ELECTRONIC™

Servicing & Technology

January 1986/$2.25

Horizontal, high voltage, vertical problems of the CTC109

Video color camera repair, 2 • Microcomputer troubleshooting, 3

LCD picture rivals CRT

Electricity and water don't mix. At least not in our Heavy Duty Digital Multimeters. Because these Oops Proof™ instruments are protected by a system of seals to ensure contamination-free dependability in even the cruddiest conditions.

Other abuse-proof features include the best mechanical protection ever built into a precision Digital Multimeter. In fact, every one of our Oops Proof multimeters will survive a drop from ten feet onto a concrete surface!

All the Heavy Duty series meters measure up to 1000 volts AC and 1500 volts DC, with full overload protection to those maximum voltages even on the lowest range settings. Overload circuitry also provides transient protection to 6KV on all voltage ranges and up to 600 volts on all resistance ranges.

We also invented a unique, long-life rotary switch for our Digital Multimeters. You can actually feel the difference just by rotating the function selector knob.

You'll find these features in a full line of Heavy Duty DMMs that offer a 4½ digit readout, 0.05% VDC accuracy, a 10-amp current range, a 2000-hour battery life, diode test, true RMS and temperature measurement. All this and a no-questions, one-year warranty.

You'll want to try one out, of course, so drop into your nearest electronics distributor and drop one.

Our lips are sealed.

NRI Trains You At Home—As You Build Your Own IBM-Compatible Computer

GET THE KNOW-HOW TO REPAIR EVERY COMPUTER ON THIS PAGE.

IBM is a Registered Trademark of International Business Machine Corporation.

Epson is a Registered Trademark of Epson America, Inc.

Apple and the Apple logo are Registered Trademarks of Apple Computer, Inc

Compaq is a Registered Trademark of COMPAQ Computer Corporation.

©1984 AT&T Technologies, Inc.

Learn the Basics the NRI Way—and Earn Good Money Troubleshooting Any Brand of Computer

The biggest growth in jobs between now and 1995, according to Department of Labor estimates, will occur in the computer service and repair business, where demand for trained technicians will actually *double*.

You can cash in on this opportunity—either as a fulltime corporate technician or an independent service-person—once you've learned all the basics of computers the NRI way. NRI's practical combination of "reason-why" theory and "hands-on" building skills starts you with the fundamentals of electronics, then guides you through advanced electronic circuitry and on into computer electronics. You also learn to program in BASIC and machine language, the essential languages for troubleshooting and repair.

You Build—and Keep—a 16-bit Sanyo personal computer

The vital core of your training is the step-by-step building of the 16-bit Sanyo MBC-550 series computer. Once you've mastered the details of this state-of-the-art machine, you'll be qualified to service and repair virtually every major brand of computer, plus many popular peripheral and accessory devices.

With NRI training, you learn at your own convenience, in your own home. You set the pace—without classroom pressures, rigid night-school schedules, or wasted time. You build the Sanyo IBM compatible computer from the keyboard up, with your own personal NRI instructor and the complete NRI technical staff ready to answer your questions or give you guidance and special help whenever you need it.

Praised by critics as the "most intriguing" of all the IBM-PC compatible computers, the new Sanyo uses the same 8088 microprocessor as the IBM-PC and

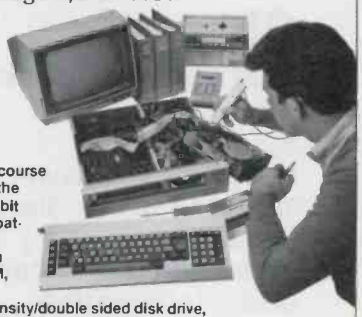
AND MORE.

features the MS/DOS operating system. As a result, you'll have a choice of thousands of off-the-shelf software programs to run on your completed Sanyo.

Your NRI course includes installation and troubleshooting of the "intelligent" keyboard, power supply, and disk drive, plus you'll check out the 8088 microprocessor functions, using machine language. You'll also prepare the interfaces for future peripherals such as printers and joysticks.

100-Page Free Catalog Tells More

Send the coupon today for NRI's big 100-page color catalog on NRI's electronics training, which gives you all the facts about NRI courses in Microcomputers, Robotics, Data Communications, TV/Video/Audio Servicing, and other growing high-tech career fields. If the coupon is missing, write to NRI Schools, 3939 Wisconsin Avenue, NW, Washington, DC 20016.



Your NRI course includes the Sanyo 16-bit IBM compatible computer with 128K RAM, monitor, double density/double sided disk drive, and "intelligent" keyboard; the NRI Discovery Lab®, teaching circuit design and operations; a Digital Multimeter; Bundled Spread Sheet and Word Processing Software worth over $1000 at retail—and more.

NRI SCHOOLS
McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue, Washington, DC 20016
We'll give you tomorrow.

For Career courses approved under GI bill, ☐ check for details.

☑ CHECK ONE FREE CATALOG ONLY

- ☐ Computer Electronics with Microcomputers
- ☐ Data Communications
- ☐ Robotics & Industrial Controls
- ☐ Video Electronics Servicing
- ☐ Electronic Design Technology
- ☐ Digital Electronics
- ☐ Satellite Communications
- ☐ Communications Electronics
- ☐ Industrial Electronics
- ☐ Basic Electronics
- ☐ Telephone Servicing
- ☐ Small Engine Servicing
- ☐ Appliance Servicing
- ☐ Automotive Servicing
- ☐ Air Conditioning, Heating, Refrigeration, & Solar Technology
- ☐ Building Construction
- ☐ Locksmithing & Electronic Security

Name (Please Print) Age

Street

City/State/Zip Accredited by the National Home Study Council 2-016

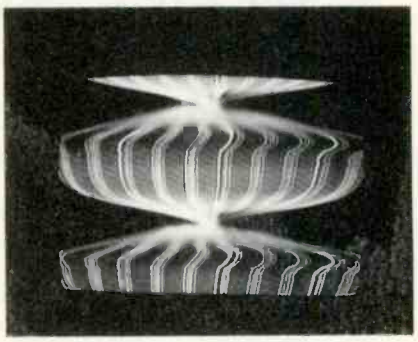
The how-to magazine of electronics...

ELECTRONIC
Servicing & Technology

Volume 6, No. 1 January 1986

Because of the implications for the entire TV industry, ***ES&T*** details the technology of the LCD TV-screen, beginning on page 6, comparing this screen with conventional CRTs. To paraphrase an editorial headline from the May 1985 issue, "It's all happening so fast!"

Departments:



It's not a pretty picture when C105, the only rectified-line-voltage filter capacitor, is open in the CTC109A. The article begins on page 8.

Weller® and Xcelite®. Programmed for advanced servicing.

Xcelite TC100 **Attaché Tool Case**

The ultimate. Contains 53 individual tools plus 31 interchangeable screwdriver/nutdriver blades and handles. Every one a top quality tool. Don't leave base without it.

Weller/Xcelite 250K
Mini Electronic Tool Kit
The best of the basics in a convenient storage case.

Weller GEC120
Electronically Controlled Soldering Gun
Sophisticated high quality tool combines the features of a temperature electronically controlled station with a light-weight easy to handle soldering gun.

Weller DS 600
Portable Desoldering Station
Contains its own vacuum source and only requires a 120 volt supply for complete desoldering capability. Grounded tip prevents damage to sensitive components.

Whatever type of computer or electronic equipment you are dealing with, you can be sure to rely on the specialized tools from Weller and Xcelite. A constant program of research and development ensures the most advanced tools capable of servicing the most sophisticated equipment. Here is a brief specification but check with your Electronics Distributor for the full data.

CooperTools

COOPER INDUSTRIES

CRESCENT® LUFKIN® NICHOLSON® PLUMB® TURNER® WELLER® WIRE-WRAP® WISS® XCELITE®
The Cooper Group PO Box 728 Apex NC 27502 USA Tel (919) 362-7510 Telex 579497

Circle (4) on Reply Card

BACK AMERICA

Editorial

Picture a new era in television

Television has experienced many changes and refinements in the decades since it was introduced. Even though a TV set of today does essentially the same things that early sets did, they do it so much better. For example, in those early sets, the brightness left a lot to be desired. The room had to be darkened to view the picture satisfactorily, and a bright daylight-lit room severely washed out the picture. Today's sets can be viewed in direct sunlight.

At the same time, as pictures were getting brighter, they were getting bigger. The small picture tube of decades ago has grown to 19, 21, 25 inches, and even larger. Further refinements have given us TV sets with beautiful color pictures, smaller size, lighter weight, greater reliability, lower power consumption and better sound quality. The list goes on and on.

A casual look inside a modern TV set compared to the insides of an early set will reveal many changes in technology, components and construction that have made these advancements possible. In old sets, you'll find vacuum tubes, their filaments gobbling up power, taking up lots of space and generating a lot of heat. In the modern set, all of the electronic functions are performed by semiconductor devices: transistors and ICs. Printed circuit boards in the modern set have replaced the old, large, heavy metal chassis and point-to-point wiring.

It doesn't take an expert to see that one thing hasn't changed. There's still that heavy, bulky CRT taking up a lot of space, requiring high voltage and presenting an implosion hazard any time servicing requires attention to it. To be sure, the picture tube in the modern set is technologically advanced far beyond that of the CRT in the older set; still, it just seems that compared to the advances in every other area of the new set the picture tube is an anachronism.

That might just change. LCD technology has recently been advancing at an incredible rate and holds promise to be a candidate to replace CRTs. Already, LCDs have been used in both monochrome and color hand-held TV sets. So far the picture quality leaves a lot to be desired, but the mere fact that it has been done is impressive. And the manufacturers of LCDs are diligently working to advance the state of those devices to the point where they will be able to compete with CRTs in terms of quality, reliability and cost. The article beginning on page 6 describes the state of the art as it stands today.

The possibility that one day, perhaps soon, the CRT will be replaced by LCDs starts one thinking about the implications for servicing. The first thing that comes to mind is that here's another new technology to be learned through a lot of hard work; and there's merit in that thought. But think of the good side of it: There goes the high voltage, the possibility of getting bit by 30,000-odd volts; no more high-vacuum device just waiting for you to be careless with a screwdriver or pair of pliers; no more flyback transformers, and no more retrace lines when things aren't working properly. If LCDs ultimately do replace CRTs, TV servicing *really* will be a brand-new ball game.

Nils Conrad Persson

ELECTRONIC
Servicing & Technology

Editorial, advertising and circulation correspondence should be addressed to: P.O. Box 12901, Overland Park, KS 66212-9981 (a suburb of Kansas City, MO); (913) 888-4664.

EDITORIAL
Nils Conrad Persson, *Editor*
Carl Babcoke, *Consumer Servicing Consultant*
Rhonda L. Wickham, *Group Managing Editor*
Marjorie Riggin, *Associate Editor*
Joy Culver, *Editorial Assistant*
Darryll Fortune, *Editorial Assistant*

BUSINESS
Cameron Bishop, *Group Vice President*
Eric Jacobson, *Publisher*
Greg Garrison, *Sales Manager*
Stephanie Fagan, *Promotions Manager*
Kelly Hawthorne, *Marketing Assistant*
Dee Unger, *Advertising Supervisor*
Karen Royall, *Advertising Coordinator*

ART
Kevin Callahan, *Art Director*
Joni Harding, *Graphic Designer*

ADMINISTRATION
R. J. Hancock, *President*
John C. Arnst, *Circulation Director*
Evelyn Rogers, *Circulation Manager*
Dee Manies, *Reader Correspondent*

ABC — Member, Audit Bureau of Circulation

ABP — Member, American Business Press

ELECTRONIC SERVICING & TECHNOLOGY (USPS 462-050) (with which is combined Electronic Technician/Dealer) is published monthly by Intertec Publishing Corp., 9221 Quivira Road, P.O. Box 12901, Overland Park, KS 66212-9981. Second Class Postage paid at Shawnee Mission, KS 66201. **Send Form 3579 to P.O. Box 12952, Overland Park, KS 66212-9981.**

ELECTRONIC SERVICING & TECHNOLOGY is the "how-to" magazine of electronics. It is edited for electronic professionals and enthusiasts who are interested in buying, building, installing and repairing consumer electronic equipment. This includes audio and video equipment, microcomputers and electronic games.

SUBSCRIPTION PRICES: one year $18, two years $30, three years $38 in the USA and its possessions. Foreign countries: one year $22, two years $34, three years $44. Single copy price $2.25; back copies $3.00. Adjustment necessitated by subscription termination to single copy rate. Allow 6 to 8 weeks delivery for change of address. Allow 6 to 8 weeks for new subscriptions.

ISSN 0278-9922 $2.00 + 0.00

INTERTEC
PUBLISHING CORPORATION

How to beat the high cost of cheap meters.

You get what you pay for.
So get the Fluke 70 Series.

You'll get more meter for your money, whether you choose the affordable 73, the feature-packed 75 or the deluxe 77.

All of them will give you years of performance, long after cheaper meters have pegged their fishhook needles for the last time.

That's because they're built to last, inside and out. So they're tough to break. They don't blow fuses all the time. You don't even have to replace batteries as often.

And they're backed by a 3-year warranty. Not the usual 1-year.

Of course, you may only care that the world-champion 70 Series combines digital and analog displays with more automatic features, greater accuracy and easier operation than any other meters in their class.

You may not care that they have a lower overall cost of ownership than all the other "bargain" meters out there.

But just in case, now you know.

For a free brochure or your nearest distributor, call toll-free **1-800-227-3800, ext. 229.**

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

FLUKE 73	FLUKE 75	FLUKE 77
$79*	$99*	$139*
Analog/digital display	Analog/digital display	Analog/digital display
Volts, ohms, 10A, diode test	Volts, ohms, 10A, mA, diode test	Volts, ohms, 10A, mA diode test
Autorange	Audible continuity	Audible continuity
0.7% basic dc accuracy	Autorange/range hold	"Touch Hold" function
2000+ hour battery life	0.5% basic dc accuracy	Autorange/range hold
3-year warranty	2000+ hour battery life	0.3% basic dc accuracy
	3-year warranty	2000+ hour battery life
		3-year warranty
		Multipurpose holster

* Suggested U.S. list price, effective November 1, 1985
** Patent pending.

FLUKE®

Circle (5) on Reply Card

IN THE U.S. AND NON-EUROPEAN COUNTRIES: John Fluke Mfg. Co., Inc., P.O. Box C9090, M/S 250C, Everett, WA 98206. Sales: (206) 356-5400, Other: (206) 347-6100.
EUROPEAN HEADQUARTERS: Fluke (Holland) B.V., P.O. Box 2269, 5600 CG Eindhoven, The Netherlands, (040) 458045, TLX: 51846.

Technology

LCD rivals CRT

The cathode-ray tube has been the standard display for electronics applications for more than 45 years. Today, however, in those applications where the CRT has well-known drawbacks – large size, weight, fragility and a requirement for high voltages – flat-panel display technologies are challenging the supremacy of the long-standing CRT.

This article was adapted from information presented by Epson America, Torrance, CA, at seminars held in October 1985 in New York City and San Jose, CA. All art is courtesy of Epson. Papers included in this article were presented by Toshiaki Saito, Director of Research and Development; Yoshio Yamazaki, General Manager, Fundamental Technology Research and Shinji Morozumi, Manager of Fundamental Technology Research.

The major flat-panel technologies competing with the CRT include: thin-film electroluminescent, known in the industry as EL; plasma display panels, known as PDP; vacuum fluorescent displays (VFD); and liquid crystal displays, or LCDs. Each technology offers unique strengths and weaknesses. None of them offers a perfect solution for every application.

The popularity of personal computers has created a strong demand for these alternative (non-CRT) display technologies, and stimulated rapid advances in flat-panel display technologies over the last two or three years. Flat-panel displays have exhibited improvements in performance, especially in terms of cost-effective LCDs.

A history of LCD

A number of existing LCDs are already being used to satisfy the needs of the personal/portable computer market. The struggle is to provide a suitable display, regardless of the technology. For any kind of display device the fundamental question is: How much information can be displayed in a given area?

First generation LCDs, introduced between 1975 and 1979,

were developed for wristwatches and calculators. These displays are extremely low cost and feature low power consumption and simple construction, making them ideal for high-volume production. Today, the annual production of digital watches is about 200 million, nearly half of the total watch volume. Another 120 million LCDs are used annually in calculators.

These displays are useful only for displaying simple numerals, however, and have limited application for computers.

Second generation LCDs, introduced in 1980, proved perfect for displaying alphanumeric characters and some graphics symbols; these displays work well in information-display panels such as found on audio equipment and domestic electrical appliances.

Third generation LCDs are just starting to appear. Featuring relatively large display area with high resolution, this generation is well suited for alphanumeric and graphic displays and high-resolution dot-matrix images such as needed for hand-held computers and color TV displays.

Simple matrix displays

The simple matrix liquid crystal display demonstrates the basic operating principle of all LCDs. The display consists of two glass substrates containing transparent electrodes, with the liquid crystal material sandwiched between them (Figure 1). The electrodes control the arrangement of molecules in the liquid crystal material that, in turn, controls the passage of light through the cell. The simple construction of this display makes it inexpensive to produce – a major reason for its rapid growth in the display market.

The basic principles of LCD operation

Liquid crystal material is an organic liquid that has the optical properties of a crystal. This material is convenient for use in making displays because the molecular structure of the liquid makes it easier to control the orientation of molecules than it would be in a crystal. Each orientation of molecules represents a particular liquid-crystal phase, and each phase affects the passage of light through it differently. Controlling the phase of a given liquid crystal material by means of a voltage applied to electrodes therefore controls the flow of light through the cell.

Although there are more than 10 liquid-crystal phases, many aren't efficient for displays; some are in early development and some are too complex to construct to be useful for commercial products. Three types are commonly used: dynamic scattering, known as DS or DSM for dynamic scattering mode; guest host, known simply as GH; and twisted nematic, which engineers refer to as TN.

Dynamic scattering mode (DSM)

Dynamic scattering mode displays were the first practical LCDs. Based on nematic materials, these displays are well suited for use in watches, calculators and other applications that don't require a fast response time.

When an electric field is applied across a layer of nematic liquid crystal material, the molecules orient themselves to the field. If you apply a sufficiently strong field (e.g. 1V/micron), the ion flow generates a strong turbulence, producing a white opaque appearance similar to frosted glass, as you see in Figure 2.

Guest host mode

In GHM displays, a dye is dissolved in a positive liquid crystal matrix. The dye has different optical characteristics parallel and perpendicular to its axes and can be aligned by interaction with the liquid crystal molecules. The dye has its maximum absorption when the electric field vector is parallel to the axis of the molecules (Figure 3). Using polarizers to direct the light produces an effect called *switched light absorption.*

This type of guest-host display has a wide viewing angle, brightness and good color brightness. You can expect to see it used regularly in automobile applications. *(See Technology, **ES&T** September 1985.)*

Continued on page 50

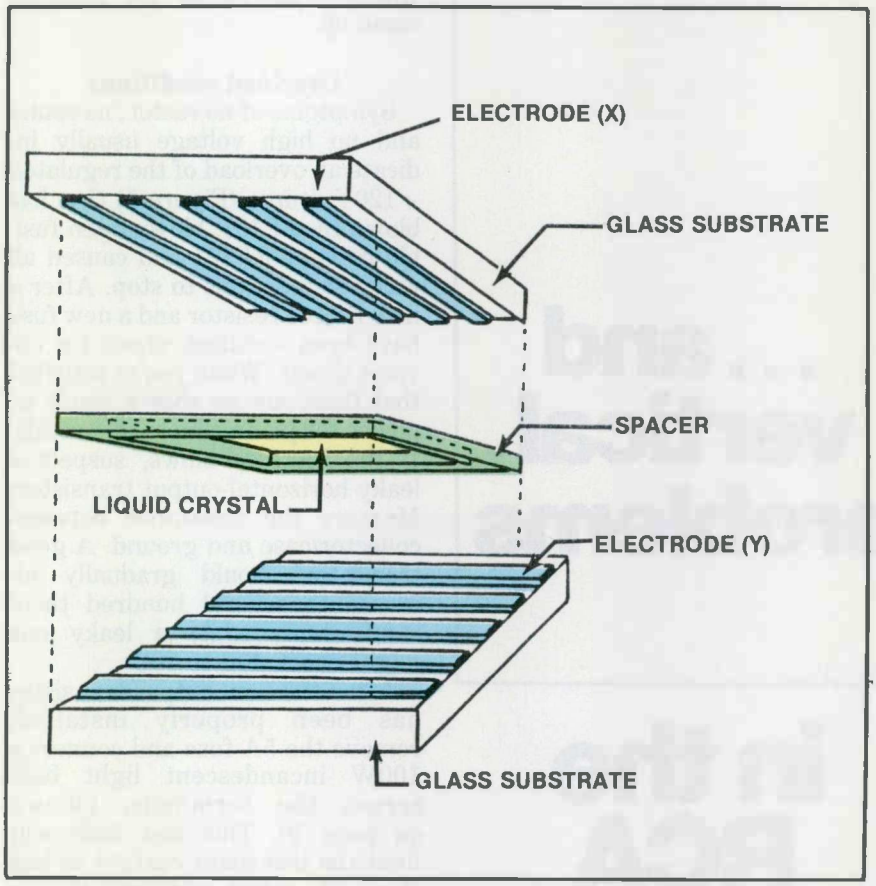


Figure 1. A simple matrix liquid crystal display consists of two glass substrates containing transparent electrodes with liquid crystal material sandwiched between.

Horizontal, high-voltage ... ...and vertical problems in the RCA CTC109A

By Homer L. Davidson

Perhaps 80% of color-TV chassis problems are found in horizontal, high voltage and vertical circuits. GER versions of the RCA CTC109A chassis have remote-control systems. Service records in this shop suggest that the horizontal-output transformers in the GER models have failed often with less than two years of operation. Other CTC109 common problems will be covered as the subjects come up.

Overload conditions

Symptoms of no raster, no sound and no high voltage usually indicate an overload of the regulated +120V source (Figure 1) that has blown fuse F101, blown open fusible resistor RF101 and caused all receiver functions to stop. After a new RF101 resistor and a new fuse have been installed, check for obvious shorts. When you're satisfied that there are no shorts, apply ac power for just a couple of seconds. If the 5A fuse blows, suspect a leaky horizontal-output transistor. Measure the resistance between collector/case and ground. A good transistor should gradually increase to several hundred thousand ohms, while a leaky one might check 40Ω to 70Ω.

After the new output transistor has been properly installed, remove the 5A fuse and connect a 100W incandescent light bulb across the terminals, (shown on page 9). This test bulb will limit the transistor current to less than 1A, while reducing the ac voltage. Also the bulb brightness shows the relative amount of circuit current.

The *on/off* switch relay in remote-control models will not switch *on* when low-input ac voltages are suplied for tests. Locate the *on/off* relay on the tuner-control chassis and look for two wires, one solid red and one white with a red stripe. Connect a jumper between the lugs where these two wires are connected (Figure 2). This will keep the ac power flowing to the bridge rectifier, even when it is only 80Vac or so.

Watch the light bulb and run the television for several minutes. Measure the Q412 horizontal-output collector voltage. A much higher-than-normal reading might indicate Q412 is open or SCR101 is leaky or shorted. Low collector voltage might indicate a leaky output transistor or damper diode CR405 or perhaps leakage to ground in the flyback.

After any necessary repairs have restored proper operation with the light-bulb current limiter, disconnect the light bulb and install a proper 5A fuse for final tests at full voltage and current.

Defective flyback symptoms

Some flyback problems can be located by sight or sound, without test equipment. If the horizontal-output (flyback) transformer feels very warm it might indicate leakage between windings, or excessive reverse current through some of the internal high-voltage diodes. A burned or raised area of the plastic outside covering indicates the transformer is defective. A loud crackling or popping noise before shutdown indicates a leaky transformer, (photo, at top, page 10).

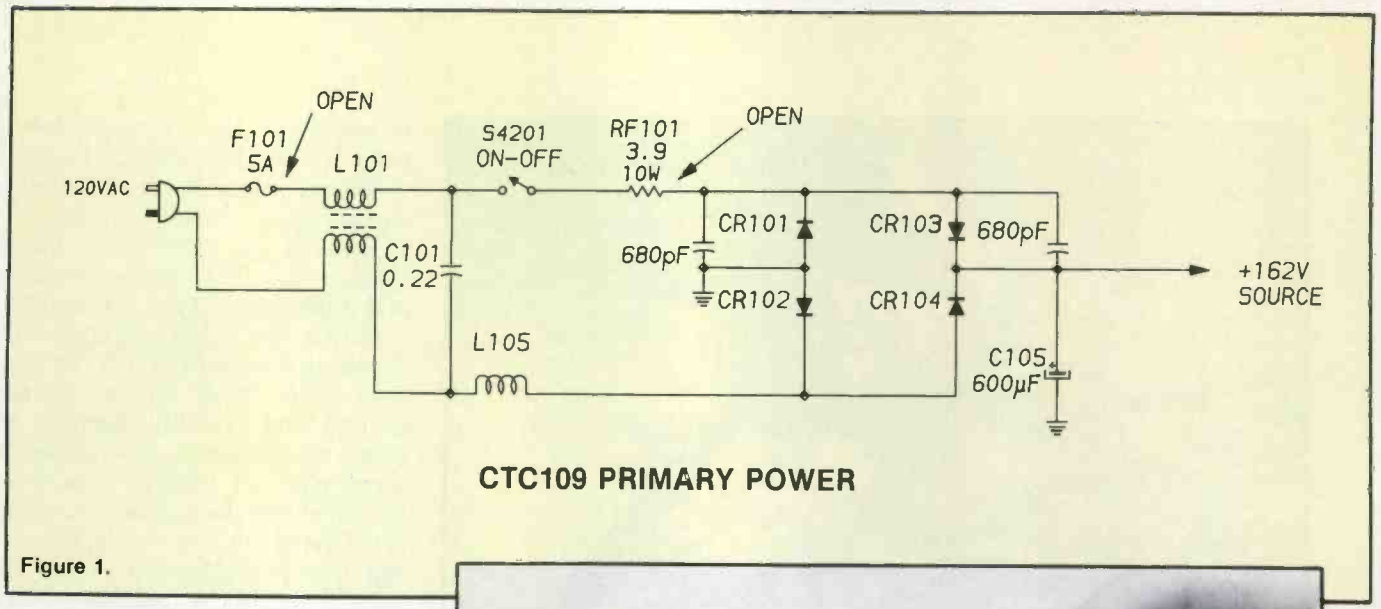


Figure 1.

Figure 1. F101 and surge-resistor RF101 are the most likely power-supply components to blow when serious overloads occur. The +162V supply is connected to the SCR regulator that is supposed to produce +120V, regulated. Any of the four bridge rectifiers (CR101 through CR104) can be shorted by transients entering on the ac line. It is wise to check them.

When suspicion falls on the flyback area of the horizontal sweep circuit, it is good protection to remove 5A F101 and connect a 100W light bulb across the terminals. This limits the current to less than 1A while it reduces the voltage in step with current increases, protecting most components. The brightness of the bulb gives an indication of the current. For example, the bulb was bright, so the horizontal-output transistor was replaced, but the bulb remained bright. Then, suspect a leaky horizontal-output transformer (flyback).

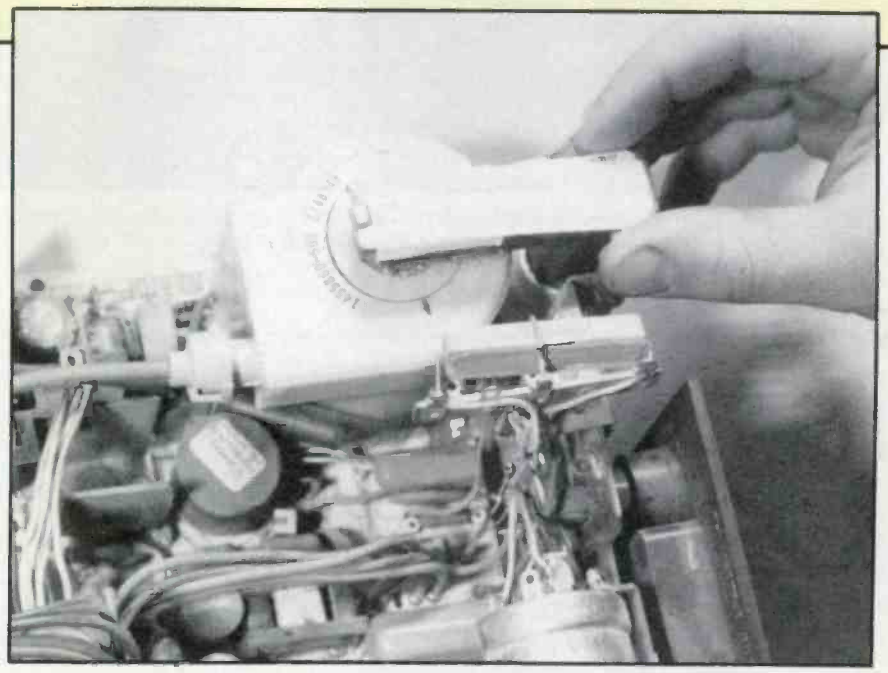


Figure 2. The GER remote-control-equipped CTC109s might not turn on at the low ac voltages used for tests. Therefore, a jumper wire should be placed across the relay contacts to provide ac voltage at all times.

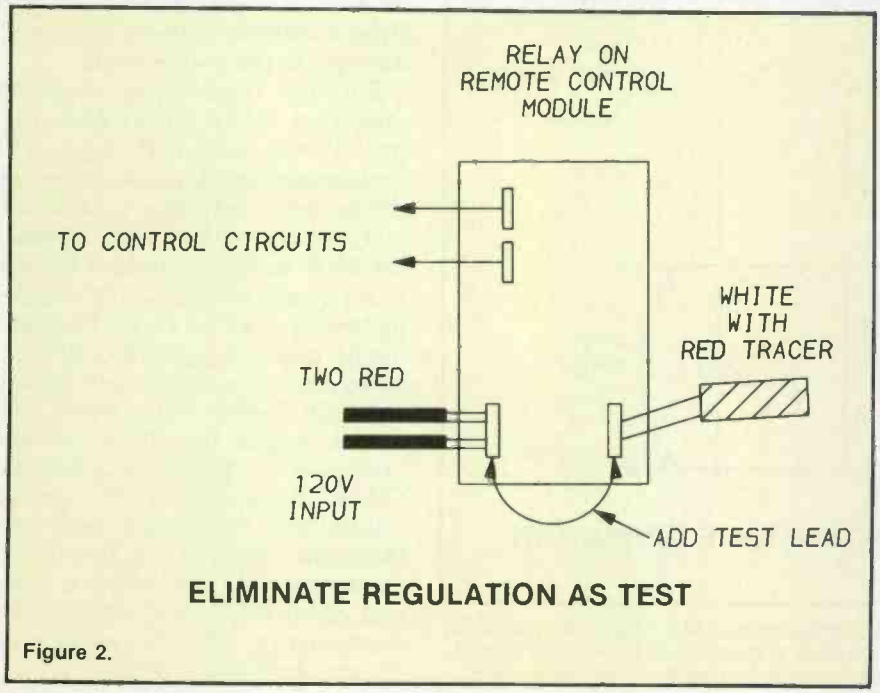


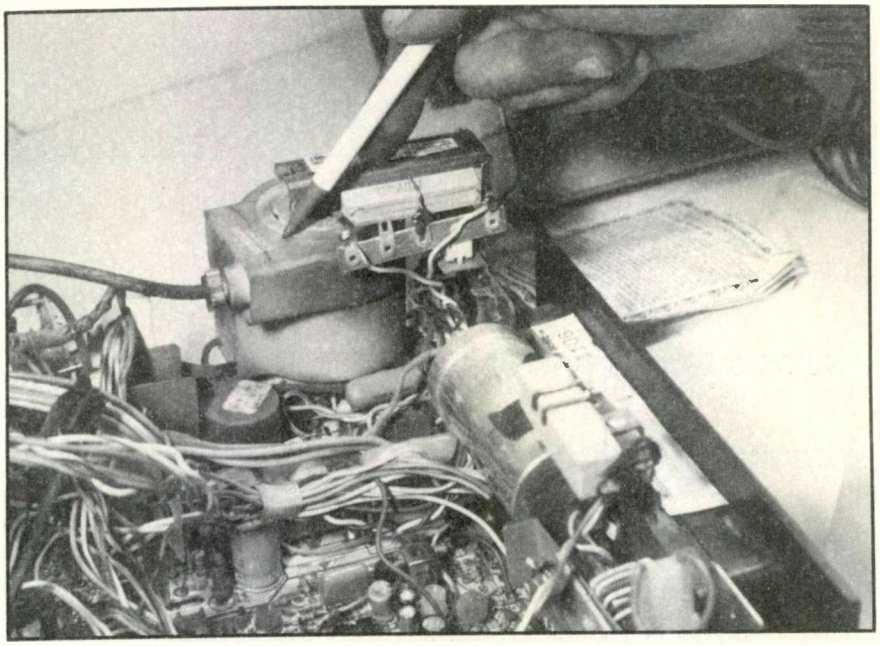
Figure 2.

If you replace the horizontal-output transistor and it is instantaneously destroyed when power is applied, replace the flyback transformer. In that situation, the transistor probably has internal leakage between collector and emitter (ground).

Replace the flyback when excessive horizontal squeal is heard from it. Large arc lines in the raster might indicate a defective flyback with internal arcing.

Identifying a defective flyback (or IHVT)

A variable ac-power transformer



Sometimes a wisp of smoke might come from a leaky flyback, or a loud crackling or popping noise might be heard before shutdown. This is almost certain proof of a defective flyback.

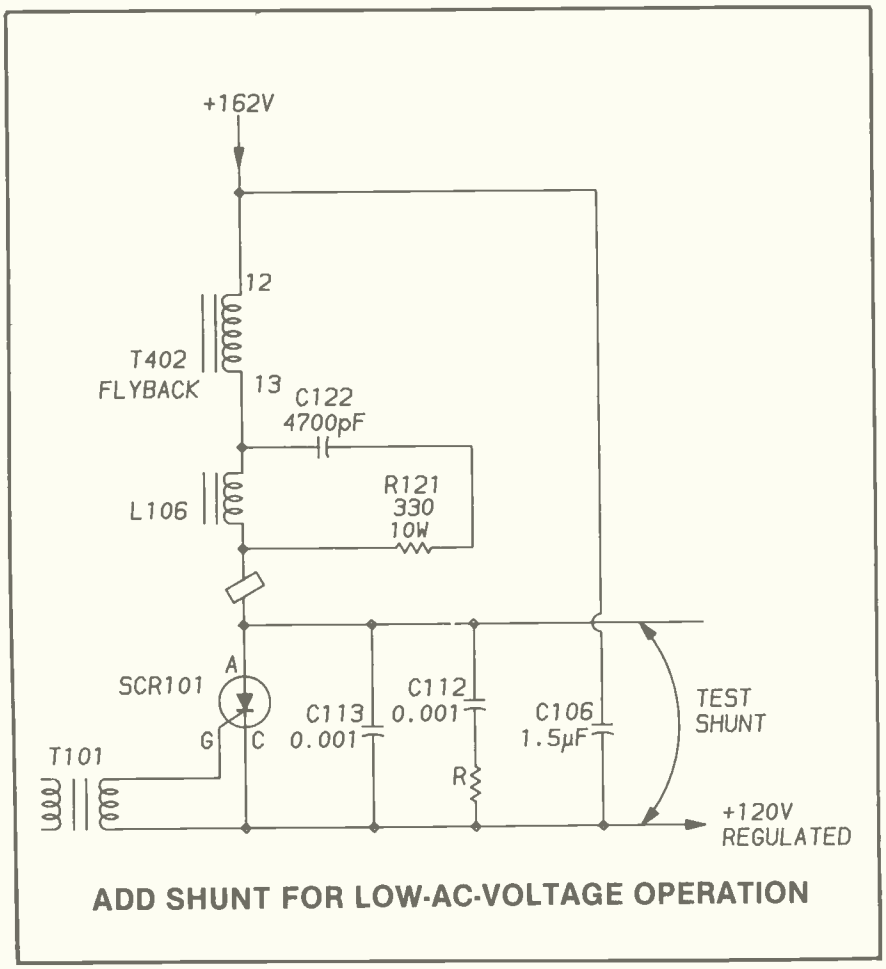


Figure 3. To disconnect the SCR regulator during tests, add a jumper wire between anode and cathode of SCR101. Better yet, solder a short piece of hook-up wire between those two SCR terminals; this prevents loose connections, shorts or arcs.

is recommended to supply lower than 120Vac line voltage to color receivers during tests of the horizontal-output transistor and the SCR voltage regulator. First, replace the fuse, fusible resistor and horizontal-output transistor.

Defeat the SCR regulator by shorting across SCR101. To prevent clip leads from moving around and possibly shorting to other components, just solder a short piece of hookup wire from the anode to the cathode terminal of SCR101 on the wiring side of the board (Figure 3). Plug the television into the variable-voltage power transformer. Starting at a low voltage, such as 40Vac, slowly increase the ac voltage until the +120V source measures about +75V or +80V. Turn *off* after a few minutes. Feel the output transistor case. Replace the flyback transformer if the transistor case is warm. Sometimes these flybacks will make odd sounds or squeal, and yet the sounds do not indicate a bad flyback. However, internal arcing, or signs of smoke from the plastic case, or arcing around the focus wire connecting to the focus-screen assembly – any of these indicate the flyback is bad.

With the horizontal-output transistor's collector voltage limited to +80V, you may investigate excessive flyback and HV voltages, or excessive current caused by a flyback defect, without danger of damage to the components.

But first the horizontal system operation should be verified, (Figure 4). Scope the Q412 base. The horizontal-oscillator and horizontal-driver are operating normally if you measure 9V. Next, monitor the 450V to 500V pulses at the collector (case) of Q412. Any smaller pulses between the 15,734Hz pulses might indicate a shorted flyback, or an excessive load on one flyback winding. Noise from arcing HV diodes might be visible on the screen; if so, replace the flyback. Other distortion of the pulses might mean the flyback's iron core is cracked; replace it to find out. If the output pulse waveform is clean and correct, you may assume the components of the horizontal-output stage are normal.

ARM YOURSELF AGAINST STATIC WITH NTE'S NEW PATENTED FIELD SERVICE KIT.

Static electricity is a real hazard to sensitive electronic equipment. Now you can protect valuable components in the field and in the plant with NTE's new Field Service Kit.

Our Kit includes everything you need to keep your equipment free of static — a 24" × 24" table top work mat, wrist strap with 8′ coil cord, 15′ clip-on grounding line and anti-static component storage bags. Both the wrist strap cord and grounding cord contain integral current limiting resistors.

Unlike other kits currently on the market, NTE's patented* three-layer construction produces controlled static drain, eliminating the danger of sparking and the chance of additional component failure during the repair operation. The static-dissipative, vinyl work surface is durable and its bright green color enhances visibility. The entire Kit folds down into a compact unit and comes with its own zip-close bag.

Look for NTE's new Field Service Kit and our other static control products — including our anti-static foam, for shipping and storing equipment, and separately packaged wrist straps — at your local NTE distributor.

*Patent issued November 8, 1983. U.S. Patent No. 4,414,260.

NTE®

NTE ELECTRONICS, INC.

44 FARRAND STREET • BLOOMFIELD, NEW JERSEY 07003

CIRCLE 274 ON FREE INFORMATION CARD

Circle (6) on Reply Card

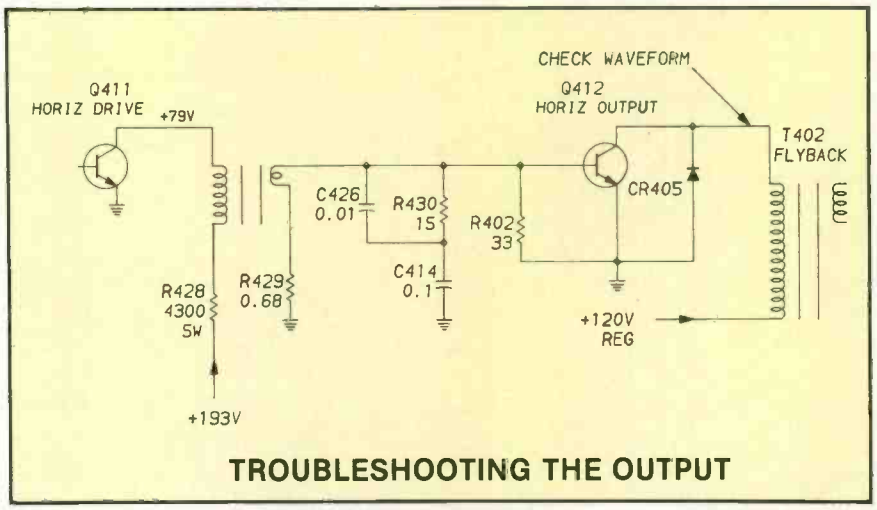
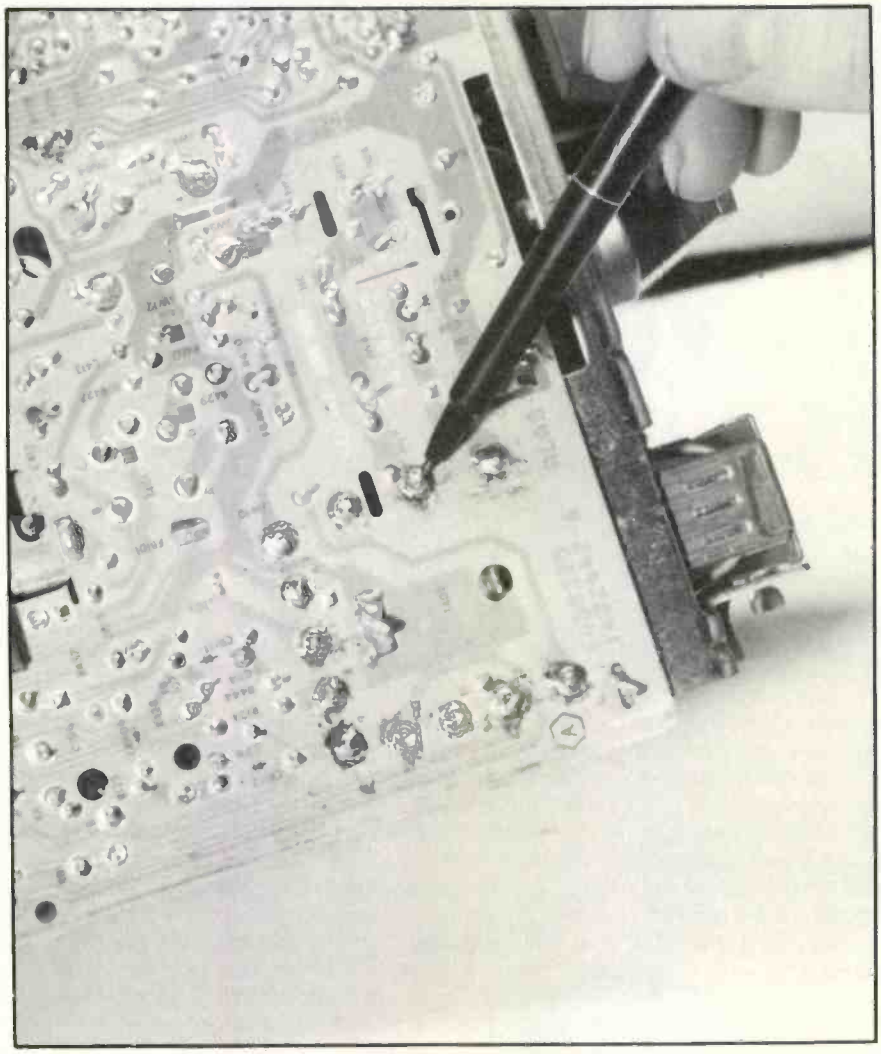


Figure 4. Check the Q412 base-to-emitter waveform to verify correct operation of the oscillator and driver stages, then analyze the collector pulses to determine whether the flyback and sweep circuit is loading down the collector signal.



Using a solder-wick and an adequately hot soldering iron, remove all excess solder from the output transformer eyelets when removing the flyback. After replacing the flyback and soldering the eyelets carefully, check between the wiring and the transformer to be certain there are no open circuits.

Shutdown can be caused by components of scan-rectified power supplies, or by defective components connected to those supplies. In Figure 5, check rectifier CR111, regulator Q302 and zener CR302 of the +11.24V source. Also, a leaky CR112 diode in the boost-voltage source can cause shutdown. Disconnect one diode at a time and notice the change of waveform at the Q412 collector. A leaky or shorted flyback transformer loads down the horizontal circuit and lowers the flyback signal voltages as well as reducing the dc voltages rectified from those signals.

Incorrect label

An improperly labeled flyback transformer in the early production CTC109 chassis can cause trouble during replacement. The incorrect label has a 146486 RCA stock number on it, and it was intended for the RCA CTC108 chassis because it produces only 26.2kV, which is adequate for a 19-inch set.

The correct label for the CTC109 chassis has a 146487 RCA stock number, having a 28.6kV rating for 25-inch color receivers. The 146487 was superseded by a 153175 number, and finally changed to the *154494*. With the 154494, the HV lead is supplied.

Removing a defective flyback

After a flyback is determined to be defective, its connecting lugs must have all excessive solder removed by braided wick and a soldering iron. Rotate the hot iron and wick around the eyelet to suck up the melted solder. Gently try to move each terminal lug to determine if the lug finally is unstuck from the eyelet.

Installing a new flyback

Before mounting the new transformer, use the iron and solder wick to remove any excess solder from the eyelet on the chassis's top side (see photo, lower left). While the flyback is removed, replace output transistor Q412, if defective. You easily can get to the transistor and solder all connecting wires, including the damper diode.

Make certain all transformer

If you can't fix your board with the enhanced 9000 Series, it's beyond repair.

Introducing a new dimension of test capabilities for the Fluke 9000 Series Micro-System Troubleshooter line.

Finally there's a way to conquer some of the most difficult board testing problems imaginable. Take control of the situation with Fluke's 9000 Series and new **Asynchronous Signature Probe option.** You'll be able to pinpoint virtually every digital hardware fault on the entire board. Even those frustrating faults in circuits that operate independently of the microprocessor bus cycle.

Begin testing boards with the 9000 Series' built-in, preprogrammed test routines. In a single keystroke, you can automatically check the entire microprocessor kernel—Bus, ROM, RAM and I/O.

For testing beyond the bus, Fluke's new probe option eliminates the need for a logic analyzer or scope to test asynchronous circuits. One complete package, easily installed into either new *or* existing 9000 Series units, offers signature analysis, waveform capture and event counting. These three vital troubleshooting functions give *any* 9000 Series the power to diagnose:

- DMA Controllers
- Disk Controllers
- Video Controllers
- Video-Generation Circuits
- Communication Circuits
- Peripheral Controllers
- Dynamic RAM timing relationships

Not only does the 9000 Series test more of the board, it also supports more 8-bit and 16-bit processors than any other tester on the market.

Call Fluke toll-free **1-800-426-0361** or contact your local representative, and put your most challenging board to the 9000 Series test. If it can't be fixed with the enhanced 9000, it's probably beyond repair.

FLUKE®

Circle (7) on Reply Card

IN THE U.S. AND NON-EUROPEAN COUNTRIES: John Fluke Mfg. Co., Inc., P.O. Box C9090, M/S 250C, Everett, WA 98206, Sales: (206) 356-5400, Other: (206) 347-6100.
EUROPEAN HEADQUARTERS: Fluke (Holland) B.V., P.O. Box 2269, 5600 CG Eindhoven, The Netherlands, (040) 458045, TLX: 51846.

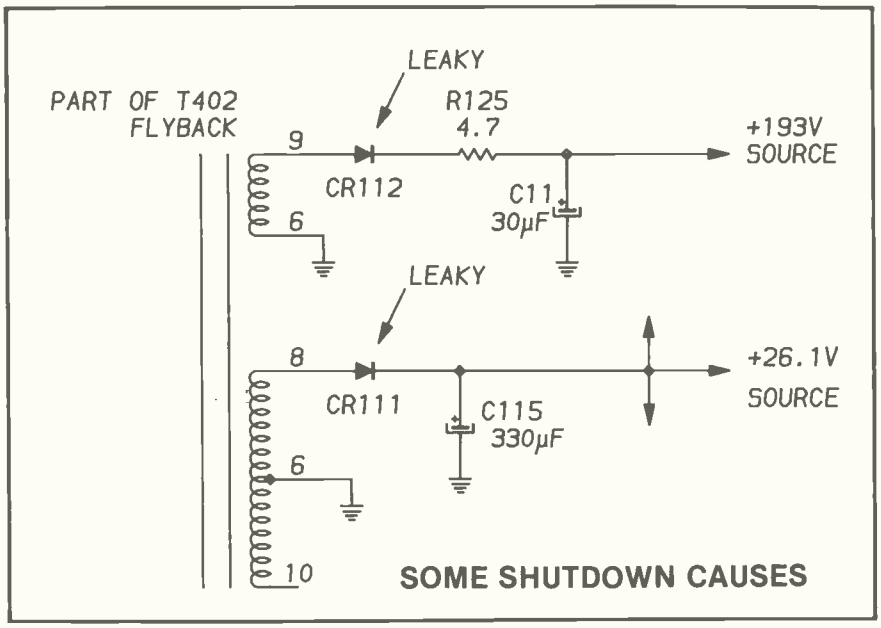


Figure 5. When the pulses at the horizontal-output transistor's collector have smaller distorted pulses between them (during tests with low voltage),check CR112 and CR111 for shorts or leakage.

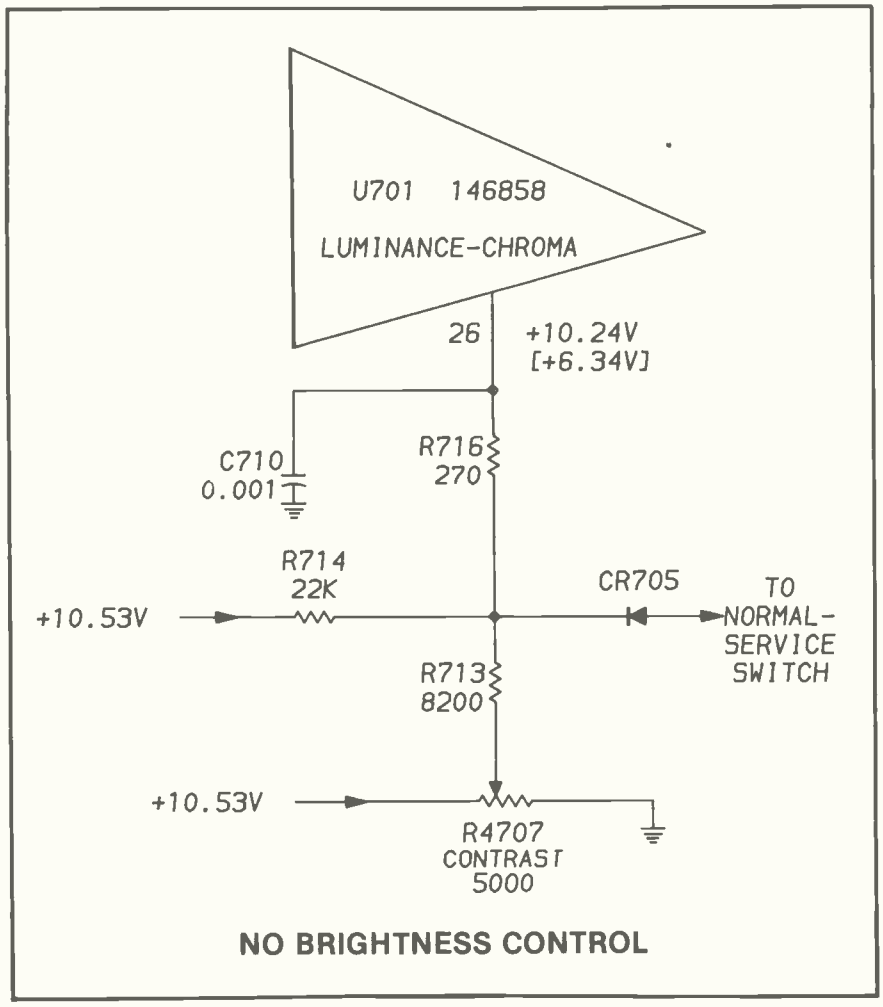


Figure 6. An analysis of the dc voltages at the U701 pins will solve most of the brightness problems.

terminals are straight before mounting the transformer. Solder both filament leads to the transformer side lugs. Dress down the brown-colored filament wire between the ferrite core and the frame. If this procedure isn't followed exactly, the CRT filament voltage will be excessive, and the picture tube might be damaged.

Apply solder to the eyelet and transformer terminal, filling up the hole with solder. Clean off excess solder and rosin from the soldered terminals using a metal brush. Now check the low-range resistance of each terminal connection to the nearest corresponding wiring component. Each should test virtually zero. Continue to resolder the transformer terminals until a low resistance reading is obtained for all.

Excessive brightness, then shutdown

A bright raster that gradually became brighter before shutdown stopped the receiver operation was the symptom. When adjustment of the brightness and screen controls accomplish nothing, measure the dc voltages at each pin of IC U701. When a pin with an incorrect voltage is found, use solder wick to remove the solder from around that pin until the pin finally is not connected to the wiring. Then measure the resistance to ground. Commonly, such leakages are about 1,000Ω or less. For all low readings, replace the leaky U701 (146858).

In another CTC109 chassis, the excessive brightness could not be controlled, resulting in shutdown. This was caused by the picture tube. Check for that by unplugging the picture tube socket and operating the set to determine if shutdown occurs. It should not.

High brightness with retrace lines

A leaky luminance/chrominance U701 IC can produce excessive brightness with or without retrace lines. The retrace lines often can be seen with the screen control turned completely down. Accurately measure dc voltage and resistance-to-ground of all IC pins (Figure 6). A lower-than-normal dc

voltage indicates internal leakage or external leakage through a discrete component.

The S701 service switch can cause high-brightness problems, even when the switch contacts test *good* on a meter. Replacement of the switch is the only certain cure.

No brightness control

Suspect leakage in luminance/-color IC U701 when the brightness control can't be turned down. First, collapse the sweep with the service switch and notice if all three colors seem to be on the screen. Turn up the screen control until all three can be seen. Check all grid, cathode and screen voltages of the picture tube after the sweep has been restored. If a raster is produced by the higher setting of the screen control, go to the luminance circuit and U701, (see photo at right).

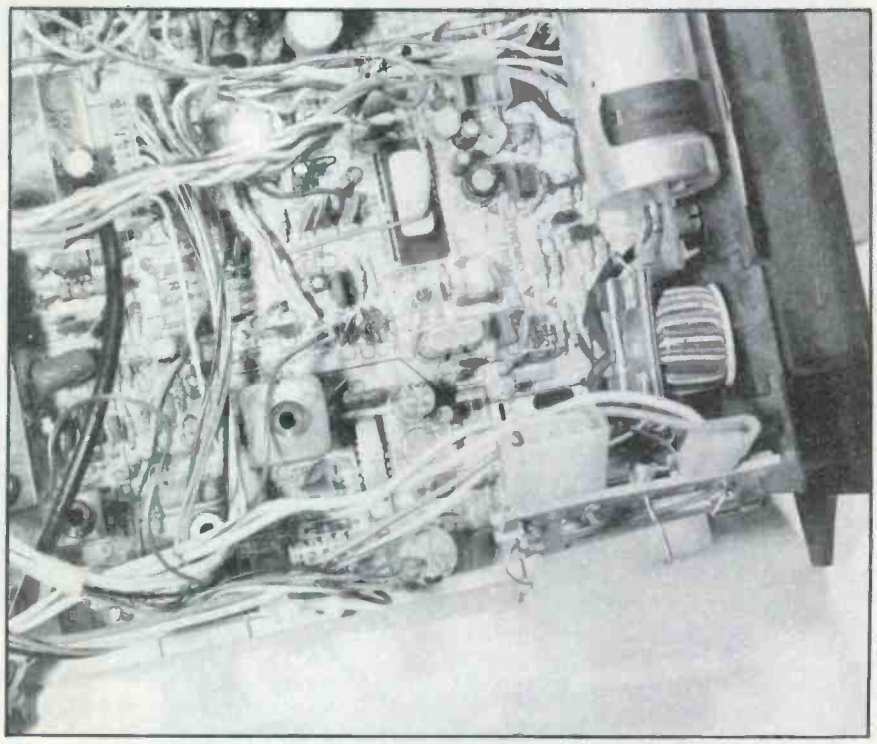
One remote control model had no control over brightness, and pin 26 of U701 measured only +4.1V (it should be +10.24 as shown in Figure 6). When pin 26 was unsoldered from the board, it measured 768Ω to chassis ground. After replacement of U701 with a 146858, the resistance from pin 26 to chassis ground was 7.1kΩ. We recommend that resistance tests be added to the usual voltage test of integrated circuits. The new IC repaired the problem.

Another CTC109 with similar symptoms and measurements was not helped by replacement of U701, which had a low voltage at pin 26. Finally diode CR705 was found to have a 2,000Ω short. Replacement of CR705 brought good operation.

Intermittent brightness

Intermittent brightness can be caused by either the luminance or the picture-tube circuits. Carefully monitor all voltages of the luminance U701, and the picture-tube socket. Check for a defective picture tube. R9 (22k) and C1 (0.01) on the CRT-socket board (see Figure 7) have caused many intermittent raster problems. Always check these at the beginning of tests.

With another CTC109 chassis, the brightness would go up and down quickly, sometimes staying low for some time. A dc-voltage measurement of CRT pin 7 indicated a constant change of voltage (Figure 7). Since this is the common screen grid, it would account for the brightness variation. R9 and C1 were tested thoroughly but both were perfect. Therefore, the entire screen-and-focus-control assembly was replaced, and that stopped all the unwanted brightness changes.



The IC near the center of the photograph is U701 the luminance/chrominance integrated circuit. Measure the dc voltage and the resistance of all IC pins to ground and compare the readings with the Photofact. Critical for brightness levels is the voltage at pin 26. Also, remember to measure the +10.53V supply that powers U701 before condemning the integrated circuit.

C705 (120pF at anode of Q701 phase compensation) might become leaky and cause the raster to darken. The picture becomes totally dark, if L807 (near Q801, the burst clamp/keyer) opens. An intermittent DL701 delay line will produce intermittent brightness and pictures.

Poor focus

If the focus control can supply focus voltage above and below the nominal 7kV rating, and if the focus adjustment brings a better sharpness of scanning lines with plenty of adjustment available on both sides (but the focus, and perhaps the brightness, is just below average) suspect the picture tube.

Verify the diagnosis by a picture-tube tester, or by operating the receiver from a picture-tube test jig, if you have one.

Erratic focus can be caused in this model by a defective focus control, which is part of the focus-and-screen-control assembly (Figure 7). Arc lines in the raster can be caused by the same assembly, which must be replaced as a unit.

An unusual picture

A very unusual problem can occur in CTC109 chassis when C105, the only rectified-line-voltage filter capacitor, is open. It has an appearance like an outdoor water fountain with its water overflowing into a similar basin below. An actual picture of the effect is shown on page 18, which shows color bars in black-and-white. When another 600μF capacitor was paralleled with C105, the performance became normal. Use an original part number capacitor for replacement.

In remote-control GER models,

THE MARK III

HV CIRCUIT SCANNER

- ★ Checks the horiz output circuit for open / shorts,
- ★ Checks the flyback, yoke, PC, and HV mult,
- ★ Checks all scan derived B+ sources,
- ★ Checks all circuits that rely on scan derived B+ voltage,
- ★ Checks for open safety capacitor,
- ★ Checks the emitter circuit of the horiz output,

THEN,

- ★ Provided the green normal light is lit, the Mark III will safely power up the TV set so that **you** can "look" for open circuits by examining the picture on the CRT.
- ★ Circumvents all start up and horiz drive related shut down circuits.

APPLICATIONS: The Mark III will analyze the horiz, flyback, hi-voltage, scan derived B+ sources, yoke, pin cushion, HV multiplier circuits in any TV set that employs either an **NPN** transistor or a single **SCR** for its horiz output device. This applies to any age, any model, any chassis, any brand - - - including Sony.

In brief, the "test" function scans for shorts, the "run" function permits you to observe any "open" circuits via the symptoms that appear in the CRT screen.

HOOK - UP: Simply remove the set's horiz output device and replace it with the scanner's interface plug. No wires to disconnect, no other connections required (not even a ground connection).

MISTAKE PROOF: No damage will result if an error is made during hook up. The scanner simply won't turn on until the error is corrected.

PUSH THE TEST BUTTON Just one of the four lights will lite.

RED OPEN LIGHT means the emitter circuit of the horiz output stage is open (no ground path).

YELLOW SHORT LIGHT means the flyback primary, HV multiplier, vertical output, horiz driver, and R-B-G color output stages are **not** shorted. Instead, a circuit that normally draws a small amount of current is shorted (i.e. the tuner, IF, AGC, video chroma, matrix, vertical or horiz oscillator).

RED SHORT LIGHT means either the flyback, the HV multiplier, the vertical output, horiz driver or one of the **R-B-G** output transistors is shorted.

GREEN NORMAL LIGHT means the TV set's entire flyback circuit is totally free of shorts. It also means that it is safe to power up the TV set with the "run" button so that you can look for open circuits by observing the symptoms on the CRT screen.

FEATURES: All **start up** circuits and all horiz drive related **shut down** circuits are automatically circumvented by the Mark III during all test and run functions. During the test function all flyback secondary output is limited to approx 80% of normal. 2nd anode voltage is limited to approx 5 KV.

This means all circuits that are not shorted will have some 80% of their normal B+ voltage during the "test" phase. It also means that any shorted circuit will have zero DC volts on it. This feature makes any short easy to isolate.

The MARK III sells for only $595^{00}

The money you are now spending for unnecessary flybacks alone will easily pay for your Mark III. Why not order yours today!

Visa and Mastercharge Welcome !

Diehl Engineering • 6661 Canyon Drive "F" • Amarillo, TX 79110
Phone: (806) 359-0329 or (806) 359-1824

ONE HUNDRED DOLLAR CERTIFICATE

100 100 100 100

How many times have you said

If I could only get this TV to power up, without burning up,

- - - I could fix it !!

Well, the Mark III will let you do just that.

The **test** button checks the entire scan circuit for shorts.

The **run** button checks the entire TV set for opens.

If you act now, this certificate will entitle you to a $100⁰⁰ discount on the all new Mark III, making the total price only $495⁰⁰ plus freight.

(See the reverse side of this card for details)

DISCOUNT CERTIFICATE

OFFER VOID JAN. 31, 1986 ONE DISCOUNT CERTIFICATE PER SALE

CUT ALONG DOTTED LINE AND USE AS AN ORDER FORM

ES&T MAG JAN

TWO HUNDRED DOLLAR CERTIFICATE

200 200 200 200

How many times have you said,

"Once I get a start up / shut down problem isolated down to circuit level,

- - - it's as good as fixed !!"

The fact is, all start up/shut down problems ultimately show up as a dead set symptom that does not relate to the actual defective circuit, start up and shut down problems are invariably caused by either a start up, H. drive, B+ "run" circuit, safety capacitor, H. yoke, pin cushion, flyback, HV multiplier, shorted scan derived B+ or, by a defective shut down circuit.

The Mark V makes the entire job of isolation easy. It puts you right where you want to be - - - in mere seconds, by automatically checking each individual portion of the overall circuit on it's own merits. If you act now, this certificate will entitle you to a $200⁰⁰ discount on the all new Mark V analyst. Making the total price only $795⁰⁰ plus shipping.

(See reverse side of this card for details)

DISCOUNT CERTIFICATE

OFFER VOID JAN. 31, 1986 ONE DISCOUNT CERTIFICATE PER SALE

CUT ALONG DOTTED LINE AND USE AS AN ORDER FORM

ES&T MAG JAN

Please Have A Salesman Call On Me . . .

I am not concerned about getting a discount on my test equipment.

However, if you will send a representative to my shop to give me a "hands on" demonstration, I agree to pay the regular retail price, as long as it will do everything that has been stated. And, as long as the unit is as easy to operate as stated in this ad.

We're growing: Having recently moved into our brand new 10,000 sq. ft. facility, we are now hiring technicians, tech writers, semi-technical production workers, regional and local sales representatives, and service oriented engineers. If you're interested, send your resume to: DIEHL, 6661 Canyon Drive Building "F", Amarillo, Texas 79110, (806) 353-5768.

Your Name _____ Street _____

City _____ State _____ Zip _____

AC ( ) _____

Phone # _____ Signature _____

Mark III Order Form

☐ Enclosed is my check for $495⁰⁰ along with this $100⁰⁰ discount certificate. payment in full for my Mark III HV circuit scanner. Please ship as soon as possible via **UPS** Blue Label (Diehl pays freight).

☐ Please ship my Mark III to me C.O.D. upon arrival I agree to pay 495⁰⁰ plus freight.

☐ Charge $495⁰⁰ to my ☐ Visa card ☐ Mastercharge card
My card # is _____ _____ _____ _____
My card expires _____ Phone orders welcome on charge card orders.

PLEASE PRINT

Name _____ Street address _____

City _____ State _____ Zip _____

AC ( ) _____ Phone # _____ Your signature _____

Mail to Diehl Engineering • 6661 Canyon Dr. "F" • Amarillo, TX 79110

Mark V Order Form

☐ Enclosed is my check for $795⁰⁰ along with this $200⁰⁰ discount certificate. payment in full for my Mark Five circuit analyst. Please ship as soon as possible via **UPS** Blue Label (Diehl pays freight).

☐ Please ship my Mark V to me C.O.D. upon arrival I agree to pay 795⁰⁰ plus freight.

☐ Charge $795⁰⁰ to my ☐ Visa card ☐ Mastercharge card
My card # is _____ _____ _____ _____
My card expires _____ Phone orders welcome on charge card orders.

PLEASE PRINT

Name _____ Street address _____

City _____ State _____ Zip _____

AC ( ) _____ Phone # _____ Your signature _____

Mail to Diehl Engineering • 6661 Canyon Dr. "F" • Amarillo, TX 79110

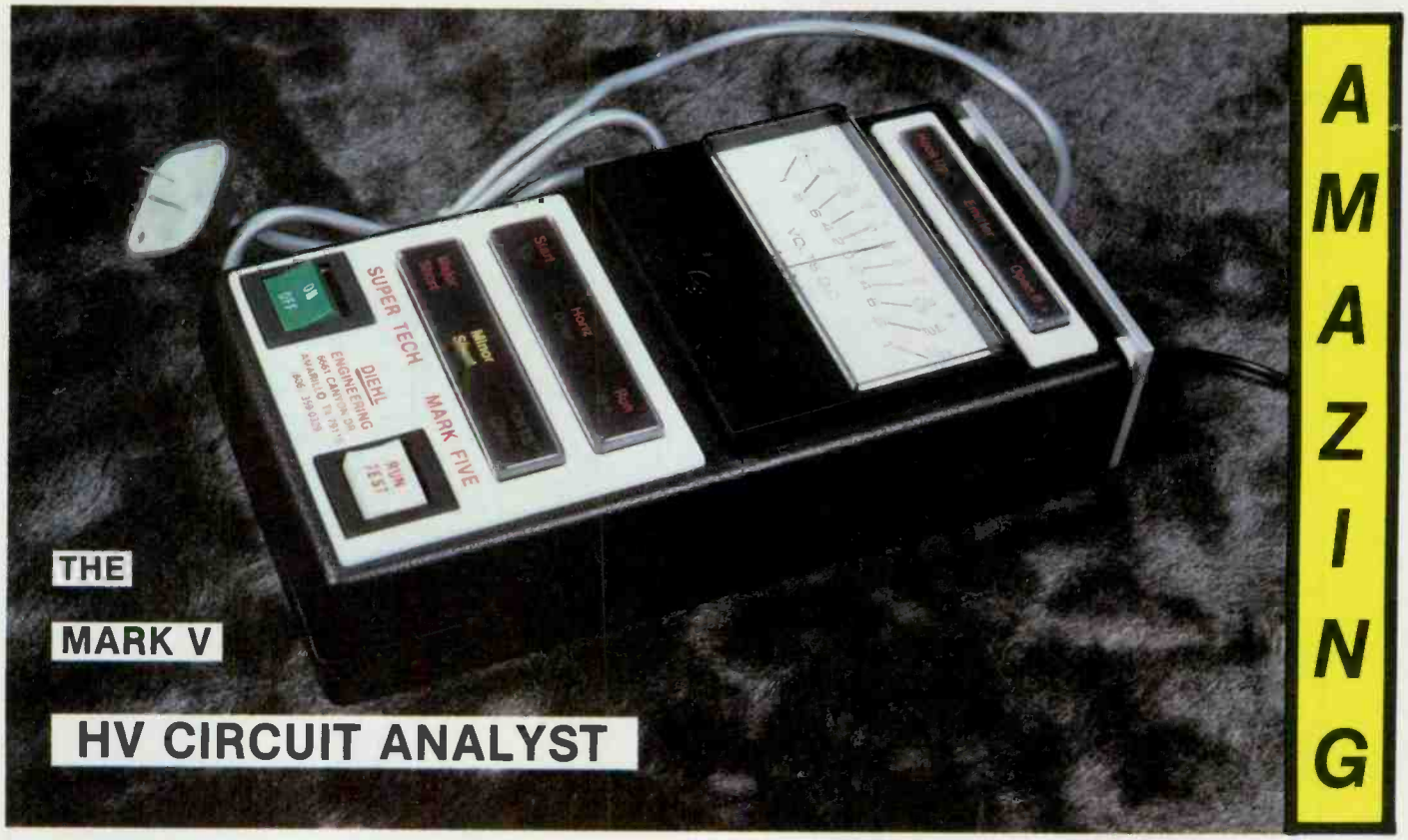
NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

Business Reply Card

FIRST CLASS PERMIT NO. 262 Amarillo, TX

POSTAGE WILL BE PAID BY ADDRESSEE

Diehl Publications
6661 Canyon Drive Bldg E
Amarillo, Texas 79110-9990



- ★ Checks the horiz output stage for opens / shorts,
- ★ Checks flyback, yoke, PC, and HV mult,
- ★ Checks all scan derived B+ sources,
- ★ Checks for open safety capacitors
- ★ Checks for open ground path for horiz output stage
- ★ Checks for open primary LV supply,
- ★ Checks for error in interface connections,
- ★ Checks for proper LV regulation,
- ★ Checks for proper start up circuit operation,
- ★ Checks for shorted horiz driver transistor,
- ★ Checks the operation of the horiz osc / driver circuits,
- ★ Checks B+ "run" supply for the horiz osc / driver circuits,
- ★ Checks all circuits in the TV set that rely on scan derived B+,
- ★ Automatically circumvents all start up circuits and horiz drive related shut down circuits.

HOOK UP: (Identical to Mark III)

OPERATION: Turn the Mark V on, turn the TV set on, then, simply look at the lights.

RED "HOOK UP" LIGHT means that you have made an error in hook up. No damage has been done, correct the problem then continue.

RED "EMITTER" LIGHT means that the ground path for horiz output stage is open. Correct the problem then continue.

RED "B+ OPEN" LIGHT means that the primary LV supply in the TV set is open. Correct the problem then continue.

No "top row lights" equals normal.

Look at the middle row of lights

RED "START UP" LIGHT means that the start up circuit in the TV set is not working (no start up pulse).

GREEN "START UP" LIGHT means the start up circuit in the TV set is working normally. Yes, it is 100% accurate. Even on Zenith's single pulse start up circuit !

RED "HORIZ DRIVE" LIGHT with a green start up light means that the horiz driver transistor in the TV is shorted (E to C).

GREEN HORIZ DRIVE LIGHT means that the horiz oscillator and driver circuits are operational.

READ THE DC VOLTAGE METER THEN,

PUSH THE TEST BUTTON

If the meter comes up to, or, falls back to, factory specified DC collector voltage, the LV regulator circuit is working. If it fails to do so, it is not working!

RED "B+ RUN" LIGHT means that the B+ source that normally keeps the horiz osc / driver circuits running after the start up B+ pulse has been consumed has become open.

GREEN "B+ RUN" LIGHT means that the B+ resupply voltage (scan derived) is being provided. All is normal if all three lights are now green.

The scan circuit short detector in the Mark V is identical in all ways to that which is used in the Mark III. Operation is also identical. Both units are virtually indestructable when simple directions are followed. Both units carry a full year's warranty against defects in materials and workmanship (parts and labor). Either unit can be easily repaired by almost any technician in his own shop.

If the green "circuits clear" light is now lit

It is now safe to push the "run" button and examine the symptoms that appear on the CRT screen, for the purpose of isolating any "open" circuits.

Except for hook up and CRT filament warm up time, this test can easily be completed in two to five seconds!

The Mark V sells for only $995.00

Stop losing money on start up / shut down scan derived B+ problems; order your Mark V today!

Visa and Mastercharge Welcome !

Diehl Engineering • 6661 Canyon Drive "F" • Amarillo, TX 79110
Phone (806) 359-0329, or (806) 359-1824

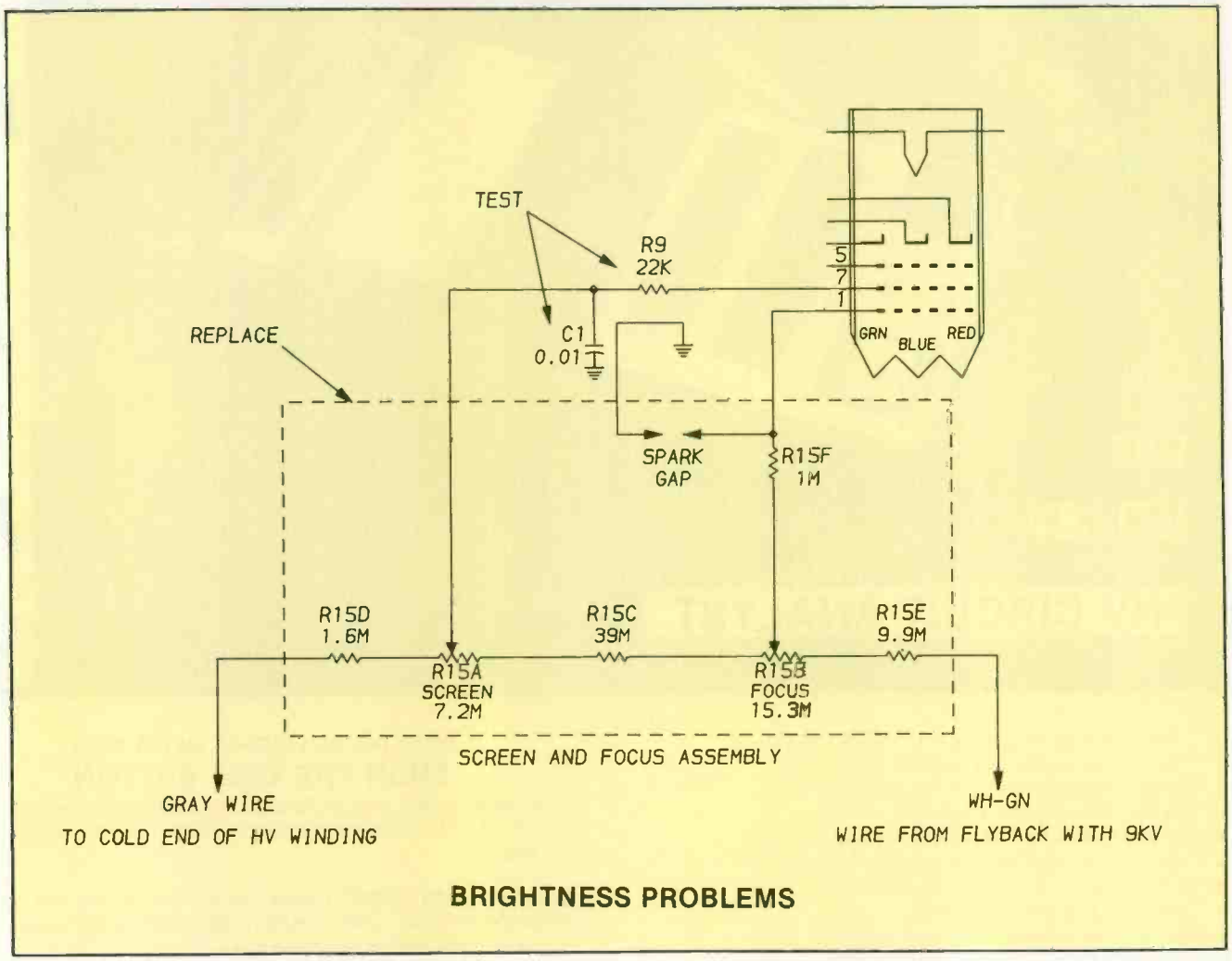
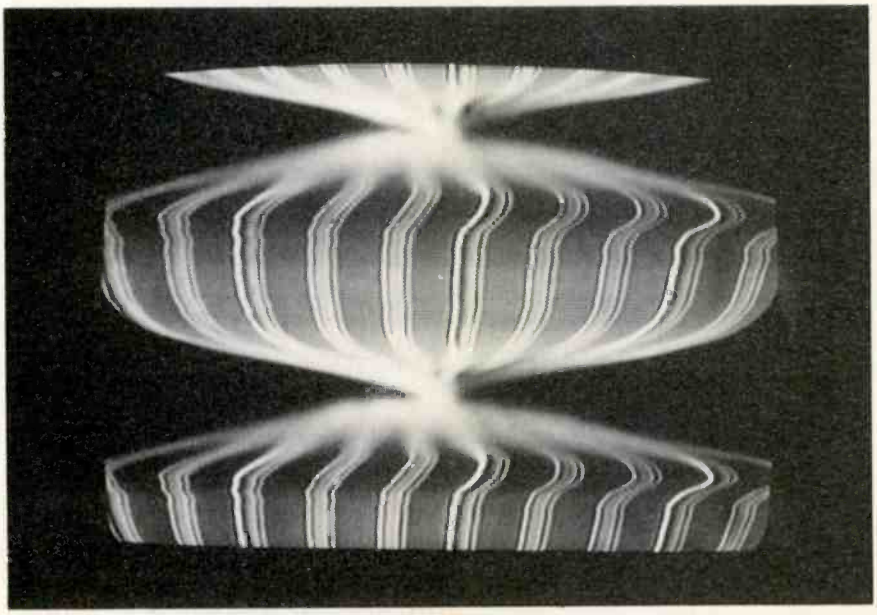


Figure 7. Most components shown can cause problems with screen brightness because of the voltage-divider type of circuit.



When filter C105 was open in the CTC109, the picture had full width only twice per raster because the filtering was virtually zero. Because the hum has a 120Hz frequency, narrow parts of the picture move slowly upward, color bars do not move.

suspect a defective C105 when the TV chassis will come *on* but you cannot switch it *off*.

One vital waveform

If the symptoms are no picture, no dial light, normal sound, and normal high voltage, check by scope for 60Vp-p negative-going horizontal pulses at pin 5 of the FS tuner control module. The schematic says −60V pulse, which might deceive the unwary into measuring with a dc meter; this will not work. The signal consists of pulses.

Check for an open L103 that is connected to the flyback's pin 7. If L103 is not open, check for erratic soldered connections on L103. If not open there, go on tracing until the open or short is found. The pulses *must* be restored to pin 5 on the control module.

ELECTRONICS BOOK CLUB

Keep In Step With the Future . . . Become a Part of the Fascinating World of Technology!

- High-Tech How-To
- Space Age Projects
- Digital Electronics
- Artificial Intelligence
- Robotics
- Computers
- Telecommunications
- *And much more!*

Select 5 Books for Only $2.95

(Values to $112.75)

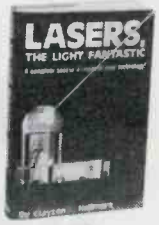
1777
List $21.95

1909
List $21.95

1625
List $21.95

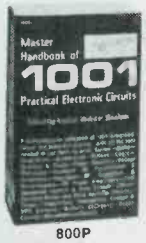
1599P
List $15.95 (paper)

1896
List $21.95

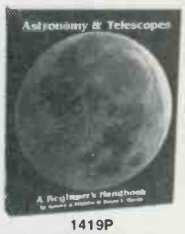


1108
List $16.95

1992
List $14.95



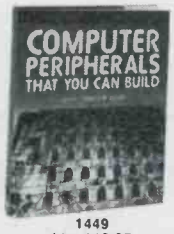
800P
List $19.95 (paper)



1419P
List $14.95 (paper)

1719
List $18.95

1531
List $17.95



1449
List $19.95


1604P
List $15.95 (paper)

1218
List $18.95

1835
List $15.95

1553
List $15.95

1474P
List $12.95 (paper)

1561P
List $18.95 (paper)

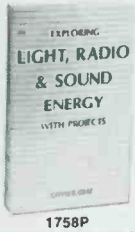
1650
List $19.95

1858
List $16.95

1605P
List $13.50 (paper)

1897
List $18.95

1977
List $26.95

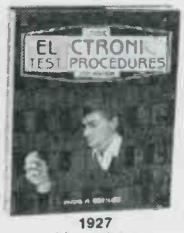


1758P
List $10.95 (paper)

1536
List $14.95

1539P
List $15.95 (paper)

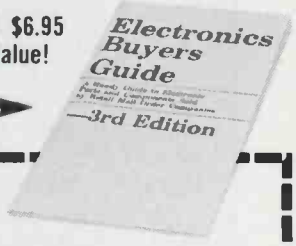
1690
List $19.95



1927
List $23.95

FREE guide to mail order sources for electronic parts and components

A $6.95 Value!



FREE When You Join Now →

7 very good reasons to join the Electronics Book Club

- **Big Savings.** Save 20% to 75% on books sure to increase your electronics know-how
- **No-Risk Guarantee.** All books returnable within 10 days without obligation
- **Club News Bulletins.** All about current selections—mains, alternates, extras—plus bonus offers. Comes 13 times a year with hundreds of up-to-the-minute titles to pick from
- **Automatic Order.** Do nothing, and the Main selection will be shipped automatically! But . . . if you want an Alternate selection—or no books at all—we'll follow the instructions you give on the reply form provided with every News Bulletin
- **Bonus Books.** Immediately get Dividend Certificates with every book purchased and qualify for big discounts of 60% to 80%.
- **Extra Bonuses.** Take advantage of added-value promotions, plus special discounts
- **Exceptional Quality.** All books are first-rate publisher's editions selected by our Editorial Board and filled with useful up-to-the-minute information

ELECTRONICS BOOK CLUB
P.O. Box 10,
Blue Ridge Summit, PA 17214

Please accept my membership in the Electronics Book Club and send the 5 volumes circled below, *plus* my FREE copy of *The Electronics Buyer's Guide* billing me only $2.95 plus shipping and handling charges. If not satisfied, I may return the books within ten days without obligation and have my membership canceled. I agree to purchase 4 or more books at regular Club prices (plus shipping/handling) during the next 12 months, and may resign any time thereafter.

800P 1108 1218 1419P 1449 1474P 1531 1536 1539P
1553 1561P 1599P 1604P 1605P 1625 1650 1690 1719 1758P
1777 1835 1858 1896 1897 1909 1927 1977 1992

Name _____
Address _____
City _____
State _____ Zip _____ Phone _____

Valid for new members only. Foreign applicants will receive ordering instructions. Canada must remit in U.S. currency. This order subject to acceptance by the Electronics Book Club.

EST-186

Circle (8) on Reply Card

Part 3

Introduction to microcomputer troubleshooting

Fundamental disk-drive troubleshooting

By Bud Izen CET/CSM

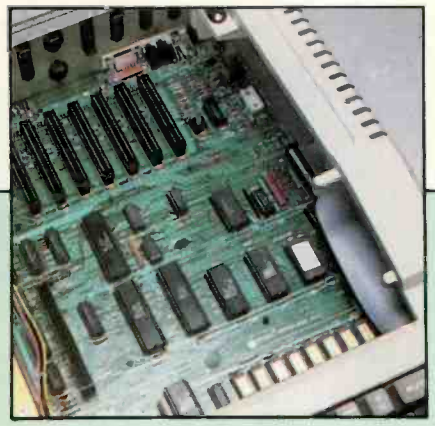


Photo courtesy Apple Computer, Inc.

From the workbench

I'm a consumer electronics analog technician from 'way back. The computer caught up with me when I discovered that a word processor helped me to prepare magazine articles and lessons for electronics courses I was teaching. I was ***on-line*** *at last! Or, I was until my one-and-only disk drive broke down in warranty.*

I discovered that I had to drive 30 miles to the nearest warranty station, and wait two weeks; not for the part, but for the warranty repair to be authorized by the factory. Then, when the unit finally was returned, it had a substitute part in the power supply that had been sloppily installed by the technician.

The same symptom reoccurred about a month after the unit went out of warranty. I knew absolutely nothing about disk drives at that time, other than how to insert and remove the disks, how to connect the drive to the interface card and how to plug it into the correct slot inside the computer. But on the other hand, I did not want to drive 30 miles each way and wait another two weeks. So I told myself the same thing that I have told countless other students and technicians: ***If you can diagnose a television, you can diagnose almost any electronic product.*** *I took a deep breath and removed the four screws holding the case to the drive.*

Braving the unknown

My first thought was, "What does this thing do normally?" It takes the information from the computer and stores it on the disk, or it takes information off the disk and loads it into the computer. Pretty simple, so far. Now, what are the failure symptoms? When I turn the unit ***on****, the in-use LED comes on and the disk spins around, but it doesn't load anything into the computer.*

Normally, this is a serious problem because all the programs that can be loaded into the computer to have it check itself out ***are on the disk****. You need the diagnostic disk to diagnose, but the mechanism you want to diagnose won't let you load the diagnostic programs. This vicious circle considerably complicates the servicing procedure.*

My first step was to turn the disk drive ***off*** *(by pressing system reset), and take voltage readings on all the pins of the ICs on the board mounted onto the drive. This ensures that all the power supply voltages are normal. Then, because the circuits are digital, I expected specific voltages to change with varying input conditions. I wrote down the voltages because there were so many of them. Having little regard for the nuances of digital, I used a $9.95 Radio Shack analog (yes, analog) meter.*

Then I put a disk that I knew had good information on it into the drive, shut the door on the drive, and gave the keyboard command (PR#6) to turn on the drive. Once again the LED came ***on*** *and the disk-drive motor came* ***on*** *but the program did not load. I wrote down the dynamic voltage measurements next to the static ones, then turned the unit* ***off****.*

Next, I referred to the sche-

matics of the disk drive interface card mounted inside the computer, and analog card that mounts on top of the drive. This was what I needed. Not every voltage was listed, because some of the lines were obviously designed to carry information that would vary between the TTL levels of zero and +5.

After examining the schematic and comparing my readings, it was apparent that some of the voltages on one particular IC did not change, yet should have. So, I called up a computer parts vendor and ordered two of every standard IC and transistor used on either disk drive board. My entire order came to less than $20.00.

Three days later, the package of parts arrived in the mail. I removed the one IC I needed and plugged it in. It worked. About a year later, the same symptom occurred, and I followed the same procedure again, using the same fancy test equipment. This time it appeared that the voltages on two ICs were not changing. It turned out to be the same IC as before, plus one other. This time the repair took five minutes from start to finish, instead of an hour plus three days of waiting. The most-time-consuming part of the job was removing and replacing the case. The second repair was as successful as the first.

Timing is everything

About six months later, my word processor program started acting up. Every so often, it would not save a file correctly. In order to treat the symptom, I began to back up my work on two separate disks at the same time. The problem kept getting worse. Sometimes neither backup copy was any good.

About that time, I remembered reading an article in one of my user-group magazines about problems relating to disk timing and how if the rotational speed of the disk (about 300Hz) varied too much or became erratic that data could be lost or become otherwise unreadable. This sounded like my problem. So I purchased another diagnostic disk from the user group and found out that was exactly what was wrong. All I had to do was to run the diagnostic program while observing the print-out on the monitor, and adjust a small pot on the motor power supply and speed control board at the rear of the disk drive. About two months later, however, the disk drive completely ceased functioning. I called up Apple, and the technician there was helpful. I explained all that I had done (everything listed above) and that nothing seemed wrong. He suggested that I take the unit to an authorized service station and have it diagnosed. He thought it was a head problem. The service station ended up replacing the entire mechanical assembly, after which the drive worked fine and still does today.

Here's one other tip that applies to every card-edge connector in a computer or any other electronic device. Clean the edge connectors with a pencil eraser once in a while to keep excess corrosion and oxidation from causing open connections, intermittent or erratic operation.

Working on computers and computer peripherals is not hard. In fact, as you see from my experiences, if you already are a competent technician, you should have few problems. →

Peripheral connections

An asterisk (*) following the mnemonic name of the line indicates that it is a negative logic line. In other words, the line is active (logically high) if a low voltage (about 0V) is placed on it, and inactive (logically low) when about +5V is placed on it.

Pin# Description

01 I/0 select*; There are 256 addresses set up for each of the seven slots. If the processor is addressing a particular slot, this pin (on the slot being addressed ony) will be pulled low. It is able to drive four TTL loads (fanout of four).
02 The Apple uses a 16-bit address system. The address lines are asserted by the 6502 microprocessor within 300ns of the start of PHI 1 (the complement of the PHI 0 system master clock).
03 A1
04 A2
05 A3
06 A4
07 A5
08 A6
09 A7
10 A8
11 A9
12 A10
13 A11
14 A12
15 A13
16 A14
17 A15
18 R/W; this is the read/write line asserted by the 6502. When the line is high, a read cycle is in progress. If low, a write cycle is in progress. This line has a fanout of 16.
19 NO CONNECTION
20 I/O STROBE*; When PHI 0 is high, this pin will go low on all slots if the 6502 is addressing an I/O device whose address is hex C800 to CFFF. Fanout of four.
21 RDY; this is the ready line to the 6502. Designed to change only when PHI 1 is high, If this line is brought low, the microprocessor will enter the halt state upon the next read cycle. This line should be asserted using tri-state logic.
22 DMA*; The direct memory access control line, which should be asserted using tri-state logic.
23 INT OUT; This interrupt line is daisy chained through the peripheral slots, and is assigned to low priority devices. Fanout of four.
24 DMA OUT; this line is another daisy chain line for direct memory access to lower priority devices. Fanout of four.
25 +5V
26 GND
27 DMA IN; this is the direct memory access daisy chain line from higher priority devices. This line looks like no more than four TTL loads to the driving device.
28 INT IN; this is the interrupt daisy chain input line from higher priority devices. Looks like no more than four TTL loads to the driving device.
29 NMI*; this is the non-maskable interrupt line to the 6502. It is active when a low voltage is applied, and should be asserted using tri-state logic.
30 IRQ*; this is the interrupt request line to the 6502. It is active when a low voltage is applied, and should be asserted using tri-state logic.
31 RES*; this is the system reset line. It is brought low by pressing the reset button on the keyboard. It is designed to drive two MOS loads per slot.
32 INH*; this is the inhibit line. If a device brings this line active (low), all ROMs will be disabled (Hex addresses D000 through FFFF). This line should be asserted with tri-state logic.
33 −12V
34 −5V
35 NO CONNECTION
36 7M; this is a 7MHz clock that can be used to drive up to 16 TTL loads.
37 Q3; this is a 1MHz signal that can be used for general timing purposes and can also support up to 16 TTL loads.
38 PHI 1; the complement of the PHI 0 system master clock. This line can drive up to 16 TTL loads.
39 USER 1; a user-defined line that must be hard-wired by means of an on-board jumper.
40 PHI 0; the system master clock capable of driving 16 TTL loads.
41 DEVICE SELECT*; the Apple system sets aside 16 addresses for each slot. If the processor reads or writes to one of these addresses, the signal on pin 41 of that particular slot will be brought low when PHI 1 is true. Fanout of four.
42 D7; lines D0-D7 represent the 8-bit system data lines. The 6502 asserts a write cycle no less than 300ns after PHI 1 is true, and expects the data to be asserted and stable no less than 100ns before PHI 1 is false. These lines can support up to eight low-power Schottky TTL loads.
43 D6
44 D5
45 D4
46 D3
47 D2
48 D1
49 D0
50 +12V

Table 1. The Apple uses its own non-standard 50-connector bus system for peripheral and expansion purposes. This table describes the function of each pin on the bus.

In most microcomputer systems, if the disk drive fails, you're out of business. Ordinarily, microcomputer users store all of their programs and data on floppy disks and if the drive won't work, there's no way to load programs or data. Fortunately, a competent technician, armed with the correct tools, test equipment and information, should have no problem restoring a failed disk drive to operation. Even if all your servicing experience is on analog equipment and you've never worked on computer equipment. The information that follows applies specifically to troubleshooting an Apple disk drive, but the procedure, with modification, is pertinent to the disk drives of most personal computers.

Disk drive specifics

Besides the drive mechanism, there are three main modules associated with the Apple disk drive system: the interface card that plugs into an expansion slot, the analog board that sits on top of the drive mechanism, and the motor control board located at the rear of the drive. The drive requires three power supplies: +5V, +12V and −12V. The +12V is used to run the motor; all three of the supplies are used on the interface and analog boards for various purposes.

The Apple uses its own non-standard bus system for peripheral and expansion purposes. This is a 50-connector bus. As you view the inside of the Apple from the keyboard, pins 1 to 25 are on the right (component) side of the bus, while pins 26 to 50 are on the left (foil) side. Pin 1 is the right-side pin closest to the keyboard; pin 50 is opposite pin 1. Table 1 describes what each of these pins does.

A thorough examination of Table 1 should give you a basic understanding of what is happening on the slot-connector lines. Here's how the disk drive system takes advantage of the lines. Because the disk drive is strictly a *slave* device, meaning it cannot cause *interrupts* or take over control of the Apple from the 6502, it has no need for many of the lines. Therefore, it does not need the information on lines 18, 20, 21, 22, 29, 30, 32, 36, 38, 39 and 40. Also because it needs only an 8-bit address, it does not use lines 10 to 17. Line 27, DMA in, is looped through to line 24, DMA out. Line 28, INT in, is likewise looped through to line 23, INT out. None of those lines are used by the disk system.

There are several ICs located on the interface board that interpret the signals on the bus so that disk read-and-write operations can take place at the correct time. Likewise, the signals going to and from the analog card are conditioned. The interface card and analog card communicate with each other over a 20-wire connector bus. This bus is described in Table 2, page 27.

Tracking down disk drive problems

Referring to Table 2: It should now be a fairly straightforward procedure to trace disk drive problems by using any of your favorite pieces of test equipment. Generally speaking, a logic probe is most useful to get you in the ballpark. If you are really in doubt as to whether or not a pulse train is

really there, the oscilloscope is your best bet for making a determination. Otherwise, you can use a standard voltmeter to track down a great majority of failures. For example, let's see what should happen if the system is writing some information to disk 1.

Starting with the information on the bus itself, the disk drive is selected via data on the address lines, and the device enable line is brought low. The I/O select line also goes low. The data then can be fed over the bus to the interface card. From there, it is sent to the analog card as follows:

The disk addressing information is sent over lines PHI 0 through PHI 3. The drive enable 1 line goes low. The write protect line stays low. The read data line is inactive. Data is fed to the disk over the write data line. The write request line goes low. All the power supply lines should be enabled. The motor should come on, and the in-use LED should light.

The disk read process is similar. Starting at the bus, the device is selected as above, while the 6502 prepares itself to receive data. The interface card then can ready itself for data input by enabling the following lines on the analog card. Lines PHI 0 through PHI 3 assert the disk-addressing information. The drive enable 1 line goes low. The read data line receives information off the disk and sends it to the interface card, which puts it on the data lines. The write data line is inactive. The write request line goes high. All the power supply lines are enabled. The motor should come on, and the in-use LED should light.

If the read-or-write operation

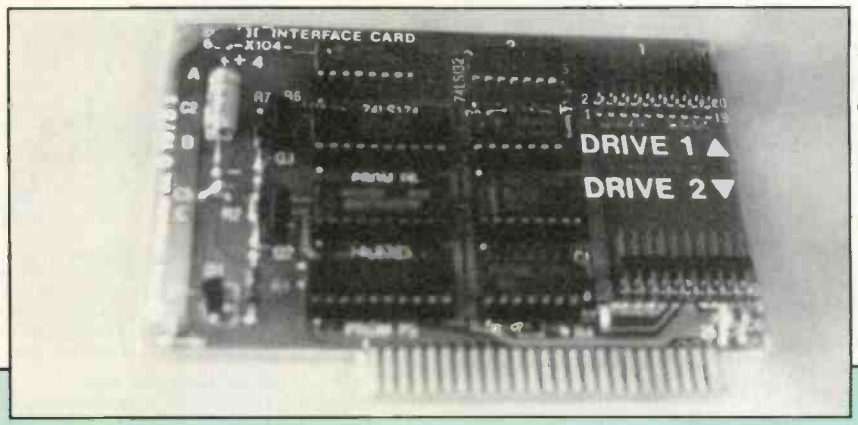
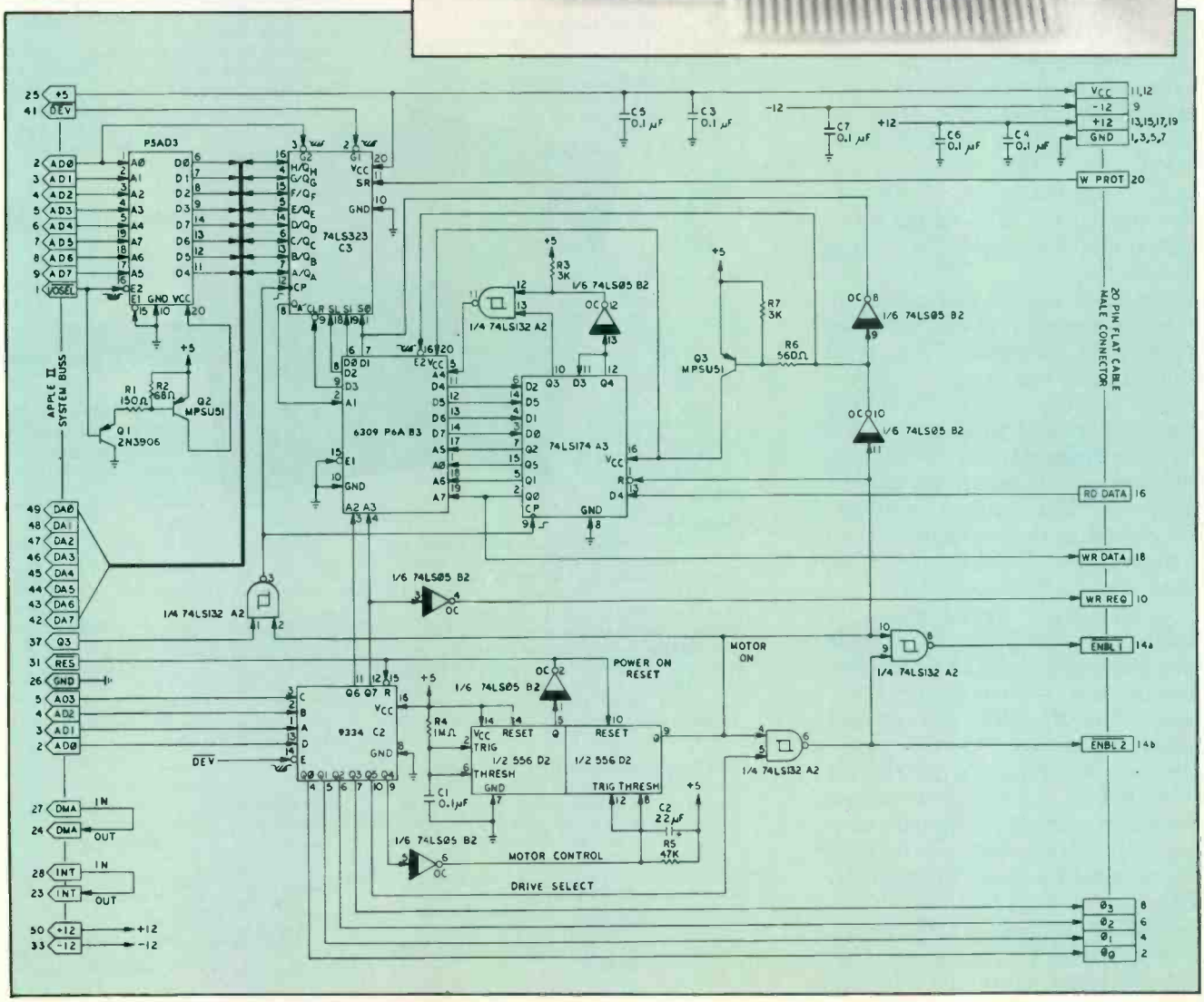
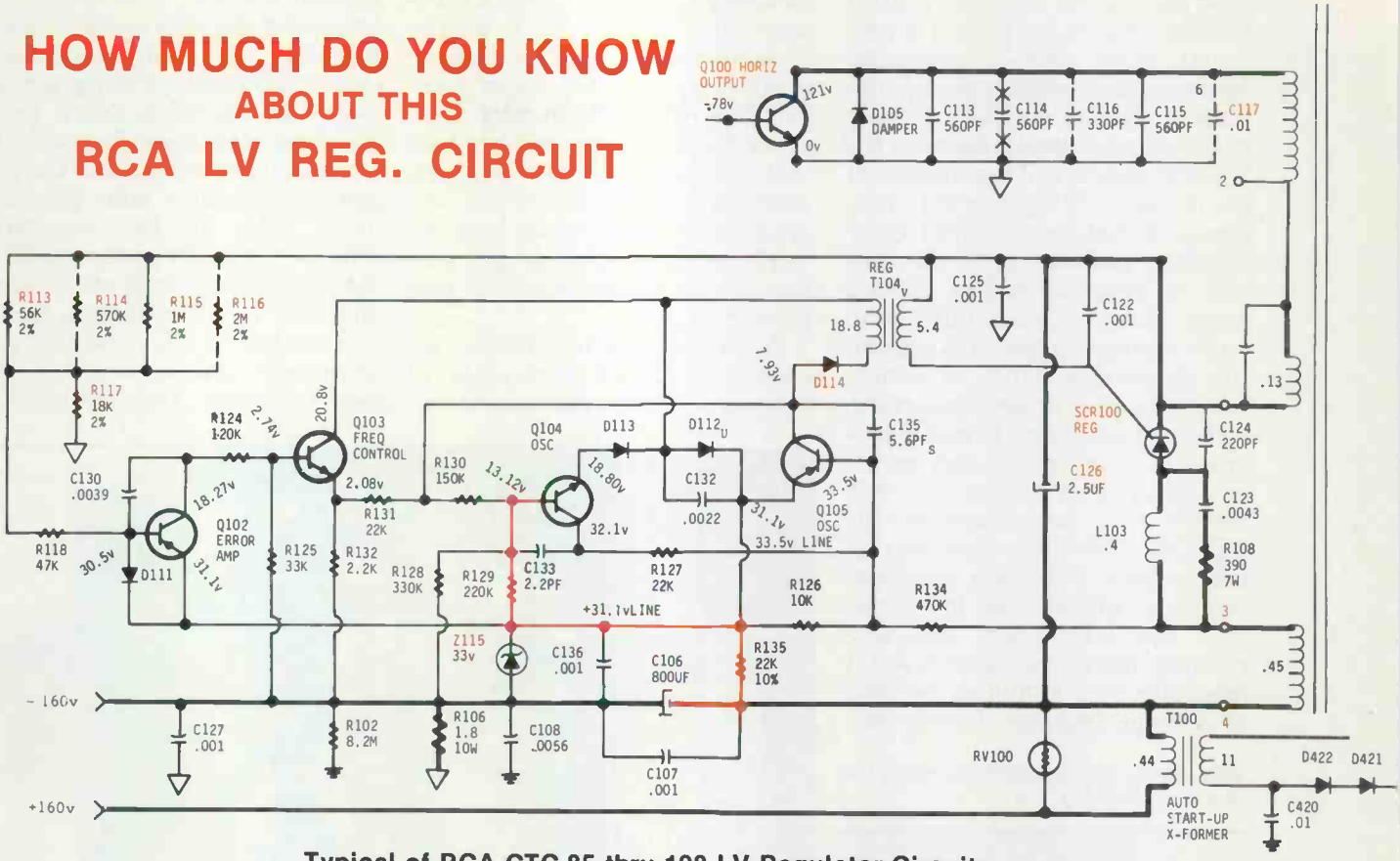


Photo courtesy Mark Anthony Computers.

The disk interface board, which plugs into the computer, contains all of the circuitry necessary to effect communications between the computer and the disk drive. The use of ICs make a complex circuit appear relatively simple.



HOW MUCH DO YOU KNOW ABOUT THIS RCA LV REG. CIRCUIT



Typical of RCA CTC 85 thru 108 LV Regulator Circuits

Schematic by Diehl Engineering

How many of these questions can you answer ?

(1) Every circuit has a beginning and an ending. Where does this circuit begin ?

(2) Specifically, what is the purpose of this circuit ?

(3) What turns it on ? What turns it off, or does it ever really turn off ?

(4) Does this circuit have a shut down feature ? If so, which components are involved ?

(5) What would happen if Q103 were to become shorted E to C ?

(6) What purpose does Z115 serve ?

(7) What would happen if D114 became shorted ?

(8) What purpose does C126 serve ? What will happen if C126 becomes open ?

(9) Is the winding between terminals 3 and 4 of the flyback a primary or a secondary winding ?

(10) What purpose does C117 serve ? Exactly what does it do, and exactly how does it do it ?

(11) Exactly what do resistors R113, 114, 115, 116, and 117 do ? What happens if they change value ?

(12) What occurs that causes this circuit to produce an initial start up pulse ?

(13) Why does this entire circuit become shorted and begin to destroy horiz output transistors if the regulator SCR becomes shorted ?

(14) There is exactly one safe and practical method of circumventing this LV regulator circuit for test purposes. This technique does not involve a variac. Instead, you must disconnect one wire then connect a jumper wire from terminal #4 directly to . Which wire do you disconnect and where do you connect the other end of your jumper wire ?

(15) If SCR100 is shorted, this circuit will still "eat" horiz output transistors even if you are using a variac. Why ?

(16) Why does this circuit use a floating ground ?

We publish a monthly magazine called the Technician / Shop Owners Newsletter. Each month we take a popular circuit and absolutely diasect it.

Using color coded pictorial schematics such as the one above, we "map out" every action in the overall sequence of events that must take place during each and every cycle.

Beginning with the very first "action" in the sequence (which just happens to be depicted in the above schematic) we explain exactly what is taking place. We then explain the function of every component in that portion of the circuit. After explaining the function of each component, we show you how to troubleshoot that particular "action" or function.

After reading our newsletter on this circuit, you could answer all of the above questions as fast as anyone could ask them. In fact, you will then know everything there is to know about this circuit. Including how to troubleshoot it !!

Regardless of whether you work on TV sets, stereos, radios or computers, just having the ability to "diasect" an electronic circuit (any circuit) is worth a fortune. In reality, "diasecting" is exactly what our newsletter is designed to teach you.

Because of the manner in which our newsletter is written, the subject matter that is gained from each monthly issue is so extremely broad that it will "spill over" into your everyday troubleshooting routine, and be applied to totally unrelated circuits.

This entire training program sells for only 119^{40} per year (12 seperate issues). Virtually every one of our subscribers agree that no other publication is as informative. By using the attatched order card you can purhase the first three of fifteen issues for only 29^{85}. Just these three issues alone will vastly improve your knowlege of electronics.

For immediate service call your order into us at (806) 359-0329 or (806) 359-1824.

Diehl Publications, 6661 Canyon Drive Bldg. E, Amarillo, Texas 79110

took place under software control (in other words, as part of a program), then after a successful operation the software should continue to execute normally. Display of the dreaded screen message I/O ERROR means that something did go wrong. Well-designed programs should have built-in error handling routines to avoid data loss or program failure in such cases. However, it is difficult to write a program that will account for all possible types of errors, either machine- or user-generated.

If you were trying to load a program or save one to disk and if something goes wrong, you will see the same error message – I/O ERROR. The only exception to this is when a bad, but otherwise complete, write-to-disk has occurred. The information was successfully placed on the disk, but it may have been stored in the form of garbage because of many factors. Some of these include a hardware defect somewhere in the system (the least likely possibility), a bad disk, or a disk speed problem. You will find out about bad saves the next time you try to load that information back into the machine for use. Either you will get an I/O ERROR or the load will work, but you will only get garbage on the screen when the program runs.

To eliminate the possibilities, try loading a known-good piece of software that was made on another machine. If it works, you know that the disk speed is within tolerance, and that the complete system is capable of doing a read-from-disk operation. Next, get a disk that you know is good and place it in the drive. Load the program in memory onto the disk. Then type in the command VERIFY from the keyboard. If the BASIC cursor prompt comes back, then the information was loaded without error. Now, load that program right back into memory. If it loads correctly, the only problem

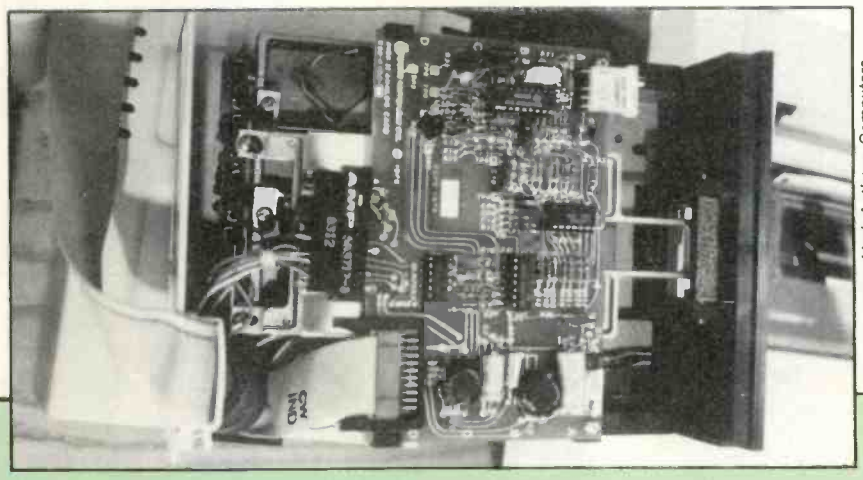
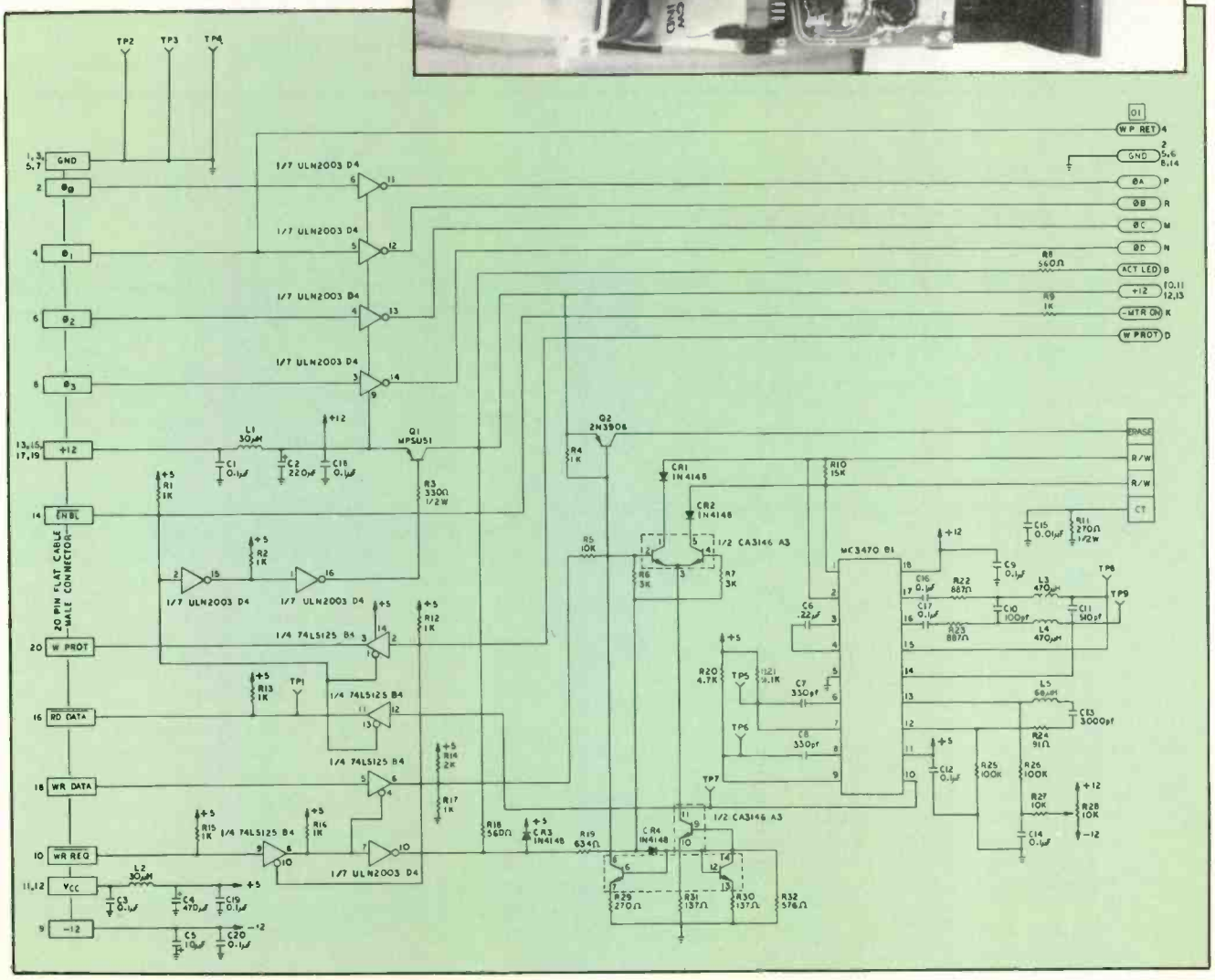


Photo courtesy Mark Anthony Computers

This analog board is located inside the disk drive housing.



you have relates to the first disk itself. If the program gives an error on load or appears to be garbage when listed or bombs when run, it is likely that there is a disk-write operation. Check the disk speed first, just in case. Then go through the hardware checks listed above. If you are careful and observant, and follow the procedures explained above, you should have little difficulty tracking down a majority of failures associated with the disk operating system.

Conclusion

The most important aspect of troubleshooting is to take careful account of the failure symptoms, relate them to your knowledge of how the system operates, and then decide which of the basic system building blocks are most likely to be causing the symptoms. After that, try to develop functional tests, such as those described in this article, either to positively eliminate those blocks that are not causing the problem or positively localize the symptom to the block that *is* causing the problem. Do not be in too much of a hurry to start using test equipment—the most important piece of test equipment is that wonderful God-given one between your ears. The more you use it, the less time you will need to use anything else. Keep an open mind; do not try to prove correct your own initial assumptions. Above all, remember that any computer system is at best a simple and repetitive one. It is certainly nothing to fear.

Table 2.

pin# Description

01 GROUND
02 PHI 0; there are four addressing lines, of which this is the first.
03 GROUND
04 PHI 1
05 GROUND
06 PHI 2
07 GROUND
08 PHI 3
09 −12V
10 WR REQ*; the write-request line, active low.
11 Vcc; +5V
12 Vcc; +5V
13 +12V
14 ENBL1*; the interface will support two disk drives. Line 14 is used to enable whichever drive is desired under software control. Drive 1 is the default drive, normally used to boot the operating system. An EXCLUSIVE OR circuit is used, preventing both drives from being simultaneously enabled. This line is active low.
14B ENBL2*; this is also an active low line, energized when drive two is selected.
15 +12V
16 RD DATA*; when this line is brought low, it enables a data read from the disk.
17 +12V
18 WR DATA; when this line is made active, it enables data to be written to the disk.
19 +12V
20 W PROT; when this line is made active, it enables data to be written to the disk.

Note that lines 1, 3, 5, and 7 are all tied together. Pins 13, 15, 17, and 19 likewise represent the same voltage source sent over four different lines and tied together upon reaching the analog card. The same is true of pins 11 and 12.

Table 2. The interface board and the analog circuit board communicate with each other via a 20-conductor connector bus. Table 2 describes the function of each of the conductors in the bus.

Test your electronic knowledge

By Sam Wilson

1. Which of the following is true about the symbols in Figure A?
A.) Both symbols represent the same device.
B.) Both are JFET symbols, but the one in (b) is not symmetrical.
C.) Both devices are used in Class B amplifiers.
D.) The one in (b) represents a device that has two bases.

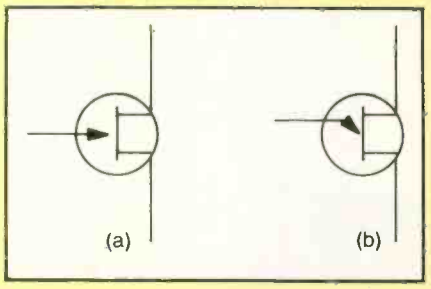


Figure A.

2. Which of the following is used as a very fast switch?
A.) VDR
B.) LDR
C.) tunnel diode
D.) zener diode

3. In which of the following might there be a deathnium trap?
A.) A microwave transmitter
B.) An AM stereo receiver
C.) A CD playback system
D.) A transistor

4. The same square wave is being used to test two different amplifiers. Assume the same scope setup for both tests. The leading edges of the output waveforms are shown in Figure B. Which of the following is correct?
A.) The amplifier for (a) has the greater bandwidth.
B.) The amplifier for (b) has the greater bandwidth.
C.) You cannot determine the bandwidth from this test.

5. To transmit and receive with the same antenna, use a
A.) duplexer.
B.) diplexer.

6. Which of the following is equal to one femto ampere?
A.) 10^{-24}A
B.) 10^{-21}A
C.) 10^{-18}A
D.) 10^{-15}A

7. For the circuit of Figure C, the positive lead of the milliammeter should be connected to
A.) point x.
B.) point y.

8. With no input signal to the class A amplifier of Figure C, the milliammeter indicates a current of 120mA. When a pure sine wave is applied to the input terminal, the current (as indicated by the milliammeter) should
A.) increase.
B.) decrease.
C.) not change.

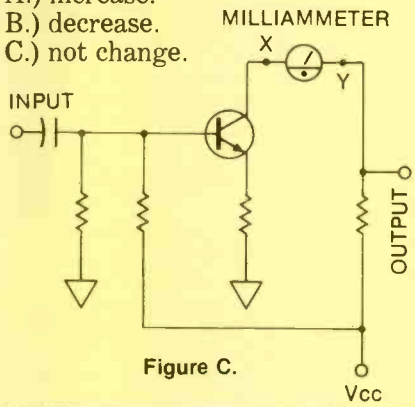


Figure C.

9. The pendulums in Figure D have the same length and weight, but the one in (a) swings through an arc that is twice the length of the arc in (b).
A.) It will take the one in (a) exactly twice as long to swing through its arc.
B.) It takes the one in (a) longer to swing through its arc, but it will not be exactly twice as long.
C.) It takes the same amount of time for the pendulums to swing through their arcs.
D.) This question cannot be answered.

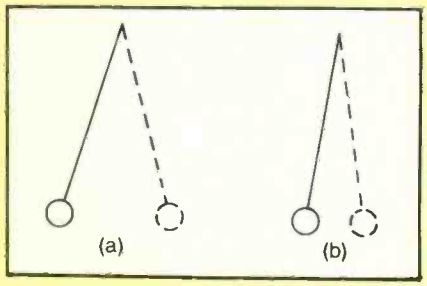


Figure D.

10. Which of the following components might be checked with a ringing test?
A.) voltage-controlled oscillator
B.) capacitor
C.) inductor
D.) tristate buffer

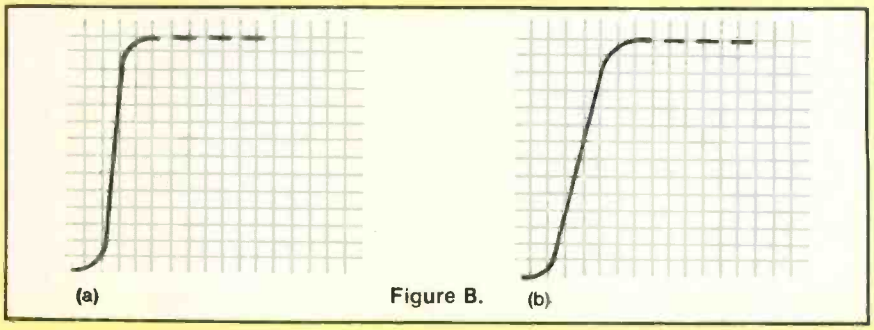
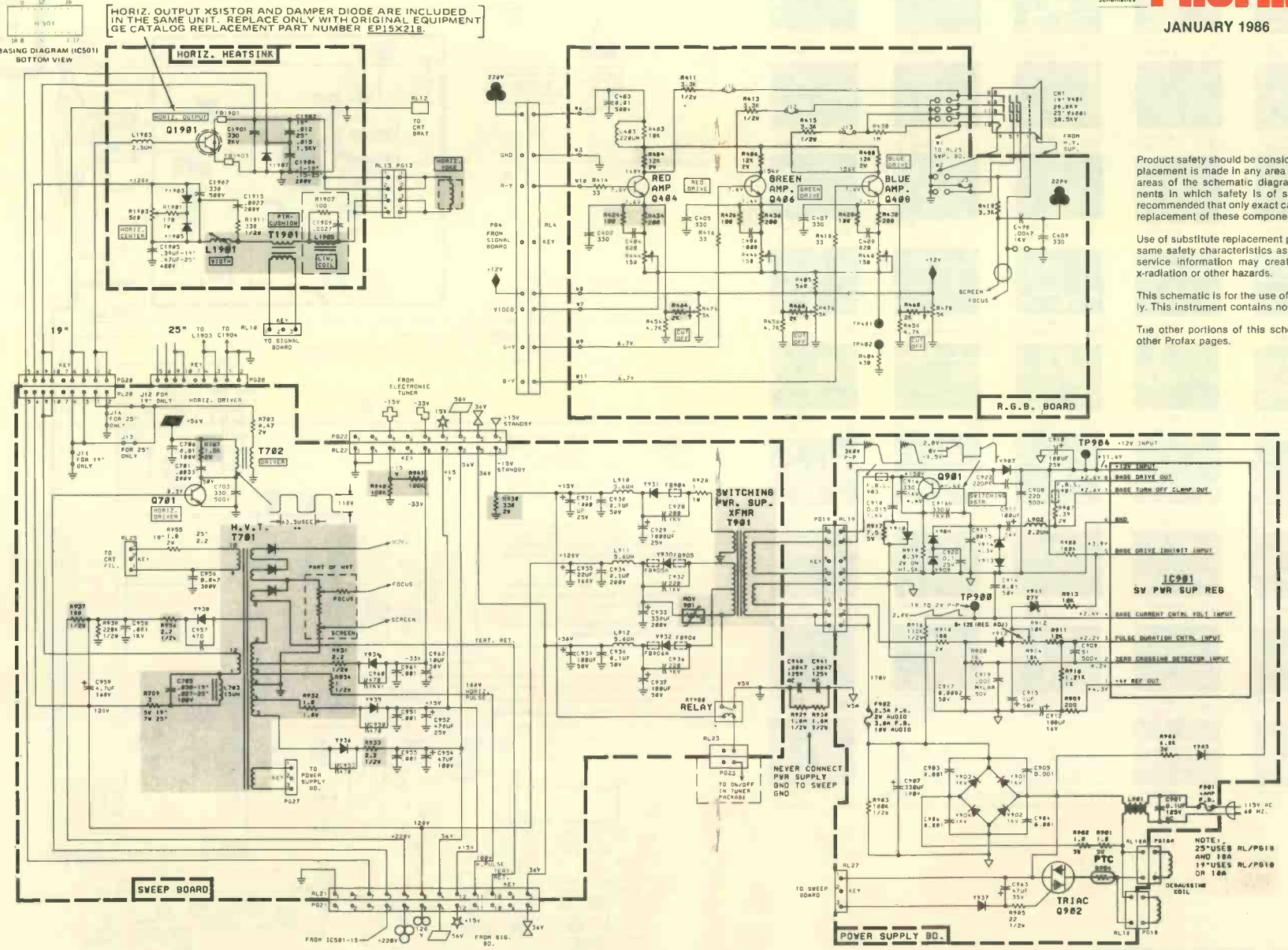


Figure B.

Answers are on page 59.



Product safety should be considered when component replacement is made in any area of a receiver. The shaded areas of the schematic diagram designate the components in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

Use of substitute replacement parts that do not have the same safety characteristics as recommended in factory service information may create shock, fire, excessive x-radiation or other hazards.

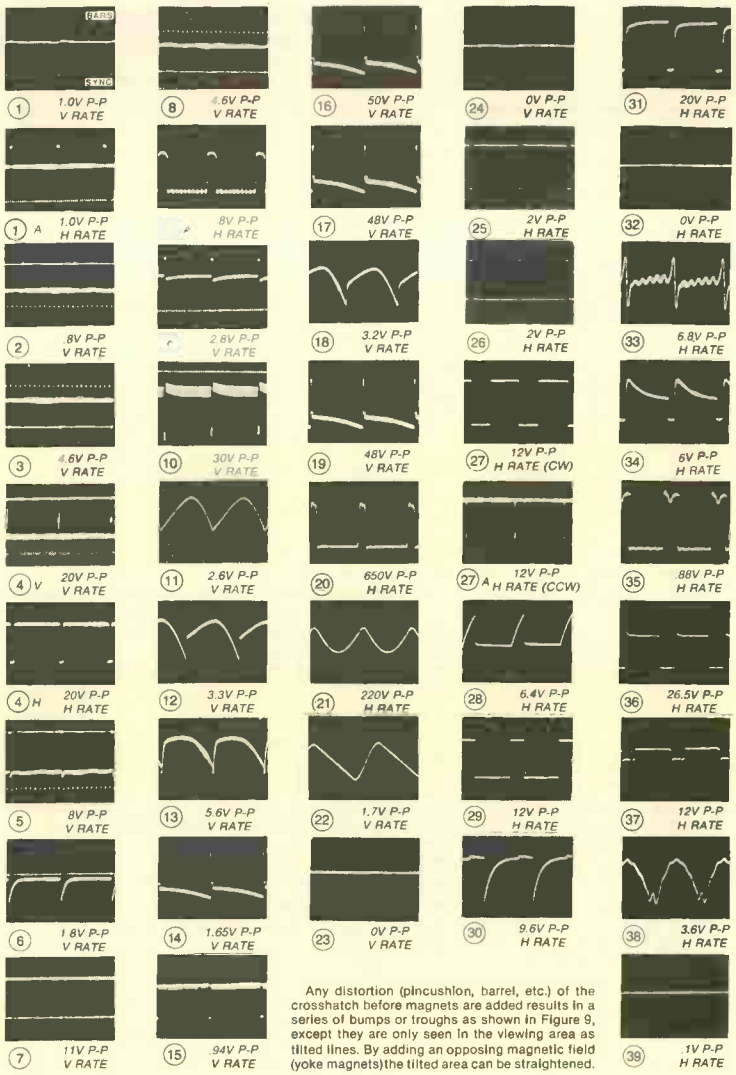
This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

The other portions of this schematic may be found on other Profax pages.

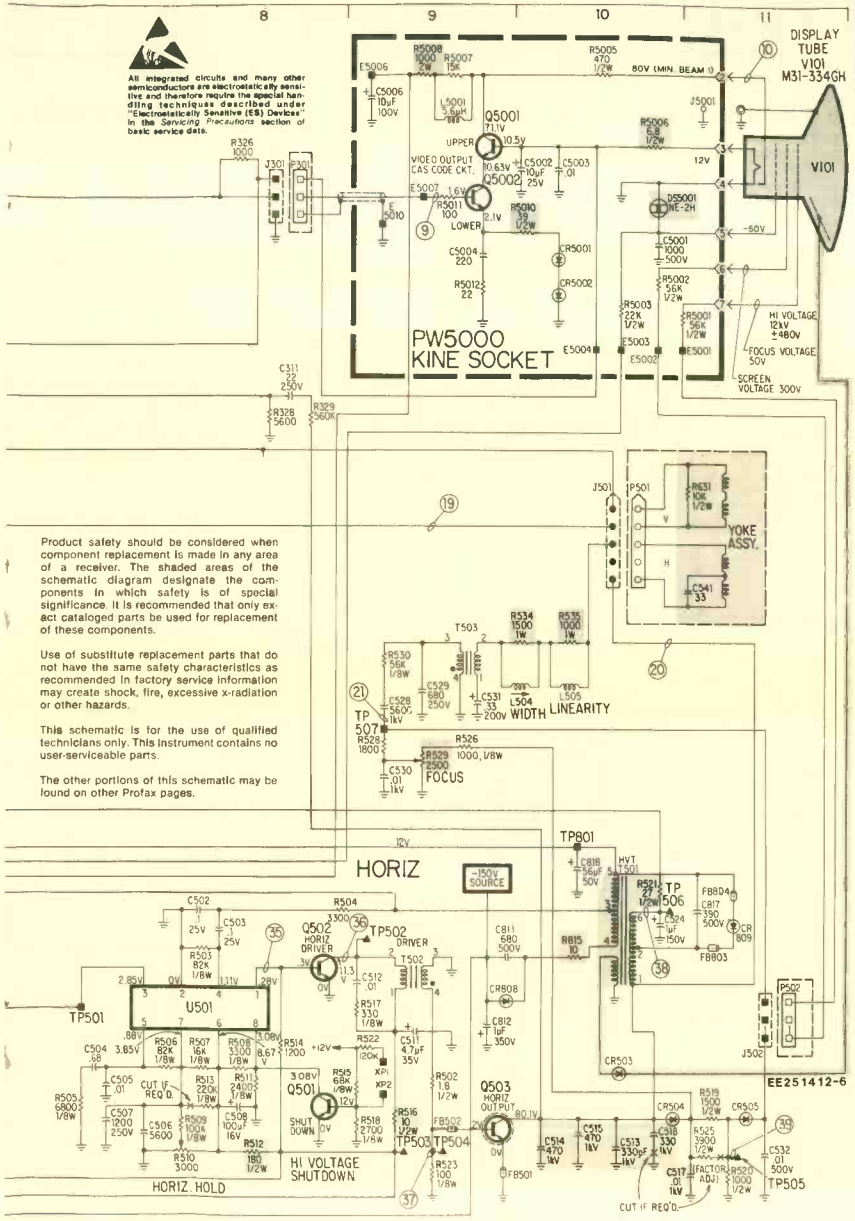
CAUTION:

THE PM CHASSIS IS A "HOT" AND "COLD" CHASSIS THAT USES A TWO-GROUND SYSTEM. THE POWER SUPPLY MODULE IS ELEVATED 70VAC ABOVE EARTH GROUND AND IS ALWAYS "HOT" WHEN THE AC CORD IS PLUGGED IN. THE REST OF THE CHASSIS IS "COLD" AND IS ISOLATED FROM THE POWER SUPPLY MODULE BY SWITCHING TRANSFORMER (T901). NEVER CONNECT THE POWER SUPPLY MODULE GROUND TO ANY OTHER GROUND IN THE RECEIVER AND ALWAYS USE AN ISOLATION TRANSFORMER WHEN SERVICING.

RCA
Video Display
Monitor
MMC100 chassis



Any distortion (pincushion, barrel, etc.) of the crosshatch before magnets are added results in a series of bumps or troughs as shown in Figure 9, except they are only seen in the viewing area as tilted lines. By adding an opposing magnetic field (yoke magnets)the tilted area can be straightened.



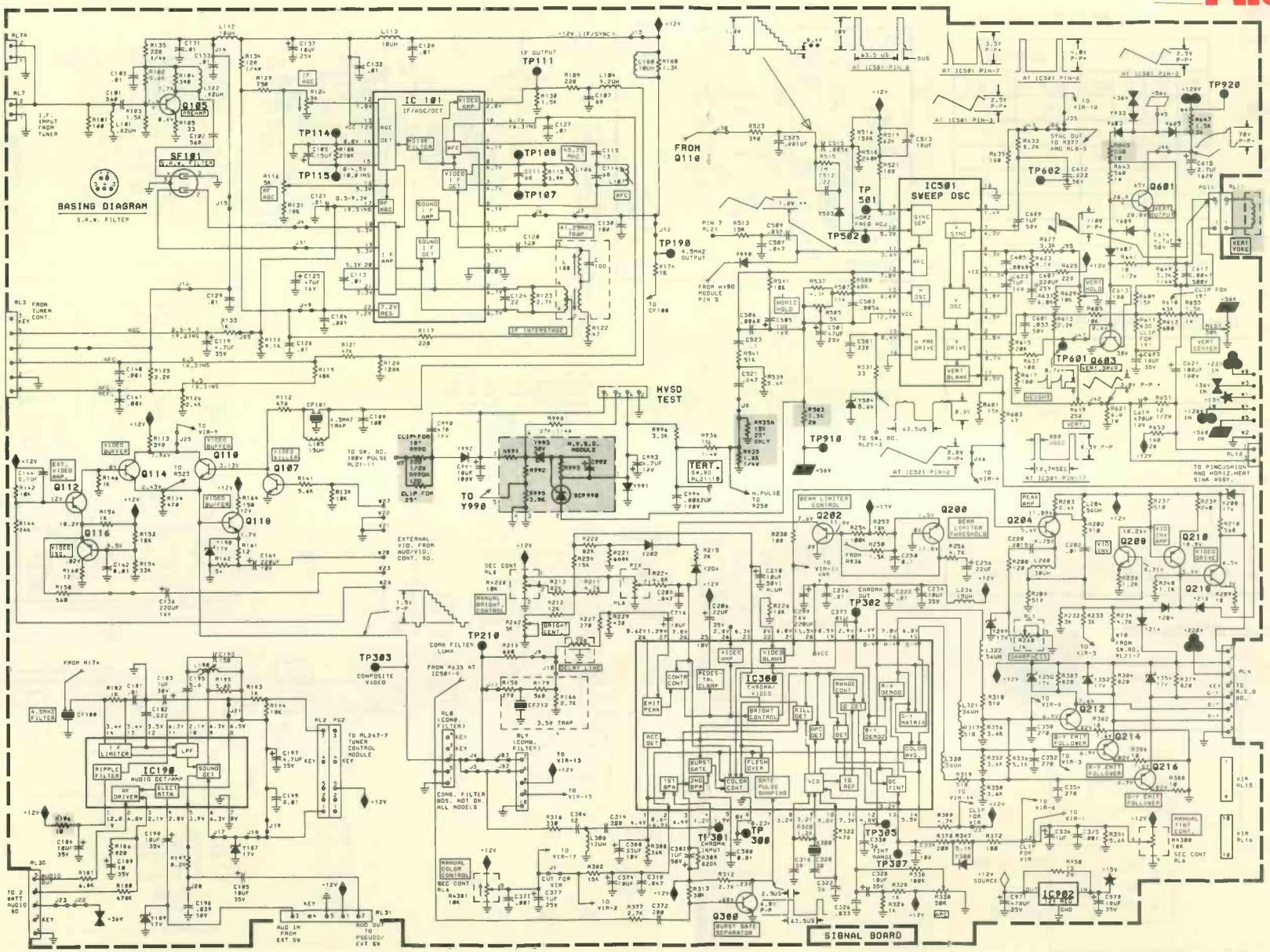
Product safety should be considered when component replacement is made in any area of a receiver. The shaded areas of the schematic diagram designate the components in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

Use of substitute replacement parts that do not have the same safety characteristics as recommended in factory service information may create shock, fire, excessive x-radiation or other hazards.

This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

The other portions of this schematic may be found on other Profax pages.

Reprinted by permission of RCA Consumer Electronics Corporation
Copyright 1986, Electronic Servicing & Technology, P.O. Box 12901, Overland Park, KS 66212



Product safety should be considered when component replacement is made in any area of a receiver. The shaded areas of the schematic diagram designate the components in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

Use of substitute replacement parts that do not have the same safety characteristics as recommended in factory service information may create shock, fire, excessive x-radiation or other hazards.

This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

The other portions of this schematic may be found on other Profax pages.

Reprinted by permission of General Electric Consumer Electronics Corporation
Copyright 1986, Electronic Servicing & Technology, P.O. Box 12901, Overland Park, KS 66212

Schematic No.	
RCA	
Video display monitor	
MMC100 chassis	2077
GE	
Color TV — PM-A chassis	2078

JANUARY 1986

Product safety should be considered when component replacement is made in any area of a receiver. The shaded areas of the schematic diagram designate the components in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

Use of substitute replacement parts that do not have the same safety characteristics as recommended in factory service information may create shock, fire, excessive x-radiation or other hazards.

This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

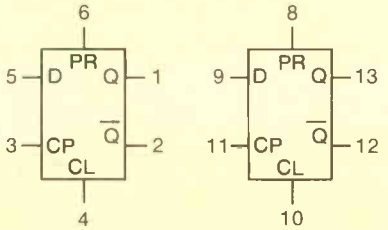
The other portions of this schematic may be found on other Profax pages.

TRUTH TABLE—'D' FLIP-FLOP

INPUTS				OUTPUTS	
CL	PR	D	CP△	Q_n+1	Q_n+1
L	H	*	*	H	L
H	L	*	*	L	H
H	H	*	*	L	H
L	L	L	△	L	H
L	L	H	△	H	L
L	L	*	△	Q_n•	Q_n•

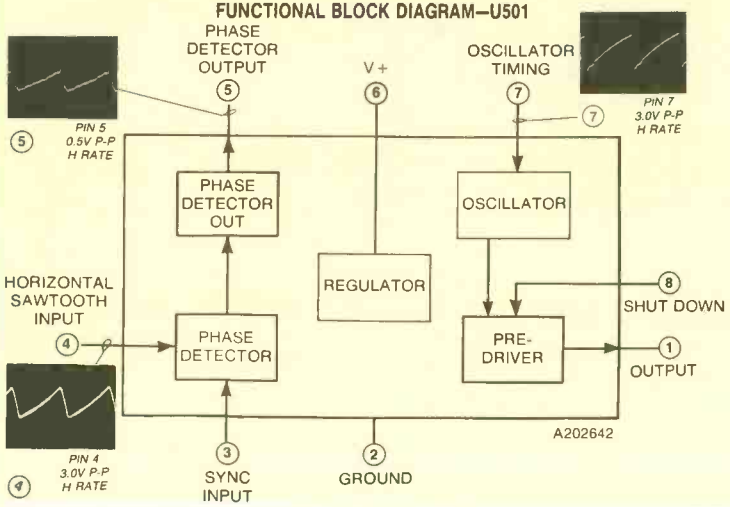
*Don't care △ Level change • No change

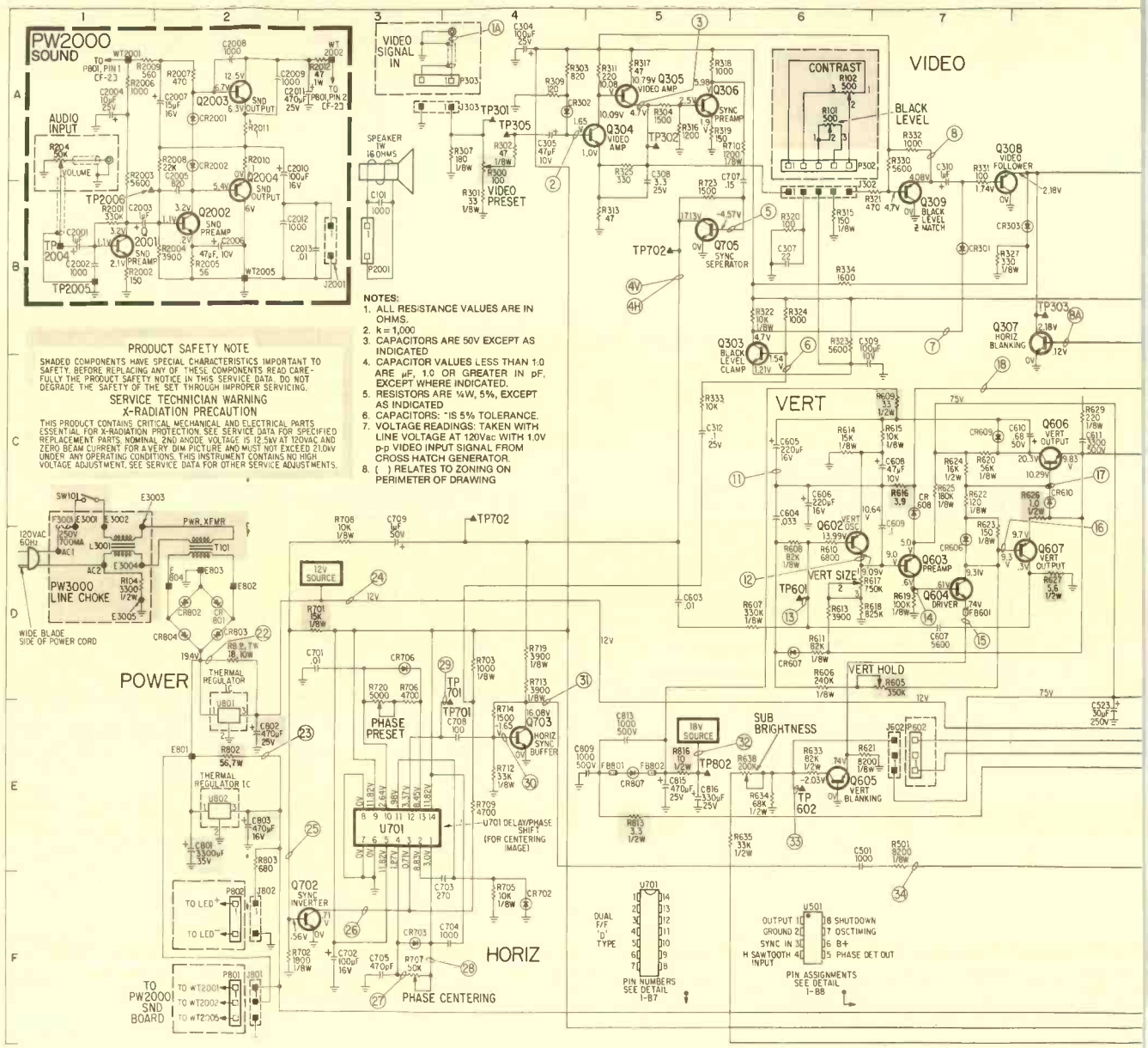
U701 (DUAL FLIP-FLOP D-TYPE)



Pin 14 V_{DD} 11.8V, Pin 7 V_{SS}; GROUND

FUNCTIONAL BLOCK DIAGRAM—U501





NOTES:
1. ALL RESISTANCE VALUES ARE IN OHMS.
2. k = 1,000
3. CAPACITORS ARE 50V EXCEPT AS INDICATED
4. CAPACITOR VALUES LESS THAN 1.0 ARE µF, 1.0 OR GREATER IN pF, EXCEPT WHERE INDICATED.
5. RESISTORS ARE ¼W, 5%, EXCEPT AS INDICATED
6. CAPACITORS: ±15 5% TOLERANCE.
7. VOLTAGE READINGS: TAKEN WITH LINE VOLTAGE AT 120Vac WITH 1.0V p-p VIDEO INPUT SIGNAL FROM CROSS HATCH GENERATOR.
8. ( ) RELATES TO ZONING ON PERIMETER OF DRAWING

PRODUCT SAFETY NOTE

SHADED COMPONENTS HAVE SPECIAL CHARACTERISTICS IMPORTANT TO SAFETY. BEFORE REPLACING ANY OF THESE COMPONENTS READ CAREFULLY THE PRODUCT SAFETY NOTICE IN THIS SERVICE DATA. DO NOT DEGRADE THE SAFETY OF THE SET THROUGH Iimproper SERVICING.

SERVICE TECHNICIAN WARNING
X-RADIATION PRECAUTION

THIS PRODUCT CONTAINS CRITICAL MECHANICAL AND ELECTRICAL PARTS ESSENTIAL FOR X-RADIATION PROTECTION. SEE SERVICE DATA FOR SPECIFIED REPLACEMENT PARTS. NOMINAL 2ND ANODE VOLTAGE IS 12.5kV AT 120VAC AND ZERO BEAM CURRENT. FOR A VERY DIM PICTURE AND MUST NOT EXCEED 21.0kV UNDER ANY OPERATING CONDITIONS. THIS INSTRUMENT CONTAINS NO HIGH VOLTAGE ADJUSTMENT. SEE SERVICE DATA FOR OTHER SERVICE ADJUSTMENTS.

News

Explosive growth predicted for PC-based instruments

Uses for personal computer-based instruments are multiplying so that the world market for these instruments will top $1 billion by 1990, according to a report from Market Intelligence Research of Palo Alto, CA. Lower prices and high performance of PCs will fuel the market to a 38% average annual growth rate between 1985-1990.

The fastest growing segment of the PC-based instrument market will be in test and measurement, according to the report. Although the number of PC-based instruments is still very small compared to the number of non-PC-based instruments now used, the spread of these instruments is remarkable considering the short time (since 1982) that PCs as test instruments have been on the market. A transformation of the test and measurement industry is expected as a result of widespread popularity of the PC-based instrument. This industry is divided into subsegments, including logic analyzers, emulators, pattern generators, temperature sensing equipment, counters and oscilloscopes.

The increase in power combined with lower prices are the driving forces: Instrument designers are finding it more feasible to incorporate their products into a PC than to build PC-like components such as CPUs, digital memory or disk drives into their instruments.

CRT safety standard update

Underwriters Laboratories is proposing the updated Standard for Safety for Implosion-Protected Cathode-Ray Tubes for Television-Type Appliances, UL 1418, for recognition as an American National Standard.

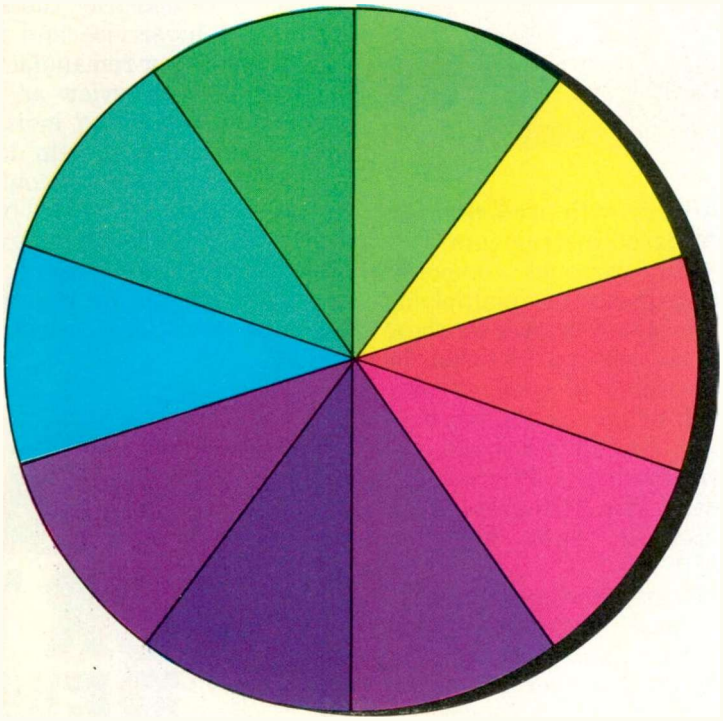
The scope of UL 1418 covers implosion-protected cathode-ray tubes, including television picture tubes and display tubes employed in appliances and business, medical, and dental equipment. The scope also covers implosion-protected cathode-ray tubes that have been in service and subsequently rebuilt or remanufactured.

UL is seeking review and comment from interested individuals and organizations to help develop a consensus upon which continued recognition of UL 1418 by the American National Standards Institute (ANSI) can be based. ANSI is a clearinghouse for information on standards and coordinates development of national consensus standards through voluntary action.

Anyone interested should contact Mavis Whitehead at UL, 333 Pfingsten Road, Northbrook, Illinois 60062; 312-272-8800, ext. 2988, and request a free copy of UL 1418-NR. Those interested should request their copy immediately so that their comments can be considered in time to meet the January 13 UL deadline for this standard.

Repairing the consumer color video camera

PART 2



Understanding and using the tools

By Neil Heller

The successful repair of any piece of equipment depends not only on the knowledge of the item being serviced, but also on using and understanding the proper tools and test equipment.

Before you attempt to make a repair on color cameras, you must have three elements: First, you must create the right environment; second, you must have the right test equipment; and third, you must understand how to use it. No other kind of video product in need of repair is as unforgiving as a color camera. Each adjustment is dependent upon the preceding one. Even after a color camera has been properly adjusted, whether or not its performance is regarded as satisfactory depends somewhat on the opinion of the viewer. Because the successful repair of a color camera is *so* dependent upon the viewing of the output signal, this article includes the setup and usage of several important pieces of test equipment: *the video monitor, the vectorscope, lighting and test charts.*

The right environment

Creating the right environment begins with positioning the camera approximately six feet from the test chart. This allows for setting the back focus so that objects will remain in focus throughout the entire zoom range of the lens. Both the plane of the camera and the plane of the test chart must be absolutely level. This is essential if the yoke is removed, as its position determines tube deflection. Only when the object the camera is viewing is level can the yoke be adjusted to show a horizontal plane. Many manufacturers recommend that prior to any adjustment the camera and test chart be checked with a leveler.

The importance of light

Human perception of color is a complex phenomenon based on hue, saturation and brightness. Because what we see as an object actually is the light reflected from it, camera adjustment must take into account the *color* of the light illuminating the object. Although the object will color consistently as a function of its makeup, the illuminating light will not. As the light source changes, the proportions of color balance can change. We express these as changes in *color temperature*, which is based on the color of the light emitted from a blackbody raised to a specific temperature. A blackbody is defined as a body which, if such a thing actually existed, would absorb all of the light that strikes it. The closest thing to a blackbody is lampblack, which absorbs approximately 99% of the light that strikes it.

As a blackbody is heated, the color of the light it emits changes as the temperature changes. These

changes are expressed in the Kelvin degree scale, whose zero value represents absolute zero. At a temperature of 3200°K, the blackbody will appear red. At 5500°K and higher, the blackbody will take on more of a bluish hue. Color temperature has no relationship to the temperature readings used for reporting weather conditions. Therefore, while a cloudy day will normally have a lower temperature than a sunny day, its corresponding color temperature is higher.

These temperature values can be applied to the light given off by various types of lighting. For example, light in a room illuminated by fluorescent lights will have a color temperature of approximately 4500°K. Sunlight filtered by cloud cover can create color temperatures as high as 8000°K. These different values of color temperature emit different colors, but to our eyes, a white piece of paper viewed under all these conditions would still appear white.

Image pickup devices do not have the same ability as our eyes. Changes in color temperature will unbalance the unity of the three primary colors that is required for reproducing white as white. TV cameras are preset at the factory to exhibit a unity-color reading under a color temperature of 3200°K, which is the color emitted by halogen lighting. This type of lighting is used as a standard because its characteristics are closest to those of natural sunlight. A properly setup camera will see a white object as white under these conditions. Move the same camera outdoors, or change the type of lighting, and the white object will take on the prevailing color of the new lighting source. For example, as noted before, as color temperature increases, so does its blue content. Our white piece of paper viewed outdoors on a cloudy day would appear blue to the color camera.

In order for a color camera to correctly reproduce color as lighting changes, it is necessary that color temperature sensed by the pickup tube remain constant regardless of the light source. Of course, this is impossible to do by natural means alone. To accomplish this, cameras use either an optical or an electronic method or a combination of both to cause the camera to believe it is seeing an object under 3200°K lighting. Most *industrial grade* single-tube cameras and all 3-tube cameras use an optical color filter wheel located in front of the pickup tube. Usually this filter system will have a number of filters to compensate for varying lighting conditions and one setting to block completely all light transmissions to the tube when the camera is not in use.

In order to achieve uniform lighting conditions during servicing, it is best to work with two lamps that are angled toward the test object. The best way to determine lighting uniformity is to use a light meter and measure the light around the perimeter of the object. Remember that if the light level is only specified in the service manual in *lux,* this specification must be divided by 10 in order to find the light level in footcandles. Once again, remember that the color camera is designed to operate under a color temperature of 3200°K, as this temperature provides the proper balance between red, blue and green, which are the three primary colors the color camera needs to see in order to produce white. Therefore, any light source used to set up the camera must generate this color temperature.

Using test equipment

Any type of camera operation or attempt to judge camera performance based on specifications relies upon the operator's ability to understand test equipment. Too often, hours, days and even months of production have been wasted due to the improper setup of the color camera. This section will review the operation and interpretation of waveforms and how they are read by both the waveform monitor and vectorscope.

The waveform monitor

A waveform monitor is a highly specialized type of oscilloscope that is applied only to making certain TV waveform measurements. It sacrifices the flexibility of an oscilloscope for the ability to measure TV signals quickly and accurately.

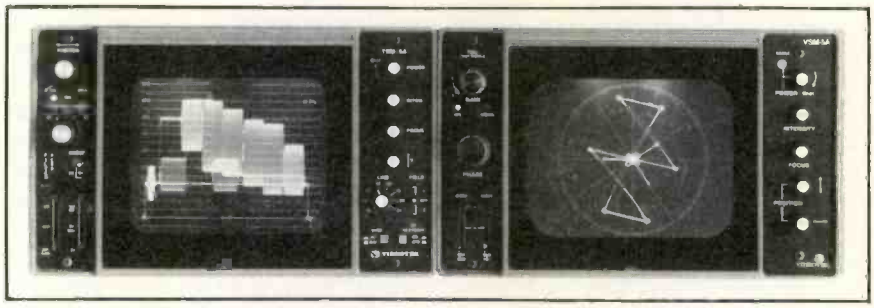
Any discussion of waveform monitor operations begins with an understanding of how to read its faceplate. The waveform monitor is used to measure the timing and amplitude of the NTSC composite signal representation of TV vertical and horizontal lines. Let's begin by interpreting the faceplate marking. Previous measurements of video signals have been in terms of voltages. The waveform monitor expresses these voltages in IRE units. The IRE scale was created by the Institute of Radio Engineers, and looks at the video signal as a relative measurement, not in absolute terms such as voltage measurements.

The reference point for the IRE scale is the zero (0) IRE mark. The part of the TV signal in a positive direction from the 0 IRE point is the active video. Signals in the negative direction from the 0 IRE point extend from the blanking level to the lowest point of the sync indicated on the faceplate.

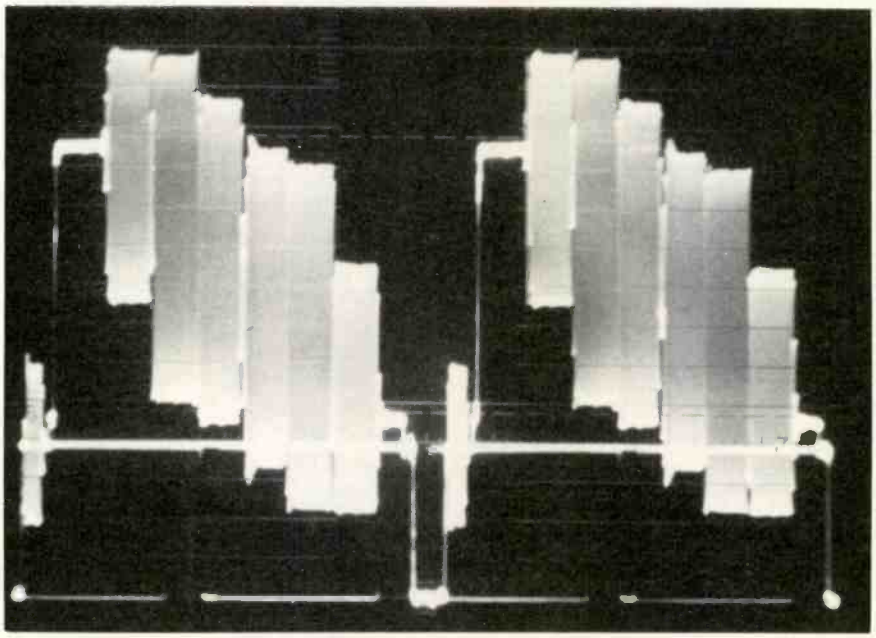
In the controlled environment of a TV broadcast studio, video waveforms are a standard amplitude of one volt each, measured across 75Ω, and also measured from the most negative point on the sync pulse (the sync tip) to the reference white level.

Under these conditions, 0 to 100 IRE units represents a voltage of 0.714V. Within this range of active video, located between the 0 and 20 IRE markings, is the 7.5 IRE point. This is known as the pedestal level, and it represents the blackest point of the active video signal. By setting the pedestal level no lower than 7.5 IRE units, we protect the darkest levels of the scene from falling below the 0 IRE level. If this occurs, the TV set might mistake the video's pedestal for sync and begin to start a new horizontal field in the middle of active video. Because the 7.5 IRE level is the starting point in terms of signal amplitude, it is usually referred to as the "setup level."

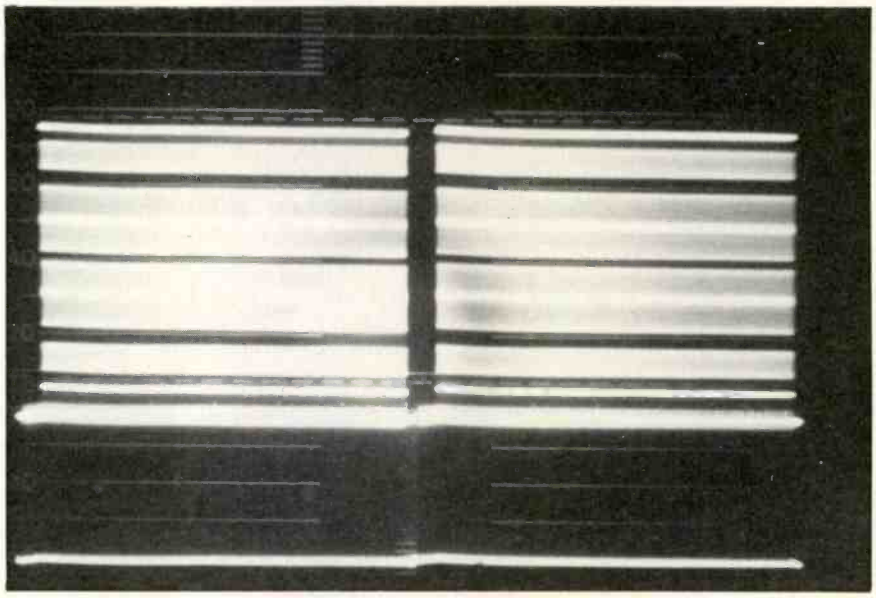
The negative transition from 0 to -40 IRE units is equal to 0.286V.



The waveform monitor (left), is a highly specialized type of oscilloscope used for making accurate measurements on video waveforms. To the right is a vectorscope, a test unit that complements the waveform monitor by measuring chroma/burst phasing and color saturation.



For this photo, the waveform monitor was set up to show the waveform of two horizontal lines of TV information.



The faceplate looks like this when the waveform monitor is adjusted to display two complete video frames.

Therefore, the 140 IRE units of total video signal can also be referred to as a 1Vp-p signal. Theoretically, the only limits on the camera signal levels result from the electronic construction of the camera. Most single-tube, and all types of 3-tube color cameras provide controls for adjusting the amplitude and phase of the sync signals. Prescribed limitations for sync and video levels are the result of the need to maintain consistency between camera and monitor. Sync levels are preset by the need of the monitor to reference to a level of 0.286V. Limits on the white level are due more to the carrier limits with the bandwidth of the TV channel, than to the electronics of the camera or monitor.

In a closed circuit system, where the signal is not transmitted by means of RF, the consequence of incurring video levels over 100 IRE will be minor loss of detail in the high light areas. However, in RF transmission, as the video level increases, so does the frequency of the RF signal. If the video level is not limited, the RF carrier can extend beyond 4.2MHz. As the carrier approaches the 4.5MHz sound carrier, there is a chance that the video can bleed into the audio and cause interference. Another way of looking at this situation is in terms of the carrier output. The amount of output carrier is determined by the strength of the modulating video signal. The higher the dc level of the video signal, the lower the carrier output. The value of the RF carrier at any given video level is represented by the right-hand set of markings on the faceplate of the waveform monitor.

The lowest point of the sync signal is the maximum amount of carrier (100%) and therefore must be represented by the same value on every horizontal line. The blanking carrier represents 75% of the carrier. Reference white is considered to be, under normal conditions, the highest level of the video picture. Although the reference white level is not fixed on every horizontal line as is sync, it is important that it not exceed the 100 IRE level. This level

Coming in...

FEBRUARY

Developments in soldering and desoldering—One thing that has remained remarkably unchanged about electronic circuits is the fact they are connected, physically and electrically with solder. Much has changed, however, about the methods of using solder to manufacture circuits, the tools used to desolder, remove and resolder components, and the techniques used to perform these operations. This staff-prepared article reports on the latest in soldering and desoldering products available, and describes techniques to use and precautions to observe in replacing components in today's circuits.

Servicing video cameras, part 3—When a color video camera needs servicing, sometimes it only needs adjustment. In other cases, replacement of components is required. This article describes how to adjust the camera for the best picture and how to determine when the pickup tube must be replaced when it has been damaged or has aged beyond its useful life. Also discussed is how to set up the test equipment for best test performance.

Servicing the Wards model GGY16229A—Homer Davidson describes the theory of operation of several of the circuits in this set, including such sections as the voltage regulator and startup and shutdown circuits. The author explores several areas that are most likely to cause problems and describes troubleshooting them.

What do you know about electronics? Padders, capacitors and finding the right resistance—Oscillators are at the heart of many electronic systems, notably communications products. This article explores the placement of padders in the circuit to obtain proper frequency tracking. Also discussed is a method of obtaining the correct value of resistance from your junk box to construct a given circuit.

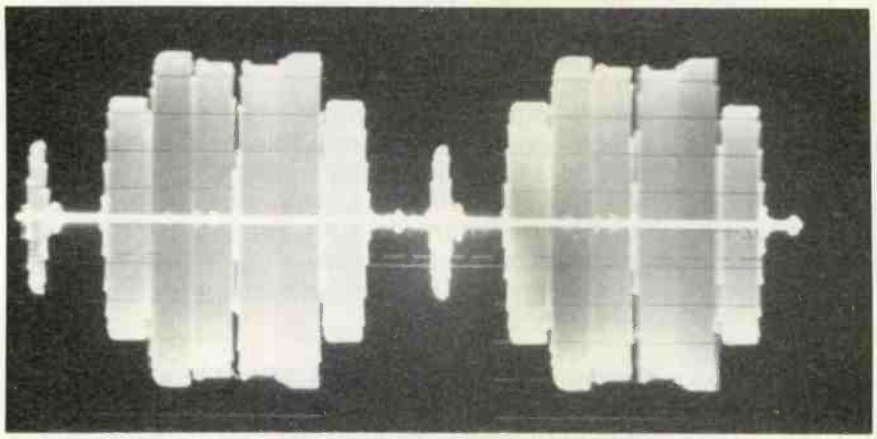
represents 12.5% of the peak carrier value. Signals higher than this value will cause two undesirable effects. First, the carrier power drops so low that any type of noise may interfere with the quality of the receiver picture. Second, the lack of video carrier creates an insufficient 4.5MHz audio carrier. This results in a buzzing sound as the video is *heard* in the audio. You may have experienced this while watching a TV program when white lettering is superimposed on the screen.

As the white level varies due to a number of factors such as reflected light and lens opening, the camera system allows some transitions over the 100 IRE level. The camera's white level usually is set between 110 and 120 IRE units. This is a 10% to 20% increase in signal level, and results in an additional 12.5% loss of carrier power, reducing it to zero. Naturally, continuing to operate at this level would render the picture unstable. This should make it obvious that monitoring the camera's signal level using the waveform monitor is a critical part of any video production.

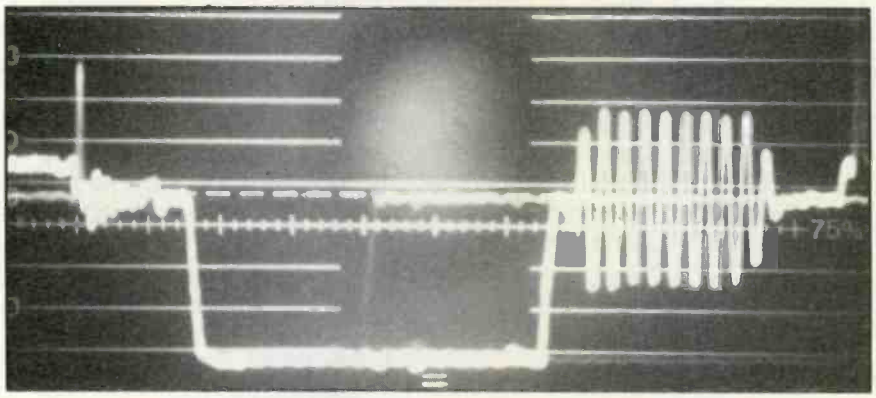
Up to this point, we have only spoken about B&W signals. Color signals have the addition of the back porch burst signals. The 0.3V burst signal is positioned between the -20 and +20 IRE levels. The TV system sees the average of these burst sine waves as an average level of 0 IRE, so there is no danger that the transition below 0 IRE will be mistaken for sync.

Using the waveform monitor for timing measurements

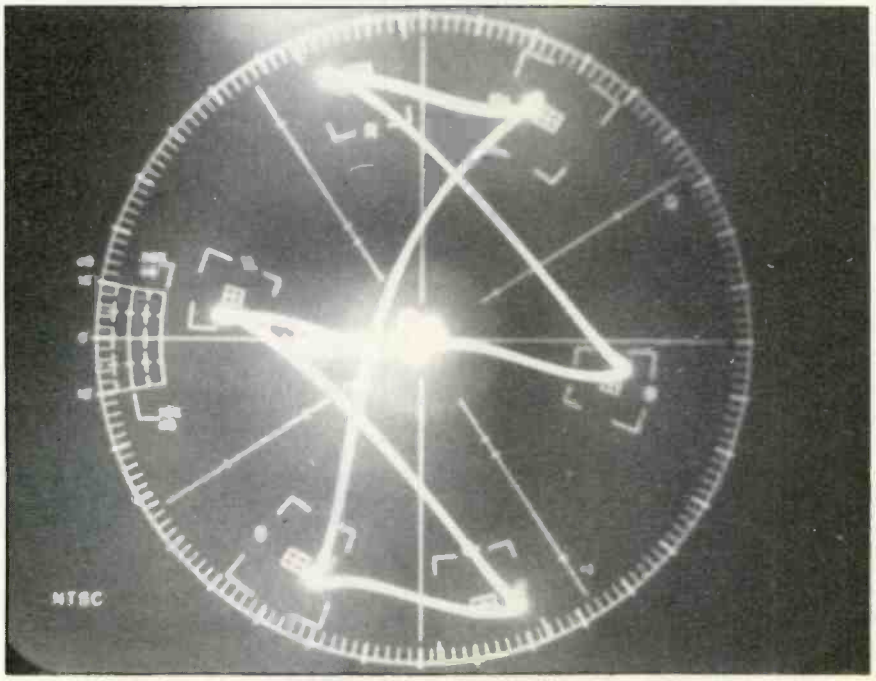
The waveform monitor also can be used to confirm signal pulse widths. In order to do this, we must change the operating mode of the waveform monitor. For amplitude measurements, the waveform monitor's sweep was set to display two horizontal lines (2H). To measure signal timing, change the sweep to show 1μs per division. In this setting, the larger divisions located at the 0 IRE line represent 1μs, while the shorter division markings represent a reading of 0.2μs.



For this display, the waveform monitor was set at 1μs per division. Shown, starting at the left: horizontal blanking, then the sync tip and at right, the color burst.



This closeup view shows only the chroma portion of the video waveform.



The vectorscope display gives information about TV signal phasing.

After timing measurements are taken, you may wish to use the two vertical sweep modes of the waveform monitor. This mode allows you to observe one complete frame of video. Although timing durations are hard to see, this can be used to show problems that occur over long time durations. The second waveform monitor mode is known as the *response mode*. All timing and amplitude measurements can be made in the *flat mode* that displays all aspects of the signal. In some cases, when attempting to take amplitude measurements of a color signal, the chroma, (which, like a burst signal, is a 3.58MHz sine wave) can distort the reading. For this reason, the operator may choose to use the IRE response position in order to filter the burst and chroma information. On the other hand, should the operator need to view only the 3.58MHz information, the chroma response mode can be used.

The final operational mode is the differential gain (Diff. Gain). This measurement shows the relationship between chroma and luminance amplitude. For normal operations, there should be no change in chroma amplitude. Because this is a function of the camera's encoder, the measurement usually is taken by selecting the camera's internal color bar generator.

The vectorscope

The functions of the vectorscope complement the functions of the waveform monitor. The waveform monitor will indicate the presence of a color signal by showing whether or not it contains burst, but it is unable to indicate the phase of the signal. And the monitor indicates luminance in terms of voltage levels. The vectorscope performs two other functions required to adjust a video camera properly: It shows phasing between chroma and burst, and it shows the strength of the color signal in terms of saturation.

The concepts of the operation of the vectorscope begin with the theory of how the eye sees color. The eye interprets color on the basis of the theory that mixing two primary colors results in the crea-

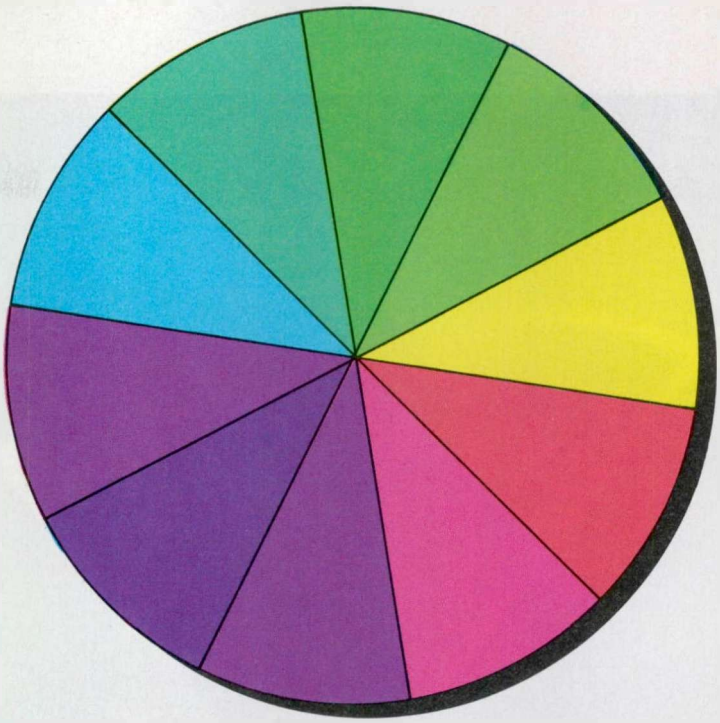
tion of a secondary color.

By picking a primary color starting point, such as green, you can trace the additive and subtractive primary and secondary relationships around a color circle until you return to green. Different primary and secondary colors can be expressed as different points on this circle. Studies have shown that, starting at any point on this circle as a reference color, the human eye will perceive a color change approximately 3.6° in any direction from this point. As a result of the additive process of primary colors, each secondary color is a result of adding two primary colors. For example:

- Green + blue = cyan, which is positioned between green and blue on the color circle.
- Blue + red = magenta, which is positioned between blue and red on the color circle.
- Red + green = yellow, which is positioned between red and green on the color circle.

The vectorscope displays the relationships of colors in very definite terms. Burst is used as the color reference point, and is located at the 180° point. The correct phase and saturation for each color is noted on the vectorscope faceplate by a group of inner and outer boxes. For color phasing, the inner boxes represent a phase difference of +1, -2.5°. The outer boxes show a phase difference of ±10°. Note the 2.5° represented by the vectorscope's setup are within the 3.5° phase limits of hue shifts sensed by the human eye.

For saturation adjustments, the inner boxes represent changes of ±2.5 IRE and the outer boxes represent changes of ±20 IRE units. Using the waveform monitor, we were able to check differences in chroma that result from changes in luminance levels. With the vectorscope, we can check changes in chroma phase that are caused by changes in luminance. A series of additional boxes is used to indicate shifts of 10° above and below the 180° to 0° point. Shifts to the plus and minus side also can be used to determine differential phase.

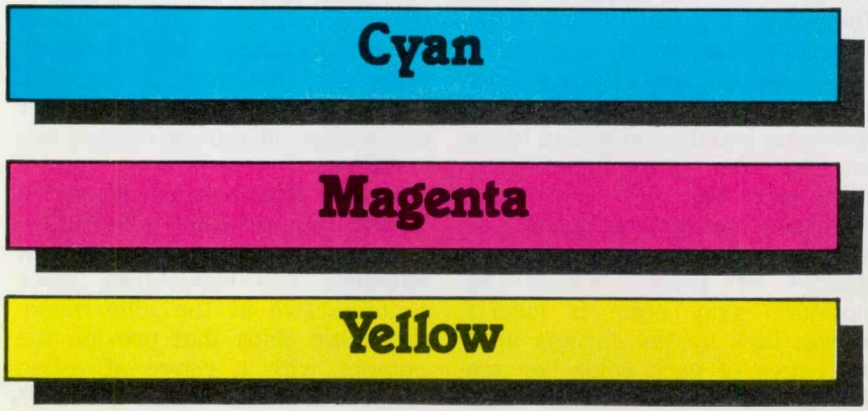


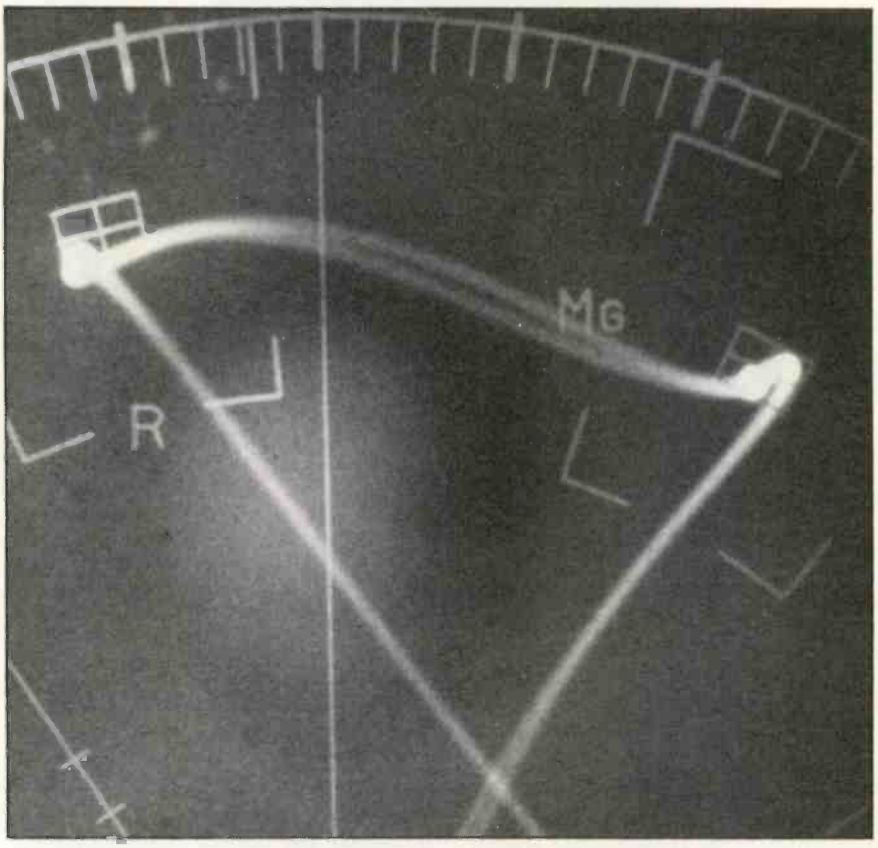
Using test charts for setup, alignment, balance

The goal of any color camera setup is to produce a good quality color picture that is an exact reproduction of the original scene. For this reason, just as the type and amount of light are specified to set up the camera properly, so are the objects that are viewed during setup.

These objects are known as test charts. Depending on their subject matter, they can be used not only for camera setup, but also for detailed alignment and determining camera specifications. For 3-tube camera setup, the most commonly used charts will be the registration and B&W log reflectance chart. The registration chart is used to align the individual red, green and blue tubes so they scan the objects in the same way. The B&W log reflectance chart is used to adjust for proper color balance so that B&W objects will appear black and white to the color camera.

Although registration is a matter of being right or wrong, color balance can be a matter of opinion. To begin with, the operator's judgement is dependent upon the condition of the color monitor. For this reason, when using a color monitor to judge the results of color balance, the monitor must be considered as a test fixture. As such, the monitor must be properly





This closeup of the vectorscope faceplate shows the setup boxes for color phase and chroma amplitude.

adjusted prior to its use.

The best way to adjust the monitor is to use a known reference signal. A good source is the camera's internal color-bar generator. All three tubes and most industrial type signal-tube cameras contain such a generator. Monitor setup begins by turning *off* all of the monitor's automatic modes. As with the automatic camera presets, monitors present input signals to preassigned levels that will not vary, regardless of changes to the input signal. Therefore, the use of automatic controls will mask any changes to camera setups. Any attempt to set up a camera using a monitor operating on automatics can be an extremely frustrating experience.

The next step is to adjust the brightness and contrast controls to show clearly all the individual shades of gray. When the monitor's gray scale is clearly shown, turn up the chroma until the edges of each color bar are distinguishable from one another. If the chroma is set too low, the colors will look faded. If the chroma is set too high, the edges of each bar will look blurred.

The final adjustment is hue, or tint. If you do this adjustment wrong, your blues will look red and your reds will look blue. As most shooting centers on people, the camera ordinarily should produce the best possible skin tones. The same is true for the monitor. To do this, adjust the tint for the best possible yellow reproduction. It is always a good idea to perform these simple and quick monitor setup procedures and compare them to the monitor presets. Remember to leave all monitor automatics *off* during camera adjustments.

Manual color balance setup of a camera requires using a log reflectance chart and a waveform monitor. The reflectance chart contains two of the nine monochromatic chips that provide the camera with a range of reflectance. This range begins with a 3% reflective black, which yields a 7.5 IRE pedestal level, and a 70% reflective white that yields a 100% IRE level. The waveform monitor allows you to see differences in each of the individual tube channels. These differences are shown as the presence of chroma when the camera is focused on the monochromatic gray scale. This chroma causes the chart to appear blue, green or red, depending on the level most out of adjustment. Color balance is achieved when all channel gains are at unity. At the specified sensitivity level, all channels will have a pedestal of 7.5 IRE, and a white level of 100 IRE. Then, the chroma subcarrier is nulled, to appear only if the camera focuses on a colored object.

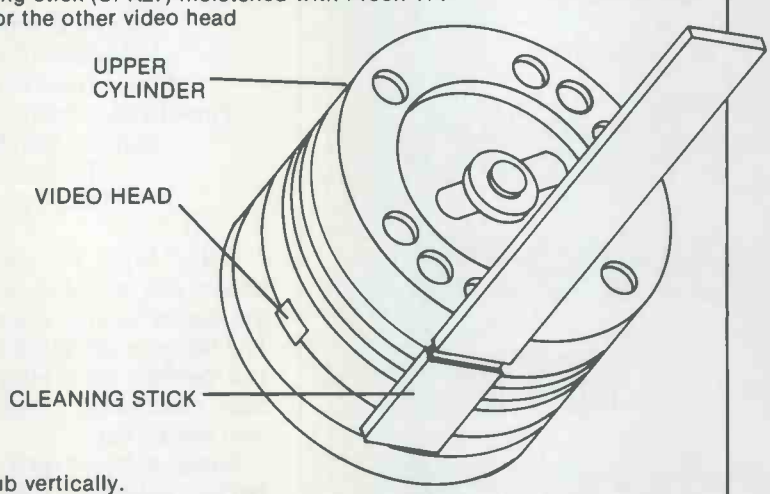
Usually, manual operator color balance adjusts only the red and blue levels. As with the registration setup, the green channel is used as the reference setting. Green pedestal sometimes is used as the camera's master pedestal, while the 100 IRE level is set by opening the lens iris. Red and blue pedestal and white levels are then used to match gains. Using the waveform monitor allows the operator to perform these adjustments quickly by minimizing subcarrier at the pedestal and white levels. In addition, the operator can confirm and adjust the horizontal and vertical blanking widths. Any shooting that will be subject to post production should have all its H and V blanking set toward its lower limits in order to compensate for pulse width expansion. The waveform monitor is also a tool that should be used during the actual shooting, to prevent video levels from rising above the 100 IRE levels and slipping into the audio carrier.

Single-tube color cameras have an advantage over that of 3-tube color cameras. They do not require the registration of the individual red, green and blue signals. The most critical adjustments for a single-tube color camera are deflection, which requires the use of a white card, and color balance, which requires the use of a reflectance chip chart. ES&T

An Important Notice

PROCEDURE FOR CLEANING UPPER CYLINDER UNIT

1. Position the video head to permit access for cleaning and hold the upper cylinder to keep it from turning while cleaning.
2. Gently rub the video head in direction of tape travel with head cleaning stick (CFK27) moistened with Freon TF.
3. Repeat for the other video head



Note:
1. Do not rub vertically.
2. Do not apply any pressure to head. If contaminant is not easily removed, continued gentle wiping will usually remove the contaminant.

In the October 1985 issue of Electronic Servicing & Technology, we published an article on page 37 entitled "Servicing video recorders, Part 3: Preventive maintenance for a VCR." In that article, on page 40, under the heading "cleaning the video heads," the article recommends, "To clean the heads use a lint-free material dampened with a freon compound. Many video stores sell video head cleaning tabs. A Q-tip also can be used but be sure to twist its end so the fibers will compress."

Since the time that issue was published, we received a letter from Don Hatton, Director of Product Services, Consumer Electronics Group, Electronic Industries Association, concerning the article. In that letter, Mr. Hatton says "In regard to cleaning the video heads, the method outlined using a lint-free cloth or a Q-tip is very dangerous. Our manufacturers recommend the use of head cleaning sticks as illustrated here. The method described will provide adequate results with the least possible chance of damage to the video heads."

In the same article, reference is made on page 41 to "Replacing the video head." Mr Hatton's letter points out that replacement of the upper cylinder is preferred to the replacement of an individual head. Actually, the procedure described is for the replacement of the upper cylinder, not an individual head. Unfortunately, the word "head" was used instead of the term "upper head cylinder."

Electronic Servicing & Technology *endorses both of these procedures recommended by the EIA.* **Don't clean the video heads with any materials other than those recommended by the manufacturer, and don't even try to replace individual video heads. When the heads need replacement, replace the entire upper head cylinder.**

What do you know about electronics?

Radio receivers and bidirectional buses

By Sam Wilson

The first practical applications of electronics were in the field of communications. Because it is the oldest use, the variety of receiver types might be expected to be almost endless.

Actually, in the history of communications, there are relatively few types of receivers. Seven of the most important types are listed here:

Crystal input
Regenerative
Super-regenerative
Tuned radio frequency (TRF)
Superheterodyne
Reflex
Homodyne

Each type of receiver listed above has advantages and disadvantages, but the superheterodyne has become the most popular. It is not perfect by a long shot, but it has reasonably good sensitivity and selectivity.

Some other types have either better selectivity or sensitivity. The regenerative and super-regenerative types can be better in both categories, but they have other disadvantages that have to be considered. For example, they radiate interference signals, and they have terrible fidelity.

The most important disadvantage of the superhet receiver is its poor (not terrible) fidelity. Unless the designer spends a considerable amount of effort and money on the IF section, this type of receiver will not produce a flat response over the range of frequencies required for a faithful reproduction of the modulating signal.

If you have ever performed a sweep alignment on the IF stage of a superhet, you are well aware of the problem of frequency response for that type.

The homodyne receiver

The homodyne receiver is considered by some technicians to be superior to the superhet.

In the early 1930s, the patents for the superheterodyne receiver were held by companies in the United States. That meant companies in England would have to

pay royalties to U.S. companies for the right to manufacture superhet radios.

To put it mildly, they didn't like the idea. Engineers in England set out to design a completely new type. They called it the *homodyne receiver*.

Figure 1 compares the superhet and homodyne receivers. In the superhet, the local oscillator combines with the incoming RF signal to produce a difference (intermediate) frequency. The lower intermediate frequency remains constant no matter what the RF and is amplified before it is delivered to the detector stage.

In the homodyne receiver, the local oscillator frequency is set *equal* to the incoming RF signal. That cancels the carrier, and all you have left is the sidebands. In an amplitude-modulated signal, *all of the useful signal is in the sidebands*.

Figure 2 shows what happens using a time-domain display. When the carrier is removed, there are two sidebands. Only one is needed to reproduce the original modulating signal, so a filter is used to remove the unwanted sideband. Then, all that is left is the original modulating signal.

Clearly, the homodyne receiver has an advantage over the superhet. It has no IF stages to clip and distort the sidebands before detection takes place, so its fidelity is a great improvement over the superhet.

Additional RF stages could be added to improve the sensitivity, but sensitivity is not a problem with most consumer radio reception today.

So, why didn't the homodyne receiver become the most popular type in the world?

One problem was that the oscillator frequency had to be maintained *exactly* equal to the RF carrier. In early versions, they

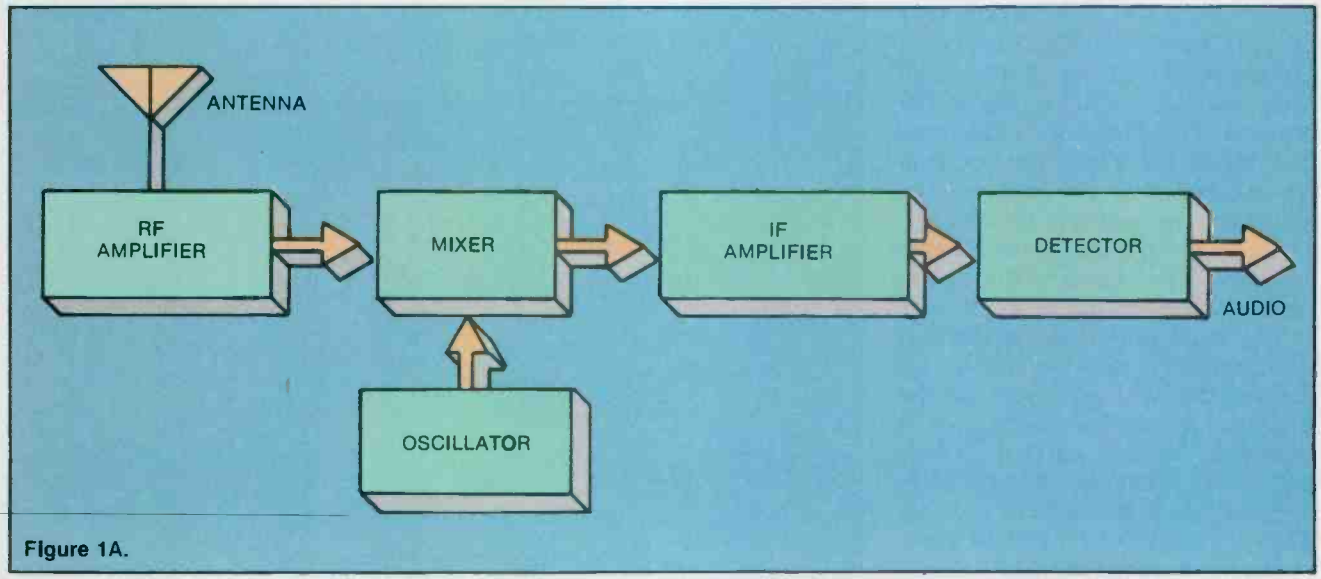


Figure 1A.

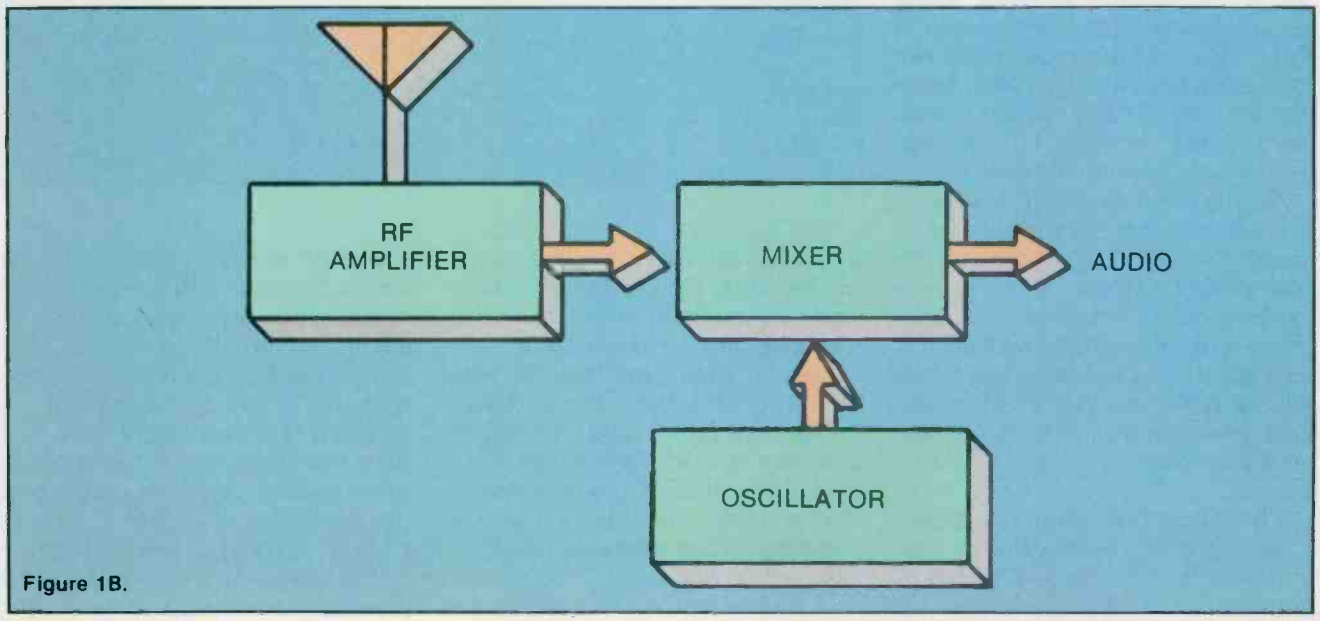


Figure 1B.

tried to accomplish this with a stable oscillator circuit. That didn't work. A perfectly stable oscillator at anything near a reasonable cost (and size) was out of reach in those days. Also, the transmitter carrier might drift a few hertz in a week.

Probably the most important disadvantage was that a certain amount of skill was needed to tune the receiver to the station.

One solution: rename it!

A superheterodyne receiver has two detectors. The first detector is the mixer (or converter) in the RF stage. Early textbooks referred to the stage that we call the detector as being the second detector.

The homodyne receiver has only one detector, so it is a *single conversion receiver*. That is the name it goes by in the United States. You have to look very hard to find the name homodyne receiver around here. There are some innovations in the modern single conversion receiver, due mostly to the advances in modern technology, that help to justify the name change. The fundamental principles haven't changed, however.

The most important advance is the circuitry now available for locking the local oscillator onto the carrier. A phase-locked loop is available for this purpose. That's not a new circuit, but it is available in integrated circuit form and that makes it very convenient to use.

Figure 3 shows how to make a single conversion receiver using an integrated circuit phase-locked loop (PLL). This circuit was given in a Signetics catalog. I once had a student build this receiver with very good results, but it was somewhat difficult to tune.

Maybe the fact that it is difficult to tune accounts for the absence of homodyne receivers from the market today. Radio receiver designers are convinced that any radio with more than two knobs is beyond the skill or comprehension of the American public. This idea has now spilled over to the design of TV receivers.

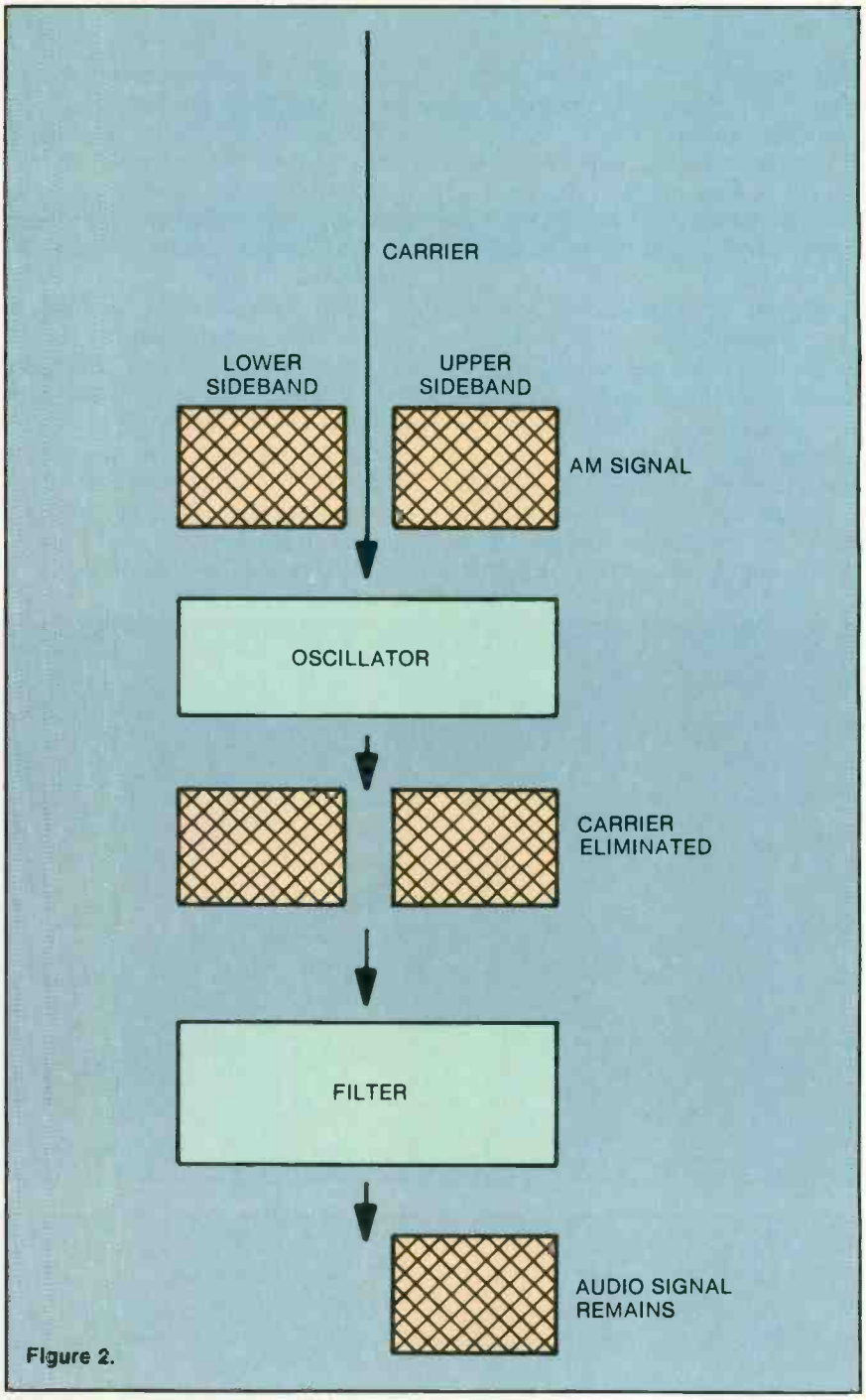


Figure 2.

The 2-way bus: How it's done

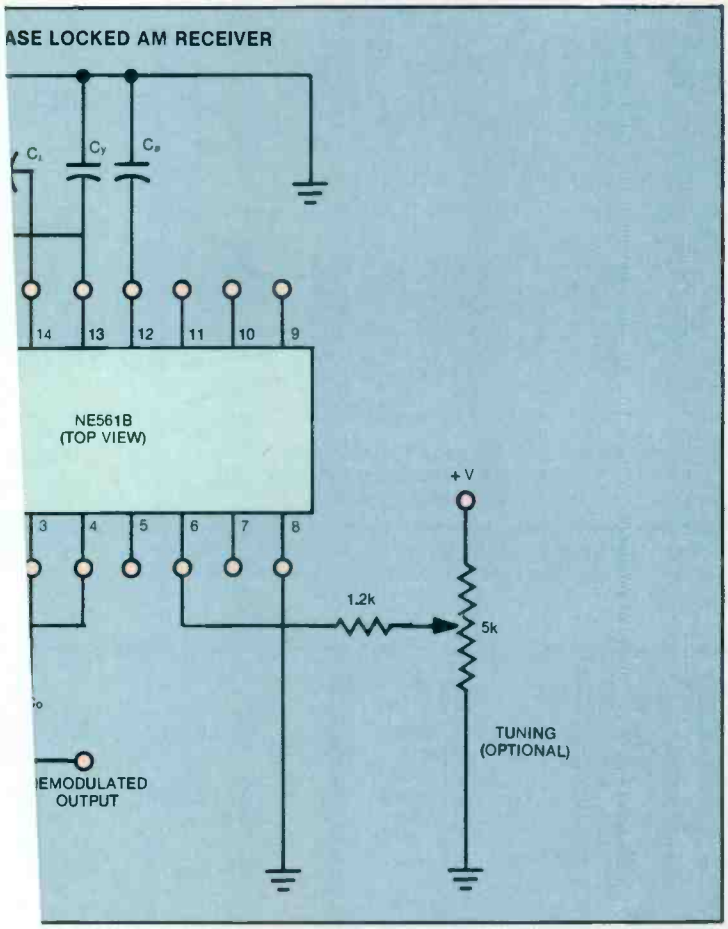
A bus is a combination of conductors used to carry a group of signals. I still like the suggestion of a man who was attending one of my lectures. He wanted to change the name from bus to train (because they have conductors).

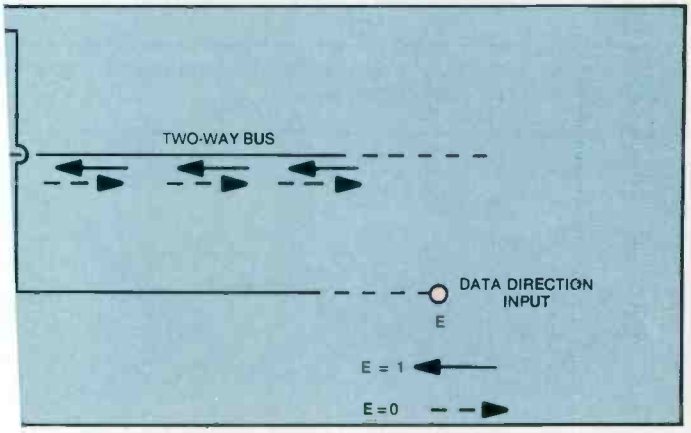
Take a dime and slice it into 2,500 equal cubes. Then, mount 1,700 transistors and associated circuitry on one of the cubes. That is the size of IBM's new semiconductor chip. They have made a complete programmable logic array on that scale.

It makes you wonder about the size of the conductors and buses on a chip that size. Whatever the size of the conductors, they reduce the amount of circuitry available.

One method used to conserve space is to use the same bus (or conductor) to carry information into or out of the chip. That requires some special circuitry to prevent the possibility of signals trying to go both ways at the same time.

If a logic 1 (+5V) and a logic 0 (0V) appear on the same conductor





to the AND gates
erter (for AND X)
r AND Y). At first
at the buffer could
ecause it does not
odifying the signal.
ncluded in the cir-
ce a propagation
in the enable logic
turn, produce a
d v at the same

gnals are always opposite, so, it is not possible for both AND gates to be on at the same time.

The direction of the signal on the bus depends upon which AND is enabled. For that reason, the enable terminal is sometimes called the *data direction bus* or *data direction terminal.*

Two-way buses also can be made with ORs, NANDs or NORs. They are used both inside and outside integrated circuits.

Continued from page 7

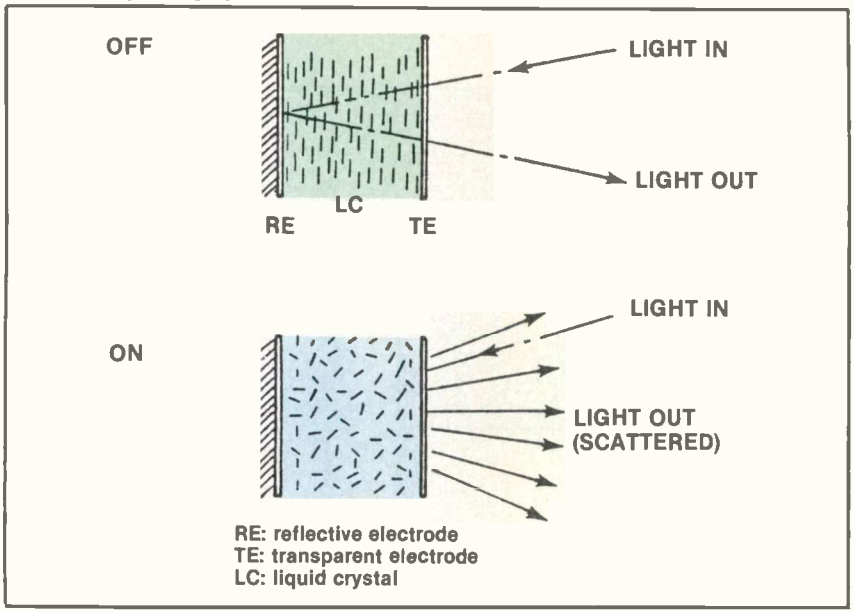


Figure 2. In a dynamic scattering mode display, application of a sufficiently strong field generates a strong turbulence, producing a white opaque appearance similar to frosted glass.

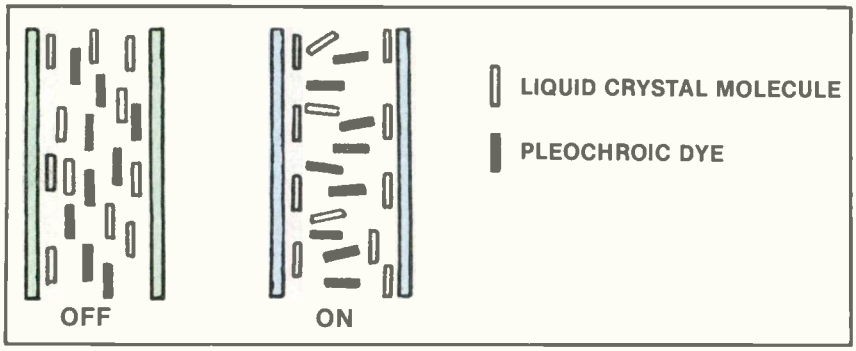


Figure 3. A guest host display uses a dissolved dye to achieve a wide viewing angle, brightness and good color brightness.

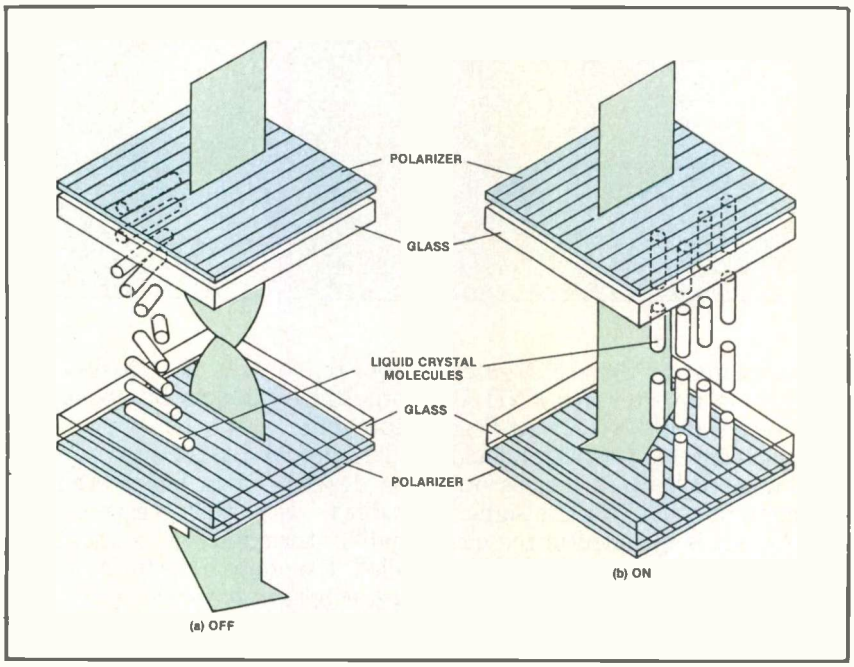


Figure 4. A standard twisted nematic display controls the liquid crystal molecule and makes it act like a valve, either allowing light to pass through or shutting it off.

Twisted nematic displays

The twisted nematic or TN display, which relies on positive nematic materials, is now the most widely known type of LCD. Because of its low operating voltage (3V to 5V) and low current consumption, the TN LCD is increasing in popularity for large volume applications.

A standard twisted nematic display (Figure 4) controls the liquid crystal molecule and makes it act like a valve, either allowing light to pass through it, or shutting the light off.

Transparent electrodes control the alignment of the molecules in the positive nematic material. Two polarizers, one on the upper glass and one on the lower glass, are aligned so that they are off by 90°. If you try to shine a light through the cell, it will be polarized by the first polarizer and then blocked by the second. The cell will always appear dark.

The positive nematic liquid crystal material in the cell is prepared so that its molecules line up along the plane of each electrode. Because the two planes are different, the orientation of the structure rotates by 90° as you travel from the upper electrode to the lower one. This rotates the polarized light coming through the top polarizer by 90°, and allows it to pass through the bottom polarizer. This rotation of light provides the 90° twist that gives these displays their name.

This is the normal condition of the display cell when the pixel is *off*—when no voltage has been applied to the electrodes. When voltage is applied to the electrodes, however, the molecules realign themselves to follow a perpendicular orientation. So the twist is eliminated and the cell switches from light to dark. The light can't pass through the bottom polarizer. Removing the charge applied to the electrodes restores the twist.

The advantages of the twisted nematic display are:

- low operating voltages (3V to 5V) which allows low-voltage integrated circuits to drive the display.
- low operating power (as little as 0.1μW per pixel) which makes them suitable for portable operation.

• a well-defined threshold (about 2V) that simplifies multiplexing and matrix addressing.
• the liquid crystal display material has a long life expectancy because of the low voltages and currents applied.

Multiplexing and matrix addressing

A major technical problem of flat-panel graphic and video displays is addressing the hundreds of thousands of picture elements (pixels). The major success of CRTs, in contrast, is a result of the simplicity of raster addressing.

In a typical CRT, such as the ones used in TV receivers, 250,000 pixels are addressed 30 times a second, with gray scale and color information transmitted at more than 6MHz. No flat-panel display has achieved this level of performance.

Each pixel of a flat panel display has a row-and-column address. A matrix of 480 rows by 500 columns, which is comparable to a TV, requires 250,000 individual addresses. To use an individual wire for each pixel is virtually impossible unless the matrix is the size of a billboard.

A pixel is usually a 2-terminal device. When a voltage is applied across the two terminals, the pixel produces a visible contrast. In order to accommodate all pixel addresses, all of the pixels in the row share one terminal; all of the pixels in each column share one terminal. To turn *on* a particular pixel, you must apply a voltage across the appropriate row and column terminals.

Unfortunately, in this matrix scheme a fraction of the applied voltage exists across the terminals of all pixels in the matrix. These pixels turn partially *on*, creating a background image that reduces the contrast of the image.

The problem of selecting a specific pixel is compounded when a second pixel on another row or column is selected. Ideally, only the two pixels would be energized; in reality, however, two additional pixels would see the full voltage across their terminals.

These two problems are inherent in the matrix addressing technique. The solution to the fractional voltage problem is to use elements that won't turn partially *on* when fractional voltage is applied to them – devices with nonlinear properties.

The solution to the multiple addressing problem lies in line-at-a-time addressing. In this scheme, rather than tying together the row terminals of the pixels, these are addressed individually. The controller addresses a column terminal and then each pixel line in sequence. Then the controller addresses the next column and each individual line terminal.

Due to the large number of lines, line-by-line addressing must happen quickly; the controller must address every line terminal in a row in the same time period that it previously took to address the entire row. As a result, the display must be responsive to a short duty cycle. The individual lines are addressed in sequence – they time-share the address cycle. This time-sharing is called multiplexing.

The duty cycle is determined by the number of lines that must be addressed within one cycle. A

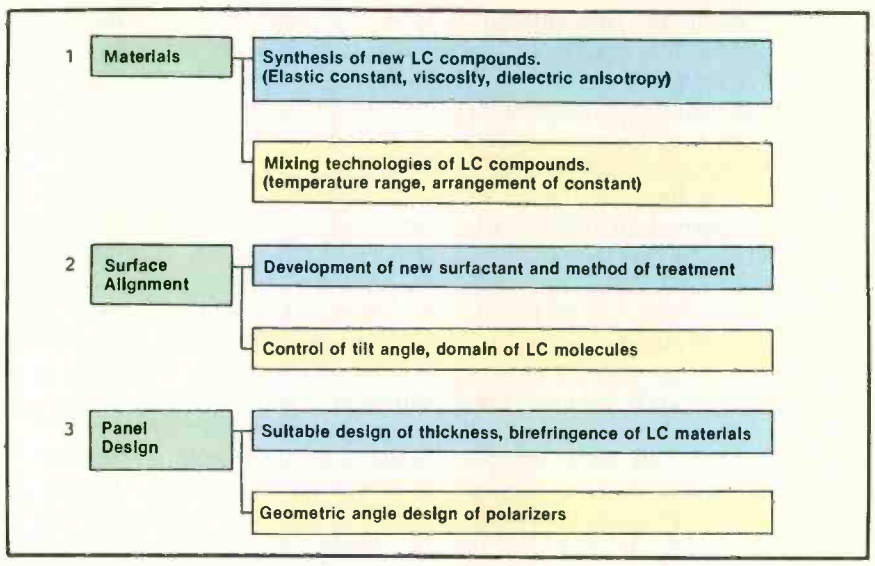


Figure 5. LCD technology is advancing in several areas: materials, surface alignment and panel designs.

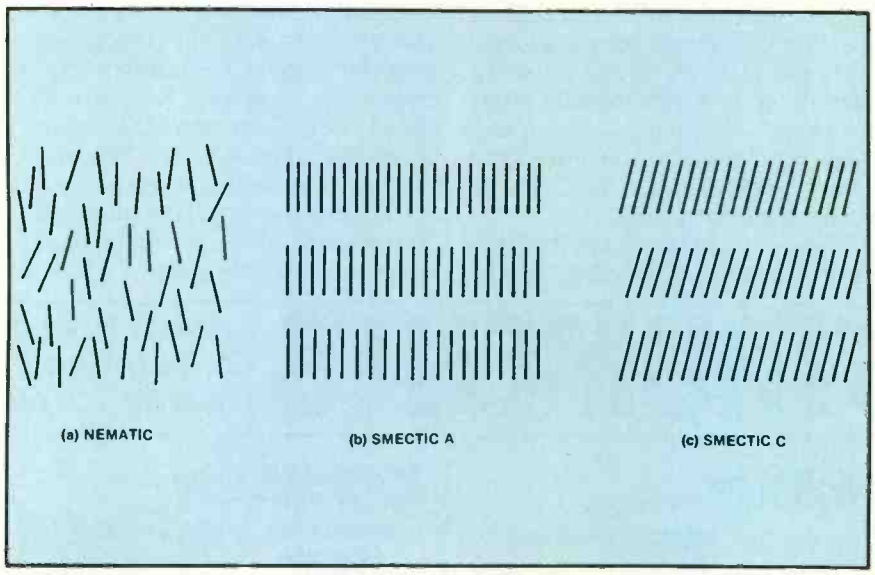


Figure 6. The molecular structure of the three most important classes of liquid crystals: nematic, smectic A and smectic C are contrasted here.

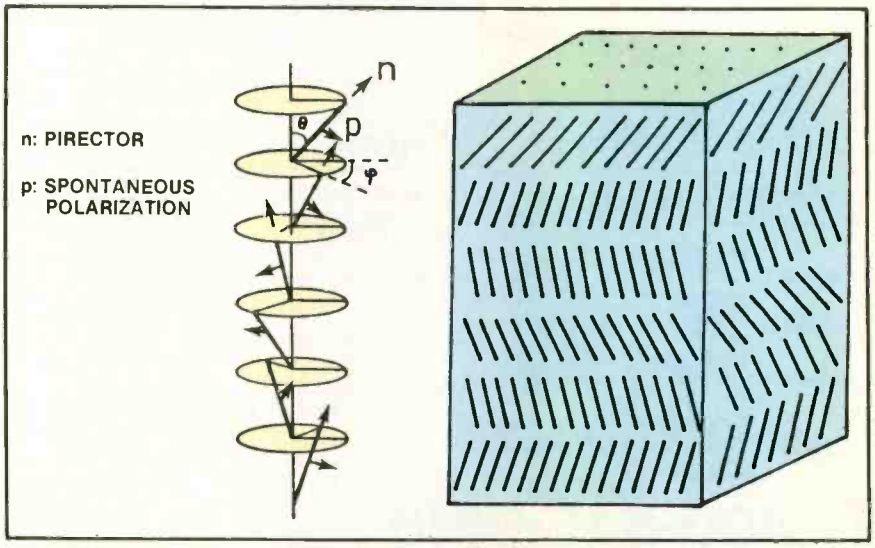


Figure 7. Smectic C liquid crystals have the potential of being ferroelectric and therefore suitable for LCDs.

1/200 cycle, for example, means that during every addressing cycle, the controller must address 200 lines.

Recent improvements in simple matrix displays

There is no all-around flat-panel display that's perfect for every application, but for portable applications, LCDs are filling more and more needs. In fact, as the displays improve, it's hard to imagine an application that LCDs won't be able to satisfy.

And there's steady improvement. Several factors have contributed to this, as shown in Figure 5: improvements in liquid-crystal materials, surface alignment and panel designs. Of these, the improvements in materials have been the most significant.

Two emerging LCD technologies hold particular promise. The first is a supertwisted nematic display, where light passing through is twisted by 270°.

The supertwisted nematic display will provide high multiplexability of more than 200 lines with good contrast. This is because of its well-defined threshold. Unfortunately, the supertwisted display will have the same slow response time as a conventional TN display.

Ferroelectric smectic

The second emerging LCD technology with promise is an LCD based on ferroelectric smectic materials.

The ferroelectric smectic display uses a smectic liquid crystal material in a simple new geometric structure. A ferroelectric material is simply a crystalline material whose polarization can be controlled by an electrical field. It is often referred to as *smectic C.*

Smectic C materials promise to provide displays with both an extremely fast response time and a memory. The rapid response time will be important in displaying high-resolution graphic images, and the memory means that the display retains what you write to it–the image won't have to be refreshed. This last quality is especially important for reducing the power consumption of displays used in portable equipment.

Figure 6 contrasts the molecular structure of the three most important classes of liquid crystals:

nematic (N), smectic A and smectic C. Neither nematic or smectic A are ever ferroelectric. Smectic C, however (Figure 7), has the potential of being ferroelectric and suitable for LCDs.

In a smectic C display (Figure 8) the smectic layers are aligned parallel to the glass surface. If the liquid crystal material is thin enough, the surface interactions will unwind the helix. This unwinding action gives the material its ferroelectric properties. A pulsed electric field switches the polarization of the cell. The closeness of the surfaces causes it to latch in that state, maintaining it indefinitely after the pulse is over. Polarizers produce a visible contrast between the two states of the cell as the light is shining through.

Because of its speed and image quality, the ferroelectric smectic C display is probably the best for highly multiplexed displays. But developments won't come easy. Very few ferroelectric materials are available now.

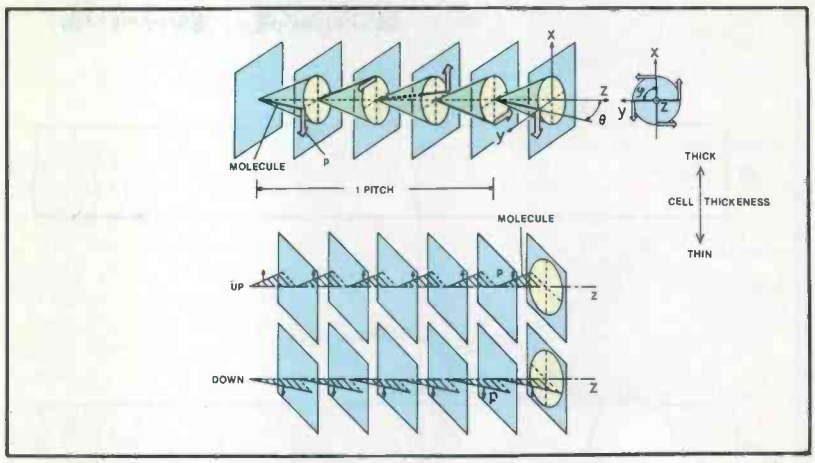


Figure 8. In smectic C liquid crystals, an unwinding action gives the material Its ferroelectric properties.

Active matrix LCD displays

Simple matrix displays satisfy the demand for flat-panel displays in many applications. And, in recent years, the technology of twisted nematic or TN displays has become extremely sophisticated; driving them at high multiplexing rates has made them suitable for products such as portable computers and pocket televisions. These products often use large numbers of scanning lines, sometimes more than 400, requiring a highly multiplexed driving method.

The operating principles of TN displays unfortunately dictate that as the duty ratio becomes higher, the image quality – that is, the contrast ratio and viewing angle – degrades. As a result, when a display is driven in a non-multiplexed manner, Its contrast ratio might be 20:1. When the display is multiplexed at a duty

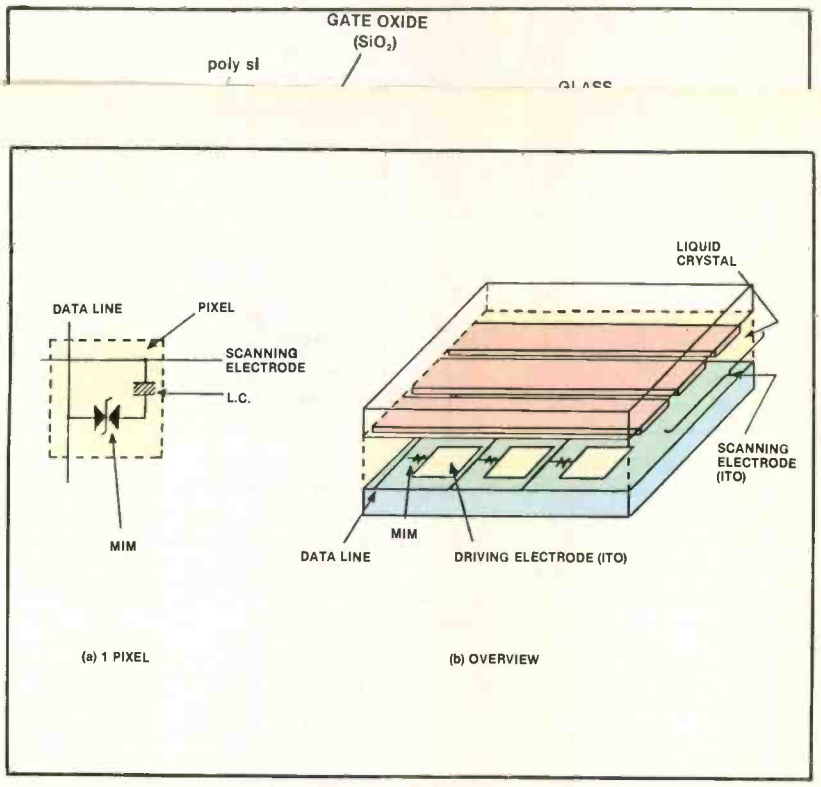


Figure 12. In an MIM LCD, the driver diodes have a stable threshold voltage; once the voltage applied exceeds the threshold the *on* current flows. Dropping the voltage below the diode's threshold turns the current *off*.

GLOSSARY OF TECHNICAL TERMS

active matrix—an arrangement in which the display contains the driver elements.
armorphous silicon—a non-crystalline form of silicon commonly used to fabricate flat-panel displays because it is easy to work with.
contrast ratio—the ratio of a display's maximum luminescence to its minimum luminescence.
ferroelectric—a material whose polarization can be controlled by an electrical impulse.
liquid crystal—a liquid of rod-shaped molecules that features many of the optical characteristics of crystal.
luminescence—a measure of the strength of the image received by a person.
pixel—a single element of a picture, such as dot on a display screen.
polarizer—a plastic film that filters light passing through it according to the light's orientation.
radiance—the rate of energy flow from an electromagnetic source (measured in joules/second or watts).
static drive—an arrangement in which the driver elements are external to the display.
thin film—a method of making devices in which components are created by the deposition of a thin film of some material.

TYPES OF LIQUID CRYSTALS:

LCDs are made from three types of liquid crystal materials.

cholesteric—The individual molecules of the liquid crystal are aligned parallel to each other, however the molecules are grouped in layers; each layer is rotated relative to the previous layer by a few degrees producing a helical arrangement.
nematic—These molecules are aligned with their long axes parallel to each other, but the molecules are free to move up and down. There are no distinct layers of molecules.
smectic—The individual molecules are parallel to each other, but confined to distinct layers that are also parallel to each other; there is no rotation between layers. There are at least nine types of smectic materials.

ratio of 1/200, the contrast ratio is 3:1.

This limitation results from a

elements. These applications yield to metal-insulator-metal or MIM diodes. Requiring a much simpler fabrication process (Figure 11). MIM displays can be made using only two or three photo masks, compared to the four required to make TFT displays. The metal film used to create the diode is deposited by a sputtering process that makes it fairly easy to fabricate displays that are over 10-inches diagonally.

A lateral structure, developed by Epson, makes large-area fabrication even easier.

Figure 12 shows the structure of an Epson MIM LCD. The driver diodes have a stable threshold voltage; once the voltage applied exceeds the threshold the *on* current begins to flow. Dropping the voltage below the diode's threshold voltage turns the current *off*.

A new MIM LCD displays 400 x 640 dots with a pitch of 0.3mm in both the horizontal and vertical axes. In a reflective display, where the light source enters from the front of the display, we easily can obtain a contrast ratio of 15:1 and a viewing angle of over 50°. In this design, each dot to be displayed is divided into two pixels so that, even if a pixel fails, the dot will be visible. This increases both fabrication yield and the display's reliability.

The specifications of our new 5.13-inch color TFT LCD and 400 x 640 dot MIM LCD are summarized in Table 1. Both offer an excellent image quality: high contrast ratio and wide viewing angle.

In a small display, such as the one in a pocket television, the problem isn't as serious because the cost will go down with the learning curve associated with manufacturing these devices. But manufacturing a large area display costs more than it costs to make a CRT.

Photofact

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

GOLDSTAR
Chassis NF9X 2371-1

GOLDSTAR
Chassis NT-01X 2373-1

KTV
KCT1950 2370-1

KTV
Chassis KAC-1901 2374-1

MIDLAND
SCJ4231A28 (24-4231-7) 2369-1

QUASAR
Chassis AMDC110F 2370-2

SANYO
Chassis A6S-47100 2372-1

SEARS
564.43030450,564.43030451 2373-2

TOSHIBA
Chassis TAC8430, TAC8432, TAC8436 2372-2

TOSHIBA
Chassis TAC8401, TAC8406 2373-3

WARDS
GNB17916A/B/C, GNB17926A/B/C 2371-2

ZENITH
SA1961PT/PT8/W/W8, SA1963W/W77, SA1971P/P5, SA1977PT/PT5 2369-2

ZENITH
A1310W1/S1, A1316W3, A1382W1, SA1319W1 . 2374-2

Computerfacts
C. ITOH
M-8510BP CP15

ZENITH
ZFA-161-52 ..... CSCS9

Symcures Wanted

Electronic Servicing and Technology needs a broader variety of television Symcures. Especially needed are reports of Quasar, General Electric, Sylvania (or Philco), Sony Sears and Magnavox.

Symcures are, by definition, solutions to problems that have been encountered during the repair of *more than one* television set of the same make and model, and that may reasonably be expected to be a source of *recurrent* failure.

Please give the brand, model number, Photofact number, a brief description of the symptoms, a rough hand-drawn schematic of the area containing the defect, and a short description of the cure (including whether the defective component was open, leaky, shorted or intermittent).

ES&T editors will adapt the material to the Symcure format and have Photofact-style schematics prepared.

Send seven Symcures each time. Only six will be published, but the extra gives the editor a spare for one already printed in the past (or otherwise not suitable to the format). $30 will be paid for each page of six actually published (remember to include full name and address).

Send to: Symcure Department
Electronic Servicing and Technology
P.O. Box 12901
Overland Park, Kansas 66212

Troubleshooting Tips

Vertical locks only on very weak signals
RCA CTC40

(Photofact 1030-2)

Because failure to lock on medium-to-strong signals can be caused by the tuner, IFs, video, AGC or sync stages, a faulty circuit was my first objective. First, I injected a video signal from a VA48 to the sync separator base. The locking was good at all signal levels. Therefore, the sync separator and vertical circuits must be working properly.

Then I injected video to the sync-amp base. The set now locked well between weak signal levels and about 1.5 times normal level. I decided this probably was normal.

Injecting video at the first-video-amplifier base allowed locking at all signal levels, but adjustment of the vertical-hold control was touchy. From the improved locking, I concluded everything was normal from the first-video-amplifier base and onward.

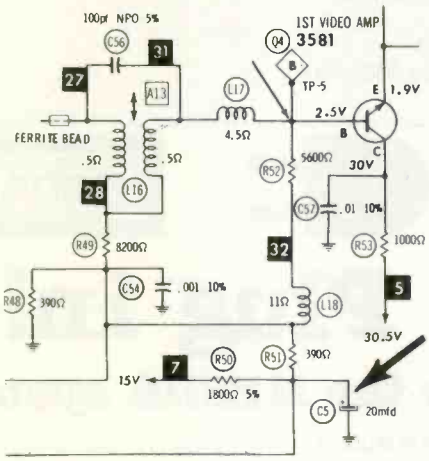
Tuner substitution also improved the locking, which seemed to indicate the tuner was working but against an AGC problem. The *RCA Television Workshop 5* contains a number of steps for isolating AGC problems. Step one was to ground the RF AGC at the tuner. According to the booklet, "If a picture is obtained by grounding the RF AGC, the problem is obviously in the RF AGC circuit."

When I grounded the RF AGC point, the locking was normal from weak-to-strong signals. Evidently the AGC circuit, and specifically the RF AGC branch, held the major defect. But where? Careful checking of likely components revealed nothing. I did the remaining steps suggested in the booklet, which pointed to AGC but did not pinpoint.

My confusion had turned to perplexity; I must be overlooking something. I got out my "RCA Volume 1," by Carl Babcoke, (from Tab Books) and read the circuit description. After finding a nice drawing that showed RF vs. IF AGC dc voltages for different signal levels, I checked those in my set against the drawing. My television did not seem to have the right relationship at the various signal levels between RF and the IF AGC dc voltages. By adjusting the noise control or inserting some dc voltage at RF AGC point, I could shift the signal level where rolling occurred, but could not eliminate the rolling completely. Nor could I get the two voltages to track properly.

If some of you are wondering why I didn't check for a leaky MOSFET in the tuner loading down the tuner AGC, remember: Changing the tuner did not solve the problem. Nevertheless, I decided to check the MOSFET anyway. According to RCA Volume 1, the voltage at feedthrough C17 (with green AGC lead disconnected) should not exceed +0.1V, and the drain voltage should not exceed +2V. My set passed.

I would like to say I finally deduced the cause of this problem using logic, but I can't say that because I didn't use logic. A lot of searching for hints finally paid off in *The Color TV Factbook*. It stated that different problems with C5 (or C364 RCA number) in the first-video stage could cause various symptoms including unstable sync and locking. I removed C5 (20μF) and checked it, finding it almost open. A *new capacitor completely restored normal operation of the color receiver.*



My relief at finally having the receiver working was much greater than my curiousity about how that little capacitor caused the problem; therefore, I returned the television to the customer without making any more tests.

Roger D. Redden
Beaver, WV

Editor's Note: *C5 bypasses several signals and circuits. The important one here is that C5 is connected directly to the AGC-keying-transistor's emitter. When it opens, it allows distorted horizontal pulses to be fed into the RF and IF voltages and the base circuit of the first video amplifier. Mixing of stray horizontal signals with the AGC and video signals can cause some mystifying symptoms, as you have found already. In general, check all AGC capacitors when the symptoms defy logic.*

Products

Diagnostic instrumentation kits

A line of diagnostic instrumentation kits offered by *Spanta* features several assortments of precision test instruments. The KD-300 Series line and the more versatile models KD-301 and KD-302 seat each instrument in a custom-fitted polyurethane pocket within an attache case.

Circle (75) on Reply Card

Remote control transmitter

Philips ECG, a North American Philips company, has introduced a line of remote control transmitters that replace original equipment units used with TV sets, video cassette recorders and channel converters. Seventy-one models available are in both infrared and ultrasonic types, for use as replacements of more than 170 known-brand transmitters. The units are completely new, not rebuilt, and key functions and legends are identical with those of the original types.

Circle (76) on Reply Card

Complete PCB repair system

APE model PRS-475 PG features a microprocessor controlled plating center, capable of depositing 50μin. of gold for mil-spec edge connector repair. The system also includes the following accessories: desoldering handpiece, solder iron, thermal tweezer with 3-blade sets, reflow solder tool with practice kit, miniature drilling system and circuit repair kit.

Circle (77) on Reply Cards.

DMM designed for low lifetime costs

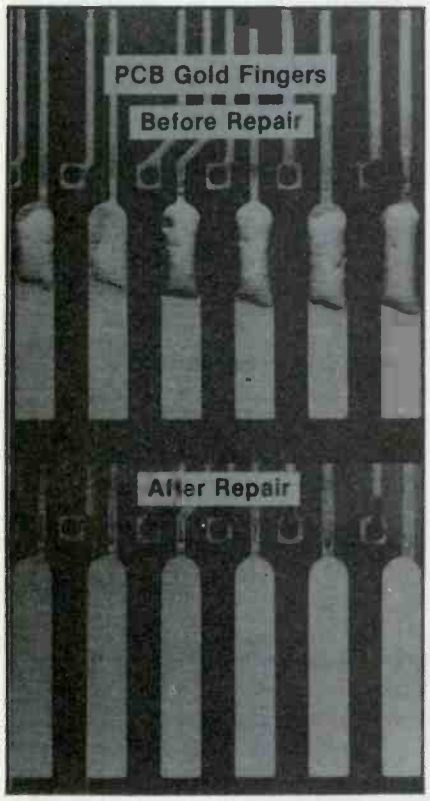
John Fluke Manufacturing announces the 8842A 5-1/2 digit multimeter, the second meter in the 8840 family, a series of system multimeters offering varied levels of performance.

Model 8842A offers enhanced measurement capabilities for such applications as production test or research and development. It features increased performance with its 0.003% basic dc accuracy and 0.08% basic ac accuracy (at one year). It also features 100nV resolution for dc-voltage measurements, 1μA resolution for dc-current measurements, and 100$\mu\Omega$ resolution for resistance measurements. Hermetically sealed, proprietary thin film resistor technology gives the 8442A a 2-year calibration cycle and warranty period.

Circle (78) on Reply Card

PCB gold repair service

Alchemitron provides a cost-effective repair service, specializing in the gold contact areas of bare or finished printed circuit boards. Solder splash, worn contacts, delaminating gold, corroded tin/lead, pitting, step plating and missing contact fingers—all are examples of board problems that can be repaired. Whether it stems



from the design, the manufacturing process, or develops in the field, the problem can be solved at a fraction of the board value, according to this repair service. Typical turnaround time is 24 hours on scheduled orders.

Circle (79) on Reply Card

Answers to the Quiz

See questions on page 28.

1. D. The component in (b) is a UJT. The one in (a) is a JFET. The electrodes on the UJT are: base 1, base 2, and emitter.

2. C. The tunnel diode is one of the fastest switches in electronics.

3. D. If you have studied what happens inside a transistor you know that deathnium trap is a fancy name for an imperfection in the material that the transistor is made of.

4. A. The shorter the rise time the wider the bandwidth. An empirical equation that is sometimes used is given here:

bandwidth x *rise time* = *0.35*

5. A. Duplexers are used in radar antenna systems.

6. C. An example of where this level of current is used is in leakage current measurements.

7. B. Connect the meter so that electrons enter the negative terminal and leave the positive terminal.

8. C. This test is used to check an amplifier for distortion. If there *is* a change in current the full-cycle average is not zero. That means the amplifier has changed the characteristic of the input pure sine wave, so the amplifier has distorted the signal.

9. C. It is a good idea to keep in touch with the basic principles of physics.

10. C. The coil is pulsed for this test. That causes it to oscillate with the distributed capacity. The result is a damped wave that can be displayed on an oscilloscope. If the coil is defective the oscillations die out immediately.

Books

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

Understanding Computer Science Applications, by Roger S. Walker, Ph.D.; Texas Instruments; 284 pages; $14.95.

Here is a book that provides a self-paced course about using computers to solve problems. Examples of computer applications and programs are included. It is the second volume in a planned set of books explaining the fundamentals of computers in comfortable language and format.

Highly technical material is presented in simplified fashion, leading readers through a review of basic computer concepts, then covering serial, parallel and network communications; distributed processing; modeling and simulations of systems; graphics; and future applications. Each of the eight chapters contains a summary and a short quiz to enable readers to gauge their progress.

Texas Instruments, P.O. Box 225474 Dallas, TX 75265

Video Electronics Technology, by David Graham; Tab Books; 256 pages; $15.95 hardbound, $10.95 paperback.

Keeping up with rapid advances in technology is easier when related information can be drawn from a single source. This book was written to provide a 1-stop reference for developing video technologies from microwave and satellite television to VCRs and laser-scanned videodiscs. Someone working in any phase of video electronics or an allied field, or simply interested in the subject, will find detailed coverage, beginning with a review of the principles of B&W television and continuing with an update of present and future recording, playback and communications systems.

Tab Books, Blue Ridge Summit, PA 17214

Digital Electronics: Theory, Applications, and Troubleshooting, by Byron W. Putman; Prentice-Hall; 350 pages; $32.95 hardbound.

The author's enthusiasm for the subject of digital electronics is infectious; he intends for this book to be read, reread and kept at hand for constant reference. Directed to the technician or those nearing technical proficiency, this text assumes that the reader has a solid background in basic electronics and transistor theory. The last chapter, which introduces data conversion techniques, also requires an elementary knowledge of op-amp theory.

No concept is introduced until it can be applied immediately to the material at hand. For example, Chapter 1 introduces the concepts of digital electronics and the binary number system, with number theory held to a bare minimum. The introduction to the hexadecimal number system is deferred until Chapter 12, when it logically supports memory-mapping techniques.

Prentice-Hall, Englewood Cliffs, NJ 07632

Analog Electronics for Microcomputer Systems, by Paul Goldsbrough, Trevor Lund and John Rayner; Howard W. Sams & Co.; 438 pages; $19.95 paperback.

Analog electronics involved in three basic building blocks of the microcomputer system are presented in this book that pulls together a broad range of analog topics and principles previously scattered among textbooks, notes and data books. The basic theory and practical circuits of the analog input subsystem, microcomputer subsystems and the power subsystem are presented clearly with ample illustrations.

It isn't necessary to be a CET or engineer to use this book effectively, but a fair understanding of digital electronics and microcomputing is recommended.

Howard W. Sams, 4300 W. 62nd St., Indianapolis, IN 46268

Literature

John Fluke Manufacturing Company, announces availability of its 12-page color brochure, *Fluke DMM Accessories* that details the accessories produced for use with this company's line of digital multimeters.

Several new products are featured, including the 80TK Thermocouple Module, which converts virtually any DMM into a digital thermometer capable of both °F and °C readouts. The 80TK plugs directly into a DMM, and uses interchangeable K-type thermocouples for a wide variety of temperature measurement applications.

The brochure also includes full color photos and detailed information on products designed for safe, precise measurement of high voltage, high current, temperature and high frequency. Convenience accessories such as carrying cases and test leads are also highlighted.

Circle (125) on Reply Card

Topaz, Inc. announces the availability of *Solutions to Power Problems,* a convenient guide for selecting the correct Topaz Power Conditioning system for any sensitive equipment application. Topaz products protect computers and other electronic equipment against electrical noise, voltage fluctuations and power outages. The product selection guide discusses each of these power disturbances, identifies its cause and effect and offers effective reference to the appropriate Topaz system for each specific need.

Circle (126) on Reply Card

AEMC Corporation has released a 1985 supplement to its catalog of portable test and measurement instruments. The catalog covers applications, specifications and ordering information for new additions to the product line, including a 50V telephone line megohmmeter designed for conducting insulation tests on telephone installations; the Bouncer II, a high-sensitivity analog multimeter in a unique, resilient rubber housing; and the model 4500 digital ground tester, designed for measuring very low resistance on large grounding systems. Also featured is the Multidisplay 2000, a unit that accepts 13 AEMC Add-a-Function modules, and directly renders readings in the correct engineering units for various parameters, including light, resistance, capacitance, frequency, and temperature, depending on the module used.

Circle (128) on Reply Card

Complete information on the new ESP Electronic Short Pathfinder is available to printed circuit board manufacturers, lab technicians, electronic circuit designers, electrical field service people and others interested in saving up to 95% of troubleshooting time and salvaging shorted PC boards. The brochure is offered by **J & L Information Systems.** It includes a complete explanation of how the ESP is operated, along with photographs and specifications.

Circle (129) on Reply Card

Choosing and installing the appropriate filter to cure terrestrial interference (TI) in earth stations is the subject of a catalog from **Microwave Filter.**

TVRO/85 contains descriptions of MFC filters used to cure destructive and non-destructive interference, as well as diagrams depicting where filters should be placed in the TVRO system.

Besides a variety of filters described in the catalog is the installer's kit, which contains filters to diagnose and cure non-destructive TI in receivers with 70MHz IF frequencies. The Sky Doc Kit, used to detect and cure both destructive and non-destructive TI, is also included.

Circle (130) on Reply Card

A catalog that features a line of miniature precision soldering irons and over 40 different interchangeable, slide-on tips for electronic assembly work is being offered by **M.M. Newman.**

The Antex Soldering Irons And Accessories catalog is complete with product specifications.

Circle (131) on Reply Card

Readers' Exchange

For Sale: New B&K model 1805 multifunction counter with probe—features include frequency period, period average at totalize and 8-digit LED display. Never used, with warranty and in original carton, $280 plus shipping and c.o.d. charges. *Stanley Todorow, G8468 Belle Bluff Drive, Grand Blanc, MI 48439.*

For Sale: Sencore VA62, NT64, CR70, LC53; B&K transistor tester. All equipment has been pampered and is in excellent condition. Send s.a.s.e. *S.G. Alfred, 1020 Ouichita, Carthage, TX 75633; 214-693-9204.*

For Sale: Sencore VA48 with manuals, excellent condition, $680. Sams Photofact folders, complete 900 to 1710, intermittent 62 to 2264, $1,200 without file cabinets. *307-587-5251.*

For Sale: Sams Photofact folders, 1,000 from 30 to 1600, $400, freight paid; Sencore VA48, $350; Sencore Minuteman oscilloscope, $150; frequency counter, 100MHz, and CB tester, $90; B&K 5MHz oscilloscope, $75; Beltron picture tube restorer, $175. Send certified check. *Dennis Hanningstad, 928 King St., La Crosse, WI 54601.*

For Sale: B&K 1077B analyst, $200; Conar capacitance/resistance analyzer, $35; Weller soldering station, W-TCP-L, $35; Radio City flyback, yoke and capacitor tester, model 124, $40. All plus shipping. *George C. Pullen, 6722 Botetourt Drive, Ft. Washington, MD 20744; 301-449-7348.*

For Sale: Ham equipment—Kenwood TS-930S transceiver with AT-930 automatic antenna tuner and CW filter, $1,300; Kenwood SM220 station monitor with BS-8 pan display, $275. *William Shevtchuk, 1, Lois Avenue, Clifton, NJ 07014; 201-471-3798.*

For Sale: Tuner rebuilders—quantities of tuners, sold only in assorted lots of 10. Make offers. *Troch's, 290 Main St., Spotswood, NJ 08884; 201-251-3042.*

Wanted: Used Futterman (Harvard Electronics) tube power amplifiers, either stereo or mono, working or non-working. Send price, address, phone, details including model number. *Joseph Bagnata, Box 26, Harleigh, PA 18225.*

Wanted: Operating manual and schematic for Hewlett Packard oscilloscope, dual trace model 180A. Will pay for copying or will copy and return. *John Kosa II, Route 1, Box 66B, Red House, WV 25168.*

For Sale: B&K 2040 CB signal generator, B&K 1040 CB Service Master, 129 Sams CB Photofact folders, $500 for all. *Meade TV & Electronics, 502½ First Ave., West Logan, WV 25601.*

For Sale: Soar dual trace oscilloscope, model MS-6023, with probes and built-in DMM, used one year, $400, or best offer; HP85B computer with memory module, software and manuals, $1,250. *Mark Vuozzo, 17632 Jordan, No. 38B, Irvine, CA 92715; 714-733-0372.*

Wanted: Sams S D manuals, 1 through 5 and 7 through 13. Please send price, including shipping. *Paul A. Todd, Box 54, Alton Bay, NH 03810; 603-875-3772.*

Wanted: Sanyo 31C36 tuner escutcheon panel (P/N 111-0-1220-24100, cont. Dec.). Also battery holder for 10 AA batteries in two rows of five for Lafayette transceiver model Dyna-Com 3B. *Larry Cope, 1612 Serenity Lane, Sanibel, FL 33957.*

Needed: Picture tube, used but good condition, type 15VAETCO1. Also information on theory and repair of remote control units on color TV sets, preferably RCA. *James E. Gregorich, 117-2nd St. North, Virginia, MN 55792; 218-749-4355.*

Wanted: Disabled man on limited income needs a tube tester, CRT tester/rejuvenator, transistor tester and capacitor tester at prices that can be afforded, or payments arranged. *Edward Gordon, 2627 Hammonton Road, Marysville, CA 95901; 916-742-9195.*

For Sale: Vibrators, Bradford TV manuals, complete Western Auto TV manuals, many Sams AR, TSM, MHF manuals. Make offer. *Osceola Electronics, 226 S. M66 Highway, Marion, MI 49665.*

For Sale: Sams Photofact folders 1 to 2312 in 4-drawer file cabinets, 69 AR, TSM, MHF manuals, also Delco radio manuals. All for $2,200. *Ted Smith, Box 706, Sophia, WV 25921; 304-683-5677.*

For Sale: Sencore VA62 universal video analyzer, Sencore VC63 VCR test accessory, Sencore NT64 (NTSC-EIA) pattern generator, Sencore CR70 universal CRT analyzer and restorer. All for $2,800. *Alan Smith, Box 1335, Sophia, WV 25921; 304-683-5677.*

For Sale: Oscilloscope, Hitachi model V-352, 2-channel, dual waveform, 35MHz, $550; B&K Precision 3010 function generator, $150; TF46 portable Super Cricket transistor/FET tester—won in contest, never used, $350. *Derrick Wallace, 136 E. Mercury Blvd., Hampton, VA 23669.*

For Sale: Thordarson—variety of horizontal transformers, mostly color, some b&w, high voltage, $15 each, plus shipping. Variety of oddball tubes, metal 6L6, for example. Send s.a.s.e. for details. Other TV and stereo parts. *Boyd Hawks TV Service, Route 3, Box 18, Galax, VA 24333; 703-236-4210.*

Wanted: EICO model 460 oscilloscope with good power transformer. Or will sell defective EICO with new NEC CRT C529P31B (CRT used only a few times). *Ernie, P.O. Box 122, Elgin, OR 97827; 503-437-5971.*

For Sale: Sencore VA48, used only once, complete with instructions and in original box. Make offer. *William J. Maida, 247 W. Sabal Palm Place, Longwood, FL 32779.*

For Sale: All copies of *P.F. Reporter* and ***Electronic Servicing & Technology,*** 1964 through 1975, and 1980 through 1984, 50 cents per copy plus shipping. *Lloyd E. O'Brien Sr., P.O. Box 105, Springfield, WV 26763.*

For Sale: New parts—Zenith color yoke 95-2638, B&W yoke S94147-01, vertical transformer 95-2851, color yoke Y108 952286; Admiral color fly 311 79D126-1; Magnavox color fly 574 361520-2; each part $20, $100 for all. *Tony Gonzales, 1605 S. 56th Court, Cicero, IL 60650; 312-652-8454.*

For Sale: Heathkit IM-48 audio analyzer, never used, $50; IB-58 harmonic distortion meter, never used, $70 or best offer. Add shipping. *C. England, 98 Montague Ave., South Zanesville, OH 43701.*

For Sale: Teletype model 33ASR machines (two), asking $90 each, with or without stands. *D. Testa, P.O. Box 9064 EST, North Newark, NJ 07104.*

For Sale or Trade: 300 Sams Photofact folders, assorted 121 to 1,000; pre-1970 manufacturers' service information on radios and televisions; old test equipment. *Frank Moon, Route 3, Box 355A, Alexander City, AL 35010; 205-839-6965.*

For Sale: Back issues of ***Electronic Servicing & Technology*** dating from 1966 and *Radio Electronics* from 1952. Make offer for all. *M.R. Easterday, 6809 W. 100, Overland Park, KS 66212.*

For Sale: Hickok tube tester model 510X with schematic, instructions and tube chart (needs line cord) $25 as is; B&K tube tester model 707 Dyna-Jet $75 as is; B&K Precision Tube Master series 10 to 12 tube and battery tester, with roll chart, in wood dovetail box, working order, $100. Payable in U.S. funds plus postage, M.O. only, no checks. *Ed Barlow, Box 29, Tweed, Ontario, Canada KOK 3J0.*

For Sale: Bound copies of *Electronic Technology* with Tekfax, 1960 to 1980, best offer; Hickok model 610A universal TV alignment signal generator, manual, cable, etc., $50 plus shipping. *M.B. Lindenaux, 15 Marlin Drive, New Port Richey, FL 33552; 813-842-4818.*

Needed: Schematic and service information for Panasonic model PVA500 VCR tuner, used with a PV-5000 VCR. Will pay for any copying costs. *Jeff Parker, 7901 Twin Oak Court, Raleigh, NC 27609.*

For Sale: Beitmain TV books, 1947 through 1970, $60 for all; Sams ARs, $3 each. **Wanted:** Sams AR170, 243, 262, 266, 292, 293, 299 and 300; tube-type TV sound tuners; SECO HC6 cathode checkers. *Jim Farago, P.O. Box 65701, St. Paul, MN 55165.*

For Sale: Heathkit digital multimeter IM-2260, with ac adapter and Ni-Cd batteries, excellent condition, $95, including shipping. *Calvin Logue Jr., 17J Washington Lane, Westminster, MD 21157.*

Wanted: Will any technician who might be using the Dandy (manufacturer) color CRT kit intended for use on any model of B&K (and others) 440 or B&K 465 please write. I will compensate you for your trouble. Thanks, *Joseph A. Gontarz, 14 Rudolph Road, Forestville, CT; 203-583-7532.*

For Sale: RCA Senior Voltohmyst with new VIZ meter movement model WV-98A, will include Simpson 260 multimeter that needs minor repairs, $100 or best offer. *Gary H. Thompson, 3648 Eastside Highway No. 5, Stevensville, MT 59870.*

Wanted: Test Equipment—Leader LCG400M generator; Leader, Tektronix, Hewlett-Packard or Sencore oscilloscopes with 60 to 100MHz, alt. time base and intensifier with calibrated delay; Sencore VA62 with NTSC and VCR accessory. Send offers. *Miller TV, P.O. Box 364, Portales, NM 88130; 505-356-4207.*

For Sale: Sams transistor service manuals TSM 1 through 139 (137 and 138 missing), $1.50 each or $150 for all, plus shipping; Sams Photofact folders 36 through 496, some missing, $1 each or 348 total for $300 plus shipping; Sams tape recorder service manuals TR1 through TR4 and TR11; Sams record changer service manuals CM-2 through CM-9, RC-11 and RC-12, $3 each or all 15 manuals for $30 plus shipping. Call or send s.a.s.e. for complete list. Also, Philco wideband oscilloscope amplifier model 8300, good condition, $15. *John Brouzakis, R.D. 3, Box 602B, Charleroi, PA 15022; 412-483-3072.*

Wanted: Schematic for Cordovex electronic piano by Elex, model PP23. *Gregg Tilles, Route 1, Box 87L, Staunton, VA 24401.*

For Sale: Sencore CG22 color-bar generator, $65; Sencore AT218 IF attenuator, $20; Sencore TR219 horizontal output drive isolation transformer, $25. All, excellent condition. *Elmer Wieland, 237 Talbot Drive, Bedford, OH 44146; 216-232-8653.*

For Sale: Sencore S6165 AM-FM-stereo analyzer, complete, $475. *Val Obal, 3201 S. 73rd St., Omaha, NE 68124; 402-393-0459.*

Wanted: New or used third video IF transformer for RCA TV model CTC-24A–Sams 912-3, RCA part No. 116544 (also used in CTC-31 and other models). *R.N. Baughman, 572 Strumbly Drive, Highland Heights, OH 44143.*

Wanted: NRI TV, video servicing courses and equipment; NRI computer and microprocessor courses, equipment and computer. Reasonably priced. *Joseph Wegner Jr., P.O. Box 262, Glendale, CA 91209.*

For Sale: Heath post marker sweep generator model IG-57-A, like new, with instructions; Pace capacity and resistor checker with instructions. Make offer. *William J. Maida, 274 W. Sabal Palm Place, Longwood, FL 32779.*

For Sale: B&K 80MHz multifunction counter model 1805 featuring frequency, period, period average, 8-digit LED and other specifics, new, never been used, $290 includes x1/x10 probe. New, never been used Fluke model 27 DMM with features that include 0.1% dc accuracy, min/max recording, relative mode, bar graph, conductance and others, $230. Prices plus shipping, insurance and c.o.d. charges. *Cathy Johnson, 72 Mary Stafford Lane, Flint, MI 48507.*

For Sale: Rider service manuals, volumes 4 through 16, 19, 20, 27 and 28, $15 each. Sams Photofact folders, bound. Folders per binder vary in number: Nos. 31 through 48, 61 through 500, 512 through 557, 578 through 616. Priced $2 per folder x number of folders per binder. Send s.a.s.e. with your requirements for quotation. Folders will not be cannibalized. *E.E. Pitsinger, Unitronix, P.O. Box 247, Galveston, TX 77553; 409-763-2207.*

Wanted: Schematic and manual for AKAI reel-to-reel tape recorder model 4000D, serial No. 70111-00266. Will pay for information. *Lloyd Spivey, WLLS AM/FM, Spinks Shopping Center, Hartford, KY 42347; 502-298-3268.*

For Sale: Sencore VA48 video analyzer in original box, $675; Sencore Z meter LC53 with 39G85 Touch Test probe and SCR224 TRIAC test accessory, $585; Heathkit 10-4101 vectorscope and pattern generator, $55; Heathkit IT-5250 color CRT tester and rejuvenator, $40; EICO 242 solid-state FET TVOM lab meter, $25. Cash only. *R.M. Hoffmeyer, 1170 Pino Solo Drive, Santa Maria, CA 93455; 805-937-4073.*

Wanted: Knight 83YX137 AF generator and RF generator with manuals; 83Y135 signal tracer manual. *C.T. Huth, 229 Melmore St., Tiffin, OH 44883.*

Needed: Schematic for Thomas organ No. 101021, year approximately 1962. *Elmer's TV, 437A Pearl Ave., Monrovia, CA 91016.*

Wanted: For VCR repairs–tape tension and spindle gauge, video test tape, etc. Also, Panasonic 12-inch picture tube No. A26JAS31X. *Ed Herbert, 410 N. Third St., Minersville, PA 17954.*

For Sale: B&K Precision 3020 sweep function generator, like new, $250; B&K Precision No. 1420 oscilloscope with probes and demodulator probe, like new, $595 or best offer. *Vandy's, 5306 N. Magnet Ave., Chicago, IL 60630; 312-775-5497.*

Wanted: Sencore SC61 PR57. *Lewis TV, 326 Main St., Huntington Beach, CA 92648; 714-536-3715, after 1 p.m.*

Wanted: A set of back issues of *ELECTRONIC SERVICING & TECHNOLOGY* dated to October 1984. Please state price including shipping. *Lyle Estabrook, 2365 SE Sedgwick Road, Port Orchard, WA 98366.*

ES&T

Classified

Advertising rates in the Classified Section are 75 cents per word, each insertion, and must be accompanied by payment to insure publications.

Each initial or abbreviation counts a full word.

Minimum classified charge is $15.00.

For ads on which replies are sent to us for forwarding (blind ads), there is an additional charge of $25.00 per insertion to cover department number, processing of replies, and mailing costs.

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

FOR SALE

AUTOMOBILE RADIO and tape replacement parts. Delco, Chrysler, Philco-Ford, Motorola, Panasonic and many others. Large inventory. Laran Electronics, Inc., 3768 Boston Road, Bronx, NY 10469. (212) 881-9600. National (800) 223-8314, NY State (800) 446-4430. 1-85-tfn

BOOTLEGGERS BIBLE for CB Modification $12.95, CB Radio Repair $10.95. Linear Amplifier Planbook $14.95, kits, etc. Catalog $1.00 refundable – APS, POB 263 Newport, R.I. 02840 401-846-5627. 12-84-tfn

SCRAMBLED TELEVISION, encoding/decoding. New book. Theory/circuits, $9.95 plus $1 shipping. Workshop, Box 393ES, Dept. E, Bethpage, NY 11714. 1-85-tfn

TV TROUBLE ANALYSIS TIPS. Over 300 symptoms/remedies by circuit area; tough ones over the years. Save time and money. Send $12.50 to CHAN TV, 8151 Grandview Rd., Chanhassen, MN 55317. 1-85-tfn

MAKE TELEPHONE answering machine servicing simple & professional. Without tying up your phone lines, our ring simulator will activate any machine on the market. You can hear the outgoing message, give your message, and also have the availability to check machines that have remote capability. Send your check for $85.00 made payable to PSI, INC, to cover cost of machine shipping and handling or call (201) 845-6669. PSI, Inc. is located at: 34, Route 17 North, Paramus, New Jersey 07652. 4-84-tfn

CABLE CONVERTERS. Lowest price. Dealer inquiries accepted. Quantity Discounts. FREE CATALOG. P.G. Video Corp, 61 Gatchell St., Dept. ES&T, Buffalo, NY 14212. 5-85-tfn

FOR SALE: TALK A PHONE, 4–KLR 2M 35.00 each; 1–KLR 2L 25.00; 1–KHP 3 50.00; 1–K CL 5 125.00; 1–K-LR-2M 35.00; 3–K-AC-610 175.00; 2–TLS 10 150.00; 1–K-C-41M 50.00; 1–K-S-100 80.00; 1–K-S-101 80.00; 1–K-SM 7.00; 1–K-SM-L 7.00; 1-HI-9R-1 100.00; 1-HI 4 30.00; 1-HI-8 75.00. Gerald Cooper, P.O. Box 500, Hagerstown, Md. 21741. 1-86-1t

REPAIR OF ZENITH circuit board 9-160-all; with dud exchange $33.00. One year guarantee. Kinirral Electronics, 68-26 64th Place, Glendale, N.Y. 11385, (718) 366-3859. 12-8-5-3t

COLOR T.V. REPAIRS, OVER 3,000 TIPS on 31 brands, 116 page manual. Send $21.00, A.F. Fernandez, Box 546110, Surfside, Florida 33154. 1-86-1t

SANYO HORIZONTAL OUTPUT TRANSISTOR 2SD1341, $1.99 plus other name brand transistors, IC's, RF-Power, Sanyo rechargeable batteries and LED's. For best buys plus service call 1-800-458-6053. PA call 1-800-672-7100. M/C/VISA honored. Savings, service, quality. At B&D we do it better. B&D Enterprizes, Box 305, Kane, PA 16735. 1-86-2t

SONY-TRINITRON REBUILTS are now available. Call for price & delivery, 1-716-621-5250. 1-86-2t

CABLE TV CONVERTERS & EQUIPMENT. Plans and parts. Build or buy. FREE information. C&D Electronics, P.O. Box 1402, Dept ES&T, Hope, Arkansas 71801. 1-86-tfn

INDIVIDUAL PHOTOFACT FOLDERS (Not sets) #1 to #1400. $3.00 first-class postpaid. Loeb, 414 Chestnut Lane, East Meadow, NY 11554. 1-86-3t

SENCORE V.A. 48 like new. Includes all leads & manuals. Must sell. $750 or best offer. 707-443-6820. 1-86-1t

WANTED TO BUY

WANTED: To buy well established TV-video repair shop in Brooklyn or Manhattan Boroughs of New York. Please Call: (718) 336-9573. 1-86-1t

HELP WANTED

CAMERA-VIDEO Technicians needed. Top pay and benefits for well trained and experienced technicians who are expert with consumer and/or industrial cameras and VCR's. Training by manufacturers such as Sony, Hitachi, Panasonic, etc., are necessary for job experience. Come to sunny Florida and enjoy your work & leisure time. Write or call ATLANTIC ELECTRONICS INC., 1881 NE 26 St., Ft. Lauderdale, FL 33305. (305) 564-8274 10 AM to 6:30 PM. Ask for Dave or Joe. 8-85-tfn

WORK IN TAX FREE CARIBBEAN: Senior Tech/Svc Manager for Electronic facility. Applicant must be capable of repairing TV, VCR, Audio Etc., and possess relevant certificates. Shop consists of Security, Satellite, 2-Way, Paging and Mobile Telephone business. Excellent equipped shop with good working conditions. Salary negotiable. Submit Resume to: Manager, 660 S.W. 63rd Court, Miami, Florida 33144. 1-86-1t

HELP WANTED (CONT.)

TV TECHNICIAN—Fully trained and experienced in TV-VCR-Repair. Top pay & benefits. Located on the eastern shore of Maryland. Send resume to Technician, P.O. Box 269, Pocomoke, MD 21851. 1-86-1t

BUSINESS OPPORTUNITIES

COLORADO. Established Television Sales and Service, southeast Denver. Authorized Sony, RCA, Zenith, Magnavox, (303) 741-3483. 12-85-2t

3 HOURS FROM SAN FRANCISCO! Town of paradise in pine forested foothills. Electronic repair business. Building/shop/equipment/7 room resident with large garden. $165K, (916) 872-1962. 12-85-tfn

SELF DESIGNERS, Investors, and Electro-Hobbists we offer you our Complete Home Robot Designs. Exclusively from Cad Design Services. For your manual, and listings of other current designs, send a check or money order for $5.00 to: CAD Design Services, P.O. Box 1192, Jackson, MI 49204. 1-86-2t

TV SALES AND SERVICE BUSINESS in booming tourist area, on the lakes. Must sell—moving. Equipment, parts inventory, service literature and van. Have good business with good reputation. Located in good shopping center. Asking $12,000. Square Deal TV, Forsyth, Mo. Phone 417-546-2262. 1-86-1t

T.V. SALE & SERVICE FOR SALE in L.A. area, California. Inventory includes 63 VAN 77 Lincoln Cont. Gross $50,000. Low rent. 10 yrs. established, asking $30,000. Ray Garcia, 13051 Woodcock, Sylmar, CA 91342. 1-86-1t

TV REPAIR BUSINESS: Excellent income. Great future for ambitious individual with electronic skills. S.R. QUINN & ASSOC., (215) 576-1372. 1-86-1t

EDUC.-INSTRUCTION

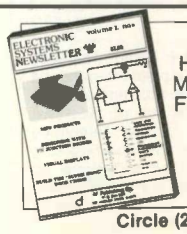
UNIVERSITY DEGREES! Economical home study for Bachelor's, Master's, Doctorate, Prestigious faculty counsels for independent study and life experience credits. Free information-Richard Crews, M.D. (Harvard), President, Columbia Pacific University, 1415 Third St., Dept. 2B80, San Rafael, CA 94901; Toll Free-800/227-0119; California: 800/552-5522; or 415/459-1650. 10-85-3t

EXPERIENCE COUNTS!
NON-RESIDENTIAL DEGREE PROGRAMS

Professionals in any field may apply for at-a-distance Bachelor's, Master's or Doctoral degree programs in Management, documenting work experience instead of further classwork, and presenting a career accomplishment project instead of a standard thesis. The cost is moderate; the time for completion is shortened. Designed for working professionals. Program authorized by the California Department of Education. Students Worldwide.

CALIFORNIA UNIVERSITY FOR ADVANCED STUDIES
School of Professional Management
Office of the Dean, Room EL-1
100 Galli Drive
Novato, CA 94947 (415) 382-1600

Use ES&T classified ads



NEW IDEAS FOR THE HOBBYIST IN A UNIQUE MAGAZINE/NEWSLETTER FORMAT. FREE DETAILS.

AF PUBLISHING
Dept. S1, PO Box 524
So. Hadley, MA 01075

Circle (22) on Reply Card

DANDY-DAPTER™

PATENTED CRT ADAPTER—Don't buy another socket for your CRT Tester! This is the Only way you can win the Socket War! Guaranteed to fit your tester & allow you to test/clean/restore ANY Color, B/W, Projection, Scope or Camera CRTs. Visa/M-Card, Checks, CODs. New Low Price $59.95 (We pay UPS) 1(800) 331-9658. DANDY ELECTRONICS, 2323 GIBSON, MUSKOGEE, OK 74403.

Circle (24) on Reply Card

NEW!...5th edition

The new 5th edition of Tech's Guide to Pricing is a step by step succession of progressive pricing tiers by product category... a totally new concept, a formula that guarantees success...

FREE with order.. 36 page booklet. .filled with ideas. answers to questions you won't find in any other publication!

For details call 1•800•228•4338
Mon/Fri 8/5 C.S.T.
You won't be disappointed!

Circle (25) on Reply Card

NEW 20-PAGE CATALOG FREE

7 MILLION TUBES
Includes all current, obsolete, antique, hard-to-find receiving, transmitting, industrial, radio/TV types. **LOWEST PRICES.** Major brands in stock.
Unity Electronics Dept. E
P.O. Box 213, Elizabeth, N.J. 07206

Circle (26) on Reply Card

ATTENTION ELECTRONIC TECHNICIANS

Highly Effective Home Study BSEE Degree Program for Experienced Electronic Technicians
Our New Advanced Placement Program grants Credit for previous Schooling & Professional Experience. Advance Rapidly! Our 40th Year!
FREE DESCRIPTIVE LITERATURE!
Cook's Institute of Electronics Engineering
P.O. BOX 20345, JACKSON, MS 39209

Circle (23) on Reply Card

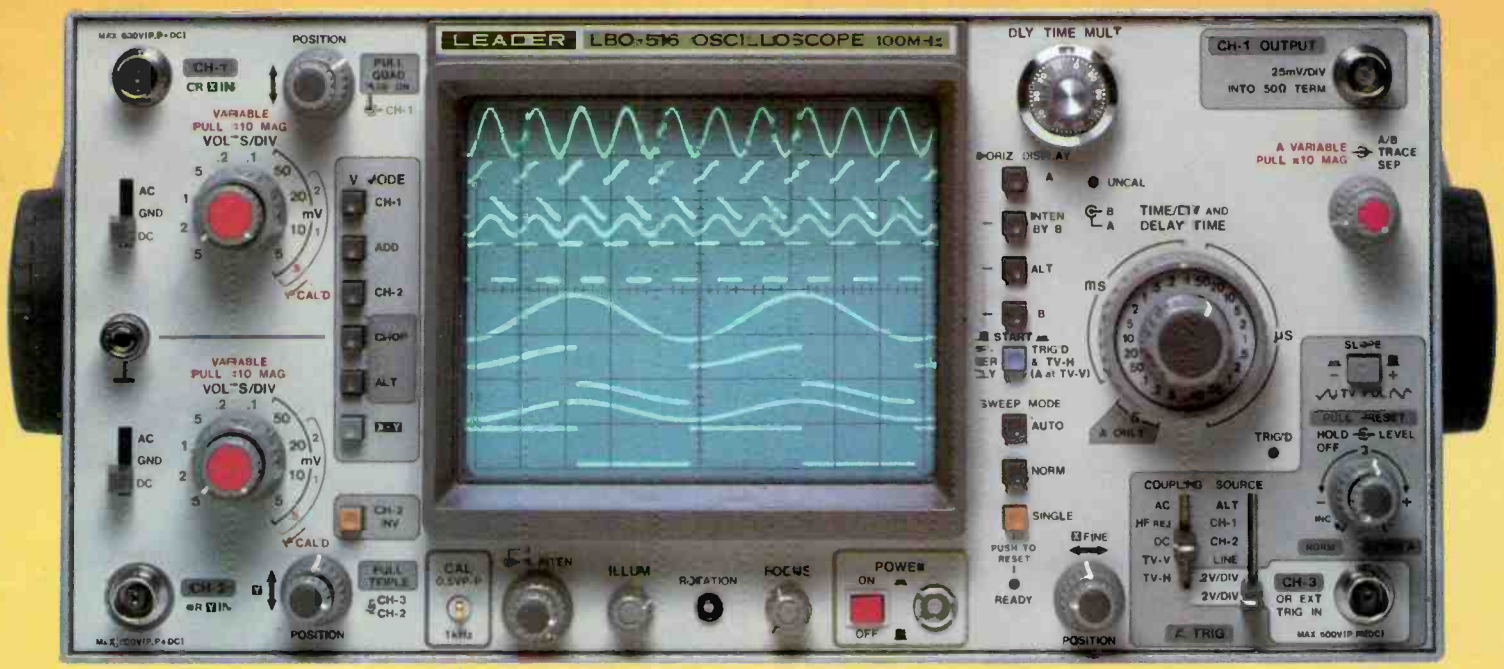
Use ES&T Postcards For Quick Response.

Advertisers' Index

LEADER

LBO-516
NEW 100-MHz OSCILLOSCOPE

$1395 Manufacturer's Suggested List Price



- 8-Trace Capability
- Alternate Triggering
- 2 Time Bases
- 3-Channel Input
- Clear, Bright Trace
- 0.5 mV Sensitivity
- 2-Year Warranty
- Coast-to-Coast Service

For immediate delivery or more information call toll-free

800-645-5104

In New York State
516-231-6900

For professionals who know the difference.

LEADER Instruments Corporation
380 Oser Ave., Hauppauge, NY 11788

For Information Circle (2) on Reply Card
For Demonstration Circle (21) on Reply Card

Go for 'em! Solid margins year-around! They're yours in the video aftermarket! With this new VCR Care Kit by Zenith!

You bet there's a VCR aftermarket out there! A sizeable one. Perhaps as big as *twenty million plus* households. So that capitalizing on it with VCR accessories like this beautifully packaged Zenith VCR Care Kit can be very, very profitable.

Look and see for yourself!

Inside this kit, latest in a long line of Zenith video accessories – and available separately, too – are a great new VCR Head Cleaner. A T-120 VHS Blank Video Tape. A VCR Dust Cover. And a clear VHS Tape Storage Cover. All proudly bearing and backed by Zenith, a name renowned for superb product performance and reliability.

They are at your Zenith distributor's place now, these new Universal VCR Care Kits, ready for immediate delivery to heads-up service techs alert to the money to be made in the overall video aftermarket.

Actually, there's more in store than ever before in this expanding line of Zenith video accessories. More than just this new Universal VHS VCR Care Kit. Solid margins, for example. The kind that can turn some 6, 7 or 8 feet of your floor space into a video accessory profit center right before your eyes.

So hurry! Quit second-guessing yourself! Neither this video accessory business nor VCR aftermarket is going to wait for you.

Call your Zenith distributor's Parts & Accessories Sales Manager!

Besides being an integral part of Zenith's new VCR Care Kit, this VCR Head Cleaner is also available separately as Model T-HC from your Zenith distributor.

Zenith Service, Parts & Accessories
11000 Seymour Avenue, Franklin Park, Illinois 60131
A Division of Zenith Electronics Corporation