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Circle (10) on Reply Card

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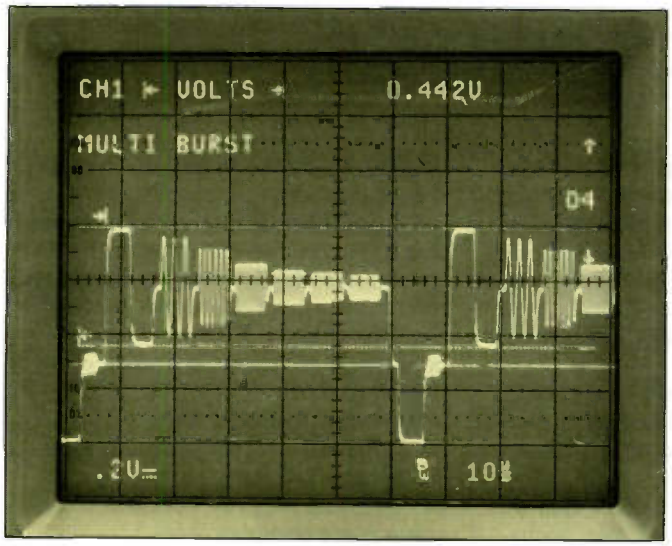

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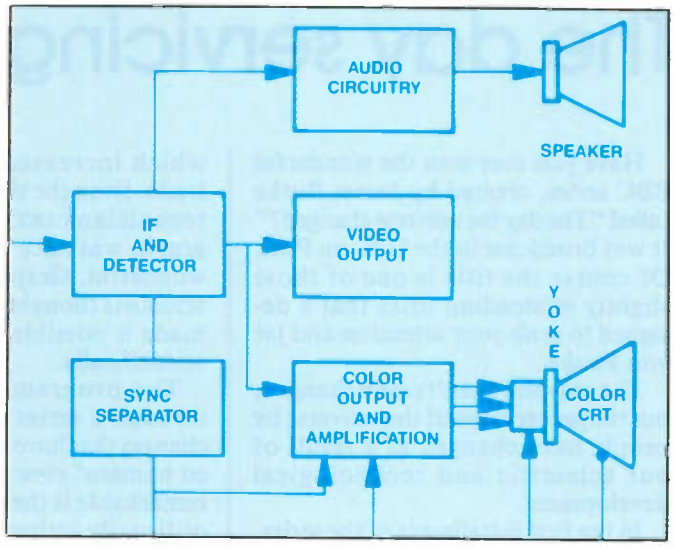

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ON THE COVER

Today's oscilloscopes provide a wealth of features to simplify diagnosis and servicing of electronics products and systems. *(Photo courtesy of Tektronix).*

THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS
ELECTRONIC
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The day servicing changed

Have you ever seen the wonderful BBC series, created by James Burke called "The day the universe changed?" It was broadcast in the U.S. on PBS. Of course the title is one of those slightly misleading titles that's designed to grab your attention and jar you awake.

The universe hasn't really changed, but the perceptions of the universe by people have changed as a result of our scientific and technological development.

In the first installment of the series, Burke presents a conversation that is supposed to have taken place between the Austrian philosopher Wittgenstein and another person. The other person said to Wittgenstein that Europeans who lived before the time of Copernicus must have been stupid because they believed that the sun circled the earth. On the basis of current information, the earth clearly circled the sun.

Wittgenstein's reply is said to have been "I agree. But I wonder what it would have looked like if the sun had been circling the earth." Of course, it would have looked just the same. The point of this is that our view of the universe, or even our little place in it, depends on the state of knowledge and technology at the time in which we live.

The series, and the companion book, go on to describe a number of critical events, precipitated by advances in scientific thought, that changed the way people see the world.

As an example, Burke discusses at length the changes in the way people see the world as a result of the invention of perspective in art. Another example, which we all learned about in history class, were the changes wrought in society by the invention of the printing press. Until knowledge became not only written, but mass produced, knowledge was transmitted orally, with all of the errors that that suggests. The invention of printing made knowledge available to anyone who could get their hands on a book and knew how to read. The traditional elite lost their exclusive claim to knowledge.

The development of astronomy changed the view of humans of their place in the universe. Moreover, it also made possible precise navigation, which increased exploration and trade. Even the simple tool that most technicians take for granted, the graph, was once newly invented and wonderful. Graphs changed the way scientists thought about motion, and made it possible to analyze motion scientifically.

The program leads the viewer through a series of discoveries and changes that have dramatically changed humans' view of the world. Most remarkable is the degree to which we ordinarily either take these occurrences for granted or aren't even aware of them. The decimation of the population of Europe by the black death, the invention of the moldboard plow, the discovery of the existence of microbes, all wrought profound changes in the world.

To me, one of the most telling points made by the series is simply the fact that the series itself was done at all. If it had not been perceived by the creators and producers of the series, and the broadcasters who carried it, that this was knowledge not possessed by most people, it would hardly have been worthwhile to do it. The point is that the adaptability of the human animal is so great that even after the most wrenching of changes we humans can, in a very short time, take the new situation for granted and 1. forget what things were like before, and 2. accept the new situation.

Of course the short span of human life compared to the periods over which many of these changes took place also has a great deal to do with the failure of the average human to be aware of many of these changes. No one is around today who lived through the black death or the invention of the printing press. Our only knowledge of those events is through our history books.

The world of electronics and electronics servicing has undergone changes that in their own small way resemble the profound changes that have taken place in the world at large. In order to truly understand where servicing has been and where it is going, every professional should have a good knowledge of the beginnings of that profession, and an appreciation of the changes that have taken place in that profession, for good and ill, over the years.

One of the most profound changes that has taken place in consumer electronics servicing is simply the increase in complexity of the product. Early black and white TV sets were pretty complex, and operated on principles that were a little difficult for the average person to understand. Today's consumer electronics products make those early sets look simple by comparison, and they just continue to become more complex.

Another important change is the vastly increased reliability of consumer electronics products. In the early vacuum tube days every set might be expected to require service once a year or more often. Today a set might operate for years without ever needing service.

Consumer electronics products today are almost unbelievable bargains, in many cases costing so little that they are very close to being throw away items, not worth the cost of having them serviced.

The introduction of MOS components has made it necessary for consumer electronics service centers to be aware of the dangers of electrostatic discharge damage and take steps to prevent it, lest they introduce problems into a set that weren't there when the customer brought it in.

The changes in the consumer electronics servicing profession have been both broad and deep. Besides the transition from monochrome to color and vacuum tube to solid state, there has been the introduction of digital to a world that was once exclusively analog, a transistion from manual record keeping to computer.

In the busy world of work, it's easy to lose sight of the fact that consumer electronics servicing has changed so vastly in less than fifty years. But just as it's important for us as a species to be aware of where we are and how we got here, it's important for professionals to be aware of how their profession, and the products and technologies on which it is based got to where they are today. ■

Nils Conrad Persson

First edition of the standard for Audio-Video products and accessories, UL 1492

Underwriters Laboratories Inc. (UL) seeks review and comment from individuals and organizations interested in helping develop the first edition of the Standard for Audio-Video products and accessories, UL 1492.

UL 1492 will cover audio and video products intended for use on supply circuits in accordance with the National Electrical Code, ANSI/NFPA 70. These requirements, where applicable, cover:

A. Audio products and accessories intended for household use and involved with the reproduction or processing of audio signals. Examples of such products include: (1) amateur radio products, (2) amplifiers, (3) intercommunicating devices, (4) phonographs, (5) radio-phonographs, (6) radio receivers, (10) tape players, (11) transceivers, (12) tuners, (13) tuner-amplifiers, and (14) similar products;

B. Video products that are intended for household or commercial use, and that receive signals in ways such as the following:

1. Off the air
2. Through a CATV/MATV cable system
3. From a video-recorded medium
4. From image-producing units such as vidicons

C. Auxiliary products and accessories intended for use with audio or video products wherein the auxiliary and accessory products are separate and do not perform the desired function, but are used in addition to or as a supplement to products according to items A and B. Examples of such products include: (1) character generators, (2) editing controllers, (3) video switches and encoders, (4) CRT degaussers, (5) video tape rewinders, (6) head demagnetizers, (7) tape erasers, and (8) similar products.

D. Video products intended for entertainment purposes in ordinary locations of health-care facilities;

E. Cellular telephones and similar transceiving devices used on a vehicle, boat, or the like when the telephone interconnects to the telephone network through a radio transmitter and receiver.

F. Portable audio or video products of the types described in items A - C and E that are intended for use with a vehicular, marine, or any other battery circuit as the power supply means.

UL 1492 will not cover battery chargers and power supplies, whether portable or for permanent installation and not packaged with or specifically referenced in literature packaged with a product but intended for use with audio or video products.

UL welcomes suggestions on functions or characteristics to be evaluated, ideas regarding the test methods or other means of evaluation, and other suggestions or comments that may help in the development of this standard. Participation will be by correspondence.

To request your free copy of a proposed draft of UL 1492, contact Barbara Dorfman at UL, 1655 Scott Blvd. Santa Clara, CA 95050. The draft is now being developed and will be sent as soon as it is available.

Workshops

The Electronic Industries Association/Consumer Electronics Group (EIA/CEG) are offering a limited number of workshops for consumer electronics technicians. The workshops satisfy the training requirements for authorization by most major manufacturers. Participants receive hands-on training covering electrical mechanical, microprocessor and servo control functions. Register now, spaces for these workshops are limited. Simply letter or fax request on company letterhead to:

Electronic Industries Association
Product Services Division
2001 Pennsylvania Ave, NW
Washington, DC 20006-1813
telephone: 202- 457-8782
fax: 202-457 -4901.

Interested technicians must work for an independent sales and/or service organization which acts as an authorized servicer of one or more of consumer electronic products. ■

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

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Literature

A guide to electrical troubleshooting

A new booklet, "Electrical Troubleshooting with Fluke Multimeters," provides a number of test techniques for troubleshooting electrical systems. The free 20-page piece includes sections on DMM safety and protection, basic electrical measurements, troubleshooting with MIN MAX recording, power measurements and power factory wiring and grounding, engine driven generators, motors and harmonics. Each section contains clear concise explanations and helpful illustrations. Products used in the examples include the Fluke 70 and 20 Series II and the new Series 10 DMMs, as well as the Fluke 80 series. All of those offer ac an dc volts, ohms, diode test, continuity beeper, and autorange with manual range. Accessories for the electrical technician include the 80i-kW Current/Power Probe, 80i-600 Current Probe, TL20 Industrial Test Lead Set, 80i-1010 ac/dc current probe, 80i-410 ac/dc current probe and the 80i-410 current probe.

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Networks and Datacomm course brochure

Six intensive short courses are described in Networks and Datacomm, offered by Learning Group International. Topics covered in the courses include: Introduction to DataComm and Networks, Hands-On Network Implementation, Network Planning, Support and Management, Computer Network Architectures and Protocols, Hands-On DataComm Troubleshooting Hands-On X.25. This brochure outlines each course, detailing the applications and subjects covered; the hands-on activities, benefits, materials provided, authors, and instructors, dates and locations, and who should attend.

Circle (2) on Reply Card

Expanded capacitors line brochure

Philips ECG has expanded its product line of capacitors and accessories to include 188 more components in four new styles.

The expanded line of capacitors adds tantalum electrolytics, memory back-up to 1.0F, axial and radial lead non-polarized aluminum electrolytics, and ceramic disks to 3000V. The complete capacitor line now consists of over 500 types, including ac motor start, motor run and polarized aluminum electrolytic styles.

A 24-page Capacitors and Accessories catalog gives comprehensive electrical and mechanical specifications plus detailed application guidelines. Also featured in the catalog is a cross reference section that crosses over 2,000 industry part numbers representing 12 popular brands to the equivalent ECG part numbers.

Circle (3) on Reply Card

Surface Mount and IC test accessory brochure

The catalog features Pomona's new DIP/SOIC, PLCC, QFP and SMD Micro test clips and assemblies, miniature pincer and hooked test clips, standard hooked test clips, alligator test clips, coaxial cable assemblies, test lead kits, and adapters, breakouts and interfaces.

Fifteen major product categories are presented with an easy-to-use index and includes the company's most popular selection of test clips and assemblies, cable assemblies, DMM test lead kits, and static control devices.

Circle (4) on Reply Card

PC Instrumentation and data acquisition catalog

Global Specialties is offering a new 16-page color catalog containing PC instrumentation and data acquisition products. The catalog features virtual instruments on a card, plus analog and digital I/O cards for IBM-PC compatibles. The boards, which plug directly into the PC I/O slots, include several multi-channel analog/digital combination cards, onto-isolated Darlington output card, 48-channel PIO card, thermocouple input card, plus two virtual instrument boards. The virtual instruments include PCI-DMM, an intelligent digital multimeter, and PCI-GEN, which is equivalent to a function generator, pulse generator, waveform generator, and counter/timer. Each PCI instrument includes the card and a software graphics package for operating the instrument. The catalog also contains several pages of accessory items which simplify application interfacing. All the products come with extensive user documentation and program examples in BASIC and "C."

Circle (5) on Reply Card

Semiconductor cross reference on floppy disk

Philips ECG introduces ECG semiconductors Instant Cross Master Guide on disk for IBM-PCs and compatibles.

ECG semiconductors distributors and their customers can now conveniently access the full ECG replacement semiconductors data base of over 262,000 industry part numbers on their IBM-PCs or compatibles. With the new software, users can instantly call up the ECG replacement device for any of the industry numbers on file. Typical access time is under one second. Over 4,000 components are available in the program.

The software operates on IBM-PCs and compatibles that have 640K of RAM, a hard drive and 3½ or 5¼-inch floppy disk drive. The program versions that are available will support 360K/1.2M and 720K/1.44M floppy disk drive; also supported are monochrome, CGA, EGA and VGA monitors. In addition to crossing the original part number, the program displays the full device description, case style and a reference to any special and general note that applies. The note or a screen printout can be called up via a single key stroke. Another feature of the software permits the user to select foreground and background colors from a palette of eight. These may be used to customize the display from the various combination possible.

The program contains the same cross reference data base as that published in the ECG Semiconductors Master Replacement Guide (ECG212Q), now in its 15th edition. ■

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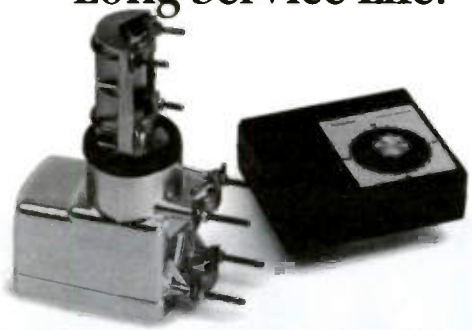

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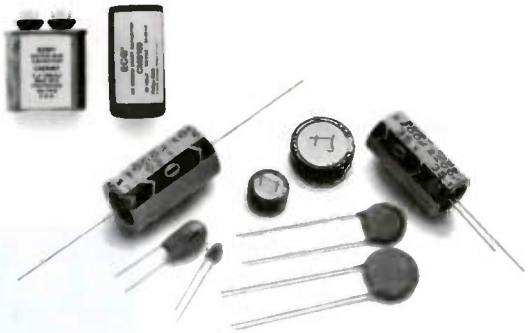

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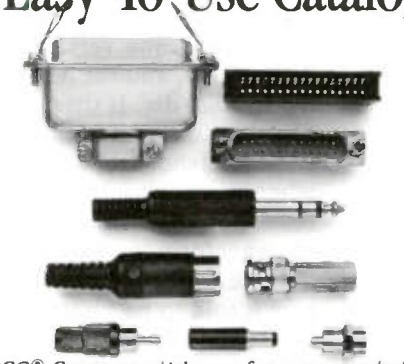

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Using oscilloscopes for CCTV system testing

By Burton Farley and Matt Ivey

From simple security systems in banks, grocery stores, high-rise apartment buildings, airports and manufacturing plants, to sophisticated industrial teleconferencing systems, closed-circuit television (CCTV) has become part of our everyday lives. As a result, installation, servicing and maintenance of such systems is now an important concern for plant managers, building maintenance firms, and security systems maintenance personnel. It also provides another option for electronics servicing businesses.

Fortunately, recent improvements in basic oscilloscope performance, plus additional TV triggering capabilities provide the tools needed for testing CCTV systems, and can help make installation and servicing of CCTV systems easier and more efficient. This article will show how to use today's oscilloscopes to test basic asynchronous and synchronous CCTV systems. This information is also useful for testing of individual video cameras, monitors and video switchers.

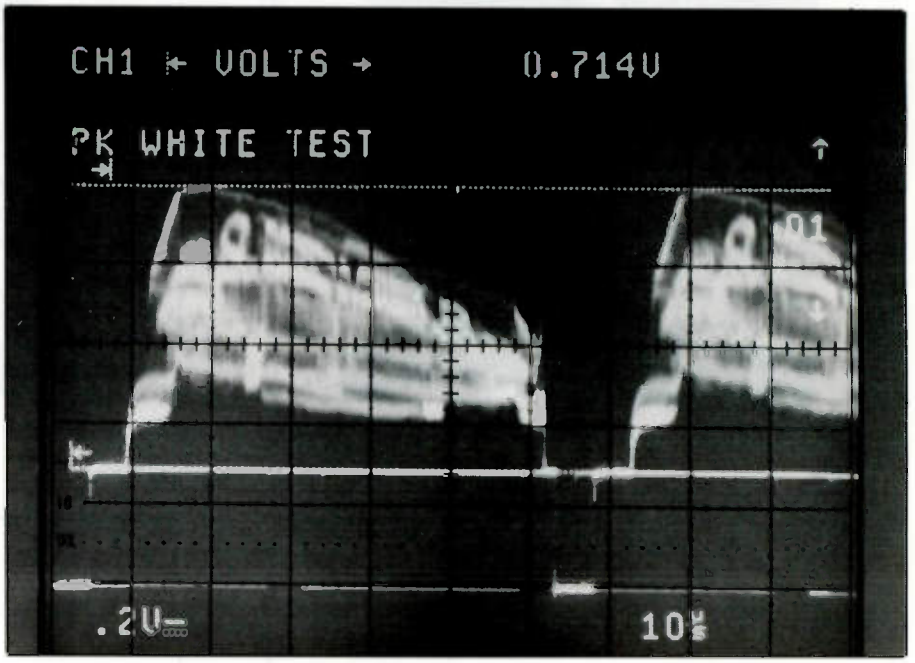

Figure 1.

Nipping problems in the bud: Pre-installation tests

Preventing problems is easier than correcting them. A functional check of each component in the CCTV system prior to installation will help to ensure that every component is up to specification and works properly. Then if problems do arise after installation, during system checkout, you can probably rule out equipment failure, making the troubleshooting task much easier.

A good way to begin is to test the cameras. To ensure that all cameras receive identical tests, it's best to use a camera test bed for all tests. A typical camera test bed will consist of a camera carrier, adequate lighting, a test-chart holder and a test-pattern chart. Standard resolution test charts are available from many sources, and will suffice for most applications.

To begin testing the camera, connect one end of a 75Ω coax cable to the camera's video output. Connect the other end to a T connector on channel 1 of the scope. Then add another 75Ω cable from the other side of the T connector to the picture monitor and properly terminate into 75 Ω. With the camera securely placed on the test bed, apply power, aim the camera at the test chart and adjust for proper focus. Then frame the image so that the arrows on the edges of the test chart match the edges of the picture monitor.

To verify proper operation of the camera, measure the white level and both the sync level and sync width. The scope can be configured for these measurements by setting the scope trigger to the TV line mode (this triggers the scope on each line of video information), the vertical scaling to 200mV/div, and the horizontal scaling to 10µs/div. If the camera is performing to specifications, the peak white level should be 714mV (100 IRE) when measuring from the baseline (back porch) to the top of the trace of the waveform, as shown in Figure 1.

If the amplitude is too high, the picture is said to be "hot."

It's like an overexposed photograph. On the other hand, an amplitude that is too low results in a dark picture, similar to an underexposed photograph.

If the camera has gain control, you can use it to make adjustments if the amplitude is too high or low. If there is no gain control and the amplitude is off, the camera should be serviced, or sent back to the factory for repair or replacement.

Keep in mind that this is a pre-instal-

Farley and Ivey are design engineers for Tektronix, Inc.

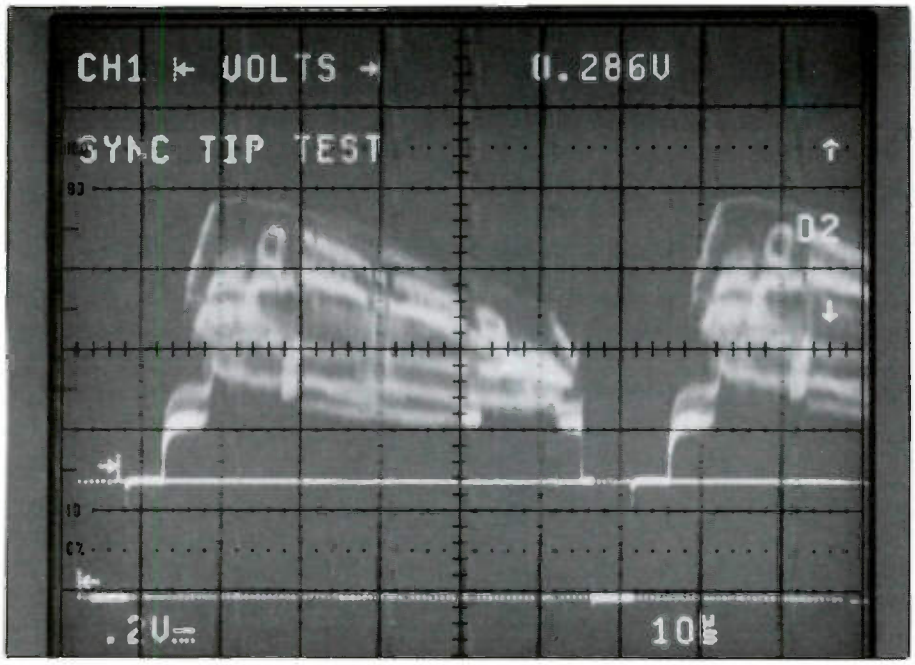

Figure 2.

lation check of camera operation. The final gain adjustment should be made after the camera is installed to accommodate lighting conditions at the installation site.

When you've measured and adjusted the white level you're ready to check the sync pulse amplitude and width. The sync pulse amplitude, as measured from the baseline to the bottom of sync pulse, should be 286mV (40 IRE) as shown in Figure 2. If the sync amplitude is more than a few millivolts off, the camera should be adjusted. If the sync amplitude is incorrect and cannot be adjusted, the equipment needs to be serviced.

Sync width is not as critical as sync amplitude, but it still should be checked to make sure the equipment is operating within defined sync limits. You can use the oscilloscope's time cursors to measure the sync width. The sync pulse width should be between 4.5µs and 4.8µs.

Some scope manufacturers offer special external graticules marked in IRE units to assist in measuring sync amplitude and width. IRE is an abbreviation for Institute of Radio Engineers, and an IRE scale is a relative scale that divides the composite video signals into 140 equal units. Since baseband video equipment signal levels are nominally 1V, the IRE unit is commonly thought of as 7.14mV.

Using the same test bed setup, you can also check the camera's resolution while observing the picture monitor, providing the monitor has sufficient resolution.

In addition, if the camera is a charge-coupled device (CCD), you can easily test for missing pixels. Because CCD pixels tend to turn white when they go bad, missing pixels will appear white on the picture monitor when light is blocked and the automatic gain control circuits in the camera are at maximum gain. So, to test for bad pixels, simply cover the lens with a black card of some type and locate any white spots on the picture monitor. Conversely, you can also point the camera at a white card and check for bad, dark, pixels.

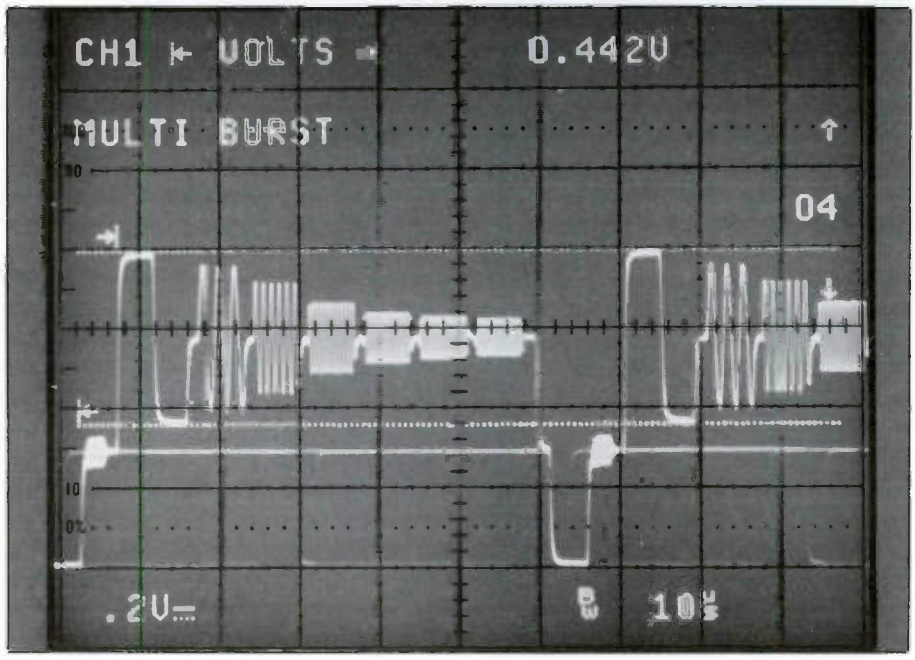

Figure 3A.

Testing the switchers

A typical CCTV system consists of a number of cameras, a switcher, and a picture monitor. Once you've performed pre- installation tests of the cameras, you're ready to test the switcher for signal degradation.

Signal degradation is most easily seen in tests of insertion gain and frequency response. In fact, correct insertion gain is often considered a prerequisite to making other distortion measurements. Any switcher must accept a 1V (140 IRE) video signal at its input and be able to transfer that same 1V signal to its output. Errors in this one-to-one transfer are called insertion gain (or loss).

Measurements for signal distortion are best accomplished using a test signal generator. A test signal generator produces a set of precise video signals with carefully defined and controlled characteristics. For all practical purposes, these test signals can be considered "perfect" signals.

Using the test signal generator, apply a known video test signal to the input of the switcher and observe the signal at the output. Any distortion or impairment, any signal degradation, caused by the switcher will appear on its output signal. In this way the test

signal generator functions as a controlled reference source. You can use it to generate a window signal that goes up to peak white, allowing you to check for insertion gain or loss. And, it allows you to check for degradation of the frequency response of a multiburst signal as the signal passes through each switcher input.

CCTV systems use either passive or active switchers. An active switcher differs from a passive one in that it has a switching mechanism that electronically, rather than mechanically, switches the signal during the vertical interval. This capability eliminates the picture roll characteristic of passive-switching- based CCTV systems.

Testing passive switchers

To test passive switchers, set the scope trigger on the TV line mode, the vertical scaling to 200mV/div, and the horizontal scaling to 10μs/div. Then plug the switcher output into the oscilloscope with a 75Ω coaxial cable and a 75Ω terminator.

After you have examined the signal from the video generator, which is displayed on the scope's channel 2, compare it with the signal from the switcher, which is displayed on channel 1. Figure 3a is an example of a distorted multiburst signal, while Figure 3b shows a strong, undistorted signal. It is useful to note that this particular test can be used on any video equipment (including distribution amplifiers) to test for performance.

Although the results won't be as precise, you can use a video camera as the signal source instead of the video generator. In this setup, compare the switcher output as it appears on the oscilloscope's CRT with the signal leaving the camera. If they are not identical, chances are that the switcher output has degraded while passing through the switcher.

Now test the active switcher by examining the vertical interval. To test the vertical interval switch of an active switcher, move the cable that was previously the scope's channel 2 input to the switcher input, and change the trigger to TV field mode. This triggers the scope on the vertical intervals of the video signal. Set the vertical scaling to 200mV/div, and the horizontal scaling to 5ms/div. Switch between the two video inputs on the switcher and verify that the video signal does not exhibit any large glitches that will cause the picture to roll.

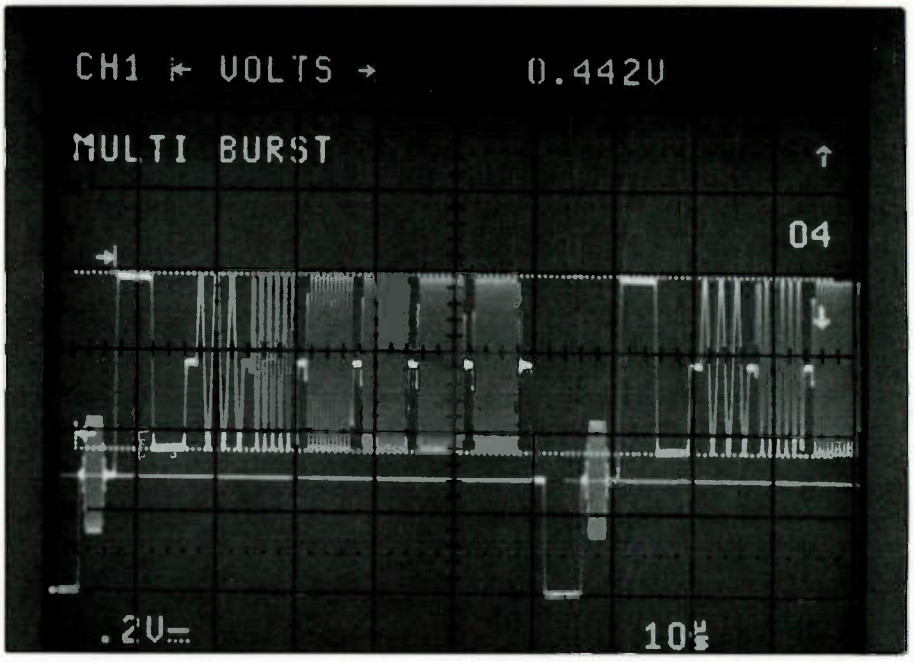

Figure 3B.

Testing the TV monitor

You'll be able to verify that the monitor is performing satisfactorily with a simple visual inspection. Simply connect the camera to the TV monitor and point it at an object to see if the picture is accurately reproduced on the monitor.

Keep in mind, though, that visual inspection of the image on the picture monitor should only be used as a rough check. Impairments seen on the monitor are subject to interpretation and averaging by the operator's eye. Additionally, only fairly large amounts of distortion are visible. For a more quantitative assessment of signal distortion, other tools are necessary.

A TV test signal generator, for instance, can be used to input a 5-step staircase to the picture monitor. Then you can tweak the contrast and gain of the monitor to check for good distinction between the gray levels. You can check black and white monitors for geometry and linearity using the

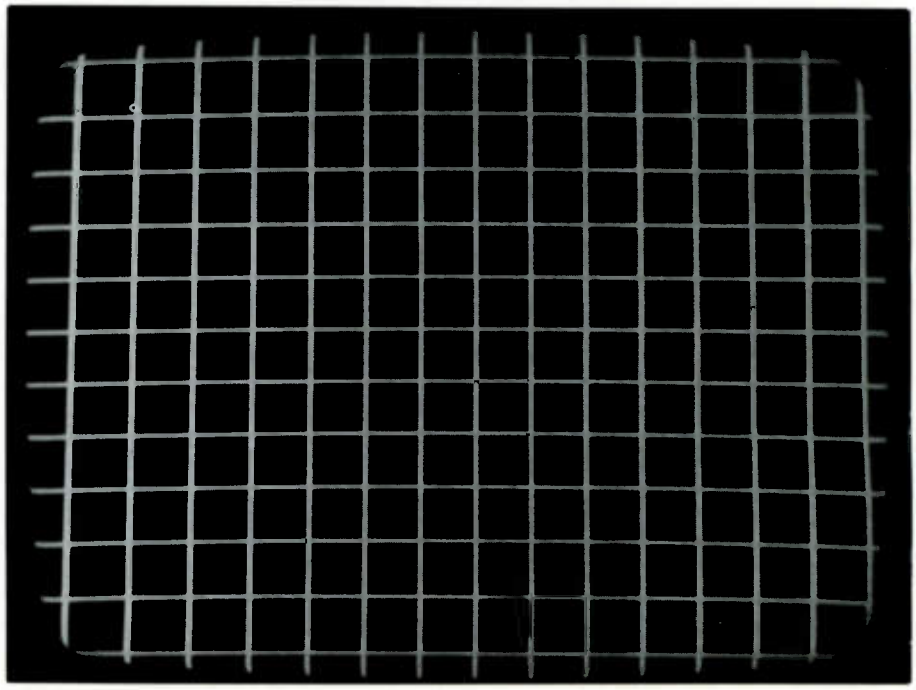

Figure 3.

convergence signal, as shown in Figure 3., and color monitors can be checked for convergence and color purity of the red, green and blue guns.

For sophisticated CCTV systems that require more in-depth testing, you may need to employ more specialized instrumentation, such as waveform monitors and vectorscopes. These tools have been specifically tailored to the TV/video environment and its unique requirements. (See the sidebar for more information about waveform monitors and vectorscopes).

Testing synchronous CCTV systems

Synchronous CCTV systems, which use active switchers, provide a superior switching mechanism that electronically switches the inputs to the TV monitor from different cameras during the vertical interval. As mentioned above, the switching mechanism accomplishes this without the characteristic picture roll of asynchronous systems.

In synchronous systems, the cameras are all referenced to a common source. This source may be either horizontal and vertical drives from a switcher or generator, a camera within the system, or the ac line itself.

In typical synchronous systems, all the cameras' output signals are locked to each other via the ac line. It is important to ensure that all cameras are synchronous with one another. To perform this test, have the scope locked to the ac line. (This triggers the scope on the 60Hz power frequency.) Then verify that the inputs shown on the outputs of the switcher are all locked to the ac line as well. If they are not locked, one of the signals will be free-running on the scope's display.

Using the scope after installation

The quality of the output on the picture monitor will always give you a general indication of the health of a CCTV system. If the picture display is unsatisfactory for the particular application, your scope and other specialized test equipment can help you

determine the severity of the problem.

For example, the scope is a useful tool to diagnose common problems such as field distortions, including hum. If video cables are placed too close to 60Hz ac lines or are not adequately shielded, hum problems may occur. When hum is introduced into the system, the picture monitor will show a distortion in the display (often seen as dark bars running through the picture). In many cases, the solution is as simple as rerouting the video cables away from the ac lines. Another cure is to add hum eliminator devices.

To troubleshoot hum problems, attach the scope to the output of the switcher. The inputs to the switcher will be signals from the cameras. Now, set up the scope with the trigger in TV field mode. Set the vertical scaling to 200mV/div and the horizontal scaling to 5ms/div. Then check the oscilloscope display for a 60Hz ac signal riding on the waveform.

Line loss is another common problem typically exhibited when the sync is below 286mV. All cameras and input sources should provide the same gain to the switcher so that there will be consistent brightness and contrast when the system switches from camera to camera.

When you have a line-loss problem, attach the scope to the switcher output. The scope's trigger should be set on TV line mode, the volts/div at 200mV and the time/div at 10μs. Aim the camera at a white object (making sure to use the same light levels for all cameras), and test the signal levels for each camera. Look at the switcher output on the oscilloscope to see if there has been a cable line loss, which will manifest itself as a sync pulse of less than 286mV.

Installing min-loss cable or adding an equalizing distribution amplifier (DA) in the system are two possible solutions to the cable line-loss problem. When using an equalizing DA, set the gain on the DA for a correct sync level of 286mV.

Oscilloscopes provide test system versatility

Using an oscilloscope to troubleshoot CCTV systems offers a number of advantages, not the least of which is the ability to test individual components in remote locations. Furthermore, as we've indicated here, they are ideal tools to use for pre- installation tests when it is often easier to diagnose and correct problems.

Specialized instruments for the TV/video environment

A waveform monitor displays the electronic signal that creates the picture in a time vs voltage mode in much the same manner as a general purpose oscilloscope. The resemblance to the oscilloscope, however, ends with the trigger, sweep, clamp, and filter functions. On a waveform monitor, these features are specially tailored to the video signal and its unique monitoring requirements. Both the luminance (brightness) and chrominance (color) portions of the video signal are displayed by the waveform monitor, in addition to the various synchronizing pulses required to create a picture. The waveform monitor is also a valuable tool for examining the timing relationship between two or more video signals.

The vectorscope operates in an X-Y voltage vs voltage mode to display the chrominance portion of the signal. It decodes the chrominance signal in a manner very similar to a picture monitor or TV receiver. While a waveform monitor displays the brightness and the amount of chrominance (which together indicate saturation), the vectorscope displays the amount of chrominance and its hue (color). Only the vectorscope can indicate the color represented by the chrominance signal.

The waveform monitor and vectorscope are typically used together to identify and quantify any distortions observed on the picture monitor.

But beyond facilitating system installation, and troubleshooting problems in remote locations, today's units often offer easy-to- use features such as voltage and time cursors, store/recall and trigger options designed specifically for TV applications. Cursors, in particular, are useful when making video measurements because they allow you to make common video measurements; such as sync pulse, color bursts and video signal amplitude; accurately, quickly, and easily.

For example, you can use the voltage cursors to make accurate voltage measurements. To perform a typical amplitude measurement, simply set the voltage cursors at the appropriate place on the waveform: the readout on the CRT will then display the voltage difference. Likewise, timing measurements of sync pulse width, picture blanking interval and back porch width can be made with timing cursors.

Store/recall is another highly useful

capability. With store/recall, you can save several front-panel setups in non-volatile memory and recall them by simply pushing a button. This feature is ideal for the repetitive testing and troubleshooting requirements that are characteristic of CCTV installation and service.

These capabilities combine to help increase the efficiency of CCTV installers and service technicians, while easing their troubleshooting tasks.

One last point: don't forget that an oscilloscope's capabilities can be applied to other problems besides CCTV installation and service. A practical, as well as versatile, general-purpose tool, the oscilloscope can be used for a wide range of testing purposes for both video and audio systems.

Glossary of common CCTV terms

Asynchronous: A system in which all sources are not locked to the same reference.

Back Porch: That portion of a composite video signal that lies between the trailing edge of the horizontal sync pulse and the trailing edge of the horizontal blanking pulse.

Chrominance: That property of light which produces a sensation of color in the human eye, apart from any variation in luminance that may be present.

Chrominanace Signal: That portion of the color TV signal that contains the color information.

Composite Video: For color, this consists of blanking, field and line synchronizing signals, color synchronizing signals, plus chrominance and luminance picture information. These ingredients are combined to form the complete color video signal.

Field: One-half of a complete picture interval, containing all of the odd, or even, lines of the picture.

Frame: One complete picture consisting of two fields of interlaced scanning lines.

IRE: The abbreviation for Institute of Radio Engineers.

IRE Scale: An oscilloscope scale that applies to composite video levels. In this scale 140 IRE units equals 1 volt.

Luminance: The amount of light intensity, which is perceived by the eye as brightness.

Picture Blanking Width: The area between where active blankins ends and where active video begins.

Reference White Level: The level corresponding to the specified maximum excursion of the luminance signal in the white direction.

Sync Pulse: The timing pulse that locks the electron beam of the picture monitor in step, both horizontally and vertically, with the electron beam of the pickup tube.

Synchronous: A system in which all sources are referenced to the same source thus locking them together.

Vertical Blanking Interval: the blanking portion at the beginning of each field. it contains the equalizing pulses, the vertical sync pulses, and vertical interval test signals (VITS). Presently, the vertical blanking interval is 18 to 21 lines in duration. ■

Cellular mobile telephone systems - Part 4

By William H. Bowen

This article originally appeared in the January 1992 issue of The Expander, a monthly publication published by Mitsubishi to provide technical information on the company's products for their authorized service centers.

The previous installment in this series described the procedures for turning on and initializing the subscriber's phone and acquiring a connection to the local cellular system. This article will describe the actual placement of a call.

Call handling

Call handling procedures require that several digital data messages be exchanged using the Control or Voice channels. The various call handling procedures include:

1. Registration
2. Call Initiation
3. Call Reception
4. Call Hand-Off

Because there is not the sharp demarcation between the Call Processing and Call Supervision portions of Call Handling in the cellular system that there is in the land telephone system, the examination of the call handling will be done on a procedure-related basis.

Registration

Every cellular subscriber unit is given its own unique identity and is assigned a Home System, just as each telephone line has a unique identity (its telephone number). However, unlike a land telephone line, any particular cellular subscriber unit could be anywhere within the system's coverage area (or possibly in another system's coverage area) at any time. The cellular system therefore needs a method by which it can ascertain where the subscriber unit is located; basically asking the question "Where are you?" This process is called "Registration."

There are two registration procedures used in the cellular system: Autonomous Registration and Non-Autonomous or Directed Registration.

Either procedure causes the same data exchange between the system and the subscriber unit; the only difference

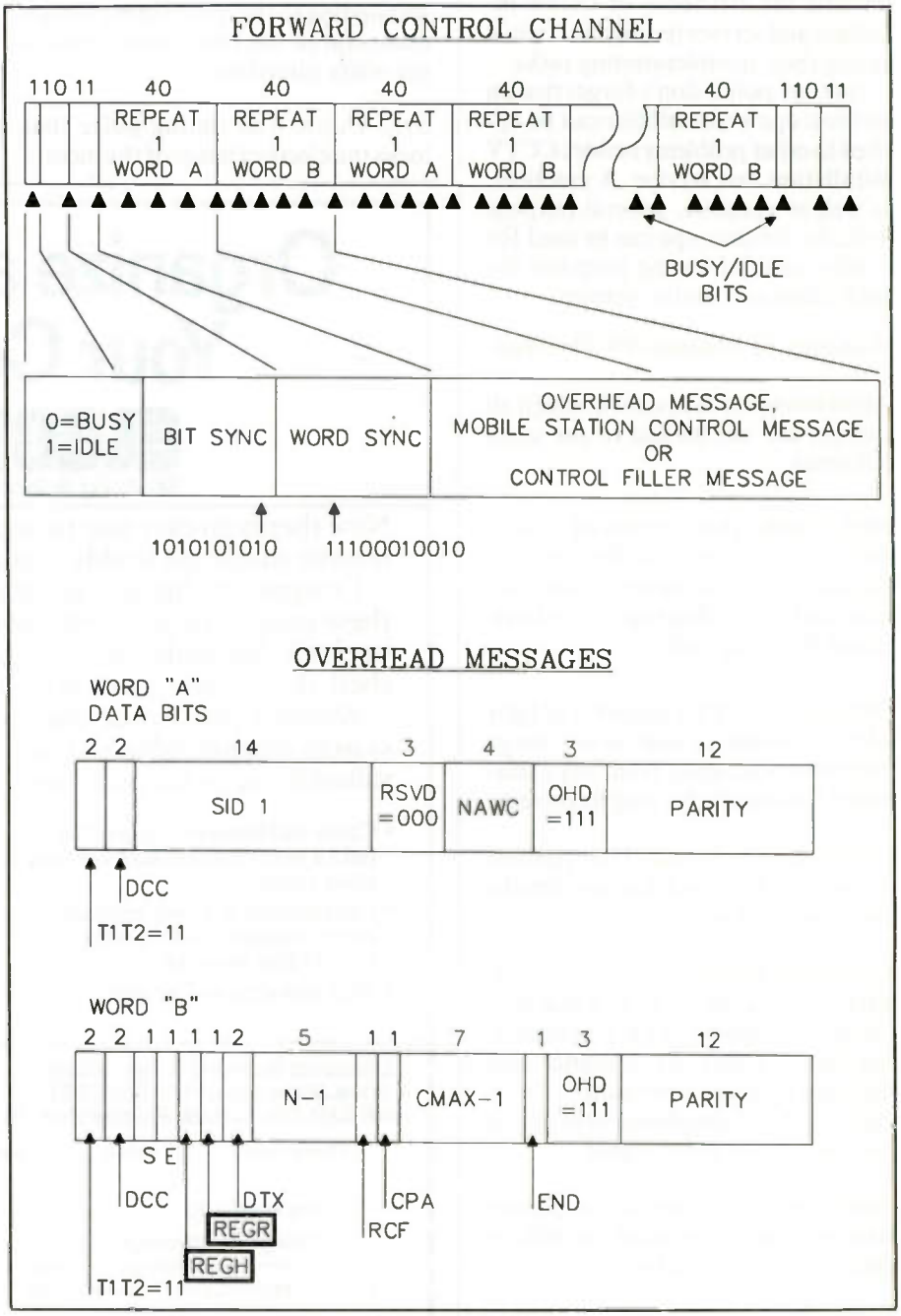

Figure 1. Control (paging) channel digital data stream.

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between the two procedures is which party initiates the registration procedure.

An Autonomous Registration is a registration requested by the cellular system and not directed by an action on the part of the subscriber unit (a request for a call placement, for instance). The Overhead Message on the Paging Channel will inform the subscriber unit if an autonomous registration is required by setting the REGH or REGR flags, as shown in Figure 1.

If the REGH flag is a "1", subscriber units whose NAM SID (Number Address Module System Identification) matches the SID in the Overhead Message (Home subscribers) are commanded to register with the system: if the REGR flag is a "1", subscriber units whose NAM SID does *not* match the SID in the Overhead Message (roaming subscribers) are commanded to register with the system.

Either, both or neither of these two flags can be set to "1" at the discretion of the MTSO (Mobile Telephone Switching Office).

The Non-Autonomous or Directed registration is a registration initiated by the subscriber unit itself. A Directed registration will take place if the LU or Local Use flag in the NAM is enabled or if a call handling procedure (a request for a call placement, for instance) is initiated. The Local Use flag informs the subscriber unit's LCU (Logic Control Unit) that registration is required before a call handling procedure is attempted.

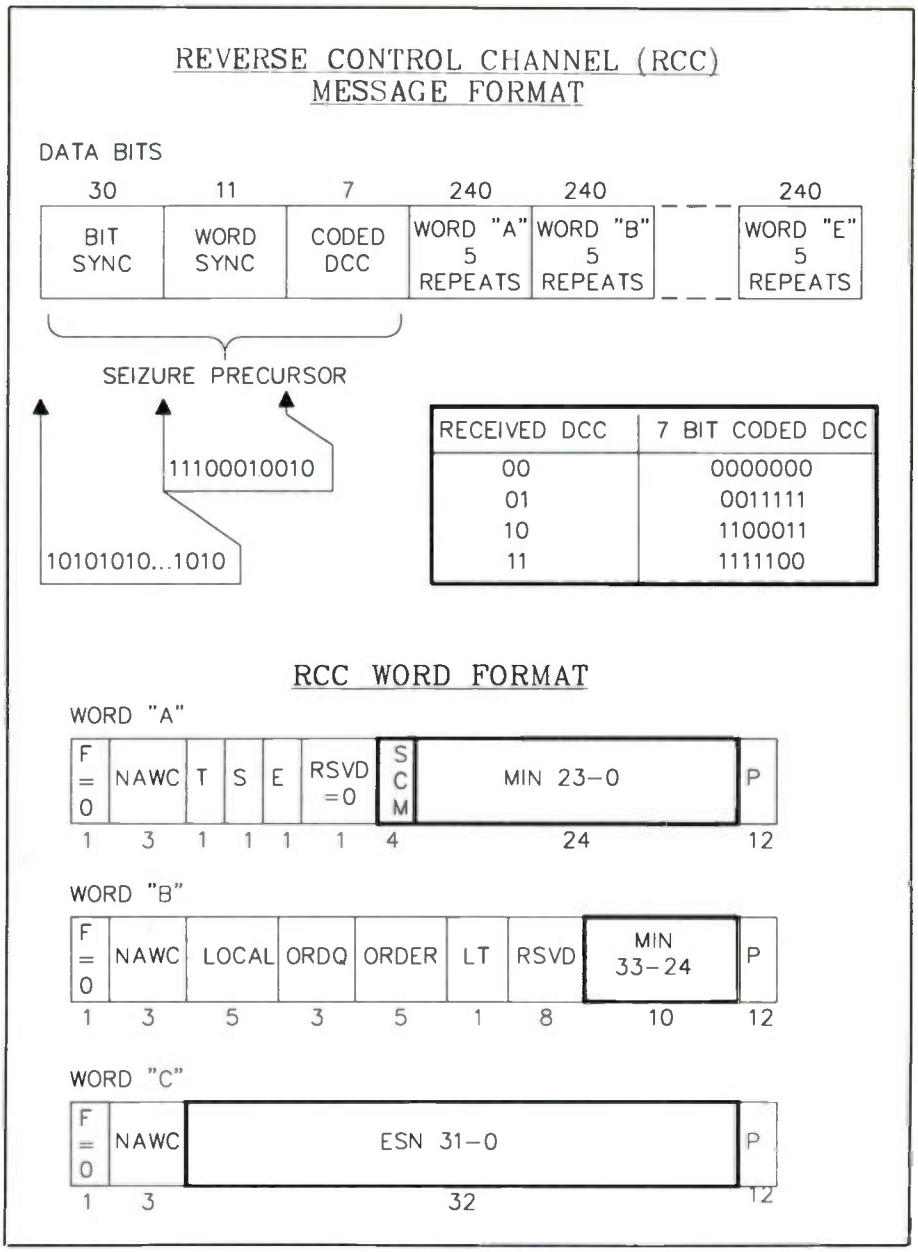


Figure 2. Reverse control channel data format.

Registration process

In order to perform a registration, the subscriber unit must first perform a system access. This is done by monitoring the Busy/Idle bits of the Forward Control Channel (FCC) data stream and attempting to seize the Reverse Control Channel (RCC) while it is idle.

If the first attempt at system access is unsuccessful, once a random delay of up to 90ms has elapsed another system access attempt is made. If, after the tenth attempt, system access is still not achieved, the maximum random delay time is increased to 1.5 seconds, then the access attempts are resumed.

Also, when the system access process is begun, an internal access timer within the subscriber unit's LCU is started. The system access must be accomplished within 6 seconds or the access timer will "time-out" and the system access attempt will be terminated. The subscriber unit will then re-scan the Control Channels and acquire a different Paging Channel. Once that new Paging Channel is acquired and the Overhead Message is read and stored, the system access attempt will be re-started.

Once the Reverse Control Channel has been seized, the registration data is transmitted to the cell site. The RCC Message and Registration formats are shown in Figure 2. A 48-bit data word containing the synchronization and a coded version of the Digital Color Code (DCC) sent from the cellular system on the FCC are sent before the actual registration data words: this insures that the correct cell has been accessed.

The registration data is sent as 48-bit words, and each word is repeated 5 times as a protection mechanism to eliminate the effects of fading.

The registration data consists of three data words and includes various pieces of information about the subscriber unit. The three most important items are the complete Mobile Identification Number (MIN) (all 10 digits), the Electronic Serial Number (ESN), and the Service Class Mark (SCM).

The Electronic Serial Number or ESN is a 32 binary bit (8 hexadecimal

character) identification number stored in a ROM within the subscriber unit, which is programmed when the subscriber unit is manufactured, that uniquely identifies that particular subscriber unit and its manufacturer. The ESN serves the same functions as the Vehicle Identification Number of an automobile, and like a car's VIN, the ESN is permanent; it is not reprogrammable.

The SCM or Service Class Mark informs the cellular system of certain operational characteristics of the subscriber unit, including its maximum RF power output, whether it is capable of discontinuous transmission (DTX), and whether the subscriber unit can use the expanded frequency allocation (666 or 832 channels). The format for SCM is shown in Figure 3.

Once the registration data has been received by the system, decoded and accepted, the cellular system sends a REGID flag in the FCC Control Filler Message as an acknowledgement. Once this acknowledge is received, the subscriber unit updates the LCU memory and then resumes the Mobile Idle state.

POWER CLASS	SCM	TRANSMISSION	SCM	CHANNELS	SCM
CLASS I (3W)	XX00	CONTINUOUS	X0XX	666	0XXX
CLASS II (1.2W)	XX01	DISCONTINUOUS	X1XX	832	1XXX
CLASS III (0.6W)	XX10				
RESERVED	XX11				

Figure 3. Service class mark format

Call initiation

The Call Initiation process, diagrammed in Figure 4, is begun by the user when the phone number to be called is entered into the handset using the keypad, or recalled from the subscriber unit's dialer memory. On some more advanced subscriber units, even direct voice entry of phone numbers is possible. When the SEND key is pressed, the subscriber unit attempts a system access and seizes the Reverse Control Channel (RCC) using the same procedure previously outlined.

If the RCC can not be seized, the same retry procedure used during

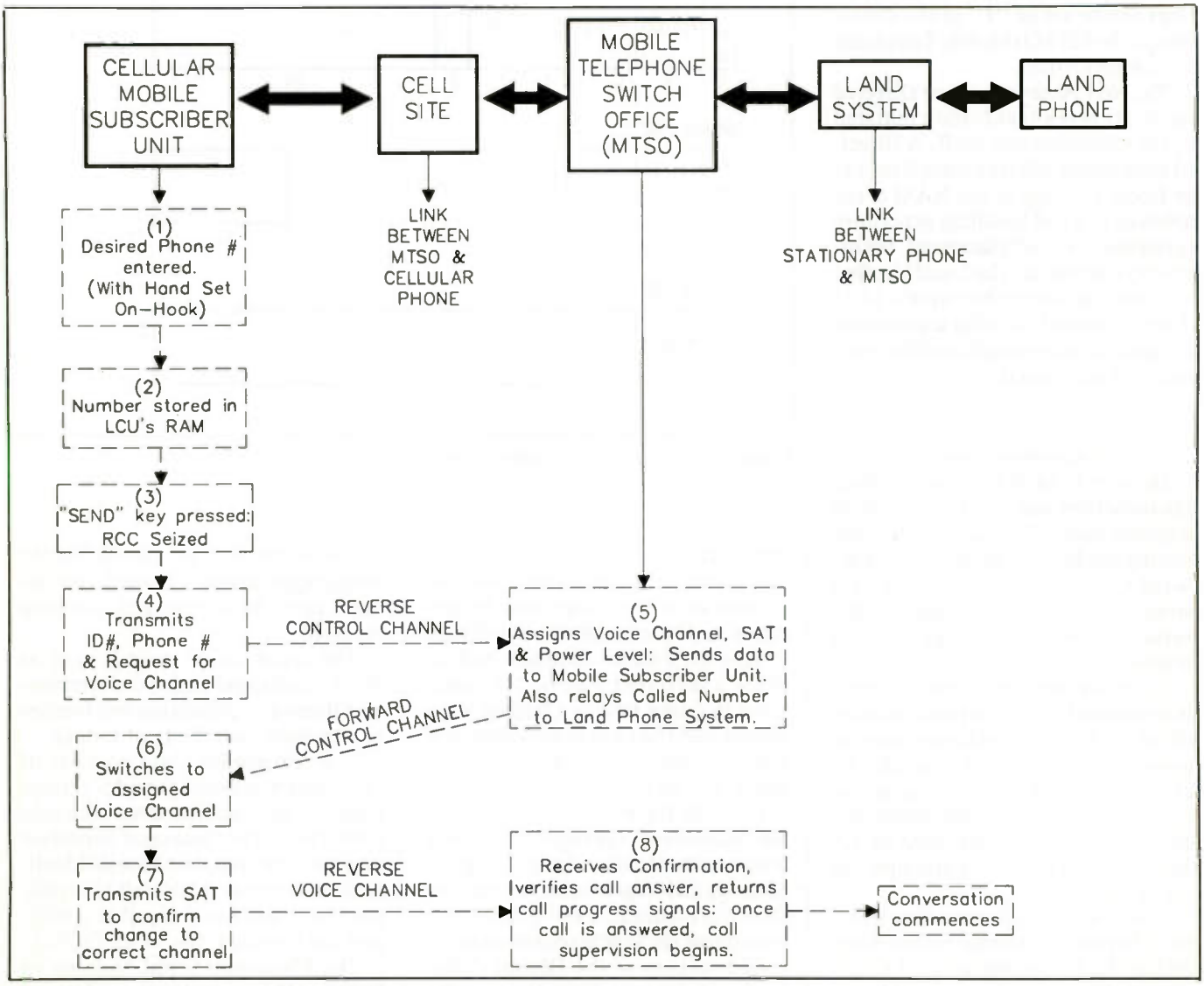


Figure 4. Call initiation (mobile to land phone call).

registration will be performed, but with two exceptions: the access timer time-out is set to 12 seconds, and if the timer does "time-out", the user will hear a RE-ORDER tone, an audio tone pulsed at two pulses per second.

Once the RCC is seized, the same three 48-bit data words sent during registration are sent to the system, then two additional 48-bit words are sent that include the phone number being called. The format for this data is shown in Figure 5. When the MTSO has accepted this data and it has been validated, the system will send the subscriber unit a Mobile Station Control Message on the FCC.

A Mobile Station Control Message, whose format is shown in Figure 6, is identifiable by the condition of the T1 and T2 bits at the beginning of the message and by the fact that the message will include the subscriber unit's MIN (Mobile Idenfication Number) to identify the particular subscriber unit for whom the message is destined. The Mobile Station Control Message informs the subscriber unit which Voice Channel will be used for the call, the proper Supervisory Audio Tone (SAT) frequency and the correct RF power level (VMAC) to use.

While the data exchange is taking place, the MTSO transmits to the land telephone system (assuming this is a mobile to land call; not a mobile to mobile call) the called telephone number and the other call processing data required for the land telephone system to complete its portion of the connection.

Once the land system acknowledges receipt of the data, the MTSO will set up the talk path connection on the assigned Voice Channel and begin transmitting the SAT on the Forward Voice Channel (FVC). The subscriber unit decodes the Mobile Station Control Message, stores the information, changes the receiver and transmitter RF channel to the assigned Voice Channel, then re-broadcasts the SAT received from the FVC through the Reverse Voice Channel (RVC).

The conversation path is now open, the mobile user will hear call progress tones from the land system until the call is answered, and will hear the called party once the call has been answered. Call processing is now complete, and call supervision commences.

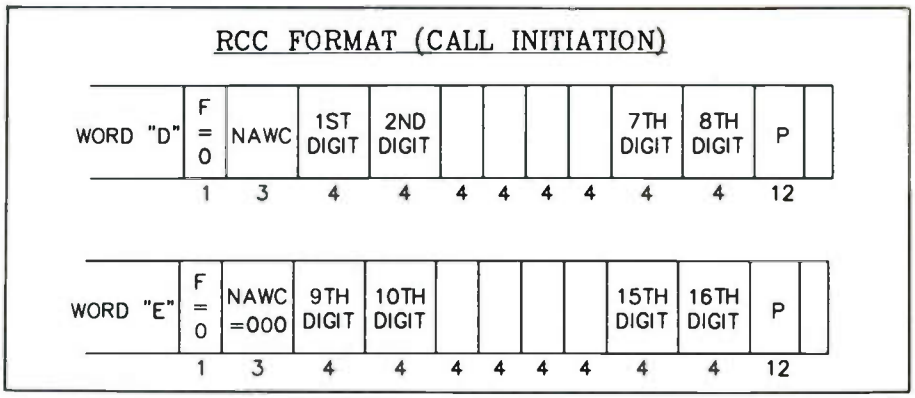


Figure 5. Called - number transmission

A mobile to mobile call is handled in a similar manner except that if both mobile subscribers are operating on the same cellular system when the call is placed (regardless of whether both have the same "home" system), the connection is handled completely by the cellular system without the intervention of the land telephone system.

If the subscriber unit is moving during the time the call is being conducted, one or more handoffs may be required. The handoff procedure will be examined shortly.

Call supervision

Call supervision in the mobile environment is a complex undertaking because the cellular subscriber unit is not connected to the telephone system by a pair of wires. As a substitute for the direct wire connection (and the continuous dc current that flows through the connection, the procedure used for call supervision in the land telephone system), the cellular mobile telephone system uses a series of audio tones and digital data messages to interactively control the call.

The supervisory audio tone

The Supervisory Audio Tone, known as SAT, is an audio tone transmitted with a deviation of 2kHz that plays a very important part in main-

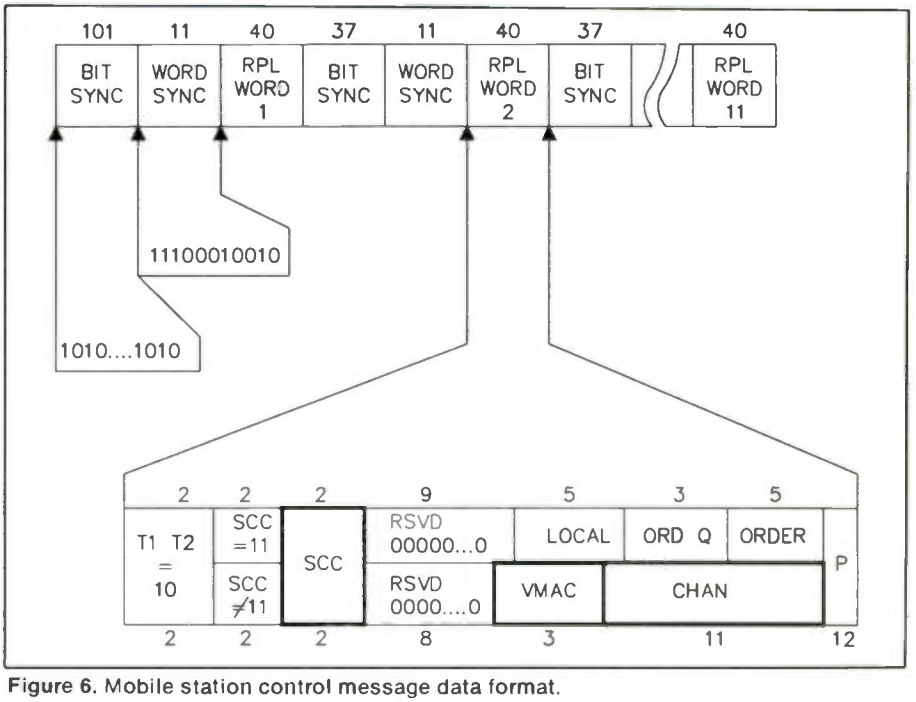


Figure 6. Mobile station control message data format.

SAT FREQUENCY (Hz)	SCC
5970	00
6000	01
6030	10

Figure 7. SAT tones and SAT color codes

taining a call. Each cluster of cells is allocated one of the three SAT frequencies to distinguish it from the neighboring clusters using the same RF frequency. The subscriber unit is advised about which of the three SAT frequencies will be used during call set-up by the SAT Color Code (SCC) included in the Mobile Station Control Message on the FCC. The subscriber unit re-broadcasts the SAT received from the Forward Voice Channel through the Reverse Voice Channel. The subscriber unit also compares the SAT received to the SAT is was told it would receive.

If the received SAT does not match the SAT that the unit was expecting, the subscriber unit's audio paths are muted: this is required to prevent inadvertent eavesdropping. The only time during a call that SAT transmission will be suspended is when data is being transmitted. The SAT transmission is only suspended in the direction in which data is being transmitted. The three SAT tone frequencies and their associated SCCs are highlighted in Figure 7.

SAT has two major uses. First, SAT maintains the closed identification loop for the cellular system, providing the same function as the loop current in the land phone system. If SAT is lost during a call, for example if the mobile user driving into a tunnel where the cell site FVC cannot be received, the subscriber unit's LCU starts a 5-second timer.

If the correct SAT is not received again before the timer expires, the subscriber unit assumes that the connection has been lost and the call is terminated. This same time-out procedure is used by the MTSO: if its timer also expires, the MTSO will terminate the connection to the land telephone system.

SAT also serves a second function: interference rejection. As mentioned earlier, each cluster of cells is allocated one of the three SAT frequencies to distinguish it from the neighboring clusters using the same RF frequency. A subscriber unit receiving co-channel interference would detect the incorrect SAT, mute the audio circuits and, if the interference continued long enough to time-out the SAT timer, terminate or drop the call.

POWER LEVEL	VMAC	NOMINAL POWER (+1–4dB)
0	000	3.0 W
1	001	1.2 W
2	010	500 MW
3	011	180 MW
4	100	70 MW
5	101	28 MW
6	110	11 MW
7	111	4.5 MW

Figure 8. Cellular subscriber unit RF power output levels.

The signaling tone

The Signaling Tone or ST is a 10kHz audio tone transmitted with a deviation of 8kHz that is used to provide additional control functions on the Reverse Voice Channel during a call. The ST has four uses, the particular use being determined by the duration of the ST tone. These four uses are:

1. Confirmation of Hand Off Request - Upon the receipt of a command to perform a Hand-Off, the subscriber unit stores the new voice channel, SAT and power level (VMAC), then sends ST for 50ms on the present cell's RVC for confirmation before completing the hand-off.
2. Hook Flash - This feature is used during a conversation to access certain enhanced services. When the SEND key is pressed, the subscriber unit sends ST for 400ms on the RVC. The system sends a Mobile Station Control message to the subscriber unit with a Send Address order included. The subscriber unit responds by returning a Hook Flash Request message to request a hook flash from the system.
3. Cleardown - Upon termination of the call by the subscriber unit or the cellular system, ST is sent by the subscriber unit on the RVC to confirm call termination.
4. Confirmation of Alert - After the subscriber unit is alerted to an incoming call and the call set-up is completed, the subscriber unit sends ST on the RVC until the call is answered. The maximum time for this ST transmission is 65 seconds, after which the subscriber unit will display the Call in Absence message (if the subscriber unit is equipped with this feature).

Voice Mobile Attenuation Code (VMAC)

One of the capabilities of the AMPS cellular system that assists in the re-use of the RF frequencies is the ability of the cellular system to control the subscriber unit's RF power level. By keeping the RF power level to the minimum necessary for communication (a requirement of government regulations), interference is reduced and system management becomes less burdensome for the cellular system.

The basic AMPS specification defines 8 different RF power levels, as shown in Figure 8. Because not all subscriber units are capable of the same maximum RF power output, the cellular system is apprised of the subscriber unit's maximum power capability by the Station Class Mark (SCM) included in the registration information. Most mobile and fixed subscriber units are in Class 1, transportables are Class 2 and portables (handheld and pocket telephones) are Class 3.

During a conversation, the cellular system monitors the received signal strength from the subscriber unit. If the signal level is outside the specified limits, an RF power level change is necessary, and a Mobile Station Control Message is sent to the subscriber unit over the Forward Voice Channel (FVC). The subscriber unit decodes the message, reads and stores the Voice Mobile Attenuation Code (VMAC), adjusts its RF power level, then sends a Confirmation Message to the system using the Reverse Voice Channel (RVC).

RF power control is also used during call set-up and other functions performed over the Control Channels: in this situation, the messages are exchanged on the Forward and Reverse Control Channels.

Call termination

The mobile telephone user terminates the call by pressing the END key on the handset keypad. This action initiates the Clear Down procedure: the subscriber unit transmits the ST tone to the system on the RVC for 1.8 sec-

onds. This action informs the cellular system that the call is finished, and the voice channel is released. Once the clear-down is completed, the subscriber unit performs a system acquisition and then finally returns to the Mobile Idle state. Call supervision is now complete.

Call reception

The Call Reception process, diagrammed in Figure 9, is begun when the land telephone system informs the MTSO that a call is arriving. The land telephone system End Office provides the MTSO with the subscriber's MIN, and the cellular system transmits a Mobile Station Control Message, which includes a paging order, on the Forward Control Channel (FCC). When the subscriber unit receives this message, it attempts a system access and seizes the Reverse Control Channel (RCC) using the same procedure previously outlined.

If the RCC can not be seized, the same retry procedure that takes place during registration will be performed, but with the one exception that if the timer does "time-out", the MTSO will terminate the call.

Once the RCC is seized, the same three 48-bit data words sent during registration are sent to the system but with a Paging Order Confirmation message included. When the MTSO has accepted this data and it has been validated, the system will send the subscriber unit another Mobile Station Control Message on the FCC. This Mobile Station Control Message informs the subscriber unit which Voice Channel will be used for the call, the proper Supervisory Audio Tone (SAT) frequency and the correct RF power level (VMAC) to use. This is the same type of message sent during Call Initiation.

While the data exchange was taking place, the MTSO has transmitted to the land telephone system (assuming this is a land to mobile call) the call processing data required for the land telephone system to complete its portion of the connection. Once the land system acknowledges receipt of the data, the MTSO will set up the talk path connection on the assigned Voice Channel (though the audio will be muted) and begin transmitting the SAT on the Forward Voice Channel (FVC).

The subscriber unit decodes the Mobile Station Control Message, stores the information, changes the receiver and transmitter RF channel to the assigned Voice Channel, then rebroadcasts the SAT received from the FVC through the Reverse Voice Channel (RVC).

The system will then send the subscriber unit a third Mobile Station

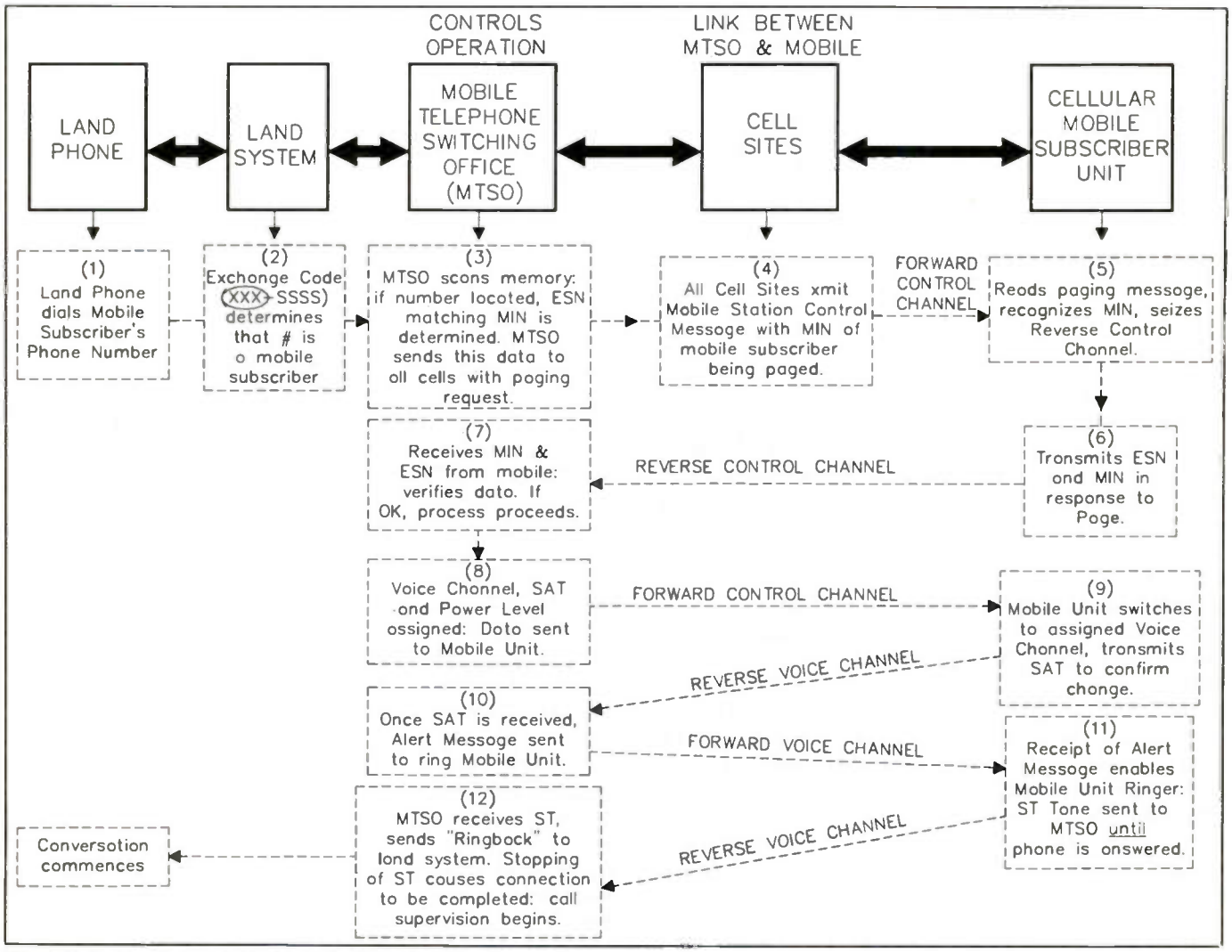


Figure 9. Call reception (land to mobile phone call).

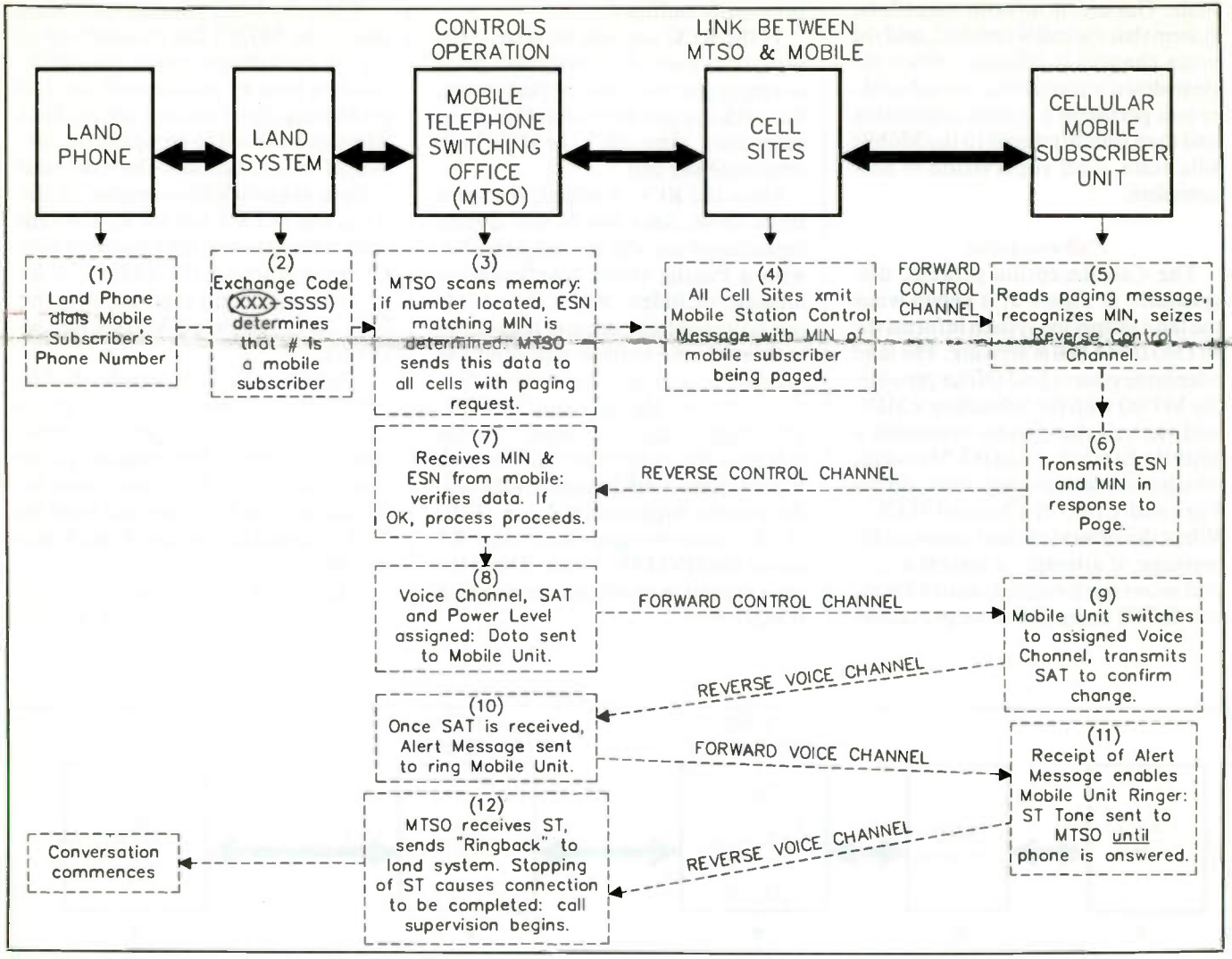


Figure 10. Call reception (land to mobile phone call.

Control Message on the FVC. This message contains an Alert Order. Once the subscriber unit has received this message, it confirms receipt by sending a continuous ST tone on the RVC, starts a 65 second timer, then enables the subscriber unit's ringer to alert the subscriber to the incoming call. The MTSO sends an alert confirmation to the land telephone network, and the calling party will then receive the ringback signal. The subscriber unit then waits for the subscriber to answer the call.

If the subscriber does not answer the call before the 65 second timer expires, the transmission of ST is terminated and a Service Order Termination message is sent to the system by the subscriber unit on the RVC, causing the cellular system to terminate the voice connection to the cell site. The cellular system will then send a recorded voice message to the calling party informing them that the cellular subscriber did not answer the call, then the call will be terminated.

If the mobile subscriber does answer the call, once the SEND key on the subscriber unit's handset is pressed, the ST tone is removed from the RVC, the audio mute is removed from the conversation path, and the call can proceed. Call processing is complete, and call supervision commences.

A mobile to mobile call reception is handled in a similar manner except, as outlined earlier, if both mobile subscribers are operating on the same cellular system when the call is received (regardless of whether both have the same "home" system), the connection is handled completely by the cellular system without the intervention of the land telephone system.

Once the call is completed, the mobile subscriber terminates the call by pressing the END key on the handset keypad, and the Clear Down procedure described previously is performed. Once clear-down is completed, the subscriber unit performs a system acquisition and then finally returns to the Mobile Idle state. Call supervision is now complete.

Handoff

One or more handoffs, a procedure diagrammed in Figure 10, may be required during the course of a call if the subscriber unit is moving during the time the call is being conducted. During the conversation, the cell site monitors the received signal strength (RSS) and/or the audio signal to noise ratio (SNR) continuously. If the RSS or SNR falls below a specific threshold, the cell site transmits data to the MTSO alerting it that a Hand-Off may be necessary. The MTSO then informs the cells surrounding the pre-

sent one to monitor the subscriber unit's RSI and/or SNR with their Signal Strength Receivers.

If a stronger signal is found by another cell site and that cell site has an idle voice channel, the MTSO prepares for the Hand- Off by setting up the voice channel at the second cell, then bridging or paralleling the new voice channel with the present voice channel: at this time the audio on the new voice channel is muted. The cellular system then sends a Mobile Station Control Message to the subscriber unit on the present Forward Voice Channel (FVC).

This message includes a handoff order. The subscriber unit decodes the message, then stores the handoff data, which includes the Voice Channel that will be used at the new cell, the proper Supervisory Audio Tone (SAT) frequency and the correct RF power level (VMAC) to use. This is the same type of message sent during Call Initiation or Call Reception.

The subscriber unit sends the ST tone for 50ms on the present cell's Reverse Voice Channel (RVC) for confirmation, then changes the receiver and transmitter RF channel to the new Voice Channel and re-broadcasts the SAT received from the new FVC through the Reverse Voice Channel (RVC). Once the system confirms the reception of SAT on the new RVC, the audio mute is removed from the new Voice Channel, the previous Voice Channel is released, and the audio bridge between the two voice channels is removed. Handoff is now complete.

Even though the entire handoff procedure takes less than a tenth of a second, the gap in transmission that occurs during the handoff process is the reason why most computer modems and many facsimile machines experience difficulties when they communicate through a cellular mobile telephone system.

System limitations

Now that the methods the AMPS cellular mobile telephone system uses to make and complete calls has been examined, here's a brief look at some of the limitations inherent in "real world" systems. In reality, the typical cellular system does not cover 100% of its defined service area. Therefore, it is not uncommon to find dead spots, called drop-out zones, in the coverage area of the system. Typically, a system will cover approximately 90% of an area with flat terrain and 75% of an area with hilly or cluttered terrain.

Sometimes calls are lost or "dropped". A high drop rate could be caused by the coverage problems previously stated or by a Hand- Off problem which may be caused by a system overload due to inadequate channel availability. Hand-off is in fact the most "dangerous" time for a cellular phone call!

Sometimes calls cannot be completed due to heavy traffic on the system, and the customer receives that aggravating Re-Order signal. As with freeway traffic, cellular traffic also experiences a rush hour traffic jam.

Coincidentally, these two types of "traffic" jams seem to occur, for the most part, at the same time! Users may also experience performance problems which can be attributed to ground clutter such as poor service in a downtown area with a high density of large buildings or in a mountainous areas. Electrical storms, even some located many miles away, can cause such difficulties as poor performance or a disruption in service.

Operating the cellular subscriber unit on a cellular system which is not the home system, a procedure called roaming, can be troublesome, since not all cellular systems are created equal. When roaming, the user may experience dropped calls and unexpected clear-downs when the system is heavily loaded, because under those conditions, the cellular system will give priority for use of the systems resources to the "home" customers.

The various roaming agreements between the cellular carriers often restrict the usefulness of the roamer system, sometimes to the point where it is nearly worthless: this is the reason behind the sales growth of dual or multiple registration cellular phones.

The cellular carrier's MTSO and cell sites are only part of the cellular system. Also affecting the overall system performance is the subscriber unit itself. The antenna selection may not be the best one and the power supply may not be consistent, especially on vehicles with marginal electrical systems. The subscriber unit may be abused and, in the worst case, may be malfunctioning electronically. When evaluating the performance and operation of a mobile subscriber unit, many items must be considered. Remembering this truth plays an important role when it comes time to troubleshoot after receiving a customer complaint.

Servicing in this growing market

The AMPS cellular system in use today provides quality communications to most users. It is configured in such a way that it will work in a very dense urban areas as well as the outlying rural area. Although it may seem to be a very complicated system, today's equipment and technology handles the requirements consistently.

With the increased demand, equipment and service cost have gone down significantly, which is why cellular communications is one of the fastest growing businesses in the United States. With the new digital and PCN technologies that are presently being implemented that will enhance the system even more, the future holds the promise of even better communications capabilities in the coming years.

Future articles about the cellular telephone system will examine the programming, installation and troubleshooting of the cellular subscriber unit. ■

Working with microcomputer display technology

Part One–Comparing Technologies

By John A. Ross

As technology changes, all the experience and expertise that we have gained helps us to adapt to the change. In many cases, our ability to adapt makes the difference to surviving in this profession. Like most of you, I entered the electronics servicing business by working with television receivers. With this type of work, we have gained experience with video display technology. Terms such as cathode ray tube, yoke, video signals and deflection have become an almost natural part of our vocabularies.

Servicing microcomputer displays is one way to give your television service business a shot in the arm. While moving into this area of electronics servicing may seem challenging, do not let the technology intimidate you. For most service problems, you can use the same test equipment and the same reliable professional knowledge that you have used for servicing television receivers. In addition, you have the opportunity to take your business in a different direction while acquiring new customers.

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

Some key differences between the display technologies

Along with the obvious similarities, video monitors and television receivers also have obvious differences. Figures 1 and 2 compare the block diagrams of a color video monitor and a color television receiver. Instead of receiving signals through antenna connections, video monitors receive signals from a either a printed circuit card or set of integrated circuits within a microcomputer.

You could think of the monitor and the system graphics adapter card as a video subsystem. When servicing the video display, you will need to provide a signal source such as the microcomputer equipped with the appropriate video card or a generator and the correct video input cable. A variety of cable types have been used to connect monitors to microcomputer systems.

Because the video display operates from the signals developed within the

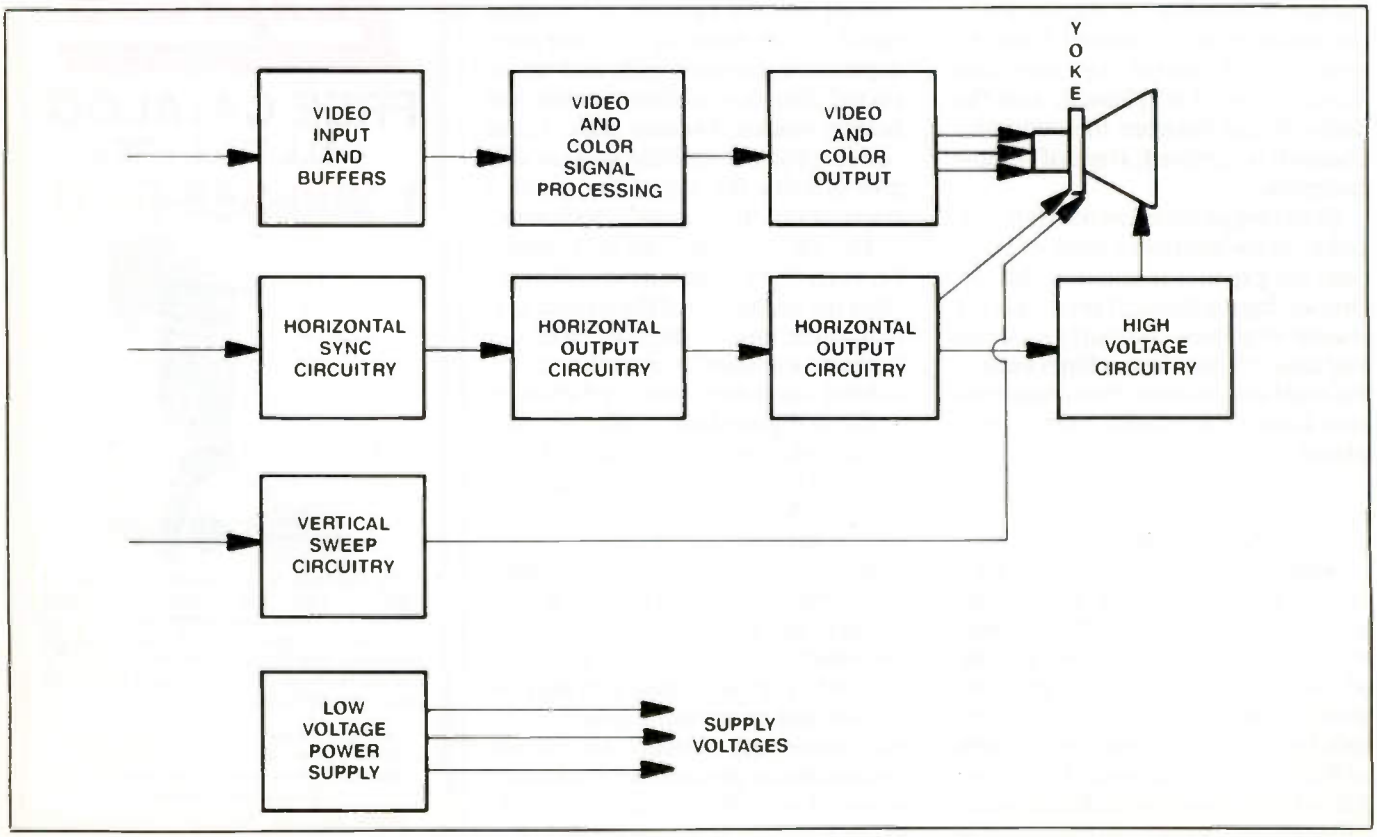


Figure 1.

microcomputer, the monitor does not feature any audio circuitry. All audio for the microcomputer system is developed internally through the microprocessor and a small speaker. More recent audio adaptations include the upgrading of the microcomputer system with an add-on sound card.

Video information displays show text as well as graphical data at much higher resolution than the resolution of television receivers. Indeed, rating video monitors on the number of individual dots (picture elements, or pixels) displayed and the dot pitch has become common practice.

For color monitors, a pixel consists of three individual dots—red, blue and green. Dot pitch is the distance between the center points of adjacent horizontal pixels on the CRT screen. Most advertisements for video display monitors will list the dot pitch measurement in millimeters. The smaller the distance between pixels, the higher the possible resolution of the monitor.

As with television receivers, microcomputer displays rely on vertical and horizontal scanning frequencies. Each line that results from the deflection scanning yields a set number of pixels. The longer horizontal dimension of the monitor will display more pixels than the shorter vertical dimension.

If the specifications of a monitor list a resolution of 640 x 480 pixels, the horizontal scan lines show 640 pixels while the vertical line shows 480 pixels. Multiplying the two figures gives the total number of pixels that the raster will display. In this case, the total number of pixels is 307,200.

Because the number of pixels depends on the deflection signals, varying the horizontal scan rate also varies the number of displayable pixels. Original monitor designs have a horizontal frequency of 15.75kHz. More recent designs use horizontal sync signals of 21.80kHz, 31.50kHz and 35kHz. Figure 3 lists the horizontal scan frequencies as they correspond with different video display types.

You may wonder why the designs do not change the vertical scan rate. By retaining the 60Hz vertical scan rate and increasing the horizontal scan rate, more horizontal lines become squeezed into the vertical cycle. An increased number of horizontal lines further improves the clarity produced by the video monitor.

Information display monitors also use higher picture bandwidths than

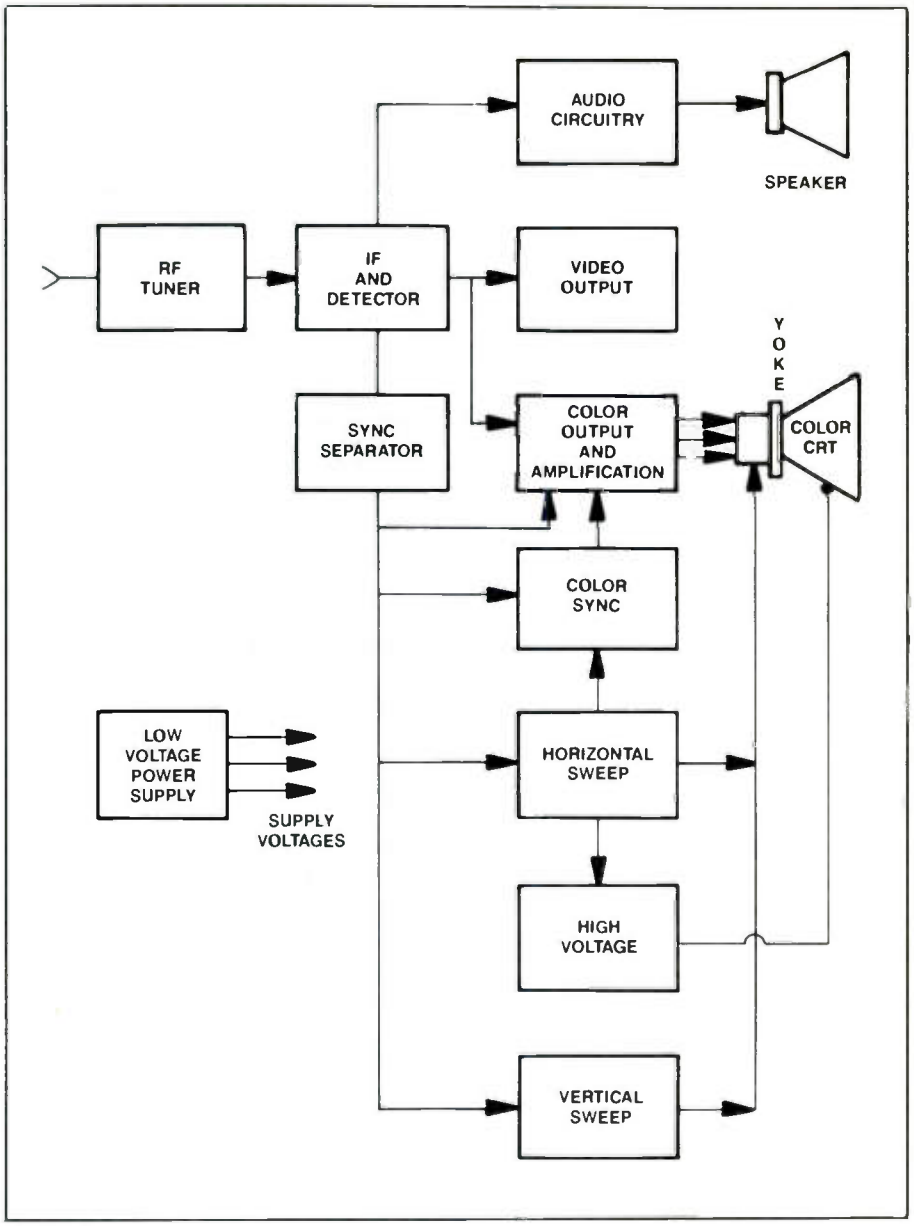


Figure 2.

Listing of Video Display Horizontal Sweep Frequencies

Video Mode	Frequency	Resolution
MDA	18.40kHz	720(H) x 350(V) Text Only
Hercules	18.40kHz	720(H) x 350(V)
CGA	15.75kHz	640(H) x 200(V)
EGA	21.85kHz	640(H) x 480(V)
VGA	31.49kHz	640(H) x 480(V)
SuperVGA	35kHz 37.8 kHz 48kHz	800(H) x 600(V) 1024(H) x 768(V) 1280(H) x 1024(V)

Figure 3.

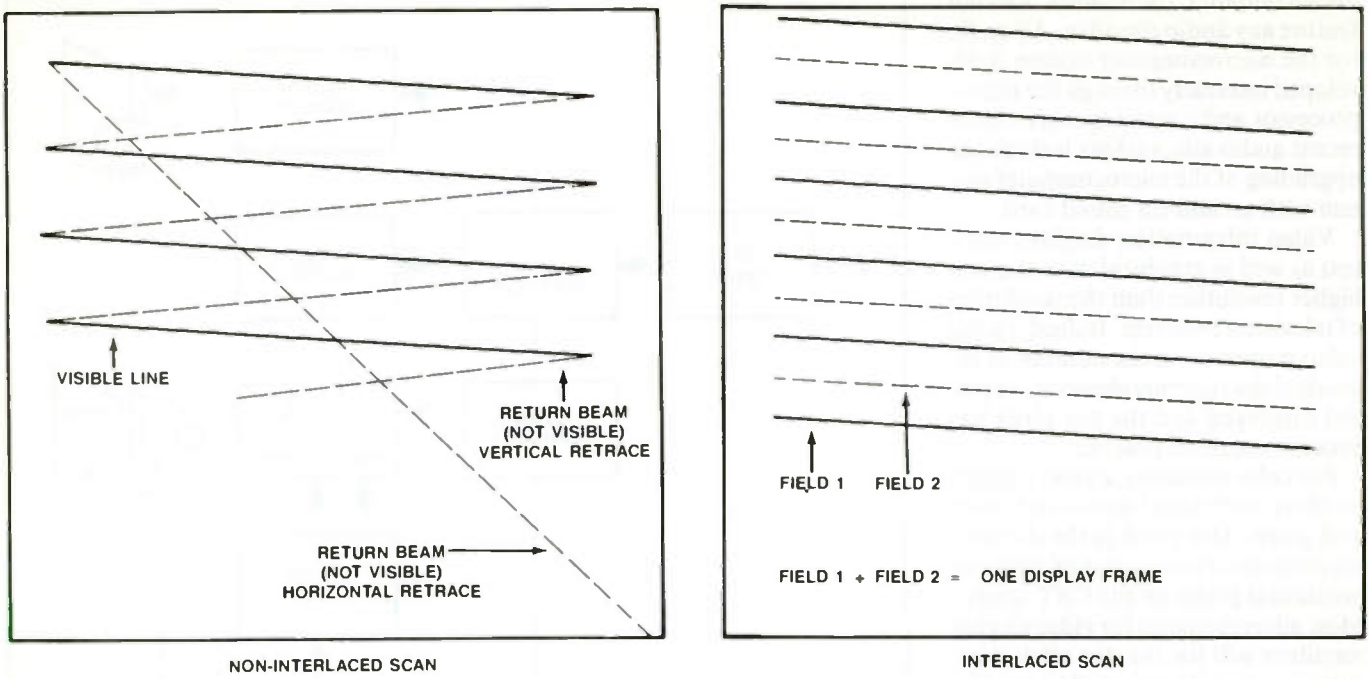


Figure 4.

television receivers. In other words, the monitor can turn its display pixels off and on more quickly than can a television receiver. Television receivers have a bandwidth of 4.5MHz. Information display monitors have a bandwidth of 35MHz or higher. The higher bandwidth allows the monitor to display more pixels during one horizontal scan.

Because of the higher resolution, any amount of flicker caused by screen phosphor decay would be noticeable and distracting. With all the individual dots displayed, some will dim as others become illuminated.

To counter the flicker problem, video displays use non-interlaced refresh scanning. That is, the deflection circuitry of the monitor will draw all odd lines then all even lines during a cycle. Figure 4 shows how non-interlaced scanning works and compares it with the interlaced scanning to which

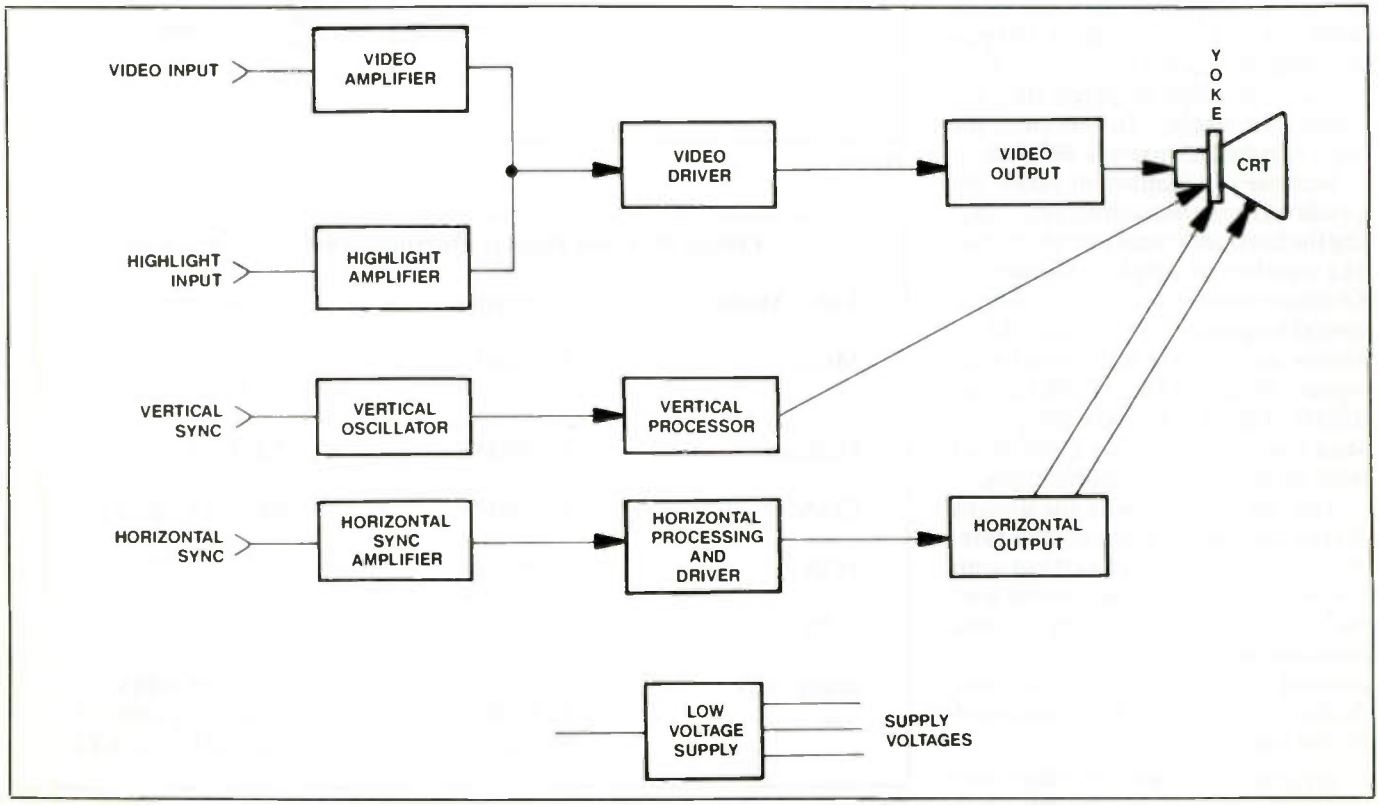


Figure 5.

we have become accustomed while working with television receivers.

Some new words to remember

Along with learning how monitors differ from television receivers, we'll also need to learn some new terms. Depending on the type, monitors use input signals called TTL (transistor-transistor logic), RGB (red-green-blue) and composite. In addition, displays are not only classified as monochrome and color but also as enhanced color displays, video graphics array displays and as multisync displays.

Finally, the adapter cards that drive the monitors have designations such as Hercules Graphics Card, Color Graphics Adapter (CGA), Monochrome Display Adapter (MDA), Extended Graphics Adapter (EGA), Video Graphics Adapter (VGA), SuperVGA, 8514/A and 34020.

Video displays or monitors have progressed from the fairly simple monochrome displays to multi-sync displays. Early microcomputers relied on a display that would show only text or pixel-based graphics. These displays used either a monochrome display adapter or a Hercules graphics adapter as a source for video signals.

As software designers pushed for higher quality video displays, this type of monitor often became inadequate. Many times, the adapter and card could not show the graphical images created through the software application.

IBM answered the need for better quality computer graphics with the color graphics adapter and the color display. The early CGA monitors could show sixteen-colors of text or graphics. Only a color graphics adapter or extended graphics adapter could drive the color monitor. As a follow-up to the CGA card, IBM introduced the extended graphics adapter and the enhanced color display.

With the extended graphics adapter, a user could replace his monochrome, Hercules or color graphics adapter and monitor with a standardized design. The extended graphics adapter/enhanced color display also gave the additional bonuses of higher resolution and sixty-four displayable colors.

Advances in technology and user demands for better quality video pushed manufacturers to produce a video system that gave microcomputer owners even more color choices and even higher video resolutions. Early VGA monitors could display sixteen colors at a resolution of 640 x 480 and 256 colors at lower resolutions.

With the introduction of the video graphics array adapter, information display video technology also moved completely away from digital signal transmission to analog signal transmission. Before the entrance of VGA technology, only RGB monitors used an analog video signal. While the digital video signals are limited to on or off states, the analog signal causes the electron beam of the CRT to vary in smaller increments. More shades of color result.

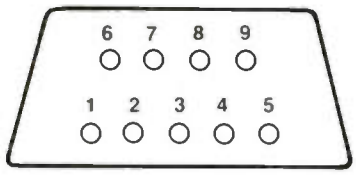
Two offshoots of the VGA technology have begun to corner the display market. SuperVGA offers even higher video resolution figures of 800 x 600 and 1024 x 768. Along with those higher resolution figures, the combination of monitor and video adapter card could also produce more shades of color at a higher resolution.

The increased number of high resolution colors has become a product of the monitor, the video circuitry and the amount of video random-access memory on the adapter card. Additionally, Multisync monitors automatically synchronize to a given scan rate. This allows the monitors to be used with any RGB, CGA, EGA or VGA video input signal.

TTL video operation

Some video displays accept TTL or transistor-transistor logic video signals. Two bipolar transistors work together in a single package and control the logic level of a signal. A TTL device has two emitters. Four TTL signals—video input, highlight input, vertical sync and horizontal sync—flow into the monitor through a nine-pin D connector. Unlike the composite video signals that separate at different stages within the monitor, the TTL signals connect directly to their respective stages.

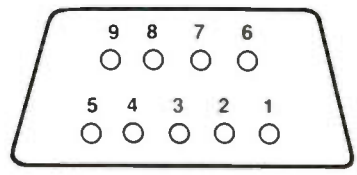
Figure 5 shows a block diagram of



Connector Pinout for MDA Video Signals

Pin	Signal
1	Ground
2	Ground
3	N/C
4	N/C
5	N/C
6	Intensity
7	Video
8	Vertical Sync
9	Horizontal Sync

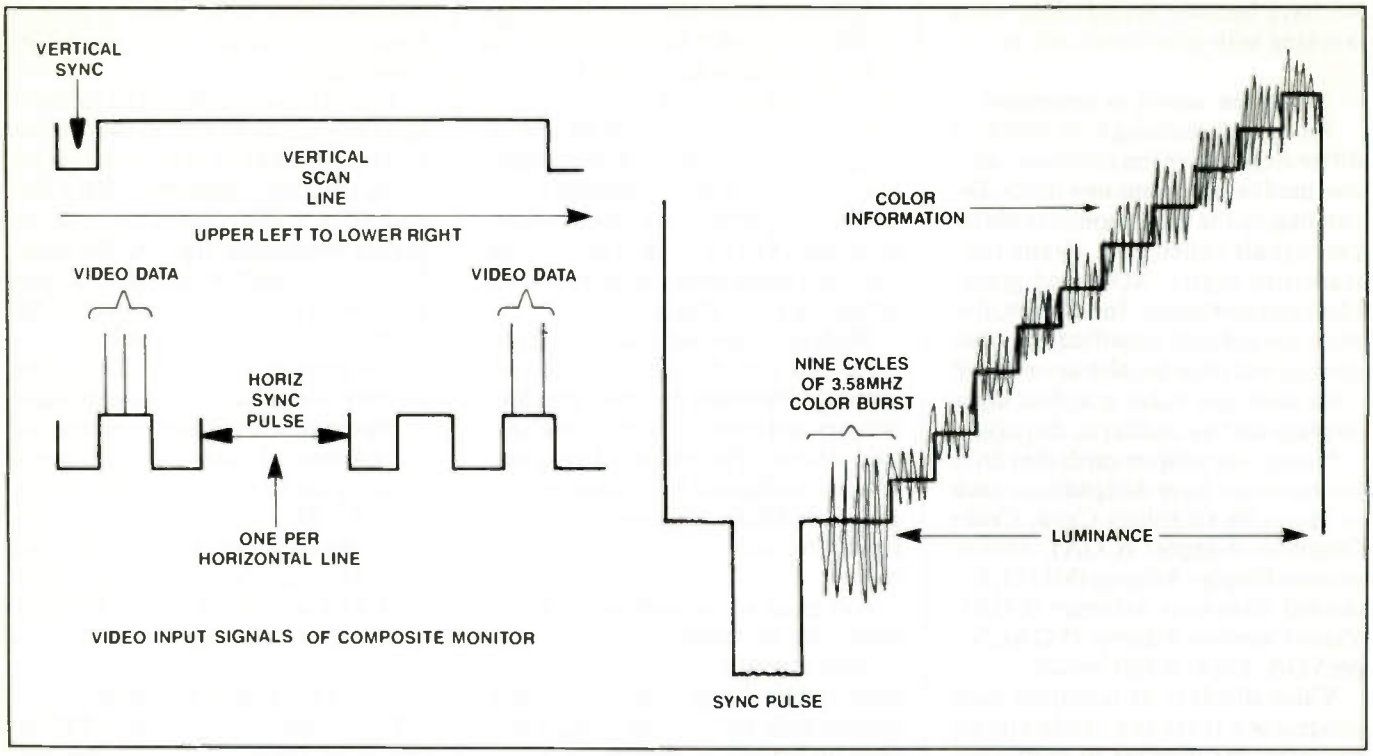
Figure 6.



Connector Pinout for Composite Video Signals

Pin	Signal
1	Ground
2	N/C
3	Red
4	Green
5	Blue
6	Intensity
7	N/C
8	Horizontal Sync
9	Vertical Sync

Figure 7.



TTL operation. With the diagram, we can easily see that the video input ties to the video amplifier stage, that the highlight input ties to the highlight amplifier, that the vertical sync signal flows into the vertical oscillator and that the horizontal sync signal ties to the horizontal sync amplifier.

Monochrome display adapter (MDA)

Early microcomputer displays could not display colors or graphics. Using an adapter called the monochrome display adapter or MDA, these early displays worked well to display twenty-five rows of eighty characters. Figure 6 shows the signals present at the video input connector of a text-only monitor. While looking at the connector pin-out, note that the MDA adapter has a vertical frequency of 50Hz and a horizontal frequency of 18,432Hz. Using these sync frequencies allows the monitor to display the 350 vertical and 720 horizontal raster lines required for good text reproduction.

Hercules

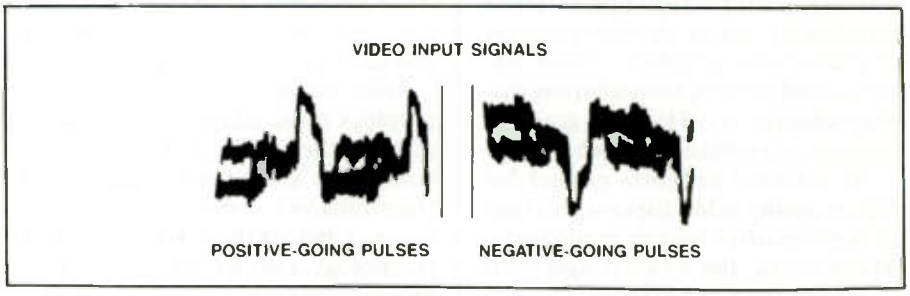
Since the original monochrome monitors could not support graphics, another type of video adapter card came into use. The Hercules graphics adapter card could attach to the older monochrome monitors but could also attach to monitors that could display monochrome graphics. Since the adapter card attached to both kinds of monitors and produced 350 vertical and 720 - horizontal lines, the Hercules adapter retained the unusual vertical and horizontal sync frequencies seen with the MDA video card.

Composite video

One video signal, along with the sync pulses, makes up the composite video signal. Thus, the composite video signal contains all the signals needed to drive a video monitor. Because of this, many early composite monitors use an RCA jack as the video input connector while others used the more standard nine-pin connector. Figure 7 lists the pin connections for the nine-pin connector.

The video portion of the composite signal

A video card inside the microcomputer generates the signals. Of the video input signals, the composite signal most closely resembles the signals that we see when working with television receivers. Figures 8A and 8B compare the video signals seen at a composite monitor and a television receiver.



Because of its design, the composite color signal is more complex than the composite monochrome signal. Brightness identifies each point of a monochrome display. With a composite color signal, three levels—luminance, hue and saturation— identify each point of the display.

As with television signals, we can call the luminance portion the Y signal and the hue and saturation portions the chrominance signals. The combined red, blue and green chrominance signals make up the luminance signal. Subtracting the luminance signal from the red and blue chrominance signals gives us the R-Y and B-Y signals or the difference signals.

At the first stage inside the monitor, the composite video signal splits into two components. One component supplies video information to the CRT

ES&T Manufacturers' schematics PROFAX

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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.

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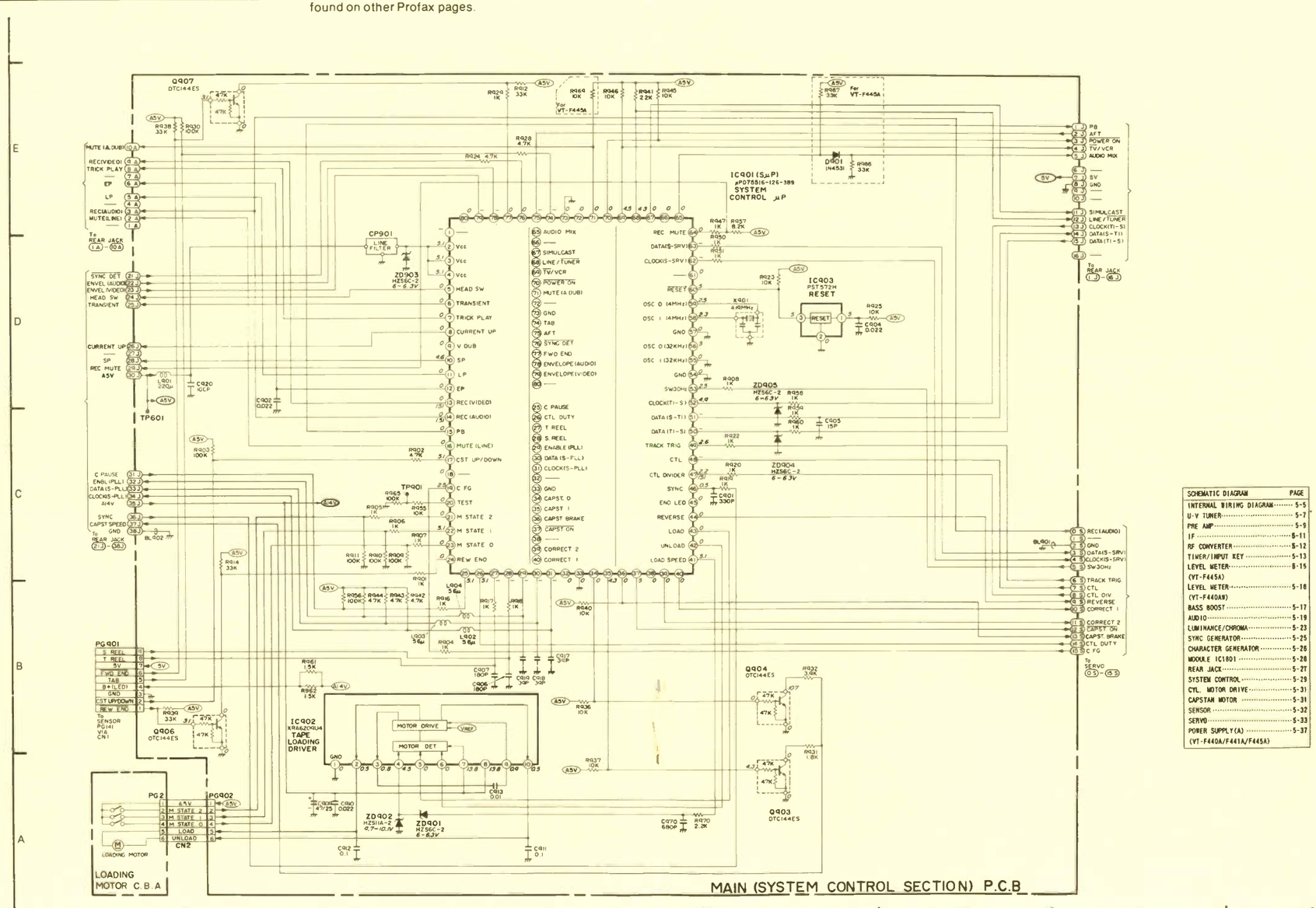

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LUMINANCE/CHROMA SCHEMATIC DIAGRAM

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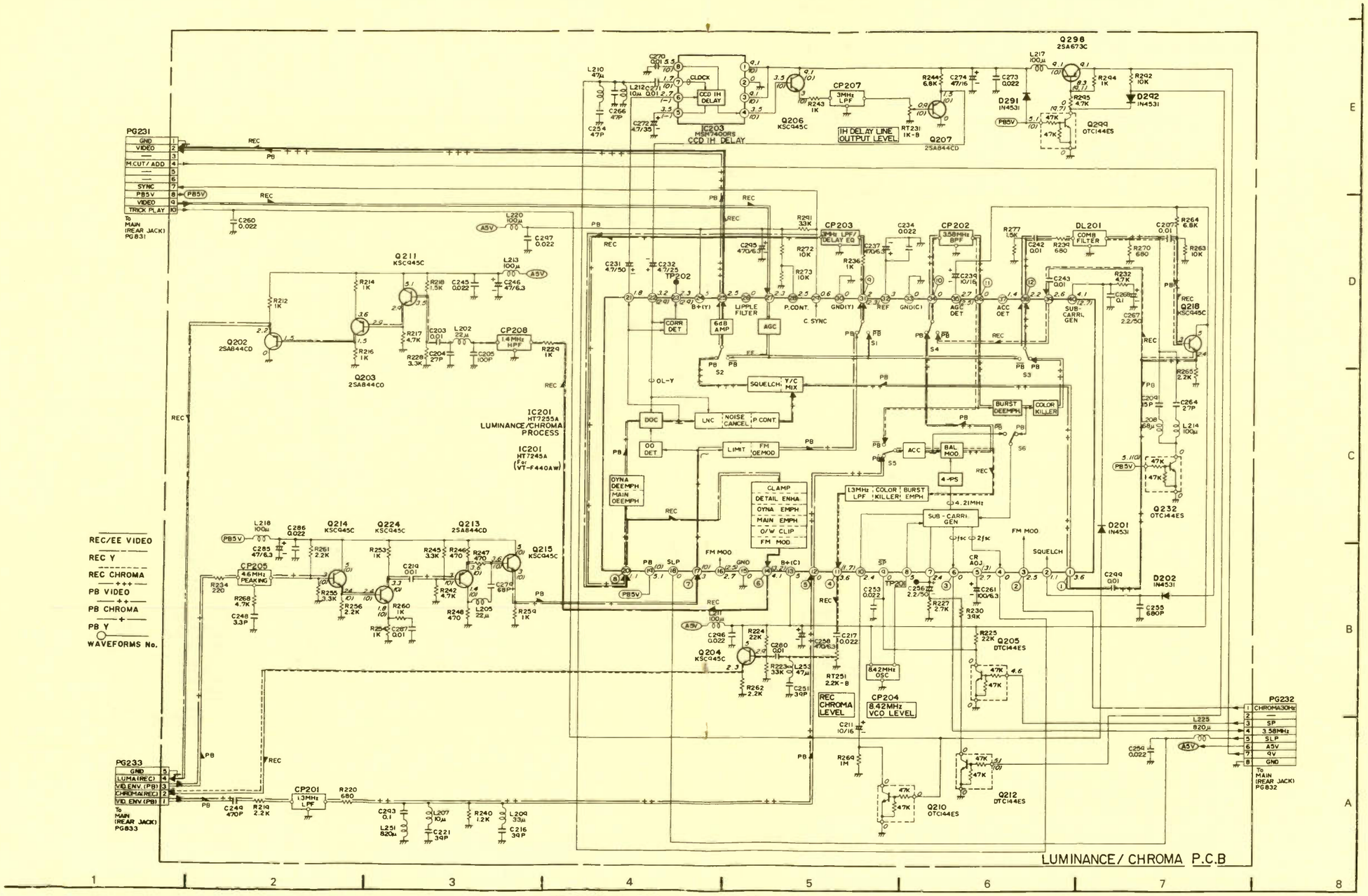

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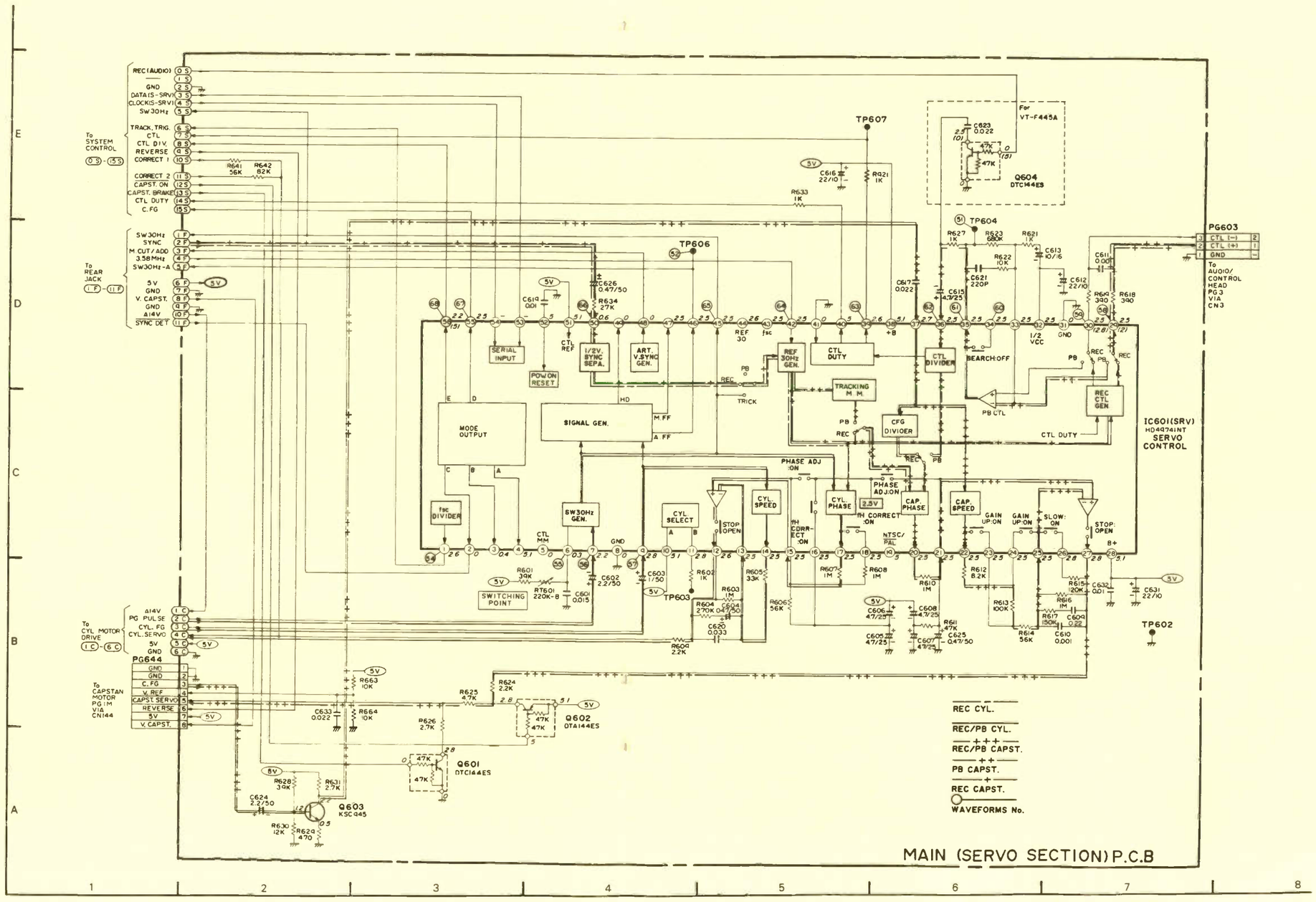

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TIMER/INPUT KEY SCHEMATIC DIAGRAM

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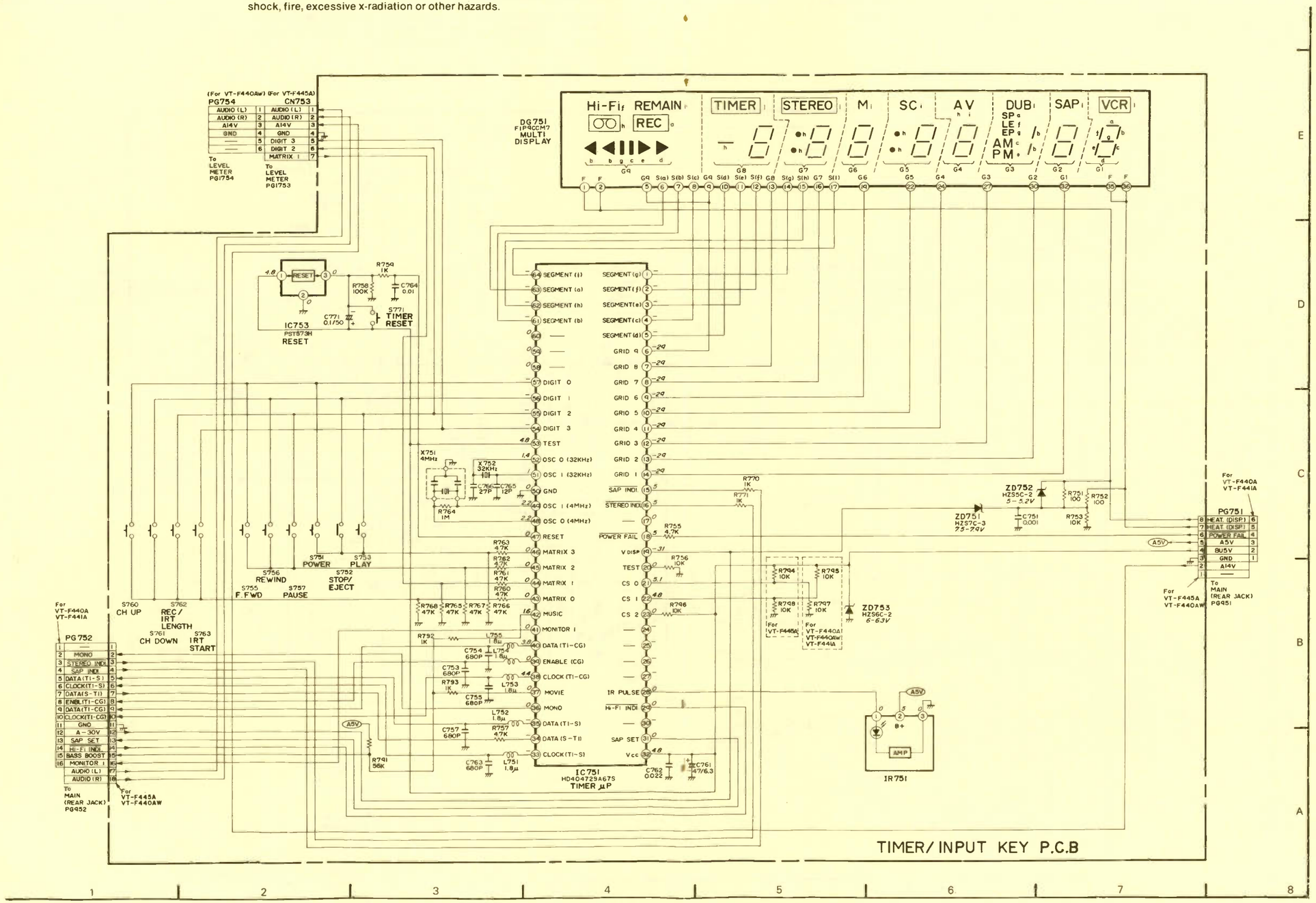

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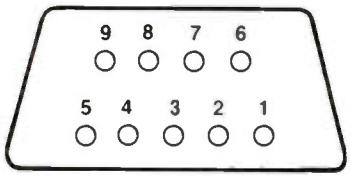

Connector Pinout for EGA Video Signals

Pin	Signal
1	Ground
2	Secondary Red
3	Primary Red
4	Primary Green
5	Primary Blue
6	Secondary Green
7	Secondary Blue
8	Horizontal Sync
9	Vertical Sync

Figure 9.

while the other component supplies the vertical and horizontal sync signals. As Figure 9 shows, the sync signals separate from the complete composite signal at the sync amplifier/separator stage.

Again, the composite monitor video stages work as the familiar television video stages operate. The 3.58MHz signal works as a reference point. If the video portion of the signal contains color information, nine cycles of the 3.58MHz color burst signal become added to the horizontal sync pulse and synchronizes the color oscillator.

Each difference signal modulates the 3.58MHz reference signal with the R-Y signal modulating a ninety degree phase-shifted subcarrier and the B-Y signal modulating a one hundred-eighty degree phase shifted subcarrier. Suppressing the subcarriers allows only the transmission of the combined modulated signal. While the phase relationship between the 3.58MHz reference and the sidebands determines hue, the amplitude of the modulated color sidebands determines the amount of color saturation.

The sync portion of the composite signal

Both the composite analog and sync signals are analog signals. With composite video operation, large differences between the timing of the vertical and horizontal signals exist. For every vertical scan, two hundred to five hundred horizontal scans occur.

DB-9 Connector Pinout for RGB Video Signals

Pin	Signal
1	Ground
2	Ground
3	Red
4	Green
5	Blue
6	Not Connected
7	Not Connected
8	Horizontal Sync
9	Vertical or Composite Sync

Figure 10.

Connector Pinout for VGA Video Signals

Pin	Signal
1	Red
2	Green
3	Blue
4	N/C
5	N/C
6	Red Video Ground
7	Green Video Ground
8	Blue Video Ground
9	N/C
10	Digital/Sync Ground
11	Reserved/mode
12	N/C
13	Horizontal Sync
14	Vertical Sync
15	N/C

Figure 11.

Video Mode	Graphics Type	Color/ Monochrome	Char X Scan Lines	Box Size	Char Resolution
0	Alpha/Num	C 16/256	40 x 25	9 x 16	720 x 400
1	Alpha/Num	C 16/256	40 x 25	9 x 16	720 x 400
2	Alpha/Num	C 16/256	80 x 25	9 x 16	720 x 400
3	Alpha/Num	C 16/256	80 x 25	9 x 16	720 x 400
4	Graphics	C 4 /256	40 x 25	8 x 8	320 x 200
5	Graphics	C 4 /256	40 x 25	8 x 8	320 x 200
6	Graphics	C 2 /256	80 x 25	8 x 8	640 x 200
7	Alpha/Num	Monochrome	80 x 25	9 x 16	720 x 400
D	Graphics	C 16/256	40 x 25	8 x 8	320 x 200
E	Graphics	C 16/256	80 x 25	8 x 8	640 x 200
F	Graphics	Monochrome	80 x 25	8 x 14	640 x 200
10	Graphics	C 16/256	80 x 25	8 x 14	640 x 350
11	Graphics	C 2/256	80 x 30	8 x 16	640 x 480
12	Graphics	C 16/256	80 x 30	8 x 16	640 x 480
13	Graphics	C256/256	40 x 25	8 x 8	320 x 200

Figure 12.

Generally, the vertical sync pulse is derived from the line frequency of the computer. As with television receivers, video monitors rely on a 60Hz vertical sync pulse. Older composite monitors have a 15.75kHz horizontal sync pulse frequency.

EGA video

EGA monitors have eight video input signals and use a horizontal sweep frequency of 21.50kHz. Along with the primary red, blue and green video signals, secondary RGB signals intensify individual color signals. With the analog RGBI monitors, the intensity bit intensified all three colors at the same time. With the EGA monitor, the secondary video signals will intensify only the corresponding primary color.

Because the secondary signals will intensify either the individual primary signals or combinations of the signals, the number of possible displayable colors rises from sixteen to sixty-four.

Sync signals also combine with the video signals. The vertical sync signal locks in the vertical oscillator while the horizontal sync signal locks in the horizontal oscillator. As with television receivers, the sync signals also blank the CRT electron beams between lines, fields and frames. EGA monitors use a fifteen-pin, D style connector called a DB-15 connector. Again, each pin carries an individual video signal. Figure 9 lists the signals found at the video connector.

Analog signals

RGB, VGA and Super VGA monitors use analog video signals. Every time the level of the analog signal changes, the monitor displays a different shade of color. Because the changes in color can be subtle, a monitor with analog video input signals could display an infinite number of colors. Only the video circuitry limits the number of colors seen by the user. Some references may consider the RGB signal as a single video signal. Actually, separate red, green and blue video signals make up the RGB input. Each signal controls the electron beam of the color gun associated with the signal.

When exploring the physical differences between RGB and composite monitors, one needs to go only as far as the video connector. When looking at the physical wiring of a RGB nine-pin connector, you can see that at least five wires are used. Figure 10 shows how each wire carries one signal.

As the name may imply, RGB signals work only to produce a color display. RGB video signals work in only two conditions—on or off. During the display of colors, the colors are a function of either the on or off state of the signal. An "on" red signal will produce a red screen. An "on" red combined with an "on" blue signal gives a magenta screen. Totaling the number of possible color combinations gives eight colors: black, red, blue, magenta, green, brown, cyan, light gray.

Some RGB monitors use extra signals to increase the possible number of displayable colors. RGBI monitors utilize a signal called an intensity bit which becomes simultaneously applied to all three basic colors. This bit intensifies the video signals and increases the number of displayable colors from eight to sixteen: dark gray, light red, light blue, light magenta, light green, yellow, light cyan, white.

VGA signals

VGA input signals are variations of the themes that we have already seen. On one hand, the VGA video monitor operates with analog RGB input signals instead of composite video signals. However, the vertical and horizontal sync signals are digital. VGA sync signals will run at different line modes to accommodate CGA, EGA, MDA and Hercules information. Figure 11 lists the signals found at the fifteen-pin video input connector of a VGA monitor.

VGA monitors will show two hundred fifty-six colors out of a choice of 256,000 colors. Even though VGA monitors utilize analog RGB signals, they will only work with VGA input signals from a VGA adapter card.

This may seem to be a problem since some software packages will only produce CGA or EGA signals. Most VGA adapter cards can change the CGA and EGA signals into a form easily displayed by the monitor.

Figure 12 lists the different VGA video modes of operation: As you saw earlier, the video graphics array display has a higher horizontal sync frequency. A higher frequency of 31.50MHz produces additional horizontal scan lines that squeeze into the area scanned by the vertical lines. More lines mean higher resolution and greater clarity.

Newer Super VGA cards can produce horizontal sync frequencies of 35.20kHz, 37.80kHz or 48.0kHz. Along with the higher horizontal scan frequencies, SuperVGA monitors also have vertical scan frequencies that, depending on the manufacturer, may vary from 56Hz to 72Hz.

The horizontal scan rate depends on the vertical refresh rate. In turn, a higher vertical refresh rate eases eye strain. As you may suspect, the demands of higher sync frequencies and higher bandwidths require improved CRT technology. SuperVGA technology must have a higher quality display than VGA technology.

Future articles

This article sets forth the basic principles for understanding how information display monitors function and how those displays differ from television receivers. In next month's article, we'll take a detailed look at RGB and Hercules monitor and video card operation. This look will include tracing the signal paths throughout the monitors. In addition, we'll discuss servicing RGB and Hercules monitors and list possible malfunctions and symptoms. ■

Test your electronics knowledge

By Sam Wilson, CET

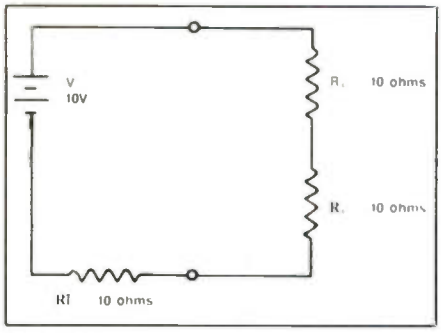

Figure 1.

1. Assuming the values and power ratings are the same, can a film resistor always be replaced by a carbon composition resistor?

A. Yes
B. No

2. What do the initials ASIC stand for?

3. What is the purpose of a type of integrated circuit called FLASH?

4. The time it takes the output of an operational amplifier to change in response to a step-voltage change at the input is called the _____.

5. In the circuit of Figure 1, what value of R_1 will allow it to receive maximum power?

6. What type of Morse code transmission has the low-static characteristic of FM?

7. Comparing a wideband amplifier with a narrow band amplifier, and assuming the same temperature for the two amplifiers which produces more noise?

8. Why can't the outputs of UARTS be used directly on a telephone line?

A. improper timing
B. cannot handle data fast enough
C. against the law

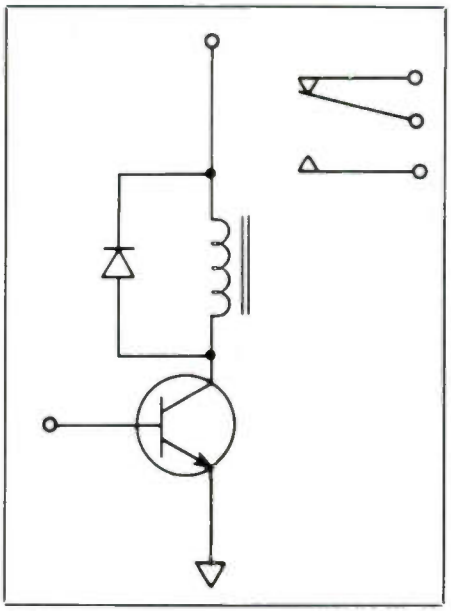

Figure 2.

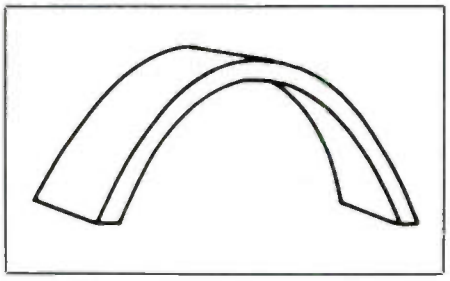

Figure 3.

9. A diode is sometimes connected across a relay coil to protect a transistor from inductive kickback. (See Figure 2.) Which of the following may be used instead of the diode?

A. triac
B. bead ledge
C. ferrite bead
D. varistor

10. The shape of a flat piece of metal has been changed as shown in Figure 3. In that condition the metal is

A. stressed
B. strained

(Answers on page 52)

Distributors showcase

Entering a business relationship with a distributor is a lot like deciding on any other kind of business relationship. Whether you choose to do all of your business with a local distributor, or whether you do almost all of your business with a mail order firm, or some reasonable combination of the two, it makes sense to choose with care the distributor(s) with whom you do business.

As you have probably already learned, distributors are as different from each other as are any other kinds of selling organizations. Most distributors are well stocked, well organized, can help you with special requirements, can help you do research to help you find the part you need; some are not. Some mail-order distributors can take your order in a number of ways including mail, telephone (some with 800 numbers), fax, etc.; some can not. Some distributors charge a reasonable amount of money for shipping and handling; some will charge you what you will conclude is an exorbitant amount. Some distributors will send your order right away even before your check clears, some will wait until your check clears, and some will keep your money well beyond the point when they should have shipped your order.

Some points to keep in mind

You're probably a careful shopper when it comes to buying consumer goods. You should also be a careful shopper when choosing a distributor.

Here are some of the things you should consider when settling on a distributor. Some apply only to the local distributor, and some apply only to mail order, but it would be a good idea to keep them in mind any time you're thinking about doing business with a new firm. These items are not listed in any particular order, for the simple reason that their order of priority or importance depends upon your particular wants and needs. Put them in order of importance for yourself.

- Does the general impression of the distributor's facilities or literature give the impression of competence and order?
- Do the distributor's prices seem reasonable and in line with what other companies charge?
- Does the distributor have most items in stock, or does he have to back order many of them?
- Does the distributor offer a broad line of products, or will you have to find other sources of supply for many of your needs?
- Does the distributor specialize in any kinds of products that you will need?
- What kind of payment options does the distributor offer: Open order account, credit card, COD, check, etc.?
- How soon after receipt of an order does the distributor ship?
- Does the distributor add a shipping surcharge, or a handling charge?
- Does the company have a toll-free number?
- Does he offer such ordering options as fax, and telex, and does he offer such computer ordering options as MCI Mail, Compuserve, and Easy-Link?
- What is his return policy?
- Are all of the distributors policies well documented, or do you have to guess at them? Or do they differ depending on his whim?
- What kind of warranty, if any, does the distributor offer?
- Is the catalog, if one exists, clear and easy to understand?
- Is there a minimum order amount, and if so, is it reasonable?
- What kind of shipping options are available: mail, UPS, Federal Express, etc.?
- What kind of special services, such as assembling cables, etc. does he offer?
- What research services does the distributor offer to help you to find the part you need?

These questions can be important

To some of you, these questions may not seem important, but from what we have learned from some of our readers, they may be very important. For example, we learned from one of our readers that one mail order company that he dealt with made a regular practice of charging unnecessarily high shipping charges on the products he sells.

Another practice that some distributors indulge in is to hold shipment of products for some time after the purchaser's check has cleared. This gives the distributor a nice little interest-free loan between the time the check clears and the time he decides to ship the merchandise. In contrast, to show that this is not necessary, when I recently ordered a product from a mail order company, they shipped the product immediately after receiving my order.

One other thing we have learned that some distributors do is to charge a restocking fee even when they were responsible for shipping the incorrect product in the first place.

Caveat emptor

Most replacement parts distributors are hard-working, well-organized, ethical companies, who will make every effort to help you obtain the correct replacement for a faulty component. It's not always easy to locate the good ones and avoid the ones that will give you problems. One approach when you're considering ordering products from a new distributor is to start out with a small order, see what kind of response you get. If the service you receive is not what you'd like, try someone else. There's nothing worse than not getting the products you ordered or being hit with exorbitant freight charges.

MCM Electronics

650 Congress Park Dr.
Centerville, OH 45459
800-543-4330
FAX: 513-434-6959

MCM Electronics is a company of dedicated people committed to offering only the best electronic parts, components and service to the customer.

Because needs in the electronic industry are constantly changing, MCM Electronics continually and thoroughly researchers the market and reacts to the changing demands. And MCM is constantly in touch with national and international manufacturers to bring both commonly used and the hard-to-find products to its customers. In fact, two full-sized catalogs are mailed each year and the last issue introduced more than 500 new items. MCM is a full-line distributor for RCA/GE replacement parts and an exclusive distributor for MultiTech/DynaTech. We also carry other brand names including: Chemtronics, Fluke, Panavise, Sams Photofacts, Weller, Xcelite and many more.

Sales flyers are mailed regularly which feature specially priced products. These flyers keep the customers continually informed of new items that are being added.

The Sales/Customer Service Department had been thoroughly trained to answer all calls on the toll-free lines promptly and efficiently. These representatives are professionals who can provide immediate information on stock availability and pricing. They are available Monday through Friday, 7:00 a.m. to 8:00 p.m. EST, and Saturday 9:00 a.m. to 6:00 p.m. EST. Orders can be placed after hours with a national toll-free number, ensuring service 24 hours a day, seven days a week. Also, MCM has highly trained electronics technicians available to answer the customers product questions.

The company's Distribution Center houses an enormous inventory of parts and components. Every order is pulled and double-checked to strive for timely and error-free shipment. Because more than 17,000 of the items in the catalog are stocked and ready for shipment, orders are shipped within 24 hours.

Even though most orders are shipped UPS, MCM offers a broad range of shipping options. Customers can establish Net 30 accounts or have their orders shipped COD, charged to MasterCard or Visa, prepaid or picked up at the Distribution Center's Will Call area. There is a $20 minimum order for COD, check and open accounts, and a $25 minimum for MasterCard and Visa orders.

For more information and a free catalog subscription, call 1-800-543-4330. (In Canada, call 1-800-824-9491; in Dayton, OH call 434-0031). ■

★ ★ ★ DISTRIBUTORS' SHOWCASE ★ ★ ★

C & S Sales

1245 Rosewood Dr.
Deerfield, IL 60015
800-292-7711
FAX: 708-520-0085

C & S Sales is a major distributor of high quality test instruments and electronic educational equipment. The company currently carries such name brands as: Hitachi oscilloscopes, Fluke multimeters, Standard amateur radio equipment, Beckman multimeters, Elenco test equipment and educational equipment, MOVIT robotics kits, and many other popular brands.

C & S Sales is a master distributor for Elenco, Hitachi, Standard, and MOVIT. This means that C & S Sales sells to other distributors as well as end users. In this way one is assured that C & S Sales will have the products you need at the lowest possible prices available.

C & S Sales has been servicing the industry since 1984. Its friendly and knowledgeable sales staff is committed to offering highest quality test equipment at the guaranteed lowest prices.

The company publishes a free 32-page catalog listing thousands of items. Their 25,000 square foot warehouse assures that these items are readily available for immediate delivery.

The company prides itself on being the most price competitive distributor in the industry. Its huge inventory capability and large sales staff assures one will get the best possible service. Since they are able to buy in volume they are able to pass these savings on to their customers. Their motto is "We will not be undersold" and this is true. They guarantee to not meet, but beat any authorized distributor's price on any products they sell. Call them and see for yourself.

The sales/customer service department has been thoroughly trained to answer all calls promptly and efficiently. These representatives are professionals who can provide immediate information on stock availability and pricing. They are available 8 a.m. to 9 p.m. (CST) Monday through Friday and 9 a.m. to 6 p.m. (CST) Saturday. Orders can also be mailed or faxed to us. Our fax machine operates 24 hours a day, seven days a week. Technical questions about a particular product can be answered by C & S Sales highly trained electronics technicians, who are available to provide the answers customers need.

Even though most orders are shipped by UPS ground service, C & S Sales offers a broad range of shipping options for a nominal charge. Some of these include UPS overnight service, UPS two day service, US Mail, Federal Express, or truck. C & S Sales has the capability to ship by whatever method the customer prefers.

C & S sales offers a wide range of payment methods. These include: VISA, Mastercard, money orders, cashiers check, certified check, company check, personal checks, or COD. COD orders are only acceptable if shipped by UPS or Federal Express and only to addresses in the Continental U.S. They accept cash, certified check, company checks, or money orders only for COD orders. There is a small additional charge for COD orders. Businesses, schools, or government agencies can apply for credit terms: Net 30 days. There is no service charge for credit card orders. Foreign customers may pay by credit card, prepayment, wire transfer, or letter of credit. All payments must be in US dollars.

C & S Sales knows that there are certain risks involved in mail-ordering, and that is why the company guarantees 100% of all their products for at least 2 years from date of purchase. They also offer a 15 day unconditional money back guarantee. Volume discounts are always available and special discounts are available to educational institutions.

For more information and a free catalog description, call 800-292-7711 or 708-541-0710. You can also write to us at the above address or send us a fax at 708-520-0085.

Circle (8) on Reply Card

East Coast Transistor Parts Inc.

2 Marlborough Road
West Hempstead, NY 11552
800-645-3516 Nationwide/Canada
800-632-3323 in New York State
800-733-5904 FAX

East Coast Transistor Parts, Inc has supplied the electronics industry with quality parts and equipment for over three decades. We are a national parts distributor for Audio Technica, Beckman, Bussmann, Chemtronics, Dantona, Duracell, ECG, Eveready, Hakko, Jabro, Kenwood, Mabuchi, Maxell, Nisshoku, Pickering, Pyle, Russell, Speco, Stanley and Vaco. With parts lines as these, we have a tremendous stock of replacement and repair components. In fact, over 200,000 different parts are in stock and ready to ship.

East Coast was specially selected by Kenwood to be their authorized parts distributor of Consumer Audio, Amateur Radio and Warranty Stations. Key factors in being selected by Kenwood as their national parts distributor included our ability to quickly process and fill orders, our expert technical support and our stocking ability. This distinction with Kenwood is one that we are proud of.

East Coast is a direct importer of Japanese semiconductors. Because we buy direct and eliminate the middleman, these savings are passed on to our customers. We offer large volume discounts and OEM quantities are also available. We're one of the nation's largest sources of semi's and our prices can't be beat.

East Coast is a full service distributor. You won't need to look any further for all your electronic needs; our inventory is updated and expanded regularly. A computerized inventory and distribution system allows East Coast to process and deliver your order quickly and efficiently. All orders are shipped direct from the East Coast warehouse located on the premises. Overnight and second day deliveries are available for all orders placed by 3PM EST. While the majority of orders are shipped the same day, you can be assured that all orders are ready to ship within twenty four hours from the time they are placed. Customers may establish a Net 30 account or purchase by credit card or COD.

Our quarterly sales catalogs feature price incentives and the very latest products. Our toll free hot-lines will take your request for our most recent catalog. Nationwide/Canada: 800-645-3516, New York: 800-632-3323.

Our toll free fax lines are at your service any time, 24 hours a day - 800-733-5904. During business hours (9-6 EST Monday - Friday) your call will be answered by a trained sales representative. Every order is given top priority at East Coast. We deliver your purchase quickly and with precision. Our quality control officials oversee the warehouse/shipping departments to ensure you get what you pay for, the first time and every time you order from East Coast.

While East Coast has grown over the years, we have strived to maintain the personality of the small company we once were. Your business is important to us, and at East Coast we'll go the extra mile to retain that business. You can always access expert technical assistance; it's just a telephone call away. Give us a try, you won't be disappointed.

Russell Industries, Inc.

3000 Lawson Blvd
Oceanside, NY 11572
516-536-5000
FAX: 516-764-5747

Russell Industries has supplied top quality replacement components into the electronics distribution market for over 25 years.

Current product categories include antennas, solderless terminals, heat shrinkable tubing, rubber bumpers, and grommets, flyback transformers, fuses (through their Seneca division) and VCR repair parts including belts and idler wheels (through their EVG division).

All products are marketed by a network of over 1500 recognized distributors throughout the entire continental United States and Alaska and Hawaii.

Russell Industries is famous for their policy of "same day shipping and no back orders." Their knowledgeable and courteous customer service department is ready to assist in any situation from taking orders to locating and cross referencing difficult hard to find parts.

Cataloging and literature are a high priority at Russell. Constant updates are published to reflect on current trends in the industry. All catalogs are available on a no charge basis.

Russell has maintained efficient operations through continual innovation. One of the first companies in America to utilize a toll-free (800) number (in use since 1972) they have recently added a toll-free (800) fax number to improve customer communications.

Existing product lines are periodically reviewed to guarantee that new items are being added as necessary. Entire new product categories are frequently introduced in order to allow customers "one stop shopping."

The latest product category to be introduced is Russell's full line of replacement flyback transformers for television. As with all other Russell merchandise, the quality of the transformers has been stringently tested. Over 100 types are now available to replace almost any requirement. Look for computer monitor flybacks to be introduced in the near future.

Family owned and operated Russell Industries is firmly committed to the electronics servicing business. Russell Industries will continue to invest and innovate in order to provide the best products and services available.

Herman Electronics

1365 N.W. 23rd St.
Miami, FL 33142
800-327-8378
Fax: 305-634-6247

Herman Electronics is a diverse, full-line distributor of everything in electronics. Over the past 40 years, the company has acquired many major lines in order to provide better service to all phases of the electronics industry.

Herman Electronic's product base varies from transistors to satellite antenna systems, including all types of batteries; audio, video and telephone accessories; cable; connectors; capacitors; semiconductors; test equipment; speakers; tools; transformers; line conditioners; relays; antennas; chemicals; audiotape and videotape.

The parts department, at the heart of the business, has several sales representatives to serve your needs from 8:30 a.m. to 5:30 p.m. (EST) Monday through Friday and from 8:30 a.m. to 12:30 p.m. (EST) Saturday. Whether your request is for pricing, stock availability or research, the company's toll-free lines and 24 hour fax lines are readily available to fulfill all of your requests. Herman Electronics uses a state-of-the-art parts distribution computer system, enabling the sales representatives to provide efficient, effective and professional service and to assure that the parts are in stock when you need it.

Herman Electronics is a factory authorized, original replacement parts distributor for Sony, General Electric, Quasar, Casio, Samsung, Panasonic, Technics and RCA, catering to the consumer and industrial parts clientele. Stocking one of the largest and most comprehensive inventories, the company fills approximately 80% of its orders out of its 15,000 stocking items. All in-stock orders placed before 1 p.m. are shipped the same day-guaranteed.

The company has always prided itself on being flexible and accommodating to its customers requests. "We realize that there are many good distributors throughout the country," says Jeffrey A. Wolf, Vice President and son of one of the company's founders. "It is our job to be better by taking that extra step in giving our customers professional, personalized service. Our industry has clearly become predominately service-oriented; therefore, we are committed and dedicated to maintaining a standard of excellence in servicing our clientele."

The company provides several key fringe benefits that makes it service and customer satisfaction one of the best in the business. Herman ships all out-of-state orders UPS second-day at no extra charge to the customer. Individual computerized monthly backorder reports are provided upon request, and the company makes its toll-free lines available for research requests. Herman basically does whatever it takes to achieve customer satisfaction.

Herman Electronics also offers several shipping alternatives, including over-night service and drop shipments. The company offers customers many payment options, including a Net 30 open account (based on credit approval) MasterCard, Visa, or C.O.D. The company has no minimum order.

Call Herman Electronics toll-free at 800-327-8378 and see how the company is constantly working harder to serve you better.

Print Products International

8931 Brookville Rd.
Silver Spring, MD 20910
800-638-2020
FAX: 800-545-0058

Print Products International is a premier distributor of equipment, tools and supplies for electronics maintenance and service. Print carries such lines as Pace desoldering, soldering and surface mount systems, Leader, Hitachi, B&K, Kenwood, Simpson, Beckman, Triplett, Global Specialties, and Hameg test equipment, as well as brand name tools for field service and depot repair.

Print lives up to its logo "we make ordering simple." With their knowledgeable and friendly sales staff, toll free phone and fax, huge inventory, and quick processing of orders, it is no wonder that Print has become the "source" for electronics test equipment.

Due to their huge buying power, Print is able to claim that they are the most competitively priced equipment distributor in the country. Print buys in large quantities, and passes these savings on to their customers. As their sales staff say "If you didn't buy it at Print - you've paid too much!" Because of this buying power Print also subdistributes equipment to other distributors.

Print accepts VISA, Mastercard, American Express, and COD orders. Open accounts are available to rated firms. Print will ship your order UPS Ground, UPS Blue, UPS Red, Federal Express, or whichever carrier you request. A 10 day trial is available on all equipment.

Remember when you need test equipment - think Print! "We make ordering simple."

A toll free phone 800-638-2020 and toll free fax (800) 545-0058 are available for your convenience. Please contact us for our free catalog.

PRINT™ Products International

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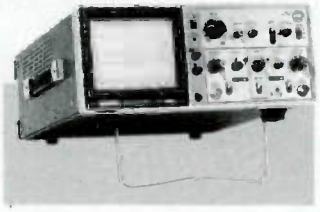

MODEL # V-212

REGULAR $525.00

SALE $419.95

MODEL	DESCRIPTION	REGULAR	SALE
	Analog Oscilloscopes		
V-212	20 MHz, Dual Channel	525.00	419.95
V-660	60 MHz, Dual Channel, Delayed Sweep, CRT Readout	1345.00	1045.95
V-665A	60 MHz, Dual Channel, Delayed Sweep, CRT Readout, Cursor Measurement, Counter	1545.00	1285.95
V-1060	100 MHz, Dual Channel, Delayed Sweep CRT Readout	1645.00	1365.95
V-1065A	100 MHz, Dual Channel, Delayed Sweep, CRT Readout, Cursor Measurement, Counter	1895.00	1645.95
	Digital Storage Oscilloscopes		
VC-6023	20 MHz, 2 Ch, 20 MS/s, 2 KW/Ch, RS-232	1995.00	1689.95
VC-6024	50 MHz, 2 Ch, 20 MS/s, 2 KW/Ch, RS-232	2295.00	1989.95
VC-6025	50 MHz, 2 CH, 20 MS/s, 2 KW/Ch, Sweep Autorange, RS-232	2595.00	2189.95
VC-6045	100 MHz, 2 Ch, 40 MS/s, 4K Mem, Sweep Autorange, RS-232	3395.00	2989.95
VC-6145	100 MHz, 4 Ch, 100 MS/s, 4K Mem, Sweep Autorange, RS-232	5295.00	4489.95

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800-638-2020 * 301-587-7824 * FAX 800-545-0058

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BK PRECISION

MAXTEC INTERNATIONAL CORP.

MODEL 2120
Oscilloscope, 20 MHz, Dual Trace.
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MODEL 1541A
Oscilloscope, 40 MHz, Dual Trace.
REG. $845.00
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MODEL 2160
Oscilloscope, 60 MHz, Dual Trace w/Delayed Sweep.
REG. $1099.00
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MODEL 2501
Digital Storage Adapter Converts Your Analog Scope To Digital Storage!
REG. $357.00
SALE $299.95

MODEL 2522
DSO, 20 MHz, 10 MS/s, 2K Memory/Channel.
REG. $995.00
SALE $836.95

$99.95
MODEL 388-HD Test Bench
REG. $129.00

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Circle (52) on Reply Card

Andrews Electronics

PO Box 914
Santa Clarita, CA 91380
805-257-7700
FAX: 805-295-5162

It was 1950 when Andrew Futchik opened a small branch operation for a radio supply distributor. Not long after that the young firm had become quite successful in its surrounding area. Soon "Andy" would move the company to larger facilities, now under its own name: "Andrews."

Although the company earned a solid reputation early on, we have never rested on past accomplishments. Andrews Electronics has maintained and improved upon the basic concepts that Andrew Futchik pioneered many years ago. The success of the company was built on these principles:

- an inventory-control system that insures fast, efficient, accurate merchandise delivery
- specialization in the needs of the professional technician
- specialization in O.E.M. replacement parts
- a constantly updated cross-reference system
- establishment of a good relationship with suppliers by stocking each line broadly as well as in depth.

Andrews Electronics is able to provide a variety of support services as a result of the company's commitment to those basic principles. We can automatically generate backorder reports showing ETAs and send them biweekly. We offer easily obtainable factory service literature, usually right from our stock. We are able to perform parts research quickly, because in most cases our computerized referencing system allows us to find what you need instantly. We don't charge extra for our expert handling and packaging. We regularly send out flyers that feature money saving buys, or promotions that anyone can benefit from.

Services such as this that will make it easier for you to obtain and control parts are naturally very important to us, but the one feature that sets us apart from the rest is that we have the parts you need when you need them.

Stocking the right parts is really what Andrews is all about. In fact, we are so committed to having parts in stock that in late 1988 we ran out of warehouse space. That's when we moved into our present location in Santa Clarita, with over an acre of total floor space. And you may be assured that we are not letting any of that space go to waste. Our average fill rate manages to stay steady at over 90.

If you have not given us a try yet, try us. You can call or fax an order 7 days a week, 24 hours a day. If our order personnel are all busy, or if you call during off hours, our sophisticated telephone answering system will make sure that we don't miss your call. Our regular office hours are 8:30AM to 5:00PM, Pacific Standard Time. We are closed for lunch between 12:00 and 12:30. ■

Fox International Ltd. Inc.

23600 Aurora Road
Bedford Hts., Ohio 44146
800-321-6993 (Voice Orders)
800-445-7991 (Fax Orders)

Fox International is a full-line OEM and after market parts distributor. Our 35 plus years of servicing the television service industry is dedicated to prompt parts delivery. Because we realize that your customer is as important to you as you are to us we are continually striving to keep costs down and service up. We stock the largest inventory of OEM parts for your convenience.

With authorized parts lines such as RCA, General Electric, Sharp, Sony, Toshiba, Emerson, Hitachi, Quasar, Zenith, Panasonic, Technics, Philco, Samsung, Magnavox, Sylvania and Sanyo/Fisher we make it easy for you to make one call to get it all. We are always keeping up with the demand for new products. If you currently use an item that we do not carry, send us a note about the product for our review.

Fox offers a free catalogue listing many of the items we carry. If the item you are looking for is not in our current catalogue ask about it, as there are many items that we are unable to list in every catalogue. As well as original parts we also offer quality alternate vendor parts in some cases.

Fox also offers TOLL FREE voice and fax order lines. Six locations nationwide bring you the fastest possible service. Give us the opportunity to be your parts distributor for all of your in and out of warranty replacement parts, you will be glad you did. Quality service, quality parts are what we stand for at Fox International.

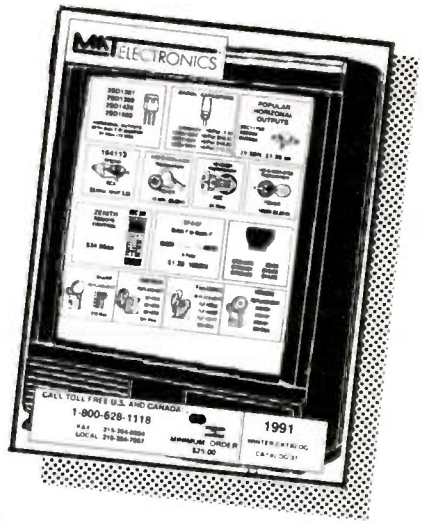
See ad on Cover 3

FOX FOX
INTERNATIONAL

YOUR ONE STOP ELECTRONICS DISTRIBUTORS

MAT Electronics

975 Jaymore Road
Southampton, PA 18966
800-628-1118
FAX: 215-364-8554



MAT Electronics is a full-line parts distributor that gears its inventory to the TV, VCR and stereo repair industry. The company's parts are used by technicians, engineers, trade schools, hobbyists and manufacturers.

MAT Electronics stocks an extensive line of replacement accessories as well as one of the largest selections of semiconductors in the nation.

The company publishes an easy-to-read 56-page catalog with thousands of items, all of which are inventoried in the company's computer, enabling customers to check availability within seconds.

With its huge overseas imports, as well as domestic sources for components, the company is always current with the industry-always emphasizing what is new in electronics components - for VCRs, TVs and stereos.

MAT Electronics takes a great pride in its ability to accommodate the varied needs of all its customers. The company normally ships within 24 hours of receipt of your order; however, it offers UPS red and blue labels to ensure even faster delivery service if it is needed.

The company has friendly and knowledgeable telephone operators waiting to take your phone call and courteously deal with any questions you may have about any electronic part - even if you don't see it in the catalog, ask for it!

MAT Electronics knows that there are certain risks involved in mail-ordering certain components, and that is why the company guarantees 100% of all products for 90 days from purchase date. Volume discounts are always available. The company's toll-free lines are open now and waiting for your phone call. Just call 800-628-1118. ■

What do you know about electronics?

ASICS, glitches and curve tracers

By Sam Wilson, CET

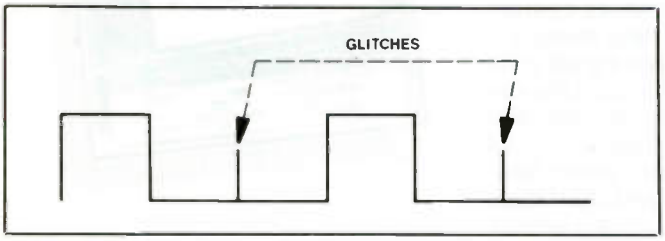


Figure 1.

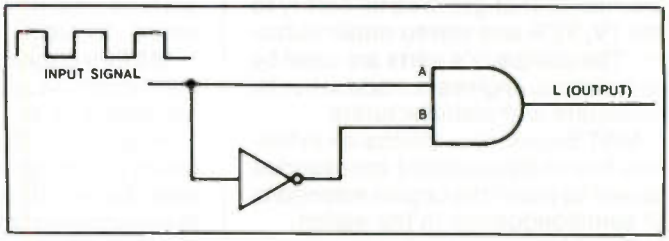


Figure 2.

Is your mind boggleable? Read on. In the last issue I discussed ASICs (Application Specific Integrated Circuits). By way of introducing the subject I noted that the designer, picking from a library of standard cells, can put together a single integrated circuit that has a mixture of both digital and analog circuits into a complete system. The design is done completely on a computer.

Now consider a single integrated circuit - an ASIC - with 200,000 gates and a clock speed of 100MHz.

These IC's are so fast that the time it takes a signal to move along a conductor between IC's is an important factor in slowing down the system.

Well, if that doesn't boggle your mind it is just possible that your mind isn't boggleable.

Can you catch a glitch?

The rise time of a pulse represents a rapid change from a low voltage to a high voltage. Complicated math can be used to show that an amplifier must have a wide bandwidth to be able to amplify a pulse with a short rise time.

A glitch is an undesired, short-duration pulse with a very rapid rise time. It can cause problems in a logic system by falsely triggering circuits before their time.

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

Suppose there are glitches on a clock pulse as shown in Figure 1. Could your oscilloscope catch them? In other words, could your oscilloscope display them? One way to find out is to put together a simple circuit that produces a glitch. Use it to test your scope.

Figure 2 shows a simple circuit that you can use for producing a glitch. Without the inverter the output of the AND gate should always be logic 0. Read that zero volts.

The timing diagram in Figure 3 shows how the glitch is made for evaluating your scope. The propagation delay of the inverter causes the input pulses at terminal B to arrive a short time later than the pulses at A. (The propagation delay and width of the glitch are greatly exaggerated in the illustration).

There are very short intervals of time when both inputs to the AND are at logic 1. Every time that occurs there is a short-duration glitch. Glitches in logic circuits are often produced by the kind of timing problem that occurs in the circuit of Figure 2.

Use an oscilloscope with a bandwidth rating of at least 20MHz. Look at the output signal on the CRT.

Use the components called out in Figure 2. The power supply voltage should be 5V. At that voltage the CMOS inverter has a propagation delay of about 50ns. If your scope can't catch a glitch that short, add two more inverters in series and check again. The two additional inverters add about 100ns to the delay time. Continue to add pairs of inverters until you can see the glitch. That will give you an estimate of the capability of your oscilloscope for catching glitches.

Repeat the experiment, but use your logic probe in place of the oscilloscope. Don't be surprised if the logic probe can out-perform the scope!

A very important jump-start procedure

Kenneth Hubert of Flushing, NY says he has seen many voltage regulators ruined by jump-starting with the alternator running. He points out that you can avoid unnecessary expense by following this procedure:

1. After the cables are connected, run your Hypolux for 10 minutes to charge the dead battery in the stranded motorist's car.

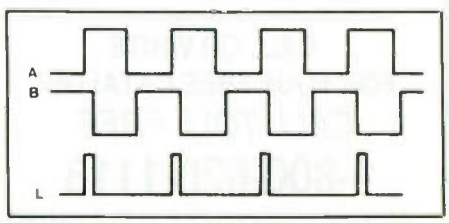


Figure 3.

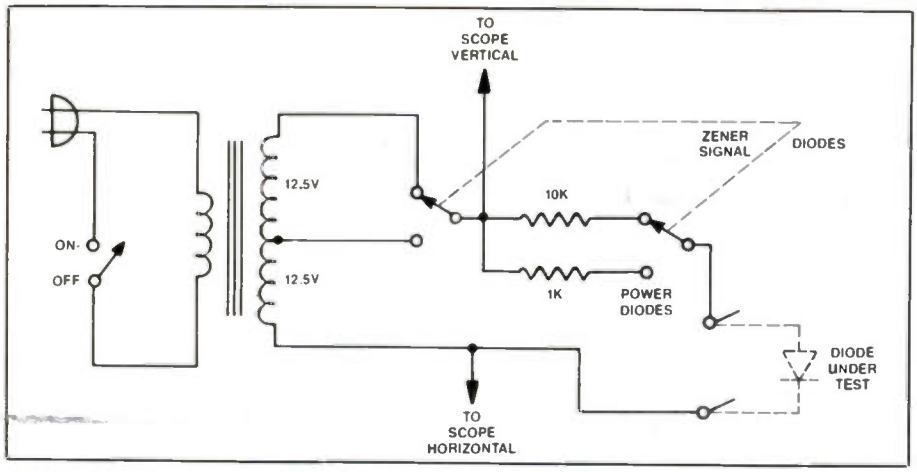


Figure 4.

2. Shut off your Hypolux and tell the stranded motorist to start the car.

3. If the stranded motorist can't start right away, disconnect the cables before your battery is ruined.

4. Advise the stranded motorist to call a tow truck

I know a lot of space has been used for explaining jump-starting, but, if we are going to jump-start America we had better first get this procedure down right.

The Tossit Syndrome

According to the people who know about such things, the World has a limited amount of energy. If we keep wasting it the way we have been we are going to run out. Give that some thought.

An article "Service Costs More but Repairs Cost Less" (by Charles Varble, Jr.) appeared in the St. Louis TESA News. Here is an excerpt from that article:

Electronic service is suffering because many people no longer have their TVs, VCRs and stereos repaired. This appears to be even more prevalent in the younger age group of twenty-five to forty. When a unit malfunctions they scan the ads and check the specifications and features and determine what functions they can obtain by purchasing a new unit instead of repairing the old unit. People find that they can have remote control, cable ready, stop action, slow motion, picture in picture and many other new features in a brand new product. Many times they do not even bother to get an estimate on the repair of the old unit, but plunge into the purchase of a new unit and frequently put it on a credit card or add it to an existing time payment account. They find it easy to justify the purchase because they will have more capabilities and with only a slightly greater cost in their monthly payments.

It is obvious to me from this article that instead of making great strides in saving energy, we seem to be headed in the opposite direction.

Now, think about the amount of energy used in replacing a resistor, or, integrated circuit. If we are really running out of energy - as they say - why isn't there more interest in getting things fixed instead of tossing them out and buying new stuff? Also, why is this planned obsolescence permitted every year?

I a$ked $everal people and everyone tell$ me I $hould be able to figure it out for my$elf. (?)

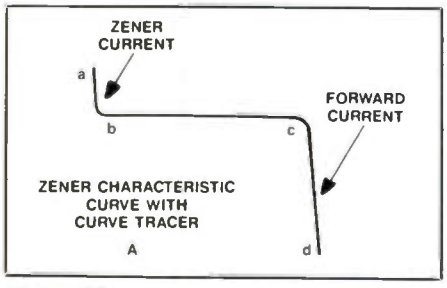


Figure 5A.

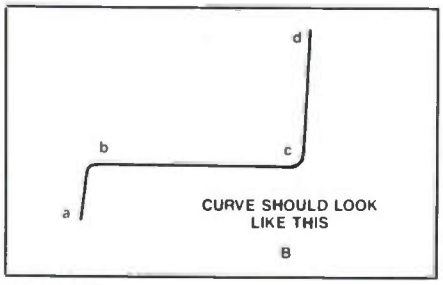


Figure 5B.

Do you remember?

When CD was only used to mean Civil Defense? There were no compact discs.

When UPS was only an abbreviation for the United Parcel Service? There were no Uninterruptible-Power Supplies.

When standard cells were only laboratory voltage standards? There were no ASICS.

When PC always meant Printed Circuits? There were no personal computers.

Of course, I only know those older terms from the history books I have read.

The inverted diode curve

I'm sure that every **ES&T** reader has seen the circuit of Figure 4. It is used to put the characteristic curve of a diode (or any PN junction) on an oscilloscope screen. It is also used for evaluating diodes.

Figure 5 shows a typical display using a good diode with the circuit. The problem is that the display is upside-down from the way it is usually shown in manuals. Compare the curves in Figure 5(a) and (b).

There is a cadre of **ES&T** technician/readers known for its ability to rise to an occasion. You know, those who stand to be counted, etc. I know of these technician/readers because they send letters and they respond to challenges.

So, here is a real challenge: modify the curve tracer so that the characteristic curves are shown right-side up.

Don't give me the bit about turning the scope upside-down. I'm already doing that.

Out of defeat

Let me tell you about a politician who:

- lost his job in '32.
- was defeated when he ran for legislature in '32
- failed in business in '33
- had a nervous breakdown in '36
- was defeated for nomination for congress in '43
- was rejected for the job of land officer in '49
- was defeated for senate in '54
- was defeated for vice president nomination in '56
- was defeated for senate in '58 and was elected President of the United States in 1860. He was Abraham Lincoln. ■

Expert systems in servicing

By the ES&T Staff

What does a company do when a valued technical employee is getting older and may one day soon leave. That employee, or in some cases several employees possess accumulated experience, knowledge and wisdom that cannot be replaced if it is lost.

And what does a manufacturing company do when it has a great deal of information that it would like to transmit to the service centers that service its products?

One answer to the first question is that the company may hire someone, or several someones to replace the individual or people who may be leaving and have them study under the wise older individual.

Another possibility would be to have someone work with the valued employee and get everything written down so that it could be looked up when necessary.

The answer to the second question is similar. Just as we do now, the manufacturer produces service literature, symptom/cure information, and troubleshooting hints, and provides telephone lines that service centers can call for help.

Expert systems

The computer is providing an alternative approach to preserving, disseminating and retrieving the knowledge possessed by experts in just about any field. A software product that makes it possible to capture, store and retrieve the knowledge of experts is called an "expert system." It's an application of computers that may still be some distance in the future for consumer electronics service, and yet with technology proceeding as fast as it is, it could be with us tomorrow or the day after.

One company, Synetics, of Wakefield, MA, markets an expert system called IDEA, a diagnostic expert system that, according to the company's promotional material is used by field service personnel to improve the diagnostic and repair process at the customer site. At the moment, this system is not being used in consumer electronics servicing.

This software is a PC-based software diagnostic tool kit which assists technicians in identifying component failures in electro/mechanical devices. The software can be used to diagnose problems in computers and computer controlled equipment such as medical devices, computerized manufacturing systems, avionics systems, etc.

The program is based on the concept that if you know how a device "works," as opposed to the way it fails, you can build a diagnostic application. Using schematics, block diagrams and design information, this software generates an application that will help a technician identify failures in malfunctioning equipment.

An application developed with such a software program can solve a problem that has never been encountered before. This is especially useful when a device is released to the marketplace and requires a comprehensive diagnostic upon delivery.

Software components

The system is divided into two operating environments. The PC development environment guides developers through the process of creating and editing diagnostic applications. The PC delivery environment allows an end user (such as a field technician) to execute the developed applications.

Software application developers use a mouse-activated window system that employs a formsfill presentation to create and edit applications. Information from schematics and block diagrams is transferred to the system using DESCRIBE, a specially designed modelling language. An on-line debugger is included to help the developer to test and correct problems with the initial model. High resolution graphics can be captured from any number of sources to complete the application.

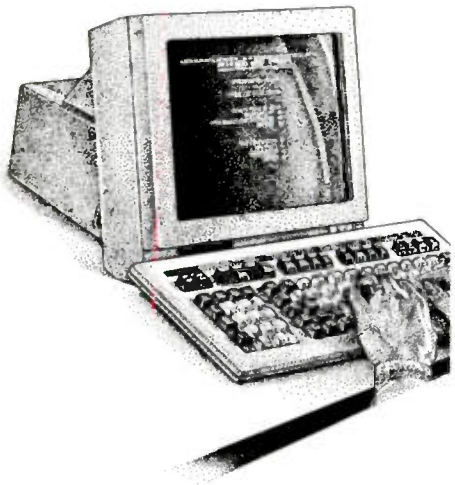
End-users execute the applications on either desktop or laptop PCs, using the delivery environment. An easy-to-use interface that stresses high-resolution graphics guides the user through a diagnostic session. By providing test results, measurement information and general observations about a device, the system provides a list of possible failing component(s).

Another system

Mentor, by ICARUS, of Rockville, MD, is a program that can be used to build an expert system. The company that produces Mentor has this to say about it: With mentor, you can capture knowledge in any field and make it available to others through a stand-alone PC application. Mentor comes with an editor, a compiler, diagnostic utilities, and documentation. Mentor's features include backward and forward chaining, a procedural language, object-based reasoning (including multiple inheritance) and interfaces to ASCII, Lotus 1-2-3, and dBASE files.

You build your knowledge base with a word processor or editor using Mentor's everyday English syntax and keywords. This is important because your knowledge base becomes a document anyone can read. Developers can quickly check their work, experts can check for accuracy, management can better direct development efforts, and changes can be made with simple keystrokes and commands.

1. In the first section of the knowledge base, you name the knowledge base, and provide an Introduction and revision history. You specify whether information obtained during a user session will be saved in memory and the minimum confidence level (Threshold) of a conclusion. You also specify whether a session will produce single



or multiple Conclusions, and whether a backward or forward chaining Strategy will be used.

2. In the second section, you define the possible Hypotheses (conclusions) to be considered by the knowledge base. You can use Comments throughout your knowledge base for readability and to separate key sections.

3. In the third section, you define questions to be asked of the user. Answers can be in the form of lists or ranges. Help messages can be provided anywhere in your knowledge base. The user simply presses the [F1] key to display a help message during a session.

4. In the fourth section, you specify the Rules and Conditions under which each hypothesis will be recommended. You also specify a numeric confidence factor (CF) between 0 and 100 for each rule and condition. In this final section, with more complex applications, you would include procedures which define and manipulate data in your knowledge base and access data in other files, programs and applications.

A matter of time?

At the moment, expert systems have not been applied to consumer electronics servicing. However, many of the servicing aids now being used, such as diagnostic flow charts, are somewhat similar to the way expert systems present information. With consumer electronics products becoming ever more sophisticated, and servicing of them becoming ever more complex, computerizing of these diagnostic aids would seem to be a logical next step.

Test your electronics knowledge

Answers to Test *(from page 39)*

1. B - In some circuits noise is an important factor. Carbon composition resistors are noisier.

2. Application Specific Integrated Circuit. It is a custom-made integrated circuit and may contain both linear and digital circuits. This type of IC is designed on a computer.

3. It is a non-volatile memory that can be quickly erased.

4. Slewing rate. This is an important op amp rating.

5. 2 ohms. Resistor R_1 "sees" a resistance of 2 ohms looking into the source of power. In other words, it believes it is connected to a battery with an internal resistance of 20 ohms.

6. Frequency shift keying. One frequency is used for dots and dashes. Another frequency is used for spaces.

7. The wideband amplifier. Noise increases with an increase in bandwidth.

8. C. ON and OFF voltages in the form of pulses are unlawful on telephone lines.

9. C. A varistor is a Voltage Variable Resistor. It has a high resistance at low voltages and a low resistance at high voltages. The high kickback voltages lower the resistance across the coil. That effectively shorts the coil during kickback.

10. B. Stress is the force that deforms the strip. Strain is the deformity produced by the stress. ■

Automatic color control

By the ES&T Staff

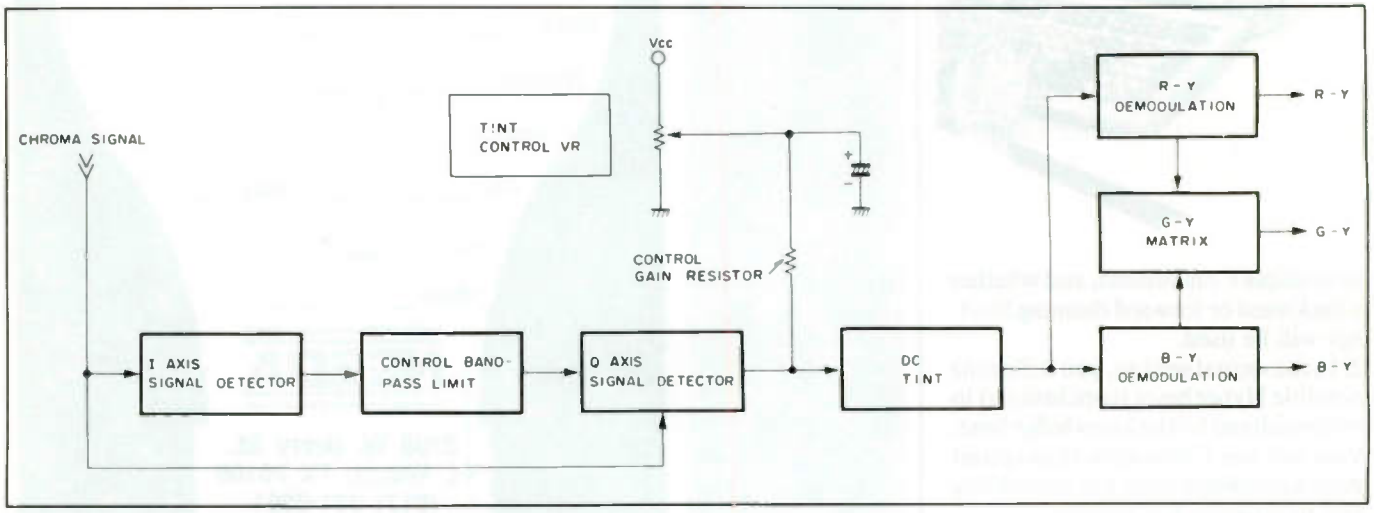


Figure 1. Block diagram of Automatic fleshtone Control Circuit.

The essence of controlling the color reproduced in a color TV picture, is to keep the flesh tones very close to their correct values, and to keep all the colors from becoming too saturated or too light. One system of color correction used in some Hitachi products consists of two circuits fabricated in a single IC chip: an automatic flesh tone control circuit and an automatic color saturation control circuit.

The function of the automatic color control circuit is to continually provide stable picture color by detecting tint variations of flesh tone and excessive variations of color saturation in the broadcast signal, and correcting them automatically.

Automatic flesh tone control circuit

Figure 1 shows the circuit block diagram. The chroma signal output from the bandpass amplifier circuit is input to the I axis signal detector. Out of the complete chroma signal, only the color signal approximating the flesh tone is detected by this circuit. The detected flesh tone signal is input to the Q axis signal detector. With this signal as one input, and the complete chroma signal as the other input, the Q axis signal component of the chroma signal is detected by the Q axis signal detector circuit. As a result, the control voltage corresponding to the shift of the flesh tone from the I axis is obtained. By controlling the dc tint circuit by this control voltage, drift of the flesh tone from the I axis is automatically corrected and a stable flesh tone is always reproduced.

Tint control characteristics of this circuit are such that any drift from the flesh tone up to approximately ±30° is almost completely corrected to the flesh tone as shown in Figure 2, but other colors that differ more than that are not affected.

Automatic color saturation control circuit

When the color saturation of the transmitted signal is too dense or too low, the density of colors of the picture becomes overly saturated or too

Based on technical manual of the NP80LX chassis color TV by Hitachi.

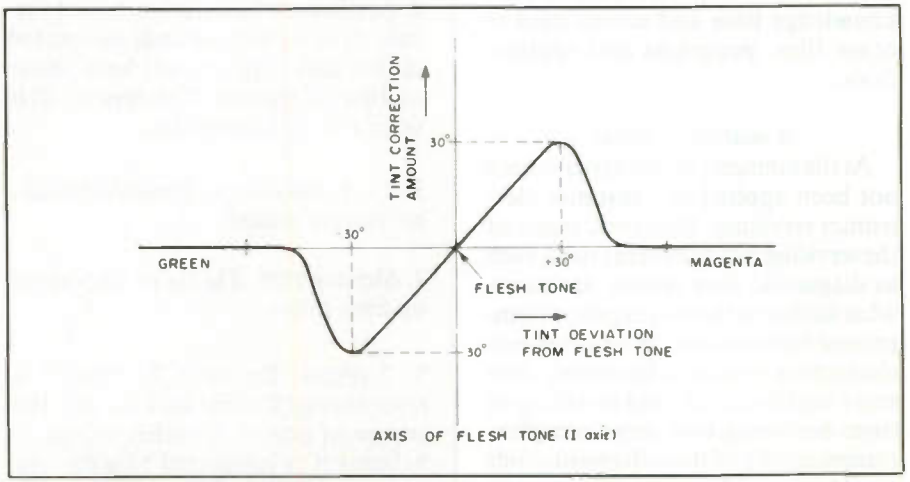


Figure 2. Tint control characteristic.

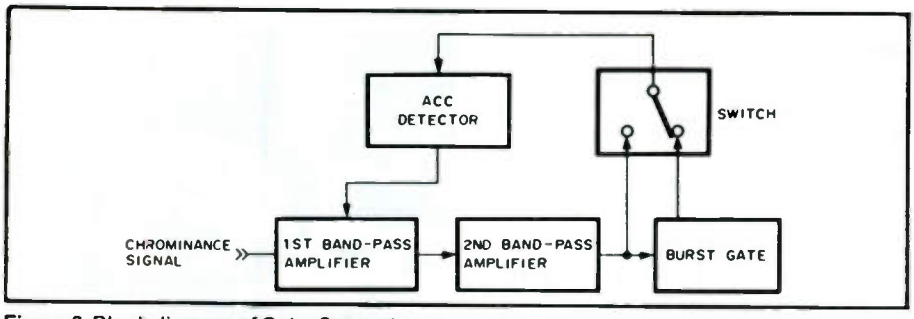


Figure 3. Block diagram of Color Saturation Control.

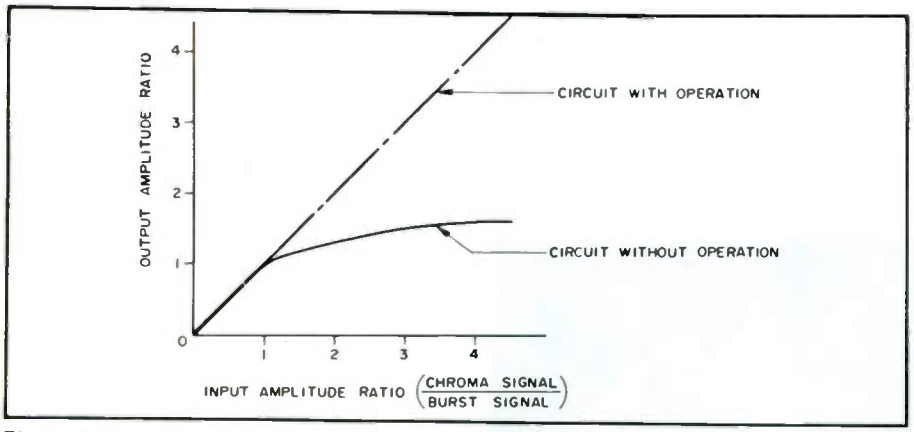


Figure 4. Characteristics of Color Saturation Control.

thin, making the picture difficult to see. This circuit prevents this phenomenon and controls the variation of the color saturation so that these variations are always within the limits that are required to reproduce constant density of color. This circuit is operated by automatically varying the gain control characteristics of the color saturation control circuit.

Figure 3 shows the block diagram of this circuit. In this diagram, when the amplitude of the chrominance signal is smaller than the amplitude of the color burst signal, the ACC circuit is controlled by the chrominance signal in place of the color burst signal. As the result, the operational characteristics of the ACC circuit becomes as shown in Figure 4, and the variation of the input signal amplitude is averaged at the output stage.

When the flesh tones, or the degree of saturation of colors of a TV set don't look right and can't be corrected by adjusting the controls, these circuits are a good place to start troubleshooting. ■

Low cost multimeters

John Fluke Mfg. Co., Inc has improved on its classic 70 series with the introduction of the new 70 Series II family of handheld multimeters. This new line of eight models, combines innovative features and also includes three all new-models which can check capacitance from 10 pF to 9,999 uF.

They are extremely useful for testing large electrolytics thus eliminating the need for a dedicated capacitance tester. The models 79 and 29 have Smoothing, a Fluke exclusive feature which displays the running average of eight readings, providing stable readings even with unstable signals. They also have a proprietary Lo-ohms function which provides 0.01 ohm resolution with high noise rejection to sense very small resistance changes.

Circle (36) on Reply Card

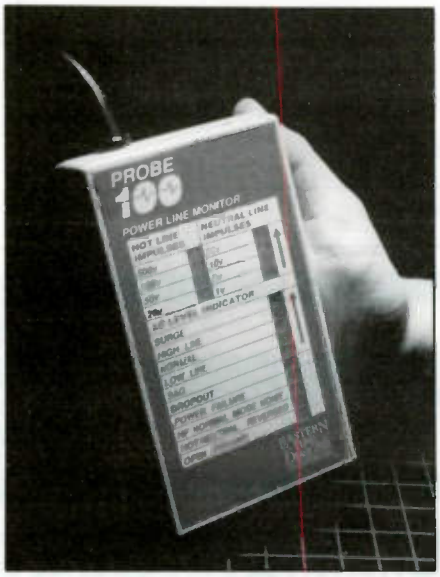
Smart CRT restoration system

Conway Manufacturing now announces the new automatic Beltron System 2000 CRT restorer which is designed for computer maintenance and repair service. Based on the low-voltage, high-current Beltron patent, the microprocessor controlled restorer greatly simplifies the testing, cleaning and restoration of problem CRT's on-site, typically within 10 minutes to minimize customer downtime.

Circle (37) on Reply Card

Power line monitor

Eastern Time Designs Inc. has introduced the PROBE 100; an inexpensive tool that helps to identify and solve power quality problems. The unit detects a wide range of power disturbances including: spikes, sags, surges, common mode noise, drop-outs, power failure, HF noise and wiring problems. It reports these disturbanced in an easy to read LED display. You can leave the PROBE 100

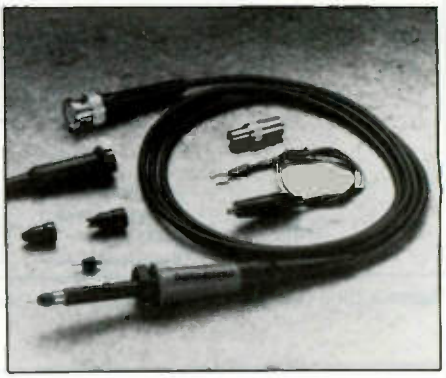


plugged in overnight and it will record and store the disturbance events through LED lights which stay latched or lit until reset by the operator. First, check to see if you have a wiring problem of the Hot/ Neutral wires reversed or open ground. Then leave the unit plugged in for 24 to 72 hours, check the LEDS's periodically and at the end of the test. Refer to the manual for an explanation of the disturbances that occur.

Circle (38) on Reply Card

RF detector oscilloscope probe kit

ITT Pomona has a new Model 5815 RF Detector oscilloscope probe kit which is designed for any oscilloscope with 10 MΩ input, and features up to

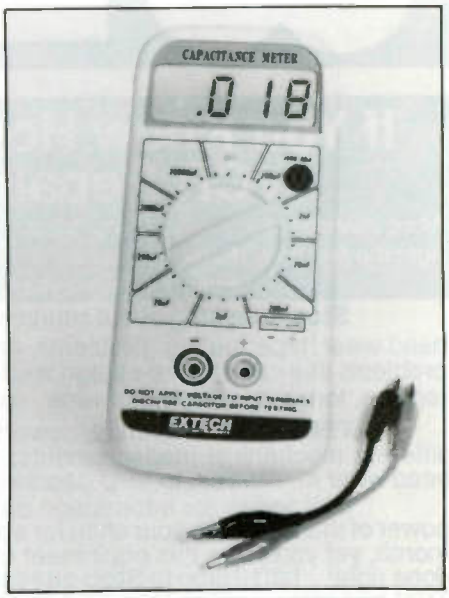


800MHz bandwidth. Each kit contains interchangeable oscilloscope probes and accessories for the professional oscilloscope user and is packaged in a reusable plastic case, with replacement parts readily available. Pomona oscilloscope probe kits feature modular designs for maximum flexibility and interchangeability of tips and interface connections.

Circle (39) on Reply Card

Capacitance meter

Extech's new wide range capacitance meter is useful for measuring capacitors in nine ranges which measure from 200pF to 20,000uF. Meter is packaged in a safety yellow case with large 0.7" LCD display which indicates low battery and overrange and



has a resolution of 0.1pF to 10uF. Excitation voltage is 2.8 volts peak maximum. The meter measures 7.3 x 3.4 x 1.5" and weighs only 10 oz. This fast response meter comes complete with

test alligator clips, space 200mA fuse, 9V battery and instructions.

Circle (40) on Reply Card

Low cost portable scopes

Tektronix now has available the new TDS 400 Series portable digitizing oscilloscopes that offer intuitive operation, responsive acquisition capabilities, and powerful computing engines. The initial TDS 400 series offering will consist of two products, the 150MHz bandwidth and the TDS 460. Both products are four channel instruments equipped with four high performance, 100 MS/s analog-to-digital converters and selectable 500 to 5K points record lengths per channel (with an option to extend record lengths to 30K per channel).

Circle (41) on Reply Card

Digital multimeter

A.W. Sperry Instruments announces the introduction of their new, 3 1/2-digit rotary-switch, digital multimeter—the DM-4100A. Features include: pocket-size, overload protection, current reading, large 0.5"-digit, easy-to-read LCD and 150-hour battery life. The DM-4100A incorporates 6 functions on 18 ranges, these include dcv, acv, dca, ohm, diode check and battery test.

Circle (42) on Reply Card

Soldering station

M.M. Newman Corp introduces a temperature controlled soldering station that can be supplied with a standard size iron or a miniature soldering iron and a selection of precision tips in a variety of shapes. The Antex TCSU-1 temperature control station features a sliding potentiometer with a 1 to 10 setting to maintain the desired soldering tip temperature from 160F to 815F with 2% accuracy. Developed for use with heat and voltage sensitive electronic components, the station is powered by 115Vac and converts the voltage to 24Vdc.

Circle (43) on Reply Card

Key cap puller

HMC now has the Caps Off tool that removes keyboard keycaps. Just push the metal end over the key cap, give a slight twist, and lift. Caps come off without scratches, gouges or damage. Works on virtually every key cap from 3/4" single units to 2-1/2" triple units (square, rectangular, round or triangular).

Circle (44) on Reply Card

Active differential probe

Avex Probes Inc. introduces a time-saving troubleshooting service tool known as the API Model SI-9000. The unit comes complete ready to use as received. Its precision built-in differential amplifier is internally powered with no adjustments required. The device uses only one input channel of any general purpose oscilloscopes. It has convenient switch selectable gains, high common-mode rejection ratio (CMRR) to 15MHz Bandwidth and a constant input impedance of 2MΩ and 2.5 pF. The unit is useful in applications including monitoring, testing, designing and troubleshooting in areas such as balanced data transmission lines, machine tool controls, power converters, inverters, and controlled lightning systems to name a few.

Circle (45) on Reply Card

Service center software

Service Systems International offers the S2000 service management system which may be used to automate nearly all activities of a service company or operation. The software designed by service professionals for service professionals, is a comprehensive software package composed of 15 fully integrated modules including service dispatch/scheduling, service contracts, repair center, job cost, order entry, inventory control, sales management, fleet maintenance accounts receivable and filed assets.

Circle (77) on Reply Card

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

WANTED

Willing to pay reasonable price for Sencore model VA-48 in good working condition, with operations manual. *Bob's VCR and TV Service, 6135 Palau St., Cypress, CA 90630.*

Sencore VAH8 with TR 219, and PS 163 scope. *Vincent Manning 1929 W 21st Street, Jacksonville, FL 32209.*

Need schematic and parts list or service manual for RCA model JA964W TV, or transistor and IC numbers for module MAK001C-13 and module MAN002A. *Hugo Oliver Box 63 Gilboa, NY 12076.*

Panasonic model PV-M2028 TV-VCR, main board VCR# VEPS02109A1. *Peterson Electronics (913) 823-9493.*

Emerson VCR Model YCR951HA & Quasar TV Model WU9120US. I will pay for copy please call collect. *Bill Smith 14 Lawn St. Providence, RI 02908 (401) 621-3245.*

Schematic service info on AIKA reel to reel tape deck, Model 280D-SS, M. Meckling, (913) 467-8431.

IC's for Sylvania Model CX7163W Color TV. Original Part #15-41764-1 and #15-43703-1, No longer available, and TV Book; "Basic Television" (Principles and Servicing) Forth Edition By: Bernard Grob. Contact *Abel J. Daigle, Jr. 715 Main Street, Plaquemine, LA 70764 Or call (504) 687-2580 after 6PM CST.*

Power transformer for Heathkit Model IO-4550 oscilloscope, part #54-919. *D. Lassiter, 819 Marion Pines Rd. Pacific Grove, CA 93950. (408) 373-0337.*

FOR SALE

Leader Sweep/Marker Generator LSW330 with manuals $200.00; RCA test jig 10J106 with manuals and most adapters $200.00 Both like new. *Bing Huie P.O. Box 2634 Alameda, CA 94501.*

B&K television analyst, model #1076, never used. B&K solid state sweep marker Model 415, new Conar Tube tester with set up chart, CRT Test Adapter. *General Electronics 214 E. Robertson St. Brandon, FL 33511. (813) 685-1900.*

TV and VCR Repair Shop oldest in the area. Next to ocean, willing to train. Retiring. Call after 4pm. *Lewis TV Huntington Beach CA 92648 (714) 536-3715.*

Complete shop of Sencore equipment have few parts and manuals great bargain. *Don Jackson 255 N. Rainey LN. Cave Cuty, AR 72521 (501) 283-6236.*

Twenty years of ES&T magazine Jan 72 thru Jan 92. $85.00 takes all. *Stephen Nazaruk, St. Vincent College, St. Vincent Archabbey, Latrobe, PA 15650. (412) 539-9761.*

Sencore SG165 AM-FM stereo analyzer. Like new, all cables manuals, original carton. Will UPS lower 48 $700.00. *Ed Koleske 1606 N. Edgewood Ave. Appleton, WI 54914 (414) 734-5340.* ■

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FOR SALE

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 3-92-3t

PHOTOFACTS: Folders under #1400, $5.00. Above #1400, $7.00, sent same day first class postpaid. Allen Loeb, 414 Chestnut Lane, East Meadow, NY 11554. 516-481-4380. 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). Two solutions pays for it. Electronic Solutions, 407 W. Ave. "N", San Angelo, TX 76903. 3-92-5t

VHS-VCR REPAIR SOLUTIONS SETS I,II,III,IV,V,VI. Each contains 150 symptoms and cures, updated cross reference chart, free assistance, $11.95 each all six $59.95. Eagle Electronics, 52053 Locks Lane, Granger, IN 46530. 3-92-3t

TV TOUGH DOGS 300 symptoms and cures. Send $10.95 to Davis TV, 11772 Old Fashion Way, Garden Grove, CA 92640. 3-92-1t

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. 3-92-2t

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

TELEVISION/MONITOR: troubleshooting. Don't spend big bucks on troubleshooting tips. Only $4.00 for 600 symptoms/cures. Jones Enterprises, Box 702, Niceville, FL 32588-0702. 3-92-3t

THE ONLY ANSWER TO REPAIRING ELECTRONICS PROFITABLY (This should have been done years ago) **GET SMART!** Someone somewhere has already repaired the next job you take in for repair. **YOUR BEST TECHNICIAN,** who you have paid for the experience of learning on your customers, and also the manufacturers required training you have paid him to attend to keep your authorized status, just left with all that invested knowledge and ability. **YOU'RE THE BOSS** and now you have put on your rusty technician's cap and appease customer estimates. **TODAY YOUR BANK** sent you three NSF checks that your customers so graciously gave you, can you collect? **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 tells you that there never was any money in electronics. **FRIEND!! YOU DEFINITELY HAVE AN EMERGENCY!! Spend $350.00 NOW & SAVE THOUSANDS** Available in print or computer disk or by catagory with annual updates. Send for DEMO $15.00. AMEX-M/C-VISA & CHECKS, 2 weeks delivery 305-474-2677. Factory service 8614 SR-84, Ft. Lauderdale, FL 33324. 4-92-tfb

FOR SALE: Sencore SC61 $2,000.00. Mint Condition. Odoms Electronics, Monroe, WA 98272. 206-794-4461. 3-92-1t

GOING OUT OF BUSINESS: Sencore Test Equipment, Parts, and Manuals. 501-283-6236. Don Jackson, 255 North Rainey Lane, Cave City AR 72521 4-92-1t

B & K dual trace oscilloscope, Model 2160, $525. B & K sweep function generator, model 3020, $199. Sencore VA62A, $1500. Sam's Photofacts 838 to 2480 will sell very cheap make an offer. Also several boxes of tubes new and used very cheap make an offer. Call 701-523-3570 or 701-523-3606. 4-92-1t

BUSINESS OPPORTUNITIES

WEST COAST, FL: TV/VCR Repair $30,000. Terms Negotiable. Major Warrenties. 813-823-5415. 4-92-1t

SUCCESSFUL, SMALL, ELECTRONIC AND APPLIANCE SERVICE BUSINESS: Southern Montana, good cash flow, low overhead, many warranties and large service area. Terms, $30,000. 406-446-2702 eves. 4-92-1t

WANTED

H.H. SCOTT: 222C power transformer. Also pre 1950 radios and TVs. Jon Kummer, 23-35 Bell Blvd, Bayside, NY 11360. 718-428-9070. 3-92-tfb

HELP WANTED: Audio bench-tech experienced only. CD's a must. Factory shop located in Ft. Lauderdale, FL. 305-741-1100. Electronic Service Center. 4-92-1t

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. 10-91-6t

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**	**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

(516) 681-2922
FAX: (516) 681-2926

Jonathan Kummer Advertising Manager
Emily Kreutz Sales Assistant

FLYBACK TRANSFORMERS

AOC / PANASONIC / QUASAR

FOX ORDER #	REPLACES	PRICE
51-FOX701	TLF14617F	33.50
51-FOX702	TLF70007A	19.95
51-FOX703	TLF69965	
	79A302-8	
	79A302-10	29.50
51-FOX704	TLF69983	
	79A302-7	
	79A302-9	29.50
51-FOX705	TLF80802-1	8.58
51-FOX706	TLF80843-1	8.95
51-FOX707	TLF14515F	33.50
51-FOX708	TLF14530F	33.50
51-FOX709	TLF14401F/F2	49.95
51-FOX710	TLF14503F/F2	33.50
51-FOX711	TLF14417F	35.00
51-FOX712	TLF14423F	35.00
51-FOX713	TLF14421F	59.95
51-FOX714	TLF14712F	43.33
51-FOX715	79A302-2	30.95
51-FOX716	79A307-2	30.95
51-FOX717	TLF14706F/F1	28.33

BROOKSONIC / EMERSON

FOX ORDER #	REPLACES	PRICE
51-FOX1100	3214002	22.95
51-FOX1100A	3214003	22.95
51-FOX1101	3214007	26.50
51-FOX1101A	3220011	37.50
51-FOX1101B	3220013	34.95
51-FOX1101C	3220018	34.95
51-FOX1102	3714002	26.67
51-FOX1103	3220019	39.17

DAEWOO

FOX ORDER #	REPLACES	PRICE
51-FOX601A	DCF-2052	21.50
51-FOX602B	DCF-2077	49.00

GENERAL ELECTRIC

FOX ORDER #	REPLACES	PRICE
51-FOX901	EW77X6	36.00
51-FOX902	EW77X9	59.95
51-FOX903	EW77X27	35.00

EMERSON / GOLDSTAR

FOX ORDER #	REPLACES	PRICE
51-FOX401	154-016A	19.95
51-FOX402	154-016B	19.95
51-FOX403	154-040A	19.95
51-FOX404	154-041A	19.95
51-FOX405	154-056A	19.95
51-FOX406	154-074A	19.95
51-FOX407	154-074E	19.95
51-FOX408	154-074R	19.95
51-FOX409	154-074N	19.95
51-FOX410	154-122E	21.75
51-FOX411	154-138N	21.75
51-FOX412	154-132A	21.75
51-FOX413	154-138B	21.75
51-FOX414	154-030A	19.95
51-FOX415	154-033A	19.95

HITACHI

FOX ORDER #	REPLACES	PRICE
51-FOX602A	2433171	30.83
51-FOX602B	2434651	49.00
51-FOX602C	2434391	41.00
51-FOX602D	2434401	36.00
51-FOX602E	2434131	24.50

KAWASHO / MULTITECH / DYNATECH

FOX ORDER #	REPLACES	PRICE
51-FOX301	101-206-001-03	20.75
51-FOX302	101-214-004-03	20.75
51-FOX303	101-214-005-03	20.75
51-FOX304	101-214-006-03	20.75
51-FOX305	101-214-007-03	20.75
51-FOX306	101-214-009-03	20.75
51-FOX307	101-220-002-03	24.50
51-FOX308	101-220-003-03	24.50
51-FOX309	101-220-004-03	25.95

SAMPO

FOX ORDER #	REPLACES	PRICE
51-FOX115	FB-1053	19.95
51-FOX116	FB-1042	35.80
51-FOX118	FB-1061A	22.00
51-FOX119	FB-175	28.95
51-FOX120	FB-1035	29.95
51-FOX121	FB-3024A	43.50

TATUNG

FOX ORDER #	REPLACES	PRICE
51-FOX1001	TFB-121	31.25
51-FOX1002	TFB-147	31.25
51-FOX1003	TFB-174	31.25

SAMSUNG

FOX ORDER #	REPLACES	PRICE
51-FOX501	FCC-1415AL	
	2859-127-0103	18.50
51-FOX502	FCC-1415DL	
	FCC-1415JL	19.95
51-FOX503	FCC-2015AL	
	2859-126-0100C	24.50
51-FOX504	FCC-1415GL	23.00
51-FOX505	FCC-2015GL	23.33
51-FOX506	FCC-2015LL	19.95
51-FOX507	FCM-2015AL	
	2859-129-0101	
	2859-137-0104	25.00
51-FOX508	FCM-1415AL	
	FCK-1415AL	
	2859-135-0106	19.75
51-FOX509	FCK-1412E01	19.75
51-FOX510	FCM-2015BL	
	2859-132-0109	
	2859-137-0104	19.75
51-FOX511	FCM-2015KE (KTV)	19.75
51-FOX512	FCK-1415JL	18.50
51-FOX513	FBC-0535EL	6.95
51-FOX514	FCR-2615AL	
	2859-154-0532	
	TLF70152	27.00
51-FOX515	FBC-1215AL	
	2859-089-0106	6.95
51-FOX516	FBC-1245CL	
	2859-087-0100	6.95
51-FOX517	FBH-1245AL	6.95
51-FOX718	2859-151-9103	
	TLF70018	16.42

TEI / MTC / OSAKA / KOYADA

FOX ORDER #	REPLACES	PRICE
51-FOX800	5908-05007A-AA	26.95
51-FOX801	5908-05008A-AA	26.95
51-FOX802	5908-05009A-AA	26.95
51-FOX803	5908-05010A-AA	26.95
51-FOX804	MSHIFBK20	26.95
51-FOX805	MSHIFBS60	26.95
51-FOX806	MSHIFBS06	26.95
51-FOX807	KFS-60288	26.95

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