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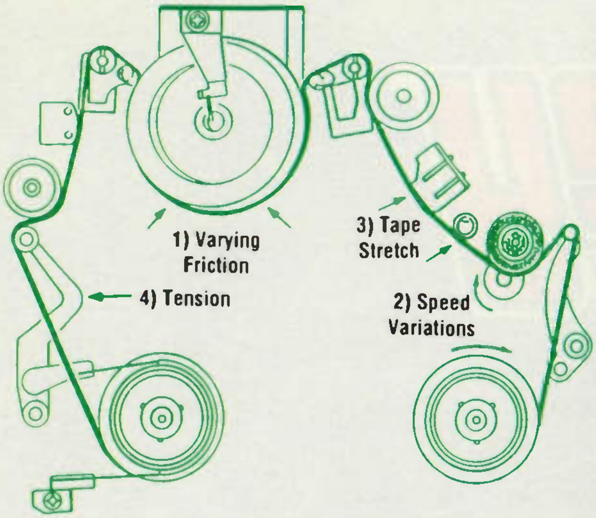

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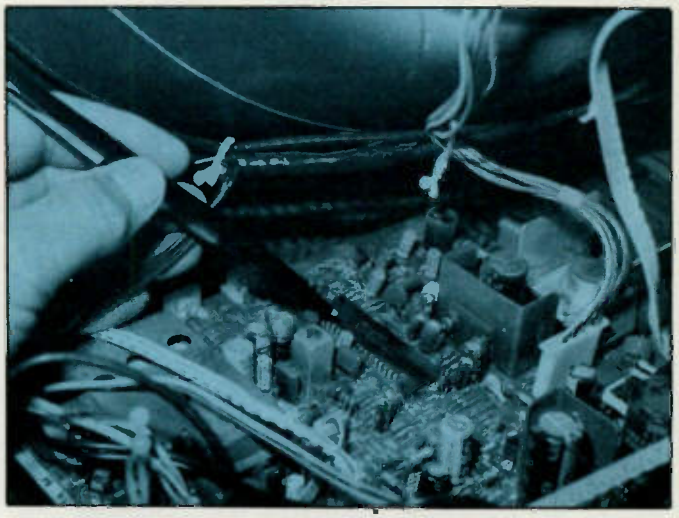

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FEATURES

DEPARTMENTS

ON THE COVER

Today's DMMs are becoming increasingly sophisticated and useful. In addition they feature higher accuracy and greater protection from breakage and environmental hazards. *(Photo courtesy ITT Pomona).*

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ELECTRONIC Servicing & Technology

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Suffering information overload? Here's why.

Do you ever feel overwhelmed by the sheer volume of what you have to know about electronics in order to be involved in servicing. If you take a look at some of the reference books, the reason becomes clear.

I was just leafing through a recently published dictionary of electronics. It's 7½ inches by 9¼ inches, over 1½ inches thick, runs to over 700 pages and contains *more than 27,000 entries*. Of this huge number of entries, there are *hundreds of new entries*, according to the blurbs on the back cover.

I did a little quick calculation. If you were starting from scratch and set out to learn those definitions one per day until you knew them all, it would take you over 70 years. Of course during the time you were learning all those definitions, the engineers, scientists and technicians would be discovering, designing and manufacturing lots of new technology, components and products, for which there were new terms, no doubt at the rate of at least one a day, so you'd still be way behind even at the end of 70 years of study. Whew!

Of course I exaggerate the problem somewhat. Everyone specializes, so many of the terms would be irrelevant. Many of the terms are either variants of other terms, or otherwise related to other terms in the dictionary, so that would cut down on the sheer number of terms you would need to learn.

And of course some of the terms are not necessary for most technicians to know. For example, it's interesting to know that Halowax is "a chlorinated naphthalene wax used as an impregnant for paper capacitors. Dielectric constant 3.4 to 5.5. Resistivity $10^{13}\Omega$-cm to $10^{14}\Omega$-cm." I don't feel that not knowing that fact before now has been an impediment to my career in electronics.

There are also some definitions that are pretty obvious and most of us would know them without ever opening this dictionary. For example, I knew before I opened the book that a hammer was among other things "1. The striking member in a wheel printer. 2. A large clapper in a bell or gong."

Still, even allowing for the large number of definitions that are of little or no use to me, and the ones I already knew, there are hundreds, at least, that I should know that either I do not, or am a little fuzzy on.

Making the problem of knowing all this stuff still more difficult is the fact that many of the definitions describe in a few words concepts that take a great deal of thought to grasp. For example, the definition of Colpitts oscillator runs about five lines, but to truly understand what's going on in that thing requires a drawing (provided in the dictionary) and the equivalent of several pages of description.

And still it comes. Every day new concepts, many of which require an entire vocabulary, are being introduced. To name just a few of the technology concepts that have been introduced, or of which we have become increasingly aware, in recent years are: LCDs, switching power supplies, electrostatic discharge, power line disturbance problems, the compact digital audio disk.

So if you sometimes feel overwhelmed by the technology and the vocabulary of electronics there's good reason that you feel that way: you are overwhelmed. And there's little that can be done about it. Recognizing, at least, that there's good reason for that feeling that you're always a little behind can make you feel better about it.

And perhaps if you try to learn two words a day, in 70 years you'll know all the current words, and maybe even those that have been introduced in that period of time, from A: "1. Symbol for GAIN. 2. Symbol for *area*. 3. Symbol for current." to Zymurgy: "The branch of chemistry concerned with fermentation." What the heck is that doing in an electronics dictionary? ■

Nils Conrad Persson

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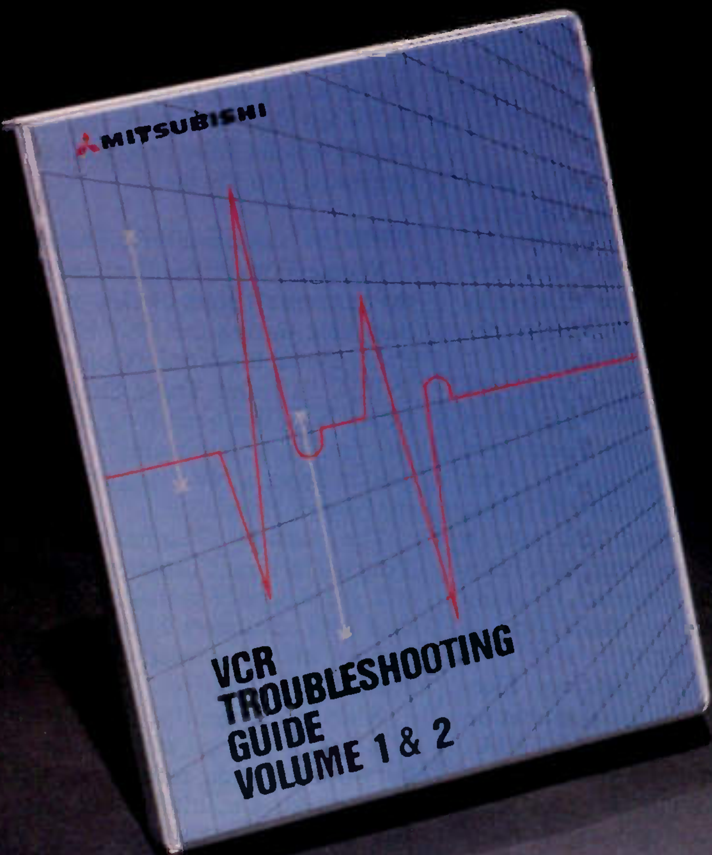

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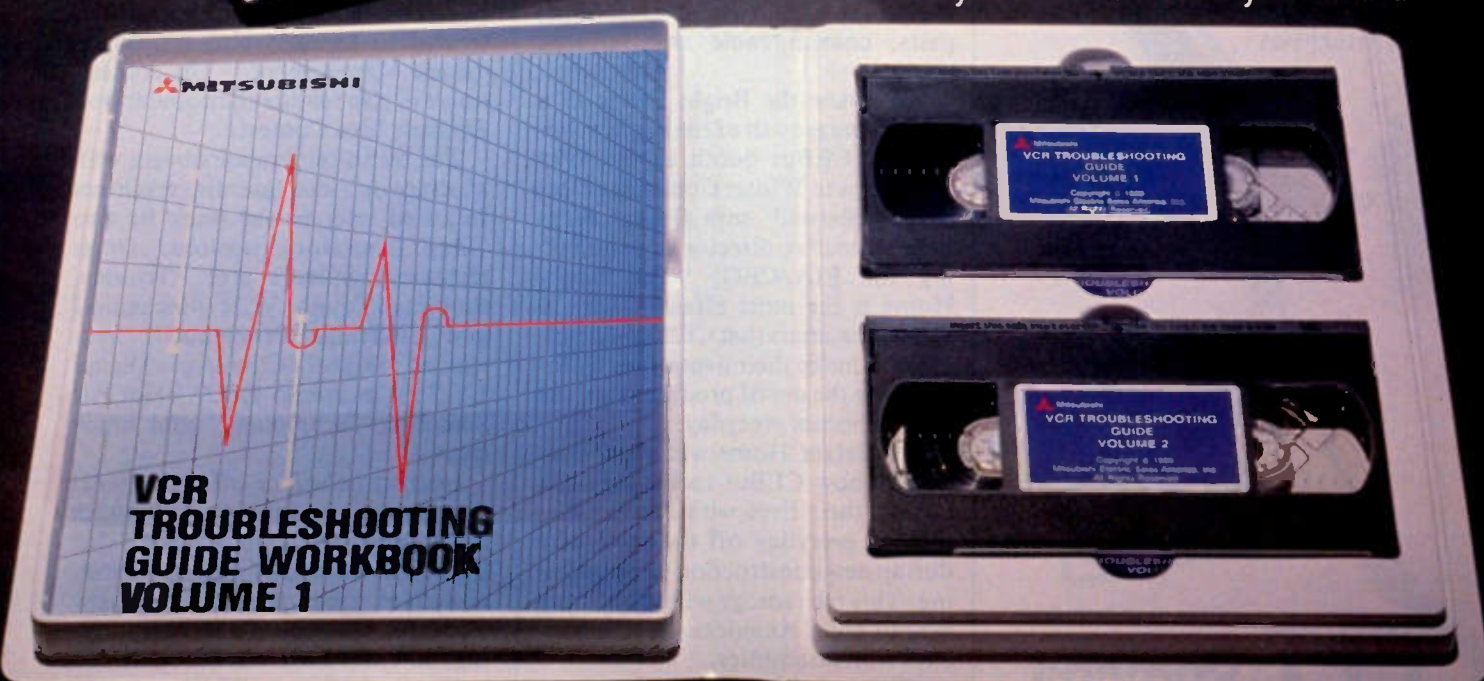

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America's first CEBus home set to open

The Bright Home, the first public working display of CEBus technology in the world, is currently being constructed in Indianapolis by Indianapolis Power and Light Company and PSI Energy of Plainfield, Indiana.

The Bright Home will link a variety of electronic equipment and appliances into a common intelligent-control system. The home will show customers that the many varied benefits CEBus technology offers can be obtained for a reasonable cost.

In fact, says Gary J. Shapiro, vice president of the Electronic Industries Association's Consumer Electronics Group (EIA/CEG), "unlike other home automation standards being proposed, consumers can take a 'building block' approach to CEBus technology, and integrate as many CEBus products into their home as their budget will allow.

CEBus, or the Consumer Electronic Bus, is the home automation standard being developed by EIA/CEG. CEBus allows communication throughout the home between a variety of electronic products over existing power lines, twisted (telephone) pairs, coaxial cable and infrared means.

"We view the Bright Home as a natural outgrowth of the goals we set for our CEBus booth at the 1989 Summer and Winter Consumer Electronics Shows," says George Hanover, executive director of engineering for EIA/CEG. "The Bright Home is the most effective way to show consumers that CEBus technology will make their lives easier by facilitating the use of products they use in their homes everyday.

The Bright Home will show consumers how CEBus technology can benefit their lives with the installation of everyday off-the-shelf wire during new construction or remodeling. This technology will specifically benefit older Americans and Americans with disabilities.

CEBus technology and products for the Bright Home are being provided by Indianapolis-based Hometronics, an integrated electronics consultant. Among the EIA-member companies contributing CEBus products to the Bright Home are Panasonic, Sony and Thomson/RCA. In addition to touring the Bright Home, visitors will be able to view an interactive video that will detail the many ways in which CEBus products can be integrated into a home.

NPEC 91' customer service seminar

Managers will view dilemmas from the customer's point of view at seminars held during 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.

The session "Turnabout: Put Yourself in Your Customer's Shoes" will show service managers how to deal with customers who have complaints, who are wrong, angry, indecisive or even abusive.

A seminar on getting the most out of a family business will be followed by workshops on retirement planning, business continuity and transfer, and business financing within a family business. Early arrivers will be treated to an early-bird session on "Basic Management." The convention will also feature the popular Best Business Idea Contest.

The technical seminars begin with a lecture on video laserdisc machines followed later in the week by two 2-day laboratory sessions. Other technical seminars are: "Troubleshooting Tough VCR Mechanical and Electronic Problems," "Advanced Digital Circuitry: Digital TV," "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. Manufacturers 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.

EIA helps tomorrow's electronic service technicians with unique model school program

A new generation of high school students interested in consumer electronics is being fashioned with the help of the Electronic Industries Association's Consumer Electronics Group (EIA). The Model School Program, now in its second year, will once again awards two all-expenses paid trips to the 1991 International Winter Consumer Electronics Show (CES) to two students enrolled in consumer electronics technician training programs developed by EIA and operating at Bladensburg, Suitland and Crossland high schools in Prince Geroges County, outside Washington, D.C. Sixty juniors and seniors in the three high schools compete against each other for the trips to CES within an established criteria developed by EIA's product services department.

EIA supports evaluation and testing of ghost canceling standard

The Electronic Industries Association's Consumer Electronics Group (EIA/CEG) has announced its support of the evaluation and testing of ghost canceling hardware here in the United States.

"The EIA/CEG is firmly behind the testing, evaluation and eventual adoption of a North American ghost canceling standard," says Gary J. Shapiro, vice president of EIA/CEG.

The process of ghost canceling employs special circuitry contained within television sets to adjust received television signals and eliminate or greatly reduce ghosts. This special circuitry uses a training pulse that is transmitted from the broadcasting source as a reference to eliminate these unwanted images, which are reflected from buildings and other objects.

Currently, efforts are underway by the EIA, National Association of Broadcasters (NAB), and Advanced TV Systems Committee (ATSC) to arrive at a standard. According to George Hanover, EIA/CEG's executive director of engineering, "actual testing of a standard should begin to take place this year."

THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS
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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.

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Literature

Broad test equipment line in new catalog

Over 100 hand-held and benchtop test and measurement products, panel meters and accessories are featured in the new, free catalog from American Reliance Inc., El Monte, CA. Complete specifications are provided for a number of new products recently added to the firm's line, including: benchtop, programmable power supplies, two function generators, with built-in intelligent 100 MHz frequency counters; a cable tester with infinite cable storage to test up to 128 points, simple "one shot" E/EPROM programmer to program EPROMS up to 27513 and EEPROMS to 28256. Also included is a hand-held, drop-proof LCR meter, with dissipation factor of D = 1/Q, a drop-proof DMM/wattmeter with true ac power measurement to 5.5KW; two heavy-duty hand-held DMM's, telephone transmission line testers, and a heavy-duty power supply, offering 1-15V variable dc power and capable of supplying up to 30A.

Circle (60) on Reply Card

New 1991 catalog

Sixty five ways to save time and money designing and testing today's electronics is a new 36-page catalog from Global Specialities, featuring high performance affordably priced electronic testing and prototyping equipment.

The catalog is packed with products: digital multimeters, test instruments, power supplies, frequency counters, logic test, breadboards, and PC prototyping cards.

New products featured include a ten instrument in one handheld multimeter, three logic analysis test kits, and a digitally synthesized function generator.

Circle (61) 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.

Circle (62) on Reply Card

New catalog introduces SMT and microprocessor test accessories

Pomona Electronics has introduced a new, 140-page 1991 catalog of electronic test accessories. Highlights include a new 32-pin PLCC (0.05 pin spacing) clip for popular new EEPROM devices and 100 and 132 pin QFP SMT test clips for Motorola 68020/68030 and Intel 80386SX microprocessors. Additional accessories to make testing SMT devices easier and more reliable provide a complete solution for this growing area.

The catalog also features new IC clip kits, coax/BNC universal adapter kits, digital multimeter test lead kits, cable and patch accessories and jumper kits.

Ten major product categories are presented with an easy-to-use index and includes the company's most popular selection of jumpers and cables, boxes, plugs and jacks, connectors, adapters, single-point test clips and static control devices.

Circle (63) on Reply Card

Home automation catalog

Heath Company announces the premier issue of "Home Automation", a catalog that encompasses a broad scope of consumer products designed for safety, security, convenience, entertainment and energy management. These products are designed to create a home environment that is a safer and easier place to live, convenient, easy to manage and energy-efficient.

This issue is a 36-page, full color catalog that is highly consumer-oriented, aimed at the do-it-yourself home enthusiast, as well as the electronics innovator. Products include whole house automation and security systems, motion-sensing indoor and outdoor lighting controls, wall switches, security cameras, portable security alarms, wireless video broadcasters, wireless phone extensions, flood sensor alarms, energy-saving thermostats, automatic lawn sprinkling systems and more.

Circle (64) on Reply Card

Honing your business skills

By William J. Lynott

The profile of the typical electronics service dealer is easy to describe. I see it frequently in my travels.

In a surprisingly high percentage of cases, today's electronics service dealer got his start (female owners of service companies are still relatively rare) as a service technician. Very often, his technical skills are considerably above the average of electronics technicians in general.

Almost uniformly, though, he founded or bought his service business with little or no formal business training. Despite his skill in maneuvering around technical problems, he lacks knowledge in all but the most elementary business considerations. As a result, his business lacks the vitality that could easily be injected into it.

And, I'm sorry to say, the older he is, the less receptive he is likely to be to the idea that his own business skills are in need of honing. (Please don't write or call to accuse me of being biased against "older" folks. After nearly 40 years in the business world, I hardly qualify as a smart alec youngster.)

Despite this pattern, though, I've also seen plenty of examples of service dealers who decided they were tired of the burden imposed on them by their lack of business training. Once they decided to do something about it, it's gratifying to see how quickly new life can be infused into their businesses.

Realistically, reading a monthly column like this isn't going to provide the kind of business training I'm talking about. It can be a start, though; especially if it sparks enough interest to generate further efforts. So, if you happen to fall into that category of technician-turned-businessman, I offer these suggestions as the *beginning* of your program for developing strong business skills to complement your technical abilities.

First, and perhaps most important of all, recognize and openly admit your need for more training. Once you've gotten that out of the way, the rest becomes much easier.

Then you should begin to look for opportunities to attend management courses. They're all around you, but you have to make at least a little effort to find them. Your local community college probably offers night classes that would fit into your schedule. If you belong to a trade association, make sure that you attend any management sessions or seminars that they sponsor.

In particular, look for courses that will help you to use and understand financial statements for your business. They are invaluable tools that can help you only if you understand the information they contain.

Next, learn to spend more time on business reading than you probably do now. And I don't mean just electronics trade journals like **ES&T**. As important as they are to the success of your business, trade journals alone cannot provide the full depth of management insights that you need to grow your business to its full potential. A visit to your local library will offer you a broad selection of general business management material. Don't hesitate to ask your librarian for help. That's what they are trained for. Describe your situation and ask for some recommendations. People like to be complimented, and asking a professional librarian for help is a genuine compliment.

Once you begin to broaden your perspectives on business management, chances are you'll become aware of another important characteristic of successful business executives - strong people skills.

If there is one universal truth in business, it is that you cannot succeed entirely on your own efforts. Without exception, the world's most successful business people affirm the need for the guidance and help of others. And one absolute requirement in recruiting the help of others - friends, family, business acquaintances, employees - is the ability to relate comfortably to other people.

It's sad but true that many fine people, fully deserving the help and guidance of others, don't get it because they haven't learned how to communicate skillfully.

If you stop and think about it, you will realize that the only effective way we have to communicate out thoughts, ideas and objectives is through the spoken or written word. How can we ask someone to support us in a given project if we are unable to communicate our thoughts with precision? And yet, that is the handicap that faces every business person who has failed to develop good communication skills.

And so, as the last step in your program for broadening your business skills, I suggest that you set about to improve your understanding and usage of the English language. Despite long years of experience, I am still surprised at the numbers of otherwise sophisticated business persons who cannot sit down and compose a lucid and precise letter. Nothing fancy, mind you, just plain, easy-to-understand English.

Years ago, I began a little collection of what I call "clunkers" - amusing business letters that are virtually impossible to decipher. The collection is large and still growing. Many were written by otherwise well-educated people who try to communicate by trying to be impressive.

I know that to some dealers this whole business will seem too much bother and much too theoretical. I hope you don't feel that way. A practical, carefully thought out marketing plan is one of the surest roads I know to success for service dealers. ■

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

Test equipment update

Wading through the new multimeters

By Conrad Persson

Let's face it: even though the benches of most technicians in well equipped service facilities bristle with the latest test equipment, all of it needed at one time or another, the test device of choice for most technicians is the trusty DMM. It's small, lightweight, compact, familiar, easy to use, and in a lot of cases it's the only piece of test equipment needed.

Of course no simple piece of test equipment will allow even the best of technicians to troubleshoot every problem; that's why there are so many specialized pieces of test equipment to make troubleshooting more efficient. But the ever increasing capabilities of today's multimeters make it possible to troubleshoot more and more kinds of problems with nothing but the DMM.

Increasing capabilities

A glance at the New Product sections of any of the magazines aimed at electronics technicians and engineers will reveal that the DMM of today is a far cry from the DMM of just a few years ago. For starters, the size of these devices seems to have standardized at something just a little larger than shirt pocket sized.

No doubt the design and capabilities of DMMs have responded to the same forces that have contributed to the recent changes in the consumer electronic products that they are used to measure. For one thing, the users have demanded that they do more and do it better, and the increasing miniaturization and decreasing cost of electronic components and ICs are making it possible to put more and more functions in a smaller and smaller space with steady or decreasing cost.

A closer look at a modern DMM will reveal some other amazing changes that have taken place in the last few years. Most of today's DMMs feature nice large LCD displays. But besides featuring large numerals for digital readout of the value being measured, most also feature some kind of "bar-graph" display; a row of small vertical bars at the bottom that react to the measured parameter, much as the pointers of the old standby analog meters.

The bar graphs were added because DMM users complained that while the digital readout was great for precise measurement of steady-state values, the swinging of the old standby pointer gave a nice indication of trends that was missing from the changing digits of the numeric display.

But that's not the only thing that's changed in the last few years. Here are some of the other features that some of today's DMMs offer.

Diode check and transistor beta

Because most of today's electronic equipment is based on solid-state components; diodes, transistors, ICs, a handy feature for electronics specialists would be a small, hand-held tester that would test semiconductor junctions and also test to see if transistors were providing the amplification they were designed for. DMM manufacturers responded to this need by adding tests for diode junction and transistor beta (Hfe).

Capacitance and frequency check

Until recently, you could check volts, amps and ohms on your DMM, but if you wanted to determine the value of a capacitor or measure the frequency of a waveform you had to pull out the capacitance meter or the frequency counter. Now that the manufacturers have added not only capacitance measurement but also frequency measurement to the high-end DMMs, you can, within limits, measure those parameters with the trusty, familiar DMM as well.

Still more

But today's DMMs don't stop there. Many also offer true RMS measurement, differential measurement, continuity indicators, reading hold, LED test, high voltage warning indicator, oversize display. Depending on your particular needs, you may want a DMM with all of these, or none, or something in between.

Keep a log

Prices of today's DMMs range from somewhat less than $100 to several hundred dollars. Which one should you buy? That's a question that only you can answer. All of the major brands of meters are reliable, rugged, accurate, and the manufacturers stand behind the product. The biggest differences in DMMs are the differences in number of functions and ranges, accuracy and ruggedness.

For example, you'll find that the low end meters typically have cases that are manufactured from a plastic material that may crack or break if the unit is dropped from any significant height. Another feature you'll find in the higher priced meters that you won't find in the less expensive meters is a gasket where the two halves of the meter come together in order to keep out contaminants.

Persson is editor of ES&T.

Furthermore, the lower end meters will usually offer only the standard functions like ac and dc volts, ac and dc milliampere measurements and ohms. They're usually lacking measurements such as capacitance, diode test, true RMS and other advanced features. The best way for you to decide which of the features and functions you'll need in a meter is to make a list of those that you regularly use or depend on and compare that list to the list of features offered by the meters you have in mind. When you find the meters that come closest to your set of requirements, consider which brand name or names you feel best about, then look at the prices.

Your best bet in a meter is the least expensive one that meets your requirements and has a name you can trust. One way to make the correct decision when decision time comes is to make notes, either separately, or on your service logs each time you make some kind of measurement.

Then when you're in the process of selecting a DMM you can review those notes to see how often you make measurements with the DMM, what kinds of measurements you make, and what kinds of measurements would have been easier if your DMM had those functions. Such a procedure will help you through the maze of modern DMMs. ■

DMM COMPARISON CHART

	YOUR NEEDS	MFR 1	MFR 2	MFR 3
MODEL				
LIST PRICE				
FUNCTIONS				
DC Volts Ranges Accuracy				
AC Volts Ranges Accuracy				
Ohms Ranges				
AC & DC Current Ranges				
Maximum Current				
Frequency Accuracy				
Sensitivity (2KHz-2MHz) Low Level Sine Waves TTL & CMOS				
Capacitance Ranges Accuracy				
Transistor Beta				
Max Reading				
OVERLOAD PROTECTION				
Volts 200 mV Ranges All Other Ranges				
Frequency Ranges				
Ohms Ranges				
INDICATORS				
Continuity				
Logic Probe				
Diode Test				
LED Test				
Battery Life				
Size				
Warranty				
Heavy Duty				
High-Voltage Warning Indicator				
Peakhold				
Oversize Display				

Figure 1. Using a comparison chart such as this, you can pin down your DMM needs and compare the offerings of several manufacturers to those requirements.

Servicing VCR servo problems

By Brian Phelps

Regardless of size and volume of business, service centers that service VCRs all have one thing in common: the defects that they encounter most frequently are mechanical. This includes belts, idlers, pinch rollers, and dirty VCRs in need of cleaning. But why are some technicians having difficulty servicing VCRs, especially if 70% of the problems are truly mechanical?

Mechanical or electrical servo

Often a technician can be misled down dark alleys when a VCR comes in for repair and the defect isn't mechanical. It's the electrical defects in 30% of the VCRs that need repair that tend to throw many techs for a loop.

Many technicians have found that VCR servo problems are tougher to troubleshoot than problems in other VCR circuits. However, with a good understanding of how VCR servos work, adequate test equipment, and organized troubleshooting methods, servicing servos can be made manageable. Let's first look at why servo circuits can present a challenge for servicers:

1). Servos have both electrical and mechanical components. Either the electrical or the mechanical defects can cause nearly the same symptoms.
2). Servos are self-correcting feedback loops. A problem in any part of the loop causes all the signals to be wrong. This makes it tough to find problems with only a meter or scope.
3). Most servos use a feedback loop inside another feedback loop (more detail on this later). A defect in either loop causes the signals in both loops to be wrong, making signal measurements confusing.

Phelps is Marketing Specialist with Sencore for Electronics Service Centers.

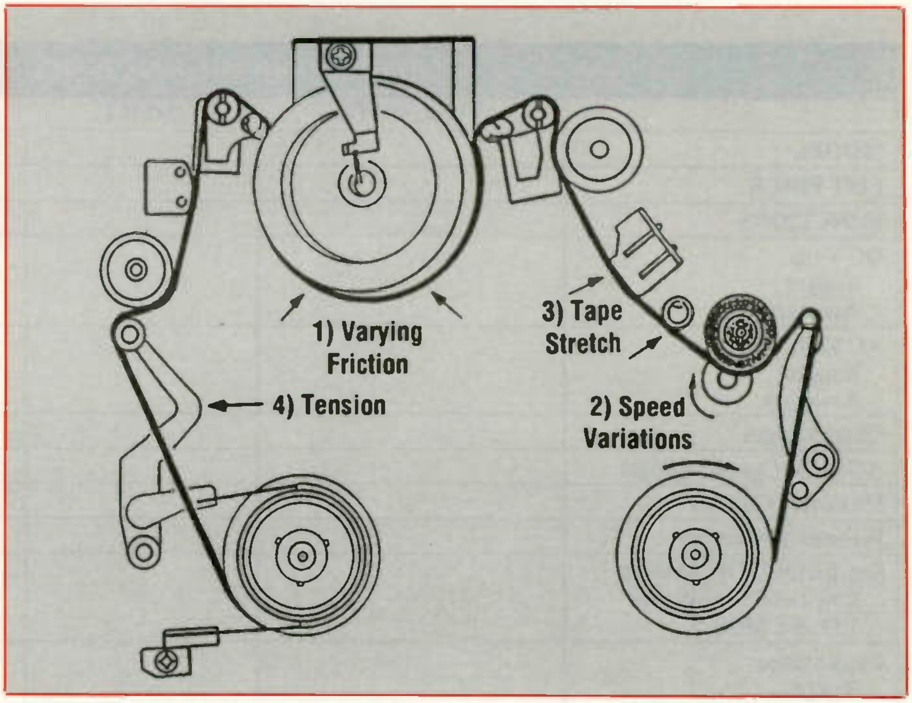

Figure 1. The electrical circuits must constantly correct for any mechanical variations. Unfortunately for technicians, many defects can be tough to determine if it is mechanical or electrical.

4). There are two separate sets of servos; the capstan servo controls tape movement, and the drum (or cylinder) servo controls the spinning video heads. Problems in one may cause symptoms similar to symptoms caused by problems in the other.
5). The servos interact with the system control circuits. Servo problems often look like system control problems and vice versa.
6). Servo problems may look like a luminance circuit defect, or vice versa.

The functions of the servos in a VCR

The main purpose of the servos in a VCR is to electrically correct and synchronize the mechanical components in order to record or reproduce video and audio. In order for the VCR to produce a normal picture during playback, the spinning video heads must travel over the exact same tape path traveled by the heads during recording. The servos must correct for many varying mechanical factors during the playback mode in order to maintain this precise head/tape relationship. Some of these mechanical factors are (see Figure 1):

1). Varying friction between the heads and the tape, which causes the speed of the heads to change.
2). Variations in the exact tape speed from one VCR to the next.
3). Stretching of the tape, which changes the tiny physical spacing between the stripes of video information.
4). Miscellaneous variations, such as power supply regulation, tape tension, wear on the motor bearings, and changes in mechanical parts.

To correct for all of these vari-

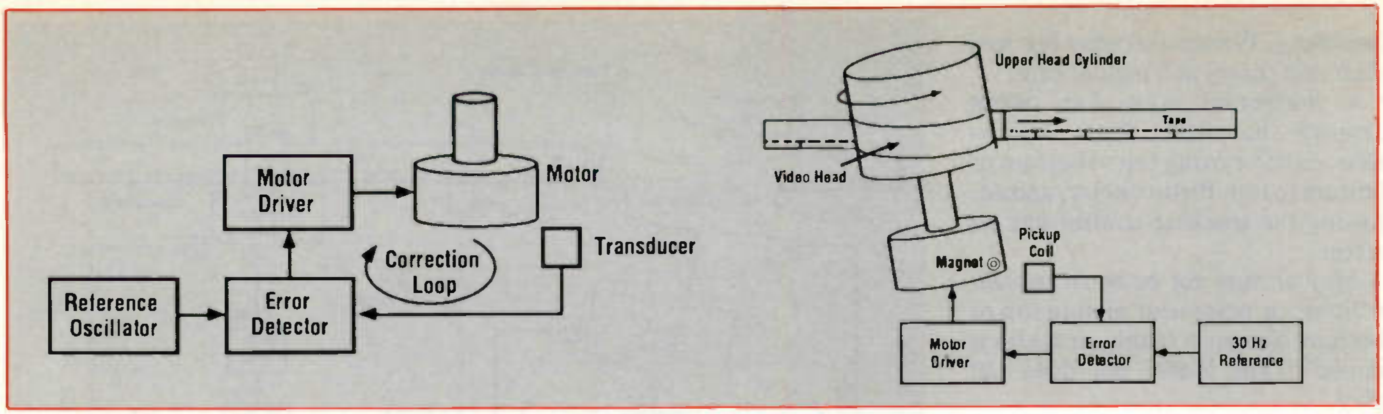

Figure 2. All basic servos are made up of these five stages: reference, error detector, motor, motor driver, and a signal transducer.

ables, the servos must track the tape through the VCR and continually make corrections. Before we can actually look at troubleshooting the servo circuits, lets take a couple of minutes and remind ourselves what makes up a typical servo.

Servo components

The basic servo has five main sections (see Figure 2):

1). Motor: The motor's speed must be controllable. Various schemes are used, but all have a way to adjust speed by varying a dc voltage.

2). Transducer: A transducer converts the mechanical motion into an electrical signal that the circuits can process in order to provide information to the correction circuits.

3). The Reference Oscillator: The only way to tell if the transducer output represents an error is to compare it to a known good signal. VCRs use a stable 29.97Hz reference signal for comparison.

4). Error Detector: The error detector compares the phase or frequency of a transducer output with the reference signal and produces a varying dc signal. The varying dc then corrects the motor speed through the motor driver.

5). The Motor Driver: The motor driver converts the dc voltage from the error detector to the form needed to control the motor's speed.

The dual-loop servo

Most VCR servos now use both a speed loop and a phase loop (see Figure 3). The function of the speed loop is to quickly get the motor to a speed near the normal operating speed. This loop can be very fast, but does not have to be extremely accurate, because it provides coarse control of the motor speed.

The phase loop, then "fine tunes" the actions of the first loop. The phase loop compares the phase of the control track or a pulse generator to the 29.97Hz reference signal, just as the single-loop servos did. However, since it only has to make minor adjustments to the correction supplied by the speed loop, it can do so quickly. By combining the two loops, we get both correct speed and precise positioning.

Organized troubleshooting methods can simply servo analysis

The main difficulty in isolating servo problems is the way several feedback loops overlap each other. It's common to spend time troubleshooting one loop, and to learn later that the trouble was really in a different loop. To avoid this, follow these steps (each is covered in detail later):

- Confirm that the symptom is really a servo problem by analyzing the symptoms with a test tape. This is a tape that you can make for yourself on a properly adjusted VCR by recording a selection of signals from a video test pattern generator, and from an audio tone generator. Record the same information in all three VCR speeds; SP, LP and SLP so that you can check both the VCR's ability to play at all three speeds and the VCR's ability to switch properly among all three speeds.
- Confirm that the 3.579545MHz reference signal is correct using a digital frequency counter.

Check the feedback loop

- Confirm if the cylinder and capstan loops are locked to each other by comparing the head-PG and the control-track signals to see if they are locked together.
- Separate problems in the capstan servo from those in the cylinder servo by testing the 29.97Hz feedback signals of both to see which one is wrong (see Figure 4).
- Once you've isolated the problem to one of the servos, separate speed from phase loop problems with a combination of signal tracing and signal injection.
- Narrow the problem to a particular component with signal tracing or component tests.

Step 1: Confirming that it's a servo problem

Most servo defects cause picture tearing, and may also affect the linear audio. Some servo troubles may also blank the picture, hiding the true symptom.

Picture tearing may take several forms. Sometimes the picture is clear for a while, gradually turns to noise, and then gradually returns to normal. In other cases, a noise bar intermittently moves through the picture, either from top to bottom or from bottom to top. In still other cases, the picture jumps up and down, or noise appears at the top or bottom of the picture.

Servo symptoms can be even more confusing when they combine with problems in other circuits. The following checklist can help you determine which problems are servo related and which are not.

Probably are servo related:

- Linear (not Hi-Fi) audio is at wrong speed.
- Linear audio is changing in pitch

(warbling). Picture alternates between clear and snowy at a regular rate.

• A horizontal noise bar passes through the picture from time to time, either moving top to bottom or bottom to top. Picture noisy, and adjusting the tracking control has no effect.

May or may not be servo related:

• Jitter, or noise near picture top or bottom. Screen is blank, or audio is muted. Tape loads, but does not play.

• Machine begins to move tape, but then shuts down.

• VCR plays tapes it recorded okay, but will not play tapes recorded on another machine.

Probably not servo related: (Probable cause shown for each)

• Picture is always snowy or constantly noisy, but tracking control changes results. (Bad head signal)

• Picture has a noise bar which remains in the same position on the screen. (Tape path)

• Picture has a line running horizontally across the screen from left to right. (Scratched tape)

• Color is intermittent (or missing) but black and white (luminance) signal is okay. (Bad color circuit or weak head signal)

• Picture changes in brightness as tape plays; especially on copies of tapes. (Copy protection on copied tape)

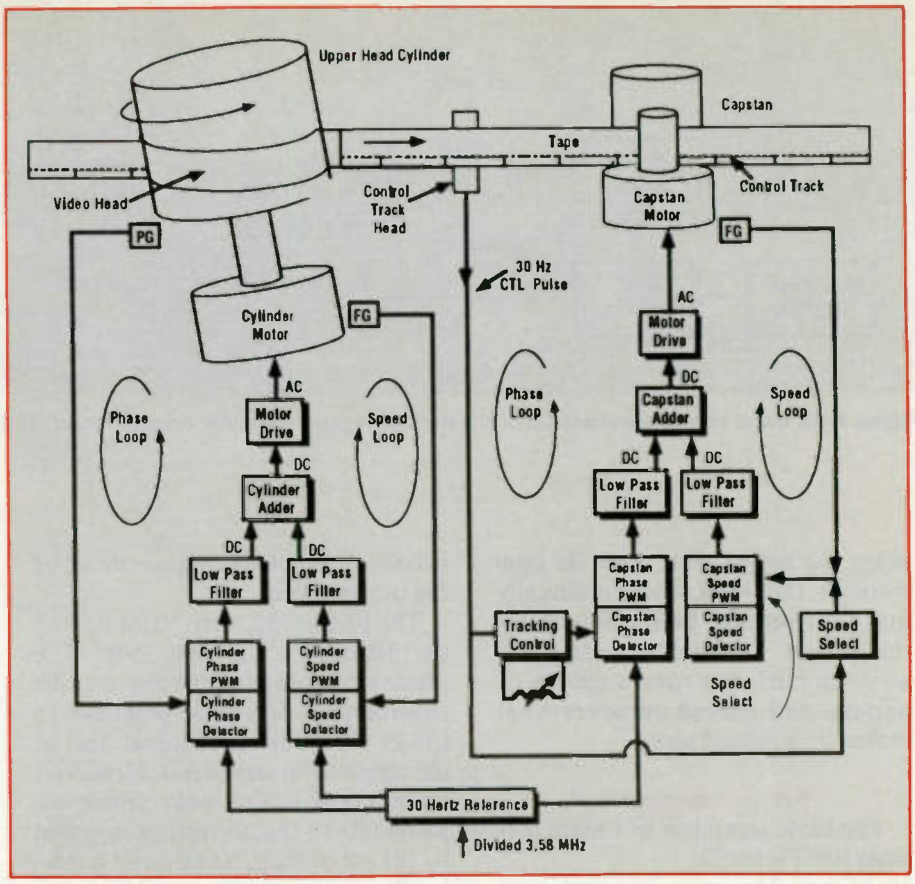

Figure 3. Modern VCR servo circuits use both a speed and a phase loop for the cylinder and capstan motors. This requires technicians to troubleshoot and understand the operation of four servo loops.

Step 2: Testing the reference signals

If symptoms point to the likelihood of a servo problem, follow a plan to isolate the specific problem. If the VCR lets you get to the 29.97Hz reference signal, test it first. Errors in this signal can produce a wide range of symptoms, including loss of color, poor horizontal sync, and incompatibility between tapes recorded in one VCR versus another.

The two essential parameters of the reference signal are its frequency and its amplitude. A quick check of waveshape with a scope is not adequate to confirm either.

The peak-to-peak amplitude must be large enough to trigger the later stages. If the amplitude is low, the circuits may intermittently trigger on the signal, which leads to unreliable operation. Simply use a "VPP" meter or count graticules on your scope to verify the correct signal amplitude.

The signal must operate at the correct frequency, since the color and sync frequencies of the played back video are affected by the servos. Even a 100Hz error in the reference can change the color and the horizontal sync frequencies enough to cause problems.

To test the reference frequency, you must use either an oscilloscope with a digital frequency display, or a frequency counter. Counting the scope graticules simply will not give you the accuracy needed.

Step 3: Compare cylinder and capstan feedback

Sometimes a servo symptom directly indicates if a problem is in the capstan or cylinder (sometimes called head or drum) servo. For example, audio at the wrong speed shows that the capstan servo is turning at the wrong rate. Or, you can occasionally confirm that a cylinder motor is turning much too fast or slow by its sound.

But many problems are more subtle. They could be caused by problems in either servo. For example, a defective capstan phase loop can cause intermittent picture tearing. The capstan's speed loop may operate the motor so close to normal that the tape's audio plays normally, which could lead you to troubleshoot the cylinder servo.

The easiest way to confirm if the servos are locked is to compare the phase feedback signal in each servo to the phase signal in the other servo. If the servos are working, these two signals are locked to each other, indirectly through comparison to the internal 29.97Hz reference signal. If they are locked, the problem is not really in the servos, so you should turn your attention elsewhere.

The capstan feedback signal comes from the control-track head. The signal at the head itself is usually very small, so you may wish to pick up the signal after an amplifier.

A special signal, called the "control track," lets the VCR detect variation in tape movement. The control track is recorded along the bottom edge of the tape by a stationary head to mark the spot where the spinning

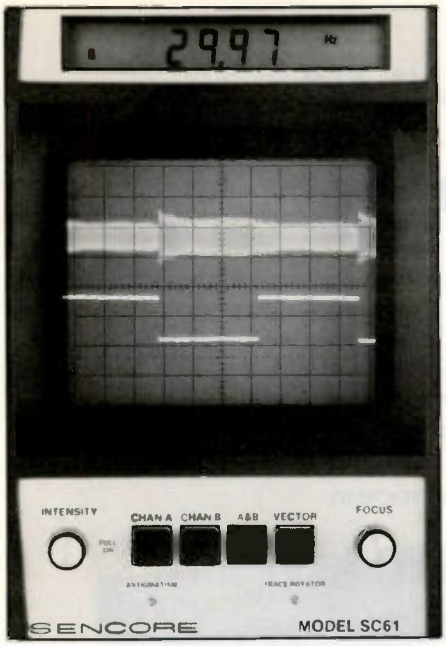

Figure 4. The exact frequency of the 29.97Hz reference signal is critical. Although most technicians and service literature refers to this signal as 30Hz, it must be 29.97Hz or the servo circuits will not operate correctly.

video head begins recording a vertical frame of video information.

The control track signal is a 29.97Hz signal synchronized to the video head rotation. One of the signal transitions marks the beginning of a video frame of information.

Because the video heads use an azimuth shift to reduce interference, the same video head must play back the signal track it recorded. The servos compare the timing of the control track transition to keep the correct head in contact with the correct signal path at all times.

The cylinder feedback comes from the PG generator on the head-motor assembly. Some VCR motors combine the PG and the FG signal into one output.

Remember, some servo problems cause the VCR to work correctly on one or more tape speeds, but not on others. If you suspect speed compatibility problems, use a test tape recorded with samples of each tape speed. Confirm that the servos properly switch from one tape speed to the next.

Separate cylinder from capstan problems

If the signals are not locked to each other, use a frequency counter to determine which one is wrong. Each PG feedback signal should measure 29.97Hz, within 0.1Hz.

If the control track signal has the correct frequency, measure the PG signal from the head assembly. If the deck uses a circuit which combines the PG and FG signal into one pulse train, you'll need a sync separator, either as part of your oscilloscope or as a separate device in order to trigger directly to either the PG or FG signal.

Separate phase from speed loops

The comparison of the 29.97Hz feedback signals identifies whether problems are in the capstan or the cylinder circuits. If the defective signal is very close to the correct signal, the speed loop is most probably working, so troubleshoot the phase loop.

If the frequency is considerably out of tolerance, you can't be certain which loop is defective, so the following steps are needed to confirm the problem.

The combination of signal injection and signal tracing works the best. Inject a dc voltage into the test point that controls the motor speed. This is the test point after the circuit that mixes the correction voltages from the error detectors from the two loops.

By manually adjusting the voltage, you should be able to control the motor's speed until it runs near the normal speed. (Sometimes, the motor will "fight" adjustment to the exact speed, since one of the servo loops may cause the voltage to change as you adjust the dc supply control to a voltage near the ideal level. The motor might jump between speeds above and below normal rates).

If you cannot get the motor to a speed near normal, suspect a problem in the motor or the motor driver. Adjust the external dc until the motor runs as close as possible to its normal speed. Then, follow the FG signal path.

Measure the FG output directly, to confirm that it produces an output of the correct amplitude and frequency. Remember that the frequency will probably not be exact, since the external dc voltage only gets the motor close to the correct speed.

If the FG signal appears normal, continue tracing the signal through the various stages back to the FG error detector. If the entire FG loop has normal signals, finish your test of the

speed loop by connecting your scope probe to the error detector output. Carefully monitor the dc level as you change the speed of the motor by varying the dc substitution voltage.

If the error detector does not respond, suspect that the error detector or the storage capacitor at its output may be the problem.

If the speed loop checks okay, the problem is most likely in the phase loop. Trace the signals from the phase-loop's PG source through the error detector, just as you did in the speed loop. One important difference happens when you vary the speed of the motor manually. The phase loop will normally alternate between highest and lowest values, even if the motor is turning at nearly the correct speed, since the phase between the PG and the reference signals are random. If you see very small changes at the error detector output, check the components related to the error detector.

Step 4: Special notes on pulse width modulator correction signals

When testing pulse-width-modulator (PWM) error detectors, watch for correction at the PWM output, ahead of the low-pass filter (LPF). Confirm normal correction by increasing the physical drag on the motor or a pulley to see if the PWM duty cycle changes in a normal fashion. Lightly touch a rotating part with your finger to cause a change.

When connected ahead of the VCR's LPF, a digital dc voltmeter shows the average dc level represented by the square wave, which is the same correction voltage at the LPF output. A scope should be used to view the actual response of the waveform.

With a servo defect, the PWM output will often be abnormally steady or varying rapidly from maximum to minimum width. The steady condition may be a square wave with constant duty cycle, one at maximum or minimum width, or a steady dc near the peak PWM value or ground.

Finally, test the motor and motor driver. Servo problems are often caused by mechanical or electrical problems in the motor or its driver, which are after the error detectors. If so, both loops will test normally as you move through the various test points, but servo errors remain.

The way the motor responds to your substitute dc controlling signal tells a lot about the operation of the motor and motor driver. Changing the substitute dc value should cause the motor to change speeds, but the motor should turn smoothly at any speed.

You might not be able to get the motor to its exact operating speed, because the motor driver has extremely high gain. It is normal for variations of only a few tenths of a volt from the normal "zero correction" level to drastically change the motor speed.

The important thing is that attentive control of the dc voltage should let you get the rotational speed near normal. If the motor fails to turn, or if it always goes too fast or too slowly with a normal range of dc inputs, the servo problem is in the driver or the motor.

If you think the motor driver circuits are at fault, continue to feed the substitute dc voltage into the driver, while you trace the two or three phase ac motor drive signals with your scope. Confirm that each driving signal has the same waveshape, frequency, peak-to-peak level, and dc bias as the others by observing the CRT. If one signal differs from the others, the driver circuits are at fault, or the motor has a bad winding.

If you still have any questions on VCR servo servicing whether it be mechanical or electrical, there are many sources of information available to help, from books, video tapes, test instrument companies, to Tech Schools. But don't get discouraged when caught in the servo loop, just remember each stage has a basic function and simply break the loop and take control of the circuit. ■

Understanding AGC–Part III

By Lambert C. Huneault, CET

This is the final installment of a three part series. In the first installment, which appeared in the February 1991 issue, the author described the fundamental principles of AGC and some of its applications. The second installment covered forward AGC, reverse AGC, AGC in FM radios and AGC in television.

This concluding segment contains information on keyed AGC, delayed AGC, AGC controls, AGC in integrated circuits, automatic color control (ACC) and automatic saturation control (ASC).

Please note that we have continued the figure numbers from the previous articles, so there are no Figures 1 through 8 in this installment. Figure 9, which appeared in Part II of this series is repeated here because the conclusion of that part is needed as introduction to this part.

Television AGC

The end result of television AGC, as discussed in Part II of this series of articles on AGC is that the video signal reaching the CRT remains virtually constant in overall amplitude (steady contrast) even when signals of different strength are tuned in.

Or so it would seem!

Unfortunately, there's a fly in the ointment . . . three of them, as a matter of fact! The first problem is that in addition to varying in response to changes in the RF signal strength (as it should), the average voltage of the detected video signal also varies in response to changes in picture brightness.

In Figure 9, the dc voltage at the output of the detector becomes more negative during a dark scene, while bright pictures produce less- negative voltage. This affects AGC operation adversely.

Secondly, if high-amplitude noise is received with the signal, excessive AGC voltage is produced.

And thirdly, simple AGC is too slow-acting to effectively combat aircraft flutter; the reason being the *long* time constant of the R1-C1 low-pass filter necessary to filter out the lowest frequency components of the video signal, such as 60Hz vertical blanking and sync.

Keyed AGC to the rescue!

Switching the AGC detector at the horizontal sync rate provides an effective and very popular solution to the triple-pronged problem. Figure 10 is an example of this switching concept, usually called *keyed AGC* or *gated AGC*.

Positive-going video is applied to the base of the AGC gate (Q1). Note that the collector of this transistor is not supplied with any Vcc voltage. Instead, positive-going keying pulses from the flyback transformer provide it with "temporary B+" during each horizontal retrace.

Q1 is normally cut off because its base-emitter junction is reverse biased by the negative dc voltage supplied via the AGC control. However, the peaks of the video signal (sync pulses) are sufficiently positive to overcome this reverse bias and drive the transistor out of cutoff at the same time as the keying pulses are applied to the collector via C1 and X1. Although very brief in duration—the

Huneault now retired, was an electronics instructor and head of the REE Department at St. Clair College of Applied Arts and Technology in Ontario, Canada.

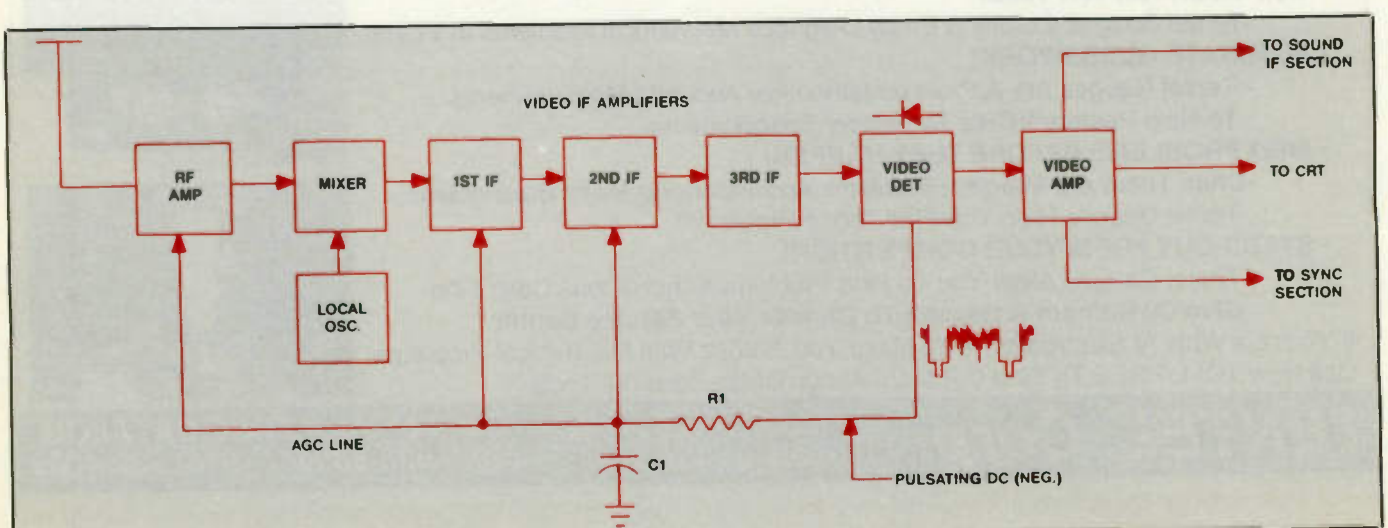

Figure 9.

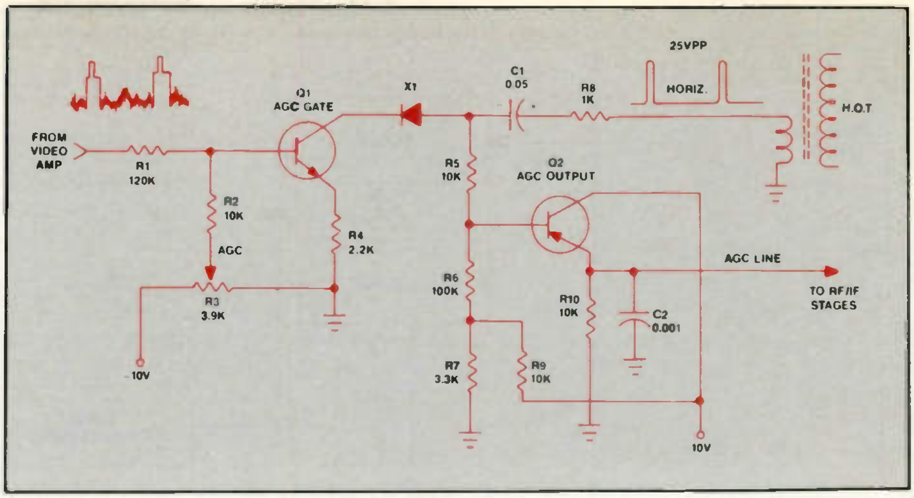

Figure 10.

transistor switches off as soon as the sync and flyback pulses end — the resulting collector current charges the AGC reservoir (capacitor C1) with the polarity shown.

Naturally, the stronger the RF signal tuned in, the higher the amplitude of the sync tips in the composite video signal, and the heavier the transistor conduction; hence, the greater the charge on C1. During the relatively long interval between keying pulses, C1 discharges to ground via R5, R6 and R7.

Q2 is an emitter follower. Forward bias for its base is supplied from a – 10V source via the R9-R7 voltage divider and resistor R6. The C1 discharging current simply increases this forward bias by an amount proportional to signal strength.

The AGC output is taken off the emitter of Q2 and filtered by C2. The negative voltage on the AGC line is applied to the controlled RF and IF stages.

X1 is a protective diode used to prevent the negative dc voltage produced by C1 (and the negative alternation of flyback transformer signal) from being applied to the collector of Q1, because it would forward bias the collector-base junction.

Advantages of keyed AGC

What's so great about keyed AGC? Well, for one thing, the AGC filter capacitor (C2 in Figure 10) can be made much smaller than in the simple AGC circuit of Figure 9, because the lowest frequency present in the AGC output is the 15kHz horizontal scanning frequency. Therefore the filter can feature a much shorter time constant, enabling the AGC voltage to change fast enough to combat aircraft flutter.

However, the main advantage results from the fact that the AGC gate remains in the off state during the relatively long period between sync pulses. It doesn't matter whether high-amplitude noise pulses occur during this interval, or whether the televised scene is bright or dark, the AGC voltage remains unaffected because the gate is turned off.

For this reason, gated AGC is generally featured in modern TV receivers, monochrome as well as color. The AGC circuitry may vary substantially from one model to another, but the circuit of Figure 10 illustrates the basic principle of keyed AGC. Also, Q2 illustrates the idea of *amplified AGC*. Although the emitter follower doesn't provide any voltage gain, its current gain is what's important because the AGC line has to supply base current to the controlled RF and IF transistors. Some circuits do, however, feature an AGC voltage amplifier.

Delayed AGC

Applying AGC to the RF amplifier is fine and dandy when strong signals are received. But when the receiver is tuned to a weak signal, any AGC voltage—even though small—applied to the tuner is bound to reduce the signal-to-noise ratio and possibly result in snowy pictures. For this reason, it is desirable to *delay* the application of AGC voltage to the RF amplifier until the signal becomes stronger.

A wide variety of *delayed AGC* circuits have been used over the years, ranging in complexity from a simple resistor connected between B+ and the RF AGC line (with or without an AGC clamp diode), to more elaborate circuitry featuring one or more transistors.

Figure 11 is a simplified schematic of a typical delayed AGC circuit; Q2 is the AGC delay transistor. The negative dc voltage produced by the AGC gate is amplified and inverted by Q1, thus providing positive control voltage for the IF amplifiers. An

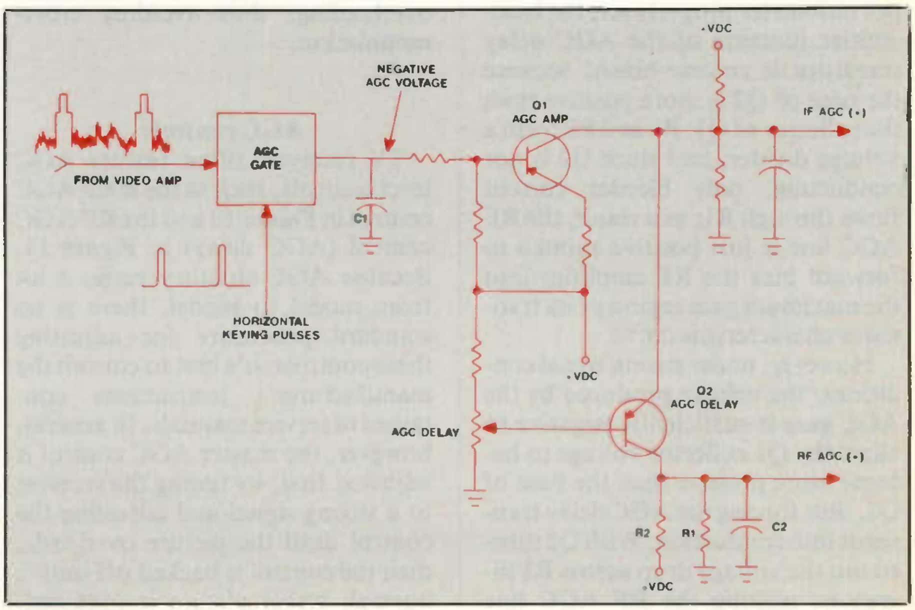

Figure 11.

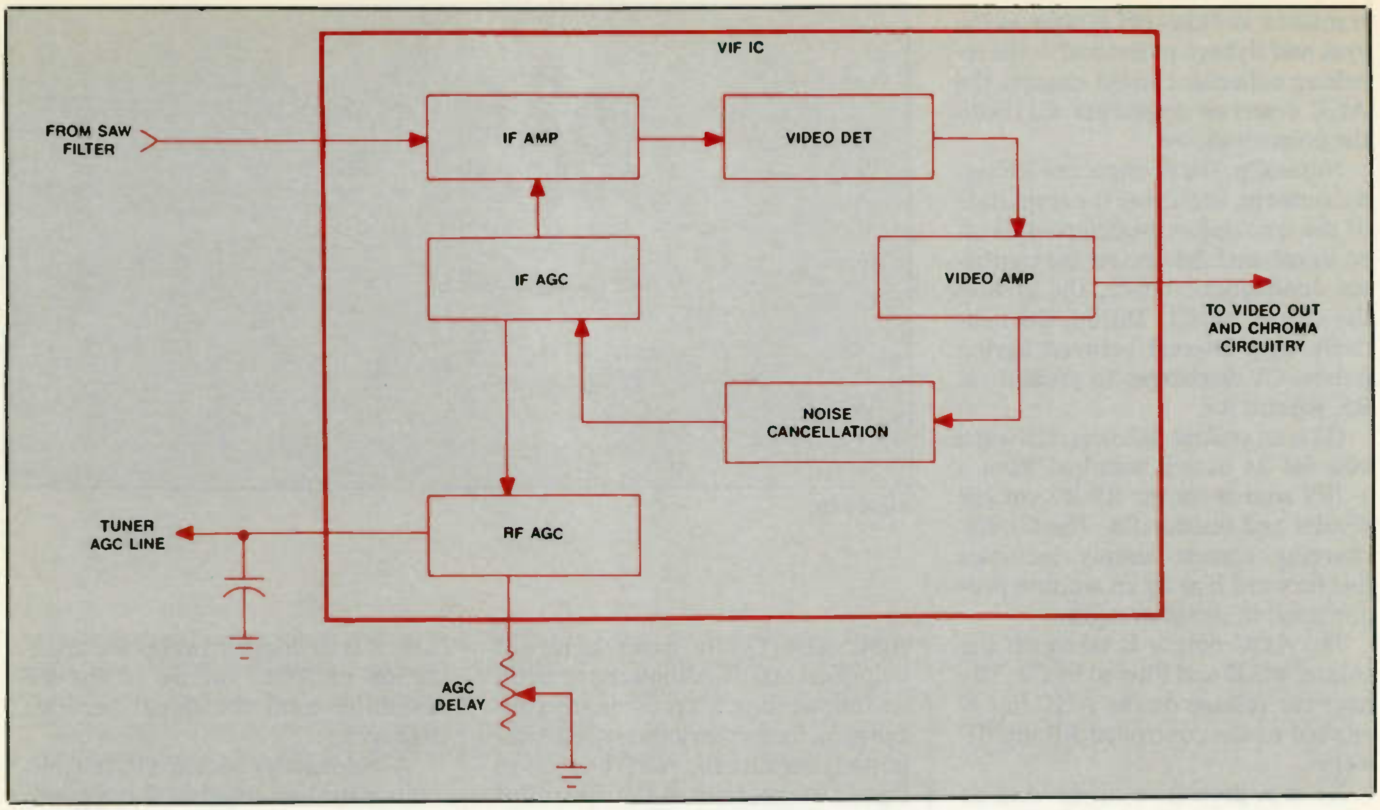

Figure 12.

increase in signal strength causes the Q1 base voltage to become less positive. The resulting increased conduction in the PNP transistor causes its collector voltage to become more positive; this increasing voltage is applied to the controlled video IF amplifiers (NPN transistors), decreasing their gain (forward AGC mode).

Under no-signal or weak-signal conditions, and with the AGC delay potentiometer properly set, the base-emitter junction of the AGC delay transistor is reverse biased because the base of Q2 is more positive than the collector of Q1. R1 and R2 form a voltage divider, and since Q2 is not conducting, only bleeder current flows through R1; as a result, the RF AGC line is just positive enough to forward bias the RF amplifier into the maximum gain region of its transistor characteristic curve.

However, under strong signal conditions, the voltage produced by the AGC gate is sufficiently negative to allow the Q1 collector voltage to become more positive than the base of Q2, thus forcing the AGC delay transistor into conduction. With Q2 turned on, the voltage drop across R1 increases, making the RF AGC line more positive and reducing the gain of the RF amplifier (NPN transistor) also operating in the forward AGC mode.

So we've seen that by delaying the tuner AGC, maximum RF amplifier gain is available for weak signals when it's needed, thus providing a maximum signal-to-noise ratio; but when a strong signal is tuned in, AGC voltage gets applied to the tuner, preventing the RF amplifier from overloading, thus avoiding cross-modulation.

AGC controls

TV receivers often feature AGC level controls, such as the main AGC control in Figure 10 and the RF AGC control (AGC delay) in Figure 11. Because AGC circuitry varies a lot from model to model, there is no standard procedure for adjusting these controls; it's best to consult the manufacturer's instructions contained in service manuals. In general, however, the master AGC control is adjusted first, by tuning the receiver to a strong signal and adjusting the control until the picture overloads; then the control is backed off until a normal, stable picture is obtained. Next, the RF AGC control is adjusted for minimum snow with the receiver tuned to a weak station.

AGC in integrated circuits

Instead of being fabricated of discrete components, the AGC circuitry is often integrated within the IF chip in modern receivers. And in some ICs, the AGC voltage is no longer keyed by horizontal retrace pulses. Figure 12 shows some of the function blocks contained in a typical picture IF chip. The block labeled IF AGC contains the AGC detector; note that it is not keyed by horizontal flyback pulses. The noise canceling circuit provides the AGC system with noise immunity.

Automatic color control (ACC)

The function of automatic color control (ACC) is to keep the overall amplitude of the chroma signal constant at the output of the bandpass amplifier, under varying input signal conditions. Without ACC, the viewer would often have to adjust the color control when changing channels. The concept is similar to AVC in an AM radio; recall that the listener would frequently have to adjust the volume control, were it not for AVC.

In a color receiver, chroma is an IF signal (3.58MHz AM sidebands) very similar to the amplitude modulated 455kHz IF signal in a radio or 45MHz IF signal in the picture IF section of a TV. It's not surprising, then, that the bandpass amplifier (sometimes called color IF amplifier) features automatic gain control. The feature is generally called ACC, to differentiate it from the RF/IF AGC.

Just as AGC circuitry produces a dc output which is proportional to the amplitude of the sync pulses in the video signal, ACC produces a dc output proportional to the amplitude of the color sync (color burst) signal. This dc output is used to control the bias—and therefore the gain—of the bandpass amplifier.

The block diagram of Figure 13 illustrates the ACC concept. Notice that the gain of the chroma (bandpass) amplifier is controlled by the ACC bias in addition to the manual color control. This dc control voltage comes from the output of the ACC detector whose input is the color burst signal. Although a separate ACC detector is featured in some receivers, the ACC bias is obtained from the AFPC circuit in others. Either way, the bias is still derived from the burst signal.

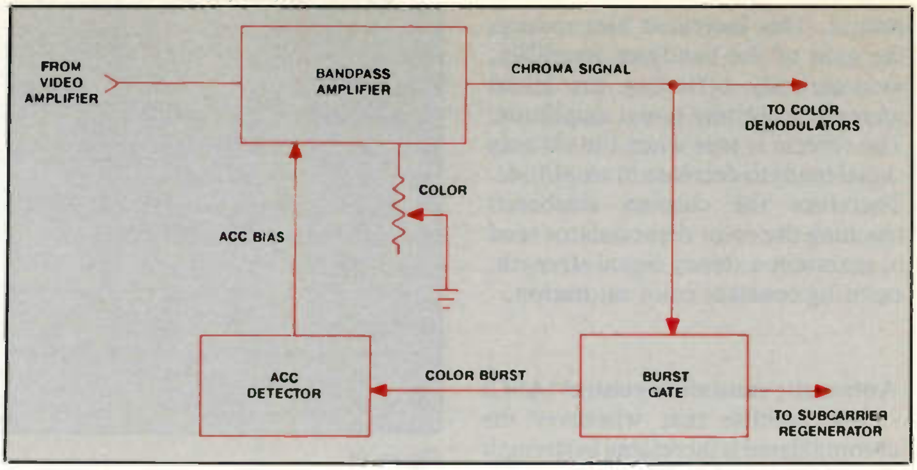

Figure 13.

When changing channels, there are variations in RF signal strength at the antenna input, as well as differences in tuner alignment and gain. These differences would affect the amplitude of the chroma signal and produce variations in color saturation, were it not for ACC.

Here's how automatic color control works. Assume that the chroma signal amplitude increases at the output of the bandpass amplifier. The amplitude of the color burst is likely to increase also, because burst and chroma signals have the same frequency (3.58MHz) and pass through the same stages (video amplifier, bandpass amplifier and burst gate).

So, the increasing burst amplitude at the ACC detector's input produces more dc voltage (ACC bias) at its output. This increased bias reduces the gain of the bandpass amplifier, automatically offsetting the initial increase in chroma signal amplitude. The reverse is true when the chroma signal tends to decrease in amplitude. Therefore the chroma sidebands reaching the color demodulator tend to maintain a steady signal strength, ensuring constant color saturation.

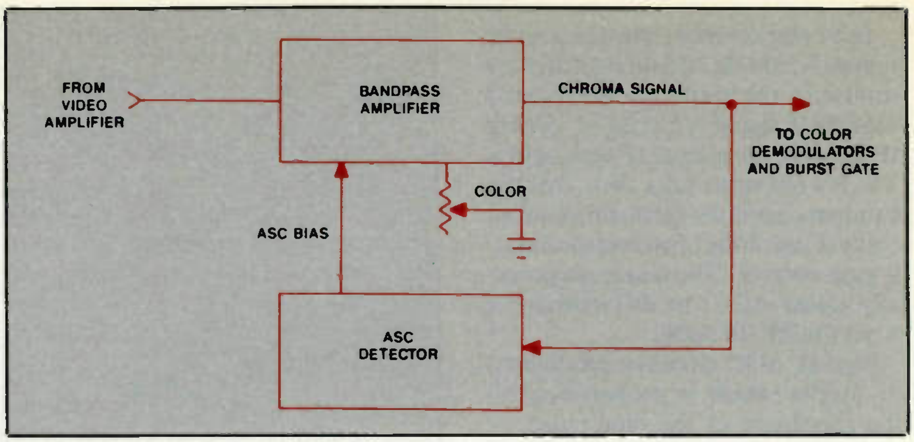

Figure 14.

Automatic saturation control (ASC)

The premise that whenever the chroma signal is increasing in strength the color burst signal does likewise, is not always true. At the broadcasting end, it's quite possible for the average color saturation to change without a corresponding change in burst amplitude; for example when the picture source switches from live programming to a taped commercial. Of course, receiver ACC cannot compensate for this situation, and excessive saturation (bleeding reds, for example) might appear on the screen at times.

To rectify this problem, some manufacturers have featured automatic saturation control (ASC) circuitry rather than ACC in their receivers. ASC serves the same purpose as ACC, i.e. it automatically controls the gain of the bandpass amplifier; but it differs from ACC in that the ASC bias is derived from the chroma signal itself, rather than from the burst.

Figure 14 illustrates the concept. Note that a sample of the chroma signal is fed to the ASC detector. Should its average amplitude increase or decrease, the resulting ASC bias would change, causing the gain of the bandpass amplifier to decrease or increase, respectively, thus maintaining fairly constant color saturation.

Unfortunately, ASC isn't a perfect solution to the color saturation problem, because it can actually prevent the reproduced colors from becoming more vivid when the saturation is supposed to increase, for example. Therefore ASC has never been as popular as ACC.

Some manufacturers—such as Electrohome, some years back—wanting the best of both worlds, actually featured both ASC and ACC in some of their receivers. The ACC bias controlled the gain of the first chroma amplifier stage, while ASC controlled the gain of the second chroma transistor.

ACC is what you're most likely to find in today's color receivers, but sometimes you have to look hard for it because it's buried somewhere in a chroma processing IC and the fine print of some schematics necessitates the use of a magnifying glass if you wish to find it. But rest assured, it's in there somewhere!

So there you have it, folks . . . a survey of AGC and its clones. If you managed to stick with us throughout the article, you should know by now that ACC, ASC, AGC, ALC and AVC are all applications of the same basic principle: automatic gain control. ■

How to boost AM reception

By John Shepler

The AM radio band is still alive and well. Programming has switched to more news, talk and weather than music. In times of major news events such as those we have experienced recently, people suddenly remember that their receivers have another band that can keep them better informed on fast breaking events. It is then in many cases that they also discover how poor the reception is.

AM reception does not have to be second rate. True, many FM receivers have a relatively Lo-Fi AM section with frequency response only to 5kHz or so. The narrow bandwidth is to filter out noise and interference. A side effect is that music sounds dull compared with FM. However, talk formats sound just great. Great, that is, only when the signal is strong.

A strong signal is needed to overcome noises such as thunderstorms and arcing motors. It is also needed to overpower the multitude of signals on the same and adjacent channels. Unlike FM, AM detectors tend to mix signals together rather than capture only one. At night ionospheric propagation, also known as skip, allows signals from thousands of miles away to fade in and out.

The easiest and cheapest solution to AM reception problems is to improve the antenna to strengthen the desired signal. First, try this trick. Simply reorient the radio. Turn the whole cabinet 90 degrees and see if reception doesn't improve dramatically.

The reason this works is that AM radios include a directional antenna in the form of a ferrite bar wrapped with a coil of wire. This is also called a loopstick. You'll find the loopstick inside the plastic case of portables and hanging off the back of AM/FM component receivers.

The loopstick picks up the most signal when either end of the bar is pointing directly at the radio station. When the flat side is pointing at the station, the minimum signal is received. The difference between maximum and minimum pickup can be dramatic.

The next step is to add more antenna. Many receiver loopsticks have terminals labeled ANT and GND. These are for connecting a wire antenna and a ground. The wire antenna can be any piece of insulated long wire. Wavelengths on the AM band are about 100 times longer than on FM. That means a 3 foot FM antenna is equivalent to a 300 foot AM antenna.

Fortunately, length is not critical. Neither is placement, although you want to avoid getting too near metal that can capacitively bypass all your signals. The ground is not absolutely essential, but connecting the radio's GND jack to a water pipe or copper ground rod can make the antenna more effective.

Perhaps the radio in question does not have external antenna connections or you can't easily get at the loopstick. Then simply wrap a few turns of antenna wire around the radio case or the loopstick, and stretch out the wire as far as possible.

The best wire antenna for medium wave reception is strung high in the air between glass insulators outdoors. The feed line is also insulated, run through a lightning arrester, and brought to the radio. Usually only ham radio operators, short wave listeners, or other electronics hobbyists will go to this much trouble. For everyone else, a piece of hookup wire strung around the baseboards or in the attic will have to do. Apartment dwellers can drop 10 feet or more of thin wire out a window for good results.

Another aid is a passive booster, which is nothing more than a tuned circuit that inductively couples to the receiver loopstick. The tuned circuit boosts the signal because it has gain due to selectively or "Q". It also helps tune out interfering stronger signals in other parts of the band.

The radio is placed next to the booster and both are tuned for maximum signal. You can buy these boosters from various mail order houses. Or, you might try building one from a spare tuning cap and a loopstick or coil of wire. Figure 1 shows these ideas.

Fortunately, most areas have strong stations within 100 miles, so AM antennas will easily satisfy a frustrated customer. ■

Shepler is an electronics engineering manager and broadcast consultant. He has more than 20 years experience in all phases of electronics.

Exploring the 80286 and 80386-based microcomputers:

Combining theory and practical service techniques

Part II: Troubleshooting the 80386 microprocessor

By John A. Ross

Part I of this two-part series of articles, which appeared in the May issue, looked at 80286-based microcomputers. The 80286 microprocessor more or less served as an interim answer to the needs of computer users for speed and processing capabilities.

In this second part, we'll concentrate on what has become a workhorse in the microcomputer industry—the 80386 microprocessor.

Generally, the 80386 microprocessor gave the world of IBM and compatible microcomputers several things: featuring a 32-bit internal architecture this processor operates at processing speeds that once seemed unattainable, it has the ability to access more system random-access memory (RAM) than its predecessors, and ultimately, with this combination of processing power, speed and the ability to access more system RAM, the 80386 provides *multitasking* power.

Multitasking simply means that several software applications may run at the same time. As an example, a stock analyst would have the capability to simultaneously receive, analyze and graphically depict financial data.

The 80386 vs the 80286

Before studying the actual processor, we'll look at each one of those factors that make the 80386 different and better than its predecessors. One basic difference rests within the 32 bit architecture. With 32-bit processing, the central processing unit can accept 8, 16 and 32 bit word formats. Thirty-two data lines connect the microprocessor to associated circuitry.

From a software standpoint, the 32-bit platform allows the microcomputer to run more types of operating system software such as MS-DOS, Windows, OS-2 and Unix.

When compared to the 16-bit standard, software also runs faster with the 32-bit architecture. Its ability to access four gigabytes of real memory and sixty-four terabytes of virtual memory adds to the speed advantage of the 80386 microprocessor.

The DX vs the SX

Essentially, the 80386 micropro-

(Continued on page 41)

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

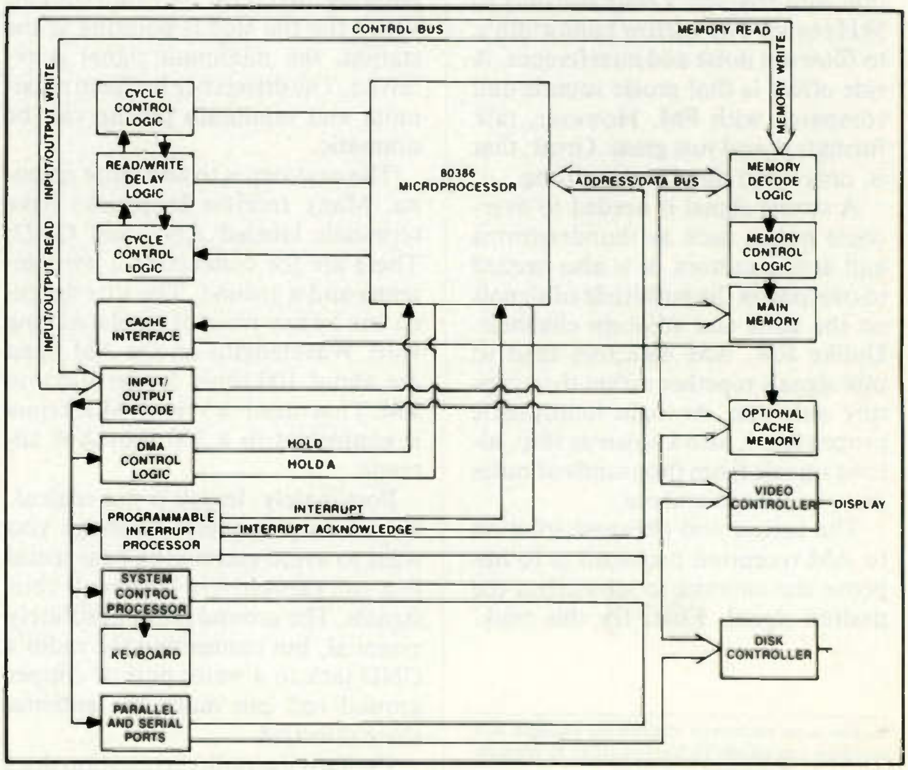

Figure 1.

June 1991

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CHASSIS SCHEMATIC SIGNAL CIRCUIT

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

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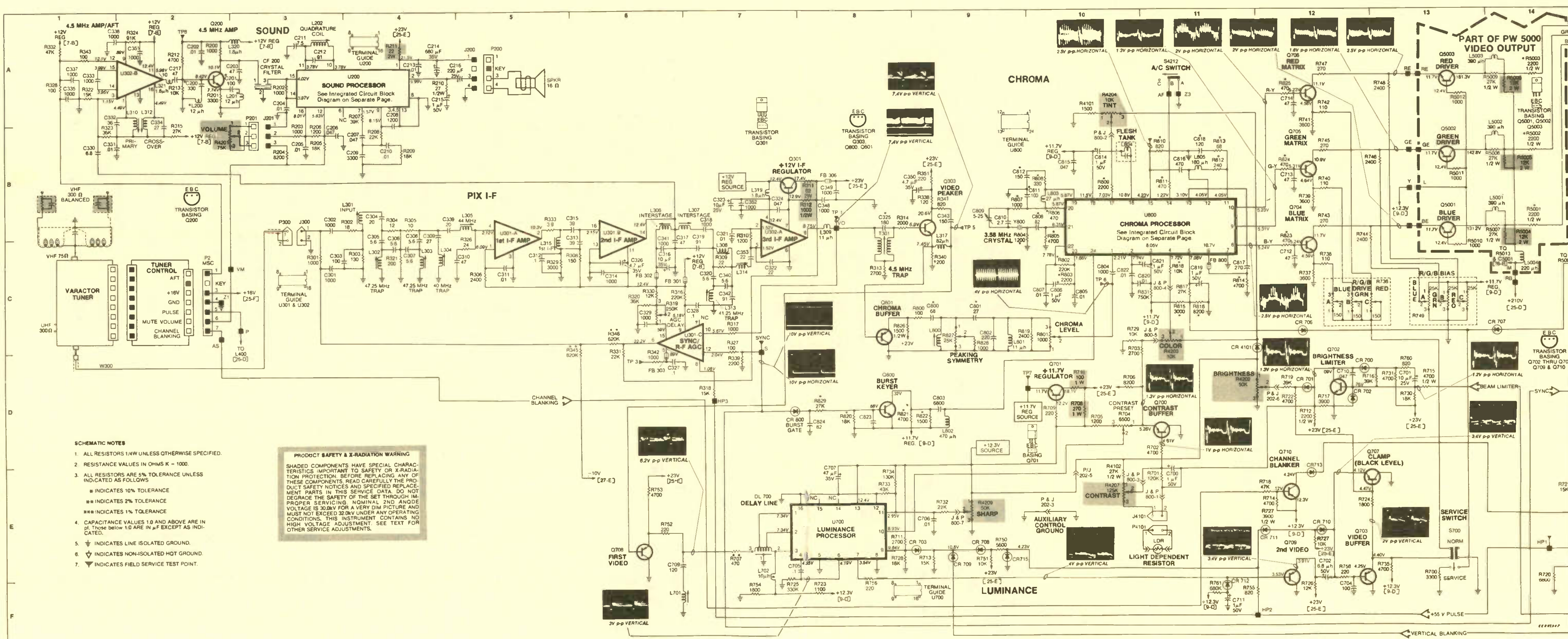
All integrated circuits and many other semiconductors are electrostatically sensitive and require special handling techniques.



PW 3000 CIRCUIT BOARD ASSEMBLY

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PW 3000 Component Location Guide

C3001	3D
C3002	3D
C3004	3C
C3005	1C
C3007	2C
C3013	1D
C3014	1C
C3015	1C
C3016	1C
C3017	1D
C3019	3B
C3022	3D
C3023	5C
C3024	5C
C3027	4C
C3028	5E
C3029	6C
C3030	6D
C3031	5C
C3032	6D
C3033	5C
C3035	5C
C3036	5D
C3037	3B
C3038	4D
C3039	4C
C3040	4D
C3041	4C
C3042	4C
C3043	4D
C3047	3A
C3048	5E
C3049	4E
C3050	4E
C3052	5D
C3068	8A
C3069	8D
C3070	4A
C3071	3A
C3073	8C
C3074	7A
C3075	7C
C3076	8A
C3077	8B
C3078	6B
C3081	2A
C3082	2A
C3084	2A
C3085	2B
C3086	2B
C3087	2B
C3088	1B
C3089	2A
C3090	2B
C3091	2A
C3092	1A
C3093	1B
C3094	1A
C3097	1B
C3101	7B
C3102	6A
C3108	6A
C3109	5A
C3110	5B
C3111	5B
C3112	6C
C3115	1E
C3116	4B
C3118	4B
C3119	5C
C3122	4A
C3123	4A
C3124	4B
C3125	5A
C3131	7C
C3132	7D
C3133	8C
C3134	8D
C3135	8E
C3137	7D
C3138	8E
C3139	7D
C3140	7E
C3141	7D
C3142	7D
C3146	6E
C3149	7E
C3150	6E
C3153	7C
C3154	7C
C3155	7B
C3156	8A
C3157	7B
C3161	6E
C3163	8D
C3165	8D
CF3001	2A
CR3001	3D
CR3002	1C
CR3003	1E
CR3004	1D
CR3006	2C
CR3007	2D
CR3009	3D
CR3010	3B
CR3011	2D
CR3013	7C
CR3014	8B
CR3015	7A
CR3101	6B
CR3102	5B
CR3103	4C
CR3104	4C
CR3105	3B
CR3106	4B
CR3107	6A
CR3108	8C
CR3109	1D
CR3110	7D
CR3111	7D
CR3112	7E
CR3113	7A
CR3114	7A
CR3117	7C
CR3119	7A
CR3120	7C
CR3121	2D
CR3122	7C
CR3123	7C
CR3124	6C
CR3131	8E
CR3132	8E
CR3134	8E
CR3135	8D
FB3001	1C
FB3002	1D
FB3003	7A
FB3004	7A
FB3005	7B
FB3006	8B
FB3007	8B
FB3008	5D
FB3009	5D
FB3010	4D
FB3011	6C
FB3012	6C
FB3013	6E
FB3014	3A
FB3015	3B
L3001	1C
L3002	2C
L3003	3E
L3004	3D
L3005	5D
L3006	4D
L3007	3C
L3008	2B
L3009	6A
L3010	2A
L3012	3A
LC3001	5D
Q3001	2D
Q3002	2C
Q3003	1C
Q3004	1D
Q3005	3C
Q3006	5E
Q3007	4E
Q3008	4E
Q3009	1D
Q3010	1D
Q3011	1D
Q3015	6B
Q3016	6B
Q3017	6C
Q3018	5C
Q3019	4B
Q3020	4B
Q3021	4C
Q3022	4B
Q3023	5B
Q3024	5B
Q3029	8E
Q3030	7E
Q3031	6E
Q3032	6E
Q3034	7C
Q3035	6D
Q3038	8E
R3001	2D
R3002	2D
R3003	2D
R3004	3D
R3005	2D
R3006	1E
R3007	3D
R3008	1D
R3009	2D
R3010	2C
R3011	1C
R3012	2C
R3013	2D
R3014	1B
R3015	1C
R3016	1C
R3017	1C
R3018	4D
R3019	3C
R3020	3B
R3021	2B
R3023	2D
R3024	2C
R3022	3E
R3025	3B
R3026	2A
R3027	4C
R3028	5D
R3029	6D
R3030	6D
R3031	6C
R3032	5C
R3033	5C
R3034	3C
R3035	5C
R3036	5C
R3037	4D
R3038	3D
R3039	2D
R3040	4D
R3041	4D
R3042	4C
R3043	1D
R3044	3D
R3045	6D
R3047	4C
R3048	3B
R3049	1D
R3050	2C
R3051	2E
R3052	1D
R3053	7A
R3054	2E
R3055	2D
R3056	2D
R3057	1E
R3058	4C
R3059	3C
R3060	3E
R3061	4E
R3062	5E
R3063	5D
R3064	5C
R3065	3C
R3068	8B
R3069	3C
R3070	8A
R3071	3E
R3072	3E
R3073	3E
R3074	4E
R3075	4E
R3076	5E
R3077	3E
R3079	2A
R3080A	4E
R3080B	4E
R3080C	4E
R3081A	2E
R3081B	2E
R3081C	3E
R3082	2E
R3083	3E
R3084	5E
R3085	4E
R3086	4E
R3087	2A
R3088	6B
R3089	2B
R3090	2B
R3091	1A
R3092	1B
R3097	8B
R3098	8A
R3099	7B
R3100	3B
R3101	7B
R3102	6B
R3103	6B
R3104	6B
R3105	6B
R3106	5A
R3107	5B
R3108	6B
R3109	5B
R3110	5A
R3111	6B
R3112	6B
R3113	5C
R3114	6B
R3115	3B
R3116	3B
R3117	3B
R3118	4B
R3119	5B
R3120	4A
R3121	2D
R3122	5B
R3123	4A
R3124	4B
R3125	5B
R3126	5B
R3127	5B
R3128	8C
R3129	8C
R3130	8E
R3131	7C
R3132	7C
R3133	8D
R3134	8D
R3135	8E
R3136	8E
R3137	7D
R3138	7E
R3139	7D
R3140	7E
R3141	7E
R3142	7E
R3143	8E
R3144	7D
R3145	7E
R3146	7E
R3147	7E
R3148	6E
R3149	7E
R3150	7E
R3151	7E
R3152	7C
R3153	6C
R3154	7C
R3155	7B
R3156	4B
R3157	8A
R3160	7A
R3162	1B
R3177	6C
R3179	7D
R3180	6C
R3182	6C
R3183	6C
R3184	5B
R3185	8D
R3186	7E
R3187	8E
R3188	6D
R3189	8E
R3190	8E
R3191	8C
R3196	6D
R3197	6D
R3198	7C
U3001	4D
U3002	2B
Y3001	6C
STAKES	
E	5B
F	2A
H	7D
L	4D
N	7A
B2	1D
C2	3C
J1	8B
J2	1E
K1	6D
K2	1C
K3	7C
M1	3A
M2	8C
S1	1E
S2	6B
T2	5E
V2	2B
V3	2A
X7	8E
Y1	4B
Y2	4B
Z1	3E
Z2	3D
BE	3E
BK	3C
BL	2D
CO	3C
CT1	3D
CT2	2C
CT3	3E
FS	3A
GE	4E
HB1	5C
HB2	1E
HD4	7B
HD6	7B
HH2	8D
HH3	7E
HT1	1E
HT2	6B
HW	7B
KP	3B
KS1	6E
KS2	7B
MG	8A
NP	7A
PC2	8B
PH1	8C
PH2	7D
RE	5E
SO	1A
SU	3A
SS1	1D
SS2	7C
SZ	1A
TG	5D
TP1	8D
VB	2D
VO	1C
VH2	6B
VH3	6B
J3001	1A
J3002	4A
DL3001	2C
S3001	1E

3077 PROFAX ES&T Manufacturers' schematics

PW 3000 CIRCUIT BOARD ASSEMBLY

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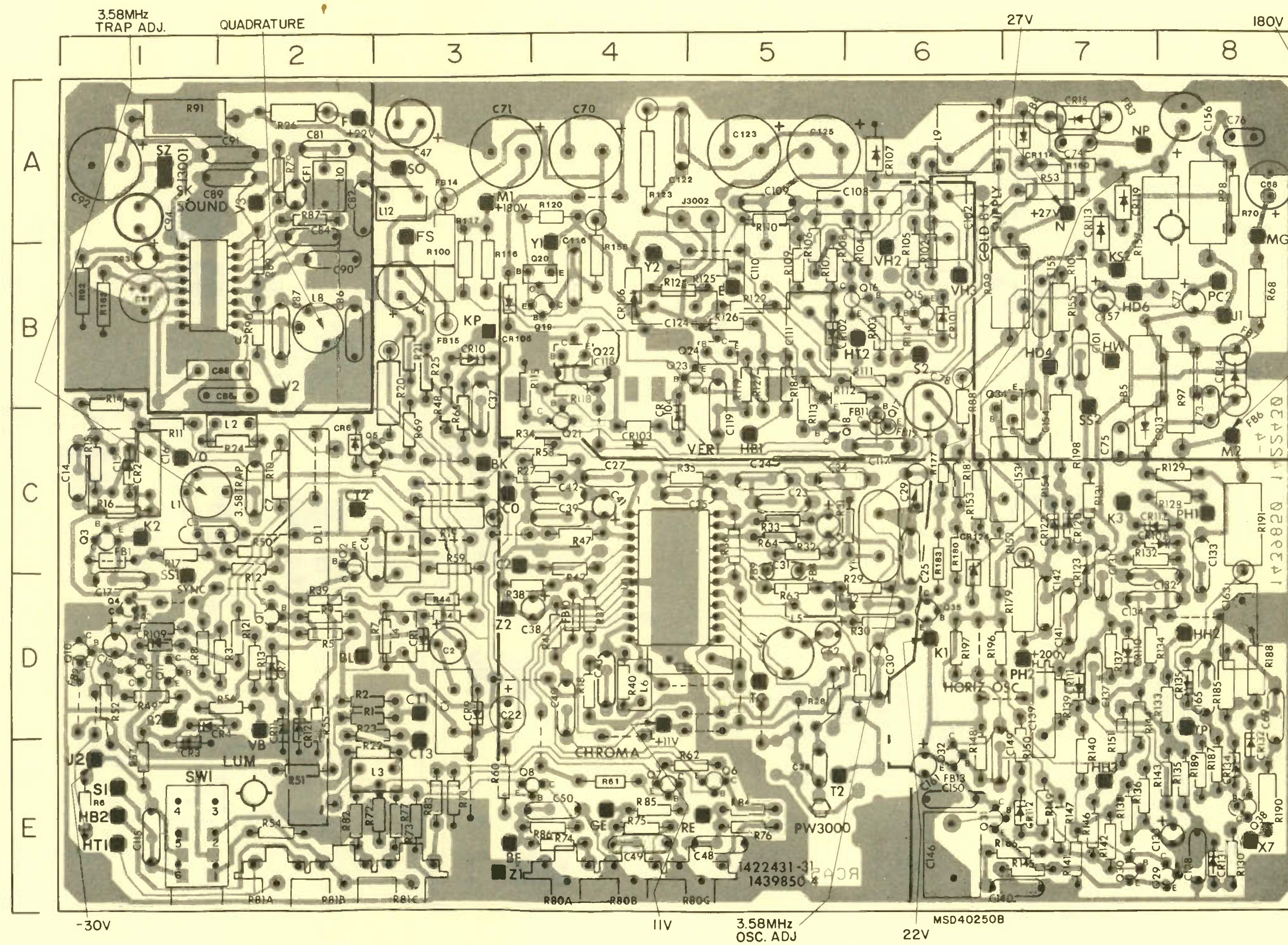

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FREQUENCY SYNTHESIS TUNER MODULE

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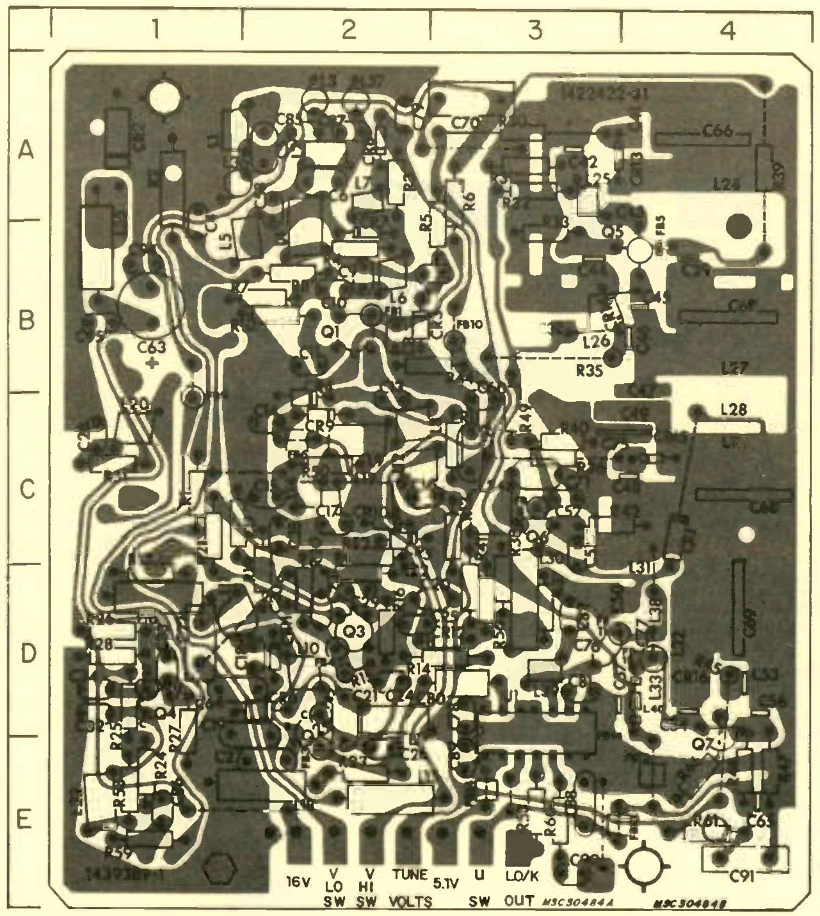

MST 003A—Component Location Guide

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

R2438 .... 3D
R2439 .... 4A
R2440 .... 3C
R2441 .... 3D
R2442 .... 3C
R2443 .... 4D
R2444 .... 3B
R2445 .... 4D
R2446 .... 4E
R2447 .... 4E
R2448 .... 4E
R2449 .... 3C
R2450 .... 2C
R2451 .... 1C
R2452 .... 2C
R2453 .... 1E
R2455 .... 3A
R2456 .... 3D
R2458 .... 3E
R2459 .... 1E
R2460 .... 3E
R2461 .... 4E
U2401 .... 3D

·NOTE: Add 2400 Series Prefix To Item Numbers

FREQUENCY SYNTHESIS TUNER SCHEMATIC

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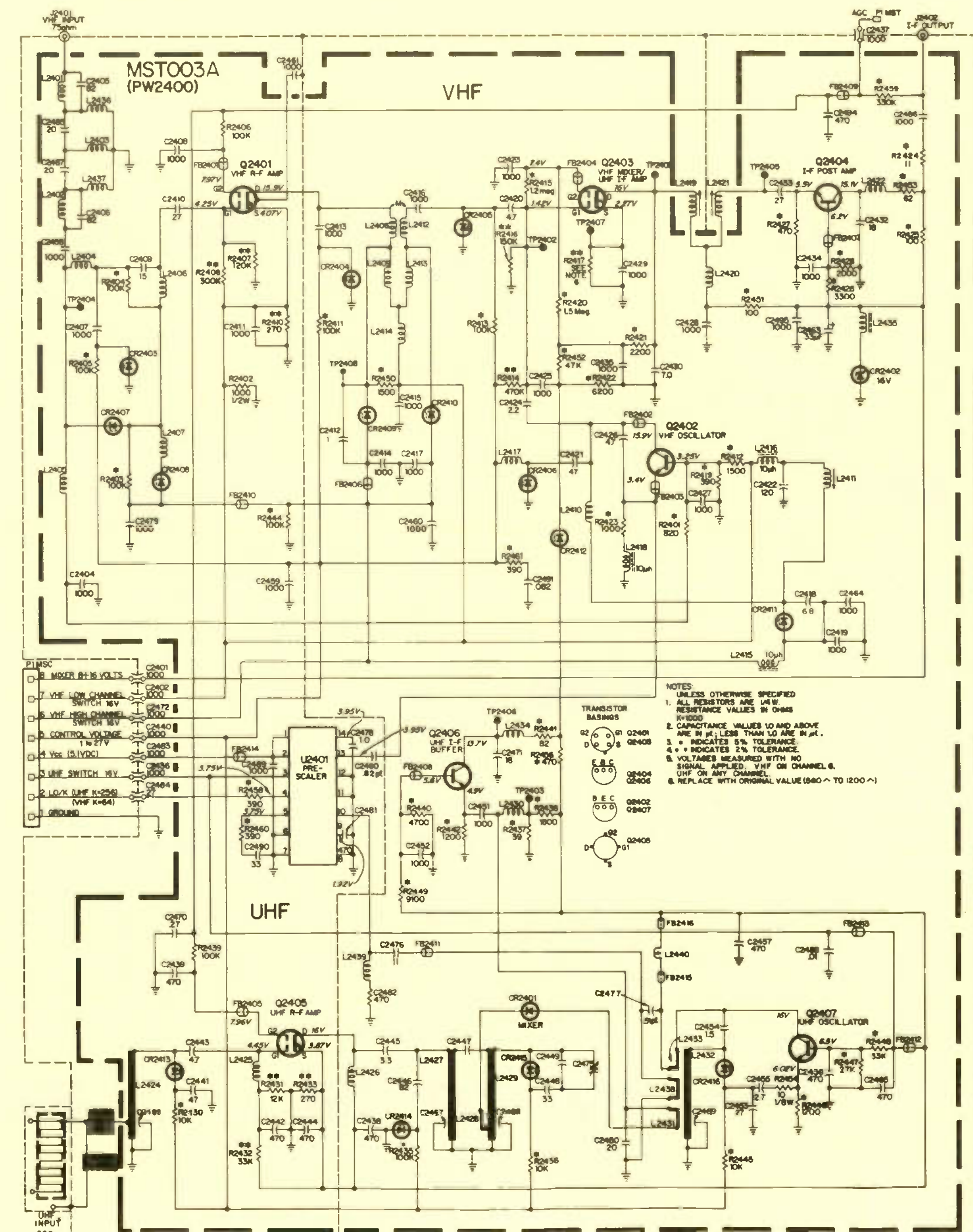

RCA
CTC 96 SERIES
COLOR TV

PROFAX
Manufacturers' schematics
JUNE 1991

CHASSIS SCHEMATIC DEFLECTION CIRCUIT AND POWER SUPPLY

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PROFAX
Manufacturers' schematics
3077

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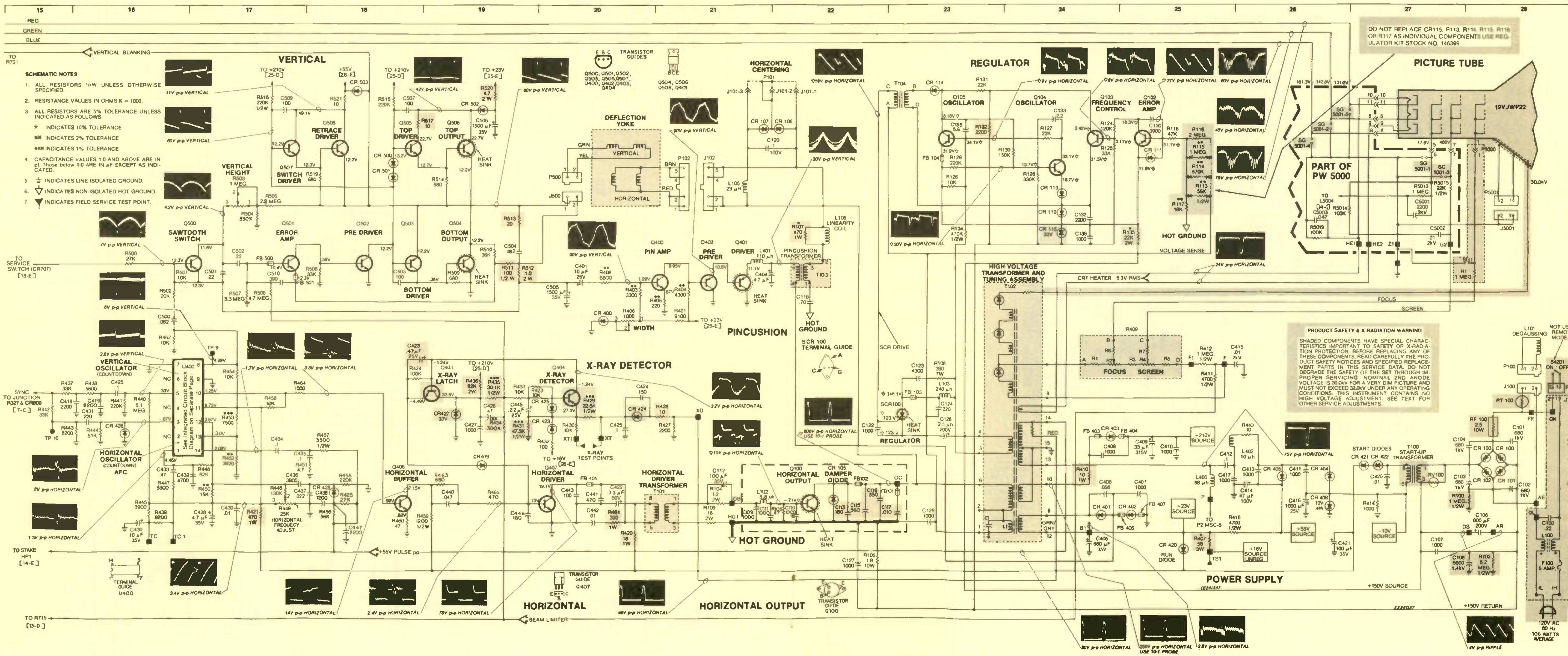


Exploring 80286 *(from page 28)*

cessor exists in two different versions. Designated as the 80386 DX, the first version features full 32-bit processing. Designed for process-intensive applications such as large databases or desktop publishing packages, the 80386 DX gives high processing speed and fast input/output operations. While early editions of the 80386 DX had operating speeds of 16MHz and 20MHz, the newer additions to the DX line offer speeds of 25MHz and 33MHz.

The other version of the 80386 microprocessor, the 80386 SX, combines the 32-bit internal architecture of the microprocessor with an external 16-bit bus. This option saves cost while offering the advantages of the 80386 microprocessor. Currently, the 80386 SX microprocessors have an operating speed of either 16MHz or 20MHz.

An in-depth look at the 80386

Figure 1 illustrates the complexities inherent with the newer design. This block diagram with the 80386 as the central part of the figure, depicts the relationships between the microprocessor and other major circuits. This diagram shows how the 80386 microprocessor addresses the logic, memory and system control functions for the entire microcomputer system. Like the 8088 and 80286-based microprocessors, the 80386 microprocessor communicates with the rest of the microcomputer through input/output, control and address busses.

The CPU: The central processing unit (CPU) section of the microcomputer contains the control logic functions of the microcomputer. This section includes the 80386 microprocessor, the coprocessor, the monitor ROM, and individual circuits for address decoding, timing, interfacing and bus control.

The I/O section: At the lower left of Figure 1 is the input/output (I/O) section. Possibly the most complex of the microcomputer sections, the I/O section contains the direct memory access (DMA) controller and logic circuits, the keyboard I/O logic circuits, serial and parallel communications ports, interrupt controllers and the system timing circuitry.

Additionally, the I/O section also contains other decoding and interface logic circuitry. As a whole, the I/O section oversees all DMA processes, system interrupts, keyboard interfaces, system timing signals plus the serial and parallel communications.

As mentioned in the introduction of this article, the 32-bit architecture of the 80386 allows the accessing of up to four gigabytes of real memory. More than likely, the largest computer you'll ever encounter will contain a maximum of only sixteen megabytes of system RAM.

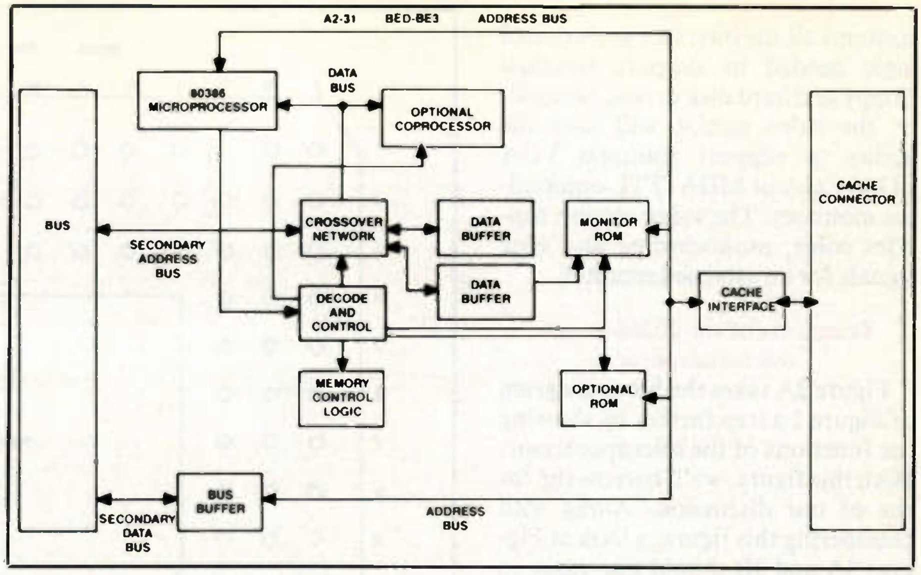


Figure 2A.

Listing of Programmable Array Logic Circuits Associated with the 80386 Microprocessor

Address Decoder Bus Cycle Decode Coprocessor Interface CPU Cycle Decoder CPU I/O Decode Crossover Buffer Control Fast Cycle Controller Page Memory Cycle Control Page Memory Cycle Output Read/Write Latch Control Shutdown Controller Slow Cycle Controller

Figure 2B.

System RAM

The memory section, which contains the system RAM, is at the right side of Figure 1. Along with that system memory, the memory section also contains interface circuitry for communication between the system busses and the system memory, address logic generation circuitry and refresh logic circuitry. Also, the section holds the control logic and parity generation logic circuitry.

Cache memory

At the left-center part of Figure 1, the cache interface allows the central processing unit to access memory caching. A *memory cache* consists of 64KBytes of high- speed static memory placed between the CPU and the system memory. Acting as a high-speed buffer, the cache stores data or instructions that result from the most recent microprocessor operation. A logic subsystem updates the cache so that it will always contain current program information. Using the cache allows the CPU to avoid the wait states that occur during cycles to the main system memory.

As an example of memory cache activity, many programs will instruct the microprocessor to repeatedly access the same area of system memory. Caching allows the duplication of this system memory segment within the static memory. When the microprocessor receives a program instruction to access the same system memory segment, it instead accesses the memory cache. Consequently, the microprocessor works faster and more efficiently.

Video and disk controller sections

At the bottom right part of Figure 1, are the video and disk controller sections. The disk controller section contains all the interface and control logic needed to support attached floppy and hard disk drives. Normally, the video section will have the ability to support common VGA EGA, CGA or MDA/TTL-compatible monitors. The video section supplies color, monochrome and sync signals for an attached monitor.

Functions of the 80386-based microcomputer

Figure 2A takes the block diagram of Figure 1 a step further by showing the functions of the microprocessor. With this figure, we'll narrow the focus of our discussion. Along with considering this figure, a look at Figures 3A and 3B should also assist in comprehension of the microprocessor. Figure 3A represents the distinctive shape of the actual 80386 microprocessor, while Figure 3B lists the signal descriptions for each pin.

Referring back to Figure 2, programmable array logic circuits (PALs) make up the majority of the decoding and control circuitry. Using Figure 2B and its brief listing of the various PAL functions as a reference, let's take a quick look at some of the PAL operations and how they affect the microprocessor operation.

Enabling of the monitor ROM, which contains power-up tests, power-up routines, and a debugger, occurs as a result of the generation of a MONROM signal by the CPU cycle decoder PAL. This circuit also generates the necessary control signals for memory circuit read/write operations, I/O circuit read/write operations and interrupt acknowledge cycles.

Another PAL, the read latch/write buffer control circuit enables each byte of data issued by the monitor ROM and places those data bytes on the system bus.

Controlling data transfer

Another set of PALs directs the passing of data between the microprocessor and the secondary data bus. A crossover buffer control circuit sequences other circuitry, such as crossover buffers, data latches and data buffers, so that the data arrives at the proper location at the proper time. This data becomes used for DMA operations, input/output read and write operations and memory accesses.

A CPU cycle decoder PAL sends signals that indicate which operational cycle the microprocessor executes. An operational cycle includes memory read and write operations, microprocessor I/O read and write operations and select signals for the monitor ROM.

During the operational cycle, the page memory cycle circuits, consisting of the page memory cycle control PAL and the page memory cycle output PAL, determine which cycle executes on the 32 bit memory card. While the page memory cycle control circuit determines which cycle should execute and develops the proper output signal for that execution, the page memory cycle output circuit uses the control output signal to develop cycle control signals for the 32-bit memory cards.

If the computer beeps during its initialization and then stalls, check the input and output signals of the page memory cycle control and output PALs. Additionally, look for the READYP signal from the fast cycle PAL. Other possible solutions include replacing a defective monitor ROM, reseating the memory card, or replacing the memory modules.

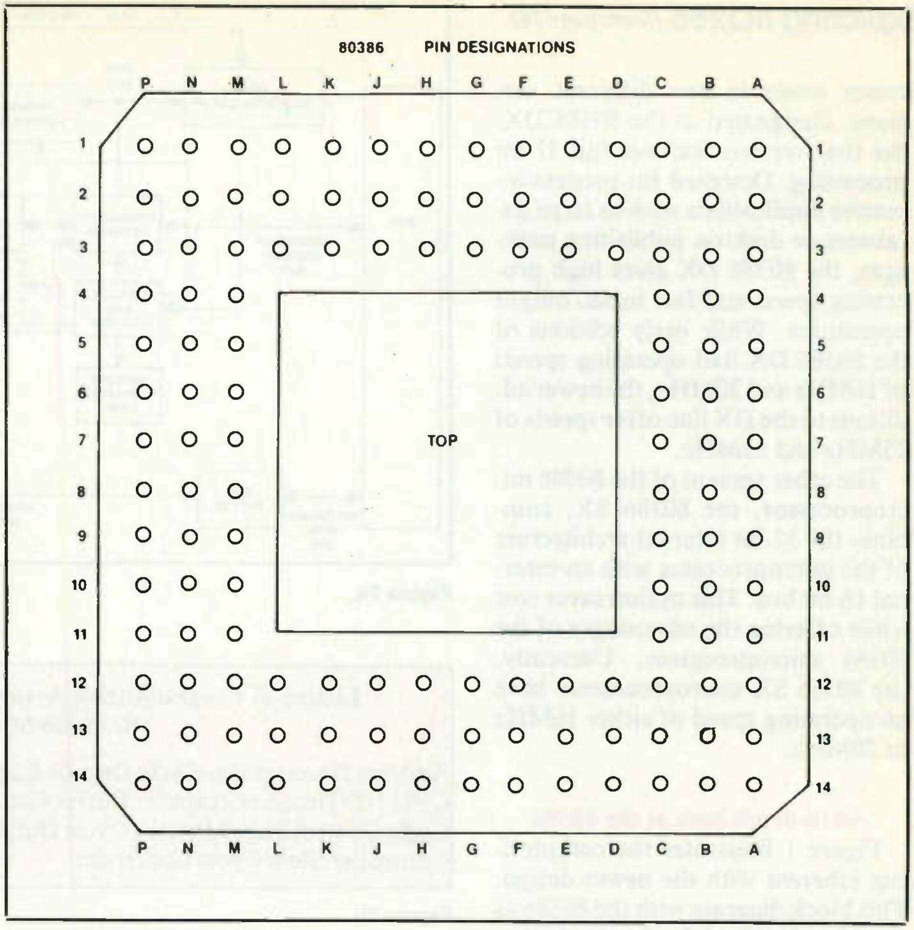


Figure 3A.

Bus cycle decode circuit

Generation of the signals that control different bus cycles, the address 0 line signal for the secondary data bus and bus address line enable signal comes from the action of the bus cycle decode circuit. Regulation of the memory reads and writes to the first one megabyte of system memory along with other memory access operations also occur with bus cycle decode PAL action.

When looking at the signal descriptions for the microprocessor, these signals appear as the SMEMR, SMEMW, MEMR, MEMW, IOR and IOW signals. Without the proper SMEMR, SMEMW, IOW and IOR signals at the bus cycle decode circuit, the monitor does not receive the video initialization necessary for cursor display.

At times, the 80386 microprocessor must operate in the slow mode which involves 8-bit or 16-bit operations. A slow-cycle control PAL initiates required wait states for the microprocessor and controls the PC and AT cycles. Accessing the fast or 32-bit memory means that the fast

80386 Microprocessor Signal Descriptions Grouped by Pin Number and Function

DATA LINES:

Data 0 through D31—Thirty-two bidirectional signal lines for the transfer of general purpose data between the microprocessor and other devices.

PINS: H12, H13, H14, J14, K12, K13, K14, L13, L14, M5, M6, M11, M12, N5, N6, N8, N9, N10, N11, N12, N13, N14, P3, P4, P5, P7, P10, P11, P12, P13, MN9

ADDRESS LINES:

Address two through thirty-one, byte enable zero through byte enable three—Thirty address signal paths plus four byte enable lines carry address information for the microprocessor.

PINS: A3, B2, B3, C1, C2, C3, D1, D2, D3, E1, E2, E3, F1, F2, F3, G1, H1, H2, H3, J1, K1, K2, K3, L1, L2, L3, M1, N1, N2, P1 = ADDRESS LINES

PIN E12—BE0

PIN C13—BE1

PIN B13—BE2 PIN

A13—BE3

BUS ARBITRATION:

PIN D14—HOLD—at its digital active state indicates that another device needs control of the bus

PIN M14—HOLDA—acknowledgment of the HOLD state by the microprocessor

BUS CYCLE DEFINITION:

PIN B10—WRITE/READ—W/R—write or read cycle

PIN A11—DATA/CONTROL—D/C—data or control cycle

PIN A12—MEMORY/IO—M/IO—memory and input/output cycles

PIN C10—LOCK—shows if the current bus cycle has locked

BUS CONTROL:

PIN E14—ADDRESS STATUS—ADS—an active signal shows the presence of a valid bus cycle definition and address on the microprocessor

PIN G13—TRANSFER ACKNOWLEDGE—READY—current bus cycle has completed; Acceptance of active bytes from the Byte Enable signals

PIN D13—NEXT ADDRESS—NA—microprocessor can accept new data even if the cycle has not completed

PIN C14—BUS SIZE—BS16—an active signal allows only the use of the low-order half of the data bus. Thus, the microprocessor only accepts sixteen-bit words during a cycle

COPROCESSOR INTERFACE:

PIN C8—COPROCESSOR REQUEST—PEREQ—coprocessor requests that the microprocessor transfer data to or from system memory

PIN B9—COPROCESSOR BUSY—BUSY—coprocessor continues to execute an instruction

PIN A8—COPROCESSOR ERROR—ERROR—previous instruction caused an internal coprocessor error

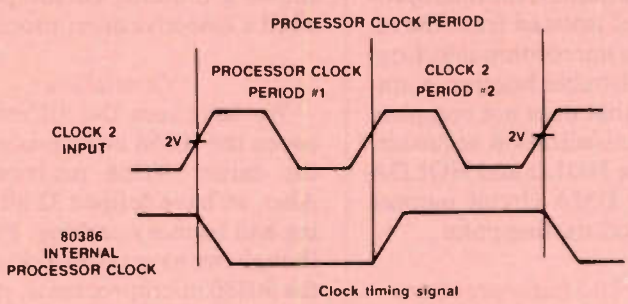
INTERRUPT:

PIN B7—MASKABLE INTERRUPT REQUEST—INTR—an active signal indicates that a normal request for interrupting microprocessor activity has occurred. The microprocessor will answer with interrupt acknowledge signal.

PIN B8—NON-MASKABLE INTERRUPT REQUEST—NMI—interrupt caused by software or hardware failure

MISCELLANEOUS:

PIN F12—CLOCK—CLK2—basic timing signal for the microprocessor; divided and to generate the internal processor clock that governs instruction execution



Clock timing signal

RESET—an active suspends all processing and places the microprocessor in a reset state which ignores all other input signals and drives bus pins to an idle state

VCC—PINS: A1, A5, A7, A10, A14, C5, C12, D12, G2, G3, G12 G14, L12, M3, M7, M13, N4, N7, P2, P8

GROUND—PINS: 19, A2, A6, B1, B5, B11, B14, C11, F2, F3, F14 J2, J3, J12, J13, M4, M8, P6, P14

Figure3B.

cycle control PAL will determine the end-point for the cycle. Unless changed by a command or a configuration setting, the microprocessor starts in the fast mode during the start-up sequence. If the microcomputer operating speed does not match the setup/configuration software settings, check for a short on the SLOW signal line found at the I/O decode PAL.

Address decoder circuit

Another PAL, the address decoder circuit, works with multiplexers to give the primary address decoding logic for the microprocessor. This logic arrives in the form of the LMEG signal and indicates when an access in the lowest megabyte of system memory happens during a peripheral access.

Another signal, WRDIS, disables writing to the monitor ROM memory. Without the active WRDIS signal at the output of the address decoder circuit, the microcomputer will halt its operation. Importantly, the address decoder PAL also generates the next address (NA) signal for the microprocessor. An active NA signal allows the CPU to place the next address on the bus before the end of the bus cycle. With this function, the microprocessor can efficiently function during CPU cycles, DMA cycles and when a temporary master has control of the bus.

Take it a little at a time

Again referring to Figures 3A and 3B, you can see the almost intimidating number of connections found on the 80386 microprocessor. Here, one of the practical lessons gained from servicing televisions again becomes applicable. Troubleshooting the television becomes easier if you divide the unit into a collection of sections. Similarly, dividing the many signals of the 80386 into smaller associated groups eases the diagnostic problems.

Address and data information occupies most of the connections on the 80386 microprocessor. Labeled as Data 0 through Data 31, 32 data lines connect the microprocessor to crossover buffers, read/write latches and an optional math coprocessor. Those buffers and latches generate a secondary bus which, in turn, connects the microprocessor to the remainder of the microcomputer.

Twenty-eight address lines, Address 2 through Address 30, carry the necessary signals for address generation. Three other address lines—Address 0, Address 1 and Address 31—do other work for the microprocessor. Lines 0 and 1, along with logic gating circuitry, generate the Byte Enable 0, Byte Enable 1, Byte Enable 2 and Byte Enable 3 signals. Each one of these signals represents eight bits of latched data that crosses to the system memory.

As an example, the BE0 signal carries data bits zero through seven. When the microprocessor activates one or more of the address lines, it also indicates which bits of data it needs passed to the bus by the system memory.

Address lines zero through fifteen carry the lower sixteen bits of the address bus. When the microprocessor selects the monitor ROM, the MONROM signal from the CPU cycle decode PAL flows on the lower address lines and works as the selection signal. At the same time, the IDIR signal controls both the output of the monitor ROM and the transfer of data to the secondary data bus.

Observe signals for troubleshooting

You may use the absence of the MONROM and IDIR signals for troubleshooting. Looking back at the circuitry associated with the microprocessor, several good signal check points stand out. As we have seen, the CPU cycle decoder PAL supplies the MONROM signal. While another PAL, the read/write latch control circuit, supplies the IDIR signal, also check all the read/write latch control input and output signals.

Lastly, the address decoder PAL circuit, gives the ROM signal for proper monitor ROM action. Without these signals, the microprocessor cannot access the monitor ROM. Consequently, no activity will occur on the secondary bus.

If the same symptoms happen when the MONROM, IDIR and ROM signals are present, the search points toward either the lack of MEMR and MEMW signals from the bus decode PAL or a defective monitor ROM.

Moving from the address and data lines to the bus control lines, three signals define the microprocessor bus cycles. Looking at Figure 3B, the W/R signal controls the write and read cycles to the microprocessor. While the D/C signal differentiates between a data or control cycle, the M/IO signal defines the cycle as either a memory cycle or input/output cycle.

Bus control

During the system operation, the microprocessor supplies four signals for bus control. Whenever the ADS signal goes to a digital active state it shows that a valid address has appeared on the address lines and identifies the beginning of a new bus cycle.

Another more familiar signal, the READY signal, shows the completion of the bus cycle and that the microprocessor stands ready to send or receive more data.

As we saw in the description of the PAL circuitry, the NA signal or Next Address Request signal allows the CPU to receive additional data before the end of the current bus cycle. If the BS16 signal goes to a digital active state, the microprocessor can use only a sixteen-bit bus during a given cycle.

More commonly used signals come into play as we move through the 80386 diagram. Bus arbitration becomes handled by the HOLD and HOLDA signals. If a peripheral device such as a printer either requests or acts as the bus master, the HOLD signal goes to a digital active state.

When the microprocessor gives control of the bus to the peripheral device, the HOLDA or Hold Acknowledge signal swings to a digital active state and stands as the only line driven by the microprocessor.

All the signals that we have just seen—the BE0 through BE3, W/R, D/C, M/IO and ADS signals—go to a high impedance state so that the peripheral device can control the bus. With these signal actions controlled by another bus master, the microprocessor becomes isolated from the remainder of the microcomputer. Logically, when troubleshooting a microcomputer that does not complete its autoboot initialization sequence, a check for the HOLD and HOLDA signals at the DMA circuit outputs stands as a good starting point.

Other important microprocessor signals

Several other signals work between the microprocessor and other sections of the microcomputer. If the user has installed an optional math coprocessor, the coprocessor issues a PEREQ signal as a request for a data transfer from either the microprocessor or the system memory. A BUSY signal indicates current instruction processing by the coprocessor and that the device cannot accept another instruction. If the coprocessor instruction generates an internal error for the coprocessor, the microprocessor will see a digital active ERROR signal.

Two lines connected to the microprocessor carry system interrupt information. If any device within the microcomputer requests information, the INTR signal becomes active. If a fault occurs within the microcomputer, the I/O section will generate the NMI or non-maskable interrupt signal. An active NMI signal will stop microprocessor activity.

If you encounter a dead microcomputer with normal power supply voltages, checking for the presence of several signals again aids the problem diagnosis. No READYP signal at the fast cycle controller PAL can cause a "dead" condition. If the microprocessor does not receive the proper clock signals from the crystals and octal bus buffers, a "dead" condition also results. With no signal activity on the INTA and INTR bus lines, the microcomputer will stop its operation.

Because an interrupt error can happen if the interrupt controller does not meet the setup time specifications, look for floppy disk drive activity. This activity includes a lighted LED on the floppy drive and movement of the floppy disk drive heads. In many cases, securing loose data interface and power cable connections will restore normal microcomputer operation. Finally, the symptom of a dead microcomputer coupled with a video display that shows a blinking cursor points toward a defective microprocessor.

Conclusion

We have seen the differences between the 80386 microprocessor and the earlier 80286 microprocessor. Also, we have defined 32 bit processing and memory caching. Primarily, though, we have taken a close look at the 80386 microprocessor, its associated circuitry and various signals. With that look, we have also discussed how problems within that circuitry can cause problems with system failures. Most importantly, we have those problems with symptoms and solutions. ■

DOS problems

By Glenn R. Patsch

You probably do not expect to have a problem with the DOS operating system. DOS is often taken for granted since it always seems to work just fine. Problems can occur, however.

Versions

Software programs can lock up the personal computer (PC) when using DOS 4. DOS 4 refers to PC-DOS or MS-DOS version 4.0 or 4.01. The lock up appears to be a hardware problem. The program starts, but nothing happens. The PC will not respond to the keyboard and must be rebooted. By running the program under DOS 3.3 the problem will often disappear.

The best way to check if the problem is with DOS is to try the program with DOS version 3.3. This often happens with older programs that have not been updated recently.

The program I was having a problem with is a custom program that does the billing for a law office. It worked fine with DOS version 3.3, but not on their new PC running DOS version 4.01. Of course, the problem was thought to be a hardware problem requiring servicing.

Updating the program to a newer version was not an option since this was a custom program written by a small company that had not released a new version in quite some time. If this were a widely available spreadsheet or word processing program, this problem might have been easily solved by upgrading to the most recent version. You may discover however, that clients do not wish to upgrade because of incompatibilities between files and macros and are quite happy with the current version of the program.

To check which version of DOS is running on a PC use the VER command. An example of the VER command is shown below:

```
>VER
IOM Personal Computer: Version 3.30
```

Hard disk space

Another problem that can occur with DOS is related to the size of the hard disk. Before 3.31, the maximum size of a hard disk was 32 megabytes. With DOS version 3.31 and 4 the maximum size can be four trillion bytes. The problem is the way DOS handles the larger file sizes. Older programs made some assumptions about files that are no longer true. The best way to fix this problem is to partition the hard disk into logical drives with a maximum size of 32 megabytes. If you have a 40MB drive, you would partition it into 32MB for the c: drive and 8MB for the d: drive. The single 40MB hard drive now appears to be two logical hard drives c: and d:.

The best way to check if a problem is with a large hard disk partition is to try the program on a hard disk that is no larger than 32MB. The problem will often appear to be a hardware problem since it will typically lock up the PC.

The DOS CHKDSK command will display the size of the hard disk as the total disk space.

Setting up a new PC

When setting up a new PC I usually partition the hard disk into logical drives of 32MB. I find this makes files easier to locate because the directory structure on each drive is less complicated than it would be on a very large disk. For very large databases, a disk larger than 32MB is sometimes needed.

When using several hard disk drives don't forget to specify the drive letters in the DOS PATH statement. A PATH statement in the autoexec.bat file might look like this:

```
PATH = c:\;c:\DOS;d:\
    Word;e:\Windows;
```

In the config.sys file the LASTDRIVE = x statement is needed when the number of logical drives is greater than three (e: drive). The x refers to the letter of the last disk drive. Partitioning a hard disk into four logical drives, c:, d:, e: and f: requires the LASTDRIVE =f statement in the config.sys file. When partitioning the drive into three or fewer parts, no LASTDRIVE statement is needed.

Mysterious problems

If you discover a program that does not work correctly, check to see what version of DOS the PC is running and the size of the hard disk. The DOS CHKDSK command will show the size of the hard disk. Try the program with DOS 3.3 and a hard disk no larger than 32 MB. This simple check could save you from spending hours trying to locate a hardware problem that does not exist. ■

Patsch is a consultant specializing in the selection, evaluation, and installation of IBM personal computer and compatible hardware and software.

Servicing directly-coupled vertical circuits

By Homer L. Davidson

Yesterday's vertical circuits consisted of tubes, transformers and blocking oscillators. Today, the multivibrator, synchronized countdown divider system and vertical countdown circuits found in TV vertical circuits consist of transistors and ICs. Vertical directly-coupled circuits are more difficult to service than fixed oscillator or countdown IC circuits.

A typical directly-coupled vertical circuit consists of a multivibrator oscillator pair of transistors, error amp, vertical preamp and top and bottom vertical output transistors (Figure 1). Vertical feedback from the output circuits to the multivibrator oscillator keep the vertical circuits operating. The duo-vertical output transistors directly feed the vertical sweep signal to the vertical yoke windings. Transistors are used throughout the directly-coupled circuits.

If the feedback circuits or any transistor fails, the symptom will be absence of vertical sweep. Waveforms are almost useless as a diagnostic tool under these circumstances, except at the final output base and emitter circuits. The multivibrator circuits will not oscillate if the output circuits are not functioning. This makes servicing the direct-coupled vertical circuits very difficult compared to the fixed oscillator or countdown vertical circuits.

Where to start

Most vertical problems occur in the output circuits, so start at the output circuits and work backward toward the front of the vertical circuits. Check the sweep waveform at the emitter of the top vertical output or at the start of the yoke winding (Figure 2). If the vertical sweep waveform is missing, suspect an open yoke winding, electrolytic coupling capacitor or improper vertical sweep.

Check the B+ voltage at the collector of the top vertical output transistor (Q506). Likewise, check the collector voltage of the bottom vertical output. A low collector voltage at the top transistor may indicate that either transistor Q506 or Q507 is leaky. Suspect either transistor open if the collector voltage at the top output is quite high compared to normal operation. You will find the B+ voltage forms a series circuit with each transistor to common ground.

Davidson is a TV servicing consultant for ES&T.

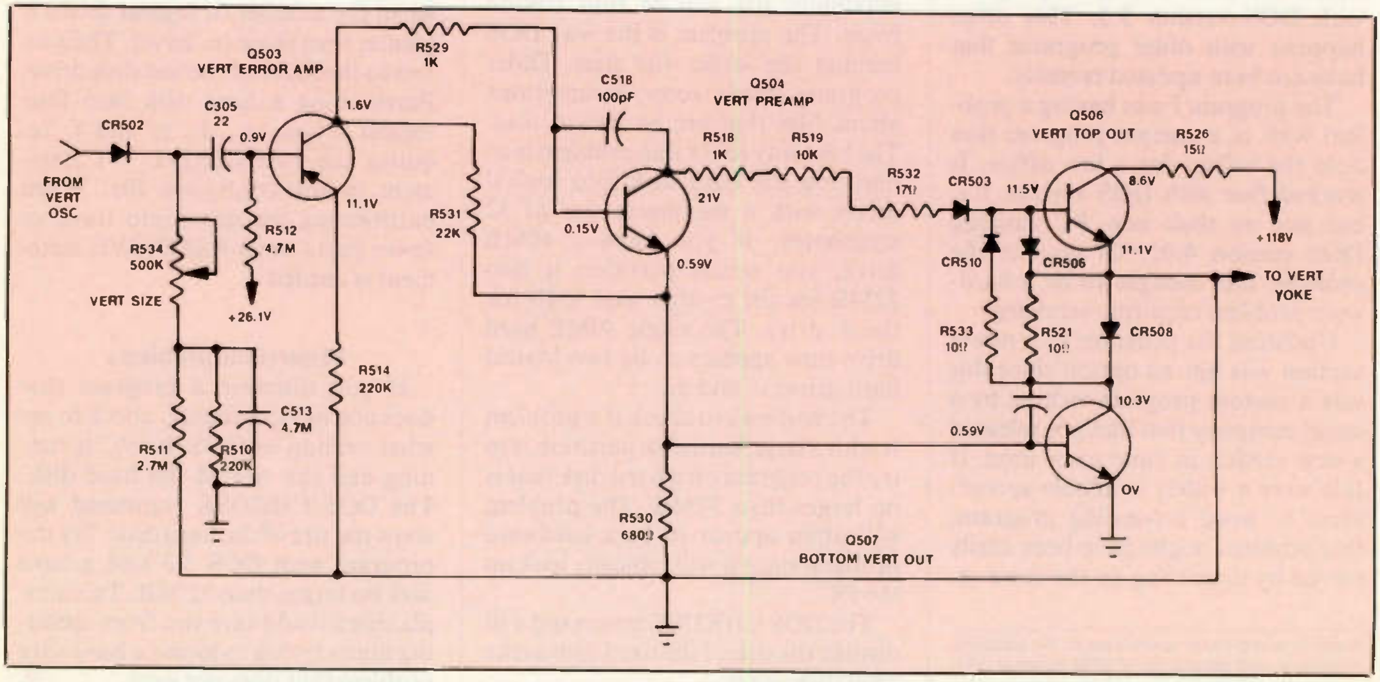


Figure 1. Vertical directly-coupled circuits are difficult to repair since one defective transistor may directly affect the others.

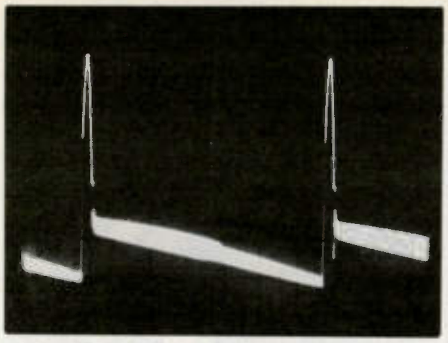


Figure 2. Check the waveform at the emitter of the top output transistor or at the yoke input terminal to determine if the vertical circuits are working.

In some cases, you may find one output transistor open and the other leaky. Always replace both output transistors when one is found to be defective. Whenever one is defective, the other is probably not far from failure, so replacement of both may prevent a callback. These transistors can be easily checked in the circuit (Figure 3).

If these voltages are quite normal, inject a sawtooth waveform from a signal generator (as similar to the actual vertical sweep pulse as possible) at the base of the bottom transistor (Q507). If the vertical deflection returns to near normal, suspect the preceding oscillator, error amp and vertical preamp circuits. If only a white horizontal line continues to appear even in the presence of the injected pulse, suspect an open yoke or electrolytic coupling capacitor.

The yoke winding can be checked with the low ohmmeter scale of a DMM, including poor or broken yoke socket or connecting wires. The vertical coupling capacitor can be quickly checked by shunting a known-good 100μF electrolytic capacitor across the suspected one. In some chassis, the coupling capacitor is located between output transistors and yoke winding and in others between yoke ground winding and pincushion transformer.

Note that these electrolytic capacitors have a high working voltage, 50 to 180V. In fact, the first thing many technicians do when they're working on the vertical circuits in a TV chassis that's 5 to 10 years old is to shunt this capacitor with a good capacitor to see if the existing one is defective. These capacitors seem to dry up and lose capacitance after several years of operation. If the raster appears when you shunt a vertical coupling capacitor with another capacitor, replace the capacitor. The symptom of a defective yoke coupling capacitor may be insufficient sweep, no vertical sweep, bouncing of picture or noisy lines in the raster.

Front end direct-coupled circuits

When the raster returns as a result of signal injection at the vertical output transistor, check the vertical oscillator transistors, vertical error amp and preamp transistors. Observe waveforms and make critical voltage measurements (Figure 4). Remember, in direct-coupled transistor circuits when one transistor or circuit component fails, the preceding transistor measurements are affected.

Troublesome components

In directly-coupled vertical circuits, check all transistors and diodes right in the circuit. When one fails to measure up, remove the suspect component for accurate open and leakage tests. Next, check critical electrolytic coupling, bypass and filter capacitors. In most sets, one or two transistors in the direct-coupled circuits seem to fail first. Check the manufacturer's literature to see if any components have a history of failure and test these first.

Intermittent vertical sweep

The intermittent directly-coupled vertical circuits can be tough to service, since each transistor depends upon the others. Monitor the vertical output stages with the scope at the emitter terminal or yoke input lead. Start by attaching the voltmeter to the collector terminal of the vertical preamp transistor. Notice if the voltage changes drastically when the raster goes to a white line. Monitor each transistor collector terminal in the same manner.

Sometimes the intermittent will operate normally when voltage, signal injection and scope tests are made throughout the circuits. Also, when testing transistors in the circuit, the transistor may pop on. Usually, transistor and diode tests solve most intermittent vertical problems.

When the vertical section is operating normally, spray each transistor several times with coolant to make the intermittent transistor act up. Then apply heat to the same transistor. Often, the intermittent transistor will act up with extreme heat and coolant applications. The same method applies to intermittent diodes and bypass capacitors.

One good way to tackle an intermittent vertical problem is to be careful not move the chassis or disturb the components on the board. Carefully and quickly test each transistor and diode in the circuit. If these checks don't point to a defective component, suspect a poor board connection or broken pc wiring. Sometimes probing around the components and pushing down at several spots upon the board may turn up the intermittent connection.

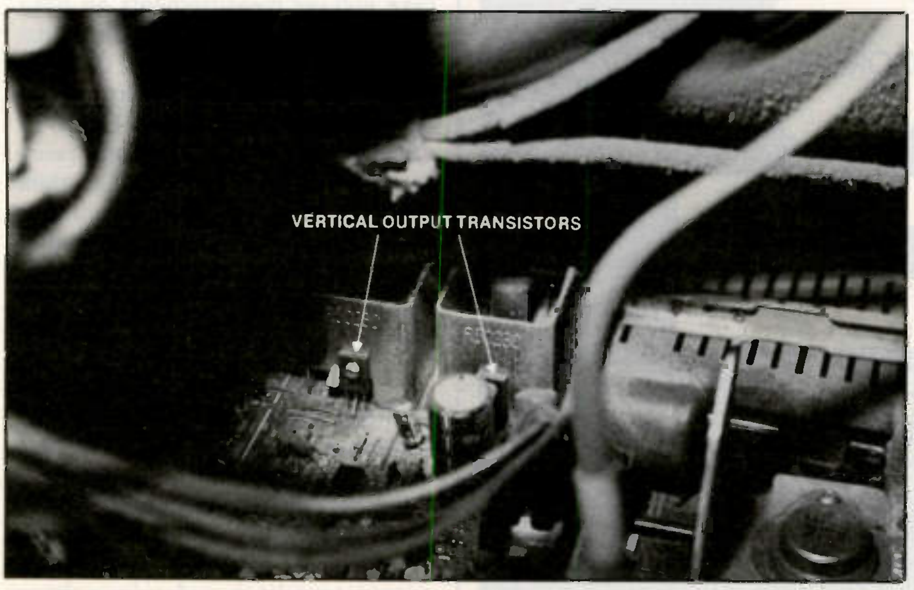


Figure 3. Often, the two vertical output transistors that cause the most vertical problems are mounted side by side on a metal heat sink.

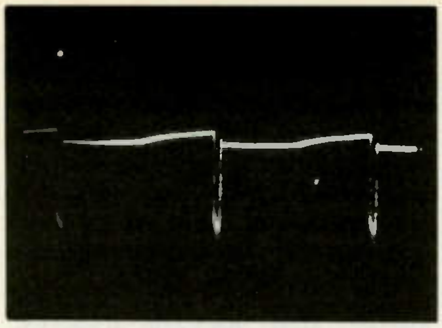


Figure 4. This waveform was taken at the base and emitter of the vertical preamp with oscillator and error amp functioning.

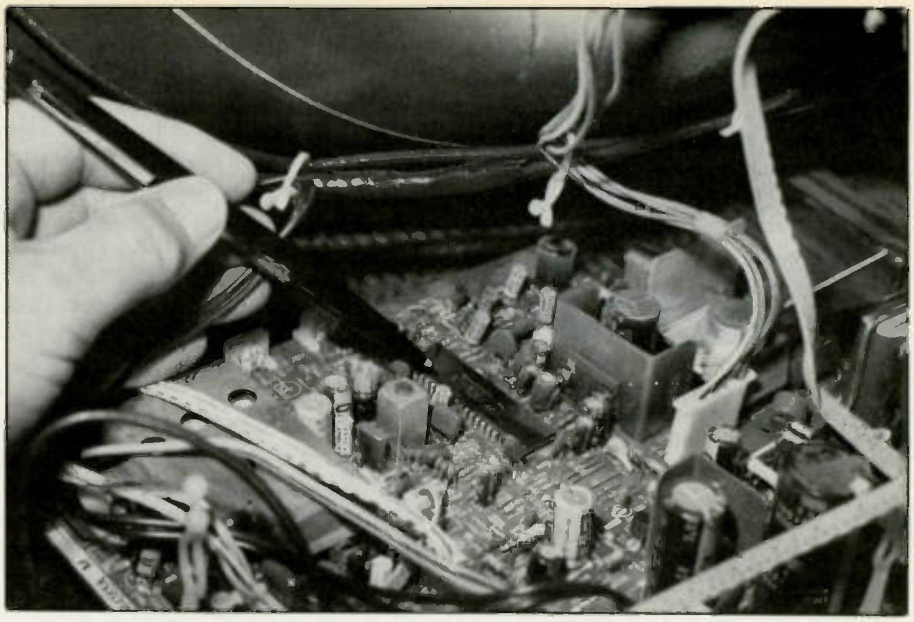


Figure 5. The vertical oscillator and amp circuits are found in one large IC component of a Sharp 19J65 chassis. Notice that the vertical output circuits are in one IC component.

IC vertical circuits

Vertical circuits that are based on a vertical countdown oscillator source are easy to service. The IC processor may include horizontal and vertical countdown circuits with both horizontal and vertical output drive pulses. Some horizontal countdown circuits in the most recent TV chassis are crystal controlled (Figure 5). Of course, the same IC component contains many other electronic circuits as well.

To diagnose a problem in the vertical circuits of one of these sets, scope the vertical drive output waveform at the IC terminal. If the waveform is present, proceed through the circuit with scope tests, right up to the vertical deflection yoke. If there is no output drive pulse at the IC terminal, suspect a defective vertical IC section. When the symptom is a horizontal white line, there is no doubt that the horizontal countdown circuits are operating, but the vertical section may be defective (Figure 6).

Check the waveforms at the base and emitter of the top output transistor (Q653). These waveforms have the same polarity. If these waveforms are normal, check on both sides of the output coupling capacitor.

On one Goldstar KMA-0401 portable I encountered, the waveform was missing on C657 at the vertical yoke side. When I shunted C657 with another 1000μF capacitor the raster returned. Replacing C657 completed the repair.

When the vertical pulse is present all the way up to the output circuits, take voltage measurements on both vertical output transistors. Check the output transistors for open or leaky conditions. Measure the resistance of R663 (22Ω) when either Q652 or Q653 is leaky. Also, check bias resistors R660, R668 and D651 when either transistor is out of the circuit. When the symptom is a horizontal white line, Don't overlook the possibility that the cause is an open R667 (1.5Ω).

Insufficient vertical sweep

Often, insufficient vertical sweep problems are related to the vertical output transistors. In fact, in some instances you may encounter, the top half of the raster may be black. If this is the case, go directly to the top half output transistor and take voltage measurements.

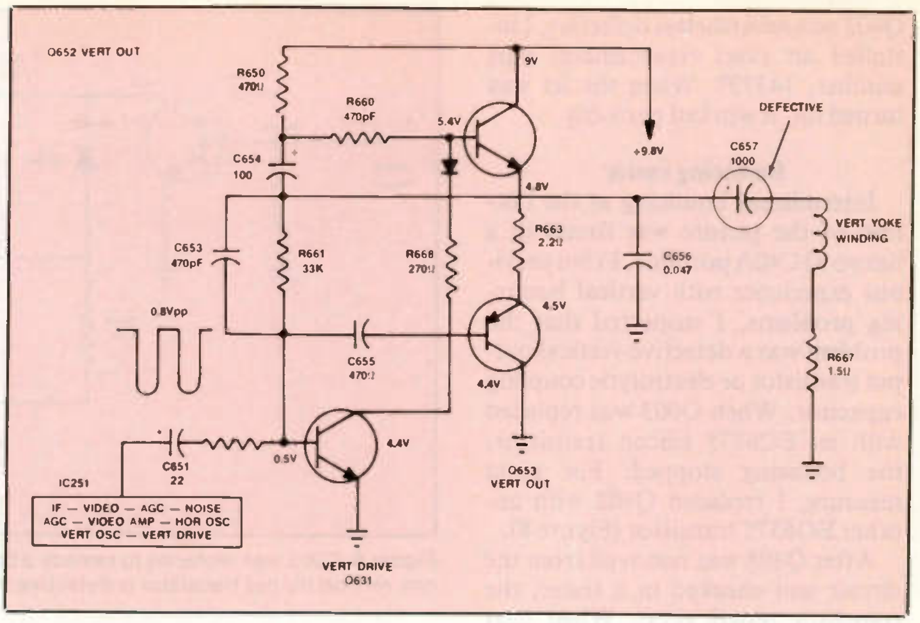


Figure 6. Defective C657 was shunted with a known-good capacitor after waveform observation indicated that the signal was correct up to that point. This restored the raster.

I encountered an RCA CTC93E that exhibited this symptom. At first I suspected that Q408 was leaky, because the voltages at all terminals were extremely low. Further checks, however, revealed that CR416 had become a dead short. When I replaced both CR416 and Q408, the whole vertical raster was restored.

External power sources

In sets where the power supply voltages are scan derived, when the chassis circuits shut down diagnosis becomes extremely difficult. If one of these sets is in shutdown and you suspect the vertical circuits, you can service the vertical circuits using an external vertical voltage source. You may also find this technique advantageous in some cases in frequency controlled power supplies. *The set should be disconnected from the 120V power when external voltages are applied.*

Two different voltage sources may be needed to power the vertical circuits. External power supplies with variable voltage sources are desired. Check the schematic for the supply voltage of the vertical oscillator or countdown IC and connect to the supply pin of the IC (Vcc). Next, connect another power source to the output circuits. The output voltage transistors may operate at a higher voltage.

Now scope the vertical circuits starting at the emitter terminal of the top output transistor or yoke winding for a drive pulse. If the drive pulse is present, the vertical circuits may not be the culprit in shutting down the TV chassis. When no waveform is found at the output, check the waveform on the vertical driver IC or vertical oscillator circuits.

If the vertical IC operates from a horizontal count down circuit and no drive waveform is present, inject a vertical drive signal (again from a signal generator) at this point. A vertical output injected waveform can check the output vertical circuits at the base of the bottom output transistor with the scope as indicator.

Retrace lines at the top

In one RCA CTC93 chassis several white lines were found at the top and one bright white line down the middle of the picture in an RCA CTC93 chassis. Lines such as this at the top in a directly-coupled vertical circuit may be caused by a leaky transistor or open resistors. In this instance, all transistors tested normal in the circuit. Notice that this vertical directly-coupled circuit has both negative and positive power sources feeding the vertical switch driver and retrace switch transistors (Figure 7).

In a TV set with direct-coupled vertical circuits, when the vertical circuits are not operating, the voltage measurements are way off. In this case, Q402 appeared to have a bad internal junction when checked quickly in the circuit. The base to emitter junction resistance was 0.243Ω, and the base to collector junction resistance was 0.623Ω when checked with a DMM diode in- circuit test. When tested out of the circuit, the transistor appeared normal. Suspecting that

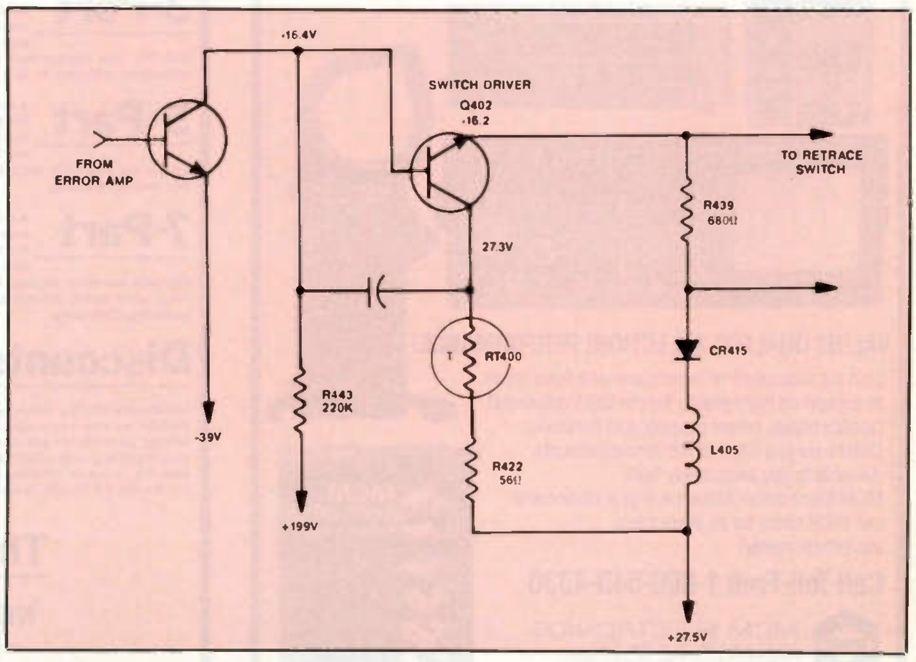


Figure 7. Retrace lines at the top of the screen in an RCA CTC93 chassis were caused by a poor internal junction of Switch Driver Q402.

Q402 was nevertheless defective, I installed an exact replacement; part number, 143797. When the set was turned on, it worked perfectly.

Bouncing raster

Intermittent bouncing at the bottom of the picture was found in a Sanyo 31C40A portable. From previous experience with vertical bouncing problems, I suspected that the problem was a defective vertical output transistor or electrolytic coupling capacitor. When Q903 was replaced with an EC6375 silicon transistor, the bouncing stopped. For good measure, I replaced Q902 with another EG6375 transistor (Figure 8).

After Q308 was removed from the circuit and checked in a tester, the transistor tested good. When heat was applied the transistor had high leakage from collector to the emitter terminals. With heat removed, the transistor returned to normal.

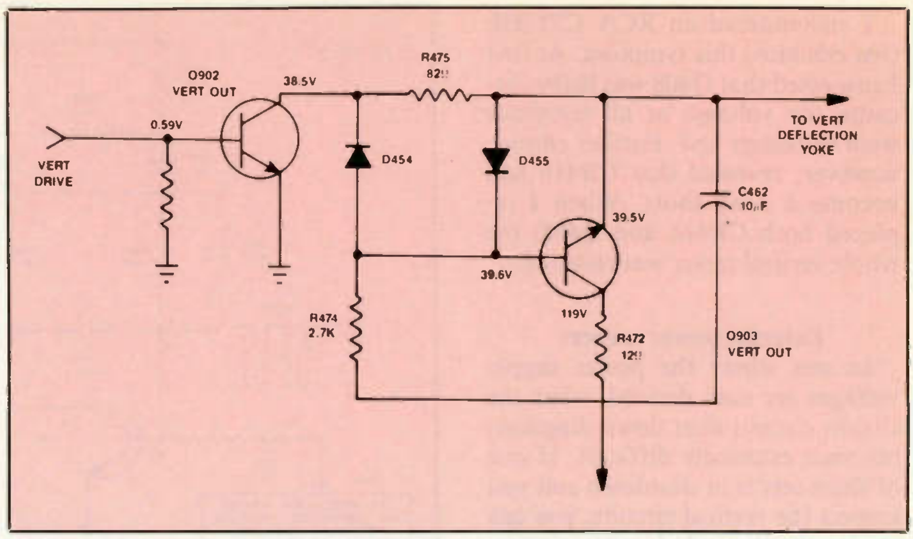


Figure 8. Q903 was replaced to remedy a bouncing raster at the bottom of picture. When one vertical output transistor is defective, replace both at the same time.

Conclusion

When you're faced with a malfunctioning TV set with suspected vertical circuit problems, your first diagnostic step should be to check the vertical output transistors using waveform observation and voltage and resistance measurements. In older TV chassis, when the symptom is absence of vertical sweep, shunt the electrolytic coupling capacitor to the yoke with a good capacitor. When the problem is intermittent, perform quick precise in-circuit transistor tests without disturbing the pc board.

In the most difficult intermittent vertical symptoms some technicians replace all the small vertical transistors since they are very inexpensive to replace. ■

Test your electronics knowledge

By Sam Wilson

All questions require a one-word answer. All answers are in the letter matrix. Even so, the range of subjects is so wide it is not expected that a super technician will be able to give more than 50% of the answers.

The words in the matrix can be spelled forward or backward, or, at a 45° angle going up or down.

Note: If you get 70% (or over) on this test send me 5 unused first-class postage stamps (worth 29 cents each) and I'll send you a prize.

E	D	A	P	H	C	T	A	R	C	S	E	T	I	A
H	W	Q	N	G	E	∀	E	E	X	I	O	E	E	Z
Z	L	J	O	H	L	C	P	L	J	N	T	R	D	G
F	J	X	I	N	Q	Z	O	P	S	L	B	U	R	A
Y	C	O	T	Q	W	G	Z	A	U	M	D	T	A	G
Q	I	O	C	L	I	I	H	A	J	J	L	A	O	C
C	L	E	I	B	I	E	F	K	U	I	E	R	B	D
W	O	L	R	P	T	S	L	C	Q	D	I	D	Y	E
J	B	Z	T	F	Z	Y	S	O	C	U	F	A	E	D
J	M	M	S	K	S	N	K	A	A	N	L	U	K	N
C	Y	F	Q	T	O	W	K	W	J	D	D	Q	T	A
B	S	F	R	D	O	Q	Y	E	A	O	I	V	H	P
X	E	O	O	C	Q	I	V	E	N	K	U	N	U	X
S	N	L	G	W	Z	I	D	L	G	W	C	S	G	E
U	Y	T	I	V	I	T	C	U	L	E	R	A	Q	Q

1. In communications, a ________ coil is added to an antenna to improve transmission characteristics in a given frequency band.

2. A partial or total local failure in the insulation or continuity of a conductor is called a ________.

3. The reciprocal of magnetic permeability is called ________.

4. A ________ is a velocity-modulated tube that has an input resonator, drift space, and output resonator.

5. If you apply sinusoidal waveforms to both axes of an oscilloscope you obtain a pattern that can be used for measuring frequency, phase, and distortion. It is a ________ pattern.

6. A ________ is a device used for encoding data. It is implemented by pressing a key.

7. When you magnetize an iron bar along its length it becomes shorter. This is called magneto ________.

8. Letter symbols used as mnemonics are called ________ mnemonics. Examples: LDA.

9. One of two (or more) equal parts of a frame is called a ________.

10. When two sinewave signals are ninety-degrees out of phase they are said to be in ________.

11. In an oscilloscope the movement of the electronic beam is speeded up to obtain the ________ sweep.

12. What is the name of a high-speed memory device used for temporarily storing the location of an interrupted program, and, used to retrieve the program after the interrupt is completed?

Wilson is the electronics theory consultant for ES&T.

(Answers on page 62)

Servicing problems in IBM PS/2 monitors

By Don D. Doerr

Lately, there seems to be an increasing number of failing VGA (Video Graphics Array) monitors. In fact, in the case of the IBM 8513, larger users are reporting more then a 50% fatality rate within the first two years. It's not just IBM having these problems. There has been an epidemic of VGA monitors failing nation-wide.

One of the major sources of these problems has been due to bad flyback transformers. Since four manufacturers supply about 80% of the monitors sold in the U. S. (regardless of what name may be on the monitor), these problems can be found in the majority of VGA monitors.

With monitor repair costing between $85 and $250 for labor, plus the cost of the flyback (most repair facilities charge from $60 to $75 for the flyback), these repairs can add up. It's no surprise to see the increasing numbers of monitor repair companies popping up all over the country. On the other hand there has also been a trend for companies to reconsider their own in-house service of these monitors.

Most of the problems with these monitors can be solved in less then 15 minutes (about the time it takes to package the monitor for shipping and fill out the paper work). Even if the flyback is bad, replacements are readily available for less then $40. In order to be able to do this repair the technician must have good soldering skills and must know the procedure for removing and reinstalling the flyback.

Doerr is President of National Advancement Corporation who for the last five years has specialized in advanced PC, printer and network repair training.

Getting Started

As with work on any other kind of CRT, make sure that the monitor is unplugged before starting work on it. The chance for getting shocked is very low. Most newer monitors have bleeder circuits that dissipate the high voltage when the monitor is turned off. The injuries that do occur from working on this high voltage occur when the person gets shocked and out of reflex pulls their hand away, scraping it on an edge in the monitor. The high voltage itself has such low current available that it will not cause any serious injury. Although, caution should still be used when working in this area.

Before attempting to remove a flyback transformer you must discharge the second anode on the CRT (just in case the bleeder circuit is not working). To discharge the CRT, after making sure the monitor is unplugged from power, use a well insulated screw driver or jumper wire and connect one side to ground and the other to the wire underneath the rubber nipple where the flyback connects to the CRT.

Make sure you are not touching any metal on the screw driver or monitor during this procedure. It is a good idea to always leave one hand in your pocket to prevent it from touching any part of the monitor. A popping sound may be heard meaning the CRT did contain a charge. It is now safe to disconnect the wire from the CRT.

NOTE: If the monitor is left standing for more then a few minutes, be sure to discharge the CRT again before resuming work on the high voltage area.

Each brand of monitor is different in its design, and a different flyback is required for each brand and model. But most monitor designs are similar and the symptoms of a bad flyback will usually be the same for any brand or model.

Usually when a flyback fails they short internally causing them to pull down the power, causing the power supply to shut off. The symptom of this failure is very simply a dead monitor (the power light on the front panel will not light). In some cases the power light will come on for about one second when the monitor is first powered on and then the light goes off. This symptom is almost always a sign of a bad flyback.

A few specific problems and solutions

IBM 8503 **Symptom:** *Dead.* **Solution:** IBM has used two suppliers for these monitors: one is an off-shore supplier (Tatung) and one is an on-shore supplier (Zenith). This fix applies to the Zenith monitor only. Check the Diode at location D124, replace if shorted.

IBM 8512 **Symptom:** Power comes on but no picture; 2401 error from system, or wrong colors are displayed. **Solution:** Any of these symptoms can be caused by the signal cable having bad connections. Open the monitor and remove and reinstall the video connector where it plugs into the main board (it may be necessary to repeat the procedure several times to scrape off any corrosion). Also check the pins on the side of the cable that plugs into the video adapter to make sure none of them have been bent. If you have a monitor that still has no picture, resolder all connections on the flyback transformer.

IBM 8513 **Symptom:** Horizontal line on screen (no vertical deflection). **Solution:** This is caused by the vertical driver IC at location Q301 (p/n TDA1670) shorting. When this part shorts it will open the resistor at location R320. The manufacturers of these monitors have experimented with different values of resistors for R320. They have used 2.2Ω, 10Ω, 12Ω and finally have settled on an 18Ω, 1W resistor. Be sure to use this 18Ω resistor regardless of the value of the resistor being replaced.

In some cases C303 (0.1μF 50V) and/or D302 (RGP-15J) will short and should be replaced. After replacing any bad parts, always check the voltage at pin 9 of the flyback transformer. If the voltage is much over 115V, replace C812, C815 and C826 in the power supply. These are a few of the many recurring problems we have found with the IBM VGA monitors.

With any equipment be it electronic or mechanical a minimum of 80% of the failures will be repeating failures in the same few components. Once the source of the problem has been discovered, repairing these recurring problems is a matter of mindless parts swapping.

Recently I found a company that has applied the same logic to the Apple Macintosh, and offer a kit (average cost about $30) with several of the most common failing parts on the Macintosh boards. All the technician has to do is to replace the parts on the board with parts from the kit. The replacement parts in the kit are a higher grade part so not only will replacing the parts fix about 90% of failures on that board, but this will also make the board more reliable. This company is Microdoc, 2635 Capitol, Eugene OR 97403, 503-344-5335.

I hope you find this article to be a valuable reference source. ■

What do you know about electronics?

What?–Errors in Test Your Electronics Knowledge?????

By Sam Wilson

Editor's note: This installment of "What Do You Know About Electronics?" was originally scheduled to appear in the March issue, but because of scheduling problems it was delayed until this issue. This is the reason that we're now addressing a couple of errors that appeared in the December 1990 issue.

There were two errors in the "Test Your Electronics Knowledge" column in the December issue.

My friend Delbert Shafer in Warren Ohio first called them to my attention. At the time of this writing, I have also received letters from: Bill Aull of Cyce, NC; Steve Harris of Arcadia, CA; and, Dan Page of Ft. Smith, AR. More letters may be on the way.

Here are the questions, the corrected answers and explanations:

Question #5 - Assume the diode in Figure A. has zero forward resistance and infinite reverse resistance. Write the values of V_{out} for the switch positions.

V_{out} for position x __________V
V_{out} for position y __________V

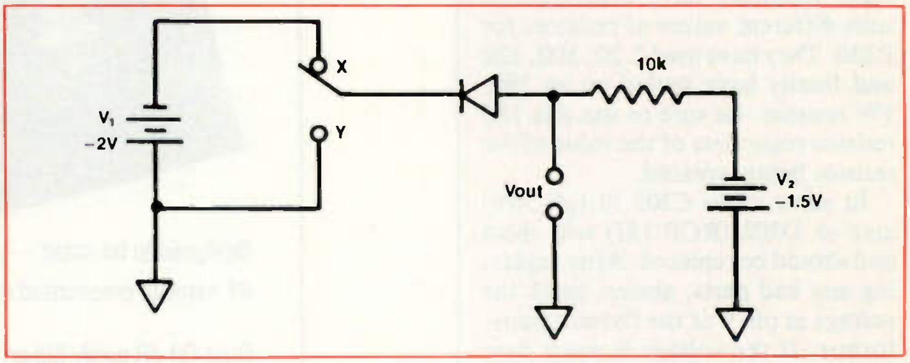


Figure A.

Answer - When the switch is in position x, the cathode of the diode is more negative than the anode. Therefore, the diode is conducting. Since it has zero forward resistance, its cathode and anode are at the same voltage [-2.OV].

When the switch is in position y the diode is reverse biased. Battery V_2 is connected to an open circuit and all of its voltage will appear across the terminals marked V_2.

Question #10 - The resistors in Figure B have a ± 10% tolerance. All resistances are at the top of their rating. So, if each resistor is 6.2K, the total resistance is 6.2K + [100% of 6.2K], or, 12.4K. Is that right?

Answer - That is the way the problem was supposed to be stated, but it didn't come out right. Of course, the statement is not true! When at the top of the 10% tolerance, each resistor has a value of 6.2K + [0.1 × 6.2]K, or 6.82K. The ten resistors in series would have total resistance of 68.2K.

A new contest

It looks to me like I was starting to get careless again. The last time this happened I had to take some drastic measures to stop it. I offered free prizes to anyone who could find an error in a six month period. Not many people claimed their prize—even though I put in an error on purpose (which I later corrected).

I have already taken steps to reduce or eliminate some errors, but anyone and everyone who finds an error in Test Your Electronics and writes to me about it, I will send a free monograph titled "Decoder." Be sure to give me your name and address so I can mail the monograph. You don't have to be fancy. If your handwriting is as bad as mine, please print. Describe the error.

I am not responsible for the illustrations. Any error you write about must be a technical error. Grammar, spelling, and punctuation do not count in this contest. Also, only one error to a customer.

I don't plan to give out a lot of these free. However I do intend to put in one error. If you want to be helpful, please include a couple of 29 cent stamps. The monograph itself is worth about $3.00. [Maybe not quite

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

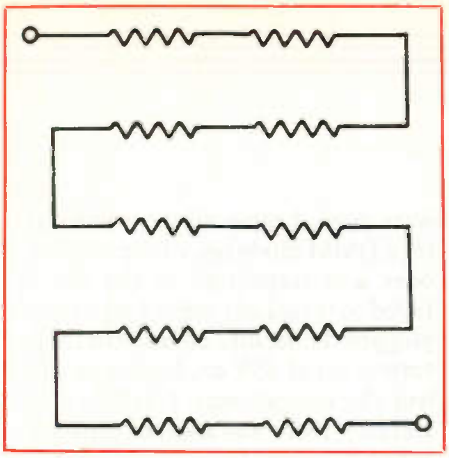


Figure B

that much because I'm going to autograph it]. Have a go!

Electronics with butter and jelly

What I am saying in this column is my opinion. It is not necessarily shared by the owners, management, or other employees of this magazine. Although it is very hard for me to understand, you may not agree with what I am saying. Your letters are important to me whether you agree with me or . . .

If your Mother wanted you to swallow a large pill when you were a child, she may have hid it in butter, or in jelly (that same technique also works with pets).

Unfortunately, a very similar technique is also used in some technician literature. For example, I have seen this statement—sometimes in different forms—in various technician literature: "For a parallel-tuned circuit, the equation for the parallel resonant frequency is the same as for a series-tuned circuit."

Once you swallow that you can go on to other things - never knowing you've been given a tranquilizer. Here is another dose you may have been asked to swallow: "A capacitor is charged by forcing electrons into one of its plates and drawing them away from the other." After you swallow that one you go about learning new things thinking you have a fairly good grasp on capacitors.

Of course, you have been tranquilized by the application of a heavy coating of technical jelly. Here is a dose that will eventually result in a waste of time and effort. "Electronic current flow is actually a flow of tiny particles called electrons." And a related one that is just as bad—"In order to have a flow of current you need a voltage source and some form of conductor." Here is one that could choke you if it is given without both butter and jelly. "Voltage is the force, or pressure that pushes electrons through a conductor."

The following statement is a jelly coated piece of nonsense that makes it impossible to really understand how a transistor works: "Electric current can flow in a material if it has a surplus of free electrons. Materials without free electrons are insulators." Here is one that could choke a moose: "A speaker converts electric energy to sound energy: and, a microphone converts sound energy to electric energy."

Now, don't get me wrong. When you are teaching or writing for technicians AT A LOWER LEVEL you have to start everywhere at once. So, it is usually necessary to resort to models, like the ones mentioned above, to get the learner off dead center. There really isn't anything wrong with that method.

When we get into trouble is when we forget to tell the learner that they are models. Worse yet, they are sometimes passed off as being true in technical literature.

How many of the above statements did you believe at one time or another? Are there any that you still believe?

While it is an accepted technique to use models for getting learners into operation, my opinion is that they have no place in literature that is designed for use by experienced technicians.

Why do they occur in technical literature in the first place? Prevailing ideas are that a technician is:

1. too dumb to really grasp what is really true; or, 2. the technician doesn't really need to know. His job does not require any real understanding of theory.

When I first started writing CET tests I got blasted with those ideas over and over. One objection to the CET test was based upon the idea that technicians are too dumb to really understand how electronic circuits work!!!

Here is a statement that I have heard many times: "The more a technician knows about theory the less he is able to fix anything."

That is butter and jelly coated garbage. Taken to extremes it means if you are a CET, or, if you read the magazines, you shouldn't be allowed to take off the back of a set.

I received a letter not too long ago from a disgruntled technician. He was looking for a job and was discouraged by the number of prospective employers that required or preferred someone with an associate degree. This is not referring to skilled technicians who have experience, but rather, to young people looking for their first or second job. It is especially true for job openings in large companies, and the trend seems to be increasing.

So much for the idea that technicians don't need to know theory, or math, or English, or some of the other things they can learn from spending a little more time learning. I'd better stop here or I'm liable to start printing names. ■

Troubleshooting Tips

Roger D. Redden
Beaver, WV

Symptom: Black screen, no sound

Set ID: Sylvania RAJ147, Chassis 13A304, SAMS 2760

I noticed when I slid the chassis back that the small printed board behind the power, volume, and channel buttons was sprung from its plastic holder. "Ah! An easy repair." I thought as I snapped the board back in place. But repeated pushing of the power button still would not turn the set on.

The power supply was a logical place to start checking. Q401 switches the primary of the chopper transformer, T402. (incidentally, T402, is labeled T400 on the bottom of the board.) When I checked the voltage in the standby mode (set not switched on), the dc collector voltage of Q401 seemed about right at 163 volts. So did the standby voltages at the secondary sources, the cathodes of D416, D417, D418, and D480. These voltages are much lower in standby than when the set is operating; for instance only 11.2V at D416 in standby mode versus 98.7V when operating.

I decided to check the voltage at the collector of Q473, the standby switch. This voltage should be nearly zero volts when the set is turned on. When I pushed the button to check the voltage, not only did the voltage go low, but the set came on. I played the set for the next two days, turning it on and off numerous times, but it continued to work normally.

I had noticed that the leads of Q401 as well as some other transistors in the chopper circuit had recently been soldered, as though the set had been worked on for this trouble before. While I wanted to believe that my checking the voltages in the set had fixed it, I couldn't quite persuade myself that I had acquired a magic touch. But I couldn't find the problem while the set was working so I returned it to the owner.

About a week later the owner brought the set back in. Again it would not come on, but this time Q401 was shorted and R401 and F400 were open. I replaced these parts after a DMM diode test of the other diodes and transistors in the circuit failed to reveal any other bad parts. I plugged the set into an isolated transformer set at 45V ac, hoping to protect the components I had just installed if there was another problem. When I checked the standby voltages I got some readings that puzzled me.

The 62Vdc on the collector of Q401 seemed normal, because that was 37% of the normal 170Vdc, and the 45Vac I was applying was 37% of 120Vac, so that was just as it should be. But the voltage at the cathode of D416, which should be 11.2Vdc in standby mode, was 67Vdc.

The voltage at the cathode of D417 was 13.9Vdc and the other secondary voltages were also higher than normal for standby mode. Could the regulator circuit be overcompensating for the lower ac input?

I stepped the ac input up to 68Vac. The voltage supplied by D416 dropped to 11.3Vdc. I increased the ac input to 90Vac and D416's output went to 11 volts in standby and all the other secondary voltages seemed near normal.

The high secondary voltages were apparently normal with low ac input while in standby mode. I might not understand all about this little puzzle but at least it was irrelevant.

Maybe Q401 had been the problem all along, I thought. While still applying 90Vac, I pushed the on/off button. The set came on and had a normal picture.

I was checking the secondary voltages when the set went out again. It had played about two minutes. Q401, F400, and R401 were bad again.

Once again I checked the other diodes and transistors in the circuit without finding any that seemed bad. Wondering if there might be an intermittent short on one of the secondary supplies, I disconnected one end of R505, D420, R418, R425, R417 and D480 to remove the loads from the chopper transformer. I also suspected Q405, and Q404, the error latch transistors, or their circuits, so I disconnected one end of R415, hoping to isolate these circuits from the chopper circuit.

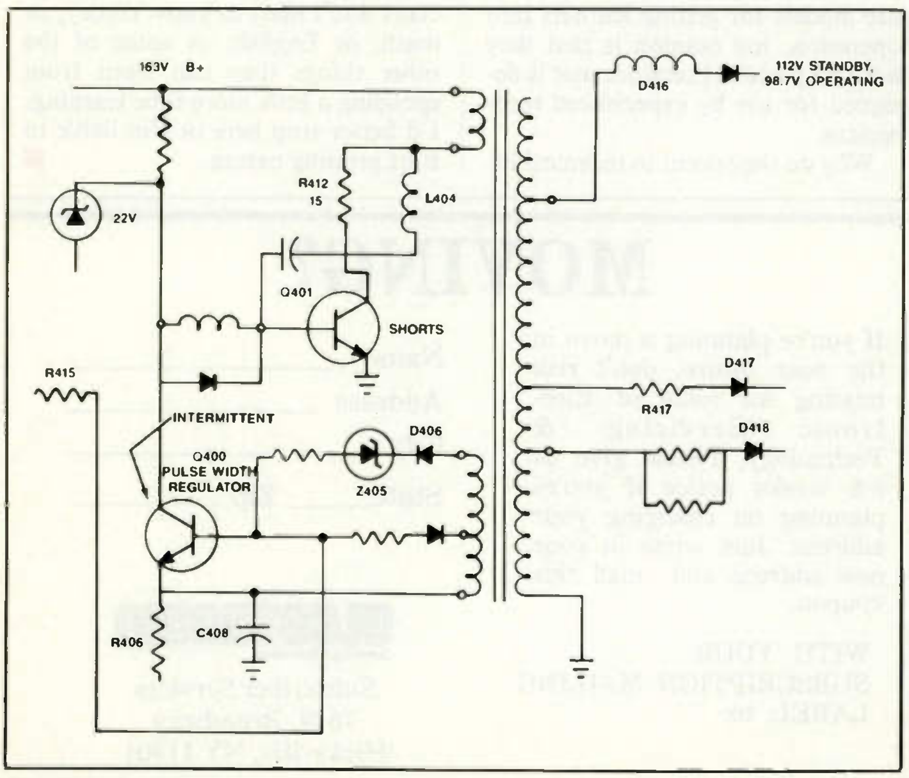


Figure 1.

After replacing the blown parts and plugging the set into 45 Vac, I monitored the chopper collector dc voltage and waveform. The dc voltage was 62.5V and the waveform was 140 VPP at about 500Khz, which seemed normal. But after a few minutes the waveform slowly spread out, showing the frequency was going lower. Also Q401 started becoming warm. I wondered if this might be due to lack of dc control from R415, so I decided to substitute -2V at the base of Q400 to replace that missing from R415. Unfortunately, when I did this, Q400 shorted, and so did Q401.

After a cooling down time - for me, not the set - I installed a new Q401 but temporarily left Q400 out. I found that Q401 will oscillate without Q400, at least with 45Vac applied, and I assume it will with higher ac inputs.

After installing a new Q400, but not substituting any dc voltage for that missing from R415, I found the waveform at the collector of Q401 was the same as before except that the frequency didn't change. Also Q401 was still cool after 5 minutes of operating in standby mode. Hmm. If the frequency slowed and Q401 became warm before, but now with a new Q400, the frequency didn't change and Q401 stayed cool, maybe Q400 had been bad all along. And maybe my inserting -2V to the base of Q400 hadn't blown it. But on the other hand, I wasn't going to risk injecting a voltage again.

I let the circuit operate for half an hour in standby and Q401 remained cool. Then I connected all the circuits and operated the set in standby for an hour, increasing the AC input about every 20 minutes until it was 120 VAC. Finally I got brave enough to turn the set on. The picture and sound seemed normal and after an hour Q401 was just mildly warm. I played the set three days after that with no problem. It has been three weeks and the customer has not brought the set back. I cautiously believe the set is repaired. If I get another of these sets with this problem I will replace Q400 immediately on suspicion.

I have a few notes that may help when working on this circuit:

- A universal horizontal output transistor draws too much base current to be temporarily substituted for Q401.
- When operating normally (set on), the frequency at the collector of Q401 varies almost constantly with every shift in video.

The troubleshooting section of the Sams diagram says D484 supplies power for the 12.8V source during standby mode. I doubt if that is right. When I had R418 and R425 disconnected and was applying 45VAC input, the 12.8V source dropped to 1.2V. When I reconnected the two resistors, this source went up to 5.1V. Also there is a straight path through D475 for the voltage from D418's cathode to supply the 12.8V supply. So unless the lowered AC input was affecting the result more than seems reasonable, D485 does not supply the 12.8V source in standby mode.

UHF connector

New from *RF Connectors* is it's RFU-503 weather resistant version of the PL-259 plug which can be used with any brand UHF Female Connector. The RFU-503 provides a moisture seal between the cable and connector and to the male/female interface. The RFU-503 fits RG-8,

RG-213 and RG-214 cable and is constructed with a nickel plated body, silver plated pin with a teflon dielectric and all weather silicon rubber gaskets. The RFU-503 is ideal for use with antenna systems in all climatic conditions and needs no external boot or tape.

Circle (65) on Reply Card

RF signal generator

Fluke has available its new RF signal generators that offer FM stereo modulation for use in consumer audio electronics applications. The instruments are suited for use in the test

and repair of consumer audio electronics. The 180MHz signal generators can be used either as a standalone benchtop tool or, using the GPIB interface, in test systems. Standard modulation modes include AM, FM and frequency sweep in addition to the FM stereo option. Modulation may be external as well as internal and parameters such as modulation frequency, sweep width, and sweep time are selectable.

Circle (66) on Reply Card

Digital multimeter

Global Specialties announces the model 735 digital multimeter. It is a 3½ digit LCD readout multimeter with auto-ranging capability. The unit features measurement functions including voltage, current, resistance, diode check, and continuity check. Advanced features include Memory Mode and Data Hold. The data hold function provides hands free operation by retaining the last measurement value even after the test probes have been removed from the circuit. The Memory Mode allows deviations and relative measurements to be made by subtracting the latest measurement from the stored value.

Circle (67) on Reply Card

Portable cable testers

L-Com offers a series of portable cable testers for modular, coaxial and twinaxial cable requirements. The six cable testers in this series sat-

isfy the need to quickly identify between good and bad cables. Each tester scans for continuity, shorts and cross wirings. The high impact case is only 2.4" × 3.75" × 1.1" and operates from one 9V alkaline battery.

Circle (68) on Reply Card

Soldering station

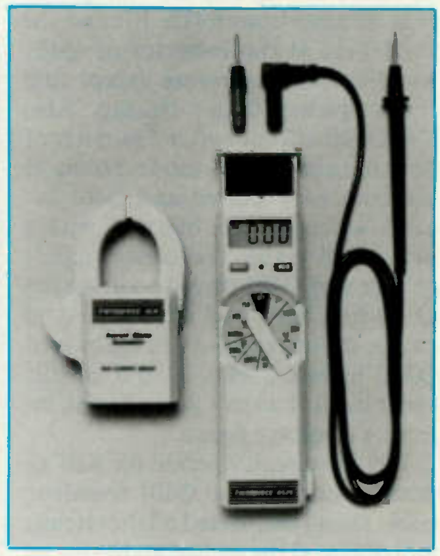
Weller introduces a new high-performance soldering station which minimizes electrostatic discharge (ESD). The company now has the HYC3000 electronically controlled soldering station, equipped with the recently introduced EC1503 42 watt high performance iron. It aslo has a

high output, high tip mass soldering pencil which features the EM Series patented tips. The soldering station is suited for use on multilayered boards and difficult applications requiring large heat outputs from a small tool.

Circle (69) on Reply Card

DMM integrates voltage checker and current clamp

Fieldpiece Instruments has introduced a small line of multimeters that integrates the functions of a digital multimeter, a voltage checker, and a current clamp meter in a drop-proof,



contamination resistant housing. The fully sealed yellow Valox case enables the meter to withstand exposure to contaminants and drops of up to 10 feet. Overload protection enables the meters to withstand exposure to contaminants and drops of up to 10 feet. Metal oxide varistors are used for transient protection. The two standard multimeter jacks come out the top to accept test leads, specially designed probe tips, and a specially designed current clamp head.

Circle (70) on Reply Card

Test lead kit

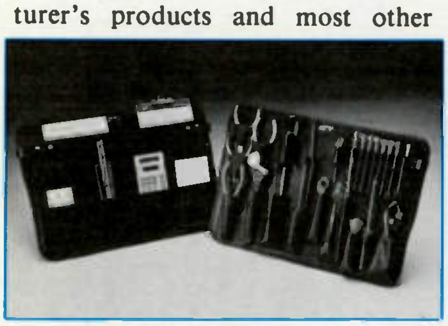
Now from *Probe Master* is a "Softie Master Kit" containing unique softie test leads with 12 accessories. The kit is a multiple interconnecting test lead kit designed to access all those hard

to reach places. Becasue the probe bends 90 degrees of more and conforms to the shape of your hand it reduces wear and lasts longer, says the manufacturer. The 48″ silicone insulated leads are softer, yet impervious to hot soldering iron burns and feature sharp stainless steel tips and screw-on insulated accessories for positive connection to large, small or subminiature components.

Circle (71) on Reply Card

Reversible pallet

An innovative product is now available from *Chicago Case Company* which fits all of the manufacturer's products and most other



cases. Model No. DPT-3x1 is a reversible, two-sided pallet which is 18″ × 13″ and is ideal to upgrade present tool cases. The pallet was designed to be compatible with the industry's standard cases. One side includes machine stitched tool pallets to keep all tools easily accessible for technicians, servicemen or field service supervisors, or anyone carrying tools on the job. It provides a versatile attache/briefcase with ample room and various sized pockets for writing instruments, clip board, supplies for outside calls, stationary measuring devices like rulers and tape, and even for a calculator.

Circle (72) on Reply Card

New handpiece for SMD removal

New from *Pace* is its Thermotweez handpiece for safe, rapid reflow and removal of a wide variety of PLCCs, LCCs and other surface mount components. Unlike other removal methods, the high power ThermoTweez grips the component leads and directs controlled conductive heat right

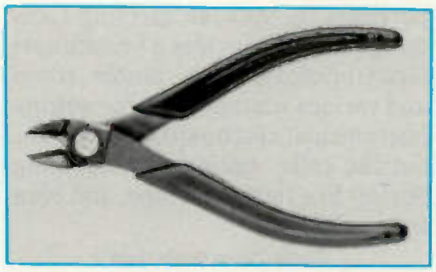
Circle (1) on Reply Card

to the joints avoiding damage to adjacent components and substrate areas. Safe, even, solder reflow is achieved in seconds, even on the largest packages. The component is then immediately removed without damage in a simple, one-handed operation. Vertical design and adjustable opening permit easy manipulation and control for operators of any skill level. Slim-line tips assure easy access and safe solder joint heating, even on densely packaged assemblies.

Circle (73) on Reply Card

Ultra-Slim shears

Xcelite introduces Ultra-Slim, flush cut shears with special grips for protection against electrostatic discharge (ESD). This feature helps to avoid damage to sensitive electronic components. The new five-inch shears (Models 96CG and 97CG) have an improved ergonomic handle

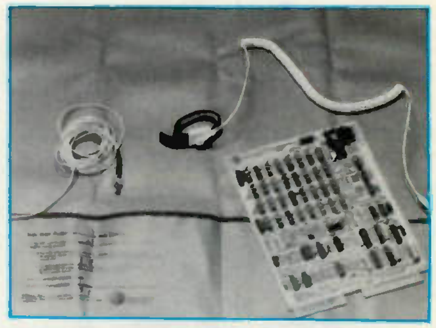


design that provides shear cutting action with less effort while reducing user fatigue. The ultra thin profile allows easier access to high density areas. Manufactured from the highest quality carbon steel, the pliers are also available with a special "Klip Grip" to hold cut-off wire. The shears are capable of cutting soft wire up to 20AWG.

Circle (74) on Reply Card

Portable static control work station

Plastic Systems announces the Field Service Kit which allows field



personnel to ground themselves and protect equipment against electrostatic discharge (ESD) while working on-site. The kit is ideal for use by field personnel who test, service, maintain or overhaul sensitive equipment. The complete kit includes a lightweight fold-up static dissipative mat, an adjustable wrist strap assembly (wrist strap, coil cord and alligator clip), a one megohm resistorized ground cord and instructions detailing proper use.

Circle (75) on Reply Card

Test your electronics knowledge

Answers to the quiz

(from page 53)

1. Loading
2. Fault
3. Reluctivity
4. Klystron
5. Lissajous
6. Keyboard

—	D	A	P	H	C	T	A	R	C	S	—	—	—	—
—	—	—	N	—	—	—	—	—	—	—	—	E	—	—
—	—	—	O	—	—	—	—	—	—	—	T	R	D	—
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—	C	—	T	—	—	—	—	—	U	—	D	T	A	—
—	I	—	C	L	—	—	—	A	—	—	L	A	O	—
—	L	—	I	—	I	—	F	K	—	—	E	R	B	D
—	O	—	R	—	—	S	L	—	—	—	I	D	Y	E
—	B	—	T	—	—	Y	S	O	—	—	F	A	E	D
—	M	—	S	—	S	—	—	A	A	—	—	U	K	N
—	Y	—	—	T	—	—	—	—	J	D	—	Q	—	A
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—	—	O	—	—	—	—	—	—	—	—	U	N	—	X
—	N	—	—	—	—	—	—	—	—	—	—	S	G	E
—	Y	T	I	V	I	T	C	U	L	E	R	—	—	—

7. . . . striction
8. Symbolic
9. Field
10. Quadrature
11. Expanded
12. Scratch pad

CATV-RF signal analyzer

Sencore announces its new FS74A Channelizer Sr. It includes an exclusive, all channel, microprocessor controlled tuner for testing all standard and cable channels to FCC accuracy, including the return channels, (sub-band), off-air VHF, UHF, and FM. The user can select FCC, HRC, or ICC carrier shift tuning—dial in the channel and read the video

or audio signal level in microvolts and dBmV on the fully autoranged meter. The patented on-channel automatic signal-to-noise ratio test eliminates time consuming signal comparisons/calculations required when referencing noise on an unused channel.

Circle (76) on Reply Card

Digital multimeter

Simpson Electric Company now has the model 467 series of digital multimeters that combine a wide range of advanced DMM features. Three models are designed for field service, plant maintenance or telecommunications work. The unit permits easy "hands free" meter reading in addition to benchtop use. An optional carrying case and neck strap keep the display in clear view when the meter is worn on the user's belt or from the neck. The model 467-2 and 467-2T have Digilog display which combines precise digital readout with rapid analog approximation by means of a bar graph. These two models also feature a differential peak hold function for simplifying work with transient voltages/currents. Both models also incorporate a 50 microsecond pulse detector for digital troubleshooting.

Circle (77) on Reply Card

Digital storage oscilloscope

Leader Instruments has announced a new battery powered 30 MS/s com-

bination digital storage oscilloscope/digital multimeter with a number of unique features and functions. The model 300 features dual, add, subtract and X-Y modes, peak to peak voltage of channels 1 and 2 and frequency readout, plus full auto setup and auto ranging for both time base and volts per division for each channel.

Circle (78) on Reply Card

ES&T periodically publishes reviews on books that are particularly applicable to our readers. We do not have any information other than that supplied below each review. Contact the publishing company for further ordering or pricing details.

Introductory Electronic Devices and Circuits, by Robert T. Paynter; Prentice Hall, 866 pages, $44.00 hard.

This book provides a thorough and practical study of electronic devices and the circuits that use them. It is written to serve as a textbook for a second course in an electronics or engineering technology course.

Devices covered range from the most fundamental diode to various FET and MOSFET to multivibrators to LEDs to IC voltage regulators. Circuit design is discussed, too, with a great deal of emphasis on practical uses of each of the devices.

The troubleshooting section of each chapter sets this book apart from numerous others written on similar topics. They are based on the author's experiences. Emphasis is constantly placed on "outside" factors that can affect operation and troubleshooting of various components and circuits. Also, there is a strong emphasis on how things work. Circuit theory is used to explain the mathematics, rather than mathematics being used to explain theory.

Prentice Hall Books, Englewood Cliffs, NJ 07632.

Beginner's Guide To Reading Schematics 2nd Edition, by Robert J. Traister and Anna L. Lisk, TAB Books, 140 pages, $18.95-hard.

This is a beginner's guide to understanding and using block diagrams, schematics, and pictorials. Many people are frightened away from a hobby or career in electronics because they don't understand schematic diagrams. Learning to read schematic diagrams and use them to analyze electronic circuits is often mistakenly viewed as complex and difficult. But as Traister and Lisk explain in this revised second edition, learning to interpret the symbols, interconnections, and component designations found on most schematic diagrams can actually be quite simple.

The guide includes new updated, drawings reflecting the latest in electronic circuitry and takes readers step by step through every phase of understanding and using electronic circuit diagrams or schematics. The author clearly explains what symbols stand for: capacitors, transformers, cables, resistors, switches, batteries, inductors, conductors, vacuum tubes and much more.

TAB Books, Blue Ride Summit, PA 17294

Operational Amplifiers, by David A. Bell, Prentice Hall Books, 348 pages $52.00

The text begins with a description of the basic operational amplifier circuit, and moves immediately into the industry standard 741 op amp. Use of the 741 as a voltage follower, noninverting amplifier and inverting amplifier is explained.

Operational-amplifier characteristics and parameters are covered. Topics discussed are biasing requirements, calculation of resistor and capacitor values for specified gain and frequency response, selection of standard value components and input and output impedances. Practical design examples are given, precautions for avoiding circuit instability are listed and additional compensating techniques are discussed. In addition to explaining the operation of each circuit, practical design examples are offered throughout.

Prentice Hall Books, Englewood Cliffs, NJ 07632.

Electrostatic Discharge for Electronics, by Neil Sclater; TAB Books, 227 pages, $29.95-hard.

Electrostatic discharge (ESD) is a hot subject in modern electronics. Each step forward in terms of reduction in size and increase in speed presents a corresponding increase in susceptibility to damage or destructions from static-electricity discharge.

To demonstrate the truly destructive nature of ESD, Sclater provides several photographs taken with a magnification of 3,000 that show "large" holes blown into semiconductor devices by static discharges.

Sclater covers the basic principles of ESD, board and system protection, protective materials and packaging, protecting the workplace, personal protection, ESD test equipment and more. The book includes a glossary and a 22-page directory of supplies and services.

TAB Books, Blue Ridge Summit, PA 17294.

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2816-1 . . . . SP315ODK/EK, SS3153DK/EK, SU3157DK/EK, YSP335ODE/EE, YSS3353DK/EK (CH. AEDC170, ALEDC170, YAEDC170)

SAMSUNG

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2813-1 . . . . TC2O55ST
2815-1 . . . . CT68OW, TC265OS/ST
2816-2 . . . . CT5313WC, TC2O6OS, TC2O63S, TC2O65S

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ZENITH

2811-2 . . . . SF2511G2/G52, SF25117TR2/TR52, SF2589W2, SF2713H2/H52, SF2719TR2/H52, SF271N2/N52, SF5521H2/H52, SS2587W2, SS6589W2
2812-2 . . . . F25OOOW/W2, F25O4TR/TR2/TR5/TR52, F5532G2
2814-2 . . . . . . SF25O1W/W2/W54, SF25O3G/G2/G5/G52/G526, SF25O5TR/TR2/TR5/TR52, SF25O7N, N2, N5,N52, SF25O9H/H2/H5/H52/H526, SF55O3H2/H52, SF5533G2/G52, SS85O3G2/G52

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Classified advertising is available by the word or per column inch. By-the-word: $1.65 per word, per insertion. Initials and abbreviations count as full words. Blind ads (replies sent to ES&T for forwarding) are $40 additional. Minimum charge: $35 per insertion.

Per Column Inch (Classified Display): $235 per column inch, per insertion, with frequency discounts available. 1" minimum, billed at 1/4" increments after that 10" maximum per ad. Blind ads are $40 addition. Reader Service Number $25 additional to cover processing and handling costs. (Free to 4-inch or larger ads.)

Optional color (determined by magazine) $150 additional per insertion. No agency discounts are allowed for classified advertising.

Contact Emily Kreutz, 516-681-2922, for information on frequency and pre-payment discounts, or to place your classified ad. Or send your order and materials to Emily Kreutz, Electronic Servicing & Technology, 76 North Broadway, Hicksville, NY 11801.

FOR SALE

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-tf

LARGEST SELECTION OF ORIGINAL TV & VCR IC'S AND TRANSISTORS: WRITE FOR CATALOG. PRELCO, PO BOX 894, UNION, NJ 07083, 908-851-8600. 5-91-1t

FOR SALE: Regulator rebuild kit for Sylvania, Magnavox and Philco. For chassis series 19C8, 20C8, 25C8, 26C8. Having problems with regulator problems in those chassis this kit is for you. Make it an easy repair. Only $27.00. Sibley TV, 531 Wentworth Avenue, Calumet City, IL 60409. 708-891-5550. 5-91-1t

ESTATE: Sencore, System Donner, etc: osciloscope, UHF, CB, waveform analyzer, 50 pieces. SASE for price list to Electronics, PO Box 252, Glenridge, NJ 07028. 6-91-1t

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 4-91-3t

5000: ACTUAL CURRENT "TECHNICIAN" TECH-TIP REPORTS: Symptoms, Cures & Part Numbers. 1987 Through 1991. TV-VCR-CD-LD-CAMERA-CAMCORDER-PROJECTION-STEREO-AMPLIFIERS-SATELLITE-MICROWAVE-CASSETTES-PHONO-ETC. We service All Consumer Electronics and Factory Authorized for 36 Major Manufacturers. If it came through our doors, it's on it's way to "YOURS"! SEND $20.00 FOR DEMO DISK OR $25.00 PRINTED FORM. $125.00 per 1000 database disk price or $500.00 for 5000, Printed form add $25.00 Per 1000 Tips. AMEX-M/C-VISA & CHECKS, 2-Wks Delivery 305-474-2677 Factory Service 8614 SR-84, Ft. Lauderdale, FL 33324. 6-91-3t

PHOTOFACTS: Folders under #1400, $5.00. Above #1400, $7.00, sent same day first class postpaid. Allen Loeb, 414 Chestnut Lane, East Meadow, NY 11554. 516-481-4380. 6-91-3t

TELEVISION AND MONITOR TROUBLESHOOTING: 350 symptons and cures, nothing old listed, $13.00 refundable. Jones Enterprises, P.O. Box 702, Niceville, FL 32578 2-91-tfn

REDUCED 85%, Diehl Mark 111 scanner $79. Diehl Mark V scanner $199. New. Restore remote control keypads with our conductive coating $8.99 ppd. WEEC, 2805 University Ave., Madison, WI 53705. 608-238-4629. 608-233-9741. 6-90-tfn

TV TOUGH DOGS: 300 symptoms and cures. Send $10.95 to DAVIS TV, 11772 Old Fashion Way, Garden Grove, CA 92640. 10-87-tfn

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. 12-89-tfn

COMPUTER AIDED TV/VCR REPAIR: 3,500 solutions, 37 manufacturers. Printout or IBM compatible. Hard drive, 5¼ disk. Time saver. Quick scan by model, chassis, and stage. Send $90 to Electronics Solutions 407 W. Ave "N", San Angelo, TX, 76903. 1-91-6t

BUSINESS OPPORTUNITIES

LARGE AUDIO/VIDEO SERVICE BUSINESS: In sunny S.W. city. Established 20 yrs. Well equipped. Price and terms negotiable. (602) 298-8827, Eves. 8-89-tfn

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MISCELLANEOUS

LOTTERY NUMBERS: With a built in 100% guarantee! Hit the lottery on purpose! Catalog of 80 IBM/Comp. programs $5. Sigma Box 24759 Dept: 02 Baltimore, MD 21220. 11-90-12t

CAMCORDER REPAIR: Don't turn away good profits let our experienced technicians provide your shop with complete camcorder repair service. Also, VCR, "Touch Dogs." Call collect (812) 332-9524. Edington VCR/TV, 204 North Kimble Drive, Bloomington, IN 47404. 5-91-1t

SERVICE: VCR Repair $49.95 any brand includes most parts. Factory authorized service center - special offer expires September 1. Add $10.00 S & H excludes motors and heads. Free warrenty repairs with proof of purchase. Avoid COD charge by sending prepaid to: The TV Shop, 530 Philadelphia Street, Indiana, PA 15701. 412-357-9448. 6-91-1t

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

ELECTRICAL ENGINEER: (MRI/CT Engineer) - Jobsite: Latham, NY: Utilizing knowledge of electrical engineering, image processing, digital & analog circuits, radio frequencies, magnetic fields, X/R systems & cryogenic equipment, evaluate type of repair or service required on Elscint MRI & CT diagnostic imaging equipment. On-site repair & after sales service of (CT) & (MRI) imaging equipment including repair of subunits, electronic boards & units like Digital computers, CDC drives & magtape, Matrix images, DEL HV & Leybold cryocooling systems. Perform testing & alignment to insure proper function of equipment. Maintain CT-MRI spare parts. 40 hrs/wk; $46,000/yr. Bachelors in Electrical Engineering ' 4 years exp in the job is reqd. Apply by resume in duplicate to: NYS Dept of Labor, 100 Borad Street, Glen Falls, NY 12801. Attn: C. Hartman/J. Kelley. Refer to JO -NY0000465, DOT 003.061.010 5-91-1t

Readers' Exchange

FOR SALE

Sencore VA62 with VC63 VCR Acc. Mint condition with original leads, manuals, and boxes $1950. *Steves TV 518-399-6120.*

Tektronix scope model 7603 with modules #7A26-7015 and 7B53A. Lab quality equipment, works like new current model. List 15500.00 will sell for $8500.00*Kens Electronic 360 E. International Anchorage AK 99518, 907-562-3443.*

150 MHz Oscilloscope, HP 1710A dual timebase, dual trace, bright scan feature etc. Solid state, 32 pounds $850, COD OK. *Tom Hamilton (619) 439-1345.*

Sencore LC53 "Z Meter" capacitor-inductor analyzer with manual. Very good condition, brand new test leads, plus SCR224 SCR/Triac test accessory ($550.00). Don's Electronic Repair, 68 East Main Street, Fort Kent, Maine 04743.

Sencore SC61 oscilloscope. Sencore PR57 Isotransformer. Tentel tentelometer and torque gauge. *Call Stan 303-234-9481.*

VCR's, SAMS, test equipment, many more items. Send for free list. *Henry Weymouth 21-1A Cassidy Rd, Budd Lake, NJ. 07826 or call 201-691-4943.*

Sencore VA-48 video analyzer, complete with box, manuals and cables. $495.00. B&K 470 CRT Restorer/analyzer with many adapters. $225.00 both excellent. *L. Harmony 458 S. Main Street, Vermonville, MI 49096 (517) 726-0485 after 5 pm EST.*

WANTED

Attenuater for Kenwood amplifier model number R24-9004-05, will pay reasonable price. *Bob Boucher 49 State St. Augusta, MA 04330, 207-623-9069*

Schematic or service manual for Panasonic 3960 Oak Trail Run 2706, Port Orange FL 32717, 904-756-9872.

Sams TV photofacts #2360 through #2800 will pay a reasonable price. *Tip Top and Appliances 18439 Sherman Way Reseda, California 91335, 818-345-1975 call collect.*

Practical Radio Electronics Home Study Course lessons 36 to 53 by "Supreme." Advanced Radio Servicing 30 lessons by "Supreme". Signal tracer and scope Vidolifzer Model 560 with test leads. Paul Williams 2364 Beaver Valley Pike, New Providence, PA 17560-9622, 717-786-3803.

Owners manual and Service manual for VCR Panasonic model PV2800B. *Ram TV, San Vicente 4E Mayaguez, P.R. 00708.*

Service manual and schematic for FIsher VCR model FVH-805A. *Sidney Creacey 1358 Turquoise Ave Mentone, CA 92359.*

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