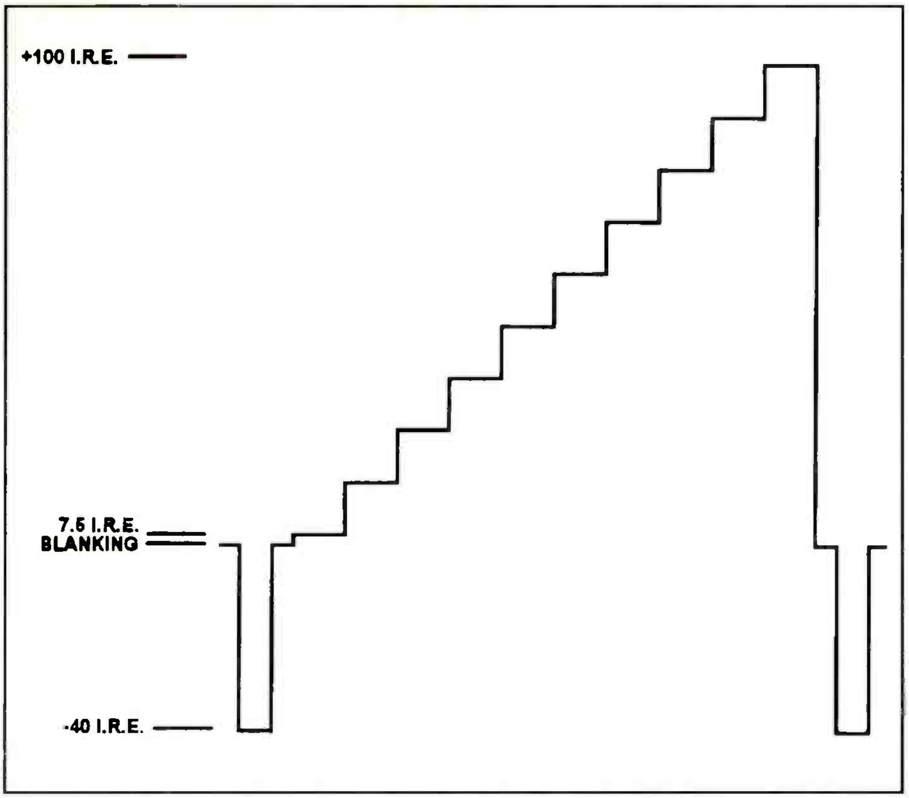


Figure 6. The IRE measurement scale is often used by camera and test equipment manufacturers to specify video and sync levels above and below the blanking reference level.

scale was developed by the Institute of Radio Engineers (IRE). This measurement scale extends 100 IRE units from blanking up to peak white (+714mV) and 40 IRE units from blanking down to sync tips (-286mV) (Figure 6). Black setup is 7.5 IRE units above the blanking level. Since the total 140 unit IRE scale corresponds to the $1V_{PP}$ video signal, 1 IRE unit equals 7.14mV.

Chroma process

Color video cameras produce a chroma signal which corresponds to the saturation and hue of light present at each point in the scene, as well as the luminance signal which corresponds to the total brightness of light at each point in the scene. The saturation of light is its color intensity, ranging from vivid to pastel. The hue of light is what we think of as its "color"; orange, brown, blue, etc. Information for both of these color characteristics is contained in the camera's chroma output signal.

A video camera creates this chroma signal starting with a multi-colored mosaic filter etched on the front of the pick-up device's light sensitive surface (Figure 7). This allows the pick-up device to sample the brightness of different colors of light present in each area of the picture. The colors of the filter segments varies in different camera designs, but are three or four primary or secondary colors (red, green, blue, cyan, magenta, yellow).

The process of sequentially sampling light levels through the multicolored segments of the mosaic filter creates a high frequency chroma signal, which carries information about the color of the light reflected from each part of the scene. This chroma signal frequency is higher than the luminance signal frequencies; the exact frequency of the chroma signal is determined by the camera design, but is typically between 5 and 10MHz.

Even though all the needed color information is present at the output of the color imaging pick-up device, the signal isn't in the NTSC standard chroma signal format required by color receivers and recorders. The camera's chroma process circuits convert the special format CCD chroma output signal into standard NTSC format chroma.

At the beginning of the chrominance

R	G	B	R	G	B	R	G	B
R	G	B	R	G	B	R	G	B
R	G	B	R	G	B	R	G	B
R	G	B	R	G	B	R	G	B
R	G	B	R	G	B	R	G	B
R	G	B	R	G	B	R	G	B

Figure 7. The color filter at the surface of the CCD allows it to sample the brightness level of different colors of light in the scene.

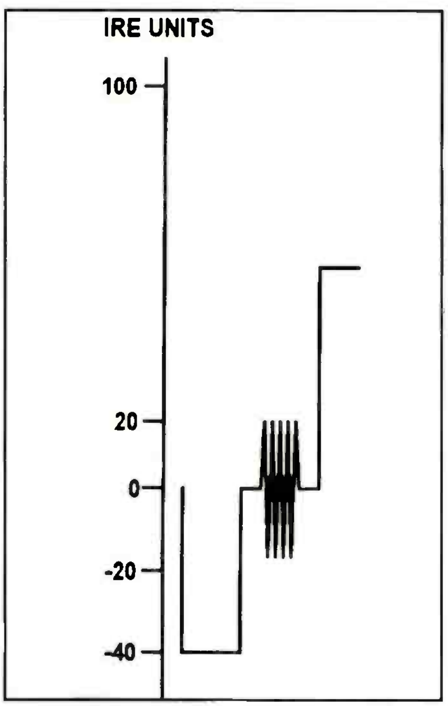


Figure 8. The chroma burst signal is an 8-to-10 cycle sample, just following horizontal sync, of the 3.58MHz reference signal the camera used to create the 3.58MHz chroma signals.

process section, the chrominance signal is separated from the rest of the video signal. This is done with sample-and-hold circuits or signal delay/summing circuits. The separated chroma signals consists of R-Y and B-Y signals, each present during alternating horizontal scan periods, or of individual red, green, and blue signals, depending on camera design.

The white balance correction circuit controls the balance between the red and blue signal levels to ensure that white picture areas are reproduced without color tinting when white, uncolored areas of the scene are being scanned. This compensates for the differences in color between the various scene illumination sources (natural, incandescent, flourescent, mercury vapor, etc.).

The auto white balance circuit analyzes the color of light arriving at the camera, by examining the output of either the R-Y/B-Y separator circuit or the white balance sensor. After averaging the color out over a period of time, it applies a gain correction signal to either the red or the blue channel in the white balance correction stage. Adjustments in this circuit set proper presets for normal indoor and normal outdoor white balance. These presets are used by the auto white balance circuit to automatically adjust for other scene illumination colors.

Gamma correction corrects the amplitude of the chroma signal the same as is done for the luminance signal. The chroma AGC amplifier operates in step with the luminance AGC amplifier by receiving a control signal from the luminance AGC detector and amplifying the chroma signal during low light conditions when the iris is unable to admit enough light to produce normal output signal level.

The R-Y/B-Y separation circuit produces separate R-Y and B-Y signals. The red and blue components of the color signal (less luma) are amplitude modulated onto individual 3.58MHz subcarriers, which are 90 degrees out of phase with each other. These two modulated subcarriers are then added to produce a single 3.58MHz NTSC chroma output signal, which varies in amplitude according to color saturation changes and varies in phase according to color hue changes. Chroma gain and chroma phase adjustments set the modulator outputs to match the saturation and hue of the camera's chroma output signal to the light input.

NTSC standard color receivers require a sample of the camera's 3.58MHz chroma reference signal in order to properly demodulate and display the camera's chroma output signal. The sync generator produces a 9 cycle sample of its 3.58 MHz reference signal during each horizontal blanking time, and combines it with the chroma signal (Figure 8).

Since this sample of the camera's reference signal is present for just a short period (burst) of time during each horizontal scan, it is refered to as chroma burst. Some cameras include an adjustment to set the burst to its proper amplitude of 40 IRE peak to peak.

Signal Output

After the luma and chroma signals have been processed, they are then added together in the Y/C adder stage (which may be shared with the camcorder VCR section), to form composite video. This signal is sent to the electronic viewfinder (EVF), the camera video output jack, and the camcorder VCR video record input. This NTSC format composite video signal contains:

- luminance signal assembled from brightness level samples at each pixel,
- horizontal blanking and sync pulses at the end of each horizontal scan line (15,734Hz rate),
- vertical blanking and sync pulses at the end of each field (60Hz rate),
- chroma signal assembled from brightness level samples through colored filter segments and then amplitude/phase modulated onto a 3.58MHz subcarrier,
- subcarrier sample burst signal following each horizontal sync pulse.

Future articles

Future articles will discuss camera testing to verify and localize video camera problems plus troubleshooting and adjustments of camera circuits. ■

How To Maximize Your PC, By Jensen Tools Inc., WEKA Publishing, $59.00

"How to Maximize Your PC," a ring-bound volume from WEKA Publishing edited by Steven S. Ross and Linda A. Schoener, is a guide to IBM/compatible equipment and general PC system troubleshooting and enhancement.

Written in simple terms, How to Maximize Your PC gives straight information about PC hardware and software. Presented exactly as the buyer might need it, it enables anyone to assess their own computing requirements. The work offers hints and recommendations, including many caveats not found in manufacturers' literature. Inside the cover is a free utilities disk from the publisher.

Major topics include IBM Standards and compatibility issues, CPUs, and Co-Processors, Operating Systems including Windows '95, Programming Language Options, Applications Software, Hardware/Peripherals (Cables, Printers, Modems etc.), Enhancement Guidelines, Networks, and Software Tips. Each section deals with typical questions, describes common problems, and outlines steps for remedial action. Updates are available from the publisher.

Jensen Tools, Inc. 7815 S. 46th Street, Phoenix, AZ 85044-5399

Digital Electronics for the Hobbyist, Technician & Engineer, By Stephen Kamichik, PROMPT Publications, 300 pages, $16.95

Digital Electronics is designed to supplement an introductory course to digital electronics, teach the electronics hobbyist about digital electronics, teach the electronics hobbyist about digital electronics, and serve as a review for practicing technicians and engineers. Illustrated with figures, tables and examples, each chapter is a lesson in digital electronics with problems included to test your understanding. With the proper equipment, you can also build the circuits described in Digital Electronics. Building and testing a circuit is the best way to understand its operation!

The information covered in Digital Electronics includes: Logic gates, logic families, logic function, logic function implementation, flip-flops, control circuits, codes, registers, encoders, decoders, and multiplexers, comparator and exclusive-OR circuits, counters, arithmetic circuits, memory, digital-to-analog and analog-to-digital converters, and more.

Author Stephen Kamichik is an electronics consultant who has developed dozens of electronics products and received patents in both the United States and Canada. He holds degrees in electrical engineering, and was employed for several years as an electronics technician at SPAR in Montreal, where he worked on the initial prototyping of the Canadarm. His other books include *Advanced Electronic Projects for Your Home & Automobile* and *Semiconductor Essentials for Hobbyists, Technicians & Engineers*, also published by PROMPT.

PROMPT Publications, 2647 Waterfront Parkway, E. Drive, Suite 300, Indianapolis, IN 46214-2041

Setting up a service bench

By the ES&T Staff

The location in the service center where the income is generated is the service bench. We have spoken about the importance of having a neat reception area, attractive signs that communicate the nature of the business to prospective customers, and well thought out advertising that brings the customer in. Those are all important facets of a successful service center. But they're all for naught if the technicians who work at the benches aren't performing service efficiently and profitably.

What goes into an efficient service bench

Simply stated, an efficient service bench is one at which all of the tools, test equipment, test accessories, service literature, and supplies can be readily brought to bear on solving the problems in consumer electronics products placed on the bench for service. It should be a comfortable, well lighted location, with all of the service support functions readily available.

For example, the service bench should have plenty of ac outlets available for plugging in test equipment, soldering tools, the product being serviced, and other electrically operated devices. Of course, because many of today's consumer electronics products are powered by power supplies that employ bridge rectifiers, isolated power supplies should be available at every work station.

The elements of a service bench

Most projects benefit from the use of a checklist. It's useful to sit down, picture the project in your mind and list as many of the requirements as you can think of. For example, when packing for a trip, it helps to have a list of all of the things that you might need so you can check off the items as you put them in the suitcase. The same is true of any other project, whether it's planting a garden or renovating a room of a house.

Here's a partial checklist of the things that make up a test bench. No doubt most technicians and service managers could add to this list.

- Surface area for the product, test equipment, tools, etc.
- Storage: drawers, shelves, bins, etc.
- Tools
- Soldering/desoldering equipment
- Test equipment
- Supplies
- Lighting: general, task and spot
- Power: ac, isolated ac, variable ac/dc power supply
- ESD (electrostatic discharge) protection
- Holder for service literature
- Communications
- Forms/writing implements
- Chemicals
- Computer terminal
- Replacement parts/supplies reception

Stocking the service bench

Everything necessary to get the job done should be at the service bench. Things that are not necessary to get the job done should be elsewhere. For example, if the technician needs a DMM every day, or almost every day, it should be at the bench. But if he needs, say, a signal level meter once a week, it should be available nearby, but shouldn't be cluttering the work area.

The items in the checklist are pretty much self explanatory, but here's a little detail about some of the critical elements.

Lighting

In many service centers today lighting is inadequate. The service area may have dark walls, ceilings, and floors. In some cases, even the workbench, shelves and back panels are dark. The lighting is provided by a few fluorescent fixtures and an adjustable lamp on the bench.

Consumer electronics servicing constitutes a difficult seeing task. The components and printed circuit board traces in modern products are so tiny they are almost invisible. The service literature in many cases has close packed wiring patterns, tiny component symbols and small print that makes it difficult for the technician to read.

Consumer electronics service today demands comfortable, non-glare general lighting to provide adequate illumination, with at least one good task lamp at every work station for close-up illumination and some sort of spot light for seeing into those dark tight places.

Power

Many consumer electronics products these days use a bridge rectifier in the power supply. This means that at least a portion of the circuitry is "hot," and if a line-powered test instrument is used to test the line-powered product, a short circuit will occur, and damage will be done.

It could save a great deal of grief to simply make sure that every bench is supplied with ac from an isolation transformer, and to make it a standard practice to plug products being serviced into the isolated supply.

Depending on the size and nature of the service center, and the number of work stations in the service center, it might be more efficient to install one large isolation transformer and distribute the isolated power to all of the benches, much as is done with standard ac. If such a scheme is used, the isolated power outlets should be physically separated from the ac line outlets and boldly marked as isolated.

ESD (electrostatic discharge) protection

Almost every consumer electronics product made today contains large-scale integrated circuits that are susceptible to ESD damage. If these devices are handled without the necessary precautions they may be destroyed or damaged.

Every service position should provide as much protection from this type of damage as possible: grounding wrist straps, static dissipative work surfaces, and static protective bags for storage of ESD sensitive components.

Communications

In a small service center, the idea of communication for the service bench may seem obvious; the technician merely has to call out to someone nearby. But in larger service centers, the technician at the bench may be a long way from the office or the replacement parts/supply area. If a technician needs to check on the availability of service literature or parts, it could mean several trips a day, causing productivity to suffer.

Such trips could be minimized by providing intercomm communications at every bench. The cost of such a system might be quickly recouped through increases in productivity. Another method of providing this communication would be by placing a computer terminal at every position that would allow the technician to place requests via the keyboard.

Parts/materials

Hand in hand with good communication goes good parts handling. In the average medium to large service center, when a technician has isolated a problem to the component level, he walks to the parts/ supplies area and submits a request for what he needs. The supply person may be busy at the time, thus causing delays. A system such as this can cause a great deal of wasted time.

In one service center operated by a major manufacturer, every service position has not only a means of communication, but a pneumatic tube station. Under this system, once the technician has isolated the problem, he can order the parts or supplies he requires and have them delivered to him without ever moving from the bench.

Of course, a system such as this requires a considerable up-front investment, but the increased efficiency can more than offset the cost of installation.

The little things

Servicing a TV presents some peculiar problems. For example, while servicing a larger set it frequently becomes necessary to perform adjustments on controls at the rear of the set while observing the results on the screen at the front of the set. One of the more efficient and well thought out service centers we know of has a large mirror fastened to the wall at the back of the bench. With this setup, it is not necessary to find a mirror and try to place it where it can be seen. It's always right there where it's needed.

Planning is an ongoing task

With every advance in technology, and with every addition of a product to the list of consumer electronics products, new problems arise in equipping the service bench. It becomes necessary to answer questions such as whether an existing service position, say one that is currently used for servicing of TV sets will be used to service a new product as well, for example personal computers. Or will a new work station be set up for servicing of these new products.

Either way, the same type of planning must be done anew. Storage has to be set aside for software, specialized tools and test equipment for computer service, etc.

If service center personnel don't think these things through as they arise, the service bench will become less efficient. No service center today can afford that. ■

Test equipment update

How to design and build a POST code reader Part 1

By Harvey Schwertly, CET

Every time a personal computer is turned on, it goes through a process called power on self test. This process tests all of the critical subsystems in the computer. If there is a problem in any of them, the computer stops the power up sequence and will not function.

This article will cover the PC booting process and describe how to program a PAL (programmable array logic) device to be used as the address decoding for all diagnostic post ports known by the author.

A future article will describe how to program a PAL to convert a four bit binary number (nibble or nybble) into a hexadecimal digit, how to design a POST code reader, and list the order in which some BIOSes (basic input/output system) emit their POST codes during bootup.

While some readers may not be interested in spending the time to build their own POST reader card, this article will provide any computer servicing technician with a more in-depth knowledge of what a POST code reader card consists of, how it works, and how it interfaces with the appropriate port of the computer. This knowledge will be of value to a technician any time he is called upon to service a dead computer.

The purpose of POST code readers

Post code reader cards are used when servicing dead personal computer systems or hard down systems. Diagnostic software is of no use when servicing dead machines, because a dead machine can't load software or operate in any other manner. Here's an experience I had while using a POST code reader that I have designed and built on what appeared to be a hard down system. The BIOS (basic input/output system) used on this partic-

Schwertly is a digital systems technican, designer and instructor.

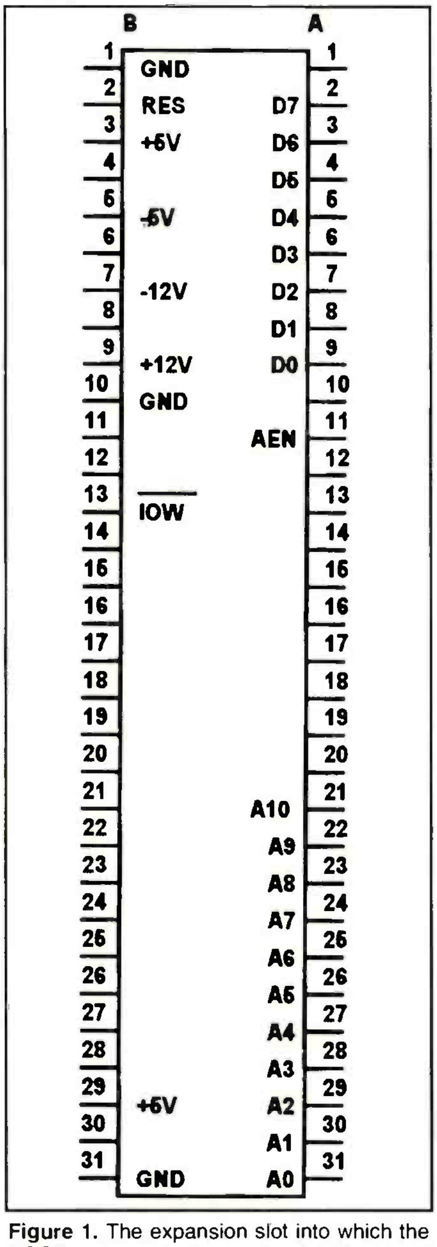


Figure 1. The expansion slot into which the POST code reader card plugs has these pin designations. Looking at the cards from the component side, the pins that plug into the motherboard are A1 to A31 starting from the rear and counting to the front of the computer. Looking at the other side, the solder side, the pins are designated B1 to B31 starting from the rear to front. The A side is used for mostly address and data pins. The other side is used for power and control pins.

Figure 2. The number of the PAL16L8 programmable array logic device gives some information about its construction. The 16 indicates that it has a maximum of sixteen binary inputs. The L indicates that it is a latch.

ular computer was from American Megatrends Inc. (AMI).

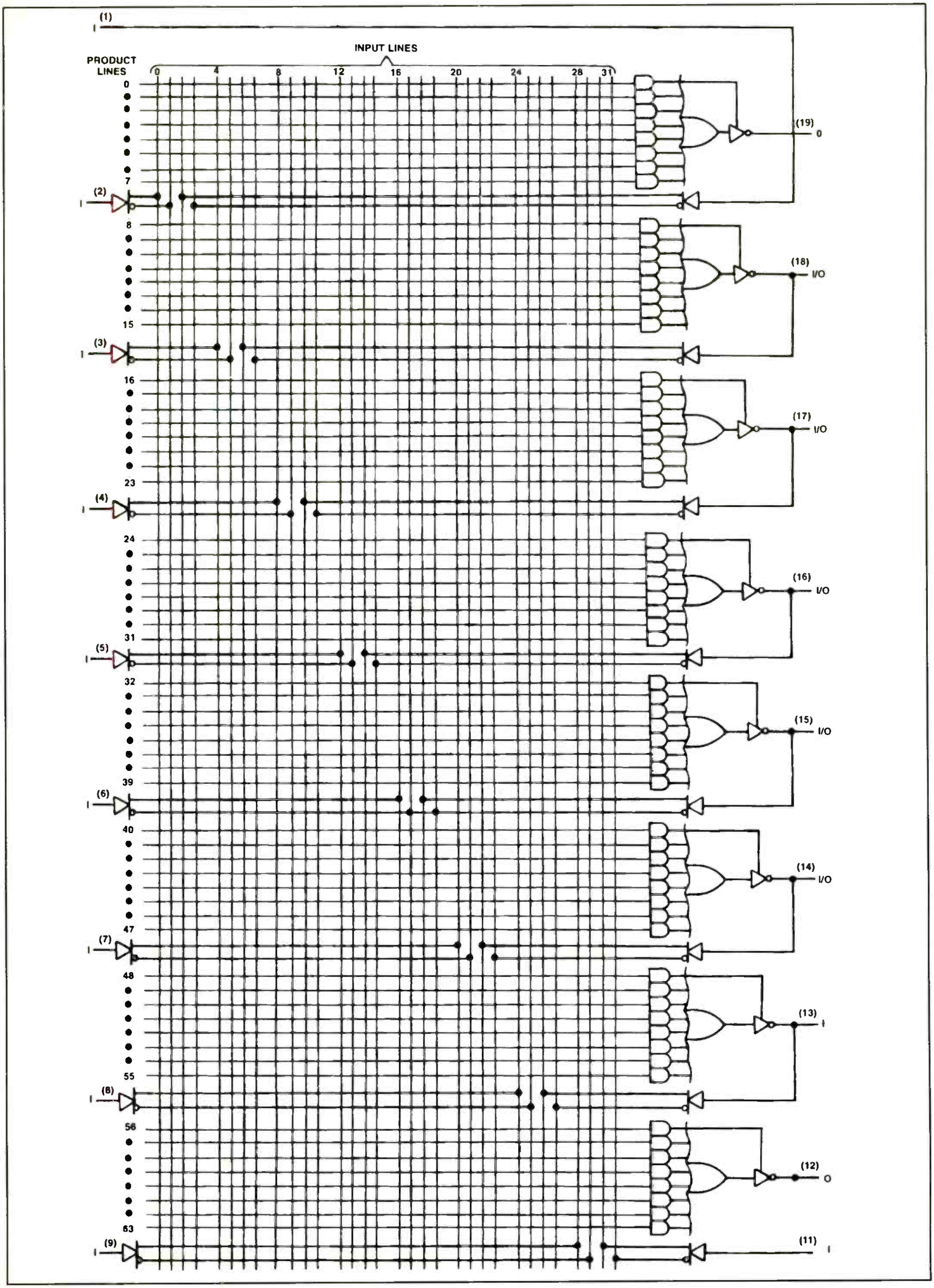
When I plugged the computer in and turned it on, it did nothing, so I turned it back off, plugged my POST code reader card into the computer, and then turned it back on. After a short while I looked at the display on the POST code reader to determine which step in the boot up process had caused the computer to stop. The code on the display was 00H.

This code indicates that the machine was trying to bootup by reading either A: or C: drive. This indication told me that the problem was almost certainly the drive controller card because both drives use the same controller. There was nothing wrong with the motherboard. After replacing the controller card everything worked great.

Another time I used the card in a different machine also with an AMI BIOS. The POST code stopped at 7A which indicated that the CMOS battery needed replacing. Fortunately I had saved the CMOS data to a file on an emergency disk, so I simply replaced the battery, rebooted and changed the time and date. The machine operated normally again.

What the POST codes tell you

The POST codes are emitted by the BIOS to tell you what the computer is doing at the present time, what it is about to do, or what it has just finished doing during the bootup process. The POST code output is in the form of hexadecimal numbers. Some computers, depending on the BIOS manufacturer, also emit a series of high-pitched sounds during bootup


INPUT LINES
PRODUCT LINES
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(19) O
(18) I/O
(17) I/O
(16) I/O
(15) I/O
(14) I/O
(13) I
(12) O
(11) I

(beep codes) to communicate the same information audibly. Not all computers are made to emit beep codes. Moreover, the technician has to know what the beep codes mean in order to interpret what the series of beeps means.

Different PCs use different ports to send the POST codes emitted by the BIOS. The Video ROM (read only memory) may also emit post codes to a different port than one to which the BIOS sends its codes. For those of you who are familiar with machine language, each POST code is accomplished by two MOVE instructions and one OUT instruction for each test. Here's an example of a program fragment used for this purpose:

```
MOV AL,01; Register Test Okay
MOV DX,0080; Diagnostic Port
OUT DX,AL; Out 01 to Port 0080H
```

The POST code ports

All PCs above the XT emit POST codes to tell you if everything is okay or it will stop on the failing test and that will indicate the area that is at fault. Unfortunately, the POST codes emitted by the BIOSes developed by AMI, one of the larger BIOS manufacturers, are not in consecutive order. We will provide more details on that subject in the second part of this article in a future issue.

The PC ports (circuit locations where the computer interfaces with the outside world) go from port address 0000H to FFFFH or 0 to 65535. Of these, only a few ports are used as diagnostic ports. To my knowledge, there are seven ports: 80H, 84H, 90H, 280H, 300H, 3BCH, and 680H. Some companies use the parallel printer port for outputting the POST codes. Some of the numbers are two or three hexadecimal digits instead of 4 digits because the microprocessor inserts leading zeros automatically. The IBM uses port 3BCH, this port is for MC (Micro Channel) computers. The POST code reader I have designed could be used with MC, but an adapter card, costing about $129.00 plus tax, would have to be used because of the different sizes of the expansion slots in the computer.

Overview of the POST code reader card

The PC board for my POST code reader card has three programmed PAL (programmable array logic) devices on it and two seven segment LEDs. The first chip acts as the clock or address decoder for the hexadecimal PAL devices that will be described in the second installment.

There are two other pins on the computer port that are used. One pin on every schematic that I have seen refers to this pin as an active high, however, it is an active low labeled AEN or A11 and I believe that it should be labeled !AEN (! indicates active low) on the schematics. The expansion slots can accept many different cards such as monitor, printer, and serial to mention a few.

Looking at the cards from the component side, the pins that plug into the motherboard are A1 to A31 starting from the rear and counting to the front of the computer. Looking at the other side, the solder side, the pins are designated B1 to B31 starting from rear to front. See Figure 1 for a diagram of the expansion slot and its pin functions.

The POST code readers plug into an empty expansion slot. The A side is used mostly for address and data pins. The other side is used for power and control pins.

I have performed troubleshooting on computers for which I didn't have a schematic just by using the expansion slot connectors. The reason that we want to use all the port addresses at one time without jumpers or switches is that we don't want to miss the POST codes. On some computers, the BIOS may use port 0080H and 0280H at different times and the video ROM may use port 0300H.

The PC booting process

This sequence will describe what happens on most PCs at a cold boot, turning on the machine or pressing RESET.

• First, the RESET pin goes low to reset the microprocessor, making all ports input to the system so that it doesn't accidentally output to any port, because a random binary number may do damage to a peripheral device. The microprocessor just disregards the inputted numbers. Another function of the RESET pin is to jump to address FFFF0H and start executing the BIOS code.

A "warm boot" occurs when you press the CTRL - ALT - DEL keys simultaneously. A warm boot does the same thing as the cold boot does, except that it bypasses the RAM test. During bootup the BIOS disables the NMI (Non Maskable Interrupt). The pin on the microprocessor cannot actually be disabled, so the manufacturer has inserted a two input AND gate and made one input to disable the other input by making this port 00A0H on the XTs. Output 00 to that port disables the AND gate. On AT type machines the port is 0070H. A one in the MSB (most significant bit) disables the NMI pin on the microprocessor.

Figure 3. The Xs on this logic diagram indicate the fuses that are to remain intact. All of the other connecting fuses on that line are to be blown. Programming is accomplished using a device called the Universal Programmer. →

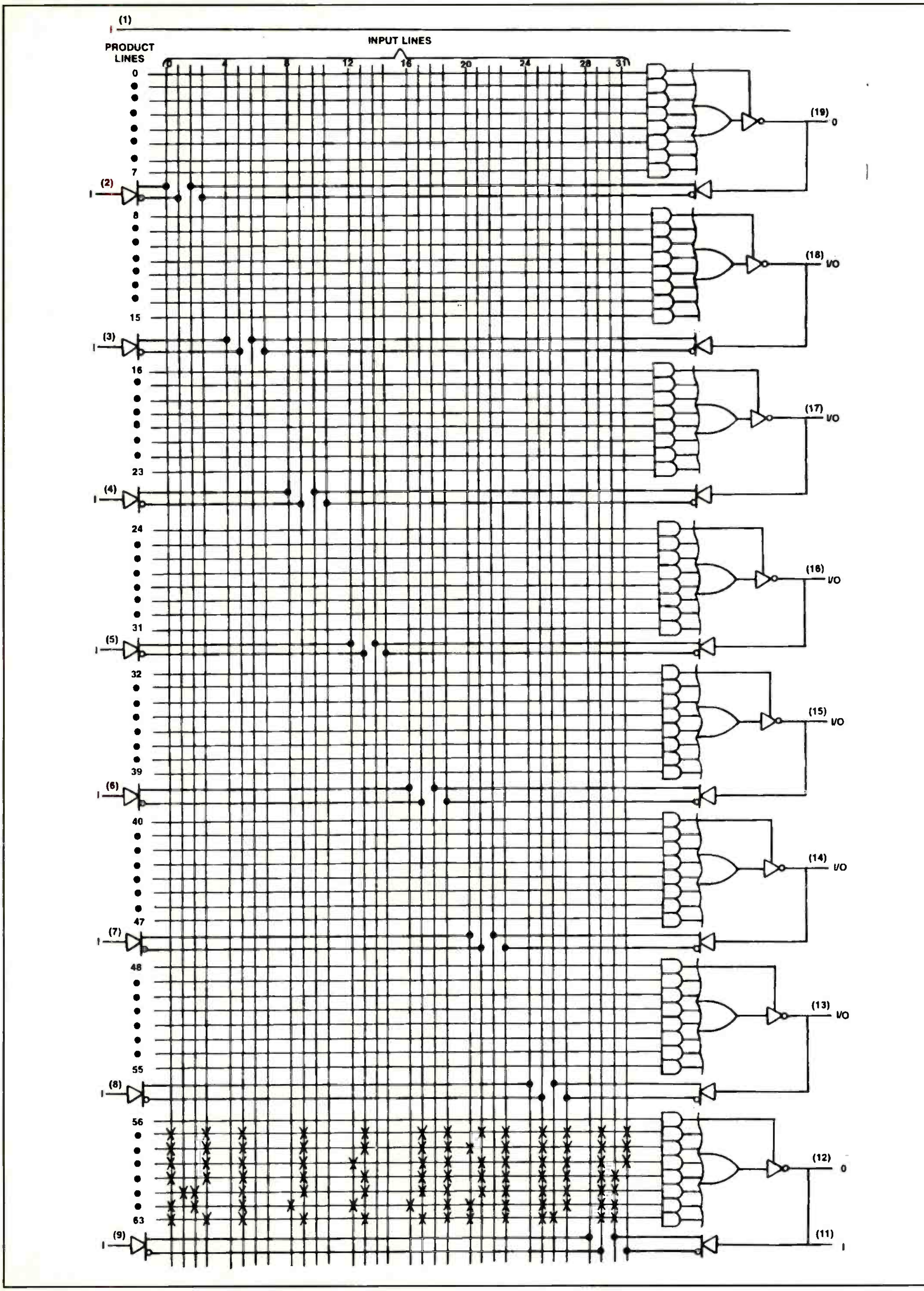
• The BIOS disables the keyboard, monochrome video, CGA video, and then checks itself to make sure all the registers are good. If any register is bad it will shut down. If all of the registers are good it checks the other chips. The BIOS checks itself by adding all the data bytes together and if the result is zero, then the BIOS ROM chip is okay.

• The 8253/4 (triple timer) is programmed and read back to check it, then the BIOS programs, the 8237 DMA (direct memory access) and DMA page resistor chips are checked. They are used to transfer data and to refresh the dynamic RAM (random access memory), commonly known as DRAM chips. The data at each address is refreshed regularly, every 2ms to 4ms.

• The BIOS checks RAM by writing data at addresses and reading it back and comparing the results. If the results are equal the DRAM chips are good.

• The BIOS programs the 8259 (peripheral interrupt controller) and writes the IVT (interrupt vector table) which is in low memory from address 00000H to 003FFH. Then it determines what equipment is attached to the system, then writes this data to the BIOS data table. The BIOS data table is at low RAM address 00400H to 004FFH. The print screen address is 00500H and 00501 and programs that do a print screen will check this address to see if a print screen is in progress.

If any of these steps fail, the computer shuts down. The BIOS checks to see if there are any other ROM chips in the system, and if there are it calculates the size of the ROM and adds all of the bytes together. If the checksum is zero then it will


(1)
PRODUCT LINES
INPUT LINES
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(19) O
(18) I/O
(17) I/O
(16) I/O
(15) I/O
(14) I/O
(13) I/O
(12) O
(11) I

transfer control to that ROM. After that the ROM chip (the EGA/VGA video for example) executes or initializes itself, the EGA/VGA then enables the screen and puts on the first screen, then puts the system in CGA mode (video mode 3) if there is color, or monochrome (video mode 7) if there is no color and then disables it and transfers control back to the BIOS.

The BIOS then checks the CMOS which is port 0070H and 0071H for types, drive sizes and other information, then writes this data into the IVT and the BIOS data table.

The BIOS has all subroutines for its interrupts and video data table, and other tables for hard drives, video tables, and for the keyboard codes.

Hard disk or floppy disk?

If the computer is based on a hard disk, the BIOS will read in the MBR (master boot record) to address 07C00H to 07 and transfer control to the MBR of the first hard drive. The MBR will copy itself to address 00600H to 007FFH. The MBR has the partition table, which indicates where the boot record (BR) is located and the size of the drive. The MBR then loads the BR, this is usually head 0, cylinder or track 0, and sector 1. It will be loaded at address 07C00H to 007EFFH and the MBR will transfer control to that address. That is why it moved itself.

The Boot Record then calculates the drive size and looks to see if these files are on the drive: IBMBIO.COM or MS-BIO.SYS and IBMDOS.COM or MS-DOS.SYS. If these files exist the computer will load part of one of these files to address 00600H and transfer execution to IBMBIO.COM or MSDOS.SYS and it will rewrite some or all of the IVT and will load the rest of itself and continue execution, then loads IBMDOS.COM or MSDOS.SYS and write some more to the interrupt vector table.

The system then loads COMMAND .COM, if no CONFIG.SYS file exists. It then executes the AUTOEXEC.BAT file if it exists, after that you will get the C: prompt. Different BIOSes may do these things in some other order.

If there is no hard drive the BIOS will read Boot Record from the first floppy drive located at head 0, track 0, sector 1 to address 07C00H to 07DFFH and continues like above. After that you have A: prompt. The colon (:) indicates that it is a device and not a file.

PC diagnostic tools

In addition to reporting the step in the POST that is being executed, POST code reader cards also monitor four power supply voltages the +5V, –5V, +12V, and –12V. These test devices also come with a manual that lists the various ports at which the POST codes are emitted by different BIOS manufacturers. The POST codes in all of the manuals, list the hexadecimal numbers in sequence starting with 00H or 01H. However the POST codes are not emitted in consecutive order.

Why use a PLD?

When an engineer is designing an electronics product, there are several ways he can achieve a given set of functions. One way is to design the product so that the circuit is fabricated from individual discrete components, or individual circuit functions such as gates.

Another way to achieve a set of functions would be to design, or have someone else design and produce, integrated circuit packages that perform the specific functions that are required.

In many cases, neither of these approaches is particularly good. Using the first method results in a high parts count, with its attendant increase in fabrication time and effort and a decrease in reliability of the product. The second method could very well result in a large increase in the cost of the product.

Another way to provide the desired functions is to use "programmable" devices. Programmable devices are integrated circuits that consist of large numbers of logic devices on a single IC chip. The method of programming of these devices depends on the particular type of device, but all of them can be customized to provide the desired inputs and outputs. Programmable devices available are EPROM (erasable programmable read only memory) family, PAL (programmable array logic) family, and PLA (programmable logic array) family. Almost all new boards have at least one PLD on it.

The PAL16L6 and PAL16R8

Two very commonly used programmable devices are the PAL16L8 and the PAL16R8 from various manufacturers. The PAL16L8 number indicates that it is a Programmable Array Logic device. The 16 indicates that it has a maximum of sixteen binary inputs. The L indicates that it consists of latches.

Similarly, for the PAL16R8, the 16 indicates that the device has 16 inputs, the R indicates that it consists of registers, the

(Continued on page 39)

I/O PORT ADDRESSES

ADDRESS LINES BINARY											HEX PORT ADDRESSES
A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	
0	0	0	1	0	0	0	0	0	0	0	0080H
0	0	0	1	0	0	0	0	1	0	0	0084H
0	0	0	1	0	0	1	0	0	0	0	0090H
0	1	0	1	0	0	0	0	0	0	0	0280H
0	1	1	0	0	0	0	0	0	0	0	0300H
0	1	1	1	0	1	1	1	1	0	0	03BCH
1	1	0	1	0	0	0	0	0	0	0	0680H

Figure 4. The first step in designing the portion of the POST code reader that decodes the I/O port information is to set up a truth table like this one and select a PAL chip that fits the table.

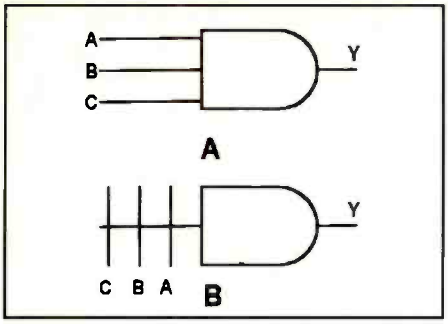


Figure 5. The AND logic gate in a is a standard AND logic gate. Note the difference between it and the PAL AND logic of b. In the case of the PAL AND logic gate, only one input is shown for each AND gate no matter how many inputs the AND gate may have.

8 indicates that it has a maximum of eight binary outputs. Both chips are twenty pin chips, with active low outputs. The logic diagram for a PAL16L8 is in Figure 2.

On the logic diagram, it is understood that every place the lines cross the input of the AND gates that the lines are connected electrically. The connections are fusible. "Programming" of the device consists of leaving those fuses intact that the designer wishes to leave intact, and "blowing" those fuses where he does not want to the lines to be connected.

In Figure 3, the Xs on the logic diagram indicate the fuses that we want to keep intact. The rest we want to destroy on that line. Programming of this device is accomplished using a device called the Universal Programmer.

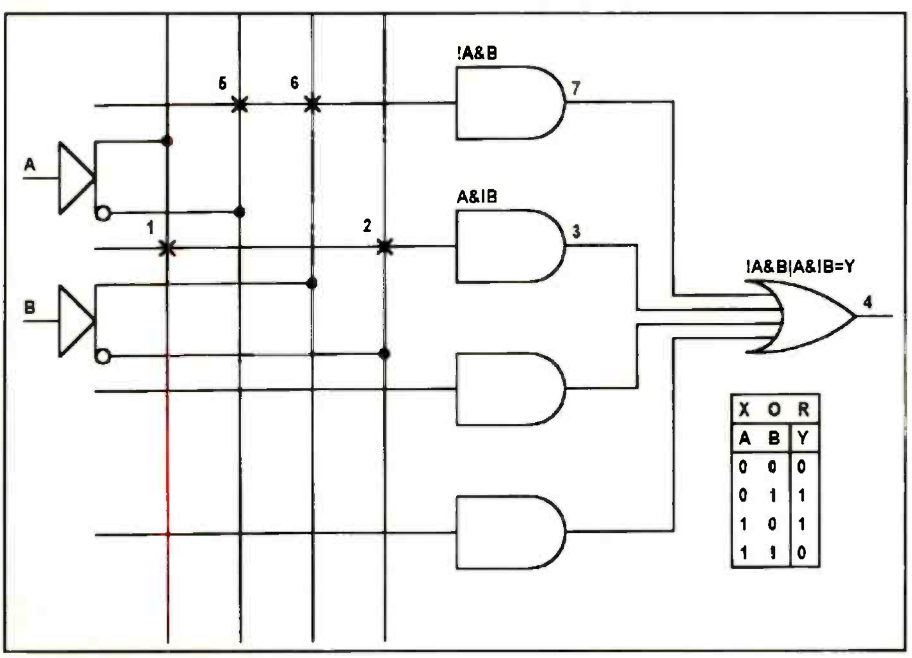
The universal programmer, in addition to allowing the user to program PLDs, also has the ability to read the chips that are inserted in its socket and display the programming to the user, as well as to program other chips or copy them. If the chip is bad you can tell from the display with a little practice. One indication of a bad logic IC chip is that all the connections are burned out.

The big advantage of using PLDs is that you can design your own chips as long as you know what input you need to give you for the desired output. It will reduce chip count and board space and therefore cost less.

Programming the PAL

I needed to design a PC board to read the POST codes that the BIOS emits during a boot up process for troubleshooting hard down computers and repairing them. The first problem that I ran into was that there was a shortage of hexadecimal displays. Moreover, the ones that I found lacked any documentation and the cost was about ten dollars per chip. So I figured that I would program my own chips for about two dollars a chip.

The first step in the process of reading and displaying the POST codes is decoding the information at the I/O port at



X	O	R
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

Figure 6. Use this detail from the PAL logic diagram To plot the Xs on the PALs where the fuses are to be left intact. See the text for the details of how to do this.

```
title{address for PORT I/O}
include p1618.h;
pin12.oe = 1;
!pin12 =
  !pin1 &   pin2 &   !pin 3 &  !pin4 &  !pin5 &  !pin6 &  !pin7 &  !pin8 &  !pin9 &  !pin13 &  !pin14 &  !pin11 &  !pin15
  !pin1 &   pin2 &   !pin3 &   !pin4 &  !pin5 &  !pin6 &  pin7 &   !pin8 &  !pin9 &  !pin13 &  !pin14 &  !pin11 &  !pin15
  !pin1 &   pin2 &   !pin3 &   !pin4 &  pin5 &   !pin6 &  !pin7 &  !pin8 &  !pin9 &  !pin13 &  !pin14 &  !pin11 &  !pin15
  !pin1 &   pin2 &   !pin3 &   !pin4 &  !pin5 &  !pin6 &  !pin7 &  !pin8 &  !pin9 &  !pin13 &  !pin14 &  pin11 &   !pin15
  pin1 &    !pin2 &  !pin3 &   !pin4 &  !pin5 &  !pin6 &  !pin7 &  !pin8 &  !pin9 &  !pin13 &  !pin14 &  pin11 &   !pin15
  pin1 &    pin2 &   !pin3 &   pin4 &   pin5 &   pin6 &   pin7 &   !pin8 &  !pin9 &  !pin13 &  !pin14 &  pin11 &   !pin1
  !pin1 &   pin2 &   !pin3 &   !pin4 &  !pin5 &  !pin6 &  !pin7 &  !pin8 &  !pin9 &  pin13 &   !pin14 &  pin11 &   !pin15;
test_vectors {
pin1  pin2  pin3  pin4  pin5  pin6  pin7  pin8  pin9  pin11  pin13  pin14  pin15  pin12;
0     1     0     0     0     0     0     0     0     0      0      0      0      L;
0     1     0     0     0     0     1     0     0     0      0      0      0      L;
0     1     0     0     1     0     0     0     0     0      0      0      0      L;
0     1     0     0     0     0     0     0     0     1      0      0      0      L;
1     0     0     0     0     0     0     0     0     1      0      0      0      L;
1     1     0     1     1     1     1     0     0     1      0      0      0      L;
0     1     0     0     0     0     0     0     0     1      1      0      0      L;
X     X     X     X     X     X     X     X     X     X      X      X      1      H;
X     X     X     X     X     X     X     X     X     X      X      1      X      H;
}
```

File 1. The IOPORTAD.PLD file is the ASCII text file, which we created. It has a title, include statement, statements such as output enable, the output statements or Boolean equations for the pins, and the test vectors or the truth table.

which the diagnostic information is output. This portion of the circuit is called an I/O port address decoder. This allows us to read the data at the address when the microprocessor writes to one of the DIAGNOSTIC POST ports.

Intel chips and Motorola chips are different in that Intel chips have memory addresses and port addresses that use the same address bus. The system differentiates between the two by including a pin which signifies that the information on the bus is a memory address if the pin is high, and if the pin is low the information on the bus is a port address.

The first step in designing the portion of the POST code reader that decodes the I/O port information is to set up a truth table (Figure 4) and select a PAL chip that fits the table. After that is finished, I write the equations and put Xs on each connection that I don't want to be destroyed by the PAL programmer, this ensures that the chip fits the requirement. Then I write for this process a program in ASCII. I use a text editor, so that the word processor program does not imbed any of its code into the program for the universal programmer. Finally, using a compiler, I compile the code and do a simulation to ensure that the code is correct.

Understanding the PAL AND logic

The AND logic gate in Figure 5a is a standard AND logic gate. Note the difference between it and the PAL AND logic, Figure 5b. In the case of the PAL AND logic gate, only one input is shown for each AND gate no matter how many inputs the AND gate may have. The PAL-16L8 (Figures 2 and 3) show that there are 64 32-input AND gates. Eight AND gates are ORRed to each output. The first AND gate for the eight outputs is the output enable gate used to permanently enable the output for that pin. The sixteen-bit port addresses, can be reduced to eleven address lines because the microprocessor automatically inserts leading zeros. So we can use A0 to A10 or eleven address lines and using the AEN and the !IOW. This gives 13 inputs and we will have one output.

There is another PAL used to control the output of the HEX (PAL16R8), this will be programmed in Part 2.

Requirements of the port address decoder

The PAL16L8 was selected as the port address decoder to clock the data from the data bus into the seven segment display. This chip has sixteen inputs maximum and eight outputs maximum (Figure 2.) This will do nicely. Notice that there are seven port addresses and we have seven AND gates which are ORRed together, then an inverted output.

Here are the pin assignments for the port address decoder, versus the computer's output port pins:

- Pin 9 A31 Address A0
- Pin 8 A30 Address A1
- Pin 7 A29 Address A2
- Pin 6 A28 Address A3
- Pin 5 A27 Address A4
- Pin 4 A26 Address A5
- Pin 3 A25 Address A6
- Pin 2 A24 Address A7
- Pin 1 A23 Address A8
- Pin 11 A22 Address A9
- Pin 13 A21 Address A10
- Pin 14 A11 !I/OW
- Pin 15 B13 !AEN.

Refer to Figure 1 for the expansion slot or channel.

This is the first part of the equation: !pin1 & pin2 & !pin3 & !pin4 & !pin5 & !pin6 & !pin7 & !pin8 & !pin9 & !pin11 & !pin13 & !pin14 & !pin15.

The compiler

The compiler software that I used was proLogic from Texas Instruments. The compiler is free from them, plus you can get a manual to learn PAL programming. Just call the TI distributor nearest you to obtain a copy. The manual will come with the compiler. The symbols that are used in the compiler for these circuits are:

! = NOT symbol 0 = input low#

& = AND symbol 1 = input high#

| = OR symbol H = output high#
X = input don't care L = output low#
() = AND/OR statement

Programming the address decoder

The first step in programming the address decoder is to take a copy of the logic diagram and put Xs where we want to keep those fuses intact. Of the utmost importance is to also make sure that the truth table will fit on the selected PAL. If it did not fit we would have to select another PAL. Refer to Figure 3 which has the hexadecimal logic X'ed out on the diagram. If there is a problem in plotting the Xs, refer to the end of this part in the section "Plotting the X on PALS."

The next step is to write the program using a text editor, not a word processing program, because the word-processing program embeds code for the printer in the beginning of the file, whereas the text editor embeds no code of its own.

The next step is to create a file named IOPORTAD.PLD. Refer to File 1. The first line of the file is the title () [the title of the file is between the parentheses]. The next line is the "include" statement to tell the compiler to use that model. Notice that the rest of the lines end with semicolon (;). The next line, pin12.oe = 1;, tells the programmer to burn out all the connects on that line. The next several lines are the equations taken from the truth table, each equation ending in a ;. The last section is the test_vectors (). The Xs can be either a one or a zero, the outputs are Hs indicating high. The rest of the lines are taken from the truth table.

The compiler displays error messages when and if they encounter a mistake. The name of the text file should have the extension PLD which stands for Programmable Logic Device.

I created the file IOPORT.PLD (File 1) using a text editor. After that, use proLogic compiler to create the file IOPORTAD.LST (File 2) and the file IOPORTAD.JED (File 3) providing that there are no errors in the IOPORTAD.PLD file. The LST file stands for list. The JED file stands for JEDEC (Joint Electronic Device Engineering Council), it is the industry standard.

Finally, after that is completed I used the proLogic Simulator which creates a file IOPORTAD.TST (File 4). The TST file stands for test. Now there are four files

Circle (61) on Reply Card

proLogic Compiler
Texas Instruments V2.0
Copyright (C) 1991 Prologic Systems

FUNCTIONS

pin12.oe=
1

!pin12=

!pin1 &	pin2 &	!pin3 &	!pin4 &	!pin5 &	!pin6 &	!pin7 &	!pin8 &	!pin9 &	!pin13 &	!pin14 &	!pin11 &	!pin15
!pin1 &	pin2 &	!pin3 &	!pin4 &	!pin5 &	!pin6 &	pin7 &	!pin8 &	!pin9 &	!pin13 &	!pin14 &	!pin11 &	!pin15
!pin1 &	pin2 &	!pin3 &	!pin4 &	pin5 &	!pin6 &	!pin7 &	!pin8 &	!pin9 &	!pin13 &	!pin14 &	!pin11 &	!pin15
!pin1 &	pin2 &	!pin3 &	!pin4 &	!pin5 &	!pin6 &	!pin7 &	!pin8 &	!pin9 &	!pin13 &	!pin14 &	pin11 &	!pin15
pin1 &	!pin2 &	!pin3 &	!pin4 &	!pin5 &	!pin6 &	!pin7 &	!pin8 &	!pin9 &	!pin13 &	!pin14 &	pin11 &	!pin15
pin1 &	pin2 &	!pin3 &	pin4 &	pin5 &	pin6 &	pin7 &	!pin8 &	!pin9 &	!pin13 &	!pin14 &	pin11 &	!pin15
!pin1 &	pin2 &	!pin3 &	!pin4 &	!pin5 &	!pin6 &	!pin7 &	!pin8 &	!pin9 &	pin13 &	!pin14 &	pin11 &	!pin15

proLogic Compiler
Texas Instruments V2.0
Copyright (C) 1991 Prologic Systems

FUSE PLOT

address for PORT I/O

p16l8 revision 89.2.1

			11	1111	1111	2222	2222	2233		
	0123	4567	8901	2345	6789	0123	4567	8901		
0	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	OE	
1	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
2	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
3	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	!pin19
4	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
5	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
6	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
7	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
8	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	OE	
9	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
10	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
11	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	!pin18
12	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
13	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
14	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
15	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
16	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	OE	
17	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
18	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
19	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	!pin17
20	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
21	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
22	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
23	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
24	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	OE	
25	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	
26	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	+	

```
27   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +    !pin16
28   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
29   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
30   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
31   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +

32   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  OE
33   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
34   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
35   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +    !pin15
36   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
37   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
38   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
39   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +

40   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  OE
41   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
42   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
43   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +    !pin14
44   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
45   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
46   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
47   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX+

48   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  OE
49   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
50   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
51   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +    !pin13
52   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
53   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
54   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  +
55   XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXX   XXXX  +

56   ——    ——    ——    ——    ——    ——    ——    ——    OE
57   X—X   -X—   -X—   -X—   -X-X  -X-X  -X-X  -X-X  +
58   X—X   -X—   -X—   -X—   -X-X  X—X   -X-X  -X-X  +
59   X—X   -X—   -X—   X—    -X-X  -X-X  -X-X  -X-X  +    !pin12
60   X—X   -X—   -X—   -X—   -X-X  -X-X  -X-X  -XX-  +
61   -XX-  -X—   -X—   -X—   -X-X  -X-X  -X-X  -XX-  +
62   X-X-  -X—   X—    X—    X—X   X—X   -X-X  -XX-  +
63   X—X   -X—   -X—   -X—   -X-X  -X-X  -XX-  -XX-  +

 || || || || || || || ||
pin2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
  |  |  |  |  |  |  |  |
 pin1 18 17 16 15 14 13 11
```

Legend:
X : Cell intact (JEDEC 0)
- : Cell programmed (JEDEC 1)

X- : True input term
-X : Complement input term
XX : Any XX pair in a product term yields product term LOW.
— : No input term (don't care). A product term comprised
entirely of — yields product term HIGH.

File 2. The IOPORTAD.LST file was created by the compiler. It lists the equations from the PLD file, and the fuse plot. This shows you what fuses have been blown and which are intact. A - indicates a blown fuse and an X indicates that the fuse is intact. The fuse plot should be compared to Figure 5. They must be the same. If they are not the same one or both have one or more errors and must be corrected.

IOPORTAD.PLD, IOPORTAD.LST, IOPORTAD.JED, and IOPORTAD.TST.

The files

The IOPORTAD.PLD (File 1) file is the ASCII text file, which we created. It has a title, include statement, statements such as output enable, the output statements or Boolean equations for the pins, and the test vectors or the truth table.

The IOPORTAD.LST (File 2) file was created by the compiler. It lists the equations from the PLD file, and the fuse plot. This shows you what fuses have been blown and which are intact. A - indicates a blown fuse and an X indicates that the fuse is intact. The fuse plot should be compared to Figure 3. They must be the same. If they are not the same one or both have one or more errors and must be corrected.

The IOPORTAD.JED (File 3) file was created by the compiler. This is the file that is used by the device programmer to program the chip. It lists the lines to be programmed and ones and zeros. Ones are the fuses that are blown and the zeros are the fuses that are intact. This file can be compared to both the JED file and Figure 3 they must all be the same. The line numbers start at 0000 and each line goes up by 32. The last line is numbered 2016. The line numbers on the IOPORTAD .JED file and the line numbers on Figure 3, the logic diagram are the same.

Next come the test vectors. They come from the IOPORTAD.PLD file. The first line of the test vectors, starting with 0, is pin 1 and proceeding in sequence to pin 15. These are the inputs from the address bus and two from the control bus. The N indicates that these pins are not programmed. The L stands for a low output, the H stands for a high output. These test vectors should match the test vectors in the IOPORTAD.PLD file.

The IOPORTAD.TST (File 4) file was created by the simulator. This file has the test vectors the same as the JED file unless it finds errors then it will tell you what is wrong. I recommend taking a little time in comparing the files to the logic diagrams. Most text books that I have seen do not give you all the files.

```
•proLogic Compiler
Texas Instruments V2.0
Copyright (C) 1991 Prologic Systems

   address for PORT I/O

p1618 revision 89.2.1

*N_csidp1618
*QP20
*QV9
*QF2048
*F0
*L1792  11111111111111111111111111111111
*L1824  01101011101110111010101010101010
*L1856  01101011101110111010011010101010
*L1888  01101011101101111010101010101010
*L1920  01101011101110111010101010101001
*L1952  10011011101110111010101010101001
*L1984  01011011011101110110011010101001
*L2016  01101011101110111010101010011001
*C15D4
*V1  01000000N0L000NNNNN
*V2  01000100N0L000NNNNN
*V3  01001000N0L000NNNNN
*V4  01000000N1L000NNNNN
*V5  10000000N1L000NNNNN
*V6  11011100N1L000NNNNN
*V7  01000000N1L100NNNNN
*V8  XXXXXXXXXNXHXX1NNNNN
*V9  XXXXXXXXXNXHX1XNNNNN
* (HEART)A4D4
```

File 3. The IOPORTAD.JED file was created by the compiler. This is the file that is used by the device programmer to program the chip. It lists the lines to be programmed and ones and zeros. Ones are the fuses that are blown and the zeros are the fuses that are intact. This file can be compared to both the JED file and Figure 3 they must all be the same.

How to use the compiler

To use the compiler program on your computer, at the DOS prompt type CD\ PROLOGIC, then type LC IOPORTAD if your file is in the PROLOGIC directory, or type the correct path name for your system. Then type IOPORTAD.

After the compiler has completed compiling the program, take the JED file on a disk and the chip to the person that is going to program your chips. Depending where you live, finding a programmer may be difficult. In San Diego California area, I had problems finding someone to program a PAL, one wanted a minimum of $500.00.

So I bought my own Universal Programmer for business reasons from:

Electronic Engineering Tools
528 Weddell Dr. Suite 4
Sunnyvale, CA 94089
(408)-734-8184

It cost around 500 dollars.

The display

This POST code reader uses common cathode seven segment displays, which means the highs will be connected to a resistor to the anodes of the displays. Data sheets for most of the seven segment displays indicate that the voltage drop across the LED is 1.6V and the maximum current is 20mA. Running the LEDs at less than maximum current will lengthen their life, so I designed the display to run at half of the maximum current.

I calculated the value of the series resistor by this formula:

5V - 1.6V/10mA = 340Ω. When the LEDs are on they drop approximately 1.6 V. I used 330Ω resistors, because this is a common resistance value.

Plotting the X on PALS

To plot the Xs on the PALs, refer to Figure 6 as it is described. Looking at the diagram, the two inputs are A and B. Let's take the case where A is a 1, and B is a 0. This can be read as A AND NOT B. Then for the A we use the noninverted line to the second AND gate, point 1, and make an X indicating that we don't want to burn out that fuse. For B we use the inverted line to the second AND gate, point 2, and

proLogic Simulator
Texas Instruments V2.0
Copyright (C) 1991 Prologic Systems

Architecture Description: p16l8.lxa
JEDEC Fuse Information: ioportad.jed
JEDEC Test Vectors: ioportad.jed

V1	0100	0000	0N0L	000N	NNNN
V2	0100	0010	0N0L	000N	NNNN
V3	0100	1000	0N0L	000N	NNNN
V4	0100	0000	0N1L	000N	NNNN
V5	1000	0000	0N1L	000N	NNNN
V6	1101	1110	0N1L	000N	NNNN
V7	0100	0000	0N1L	100N	NNNN
V8	XXXX	XXXX	XNXH	XX1N	NNNN
V9	XXXX	XXXX	XNXH	X1XN	NNNN

No errors detected with 9 Test Vectors.

File 4. The IOPORTAD.TST file was created by the simulator. This file has the test vectors the same as the JED file unless it finds errors then it will tell you what is wrong.

make an X indicating that we don't want to burn out that fuse. So now, the second AND gate, point 3, will have a high output. The OR gate will also have a high output, point 4. If A is a 0 and B is a 1, this can be read as NOT A AND B.

Then for the A we use the inverted line to the first AND gate, point 5, and make an X indicating that we don't want to burn out that fuse. For B we use the noninverted line to the first AND gate, point 6, and make an X indicating that we don't want to burn out that fuse. So now the first AND gate, point 7, will have a high output. The OR gate will also have a high output point 4. The other two conditions are A is a 0, and B is a 0, and A is a 1, and B is a 1. This will give points 3, 7, and 4 a low output. This circuit can be used for an EXCLUSIVE OR gate compare with the truth table for the XOR gate Figure 6.

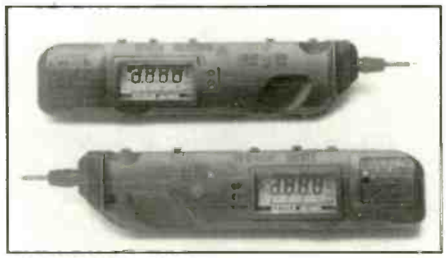
A note from the editors

This article is being published because more and more of the readers of this magazine are servicing personal computers. Because POST code reader cards are really not terribly expensive, many technicians would rather buy one than spend the time and effort required to build one.

However, even if a reader of this article has no plans to build this device, the details on programming and using the device provides useful information on the POST code reader and its interface to the computer that will result in more efficient troubleshooting. Moreover, because many modern electronic products incorporate programmable logic devices, the details of the devices and there programming provide information of which every technician should be aware. ■

Circle (62) on Reply Card

PRODUCTS



Pen multimeter with frequency and logic test

Extech's pen multimeter is ideal for troubleshooting PC boards, TVs, and all digital and analog circuits. Two LCD displays, one on each side of the meter, permits the user to observe display and probe tip connection at the same time during right or left handed operation. Measurements include dcV up to 500V with an accuracy of +-0.5%, acV up to 500V, ac and dc current, resistance, and frequency plus Logic test for indicating CMOS/TTL threshold levels, and audible continuity and diode tests. Data Hold and Auto/Manual range selection are also featured. Display up to 3200 counts with analog bar graph with indication for Function, Auto Polarity, Low Battery, and Overrange.

Circle (31) on Reply Card

Triple output power supply

B&K Precision has announced the Model 1670, a triple output power supply, for applications for servicing, education and hobbyists. The unit features a variable dc supply, 0V to 30V at 0A to 2.5A with variable current limiting, constant current or constant voltage operation, tight regulation, (1%) low ripple, (5mV rms) and separate digital LCD current and voltage meters.

Another fixed 5V, 0. 5A output is provided for TTL projects and a fixed 12V, 0.5A supply is included for mobile electronics and digital CMOS projects.

Circle (32) on Reply Card

SMD Tools

TopLine is offering a new line of ESD safe plastic tweezers. Three styles are available featuring straight or curved tips. Tweezers are heat resistant to 428F, nonmagnetic, acid resistant and do not contaminate. The tips do not spread under pressure. They are useful for handling semiconductors, chips and wafers without damage.

Two materials are available, static dissipative and conductive. The surface resistivity of the static dissipative and conductive. The surface resistivity of the static dissipative is 3 to 4.5 x $10^5\Omega$/sq. and the transversal resistivity is 1.5 to 2.5 x $10^2\Omega$/sq. The surface resistivity of the conductive tweezers is 3 to 4.5x$10^2\Omega$/sq. and the transversal resistivity is 1.5 to 6x$10^2\Omega$.

The tweezers come in three styles: straight flat round tip, very fine straight tip and very fine curved tip. The overall length is 4.5".

Circle (33) on Reply Card

Leakage current locator

Electronic Design Specialists announces the LeakSeeker 82A, a test device that locates leaky or shorted components. Touch the unit's probe anywhere on the pc foil that is showing a low resistance, and it automatically calibrates itself to the resistance of the bad component. Move the probe in one direction, then another, and the tester will beep higher or lower, and light the LED scale to show you if you are getting closer or farther from the leaky part. The tester will automatically recalibrate itself as you make progress, so there is no adjusting required. The solder connection where the beep is highest is the bad component.

The tester will locate not only shorted components, but leaky components that can be as high as 150 Ω. It can even find shorted components on the other side of a power supply diode, where an ohmmeter would read infinite.

There is also a three-wire test mode, to locate thermally defective leaky components.

Circle (34) on Reply Card

DMMs

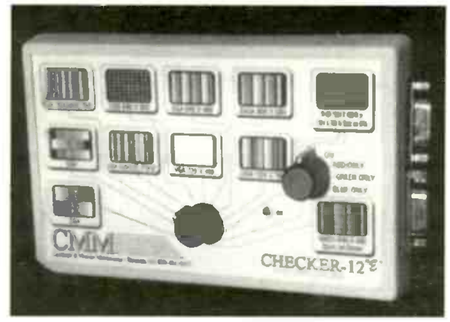
Metrix Instruments announces a new series of 50,000-count true RMS (DMMs) that provide a high level of both accuracy and resolution, as well as unsurpassed safety features.

All models in the ASYC II series digitally display resolution of 50,000 counts, a 25-fold improvement over traditional 2,000-count multimeters. All have capabilities for True RMS measurement (ac, and dc plus ac), for accuracy in handling non-sinusoidal, or irregular, waveforms. In addition, the meters feature basic dc accuracy to 0.025% and bandwidths to 100KHz, as well as facilities for automatic storage of the last reading, hold, fast, peak capture and relative reading modes. Also included are comprehensive autoranging voltage and current, capacitance and frequency (to 500KHz) measurements, as well as percentage duty-cycle, positive or negative pulse width and pulse counting facilities. *Metrix* has a patent pending on its resistive power function included in the top of the line model, which offers a choice of reference resistances.

Circle (35) on Reply Card

Monitor tester

Computer & Monitor Maintenance Inc. announces the "Checker 12 E," a re-engineered version of the popular Checker 12, which features two additional operating modes: 56KHz horizontal/70Hz vertical, and 64KHz horizontal/70Hz vertical.



The tester was developed in response to requests for higher horizontal scan rates. It is a hand held, battery operated (ac adapter included) computer monitor test pattern generator.

With the tester, a field service technician can quickly isolate display problems without having to open the computer. By simply connecting the monitor to the unit, most problems can be quickly isolated.

Circle (36) on Reply Card

Circle (51) on Reply Card

A brief look at color television receiver circuits

By Lamarr Ritchie

This is the third part of a four-part article that describes all of the circuits in a modern TV receiver. The fourth and final part, deflection circuits and high voltage, will be published in July 1996 **ES&T**.

Chroma bandpass amps

The chroma bandpass amplifiers remove the color portion of the video signal and amplify it in addition to the color burst. The key points concerning chroma bandpass amplifiers are:

• They are tuned amplifiers with a bandwidth of at least 1Mhz.

• The last bandpass amp before the demodulators may be keyed off during retrace to prevent the burst from reaching the demodulators.

• The level control for the color will be found in one of these stages, or at their output for the user to adjust the saturation, or amount of color.

• Two voltages associated with the bandpass amps are the color killer bias and ACC (automatic color control) bias.

• Peaking is used at about 4.08Mhz to compensate for the sloping part of the video IF curve that contains the color, as shown in Figure 1.

Figure 2 illustrates a typical chroma bandpass amp.

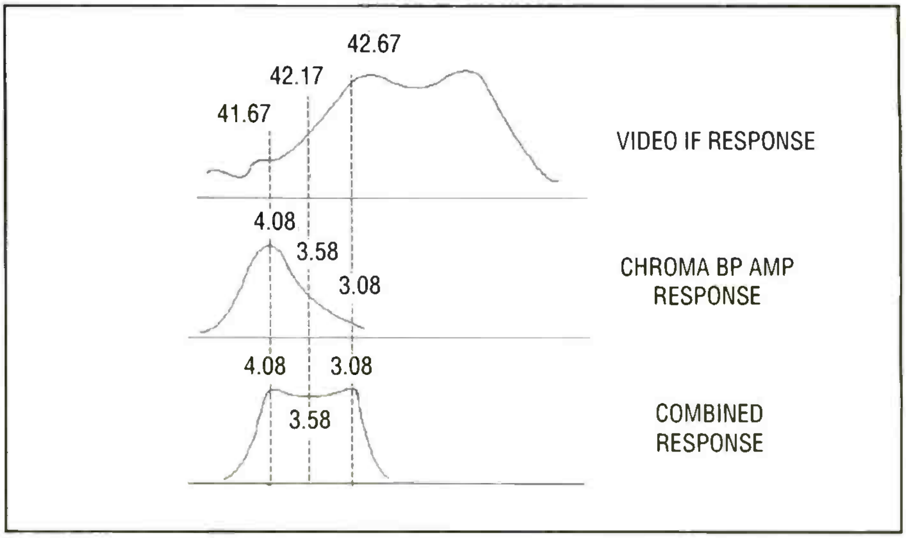


Figure 1. Peaking is used in the chroma bandpass amplifier at about 4.08Mhz to compensate for the sloping part of the video IF curve that contains the color.

Burst amplifier

The burst amplifier removes and amplifies the color burst which is used to lock in the color oscillator. To enable this amplifier to amplify only the color burst, it must be a keyed amplifier, keyed on during the blanking interval when the burst occurs. It may be keyed using pulses from the flyback transformer, or delayed pulses from the sync separator.

Keying from the sync has the advantage of making the timing independent from the horizontal hold control or AFC circuits which could change the phase of the amplifiers output and therefore, the hue of the picture.

Ritchie is an electronics instructor at Kentucky tech, hazard Campus.

In the example circuit of Figure 3, the keying pulses provide the base bias voltage to the transistor allowing it to amplify the signal supplied from the chroma bandpass amp during this time. Since it is the color burst that occurs during this time, this is the only signal that will appear at the output of this stage.

Color oscillator

The color oscillator is a crystal oscillator at 3.579545Mhz. This oscillator is used to reinsert the color subcarrier that was suppressed by the color camera circuitry. The CW from the oscillator will be used as a reference in the demodulators to recover the color video signal.

A crystal oscillator alone is not stable enough to mimic the frequency and phase of the original subcarrier, so it must be used in conjunction with the color sync to provide a phase-locked reference signal.

Associated with the color oscillator, or burst amp feeding the oscillator, is the hue control for the color. Varying the phase of the oscillator CW will vary the phase of

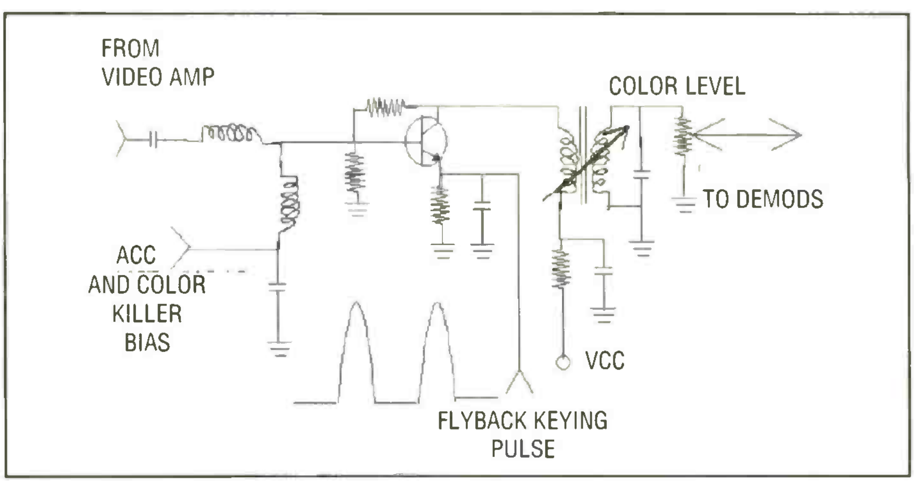


Figure 2. A typical chroma bandpass amp.

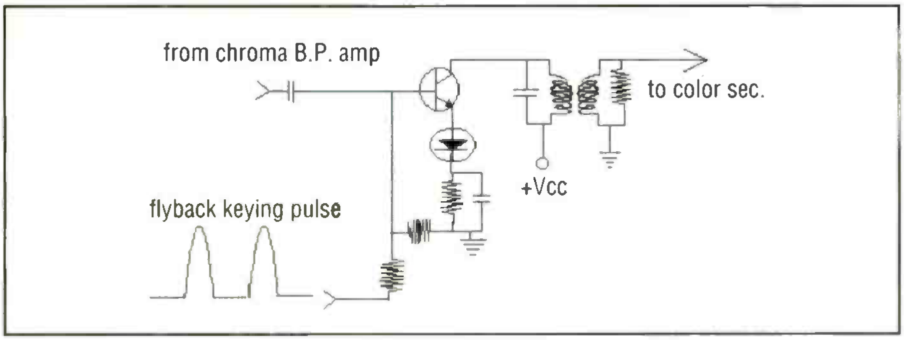


Figure 3. The burst amp removes and amplifies the color burst used to lock in the color oscillator. To enable it to amplify only the color burst, it is keyed on only during the blanking interval when the burst occurs.

the demodulated R-Y and B-Y signals, thereby varying the hue or tint of the color.

It is well to note here that *any* internal adjustments of the bandpass coils and transformers associated with either the burst amp or oscillator will vary the phase, and hue, of the color signal.

Chroma demodulators

The chroma demods take the color signal input from the chroma bandpass amps along with the CW signal from the color oscillator and recover the original color difference signals. TV receivers have either two or three demods. Most receivers have R-Y and B-Y demods to recover these two original signals. In most older receivers, a matrix circuit mixed these two in proper amounts to produce the G-Y signal. Obtaining the G-Y signal in this way requires fewer parts and is a little cheaper and easier to accomplish where integrated circuits are not used. Most modern receivers have a G-Y demodulator instead of the matrix circuit. Some receivers used X-Z demodulators. These altered the phase angles to make it easier to recover the G-Y signal.

In addition to demodulating the color signal, the demods must also restore the proper amplitude to the color difference signals. These were altered during the modulation process. Since blue colors tend to be darker, if the correct amplitude of the color signal for a saturated blue were used, the negative half-cycle of the color signal would extend well into the sync region. To prevent this interference from happening the B-Y signal is reduced in proper amplitude.

Likewise, hues containing red are reduced in amplitude, but not as much as the blue. Since the eye is more sensitive to hues containing green, and green is the major component of white light and thus the luminance signal, the G-Y signal is increased in proper amplitude. The actual changes in proper amplitude for the three signals are:

B-Y 0.49
R-Y 0.877
G-Y 1.423

The receivers demods must have their gain altered to compensate, so their relative gain must be:

B-Y 1/0.49 = 2.03
R-Y 1/0.877 = 1.14
G-Y 1/1.423 = 0.70

Basically, a color demod is a differen-

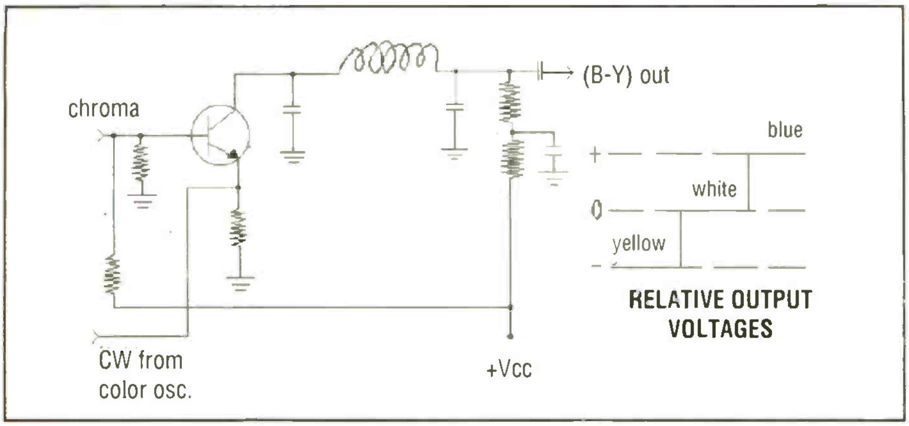


Figure 4. A color demodulator is a differential or additive type amplifier with the color signal at one input and the 3.58Mhz oscillator CW at the other. As the phase between the two vary, the output amplitude will vary. This is an example of a B-Y demodulator.

tial or additive type amplifier with the color signal at one input and the 3.58Mhz oscillator CW at the other. As the phase between the two vary, the output amplitude will vary.

Although we will be discussing some of the discrete circuits, as we have been doing, it must be pointed out again that modern receivers have these circuits within integrated circuits. The "color IC" for a TV may contain all of the color circuits from bandpass amps through demodulators. An understanding of the circuit operation is still necessary to assist in recognizing color problems and diagnosing problems in discrete components in the color circuits. Figure 4 is an example circuit of a B-Y demod.

The two signals are fed to the transistor as shown. When the phase of the chroma is at 0 degrees, it is in phase with the oscillator CW and minimum output current occurs because there is little difference in voltage between the transistor base and emitter. This will produce maximum collector voltage at this point. If the chroma signal were to be at 180 degrees, roughly corresponding to the color yellow, then maximum collector current will flow producing minimum collector voltage.

The diagram shows the relative outputs that would occur for the colors yellow, white and blue.

The output circuit of the demods is a low-pass filter with a cutoff frequency of about 0.5Mhz to 1.5Mhz, depending on the receiver. This filter eliminates the 3.58Mhz signals and produces only a varying signal voltage that corresponds to the average of the total difference in phase of the two input signals. The smaller the phase angle between the two signals, the greater the output voltage. Keep in mind that the encoded color signal is input to the demods. This is not video. The output of the demods is a video signal.

For input to the grid of the CRT, the above circuit has the proper phase, since positive video must be used there. However, for cathode drive the signal must be of negative phase. That is, we will need

ES&T Calendar

WESA (WI) 36th Annual State Convention
June 7-9, 1996
Green Bay, WI
414-425-6193

1996 Satellite Dealers Association Annual Conference
June 13, 14, 15
Faribault, MN 55303
800-288-3824

National Professional Service Convention and Professional Service Trade Show
August 5-10, 1996
St. Louis, MO
817-921-9061

ServiceTech '96: Fourth Annual Conference of Innovation in Services Technology
September 9-12
Boston, MA
800-333-9786 or 941-275-7887

26th World Conference and Exhibition
October 27-29
San Diego, CA
800-333-9786 or 941-275-7887

-(B-Y) instead of B-Y. This is no problem because the following stage can invert the phase of the signal.

Transistor chroma demods

The only difference between this demodulator and the R-Y demod is that the oscillator signal is shifted in phase by 90 degrees before being input to the demod. Then, if the color signal phase is near 90 degrees it will be in phase with the oscillator signal, and maximum collector voltage will be produced.

Figure 5 is an example diagram of transistorized R-Y and B-Y demodulators. A circuit known as a balanced demodulator circuit has been used in some receivers and can be implemented using diodes instead of transistors.

Although a separate demodulator can be used for the G-Y signal, it has been noted that this signal can be derived by mixing the R-Y and B-Y signals in the proper proportion. This is possible because all three color signals were used in a mixture to produce the two color difference signals. Figure 6 shows a method of obtaining the G-Y signal.

This diagram also shows a method of mixing the luminance (Y) component back in to the color difference signals. This is the most often used method of color demodulation. In this method, one of the two signals (Y and color difference) may be fed to the base of the amplifier transistor and the other to the emitter. The output would then contain R, G, or B with the proper amount of luminance.

Matrixing, or mixing of the signals can be accomplished at the picture tube also, using both the grids and cathodes of the CRT. For instance, the separated color difference signals (at a negative phase) can be tied to the individual cathodes. The luminance signal (at a positive phase) from a Y output amp can be connected to the three control grids, the grids all being connected together.

To help in the mixing process to obtain the G-Y signal, phase angles other than 0 degrees and 90 degrees can be demodulated in an X-Z demodulator. The phase angle of the two demodulators, compared to the G-Y signal is shown in Figure 7.

With the vectors positioned as shown, equal amounts of the X and Z signals produce the G-Y signal. Figure 8 is a simplified diagram illustrating how this is done.

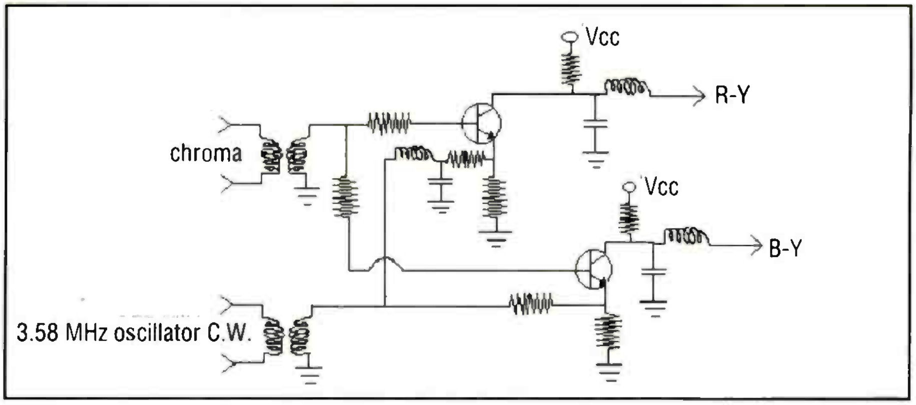


Figure 5. This is the schematic diagram of transistorized R-Y and B-Y demodulators.

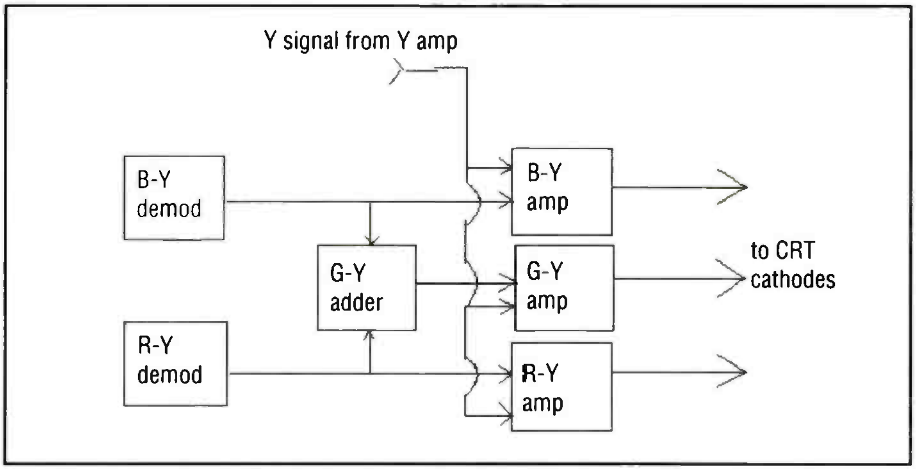


Figure 6. This illustrates a method of obtaining the G-Y signal, as well as a method of mixing the luminance (Y) component back in to the color difference signals.

The altered phase angles allow the G-Y signal to be developed across the common emitter resistor. The Z signal contains -(B-Y) and G-Y. The X axis contains -(R-Y) and G-Y. The signal common to both will be present at the emitters. This signal will then cancel the G-Y signal in the two demods (the emitter signal is opposite in phase to that of the base). The phase shift in the transistors changes the -(B-Y) and -(R-Y) to B-Y and R-Y. The G-Y at the emitters is already at the proper phase so the common base G-Y amp does not invert its phase.

There is an added advantage to this arrangement in that, sharing common signals at the emitters, changes in one are more likely to affect all three and the color will remain more accurate.

In color demods, no matter which type, a change in phase of the C signal varies the output of the demods in different proportions producing different mixes of the colors and therefore, different hues. A change in amplitude of the C signal, however changes the output of each in the same proportion, changing the color saturation but not the hue.

The Y signal, in some cases, is mixed back in with the color difference signals at the demods.

The video amps following the demods are called either the *color difference amps* (R-Y, G-Y or B-Y amp) or *color video amps* (R, G or B amp) depending on whether their output has the luminance mixed back in or not.

Blanker stage

Although the video signal was designed with blanking pulses to turn off the CRT during retrace, these pulses are not really sufficient to do this. For them to work it would require very accurate adjustment of internal and consumer controls. The blanking pulses are only 7.5% "blacker" than the black level of the video. If the brightness were adjusted so that blacks were not really black, but a gray tone, then the blanking might be

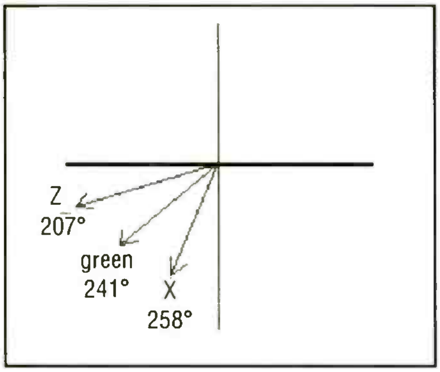


Figure 7. This diagram shows the phase angles of the X and Z signals relative to that of the green signal.

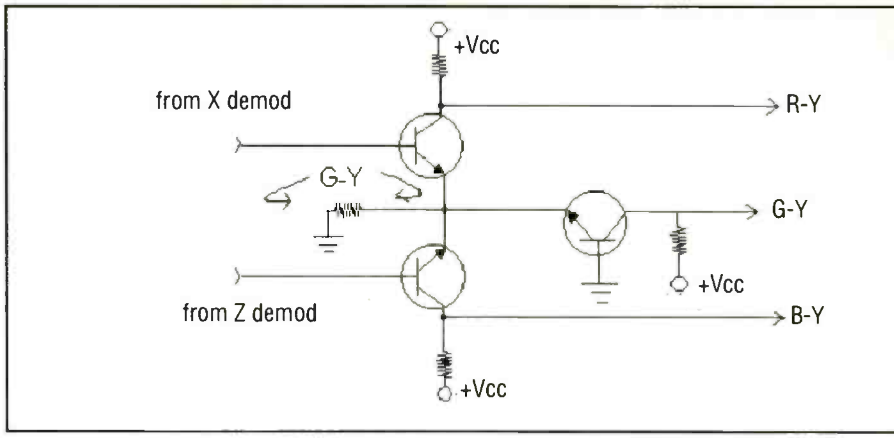


Figure 8. With the vectors positioned as shown in Figure 7, equal amounts of the X and Z signals produce the G-Y signal. This is a simplified diagram of the circuit that produces the G-Y signal from the X and Z signals.

above the black level. Retrace lines would then be visible on the CRT screen.

To keep this from happening, TV receivers usually use high amplitude pulses from the deflection circuits as blanking for the CRT. Vertical pulses may be fed to video amp stages or the CRT. High amplitude negative pulses may be fed to the screen grids of the CRT to cancel the positive screen voltage during vertical retrace. To provide blanking of the screen during horizontal retrace, a blanker stage is often used. An example of a blanker stage is shown in Figure 9.

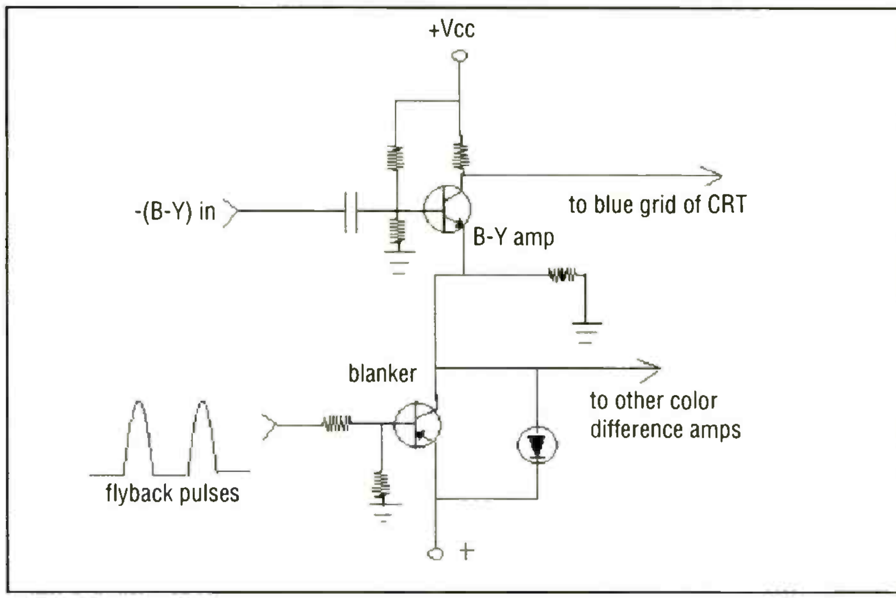


Figure 9. A blanker stage, such as this one provides blanking of horizontal retrace.

In this example, the positive flyback pulses are inverted in phase by the blanker's common emitter configuration and applied to the emitters of the color difference amps. Being input to the emitter, the pulses will not be inverted in phase by these amplifiers, and so will still be negative at the CRT grids, putting the CRT in cutoff at this time.

A blanker stage is sometimes used for vertical blanking also, as is a blanker that is fed pulses from both deflection circuits through a resistive matrix circuit. In some receivers the amplitude from the blanker is adjustable and is adjusted to eliminate retrace lines in the picture.

Color killer and acc (automatic color control)

The color killer and acc circuits are related as shown by Figure 10. The purpose of the color killer is to disable the color bandpass amps during a monochrome broadcast.

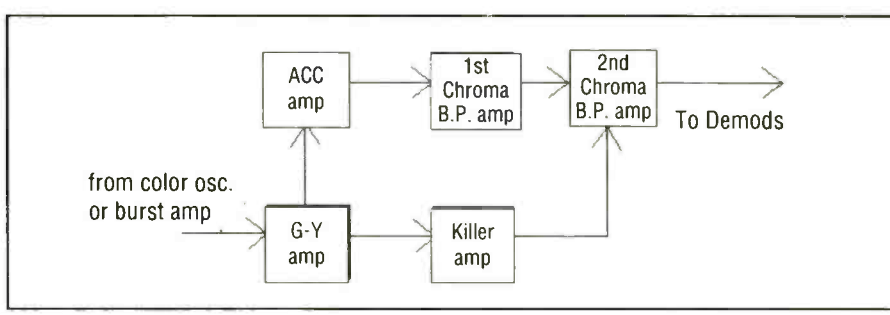


Figure 10. The color killer and acc circuits are related as shown here.

If the color circuits were not disabled, random noise might cause colored snow or "confetti" on the screen that would be objectionable. The color killer senses the presence of the color burst, either out of the burst amp or the color oscillator. Figure 11 is an example.

For this circuit, the killer amp supplies the bias for the chroma bandpass amp. If the color burst is present, the output of the color oscillator increases somewhat and biases on the killer detector, which sends bias to the bandpass amp, allowing it to operate. If the burst is not present, the killer amp will not be biased on and will not develop the required bias for the bandpass amp. It will thus be disabled.

The ACC circuit works similarly, the

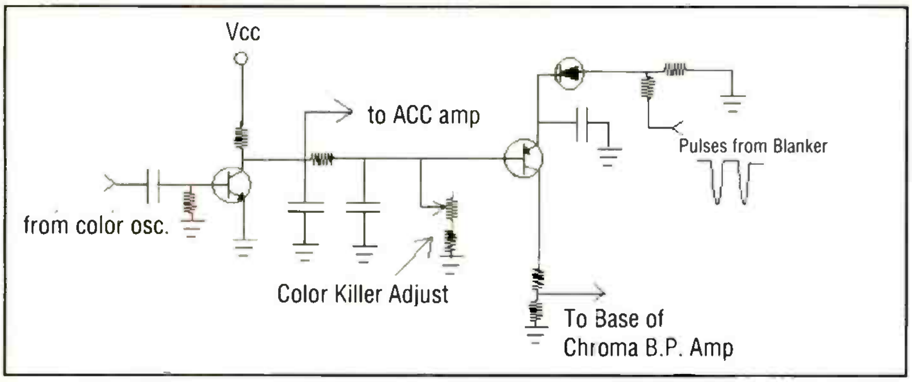


Figure 11. The color killer, shown here, senses the presence of the color burst, either out of the burst amp or the color oscillator. If the burst signal is not present, the circuit causes the set to produce only a monochrome picture.

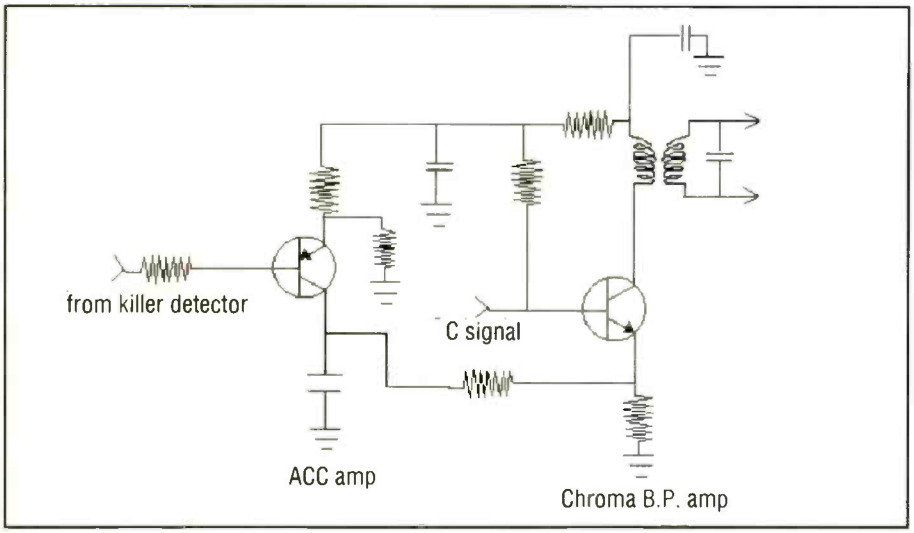


Figure 12. This circuit connects to the point in the circuit of Figure 11 marked "to ACC amp". It is an automatic gain control for the color signal.

only difference being the amount and polarity of bias voltage developed.

This circuit (shown in Figure 12) connects to the previous diagram labeled "to ACC amp". At that point, an increase in the color signal will cause a decrease in voltage because of the increased conduction of the transistor. This "less positive" voltage will cause the PNP ACC amp to conduct more heavily. This, in turn, causes the emitter of the NPN bandpass amplifier to become more positive, thereby lowering its gain. This circuit, then, is actually an automatic gain control circuit for the color signal.

Automatic tint control (atc)

Color circuits such as these may be known by different names in different brands of receivers. This circuit acts to keep the hue of the color constant for different color broadcasts. Actually, it works to keep the hue of the flesh tones constant, regardless of the other colors, since it is the most important recognizable color. These circuits are not as important today as they were in earlier receivers because the broadcast equipment and standards are much better now.

Two general methods are used for the automatic tint control:

- Emphasize the red hues by increasing the gain of the R amp or decreasing the gain of the B amp.
- Shift the phase of the B-Y demod closer to the phase of the R-Y.

Refer to the circuit example of Figure 13. When the ATC switch is turned on, Q1 conducts causing Q2 to saturate. This effectively ties the end of C1 to ground causing a phase shift in the B-Y demod. Also, the end of R1 is now effectively grounded through the saturated Q2 and being in parallel with the emitter resistance of the Red amp, raises its gain.

Not to be confused with these circuits, some receivers have factory preset adjustments for controls like the brightness, contrast, color and hue. A switch on the TV (it is known by various names depending on the manufacturer) will throw in all factory preset controls in lieu of the consumer controls. This would prevent the customer from having to make any adjustments to the television if these settings are acceptable.

These controls are sometimes located on the chassis and not easily accessed for adjustment. Some of these controls however, are placed where they can be easily changed. For example, they might be ganged to the main control such that a small screwdriver can be inserted through a hollow shaft of the main control to adjust the preset control.

Automatic brightness level (ABL)

This type of circuit is often used in color receivers to improve the quality of the picture. The ABL generally does two things. It maintains the correct brightness with changes in ac line voltage, and maintains the correct levels for changes in CRT anode current. Figure 14 is an example of an ABL circuit.

Note the operation of the brightness control here. The control is varying the bias of the video amp. As the wiper moves up, the base of the amp is made more positive (less negative) and the transistor conducts less, making the emitter go more positive. This at the cathode of the CRT makes the picture darker. Moving the wiper down would have the opposite effect and make the picture lighter.

One of the supplies for this control is an unregulated supply. If the line voltage rises this would tend to increase the high voltage and video levels and make the picture brighter, but a rise in positive voltage at the base makes the video amp conduct less and raises its emitter voltage. This has the effect of darkening the picture and counteracts the increase. The regulated supply is mixed with the unregulated voltage to "tone down" this effect for the correct amount.

The brightness limiter transistor regulates against changes in beam current using the B++ voltage. This voltage, mixed with the +15V regulated supply normally keeps the transistor saturated.

If there is excessive brightness, causing too much beam current, the B++ voltage will fall because of the excessive current drain. This will cause the transistor to come out of saturation and its collector voltage will rise causing the base voltage of the video amp to become more positive. As seen before, this will darken the picture and tends to limit the maximum brightness to the point where excessive beam current would cause the high voltage to fall.

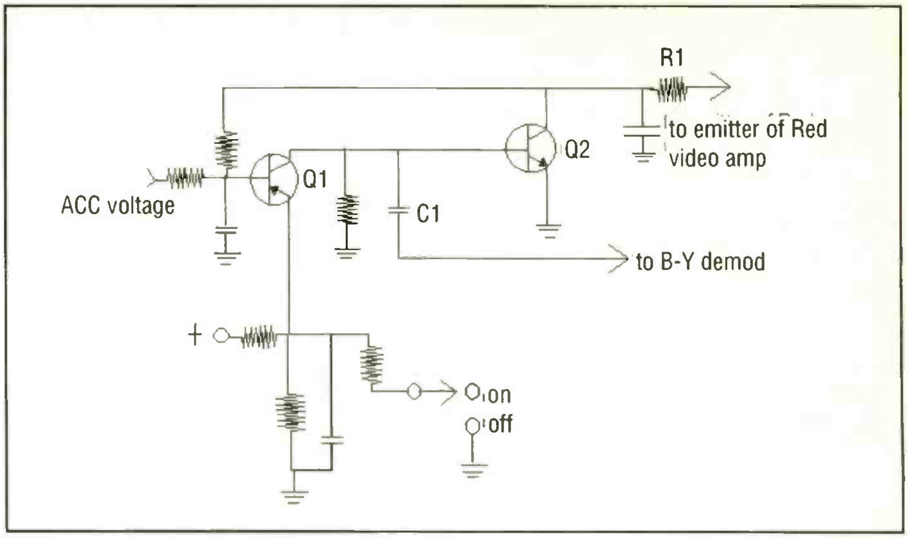


Figure 13. The automatic tint control (ATC) provides for correct picture tint.

Video delay line

The video delay line is in the luminance signal path to match the delay in the color circuits. The delay is about 0.8µs.

The delay line is a coil wound over an insulating tube and foil strip. The effect is like having a capacitor in parallel, to ground, for each turn of the coil as shown in the equivalent circuit of Figure 15. The resistance of the wire is also a part of the equivalent circuit.

The delay line must be terminated with its characteristic impedance, typically 600Ω to 700Ω. Its dc resistance is usually about 100Ω to 150Ω.

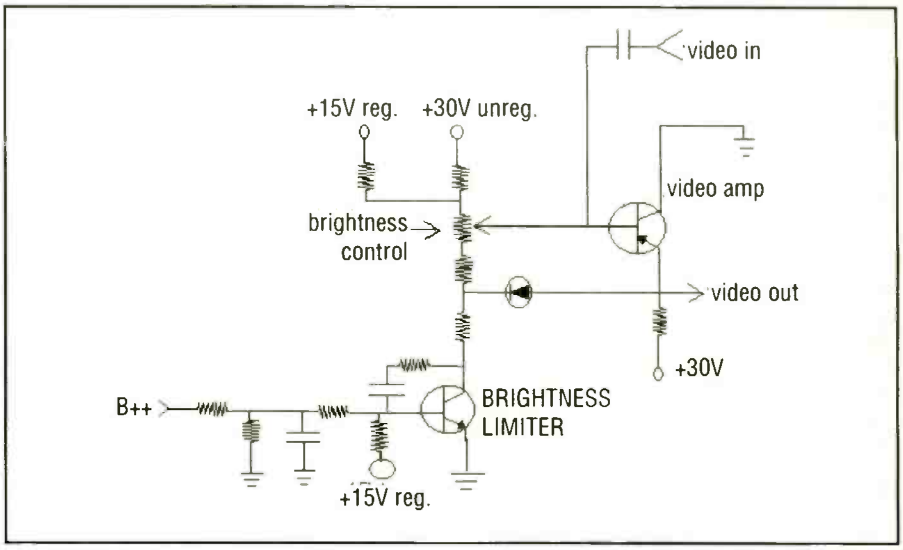


Figure 14. The automatic brightness level (ABL) circuit generally does two things: it maintains the correct brightness in spite of changes in ac line voltage, and maintains the correct levels in spite of changes in CRT anode current.

Deflection and high voltage

The final installment of this series, scheduled for publication in July, will cover deflection and high voltage. ■

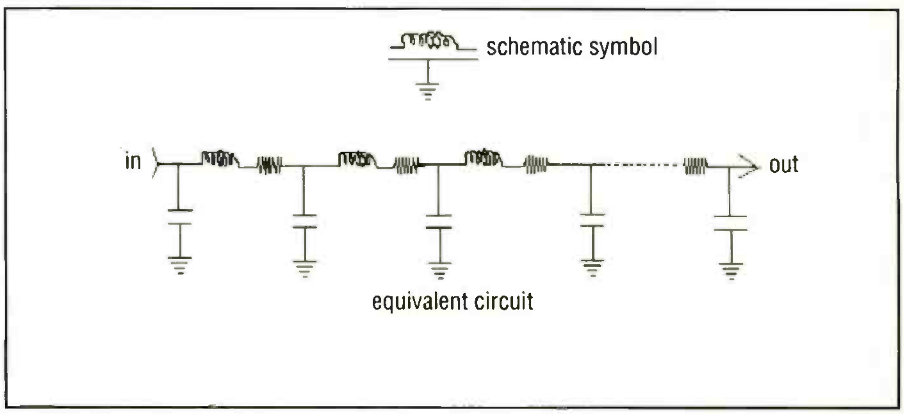


Figure 15. The video delay line is in the luminance signal path to match the delay in the color circuits. The delay is about 0.8µsec. It is a coil wound over an insulating tube and foil strip. The effect is like having a capacitor in parallel to ground.

NEWS

(from page 7)

Challenges and opportunities for mail-order/telephone order retailers

Mail-order/telephone order retailers will be hit hardest by the success of Internet shopping if they choose not to go on-line. Forty-six percent of users expressed a high likelihood of shopping less via mail-order/telephone-order if they shopped on-line.

"Although this segment of retailers stands to lose business to Internet shopping, they are also those best positioned to take advantage of the opportunities on-line," said Spatola. "They already have in place the infrastructure to support remote shopping, such as call centers for orders and customer service, established order fulfillment and delivery mechanisms and, in many cases, brand recognition." ■

Selling and pricing service

By Charles Varble, Jr.

Service labor income produces most of the income for consumer electronics service facilities. It is important that every service center owner and service manager be aware of the importance of this source of income. Service labor income usually produces about 80 percent of the gross revenue for the average service facility, and so it deserves very special consideration. It is extremely important that you be familiar with all of the factors included in the sale of service. This article will review the segments of service that are necessary in order to look at charges in the proper perspective.

Selling service is frequently neglected by the typical electronic service shop. Many take the attitude "we tell the customer what it will cost and we let them decide if they want to authorize the repair." Consumers want to make a wise choice when they decide whether or not to repair a product. They can be helped in making this decision by receiving the honest opinion of a technician or service manager about whether or not their products should be serviced or replaced.

Service Price List

Product	Minor	Intermediate	Major
Auto Stereo	30.00	45.00	60.00
Auto Stereo Foreign	40.00	60.00	80.00
Camcorder	55.00	82.50	123.75
Color TV 2" to 10"	33.00	49.50	66.00
Color TV 11" to 19"	35.00	52.00	70.00
Color TV 20" to 27"	38.00	57.00	76.00
Color TV 30" to 40" direct view	45.00	80.00	120.00
Projection TV	52.00	100.00	165.00
VCR Player Only	40.00	60.00	80.00
VCR	45.00	67.50	90.00
Each additional problem add	5.00	10.00	15.00

Figure 1. You should have a service price list such as this, based on your own cost of doing business. It gives your customers and potential customers a good idea of what it might cost them to have their product serviced at your service center.

Repair or replace?

In some cases the consumer should purchase a new product instead of having service performed on a product that has failed. If that is the case, you should advise them accordingly. In many cases, however, they are using good judgment when they repair an item that they have owned for some time and you should give them your opinion on this.

For example, a VCR that is five years old and has a cast tape deck is certainly much better then a more recent inexpensive one that has a plastic deck. Replacing a video head still makes good sense in one of these older units. Replacing a high voltage transformer may be justified in a good console television set, but not in one that has a weak picture tube or needs the tuner replaced as well.

Varble is a retired consmer electronics service business owner.

The customer wants to use good judgment when they have an item serviced and they need to know how it will work and if it will be guaranteed before they authorize the repair. It is important that they fully understand the value of having the product serviced, as opposed to replacing it. If you provide your customers with sufficient information on which to base a service/replace decision, in many cases they will choose service.

Pricing service labor

You purchase labor just as you purchase parts. You hire someone with the skills that you need and you pay them a certain number of dollars a week. You probably give them vacation and sick time. You might also pay some, or all, of the medical insurance. Some employers also provide a retirement plan, or maybe they contribute to a 401K plan.

You have additional expenses for each employee including social security taxes, Medicare taxes, unemployment taxes for state and federal, workmans compensation and other expenses. Most employers in the consumer electronics service business discover that the total cost of labor is about three times the direct wages paid to the employee. Your cost may vary from this, but it would be a serious misconception to believe that it is only slightly more then the direct wages.

Labor is "perishable"

Your inventory of labor is even more critical to your success then the parts inventory and it is different in several ways. You can keep parts in stock and use them later, but if you do not use the technician's time when it is available, you will still have to pay for it

Sometimes when you accumulate parts in stock that you do not use you can return them for credit. But you cannot obtain any credit for service time not used.

When a product is returned to you for reservice because parts have failed, the parts are covered by guarantee and they will be replaced free of charge to you, but the service time must be paid for again, and you will not receive any credit for it. When business is slow the technicians will appear busy all of the time and they will complete the work, but when you are busy they will not be able to produce more work to make up for the slow times in the business cycle.

Pricing your service is critical to the success of your business and you must figure all of the many components when you establish your prices for the sale of service. No good businessman would sell his parts for less then his cost but many do sell labor for less then it costs them. If you had purchased two hours of labor for \$80.00 would you bill it for only \$40.00?

The factors that comprise labor cost

The factors that make up your service cost are many and varied. The direct wages of course are recognized by everyone. The indirect cost of support personnel is frequently not correctly reflected in the price of your labor.

For example, the person who answers the phone and waits on the customers is a part of the burden factor for the technicians who produce the income. The parts personnel are a very important part of your total cost and of course must be factored into the prices that you charge for service. The service manager and even the owner of the company are paid out of the income from service.

Develop a service price list

A printed list is essential for you to use when you bill out service. If you do not use a printed list now, make yourself one as follows. Start with three categories for each product type and label them minor, intermediate and major. List these as column headings starting with Product, Minor, Intermediate, Major and under these you can show the products and fill a service price for each category.

You may choose to use more then one product type for the same type product. If, for example, you find that certain brands take you longer and cost more to repair, create a type for them, such as "Foreign Auto Stereos." You may also wish to have another product listed as "Auto Stereos." This will give you three separate prices listed, one for each distinct type of unit. You will find that you will be more properly compensated for service when you have a list for each item that is the normal billing cost for the repair. See Figure 1 for a sample of the type of chart you may wish to make.

The importance of business skills

Technical skill was the prime requirement of starting a service business many years ago when most of the current consumer electronics service businesses began operating. While technical skills are still very important, they are not the most critical factor in today's business. Business skills have become as important, if not more important.

It still is, of course, important that every technician who works on products should be trained properly and this means attending seminars and updates sponsored by the manufacturers. Other groups, such as the Electronic Industry Association, also put on some wonderful training sessions that will greatly improve the technical skills of those attending.

However, business skills have become the most critical factor in the operation of a successful business today. You have to know the relationship of the pricing, advertising, warranty servicing, prompt service and technical skill, in the application of better business practices for a successful profitable business today.

You spend a lot of time every year updating your technical skills and this is important and necessary. You should spend some time every year updating your business and management skills.

Trade associations can help

Trade associations frequently hold seminars that will show you how successful managers operate a consumer electronics service business in a profitable and professional manner. For example, just about every year there are changes in the tax laws that affect your business, of which you should be aware. While you may have a CPA who does your taxes and reviews your profit and loss statements, he may not be aware of the subtle changes in the tax laws that may be applicable to your business. It is your responsibility as a manager to keep up with the many changes that affect your business. You can learn a great deal by talking to others in the same business and discuss changes that will improve your productivity and increase your profit.

Trade associations provide a very valuable format for meeting others in the same business and discussing the problems and opportunities that will affect your business. By joining you receive many benefits. Moreover, most trade associations publish a newsletter that will have articles that specifically address your business. They hold annual conventions and trade shows where you can see the latest in hardware and test equipment, new software, and business services designed for your business.

Many seminars will be presented that address both the technical and business side of your business. You will gain additional business knowledge by talking with many others in different parts of the country who are in the same type of business. Many problems, both technical and business, are solved by attending these meetings. You will discover for example, how different managers have handled the compensation problem with their employees by changing the method by which they pay them.

Local trade associations and the chamber of commerce

Most areas have a local trade association, which usually is part of a national one, and they usually meet monthly and present programs that are valuable to the members. They may have a guest speaker who addresses telephone manners, retirement plans, and many other topics that will help the members in the managing of their businesses.

Businessmen from many other businesses frequently meet at a chamber of commerce meeting, or similar type meeting, for the purpose of mutual help and to improve their area so that it is a favorable place for consumers to shop. You can provide valuable input and learn much by taking an active part in these meetings. You might be surprised to learn that other businessmen have the same problems as you do regarding bad checks, credit, etc..

Consumer electronics service is very much a people oriented business which means providing great service should be a top priority. Your firm should actively promote and sell service as if that is your main product. You must price your service to make a profit if you are going to continue to provide the service that your customers need. ■

PHOTOFACTS

CROSLEY
CT2722B101 3644
CV1310AT01 ..... (sim to) VCR-275
27X102 3644

DAEWOO
CN100C 3648
DTQ-1456FC 3648
DTQ-1456FN 3648
DTQ-1459FC 3648
DTQ-1459FN 3648
DTQ-2056FC 3648
DTQ-2056FN 3648
DTQ-2059FC 3648
DTQ-2059FN 3648

FISHER
G4Z-50200 3640
PC-5020 3640
G3V-55250 3652
PC-5525 3652

GE
CN-150 3663
CTC177AR2 3660
19GT300 3663
25GT515FE1 3660
25GT515TX1 3660

HITACHI
A3LXU2 3641
M3XU 3643
20SA3B 3643
35TX20B 3641
3503TB 3641
A3LXU2 3659
31CX5B 3659

MAGNAVOX
VR9223AT01 .... VCR-275
TP2782C101 3653
TP2782C102 3653
TP2792B103 3656
TP2794B101 3656
TP2794B102 3656
27R501 3653
27R501-00BB 3653
27R512 3653
27S501 3656
27S501-00BB 3656
27TP82C101 3653
27TP82C102 3653
27TP82C104 3653

PANASONIC
AEDP257 3636
ALEDP257 3636
AMEDP257 3636
CT-20G20CT 3636
CT-20G20CT-1 3636
CT-20G20T 3636
CT-20G20T-1 3636
CT-20G30CT 3636
CT-20G30CT-1 3636
AEDP246 3655
ANEDP246 3655
CT-G2970LT 3655
CT-G2970VT 3655
CT-27G20CT 3655
CT-27G20T 3655
CT-27G20UT 3655

PHILCO
VT2521AT01 ..... (sim to) VCR-275
P1920RC1 3650
19S401 3650

QUASAR
ALDC243 3645
TP917T 3645

RCA
CTC177AA 3638
CTC177BH3 3649
F27253GYFE1 3649
X25103SGFE1 3638
CTC177AM2 3658
E09302BCF24 3662
G25343WKDX1 3658
G27302ATKF1 3658
G27304DTKF1 3658
TX826QD 3662

SHARP
13G-M80 3647
13G-M100 3647
13G-M150 3647
19G-M80 3647
19G-M100 3647
19G-M120 3647
19G-M150 3647
25G-M80 3642
25G-M100 3642
25G-M120 3642
VC-H942U VCR-276
27G-S80 3661
27G-S100 3661
27G-S120 3661

SYLVANIA
VC4510AT01 ..... (sim to) VCR-275
SSC3184101 3646
SSC3184202 3646
31X104 3646
31X304 3646

TOSHIBA
CE27E15 3639
CF27E50 3639
TAC9516 3639
TAC9540 3639

ZENITH
SR1917SG 3637
CN-150 3651
SR1324S 3651
SR1327S 3651
SR1327X 3651
SR2049DT 3654
SR2573DT 3657
SR2573DT1 3657

CLASSIFIED

Classified advertising is available by the word or per column inch.
By-the word. $1.65 per word, per insertion, pre-paid Minimum charge is $35 per insertion. Initials and abbreviations count as full words. Indicate free category heading (For Sale, Business Opportunities, Miscellaneous, Wanted). Blind ads (replies sent to ES&T for forwarding) are $40 additional. No agency discounts are allowed for classified advertising by the word. Contact Kirstie Wickham at 516-681-2922 to place your classified ad (by-the-word). Mastercard, VISA, American Express and Discover are accepted for FAX or mail orders.
Per column Inch (classified Display): $235 per column inch, per insertion, with frequency discounts available, 1" minimum, billed at 1/4" increments after that 10" maximum per ad. Blind ads are $40 addition. Reader Service Number $25 additional to cover processing and handling costs. (Free to 4-inch or larger ads.) For more information regarding classified display advertising please call 516-681-2922. Optional color (determined by magazine) $150 additional per insertion.

Send your order, materials and payments to:
Electronic Servicing & Technology, 76 N. Broadway, Hicksville, N.Y. 11801 Attn: Classified Department Ph: 516-681-2922 FAX: 516-681-2926

FOR SALE

*************** 18,000 Technical TIP Repairs *************** TV's, VCR's, Projection TV's, CAMCORDER's, CD Players, Audio & other repairs organized in an **EASY** to use Computer Program - **The TECHNICAL TIP REPAIR Program.** PROFESSIONAL BOARD & COMPONENT LEVEL REPAIRS. **ADD** your own tips. **PRINT** tips. **BACKUP** & save your own tips. Have your own tips? Ask about our **TIP EXCHANGE** policy with **FREE Updates.** ************FREE DEMO************ Works on IBM compatible computers with a hard drive (Also works on some Apple Macintosh computers). **FREE SHIPPING. NEW VERSION works in DOS, WINDOWS 3.1 & WINDOWS '95.** ***************CALL 1-800-215-5081/1-516-643-7740.*****************

24,000 THE LARGEST TECH-TIP PROGRAM IN THE USA. 24,000 "NEVER BEFORE HAS THERE BEEN AN OFFER LIKE THIS" THE *PROOF IS IN OUR PRODUCT - TEST OUR FULL PROGRAM.* *(((((((((((((((((((((((((("FREE" "FREE" "FREE"))))))))))))))))))))))))))))* We are so sure you will find our computer Tech-Tip Program to be **THE BEST OFFERED ANYWHERE,** that we will ship our **ENTIRE PROGRAM** at **NO COST TO YOU**. Test 1 week, if you are dissatisfied, simply return the program Postage Paid - there is absolutely **NO RISK or COST TO YOU. "OUR TRUST IS IN YOUR SATISFACTION". *************(Proven to pay for itself within a few repairs)************ **FEATURES INCLUDE:** "FREE" FCC-ID MANUAL with 12,261 VCR and 591 Microwave cross references. "FREE" Product Processing Forms. Our One-Time Membership Fee Provides you 24,000 Repairs 1977 thru Nov. 1995, TV, VCR, CD, LD, Projection, Monitor, Stereo, Camcorder, Amplifier, Combo Units, Fax Machine, Satellite, etc., "FREE" 40 page **SEMI-ANNUAL NEWSLETTER magazine** with **Step-By-Step Repairs WRITTEN BY OUR TECHNICIANS** using today's techniques and technology. **NEW** product information, **Industry News and Service Center Assistance. WE ARE THE ONLY TECH-TIP COMPANY** that publishes our **ENTIRE PROGRAM IN PAPER MANUALS EVERY 8 MONTHS** for service centers who are not computerized. **"FREE"** format changes to computer or paper at each update. **One-time membership "PAYS". OUR MEMBERS RECEIVED ((10,000)) NEW TECH-TIPS "FREE" IN OUR NOV. 95 UPDATE.** To those Computerized, we offer the most advanced **DOS** or **TRUE WINDOWS PROGRAM,** for all versions **INCLUDING WINDOWS 95**, in which you may Enter, Edit or Print Out repairs. Our program covers complex repairs, **192 BRANDS ALL IN ONE CONVENIENT PROGRAM.** Press 1 key and print-out all the repairs on a particular model or chassis. Repairs are collected daily at four major service centers and sent weekly to our Data Center where each Tech-Tip is gone over completely. Additional Lookup and Cross Reference Information is added. This process is how we constantly **IMPROVE** and **INCREASE** the program **FOR YOUR BENEFIT** at each **UPDATE. SAVE TIME** diagnosing, **ORDERING** service manuals and **RESEARCHING** part numbers you may not need! **GET TO THE BOTTOM LINE "PROFITABLY,"** Call and speak to a Service Center Owner and Technician **Ed Erickson, NESDA Member and Past President of (THE PROFESSIONAL ELECTRONICS ASSOCIATION OF SOUTH FLORIDA) YOU'LL BE GLAD YOU DID! (800) 474-3588 (407) 750-9922 .** Look for us at **Conventions** or scheduled **Seminars** in your area, or find us in your **1996 NESDA Directory.**

FURTHER PRICE REDUCTION. Diehl Mark III $49, Diehl Mark V Horizontal circuit tester $169. New. Conductive coating for remote control keypads $9.99 ppd. **WEEC,** 2411 Nob Hill Road, Madison, WI 53713. 608-238-4629, 608-273-8585.

TV & VCR repairs - on disk. Installs on your hard drive. Easy look-up by Model/Chassis number. **FREE DEMO. 1-800-215-5081.**

FOR SALE

*ELECTRONIC SOFTWARE DEVELOPERS IS PLEASED TO ANNOUNCE the release of THEIR LATEST VERSION OF SERVICE TIPS!!!! 19,933 Service Tips PLUS with our NEW VERSION you will now be able to BACKUP & RESTORE ALL OR PART OF THE DATA IN A COMPRESSED FORMAT WITH ONLY 1 OR 2 DISKS. SERVICE TIPS IS THE MOST COMPREHENSIVE and ECONOMICAL technical tips program available today. Used by thousands of service centers across the country and in Canada, we are the fastest growing technical tips program. **SERVICE TIPS** DISTINCTIVE FEATURES organizes all the information in ALPHABETICAL ORDER by Brand Model/Chassis & Symptom with 3 lines for Symptom and 8 for Solution it includes Part Numbers, Values, Locations and Concise Solutions. YOU CAN REVISE, EDIT, or PRINT any service tip in our database OR ADD YOUR OWN INFORMATION and it will automatically be alphabetized and sorted. **SERVICE TIPS** contains ACTUAL TECHNICIANS FINDINGS on TV's, VCR's, Camcorders and other consumer electronic equipment. Our database contains information on products that YOU ARE SERVICING NOW! We have no Black & White or tube type sets. **SERVICE TIPS** IS THE MOST COMPREHENSIVE technical tips program available today. Developed for the technician by technicians, who own and manage their own service centers, they see the products that are failing today and the importance of repairing them economically. This makes **SERVICE TIPS** an INDISPENSABLE TOOL FOR YOUR SERVICE CENTER. It will definitely increase your profits, reduce your troubleshooting time and lower your parts expenses. **SERVICE TIPS** INSTALLS easily in minutes and works in DOS and is Windows Compatible. These are ONLY A FEW OF THE UNIQUE FEATURES included in our program. **SERVICE TIPS** is the ONLY Program that has Quarterly Data Updates and we also offer FREE DATA UPDATES as well. **SERVICE TIPS is available for ONLY $149.95 plus s&h**. For more information or to order **CALL us at 1-800-621-8477** (from US & Canada) ELECTRONICS SOFTWARE DEVELOPERS INC. 826 SO. MAIN ST., SOUTH FARMINGDALE, NY 11735.*

**************************FREE ZENITH CURES******************************** **Earn $$$** Repair Zenith TV modules found in over 1,000 models, 1983-1993. Symcure manual shows you how. $89.95 or send SASE for **FREE** samples. **ZMEX,** 807 Queen Palm Lane, Sarasota, FL 34243

Monitor Service Information. Techtips Repair Program on Disk, FCC ID Cross Program on Disk, and **Monitor Schematics.** From $39.95. Visa/MC **MI Technologies** 513-335-4560.

SERVICE DATA & HARD TO FIND PARTS previously-owned SAMs, manufacturers data, books, FREE catalog. **AG Tannenbaum,** Box 386, Ambler, PA 19002, 215- 540-8055, fax 215- 540-8327.

Free 9-516/517 MODULE CURE!!! Stop replacing! Repair easily yourself. Send business SASE: **TEK Enterprises** 212 Marabou Drive, Newark, DE 19702.

TV CASE HISTORIES: Booklet with 2,440+ histories. Satisfaction assured. Only $49 (plus $3.00 for priority mail). **Mike's Repair Service,** P.O. Box 217, Aberdeen Proving Ground, MD 21005. Same mailing address 32 years. Send SASE for samples. 410-272-4984,1-800-2-FIX TVS 11am-9pm.

TV & VCR repairs - on disk. Installs on your hard drive. Easy look-up by Model/Chassis number. **FREE DEMO. 1-800-215-5081.**

FOR SALE

*********SPECIAL OFFER******* For a LIMITED TIME ONLY Purchase our FCC & MODEL to MODEL CROSS REFERENCE GUIDE for ONLY $29.95 plus $5.00 s&h & RECEIVE AT NO ADDITIONAL COST 2 Editions of our SERVICE TIPS Library. Our Cross Reference Guide contains 248 FCC numbers & 94 brands & over 3,000 model to model cross references on VCR's, Camcorders, TV's & Computer Monitors. Mail Check or Money Order for $29.95 plus $5.00 s/h to: ELECTRONIC SOFTWARE DEVELOPERS INC. 826 SO MAIN ST. SOUTH FARMINGDALE NY 11735.**

TEST EQUIPMENT BOUGHT & SOLD: OSCILLOSCOPES, ETC. 1-408-738-4206. FAX 1-408-736-6946.

Shorted picture tube! (Red, Green or Blue screen with retrace) Save the Job! Remove effects of heater-to-cathode shorts. Wind your own isolation transformer in 3 minutes with 10 turns of ordinary speaker wire and our special cores. $3 each (1-4). Kit $3.30. Wound $6.00. **KDTV** 514 3rd Street, Aurora, IN 47001. 812-926-4321.

Electronic Service Tips. 3500+ Real world tips from our Service dept & others. TV, VCR, other types, sorted alphabetically by model or chassis and alphabetically by symptom within a given model. Paper version 6.0 $39.95 + shipping. **KDTV** 812-926-4321. 514 Third Street, Aurora IN 47001. Fax 812-926-1014.

****** SONY TUNER CURE **** 1-465-371-11/-12** Stop replacing! Repair easily yourself & save! Send $15.00: **TEK Enterprises** 212 Marabou Drive, Newark, DE 19702.

Sencore equipment, VG91 $1000.00, TVA92 $1000.00, VC93 $2000.00 and SC3100 $2000.00. 412-329-4658.

TV/VCR repair and sales with floor plan. Busy location. Computerized. Everything must go, $25K. Northwest, IN. Ask for Jim, 708-891-5550.

Universal CRT Tester - adapts your tester to clean, restore, remove shorts in ALL color, monitor, projection CRTs, Only $60.00 MC/VISA. Dandy Electronics, 918-682-4286.

FOR SALE

*******Everything you need for a TV/VCR Repair Shop!******* Sencore** SC61, Sencore PowerRite, B&K Variable Isolation Transformer, Sencore VA48 Analyzer, Sencore CR70 tube rejuvenator, other test equipment, **Sams** Manuals1200 to 2500, 2900 to current plus %50 of manuals in between, four filled drawer cabinets with **Sony, RCA, Quasar, Panasonic, Magnavox, Zenith** and others, Sams VCR FACTS and lots of VCR and Camcorder manuals. Tons of idlers, RF boxes, tuners, displays and other Misc. stuff, large stock of ECG components all organized, four full Workbenches plus TV island. Parts bins with thousands of capacitors and resistors all organized. 20 36 x 18 inch nine shelf VCR shelf's and six 4 x 2 foot three shelf TV shelves. Also Super high 8 x 3 foot and a 4 x 3 foot TV shelf. Two Office desks with Chairs, one four drawer file cabinet, three adjustable bench seats. All office supplies, also a computer with over $3000.00 in related tech programs. Over 75 fixable **TVs**, 50 **VCRs** and lots more for Parts. **Too much more to mention. Looking for $12,5000.00 or best offer. Call 908-901-7165.**

Surplus electronic test equipment for sale. Phone or fax to request the current list. Phone: 908-722-6157, Fax: 908-722-6391.

Sencore VC93 all format VCR analyzer. Great for "tough dog" VCRs. Excellent condition. Save over $1000.00, only $1700.00 O.B.O. George, 805-659-7254.

Repair Management Software - Multiple Pick-up stations, invoicing, inventory, purchase orders, parts cross, FCC cross, POS, mouse, $199.00. (DOS) FREE Demo Disk w/Doc's 602-813-6119.

SENCORE EQUIPMENT (all models). We **BUY, SELL, & TRADE** all models. Please call **"CHOICE ELECTRONICS"** for all of your test equipment needs. Complete financing options available. Call 605-361-6386, ask for Lance Tople.

BUSINESS OPPORTUNITIES

Well Established, Fully Equipped, Factory Authorized Service Facility. Excellent Location and Reputation. Owner Financing and Training Available. $55,000.00. Call 904-645-0133.

READERS' EXCHANGE

Readers' Exchange is a free service.

The following restrictions apply to Readers' Exchange:

• Only individual readers may use Readers' Exchange, and items must be restricted to those that are ordinarily associated with consumer electronics as a business or hobby. If you're in business to sell the item(s) you want to offer for sale, the appropriate place for your message is in a paid advertisement, not Readers' Exchange.

• Readers' Exchange items must be restricted to no more than three items each for wanted and for sale, and may be no more than approximately four magazine column lines in length (about 20 words).

• All submissions must be typed or printed clearly!

Readers' Exchange, Electronic Servicing & Technology
76 N. Broadway, Hicksville, NY 11801 Ph: 516-681-2922 FAX 516-681-2926

FOR SALE

Sencore waveform analyzer (SC61) like new, used very little, in original box with probes and manual, $1400.00. *Contact: Gerald, 919-745-4493 or 919-745-5707.*

Sams Photofact TV and radio service manuals $7.00 each postpaid. Good originals from collection covering Sams #25 to #3071. *Contact: William Miller, 2691 Fox Hill Drive, Camby, IN 46113, phone: 317-831-0896, E-mail eagle@trader.com.*

Seeburg - stereo speaker 17"Lx12W. Wireless phono-portable model 6J. *Contact: Ann Bichanich, 151/2 W. Lake Street, Chisholm, MN 55719, 218-254-4421.*Sencore VG91, TVA92, SC3100, CR70, HP200, asking $6000.00 or best offer. *Contact: 810-785-5084, please leave message.*

Flyback transformers, mostly monitor types, over $1200.00 worth, selling for $500.00. Also old test equipment for sale (H-P, military, etc.), make offer. Send SASE for lists. *Contact: Marc Loring, 1924 Mark Street, NE, Olympia, WA 98516, 360-491-2802.*

Sencore VA62 includes VC63, NT64, EX231, and protective cover. $1500.00. Sencore SG165 AM-FM stereo analyzer, $500.00. Sencore SC-61 scope $1500.00. All equipment in excellent condition with original boxes, cables, and manuals. *Contact: Ron Walker, 1175 Waldo Way, Twinsburg, OH 44087, 216-425-9038.*

Sencore VA62, $1500.00, Simpson 380 microwave leakage tester, $225.00, B&K 820 capacitance meter, $125.00. All accessories included. *Contact: Ray, 706-863-2480.*

READERS' EXCHANGE

FOR SALE

Sencore VG91 and TVA92, new condition $3500.00. Sams Photofact 543 through 1759, best offer. *Contact: 803-385-6467 (evenings).*

Sams folders or sets misc. 1 - 2,000, 25 cents each and up plus postage, minimum $10.00. *Contact: McCombs Electronics, 703 Old Cedar Rock Road, Easley, SC 29640, 864-859-6032.*

Must sell. Sencore CVA94 camera video analyzer with VR940 light box, VC93 VCR analyzer, SC61 dual trace scope. *Contact: Jim, 915-235-3520, 915-236-6209 PM.*

Sencore VC93 all format VCR analyzer. Original box, manuals, cables. Like new, $1300.00 Firm. *Contact: Mike, 541-839-6609(day), 541-825-3268 (eve).*

Phillips TV and VCR service literature 1991-1995. Offer or trade. *Contact: Dave Burruss, 1540 Shady Lane, Keizer, OR 97303, 503-463-4425.*

Sencore VC93 VCR analyzer. Like new. All cables, manuals, videos and original box included. Paid $2600.00, Must Sell. Make an offer. *Contact: 410-532-8215.*

HP scope model 1715A. *Contact: Jack Schultz, 912-352-0585 or 800-866-8938, pager, 912-239-4377.*

Sencore MU150 tube tester, TC162 tube tester and much more. Best offer. SASE (legal size). *Contact: Fred Ingersoll, GI Electronic, 6845 Lathers, Garden City, MI 48135.*

B&K model 470 CRT checker with 12 adapters, $150.00. B&K model 1249A NTSC signal generator $150.00. B&K model 2125 scope $100.00. All good working order with manuals, test leads, original boxes. *Contact: Steve Mack, 1335 Avenue F., Billings, MT 59102, 406-245-0799.*

Sencore VA-62, VC63, NT64, for $950.00, SC61 for $900.0. LC53 for $375.00, TF46 for $300.00, All leads cables and manuals included. Contact: Al 516-395-4862.

WANTED

Service manual wanted for Sony projector model FP60. *Contact: Tom, T&D Electronics 410-398-0471.*New or good used scope DVM-636 40 pin IC model TSC7106 CPL/8707BJ; Sylvania VC4526 portable VCR service manual; Microprocessor, 42 pin IC5001 model UPD1511C-081 for a candle JCTV 3150 chassis no. 20404. *Contact: Fred's Electronics, Box 463, Elkhorn, MB Canada Fax/Phone 204-845-2359.*

Tentel video head protrusion gauge in good condition including brackets. *Contact: Walt, 616-599-3220.*

Heathkit 6809 conversion for the ET-3400A µP trainer and documentation. Pioneer SM-B200A tube receiver schematic. *Contact: Edward Bolt, PO Box 1807, Laramie, WY 82070, 307-742-6580.*

Need computer interface card for "The Complete Page Scannex" model no. 00-2002-01. *Contact: Leslie Robensin, 4662 Esther Street, San Diego, CA 92115-3834, 619-582-5153.*

Motorola 12V equlalizer amplifier for car stereo system. Also any other Motorola aftermarket stereo items you might have for cars. AM/FM cassette players, speakers, etc. *Contact: William K. West, 330-966-1335, 340 Hillcrest Apt. 8, N. Canton, OH 44720.*

Mitsubishi horizontal Oscillator coil part no. 332P00501 from Mitsibishi CS2594 TV. (NLA). Also Mitsubishi tuner part no. 295P20701 from Mitsubishi projection TV model VS-510U. *Contact: Anchor VCR & TV Rpeair, Klamath Falls, OR, 541-884-5985.*

Sony TC142 portable cassette. Need cassette lid/door (new or used). Sony part no. X-3538-807-0 nla. *Contact: Liberman Sound, 510-444-5547.*

New or used chips and flybacks wanted for 1970s and early 1980s TVs. Will pay up to $20.00 for certain items. Ask for complete want list. *Contact: W. Worley, 305 Hickory Bend Road, Enterprise, AL 36330, 334-347-5281.*

ADVERTISERS' INDEX

Company	Page Number	Reader Service Number	Advertiser Hotline
American Hakko	49	51	800/88HAKKO
AnaTek Corporation	39	52	800/999-0304
Andrews Electronics	45	53	800/289-0300
D.A.T.A. Business Publishing	59	55	800/447-4666
Dalbani Corporation	39	54	800/325-2264
Eagan Technical Service, Inc.	45	57	800/285-1873
Electronics Technicians Association	64	56	317/653-4301
Fluke Corporation	BC	2,3	800/59-FLUKE
GEnie Radio & Elec. RoundTable	64	73	800/638-8369
Herman Electronics	7	58	800/938-4376
ISCET	46		817/921-9101
ITT Pomona	51	59	800/241-2060
Instek	19	70	818/336-6537
International Components Corp.	64	60	800/645-9154
Jesse Jones Industries	41		800/825-6690
LG Precision	41	61	310/404-0101
Leader Instruments	1	6,7	800/645-5104
MAT Electronics	46	62	800/628-1118
MCM Electronics	IFC	111	800/543-4330
NESDA	49,52		800/600-3732
Parts Express	44	63	800/338-0531
Sams & Company, Howard	63	64	800/428-7267
Sencore	Insert 12A & 12B 13,IBC	4,5	800/SENCORE
Sony	15	65	
Sperry Tech	64	66	800/228-4338
Tentel	21	67	800/538-6894
Thomson Consumer Electronics	5	81	
Wavetek	3	71	800/854-2708

We'd like to see your company listed here too. Call Diane Klusner at 516/681-2922 or E-Mail her at dianekest@aol.com to work out an advertising program tailored to suit your needs.

SALES OFFICE
PHONE (516) 681-2922
FAX (516) 681-2926