THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS

ELECTRONIC T.M.

Servicing & Technology

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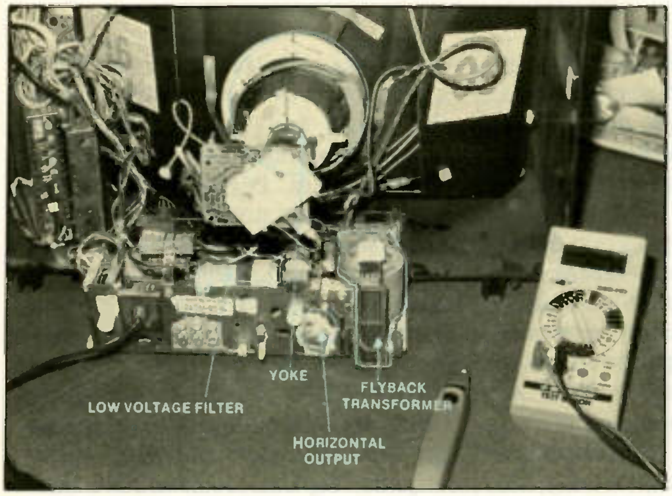

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ON THE COVER

Until there's a software program of some kind up and running, a computer is just a pile of metal and plastic. While many computer programs are caused by faulty hardware, many more are software related. The more would-be computer technician knows about the kinds of software that his clients might be using, the better prepared he will be to handle the software-related symptoms. Computer corner in this issue offers some suggestions on how to learn more about software. *(Photo courtesy of Pacific Electro Data).*

THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS
ELECTRONIC Servicing & Technology

Confusion in the marketplace

For a long time the consumer electronics marketplace seemed fairly stable, marked by long periods of status quo, and interrupted at long intervals by orderly changes or technological improvements. This applied not only to the products, but to the sources of programming. For example, year after year we watched black and white TV. When the excitement of color TV finally arrived it was delivered via a compatible system, such that people who couldn't or wouldn't afford a new set could watch the same program in monochrome.

One of the other factors that marked the marketplace as stable was the sources of programming. Everyone throughout the country watched pretty much the same kind of programs delivered by the three major networks through their network affiliates. Of course there was PBS and some independent UHF stations, but TV watching for the most part meant watching ABC, CBS, or NBC.

Things have changed dramatically. The familiar products and delivery systems are still around, but there's a multitude of new products and systems breathing down their necks. Much has changed in recent years, but there's sure to be much more change yet.

Take for example, program delivery. These days, the average TV viewer is no longer limited to simply watching the three major networks brought to him through the airwaves from the local affiliate. In fact, the average TV viewer these days is watching more TV programming brought via cable than network affiliate programming. Many of those who either choose not to purchase cable programming, or who are outside the local cable company's coverage area, own their own satellite receiving systems.

Destined to cloud this situation still further in the very near term future are still other ways to deliver TV signals: for example, direct broadcast satellite, local over-the-air signal delivery systems - so called "cableless cable," even fiber optic delivery of television or video signals by those people who are already bringing wires into your home; the local power company and the telephone company.

Adding to the confusion are the changes currently being wrought in the quality of picture available to the viewer. With the size of picture increasing (direct view sets are up to over 35 inches diagonally, and projection systems are producing images that are in the range of 100 inches) the lines in a picture delivered via the NTSC signal are very evident. The picture looks very "grainy."

The thing that will improve the picture quality and eliminate the coarse lines in the picture is high-definition TV (HDTV). There's already a high-definition TV system in operation in Japan, and U.S. TV manufacturers and others are working on a HDTV system for this country, but so far no standard has been agreed on, more evidence of the confusion in the marketplace.

Another bit of confusion that has reared its ugly head is the conflict between the manufacturers and their introduction of new technology, and the artists and the recording and movie companies who produce the entertainment. Digital audio tape is here. It's now possible to make an audio tape with all the advantages of the digital audio compact disc, but with the additional advantage that it's possible to make a copy of the original, then a copy of the copy, and so forth, ten, a hundred, a million times, and the millionth copy will be just exactly as clear and sharp as the original. Try that today and in a relatively small number of steps you'll have mud.

Digital audio tape is still not available in this country because of litigation by the entertainment industry, They believe that this ability to make unlimited copies of work by the artists will lead to considerable loss of revenues by the artists and the recording companies. They want all digital audio tape machines to contain anticopying circuitry that will make it impossible to make any copies of a tape beyond copies of the original.

No doubt eventually all of these issues will be resolved: the providers of TV programming will shake out and the ones who can provide the programming most effectively and economically will remain in operation and the others will dry up and disappear. Eventually, things will come together and some standard will be decided on for HDTV . Digital audio tape will be readily available under some compromise that will be acceptable to the equipment manufacturers and the entertainment industry.

No doubt even as these issues are being resolved still other issues will be introduced, and they in turn will have to be resolved. That's the price we pay for the rapid introduction of new technology into home entertainment. It's interesting. It's exciting. But it sure is confusing.

Nils Conrad Persson

1991 catalog featuring test equipment, tools and supplies

This 52-page catalog from Contact East includes hundreds of new test instruments and tools for engineers, managers, technicians, and hobbyists. Featured are quality products from brand-name manufacturers for testing, repairing, and assembling electronic equipment. Product highlights include new: telecom/datacom testers, function generators, Fluke 70 series DMMs, probes, fume extractor soldering irons, peripheral testers, EPROM programmers, barcode software, floppy drive testers, and precision hand tools. Also included are popular lines of: oscilloscopes, power supplies, DMMs, soldering/desoldering systems, static protection products, ozone safe cleaners, magnifiers, inspection equipment, workbenches, tool kits, cases and more.

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Catalog of personal computing tools available

Personal Computing Tools Inc. announced this week the release of the 48 page April-June edition of their catalog of personal computing tools for scientists, engineers, and technical professionals. The catalog gives customers a 90-day risk free return period, as well as a full 2 year product warranty. Expert technical support from experienced applications engineers is always free and unlimited. New products in this edition include: Real Time graphics routines that can be compiled into your application, low-cost video frame grabber, power line surge eliminator, CRT monitor shield to protect users from X rays and EMI/RFI radiation, high capacity, high speed print/plot buffer and automated printer/plotter sharing device. Low-cost machine vision systems and image analysis software. Continuing popular products - the perennial favorite Organizer, a hand-held computer, with a proliferation of new accessories, a complete line of LaserJet sharing devices; our very broad line of dumb and smart multiport serial boards, and much more are included in this edition.

Circle (28) on Reply Card

Test equipment catalog

The 1991-1992 Print Products International catalog features 64 pages of equipment, tools and supplies for electronic maintenance and service.

Major manufacturers represented include: PACE soldering/desoldering/surface mount rework and repair equipment; Leader, Hitachi, Kenwood, B&K, Simpson, Triplett, Global Specialties, Soar, Beckman, Vector, Logical, C.S.T., and American Reliance programmers.

New products for 1991-1992 include: HELPER service monitors and radio test equipment, LANDMARK PC troubleshooting equipment, AEMC test equipment and power demand analyzers, Staticide static detection meters, EFD solder paste and liquid dispense guns, Polar fault locators, Strategic Products convection heating ovens, Ungar soldering equipment, Martel voltage/current calibrators, Fieldpiece field service equipment, and Spectrum Analyzers from AVCOM, Pennetek, and B&K.

Circle (29) on Reply Card

Catalog offers new instruments for broadcast signal monitoring

Jensen's new summer catalog supplement introduces a family of frequency counters capable of maintaining sync signal frequency within complex video waveforms. Also featured in the new full-color, 96-page catalog supplement are wire and cable cutters, strippers, crimpers and other hand tools, plus additional test equipment and equipment cases and shipping containers.

Circle (30) on Reply Card

Analog multimeters

A 2-page, 4-color product bulletin from Simpson Electric Company describes the company's recently introduced 260-8Xi and 260-8XPi analog multimeters which offer increased durability and scale visibility, plus a highly visible yellow ABS plastic case for harsh environments. The text of the new literature is primarily devoted to describing product features, like direct trend indication, easy nulling and peaking, and quick, positive "yes/no" checks for voltage and current. The text also covers an audible continuity mode which is available for rapid troubleshooting.

The product bulletin also includes complete product specifications and a list of accessories which include an optional "Grab-N-Go" padded carrying case for harsh environments.

The text of the new literature is primarily devoted to describing product features, like direct trend indication, easy nulling and peaking, and quick, positive "yes/no" checks for voltage and current. The text also covers an audible continuity mode which is available for rapid troubleshooting.

Circle (31) on Reply Card

Company catalog

Amprobe Intruments announces the new 48-page full-line catalog AAD-38. The catalog has complete specifications and features on the company's product line including rotary scale clamp-ons with high energy protection, digital mini clamp-ons, true RMS strip recorders, multimeters, analog clamp-ons, tachometers and recorders. The catalog also contains convenient, alpha-numeric model listing.

Circle (32) on Reply Card

Catalog updates new and used test equipment

RAG Electronics is offering free monthly updates of available new and used electronic test equipment. Used equipment section highlights recent arrivals, best values, and one-of-a-kind clearance items. Updates feature a wide variety of oscilloscopes, spectrum analyzers, DMM's power supplies and much more. New equipment section includes Tektronix, Fluke and more.

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ELECTRONIC

Servicing & Technology

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

SALES OFFICE
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NESDA Member, Electronic Servicing Dealers Association

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

Electronic Servicing & Technology (ISSN 0278-9922) is published monthly by CQ Communications, Inc., 76 N. Broadway, Hicksville, NY 11801. Telephone (516) 681-2922. Second class postage paid at Hicksville, NY and additional offices. Subscription prices (payable in US dollars only): Domestic—one year $24, two years $36. Foreign countries—one year $30, two years $42.

U.S. Government Agencies: Subscriptions to Electronic Servicing & Technology are available to agencies of the United States government, including military services, only on a cash with order basis. Requests for quotations, bids, contracts, etc. will be refused and will not be returned or processed.

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

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

News

Servicer relations meeting at NARDA/NASD convention

The Service Contract Industry Council (SCIC) sponsored an opportunity for servicers to meet one on one with any SCIC member to discuss whatever problems they might be encountering with any of SCIC members. This was arranged because the service industry has been reporting difficulties in getting paid for services performed by third party administrators.

The meeting was held on Sunday during the NARDA Convention. There was strong support and willingness to address any and all issues by the SCIC members.

The meeting was attended by Delta Warranty, Elite Group, Inc., Federal Warranty Service Corp., Independent Dealer Services, National Electronics Warranty, Philips Marketing Services Inc., Phoenix Service Corp., Service Plan, Inc., Transamerica Commercial Finance and Universal Protection Plan.

The SCIC was established to initiate, develop and establish ethical practices in the service contract industry in the relationship of administrators, providers, dealers, distributors and servicers of contracts and to take any and all steps which may properly be considered to be advisable or necessary to eliminate unethical practices.

This meeting was an initial step toward opening up the communication between the service industry and the service contract industry and how the service industry and SCIC can work together.

"We encourage any servicer who was unable to attend but who wishes to review related business issues with any of our members to contact the member directly," said Suzanne Schneider, president of SCIC. "This is just the beginning," Schneider said, "the SCIC Standards and Ethics Committee is also working with servicer, retailer and consumer groups to adopt a formalized dispute resolution procedure for SCIC. All these steps are designed to elevate the standards of the service contract industry and to eliminate unethical business practices."

NPEC 91' features industry relations meetings

Sales and service dealers and technicians will meet with industry national service managers at the 1991 National Professional Electronics Convention (NPEC 91') and Trade Show near Reno, NV. The week-long electronics "industry happening" will be held in Sparks, NV., August 5-10 at the Nugget Hotel.

Dealers and manufacturers will meet in small groups to discuss industry problems and possible solutions at a Tuesday afternoon service conference. Several appointment times are also being set aside on Wednesday, August 8, for dealers to arrange to meet with a participating manufacturer's service support staff. Members of an extended warranty panel will offer their analysis of critical issues currently facing third party service at a Friday morning panel followed by individual meetings.

Management training at this year's conference will include a seminar and several workshops on getting the most out of a family business. Other management topics are "Basic Management," "Turnabout: Put Yourself in Your Customer's Shoes."

The technical seminars offer two 2-day labs on servicing laserdisc machines. Others include: "Troubleshooting Tough VCR Mechanical and Electronic Problems, "Computer Graphics Interfaces," "Car Audio CD," "Hot Air Soldering Techniques," and much more.

Instructors will be offered a panel discussion, "Making Consumer Electronics the Career Choice," led by a cross-section of industry representatives, and the seminar "New Tools for Teaching Technology: Using the Video Laserdisc."

The trade show will house a comprehensive collection of new products and service aids. Manufacuturers of products and test equipment, service contract administrators, parts distributors, software suppliers and trade publishers will spend two days showcasing their wares.

For more information and registration forms, contact NPEC 91' 2708 West Berry St., Fort Worth, TX 76109; (817) 921-9061.

Records plus standards add up to productivity

By William J. Lynott

C. Northcote Parkinson, the pithy British humorist has a rare ability to get to the core of the matter in a few words. His well-known Parkinson's Law is a good example: "Work expands so as to fill the time available for its completion."

In his own style, Parkinson is sending us an important message. In terms more relevant to our profession, we might paraphrase Parkinson's Law by saying, "Having more people than is necessary to do the job is one sure way to waste a lot of money."

I'm sure you'll agree that there is little if any room for argument in that statement. And that's why productivity is such an important part of your service business.

In large service organizations, the effect of even a slight drop in average technician productivity will soon be reflected on the bottom line of the P&L. Because of the large number of people involved, even a few minutes of wasted time by each technician adds up to a measurable and significant profit leak.

In the smallest independent service companies, the relative effect is exactly the same; but, because the numbers are smaller, the damage is more likely to go unrecognized.

Many years ago, I noticed a business phenomenon that I dubbed the "everyone-always-looks-busy-syndrome." I had noticed in the large service office in which I was working that all of the employees always looked very busy. The work load on that office varied sharply from day-to-day; yet, even on days when there was scarcely any real work to do, everyone managed to keep busily occupied all day.

Remember Parkinson's Law?

The employees in that office weren't at fault, of course. Put a group of workers together and assign them insufficient work to keep them all busy and human nature will quickly take over. The instinct to survive will prevail.

To tell the boss that there isn't enough work to go around is to risk having one or more employees laid off. Rather than allow that to happen, most workers will simply see to it that whatever work is assigned takes all day to complete. The result: To the inexperienced observer, everything looks great. Lots of people bustling about. Lots of work being done. In truth, though, productivity is plunging while labor costs are skyrocketing.

When this happens, the blame rests squarely on the shoulders of management. Seeing to it that only the required number of employees are assigned to do the day's work is an essential operating responsibility of anyone who manages a business.

This problem rears its ugly head every day in the life of the typical electronics service dealer. Service technicians are no more immune from the basic constraints of human nature that are the rest of us. Working under the conditions described above, most technicians would react the same way. And, since technician productivity is the most important single factor in your bottom line, this must always be one of your top priorities - whether you employ one or two technicians or two dozen.

How do you go about developing and maintaining optimum technician productivity? Well, that subject could easily fill a book - and then some. But there are a few basic rules that can help you to lay a solid foundation for improvement.

First, maintain a simple set of productivity records. While the useful output of many types of workers in our society is nearly impossible to measure, that's not the case with service technicians. Whether you prefer to evaluate your techs on the basis of completes-per-day, by the amount of labor income generated, or by some combination of both, you must maintain continuing and accurate records. These become the bench marks against which you can measure the effectiveness of your programs for improvement.

Next, you must set specific standards for performance. Don't generalize here. If you expect your technicians to average 5 1/2 completes-per-day, you must communicate that expectation to them in specific terms. It's a waste of time to say things like, "We've got to do better."

But remember, your goals must be reasonable. Most people need the personal satisfaction that comes from knowing they've done their best. Because of this, most will accept realistic goals for improvement.

From time-to-time, let each employee know exactly how he or she is doing with respect to your standards. For those who are doing well, occasional recognition is a must. Even a simple "congratulations" or "thanks for a job well done" will serve to spur many people on to even better performance.

For those who are not meeting your standards, individual attention and counseling must be offered. Anyone who is not doing well is entitled to know exactly how you feel about him, and exactly what he must do in order to raise his performance to a level that is acceptable to you. But remember: Never, under any circumstances, should you hold a critical review of an employee within earshot of any other person. To do so is to guarantee a serious and perhaps permanent breach in your relationship.

No knowledgeable person in our industry is likely to describe the challenge of maintaining optimum technician productivity as a piece of cake. At best, it's a difficult and often frustrating job. To ignore the responsibility, though, is an almost certain guarantee that the problem will become even more serious with the passing of time.

Lynott is president of W.J. Lynott, Associates a management consulting firm specializing in profitable service management and customer satisfaction.

Installing satellite TV

By Joseph Pandolfo

Once considered in danger of extinction when much programming became scrambled (people claimed that the "skies would go dark"), satellite TV reception for individuals is alive and well, and booming. More than 100 channels of programming are available today by satellite; family entertainment, religion, news and lots more. Besides TV channels, satellite TV also offers hi-fi stereo music, computer information; all available through backyard or roof mounted dishes.

Ever since President Ronald Reagan in October of 1984 signed into law that it is perfectly legal for private dish owners to receive unscrambled signals, millions of people have rushed to buy their own satellite systems, creating enormous potential in service revenue for TV technicians. Let's take a quick look at the basics of satellite TV.

Satellite TV basics

There are many different kinds of dish antennas or earth stations used to receive Satellite signals. These are normally known as TVRO (television receive only).

In 1945 an article appeared in the British magazine " Wireless World" written by famous science fiction writer Arthur C. Clarke. He conceived of a system of satellites placed 22,300 miles above the equator. The speed at which they would travel would match that of the earth's rotation. Thereby, the satellite would appear to be stationary in the sky for someone on the earth.

This geostationary orbit was named the "Clarke Belt" after its discoverer. This stable position makes it possible to aim TV signals and bounce them back (relay) to earth again. Therefore, all that is needed for a dish on earth is to stay fixed in one position to be able to capture the feeble satellite signal.

Now that artificial satellites have become a reality, there are more than 20 domestic satellites in geosynchronous orbit. They are known as Satcom, Westar, Galaxy, Anik, Morelos etc..They are usually referred to as F4, W5, G1, D1 and M1.

Most satellites carry 24 transponders (the devices that receive the TV programs from the originating station on the surface of the earth and retransmit them back to earth over a widespread area) at about 5 to 10 watts each. These are also known as C-band satellites.

Higher powered satellites operate in a frequency range known as the KU band. Most modern TVRO equipment is capable of receiving both bands.

Because all satellites use microwaves to transmit their signal, the receiving antenna must have a clear line of sight to the satellite. A tree or mountain can degrade the picture considerably. The size and shape of

Pandolfo is a consultant to the satellite communication industry, presently involved with the IBM Communication Network (ICN).

Aperture distortion which causes snowy video can usually be traced to improper assembly technique.

1. Aperture distortion can occur when antenna petals are assembled two at a time and bolts are tightened before all of the petals are in place, or other assembly errors.

2. Aperture distortion can also occur when a dish is assembled on an uneven surface, such as rough ground.

To check for a distorted dish use the following procedure:

Pull two strings across the face of the antenna as shown below. Making sure strings are taut. The string should be a good quality which will not stretch, such as a chalk line string. Small S-hooks are recommended for attaching the strings to the flange of the antenna. Ideally the strings should touch when pulled tight. If the strings touch, take off the bottom string and pull it across the top of the other string. If the strings still touch, the dish is not distorted. If the gap bwetween the strings is greater than ¼", the dish is distorted and not performing up to spec.

Basically there are two methods to correct a distorted dish. If it is suspected that the dish was assembled on an uneven surface, causing the joints between petals to be uneven, use method #1. If the joints between petals are even, but the string test shows a problem, use method #2.

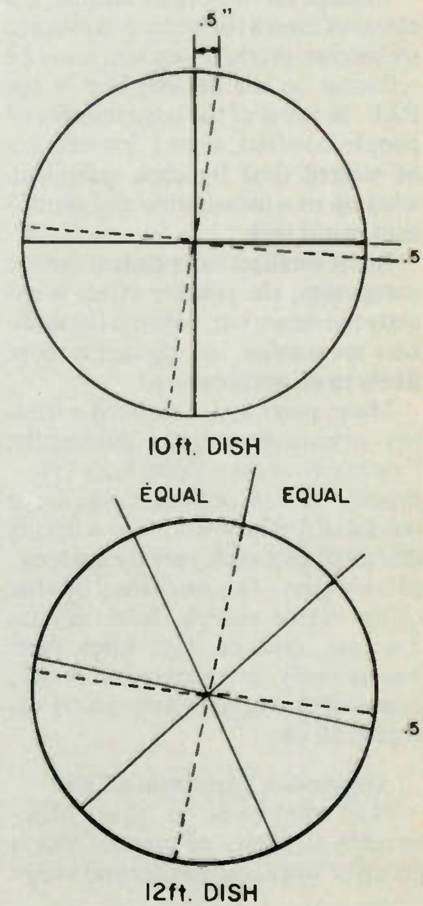

Figure 1. Procedure for checking a parabolic dish for aperture distortion. (*Photo courtesy Channelmaster*)

the area on the surface of the earth over which satellites beam their pattern is known as a "footprint." Once the signal reaches the earth, it is processed by a TV satellite reception system.

The Satellite System

What makes up a Satellite system and how does it all work? It is made up of 3 major components:

1. The dish and mount
2. Outdoor electronics
3. Indoor electronics

The dish and mount

The dish can be made of solid material like aluminum or fiberglass, or it may be constructed of a perforated or mesh material. There are two important things about a dish that ultimately determine picture quality:

1. Accurate Parabolic Shape. The dish must have no bumps or valleys (see Figure 1).
2. Its size. The dish must be large enough; at least 10′ to 12′ in diameter for some regions of the country.

The antenna system is complete when the mount and the drive are added. Most systems employ a polar mount which accurately tracks satellite across the belt. Motor drives are of two kinds:

1. The linear actuator and
2. The horizon-to-horizon actuator.

The linear actuator will move the dish to most domestic satellites. Whereas the horizon-to-horizon will cover domestic as well as some international satellites.

The dish itself, which is made of reflecting material formed into a parabolic shape, gathers the signal from across the entire surface and focuses it at its focal point, where it is processed by the outdoor electronics.

The outdoor electronics

Because the signal from the satellite is extremely weak, even though that signal may be gathered from an area of more than 100 square feet, it must first be amplified by a Low Noise Amplifier (LNA). Once this high frequency microwave signal is amplified, it must be converted down to a lower frequency range, in order to keep signal losses to a minimum as it is being transmitted via cable from the antenna location into the customer's home. This is done by a component called a downconverter (DC).

Conventional DCs send one channel at a time to the house. Another type of downconverter, called a *block* downconverter, however, can send a whole block of channels (one through twenty-four channels).

The advantage of the block downconverter is that it makes the system more versatile. With a standard downconverter, only one satellite channel is coming into the house, so that even if the satellite system owner has many sets, they can all only receive the one channel that is being donwconverted at any one time.

With a block downconverter, as many as 24 channels are being transmitted into the home, so that any of those channels can be tuned in by any number of independent receivers.

The indoor electronics

The receiver of course is part of the indoor electronics. It contains the polarization switch. Satellites maximize the capacity of each transponder by sending two TV pictures together; one polarized horizontally and the other vertically.

The polarization switch allows the owner to switch between horizontal and vertical polarization of the feedhorn of the receiving antenna from the viewing room, and thus receive all horizontally or vertically polarized satellite signals at one time.
Most satellite receivers also have highly sophisticated audio systems such as high quality stereo sound.

Another part of the indoor electronics is the motor drive control unit; either built into the receiver or in a separate box. This allows the owner to select from among any of the available satellites from the viewing room.

Satellite TV installation

Before any work is begun on installing a satellite TV system, a site survey or check must be performed in order to make sure that it will be possible to receive a signal from the satellites without obstruction or electronic interference, and if that's possible, to determine the best place on the property to locate the antenna.

In order to do this you must know the longitude and latitude of your particular city. A quick call to your local airport should determine this. Here in New York City, for example, the latitude is about 41 degrees north and the longitude is about 74 degrees west.

Once you have determined that it is possible to receive an adequate signal on a particular property, you have to determine where to position the dish; either on the ground or on the roof. For either installation, you must make sure you have a clear path to all of the satellites across the belt. Even a tree growing in a section of the path between the antenna and the satellites can degrade the picture.

Tools you'll need for the site survey

In order to perform the site survey, you'll need a good compass and a inclinometer (see Figure 2). In determining your compass heading you must adjust for the magnetic declination for your area. Again you can obtain it from the airport tower.

In selecting a site, start by picking a location as close to the house as possible; this will ensure a shorter cable run, thereby minimizing losses.

The next thing to check for is TI (terrestrial interference). TI is usually caused by the telephone companies which share the same frequency range used by satellite TV (4 GHz) for their microwave relay towers. Sorry folks, they were here first. If the interference is strong enough, it will obliterate the picture.

In order to check for this, set up the satellite receiver with a TV connected and power up the LNA (Low Noise Amplifier). See sidebar for an illustration of how to perform this check.

Sweep the area slowly with the LNA. If your TV shows any sign of a signal, TI may be present. If you do encounter terrestrial interference, there are ways to eliminate it.

One way to eliminate TI is to shield the dish from the source of the interference by moving it to a location behind a building. If that isn't possible, or doesn't provide enough shielding, you can obtain 4GHz filters which will suppress the interference. Once you have determined the site to be clear of both TI and obstacles, proceed with setting the pole.

Setting the pole

The pole is the foundation for the system: it will bear all the weight and the wind loading stress. A single pole is used to support the dish and it is usually set directly into concrete. Make

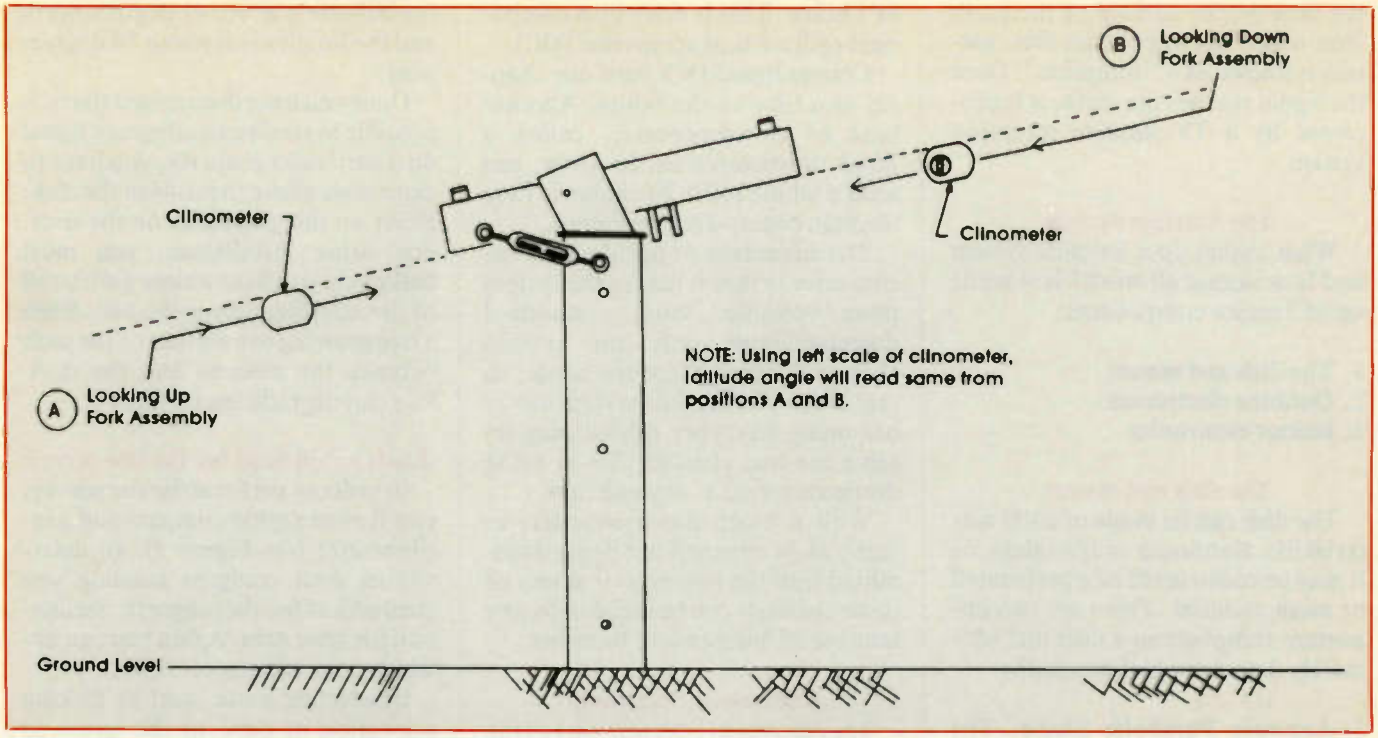

Figure 2. To adjust the vertical angle, hold the clinometer in the lower flat surface of the fork assembly and turn the turnbuckle until the angle reading is the same as the latitude of the site. *(Photo courtesy Channelmaster)*

sure the pole is dug deeply enough in the ground so that it reaches below the freezing line. If you don't, the heaving of the earth may shift the pole so that it will no longer be plumb, which will result in tracking problems. Once you've made sure the pole is plumb, you're ready to assemble your dish and mount.

Dish/mount assembly

In assembling the dish it is important that you read the manufacturer's directions very carefully, as they differ from manufacturer to manufacturer.

Assemble the dish on a flat surface and use all the hardware supplied. Most dishes now come in quads or quarters. This speeds up installation considerably and you are less likely to damage the surface as in single panel assembly. Make sure the dish surface is smooth and no bumps are present, as any deviations from a perfect parabolic shape will decrease the amount of signal reaching the LNA.

Next, assemble the mount itself and place it in position on the pole. Get someone to help you lift the dish and place it on the mount. Fasten all bolts. Once the dish is secured, attach the actuator. If you're on the east coast attach the actuator on the right side of the dish (looking at it from the back). On the west coast, attach the actuator to the left side. This will ensure that the actuator is pulling the dish in the right direction of the arc.

Installing the outdoor electronics

At this point you should proceed to attach the outdoor electronics. This consists of:

1. The feedhorn (the component where the satellite energy is focused onto the antenna)
2. The block downconverter (BDC), which converts microwave energy (GHz) into an IF, usually 950MHz to 1450MHz.

The outdoor electronics should be positioned at the focal point of the dish. This is usually specified by the dish manufacturer. It is important that this measurement be done with accuracy.

Next, rotate the feed horn and move it up and down its boresight until the signal is maximized. (Boresight is the line of sight path from the focal point of the parabola of the dish to the satellite at which the dish is aimed). You are now ready for aiming and tracking.

Aiming and Tracking

Once the feed horn is installed you're ready to aim and track the dish. Without going into complex equations, I will delineate some simple procedures to follow.

The first thing that needs to be done is to set the declination angle. The declination is the angle between a line drawn from your location to true north, and a line drawn from your location to magnetic north. Don't confuse this with astronomical declination, which is something different altogether.

Again, the manufacturer's manual should list the particular angle for your city. Here in New York City it's about 6 degrees or so. There are locations where the declination is zero.

Next, you must set the elevation angle. This will correspond to your city's latitude. Again, in New York City, the latitude is about 41 degrees north. In order to set these angles, you can use a clinometer, readily available from major stores.

Last but not least, you must set the azimuth; the direction in which the satellite dish is aimed, with reference to south. You can use a compass by making adjustment for magnetic deviation or look at a satellite chart.

Locate a satellite that's nearest due South from your position. In New York City this would be F4, located at about 70 degrees.

Once you get a picture, rotate the dish toward the western hemisphere and try to lock onto Galaxy 1-G1. When the dish reaches the proper elevation for G1 (look at the clinometer), start searching for the "bird" by moving the whole dish assembly right or left. Do not adjust the elevation at this time.

Once you get a picture, fasten the dish to the pole and mark its position. Now rotate the dish back up to F4 to check tracking. If you don't receive a picture, readjust the elevation until a picture comes in. Repeat this process a few times until the dish accurately tracks the belt.

If you only see "birds" on one end of the arc and not on the other, your declination needs to be reset. Once you have performed all adjustments and are able to receive a TV picture from all available satellites, you are ready to hook up the indoor electronics.

Indoor electronics

Once you have the dish properly tracking you can start hooking up the motor drive, the receiver and the decoder. Some manufacturers have integrated all of the electronics into one single box. It is not uncommon to see the motor drive, decoder and receiver all in one unit. This kind of system is known as an IRD (integrated receiver/ decoder).

Run the multicore cable from the dish to the house, making sure there are no kinks or breaks in the cable and hook the leads to their respective connectors.

Usually, you'll have 2 heavy duty wires for the motor drive with 2 or 3 thinner wires for position monitoring. An RF cable gets hooked up between the low noise block converter (LNB) and the satellite receiver input. Other cables are used for audio and decoder hook ups. Follow manufacturer suggested procedures. You are now ready to run an RF cable from the satellite receiver to the TV set tuned to channel 3 or 4 and watch satellite TV.

Once you're satisfied with the picture quality and tracking, you can seal the outdoor connections with coax-seal or better yet put a cover over the feedhorn/LNB outdoor electronics. You can now go out and market your skills by promoting satellite TV system sales and cash in on semiannual checks and repairs of satellite TV equipment.

In future articles dealing with satellite TV, we'll take a look in more detail at the electronic systems, the theory of how they operate, the kinds of things that can go wrong with them, and how to diagnose and repair those problems.

The test procedure is as follows:
1. Turn on TV set and satellite receiver
2. Put receiver in the scan mode
3. Place hand over the opening in the polarizer
4. Adjust receiver IF gain control to set a reference level on the signal strength meter on which to base any meter deflection due to TI. Also, observe the television screen for normal operation without any TI interference indications.
5. Remove hand from in front of the polarizer, hold feed in a horizontal

(continued on page 59)

TI, what it is and how to deal with it

Terrestrial interference (TI) is the existence of earth based electromagnetic signals in the vicinity of a satellite reception antenna that is of a frequency such that it interferes with the satellite signals that you wish to receive. Most of this TI is produced by the transcontinental 4GHz point-to-point microwave network used for long distance telephone services.

The interference caused by these unwanted signals will appear on the TV screen as white dots, black dots, black streaks or total wipeout of the picture. Excessive signal strength will accompany microwave interference. The frequencies assigned for these telephone transmissions are midway between satellite transponder frequencies which are 20MHz apart, or, in other words, ± 10MHz from the center frequency of the desired satellite channel. When the entire 3.7GHz to 4.2GHz spectrum is downconverted, the satellite channel appears at 70MHz, and the unwanted telephone frequencies appear at 60MHz and/or 80MHz.

The use of 60MHz and/or 80Mhz bandstop filters will usually eliminate the interfering dots (black or white) and black streaks. In a channel wipeout situation (no video, blank raster) the above filters will need the added attenuation of a wire mesh fence positioned around the dish itself. This may require trial and error positioning of the mesh screening to find the precise location for maximum rejection of the unwanted signal. Screening, which should be of the density of window screen, will need to stretch beyond the edges of the dish.

The procedure described here can be used to effectively determine the presence of terrestrial interference at a potential TVRO site. The equipment you will need includes:

1 - Feed assembly (LNA Choke Plate, polarizer) with the choke plate aligned with the outside edge of the polarizer.
1 - 70MHz downconverter
1 - 70MHz satellite receiver with Scan
2 - Coaxial cables with F fittings on each end
1 - 2 conductor wire.

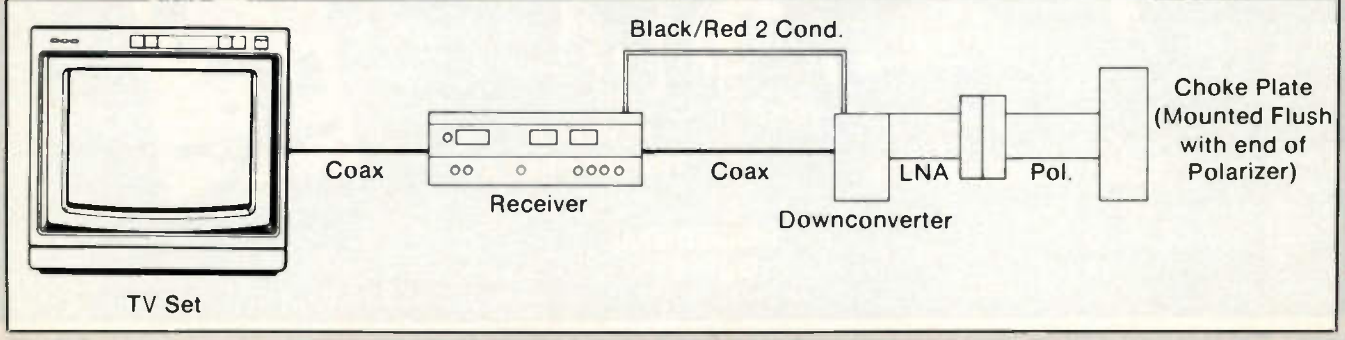

Figure 3.

Troubleshooting RCA CTC120 sweep circuits

By Homer L. Davidson

Eighty percent of the troubles that occur in TVs are located in the sweep circuits. Dead and blown fuses, tic-tic noises, shut down and start up problems are a few of the symptoms of problems caused by defective components in the horizontal circuits.

A horizontal white line across the center of a black screen, shrinking of the picture from the top of the screen, intermittent vertical sweep and the presence of visible retrace lines are all symptoms of problems in the vertical sweep circuits (Figure 1).

Most horizontal sweep problems are related to a leaky horizontal output transistor, flyback transformer, sweep IC or hold down capacitor. In the vertical circuits, defective vertical output transistors, diodes, electrolytic capacitors and improper supply voltage are frequently the source of problems. Let's tackle some vertical and horizontal sweep problems in the CTC120.

Davidson is a TV servicing consultant for ES&T.

Dead - Blown fuse

When a blown fuse is the problem, replace the fuse, leave the set turned off, then go directly to the horizontal output transistor and take a resistance measurement from collector (metal body) terminal to chassis ground. A low resistance measurement (under 100Ω) indicates a leaky

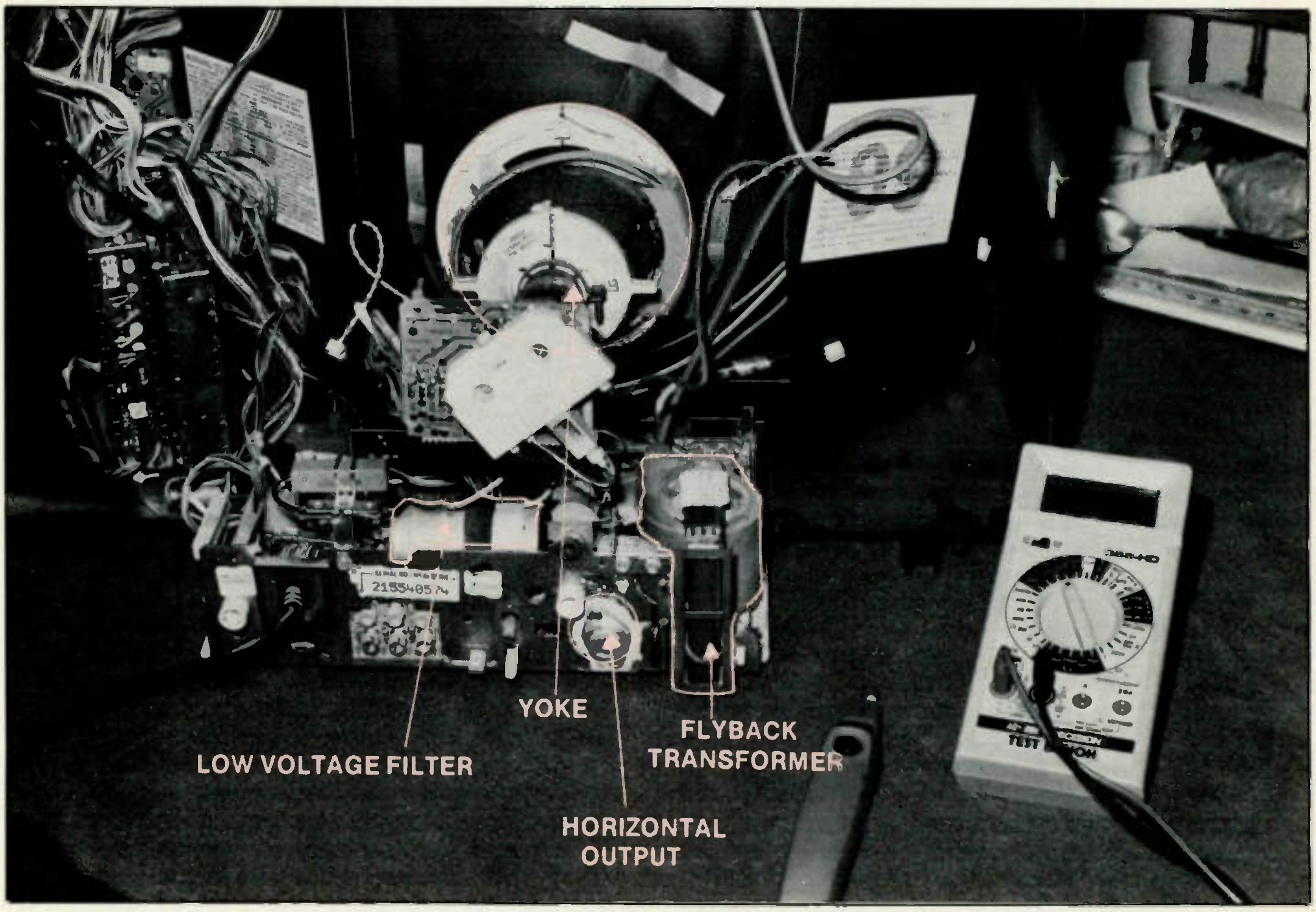

Figure 1. Eighty percent of TV troubles are caused by components in the sweep circuits. Most horizontal failures are caused by flyback transformers, horizontal output transistors, deflection ICs, filter capacitors and shorted yokes.

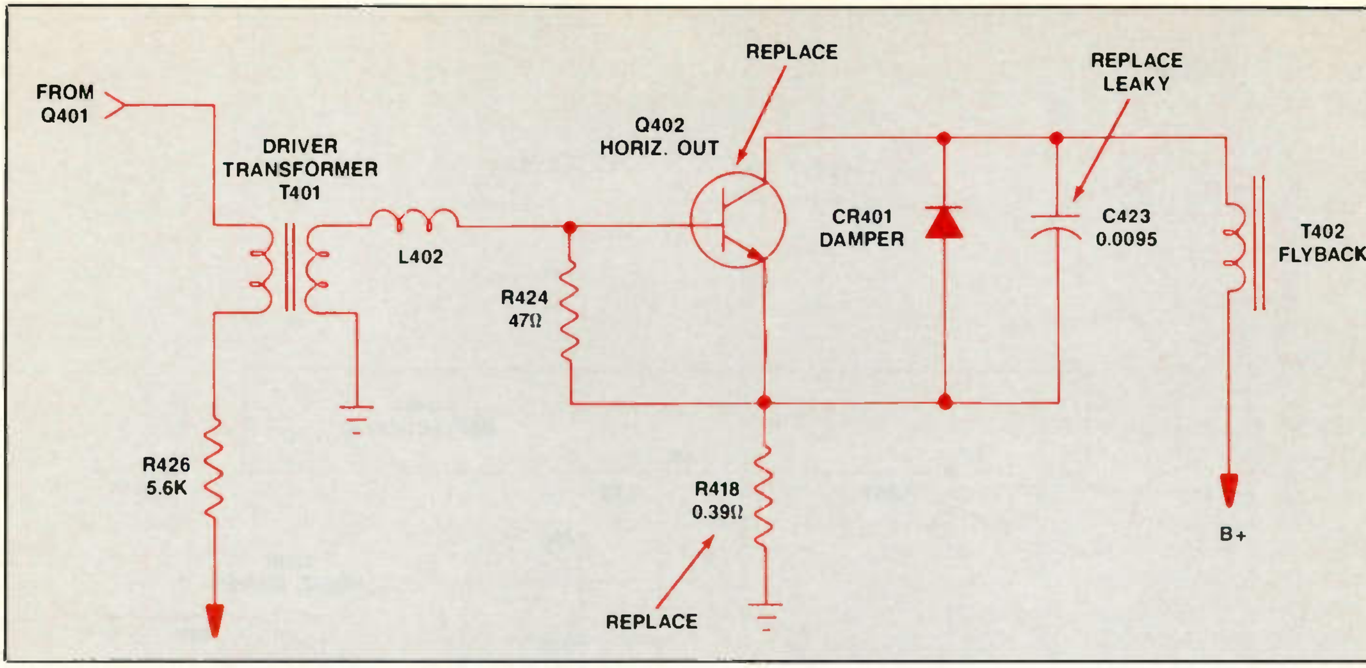

Figure 2. In one CTC120, R418 was open and hold down capacitor C423 was leaky. When these components are faulty, the transistor is probably bad also, so replace it as well.

output transistor or damper diode.

Normally, you should have a resistance measurement around 500Ω in one direction. If you can get at the damper diode, disconnect one end and check it out of circuit. If the damper diode is not accessible, remove the horizontal output transistor and test it out of the circuit for leakage.

In the RCA CTC120 shown in Figure 2, I measured infinite resistance from collector terminal of Q402 to chassis ground. Upon checking the schematic, which listed a value for R418 of 0.39Ω, I determined that the resistor must be open. I removed Q402 from the chassis and tested it. It was good. A resistance measurement from Q402 mounting screw indicated a leakage of 13Ω. No doubt the damper diode, CR401, was leaky.

After I disconnected the collector terminal of CR401 from Q402, it tested normal. Either the hold down capacitors or flyback were leaky to ground. Further checks revealed that C423 (0.0095μF) was leaky. In addition, R418 was found to be open and replaced. The set was restored after I changed R418 and C423. In another CTC120, open R418 was caused by a shorted Q401 output transistor.

Dead set, only a tic-tic sound

Low ticking noises heard when your ear is held close to the flyback transformer may indicate the absence of horizontal sweep pulses, or an open or leaky output transformer or flyback. If you suspect the flyback, before you remove it check to make sure that the symptom isn't caused by some other component. A very good reason for this cautious approach is that it takes a lot of service time to remove the flyback from the pc wiring (Figure 3).

In one set, after replacing the 5A fuse, F101, and checking Q402 and flyback continuity, I powered the set via a universal line isolation transformer. I connected the scope to the base of Q402 and monitored the low voltage at filter capacitor C105A. I gradually increased the line voltage. When it reached 60Vac, Q402 began to warm up. There was no drive voltage.

I turned the line voltage down to

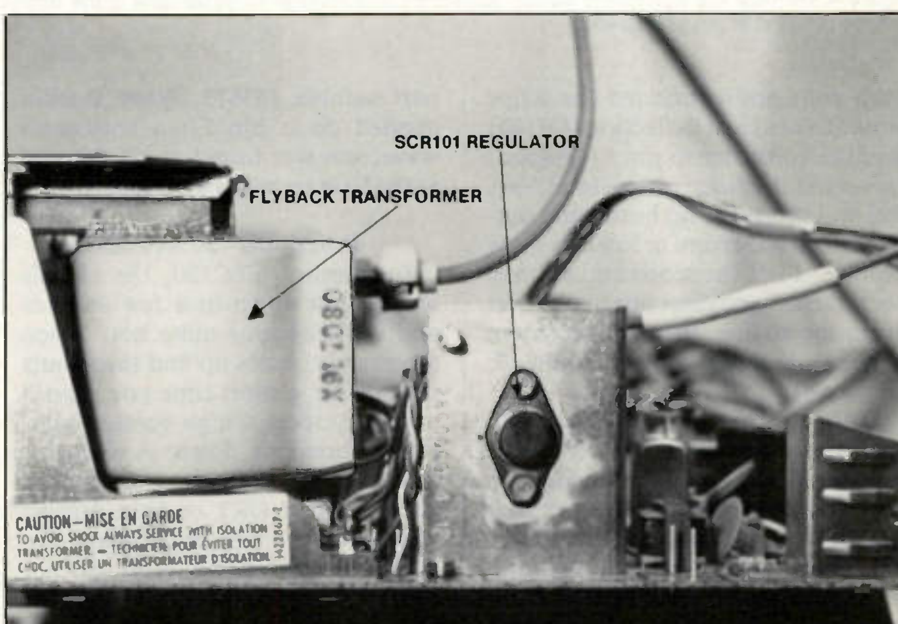

Figure 3. When you suspect that the flyback transformer is faulty, check connected components first before removing the transformer, to confirm that it is the source of the problem. Most flyback transformers take a lot of service time to replace, so you'll be wasting a lot of time if you remove a good one.

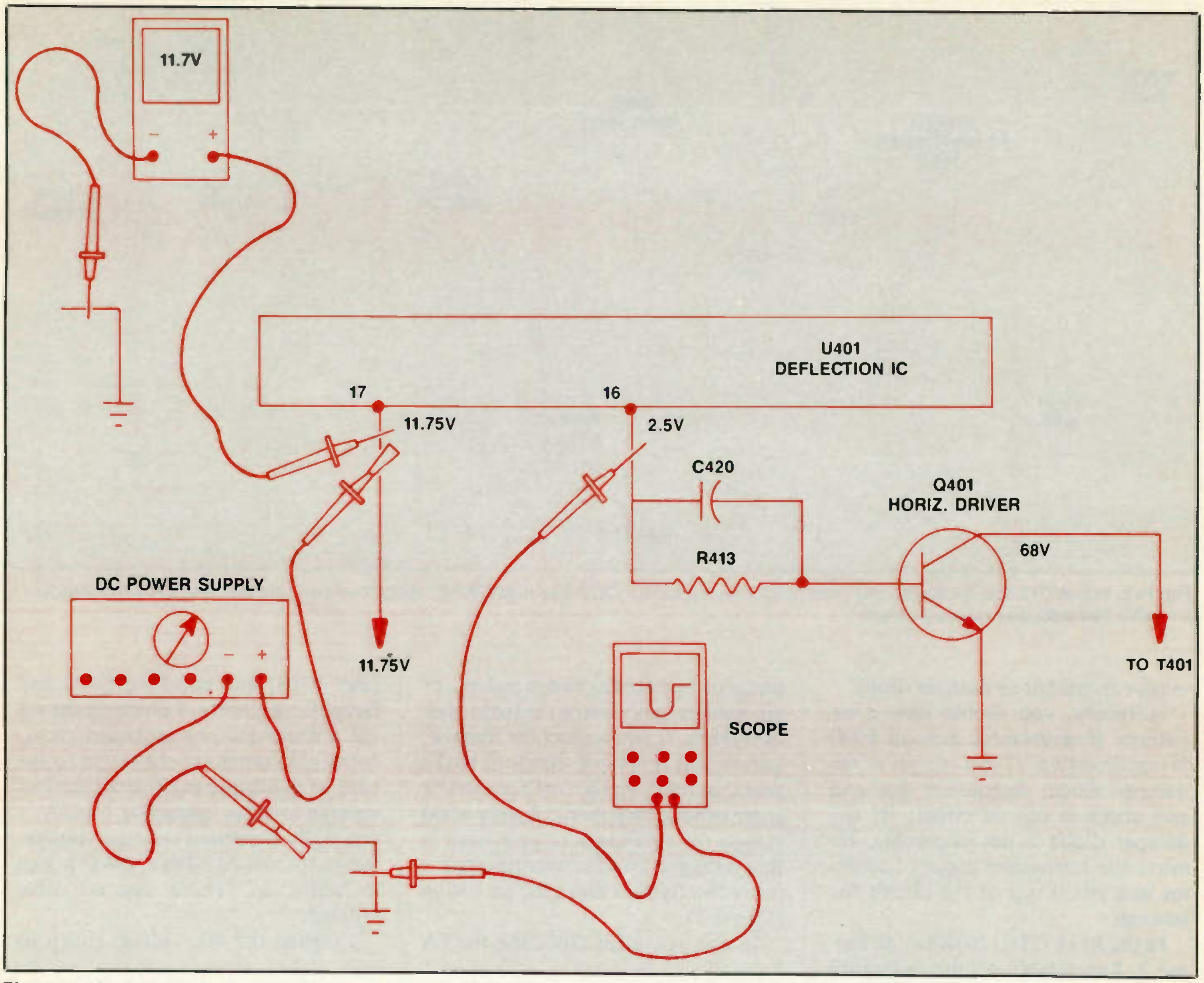

Figure 4. Monitor the horizontal sweep waveform and voltage to determine if the deflection IC (U401) is defective. Inject external voltage (11.75V) at pin 17 of U401.

zero volts and connected the scope probe to pin 16 of deflection IC U401 and the voltmeter to pin 17. Again I increased the line voltage to 60Vac, but still there was no horizontal output sweep waveform or low dc supply voltage. I left the scope and voltmeter attached and disconnected the set from the ac line, then connected an external dc power supply to pin 17. (Figure 4).

Although the no-load voltage of the supply was set at 39Vdc, the dc voltage at pin 17 would only come up to 7.7V. This made me suspect that the deflection IC was leaky. If the IC was operating normally, the dc at pin 17 should have produced a horizontal waveform at pin 16. No waveform was observed with the external dc voltage attached. Although no leakage was found at pin 17, I replaced U401 with an exact replacement part, part number 153875. When I again applied dc at pin 17, a horizontal waveform was found at pin 16, and at the base terminal of Q402.

Shut down - 20 seconds

In another CTC120, the chassis would shut down in a few seconds and Q402 became quite hot. When the chassis comes up and then shuts down after a short time you should usually suspect a high voltage component breaking down. A defective flyback transformer, deflection yoke, shorted CRT or scan derived secondary circuits may cause the chassis to shut down. Also, do not overlook the possibility that other leaky components in other circuits may be overloading the power supply and causing the chassis to shut down.

In this case, in order to protect Q402 I used a variable isolation transformer to raise or lower the dc voltage. When I turned the set on with only 75Vac applied, it took longer to shut down. This made me suspect that something in the high voltage flyback circuits was causing the shutdown. Because there are several different scan-derived voltages in the flyback secondary circuits, I checked for a possible shorted picture tube or yoke. I disconnected each of them in turn, observing appropriate safety precautions while working around the picture tube.

The chassis shut down, even with the picture tube HV anode lead removed. When I applied power to the set with the red lead of the yoke disconnected, the set did not shut down. Of course with the yoke lead disconnected, the high voltage was very low. At least the chassis did not shut down with the yoke out of the circuit.

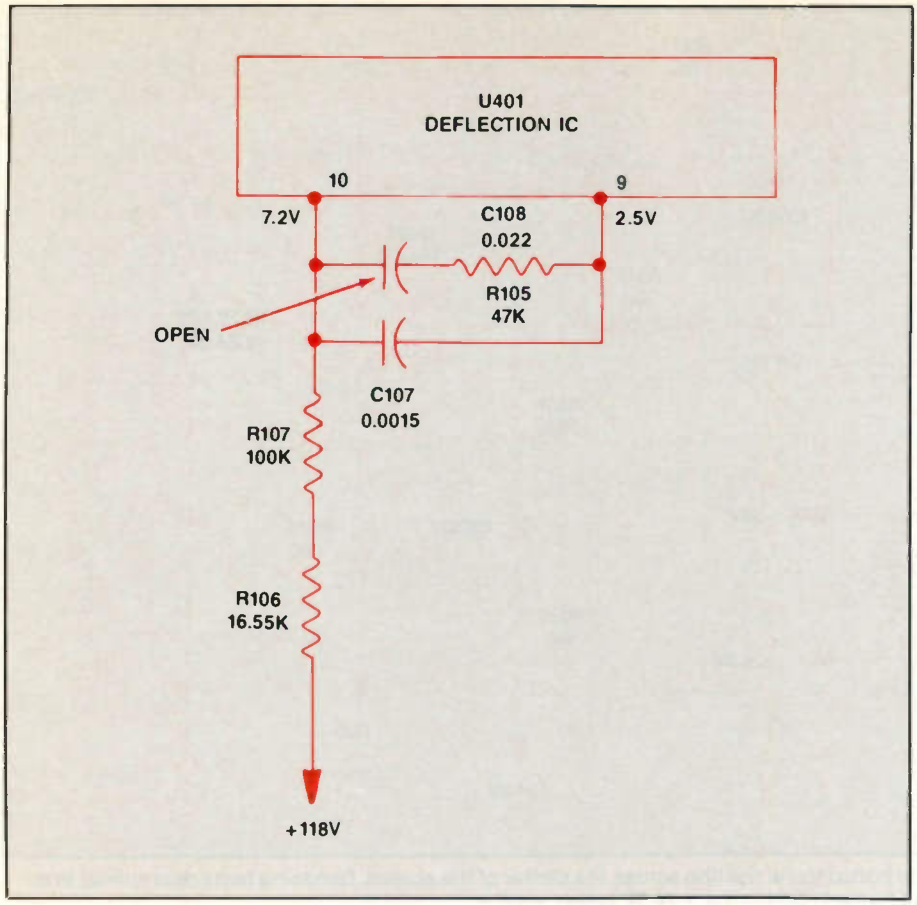

Figure 5. An open or leaky C108 capacitor tied to pin 10 of U401, caused intermittent shut down in the CTC120 chassis. Check SCR101 for leakage.

Q402 remained cool. Because these diagnostic steps did not point to any other particular problems, Q402 and DY100 became the primary suspects. Replacing them both solved the problem of the delayed shut down chassis.

Intermittent shut down in the CTC120 chassis may also be caused by a leaky C108 capacitor at pin 10 of the deflection IC, U401 (Figure 5). Do not overlook the possibility that a leaky regulator SCR101 is placing higher than normal voltage at the +118V source.

Intermittent start-up

Many faulty CTC120 sets will not start up even when normal or higher ac line voltage is applied. In this case, go directly to the horizontal driver circuits and check the voltage at the collector terminal of Q401. If this voltage is lower than 55V, suspect R426, a 5.6Ω resistor. This 5W resistor is located in front of the flyback transformer (Figure 6).

Check the resistance of R426. If the resistor has increased in value, the chassis may be intermittent with normal or higher ac line voltage. The B+ voltage supplied to Q401 is taken

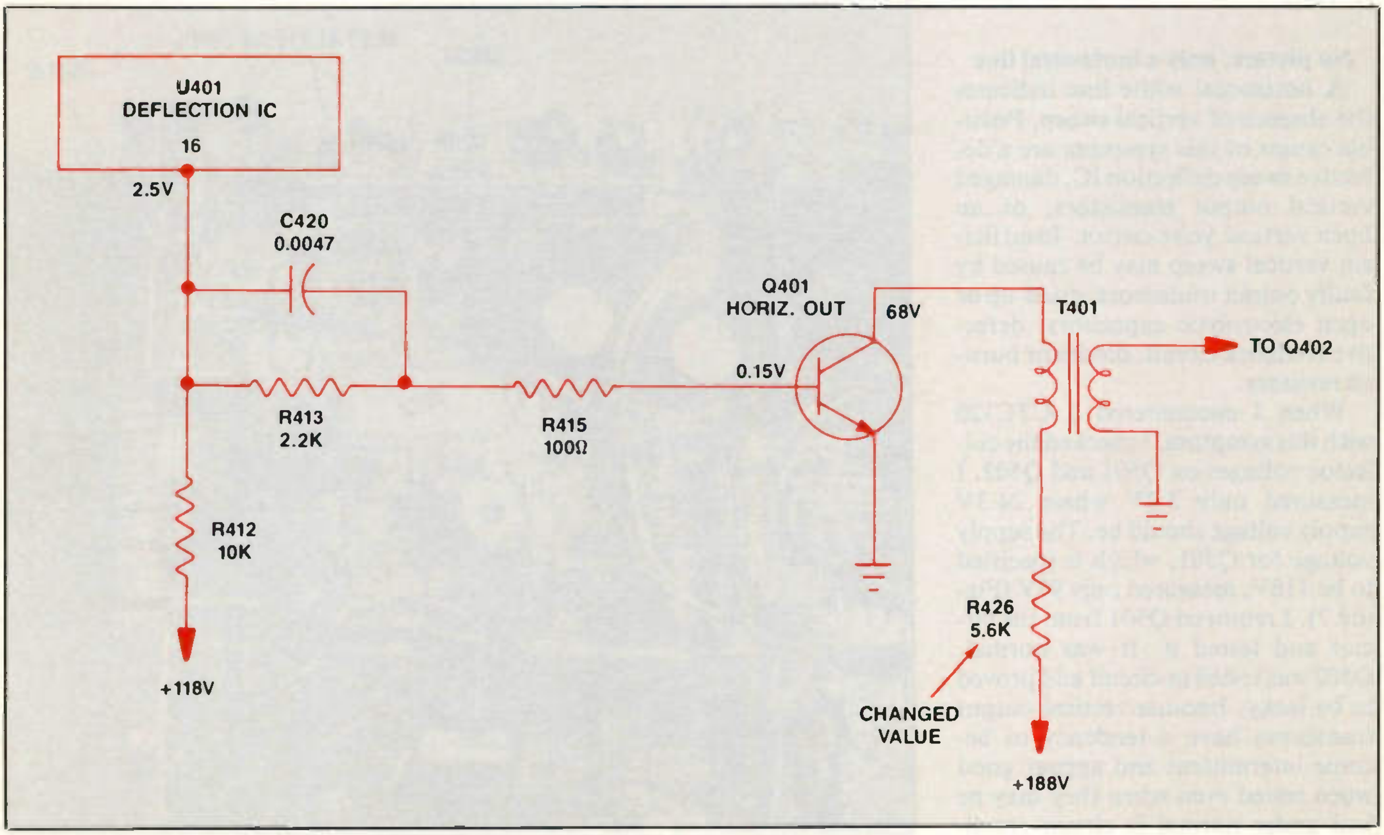

Figure 6. A change in resistance of R426 (5.6K) in the B+ leg of T401 may cause intermittent start-up with normal or higher power line voltage.

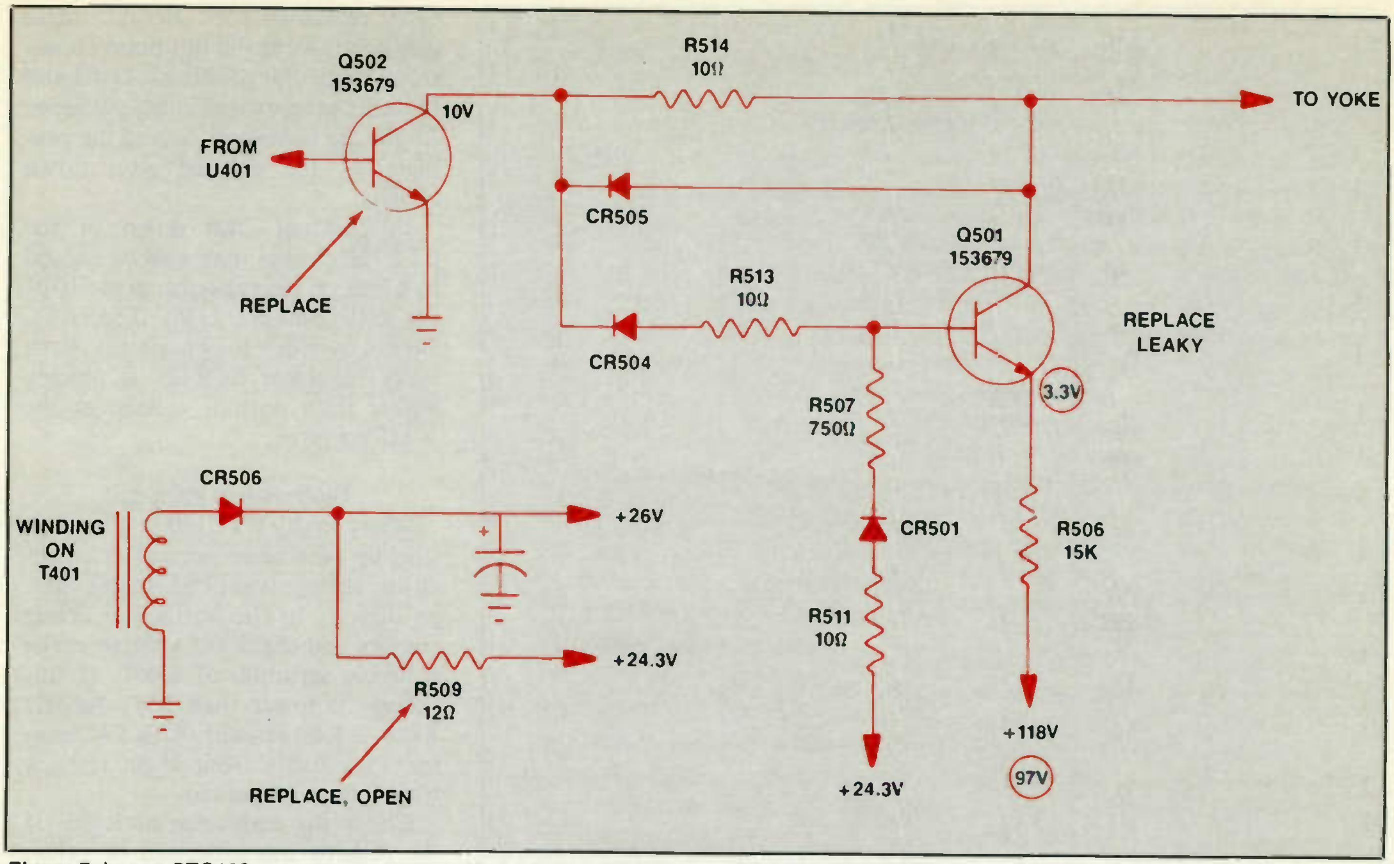

Figure 7. In one CTC120 the symptom was a thin horizontal white line across the center of the screen. Servicing tests determined that the cause of this symptom were leaky Q501 and burned R509 in the +24.3V power source.

from the 188V scan derived voltage of T402.

No picture, only a horizontal line

A horizontal white line indicates the absence of vertical sweep. Possible causes of this symptom are a defective sweep deflection IC, damaged vertical output transistors, or an open vertical yoke circuit. Insufficient vertical sweep may be caused by faulty output transistors, dried-up or open electrolytic capacitors, defective feedback circuit, diodes or burned resistors.

When I encountered a CTC120 with this symptom, I checked the collector voltages on Q501 and Q502. I measured only 3.3V where 24.3V supply voltage should be. The supply voltage for Q501, which is specified to be 118V, measured only 97V (Figure 7). I removed Q501 from the circuit and tested it. It was normal. Q502 was tested in-circuit and proved to be leaky. Because vertical output transistors have a tendency to become intermittent and appear good when tested even when they may be bad under normal in-circuit conditions, I replaced Q501 as well as Q502 with ECG152 replacements.

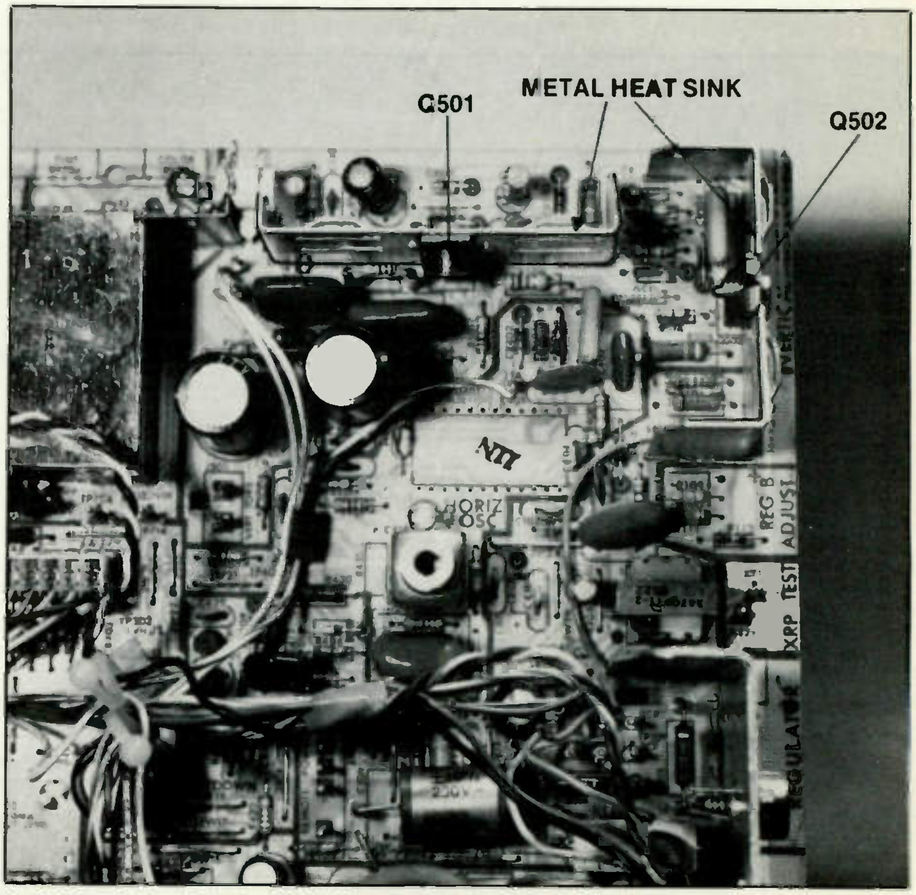

Figure 8. The two vertical output transistors are located upon a separate metal heat sink in the CTC120 chassis (Q501 and Q502).

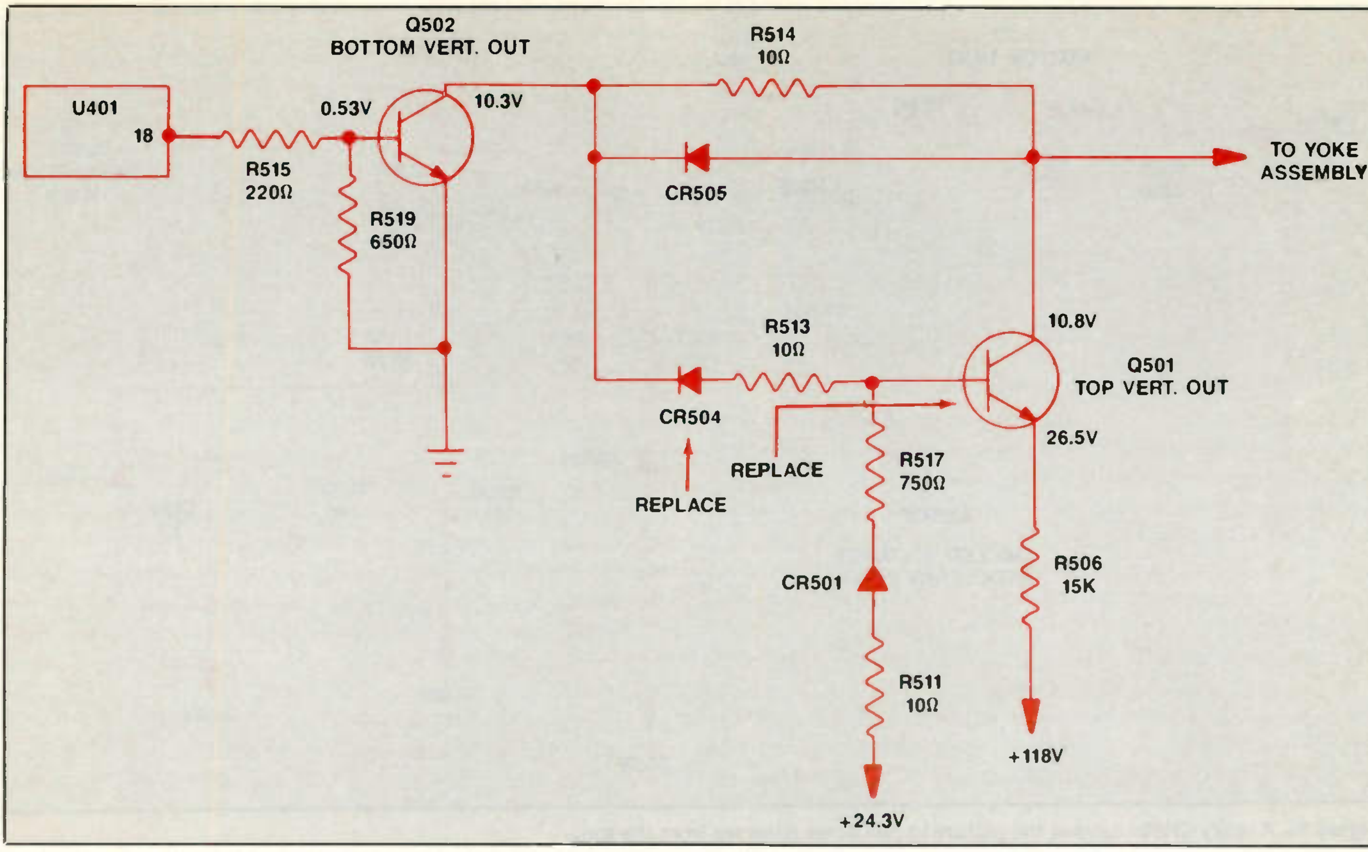

Figure 9. CR504 was intermittent and caused insufficient vertical raster. The problem was narrowed down to this component when applying coolant to CR504 restored normal operation and heating it caused the symptom to return.

I fired the chassis up expecting full vertical sweep, but still observed only a white line. Again I checked voltages with the same results. I traced the supply voltage back to the scan derived voltages upon the flyback. CR106 tested good, but R509 (12Ω) was open. Replacing R509, Q501, and Q502 solved the no sweep symptom.

Intermittent vertical sweep

In another CTC120 chassis, the customer complained, of the raster collapsing from time to time. Otherwise the set was just fine. When the outside technician picked up the set, he observed only a horizontal white line. Because the problem was intermittent, the set was brought into the shop for service.

After I replaced open resistor R509 (12Ω) in the scan-derived voltage supply, the set played normally for a full week.

Suspecting that I hadn't corrected all the problems in this set, I operated it for an extended period of time and applied cold sprays and heat alternately to Q501 and Q502 without any results (Figure 8). I sprayed components within the vertical circuits with coolant and heated them, and lowered and raised the line voltage but the set continued to operate just fine.

The chassis acted up exactly one month after it had been repaired. In fact, even after it was brought back in for service, the set operated for a whole week until the vertical finally collapsed, one morning shortly after the bench switch was turned on.

Investigation revealed that R509 was running quite hot. I sprayed each component with coolant to see if this might reveal the culprit.

When CR504 was sprayed with coolant the raster returned. When heat was applied to CR504 the raster collapsed again. Spraying the diode with coolant again restored the picture (Figure 9). No doubt I had missed CR504 the first time around.

Picture height 8 inches from top

On one set the raster was pulled down from the top of the picture 8 or 9 inches indicating vertical problems caused by the top vertical transistor (Q501). Voltage measurements at Q501 terminals were about the same at both base and collector terminals. The collector voltage was about 10V lower than the manufacturer's literature specified (Figure 10).

Q501 tested leaky in the circuit and was replaced, but the problem persisted. Resistor R509 was quite warm. Q502 tested good. CR501, CR502, CR504, and CR505 were tested in circuit and appeared normal.

Because Q501, Q502, CR505 and CR504 have caused problems in other CTC120 sets, I decided to replace them one at a time. Q502 was replaced first and then CR504.

When CR504 was replaced the raster returned to full height. The CR504 that I had removed from the set showed leakage when I tested it. Sometimes when diodes and transistors are tested in circuit the internal junctions may test normal, while under actual operating conditions they may break down.

Retrace lines at the top

Retrace lines in the raster may be caused by leaky output transistors or diodes, or resistors that have changed in value.

In the case of one CTC120 I worked on, when I observed retrace lines at the top of the screen, I immediately checked components within the vertical section, especially the top transis-

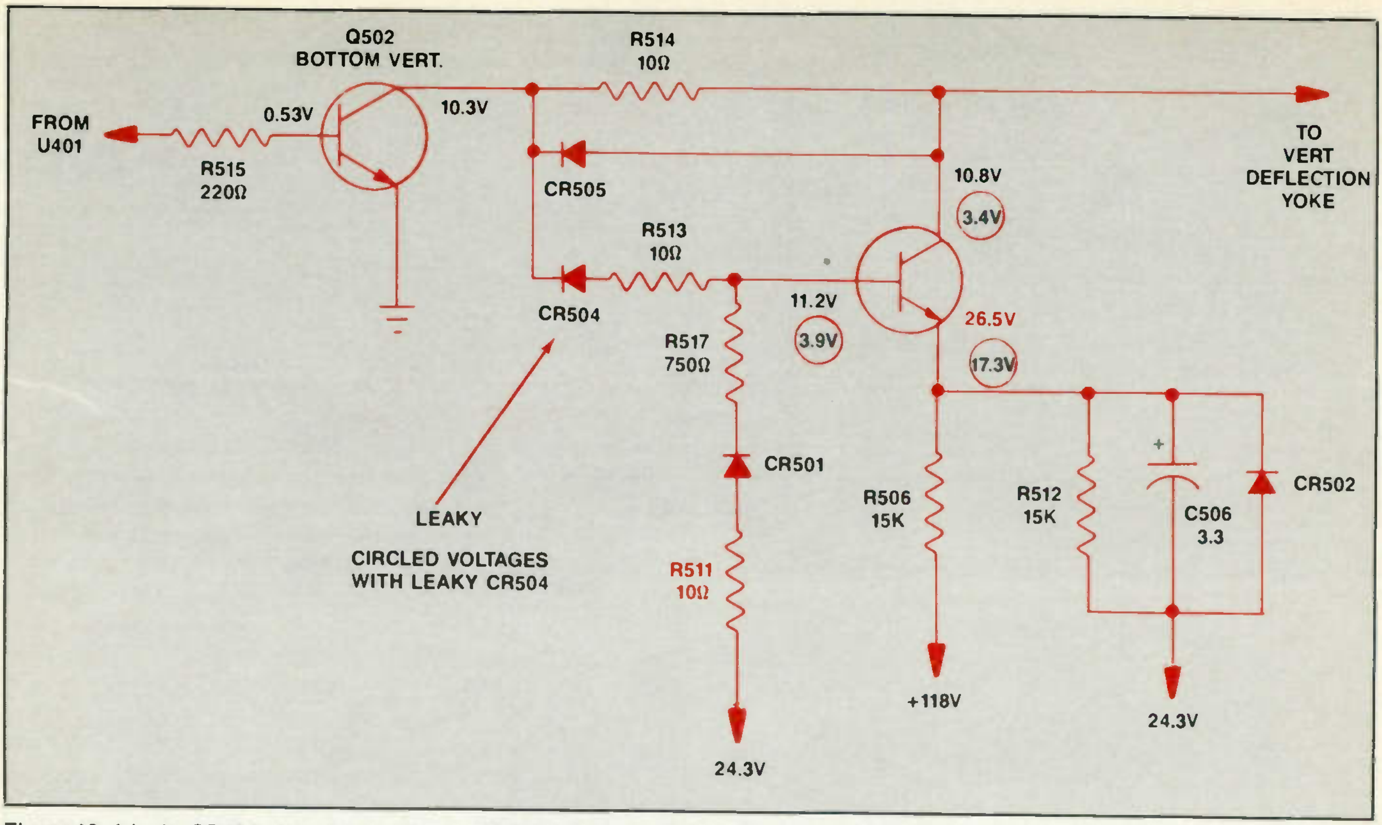

Figure 10. A leaky CR504 caused the picture to pull down 8 inches from the top.

tors. In addition to the retrace lines, the raster was a little distorted for the first couple of inches.

Before replacing suspected transistor Q501, I checked all resistors in the base and emitter circuits. Even CR502 tested normal. The voltages on Q501 were quite close to specified values. This transistor still seemed to be the prime suspect, so I replaced it. The symptom remained.

CR501, CR504, and CR505 checked normal in the circuit when I checked them with the diode test of the DMM. Next I turned the power off and one at a time clipped known good capacitors in parallel with electrolytic capacitors C505 (10μF) and C506 (3.3μF).

When I turned the power on with a replacement capacitor clipped in parallel with C505 there was no change in the symptom, but when power was applied to the set with a replacement clipped across C506, the retrace lines disappeared. Further checking showed that C506 was open (Figure 11). Replacing the 3.3μF electrolytic capacitor completed the repair.

Unusual stripped wiring

One CTC120 was brought in that appeared to have been struck by lightning. Although, the 5A fuse, R120 (3.9Ω), CR101 and CR102 were blown, no burned marks were found around these components or the power cord. I replaced the low voltage components, but the chassis remained dead. Often, although not always, when lightning strikes a TV set the damage is beyond economical repair.

Although in this case there were no burned marks on the etched wiring, four different pieces of wiring were stripped from the board (Figure 12). Removing the bottom IF shields indicated excessive lightning damage. Since wiring was stripped from the board and the IF shielded circuits were damaged, I labeled the set a total loss. Even if this set could have

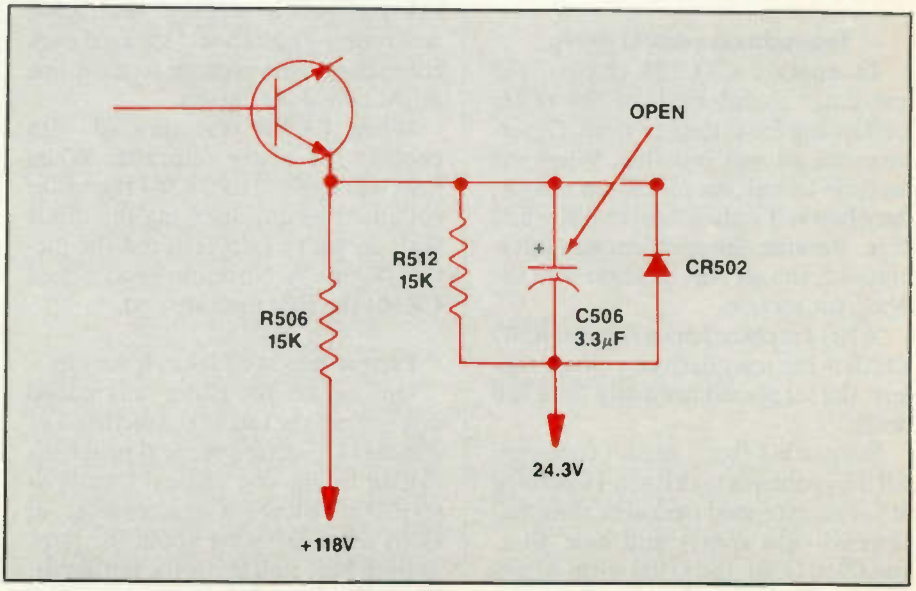

Figure 11. Check C506 when retrace lines are found at the top of the picture. Clip another 3.3μF capacitor into the circuit with power off.

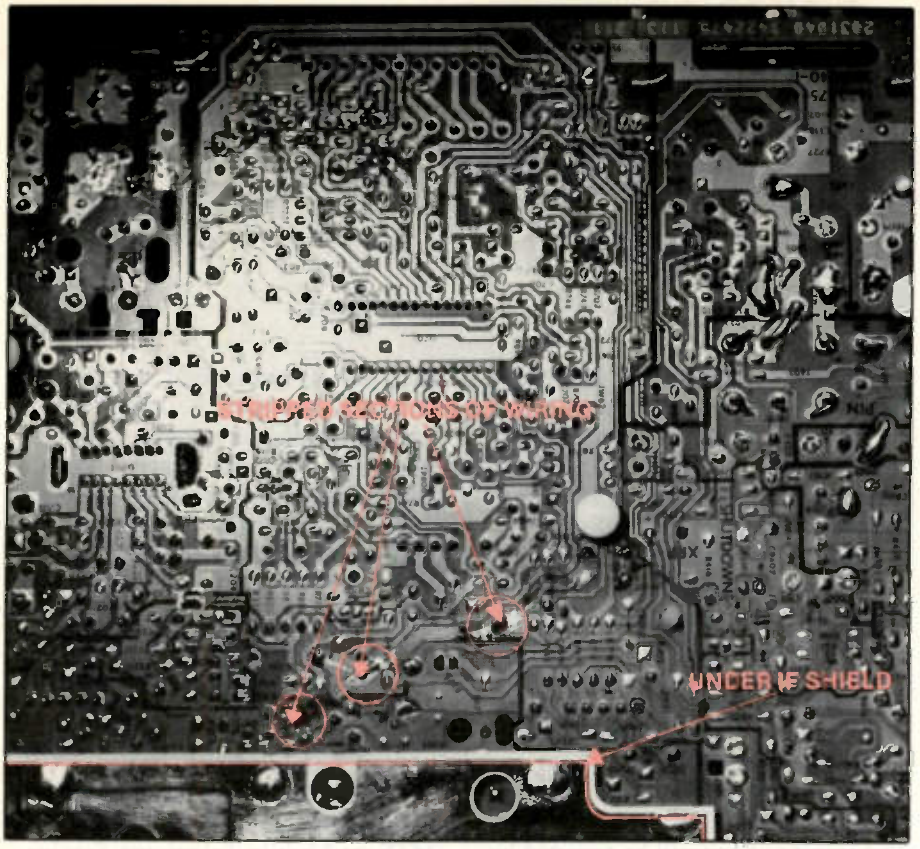

Figure 12. Stripped pc wiring caused by lightning made this CTC120 chassis uneconomical to repair.

been repaired for $200 or $300, more problems were likely to develop later on.

Conclusion

Voltage measurements and scope waveform tests may help to locate the defective component in the sweep sections. Scope waveforms at pin 16 and 18 of the deflection IC (U401) determine if vertical and horizontal waveforms are present. Most horizontal and vertical components can be replaced with universal replacement. Try to replace IC components with the original part number.

Replace all components that have run hot or show signs of having overheated. Always replace both vertical output transistors when one tests leaky or open. Don't overlook the possibility that components U401, Q402 and R426 are the cause of intermittent horizontal circuits. By similar logic, check components CR504, CR505, Q501 and Q502 in the case of intermittent vertical raster. Mark all defective components and symptoms on the service schematic for future reference.

Cellular telephone systems

By the ES&T staff

Adapted from an article in "The Expander," a publication published monthly by Mitsubishi for their authorized service centers.

The advances in technology have a tendency to change the definition of things. At one time, a computer was something that occupied a large room, consumed huge gobs of power, cost a lot of money, and was something that large corporations, banks and such used for keeping track of accounts, generating reports, etc.

Today a computer is an inexpensive tool that costs a few thousand dollars and sits on your desk or can even be carried about and used in your lap, and can be used for anything from keeping track of accounts to word processing, page layout and design, and other tasks too numerous to mention.

But even as new technology is introduced and becomes established, improvements come along that challenge existing notions of what it is and how it is used. For example, the idea of the home office was introduced only a short while ago, but new technology has already changed the meaning of "home office." While many small companies have their headquarters in their home, others that require more mobility have much of the paraphernalia of their business in a car or van, and do much of the business of their home office in that vehicle.

The technologies that have made this kind of freedom and mobility possible are things such a mobile telephones, laptop computers with hard disk drives, easy to read backlit LCD screens and modems, and portable fax machines. All of these together allow the person who needs to do so to run an office out of a vehicle.

The cellular link

Perhaps the key link in the car/van based "home office" is the cellular telephone. This amazing technology allows the business person of today to be in contact with customers, headquarters, vendors, just about anyone even while driving around in the car making business calls.

Estimates are that at the present time, more than 5,500,000 cellular telephones are in use in the U.S., with nearly 700,000 units in use in Canada. In addition, there are an estimated 3,500,000 units in use in other countries for a total of nearly 10 million cellular telephones. These are premium priced products that are used in conjunction with an expensive service. They will be serviced by someone. There is no doubt that some of the readers of this magazine will eventually be doing some of that service. Some may already be doing so.

This article, adapted with permission from "The Expander", a monthly publication published by Mitsubishi Electronics America, Inc., for its authorized service centers, will describe the evolution of mobile telephone systems from the inception of the early mobile telephone systems to today's cellular mobile telephone systems as background information for those who may be contemplating doing cellular telephone service. Future articles will deal with other aspects of cellular telephone systems, including actual servicing of the product.

The early systems

The first practical, publicly available mobile telephone system, the MTS or Mobile Telephone Service, was introduced in St. Louis, MO by the Bell Telephone Company in 1946. A functional block diagram of the original MTS system is shown in Figure 1. This new service quickly expanded, and by the end of 1947 mobile telephone service was available in more than 25 U.S. cities.

This original MTS service used

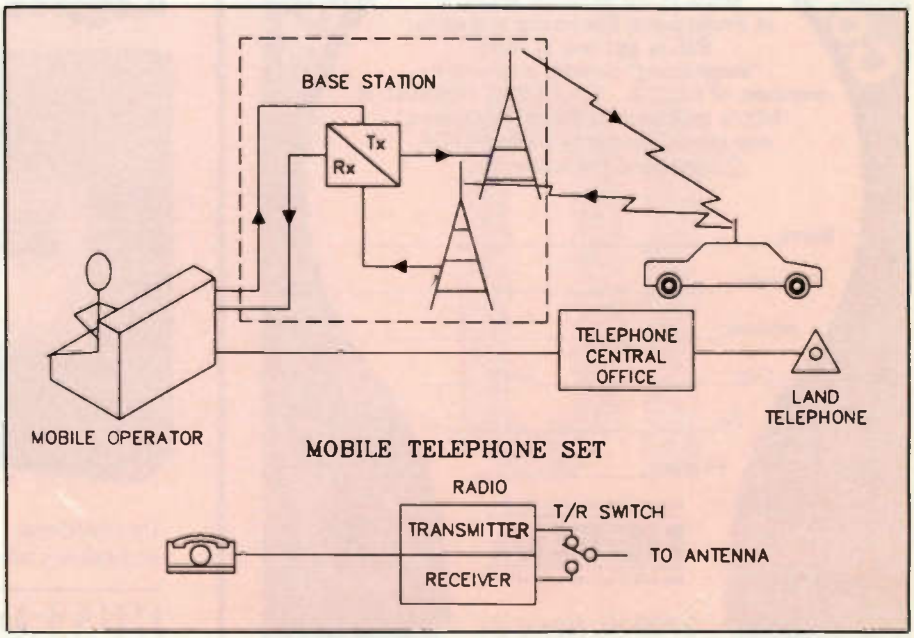

Figure 1. An early mobile telephone system such as this one was limited in its ability to provide service to the number of channels available on the system. In the earliest systems, this was about 400.

four RF Channels in the 150MHz VHF region. Because wideband FM (modulation index of 25) was used as the modulation method, the channels were spaced 120KHz apart. Each channel consisted of a pair of frequencies: a land or base station transmit frequency (known as the forward channel) in the range of 152.510MHz to 152.860MHz, paired with a mobile station transmit frequency (known as the reverse channel) offset 5.26MHz higher.

Because two RF frequencies were available, you might imagine that the system operated in a duplex mode, which would have permitted simultaneous conversation between the mobile telephone and the fixed telephone to which it was connected.

Unfortunately, the system instead operated *half*-duplex.

The fixed station end of the system did operate in duplex mode, but the technology for manufacturing the necessary components to make practical duplex operation possible in the mobile unit did not exist in 1946. Therefore, these first-generation mobile telephone units operated in the same way a typical 2-way or CB radio does, permitting conversation in one direction at a time.

The direction of the conversation was controlled by the mobile customer. When the mobile unit wished to transmit, he would press a push-to-talk switch on the handset, and when he wished to receive he would release it.

System limitations

In addition to the limitations of the half-duplex form of operation, this first-generation mobile telephone system had several other distinct disadvantages.

The MTS system uses a single, centralized base station site, which makes it a one-cell system. Therefore, the total number of conversations that could be processed by the system at any one time was restricted to the number of channels available on that particular system.

To provide an adequate communications range, the mobile subscriber's transceiver was required to operate at a power level of 50W, which strained the 6V electrical systems in most vehicles in the late 1940s.

Because each mobile customer was assigned a specific *home channel*, to keep *blocking* (the term used to describe the unavailability of a channel when it is desired) to a reasonable level, a total of only 400 customers could be accommodated by each system. Obviously, given the population of any large city, the number of requests for mobile telephone service would far exceed the capacity of the system to provide service.

In fact, the demand for MTS service grew quickly and stayed ahead of capacity for many years: a waiting period of five or six years before service could be acquired was not unusual.

Call processing and supervision

A telephone call placed using a mobile telephone requires the same level of call processing and supervision services as a call made totally on the land telephone network. Because there is no direct wire connection between the mobile subscriber unit and the land mobile telephone system, some of the call processing and supervision procedures become even more complex than in the land telephone system.

The original MTS mobile telephone system used a totally manual control system in which all call processing and supervision operations were performed using verbal contact between the mobile subscriber and the mobile system operator. This control system was actually *less* capable than those used in the land telephone systems at the turn of the century. Because the mobile telephone subscriber unit functioned in a manner so different from that of the typical land telephone, special training was required to operate the MTS mobile telephone, further restricting its usefulness.

MTS improvements

The original MTS system was *not* a really satisfactory solution to the need for mobile telephones. The reason that it quickly became very popular was because it was the *only* solution available at the time. Fortunately, some of the shortcomings and limitations of the system were soon addressed. There were three advancements in technology that had a particular impact on the MTS system.

Audio signalling

The first advancement was the development of audio tone signalling, which replaced the use of verbal paging for completion of land to mobile calls. A tone decoder, programmed to respond to a series of audio tones that corresponded to a particular mobile unit's telephone number, was incorporated into the mobile unit's receiver. If the correct sequence of tones was received, the decoder would activate audio and/or visual indicators on the mobile telephone handset cradle, signalling the subscriber that a telephone call was coming in.

This marked a great improvement over having to listen to all the traffic on the home channel to receive paging for a call. This tone signalling system was a predecessor of the signaling system used by the cellular mobile telephone system.

NBFM, RCCS and UHF

The second advancement was the development of narrow-band FM (NBFM). With NBFM, the amount of RF spectrum consumed by each signal was reduced by more than 50%. This advance, coupled with tremendous increases in the frequency stability of both the mobile transmitters and receivers, permitted the existing 120KHz channels to be split, reducing inter-channel spacing to 60kHz.

This splitting in turn permitted an expansion of the number of available channels to 8, which was of some assistance in alleviating the chronic overcrowding of the MTS channels.

Additional allocations of RF spectrum were also made available for MTS. The first of these, 10 channels using a 40kHz spacing between channels an 8MHz base/mobile frequency offset, were allocated in the 40MHz region. These channels were allocated mainly for use in rural areas where the reduced path loss of the lower RF frequency made a system with increased range possible.

An additional four channels in the 150MHz VHF region were also allocated. However, these additional channels were *not* allocated for use by the local telephone companies, but were reserved for use by an independent provider of mobile telephone service. These independent companies are known as *radio common carriers* (RCCs). This dual-system strategy was inaugurated to promote competition in the expectation that this competition would spur growth and technological innova-

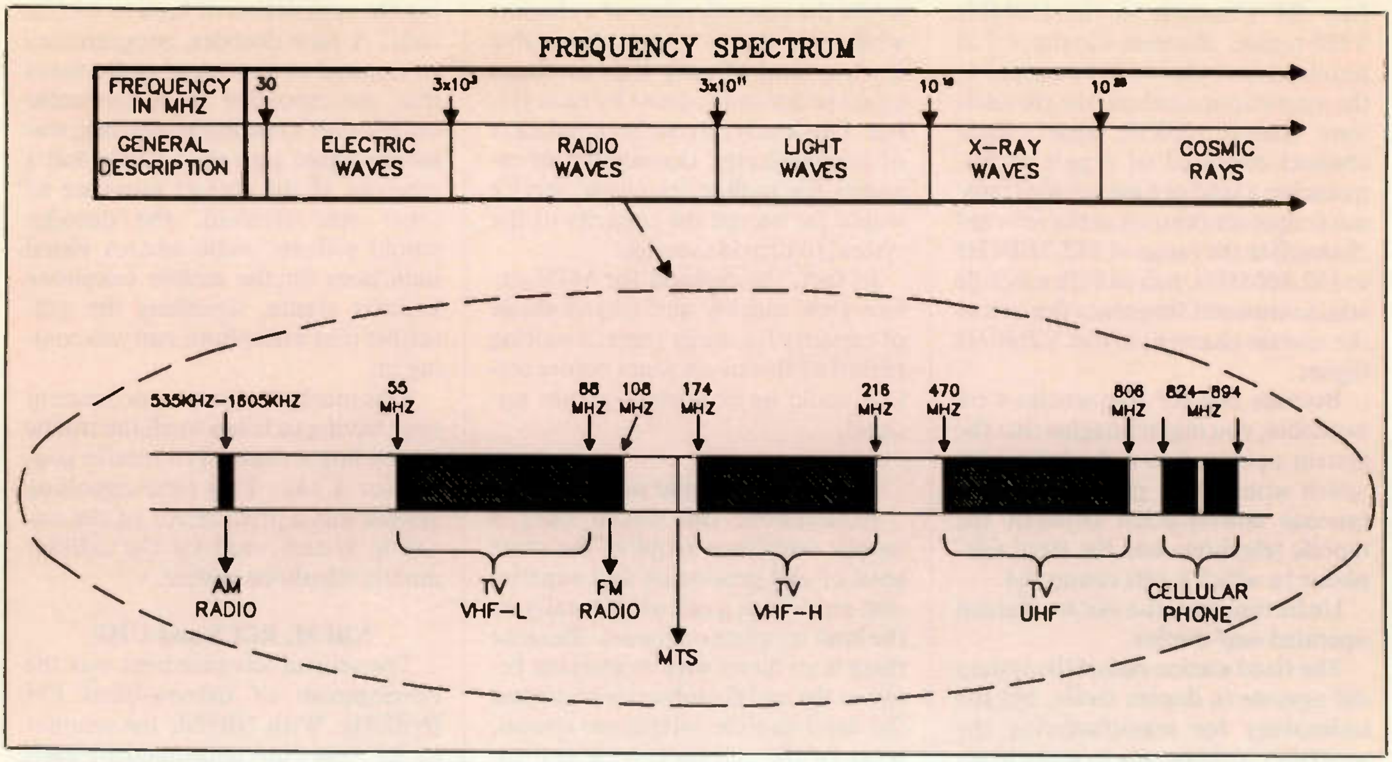

Figure 2. Only a very small portion of the RF spectrum, less than one-quarter of the space taken by a single television channel was allocated to the entire MTS systems.

tion. While only moderately successful in its aims, this dual-system strategy was retained when the cellular mobile telephone system was outlined, and is in use today.

As the use of higher RF frequencies became practical, 19 channels in the 450MHz UHF region were allocated for MTS use. This group of channels was split into three groups: 7 channels reserved for RCC use, 6 channels for use by the local telephone companies, and 6 channels for a new version of MTS: an air-to-ground MTS called Aircraft Mobile Telephone Service.

Finally, 5 channels in the 158MHz VHF region were allocated for another new service called Marine Public Coast; a ship-to-shore version of MTS. Both the Aircraft Mobile Telephone and the Marine Public Coast MTS services are still operating today.

Trunking

One of the most persistent problems with MTS was a high rate of blocking caused by severe overcrowding of the system: too many subscribers on too few channels waiting too long to be able to make a phone call. Figure 2 illustrates why: only a very small portion of the RF spectrum, less than one-quarter of the space taken by a single television channel, was allocated to the entire MTS systems.

Splitting and adding channels had only a marginal effect. The invention of *trunking* did more to reduce overcrowding than any other development. Figure 3 shows a graphic comparison between non-trunked and trunked systems.

The early MTS mobile subscriber units were designed to operate on one specific channel. As described earlier, each subscriber was assigned a specific home channel from the total number of channels available, and all subscribers assigned to that channel shared it like a party line.

If for example, Channel 1 was in use, all other subscribers assigned to Channel 1 are blocked from either making or receiving a phone call *even if every other channel in the system is unused*. Overall efficiency suffers in such a non-trunked system.

In a trunked system, however, each mobile subscriber unit is designed to operate on every channel, and every channel is shared among the total number of subscribers on the system. If Channel 1 is busy and Channel 2 is vacant, the next subscriber to demand service would use Channel 2.

If both Channels one and 2 are in use, the next subscriber would use Channel 3, and so forth, until all channels in the system are in use. At that point, blocking would occur. Each subscriber may find himself actually using any one of the group of channels for any given call. One well-known example of a trunked radio system is the 27MHz Citizen's Band radio service.

Trunking adds tremendously to the efficiency of the system. This improved efficiency does not come without cost, however. The mobile subscriber unit in a trunked system is more complex and costly, since the transmitter and receiver are required to operate efficiently on a variety of frequencies.

Trunking, either manual or automatic, has one additional disadvantage. A trunked system, in order to operate at maximum efficiency, requires a dedicated calling or paging channel, which of course reduces the number of channels available on the system for communications. If a dedicated calling or paging channel were not used, paging for land to mobile calls would have to be repeated on all idle channels in the system, because a subscriber unit could be tuned to any of the idle channels at any given time.

The first trunked MTS systems operated manually: the subscriber would search each channel and would determine by listening which channels were occupied, then select a vacant channel to initiate the call. The Marine, Aircraft and 40MHz land MTS systems still use manual trunking.

In the early 1960s, the trunking process for the other land- based MTS systems was automated. Special circuitry in the subscriber unit would automatically search for a special audio tone placed on all vacant channels by the land station, selecting the first vacant channel found for call initiation.

IMTS

In 1964, a package of enhanced services, including automatic trunking, direct dialing of mobile to land calls, and full-duplex operation, was introduced to land mobile telephone subscribers, under the acronym IMTS, which stands for Improved Mobile Telephone Service. IMTS service is still available in many areas of the country, though it has been largely supplanted by the cellular mobile telephone service.

The introduction of IMTS was the culmination of much research and development. Introduced first for MTS channels in the 150MHz VHF region, and later for channels in the 450MHz UHF region, IMTS was designed to simulate the convenience and features of the land telephone system, and it was largely successful. In the early 1970s the invention of the microprocessor enable the inauguration by the RCCs of an enhanced version of IMTS called SMART, which is the technical "father" of the cellular mobile telephone service.

IMTS and SMART demonstrated the technical viability of NBFM, mobile duplexing, automatic interconnection, automatic trunking and other features including *roaming*.

Roaming is a special set of signalling protocols that permits a mobile subscriber to use their telephone on a mobile telephone system other than the one to which they are a subscriber. Roaming is a very helpful feature for people who travel over a large territory served by more than one mobile telephone system.

However, one problem that had haunted MTS from the very beginning remained: the severe lack of available channels. Some extra breathing room was gained by reducing the signal bandwidth of the transmitted signal when an existing MTS system was converted to IMTS. The channel spacing was then again split, yielding channel spacings of 30KHz (VHF) or 25KHz (UHF): this doubled the number of channels. This was still not a sufficient number to accommodate demand in most areas of the country.

The cellular concept

At about the same time that the IMTS system was being introduced, AT&T, the Bell Telephone Laboratories, Motorola and the Federal Communications Commission were putting the finishing touches on the basics of a radical new design concept for mobile telephone service.

The aim of this plan was to design a mobile telephone system that would, once and for all (they hoped), eliminate the RF spectrum shortage and allow the mobile telephone service to become the type of high-quality, universally available service that the land telephone system had become.

The three criteria

Three basic criteria were deemed of paramount importance in the design of this new system:

1. Any new system *must* be able to overcome the single greatest limitation of the existing mobile telephone system: the severe overcrowding that had plagued mobile telephone since its inception in 1946. This over-

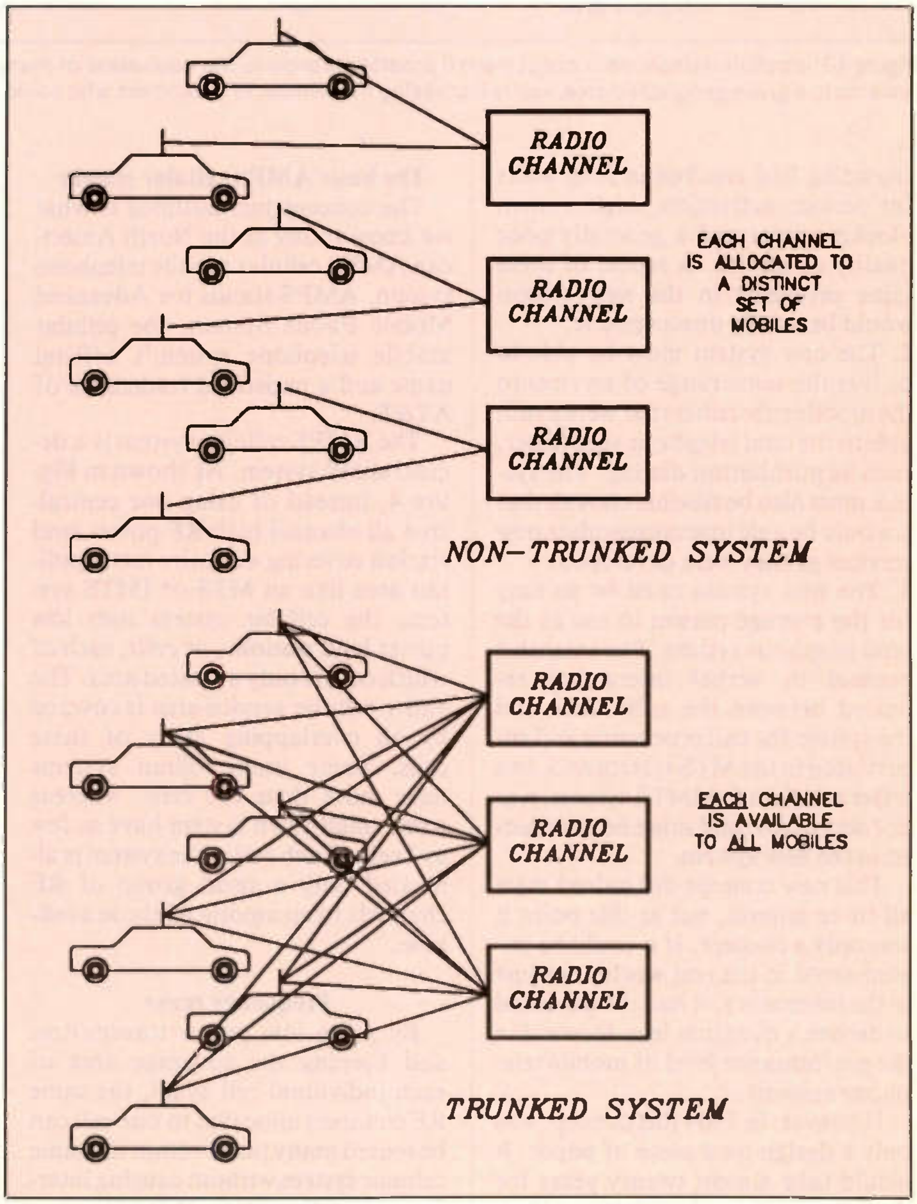

Figure 3. The introduction of trunking reduced blocking by allowing mobile telephone customers to use any unused system channel, rather than having to wait for the one channel to which they had been assigned to become free.

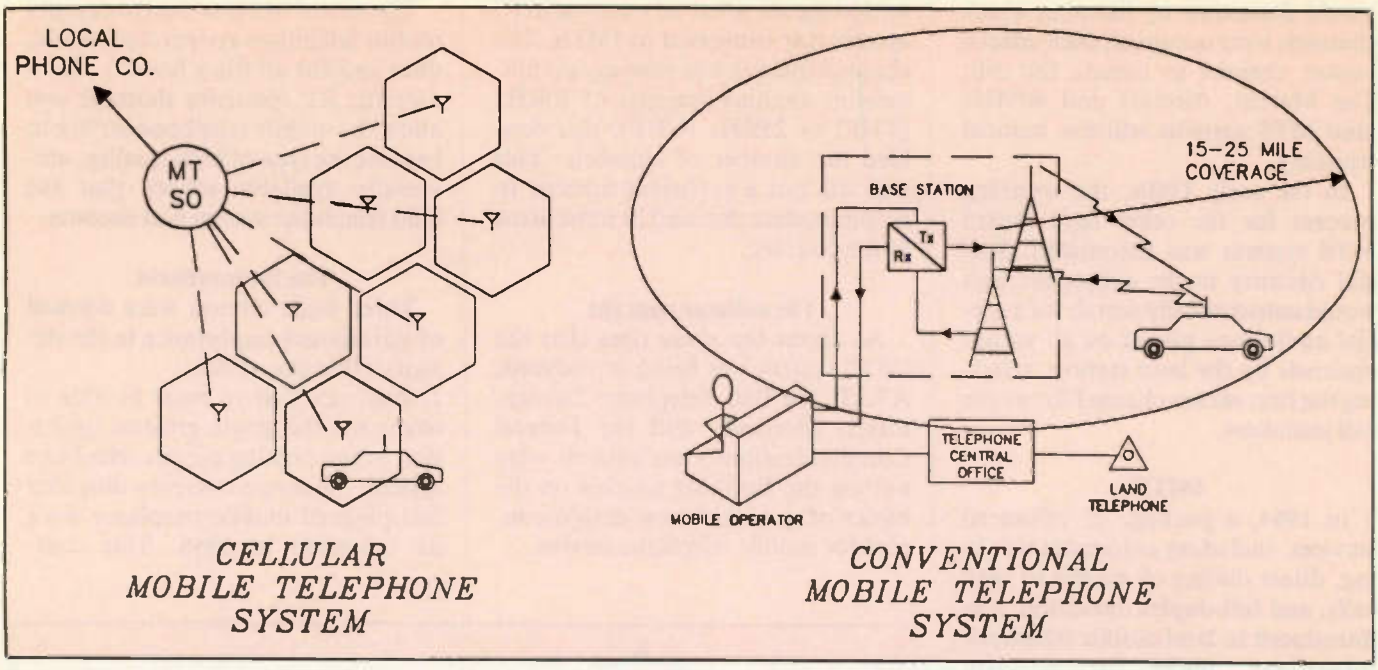

Figure 4. The cellular telephone concept made it possible to provide the equivalent of many smaller, lower-powered mobile telephone systems in a given geographic area, vastly increasing the number of customers who could be served.

crowding had resulted in long waits for service activation, high system blocking rates and a generally poor quality of service. A repeat of these same problems in the new system would be totally unacceptable.

2. The new system must be able to deliver the same range of services to the mobile subscriber that were available to the land telephone subscriber, such as pushbutton dialing. The system must also be flexible enough that it would be able to accommodate new services as they were developed.

3. The new system must be as easy for the average person to use as the land telephone system. The extensive manual or verbal interaction required between the subscriber and the system for call processing and supervision in the MTS system and, to a lesser extent in the IMTS system, was *not* acceptable and must be eliminated in the new system.

This new concept did indeed meet all three criteria, but at this point it was only a concept. If it could be implemented in the real world, not just in the laboratory, it had the potential to deliver a quantum leap forward in the performance level of mobile telephone systems.

However, in 1964 this concept was only a design on a piece of paper. It would take almost twenty years for the events to take place that would allow this concept to reach the real world.

The basic AMPS cellular system

The concept just outlined is what we know today as the North American AMPS cellular mobile telephone system. AMPS stands for Advanced Mobile Phone System, the cellular mobile telephone system's official name and a registered trademark of AT&T.

The AMPS cellular system is a decentralized system. As shown in Figure 4, instead of using one centralized all-channel high RF power land station covering an entire metropolitan area like an MTS or IMTS system, the cellular system uses low power land stations, or *cells*, each of which covers only a limited area. The entire cellular service area is covered by an overlapping array of these cells. Some metropolitan systems have more than 100 cells, whereas some small-town system have as few as 2 cells. Each cell in the system is allocated only a small group of RF channels from among all those available.

Frequency reuse

By using low power transmitters and keeping the coverage area of each individual cell small, the same RF channels allocated to one cell can be reused many times within the same cellular system without causing interference or disruption of service.

This concept, called *frequency reuse*, permits many more users or subscribers to be accommodated on one cellular system than could be accommodated by all the MTS and IMTS systems in the entire country combined! The use of the concept of frequency reuse, in conjunction with a much larger RF spectrum allocation in the 800MHz band provided for cellular (see Figure 2) fulfills the first criterion, relieving the severe system overcrowding, now seems possible.

Call switching

In an MTS or IMTS system, the switching equipment, which is the interface to the land telephone system and provides the facilities to perform the call processing and call supervision duties, is usually located at the same central point as the RF portion of the system.

In a cellular telephone system, the switching equipment is called the Mobile Telephone Switching Office (MTSO). The MTSO is centralized as well, but within the system's service area. The cellular MTSO performs the additional duties of acting as the common connection point, tying all the system's individual cells together as a system.

The MTS or IMTS system, with its centralized land station, communicated with the user throughout the entire coverage area. The cellular concept has a physical disadvantage in this regard since it uses small, limited coverage land stations.

Unless the cellular customer is expected to remain stationary throughout the call, a very unreasonable expectation, a cellular system must have the capability to follow the subscriber throughout the entire coverage area of the system.

Providing this capability in such a way that the subscriber was unaware of any action by the system as it switched the call from cell to cell proved to be one of the most difficult parts of the cellular equation.

Call processing and handoff

As shown in Figure 5, when a cellular subscriber places a call, the RF connection is made through the cell nearest the subscriber with the switching being performed by the centralized MTSO: the call is routed from the mobile unit through the cell (Cell 1 in our example) to the MTSO, then onto the land telephone network.

The call processing procedures are basically the same as those in an IMTS system, but they are done using a totally different technology that will be examined in future articles.

While the call is in progress, if the subscriber moves from Cell 1 into Cell 2, the call must follow the subscriber if the connection is to be maintained: this is a situation not faced by an MTS or IMTS system. Since the call is routed through the centralized MTSO, if the call is switched from Cell 1 to Cell 2, the call can indeed follow the moving subscriber.

This procedure, called *handoff*, involves finding an idle RF channel from among the group of channels allocated to Cell 2, directing the mobile subscriber unit to change to the selected channel, then, while the mobile subscriber unit is changing channels, switching the call connection from Cell 1 to Cell 2. The entire procedure is achieved quickly with very little or no disturbance to the user, and demonstrates that the new system does indeed fulfill the second and third basic design criteria.

Handoff illustrates the second major difference between a conventional mobile telephone system and the cellular system: the use of digital control, supervision and switching. This complex undertaking is made possible because of the power of digital computers, microprocessors and advanced switching systems, technology that did not exist when the basic concept of the cellular system was developed.

More to come

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 dense urban areas as well as outlying rural areas. 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 costs have gone down sufficiently, which is why cellular communications is one of the fast growing businesses in the United States.

Future articles will provide more detail on the cellular telephone system and provide some actual troubleshooting suggestions. ■

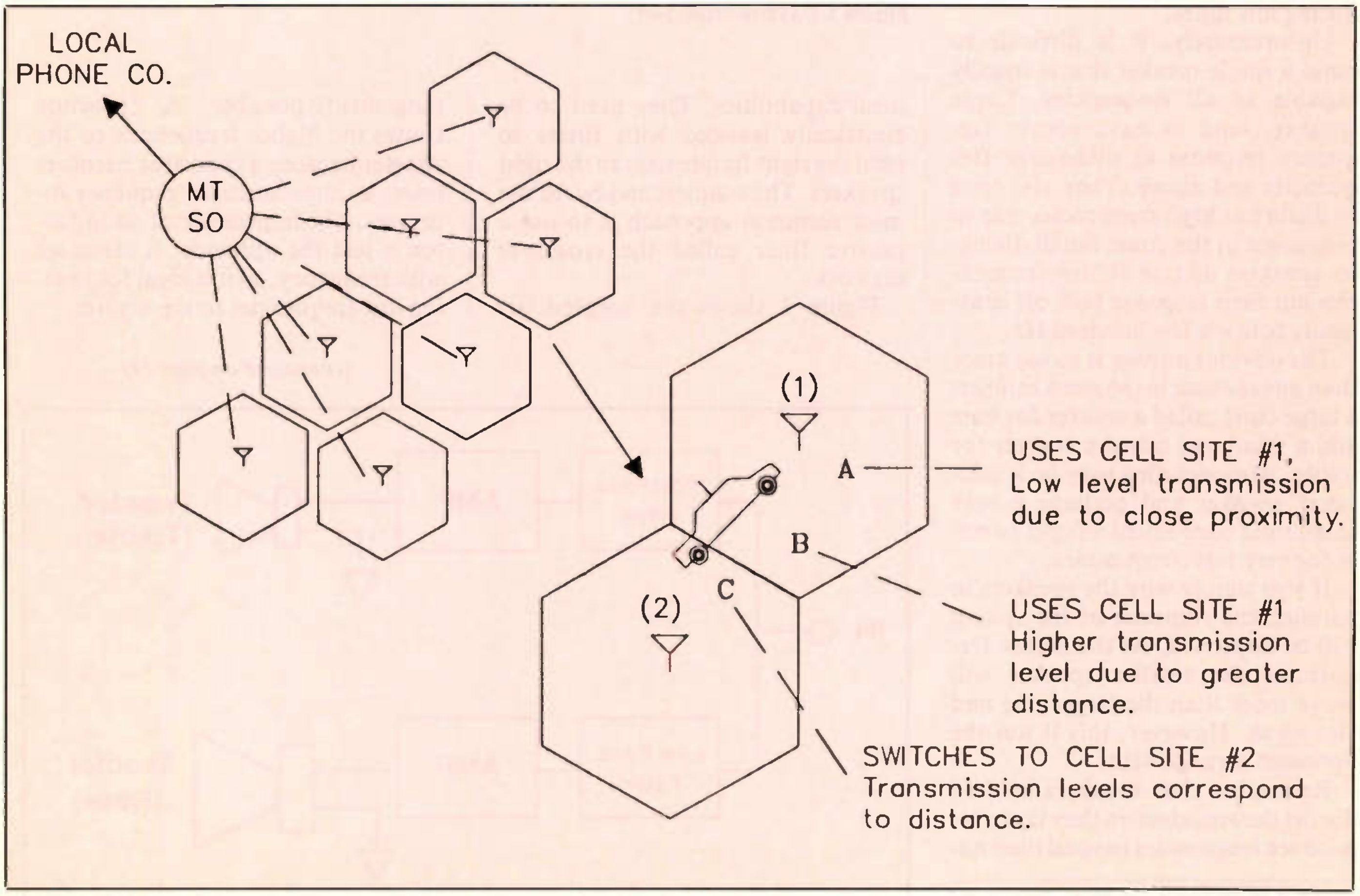

Figure 5. Modern digital circuitry makes it possible to switch a cellular telephone call from cell to cell (handoff) as a customer drives throughout the area, without the customer being aware that the action has taken place.

The story behind biamp

By John Shepler

What is biamp and why would anyone want it? That's this month's topic.

Biamp refers to biamplification; the use of two amplifiers to drive a speaker system. The idea is that driving each speaker cone with a separate amplifier reduces distortion and improves the sound clarity. To understand why, we need to revisit speaker system construction.

The first radios and phonographs had only a single loudspeaker. These speakers grew larger in console models because the low frequency response is dependent on the diameter of the speaker. The larger the speaker, the more efficient it is at reproducing low notes.

Unfortunately, it is difficult to build a single speaker that is equally capable at all frequencies. Large speakers tend to have poorer frequency response at mid-range frequencies and above. They also tend to distort at high frequencies due to resonance in the cone. Small diameter speakers do fine at high frequencies but their response falls off drastically below a few hundred Hz.

The obvious answer is to use more than one speaker in the same cabinet: a large cone called a woofer for bass and a small one called a tweeter for treble. Also included may be a mid-range speaker and perhaps a very small rigid cone called a super tweeter for very high frequencies.

If you simply wire the speakers in parallel, the response of the system will be improved. At the higher frequencies the smaller speaker will move more than the larger one and vice-versa. However, this is not the optimum arrangement.

Remember that speakers tend to distort the sound when they try to reproduce frequencies beyond their natural capabilities. They need to be electrically isolated with filters to send the right frequencies to the right speakers. The simplest and by far the most common approach is to use a passive filter called the crossover network.

Figure 1 shows the simplest arrangement possible. A capacitor routes the higher frequencies to the tweeter because a capacitor becomes lower in impedance as frequency increases. The impedance of an inductor is just the opposite. It increases with frequency, so it is ideal for routing low frequencies to the woofer.

(continued on page 39)

Shepler is an electronics engineering manager and broadcast consultant. He has more than twenty years experience in all phases of electronics.

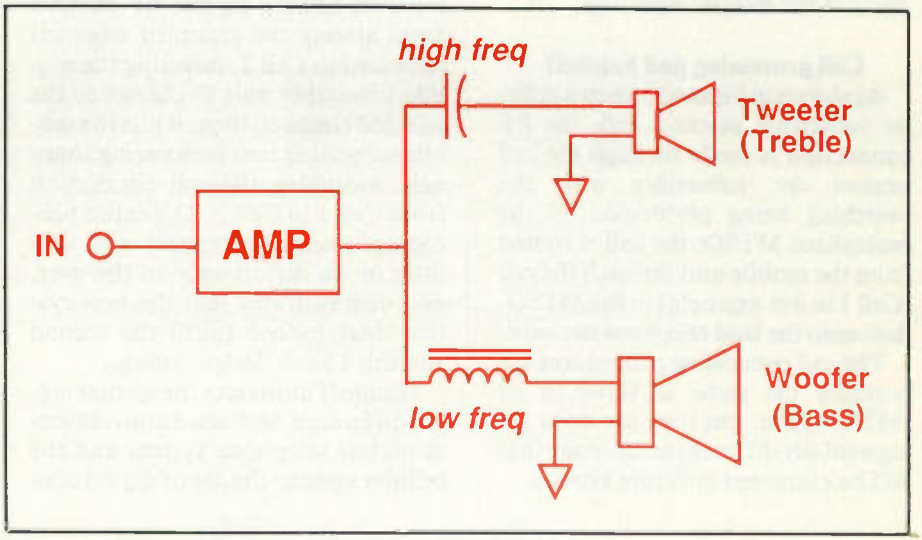

Figure 1. Passive crossover

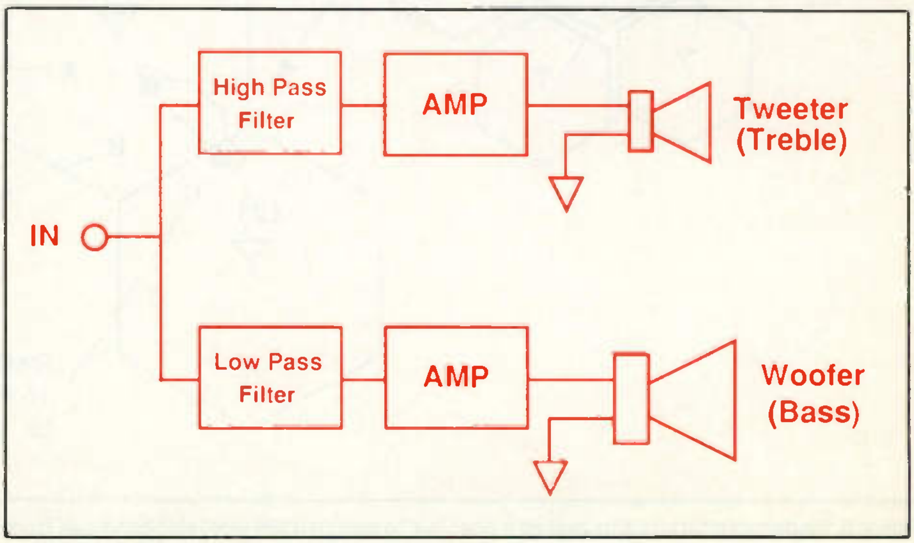

Figure 2. Active crossover

July 1991

Profax Number

RCA
CTC 107 Color TV 3078

CHASSIS SCHEMATIC—SIGNAL CIRCUIT

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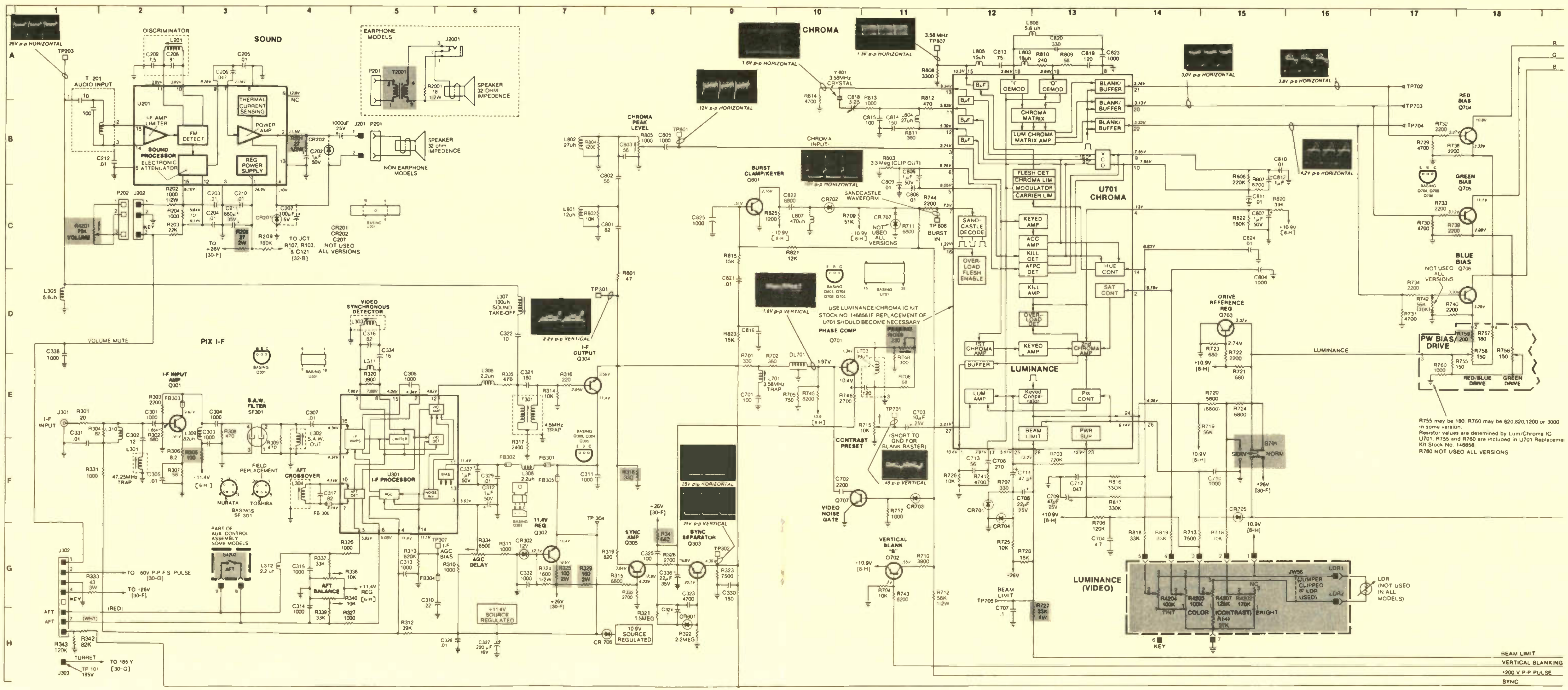

F.S. TUNER SCHEMATIC

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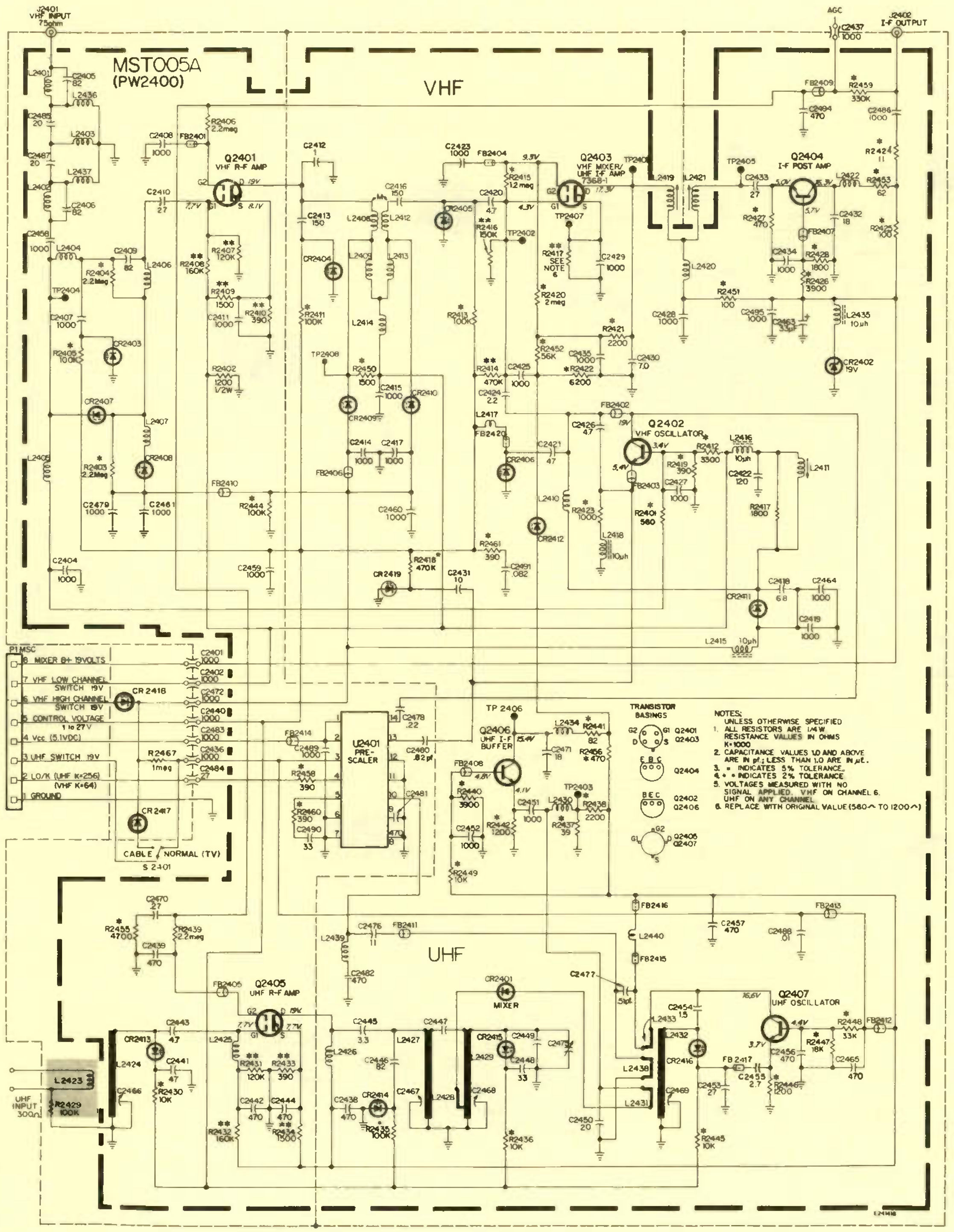

FREQUENCY SYNTHESIS TUNER MODULE

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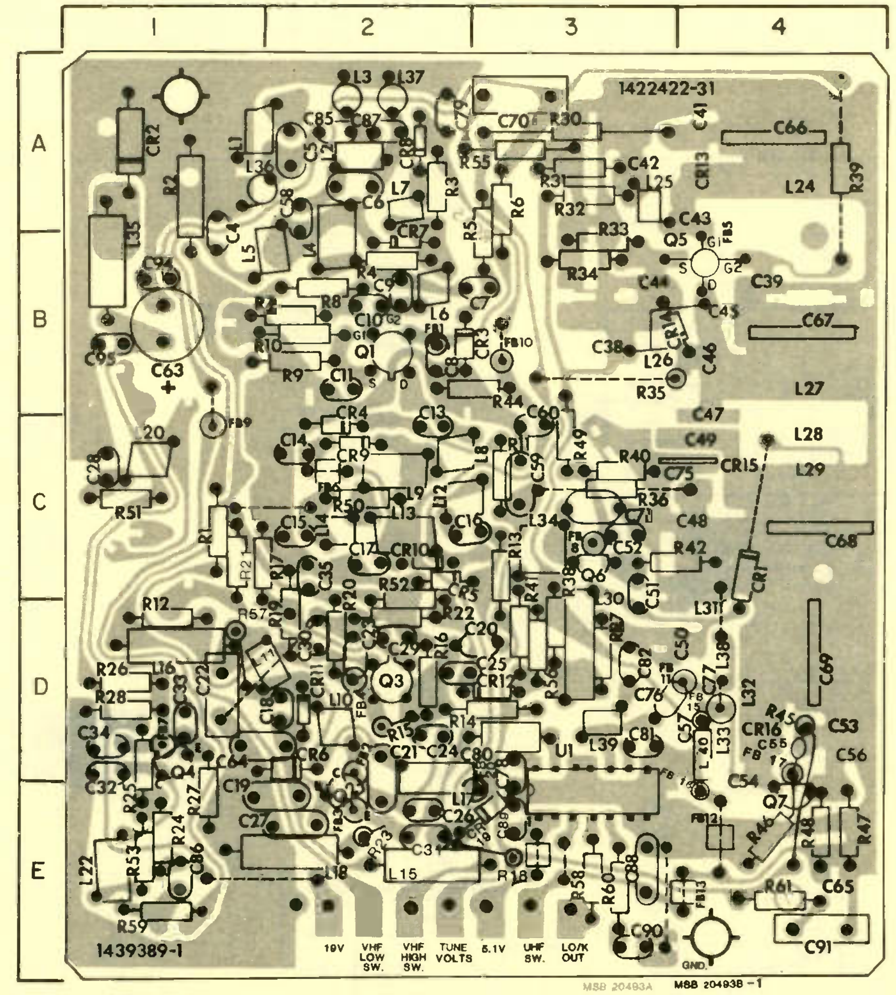

PW 2400—Component Location Guide

C2404 1B	C2426 2E	C2451 3C	C2478 3E	CR2407 2B	FB2411 3D	L2416 1D	Q2401 2B	R2415 2D	R2438 3D
C2405 2A	C2427 2E	C2452 3C	C2479 2A	CR2408 2A	FB2412 4E	L2417 2E	Q2402 2E	R2416 2D	R2439 4A
C2406 2A	C2428 1C	C2453 4D	C2480 3D	CR2409 2C	FB2413 4E	L2418 2E	Q2403 2D	R2417 1C	R2440 3C
C2407 3B	C2429 2D	C2454 4D	C2481 3D	CR2410 2C	FB2414 3E	L2420 1C	Q2404 1D	R2418 3E	R2441 3D
C2408 2B	C2430 2D	C2455 4E	C2482 3D	CR2411 2D	FB2415 4D	L2422 1E	Q2405 3B	R2419 2D	R2442 3C
C2409 2B	C2431 2E	C2456 4D	C2485 2A	CR2412 3D	FB2416 4E	L2424 4A	Q2406 3C	R2420 2D	R2444 3B
C2410 2B	C2432 1D	C2457 4D	C2486 1E	CR2413 4A	FB2417 4E	L2425 3A	Q2407 4E	R2421 1C	R2445 4D
C2411 2B	C2433 1D	C2458 2A	C2487 2A	CR2414 3B	FB2420 3E	L2426 3B		R2422 2D	R2446 4E
C2413 2C	C2434 1D	C2459 3C	C2488 3E	CR2415 4C		L2427 4B	R2401 1C	R2423 2E	R2447 4E
C2414 2C	C2435 2C	C2460 3C	C2489 3E	CR2416 4D	L2401 1A	L2428 4C	R2402 1A	R2424 1E	R2448 4E
C2415 2C	C2438 3B	C2463 1B	C2490 3E	CR2419 3E	L2402 2A	L2429 4C	R2403 2A	R2425 1E	R2449 3C
C2416 2C	C2439 4B	C2464 1D	C2491 4E		L2403 2A	L2430 3D	R2404 2B	R2426 1D	R2450 2C
C2417 2C	C2441 4A	C2465 4E	C2494 1B	FB2401 2B	L2404 2B	L2431 4D	R2405 3A	R2427 1E	R2451 1C
C2418 2D	C2442 3A	C2466 4A	C2495 1B	FB2402 2D	L2405 1B	L2432 4D	R2406 3A	R2428 1D	R2452 2C
C2419 1E	C2443 3A	C2467 4B		FB2403 2E	L2406 2B	L2433 4D	R2407 2B	R2430 3A	R2453 1E
C2420 3D	C2444 3B	C2468 4C	CR2401 4C	FB2404 2D	L2407 2A	L2434 3C	R2408 2B	R2431 3A	R2455 3A
C2421 2D	C2445 4B	C2469 4D	CR2402 1A	FB2405 4A	L2408 2C	L2435 1B	R2409 2B	R2432 3A	R2456 3D
C2422 1D	C2446 4B	C2470 3A	CR2403 2B	FB2406 2C	L2409 2C	L2436 1C	R2410 2B	R2433 3B	R2457 1D
C2423 2D	C2447 4B	C2471 3C	CR2404 2C	FB2407 1D	L2410 2D	L2437 2A	R2411 3C	R2434 3B	R2458 3E
C2424 2D	C2448 4C	C2475 3C	CR2405 2C	FB2408 3C	L2411 1D	L2438 4D	R2412 1D	R2435 3B	R2459 1E
C2425 2D	C2449 4C	C2476 3D	CR2406 2D	FB2409 1C	L2412 2C	L2439 3D	R2413 3C	R2436 3C	R2460 3E
	C2450 3D	C2477 4D		FB2410 3B	L2413 2C	L2440 4E	R2414 3D	R2437 3D	R2461 4E
					L2414 2C				
					L2415 2E				U2401 3D

NOTE: Add 2400 Series Prefix To Item Numbers

CHASSIS SCHEMATIC—DEFLECTION CIRCUIT AND POWER SUPPLY

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3078 PROFAX Manufacturers' schematics

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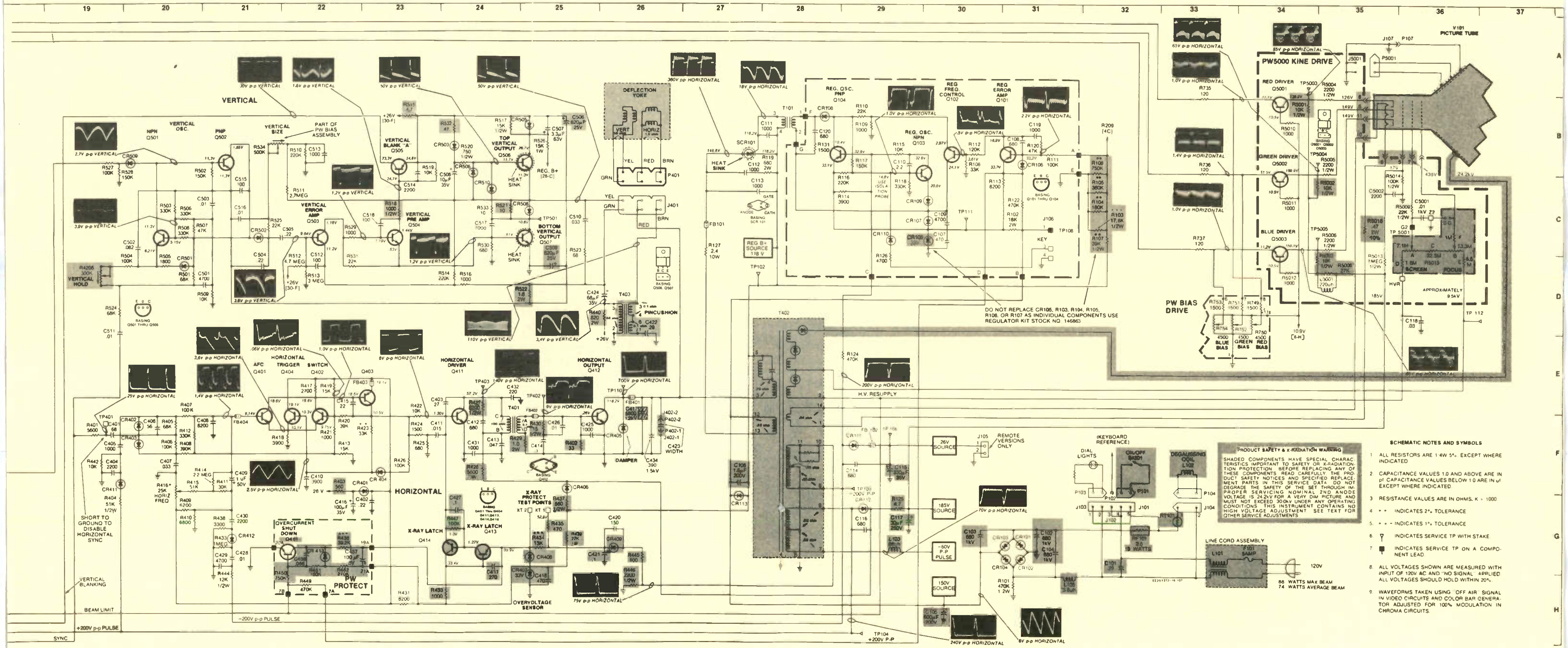

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MAIN CHASSIS CIRCUIT BOARD

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CIRCUIT BOARD ASSEMBLY

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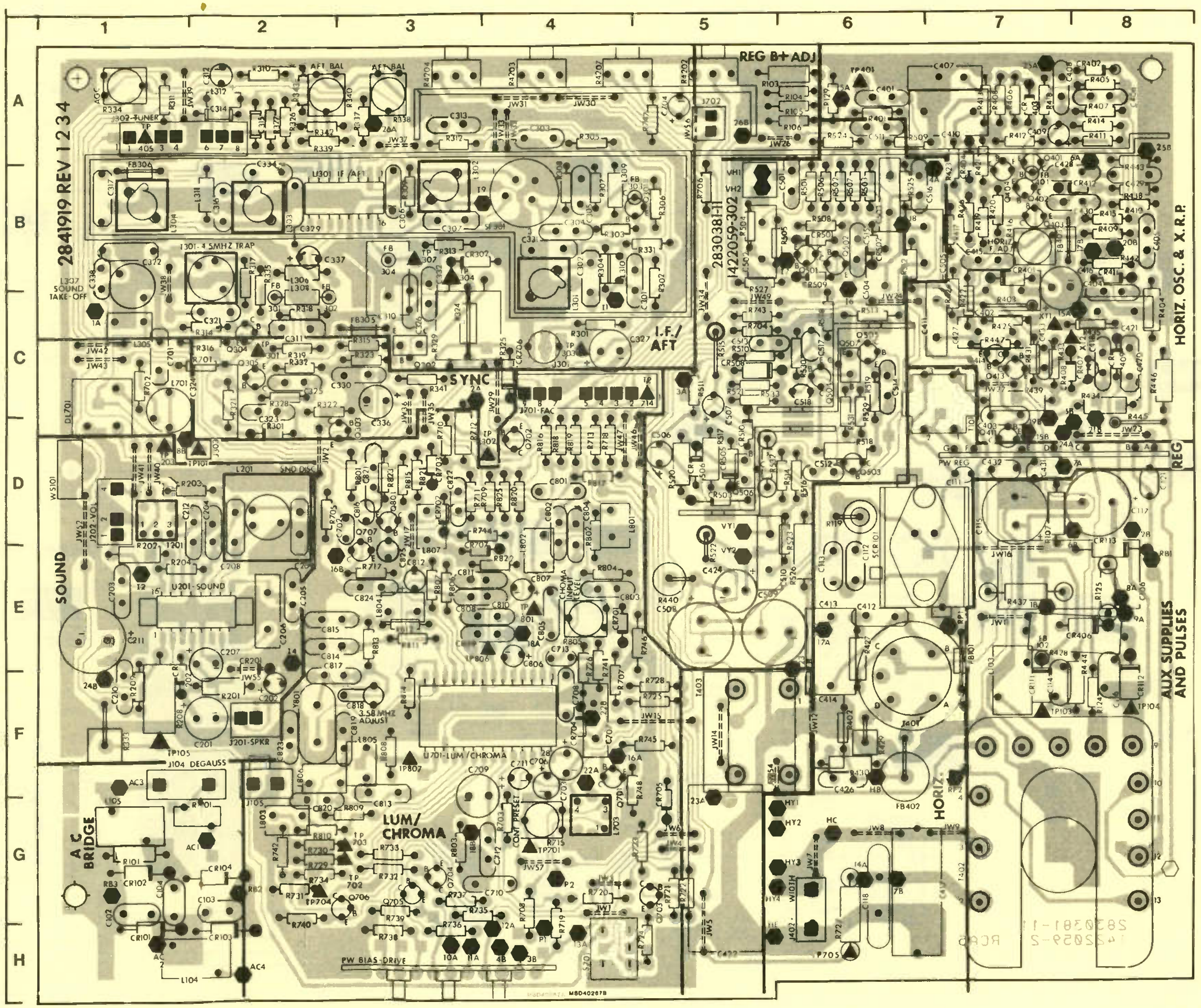
Component Location Guide

C102 ...... 1G	C502 ...... 5B	FB101 ...... 7B	R119 ...... 6D	R435 ...... 8C	R743 ...... 5C
C103 ...... 2G	C503 ...... 6B	FB102 ...... 7E	R124 ...... 8F	R437 ...... 7E	R745 ...... 5F
C104 ...... 1G	C504 ...... 6B	FB301 ...... 2C	R125 ...... 8E	R438 ...... 8B	R756 ...... 5E
C106 ...... 8E	C505 ...... 7B	FB302 ...... 2C	R201 ...... 2F	R439 ...... 7C	R748 ...... 5G
C111 ...... 7D	C506 ...... 5D	FB303 ...... 5B	R202 ...... 1E	R440 ...... 5E	R801 ...... 3D
C112 ...... 6E	C508 ...... 5E	FB304 ...... 3B	R204 ...... 1E	R442 ...... 8B	R802 ...... 4D
C113 ...... 6E	C509 ...... 5E	FB305 ...... 3C	R205 ...... 2F	R443 ...... 8B	R804 ...... 4E
C114 ...... 7F	C510 ...... 6E	FB306 ...... 1A	R207 ...... 1D	R444 ...... 8F	R805 ...... 4E
C115 ...... 7D	C511 ...... 6A	FB401 ...... 6G	R208 ...... 1F	R445 ...... 8D	R806 ...... 3E
C116 ...... 8C	C512 ...... 6D	FB402 ...... 6G	R301 ...... 4C	R446 ...... 8G	R807 ...... 3E
C117 ...... 8D	C513 ...... 5C	FB403 ...... 8B	R302 ...... 5B	R447 ...... 7C	R808 ...... 3F
C118 ...... 6H	C514 ...... 6C		R303 ...... 5B	R501 ...... 6B	R809 ...... 3G
C201 ...... 2E	C515 ...... 6B	J104 ...... 1F	R304 ...... 4B	R502 ...... 6B	R810 ...... 2G
C202 ...... 2F	C516 ...... 7B	J105 ...... 2F	R305 ...... 5A	R503 ...... 6B	R811 ...... 3E
C203 ...... 1E	C517 ...... 6C	J201 ...... 2F	R306 ...... 5B	R504 ...... 5B	R812 ...... 3E
C204 ...... 2D	C701 ...... 1C	J301 ...... 4C	R307 ...... 4B	R505 ...... 6B	R813 ...... 3E
C205 ...... 3E	C702 ...... 3D	J302 ...... 1A	R308 ...... 4B	R506 ...... 6B	R814 ...... 3F
C206 ...... 2E	C703 ...... 4F	J303 ...... 3E	R309 ...... 3B	R507 ...... 6B	R815 ...... 3D
C207 ...... 2E	C705 ...... 4G	J401 ...... 5E	R310 ...... 2A	R508 ...... 6B	R816 ...... 4D
C208 ...... 2D	C706 ...... 4F	J402 ...... 6H	R311 ...... 1A	R509 ...... 6A	R817 ...... 4D
C209 ...... 2D	C707 ...... 4F	J701 ...... 4C	R312 ...... 3A	R510 ...... 5C	R818 ...... 4D
C210 ...... 1F	C708 ...... 4F		R313 ...... 3B	R511 ...... 5C	R819 ...... 4D
C211 ...... 1E	C709 ...... 4F	L103 ...... 7F	R314 ...... 2C	R512 ...... 6B	R820 ...... 4D
C212 ...... 2D	C710 ...... 4G	L104 ...... 1H	R315 ...... 3C	R513 ...... 6C	R821 ...... 3D
C301 ...... 5C	C711 ...... 4F	L105 ...... 1G	R316 ...... 2C	R514 ...... 6D	R823 ...... 3D
C302 ...... 4B	C801 ...... 4D	L201 ...... 2D	R317 ...... 2B	R515 ...... 5C	R825 ...... 4D
C303 ...... 4A	C802 ...... 4D	L301 ...... 4C	R318 ...... 2C	R516 ...... 6D	
C304 ...... 4B	C803 ...... 4E	L302 ...... 3B	R319 ...... 2C	R517 ...... 5D	RT101 ...... 2G
C305 ...... 4B	C805 ...... 4E	L303 ...... 2A	R320 ...... 2B	R518 ...... 6D	
C306 ...... 3B	C806 ...... 4E	L304 ...... 1B	R321 ...... 2C	R519 ...... 6C	
C307 ...... 3B	C807 ...... 4E	L305 ...... 1C	R322 ...... 2C	R520 ...... 5D	S701 ...... 4H
C310 ...... 2C	C808 ...... 4E	L306 ...... 2B	R323 ...... 3C	R521 ...... 5C	
C312 ...... 2A	C809 ...... 4E	L307 ...... 1B	R324 ...... 3C	R522 ...... 5D	
C313 ...... 3A	C810 ...... 4E	L308 ...... 2B	R325 ...... 4C	R523 ...... 6E	SCR101 ...... 6D
C314 ...... 2A	C811 ...... 3E	L309 ...... 4B	R326 ...... 2A	R524 ...... 6A	
C315 ...... 2A	C812 ...... 3E	L310 ...... 4B	R327 ...... 2A	R525 ...... 6B	
C316 ...... 2B	C813 ...... 3F	L311 ...... 2B	R328 ...... 2C	R526 ...... 6E	SF301 ...... 4D
C317 ...... 1B	C814 ...... 3E	L701 ...... 1C	R329 ...... 3C	R527 ...... 5B	
C320 ...... 3B	C815 ...... 3E	L703 ...... 4G	R330 ...... 2A	R528 ...... 6C	T101 ...... 7D
C321 ...... 1B	C816 ...... 3D	L801 ...... 4D	R331 ...... 5B	R529 ...... 6C	T201 ...... 1D
C322 ...... 1B	C817 ...... 3F	L802 ...... 4D	R332 ...... 2C	R530 ...... 6C	T301 ...... 2B
C323 ...... 2C	C818 ...... 3F	L803 ...... 2G	R333 ...... 1A	R531 ...... 6D	T401 ...... 7F
C324 ...... 2C	C819 ...... 2F	L804 ...... 3E	R334 ...... 1F	R532 ...... 5D	T402 ...... 7G
C325 ...... 2C	C820 ...... 2G	L805 ...... 3F	R335 ...... 2B	R533 ...... 6C	T403 ...... 5F
C326 ...... 3C	C821 ...... 3D	L806 ...... 2F	R337 ...... 3A	R701 ...... 2C	
C327 ...... 4C	C822 ...... 3D	L807 ...... 3D	R338 ...... 3A	R702 ...... 1C	
C329 ...... 2B	C823 ...... 2F		R339 ...... 2A	R704 ...... 5C	U201 ...... 2E
C330 ...... 3C	C824 ...... 3E	Q301 ...... 5B	R340 ...... 3A	R705 ...... 2D	U301 ...... 2A
C331 ...... 4B	CF201 ...... 1D	Q302 ...... 3C	R341 ...... 3C	R707 ...... 4F	U701 ...... 3F
C332 ...... 3C	CR101 ...... 1H	Q303 ...... 3D	R401 ...... 6A	R708 ...... 4G	
C334 ...... 2B	CR102 ...... 1G	Q304 ...... 2C	R402 ...... 6F	R709 ...... 4D	Y801 ...... 3F
C336 ...... 3C	CR103 ...... 2G	Q305 ...... 2C	R403 ...... 7C	R710 ...... 3D	
C337 ...... 3C	CR104 ...... 2G	Q401 ...... 7A	R404 ...... 8C	R711 ...... 3D	
C401 ...... 6A	CR111 ...... 7F	Q402 ...... 8B	R405 ...... 8A	R712 ...... 3D	TEST POINTS
C402 ...... 7C	CR112 ...... 8F	Q403 ...... 8B	R406 ...... 7A	R713 ...... 4D	
C403 ...... 7D	CR301 ...... 2D	Q404 ...... 8B	R407 ...... 8A	R714 ...... 4D	
C404 ...... 8C	CR302 ...... 3B	Q411 ...... 7D	R408 ...... 7A	R715 ...... 4G	TP101 ...... 3E
C405 ...... 8B	CR401 ...... 7B	Q413 ...... 7C	R409 ...... 8B	R716 ...... 4G	TP102 ...... 7E
C406 ...... 8A	CR402 ...... 8A	Q414 ...... 7C	R410 ...... 8B	R718 ...... 4D	TP103 ...... 7F
C407 ...... 7A	CR403 ...... 7A	Q501 ...... 6B	R411 ...... 8A	R719 ...... 4G	TP401 ...... 8F
C408 ...... 7A	CR404 ...... 7A	Q502 ...... 6B	R412 ...... 7A	R720 ...... 4G	TP105 ...... 2G
C409 ...... 7A	CR406 ...... 3E	Q503 ...... 6D	R413 ...... 7A	R721 ...... 5G	TP203 ...... 1D
C410 ...... 7A	CR407 ...... 8C	Q504 ...... 6C	R414 ...... 8A	R722 ...... 5G	TP301 ...... 2C
C411 ...... 7C	CR408 ...... 3C	Q505 ...... 6C	R415 ...... 8B	R723 ...... 4G	TP302 ...... 4D
C412 ...... 6E	CR411 ...... 8B	Q506 ...... 5D	R416 ...... 8B	R724 ...... 5H	TP303 ...... 2A
C413 ...... 6E	CR412 ...... 8B	Q507 ...... 6C	R417 ...... 7B	R725 ...... 5F	TP304 ...... 3B
C414 ...... 6F	CR501 ...... 6B	Q701 ...... 4F	R418 ...... 7A	R726 ...... 4E	TP307 ...... 3B
C415 ...... 7B	CR502 ...... 6B	Q702 ...... 4D	R419 ...... 7B	R727 ...... 6H	TP401 ...... 6A
C416 ...... 8B	CR503 ...... 5D	Q703 ...... 5G	R420 ...... 7B	R728 ...... 5F	TP403 ...... 6F
C417 ...... 7H	CR505 ...... 5D	Q704 ...... 3G	R422 ...... 7C	R729 ...... 2G	TP405 ...... 1A
C418 ...... 8C	CR506 ...... 5D	Q705 ...... 3G	R423 ...... 7A	R730 ...... 2G	TP701 ...... 4G
C420 ...... 8C	CR508 ...... 5C	Q706 ...... 3G	R424 ...... 7C	R731 ...... 2G	TP702 ...... 3G
C421 ...... 8C	CR509 ...... 6B	Q707 ...... 3E	R425 ...... 7C	R732 ...... 3G	TP703 ...... 3G
C422 ...... 5G	CR510 ...... 5D	Q801 ...... 3E	R426 ...... 7B	R733 ...... 3G	TP704 ...... 3G
C424 ...... 5E	CR701 ...... 4E		R427 ...... 6E	R734 ...... 2G	TP705 ...... 6H
C426 ...... 6G	CR702 ...... 3D	R101 ...... 1G	R428 ...... 7E	R735 ...... 3H	TP714 ...... 5C
C427 ...... 7C	CR703 ...... 3D	R103 ...... 6A	R429 ...... 6F	R736 ...... 3H	TP806 ...... 3E
C428 ...... 8B	CR704 ...... 4F	R104 ...... 6A	R430 ...... 6E	R737 ...... 3G	TP807 ...... 3F
C429 ...... 8B	CR706 ...... 4C	R105 ...... 6A	R431 ...... 7C	R738 ...... 3H	
C430 ...... 8B		R106 ...... 6A	R433 ...... 7C	R739 ...... 3H	XT1 ...... 7C
C501 ...... 6B	DL701 ...... 1C	R107 ...... 7D	R434 ...... 8C	R730 ...... 2H	XT2 ...... 7C



Audio Corner

(from page 26)

Some crossovers are more complex, with LC filters for each leg. If there are two speakers it is called a two-way system and three speakers, a three-way, etc. The tricky design part is to match the frequency range of the crossover network to that of the speakers and make the impedance constant to the amplifier.

Crossover networks are something of a compromise because they are limited in their ability to keep the lows and highs from mixing. It is hard to get precise filter frequencies. The amplifier is driving a passive network, not the voice coils directly, so damping factors are reduced.

A more advanced solution is called biamping. This means placing the filters before the amplifiers and using an amp for each speaker. Figure 2 shows how. This could just as easily be a three way system, or triamp, by adding another filter and amplifier.

The advantages of the biamp setup are that the speakers see the output of the amplifiers directly and cannot possibly affect each other. The filters can be precise op-amp filters, since the power amps come afterward. These filters can be more precise and they can be made adjustable for fine-tuning.

The disadvantages of this arrangement are primarily cost and complexity. Most passive speaker systems are accurate enough to suit even fussy consumers. The biamp and triamp schemes are generally found only in high-end audio systems where price is less of a concern. The other application is in professional sound systems, like those used by bands, where multiple amps are needed anyway to generate enough power. Splitting the frequencies is a bonus.

It is possible that you'll also run into a biamp system in a TV or stereo. The falling cost of electronic filters and amplifiers makes this a sensible idea. ■

Diagnosing video head problems

By Victor Meeldijk

In this article we look at video heads: failure symptoms, checking them, cleaning and replacement. We will show you photographs of the degraded and snowy pictures that worn or failed video heads cause.

Symcure 5 of the September 1986 issue of **ES&T**, tells servicers that for some models of RCA and Panasonic VCR's "Replace the upper cylinder with its video heads if the picture is snowy without color, or color noise is intermittent and cleaning the video heads does not improve performance."

Before replacement of the upper cylinder and the video heads however, remember that while the video heads may be one of the first things suspected when the playback picture is bad, a problem in anything from the video heads to the output of the head switcher may be the actual cause of the problem. Before the heads are replaced the other sections of the circuitry should be checked to verify their operation.

Symptoms related to video head, or other circuitry problems, include:

- Snow bar or sometimes clear/sometimes snowy picture
- Noisy Picture or Lack of Video
- Flickering of color in playback
- Hi-fi sound problem on playback, normal audio ok
- Hi-fi Audio sounds raspy.

If you encounter any of these symptoms when servicing a VCR, take the steps outlined here to check out and resolve the problem.

Snow bar or sometimes clear/ sometimes snowy picture

Check the tracking control settings, the capstan phase (to determine whether or not the video heads are tracing the incorrect-azimuth track or guard band), the video heads, and tape back tension (especially if there are a lot of dropouts in the picture).

If the tracking control is grossly misadjusted, one head may mistrack enough so a small clear picture will appear at the bottom of the screen in the SLP mode. In general, however, if the top portion of the picture is clear when the VCR is in SP mode, or the bottom portion of the picture is clear when the VCR is in SLP mode, the heads are not the problem and the video head relay should be checked.

This relay shorts out the heads that are not being used to generate a video signal in a particular mode. If the unused heads (for a particular mode) are not shorted out, they will also generate a signal and distort the picture.

In SP mode the SP heads read the video tape first and then the EP heads contact the tape. If the EP heads are not shorted out, the bottom portion of the picture is distorted. Similarly, in SLP mode the SP heads contact the tape before the EP heads, and in this case if they are not shorted, the top part of the picture is affected.

Noisy Picture or Lack of Video

When the symptom is a noisy picture, or lack of video, check the following circuit areas:

- Video heads (if the symptom occurs at all speeds. If the symptom only occurs at one speed, or if a portion of the picture is clear, check the head switching circuits and preamplifier).
- Video head preamplifiers
- Playback/record switching transistor
- RF modulator
- Luminance (B/W picture) circuits
- Rotary transformer
- Power supply
- Chrominance (color) circuits
- 3.58MHz oscillator
- 4.2MHz conversion circuit
- 30Hz and 15Hz reference signals
- 629 (688 for Beta) KHz color subcarrier

On older VCRs with fine tuning channel controls, if the problem is not observed on all channels, the first thing that should be checked is the thumbwheel setting. The thumbwheel may be improperly set or may be intermittent due to dust and dirt. Luminance problems, or poor definition picture (lacking sharpness) may be related to the video preamp circuit or the noise canceler circuit.

Noise or Snow may indicate problems in the tracking control circuit or dirty heads. If the snow is coarse grained check for dirty heads. Dirty heads account for about half of the noise or snow associated with VCR problems.

A herringbone pattern on the screen when playing a known good tape may be the result of a carrier leak. Check the FM demodulators and limiters. If the problem does not occur when a B/W picture is playing (turn TV color controls off) check color/luminance circuits for leakage.

A narrow band of noise at the bottom of the picture indicates that the heads are switched too soon. Check the 30Hz control- track logic pulses and 30Hz reference signal.

Flickering of color in playback

When you observe these symptoms, check these areas:

- Automatic color control circuit
- Video heads (especially if a B/W picture problem also)
- Video head preamplifier balance

Hi-fi sound problem on playback, linear audio ok

When the problem is hi-fi sound

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problems on playback but the linear audio is ok, check the following:

- Hi-fi audio heads (on cylinder)
- Rotary transformer
- Audio preamplifiers
- Audio head switching relay

Hi-fi audio sounds raspy

When the hi-fi audio sounds raspy, check the following:

- Head switching relay and circuitry
- Audio dropout detection circuitry

Like the video heads the audio heads in a hi-fi VHS machine are located on the cylinder and are switched at a 30Hz rate. The audio heads are 120 degrees from the adjacent video head and have an azimuth angle of +30 degrees. Audio head switching is delayed slightly from the video head switching by an audio phase shifter circuit. Incorrect audio head shifting results in loss of, or noisy, hi-fi audio.

In operation, the audio signals are recorded first, with the video signals recorded over them. The different head gaps enable this depth multiplexing where the audio signals are recorded deep into the tape, with the video signals only recorded to a shallow depth. The audio heads reject video data because of their +30 degree azimuth. Further video signal rejection is done by bandpass filtering of the audio head signals.

In Beta machines the FM luminance frequency is moved up a small amount so that the sidebands of audio converted to FM signals will not overlap with the sidebands of the FM luminance and downconverted chroma. Therefore, different head azimuths are not needed to keep the audio converted FM signals separate from the video FM. Beta machines use the video heads to also record hi-fi audio using 4 different audio to FM frequencies. Filters switch in during playback to prevent audio tracks from interfering with the video information.

Checking the video heads

There are various ways of checking the video heads but each one has its merits and drawbacks. Test devices and procedures that are useful in checking video heads are:

- Microscope
- Signal substitution
- Inductance head checker
- Mechanical head protrusion gauges

Figure 1. Picture in SLP (6 hour) playback mode

Estimation of head wear from hours of usage

A microscope or magnifier can be used to detect a broken head, or a clogged one, but it is very difficult to use a microscope to judge head wear, and remaining head life.

Signal substitution will confirm whether the head, or preamplifier or other circuitry is the problem, but it cannot judge head wear. (It is hard to signal trace the video head, as signals from the head are on the order of 500μV; below the measuring capabilities of most oscilloscopes). A voltmeter can't be used either, because the frequencies being measured are around 4MHz and meters usually have upper frequency limits of 20KHz to 100KHz. An ohmmeter check, however, can be done, be-

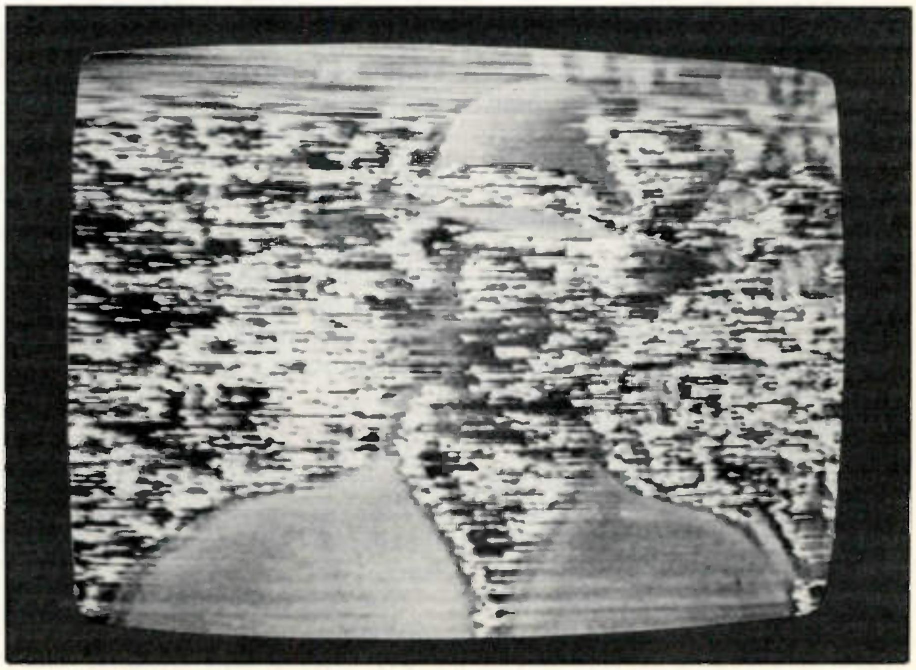

Figure 2. Picture in SP (2 hour) playback mode

cause head resistance is usually 1Ω to 3Ω. Signal substitution can help decide whether the problem is electrical (are the heads not switching properly) or the tape path alignment is off (are the heads mistracking).

An inductance head checker will determine if a head is bad or if the head pairs do not match in inductance.

Inductance change is some measure of head life as the inductance will decrease as material is worn away. These meters measure the inductance of a video head using a bridge type circuit, with a 1MHz test signal. There are usually different instruments for VHS and Beta/U-Matic machines. The inductance ranges for each VCR model that you may have to measure are: from 0.2μH to 1.5μH for VHS heads; 0.8μH to 2.2μH for Beta/U-Matic VCR's.

While a zero reference point is provided on each scale, below which a head is usually considered to be worn (0.9, 1.4. and 0.85 for VHS machines and 1.5, 1.2 and 0.95 for Beta/U-Matic), the inductance is usually checked against manufacturer specifications (although this parameter usually does not appear in service manuals) or readings contained in a booklet that comes with the meter.

Mechanical head protrusion gauges, depending on accessories or types purchased, provide an excellent assessment of head life but don't check actual head condition. Some head protrusion gauges, such as the one sold by the Tentel Corporation, El Dorado Hills, CA, are also used to measure head eccentricity, or "off-centeredness" of the video head drum.

While VHS heads are usually self centering, U-Matic and early Beta heads need to have the drum centered during replacement.

Remaining head life can also be estimated based upon the history of the VCR use. If only name brand or high quality tapes are used (even rental tapes if the original tapes supplied are name brand tapes), head life is about 3000 hours.

Therefore if a VCR is 2 years old and used an average of 10 hours a week, we have 1040 hours of use. The VCR has about 4 years of head life left at the same usage rate. (Constant use of low quality no name tapes can reduce the 3000 hour life to as little as 1000 hours).

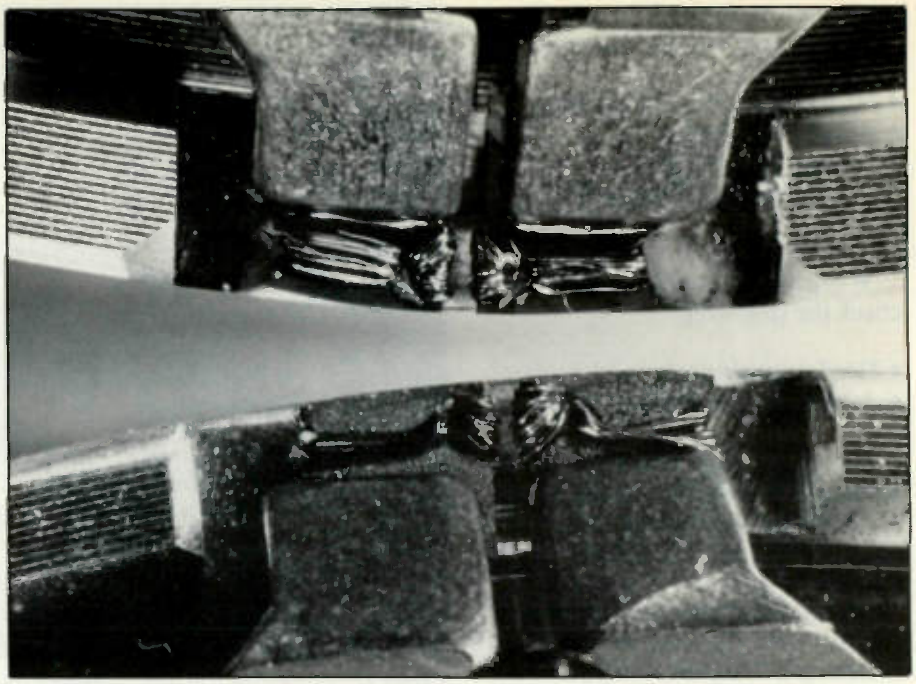

Figure 3. The upper part of the photo shows what new video heads look like. The lower part of the photo shows worn heads. There is not a great deal of apparent difference, but the new heads protrude past the curved surface of the head drum.

VCR head failure symptoms

The head failure symptoms in a Panasonic model PV-1560 included noise streaks in the picture in SLP mode. The noise was worse in LP mode and in SP mode the problem looked like the video head amplifier was causing the picture to be overloaded and white out.

Figures 1 and 2 show the pictures that were observed. Recordings made on this VCR, however, did not exhibit such drastic picture problems when played back on a known good VCR. Figure 3 compares the worn video heads with a new video head. Note that this is not a single video head but the SP and LP/SLP heads side by side (as verified by the number of electrical connections going to the assembly).

If a connection to one of the video heads had opened, or one of the fine wires in the video head opened, the snowy picture shown in Figure 4 would be seen.

VCR cleaning methods

The first step in determining the cause of VCR video head problems is to clean the video heads to determine if a clogged head is causing the problem.

There are a few distinct cleaning methods:

- Dry cassette tape cleaners. This method uses an unpolished or partially polished recording tape, and may employ a wiping action.
- Wet cassette type cleaners. This cleaner uses a soft synthetic or chamois cleaning ribbon in a cassette housing which is moistened by a cleaning solution.
- Chemical cleaning aerosol sprays.
- Lint free swabs (chamois swabs) and a cleaning solution.

The pinch rollers, heads and other parts of the tape transport mechanism are individually cleaned using a moistened swab. I recommend only the last method for professional VCR cleaning, as this is the only way to thoroughly clean the entire VCR mechanism.

The use of unpolished tape is an abrasive approach and leads to additional head wear. (This head wear is small however, only about 0.25 millionths of an inch are removed during a 30 second cleaning interval which equates to about 6 to 10 minutes of average head wear).

The wet cleaning cassette may leave fibers on the video heads from the cleaning ribbon, and Freon aerosol sprays, if sprayed directly on the heads, may create a rapid temperature change of the head resulting in head damage from the different temperature characteristics of the epoxy, ferrite, brass and copper materials used in the head. Epoxy failure will

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allow the ferrite to crack or the head gap to open, either of which results in a head failure.

VCR cleaning procedure

Maintenance and Cleaning of VCR's was discussed in my article in the May 1987 issue of this magazine. A summary of the steps to follow is as follows:

1. Make sure the machine is turned off, without a cassette. Unplug the unit from ac power.
2. Remove the tape cover of the machine to gain access to the tape transport mechanism.
3. Moisten a chamois cleaning swab with a cleaning solution: methyl alcohol (this does the best job but can be a health hazard), isopropyl alcohol, Freon TF or trichlorotrifluorethane and alcohol.
4. Clean the rest of the tape path. Be sure to clean the audio/servo head, erase head, tape guides, pinch roller, capstan shaft assembly, and the index head (if there is one).
5. Stubborn contaminants adhering to the capstan shaft can be carefully scraped off with a hobby knife or razor blade. Be very careful not to scratch the capstan shaft.

Some don'ts

Don't use a cotton swab, it may leave lint particles. Foam swabs may be used, but only with great care. They can snag on the video head and possibly damage it. Don't apply vertical cleaning strokes, as motion in other than that of normal tape path motion can damage the very fragile heads.

Don't use acetone or MEK (Methyl Ethyl Ketone) or other strong solvents, they may dissolve the varnish insulation from the head magnet wire coils.

Don't spray Freon aerosol directly on the video heads, because this can create a rapid temperature change of the head assembly which can result in head damage.

Video head replacement

If the video heads have been identified as the problem, the replacement of the video head is accomplished by the following procedure. These are general procedures; the actual service manual recommendations should be followed.

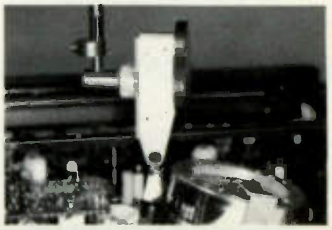
Because the video heads are extremely fragile and need to be properly installed and aligned in the upper drum assembly, they are not replaced individually. Replacement of the video heads is performed by installing a new upper drum assembly.

To accomplish this, the screws, washers and brush assembly are first removed. Then the connections to the wires on the top of the upper drum assembly are unsoldered.

The screws (and commutator plate if used) on top of the upper drum are then removed and the upper drum is gently pulled up and removed from the VCR.

When installing a new upper cylinder with the heads, clean the new unit before installation so any dirt or solder flux which may remain from manufacturing will not interfere with the lower cylinder and upper cylinder (head) spacing and therefore head alignment/tracking.

When fitting the new upper drum, avoid touching the video heads and take care not to scratch the drum. Be sure to run the correct wires through



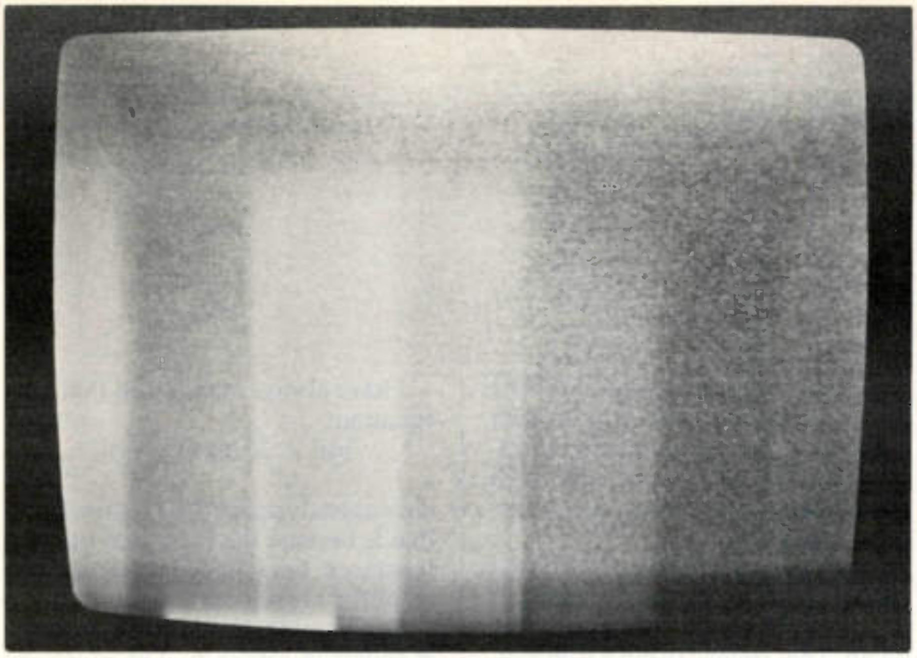


Figure 4. The snowy picture you would see if only one head is failed

the holes (or align the circuit pins properly) which need to be soldered in place (there may be numbers or a color coding which will enable you to properly position the new upper cylinder assembly on the cylinder assembly).

Make sure that the brush assembly contact is on the central portion of the commutator (or within manufacturer recommended tolerances). After head installation, check the head drum eccentricity (the centering of the upper drum on the lower drum assembly). This check serves to eliminate picture jitter/distortion, and audio wow and flutter problems in VHS hi-fi units. It is also critical for Beta and U-Matic machines. Loosen the screws (and commutator plate, if used) on top of the upper drum to adjust drum centering.

After this adjustment is made, verify that the tape moves evenly and smoothly over the drum/heads and adjust any guides, or rollers, to eliminate any tape creases or curls. Note, various electrical checks and alignments are required for PAL and SECAM machines and the individual VCR service manual should be consulted. ■

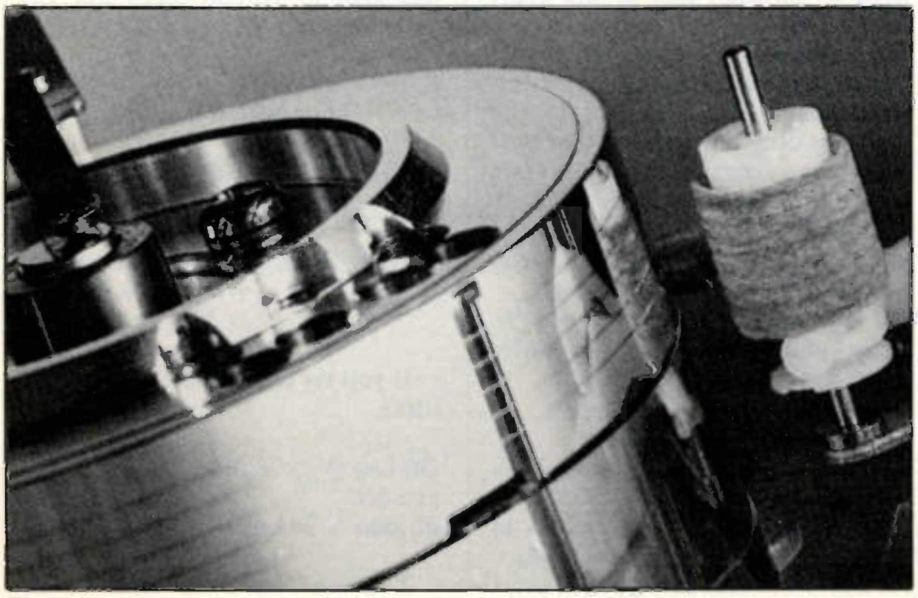


Figure 5. In some newer VCR's there is a roller that automatically cleans the heads just before a tape is played.

Mail cycles

By Sam Wilson

One of the interesting things about writing this column is that the type of mail runs in cycles.

Not very long ago I got a barrage of mail pointing out errors I made mostly in "Test Your Electronics Knowledge" (hereafter referred to as TYEK.

Most of those letters were on a professional level. By that I mean they didn't contain insults and/or bad language. [It has nothing to do with whether or not they were typed or had misspelled words.]

I always answer every one of those letters - sometimes very late - and give credit in my columns to the letter writer when there was an important point to be called to the attention of the reader.

Now I am getting another mail cycle. I am getting very insulting letters from a few readers who are anything but professional. They accuse me of not being capable of changing my mind, not knowing the first thing about what I am saying, attacks on my personality and even on my noble heritage.

Norma opens my mail and delivers that unprofessional garbage directly to the wastebasket where it belongs. Recently, however, Norma allowed two such letters to get to my desk. That happened after I forgot Valentines Day and Secretaries Week.

I wouldn't dignify either of those letters by printing them in a professional magazine, but you may find the technical aspects interesting.

One of the two readers took exception to my definition of a word. I used the definition from the Webster's New 20th Century Dictionary of the English Language (Unabridged). He insisted that the only true definition of the word was the specialized jargon used in one branch of electronics.

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After an initial exchange in which I gave my reason for using the broader meaning of the term, I got piles of unprofessional mail from him with photocopies, quotations, and tersely-written globs.

This went on and on and on until I finally had to promise Norma I would never forget Valentine's Day again. That seemed to put a stop to it.

In the other letter the reader found fault with this bonus question in TYEK: "Who was the first person to send a radio message in the United States?" A. Hertz; B. Marconi; C. Bell; D. Edison. Answer: Edison.

By coincidence, an article in another magazine mentioned that Tesla won a court case proving that he had transmitted communications in 1893; two years before Marconi.

The fact is that Marconi had to pay Edison for rights as outlined in one of Edison's patents. Edison's experiments were conducted in *1895* - eight years before Tesla's claim!

Neither Edison nor his heirs could make any claims - having sold the rights to Marconi - so, there was no need to mention him in the court case.

The letter I got from the reader could have said something professional like: "Your answer to the question does not appear to be correct when a court case between Tesla and Marconi is considered."

Instead, the writer written accused me of not being interested in facts, and heaped other insults on me.

I can tell you this for sure: I'm never going to forget Secretaries Week again either!

Useless equation

I have been corresponding with Michael A. Roberge of Milton, Vermont regarding some questions in Test Your Electronics Knowledge. As a result of that correspondence, I want to pass on some information about amplifier dB gain.

I have always maintained that the equation:

$$[\text{dB} = 20 \log (V_2/V_1)]$$

is completely uselss. The reason I say that is because the input and output resistance (and impedances) of an amplifier are seldom equal.

For example, consider the amplifier shown in Figure A. The equation for *voltage gain* is simply the output signal voltage divided by the input signal voltage. For the circuit shown the signal voltage gain is 1.0. (I picked easy values to work with so we don't get sidetracked with a lot of decimal values.)

The signal voltage gain doesn't tell the complete story. The input and output *resistance values* are not equal, and the amplifier has to deliver more current to R_L than flows through R_{in} in order to get the voltage gain of 1. In other words, there has to be a current gain and a power gain in order to get equal input and output signal voltages.

The example in Figure A shows why dB gain is more useful than voltage gain or current gain. For the values given:

$$\text{INPUT POWER} = (V_{in})^2/R_{in} = (2)^2/200 = 0.02\text{W}$$

$$\text{OUTPUT POWER} = (V_{out})^2/R_{out} = (2)^2/100 = 0.04\text{W}$$

$$\text{THEN: dB gain} = 10 \text{ Log} (P_{out}/P_{in}) = 10 \text{ Log} (0.04/0.02) = 3^+$$

If you try to calculate the dB gain using

$$[20 \text{ Log} (V_{out}/V_{in})]$$

you get

$$\text{db gain} = 20 \text{ Log} (V_2/V_{in}) = 20 \text{ Log } 1 = 0\,[?]$$

You can't have one value of dB gain when you use power values and another value of dB gain when you

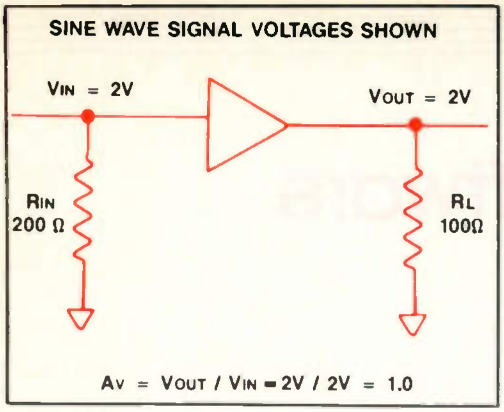


Figure A.

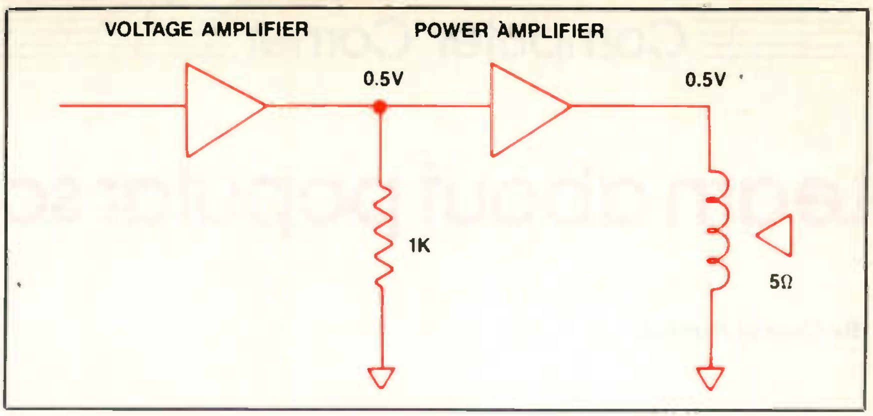


Figure B.

use voltage values. That would *really* create a mess.

The reason you get different values for dB gain in this example problem is that *the equation for dB using voltages is wrong, wrong, WRONG!!* The correct equation is:

$$dB = 20 \text{ Log } (V_2/V_1) + 10 \text{ Log } (R_{in}/R_{out})$$

When you poke the values in Figure A into this equation you get:

$$dB = 20 \text{ Log } (2/2) + 10 \text{ Log } (200/100) = 3+$$

Note that the dB gain is now exactly the same value as for the dB gain based upon power.

You could *call* the db gain of Equation 2 the "dB voltage gain" and disregard the dissimilar input and output resistance values. If you did that, you would be obliged to explain what use the value would be. You might as well go with the simple equation for voltage gain. Actually, that value would be more useful.

For example, a voltage gain of 4.5 tells you the output signal voltage is four and a half times the input signal voltage.

How many people could tell you - without reaching for a calculator - that a "dB voltage gain" of 13 means the output signal voltage is four and a half times the input signal voltage?

Here is the kind of convoluted reasoning that occurs when the input and output resistances are ignored. Consider the block diagram of Figure B. Using the useless voltage-only calculation for the power amplifier:

$$dB = 20 \text{ Log } (V_{out}/V_{in}) = 20 \text{ Log } (6/6) = 0 \text{ [?]}$$

Someone might reason that since there is no gain you can eliminate the power amplifier. Just connect the voltage amplifier directly to the speaker.

However, the real dB gain for the power amplifier in Figure B is:

$$dB = 20 \text{ Log } V_2/V_1 + 10 \text{ Log } R_1/R_2 = (20 \text{ Log } 1) + (10 \text{ Log } 200) = 23+$$

You can get this same value by using the power equation. The input power (P_1) is -

$$P_1 = V_1^2/R_1 = (0.5)^2/5 = 0.05W$$

The output power (P_2 is -

$$P_2 = V_2^2/R_2 = (0.5)^2/1000 = 0.00025W$$

Then, $dB = 10 \text{ Log } (0.05/0.00025) = 23+$

So, why do so many books give the equation $dB = 20 \text{ Log } (V_2/V_1)$ for calculating dB gain?

Well, that equation is O.K. for amplifiers in transmission lines where the input and output impedances are the same. Of course, that is an isolated case. A more important reason is that everybody does it.

Class C bipolar transistor amplifiers

I've had so many letters on this subject I can no longer ignore it.

Before reading further, look at the amplifier in Figure C. Determine for yourself which class of amplifier is shown. In the past I always answered Class B because there is zero volts bias on the transistor.

Read on. A Class B amplifier can be defined as being one in which there is an output signal for 50% of a sinewave input cycle. If there is zero volts between the emitter and base, the input signal cannot start conduction in the transistor until the signal

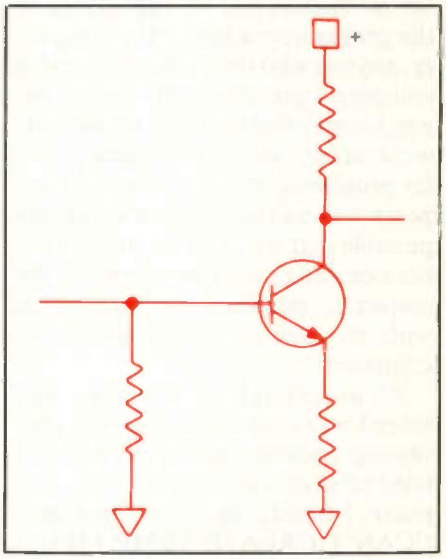


Figure C.

reaches 0.7V. A silicon transistor is assumed.

In other words, when there is zero volts bias on the transistor, the transistor is biased *below* cutoff. Furthermore, there is an output signal for less than one-half cycle.

That means that the transistor in Figure C is biased for Class C operation.

In vacuum tube circuits Class C operation was accomplished by biasing the grid well below cutoff. That meant there was a highly-negative voltage on the grid and only the positive peaks of the input signal could drive the tube into conduction.

It is not a good idea to put a high reverse voltage on the emitter-base PN junction of a bipolar transistor because it can create high reverse leakage currents. So, instead of defining the class of operation by describing the amount of bias - as was sometimes done with tube circuits - it is a better idea to define it in terms of the input and output signals.

Thanks to the reader who wrote about this.

Learn about popular software

By Conrad Persson

Because of the variety of software for computers and its importance in the proper operation of the computer, anyone who truly wants to service computers professionally should expend some effort to learn about software, at least some of the most popular programs. When a computer appears to malfunction, it's entirely possible that the problem might have been caused by an idiosyncrasy of the software, possibly in conjunction with an unusual condition of the computer.

As an example, a few years ago when I was working with a word processing program called XyWrite, I tried to save a document. The computer beeped, an error message, "CAN'T CREATE TEMP FILE," appeared on the command line, and a blank piece of paper spit out of the printer. If I hadn't had at least a passing familiarity with the program, I might have come to the conclusion that some part of the computer was having a problem.

In this case, while the message came as a surprise to me, it occured to me that this might be a disk problem. In fact, I knew that the 20MByte hard disk in this machine was pretty close to full so I exited the word processing program and ran a CHKDSK command.

As I suspected, my hard disk was simply too full. What happens with XyWrite, is that when you print a file that's longer than can be held in the print buffer, the program automatically creates a temporary file on the hard disk. It couldn't do that with a full disk. As an aside, I really shouldn't have had the disk that full, as it was causing a lot of other problems as well: things such as causing the keyboard to lock up from time to time.

Persson is editor of ES&T.

If I had been less familiar, and less comfortable with this particular application program, I might have wasted a considerable amount of time running diagnostics before I realized that in fact there really was no problem; I merely had to clean up the hard disk.

Too much

Learning how various software programs operate may take some time, but time spent learning about the most popular products will probably be rewarding. In addition to giving you some insight into some of the potential problems in the products that you'll be servicing, you might find the programs useful in your own business.

There seems to be a huge number of programs in use, and so it might seem that to try to learn about them would be an exercise in futility. There's certainly some basis for thinking that way, but on the other hand, there's a relative handful of software products that probably accounts for 80 percent of the software used regularly by computer owners. For example, some of the most popular programs are Lotus 123 and similar programs for spreadsheet work; Word Perfect, Word Star, PFS Write and a few others for word processing; DBase III and RBase and a few others for data base work. Knowing something about each of these would be a valuable asset in many cases of computer problems; especially when some combination of a computer condition and an idiosyncrasy of the software is the cause of what appears to be a computer fault.

Learning the software

One good way to learn some of these programs is to take a course at a local school or a community group. For example, popular computer courses are taught at the community college just down the road from this office. And just recently a flyer published about events going on in the city announced that the parks and recreation/community center organization is sponsoring classes in several popular programs, including 123 and DBase.

Another way to learn the software is to simply go out and buy a copy and learn it on your own. This has advantages and disadvantages. The obvious disadvantage is that some of this software costs a lot of money. The other disadvantage is that learning the software entirely on your own can take a lot of time. The advantage, of course, is that you can learn in your own time and in your own way, and when you're through the software belongs to you.

Shareware

Something that can make this approach a little less painful is the existence of programs, both commercially available, and those available in the form of shareware that are very similar to, but less expensive than, the brand name software. There are shareware spreadsheet programs, database programs and word processing programs, to name a few, that are similar to the name brands.

The concept of shareware is that instead of going to a store and buying it, you may download it from a bulletin board, or purchase it through a shareware clearinghouse for about the price of the blank disc and a little for shipping and handling - usually about $3.00 or so. You load it up and work with it for a while. If you like it, you send the software writer the amount of money he's asking for it. If it doesn't suit you, you can recycle the disk.

Don't confuse this with public domain software, for which there is no copyright. Shareware is in fact copyrighted by the originator, and if you try it and like it, and begin to use it regularly you have an obligation to pay for it. It is merely the concept of distribution that is a little unusual.

Many of these programs are considerably less expensive than the brand name software, and in some cases may not posses the full capability of the brand name products, but they are adequate for many uses, and if the idea is simply to learn the principles of operation of the type of program, they're more than adequate.

Perhaps the easiest way to find a listing of some of these shareware programs is to simply pick up a copy of one of the popular computer magazines off the newsstands and flip through it until you find an ad listing shareware programs, find the program or programs that look interesting and order them. If it turns out they're of no use to you, you're only out a few bucks, and at least you have a disk you can reformat and reuse.

The computer/software synergy

Servicing personal computers is different from servicing just about any other consumer electronic product. The computer is really only a "computer" when the software is loaded and operating. Software problems may be just as frequent and just as difficult to troubleshoot and correct. Hardware problems may masquerade as software problems and vice versa. The best way to learn to spot which is which and to correct either one is to know as much as possible about both aspects of the computer. Learning as much as you can can about as many types of software as possible is a good way to hone your computer servicing skills.

Test your electronics knowledge

By Sam Wilson

1. Refer to the circuit in Figure 1. What is the output voltage waveform when the input signal is the short-duration pulse shown? ________.

2. In which of the following ways is a Schottky Barrier Diode similar to a point contact diode?

A. Low forward voltage during conduction
B. Low noise (compared to a junction diode)
C. Metal/semiconductor interface
D. All of these choices are correct

3. The series connection in Figure 2 is used to reduce the peak inverse voltage across each diode. The diodes are the same type and have the same current ratings. During the half cycle of input when the diodes are reverse biased the reverse voltages across the diodes are not equal. Give two reasons for this.

4. Find the actual value of R (using a standard value) in the basic Class A amplifier of Figure 3.

5. Using very accurate measurements, the resistance of a power transformer primary is found to be a 3.8Ω, and the resistance of the secondary is found to be 1.4Ω. Can you determine the transformer turns ratio?

Turns ratio = ________.

6. Find the value of R_2 in the circuit of Figure 4.

7. The time constant of the RC circuit in Figure 5 is made to equal ten times the period of one half cycle of the lowest frequency being amplified. The lowest frequency is known to be 100Hz. What value of capacitance will you have to buy for C?

Wilson is the electronics theory consultant for ES&T.

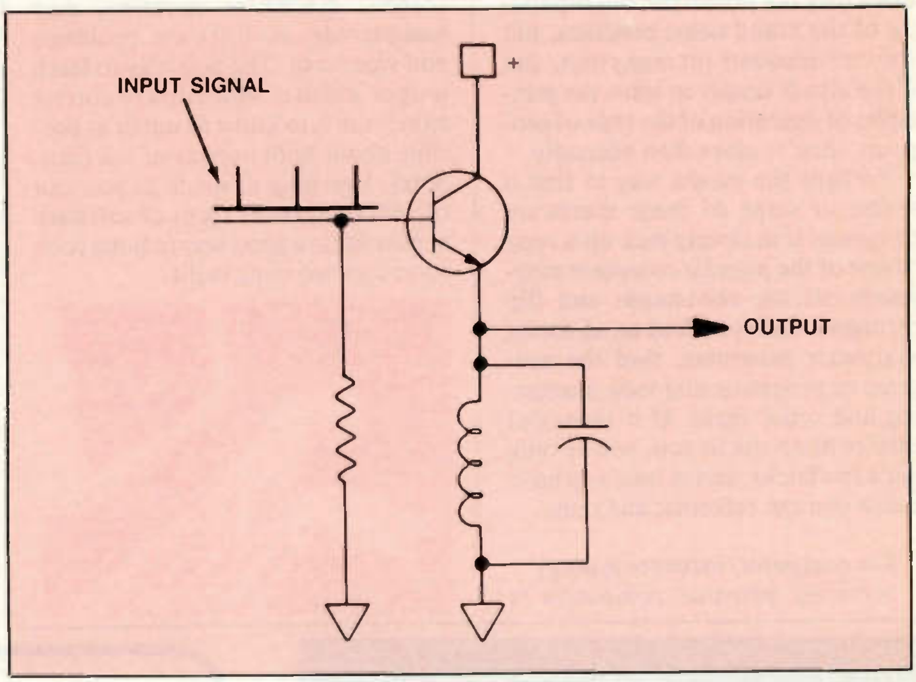


Figure 1.

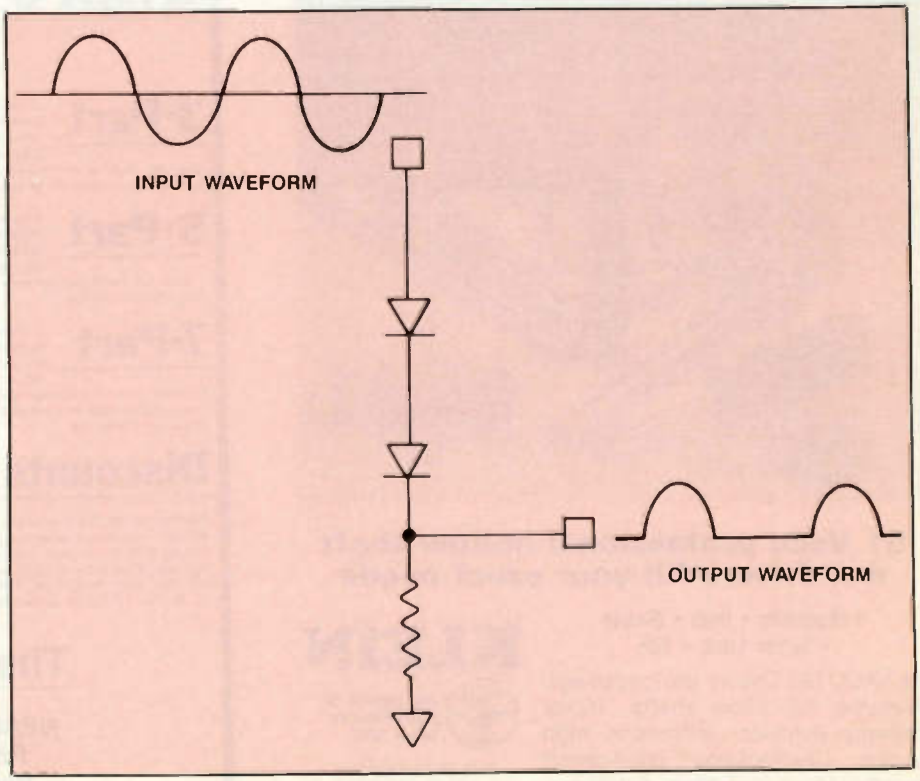


Figure 2.

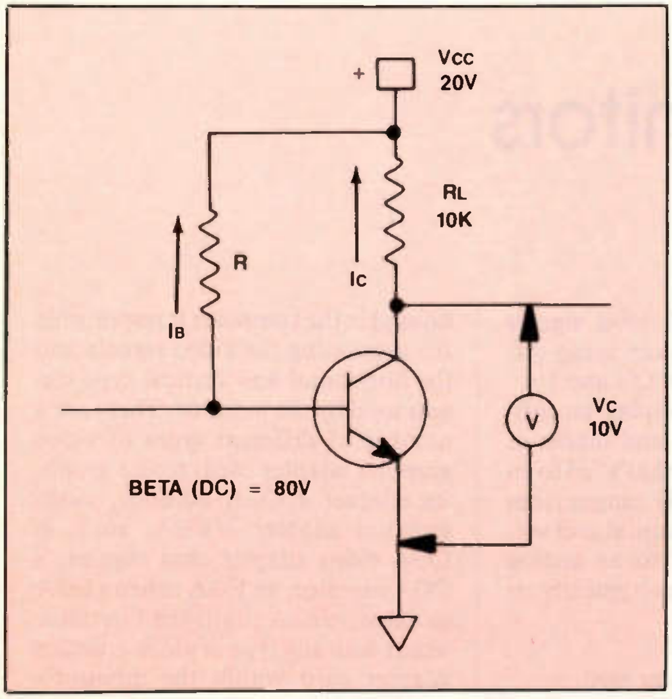


Figure 3.

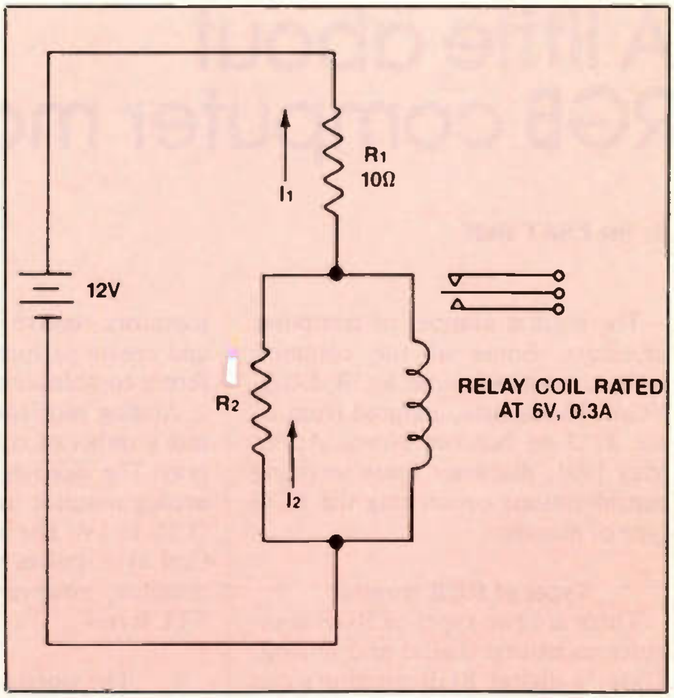


Figure 4.

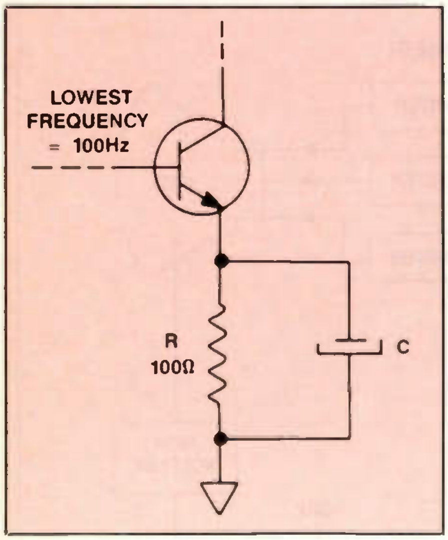


Figure 5.

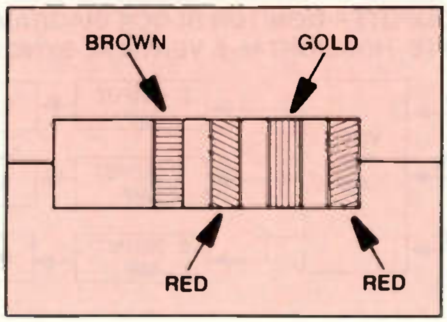


Figure 6.

8. What is the biggest value the resistor in Figure 6 can have and still be in tolerance?

9. Meaningless and unwanted information stored in a computer memory is called hash. It is also known as __________.

10. Here are the numbers of three popular integrated circuits. Place the name (or purpose) of the IC beside its number. You have to get all three right to get credit for this question. EXAMPLE: 565 - Phase Locked Loop

(1) 317 - __________
(2) 741 - __________
(3) 555 - __________

Bonus Question (+ 10 points) - The professor said, "There can never be an ac motor because it would reverse directions each half cycle." A young man in that class takes it as a personal challenge. Soon he knows how to do it! His name is __________.
(Hint: At one time he worked for Thomas Edison.)

(Answers on page 59)

A little about RGB computer monitors

By the ES&T staff

There are a number of computer monitors. Some of the common types are monochrome, RGB, EGA, VGA. This article, adapted from issue #153 of Sencore News, April/May 1991, discusses some servicing considerations concerning the RGB type of monitor.

Types of RGB monitor

There are two types of RGB computer monitors: digital and analog. Today's digital RGB monitors can display eight, 16 or 64 colors. These monitors receive TTL level signals and create various colors using different combinations of O's and 1's.

Analog monitors display an infinite number of colors and shades of gray. The video signal that's fed to an analog monitor usually ranges from O.7V to 1V. The horizontal and vertical sync pulses sent to an analog monitor, however, are typically at TTL levels.

The video adapter card

The video graphics adapter card housed in the computer is responsible for generating the video signals and the horizontal and vertical sync signals used by the monitor. There are a number of different types of video graphics adapter cards (color graphics adapter a CGA monitor, video graphics adapter - VGA, etc.). A CGA video adapter card requires a CGA monitor, an EGA card an EGA monitor, etc. A multi-scan monitor works with any type of video graphics adapter card within the monitor's range.

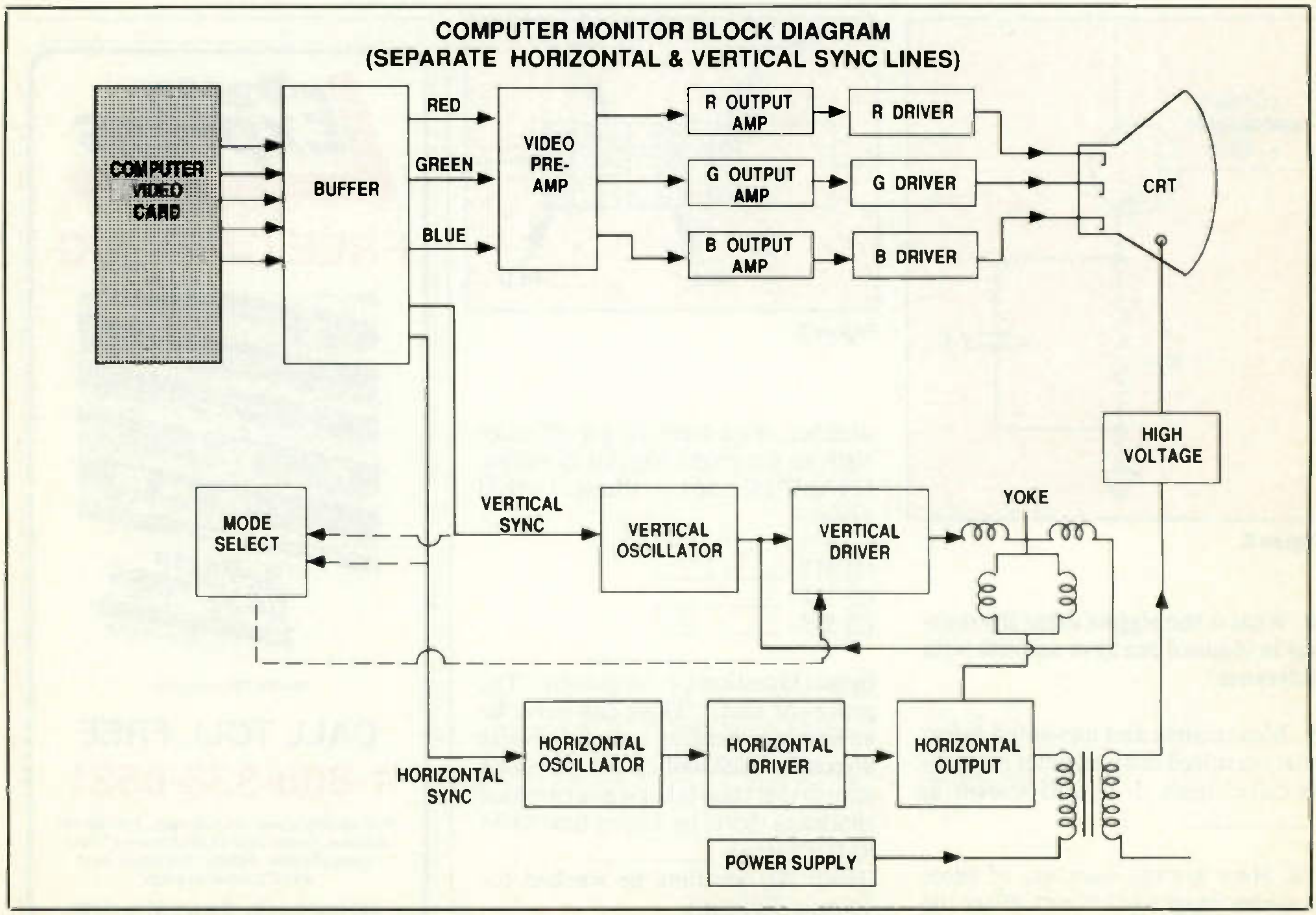


Figure 1. The block diagram of a typical RGB computer monitor would look approximately like this.

MODE	HORIZONTAL RESOLUTION	VERTICAL RESOLUTION (PIXELS)	HORIZ SYNC POLARITY	VERT SYNC POLARITY (LINES)
1. VGA	640	350	(+)	(−)
2. VGA	720	400	(−)	(+)
3. VGA	640	480	(−)	(−)

Figure 2. Specifications for the three VGA modes

Video circuits

The video circuits in a computer monitor are similar to those in the video output stages of a television. They are responsible for amplifying the video signals and setting the correct bias for driving the CRT. Because of the increased scanning frequencies and higher resolutions, the bandwidth of the video amplifiers in a computer monitor is much greater than those in a television. It is not uncommon to see video bandwidths of 50MHz or greater (the maximum bandwidth of an ideal TV, in contrast, is 4.2MHZ). When testing a computer monitor, it's important to make certain that the video amplifiers have a wide enough bandwidth to display individual screen pixels.

Horizontal and vertical sync

The horizontal and vertical sync signals are generally fed to the computer monitor on separate lines from the video graphics card in the computer. The sync lines feed directly into the horizontal and vertical oscillators. Some monitors have a separate horizontal and vertical composite sync line and others, such as the Apple Macintosh monitors have sync placed on the green video line. In the Macintosh monitors, the sync must first be separated from the green video. Then the horizontal and vertical sync are separated from one another and are fed to their respective circuits.

Mode select

Some of the computer monitor standards have a number of different graphics modes. Figure 2 shows the three VGA modes: 1. 640 horizontal pixels by 350 vertical lines, 2. 720 horizontal pixels by 400 vertical lines and 3. 640 horizontal pixels by 480 vertical lines. With everything else being held equal, the height of mode 1 with 350 displayed vertical lines would be less than the height of mode 3 with 480 vertical lines. Therefore, mode 1 wouldn't fill out the raster and the display would be compressed vertically.

To compensate for a compressed display, the mode select circuit signals the vertical driver circuit which graphics mode it's receiving. The vertical driver circuit then adjusts the drive current for a full raster display. For example, if the monitor is being fed graphics mode 1 with only 350 vertical lines, the mode select circuit signals the vertical driver to increase the drive current to increase the height of the picture.

The mode select circuit knows which graphics mode the computer is sending through a special code. If the video graphics card sends a positive horizontal sync pulse and a negative vertical sync pulse, the mode select circuit in the monitor knows that it's receiving a 640 horizontal pixel by 350 vertical line signal. If the video graphics card sends a negative horizontal sync pulse and a positive vertical sync pulse, the mode select circuit puts the monitor in the 720 horizontal pixel by 400 vertical line mode. Both negative pulse puts the monitor in the 640 by 480 mode.

Vertical and horizontal circuits

These circuits are the most similar to those found in televisions. The only difference is that they operate at non-NTSC scan rates. Vertical deflection, horizontal deflection and the high voltage are developed in much the same way as TV. You can employ the same kinds of troubleshooting techniques for computer monitor troubleshooting as you use troubleshooting TV circuits. ■

Design and Build Electronic Power Supplies, By Irving M. Gottlieb; TAB Books; 176 pages, 98 illus; $17.95 paper, $26.96 hard.

Power supply technology has come a long way in the last few years, largely as a result of new techniques that allow higher switching rates with no significant loss in performance.

Engineers, technicians and hobbyists need a complete and detailed overview such as this to bring them up to date on today's most advanced power supply circuits, components, and measurement procedures - one that emphasizes practical, real-world applications over mathematical theory.

Gottlieb includes full coverage of the older 20-kHz power switch standard, but he also describes how new high frequency devices are reducing production costs and dramatically improving power supply efficiency, reliability, compactness, and volume.

Readers will also learn about new advances: Electronic and synchronous rectification, Resonant-mode switching, Sine-wave power supplies, Current-mode control, IGBT power switches, MCT thyristors.

Regardless of their level of experience, Gottlieb's guidance and practical insight will help readers to benefit from the experimentation and creative engineering happening now in the dynamic field of power supply technology.

TAB Books, Blue Ridge Summit, PS 17294

Troubleshooting and Repairing VCRs 2nd edition, By Gordon McComb; TAB Books; 432 pages, 189 illus; $19.95 paper. $32.95 hard.

With simple and straightfoward instructions, McComb explains how to maintain and repair all types of videocassette recorders, including more than 100 different brands of Beta, VHS, and 8mm VCRs, as well as the popular camcorders. Readers will find complete coverage of: Tools and supplies for VCR maintenance, preventive maintenance schedules and cleaning procedures, troubleshooting and repairing problems not caused by the VCR - including the Macrovision anticopying signals that are now used on over 95% of all prerecorded tapes plus comprehensive flowcharts for a variety of common VCR malfunctions.

TAB Books, Blue Ridge Summit, PA 17294

RS-232 Made Easy: Second Edition, Single Source To Connecting Computer Equipment, By Martin D. Seyer; Prentice Hall Books; $42.00 hard, $29.95 paper.

If connecting computers, printers, modems and other computer equipment is a mystery to you, according to the publisher this book is for you. Prentice Hall announces the publication of RS-232 Made Easy. This is a complete guide to connecting computer equipment with the RS-232 interface. This edition features easy-to-follow instructions for connecting more than 1,000 devices, 800 more than the previous edition. Written in non-technical language, Seyer begins with the basics of interfacing and gradually builds-up to discuss complicated interfacing issues with the RS-232. He devotes an entire chapter to the most common questions surrounding connections of computers and peripherals provided by vendor support hotlines. The book features:

• Complete descriptions of the functions of each lead of the RS-232 interface
• Charts outlining pin assignments, connections, port genders, and flow control information for more than 1,000 devices and options
• Interconnections of printers, CRT's and computers employing the RS-232-C interface
• Over 3,600 cable design diagrams.

Chapters include: introduction to the RS-232 interface; communication jargon, asynchronous modems and RS-232-C; RS-232-C operation in a private-line environment; synchronous environments; secondary signals and flow control; cross sections; interfacing equipment; most frequently asked questions when connecting computers, modems, printers and terminals.

Seyer adds numerous appendices to this edition covering: EIA standard RS-232; EIA standard RS-449; industrial electronics bulletin No. 12; RS-232 circuit summary with CCITT equivalents; tools of the trade; RS-232 pinouts for computers and peripherals; null-modem cables and other cable designs; Industry standard and modular cables; common connectors, pinouts and numbering schemes; TRW modular adapters; rules for cable design; interfacing problems and numbering schemes; TRW modular adapters; rules for cable design; interfacing problems and remedies; and ASCII character set. The book ends with a comprehensive index.

Prentice Hall Books 200 Old Tappan Rd. Old Tappan, NJ 07632.

Build Your Own Test Equipment, By Homer L. Davidson; TAB Books, 304 pages $23.95 paper, $36.95 hard 304 pages, 336 illus.

Why would anyone want to build their own electronic test instruments when there are so many commercial units available? For working technicians, it's a fun and relaxing way to practice their trade in the privacy of their own shops. For ambitious hobbyists, it's an opportunity to sharpen old skills and learn exciting new ones while stocking their workbenches with devices that will last for years.

Whatever their level of expertise, electronics professionals and enthusiasts will find that building their own test equipment can save them hundreds of dollars and allow them to customize their shops with instruments that are not currently on the market.

The book explains all there is to know about constructing inexpensive, high-performance equipment for troubleshooting almost any electrical circuit, connection, or power supply.

Veteran electronics whiz Homer L. Davidson leads readers step by step through the entire process: Finding and buying components, substituting components, designing PC boards, building and testing projects, putting completed instruments to work.

The book contains projects for everyone from beginning experimenters to seasoned professionals. Each is accompanied by Davidson's simple, easy-to-follow instructions, photographs, and working diagrams.

Many of the instruments detailed in this valuable project book can be built by novices in one evening, while others require special skills and a few days of challenging work.

TAB Books, Blue Ridge Summit, PA 17294

Electronic Signals - Television, Stereo, Satellite TV , and Automotive, By Stan Prentiss, 272 pages, TAB Books, $26.95 paper, $39.95 hard.

To fully define signal characteristics, electronics hobbyists and technicians must have a working knowledge of the equipment producing the signals. Now, in Electronic Signals: Television, Stereo, Satellite TV and Automotive, Stan Prentiss presents a detailed study of signal analysis as it applies to the operation and signal-generating capacities of today's most advanced electronic devices:

- Test equipment - spectrum analyzers, digital storage oscilloscopes (DSOs), logic analyzers, high-end multimeters, and frequency counters.
- Transmission media - coaxial cable/fiber optics analysis, AM and FM stereo modulation and demodulation, vectors, and a broad-spectrum study of today's major television antennas.
- Satellite earth terminals - the latest developments in C and Ku bands, low-noise block downconverters, and a 1.2 - meter reflector for use with Ku-band video, voice, and data traffic.
- Monophonic and stereophonic audio - C-QUAM, AM stereo transmission/reception, Bessel functions and tables, harmonic distortion, and stereo separation - all illustrated with spectrum-analyzed waveforms.
- Multiple and satellite master antenna systems - with new item offerings and special calculations for a small and expandable MATV. Suggestions for SMATV and MATV combinations, including warnings and special electronic conversion charts.

Prentiss also examines the latest developments in analog color television systems, and the last chapter covers automotive electronics including conventional distributors, fuel injection, turbos, and superchargers. This chapter was specifically included to reach many of those electronic engineers and technicians who service their own vehicles.

TAB Books, Blue Ridge Summit, PA 17294

EMERSON

2822-1....TS2581RD (SUFFIX A)

PANASONIC

2820-1..CTM-277OS, CTM-2771S, CTM-2775S, CTM-2776S, CTM-2778S, CTM-2781S, (CH. AEDP182, AEDP184, ALEDP182, AMEDP182

PHILIPS

2823-1.PK7605, POK171, POK261, POK271, POK371, TOK261, TOK271, TOK471, 20K161, 20K171, 27K251, 27K261, 27K271, 27K471, 27K472, 31K371, 31K571, (CH. 20R101, 27R101, 27R104, 27R106, 31R1O2, 31R1O3)

QUASAR

2818-2.....SL2734EK, SL2738EP, SL2739EP, SP273OEE, SP2730EW, SU2735ED, SU2737EP (CH. AEDC182, AEDC184, ALEDC184)

2821-1...TP1O2OEE, TP1O2OEH (CH. AGC159/K12)

SAMSUNG

2819-2.....CT6816WC, TC275OS, TC2755OSA

SHARP

2817-1.......2OSV7O, 2OSV71O, 2OSV72O, 2OSV74O (CH. 2OS1)

2822-2..................27SV7O

2823-2.......2OSV6O, 20SV61O, 20SV62O, 2OSV64O (CH. 2OS1)

SONY

2817-2 .... KV-32XBR65, (CH. SCC-C59G-A, SCC-C6OE-A)

2818-1.KV-32XBR1O, KV-32BR7O (CH. SCC-C59B-A, SCC-C59F-A, SCC-C6OB-A)

2819-1 .... KV-32XBR15, (CH. SCC-C6OH-A)

2821-2.............KV-32HSR1O (CH. SCC-C59E-A, SCC-C60D-A

ZENITH

2820-2 . . . SS2O25W/W2/X2/Y/Y2

Tension mask high-resolution color display provides bright, high-contrast, high color fidelity picture

Zenith Electronics Corporation demonstrated a prototype computer monitor built around a new 17-inch version of their "flat tension mask" (FTM) color display, at the 1991 Society for Information Display (SID) symposium in Anaheim. The new 17-inch display is the first in a series of larger-screen, higher-resolution FTM displays.

Charles J. Sindelar, president of Zenith's Display Division, said the company plans to use the new 17-inch FTM display in multi-frequency, 1024 × 768 pixel resolution monitors for the personal computer industry and higher-resolution (1280 × 1024 pixels) workstation monitors.

The FTM display, the only high-resolution color cathode ray tube mass-produced in the United States today, features a perfectly flat, reflection-free faceplate and a fully stretched shadow mask.

"The result is American display technology with world-class performance in brightness, contrast, color fidelity, resolution and ergonomics," Sindelar said.

Building on experience in 15-inch FTM picture tubes for high-resolution color computer monitors, Zenith plans to capitalize on the rapidly expanding market for higher-resolution color displays, both in the personal computer and workstation markets.

By late 1992, the company plans to build 22-inch FTM tubes.

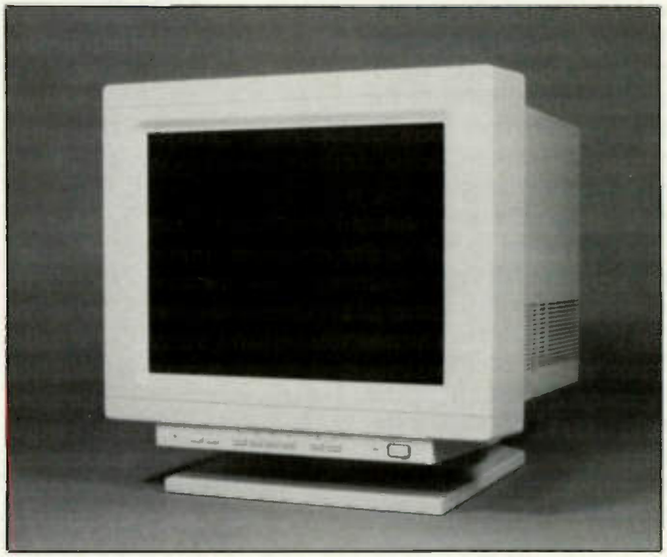


Figure 1. Here's the first color computer monitor using a new 17-inch version of Zenith's "flat tension mask."

How it works

Both the FTM video display and conventional color cathode ray tubes (CRTs) use a shadow mask. This thin metal sheet, with hundreds of thousands of tiny etched holes, directs beams from the tube's electron gun to the screen, where they excite red, blue and green phosphors, creating the video image.

In a conventional CRT, a curved shadow mask is supported by a frame and suspended by springs inside a tube. As electron beams strike the mask, it heats up and causes unwanted movement.

In FTM tubes, the shadow mask is stretched flat and held under tension directly behind the tube's flat glass face-plate. The mask does not move at all under most display conditions - even at much higher brightness levels that cause discolored images in conventional tubes.

Advantages

The FTM is up to 80 percent brighter than a conventional higher-resolution CRT at equivalent levels of resolution and contrast.

The FTM offers a 70 percent increase in contrast ratio (over conventional high-resolution CRTs at equivalent levels of brightness and resolution). Blacks are blacker. This improves overall and small-area detail contrast and is perceived as higher resolution."

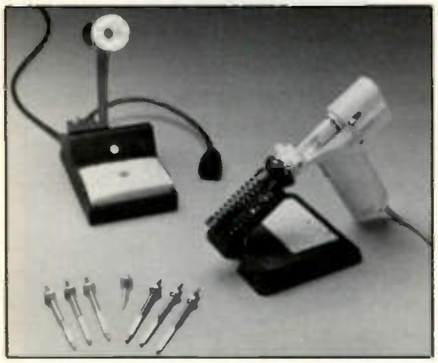
When bright patches are displayed for a length of time, conventional shadow masks deform, creating discolored images. The FTM's shadow mask, stretched tight, is virtually immune to this effect, known as "doming."

Because of the inherent precision of the shadow mask under tension, the FTM offers a higher-resolution display than other displays at equivalent levels of brightness and contrast.

The FTM's flat tube face offers essentially glare - and reflection-free viewing because it does not reflect ambient light as does a convex tube face and because it can be economically treated with anti-reflection and anti-glare coatings.

Desoldering gun

Solder Removal Company, offers a hand-held, self-contained, portable desoldering gun. The UL-approved desoldering gun has been certified by Hi-Rel Laboratories to conform with Department of Defense



Specification DOD-STD-2000-1B. The SC-5000 desoldering gun contains a motorized diaphragm pump, activated by trigger touch, with a 15 liter/min. vacuum capacity. The combination suction nozzle and vacuum pump design achieves a 0.1 to 0.2 second arrival time, with peak vacuum of 600mmHg. The gun operates from any 120V outlet and no factory air hookup is required. The unit also contains a ceramic heater with built in thermal sensor that allows it to be used as a hot air blow gun for shrink tubing and thermal heat checking.

Circle (41) on Reply Card

Soldering station

Hexacon Electric Company announces a new soldering station called Bantam which has been added to the Therm-O-Trac Station family, to meet the demanding requirements of hand soldering on densely populated circuit boards. The new station has a controlled temperature range from 500F to 850F, and has excellent thermal capacity for soldering on high

density circuit boards. The product is free from electrostatic, electrical and magnetic effects.

Circle (42) on Reply Card

Voltage and current graph

BMI's new PowerVisa shows both voltage and current on one graph. Being able to see the relationship between voltage and current is the best way to understand power quality. The unit includes advice on what to do to solve the power problem. This feature helps a novice determine if equipment needs repair or if an electrical contractor should be called. It can also help an expert select appropriate power conditioning equipment or track down an offending load. The product starts to work as

soon as it's plugged in and it detects all disturbances that are harmful to sensitive electronic equipment. Users can find out if power is the source of equipment problems, which is now a greater possibility that just a few years ago.

Circle (43) on Reply Card

True-RMS DMM

Leader Instruments announces a new bench-top digital multimeter, the model 856. The unit provides comparison of measurement results, frequency measurement, and calculation functions (deviation, relative, and decibel measurements), as well as the conventional voltage, current and resistance measurements. An auto-ranging, multi-function, 4.5 digit unit, the 856 utilizes a true-rms technique providing extremely ac-

curate measurements of waveforms with crest factors up to 3. Frequency measurements range from 5Hz to 300kHz with a maximum 30,000 count and resolution of up to 0.01Hz. A last-memory function automatically saves front panel key settings each time power is applied. A key-lock function helps eliminate errors when a specific, or continuous mode of operation is required.

Circle (44) on Reply Card

New multimeters

Fluke announces a new version of the 70 series with the introduction of the new 70 series II family of handheld multimeters. This new line of eight models, includes three all-new models and enhanced versions of the exisiting five models. The two new high-performance models, the 79 and the 29, can check capacitance from 10pF to 9,999μF, useful for

testing large electrolytics. An innovative frequency function can simultaneously display frequency ranging from 1Hz to 20kHz - on the digit display and ac voltage on the analog bar graph. This allows users to see how much potentially hazardous voltage is present when making frequency measurements. A new 63-segment bar graph that updates as fast as the eye can follow simulates the functionality of an anlog needle for watching trends, peaking and nulling.

Circle (45) on Reply Card

ATE low-cost testers

Maxtec International now has a new line of advanced benchtop testing equipment designed to test and troubleshoot PC boards. Called the Pro-Line series, the testers are designed for benchtop production and depot repair, independent or third-party service organizations, testing and analyzing in production military

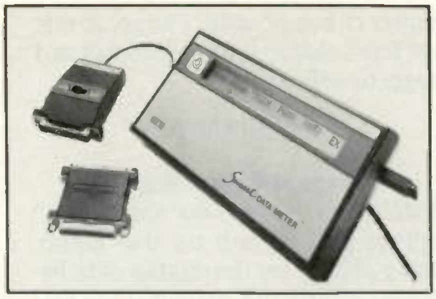
and aerospace organizations and large electronic equipment users such as banks, hospitals, and TV stations.

The new product group will include a range of loaded-board and device testers designed to help even small organizations isolate board faults down to the component level. The initial offering includes three benchtop instruments. The Pro-Line model PL 5000 PC Board Diagnostic System is an in-circuit and out-of-circuit tester of TTL, CMOS, ECL and analog devices with a 48 channel capability including six guard points (tests up to 64 channels with expansion option).

Circle (46) on Reply Card

Protocol analyzer

HMC Material Company announces the Smart Data Meter which tests both DCE and DTE devices. It generates test patters and receives data transmissions, baud rate, word length, parity, stop bits and more. Easy single-button operation lets you select from menu options. READ displays, on a 32-character LCD, data being sent from the RS-232 device. Parameter Scan sequentially sends all possible protocol combinations to the device being tested until the correct protocol is found. Param-

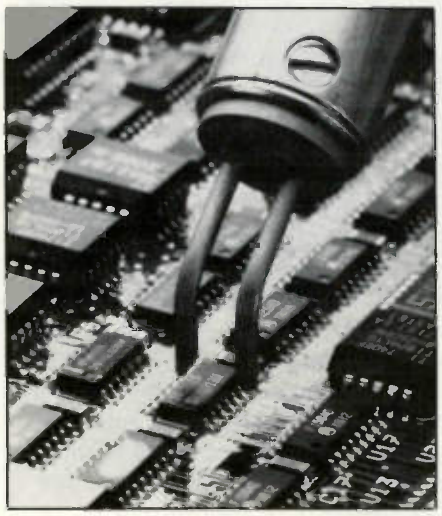


eter Selection permits selection of serial protocol for output. The internal electronics of the Model SDM931 allow it to make virtually any RS-232 hardware connection. Comes complete with 4-foot RS-232 interface cable with male DB25 connector, female gender changer, 9-volt battery, carrying case, and operations manual.

Circle (47) on Reply Card

Hot jet handpiece for SMD installation

Pace Inc has introduced its new Mini ThermoJet handpiece for installation of a wide range of leaded and leadless surface mount components.



The Mini ThermoJet provides a precision focused jet of heated air for rapid solder joint reflow without damage to adjacent components and substrate areas. A comfortable pencil-grip design and an assortment of nozzle geometries allow easy targeting for operators of any skill level.

Circle (48) on Reply Card

Information booklet on Power Solutions

Deltec Corporation, is now offering a free information booklet, called Power Solutions: AC Power Product

Guide. The guide explains power problems, their effects on computers and other sensitive equipment and how you can solve them. The guide answers some of the most frequently asked questions about power problems: including causes and effects of power problems and how to determine if you have them. It also helps you decide on what type of power protection you need, the value of on-line versus off-line UPSs and what a high UPS efficiency rating can mean in dollars and cents.

Circle (49) on Reply Card

Compact soldering station

Cooper Tools announces a new electronically controlled soldering station. Model WCC100, is adjustable from 350F to 850F. The 40-watt pencil is fitted with an ETA tip and can be used with the full range of

Weller ET series replacement tips to cover all applications.

The tool's compact design incorporates a zero voltage circuit that ensures that no-high voltage spikes or magnetic fields are present at the tip to damage sensitive components.

Circle (50) on Reply Card

Installing Satellite TV

(from page 11)

position, and scan the horizon in approximately a 90- degree quadrant. Repeat for the other three quadrants.
6. Observe any change in the magnitude of the signal strength meter deflection from the deflection noted in step 4 above.
7. Look for visible changes in the raster on the TV screen (e.g., white lines across the screen, increased noise level, screen goes black, etc.).
8. Take the receiver out of the scan mode and go through each channel individually while observing the TV screen and signal strength meter for indications of TI.
9. Move around the property for locations that may be shielded from the microwave signal source. Record the signal strength level and the alternate site or sites. Be sure that in shielding the dish from the microwave interference that you don't restrict the view the full satellite polar arc.

This detection system is extra sensitive. It may detect terrestrial interference that is present at such levels that it might not show up as reduced picture quality.

If the above tests indicate the presence of TI at the site, it would be advisable to go ahead with a full site demo, to observe the actual picture quality that may be expected.

It would be a good idea to run through all satellites for possible TI problems, because TI levels can change from satellite to satellite. Additionally, it would be advisable if possible to select a specific installation site that that might offer natural shielding (i.e. buildings, trees, etc.) from the TI.

This may preclude or minimize the need for filtering in the future should the level of TI increase, or channel usage change. Obviously it cannot take into account potential interference resulting from new point-to-point sites that might be installed in the future. ■

Test your electronics knowledge

Answers to the quiz *(from page 51)*

1. The output signal for this ringing oscillator is *not* a sinewave as sometimes thought. It is a damped wave. Each cycle has a lower amplitude than the previous one. The rate at which the amplitude decreases depends upon the Q of the tuned circuit. With a high-Q circuit the decreasing amplitude is difficult to detect. A damped wave can be compared with a sine wave as follows: damped waves contain harmonic frequencies; sine waves do not.

2. D - Another name for Schottky Barrier Diode is *hot carrier diode.* One advantage it has over a point contact diode is in its ability to handle a higher current.

3. (1) The junction capacitance values are not the same.

(2) The reverse resistances values are not the same.

This can be true even though they are the same types of diodes.

4. Solution for the value of R in Figure 3 - This problem is solved with ohm's law and just a little bit of transistor theory.

Step 1 - Find the collector current (I_C).
$I_C = (V_{CC} - V_C)/R_L = (20\text{-}10)/10K = 0.001A$

Step 2 -Find the value of base current (I_B).
dc Beta = I_C/I_B.
Therefore, $I_B = I_C/\text{dc Beta} = 0.001/80 = 0.0000125A$.

Step 3 - The voltage across R = V_{CC} - V_B (where V_B is 0.7V for the silicon transistor.
So , the voltage across R = 20-0.7 = 19.3V.

Step 4 - Knowing the voltage across R (19.3V) and the current through R (0.0000125A) the value of R can be found by ohm's law: R = V/I = 19.3/0.0000125 = 1.544MΩ. Select a standard value of 1.5Ω for R. (Note: by using 1.544MΩ instead of the calculated value of 1.544MΩ the collector voltage is slightly reduced.) This is not a stable circuit.

5. No - The primary and secondary are likely to be wound with different wire sizes. Use primary and secondary voltage measurements.

6. There must be 6V across R_1 in order to get the correct voltage across the coil. So, the current through R_1 is $I_1 = 6/10 = 0.6A$. Only 0.3A can flow through the coil, so, the balance of 0.3A must flow through R_2. The voltage across R_2 must be 6V - the same as the voltage across the coil. Therefore, $R_2 = 6/0.3 = 20\Omega$.
(Fish around in your junk box and see if you can find a 12V relay.) The resistors needed for this circuit waste power.

7. The period (T) for one cycle of 100Hz is:

T = 1/f = 1/100 = 0.01 sec.
The one-half cycle time is:
0.01/2 = 0.005 sec.
Then, T = RC
0.005 = 100C
C = 50μF.

Due to the wide tolerance of electrolytic capacitors you should buy a 100μF capacitor.

8. It is a 1.2Ω resistance with a tolerance of 2%. The highest value is found from the equation: Range of resistance = R ± (% tolerance x R) = (highest value when + is used and lowest value when - is used).

So, 1.2 + (0.02 × 1.2) = 1.244Ω.

9. Garbage. You will sometimes see the expression GIGO which means garbage in/garbage out. Not very sophisticated, but, the terms are in popular use.

10. (1). 317 - power supply regulator
(2). 741 - op amp
(3). 555 - timer

Bonus question - Tesla

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

The following restrictions apply to Reader's Exchange:

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

Send your Reader's Exchange submissions to:

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

FOR SALE

Fluke model 87 DVM. New condition. $195.00. Price includes ship by UPS. *Bob Goodman, P.O. Box 452, Alexandria, Louisiana 71309 318-442-7170.*

Complete parts, test equipment, and service literature from TV service shop. Owner retiring. $4000.00 *Chequamegon Electronics 917 MacCarthur Ave. Ashland, WI 54806 715-682-9494.*

Sams photofact No's 1516 thru 2305 $3.00 plus shipping. B&K 1077B $50. B&K 467 CRT checker $200.*Art Diedrich, 10426 Abbeville St. Springhill, FL 34608. 904-688-5782.*

Sencore LC77 Auto-Z cap-inductor analyzer, SCR250 SCR-TRIAC tester and carry case: $1,295.00 call Don 707-425-9362.

B&K 470 Pix tube tester $2.50 B&K 530 semiconductor tester $200. Sencore VA48 video analyzer $400. *All in good cond. Danny Rushing Rt. 2 Box 386 Pasrons, TN 38363 901-847-6710.*

Electronic components, tubes, transistors, courses, books, schematics, Heathkit 2 band radio. Knight 5 band radio, send a LSASE for each list.*J. Horsley 67 Theodore Street, Buffalo, NY 14211.*

Sound Technology 1701A distortion analyzer with IMD option $17550.00.*Electronic Services 5814 Industrial Rd., Ft. Wayne, IN 46825 219-484-3326.*

Sencore equipment SG165 AM/FM stereo analyzer - $965. CR 31A CRT tester - $550.00 LC53 Cap and coil Z meter $600. Much more send SASE (legal size). *Fred Ingersoll 6845 Lathers Garden City, MI 48135, 313-427-00499.*

NRI VCR training course (VHS and Beta Formats), with 2 HR VHS training tape $125 obo. *Ronald Grega, 107 Ridgeview Dr., Dunmore PA 18512; 717-347-6842*

Fluke 8000A and 8024 digital meters $100. Ohmite VY10 power supply $50. Weller WTCPN $50. Xlite tool kit $30. Also misc hand tools.*Max E. Bingman Box 9088 Moscow, Idaho 83843, 208-882-2273*

Power board OEPS - O611OAAI for Panasonic VCR PV-1530.*Joseph Lag 941 Rice Rd., Elma NY 14059 716-652-9164*

300 magazines Radio-Craft to ES&T, send SASE for list or make offer.*Tom Verespie, 31 Datura Ave., Milford, CT 06460.*

Sams photofacts #1000-2543 complete with cabinets $4500.00 shipping extra. Call anytime*David Lehmann 1-417-924-3350.*

Sencore SG165 stereo analyzer, like new money back guarantee, $700 plus shipping *(516) 482-5829 or William Bernstein 215 Middleneck Road, Great Neck, NY 11021.*

Ampex VPR 5800, 1" open reel video recorder $450.00. Concord VTR 1100 1/2" open reel video recorder $250.00. Both units like new, but need belts.*Ken Wilson 201-454-2727.*

1 B&K Oscilloscope model 1474 30MHz Dual Trace. Probes and manual $400.00. 1 Heathkit Power Supply $200.00. One large box ass new C.B. Take all $100.00. *Call Shawn 602-782-0234.*

Electronic tubes, transistors, components, courses, books, schematics, Heathkit 2 band radio, Knight 5 band radio. Send a LSASE for each list.*J. Horsley 67 Theodore St. Buffalo, NY 14211.*

B&K 1077-B TV analyzer. $100. Leader LBD-511 10MHz single trace oscilloscope, $110.00 Heathkit IT-5230 3-meter CRT tester, $120.00 All with manuals.*Gene Bartley, 1805 Sylvia Arkadelphia, AR 71923. Phone 1-50-246-7234.*

Various Sams Photofact & Audio Radio Schematics 1948 to 1960. Sams Auto Yearbooks 57-58, 59-60 and 1968. Misc-Motorola 1937y Mopar D33&34, P19 &20, P22 & 23 Philco Un6-1000 Instllation sheet 1956 Corvette radio schematic.*Frank Krider 602 Spruce St. North Wales PA. 19454.*

WANTED

Schematic for Panasonic CB model RJ 34590 (SAMS CB 231). Service manual for Tektronix 475A Scope. *John Pemberton Jr. P.O. Box 837 Caddo Mills, Texas 75005.*

VCR service manuals, VCR parts Gross reference literature, hand remote for Fisher VCR FVH-4000. *Ed Herbert, 410 N. Third St., Minerville, PA 17954.*

Sencore CR70 beam builder. *Cliff Christensen PO Box 21973, Waco, TX 76702.*

ECG 792 (Sylvania # 15-37700-11) horizontal processor any quantity. Two 7 A 12 or 7 A 26 dual vert amp and 7B 53A time base for Tektronix scope model #7613. *Richard Fela P.O. Box 193 Lake Delton, WI 53940, 608-253-5351*

Schematic operations manual for Knight Kit 83YX123D R-F sweep generator. Dale G. Miller, 15130 Jackson Rd., Mishawaka, IN 46544 (219) 255-9443.

Used RCA flyback 1439849 on CTC 97H chassis. Used 17VAYTC01 and 19VJD P22 CRT's. *Paul Farrow (217) 446-1147.*

Conar model 255 scope *William P. Jarvis 1214 Fifth Avenue, Beaver Falls, PA 15010-4444 (412) 846-7735.*

Heathkit SW-7800 shortwave radio, in kit form or assembled.*S. Lindell 7714 Woodbine Ave Philadelphia, PA 19151.*

VCR any repair shop that has developed a VCR complete T/S and Repair Solution guide for Sale or copy. Just beggining any help appreciated. *Murray's Repair Service 8842 Grange Hill Rd. Sauquit, NY 13456 (315) 737-7192*

Need Flyback transformer part #361846-2 for model #Magnavox DCR476PE02, CHassis #25C116.

Assembly operator manuals for Heath Model IT-121 transistor checker and Heath bench power supply model IP-20. Will buy or copy and return.*leonard Hicks 16043 42nd Ave, SO Seattle, WA 98188.*

Copies of service manual and owners manual for Okidata microline 293 printer. Model No. 6E8261B. *David Truran, 1582 Rosehedge Dr., Poland, Ohio 44514 (216) 758-4705.*

VHS training tapes on TV repair. *James Gregorich 117-2nd St. No Virginia, MN 55792, 1-218-749-4355.*

520 RB 22 CRT-Sony, will pay $25 shipping and handling. C.O.D. *Chuck Kelly 708-623-2597 (N.E. Ill.)*

Sams Photofact No. 149-11 for Revere Tape Recorder Model T100. Advise price for original or copy. *Jim Brugh, 1132 Sperling Drive, Pittsburg, PA. 412-371-6478.*

Zenith Stratosphere - 1936 floor model radio with 25 tubes, 2 chassis and 3 speakers. Has large black dial behind two sliding doors. *Doug Heimstead 1349 Hillcrest Dr., Fridley, MN 55432 612-571-1387.*

Owner manual and wiring if possible, for Tektronix type 564B storage oscilloscope with auto-erase. *E. Cardona, Apeninos 633 Pro Nuevo, Puerto Rico 00920.*

Fisher VCR service manuals, VCR parts cross reference literature.*Ed Hernert, 410 N. Third St., Minersville, PA 17954.*

Classified

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

By-the-word: $1.65 per word, per insertion, pre-paid. Minimum charge is $35 per insertion. Initials and abbreviations count as full words. Indicate free category heading (For Sale, Business Opportunities, Miscellaneous, Wanted). Blind ads (replies sent to ES&T for forwarding) are $40 additional. No agency discounts are allowed for classified advertising by the word. Contact Emily Kreutz at 516-681-2922 to place you classified ad (by-the-word). Or send your order, materials and payment to Emily Kreutz, Electronic Servicing & Technology, 76 North Broadway, Hicksville, NY 11801.

Per Column Inch: (Classified Display): $235 per column inch, per insertion, with frequency discounts available. 1" minimum, billed at ¼" increments after that 10" maximum per ad. Blind ads are $40 additional. Reader Service Number $25 additional to cover processing and handling costs. (Free to 4-inch or larger ads.) For more information regarding classified display advertising please contact Jonathan C. Kummer at 516-681-2922. Optional color (determined by magazine) $150 additional per insertion.

WANTED

OLD ANTIQUE RADIOS AND TV"S: Pre 1950. Any condition will repair some. Old tubes wanted. Thrifty TV, 16 E. Marie Hicksville, NY 11801, 516-822-4501. 12-91-tfn

FOR SALE

TV TOUGH DOGS: 300 symptoms and cures. Send $10.95 to DAVIS TV, 11772 Old Fashion Way, Garden Grove, CA 92640. 7-91-tfn

COMPLIMENTARY CATALOG: "Apex Industrial Screwdriving Bits". Pick you size. Get the results you want! The service is even more amazing. Fast! Shockey's, Box 24042-ES, Dayton, OH 45424-0042. 513-236-2983. 7-91-1t

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. 6-91-3t

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 Avenue, Madison, WI 53705. 608-238-4629. 608-233-9741. 6-91-tfn

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. 7-91-3t

TELEVISION AND MONITOR TROUBLESHOOTING: 350 symptoms and cures, nothing old listed, $13.00 refundable. Jones Enterprises, P.O. Box 702, Niceville, FL 32578. 7-91-tfn

ATTENTION VCR SERVICE CENTERS: 1000 VCR symptoms/cures from experience and manufacturers publications. Computer printout $90. Guaranteed satisfaction. VCR Tuneup Center, 43 James Avenue, Redwood City, CA 94063 or call 1-800-777-7883. Mastercard and Visa accepted. 4-91-tfn

TV/VIDEO CURES: Over 630, "3x5 Format" $25.00 Shippped. (Outside "48", $27.00) Cash or Certified Check Quickest! C. Mott (Ent.), 221 Mobileland Court, Bloomington, IL 61701. 7-91-1t

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. 7-91-tfn

SAM'S PHOTOFACTS: 51-887, old tubes and radios. Best offer. NEWELL'S TV, 112 E. Main Street, Ligonier, PA 15658, 412-238-2381. 7-91-1t

SENCORE TEST EQUIPMENT: VA62, VA63, VA64 $2,200 or best offer. Call Terry at 801-967-7211. 7-91-1t

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TV-VCR-CAR STEREO REPAIR & INSTALLATION: Excellent opportunity-fully equipment-long lease-busy area. Many authorizations. Brooklyn, New York 718-531-0149. 7-91-1t

SOUTHERN CALIFORNIA LA AREA: 16 Years. T.V., VCR, Stereo, Sales & Service, Great Lease, Over 2,000 Sq. Ft. Great Corner Location. Owner Retiring $50,000. 213-863-1919. 7-91-1t

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GOING OUT OF BUSINESS: Must Sell. Sencore VA62, 63, 64. Mint Condition, used less than 100 hours. Under $2,800. 313-946-5282. Ask for Ron. 7-91-1t

LEARN VCR REPAIR: Home study, high-profit repairs without investing in high-tech instuments. Full or part time opportunities. FREE career literature. 800-362-7070. 7-91-1t

Readers' Exchange

WANTED

Compute magazines will pay a reasonable price. *Jack Grossman 98-17 HOR. HDG EXPY. Corona, New York 11368 (718) 271-2775.*

Schematic diagram for a Sony AM/FM stereo cassette sports water resistant radio model # CFS930. *Roger D. Carbone 805 Colusa Ave. Oroville, CA 95965*

Need schematics and service info for SUPRA VCR model #SV70. Will Pay reasonable fee. Copy OK. Call or write *John Ohrnberger 20 Narragansett AV, Medford, NY 11763 286-4185.*

Hand remote control for Fisher VCR FVH 4000, VCR service manuals. *Ed Herbert, 410 N. Third Street., Minersville, PA 17954.*

Philco TV main circuit board, Part No. 02-3017587-1 for Chasis #34-7. Part is no longer available from Philco (Philips). *James Powell 42372C, FCN McGuire AFB, NJ 08641, (609) 723-1103.*

Heath model IB-2A Impedance Bridge, in good condition with manual. *Bob Kramer, 919 Grove Street, Aurora, Ill 60505 (708) 898-4044.*

Waveband switch for Philco model 66. Pdt No. 42-1066 two compensating condensers, 1st IF primary and secondary, part No. 0400M for Philco model 71. Pin drive transformer for speaker of a Crosley model 706. *Paul Williams 2364 Beaver Valley Pike, New Providence, 17560 (717) 786-3803.*

Hand remote control for Fisher VCR FVH-4000; VCR service manuals. *Ed Herbert, 410 N. Third St., Minersville, PA 17954.*

Schematic and set up procedures and adjustments for B&K model #1450 diagnostic oscilloscope. Will copy and return or pay for copy. *Gerard O'Gara 11 Crag Lane, Levitown NY 11756, 516-731-4075.*

Service manual or schematic for a Ward's GOJ12966 color TV. *Henry Fuqua, 1423 Jordan Dr. S, Salem OR 97302.*

Copies of schematics, parts lists or other technical docummentation for Wyse 50 and Wyse 60 data display terminals.

High voltage tripler for Mitsubishi model VS-707V. Part #935B003030. *Andy Macpherson 5430 N. University Dr. Lauderhill, FL 33351.*

Heathkit model IB-2A impedance bridge, & Heath HD-1250 Dip meter, both in good condition with manuals. State prices and shipping. *Bob Krammer, 919 Grove Street, Aurora, IL 60505. 708-898-4044.*

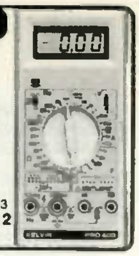
General Electric TV, model WM261CWD, WM264CWD, or WM269CMD. *Mike Kroll 6355 Rosemont, Detroit, MI 48228, 313-336-3130.*

Schematics or service manual for SX64 commodore computer. Will either buy or pay to copy and return. *Floyd A. Demory Rt. 2 Box 147 Lovettsville, VA. 22080.*

Service information or schematic/parts list for a Burwen DNF1201 dynamic noise filter. Burwen is apparently out of business. *Erik Nagley P.O. Box 22724, Honolulu, HI., 96823*

Sencore VA-48 analyzer, Z-meter and other test equipment. Will pay reasonable price call *717-652-1703 Mr. Roger Goldberger 3909 Dora Circle Harrisburg, PA 17110.*

Manufacturers service literature for major brands of stereo equipment. Technics, Pioneer, Kenwood, etc. *John Hagle, Electronic Service Place, 176 West Fairmount Ave, Lakewood, NY 14750. (716) 763-5938*



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