THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS

ELECTRONIC Servicing & Technology

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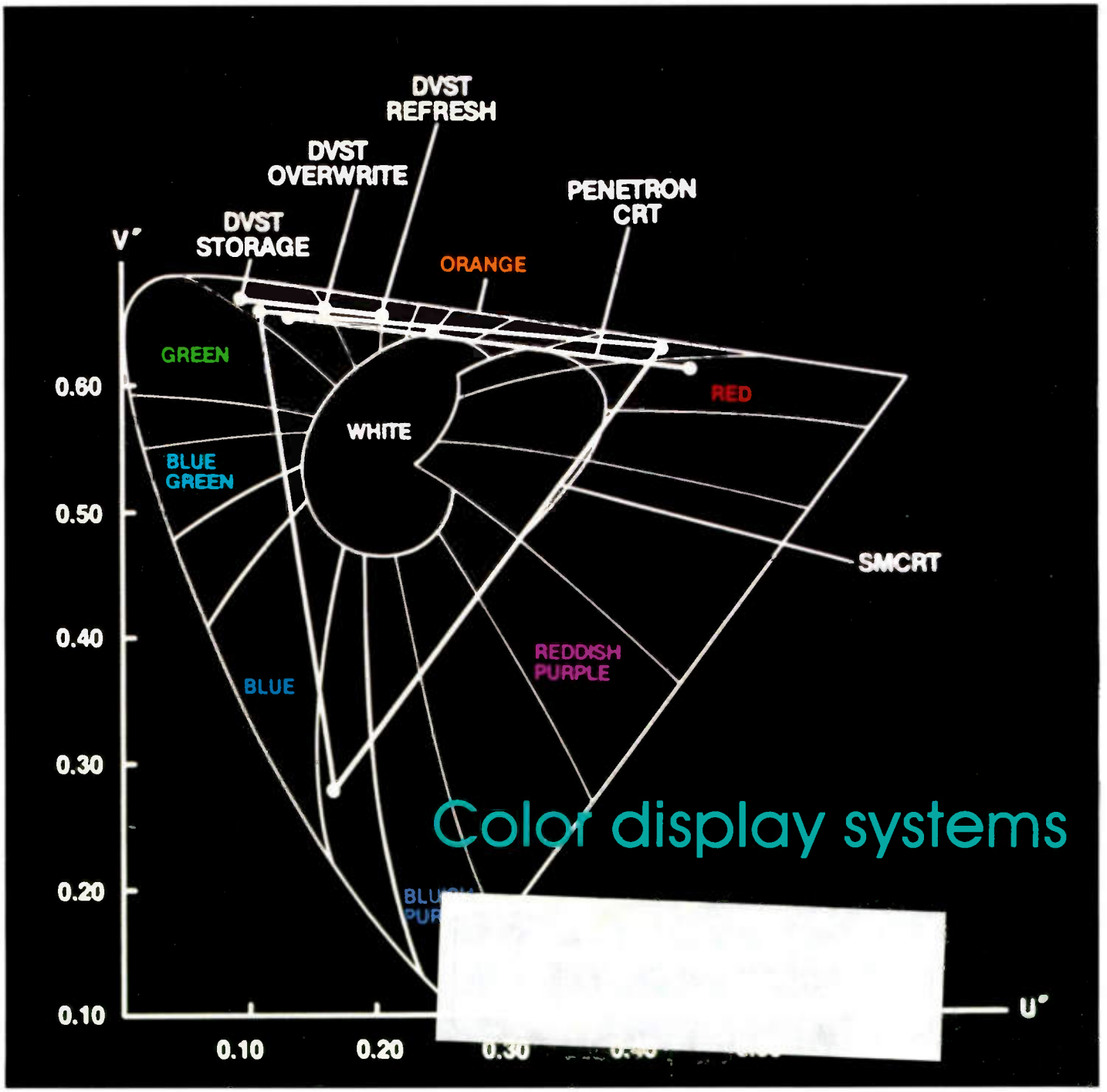

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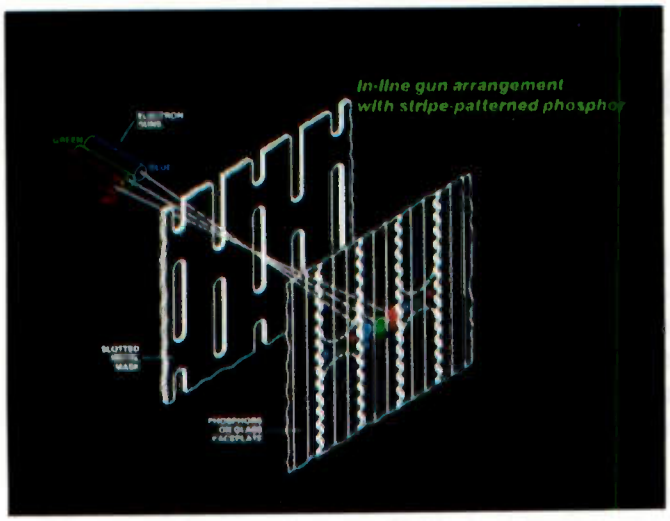

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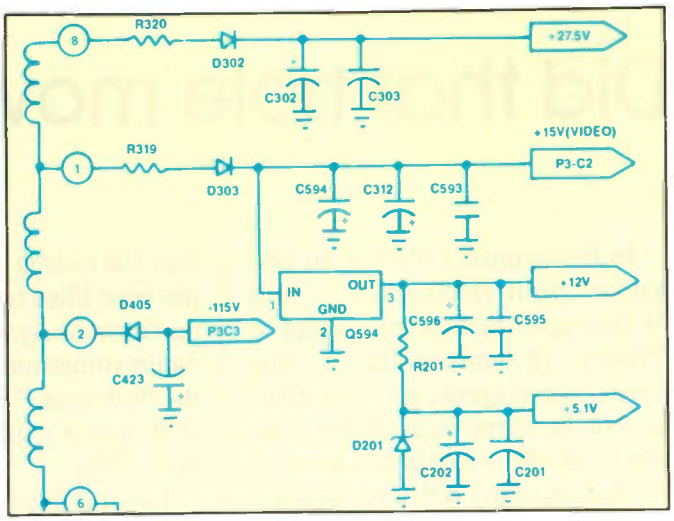

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FEATURES

DEPARTMENTS

THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS
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ON THE COVER

In addition to the shadow mask color picture tube that is so familiar to consumer electronics service technicians, there are other CRTs that can produce color, and there are some technologies in color displays that are being experimented with. *(Cover photo courtesy Tektronix, Inc.)*

Did that hole move?

In this month's "What do you know about electronics?" Sam Wilson again tackles the concept of "holes" in semiconductors. The event that triggered this new mention of the subject was a letter from someone who wrote in and asserted "a hole is really nothing, right?"

It sometimes seems that we who have chosen electronics as a profession waste a great deal of time going over the same ground over and over again. What makes it even worse is that it seems that sometimes we look at things one way, and other times we look at the same subject matter a different way. And it confuses the issue.

There are many subjects within the study of electronics that seem to crop up over and over again, and never get resolved. No doubt it's the same in other professions and in other branches of science and technology. A good example is in astronomy, where the scientists can't quite seem to decide whether the universe started with a "big bang" or if the universe is undergoing "continuous creation." If I remember correctly, the most recent evidence uncovered added credence to the big bang theory.

Here are a few examples of difficult subjects in electronics that constantly occupy people and never quite seem to be resolved: hole flow in a semiconductor, "conventional" vs electron current, rms power.

I will make an unequivocal statement based on the way I view the subject: holes, the "things" that are majority charge carriers in P type semiconductor material, and minority charge carriers do *not* move. That's based on my view that the hole is there even when it has been filled by an electron; it can and most likely will lose an electron again sometime later, and exhibit its "holeness." Some would assert that once it's filled it's no longer a hole. OK.

I would like to quickly add that if we could see "holes" in a semiconductor under the influence of an electrical gradient, they would probably appear to move, and it helps in understanding the concept of holes to picture them as "moving", but holes are locked into the atomic structure of semiconductors and do not move.

We have occasionally used the concept of empty parking spaces in a parking lot to describe the holes, and that's really a good concept, but it has one problem. If you then picture the parking lot empty, and there are no lines on the pavement marking parking spaces, then the holes disappeared along with the cars when the parking lot emptied.

The holes in semiconductor material would not disappear if there were no electrons filling some of them. The "holes" in semiconductor material are actually atoms of the material that have lost one or more electrons and consequently have a net positive charge and therefore tend to attract electrons. To an electron, they appear to be holes.

A good way to look at P type material is that it may be conceived to be like an egg box. To fill the holes, the cavities that are formed into the box to hold the eggs, let's put in some golf balls instead of eggs. This is still an inadequate model because the golf balls are not attracted to the spaces in the egg box as the electrons are attracted to the holes.

Now if you remove one golf ball from one end of the box, an empty space, a "hole" appears. If you move the ball in the second position into the "hole" vacated by the first ball you moved, the second space in the box becomes vacant. The hole appears to have moved. Now picture moving the next ball in line into that space. Now a hole appears further down. Again, the vacant spot is in a different space. But the egg box is a rigid structure and the spaces have stayed exactly where they were in the first place. But the empty spot has moved.

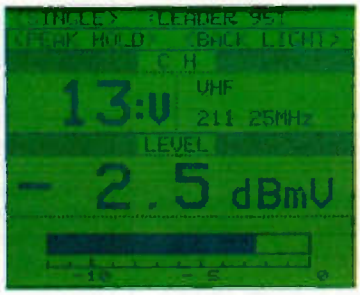
To make this model really work, you have to come up with some kind of force that attracts the golf balls to the spaces in the egg box, and something that causes the golf balls to move.

Of course, a lot of people ask why anyone would spend so much time trying to understand or explain such abstruse concepts. It doesn't help anyone service a TV or a VCR. Actually it can. Understanding the operation of the circuitry of a TV or a VCR is enhanced when the concepts of operation of the components of that circuitry are understood. Operation of the components is enhanced when their actual physical, electrical and/or chemical operation is understood.

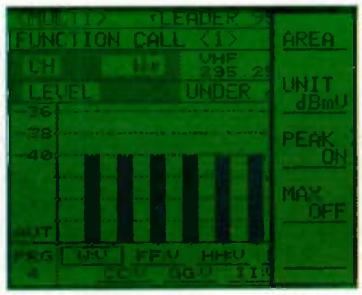
It would be nice, it seems, though, if we could simply nail these concepts down and get on with the job. Sure; but it would be a lot less fun.

Nils Conrad Person

Multi-Channel Bargraph Eases Comparison of Channels



Single Channel Display Includes Digital and Analog Readouts



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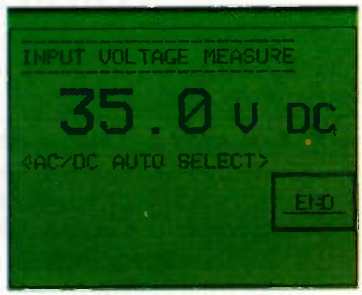

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Circle 32 For Product Information Only

Circle 33 For Product Information and Demonstration.

Computer and electronics catalog

Jameco Components and Computer Products just released a new Spring Supplemental Catalog. The 48 page full-color catalog features over 3,000 items from integrated circuits to computer products, to electronic components, to test and measurement equipment. With this Spring Catalog, Jameco announces its new Computer Repair and Support Services.

If a computer is down or underperforming, the special service toll-free 800-number connects customers with an experienced service specialist. Repair or upgrade options can be discussed and the computer can be shipped for speedy and economical servicing.

The spring catalog also features a special "Guide To Computer Upgrading." This four page foldout has clear educational information guiding readers from the computer capabilities desired to the components they can install themselves to do the job.

Circle (17) on Reply Card

RF power measuring equipment catalog

Bird Electronic Corp. has released its new 56-page 50th Anniversary full-line catalog of RF power measuring equipment and accessories. The catalog includes hundreds of photos plus detailed descriptions, specifications and ordering information for thousands of precision products.

In addition to the extensive line of wattmeters - including high accuracy, peak reading, high power, low power, multi-power and low frequency models - the new catalog presents comprehensive selections of RF loads, attenuators, switches, directional couplers, filters, and a wide range of accessories.

Circle (18) on Reply Card

Catalog of electronic parts, computers and accessories

The 1992 Spring catalog of electronic gadgets, computers, and related parts and components is now available from American Design Components of Secaucus, NJ. Geared to meet the various needs of today's hobbyists small and large manufacturers, schools, universities, researchers, engineers, and computer buffs, the 48-page fully-illustrated catalog, includes components such as: integrated circuits and semis, LEDs, connectors, switches, relays, fans rechargeable batteries, pumps, motors, and power supplies. Also featured are computers and related products such as floppy and hard disk drives, monitors, add-on boards and game accessories. All items are in stock and ready for immediate delivery.

Circle (19) on Reply Card

Sealants and encapsulants brochure

"GE Silicone Sealants and Encapsulants," a new brochure available from GE Silicones, describes the specific properties of, and recommended applications for, room-temperature-vulcanizing (RTV) silicone sealants and encapsulants. These products are widely used in industries such as automotive and electronics that require precise standards for bonding, sealing, potting and coating. The brochure covers two classes of silicone products: one-part RTV adhesive sealants, which are supplied ready to use, and two-part RTV potting and encapsulating compounds, which require the mixing of two components. Quick-reference charts show which sealants or encapsulants are suggested for specific applications. Tables also include standard product specifications such as UL, Mil Spec, and USDA listings.

In addition, the publication answers many common questions about silicone sealants and encapsulants. Also provided are data on by-products, cure rates, and primer requirements. A chart aids in estimating the amount of product required for specific tasks.

Circle (21) on Reply Card

Tools and test instruments catalog supplement

A new, 48-page catalog supplement from Jensen Tools Inc. features the latest electronic tools and test instruments from Jensen, Fluke, Tektronix, Beckman, Extech, Huntron, Navtel, and other major manufacturers. Included are diagnostic tools and tool kits, analyzers, monitors, meters, circuit testers, magnetic field detectors, and diagnostic software, plus soldering supplies, ESD protection, benches, instrument carts, shipping containers and more. ■

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Servicing & Technology

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NPEC '92 management seminars

Featured management seminars at the National Professional Electronics Convention (NPEC) promote business growth through advance planning and adapting to change. NPEC '92 will be held Aug 3-8 at the Worthington Hotel in Fort Worth, TX. A dozen workshops led by instructors and manufacturer trainers are free to convention registrants.

"Dollars & Sense: A Profit Plan For Your Business," a seminar led by Sandy McMillen Cloud, examines the use of a cash flow approach for managing a business. Financial management, making a profit and loss statement, and budgeting are also covered. The seminar will serve as a study session for anyone taking the Certified Service Manager (CSM) test at the convention.

Wayne Peterson will conduct a seminar on "Developing a Strategic Plan for Small Businesses." Peterson, a certified financial planner, emphasizes strategic planning as "the plan before the business plan" for an emerging business. For established businesses, Peterson advocates putting strategic planning to use in mapping out short or long term strategies.

"Growing Your Business" employs a dealer panel. Panelists will share their experiences in businesses that have achieved substantial growth in the past year. Another industry panel, "Customer Relations and Customer Rights," will define problem customers and show how to handle them. Steve Hall, owner/manager of Telco Electronics in Boise ID will be the moderator. Panelists include: Sally Browne, Executive Director of consumer affairs for EIA/CEG in Washington, DC; Jack Hopson CET, First Electronics Service, Omaha NE; Gerry McCann CET/CSM, owner/manager of McCann Electronics in Metairie LA, and Kathryn O'Brien, Sony Corp., Park Ridge, NJ.

Additional seminars and their leaders are: "Best Business Idea Contest," by Gerry McCann CET/CSM; "The Future of Consumer Electronics," by EIA's Don Hatton, "Leadership Styles," by Bruce Fisher of Organizational Psychologists, sponsored by NEC, and "Shifting Gears," by Art Weinenger, owner/manager of ABL Electronics in Madison Heights MI.

The week-long NPEC offers servicers additional benefits through technical seminars, industry relations meetings, and an instructors conference. A two-day trade show houses a comprehensive collection of new product and service technology. Manufacturers of products and test equipment, service contract administrators, parts distributors, software suppliers, and trade publishers showcase their best products and processes.

NPEC '92 special room rates are only $69 for a single or double. All prescheduled meals and activities are included in the full convention registration fee. Discounted rates for registering prior to June 30 are $200 for the first adult, $180 for each additional adult from the same family or business, and $115 for the special children's program, ages 5-18. At the door rate $275 for adults and $150 for children. Daily rates are available.

For more information contact NPEC 92, 2708 West Berry St., Forth Worth, TX 76109 (817) 921-9061.

NARDA forms distribution update

NARDA/NASD announces a new distribution system for all NARDA forms. Effective April 1, 1992, all phone orders will be taken at a new toll-free number, 1-800-242-8678, Monday through Friday, 8:00 a.m. to 5:00 p.m. eastern time. For fax orders, the number is 1-717-697-0928 and is open 24 hours a day for ordering convenience. The mail order address is NARDA, Inc., P.O. Box 480, Mechanicsburg, PA 17055.

All other NARDA/NASD member services are at the same phone numbers and address used previously.

NARDA/NASD has distributed the various universal NARDA forms since 1975.

Convention break-out session titles announced

The Greencastle Indiana headquarters of SDA has announced titles for 9 special-interest sessions for satellite dealers. The sessions occur on the two days devoted to the satellite trade show, July 10 and 11.

Prior to these 2 days for the New Orleans National Convention and Trade Show, ETA-I, the Electronics Technicians Assn., Int'l, is producing a 2-day Electronics Technology and Servicing School; A Satellite-Antenna-MATV 2-day school, and an all-day Business Management Dealers school. The special-interest breakout sessions are in addition to the schools.

Prior to the opening of the trade show five of the sessions take place on Friday with two others occurring during the show hours: The morning sessions are: 1. Ten ideas guaranteed to increase sales, 2. Be your own cable company, 3. Zoning - you can win, 4. DBS - Its effect on the dealer and technician, 5. Signal compression - What is it? For information contact New Orleans convention 800-866-8262.

Video products sales rise

Total sales to dealers of video products rose 6.3% in the first quarter of 1992 versus the same period last year, according to statistics released today by the Electronic Industries Association's Consumer Electronics Group (EIA/CEG).

In a reversal against recent trends, March sales of video products were led by sales of color televisions less than 27 inches. Sales of this group of screen sizes, which accounts for approximately 85.3% of all color TV sales yearly, increased 6% in March 1992 versus March 1991, while sales of sets 27 inches and over rose 2.3%. Total color TV sales sold at an annual rate of over 20.9 million units during the last four weeks of March 1992.

Two additional video products posted increases in March 1992. Projection television sales rose 2.6%, and laserdisc players rose 2.3%, over March 1991. Also, sales of projection TVs have risen 46.7 percent year-to-date.

Total unit sales of video products rose 0.4% in March 1992 compared to March 1991. This slowing of video product sales may have been caused in part by the fact that the Easter holiday, traditionally a big early season shopping weekend, occurs in April this year, as opposed to 1991, when it appeared in March.

(Continued on page 56)

Color display systems

By Vaughn D. Martin

Nothing gives more life to certain images than a color display. Even the appearance of text is enhanced when it's displayed in color. In a color display system, it is the CRT that determines what predominant characteristic the system will have. While other factors affect visual systems, the CRT, more than all other components combined, affects the system performance.

While most TV servicing technicians are intimately familiar with shadow-mask picture tubes, there are other types of color CRTs that are used for other types of color display: for example, storage oscilloscopes, graphic displays for computer-aided drafting, and the displays used by air traffic control radar systems.

Because consumer electronics servicing technicians may at some time be exposed to CRT technologies other than shadow mask tubes, this article is being published here. It will discuss the technologies of the three main types of CRTs as well as the three methods of displaying color graphics on color CRTs.

Also discussed are two experimental display technologies that service technicians may one day encounter: the liquid crystal field sequential color display and the current-sensitive CRT.

The three types of color CRT tubes used in color systems are the penetron tube, the color write through tube, and the shadow-mask tubes.

Martin is Chief Engineer in the Automatic Test Systems Division at Kelly Air Force Base.

The penetron tube

The penetron tube resembles a monochrome CRT. It is different, however, in that it has two phosphors. These phosphors, red and green, are distributed in separate layers (Figure

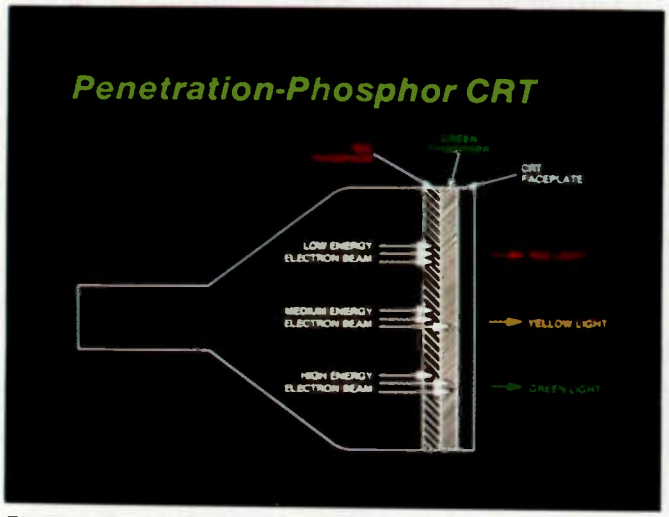

Figure 1. The penetron phosphor CRT.

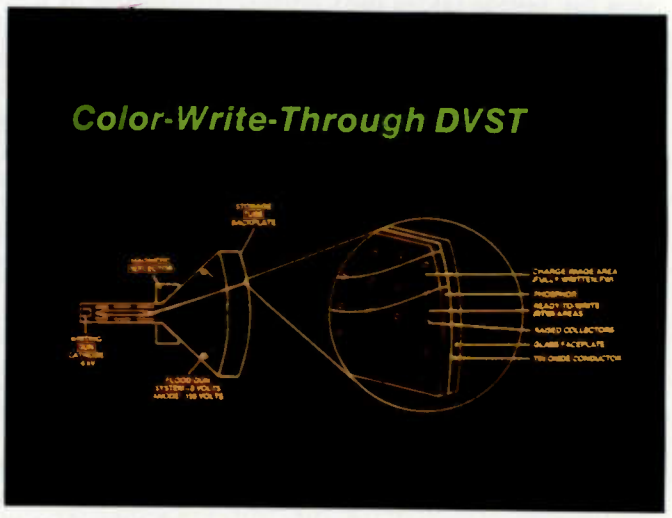

Figure 2. The color write through direct view storage tube (DVST).

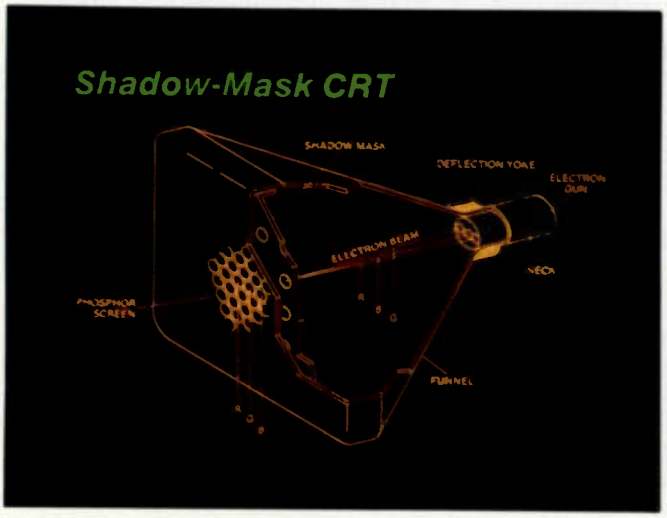

Figure 3. The shadow-mask CRT.

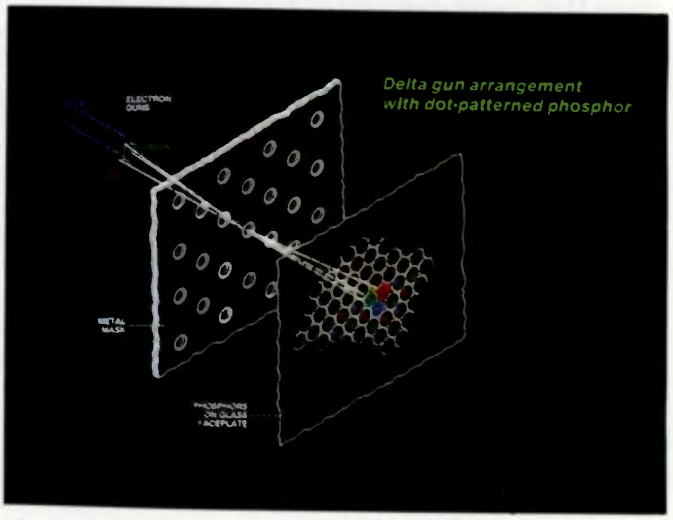

Figure 4A. A delta gun arrangement.

1). Each layer of phosphor requires a different energy level to activate it. In one method, shown in Figure 1, the red phosphor acts as an energy barrier which the beam must *penetrate* to reach the green phosphors, thus name *penetron*.

Although it is theoretically possible for such a tube to have more than two layers of colored phosphors, it has proven impractical to implement. A low energy electron beam (6kV) ex-

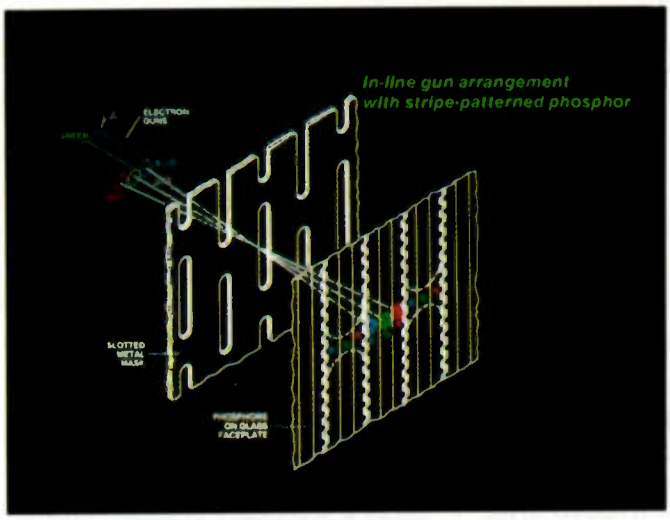

Figure 4B. An in-line gun arrangement.

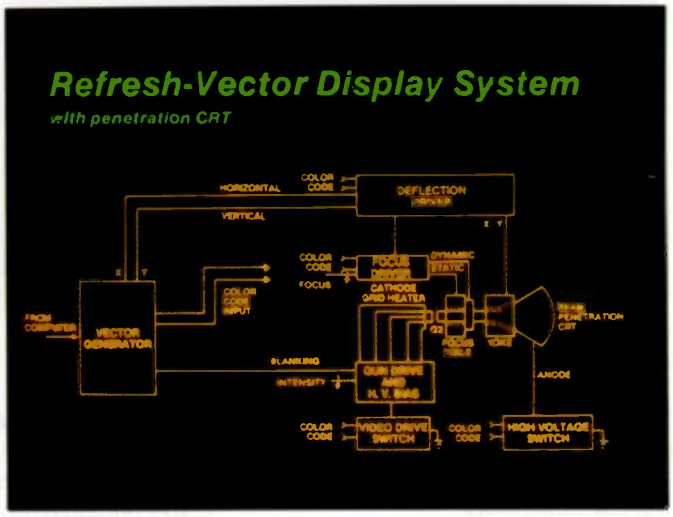

Figure 5. A raster-vector display system.

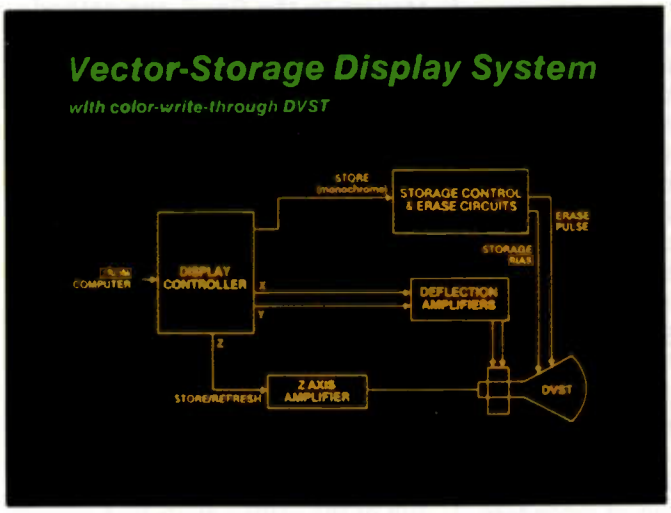

Figure 6. A vector storage display system.

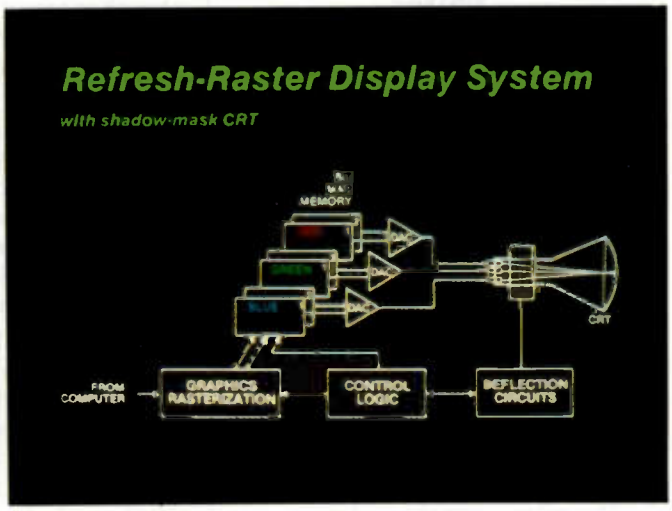

Figure 7A. A refresh raster display system.

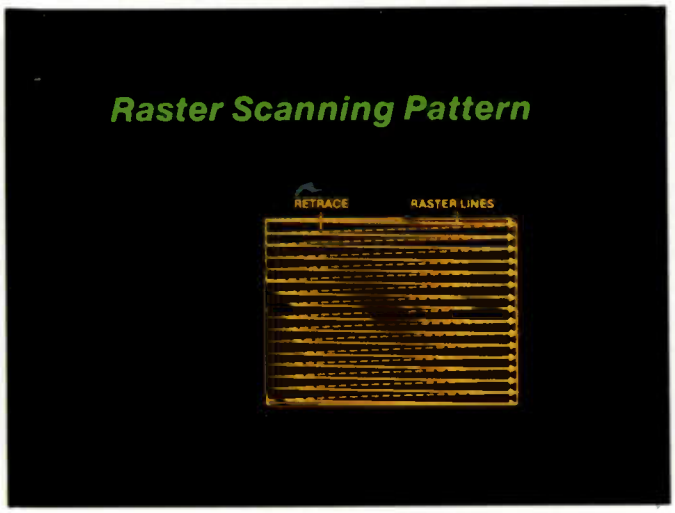

Figure 7B. A raster scanning pattern.

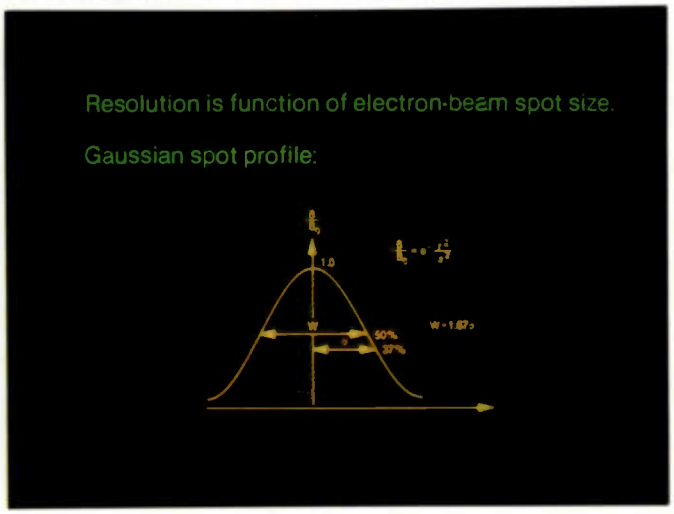

Figure 8. A Gaussian spot profile.

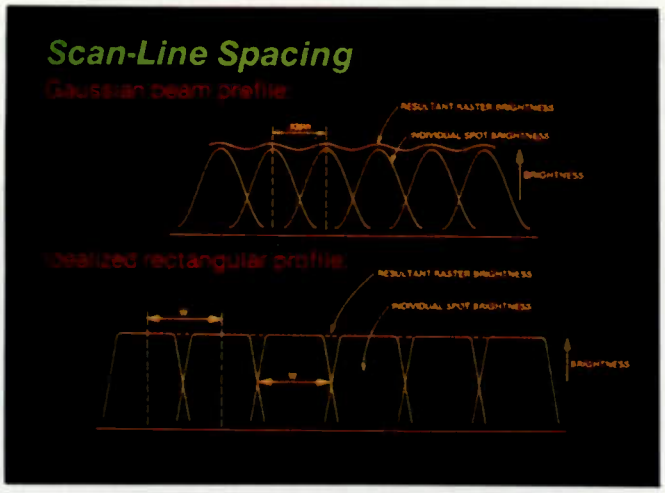

Figure 9. Scan line spacing.

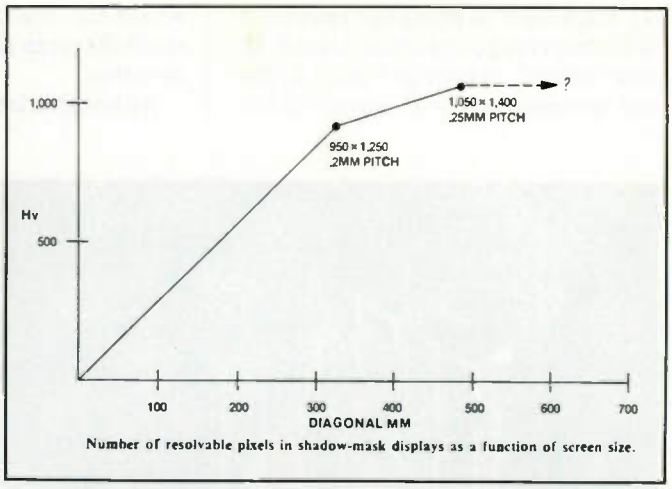

Figure 10. Screen size versus pixels.

cites only the outer red phosphor. A high energy electron beam (12kV) penetrates the red layer and excites the green phosphors.

Obtaining different penetron beam energies

There are a number of ways to reach different energy potentials. Two of these ways are in common use. The first way to achieve different energy potentials, as we have just discussed, is to switch the target potential. In the second method, two electron guns operating at different potentials, are employed. Current then is simply turned on in one or the other of the guns. In either system, each color requires a different deflection voltage or current to deflect the beam to a particular point on the screen.

The color write through system

The color write through system is the second type of color CRT. This tube is what is called a direct view storage tube (DVST). Refer to Figure 2, and note that this type tube has a writing gun operating at a large negative potential (6kV) with respect to the target. The tube also has an array of low voltage flood guns and a special phosphor target.

The phosphor is separated from a transparent conductor by an insulating layer pierced with an array of conductive dots. As in the penetron tube, there are actually two phosphors present. Small particles of each phosphor are mixed together. The normal green phosphor for storage is mixed with red phosphor particles that are surrounded by a dead layer. The normal storage operation of the DVST is unaltered by this arrangement of phosphors.

The flood guns are kept at ground potential and continuously flood the entire phosphor target with electrons. This maintains it near ground potential through the action of secondary emission. When the DVST is in the storage mode, the writing gun scans the target and writes by leaving a charge on the phosphor dielectric.

Because the high energy beam produces a secondary emission greater than unity, the written to areas charge to a potential of about +300V with respect to the flood-gun cathode. When the flood electrons strike the written target area, they cause the phosphor to luminesce. The unwritten areas, which are maintained at or near ground potential, do not luminesce.

To return the screen to the proper condition for being written to, these written-to areas are erased by pulsing the conductive backplane and resetting the phosphor potential to its lower bistable state.

If the writing beam current is decreased below a certain threshold, no information can be stored on this type of CRT tube. When this occurs, the phosphors illuminate briefly as a result of the writing gun's high energy. This phenomenon is called "write through." With the penetration phos-

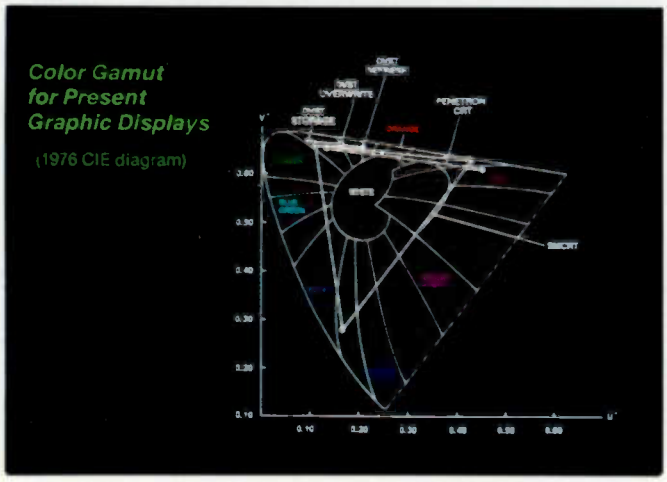

Figure 11. The color gamut of present color technologies.

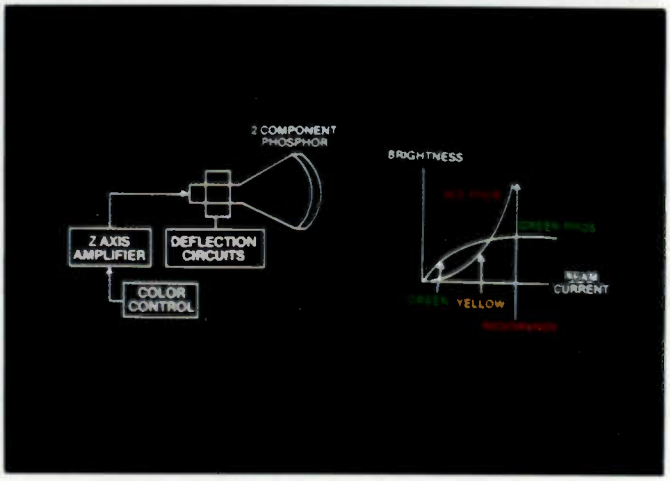

Figure 12. The current sensitive color CRT experimental technology.

phor in place the writing beam's high energy electrons penetrate the red phosphor's dead layer and excite both phosphors. This produces a yellowish green trace. This is referred to as "color write through", thus the name of this type color CRT.

While this occurs, the flood electrons are at a much lower energy state and excite only the green phosphors where the image is stored. Only one color is available for stored images but other colors can be obtained in the non-storage mode or by writing over the stored trace with the write beam.

The shadow-mask tube

The shadow-mask CRT is the last type color CRT. It is the most popular, and also, unfortunately, the most complex. It is also, of course, the most familiar CRT to TV servicing technicians. Refer to Figure 3 for an illustration of its theory of operation. Note that in the shadow-mask tube three electron guns are used to address either three primary color phosphor dots or three primary color stripes. The dots and stripes are grouped in groups of three, called triads. They are packed so closely together that they appear as a single dot.

Color in a shadow-mask tube is the result of a proportional mixing of the luminescence from the individual dots or stripes that make up the triads. The shadow mask assures that each beam addresses only its assigned color dot or stripe. The beams from the red, green, and blue guns must be angled properly to pass through the shadow mask openings and strike the corresponding phosphor while all other phosphor dots are shadowed.

Because the dot pattern permits smaller horizontal spacing between triads, dots are used when maximum resolution is required. The guns are typically configured in a delta or triangle for dots, and in-line for stripes: Figures 4A and 4B. Although in-line guns can be used with dot phosphors, less convergence circuitry is required if a delta arrangement is used.

Misconvergence typically occurs because the three beams pass through the deflection yoke at slightly different angles and locations. This deflects them to slightly different spots on the screen. Here is where correction circuitry comes in to ensure proper alignment or registration of the three primary colors.

Misalignment can be avoided by displaying all three colors one at a time. This technique is used by Tektronix on their DAS color systems. They also use a special CRT with red, green and yellow dots.

Color display systems

Three methods are commonly used to display color graphics on CRTs:

- vector storage
- refresh vector
- raster refresh systems.

The vector storage system must use a DVST. Theoretically, both the refresh-vector and the refresh-raster displays could use either the penetron or the shadow-mask type CRT. However, the refresh vector is more easily implemented with the penetron type CRT. The refresh-raster is used almost exclusively with the shadow-mask CRT.

The principle of refresh vector is illustrated in Figure 5. Note the use of a penetron type CRT in this typical application. Vectors are drawn on the screen by deflecting the beam between the specified end points of the vector. An image formed from a combination of vectors can be rapidly changed by merely changing the vector end points.

The dynamic capabilities of this type of technology are very great because relatively few points are required to define images consisting mainly of lines. However, the complete image must be refreshed (repeated) often so you perceive a constant luminance deflection speed. This usually limits the number of vectors which can be drawn before flicker becomes apparent.

As you recall, the penetron CRT requires a different deflection amplifier gain for each of the two colors; therefore, field- sequential operation is often used. In field-sequential operation, the red information is written in the first field, then the deflection amplifier gain is changed before the green information is written in the second field.

A third color may be obtained by overlapping (registering). Displaying a third color by this method is difficult, however, so it is sometimes done by use of a third acceleration potential in a third field.

Vector storage

Storing vectors on the screen allows the vector storage display to overcome the limit on the number of vectors that is inherent in a refresh-vector system because of the flicker problem. A typical vector-storage display system using a DVST with color write-through (CWT) is shown in Figure 6.

Note the similarity to the refresh-vector system. Deflection speed is not critical when the DVST is set to the storage mode, however, because green vectors are stored on the screen. This allows deflection speed to now only affect the time required to draw a complete graphics image. No matter how many vectors are drawn there is no flicker. The DVST is, therefore, an excellent choice when drawing complex intricate images.

By using the capabilities of the DVST with CWT, images with another color can be added to the display. When the write beam is operated at reduced currents, storage is prevented from occurring and a yellowish-orange spot appears on the screen. This non- stored spot can be deflected to produce refreshed vectors. The number of vectors in this second color however is limited by maximum deflection speed and flicker.

A third color is obtained by writing the refresh vector on top of an identical stored vector. This mode produces a greenish- yellow color. Unlike the penetron, no misregistrations occur, because the same writing beam potential is used in all operating modes. While a stored image must be erased all at once, a refreshed image can be selectively updated and can even display motion, for example, the motions of a mechanism in action.

Refresh vector

The refreshed vector is the most common color graphics system. Refer to Figure 7A for an example of this system using a shadow- mask CRT. This system uses three beams deflected together over the phosphor screen in a predetermined raster pattern (Figure 7B). A bit-map memory determines when each of the three guns receives current and how much. This results in control of how much of each color is produced at each pixel or point on the screen.

The information in the bit map must be read out repeatedly at a rate fast enough to avoid flicker. Conversely, the time required to change images on the screen is determined by how fast scan conversion can reload a bit map. The larger the bit map is,

naturally, the slower this process occurs. Therefore, raster scan images with many pixels must trade off speed of interaction and dynamic images.

As the number of pixels increases, so does the rate at which information must be clocked out of the bit map. The deflection speed of the CRT beam and the bandwidth of the CRT video amplifier must increase accordingly and ultimately limit the number of pixels.

Characteristics of color graphics displays

There are two characteristics of a color display which are particularly important:

- display quality
- information handling

Display quality encompasses a broad range of factors, including optical characteristics such as resolution, edge sharpness, brightness contrast and color quality. Also, temporal noise adds such adverse effects as flicker, jaggies and moire patters, all to be explained shortly.

Information handling includes such factors as display size, number of vectors or pixels, number of colors, and interactivity.

Image-quality characteristics

Resolution affects image quality more than any other factor. In discussions of raster displays the term resolution is often incorrectly used as being synonymous with the number of scan lines (addressability).

Resolution is the display's ability to resolve, that is, to separate, two closely spaced points or lines. Resolution is the essential characteristic that determines image sharpness. It is not dependent upon display size. Smaller displays, however, need higher resolution than larger displays require to resolve an equal number of lines or pixels.

Addressability is the display's ability to position lines or pixels anywhere on the screen. A display's addressability can exceed its resolution while not affecting resolution. However, if the addressability is not high enough, the resolution of complex images will either be not presented at all or will be misplaced on the screen.

The electron beam spot size is the primary factor in determining resolution of a vector type display. As vectors are generated, images consist of lines equal in width to the spot. The current distribution in an electron beam usually is Gaussian and circularly symmetrical (Figure 8).

There are several methods to specify resolution of displays. The modulation transfer frequency (MTF), however, is a comprehensive method that takes into account not only spot size but also the minimum spacing between spots. Images can be thought of as being made up of a set of pairs of different spacings (spatial frequencies) and contrast; much the same as thinking of electrical signals as a set of sine waves of different amplitudes and frequencies.

The MTF measures how well a display passes the different spatial frequencies in an image. MTF then can be plotted as contrast versus spatial frequency. Spatial frequencies where the MTF is large almost always indicates good resolution.

The most common method used to measure CRT resolution is to display a raster of lines and then shrink the raster until the lines can no longer be resolved. You can then divide the raster height by the number of lines as a measure of how close the lines can be placed and still provide an acceptable image.

This method, however, yields only the upper limit of the MTF profile and the shape of the spot must be known before the MTF can be calculated. Figure 9 shows the line spacing obtained with this method for a Gaussian spot shape and an idealized spot shape which plots as a rectangle. In practice the spot is somewhere between rectangular and Gaussian. Whatever the shape of the current distribution plot, the perceived CRT spot is round.

Design trade-offs

You can improve resolution in both refresh-vector and vector- storage displays by trading off brightness for a smaller spot size. Spot size is the limiting factor, and lower beam currents produce a smaller spot. It is also possible, though, to exceed the eye's resolution at normal viewing distances.

Video amplifiers

Video amplifiers, in addition to spot size also determine resolution in the horizontal axis. The time between adjacent pixels is given by:

$$t(pixel) = T(frame)/[(Nv)(Nh)]$$

where T(frame) is equal to the active frame time, Nv is the number of scan lines and Nh is the number of pixels per horizontal line. As the number of pixels [Nv x Nh] increases, so does the bandwidth required of the video amplifier. To reduce bandwidth, some raster display systems use a 30Hz rather than a 60Hz interlaced raster. The drawback with this approach is to increase the tendency towards flicker.

Addressability revisited

As mentioned before, addressability is necessary for high resolution and many pixels or vectors, but does not alone guarantee it. Vector displays have inherently high addressabilities which are limited only by D/A converters and noise.

As an example, a vector display capable of resolving 1,000 lines may be able to position vector end points on a 4,000 by 4,000 grid. Generally, to ensure a smooth line, the D/A converters limit addressability to about four times the resolution. In a shadow mask display, the number of resolvable pixels is a function of the screen size (Figure 10).

Raster display limitations

Raster displays are more limited because of the fixed pattern of the beam. The size of the bit map limits addressability because the number of pixels is limited. Useful bit-map size is determined by the number of scan lines and the bandwidth of the video Z-axis amplifier. The number of scan lines limits addressability vertically while video bandwidth limits it horizontally. Increasing the number of pixels in either the vertical or horizontal dimension requires a corresponding increase in the pixel clock rate and a faster bit-map memory system.

Image artifacts

Vector displays present relatively smooth lines. Raster displays, however, produce artifacts in addition to the desired image. An artifact is any unwanted image caused by the sampling effects of the raster pattern. Sampling produces high spatial frequencies on the display which do not exist in the intended image.

Higher frequency artifacts (aliasing) appear as noise on any edges oriented in any direction which is not vertical or horizontal. It is aliasing that makes a sloping line look like a staircase rather than a smooth line. This staircase is referred to as a "jaggie."

Moire patterns

A Moire pattern is an artifact produced by either the interference between the frequencies of image lines or the interference of the raster lines with the sampling frequency of the shadow mask. When the spacing of raster lines is close to the spacing of the mask, brightness varies periodically across what should be a uniformly colored field unless the spot size exceeds the shadow-mask spacing by a sufficient margin.

Generally, you would select a spot size from 1.2 to 1.5 times the shadow-mask pitch, with the raster spacing about equal to the spot width. Resolution depends on spot size, as mentioned previously, which is related to the mask pitch. Therefore, the shadow-mask pitch is the primary limitation to resolution of a shadow-mask display.

Color quality characteristics

The quality of color includes four factors:

- brightness
- contrast
- purity
- convergence

Brightness

The brightness (B) of a CRT is determined by the following formula:

$$B = kEIV/PA$$

where k = the attenuation factor due to the glass faceplate and the shadow mask, E = the phosphor efficiency, I is the time averaging of the beam current and V is the accelerating voltage in volts. The scanned or written-to area is A.

The brightness of the penetron CRT in a refresh-vector system can be quite high. It is limited only by the beam current and the current saturation of the phosphor. (The efficiency E decreases with high beam current.)

Conversely, the DVST with color write through has limited brightness in both storage and refresh modes. The stored-image brightness is limited because only the low-voltage flood electrons excite the phosphor. The color refresh image brightness is limited; although it is produced by the high-voltage writing beam, since the writing beam current must be kept low to prevent unintentional storage.

The brightness of a color raster display, although good for low resolution CRTs, is limited by shadow-mask interception of about 80 percent of the beam current. The presence of three beams partially compensates for this loss.

Contrast

There are two ways to consider the contrast of CRT displays: intrinsic contrast and extrinsic contrast. Intrinsic contrast is the contrast of the written-to parts of the image relative to the unwritten-to parts of the image. These are measured in a dark room. The intrinsic contrast, Ci is defined as:

$$Ci = Bw/Bunw$$

where Bw and Bunw are the brightnesses of the written-to and unwritten-to areas of the screen respectively. This contrast is quite high for both the refresh-vector and raster color displays. The DVST has low intrinsic contrast because the unwritten to areas of the target receive some excitation from the flood guns.

The other type of contrast is extrinsic contrast and it much better relates to the "real world" since it takes cognizance of both reflected and scattered light as the following equation shows:

$$Cex = (Bw + R)/(Bunw + R)$$

where R is the reflected and scattered ambient light off the phosphor and screen surface. Since all three types of color displays reflect, and in turn scatter approximately the same amount of ambient room light, their contrasts are primarily determined by their brightness. An optical glass filter is often placed in front of the screen which improves extrinsic contrast. These filters obviously attenuate emitted light while reflected light must pass through the filter twice, and is therefore attenuated twice.

There are more efficient filters which are by design more selective in that they absorb room light while transmitting the light emitted from the display. The CRT itself can have either an "anti-glare" coating added to the front, or a matte finish to prevent specular reflections.

Color purity and convergence

Color purity generally refers to the uniformity of color over a large area of the screen. Purity is essentially a

measure of whether or not the color is spectrally pure. Refer to the inset "How the eye 'sees' color" for a more detailed explanation.

Purity is not a problem with the penetron and the DVST/CWT. Purity can, however, be a real problem with the shadow-mask type color CRT. This is because the three color beams have to excite the entire phosphor dot, and only that dot. If the beam spills over and illuminates dots that should be illuminated by another color beam then that color will not have its proper clarity.

This all hinges upon how properly aligned the electrons are which pass through the shadow-mask hole. Slight misalignment errors are unavoidable as expressed in the tolerances associated with the very manufacturing processes. Thermal distortions, once the tube is heated, is also a culprit.

Convergence is a measure of whether or not each primary color image is in perfect registration with the other two primary color images. Convergence usually differs from place to place on the CRT.

Number of colors

The penetron CRT is limited to three distinguishable colors at the most. The DVST with CWT also has a maximum of three colors. Only the shadow mask CRT has a full range of colors (Figure 11). The CIE is a French acronym for "Commission Internationale De L'Eclairage," which translates roughly to The International Commission on Lighting, and was an attempt in 1931 at establishing a standard observer curve, also known as the photopic curve.

This curve represents the eye's response to various wavelengths of light. The curve peaks at 555 nanometers in the yellowish- green region. Note that the shadow mask CRT (SMCRT) is the one with the widest color range.

Experimental color CRTs

One technology that shows promise for the future is the current-sensitive CRT (Figure 12). This limited-color display uses a mixture of two phosphors with different colors. The two phosphors have different current-saturation characteristics, so that as current is increased, the color changes from red to green.

Another display which shows even greater promise is the liquid crystal field sequential color display. An electronically controlled color filter is placed in front of a single color (monochrome) CRT. By synchronizing the red information written on the CRT during phases, you have in essence a color switch. Refer to Figure 13 and note the color polarizers and how varying degrees of color polarization are possible. This enables the display to show all red, all green, or varying hues in between. ■

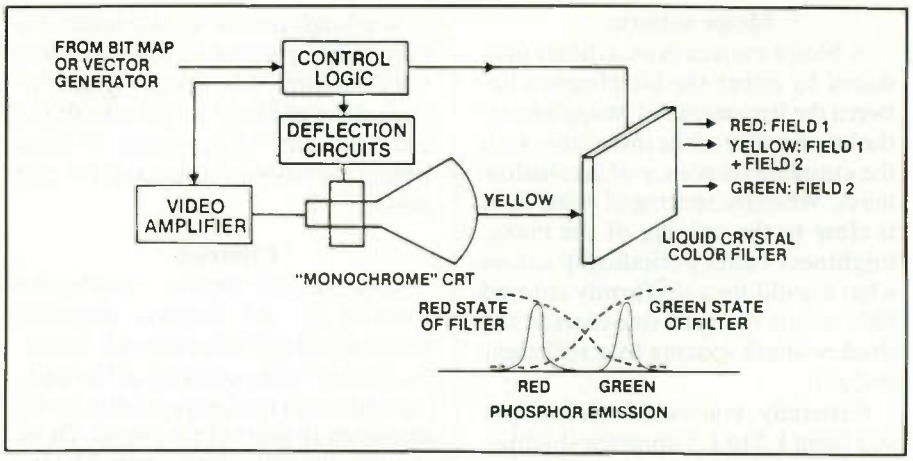

Figure 13. The liquid crystal shutter color TV.

How the human eye 'sees' color

Within the Brain

The psychological aspects of color perception originate in the brain. The brain has two separate regions. These are the chromatic and achromatic regions. In most instances, both regions help process visual data. If data is in black and white, one whole region (the chromatic region) of the brain is deprived of its ability to process data, especially complex visual information.

The Ergonomics of Color

Obviously, color is a product of human perception. It is the result of the eye reacting to "visible" wavelengths of electromagnetic radiation. The optical and sensory mechanics of the eye give color its three basic qualities: hue, saturation, and lightness.

Hue identifies the color in relation to other colors within the light spectrum.

- Saturation defines the "purity" of the color. As colors within the spectrum become less pure, they start to appear gray or white.
- Lightness refers to the relative strength of the light coming from the color, as perceived by the viewer.
- Pure colors can be desaturated by increasing lightness until the color is almost entirely "washed out."

Color distribution and saturation play an important role in color perception. Colors widely separated in the spectrum, such as red and green, are easier to discriminate than neighboring colors. Also, "grayish" colors of low saturation become difficult for the brain to separate.

Conversely, colors with high saturations, which are also widely separated in hue, require the eye to refocus. This can be a source of fatigue. Lastly, the eye's foveal region, which yields maximum visual resolution, is essentially "blind" to blue. This makes blue a poor choice for presenting detailed information. But let's further investigate the anatomy of the eye.

The anatomy of the eye

The lens of the eye is adjustable, like a camera. It enables light images to be focused on the retina at the back of the eye. The pupil is also adjustable to adjust the brightness or intensity of the light reaching the retina. These adjustable qualities make the eye very "forgiving" of ambient light colors.

Continuing with the eye's anatomy, the aperture or hole of the pupil is small when viewing brighter light images and larger for viewing dimmer images. This aperture allows the average intensity at the retina to be held constant over approximately a 16:1 ratio variation in the brightness of the object being viewed.

The Retina has approximately 100 million rod-shaped cells and seven million cone-shaped cells. The rods respond to dim light (below 0.001 candela per square meter) and the cones require brighter levels (approximately 10 candelas per square meter). However, the rods do not sense color whereas the cones do. Also, the cones, which reside in the central part of the retina, can distinguish between very small objects.

Conformal coating removal

By Jay W. Parton

Has this ever happened to you? You open up a product that was brought into your service center for service, perform a few preliminary checks, isolate the problem down to the board level, then begin checking out the components on the board, only to find that the board has been encapsulated in some kind of plastic skin?

What do you do now? One choice is to button the unit back up and tell the owner that you can't service it. The only problem here is that if he does find someone who is able to fix the unit he may bring all of his other products to that other company for service in the future.

Another possibility is to try to physically cut, or abrade your way through the coating, but this might wind up damaging the board, then you're liable for correcting the problems that you introduced.

Throughout the electronics industry, more and more electronic devices are protected by a plastic or resin. Fortunately, manufacturers of products for the service industry have been at work coming up with products to solve the problem of getting through the conformal coating. In many cases, ease of removal of the plastics used in the coating will determine the best system to be used.

What are conformal coatings and why are they used?

Conformal coatings are thin layers of synthetic resins or plastics that are applied to electronic devices for protection against a variety of environmental, mechanical, electrical and chemical problems, such as:

- humidity and moisture
- fungus and mildew
- dust and dirt
- alpha particles
- stress
- mechanical shock and vibration
- thermal cycling
- corrosion
- process solvents, fuels, hydraulic fluids, other fluids

While most conformal coatings are used on printed circuit boards (PCBs), they are also used to protect discrete components, such as transistors, diodes, rectifiers, resistors and LEDs; integrated circuits (ICs); and hybrid circuits, including multi-chip modules (MCM) and chip on board (COB).

Originally developed for military, aerospace, and marine applications, conformal coatings are now finding widespread use in telecommunications, industrial controls and instrumentation, consumer electronics, and the automotive industries, all applications in which product reliability is of primary importance.

Types of coatings

Currently six major types of conformal coating chemistries are available:

- epoxies
- acrylics
- urethanes
- silicones
- parylenes
- ultraviolet-cured materials

The military specification for coating printed circuit assemblies, MIL-I-46058, recognizes 5 types of conformal coatings:

- Type AR (acrylics)
- Type ER (epoxies)
- Type SR (silicones)
- Type UR (urethanes)
- Type XY (paraxylylenes)

Ultraviolet (UV) cured materials are also recognized, but are not listed as a separate group; they are included within the above five categories. While each of these coating types exhibits properties that make it the best choice for a particular application, special attention should be paid to the techniques used for removal of the conformal coating. These techniques include mechanical, thermal, and chemical methods.

Mechanical removal

Mechanical removal methods include cutting, abrading, sanding or blasting the area of coating to be removed. However, most of the conformal coatings are very tough and abrasion-resistant, making the probability of damage to the board high.

Thermal removal

Thermal removal methods (including burn-through techniques) are somewhat more effective than mechanical methods, but in many cases require very high temperatures and/or long exposure times. These, in turn, can cause discoloration, leave residues, and adversely affect solders and/or other materials used in the construction of the board or its components. Also, temperature-sensitive components may be damaged.

Chemical removal

Chemical removal methods offer the highest probability for complete coating removal without adversely affecting the board or its components. However, there is no one perfect solvent for all applications, and in some cases no solvent will be suitable.

Of course, the first problem faced by someone in product service who must remove a conformal coating is determining the composition of the coating that is to be removed. If information concerning the nature of the coating isn't included in the product

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TABLE #1

Solvent Selection Guide For Removal of Conformal Coatings

CONFORMAL COATING TYPE	THICKNESS	RECOMMENDED SOLVENTS AND APPROXIMATE TIME FOR REMOVAL													
		Tetrahydrofuran Base	Methylene Chloride Base/ Acid Activator	Methanol Base/ Acid Activator	Methylene Chloride Base/ Acid Activator	Hydrocarbon Base/ Acid Activator	Hydrocarbon Base/ Acid Activator	Hydrocarbon Base/ Acid Activator	Butyrolactone Base	Methanol Base/ Acid Activator	Methanol Base/ Acid Activator	Ethylene Glycol Ether Base/ Alkaline Activator	Ethylene Glycol Ether Base/Alkaline Activator	
EPOXY															
All Types			For Spot Removal Only												
ACRYLIC															
Conap CE-1170	.007"								1 hour						
Conap CE-1171	.007"								1 hour						
Furane Acrylane 5730									•						
Humiseal 1B31									•						
Humiseal 1B31-66									•						
Humiseal 1B31-FR									•						
Humiseal 1B73									•						
Hysol PC20M									•						
Hysol PC20-35M									•						
POLYURETHANE															
Conap CE-1155	.004"			2.5 hrs.						•	1.5 hrs.	•	•		
Conap CE-1155-35	.004"			2.5 hrs.						•	1.5 hrs.	•	•		
Conap CE-1164	.004"			2.5 hrs.						•	1.75 hrs.	•	•		
Conap CE-1165				•						•	•	•	•		
Conap CE-1166				•						•	•	•	•		
Conap CE-1175	.004"			2 hrs.						•	1 hour	•	•		
Furane 5750-A/B(LV)				•						•	•	•	•		
Furane 5751-A/B				•						•	•	•	•		
Humiseal 1A20				•						•	•	•	•		
Humiseal 1A33				•						•	•	•	•		
Humiseal 1A34				•						•	•	•	•		
Humiseal 2A64				•						•	•	•	•		
Hysol PC18M				•						•	•	•	•		
Hysol PC29M				•						•	•	•	•		
Products Research PR1568				•						•	•	•	•		
SILICONE															
Chemtronics Konform	.003"				15 min.	30 min.	15 min.	15 min.							
Conap CE-1181	.006"				15 min.	30 min.	30 min.	30 min.							
Dow Corning 3140 RTV					•	•	•	•							
Dow Corning 3145 RTV					•	•	•	•							
Dow Corning 1-2577	.008"				15 min.	1.5 hrs.	1 hour	1 hour							
Dow Corning 1-2577 UVI					•	•	•	•							
Dow Corning Hipec 3-6550	.005"				15 min	30 min.	45 min	15 min.							
Dow Corning Hipec 648	.002"				15 min.	24 hrs.	5 hrs.	3 hrs.							
Dow Corning Hipec 01-4939	.005"				15 min.	15 min.	15 min.	15 min.							
Dow Corning 01-2620					•	•	•	•							
Dow Corning 01-2620 UVI					•	•	•	•							
Dow Corning 03-6614					•	•	•	•							
Dow Corning 03-6614 UVI					•	•	•	•							
Dow Corning R4-3117					•	•	•	•							
GE SR900	.004"				30 min.	30 min.	30 min.	30 min.							
GE ECC 440					•	•	•	•							
GE ECC 450					•	•	•	•							
McGhan Nusil R-1075					•	•	•	•							
SWS T-81					•	•	•	•							
W.R. Grace & Co. Amicon SC-120-4					•	•	•	•							
W.R. Grace & Co. Amicon SC-3613					•	•	•	•							
W.R. Grace & Co. Amicon SC-930					•	•	•	•							
PARYLENE															
Novatran Parylene C	.001"	2-4 hrs.													
Para Tech Parylene C	.001"	2-4 hrs.													

NOTE: • means solvent is recommended but time data is not available.

literature, the only recourse that a servicing technician has is to contact the manufacturer and ask.

The following sections discuss the chemical removal methods for each of the above mentioned conformal coating types. For the purposes of general information, these solvents are available in quantities from one pint right on up to 55-gallon drums.

Polyurethanes

Offering good dielectric properties, with excellent humidity, abrasion, and chemical resistance, polyurethane conformal coatings are the most cost-effective and widely used coatings. Currently available for removal of polyurethane coatings are several solvents which provide a wide range of speed and selectivity that can be matched to a specific application.

These solvents include: methanol base/alkaline activator solvents, which are the slowest and most selective; other methanol base/alkaline activator solvents that are somewhat faster acting and are the most popular; and ethylene glycol ether base/alkaline activator solvents, which are the fastest and least selective.

Complete removal of the coating is accomplished by immersion of the board into the solvent at room temperature. The amount of time required for coating removal will vary with the solvent being used, the particular coating used, and coating thickness. Typically, most polyurethane coatings of 0.004-inch thickness can be removed in one to three hours.

The use of ultrasonics, or any agitation of the solvent will help to reduce the time required. The board should be removed from the solvent periodically; if it has a milky-white appearance, coating removal is not yet complete, and it should be returned to the solvent. Occasionally, light brushing or wiping may be required to remove any last traces of coating.

To be certain that no residue remains from either the coating or the solvent, it is extremely important that the board be thoroughly washed in alcohol (isopropanol or methanol) immediately after coating removal is complete. The board may then be rinsed with deionized (DI) water and dried.

Because all of these solvents contain small amounts of ionic materials, it is advisable to test the rinse water for ionic contamination with a conductivity meter.

If you only need to remove a small area of the conformal coating to get at a few components or circuit traces, you can use a spot removal technique to remove polyurethane conformal coatings. In this case, you use a higher viscosity, or gel, form of the solvent, and apply it with a brush, cotton pad or a cotton-tipped swab. All of the solvents discussed here are available in gel form for spot removal.

Silicones

Silicone conformal coatings offer high humidity, corrosion, and thermal resistance, which make them the preferred choice for high temperature applications. Over the past several years, chemical companies have developed solvents that are effective in removing silicone conformal coatings. Of these, the fastest and most popular is a methylene chloride based system. Several hydrocarbon-based solvents are alternatives to the methylene chloride based solvent.

While not as fast as the methylene chloride, the hydrocarbon based solvents are more selective, and when not contaminated by water, will not attack epoxy-glass PCBs, their components, metals and most plastics.

As in the case of the polyurethanes, the coated board is immersed in the

TABLE #2

Solvent Selection Guide For Removal of UV-Cured Conformal Coatings

UV-CURED CONFORMAL COATING TYPE	THICKNESS	RECOMMENDED SOLVENTS AND APPROXIMATE TIME FOR REMOVAL								
		Dimethylformamide Base	N-Methylpyrrolidone Base	Methylene Chloride Base/ Acid Activator	Hydrocarbon Base/ Acid Activator	Hydrocarbon Base/ Acid Activator	Butyrolactone Base	Methanol Base/ Acid Activator	Ethylene Glycol Ether Base/ Alkaline Activator	
URETHANE ACRYLATE										
Dow Corning X3-6765	.007"			30 min.	- Followed By -			4 hours 1.5 hours		
Dymax Multi-Cure 984	.006"	15 min.		15 min.				1 hour		
Dymax Multi-Cure 984F	.006"	15 min.		15 min.				1 hour		
Dymax Multi-Cure 984RF	.006"	15 min.		15 min.				1 hour		
Loctite Shadowcure 361	N/A	NO SOLVENT WAS FOUND SUITABLE FOR REMOVAL								
W.R. Grace & Co. Amicon UV-920	N/A			2.5 hours					24 hours	
ACRYLATED EPOXY URETHANE										
DuPont Quickcure B-565	.003"	15 min.	1.5 hours	15 min.			45 min.			
DuPont Quickcure B-566	.003"	15 min.	1.5 hours	15 min.			45 min.			
Westinghouse Electric Corp. UVCC-10 B565	.003"	15 min.	1.5 hours	15 min.			45 min.			
Westinghouse Electric Corp. UVCC-11 B566	.003"	15 min.	1.5 hours	15 min.			45 min.			
SILICONE										
Dow Corning X-4013	.011"			15 min.			45 min.	15 min.	45 min.	
Dow Corning X3-6760	.004"			30 min.	1 hour	45 min.			1.25 hrs.	

Note: Although more than one of the chemical formulations at the top of these charts appears to be the same, they may not be. There may be lesser or greater concentrations of the materials, depending on the particular conformal coating to be dissolved. Consult a manufacturer of the coating material, the manufacturer of the solvent, or both to determine which particular solvent to use.

solvent at room temperature and allowed to stand until the silicone has dissolved or can be easily brushed off. The time required will vary with the solvent used, the type of silicone coating, the coating thickness, and the amount of surface area exposed. Typically, most coatings of 0.010 inch or less will be removed in 15 minutes to one hour. Certain chemically-resistant silicones may require extended immersion for several hours. The use of ultrasonics or agitation will reduce dissolving time.

After coating removal is complete, it is very important that the board be thoroughly washed in alcohol (isopropanol or methanol), then rinsed in DI water and dried. A saturated cloth or cotton-tipped swab may be used for spot removal. Repeated applications and brush may be necessary.

Acrylics

Acrylic conformal coatings have good humidity resistance, long pot life, and are relatively easy to apply. However, they have poor abrasion and chemical resistance. In the past, chemical removal of acrylic coatings was done with highly volatile or flammable solvents such as methylene chloride, trichloroethane, aromatics or ketones. Many of these chemicals are no longer acceptable due to physical hazards, toxicity, or environmental regulations.

A relatively safe alternative based on butyrolactone has been developed for removal of acrylic conformal coatings. Most typical acrylic coatings will be removed within one hour after soaking in this solvent. After removal is complete, the PCB should be rinsed with alcohol or DI water and then dried.

Epoxies

Epoxy conformal coatings provide good humidity, chemical, and abrasive resistance. Complete coating removal for repair is nearly impossible by chemical means (except in the case of hermetically sealed hybrids), as the solvent can't discriminate between the epoxy coating, the epoxy-glass printed circuit board, and any epoxy-coated or potted components. However, if done carefully, spot removal of the coating may be accomplished by the application with a cotton-tipped swab of a solvent with a methylene chloride base and acid activator.

Paraxylylenes

Paraxylylene conformal coatings, or parylenes, are applied by a vacuum deposition process. They offer excellent resistance to humidity, moisture, abrasion, high temperatures and chemicals. However, while they cannot be dissolved, they can be removed. The coated board should be immersed in a tetrahydrofuran base solvent for a period of two to four hours. This will cause the parylene coating to separate from the board. Rinse the board in alcohol and let dry; then physically remove the coating with tweezers.

UV cured materials

The passage of strict environmental laws drastically reducing volatile organic compound (VOC) emission levels created a widespread need for a solventless conformal coating. Consequently, the early 1980's saw the development of ultraviolet light (UV) curable conformal coatings as a way to eliminate air pollution, significantly reduce processing time, and reduce energy costs as compared to solvent-based, thermally cured coatings. These coatings were successfully developed by creating acrylated oligomers: epoxy acrylates, urethane acrylates, polyester acrylates, or combinations of several of them.

Epoxy acrylates provide improved chemical resistance. Acrylated urethanes are flexible and tough. However, because of the "hybrid" chemical structure of these UV cured conformal coatings, chemical removal can be a little more complicated. While two different manufacturers' coatings may be of the same type of oligomer, for example acrylated urethanes, they may be different enough in composition that they require two completely different solvents to remove them. In some cases, a combination of two solvents used in succession may be required. With some conformal coatings, such as Loctite's Shadowcure 361, no solvent was found to be suitable.

Table 2 provides a guide for proper solvent selection for removal of UV cured conformal coatings. Generally, the removal process is the same as that for other coating types: the PCB should be immersed in the appropriate solvent; when coating removal is complete, the board should be thoroughly washed in alcohol, rinsed in DI water, and dried.

Removal times can vary anywhere from 15 minutes to 24 hours, depending upon the coating, coating thickness, and the solvent used. Agitation, or the use of ultrasonics will speed up the procedure. Spot removal may be done by application of the solvent with a brush, cotton pad, or cotton-tipped swab. Some of the solvents may be available in a gel form for spot removal applications.

Choosing a solvent

When choosing a solvent for the removal of a particular conformal coating, you should examine the following criteria:

- does it quickly and completely remove the coating?
- does it selectively remove the coating while not damaging or adversely affecting the substrate and/or other components or devices?
- is it safe to work with?
- is it environmentally acceptable?

Since regulations vary not only from state to state, but also from company to company, the answer to some of these questions can only be determined by the individual company. However, to aid in your selection of a solvent for any of the standard (non-UV) type conformal coatings we present here a solvent selection guide for removal of conformal coatings (see Table 1). While a number of coatings are listed in this guide by brand name, it is expected that the recommended solvents will effectively remove similar coatings from the same or from different manufacturers.

We would like to thank the following conformal coating manufacturers for their assistance in the preparation of this information.

- Chemtronics, Inc.
- Conap, Inc.
- Dow Corning Corp.
- DuPont Electronics
- Dymax Corp.
- GE Silicones
- Loctite Corp.
- Novatran Corp.
- Para Tech Coating Co.
- W.R. Grace & Co.

Editor's note: The use of deionized (DI) water for rinsing of printed circuit boards after removal of the conformal coating is mentioned several times in this article. Any time water is introduced to any kind of electronics circuitry, it should really be deionized. Most service facilities don't have access to a source of DI water, however. Under those circumstances, the use of distilled water for rinsing should be adequate for most purposes. ■

Servicing vertical circuits without a schematic

By Homer L. Davidson

Problems in vertical circuits usually result in one of the following symptoms: a horizontal white line (no vertical sweep); insufficient vertical sweep; intermittent and rolling picture. Other symptoms of vertical problems that are less frequently encountered are vertical bouncing, foldover at the top, vertical lines at the top, vertical bunching and crawling.

The most common cause of a bright horizontal line is absence of vertical sweep in the vertical output circuits. Another cause of a horizontal white line is absence of vertical drive pulses from the IC vertical oscillator or transistor. Defective, open, or leaky, driver and output transistors cause most vertical problems. Open or burned bias resistors or diodes may cause absence of vertical sweep. Other possible causes of this symptom are open electrolytic output coupling capacitors and yoke windings (Figure 1).

Insufficient vertical sweep may result from any of the following conditions:

- improper vertical drive pulses or driver signal.
- leaky output transistors.
- improper voltage source fed to the vertical oscillator or countdown IC and transistors.
- bias resistors that have burned or increased in value.
- dried up or defective electrolytic capacitors in the vertical circuits.

When the symptom is insufficient vertical sweep, always try to adjust both vertical linearity and height controls before beginning other diagnostic procedures.

Davidson is a TV servicing consultant for **ES&T**.

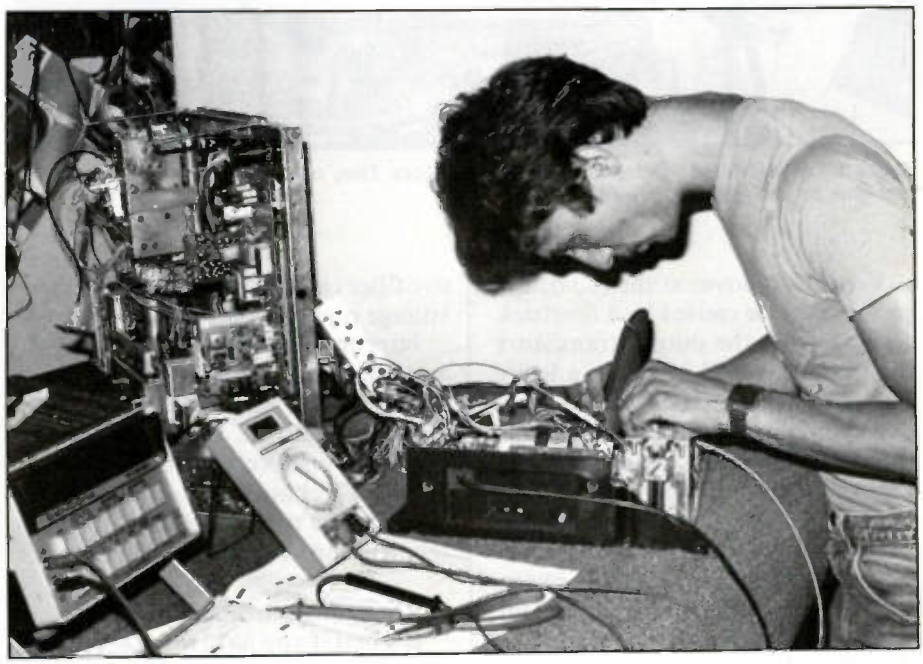

Figure 1. The technician is soldering vertical connections in the TV circuits.

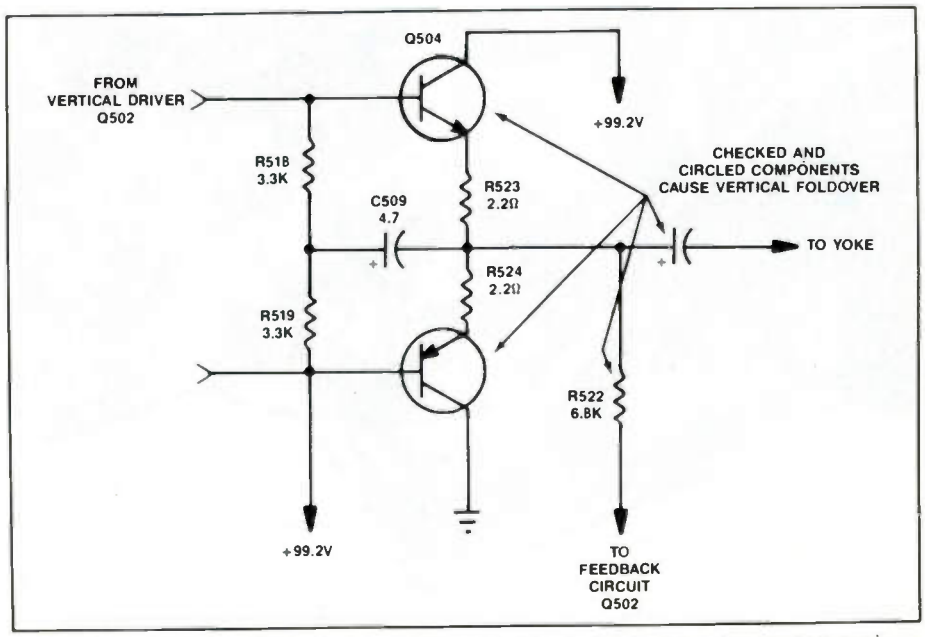

Figure 2. Check the indicated components within the vertical output circuits for possible vertical foldover.

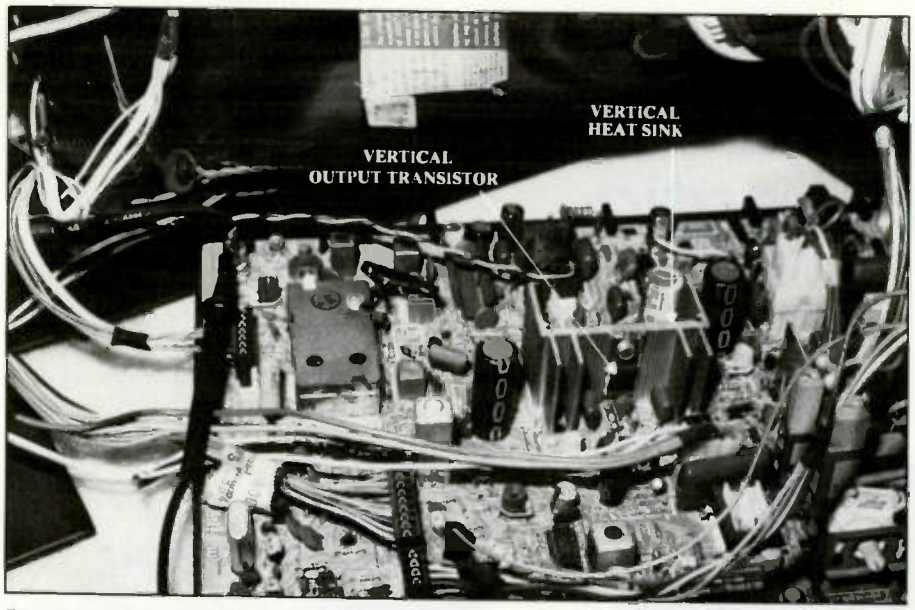

Figure 3. Try to locate the vertical output transistors. They're located on a large metal heat sink on the main PC board.

Vertical foldover at the top of the picture may be caused by a feedback resistor from the output transistors that has increased in value, a leaky output transistor, defective resistors, or a change in the pincushion circuits (Figure 2). Unusual vertical bouncing may result from a leaky output transistor or defective yoke coupling capacitor to the vertical output transistors. Intermittent vertical sweep may be caused by any intermittent component in the vertical circuits or poor board connections. Often, vertical crawling is the result of a defective filter capacitor in the vertical low voltage power supply.

Improper vertical sync or burned and open resistors in the sync separator circuits of early model sets may cause vertical roll. Do not overlook broken or open vertical hold controls in early TV chassis. Improper vertical sync can be easily located with the scope in the vertical input circuits.

Locating schematic diagram

It's best if you have the correct TV schematic when trying to locate vertical problems. If the correct schematic is not available, try to locate a schematic diagram for a similar TV chassis of the same manufacturer.

Often the vertical circuits are very similar year after year in sets from the same manufacturer. If the set is an import and its schematic is difficult to locate, try to locate the vertical output transistor or IC components in the set and compare them with the vertical circuits of similar sets. Many different TV brands may be manufactured by one manufacturer. If you locate a schematic of another set that has similar vertical output components, you can at least use the schematic diagram of that set as a rough guide.

Early TV chassis may have directly coupled transistors in all the vertical circuits. In subsequent sets, the vertical oscillator and sync circuits were combined in one IC component. Still later sets featured countdown sweep circuits with vertical and horizontal oscillator circuits. After that the separate vertical output IC fed directly to the yoke winding. The vertical oscillator and driver circuits may be found in one large IC sweep component. In many of today's sets, the entire vertical circuit may be located in one large IC part.

Locating vertical output circuits

When you encounter a TV set with vertical sweep problems, your first diagnostic step is to try to locate the vertical output transistors or IC components (Figure 3). Usually, the vertical output transistors are mounted on one large heat sink, or separate heat sinks fastened to the main pc board. Sometimes they are hidden down out of the way and fastened to the metal TV chassis.

In the latest sets, a single large IC component may contain the entire vertical circuits or a separate output IC may be mounted upon a separate heat sink (Figure 4). You may find the vertical oscillator, count down and driver circuits in one large IC with the horizontal sweep circuits. In this case, locate the vertical output component and start from there.

Vertical output voltage tests

After locating the two output transistors on the heat sink, take critical voltage measurements. Improper low voltage applied to the vertical circuits may cause insufficient vertical sweep, or complete absence of vertical sweep. Measure the voltage at the metal heat

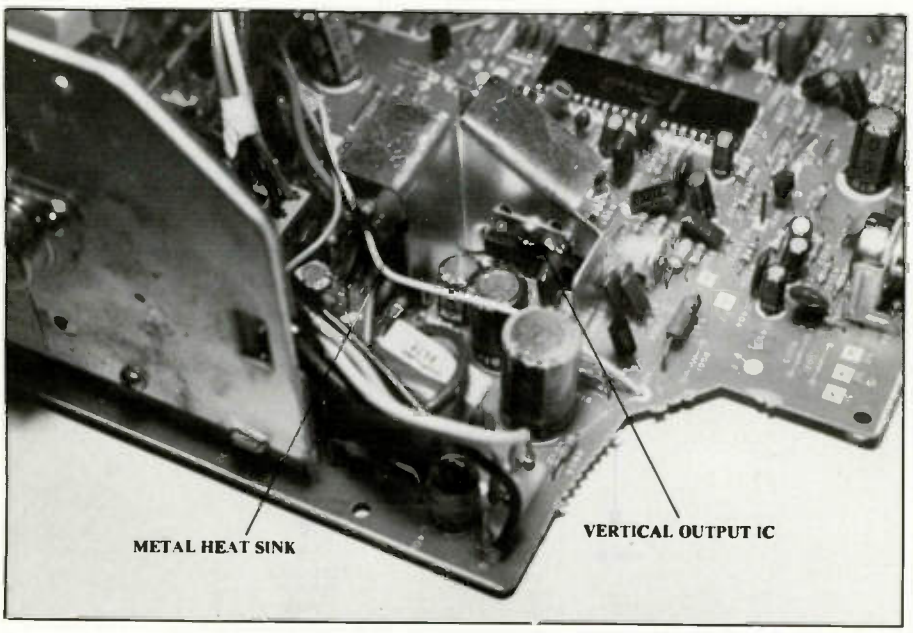

Figure 4. Many of the latest TV chassis feature a vertical output IC mounted on a metal heat sink or on the chassis.

sink terminal. Usually, the collector terminal of the output transistors are bolted to the metal heat sink. One collector terminal will be isolated with an insulator and the other bolted directly to the heat sink (Figure 5).

Extremely high voltage at the ungrounded collector terminal may indicate an open emitter bias resistor or bottom output transistor. You may assume the grounded collector terminal transistor is open if the same high voltage is found at the emitter terminals and resistors.

A leaky output transistor may have the same voltage at the emitter as at the collector terminal. If the top transistor measures a high dc voltage on collector and emitter terminals and not on the emitter of the grounded-collector transistor, suspect a burned or open emitter resistor. The same or quite close voltage found at collector, base and emitter may be caused by a leaky output transistor or leaky diodes in the base circuits.

Low voltage at the ungrounded collector terminal may be caused by a leaky output transistor or improper low voltage source from the low voltage power supply. Determine if the low voltage is coming from a scan-derived voltage source or low voltage power supply. Disconnect the collector (center) terminal from the pc board with desoldering braid. If the voltage at the PC board terminal increases, a malfunction in the vertical circuits is loading down the dc voltage source.

If the symptom is a horizontal white line and the B + voltage in the vertical circuit measures very low, go directly to the low voltage power supply or flyback scan derived voltage source. Simply trace the wiring back to the flyback transformer. Remember, the low voltage dc source for the vertical circuits comes from the flyback circuits. Usually you'll find an open isolation resistor or diode in the leg of a separate winding of the flyback (Figure 6).

If there's a horizontal white line, even if there's insufficient vertical sweep, you know that the horizontal and flyback circuits are operating. Check the continuity of the flyback winding and R102. Check D102 to see if it's open or leaky. If R102 and D102 are normal, but the voltage developed in the scan-derived voltage source is low, suspect C102.

To confirm your suspicions, disconnect the set and clip a known good

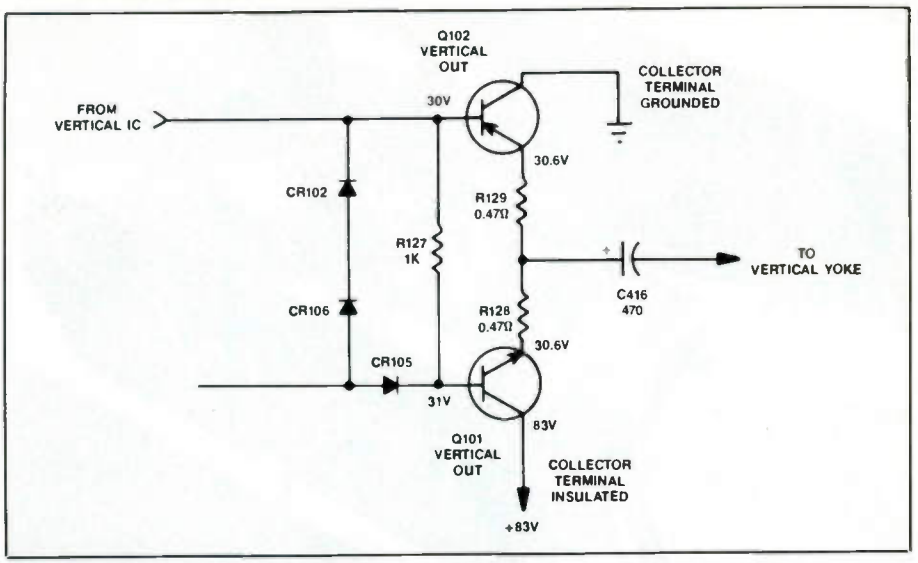

Figure 5. You may find one vertical output transistor collector metal terminal bolted directly to ground and the other insulated away from the metal heat sink.

100μF capacitor across this small filter capacitor. If the set operates properly when you turn it on, replace C102 permanently. This capacitor may dry up or have open internal connection.

Often, high voltage source tied to the vertical circuits is fed from the low voltage circuits. If the horizontal and sound circuits are normal, suspect an open or burned resistor in the vertical voltage source. Improper or low voltage may be caused by an increase in the value of the voltage dropping resistor or a separate filter capacitor in the low voltage circuits.

Testing output transistors

Determine if the output transistors are defective by measuring the voltage at the ungrounded collector (metal) terminal. Check each transistor in the circuit with a transistor tester or the diode junction test of the DMM. Sometimes, when these output transistors are removed from the circuit for tests, even if they're intermittent or open, they may test good. Make in-circuit tests before removing from the circuit.

Identify the transistor terminals using the transistor tester or use the base terminal as common with diode-junction tests. In some cases you may find one output transistor leaky and the other open. At other times, both transistors may appear leaky. Double check the base circuits for the presence of shunting diodes or low value resistors that might give an erroneous measurement in leakage tests.

Remove the suspected output transistor from the board and test again. Replace transistors that appear to be intermittent. Always test the replace-

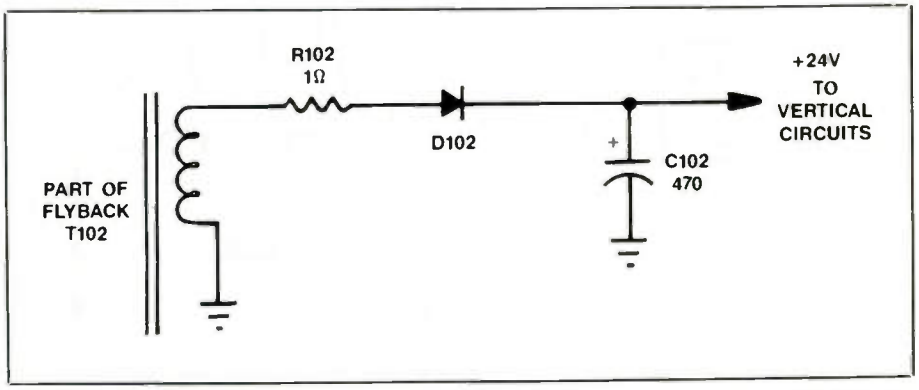

Figure 6. Improper or insufficient vertical sweep may be caused by low supply voltage from the low voltage power supply or flyback circuits.

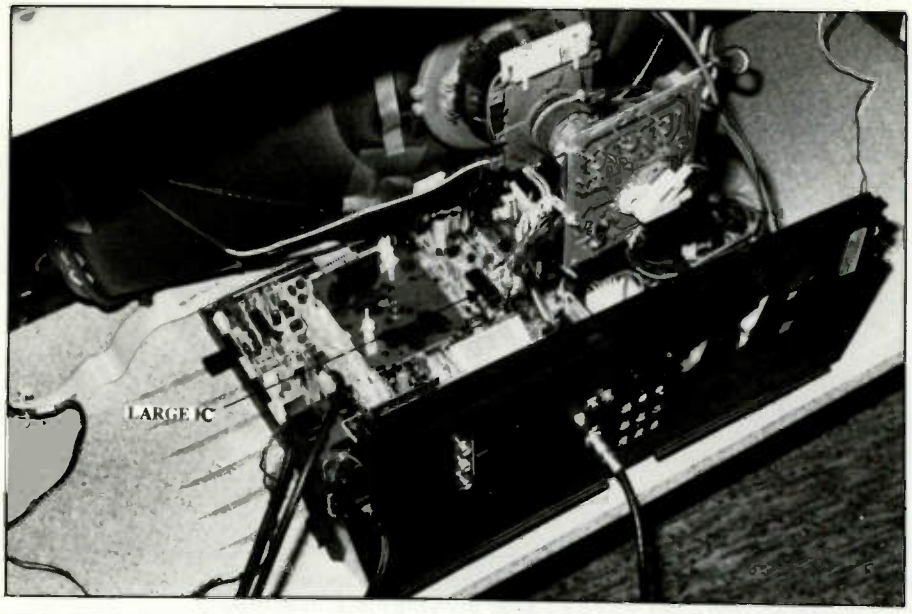

Figure 7. The vertical oscillator, driver and amp may be included in a large IC with many other circuits in the latest TV chassis.

ment transistor before installation. You may find the new replacement defective.

Scope tests

Often, scope tests within the vertical circuits may prove fruitless in diagnosing the vertical output circuits. It's best to take a scope check at the vertical oscillator circuit and output coupling capacitor. A scope waveform at the oscillator driver or amp circuit of the deflection IC will indicate if the vertical sweep pulse is present. The scope test at the output coupling capacitor or vertical yoke lead will determine if the overall vertical circuits are normal. Otherwise, scope tests in the vertical feedback circuits will not help.

No vertical sweep - white line

When the symptom in an imported set is a horizontal white line, if no schematic is available, examine the physical layout of the set to see if you can locate the vertical output circuits. Determine if the chassis is fairly old or a new model. Several transistors may be found throughout the vertical circuits in the older models. After locating the vertical output transistors, they'll be mounted on heat sinks, check for a large functional IC nearby (Figure 7). Usually, the latest chassis have the vertical count-down or oscillator and amp included in the large IC component.

Measure the voltages at the metal collector terminals. Take a quick scope check at the emitter terminals or output electrolytic coupling capacitor to see if the vertical yoke drive pulse is normal. Measure the voltages on all transistor terminals and record them. Low dc voltage, may indicate a defective low voltage source or overloaded vertical output circuits. Test each output transistor within the circuit.

Locate the large sweep IC and observe the waveform at each terminal. Follow the PC board traces from the horizontal output transistors back to the vertical oscillator or count-down terminal and observe the waveforms there. Weak vertical drive pulses or none at all may indicate a defective sweep IC. Of course, you know the horizontal sweep is okay or you would not have any sound or white horizontal line. It's possible for the vertical circuit to be defective, while the horizontal sweep circuit in the same IC is normal. Replace it.

If the square wave vertical pulse is normal, signal trace it with the scope up to the vertical driver or amp and then to the vertical output circuits. You may find in the latest vertical circuits a sawtooth switch transistor and error amp is capacitively coupled between deflection IC and output circuits. Test each transistor and measure voltages where the signal is missing.

Vertical IC output circuits

In the latest import TV chassis, you may find that the vertical output circuits are contained in an IC instead of consisting of discrete transistors. Locate the IC bolted to a separate heat sink or metal chassis. Take critical voltage measurements at each terminal and record. Observe the waveform at each terminal.

You may find that the terminal of the IC where you measure the vertical drive pulse is connected directly to the vertical yoke windings (Figure 8). If a sawtooth waveform is coming into the output IC and there is no output yoke drive pulse, suspect a defective vertical output IC.

Try to locate the voltage source supply pin of the IC and carefully measure the voltage. Normally this (Vcc) pin is the one with the highest voltage. Trace this pin voltage source back to either the low voltage power supply or flyback circuits. Some vertical circuits

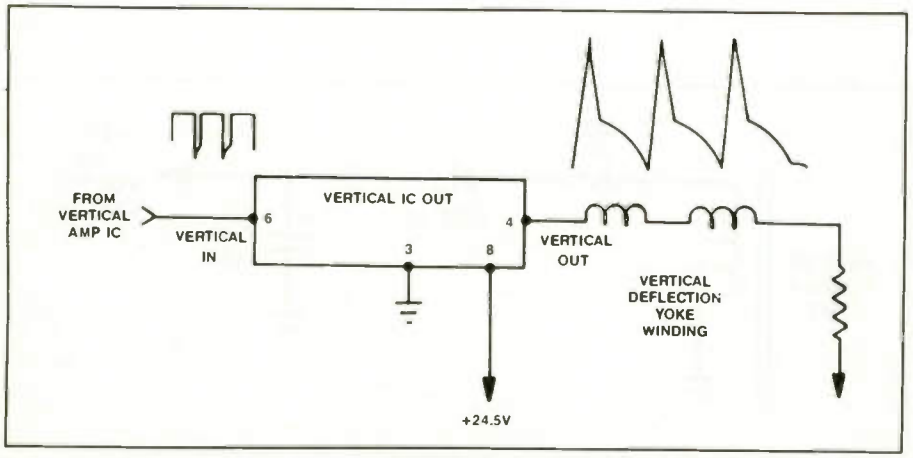

Figure 8. Scope the Input and output terminals of the vertical output IC. Take critical voltage measurements of voltage supply terminal.

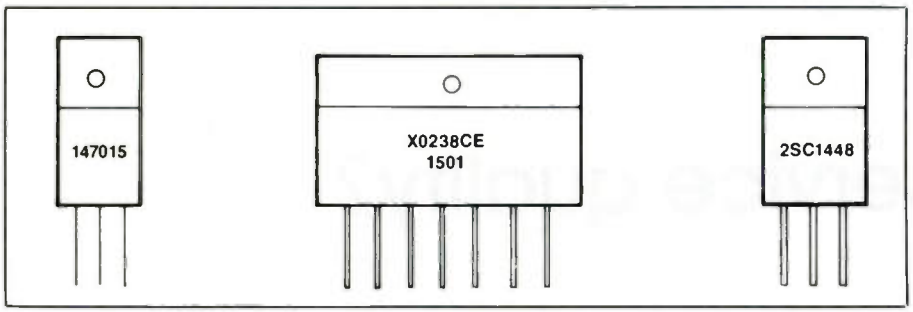

Figure 9. Look for transistor or IC part numbers upon the body of the component. If necessary, compare the vertical output IC with one from another chassis of same manufacturer.

are supplied from a chopper power source.

Determine if supply voltage is low or if the IC is leaky. Disconnect the voltage supply pin from the PC board with desoldering braid. Take a resistance measurement between the IC and common ground. A low measurement indicates the IC is leaky. Test the supply voltage and notice if it has greatly increased. If so, the vertical output IC is defective.

Transistor and IC replacement

In replacing defective unmarked transistors, determine if both output transistors are NPN, or if one of them is a PNP type. You may find both in different vertical output circuits. In this case, it may prove a little more difficult to determine if the transistor is leaky or open.

Remember, the NPN transistor has a positive voltage applied to the metal collector terminal while the PNP has a negative supply voltage. The metal collector terminal grounded to the heat sink is a PNP type. Otherwise, a transistor test or diode-junction DMM test will indicate the type of transistor.

Transistors and IC components may have a part number or production number stamped on the surface. Try to locate the stamped number in the solid-state semiconductor reference manual. Sometimes, the last few numbers or letters are stamped upon the transistor body (Figure 9). Try to compare the vertical transistors with a similar schematic. Then, look up the replacements in the semiconductor replacement manual.

If no numbers or letters indicate what number the defective transistor may be, check the voltages applied and compare with available RCA, ECG and GE replacements. Some vertical output transistors operate at higher voltage than others. You may find a few that operate under 25V while others operate around 100V. Choose the correct working voltage, NPN or PNP and mounting type of transistors.

By comparing with those found in American brand vertical circuits and choosing from the semiconductor manual most vertical components can be replaced. Universal transistor and IC components work well in vertical circuits.

For IC components in the vertical circuit, try to locate a number on the body of the IC. If a vertical part cannot be located in this manner, compare with another chassis of the same manufacturer. When all else fails, call the model number and type of component to the manufacturer or service depot. This does not mean you will get the correct part every time.

In one case, the manufacturer sent three different ICs and none of them worked. Finally I sent a photo of the chassis showing the location of the IC to the manufacturer. This time we got the correct IC. ■

How's your service quality?

Did you know that even if you repair a TV or VCR so that it's as good as new, the customer will probably not be satisfied with your service if the repair took more than two weeks?

And did you know that one of the most important things you can do to satisfy a customer is to simply try to understand their point of view? They want to know that you understand why they're concerned, and they want you to reassure them that you have their best interests at heart.

These were just two of many findings that were brought to light in a recent survey by a major manufacturer of consumer electronics products. This company surveyed a random sampling of customers who had recently had a product serviced. The purpose of the survey was to determine how satisfied those customers were with their service experiences, and how the service satisfaction of their customers stacked up compared to the service satisfaction of customers of other companies.

The results of the survey were revealing and useful to the company, but anyone who services consumer electronics products can learn a lesson from it.

What is service quality?

Servicing appears on the surface to be a straightforward transaction between the service center and the customer. If the product gets serviced properly, and works for a reasonable length of time after it is serviced, the customer should be satisfied. Right? Not necessarily.

There are five aspects of service quality. If a service facility fails to measure up to the consumer's expectations in any one of these areas, it's likely that the customer will be deeply dissatisfied.

- Tangibles - How does the service center look? How do the personnel look? Do things seem to be operating smoothly and efficiently?
- Reliability - Is the service center likely to repair the product correctly?
- Responsiveness - Is the service center willing to provide prompt service?
- Assurance - Do the service center people explain the service in language the customer can understand? Do the consumer contact people seem trustworthy and knowledgeable?
- Empathy - Do the service company and personnel seem to have the best interests of the consumers at heart? Do they provide thoughtful, caring and individualized attention?

Here's what the survey showed

The single most important thing that a service organization can do to satisfy its customers is simply to treat them well; let them know that they're valued customers whose products will be serviced and treated carefully. (See Figure 1).

- What consumers appreciate most besides caring, concerned treatment is service personnel who know what they're doing and look it.
- Promptness is crucial to customer satisfaction. Any delay of longer than around two weeks in getting the product back to the customer will be interpreted as a negative experience. If you promise to get the product back by a set date and fail to keep your promise, the customer will be angry, even when it is explained that the delay was to order special parts.
- Any time service personnel fail to deliver on promises consumers got angry. Promises should be realistic.
- Customers have widely different expectations depending upon which category of product they bring in for service: camcorders, computer monitors, lap top computers, projection televisions, "regular" televisions and audio products.

"I'm satisfied with the service I received because..."

1. I was treated well by service center personnel. (75%)
2. The service center solved the problem; knew what was wrong. (50%)
3. The service center personnel were helpful, they listened and answered questions. (41%)
4. My product was returned promptly. (28%)
5. The service center contacted the manufacturer directly. (24%)
6. The service center called the same day I reported the problem; came promptly - when promised; kept the appointment. (23%)
7. Some aspect of the service was outstanding, or the service center went out of way, or paid special attention. (22%)
8. There was no charge; I was reassured. (21%)
9. I had higher expectations for the product. (18%)
10. The product was important for work or family. (13%)
11. A replacement given during the repair. (11%)
12. The service center did other checking on product. (10%)
13. The service center promised that the service would be provided as fast as possible and delivered on that promise. (8%)
14. The service center said that they would call when the repair was completed and did. (7%)
15. Service center personnel gave other useful advice on that product or other products. (7%)
16. I expected a problem with getting repair completed but there was no problem. (7%)

Figure 1. These are some of the things that pleased customers when they brought a consumer electronics product in for service.

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"I'm dissatisfied with the service I received because..."

1. The repair took too much time. (65%)
2. The problem came back. (54%)
3. I had high expectations for the product and it failed. (48%)
4. The performance of the service center reflected poor planning and inadequate service. (44%)
5. The service person disagreed with me, said "nothing is wrong." (31%)
6. The service person never came back, didn't call back or didn't call or come when he promised. (29%)
7. The service center didn't have needed parts on hand and had to order. It took longer than expected. (26%)
8. The charges were unreasonable. (24%)
9. The service center sent the product away, never to return.(22%)
10. I had to contact the manufacturer directly. (22%)
11. They humored me. (20%)
12. I was given no information. (19%)
13. I had a hassle with the warranty. (18%)
14. Personnel were not helpful. (17%)
15. The service center promised as fast as possible and didn't deliver. (17%)
16. Action was promised but not delivered. (14%)
17. I had to call back too many times to get information. There were too many long distance calls. (14%)
18. The service center promised to call back when finished and didn't. (12%)
19. I lost faith with the manufacturer. I will never buy one of their products again. (12%)
20. I took the product home and it still didn't work. (10%)

Figure 2. These are some of the things that made customers angry or upset when they brought a consumer electronics product in for service.

	Overall	Camcorders	Computer Monitor	Laptop	Proj # TV	TV	VCR	Aud.
Positive Service Experience	58%	66%	63%	61%	66%	52%	54%	55%
Negative Service Experience	42%	34%	37%	39%	34%	48%	46%	45

Figure 3. The category of product that a customer brought in for service had considerable bearing on whether he or she was satisfied with the treatment and service received.

Positive and negative service experiences

What the customers said in writing in this survey shows how service performance and customer expectations line up. The positive customer experiences were based for the most part on how the customer felt about how he was treated. People wanted to be treated as special.

On the negative side, if a customer did not feel that the time and trouble had been taken to find out what the customers' concerns were and deal with them, then he won't be satisfied. (See Figure 2).

Emotional questions aside, it is clear that consumers also expect their service contacts to be knowledgeable. Increasingly sophisticated consumers expect service personnel to be competent in handling technically complex products. In other words, service center personnel must look and sound like competent technicians.

In addition, educated and affluent consumers are used to being informed and being in control. According to the survey, customers overwhelmingly said that they were not given information about what was going on in the service process. This lack of needed and desired information and a feeling of control contributed heavily to the negative service experiences.

Different expectations for different products

The responses of customers varied by product category, suggesting that service centers should take different approaches to different customers, depending on the product being brought in for service. For example, lap top computer customers expected professionalism from service personnel to a much more marked extent than did customers of the other product lines.

Purchasers of projection TV were much more demanding of service personnel than were others. Interestingly, however, people who had a projection TV serviced were were more positive in many areas. Because the projection television is repaired in the home more frequently than are other products, consumers are able to exercise a high level of information and control because the work is done right before their eyes. This may offer insight into approaches to improve service quality in many, many other product categories.

Keeping the customer satisfied

The results of this survey make it abundantly clear that most, if not all, of the things that contribute to a negative service experience are within the control of the manufacturer and service centers.

Here are some of the things you can do to keep customers satisfied and coming back:

- Don't keep the customer waiting for the product any longer than necessary.
- Let customers know what's going on, and let them feel that they have at least some control over the service process.
- Make customers feel that they are special and that you care about their feelings and the welfare of the product they brought in for service.
- Any efforts you make along those lines will pay rich dividends in improved customer satisfaction. ■

"Service Profit Profiles" is a free quarterly magazine published by the Electronic Industries Association/Consumer Electronics Group (EIA/CEG) for the consumer electronics servicing industry. Subscriptions are available to qualified service personnel by contacting EIA/CEG at 2001 Pennsylvania Ave. N.W., Washington, DC 20006-1813.

Test your electronics knowledge

By Sam Wilson, CET

1. The voltage at 'X' in Figure 1 should be

A. positive
B. negative

2. Another name for the circuit called pulse stretcher is _____ (ten letters).

3. The voltage at 'X' in Figure 2 should be

A. positive
B. zero volts
C. negative

4. The circuit in Figure 2 will act as a buffer when R_f equals _____.

5. The secondary of a certain transformer is marked 6.3V. What is the RMS value of the secondary voltage?

6. In audio specifications the letters THD stand for _____.

7. When measured in dB, the ability of a tuner to select the stronger of two conflicting signals is called the. _____

8. For the dB value that was defined in Question #7, a

A. higher number is desired
B. low number is desired

9. In the phase locked loop of Figure 3, the block marked 'X' is a/an _____.

10. For the PLL of Figure 3, when $f_1 = f_2$ the output at 'Y' should be

A. positive
B. zero
C. negative

(Answers on page 56)

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

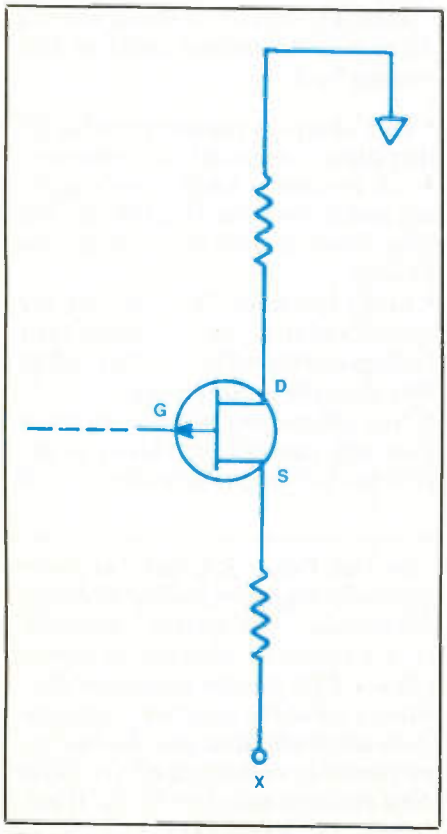


Figure 1.

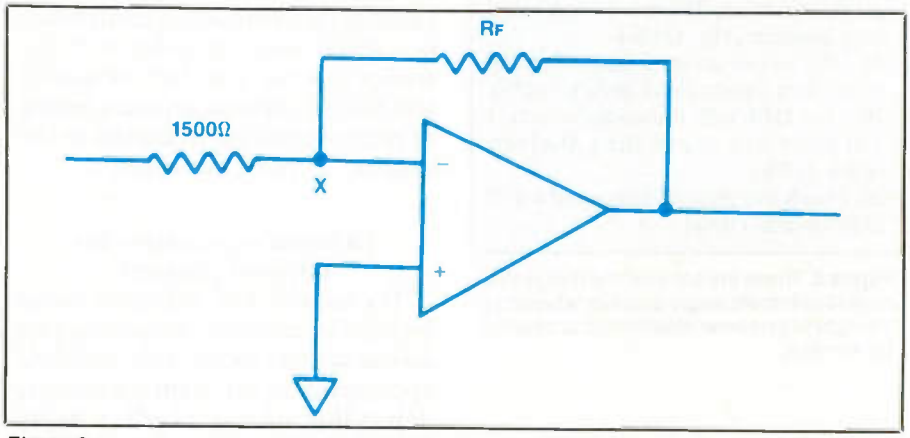


Figure 2.

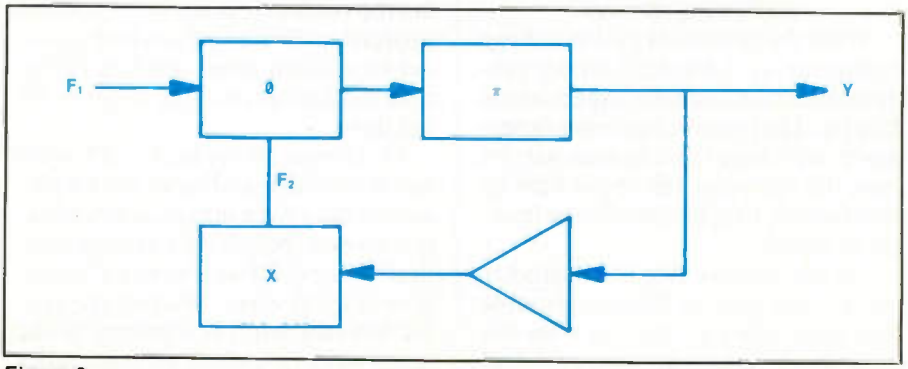


Figure 3.

ES&T Manufacturers' schematics **PROFAX**

JULY 1992

Profax Number

HITACHI

VT-F551A, AW NO. 3487E VCR **3090**

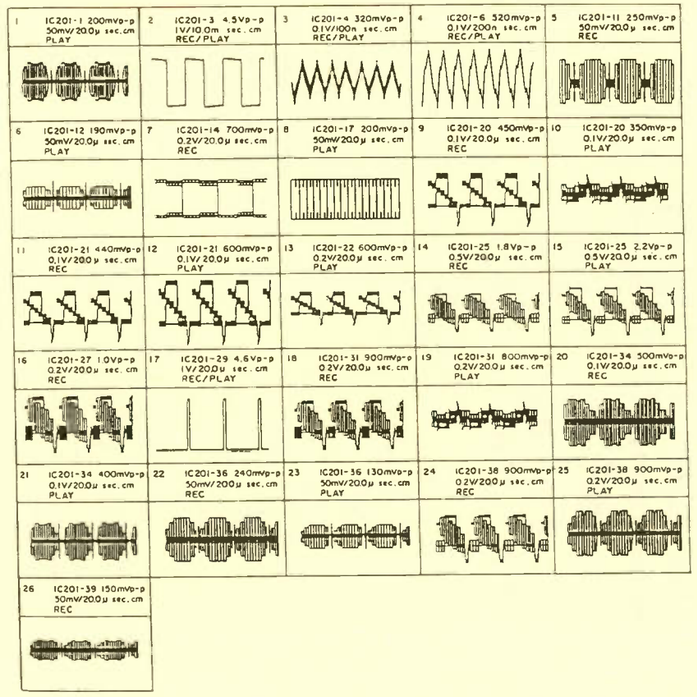
LUMINANCE/CHROMA WAVEFORMS

Product safety should be considered when component replacement is made in any area of an electronics product. A star next to a component symbol number designates 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.



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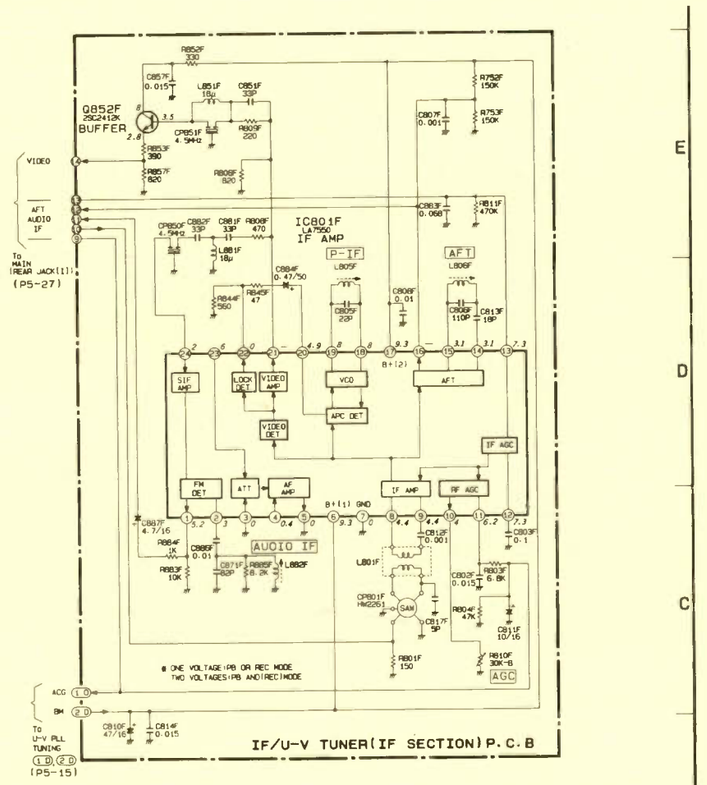
All integrated circuits and many other semiconductors are electrostatically sensitive and require special handling techniques.



AUDIO SCHEMATIC DIAGRAM

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Manufacturers' schematics PROFAX 3090

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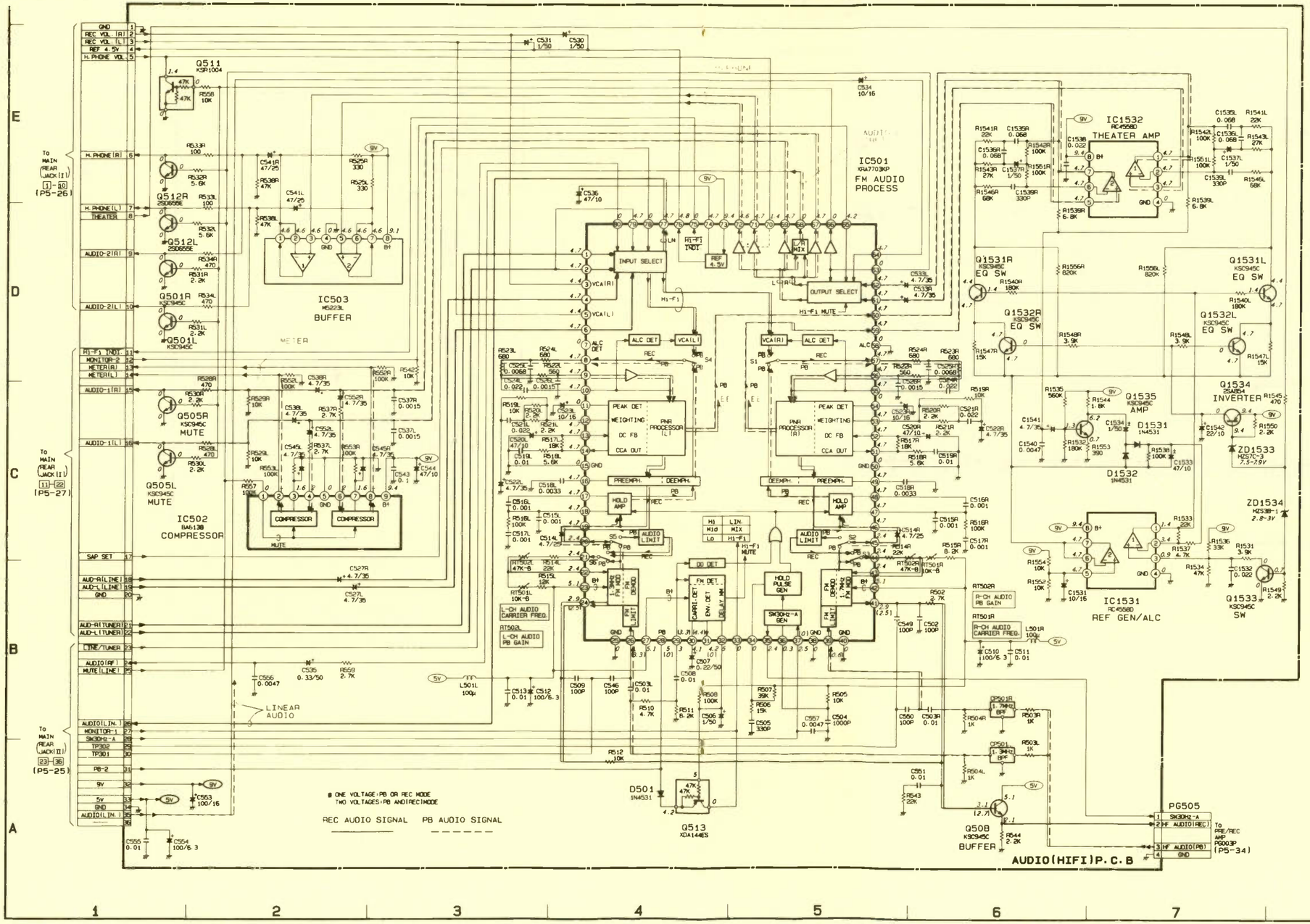

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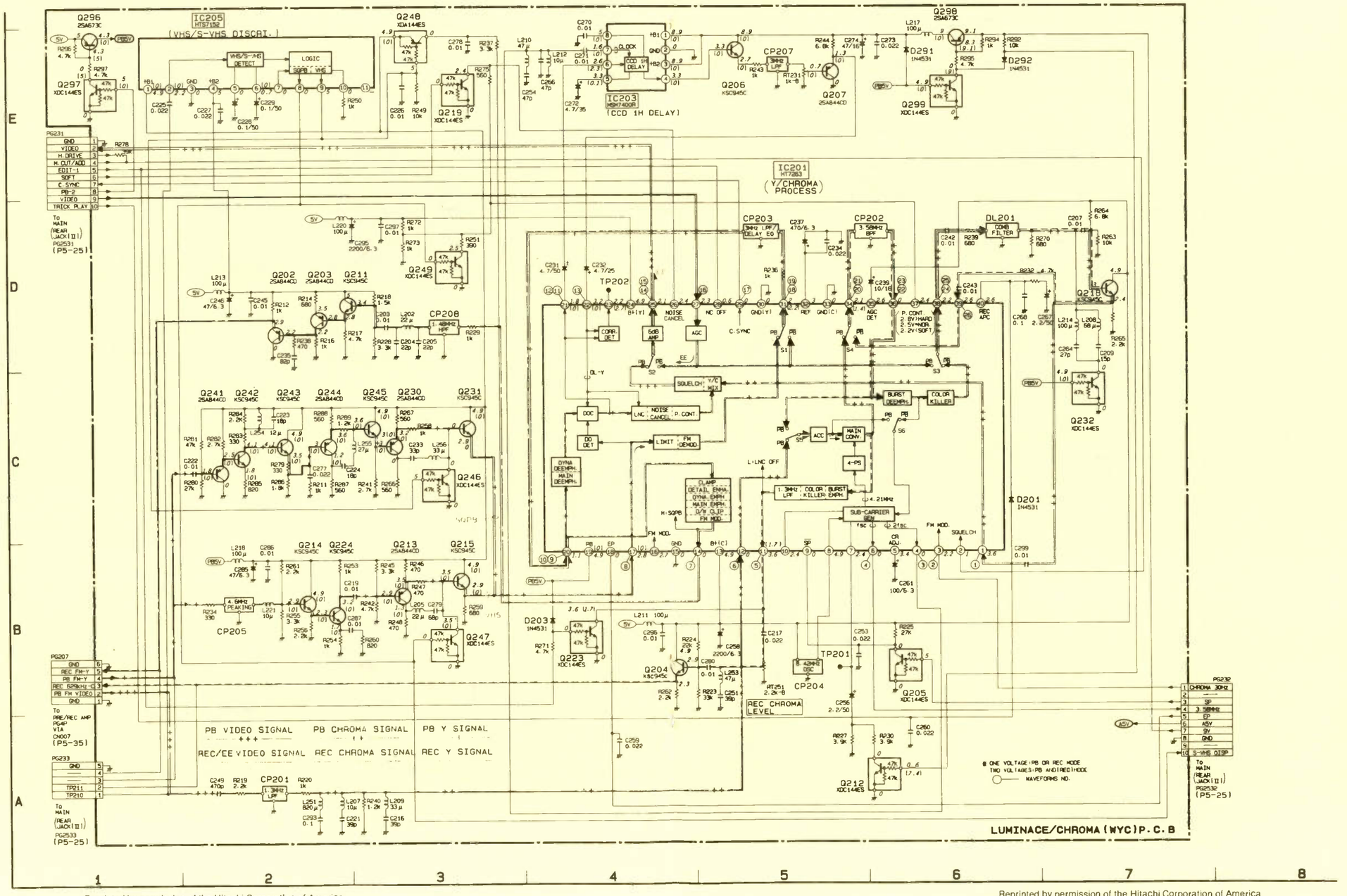

HITACHI VT-F551A, AW NO. 3487E VCR

INTERNAL WIRING DIAGRAM

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INTERNAL WIRING DIAGRAM

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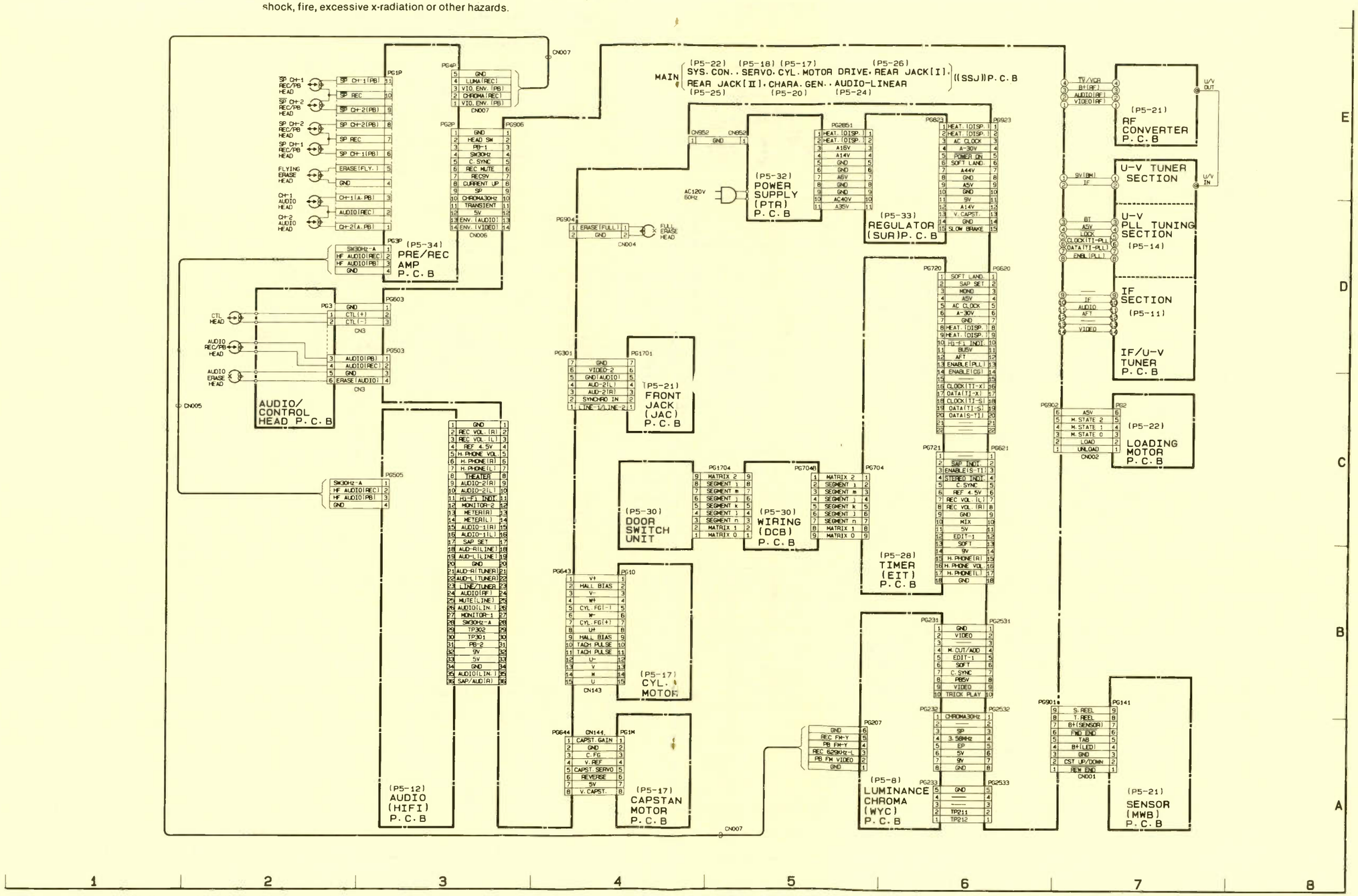
All integrated circuits and many other semiconductors are electrostatically sensitive and require special handling techniques.

Manufacturers' schematics PROFAX 3090



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Working with microcomputer display technology

Part III - More about Hercules and RGBI displays

By John A. Ross

The article in last month's issue "Working with microcomputer display technology : Part II - More about Hercules and RGBI displays," described the Hercules/RGBI adapter, and provided some details about the Hercules video display, and tracing Hercules video signals. This installment provides details on Hercules sync signal processing, gives tips on troubleshooting problems in Hercules sync and sweep circuits, and lays the groundwork for understanding RGBI video.

Horizontal Sync Signals Processing

On the horizontal side, one integrated circuit, IC101, controls phase detection, oscillation, regulation and the predriving of the horizontal signal (see Figure 1). A negative sync signal to pin 3 of the integrated circuit strobes the phase detector current source.

The phase relationship between the sync signal and the sawtooth waveform at pin 4 determines the current division of the phase detector differential amplifier. A phase difference at the output of the differential amplifier within the IC allows current to pass through pin 5 of the integrated circuit. This current flows from pin 5 through pin 7 and controls the oscillator.

A relatively simple RC circuit consisting of C101, R104 and IC101 sets the horizontal oscillation frequency.

Photo courtesy of Zenith Data Systems

Ross is a technical writer and a microcomputer consultant for Ft. Hayes State University, Hayes KS.

Using the current from the output of the differential amplifier, one resistor charges the timing capacitor to a "trip" voltage set by the integrated circuit. After reaching the trip voltage, the capacitor discharges to a new trip voltage value.

The process repeats again and again forming a sawtooth waveform at pin 7 of the integrated circuit. Even though the output of the phase detector controls the oscillator, the oscillator circuit also uses a horizontal hold control and two resistors to keep the 18.432Hz horizontal oscillator frequency centered.

Four transistors within the predriver circuit use the sawtooth voltage created at pin 7 to produce a duty cycle waveform at pin 1. After two transistors reduce the amplitude of the waveform, it feeds to the base of the horizontal output driver transistor, Q101. A series of clipping resistors set the bias voltage on pin 8 which, in turn, sets the "on time" of the output waveform. Resistors R106, R107, R127 and R132 act as the clipping resistors.

Regulation for the horizontal circuit is produced at pin 6 of IC101. Two high-current diodes and a zener diode make up the external regulator. One resistor, R108, ties the zener diode to the +16.2V power supply.

Troubleshooting horizontal sweep problems

Troubleshooting horizontal sweep problems is generally straightforward because of the limited number of components in the circuit. If components in the horizontal hold circuit fail, the monitor will lose horizontal sync. Common component failures include the horizontal hold control (R101) and CX104, the electrolytic filter capacitor in the horizontal hold circuit.

In addition, a defective Q404 sync separator transistor or horizontal processor integrated circuit (IC101) can cause the horizontal oscillator to lock onto the wrong frequency. Even though the transistor and IC may seem like obvious choices for replacement, out-of-tolerance components tied to the transistor and IC may cause similar problems.

Vertical sync signal processing

As with the horizontal sweep circuit, the vertical sweep portion of the monitor is limited to only a few components. While two transistors, Q301 and Q302, make up a free-running oscillator, sync pulses at the junction of two resistors lock the oscillator into the 50Hz vertical scan frequency. Resistors R302 and 303 and the vertical size control set the amplitude of the sawtooth voltage and control the vertical size of the raster. Riding on a dc reference voltage, the sawtooth voltage arrives at pin 7 of IC301, a power amplifier integrated circuit.

The power amplifier drives the yoke with the amplified vertical scan signal and provides linearity correction. Vertical retrace exists through the flyback generator included in the power amplifier circuit. In addition, pin 3 of IC301 becomes the source for vertical retrace blanking.

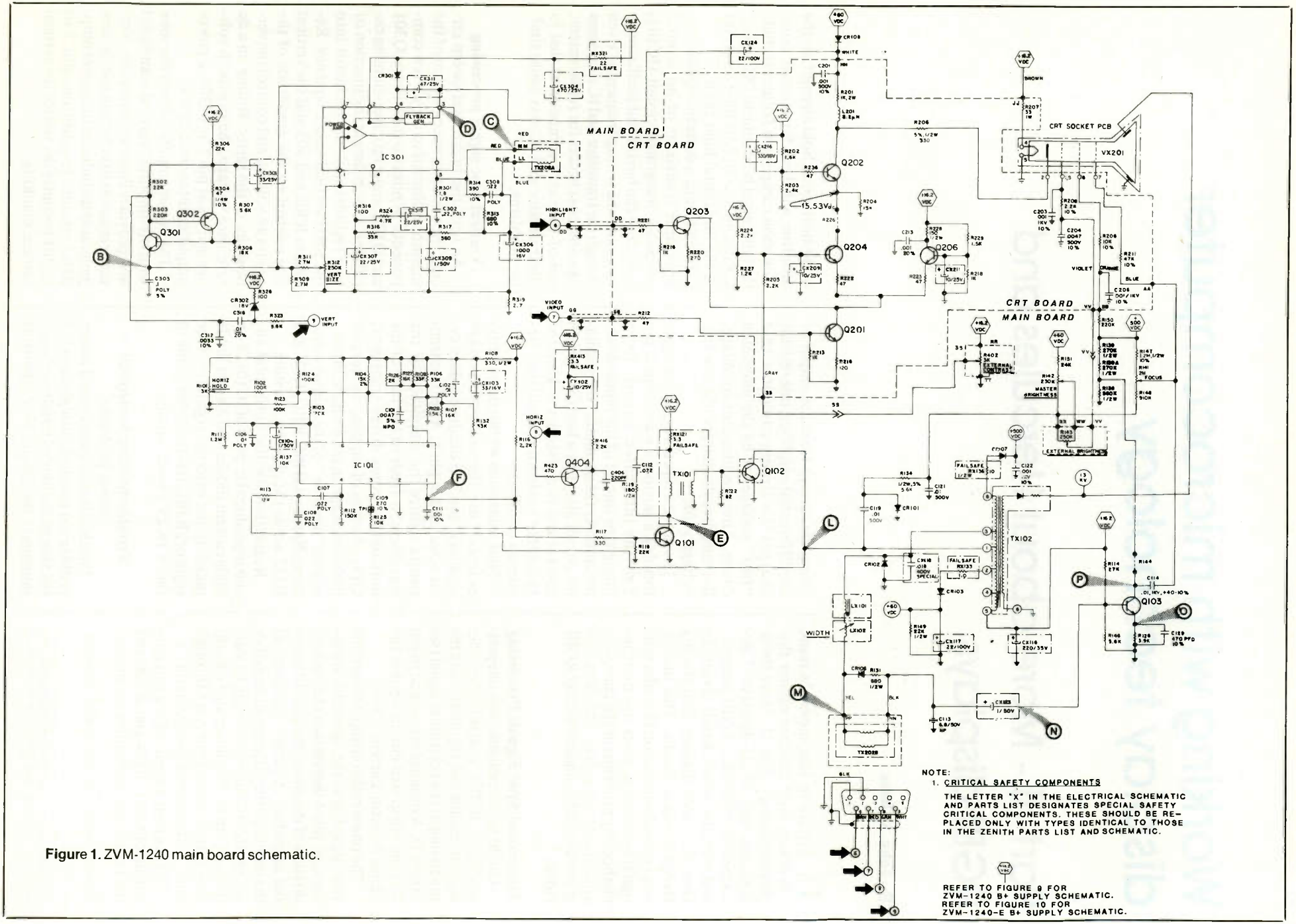

Figure 1. ZVM-1240 main board schematic.

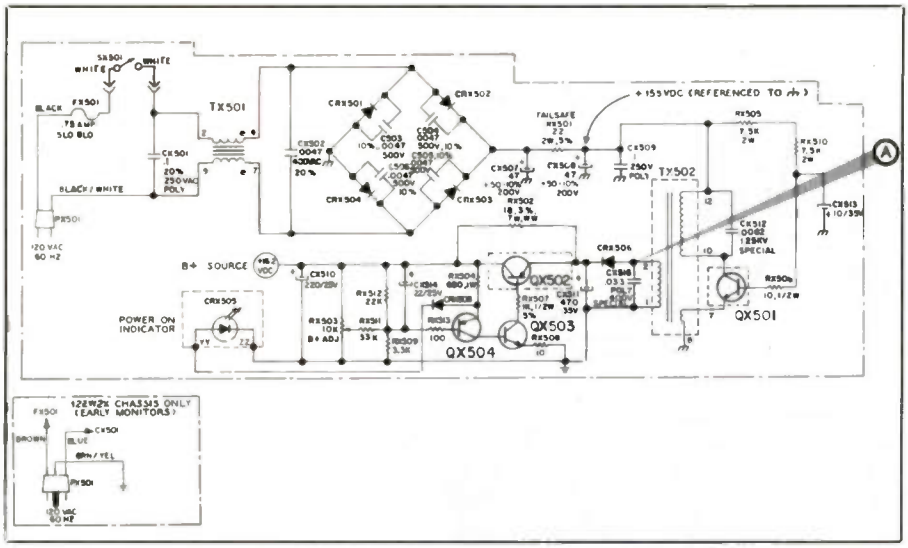

Figure 2. Schematic for the ZVM-1240 B+

Color Range	Red Level	Green Level	Blue Level	Intensity Level
1	0	0	0	0
2	0	0	0	1
3	0	0	1	0
4	0	0	1	1
5	0	1	0	0
6	0	1	0	1
7	0	1	1	0
8	0	1	1	1
9	1	0	0	0
10	1	0	0	1
11	1	0	1	1
12	1	0	1	0
13	1	1	0	0
14	1	1	0	1
15	1	1	1	0
16	1	1	1	1

Figure 4. Listing of sixteen color combinations.

Troubleshooting vertical signal circuits

We can divide troubleshooting the vertical signal circuits into two general categories. If the monitor has no vertical deflection, the search concentrates on six components: vertical oscillator transistors Q301 and Q302, the vertical output IC, the yoke, diode CR302 and transformer TX202A. Both vertical oscillator transistors and the vertical output integrated circuit work together to produce the deflection signal. Pay special attention to the rectifier diode that connects between the B+ voltage and pin 6 of IC301.

In some cases, a yoke transformer with a shorted winding will not allow the deflection circuits to properly function. A defective vertical output integrated circuit can cause problems such as an off-frequency vertical sync signal or only half vertical deflection. The complete loss of vertical sync may

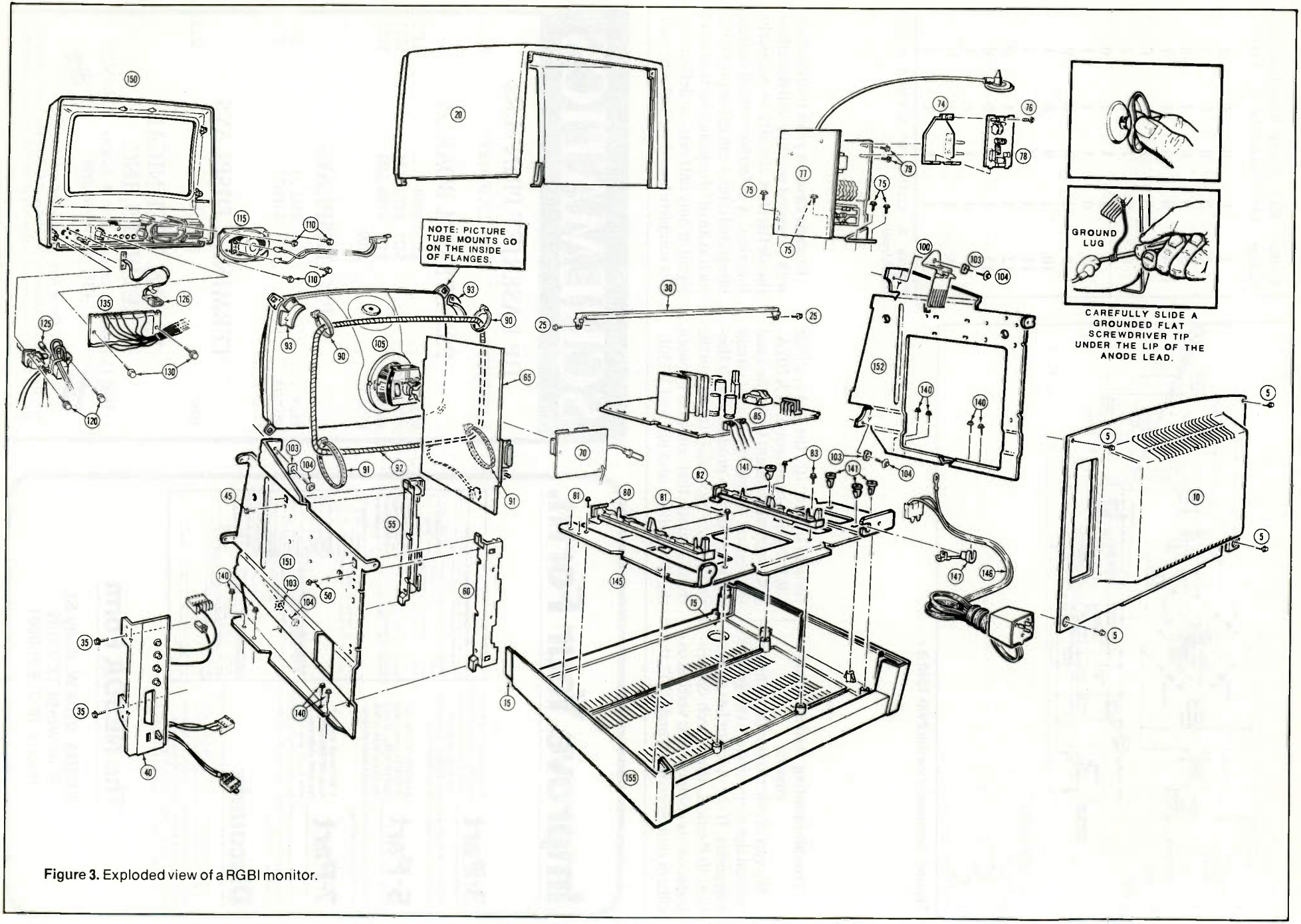

Figure 3. Exploded view of a RGBI monitor.

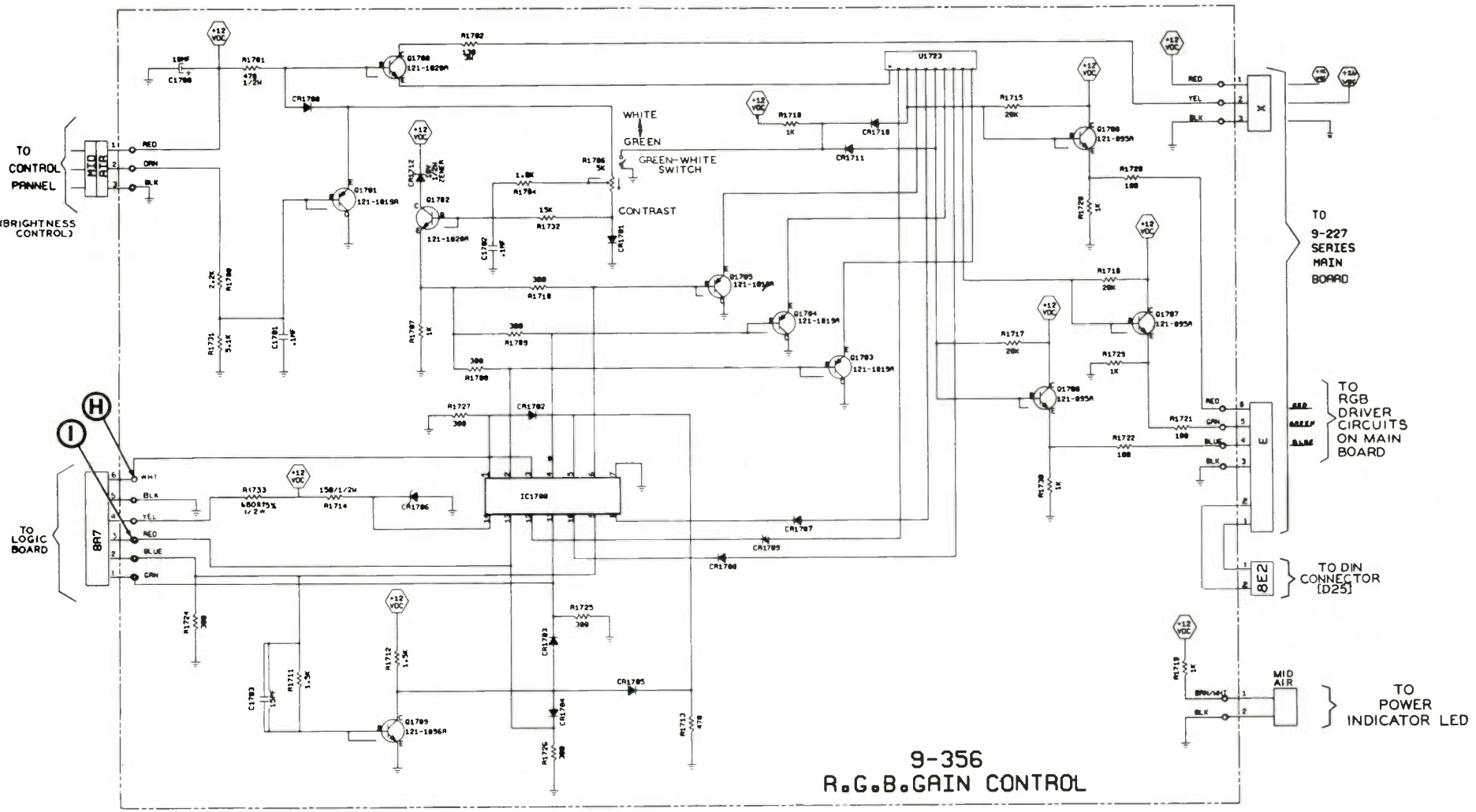

Figure 5. Schematic of RGBI video input.

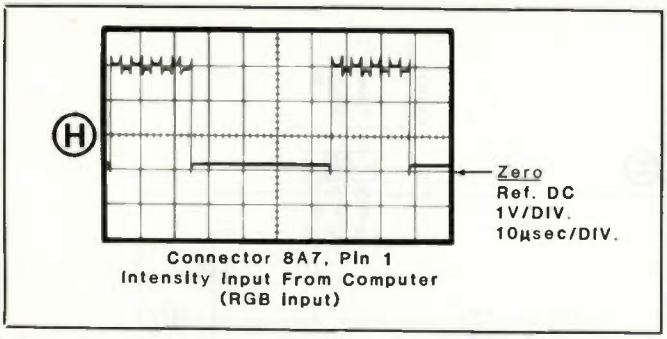

Figure 6. Waveform of the intensity video input signal.

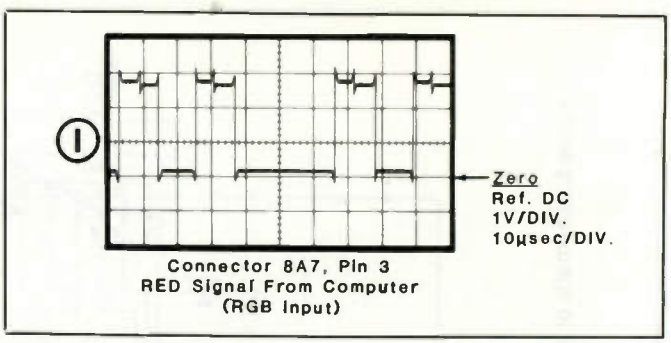

Figure 7. Waveform of the red video input signal.

(Figure 8 on page 43, Figure 10 on page 44)

be due to a bad 16.2V zener diode, a shorted vertical oscillator transistor, open resistors R323 and R326 or leaky capacitors C312 and C316.

Tracing Hercules low and high voltages

The low voltage power supply for the Hercules monitor is the straightforward full-wave bridge rectifier circuit pictured in Figure 2. Along with the bridge circuit, the low voltage power supply consists of switching transistor QX501, a small transformer, resistors and the filter capacitors.

After rectifying the dc voltages, the power supply develops the + 155Vdc, + 24Vdc, and the + 16.2Vdc needed for monitor operation. Also, a B + adjustment control allows the technician to set the B + to the proper + 16.2Vdc level. If the B + goes above a certain tolerance, zener diode CR302 prevents vertical sync pulses from coupling through one of the filter capacitors. As we have seen with television receivers, an excessive B + voltage raises the high voltage level and can cause damage to the monitor.

Generation of high voltage begins with the signal from the horizontal output driver, Q101. This signal couples through the base of a horizontal driver transistor, Q102, and into the horizontal driver transformer, TX101.

Also controlling the current into the horizontal output transformer, TX102, the horizontal driver transistor switches the scan current in the yoke for the right side scan. A combination of capacitor action, diode action and the yoke inductance reset the beam for the left side scan. As usual, the horizontal output transformer steps up the retrace pulse to form the high voltage needed for the CRT.

A "no raster" condition is the tip-off that a power supply problem exists. Just as when working with television receivers, begin by checking the B + supply voltages. If the low voltages are not present or do not have the proper amplitude, you can limit the search to the low voltage supply areas.

An open low voltage diode, CR102, or open resistors RX133 and RX136 can cause the loss of the raster. If the 16.2Vdc, 24Vdc and 155Vdc voltages exist at the test points, you can shift your attention to the high voltage circuitry. Defective horizontal driver transistors such as Q101 and Q102, an open yoke winding or a bad flyback transformer can cause the loss of high voltage.

RGBI video

Figure 3 is an exploded view of an RGBI monitor. Red, green, blue and intensity video input signals produce a display on the monitor with each signal having a voltage set at a digital level. Since the monitor uses four digital input signals, variations of the signals can cause sixteen possible color combinations.

For example, a combination of high red, high green, low blue and high intensity signals produces one color. The intensity bit gives the displayed color more drive and enhances its hue. Figure 4 details the sixteen color combinations given by the four digital signals.

Figure 5 is the schematic diagram for the RGBI monitor video input section. The video input signals enter the monitor chassis through a DB-25 connector and then become applied to a hex buffer/driver integrated circuit. While the intensity bit goes to pins 1 and 3 of IC1700, a digital low red or green signal causes the red and intensity signals to output to pins 2 and 4.

Figures 6 and 7 show the intensity and red input signal waveforms. An active intensity signal forces the signals present at pins 8, 10 and 12 to a digital low state. From those pins, the

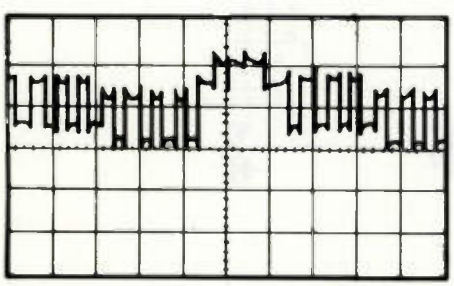

Figure 9. Waveform of the blue video signal.

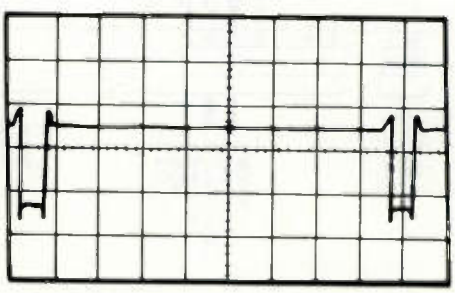

Figure 11. Waveform of the horizontal scan signal.

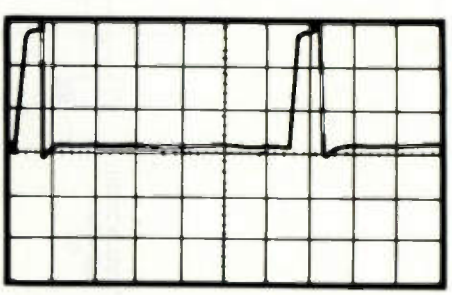

Figure 12. Waveform of the vertical scan signal.

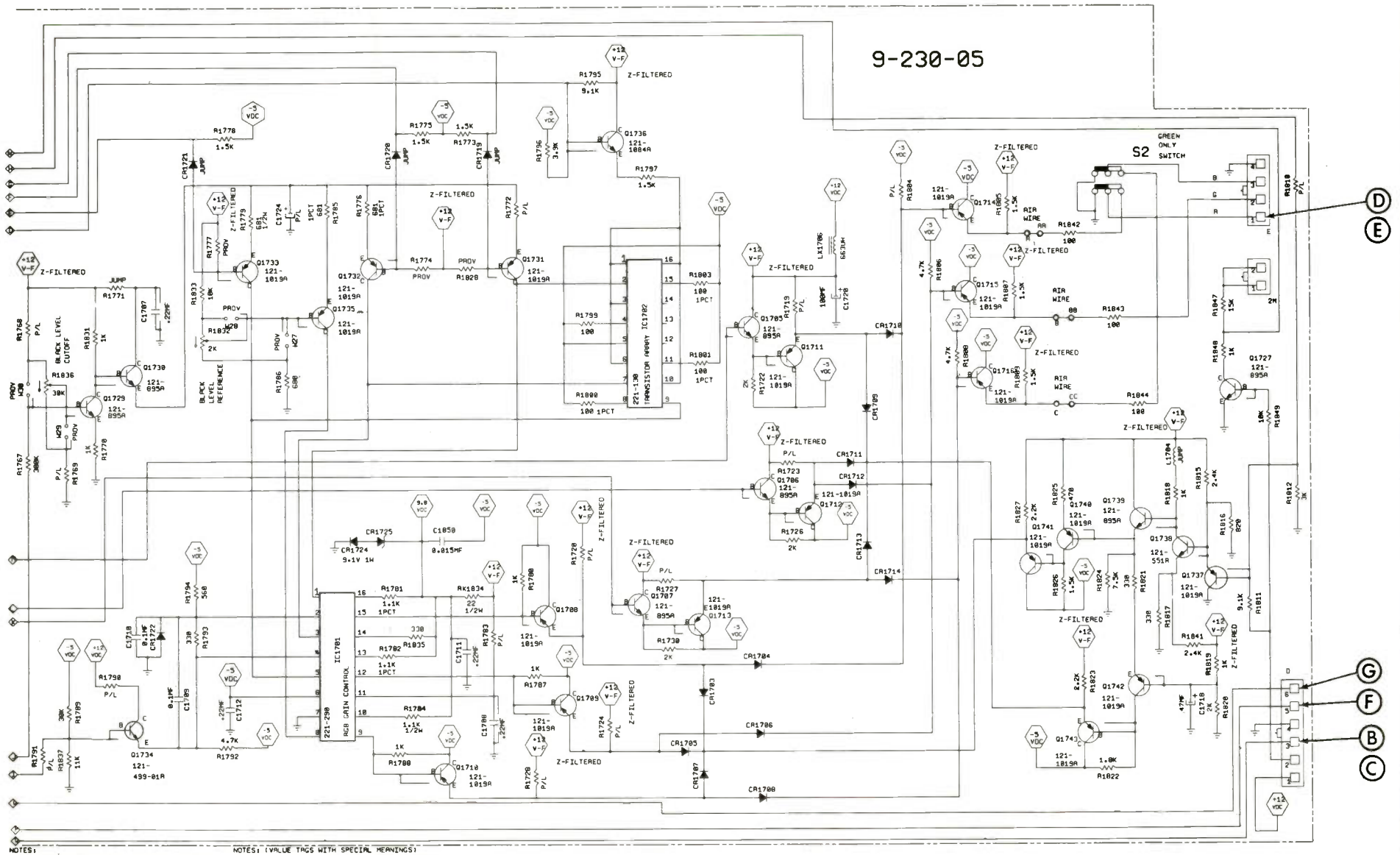

Figure 8. Schematic for the RGBI video processing section.

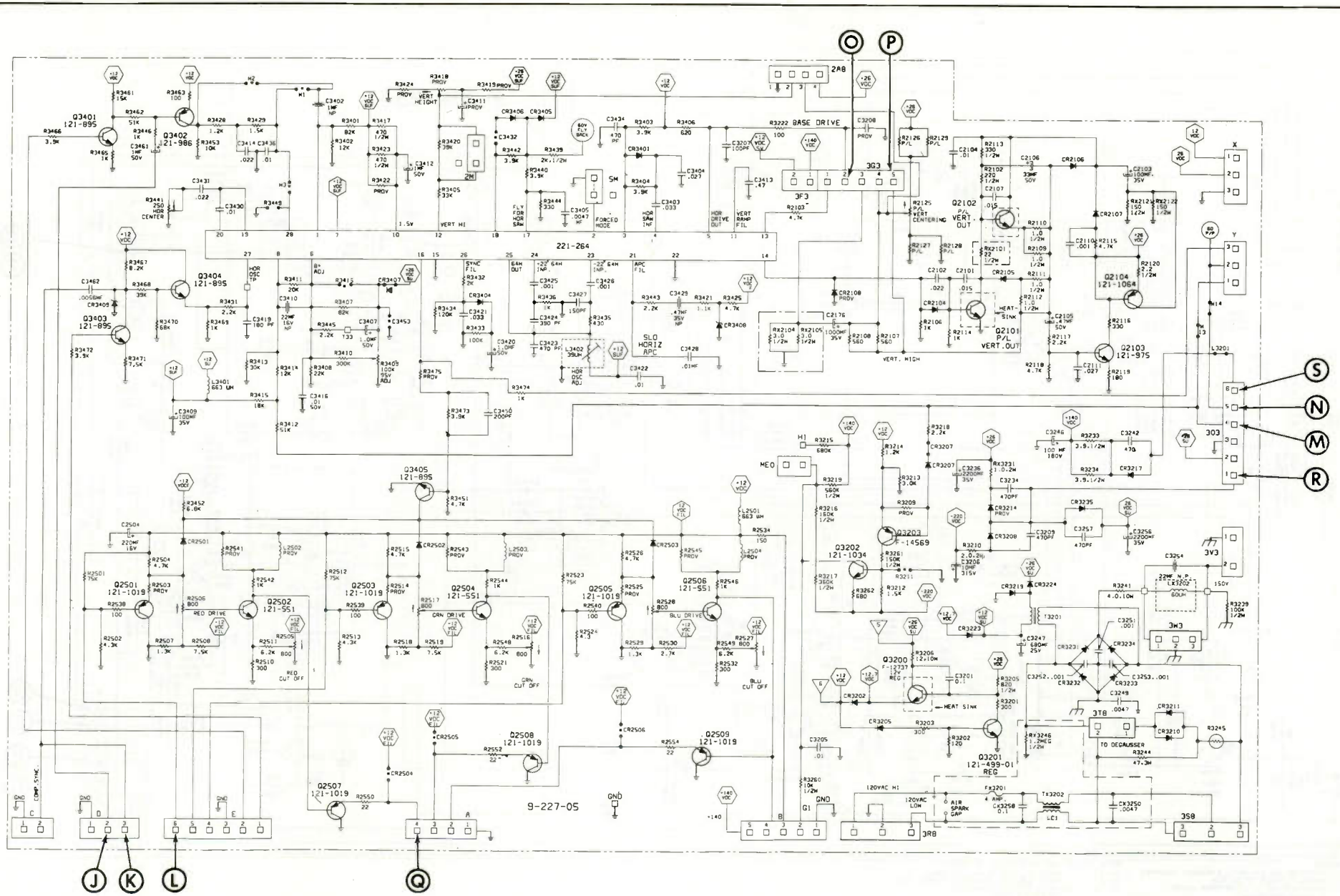

Figure 10. Waveform of the vertical scan signal.

intensity data information flows through three diodes and arrives at the digital to analog (D to A) integrated circuit, IC1723.

IC1723 processes the data and then provides additional drive for the red, green and blue signals present at pins 8, 2, and 5. Those signals provide additional base bias for three RGB output transistors: Q1706, Q1707 and Q1708. These transistors now have higher level RGB signals at their emitters. Figure 8 shows the schematic for the RGBI video processing section.

Stepping back to the video input, Figure 5, the digital low red and green signals outputted from IC1700 go to the bases of transistors Q1703 and Q1704. Base current for each transistor comes from a network consisting of the hex/driver IC, a resistor and a diode. A digital low blue signal drives Q1704 into conduction.

When Q1704 conducts, the red and green drive signals reduce and the signals become equal to one another. Going through an identical buffer-resistor-diode network, the blue signal drives the base of transistor Q1705. Figure 9 shows how the waveform for the blue signal would appear.

RGBI monitors use conventional 15,750Hz horizontal and 60Hz vertical scan frequencies. Unlike most video display designs, though, RGBI monitors employ progressive scanning instead of the normally used interlaced scanning.

Progressive scanning has the lines scanned in order and ignores any even or odd ordering. The scanning starts with line one and ends with line 240 by drawing the lines from the top to the bottom of the raster. All this gives us a resolution of 640 × 240 needed for RGBI operation.

While Figure 10 illustrates the schematic diagram for the scan section of a RGBI monitor, Figures 11 and 12 show the horizontal and vertical scan waveforms. Both signals are measured from the RGBI input connector. Actual sync signal processing takes place within a processor integrated circuit.

IC3401 contains all the circuitry necessary for vertical and horizontal sync signal generation. Vertical signals flow from pin 14 of IC3401 to two transistors, Q2101 and Q2102. These transistors output the scan signals to the sweep circuitry. Horizontal signals flow from pin 5 of the integrated circuit to the sweep assembly. The signals then drive the horizontal output transformer.

Next time

As we progress to the next article, we'll look at another set of video display strategies. The next article on CGA and EGA video adapters and displays will include diagrams, schematics and more troubleshooting tips. Even though microcomputer display technology has become oriented predominantly toward VGA and Super VGA, the information about the CGA and EGA technologies should have a valued place. ■

Direct broadcast satellite television

Long awaited, finally almost here

By Conrad Persson

Good quality TV signals are available to city dwellers from a number of sources: broadcast signals from local stations, network affiliate and independent stations, cable.

For the suburban or rural viewer, this is frequently not the case; many people outside the range of broadcast stations and outside the service area of cable systems have few options for receiving. Many of them have, in the past, had to be satisfied with dim snowy signals, or no television programming at all.

For the past few years, the relatively affluent and adventurous rural dwellers have been able to enjoy clean, crisp TV signals via satellite. Satellite provides a welcome service where previously there was no service at all, and many satellite dish owners are extremely happy with the results.

Of course it's expensive to install a satellite system. And the programming was never really intended for reception by individual consumers at all. All programming that's on satellite today is meant to be fed from network locations or providers of premium services either to the local broadcast stations throughout the country, or to cable service providers.

Enter DBS

All of this is about to change. A number of years ago we began to hear distant rumblings of a television service that would use satellites to deliver TV signals direct to the consumers: direct broadcast satellite (DBS).

In the case of DBS, the programming would originate somewhere on the surface of the Earth and be beamed to the satellite, to be, in turn, beamed back to Earth. But in this case, instead of being fed to local TV stations and cable systems for further distribution (and, incidentally, home satellite dishes) these signals would be beamed directly to the homes of individual consumers.

Persson is editor of **ES&T**

The systems

At the moment, there are two very different systems in various stages of completion: SkyPix, and DirectTV. SkyPix programming is expected to be available for public consumption within a relatively short time. It will be broadcast via medium-power satellites that are currently in geosynchronous orbit. DirecTV, in contrast will use high-power satellites that will not be launched for some time, and will be available for public viewing sometime in 1994.

SkyPix

Skypix operates the world's first fully digital broadcast system (DBS, not to be confused with DBS meaning direct broadcast satellite) offering improvements over conventional broadcast and cable entertainment delivery systems. This system combines advanced digital technologies, including digital video/audio encoding, digital signal processing, digital tuning and digital error connection, to offer viewers convenience, control, choice, and quality in video and audio entertainment.

One important element in the operation of this digital broadcast system is the use of advanced digital technology which enables eight separate video programs to be transmitted in the satellite transponder bandwidth normally occupied by just one program.

Why digital technology?

At the most basic level, digital technology enables SkyPix to offer consumers an eightfold increase in viewing choices, while keeping the cost of program delivery at a minimum. Using just 100 transponders aboard the Hughes SBS-6 medium-power Ku-band satellite, SkyPix broadcasts 80 channels of programming. The receiver is capable of receiving over 250 channels.

Digital technology represents an advantage in the quality of broadcast TV pictures and sound. Because the signal is composed of digital data (not analog waveforms), picture and sound quality are not degraded by the transmission process. In standard analog broadcasts, the signal is distorted and weakened during transmission, resulting in ghosting, picture noises and poor quality. With a digital signal, as long as the numerical data used to encode the video can be received intact (or corrected by error correction technology), reception quality will be identical to the broadcast source.

What is digital compression?

Digital compression is a way of representing a digitized TV signal in a shorthand version, thereby reducing the number of bits necessary to recreate the original picture and sound. The SkyPix digital compression process operates in excess of a 50:1 compression ratio via an extremely complex set of computer algorithms (formulas).

Audiophiles who are familiar with compact disc digital audio technology are already aware of the necessity of error correction in the storage and retrieval of digitized stereo audio. A similar need exists with digital TV broadcast. SkyPix's compression technology contains a forward error correcting technique that prevents bit errors from causing image degradation right on the spot.

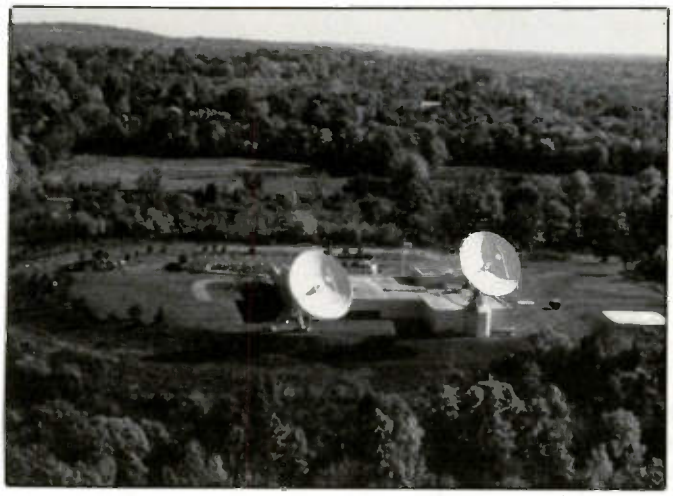

Fig. 1. SkyPix will use existing satellite technology to deliver 80 channels of television programming to subscribers.

Fig. 2. The receiving dish for SkyPix will be three feet in diameter. The company estimates that installation costs will be in the range of $150.00.

To guard against such losses, SkyPix has developed what they claim to be an extremely powerful error correction system. It will correct up to 24 errors per thousand in any sequence, in the digital bit stream. By way of contrast, the error correction system used in current VSAT systems (very small aperture satellite transmissions, used for instance, by department stores and banks to transmit data among branches) can only correct about four errors per thousand. In addition to this error correction protocol, the system also features a smart broadcast/receiving technique that helps alleviate the problem of interference, thereby minimizing the likelihood of uncorrectable data errors.

How broadcasts reach the home

Compression is just the first step in the preparation of a SkyPix signal for broadcast. In order to give viewers up to date information about what's available on other channels, billing information and so on, additional data must be injected into the video data channel.

The ability to transmit simultaneous non-video data on each channel is also key to the smart receiving technology. This technique makes it possible to vary the transmission frequency of each channel when interferences on that frequency threatens its data integrity. To accomplish this, a digital control signal is transmitted to all receivers on the system, which causes them to re-tune to the new broadcast frequency.

Digital compression, channel capacity and transmission bandwidth

Programs are delivered via quadrature phase shift key (QPSK) carriers. The extra bandwidth available on the transponder is traded off in a complex power budget, which enables SkyPix to use the smallest possible receiving antenna over the widest possible geographic area. The extra bandwidth also enables the system to vary its carrier frequencies to minimize interference problems.

(Continued on page 54)

Holes in semiconductors are not "nothing"

By Sam Wilson, CET

I have received a letter with no name and no date. Somehow it got separated from its envelope, so, I don't even know where it comes from. The letter writer gives interesting ideas about how he has learned to understand some of the theories of electronics by using his own models.

In one part the author of the letter says he never caught onto the idea of holes (as in P-type materials). He says: "After all, a hole is nothing - right?"

Sam Says - "Wrong!"

If you have ever paid for a parking space you paid for a hole in a line of parked cars.

The hole in a donut serves a very important function. It permits a greater area of donut to be covered with coffee when the donut is dunked.

You can't plant a full-grown tree in your yard without first obtaining a hole.

The list of things you can do with a hole is nearly endless.

In Figure 1 the balls are being moved from left to right. Assume they have to be moved one at a time. Note that the holes - which are places for the balls - are being moved from right to left! That illustration makes a good model for hole flow and electron flow.

Today, in polite company, the people who know about such things prefer to think about holes as positive charge carriers and electrons as negative charge carriers. That gets us around the idea about a hole being nothing.

Back in the old days they tell me that the idea of electricity being a flow of electrons started with the invention of the vacuum tube diode. The electrons can go from the cathode to the plate, but, there was no apparent flow from the positive plate to the negative cathode. So, they reasoned that electricity must go from minus to plus. However, electricians who seemed to spend a lot of time electroplating found that the plating often occured on the negative electrode, so, electricity must be going from positive to negative.

Well, that is how the story goes. Now, think about this: when an electron leaves the cathode it leaves a hole behind. When it gets to the plate it fills a hole. Which way did the hole go? Remember that the holes are considered to be positive charge carriers. That means there is electricity flowing within the diode from plate to cathode.

If you watch attendants who seem to be moving cars around a parking lot you can easily lose sight of the fact that they are not actually moving cars. After all, they are not renting cars. They are moving holes. It is the holes they are renting. In the morning they have a lot that is full of holes.

The point is that you move what you've got available. In N-type material you have mostly electrons available and they are the majority charge carriers. In P-type material you have holes available and the hole is the majority charge carrier.

Study the information in Figure 2 very carefully and think about what I have just said about moving what you have.

Let me try to head off some letters. I have been using a model to explain hole flow. However, it is a very good model. Using covalent bonds, deathnium traps, interstitial atoms and atomeic theory can get you a little closer to the true picture, but that wont help anyone who is fighting the idea that a hole is nothing!

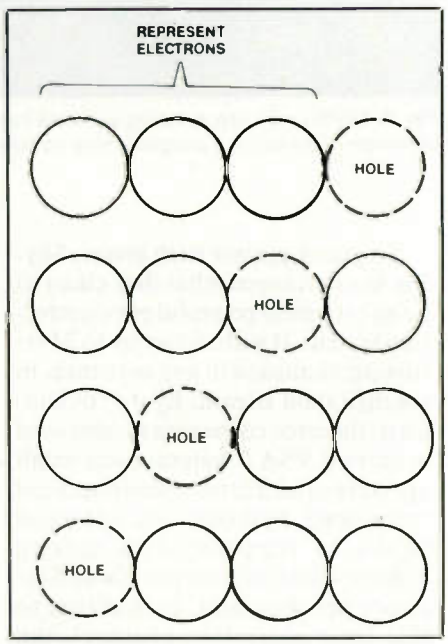

Figure 1.

Television philosophy

Whenever someone starts complaining to me that television is a vast mental wasteland, I remind then of the many occasions when great words of wisdom come forth from the "boob tube." For example, think about these words of wisdom from the Barney Miller Show: "You can shoot a horse with a broken leg but that won't fix the leg."

Now I ask you - is that deep or what?

The brandy solution

What is that brandy doing in the TV shop? Read on. I have an article written by Bernard B. Daien that proposes an exciting new dimension to troubleshooting electronic equipment. Daien points out that solvents in certain tuner sprays, contact cleaners, etc. will attack the seals in aluminum electrolytic capacitors. That allows the capacitor's dielectric goodies to ooze out. Not good.

So, use pure alcohol to clean away flux after soldering a replacement aluminum electrolytic capacitor into a

There are 2.54 centimeters in one inch. A cubic centimeter of pure germanium has about:

44,000,000,000,000,000,000,000

or forty-four thousand million million million or 4.4 times 10^{22} atoms.

At 300 degrees Kelvin ("room temperature") its resistance between opposite faces is about 50Ω.

(Resistivity = 47 ohm-centimeters) It has about 25,000,000,000,000 or twenty-five million million or 2.5 times 10^{13} free electrons and an equal number of holes.

Ionization and recombination are occurring continuously at equal rates, a condition of equilibrium; the number of carriers at any instant is a matter of statistical probability, just as the number of automobile accidents is related to the number of accident possibilities.

If lightly doped with Acceptors (about 3.66×10^{14}), its resistance goes down to about 10Ω, and it has about:

368,000,000,000,000 or 3.68×10^{14}

holes (about 15 times as many holes as the undoped specimen and only about:

1,700,000,000,000 or 1.7×10^{12}

free electrons (about one fifteenth as many free electrons as the undoped specimen).

With doping, the number of minority carriers goes down because there is a greater probability that minority carriers will recombine, since the density of majority carriers is increased. Ionization and recombination occur at the same rate as before. An N type specimen of equal resistivity would have to be more lightly doped because the mobility of free electrons is greater than that of holes.

Figure 2.

circuit. In an emergency, you can use some of the medical brandy which is sometimes found in service shops... usually in the office.

This is only a problem with aluminum electrolytics. Tantalum types don't require seals so those capacitors can be hermetically sealed.

Here is a question often asked: Can a tantalum electrolytic always be used to replace an aluminum type? The answer is No!

If there is a possibility of voltage spikes or any over-voltage condition the tantalum capacitors can be destroyed. Aluminum electrolytics are better suited to that environment.

Fast response

In a previous issue I asked readers to tell me how to turn a diode characteristic curve right-side up. Most popular home-made diode curve tracers show the curves upside down.

The first and only (so far) response came from Royce at Fessenden Technologies in Ozark, MO. He says he hits the invert button on one channel of his scope to turn the curve right-side up.

A former student - who doesn't want his name printed tells me the curve is not only upside-down, it is also right-to-left reversed.

Maybe it depends upon the brand of scope used. Maybe I'll get some more letters.

An infrared mystery

Matt J. McCullar of Ft. Worth, TX has written about the fact that TV and VCR remote controls can be checked with an operating AM radio. He asks how this is possible.

I don't think this is a good test! It doesn't give you a clear indication of how well the infrared diode is working. It was about three years ago that I included a letter on this subject in WDYKAE? I haven't located the letter so I can't give the writer's name. I do remember trying it at that time and it seemed to work very well.

I haven't conducted a lot of experiments but I have an opinion about how it works. I don't think it has anything to do with infrared.

A pulse waveform with a fast rise time and a fast decay time has a wide range of frequencies. The relatively high pulsed current flowing in wires connected to the infrared LED radiate that wide range of frequencies and some of those frequencies are in the broadcast band.

To demonstrate that infrared has nothing to do with it, cover the infrared lens with black tape and try it again. If you hear the same noises in the AM radio I'm right! ■

Home VCR Repair Illustrated, By Richard C. Wilkins and Cheryl A. Hubbard, $19.95 soft.

Most VCR problems are caused by one component that is worn out, loose, bent or dirty. This book is aimed at the owner of a VCR, but contains information that may be helpful to professional servicing technicians as well. The authors, according to the publisher, provide many high-quality photos that help illustrate how to find and correct many of the most common VCR malfunctions, such as jammed videocassettes, clogged video heads, blown fuses, and water damage. The publisher also promises that you will learn trade secrets for repairing problems with picture and sound quality, fast forward and rewind, dc motors, tension and roller guides, undercarriages, takeup spindles, audio heads, and more.

TAB Books, Blue Ridge Summit, PA 17294.

Performance Assessment For The Workplace Volume I and II: Technical Issues, By Alexandra Wigdor and Bert Green Jr., National Research Council, Volume I 256 pages $34.95 hard, Volume II 344 pages $39.00 hard.

Although ability testing has been an American preoccupation since the 1920's, comparatively little systematic attention has been paid to understanding and measuring the kinds of human performance that tests are commonly used to predict such as success at school or work. Now, a sustained, large-scale effort has been made to develop measures that are very close to actual performance on the job. The four military services have carried out an ambitious study, called the Joint-Service Performance Measurement/Enlistment Standards (JPM) Project, that brings new sophistication to the measurement of performance in work settings.

Volume I analyzes the JPM experience in the context of human resource management policy in the military. Beginning with a historical overview of the criterion problem, it looks closely at substantive and methodological issues in criterion research suggested by the project: the development of performance measures; sampling, logistical, and standardization problems; evaluating the reliability and content representativeness of performance measures; and the relationship between predictor scores and performance measures - valuable information that can also be useful in the civilian workplace.

Volume II covers a number of measurement and analytical issues in greater technical detail, including range restriction adjustments, methods for evaluating multiple sources of error in measurement comparing alternative measures of performance, and strategies for clustering military occupations.

National Research Council 2101 Constitution Avenue, NW Washington, DC 20418.

Easy DOS, By QUE Development Group, Prentice Hall Computer Publishing 198 pages, $19.95.

Once properly introduced to DOS, most computer users have little trouble getting the most from their computer. With a solid understanding of DOS basics, it's easy to learn other programs and functions.

QUE's East DOS is filled with practical facts and useful tips on how to use a personal computer - and DOS - to complete common computer jobs. The streamlined format gives instructions one simple step at a time.

Users learn the secrets behind the "mysterious" DOS code; what is, what it does, and how it can make computing fun. There are step-by-step instructions on how to copy files, create directories, and work with floppy diskettes. DOS tasks are explained in plain English and illustrated with actual screen graphics. User-friendly "Oops" tips tell users what to do if they make a mistake. Users can follow along with chapters for a beginning course in DOS or skip around - they're bound to find new tips, tricks, and answers to questions.

Prentice Hall Computer Publishing, 11711 North College Avenue Carmel, IN 46032

Using PC Tools 7.1, By Walter R. Bruce III with Jodi Schroth, Prentice Hall Computer Publishing, 844 pages, $24.95.

Beginning and intermediate users find that this combination how-to/reference book adds peace of mind and power to their personal computing. Giving users the necessary information about files, directories, and disk management with PC Tools, this book makes it possible for users to become surehanded with the methods for gaining complete control of the PC.

Using PC Tools 7.1 provides clearly focused examples and in-depth advice that assists users with each PC Tool, including PC Shell, Central Point Backup, File Fix, Rebuild, PC Secure, Central Point Commute, and updated Windows capabilities. They learn how to back up the hard disk, organize files and directories, add security and power to hard disk performance, recover accidentally deleted files and inadvertently formatted disks, run PC Tools within Windows 3, and speed up work with PC Tools macros.

Special tips, notes, and cautions inside Using PC Tools 7.1 help users improve performance. The book teaches readers how to use the latest PC Tool companions to organize thoughts, manage information, streamline schedules, communicate through the computer and a telephone, send fax, and perform numeric and financial computations. The book covers PC Tools versions 6 and 7.1. In addition, the book helps users fix damaged 1-2-3, Symphony, and dBASE files.

Prentice Hall Computer Publishing 11711 North College Avenue Carmel, IN 46032

Understanding Data Communications, By Gilbert Held; Prentice Hall Computer Publishing, 368 pages; $24.95.

Understanding Data Communications takes the vast, complex world of computers and condenses it for the layperson. This uses plain English and illustrations to explain how various computer hardware and software components work and communicate. An overview of data communications introduces readers to the basics and how they are connected to the real world. This volume discusses database services, information utilities, electronic bulletin boards, and other up-to-the-minute technologies. These concepts and principles are accom-

panied by a thorough look at the world of digital communications. Here, the book spells out the advantages and disadvantages of local area networks, packet networks, and network design and management.

The book is arranged somewhat like a textbook, with chapters that start and end with a summary, plus a short multiple-choice quiz on each chapter's contents.

Prentice Hall Computer Publishing 11711 N. College Ave, Carmel IN 46032

1992 EIA Directory, By The Electronics Industry Association, $85.00 for members, $200.00 for non members.

The Electronics Industries Association (EIA) has published the 1992 edition of its annual "Trade Directory and Membership List." The current listing of more than 1,000 member companies represents the full spectrum of the $271 billion U.S. electronics manufacturing industry. This useful publication describes EIA members; corporate and division locations, telephone numbers, trade names, as well as executive level personnel. Products and services of each company are also included. The EIA 1992 Trade Directory and Membership List includes a valuable section on facilities by geographical location. There is a convenient "cross-reference" of companies by product category. The directory also features a section on the Association's Board of Governors, Groups, Division and Departmental officers, committees, councils and panels, as well as a staff listing.

Electronic Industries Association Public Affairs Office, 2001 Pennsylvania Ave, N.W. Washington, D.C. 20006.

Hands-on Resource To Understanding Automotive Electronics; By William B Ribbens, Ph.D.; Prentice Hall Computer Publishing, 392 pages; $24.95.

Automotive electronics change a great deal during the 80's and early 90's. Understanding Automotive Electronics, Fourth Edition, brings electronics buffs up to date on the latest technology.

This volume explores electronic engine control and the development of all-new automotive subsystems. Readers discover step-by-step, self-paced tutorial lessons that introduce the most vital areas of electronics within the auto environment. They learn how and why electronic circuits and devices now replace what used to be mechanical and pneumatic.

Packed with essential reference material and illustrations this book helps readers define the systems approach to control and instrumentation, understand how sensors and actuators operate, discover the latest digital engine control techniques, understand the elements of automotive instrumentation and diagnostics, and look into the future of automotive electronics systems.

Prentice Hall Computer Publishing, 11711 North College Ave. Carmel, IN 46032.

Servicing IBM computer monitors

By T.V. Kappel

Once you get through all that metal shielding inside a computer monitor, you'll find that the workings are familiar; similar to those of a television set. You'll also find all the same servicing problems and headaches: the tight quarters make it difficult to work on, schematics are hard to locate and purchase, finding parts sources is a headache. Compounding the problem in the case of monitors, however, are all of the different scan modes, which can make them difficult to test before and after repair.

That's the bad news. The good news is that computer monitor servicing is a lucrative and profitable business area and one that many computer maintenance shops would love to subcontract out. There is definitely money to be made here. So, let's get to work and repair a few monitors.

IBM Model 8513001

You will find that there are actually two manufacturers for this model. I use the FCC ID Number to keep them separate in my notes. You should keep a note book on every monitor that you repair. It will be worth its weight in gold.

FCC ID Number BJM9UBCM-2A01 s manufactured by the Tatung Company, 22 Chungshan N Road Sec 3, Taipei, Taiwan 10451. FCC ID Number ANO9SA8513001 is manufactured by the IBM Corporation, Old Orchard Road, Armonk, NY 10504. I have found and purchased schematics for these products from Eagan Technical Services, Inc., 1380 Corporate Center Curve, Suite 107, Eagan, MN 55121, Tel.:612-688-0098. They refer to the Tatung model as the 8513-72, and the IBM model as the 8513-23. Since it is easier, I will adopt that nomenclature.

Kappel is Telecommunications Engineer for the District Library, Instructional Technology Services, for the Alburquerque, NM, Public Schools.

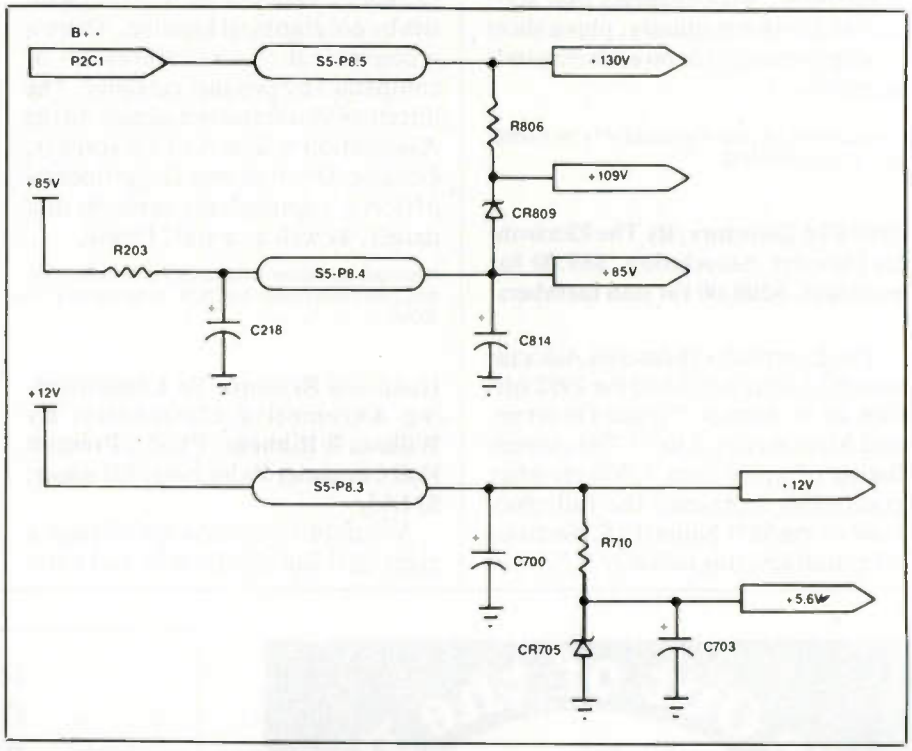

Figure 1. The cause of a burned R203, 120Ω, 5%, 1/2W resistor in this 8513-23 monitor was that one leg of C218, a 10μ, 100V, electrolytic capacitor had ringed and broken free of the motherboard.

Model 8513-23 repairs

As with television sets, I have found common repetitive failures with computer monitors. The Model 8513-23 has a couple of these. One repetitive problem causes a variety of symptoms: dead set, flashing picture, arcing sound, burning smell, and others. It is a common problem and quite simple to fix. The ac socket mounted on the motherboard has become ringed or broken loose at the solder points. I have repaired this on a number of such units by resoldering, or running a wire jumper to strengthen the connection. In some cases, if the monitor is unplugged and moved often, I have used silicone compound to fortify and support the socket itself.

The symptom on another 8513-23 was that when it was plugged in smoke rose in a tall thin column from the rear of the unit. After disassembling this unit, I found that R203 was burned to a crisp. It was so badly damaged that I couldn't identify its value without a schematic diagram, or another unit to compare against. It turned out to be a 120Ω, 5 percent, 1/2W resistor.

Further examination of the circuitry revealed that the cause of the burned resistor was that one leg of C218, a 10μF, 100V, electrolytic had ringed and broken free of the motherboard (See Figure 1). After obtaining a schematic, I learned that both of these components are in the 85V supply line. Replacement of both components solved this problem and restored this monitor to proper operation.

When I opened the next unit, I found bits and pieces of an electrolytic capacitor that had been blown apart all over inside. I located the remains of this capacitor, C228, and learned from the marking on the can that it

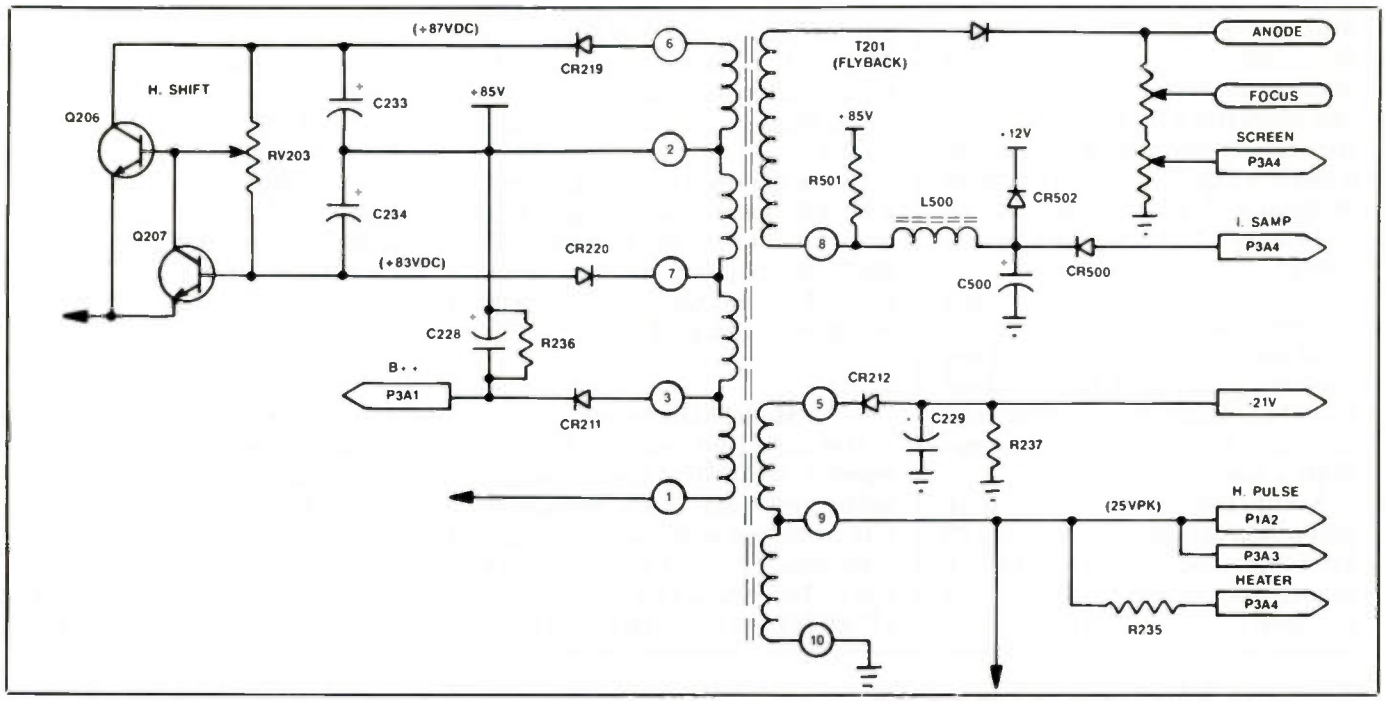

Figure 2. In this 8513-23 I found bits and pieces of C228, a 10μF, 100V, electrolytic capacitor. Following the copper traces I found that CR211 off pin 3 of the flyback transformer was dead short. R236, a 22KΩ, 5% resistor in the same path was burned open.

was a 10μF, 100V, capacitor (see Figure 2).

Following the copper traces to see what might have caused this kind of catastrophic failure, I found that CR211 off pin 3 of the flyback transformer was dead short. I obviously had a dc supply diode short which blew the capacitor apart.

A little more checking for damage turned up R236, a 22KΩ, 5 percent resistor in the same path that was burned open. I replaced the FR105 diode with an ECG552 and replaced both the capacitor and the resistor. This restored the monitor to normal operation.

Model 8513-72 repairs

The common repetitive problem that I have encountered on the Model

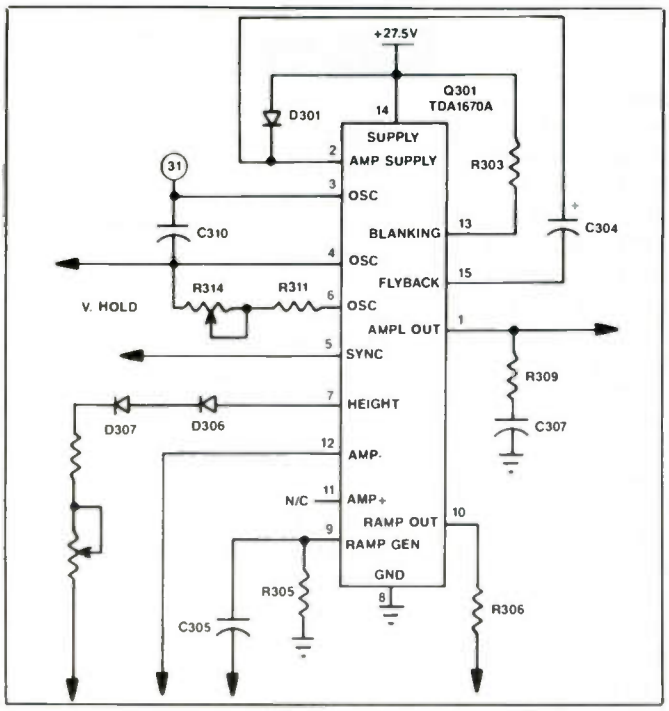

Figure 3A. In almost every case of an 8513-72 monitor where the symptom is a bright thin line across the center of the screen, you'll find that the vertical IC, a TDA1670A, is bad.

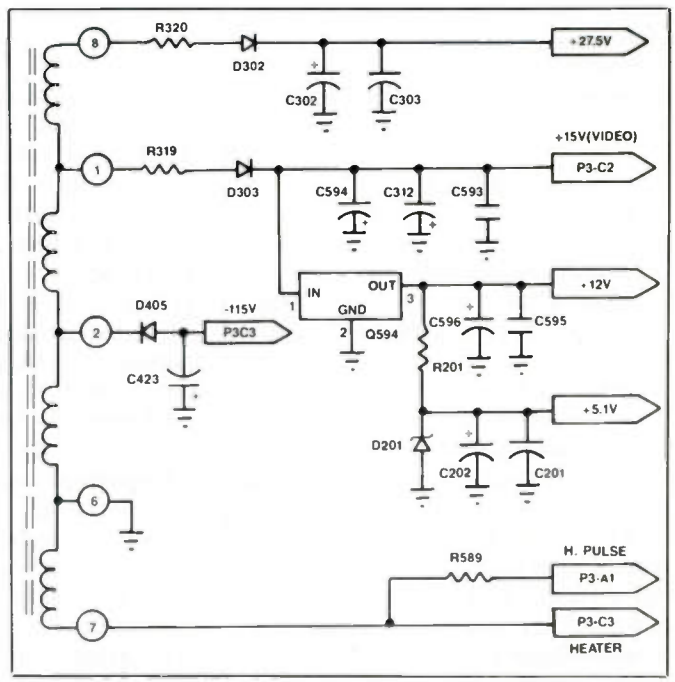

Figure 3B. In one 8513-72 monitor, the problem of a bad TDA1670A IC was complicated by the failure of the 27.5Vdc supply diode, D302, a shorted RPG15J, connected to pin 8 on the flyback, and a burned resistor R320, a 100Ω, 2W.

8513-72 is vertical collapse: the display shows only a bright thin line across the center of the screen. In almost every case where this is the symptom, you'll find that the vertical IC, a TDA1670A, is bad (see Figure 3A). This IC can be replaced with an ECG1862. But replacement of the IC may not be enough.

I serviced one unit that was brought in from another service center on which the technician had replaced this integrated circuit, and when it did not solve the problem, he pulled it out and reinstalled the old one and gave up. What a waste.

A little more patience and examination would have shown that the 27.5 Vdc supply diode, D302, an RPG15J, connected to pin 8 on the flyback, had also shorted, and resistor R320, a 10Ω, 2W, had burned open (see Figure 3B). The new IC he had worked so hard to install had no Vcc supply voltage to run it. He never checked. He just gave up. So close and yet so far.

Replacing D302 with an ECG552, R320 with a new resistor, and vertical output IC TDA1670A with an ECG-1862, restored proper operation to this unit and the next half dozen units with exactly the same problem.

Model 8514 repairs

This large IBM monitor, FCC ID Number ANO9338514, also has a repetitive problem. It was brought in with a dead-set symptom. A physical examination showed nothing burned and no fuse open. This monitor uses a 2SD1849 and a 2SD1850 to provide horizontal sweep and high voltage. An examination showed that Q560, the 2SD1849 horizontal output transistor was a dead short.

I ordered a replacement transistor from a distributor, and the schematic from Eagan Technical Services. This schematic is also available from Panasonic and IBM; part number 75X8236. Replacing this transistor restored proper operation to the unit.

It appears that when this device fails, the power supply shuts the set down without further damage. I wish other units worked this well.

I use a Sencore Computer Monitor Analyzer Model CM2000 to troubleshoot, test and burn in these monitors before and after repairs, although an inexpensive PC with the proper display card can also be used as a piece of test equipment.

Finally, many of the IBM monitors use tamper-proof Torx screws to restrict access, so be sure to have a set of Torx screwdrivers on hand for monitor work.

When you finally get inside a computer monitor, you do find many of the familiar circuits and problems that you have repaired in TVs in the past. Don't let this lucrative market pass you by. Check it out today. ■

Art supplied by Eagan Technical Services.

Some useful information

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FCC IC Code ANO

IBM Corporation
Old Orchard Road
Armonk, NY 10504

Video Corner *(from page 47)*

With a digital system, you do not experience the differing degrees of reception quality that analog systems display. At or above threshold the system will either fail to initialize or, if already initialized, will display a freeze frame, block breakup, menu default, and other types of errors. The opportunity to get close and then peak does not exist with a digital system.

DirecTV

DirecTV is a DBS system that will use a new generation of high- power Ku-band satellites using the latest digital video compression technology. The satellites, and programming administration will be handled by Hughes Communications. The consumer equipment: receiver and an 18-inch antenna, will be provided by RCA. This system is expected to be in operation by early 1994.

This system will be capable of providing up to 128 channels of programming from 2 high-power geostationary satellites. According to information available from RCA at the summer Consumer Electronics Show in June, this system will be capable of superior audio and video quality that will rival laser disc.

The programming is expected to include the best in movies, sports and unique pay per view events. Technologically, the system will be forward compatible with widescreen TV (the same 9 by 16 aspect ratio as motion picture screens) and high-definition TV.

Installation

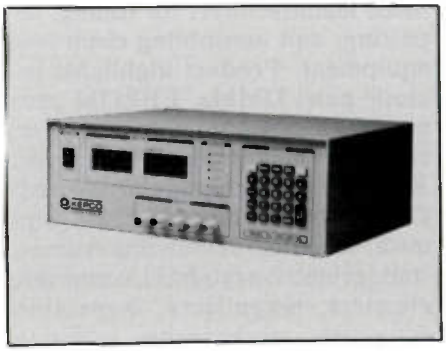
SkyPix claims to have trained over 2500 industry professionals as authorized installers. SkyPix began the first phase of its Authorized Installer training in mid-January 1992. Interested parties may obtain more information at 800-622-5990. Because of the small, 18-inch diameter, size of the DirecTV antennas, current planning is to sell the antenna, receiver, and wiring as a package that is installable by the user.

Opportunities for service centers

Over the next several years, as first SkyPix and then DirecTV, and possibly other direct broadcast satellite TV systems come on line, there will be opportunities for consumer electronics service centers to install, troubleshoot, service and adjust these new systems. Stay tuned to this magazine: we'll keep you informed of what's going on and what it may mean to you. ■

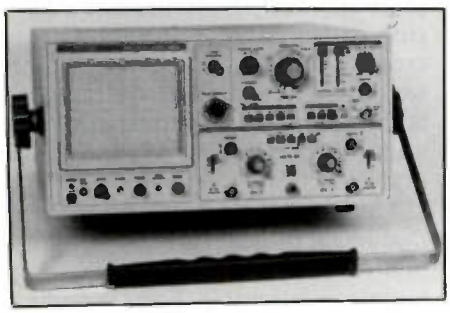
DPS power supply

Kepco announces a new digital power supply DPS which provides 75W of well-behaved dc power in four ranges from 0V to 12.5V to 0V to 125.OV. DPS is controlled by a front panel keypad that commands a built-in microprocessor to set voltage, current limit, range, OVP, displays and



over-current protection. Remote talk-listen control is exercised via a simple RS232C connection that may be addressed in BASIC or most common languages. Keypad SLEW controls permit continuous adjustment of the voltage up and down for fine adjustment while the output is enabled. Separate large-character LED displays are provided for both voltage and current.

Circle (52) on Reply Card



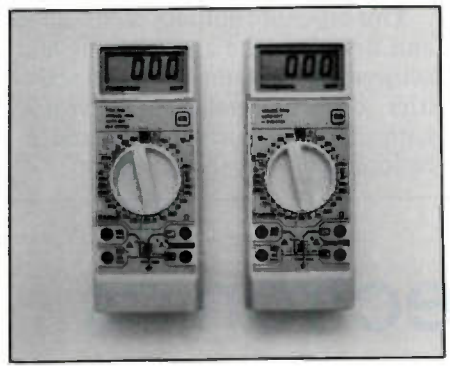
100MHz, 3-channel analog oscilloscope

Goldstar Precision has announced the arrival of their newest 100MHz 3-channel and 8-trace analog oscilloscope. Other features include 6 inch CRT display, dual time bases, delayed sweep, illuminated graticule, multicoupling, multitriggering and variable holdoff.

Circle (53) on Reply Card

Heavy duty DMM's

Fieldpiece Instruments has added models HB75 and HB77 to its full sized heavy duty HB70 series line of multimeters. The meters include a variable pitch tone, a built-in logic probe, and true RMS. Both models feature a variable pitch tone which produces proportionally high pitch tone for a high reading and a low reading. Both meters have a built-in logic probe that responds up to 200MHz. High and low are indicated both in the display by up/down arrows and by a beeper with two different tones to indicate the high and low. Both also have built-in capacitance meter that measures capacitors up to 200μF.



Circle (54) on Reply Card

PC Maintenance Annual

Jensen Tools Inc. offers a 375-page illustrated reference book containing all the maintenance and repair information needed to support IBM/Compatible and Macintosh PCs and peripherals - and in form that will not be obsolete in six months. The PC Computer Maintenance Annual is packed with detailed drawings and illustrations and cover over 200 step-by-step procedures for troubleshooting and repair of specific equipment. Annual owners receive additional pages and updates quarterly at no additional cost for one year. (Requests for updates are renewable for an additional fee every 12 months.)

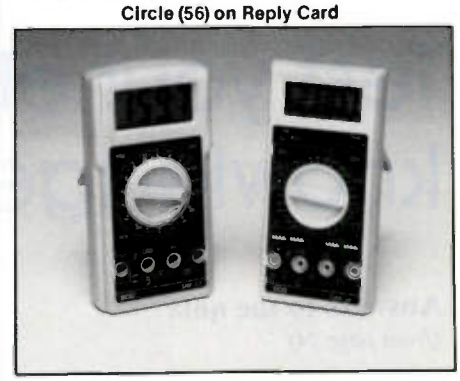
Circle (55) on Reply Card

Surge suppressor

Tripp Lite now features a new surge suppressor with built-in diagnostic indicators to pinpoint power and wiring problems. Th unit has a direct plug-in design with two surge protected and

noise filtered ac outlets. Sine wave tracking provides fast accurate surge suppression. Separate multi-color LED indicators display ac power present, power protection circuitry status and wiring faults, such as phases reversed, missing ground, or other wiring errors. Tripp Lite will repair or replace both the suppressor and connected equipment if damaged by a surge, for life.

Circle (56) on Reply Card



Multimeters

Philips ECG introduces two new digital multimeters, each designed to fill a particular need in the electronic servicing industry. The DM-38 meter combines the nine most frequently needed functions and ranges in one dependable hand-held instrument. Special features offered include a 3-3/4 digit LCD display, peak data hold, and rugged construction. Functions measured are capacitance to 40μF, frequency to 4MHz, logic (TTL type), transistor hFE, voltage to 750Vac/1000Vdc, current to 20A, semiconductor junctions and audible continuity. The meter provides 0.5% basic accuracy in a multicapability meter, for field, lab and shop.

Circle (57) on Reply Card

Catalog of personal computing tools

Personal Computing Tools Inc. announced their week the release of the 64-page, April-June 1992 edition of "The Catalog of Personal Computing Tools for Scientists, Engineers, and Technical Professionals."

The catalog gives customers a 90-day money back guarantee, as well as a full 2 year products warranty. A 48-hour delivery guarantee is offered on most products. Products are shipped FedEx Economy Two-day Service at no extra cost to the customer. Expert technical support from experienced applications engineers is always free and unlimited. A sampling of new products include: multi-axis, simplify field data acquisition with the HC mobile computer, check out two A/D boards providing 20KHz sampling, and 8 inputs, read data from any RS-232 device directly into any PC application without hardware or programming with the SoftwareWedge.

LAN and PC courses offered in brochure

Ten intensive short courses are described in a new brochure, LAN & PC courses, offered by Learning Group International Topics covered in the courses include: Hands-on PC Configuration & Troubleshooting, Advanced PC Configuration, PC Networking, Hands-On LAN Troubleshooting, Hands-On Novel Networking, Managing PC Networks, Multivendor Networking, Internetworking: Bridges, Routes, Gateways.

This brochure outlines each course and describes the applications and subjects covered, the hands-on activities, benefits, materials provided, authors and instructors, dates and locations, and who should attend.

Supplies supplement for test equipment and tools

The 48 page supplement to the Contact East general catalog comes packed with hundreds of new test instruments and tools for engineers, managers, technicians, and hobbyists. Featured are products from brand-name manufacturers for testing, repairing, and assembling electronic equipment. Product highlights include new: DMMs, EPROM programmers, power supplies, adhesives, tool kits and portable digital scopes. Also included are popular lines of: DMMs, communication test equipment, soldering/desoldering systems, static protection products, ozone safe cleaners, magnifiers, inspection equipment, workbenches, precision hand tools, tool kits, cases and more.

Service Contract Industry Council (SCIC) becomes independent organization

The National Association of Retail Dealers of America (NARDA), announced today that the Service Contract Industry Council (SCIC) was moving forward as an independent organization and no longer a NARDA division. Mr. Ed Knodle, NARDA President stated, "Two and one-half years ago, when SCIC became a division of NARDA, our goal was to create a disclosure document which would provide retailers with important information regarding extended warranty companies. We have met that goal."

The NARDA/SCIC Disclosure Document provides critical information for a retailer prior to entering a business relationship. Facts regarding insurance, administration, and management are all clearly set forth. The disclosure documents provide retailers a basis to compare competing companies. SCIC has now proposed model legislation to regulate the service contract industry. It is possible that the position of SCIC and independent retailers may vary and thus, it was time for both groups to move forward independently.

NARDA is a not-for-profit trade association of more than thirty-five hundred independent retailers. ■

Test your electronics knowledge

Answers to the quiz

(from page 24)

1. (a) . . . It is a P-channel JFET. Its drain must be negative with respect to its source.

2. monostable . . . A narrow input trigger pulse results in a wider output pulse.

3. (b) . . . The point marked 'X' is called the virtual ground. The operational amplifier always works to keep that point at zero volts.

4. 1.5K . . . When R_f equals the input resistance (1.5K) the gain of the circuit is 1.0 and the circuit acts like an inverting buffer.

5. 6.3V . . . Transformers are marked with RMS voltages.

6. Total Harmonic Distortion

7. Capture Ratio . . . The definition is stated by the question

8. (b)

9. voltage-controlled oscillator (VCO).

10. (b) The circuit is connected as an FM detector and f_1 is the input signal. In that application the VCO is locked onto the carrier frequency. As the carrier swings above and below the carrier frequency at an audio rate the output voltage at the low-pass filter also swings at the audio rate. Note that the condition given in Figure 3 is $f_1 = f_2$.

Readers' Exchange

Reader's Exchange has been reinstated as a free service.

The following restrictions apply to Reader's Exchange:

- Only individual readers may use Reader's Exchange, and items must be restricted to those that are ordinarily associated with consumer electronics as a business or hobby. If you're in business to sell the item(s) you want to offer for sale, the appropriate place for your message is in a paid advertisement, not Reader's Exchange.
- Readers Exchange items must be restricted to no more than three items each for wanted and for sale, and may be no more than approximately four magazine column lines in length (about 20 words).

Send your Reader's Exchange submissions to:

Reader's Exchange
Electronic Servicing & Technology
76 N. Broadway
Hicksville, NY 11801

FOR SALE

Service information on AKAI AD6900C stereo cassette deck: search coil for compass 77B meter detector. *Errol May Box 81 Buffalo, NY 14207.*

Sams Photofacts #1025 to 2746, most like new. Many in the 1800, 1900, 2000, 2100 series. $4.00 each. *George Eaton 803 293-2822. Big Pines TV 3648 Socastee Blvd Myrtle Beach, SC 29577.*

Electronic test equipment, books and magazines. Send SASE to *Daniel Seidler 3721 W 80th St. Chicago, IL 60652.*

Sams Photofacts from 1 to 1094 plus auto radio series from 19-171 also hundreds of TV tubes new in cartons. *Ann Bichanich 218 254-4421 Chisholm, MN.*

Leader LSW-333 sweep marker generator like new. $450.00. Eico model 944 Yoke and flyback tester. $250.00 call *Brian at 616 347-7810.*

New tubes in factory cartons 90% off list price, parts, text books, service manuals. Send large SASE. *M. Seligsohn 1455-55th St Brooklyn, NY 11219.*

B&K Model 1035 WOW + Flutter meter used very little $600.00. Leader model LDM 171 distortion meter used very little $600.00. Sencore SG165 stereo analyzer. *David Kissiah 2206 S. Cannon Blvd. Kannapolis, NC 28081.*

B&K 1541 scope $500, 1805 freq counter $150, 1251 N + SC generator $750, LSG-17 freq generator $150. *Ed Smerud 319-544-4656.*

PTV Magnavox reflection module A10038B002, Power supply module for Magnavox APW096-003 $75.00 a piece. PTV ASG014 video bands for Magnavox $50.00, PTV Yokes 362107-3 $20.00. And a 19C5 Magnavox chassis with MC2 tuner $75.00. Much more. *Ugene Otto 419-523-0680.*

Conar 225 scope with probes $125.00. Heathkit Yoke and Flyback tester $50.00. Anders Capacitor checker $25.00. Send SASE for more to *ECO Electronics 9709 Zimbro Ave, Monassas, VA 22110.*

Service manuals: Mfrgs, NR1 Vol 1&2, Joh F. Rider. Sams PF: TV, VCR, AR, TR, MHF. etc. Modules: Zen, RCA, Quasar, Mag, Parts: IC's transistors, diodes, resistors, capacitors, etc. Some equipment send LSASE. *Wade Nelson, 22687 Miriam Way, Grand Terrace, CA 92324 914-825-2287.*

Sams TV Photofacts, from #1000 through #2600 $1.50 each like new. *City Wide Electronics 1503 N. Maple, Fresno, CA 93703 209-252-4112.*

Zenith service literature 1976 to 1972 clean 1500.00. Sencore CB42 analyzer with 178 Sams C.B. Facts 500.00. TV and Radio tubes in most original box 1500.00. Part of set of Sams Photofact maybe 1500. SOme old-some dirty, all for 250.00. *Dales TV RT1. Box 236 MTN. View, MO 65548 417-934-6655.*

Magazines for Commodore C-64/C-128 Ahoy-Computer Gazette-Run-Commodore. *Jack Grossman (Apt 7N) 98-17 Hor. Hdg. Expy Corona, NY 11368 718-271-2775.*

B&K 480 CRT tester, restorer, manual, 4 month old. *Walt Joyce 704-563-1959.*

Entire inventory TV-VCR repair shop $2,500 lists at $10,000 over 1/2 in solid state 15 yrs + select tech mags $100 plus shipping. *E. Odom 209-732-1240.*

Sencore 153 deluxe color generator $20, B&K Model 600 tube tester $15, Heathkit TS-4A alignment generator $25, heathkit IG-37 FM stereo generator $95. *Leonard Duschenchuk 255 Stewart Ave, Bethpage, NY 11714.*

Sencore - CR70, VA62A w/expander, VC63, NT64 and accessories. All manuals. Excellent condition. A real buy at only $2975 and shipping. *Call Paul 408-249-1337.*

Sencore equipment all like new with cables manuals and schematics. VA62, VC63, ST65, LC75 with SCR250 and PR57. Will sell separately or as package. *Marc Derkrikorian 603-434-0041.*

B&K model 541 component comparator (IC tester) with all leads and manuals. Like new condition. $2250.00. *Davis Electronic Service, 1729 Parkview Dr., Chesapeake, VA 23320, 804-523-6591.*

138 cordless phone antennas. C.B. accessories. *Ralph Bianco 1431 Robinson Place Havertown, PA 19083 215 446-4519.*

WANTED

Schematic service info on Panasonic tape RQ 335. *Lando Moyer Box 38 Bedmonster PA 18910.*

Service documentation for NEC 3550 letter quality printer. Repair courses on printers and facsimile equipment. *J. Brady P.O. Box 7711 York, PA 17404.*

Used VCR remote controls; Fisher VCR RF modulator #4-1164-011610; Panasonic Flyback #TLF 14712F. *Ed Herbert 410 N. Third Street; Minersville, PA 17954.*

Field strength meter. VHF-UHF, leader channel master, etc. Reasonable price *Les Gaskell 15W. Owens Ave.* #86 N. Las Vegas, NV. 89030, 702-642-0325.

Service manual or schematic for a tour sound stereo amplifier 850sc soundmaster power system module 242 S. Stereo will pay for copies. *A.R. Vickery The Music Shop 548 Main Street. Torrington, CT. 06790.*

To trade: our quick-fix symptoms and cures, these are no bull - money makers! Call *614-774-2488.*

Copy of printed board surrounding DC input connection (from AC adapter) of stereo radio/cassette player. Please, not just a Sam's photo of components board not sufficient. *S.O. Sellers 7308-Franklin Drive Bess AL 35023.*

Need a black and white picture tube #4ADC4 new or used. *Lev Wojnar 624 N. 4th Ave Lindenwood, NJ 08021.*

Transistor radios: Regency, Motorola, Sony, *S. Martin 815 N. Hayden Rd. B-204 Scottsdale, AZ 85257. 602-994-3162.*

CIE Electronics Engineering lessons, complete or else. COD shipping. Please contact *Noel Barrette C.P664 Barraute Abitibi, P. Que, Joy IAO Canada.*

Power transformer for Eico model 460 oscilloscope part #30015. *Ramon Rodriguez 9523 Joe Prt Richey, FL 34669.*

Keyboard or schematic for Xerox T200 computer. *D. Beard 10587 McKenzie RD. Fairhope AL 36532.*

Pre 1965 Citizens Band radios, literature or schematics, especially oddball sets. *Phil Grant 119 Hoeshop Rd. Bernardston, MA 01337.*

Classified

Classified advertising is available by the word or per column inch.

By-the-word: $1.65 per word, per insertion, pre-paid. Minimum charge is $35 per insertion. Initials and abbreviations count as full words. Indicate free category heading (For Sale, Business Opportunities, Miscellaneous, Wanted). Blind ads (replies sent to ES&T for forwarding) are $40 additional. No agency discounts are allowed for classified advertising by the word. Contact Emily Kreutz at 516-681-2922 to place you classified ad (by-the-word). Or send you order, materials and payment to **Emily Kreutz, Electronic Servicing & Technology, 76 North Broadway, Hicksville, NY 11801.**
Per Column Inch (Classified Display): $235 per column inch, per insertion, with frequency discounts available. 1" minimum, billed at 1/4" increments after that 10" maximum per ad. Blind ads are $40 addition. Reader Service Number $25 additional to cover processing and handling costs. (Free to 4-inch or larger ads.) For more information regarding classified display advertising please contact Jonathan C. Kummer at 516-681-2922. Optional color (determined by magazine) $150 additional per insertion.

FOR SALE

THE ONLY ANSWER TO REPAIRING ELECTRONICS PROFITABLY (This should have been done years ago) **GET SMART!** Someone somewhere has already repaired your next repair **YOUR BEST TECHNICIAN,** who's training you have paid for JUST LEFT TODAY! **YOU'RE THE BOSS** and now you have put on your old rusty technician's cap. **TODAY YOUR BANK** sent you three NSF checks your customers graciously gave you, and you don't have time to chase them down to collect, **THEY LEFT TOWN. IT'S TAKING YOU LONGER** to assess the repairs and your customers are now coming to collect their units. You promised to give them a **FREE** estimate, but you just realized you don't have a schematic or time to do it. **NOW YOU ARE DOING NIGHT REPAIRS** because during store hours the phone rings off the hook with nuisance questions about setting VCR clocks and you have parts to order, bills to pay and service literature to file. **CIRCUIT CITY JUST MOVED IN** and your wife says there's no money in repairs. **FRIEND!! YOU DEFINITELY HAVE AN EMERGENCY!!** Spend $350.00 NOW & **RECEIVE A MILLION AND ONE HALF DOLLARS VALUE IN TECH-TIPS.** 8,000 Technician Tech-Tips, 1987- through 1992 with annual updates of approximately 2000 tips for $100.00 per year. **I CAN ASSURE THESE TECH-TIPS ARE NOT DUSTY OLD REPAIRS YOU'LL NEVER SEE.** Send $15.00 for Computer or Paper Demo. **Overnight.** AMEX-M/C-VISA, CHECKS & COD. **TV-MAN SALES & SERVICE** 8614 SR-84 Ft. Lauderdale, FL 33324 305-474-2677. 6-92-tfb

VCR EXPLODED VIEWS: of cassette, transport and moving mechanisms with a complete parts list; most views exact, others similar. Volume 1, $16.95 covering 100 models of Emerson, Samsung, Goldstar and Shintom. A complete listing of other available brands and models included with your order. GOODCO, PO Box 921032, Norcross, GA 30092. 7-92-1t

YOUR CONDUCTIVE SOLUTION Super thin liquid allows effective rejuvenation of rubber conductive pads on remote controls/keypads. Will layer for decreased resistance. Detailed instructions/hints included. $14.95 MC/Visa. COD add $4.00. 1-800-742-8165 Ext 10. 6-92-3t

VHS-VCR Repair Solution Sets I, II, III, IV, V, VI, VII. Each contains 150 symptoms and cures, updated cross reference chart, free assistance, $11.95 each, all seven $69.95. Schematics available. Visa/MC. Eagle Electronics, 52053 Locks Lane, Granger, IN 46530. 6-92-7t

REPAIR MANAGEMENT SOFTWARE: for IBM PC's. Repair tracking, inventory, reports, billing, maillist, more. Demo disk $15. CAHILL ELECTRONICS, PO Box 568, Kingston, NH 03848. 603-642-4292 6-92-2t

PHOTOFACTS: Folders under #1400, $5.00. Above #1400, $7.00, sent same day first class postpaid. A. G. Tannenbaum, P.O. Box 110, East Rockaway, NY 11518. 516-887-0057. 11-91-5t

COMPUTER AIDED TV/VCR REPAIR SOLUTIONS: 5 1/4" IBM Compatible disks. 1,000 VCR, Printout $83, Disks $72. 5,400 TV, Printout $135, Disks $113 (Hardrive). Add to or quick scan by chassis, model and stage. Two solutions pays for it. Electronic Solutions, 407 W. Ave. "N", San Angelo, TX 76903. 3-92-5t

TV TOUGH DOGS 300 symptoms and cures. Send $10.95 to Davis TV, 11772 Old Fashion Way, Garden Grove, CA 92640. 7-92-1t

VCR HEADACHES? 500 Most common problems and cures. Printout $49. 1300 Symptoms and cures. Printout and IBM disc. $125.00. Guaranteed satisfaction. VCR Tuneup Center, 43 James Avenue, Redwood City, CA 94063 or call 1-800-777-7883. Mastercard and Visa accepted. 6-92-2t

SENCORE: VA62, VC63, SC61, ST65, CR70 all like new with manuals. $5,000. Coultas Electronics, 132 N. Monroe, Pittsfield, ILL 62363. 217-285-5155. 7-92-1t

SENCORE: SC61 Scope. Used only 4 months. $2000. 913-738-3332. Ask for Gary. 7-92-1t

B & K 467 color picture tube restorer/analyzer. $500. Mint Condition. Call Jim at 216-779-5198. 7-92-1t

REDUCED 85%, Diehl Mark 111 scanner $79. Diehl Mark V scanner $199. New. Restore remote control keypads with our conductive coating $8.99 ppd. WEEC, 2805 University Ave., Madison, WI 53705. 608-238-4629, 608-233-9741. 12-91-tfb

WANTED

1950's TRANSISTOR RADIOS: with civil defense markings brought! Paying $25-$500. Harry Poster, Box 1883, So. Hack., NJ 07606. 201-794-9606 Before 7 pm. 5-92-3t

MISCELLANEOUS

CAMCORDER REPAIR: Don't turn away good profits let our experienced technicians provide your shop with complete camcorder repair service. Also, VCR, "Tough Dogs." Call 1-800-846-4648. Edington VCR/TV, 204 North Kimble Drive, Bloomington, IN 47404. 7-92-1t

BUSINESS OPPORTUNITIES

ESTABLISHED ELECTRONICS REPAIR BUSINESS for sale in Florida Currently repairing TV's & Microwave ovens. Interested parties call Jim 904-682-4498. 7-92-1t

HAWAII TV & VIDEO STORE good cash flow and reputation. Only sales and repair business for community of 15,000. Van, equipment, merchandise, 1,000 plus videos. Employs 2 technicians, 2 secretaries. On main highway of main island. Apartment and car available. $75,000. Dave Helms, Box 150, Haleiwa, Hawaii 96712. 808-637-6668. 7-92-1t

MOVE TO FLORIDA KEYS! In Key Largo there is a 8 year old Electronic Repair Shop for sale. Located on the ocean with an excellent reputation for repairing TV's, VCR's, marine electronics and two-way radios. An ocean front apartment is available for rent above the shop. Marina facilities, boat slips and trailor lots are available on the same property. $55,000 includes equipment, schematics, inventory and much more. Call Mike at 305-852-7986. 7-92-1t

Readers' Exchange

FOR SALE

1-B&K television analyst model #1076. 1-Simpson signal gen Model 415A-7-Band + 1 band on harmonic. Both come with manuals and cables. Make offer. *LH Binkley 219-522-0262,*

Leader curve tracer org. box. model #LTC-905 $75.00. Leader wideband signal generator org. box. model #LSG17 $125.00. B&K signal level meter, model #430. All like new with manual for each 450.00. *Vernon Chambers 159 Bright Ave Jackson, CA 209-223-1655.*

New tubes in factory cartons. List price, parts, text books, service manuals. Send large S.A.S.E..*M. Seligsohn 1455-55th Street Brooklyn, NY 11219.*

Sencore VA48 complete with manual used 3 times $375.00 plus shipping. 53 Sams photo facts various numbers 1300 thru 2231 $50.00 for all plus shipping. *Donis Electronics 1100 N. Grant Lexington, NB 68850.*

Power Inverter-Tripp lite 250FC watt change 12VDC to 11.7 VAC 60HZ.(Freq controlled) ideal for mobile labs, RV's VCR's TV test instrument call *Ray Dorsner 303 686-7204.*

Digital capacitance meter-measures up to 20,000 MF + $40.00 new auto radio stereo sound booster new -$15.00. *Joe Oracki 410-254-0284.*

WANTED

Schematic or service info on Pioneer model SR-303 Reverb Amp. *Kentucky Home Products 502-348-4983.*

Service data on Multitech VCR - model No. MV-085 serial #HI8629198 - *Jose Gonzalez 2925 Lyons Rd. Austin TX 78702. 512-926-0294.*

R.E.L. (Radio Engineers Labs) "Prelude" FM tuner, model 646 or similar. Also need schematic/service info. *Mike Zuccaro 8795 Corvus Pl, San Diego, CA 92126 619 271-8294.*

TV modules and parts; now 8 page list. Electrolytic and misc. capacitors for radio, TV motors etc. Send SASE for each set and specify group. *Chuck Vaccaro, 708 Booth Lane #E, Ambler, PA 19002, 215 646-3641.*

Parts list and/or schematics, service literature for scientific audio electronics stereo power amplifier, model MK2200. *Steve Donohue, 4 Riverhurst Rd., Billerica, MA01821 508 663-4996.*

Service schematics for a high resolution mono monitor #LVM-00-1900-ZM trade mark "L*VIEW" made by Sigma Design Inc. Will pay for copy. *George TV Service 3003 Chestnut St. Lafayette Hill, PA 19444.*

For Emerson EC101R color TV high voltage transformer Part No. 4221071021. For GE color TV ch. AC-B high voltage transformer part no. EP-77X45 focus divider part EP 14X172. *S. Pearlman 7513 E. Caminode Querabi, Tucson AZ 85715 602 296-5904.*

Manufacturers Parts and Literature Directory

This monthly section is sponsored by manufacturers to help you find the parts and technical literature needed to service their equipment. Call them for replacement parts or for the name of their nearest distributor.

Hitachi Home Electronics 401 W. Artesia Blvd. Compton, CA 90220 800-HITACHI	**Mitsubishi Electronics America** 5757 Plaza Drive Cypress, CA 90630 800-553-7278 fax 800-825-6655	**NEC Technologies** 1255 Michael Drive Wood Dale, IL 60191 800-366-3632
Panasonic 50 Meadowlands Parkway Secaucus, NJ 07094 800-545-2672	**Philips ECG** 1025 Westminister Drive Williamsport, PA 17701 800-526-9354 fax 800-346-6621	**Quasar** 50 Meadowlands Parkway Secaucus, NJ 07094 800-545-2672
Technics 50 Meadowlands Parkway Secaucus, NJ 07094 800-545-2672	**Thomson Consumer Electronics** 2000 Clements Bridge Road Deptford, NJ 08096 800-257-7946 fax 800-524-1498	**Zenith Electronics Corp.** 1900 N. Austin Avenue Chicago, IL 60634 312-745-2000

Call Jonathan Kummer at 516-681-2922 to reserve space in this special section.

Advertisers' Index

We'd like to see your company listed here too. Contact Jonathan C. Kummer to work out an advertising program tailored to suit your needs.

SALES OFFICE

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FAX: (516) 681-2926

Jonathan Kummer Advertising Manager
Emily Kreutz Sales Assistant

To Order Back Issues

Send $3.50 Per Issue (Check, Money Order, Mastercard, VISA, And AMEX).

Send All Correspondence To:

CQ Communications
76 North Broadway
Hicksville, NY 11801
Or Call
516-681-2922
FAX 516-681-2926

The DMM our customers designed.

Before we built the new generation Beckman Industrial Series 2000 DMMs, we asked people like you what you *really* want.

You want more. More test and measurement capabilities. More troubleshooting features. All in an affordable hand-held DMM. The Series 2000 features the widest range Frequency Counter in any professional DMM, a full-range Capacitance Meter, True RMS measurements, Intermittent Detection, 50ns Pulse Detection, and Peak Measurement capabilities. Plus, the Series 2000 is the only meter to offer autoranging Min/Max recording and relative modes.

You want a DMM that's easier to use. The Series 2000's display is 25% larger, with bigger digits and backlighting for easier reading, even in the worst light. Plus the fast 4 digit display provides the high resolution needed for adjusting power supplies and generators down to 1mV. And only the Series 2000 features a menuing system for fast, simple feature access.

Made in the USA

The Beckman Industrial Series 2000, priced from $209 to $279 offers you the best performance for your dollar. Look again at these features:

- 4 Digit, 10,000 Count Resolution
- Basic Accuracy to 0.1%
- True RMS, AC or AC on DC
- 0.01Ω Resolution
- Automatic Reading Hold
- 1ms Peak Hold
- Fully Autoranging Relative and Min Max Modes
- Intermittent Detector
- UL1244, IEC1010 Design
- Three Year Warranty

The Series 2000 offers the most solutions for your everyday test and measurement needs. The only DMMs designed by the people who use them. You.

For more information on these new DMMs call (outside CA) 1-800-854-2708 or (inside CA) 1-800-227-9781. Beckman Industrial Corporation. 3883 Ruffin Rd., San Diego, CA 92123-1898.

BI™

Beckman Industrial™

An Affiliate of Emerson Electric Co.

Circle (23) on Reply Card

The Fluke 79: More Of A Good Thing

More high-performance features. More advanced measurement capabilities. More of the vital information you need to troubleshoot even the toughest problems — with both analog and digital displays.

Meet the latest, greatest member of our best selling 70 Series II family — the new Fluke 79 digital multimeter.

It picks up where the original family left off. In fact, it's a quantum leap forward — in performance, value and affordability.

It's got the features you'd expect from Fluke. Including high resolution. Fast autoranging. Patented, automatic Touch Hold®. A quick continuity beeper. Diode test. Automatic self-test. Battery-conserving sleep mode. And it's just as rugged and reliable as the rest of the 70 Series II family. Easy to operate, too — with one hand.

And thanks to the Fluke 79's proprietary new integrated circuit technology, that's only the beginning. When it comes to zeroing in on tough electrical problems, the Fluke 79 leaves the competition behind:

Hz

Frequency: The Fluke 79's built-in frequency counter lets you measure from below 1 Hz to over 20 kHz. And while you view frequency on the digital display, the analog bar graph shows you AC voltage. So you can see if potentially hazardous voltage is present.

Fast 63-segment analog bar graph: The Fluke 79's bargraph moves as fast as the eye can see, updating at a rate of 40 times per second to simulate the functionality of an analog needle. You get the high speed *and* high resolution you need to detect peaking, nulling and trending.

Capacitance: No need to carry a separate dedicated capacitance tester; the Fluke 79 measures capacitance from 10 pF to 9999 µF.

Actual Size

40Ω

Lo-Ohms range: Our proprietary Lo-Ohms function lets you measure resistance as low as 0.01 ohms. High noise rejection and a test lead Zero Calibration function make the Fluke 79 ideal for detecting small resistance changes.

SMOOTHING

Smoothing™: Our exclusive new Smoothing mode gives you a stable digital readout for unstable signals — by displaying the running average of eight readings. No more jitter or "digit rattle" due to noisy signals.

Get a good thing going: To put more meter to work for you — at a price that works for you, too — head for you nearest Fluke distributor. For the name of your nearest distributor, or for more product information, call **1-800-87-FLUKE.**

The Fluke 79 comes with a yellow holster and patented Flex-Stand™ — easy to hang from a door or pipe, clip onto a belt or tool kit, or stand at virtually any viewing angle. There's even storage space for test leads.

Fluke 79 Series II
$185*
4000 Count Digital Display (9999 in Hz, capacitance, and Lo-Ohms)
63-segment Analog Bar Graph
0.3% Basic DC Voltage Accuracy
Automatic Touch Hold
Diode Test, Audible Continuity Beeper
Autoranging, Manual Ranging
Holster with Flex-Stand
Frequency Counter to over 20 kHz
Capacitance, 10 pF to 9999 µF
Lo-Ohms Range with Zero Calibration
Smoothing
700 Hours Battery Life (alkaline)
3-Year Warranty

** Suggested U.S. list price*

FLUKE AND PHILIPS
THE T&M ALLIANCE

FLUKE®

Circle (41) on Reply Card