THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS

ELECTRONIC Servicing & Technology

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Understanding and servicing VCR servo systems

Video corner: Diagnosing VCR vertical sync problems

equipment update: Diagnostic tools continue to get smarter, easier to use

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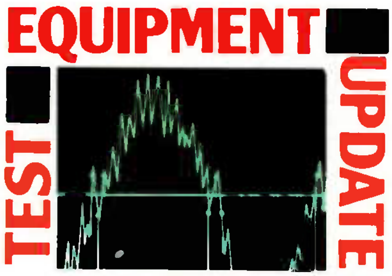

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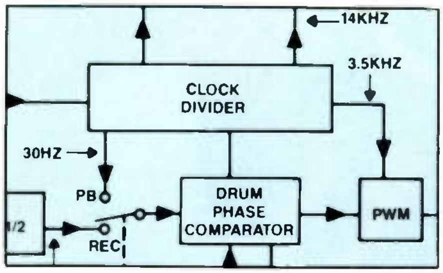

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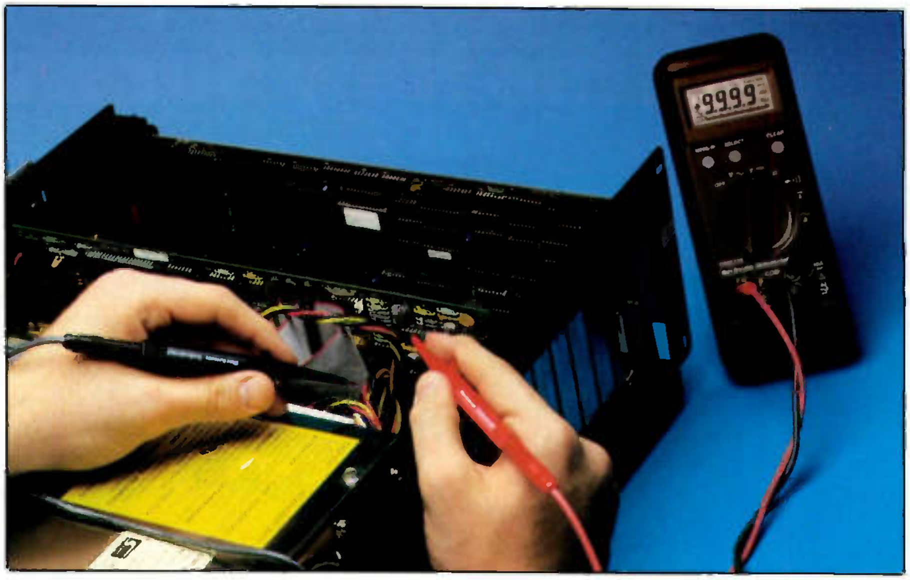

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DEPARTMENTS

ON THE COVER

As electronics products become more complex, the printed circuit boards become more crowded, circuit traces become thinner, and the leads on the ICs multiply, and get smaller and closer together. The right test clip will make it easy for you to probe all the leads of that tiny IC. *(Photo courtesy of ITT Pomona, Pomona, CA.)*

THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS
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LEADER STACKS UP A SELECTION FIT FOR A KING
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For Demonstration Circle (16) on Reply Card

Solving those servicing puzzles

Have you ever done one of those word puzzles? You know the kind I mean; "There are four men: Mr. Brown, Mr. Green, Mr. Smith and Mr. Jones. One of the men is a lawyer; one is a banker . . ." and so forth. The puzzle proceeds to tell you various things about each of the characters in terms of the other characters, so that a little at a time you can discover something about each of them. The question you have to answer, which constitutes the core of the puzzle is usually something like, "Which man is the grocer?"

One of the clues might be, "Mr. Brown hired the lawyer to represent him in court." That clue tells you that Mr. Brown is not the lawyer. One at a time the clues mount up, some stated directly and some implied so that you have to be thinking sharply, until after a while you have enough clues to answer the question.

The only problem with this kind of puzzle is that you are presented with each fact in a way that makes it difficult to understand its significance in relation to the rest of the facts. Hey! If it was easy it wouldn't be a puzzle, and it wouldn't be any fun to work it.

Servicing of electronics products can be a lot like those puzzles. You're presented with a fact, or several facts at the outset. For example, the thing won't work at all, or the thing works, but the sound is wrong, or there's no picture, or the picture is snowy. Then based on those clues you have to begin probing for more clues that slowly form a pattern that in turn point toward a solution.

Several years ago one of my children, then still in grade school, brought home a book full of puzzles like the one I mentioned above. The only difference was this book included some grids and suggested a method of solving the puzzle. You'd put the name of each character in one of the boxes horizontally along the top of the grid. You'd put the name of each profession, or whatever attribute you had been given about the character, vertically along the left side of the grid. Then in the box where the column with the person's name met the row with the person's profession, which you found out through working through the puzzle, you put an X, or check mark.

After just a little while, most, or sometimes all, of the boxes were full, and it was obvious that Mr. Smith had to be the grocer, which was what you had to find out.

My first reaction to this book was that it really wasn't much fun because solving the puzzles was too easy. The puzzles really mustn't be that hard. After all, the book was for grade-school children. Then I tried a different approach to the problems. I tried doing them in my head, as I had done every time I was faced with that kind of problem in the past. The problems actually became more fun, because using this haphazard method of solution they became far more mysterious and difficult. After all, puzzles aren't supposed to be easy, and puzzles like these are enhanced by a certain air of mystery. But I didn't solve a single one when I tried doing it this way. It became clear that the reason I was able to solve the puzzles in this book so easily was not because I was suddenly smarter than before, or that these puzzles were easier than others I had worked on, but I had been given a systematic method of solving the puzzles, and with that as a tool the rest was easy.

Of course troubleshooting a piece of electronics equipment isn't like solving a puzzle like this one. For one thing, you aren't given all the clues in a neat little package with all the clues in place just waiting for you to solve the puzzle. When you're troubleshooting, you have to write part of the puzzle yourself. You have to go out and probe here and there to come up with the clues. On the other hand, there are similarities between one of these puzzles and testing an electronic product. When you are faced with a "tough dog" as often as not it resembles one of these word puzzles because in both cases you have a lot of information floating around in your mind, whose relationship to the rest of the information is not clear.

One way to pin some of this down is to write things down, perhaps in grid form. As an example, you could draw a grid with a list of symptoms along the top and a list of the major subassemblies in the product you're working on down the left hand side. Then each time you take a reading or observe some other symptom, make a note of the observation (and I mean write it down!) and also think about what subassembly might be involved and make an X in the box where the symptom and circuit come together. If you're lucky, after a while a pattern may emerge and you'll be close to a solution.

If you're a typical servicing technician, you enjoy your work because some of its aspects are fun. You enjoy being presented with a puzzling problem in a product, assembling the clues and coming up with that "eureka!" feeling when you've solved it. A method like the one described here might help that feeling come a little sooner.

Nils Conrad Persson

FLUKE AND PHILIPS – THE GLOBAL ALLIANCE IN TEST & MEASUREMENT

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FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

Circle (9) on Reply Card

FLUKE

Home appliances and automation federation proposed

In the opening session of the NARDA/NASD Convention and Expo '90, on March 11, Thomas P. Friel, Vice President of the Electronic Industries Association Consumer Electronics Group invited members of the two associations, plus other associations serving the appliance, electronics, construction, security and utility industries to join with the EIA in forming a new industry consortium. Friel extended his organization's offer to act as a clearing house for the proposed Home Appliances and Automation Federation.

"By trading memberships, we can create an unprecedented federation to serve a broader base and more diverse interests than ever before," Friel said, and outlined the following:

* The various facets of the industry can join efforts on Capitol Hill to ensure fair and equitable legislation and regulatory activities for the industry;
* Interested parties could share pertinent statistics and exchange engineering expertise;
* Federation members could work toward achieving synergy for the members of various associations; and
* Collectively, federation members could participate in promotional and/or lobbying activities that could be cost prohibitive for any single association.

Friel said that such joint efforts are necessary in order for the industry to continue its strength and successes into the 21st century.

Five companies added to CEG

Five new member companies have recently joined the Electronic Industries Association's Consumer Electronics Group: Aura Dynamics, Inc.; Diablo Research Corp.; M&S Audio; Proton Corp.; Virginia Technologies Associates, Ltd.

Three of the companies, Aura, M&S and Proton have joined CEG's Audio Division. Diablo, a company specializing in the design and development of "intelligent" consumer electronics products capable of communicating with one another by way of existing power lines, twisted pair (telephone) wiring, coaxial cable, infrared and RF media, has joined CEG's Home Automation Division.

The fifth company, Virginia Technologies, has become a member of CEG's newest division: the Assistive Devices Division. The company is active in the research and development of technologies designed to enable people with physical and cognitive disabilities to function effectively both at home and in an office environment. ■

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

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Literature

Electronic components catalog

The MCM Electronics catalog contains over 15,000 high-demand parts and components; more than 500 of them being offered to customers for the first time in this edition. Among the categories of products offered are: semiconductors, television parts, computer equipment, power centers and regulators, telephone parts and accessories, connectors, tools, batteries, speakers, VCR parts, audio parts and accessories and more.

Circle (125) on Reply Card

Presaturated cleaning products

Texwipe's new Presaturated Products Brochure describes its presaturated products, including 17 different premoistened pads and foam swabs featuring 5 products for cleaning CRT screens and keyboards. These pads and swabs are self contained products, with applicator and solvent in one packet. Included is information on the company's newest product, a fax cleaning sheet, as well as products for cleaning tape heads, office equipment, pc boards and optical surfaces, as well as antistatic products and ink removing products.

Circle (126) on Reply Card

Electronic instrument catalog

The Spring/Summer 1990 Catalog from Genstar REI Sales Company lists thousands of like-new instruments immediately for sale. These are instruments that have been previously rented through the parent company Genstar Rental Electronics, Inc. and include analyzers, desktop computers, printers, recorders, oscilloscopes, generators and more, from major manufacturers.

Circle (127) on Reply Card

DSO application guides

Three new applications guides now available from John Fluke Mfg. Co., Inc., offer answers to questions commonly raised by those considering the purchase of a digital storage oscilloscope (DSO). "Understanding DSO Bandwidth and Sampling," "DSO Truth in Digitizing," and "DSO Analysis Power," are part of the "Straight Talk" series from Fluke. The series explains how DSOs, through increased signal acquisition power, extensive analysis capabilities, automation, and ease of use, are rapidly replacing analog scopes in many applications.

Circle (128) on Reply Card

Tool catalog

A catalog from Jensen Tools Inc. features tools, tool kits and test equipment specifically for use in workstation and network servicing. The 10" by 9" format of this full-color 32-page product guide accommodates complete technical specifications and informative display of each item. The catalog features service kits for computer, workstation and LAN maintenance. Other products include strippers, crimpers, connectors, and other LAN accessories, plus cable tools, datacom test equipment, diagnostic software, disk storage, disk drive and circuit board repair products, shipping containers, static control and more.

Circle (129) on Reply Card

Ozone-safe dust remover

Chemtronics introduces the E-Series Ultrajet gas duster, containing a second-generation EPA-exempt fluorocarbon. The product offers high purity, low toxicity, inertness and non flammability. The product delivers powerful jet blasts for cleaning critical electronic systems and has variable pressure of up to 120 psi for maximum cleaning efficiency. Ultra-filtered to less than 0.2 microns, the product is non abrasive.

Circle (130) on Reply Card

Test equipment updates

RAG Electronics is offering monthly updates of available used test equipment. These monthly updates highlight the company's newest arrivals, best values and one-of-a-kind clearance items. Test equipment from manufacturers including Hewlett-Packard, Tektronix and Fluke, covering a wide variety of oscilloscopes, spectrum analyzers, DMMs, power supplies, signal sources and more are featured. ■

Circle (131) on Reply Card

EQUIPMENT TEST UPDATE

Test equipment update

By The ES&T Staff

A number of factors drive the constant improvement in test instruments:

1. **Necessity:** As the electronics products that require testing, diagnosis and repair increase in sophistication and complexity, the equipment used to test those products must increase in sophistication in proportion.

2. **Ability:** As the technology that goes into electronics products increases in sophistication, so the technology that is available for use in test equipment increases in sophistication.

3. **Competition:** When one of the leading manufacturers of test equipment makes a step forward in technology, or a breakthrough in price, or both, the other leaders feel compelled not only to improve their own products to that same level, but to make an improvement that takes the state of the art yet a step further.

4. **Pride:** The engineers and technicians who design test equipment are driven by factors other than money. They constantly strive to do better than other engineers involved in the design and development of the same kind of product.

Given this level of impetus to excel, it should come as no surprise that with some degree of regularity test

equipment provides ever increasing sophistication, greater accuracy, more functions and smaller size, frequently at the same or even lower price.

DMMs

Digital multimeters are a good example of this kind of advance. Early DMMs featured 3 1/2 digits of precision in a bench size package. They could measure the basic parameters: volts, ohms, and milliamps. Over the years DMMs have become smaller and lighter, and more features have been added. In addition to the basic parameters, many of today's DMMs can check semiconductor junctions, give true rms readings, and some even provide things like frequency measurement. On many DMMs bar graphs have been added to the display to give trend information.

Yet with all these features added, today's DMMs are still quite inexpensive, and in many cases less expensive than the early, far less sophisticated instruments.

Oscilloscopes

Oscilloscopes are another example of advances in test equipment technology. Early oscilloscopes provided little more than a picture of a waveform that gave some useful, but limited information about the signal that was being observed. Gradually the technology has improved and features have been added, until today the oscilloscope is truly a waveform measurement and analysis tool.

As an example of the strides that have been made in oscilloscope technology, scopes with 100MHz bandwidth are now available at prices that won't empty your wallet; and even multitrace scopes are affordable. Digital storage oscilloscopes make it possible to measure, store and compare waveforms now or later, on the spot or back at the shop. And with computerized analysis of waveforms, it's no longer even necessary to count scope face graticule divisions and perform mathematical calculations to determine signal magnitudes and frequencies: it's all displayed numerically on the face of the oscilloscope.

Counters

For extremely accurate frequency measurements, or for measuring frequencies that are too high to be displayed on an oscilloscope, a frequency counter is the testing device of choice. It's not a product that's on the bench or in the toolbox of most electronics servicing technicians, but it's a test instrument that every technician should have at least a passing familiarity with. As with just about every other kind of test instrument, counters have undergone advancements in the 1980s. The microprocessor has shown up here as it has in every other imaginable electronic product, and enabled engineers to improve product operation and add features while keeping prices at the same level.

Computer diagnostics

One of the beauties of a personal computer is that it can serve as a test instrument, even to the extent of being used to diagnose itself. Of course, using a computer to test itself won't work if the unit is totally dead, but in many cases, diagnostic and tune-up programs can be used to determine the nature of a computer's problems, and in some cases, can actually be used to make a sick computer well. For example, there are utility programs that will write data into RAM (random-access memory) and then read the data out again. If the data read is different from the data written, the computer will be able to tell the operator that there is a problem and precisely where.

Other programs can take data that's in files that are broken into little bits all over the disk as a result of frequent writing and erasing ("fragmented" files) and reassemble them into contiguous files. The disk operates much faster after this is done.

Still other diagnostic and tune up software utilities can diagnose and/or cure ailing computers in other ways, and more such programs are being made available every day.

Test accessories

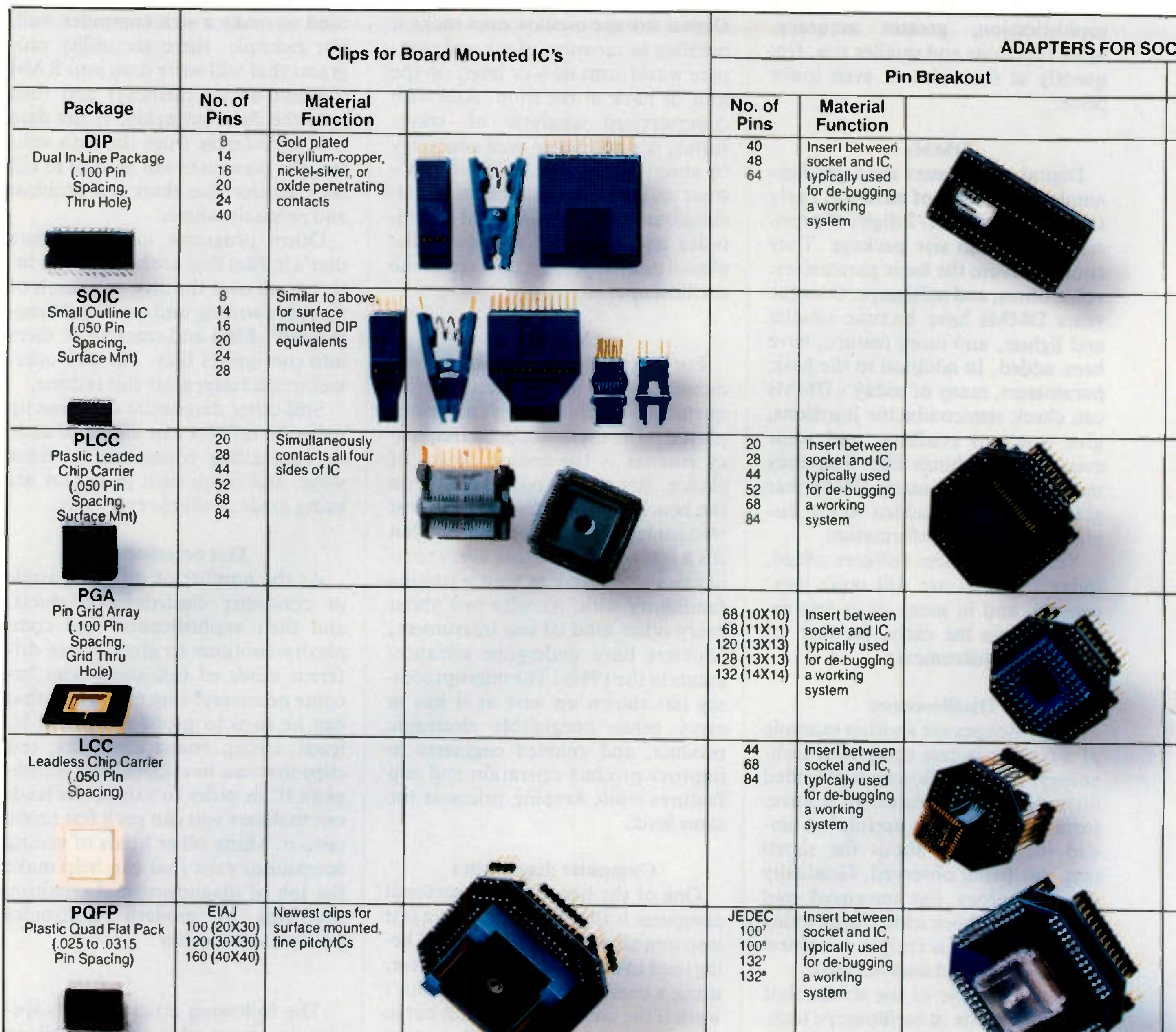
As the number of different kinds of consumer electronics products, and their sophistication and complexity continue to grow, more different kinds of test accessories become necessary: tiny test hooks that can be used to probe individual IC leads, circuit board extenders, test clips that can be clipped over a complete IC in order to extend the leads out to where you can get a test probe onto it. Many other kinds of testing accessories exist that can help make the job of diagnosing and repairing problems in modern electronics products a lot easier.

The following articles in this special report provide some detail on these kinds of advanced diagnostic and repair technology. ■

TEST EQUIPMENT UPDATE

Accessing ICs for testing even hard-to-reach SMDs

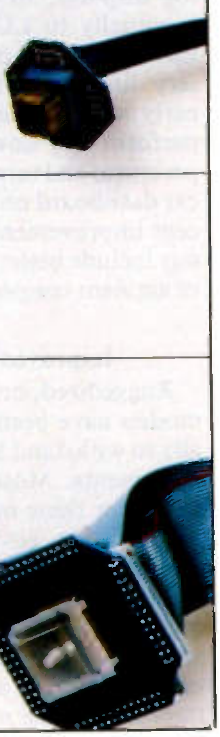
By Bill Hansen



	Clips for Board Mounted IC's			ADAPTERS FOR SOCK		
				Pin Breakout		
Package	**No. of Pins**	**Material Function**		**No. of Pins**	**Material Function**	
DIP Dual In-Line Package (.100 Pin Spacing, Thru Hole)	8 14 16 20 24 40	Gold plated beryllium-copper, nickel-silver, or oxide penetrating contacts		40 48 64	Insert between socket and IC, typically used for de-bugging a working system	
SOIC Small Outline IC (.050 Pin Spacing, Surface Mnt)	8 14 16 20 24 28	Similar to above for surface mounted DIP equivalents				
PLCC Plastic Leaded Chip Carrier (.050 Pin Spacing, Surface Mnt)	20 28 44 52 68 84	Simultaneously contacts all four sides of IC		20 28 44 52 68 84	Insert between socket and IC, typically used for de-bugging a working system	
PGA Pin Grid Array (.100 Pin Spacing, Grid Thru Hole)				68 (10X10) 68 (11X11) 120 (13X13) 128 (13X13) 132 (14X14)	Insert between socket and IC, typically used for de-bugging a working system	
LCC Leadless Chip Carrier (.050 Pin Spacing)				44 68 84	Insert between socket and IC, typically used for de-bugging a working system	
PQFP Plastic Quad Flat Pack (.025 to .0315 Pin Spacing)	EIAJ 100 (20X30) 120 (30X30) 160 (40X40)	Newest clips for surface mounted, fine pitch ICs		JEDEC 100[7] 100[8] 132[7] 132[8]	Insert between socket and IC, typically used for de-bugging a working system	

Figure 1. IC test clips and adapters, such as this, can make it easier to get your test probes connected to the points you need to test, and reduce the chance of your shorting two pins together with disastrous results.

ET MOUNTED IC'S		
	Socket Interface	
No. of Pins	Material Function	
20 23 44 52 68 84	Replaces ICs on PC board, typically used for IC emulation	
JEDEC 100[7] 100[8] 132[7] 132[8]	Replaces ICs on PC board, typically used for IC emulation	



If you're trying to access ICs mounted on PCBs for testing purposes, chances are you're having problems. A recent survey of engineers and technicians involved in testing proved that. The most common complaints were not enough room, test clips were hard to put on and didn't stay on. The reason why is obvious—all involved the use of alligator clips.

Well, you don't have to try and make-do with alligator clips or a soldering iron and fine wire. Whether you're troubleshooting the most common IC types, such as DIPS (dual in-line packages), PLCCs (plastic leaded chip carriers) or SOICs (small outline integrated circuits), or wanting to test the newest plastic quad flat pack (PQFP), there is a clip or adapter that will let you access the leads quickly and dependably.

The chart in Figure 1 lists a number of IC packages and shows some of the clips and adapters available to match. The easiest solution to all of the IC testing access problems mentioned earlier is to inventory a broad range of clips, for each package type you might be testing.

Different clips for accessing different ICs

The clothes-pin type clips are fairly well known. Spring loaded, you squeeze the two halves open, position them over the ICs with the contacts aligned to the leads, and clamp them in place. Clips for newer four-sided devices fit over the ICs in a slightly different manner. You align them using a pin locator, then slide them down over the ICs, where they wedge into place.

Hansen is Engineering Supervisor for ITT Pomona

For a number of socket mounted packages, pin breakouts can be used. With these, an adapter is fitted into the IC's socket, between the board and the IC to be tested. Also, socket interfaces allow your emulator to directly access the PCB for development or testing. Each of these allows you to perform hands-free testing.

High testing cost means efficiency is valuable

With the cost of testing already high and increasing—in industry a fully burdened technician's hourly rate means that it can cost hundreds of dollars to test a board—it's surprising to discover that so much testing appears to be done in makeshift fashion. Testers are attempting to latch on to pins on 0.023-inch centers with single contact clips. Many still reach for a soldering iron and the finest wire they can find.

With the high cost of testing, even the most expensive clip cost seems low in comparison to the utility they offer and the savings in making a test set-up from scratch. They provide good contact, they hold the contact and allow you to complete an accurate test, hands free. They're easy to use, and go on and off quickly. They are available to fit most of the standard IC packages. So put away your wire and solder, and your alligator clips, when you're testing Ics. Doing it right is not only better, it's cheaper.

After all, the whole idea of accessing an IC for testing is to make a good contact and make sure the contact is held for the length of the test. Speed

(Continued on page 58)

TEST EQUIPMENT UPDATE

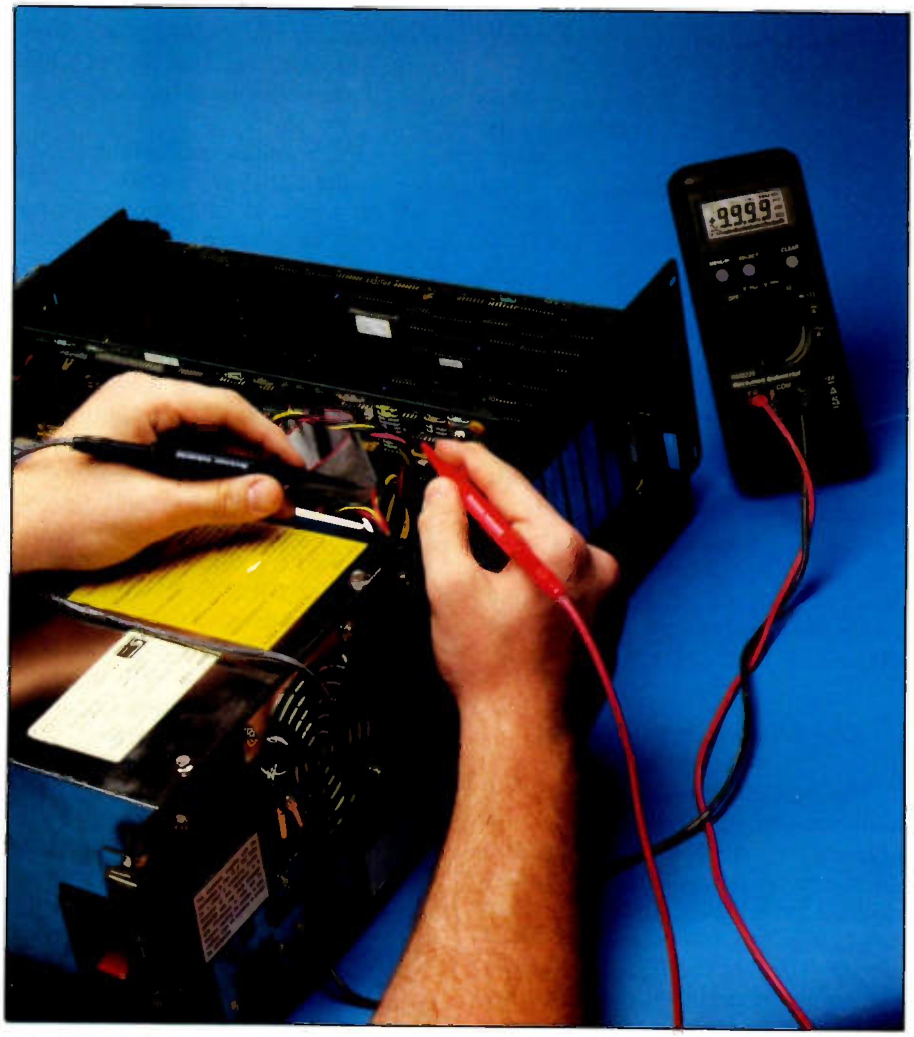
The evolution of DMM design

By Jim Bordyn

Digital multimeters, or DMMs, have become so widely accepted as everyday test instruments that many early innovations in DMM design are taken for granted. However, the era of quiet innovation isn't over for DMMs, and some products that are just being introduced point to some important design trends in these essential tools.

Described here are some of the more significant DMM product innovations of the last decade, as well as some improvements that are just now coming on the market.

Bordyn is Vice President, Marketing for the Instrumentation Products Division of Beckman



Modern DMMs provide the technician with an impressive array of features, including continuity, bar-graph display, diode check and more.

Continuity

Here's an example of a product innovation that today is pretty much a standard DMM feature. It might be difficult to remember that a built-in continuity indicator was not available on DMMs until 1979. Previously, you had to check for opens and shorts in resistance mode and wait for the digital display to "settle down."

Display technology

Meter display technology has moved from the old d'Arsonval analog displays, to digital LEDs, and eventually to LCDs. LCDs require less current and promote longer battery life. Unfortunately, however, early liquid crystal displays tended to perform very slowly in freezing temperatures and turned black if left on a car dashboard on a summer day. Recent improvements in LCD technology include better response over wider ambient temperature ranges.

Improved durability

Ruggedized, or heavy duty, DMM models have been designed specifically to withstand harsh industrial environments. Most of the added expense for these models is in the impact-resistant, environmentally sealed casing.

Although DMMs for heavy duty applications are likely to remain a special product category, the physical durability of all DMM models is improving. The main reason is that new, inexpensive thermoplastic materials are becoming available. Cases molded from these plastics offer better resistance to solvents, physical shock, and thermal stress.

Input protection

Increasingly, the preferred device for high-voltage input protection is the metal oxide varistor (MOV). A MOV reaches breakdown at a specific voltage, changing its characteristic from a resistor to a conductor, and shunting the overload to ground. The MOVs currently found in the protection circuits of some professional and heavy duty DMMs can handle overloads of several thousand volts.

The traditional way to protect current ranges is with fuses. Fuses are becoming smaller with higher voltage ratings available. It probably will be typical of future DMMs that all current ranges will be fused.

Another improvement is that some DMMs now offer "self- resetting fuses." These are not really fuses at all, but special positive temperature coefficient (PTC) resistors. In series with the input, the PTC resistor reacts to a current overload by heating up, which in turn causes its resistance to increase rapidly. The higher resistance reduces the inrush of current, thus protecting the current shunt in the meter. When the overload is removed, the PTC resistor cools, and the meter quickly recovers.

Bar graph

Some newer DMM models include a bar graph in the display that supplements the numeric reading. This simulates d'Arsonval pointer (analog) movement for making quick visual checks.

With new display controller chips in DMMs, bar graph gradations have become finer, permitting more accurate representation. One new DMM model offers a 41 segment analog bar graph, which is a 33 percent improvement in visual resolution over previous models, on which bar graphs typically have just 31 segments. This increased resolution is particularly useful for observing slowly varying signals. It also facilitates peaking and nulling adjustments.

Auto-ranging and audible bar graph

Auto-ranging DMMs based on earlier digital technology use an analog-to-digital (A/D) converter for range selection. To find the correct range and to display a reading quickly, the A/D conversion process is made considerably faster than in a meter that does not perform auto-ranging. Fast A/D circuits tend to be noisy, however, so that several readings must be taken and averaged to assure accuracy. This is done in software, and then the reading is displayed.

Some new DMMs implement auto-ranging and A/D conversion differently in order to achieve faster response time. Two parallel circuits are used—one to select the range and another to take the reading. In the first circuit, a voltage-to- frequency converter selects the range. It is not accurate enough to make the actual measurement, but it is very fast and is sufficiently accurate to select the appropriate range. A related benefit is that this signal can be amplified and connected to a speaker so that the user can actually hear the reading as a tone. This tone is proportional in frequency to the magnitude of the reading. It is, in effect, an audible bar graph. Since this audible readout operates off the very fast voltage-to-frequency converter, the tone reacts quickly to any change in the parameter being measured. This response is fast enough to detect transient or intermittent signals that would go undetected by DMMs with slower A/D conversion circuits.

Once the range is determined, a low-noise A/D circuit makes the actual measurement, measuring the parameter only once (rather taking the average of a series of readings) and displaying the result on the LCD.

True RMS measurement capability

The typical DMM uses an "average-responding" conversion approach to measuring AC voltage and current. The circuit used for average-responding works fine for pure, undistorted sine waves, but can be very inaccurate for those nonsinusoidal, or clipped, sine waves, which are encountered increasingly around switch-mode power supplies, motor controllers, and copiers. The average-responding DMM usually rectifies and filters the AC signal, and thus creates a DC, or average, level that is proportional to the root-mean square (RMS) value of the signal. The DMM circuitry uses a fixed multiplier of 1.11 times the average value to obtain the RMS value to be displayed. However, the scaling factor of 1.11 is only accurate for the measurement of pure sine wave signals.

On the other hand, DMMs with true RMS measurement capability can accurately measure the RMS value of AC signals, virtually regardless of their waveform or distortion.

Automatic shut-off

Although auto-off has been advertised widely in the test instrument marketplace in the past, the claim rarely meant that the device would shut itself down completely. On some DMMs with this feature, the device just switches to a low-drain condition. The new DMMs, however, will turn themselves off—completely—after an hour of unattended operation.

Microprocessor enhancements

Microprocessors are finding increasing use in the latest auto-ranging DMM designs. They provide both memory and math capabilities, which make some very useful measurements possible.

Minimum/maximum recording capability.

Min/max capability allows you to leave the meter unattended for long periods of time during which the meter can measure and store the highest and lowest values sensed.

Recent innovations allow auto-ranging DMMs to also perform auto-ranging when in min/max recording mode. So, you need not be concerned with the meter's setup prior to initiating the recording mode.

Automatic recording hold. A number of new DMMs offer a very useful capability for making a measurement when you are not able to observe the display at that moment. With this capability, the meter automatically detects and holds any steady readings. You can remove the test leads from the circuit and then observe the display when it is convenient or safe to do so.

Relative mode

This function enables the DMM to subtract offset voltages, resistance values, or current values automatically. When relative mode is engaged, the meter takes the initial measurement reading, stores the value in memory, and then shows zero in the display. Upon any subsequent measurements, the meter displays the difference between the initial and the present measured values. For example, relative mode can be used to zero- out test lead resistance in order to improve the accuracy of a low-resistance measurement.

Resolution/price tradeoffs

DMM buyers now enjoy a wider selection of display resolutions, at different price levels. Until recently, most DMM offerings include display counts of 3½ digits (0000 to 1999 counts) or 3¾ digits (0000 to 3999 counts). Higher priced models offer 4½ digits (00000 to 19999 counts). A recent development is that full 4-digit DMMs now are available at relatively modest cost. These meters provide readings of 0000 to 9999 counts.

The resolution of a DMM refers to the smallest numeric value that can be read on the display. Factors that determine resolution are the number of digits displayed and the number of ranges available for each function.

One benefit of DMMs with a greater number of display counts is the ability to resolve smaller differences in commonly encountered measured values. For instance, a 3999-count DMM can display an AC voltage of 230.2, whereas a DMM with 1999 counts can only display 230 for the same measurement. In other words, you won't be able to see voltage changes in tenths on any voltage over 199.9.

The newer 4 or 4½ digit DMMs offer even more resolution. You can, for example, measure 480VAC signals with 0.1V resolution. This cannot be done with either the 3½ or 3¾ digit DMMs.

Amid all these technical considerations, let's not forget the basic good news that all of the product improvements and enhancements described here are becoming available on professional-grade DMMs at relatively modest prices. This may be a pleasant surprise for the individual user, but it can be major deciding factor for the service manager who needs to buy a hand-held DMM for every technician on the staff. ■

TEST EQUIPMENT UPDATE

When is an oscilloscope not an oscilloscope? When it's a computer

By The ES&T Staff

As mentioned in the introduction, oscilloscopes have come a long way in the past decade or so; advancing from waveform viewers to waveform analyzers. Microprocessors have allowed test equipment engineers to add such features as waveform parameter calculation and display, waveform storage, multiple traces, and more. Actually, taking a look at some of the products coming to the market, you might get the idea that oscilloscopes are becoming more like computers, and, conversely, computers are more and more being used as oscilloscopes.

A scope that thinks it's a computer

Here's a description of the features of a new test instrument, called the OmniLab, from Orion Instruments of Menlo Park, CA:

- Dual-channel 100MHz, 204 Megasample/sec digital oscilloscope
- Time-aligned logic analyzer (up to 96 channels)
- Arbitrary analog function generator
- 500 MHz frequency counter
- 20 MB hard disk

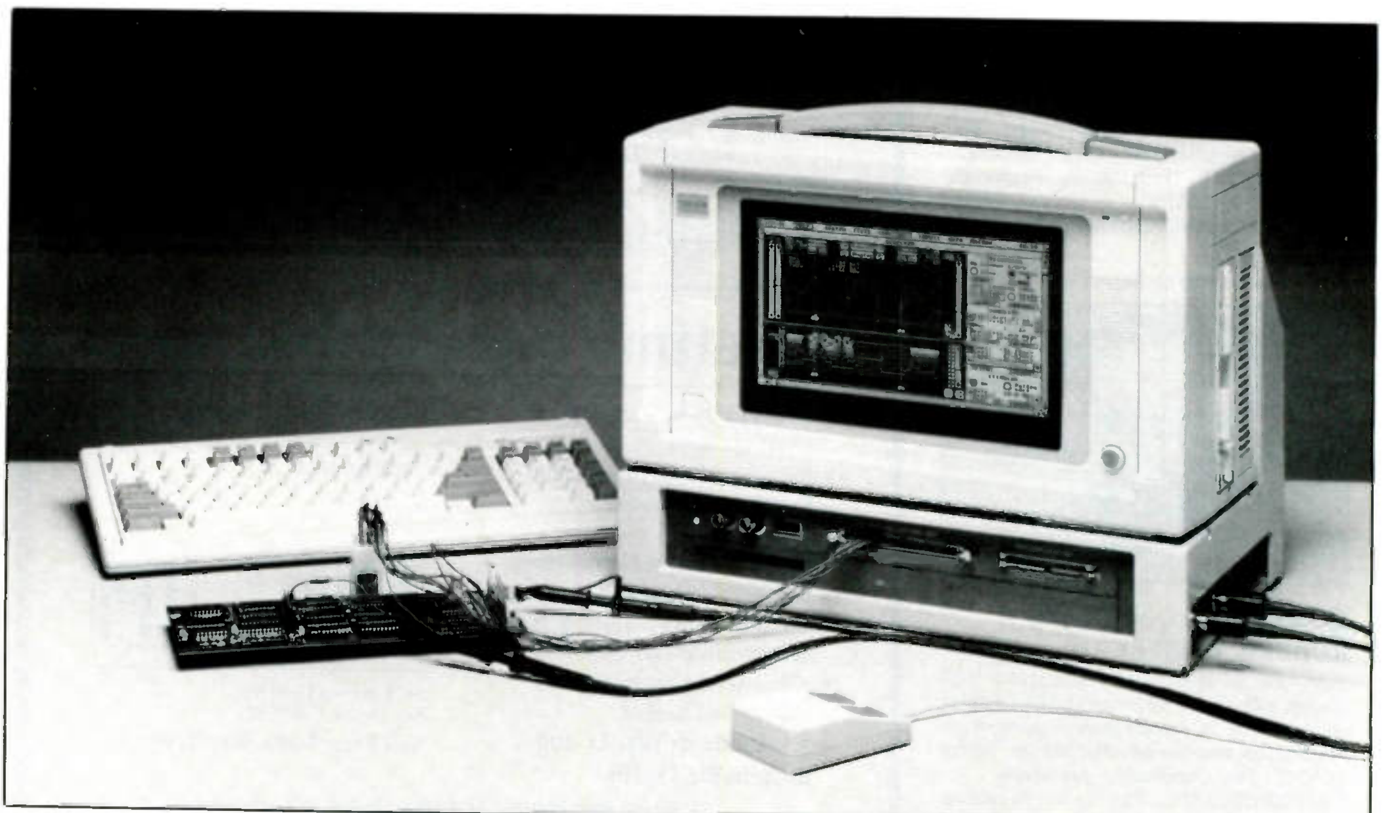


Figure 1. Increasingly sophisticated, microcomputer-based test instruments such as this oscilloscope, are displaying many of the attributes of computers, including data storage on disk, the ability to control other instruments and be controlled by other instruments, and to store detailed test procedures.

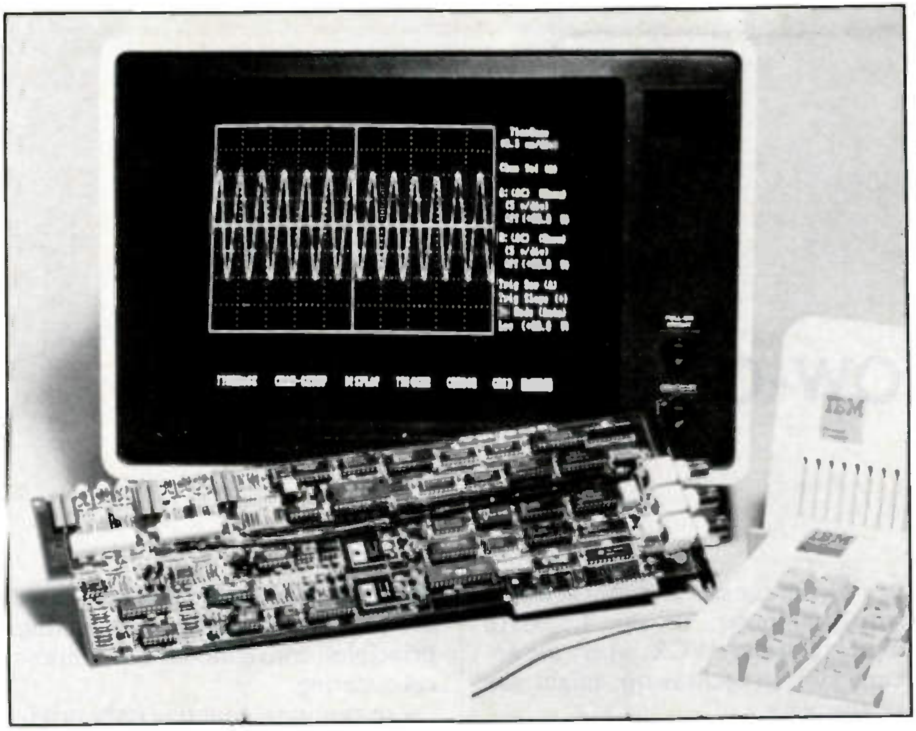


Figure 2. Add-in boards such as this oscilloscope board are being used to turn personal computers into powerful test equipment.

- 1.2 MB MS-DOS compatible floppy disk
- Printer port

At around $14,000 per copy it's pretty much outside the comfort range for most, if not all servicing facilities, but the way performance has been going up while prices have been coming down, one day, in the not too distant future, this kind of product might be on every servicing bench.

A user can configure the unit for a specific test set-up using a mouse to adjust the settings until the test works correctly, then save the set-ups on disk. When the set-up information is recalled from disk later, the control settings, triggers, and other settings are displayed as they were originally configured. Test sequences can include prompts to guide a technician through a logical troubleshooting procedure by indicating where to connect scope probes and DIP clips.

And vice-versa

Pop this board into your PC or compatible and it can turn into an oscilloscope at the touch of a few keys on the keyboard. According to the manufacturer, Metrabyte of Taunton, MA, the PCIP-SCOPE is a 20 MHz digital sampling oscilloscope that provides all the features of a comparable bench top or rack mount instrument.

This unit provides dual-channel operation, 8-bit vertical resolution and full input protection. Software for the scope/computer comes in the form of a device driver that is loaded during system configuration each time the computer is rebooted or turned on. The user then accesses the oscilloscope by opening the device after which software commands are PRINTed to the oscilloscope circuit board and INPUTted from the board.

This device uses the computer screen for all instrument displays. Activated by a user defined hot key sequence, the display will pop up on the computer screen. The computer keyboard is used to control all instrument functions including Channel Select, Input Range, Sweep Time, Sampling, Trigger Source, Trigger Level and Function.

What's next?

Oscilloscopes along with their relatives, waveform analyzers and logic analyzers, have become truly sophisticated instruments capable of revealing a great deal about the circuits that they are being used to check, with less and less knowledge demanded of the operator. Perhaps future generations of these products will be just the test devices needed by future technicians to diagnose and repair increasingly complex consumer-electronics products. ■

TEST EQUIPMENT UPDATE

Selecting a low-cost counter

By Mark Mullins

Frequency counters are used widely for accurate frequency measurements, for example, in telecommunications and navigation systems, and in general electronic and electro-mechanical equipment. Frequency counters are mainly used in service and maintenance, and in small-scale production testing.

One of the things that a consumer electronics servicing technician might test with a frequency counter is the frequency of the local oscillator in a TV, or the clock crystal in a personal computer, or the 3.58MHz master clock in a VCR, where the accuracy of an oscilloscope might not be adequate.

These products have matured during the 1980s. Modern frequency counters are microprocessor-based, and offer a significantly increased performance/price ratio compared with traditional counters designed during the 1970s.

Mullins is a Product Marketing Manager with Fluke

Resolution determines accuracy

Together with the timebase stability, the resolution determines the accuracy of the measurement. There are basically two different counting principles: conventional and reciprocal counting.

Conventional counting is the original frequency counting principle; still used by most low-cost counters. Here the input cycles are gated to a counting register during a fixed gate time; normally 1s, but changeable in decade steps. This method has an inherent +1 input count error, which gives a resolution of 1 Hz for a 1s measuring time, regardless of the input frequency. As a result, the relative resolution is very poor for low input frequencies, and is good only for very high input frequencies (see Figure 1).

The use of microprocessors in counters made reciprocal counting possible. Instead of counting input cycles during a preset time, clock pulses from the internal timebase are accumulated during an integral number of input cycles. The measurement is always synchronized with the input period, and hence there is a +1 clock pulse error, but since the timebase oscillator normally operates at 10 MHz, the relative resolution is 1 pulse in 10 million pulses over a 1s measuring time, or 10^{-7}, for any input frequency (see Figure 2).

The displayed resolution is, of course, always limited by the available number of display digits. So a counter should have sufficient display digits to prevent the display itself from limiting the achievable resolution. Normally, 8 or 9 digits are sufficient.

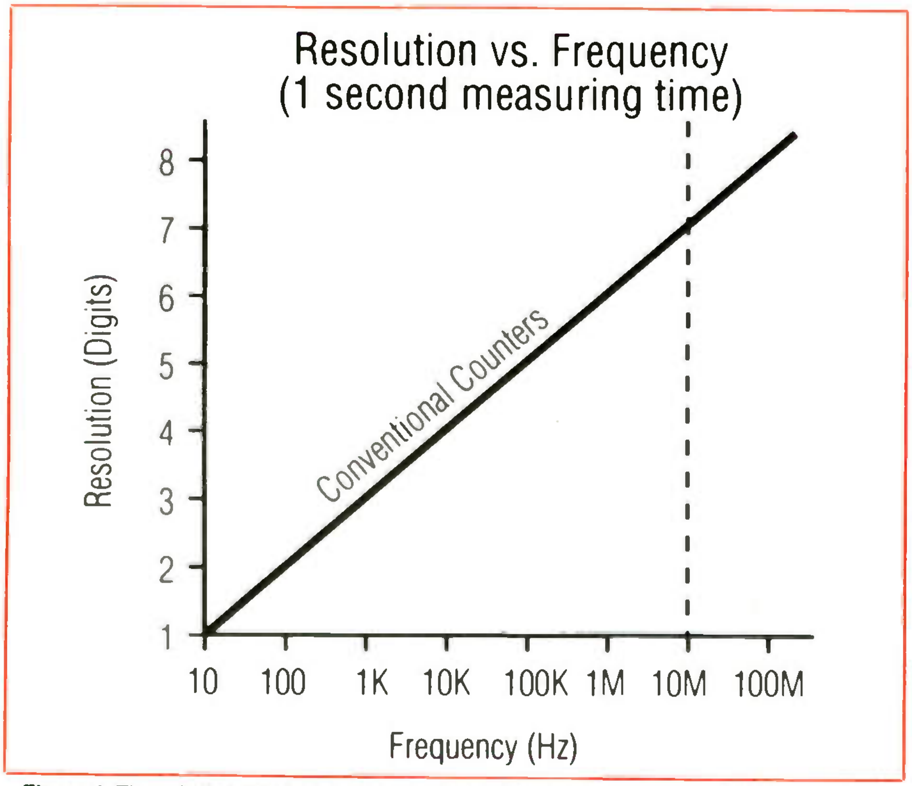


Figure 1. The relative resolution of a counter using conventional counting is very poor for low input frequencies, and is good only for very high input frequencies.

Time base stability sets accuracy limits

The stability of the internal timebase sets the accuracy limits of the measurement. In counters, only quartz crystal oscillators are used. However, there are different categories of quartz crystal oscillators, with different levels of stability and, of course, with correspondingly different price tags. The major factors affecting oscillator stability are aging and temperature stability.

Aging is a property of crystals, and cannot automatically be compensated for in the oscillator circuits. Aging can be expressed as frequency drift against time, and determines the time between oscillator recalibrations for any desired level of accuracy. Good crystals, not surprisingly, have lower drift figures than lower quality ones. The monthly aging typically ranges from 10^{-6} to 10^{-8}, and the annual aging rate is typically 5 to 10 times higher.

Temperature stability is also a property of a crystal, but unlike aging, it can automatically be compensated for. The oscillators can be divided into four categories, depending on their frequency versus temperature characteristics. The different categories of timebase oscillators are: UCXO (or standard timebase), TCXO, MTCXO and OCXO.

UCXO, UnCompensated X-tal Oscillator, which contains a standard quartz crystal, intended to operate at room temperature. Typical stability of a UCXO is 10^{-5} over the specified temperature range, e.g. 0 to 50°C. With a UCXO, you can count on 5 relevant display digits. TCXO, Temperature Compensated X-tal Oscillator, contains a compensating network, which measures the temperature and applies a correcting voltage to the tuning circuit of the oscillator. The residual frequency stability after compensation is typically 10^{-6} over the specified temperature range, e.g. 0 to 50°C, or ten times better than for the UCXO. You can count on 6 relevant display digits with a TCXO.

MTCXO, Mathematically Temperature Compensated X-tal Oscillator, consists of UCXO, a temperature measuring circuit and a ROM memory in which the crystal's temperature dependency curve is stored. In use, the operating temperature of the crystal is measured, the corresponding compensating factor is looked up in the ROM, and the microprocessor compensates the measuring result before it is displayed (see Figure 3).

This "software compensation" method yields an even better stability than the "hardware compensation" of a TCXO; typically 10^{-7} over the specified temperature range, or 100 times better than the UCXO. You can count on 7 relevant display digits with an MTCXO.

OCXO means Oven Controlled X-tal Oscillator. In these timebase oscillators, the complete oscillator circuitry is kept in an enclosure (oven), whose temperature is controlled; normally to 70°C + about 0.1°C, or sometimes to 0.01°C.

The OCXO is quite expensive, but also provides the best stability, typi-

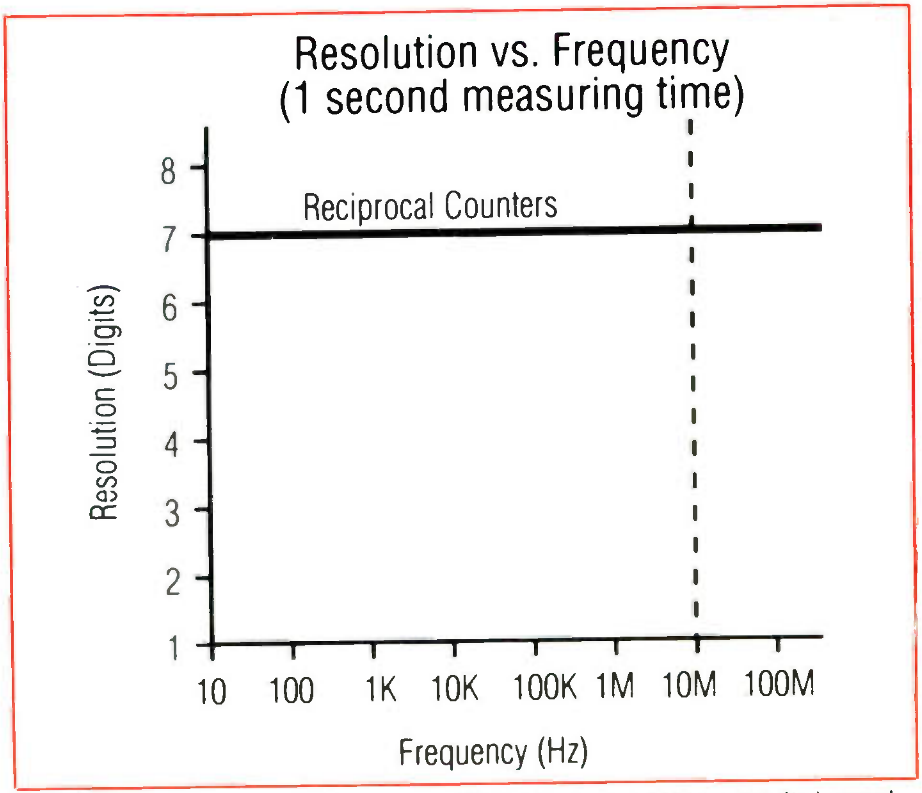


Figure 2. Reciprocal counting, made possible with microprocessors, results in excellent relative resolution at all frequencies.

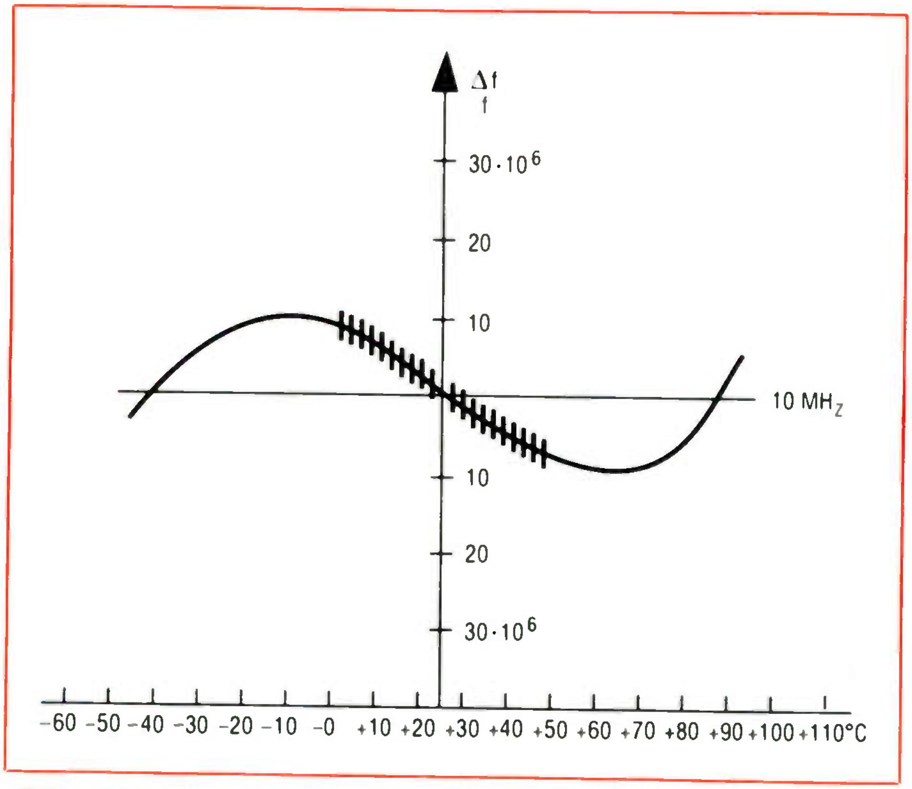


Figure 3. In a mathematically temperature compensated crystal oscillator (MTCXO), the temperature dependency curve of the crystal is stored in a read only memory. The hardware senses the temperature of the crystal, looks up the corresponding compensation information and applies it.

cally ranging from 10^{-7} for the low-end OCXOs up to 10^{-9} for the high-end oscillators. You can thus count on 7 to 9 relevant display digits.

Input trigger circuitry

No frequency counter is better than its front-end circuitry. Any counter will trigger on noisy, distorted, or low-level signals; signals with very high or very low duty factor, AM-modulated signals etc. A high-quality counter also has a high input overload protection. Generally speaking, the design of the input front-end circuitry represents the most significant difference between high-quality and low-quality counters.

To be able to measure on low-level signals, for example on telecommunications equipment, the counter must have a sufficiently high sensitivity; at least $\leq 30\ mV_{RMS}$. A flat frequency response is important when measuring on signals that contain harmonics, subharmonics or significant noise components. The frequency response curve must under no circumstance show any discontinuities, with "sensitivity peaks" at some frequencies. However, even a "flat", highly sensitive input will be sensitive to noise, spikes and spurious signals. When measuring on high-level signals, superimposed noise or interference can cause false triggering if the input sensitivity is too high. For audio frequency measurements, a low-pass filter can be used to reject HF noise.

However, to increase the noise immunity for all input signal frequencies, it is of the utmost importance that the input signal can be attenuated over a wide range, in not less than 10 dB steps (see Figure 4). Attenuators in the form of an AGC (Automatic Gain Control) cannot be used for measurements on AM-modulated signals. A passive input attenuator is therefore the preferred solution.

All frequency counters have AC-coupled inputs. These inputs can cause problems when making measurements on asymmetrical signals.

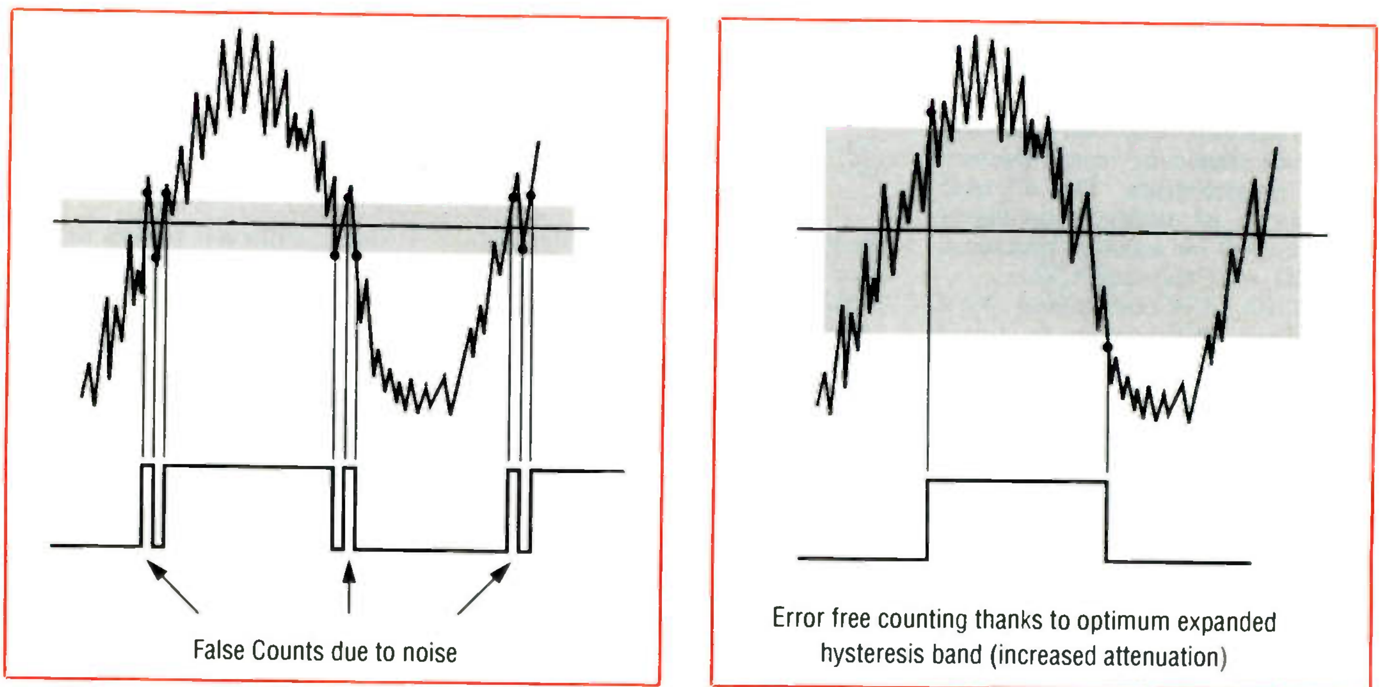


Figure 4: A variable input attenuator allows the influence of noise to be suppressed.

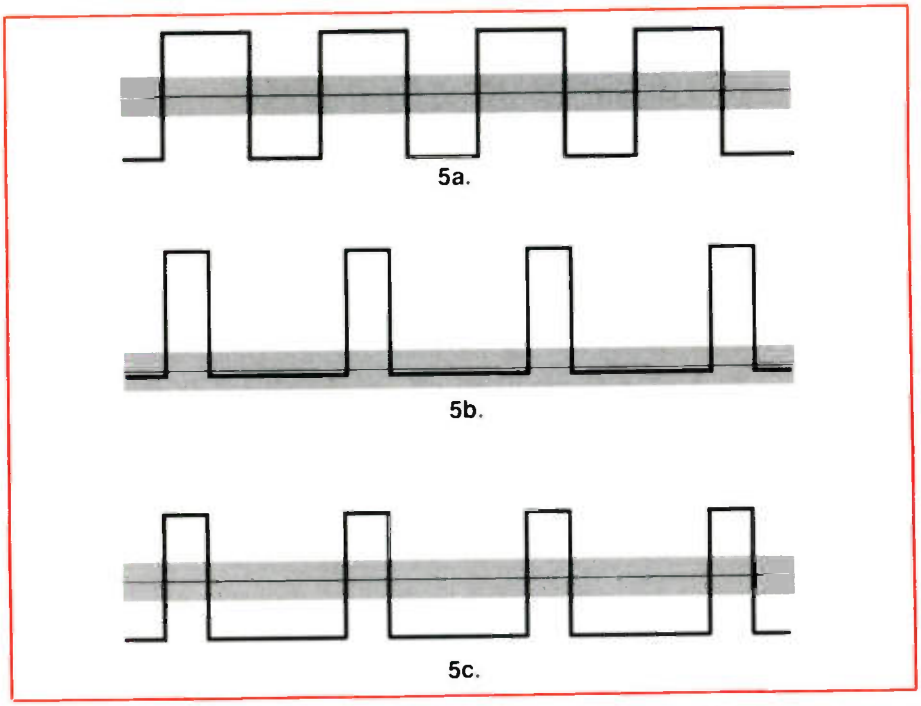


Figure 5: A trigger level offset is necessary for correct triggering on any input waveform.

With symmetrical pulses, the trigger window of the counter is neatly positioned right in the middle of the signal (see Figure 5A). When the pulses are narrower (lower duty factor), the average DC component of the signal is closer to the baseline (Figure 5B). Because of the input's AC coupling, the trigger window follows the V_{DC} level of the input signal. In the example shown in Figure 5B, the input will not trigger, since the signal has been shifted and will no longer cross the trigger window.

Most low-cost counters can't measure the frequency of signals which are too asymmetrical. There is, however, a way to solve this problem: a Trigger Level Offset. By offsetting the trigger level with a voltage equal to approximately 50% of the trigger window, the trigger window is moved back into the signal, and the input will trigger (Figure 5C).

This trigger level offset facility can be implemented automatically, i.e. the counter will automatically detect if the duty factor of the input signal is close to 0.5, very high or very low, and will set the corresponding offset. In other counters, the offset must be set manually, which means that the operator must know the characteristics of the input waveform.

Another measure of input circuitry quality is the degree of input protection against incidental overloads. A minimum requirement is that the input must be able to withstand the ac-line voltage without damage.

Good RF screening essential

The counter must not itself generate RF radiation that could be picked-up by the measuring object. Good RF screening also protects the counter from the influence of external RF sources. Good screening of RF interference (RFI) requires that the counter have a metal cabinet that provides a closed box. Under all circumstances, counters must comply with the internationally accepted FCC part 15J regulations (US) and VDE 0871B regulations (Germany).

Ruggedness and durability for field service

A counter used for field service will need to have rugged construction, so that it can withstand abuse, and it must have a wide operating temperature range.

The electrical design is also very important for long trouble-free operation. Modern, highly integrated designs give a longer MTBF (Mean Time Between Failure) than older designs. In modern microprocessor-based counters, the counting circuitry is sometimes contained in only two components: a one-chip microcomputer and a one-chip LSI counter.

Unnecessarily complex operation or a cluttered and unclear front-panel layout could lead to operator mistakes. The modern microprocessor-based counters are, in general, more user friendly than older "hard-wired" designs. The microprocessor can automate settings (like trigger level offset), make validity checks on connected external reference signals, automatically set the correct measuring range, calculate correct display resolution, give warnings and error messages, etc.

Performance upgrading to meet changing demands

No single counter model can fulfill all possible user requirements at the same time. However, the best solution is when the basic counter model can be extended later, for example by adding a UHF input, a high-stability timebase oscillator, a battery power pack, a GPIB interface etc., whenever the need arises. Ideally, it should be easy for the user to upgrade the counter in the field by simple addition of the desired options to the basic instrument. ■

EQUIPMENT TEST UPDATE

Keeping PC hard disk drives up and running

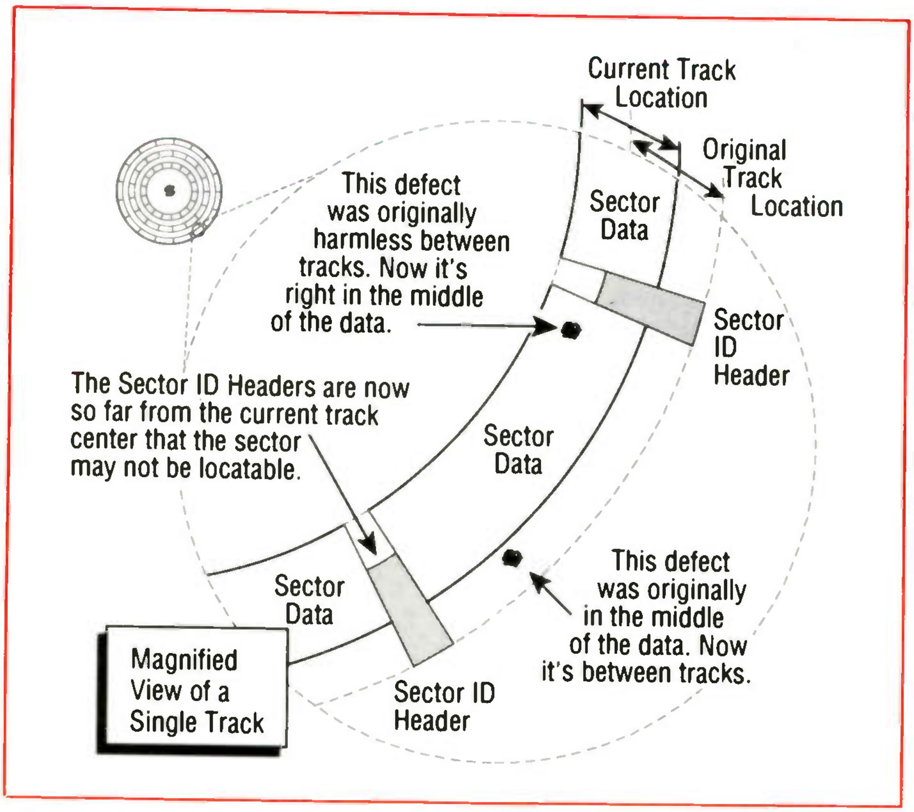
Hard disks age and develop frustrating errors. Preventative maintenance products are available, which will correct potential problems before they happen.

By Steve Gibson

Today, most personal computers contain hard disks that often end up being a source of frustration both for the users and for those who support and service the PCs. Users expect that the data stored on the disk will always be available for use. Even though they are warned over and over again that the hard disk should be backed up after every day's use, most users don't really think that their hard disks will ever go bad. But hard disks can and do fail. They either fail due to an electromechanical problem, or because the drive will simply not read data that has earlier been written to the disk. The inability to read data is by far the more common problem.

Gibson is President of Gibson Research Corp., Laguna Hills, CA.

Products exist on the market that can prevent "inability to read data" problems from ever occurring. These products perform functions such as testing the disk's surface looking for defects in order to mark the bad sectors as off-limits for new data; rewriting the low-level format so as to realign the heads and the tracks on the disk; and tuning up the disk drive in a variety of other ways. Some of these products can even recover data after it is seemingly lost.



Over a period of time, the data on the hard disk may become out of position relative to the original low-level formatting, resulting in "sector not found" errors. Software that is now available can keep hard disks "tuned up", and prevent this problem.

What can go wrong on the drive?

All hard disk drives have one or more surfaces coated with magnetic material. Each surface is subdivided into a number of tracks. Each track is divided into smaller pieces called sectors. Sectors begin with special sector-addressing information, followed by 4096 data bits organized into 512 bytes. Drives that use MFM encoding store 17 such sectors per track, while drives that use RLL encoding squeeze 26 sectors into the same space. When a drive is looking for a sector, the heads are first positioned over the appropriate track and then the track is continuously read until the proper sector-addressing in-

(Continued on page 37)

3065

HITACHI
VP7X2
CHASSIS
PROJ.
COLOR TV

PROFAX

CQ/T Manufacturers schematics

JUNE 1990

HITACHI CT4580K, VP7X2 CHASSIS PROJECTION COLOR TV
DEFLECTION SCHEMATIC

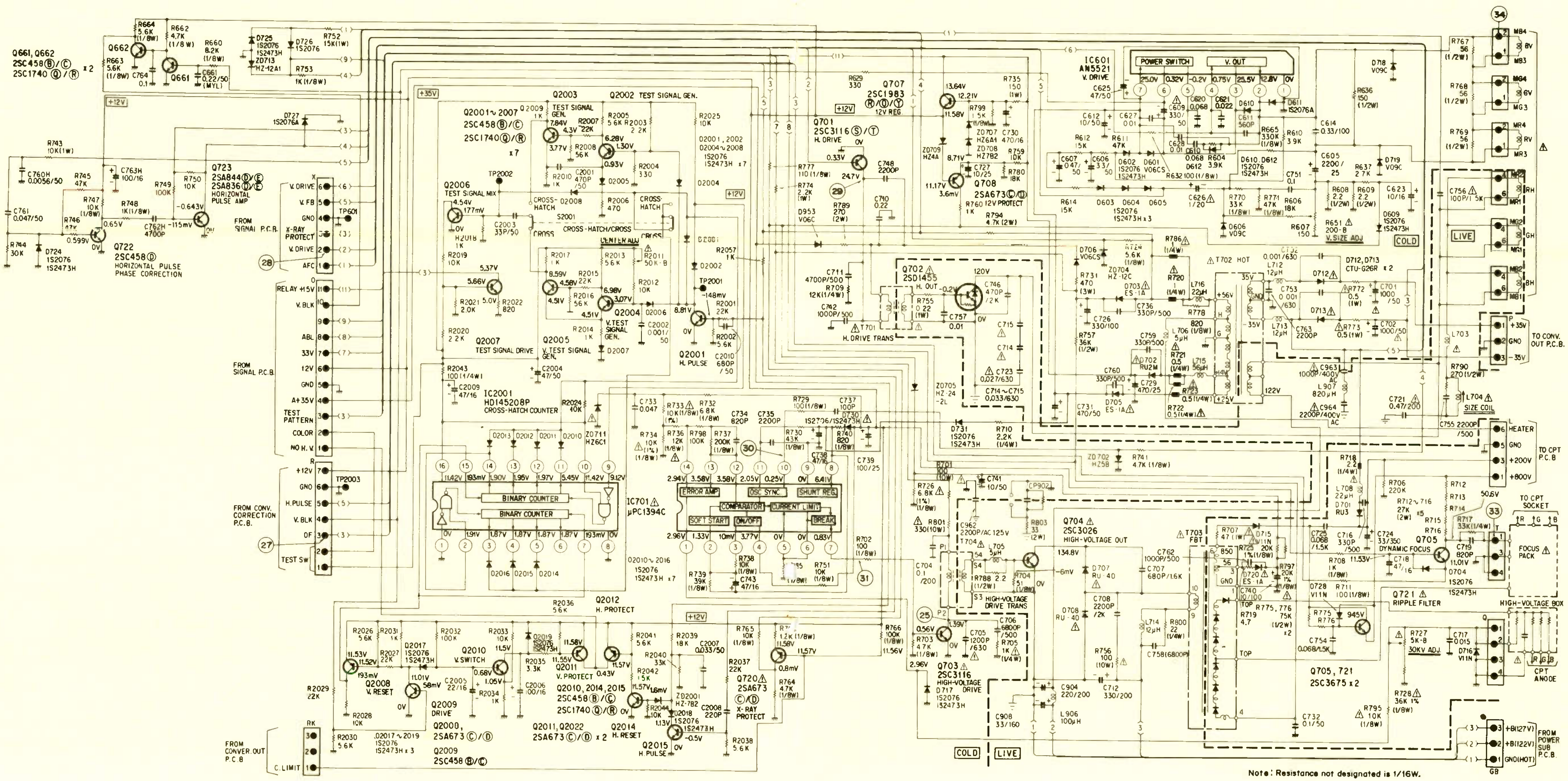
Product safety should be considered when component replacement is made in any area of an electronics product. A star next to a component symbol number designates components in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

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

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

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

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



HITACHI CT4580K, VP7X2 CHASSIS PROJECTION COLOR TV CONVERGENCE ADJUSTMENT

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3065 PROFAX 8S&T Manufacturers' schematics

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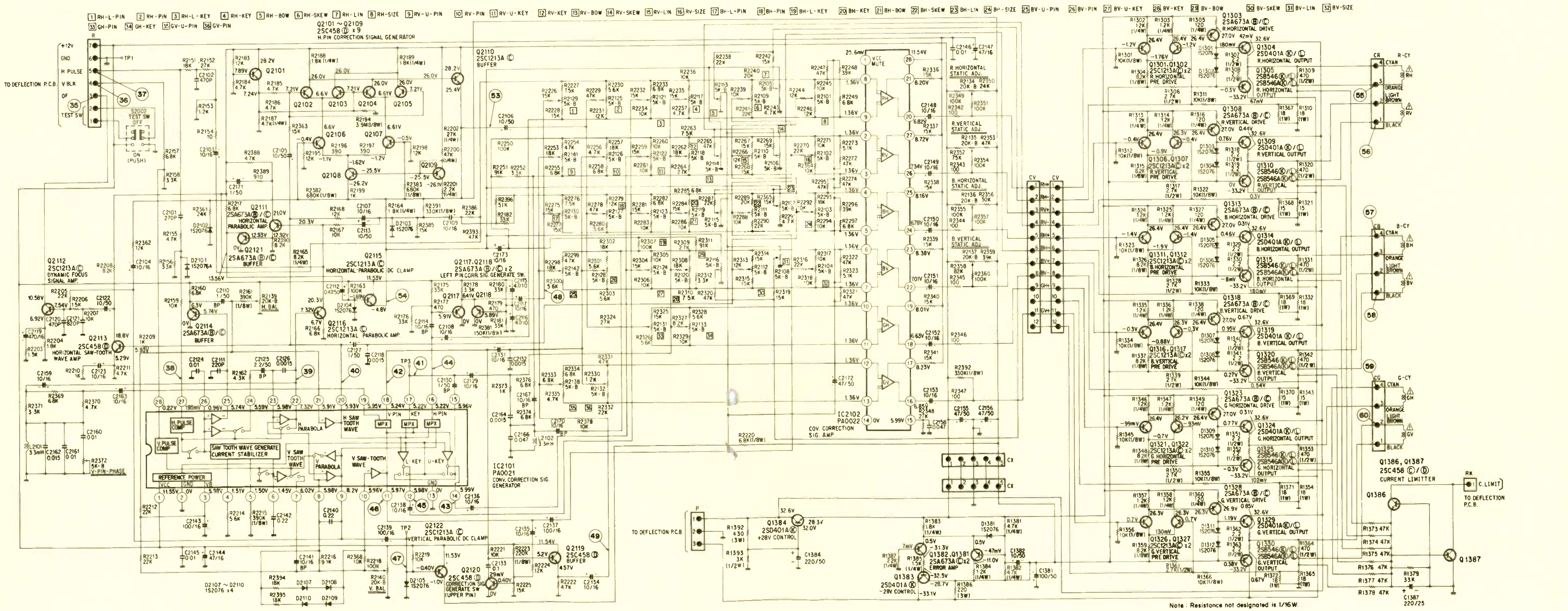
CONVERGENCE CORRECTION AND CONVERGENCE OUT CIRCUIT DIAGRAM



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HITACHI CT4580K, VP7X2 CHASSIS PROJECTION COLOR TV
SIGNAL CIRCUIT 1/2

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BS&T Manufacturers' schematics PROFAX 3065

HITACHI CT4580K, VP7X2 CHASSIS PROJECTION COLOR TV
SIGNAL CIRCUIT 1/2

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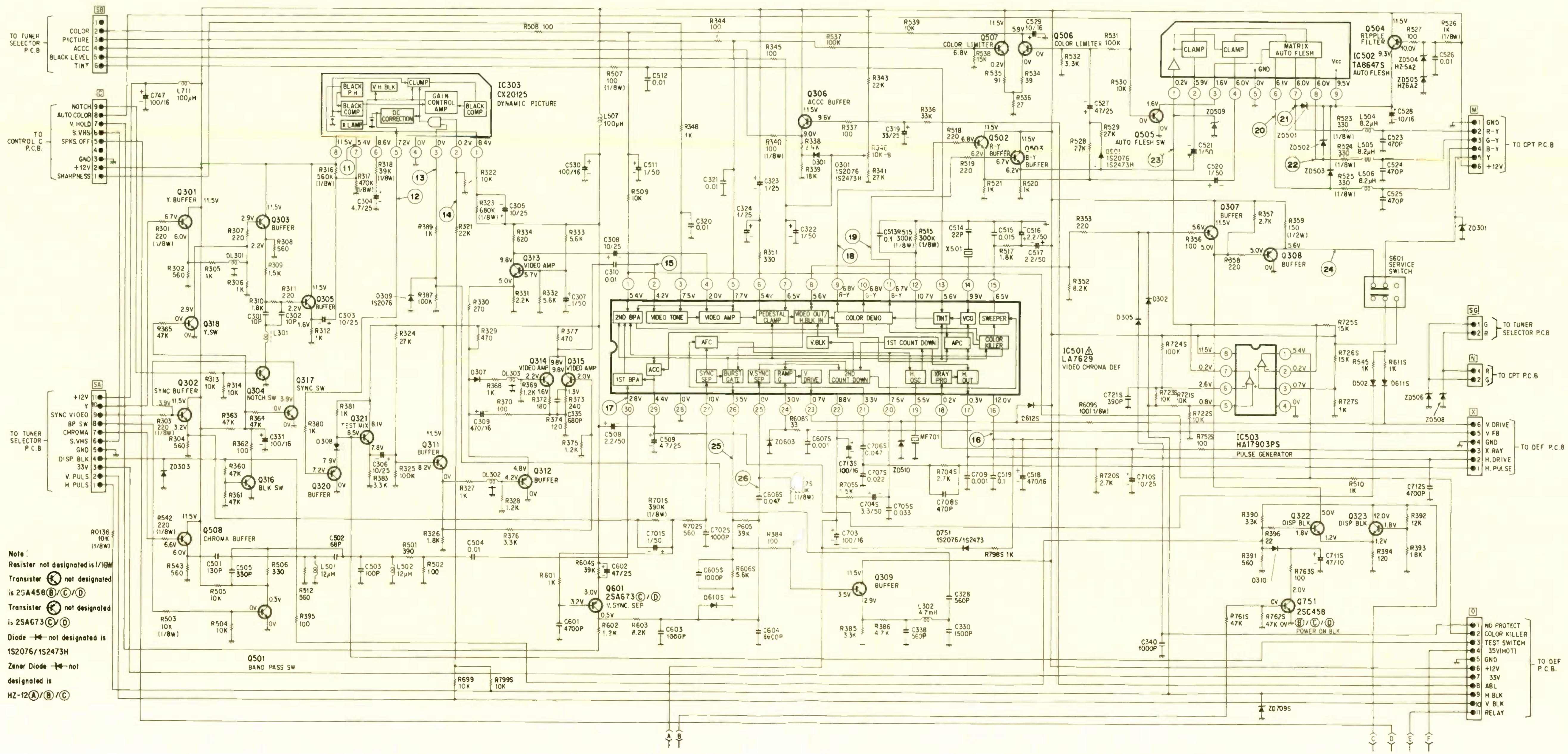

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ES&T Manufacturers' schematics **PROFAX**

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HITACHI CT4580K, VP7X2 CHASSIS PROJECTION COLOR TV SIGNAL CIRCUIT 2/2

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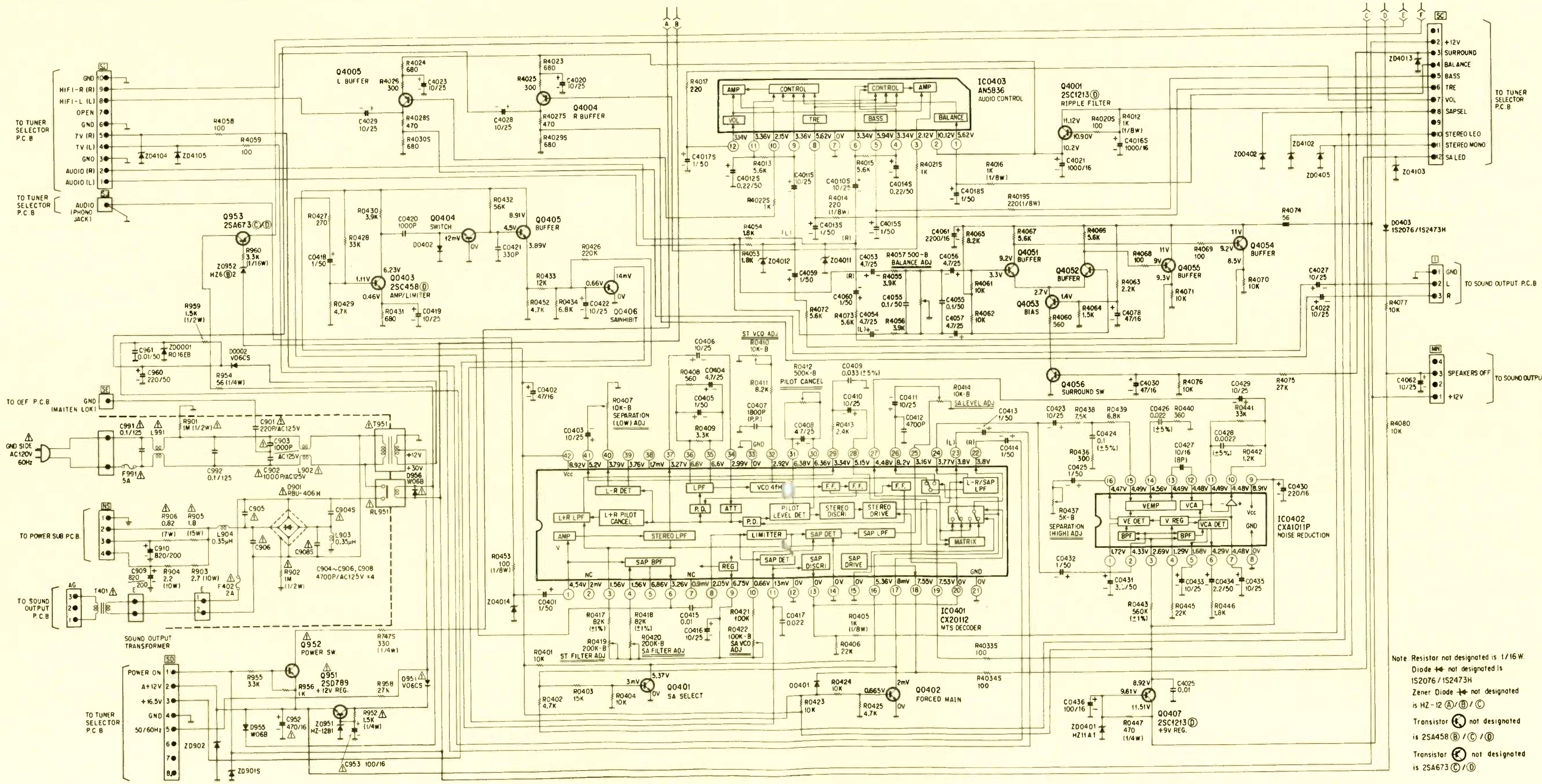


Keeping PC hard disk drives up and running

(from page 24)

formation is located. Finally, the data is read from the sector location.

This sector-addressing information is originally written to the disk's surface during a process known as low-level formatting. In other words, the low-level format actually defines the location of the tracks and sectors on the surface. Low-level formatting differs from the normal format command that exists in DOS. The format command when used on a hard disk does several things, the most important of which is to erase the File Allocation Table (FAT), which records where each file is located on the disk. Without data in the FAT, the computer cannot locate any files on the disk drive. Once the FAT is erased and reinitialized, the computer is free to rewrite new data over sectors that already have old data in them, thus eliminating any chance of recovering the old data from the drive. If a drive has been formatted in error, but new data has not been rewritten into the old sectors, there are utilities on the market that can rewrite the original FAT, thereby recovering the lost files.

One of the major problems that lead to hard disk failures is the aging of the low-level format. Remember, if the sector location information cannot be accurately read by the drive's head, data cannot be located on the drive. Think about it, every time a sector's data is changed, the entire sector is rewritten, thus strengthening the magnetic image of the data in that sector. But, the sector-addressing information put down during the low-level formatting is never rewritten. It sits there, slowly fading away, until the disk controller is finally unable to locate the sector at all. That's when DOS sends those undesirable "sector not found" messages. It is clearly much more desirable to occasionally renew the magnetic strength of the sector-addressing information.

Another leading contributor to the "sector not found" problem is alignment drift due to long-term change in the relative position of the head and the track. If the track is not where the head positioner thinks it should be, it can't be read. Since the head positioner is a mechanical device, any wear in the mechanics of the head positioner results in misalignment of the head and the track. The gradual drifting of the relative position of the head to the track doesn't hurt the readability of the sector's data, since newly written data is position exactly underneath the current location of the read/write head. However, the gradual drifting of the drive's alignment drastically affects the drive's ability to find the sector in question, since the low-level format, which is always required to identify the sector, is never rewritten, and thus gradually becomes misaligned.

With time, the drive's heads can drift far enough from their original alignment that even newly written data cannot be found, because the sector cannot be found. If the low-level format of the drive is periodically rewritten, this problem will never arise.

The floating defect problem

When a drive is first manufactured, the disk surfaces are scanned and defective areas are noted. When the drive receives its initial low-level format, these defects are normally entered into the formatter, so that the sectors containing the defective spots can be flagged as bad and be completely skipped over by the DOS filing system. If the head/track alignment drifts, defects that were once located in the middle of tracks, may now "float" harmlessly between the new track locations, which frees once bad sectors for fresh data storage, and new defects that were previously unseen between tracks now migrate directly into the new track locations causing sectors that were good to become unreliable. Thus, even if the tracks are rewritten to align them with where the head positioner is, it is also necessary to rigorously test the track locations for defects and update the DOS filing system with this information.

In addition to the above problems, hard disk drives can also experience a variety of other problems, some of which result in catastrophic format damage. It is clear from this discussion that the best form of preventative maintenance for hard disk drives is the occasional rewriting of the low-level formatting of the drive (at least once every 3 months is suggested).

Rewrite the low-level format non-destructively

Two approaches exist for rewriting the low-level format of the drive: destructive rewrite and non-destructive rewrite. Most available low-level formatting software instructs the user to completely back-up the information on the drive. This is necessary since the process of low-level formatting with these products erases all data on the existing tracks. The data must be restored after the low-level format is rewritten.

However, products do exist that can non-destructively rewrite the low-level format. That is, they take the data off a track and temporarily hold it in the computer's memory. Then the sector-addressing information is rewritten to eliminate the head/track misalignment, and the data is written back onto the newly located track. All of this is done without destroying any existing data or requiring its backup or restoration. Such products not only do a non-destructive low-level format, but also check the new tracks for defects to eliminate the floating defect problem. They may also tune up the drive by allowing the user to adjust the sector interleave factor for maximum drive throughput. ■

Drum and capstan servo systems

In VCR servicing, one of the more common problem areas has been the servo circuitry.

Videocassette recorders are immensely complex systems. Within a VCR, the drum in which the record and play heads are mounted spins at a high rate of speed. The capstan pulls the tape past the head drum. In order for a VCR to produce a stable picture, the speed of this drum must be precisely controlled. In addition, the tape speed as determined by the capstan motor speed, the precise position of the capstan motor, and the position of a point on the circumference of the drum must be precisely controlled so that during playback the tape head comes in contact with the tape in precisely the same place where the head contacted the tape during the recording process.

The servo systems are the systems within the VCR that provide this control. The drum servo system controls the speed and the position (normally called phase by VCR manufacturers) of the head drum, and the capstan servo controls the speed of the capstan motor and therefore the tape speed, and the absolute position of the capstan motor at any moment. A VCR servo system provides the input that sets the speed of each motor, which in turn adjusts the relative phase of the motors, and also has components that sense phase and position and adjust the magnitude of the input to the motor to adjust that position and speed.

A rough nonelectronic analogy to a servo system is the driver of a car cruising down the highway. The driver keeps his foot on the accelerator to maintain the correct speed. He looks at the speedometer and sees that he's going five mph below the speed limit so he presses a little harder on the accelerator. After a short time he looks at the speedometer and sees that he's let the car's speed get up to three miles above the speed limit, so he eases the pressure on the accelerator to slow down. The engine of the car is the controlled device, analogous to the head drum motor. The speedometer is the feedback signal, and the pressure on the accelerator is the input, analogous to the voltage that controls the head drum motor speed.

VCR servo systems are, in reality, a type of PLL (Phase Lock Loop) configuration. The controlled device in a conventional PLL circuit is a VCO (Voltage Controlled Oscillator), such as the local oscillator in a television tuner. A servo mechanism is a PLL in which a mechanical action is controlled. The drum and capstan servo systems in VCR control both the speed and phase (position) of the drum and capstan motors.

Adapted from an article in "The Expander," written by Ron Smith, head technical writer, Mitsubishi Sales America, Inc.

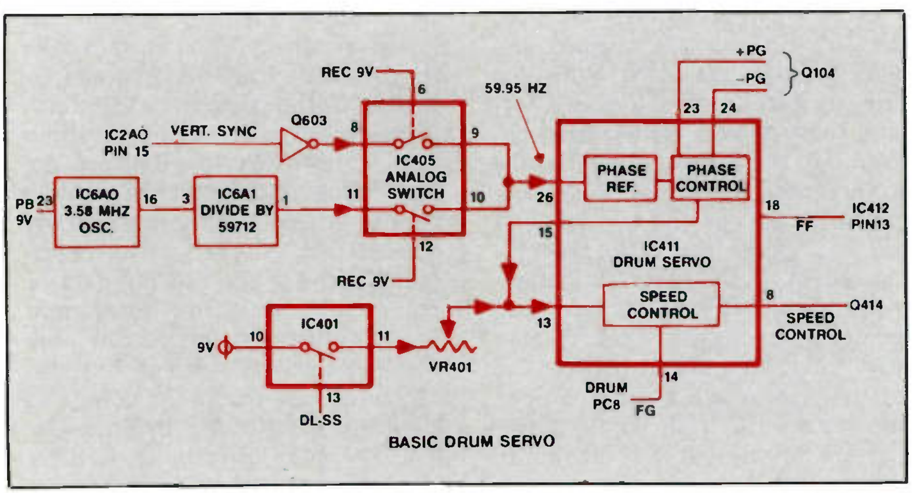


Figure 1. The drum servo controls the speed and phase (position) of the video head drum motor.

Basic speed control

In a VCR, the basic motor speed is initially determined by the voltage developed by a servo control IC as determined by the adjustment of a servo speed potentiometer. Correct speed is maintained by monitoring a reference signal output from the motor. This reference signal is proportional to the speed of the motor. Both the drum and capstan motors have an internal frequency generator (FG). The frequency of the FG signal is determined by the motor speed, increasing as the motor speed increases, and decreasing if the motor begins to slow. If the speed of the motor is incorrect, the FG frequency detected by the servo circuitry, will be incorrect, and an error correction voltage will be directed to the motor drive circuit to correct motor speed.

Basic phase control

Phase Control (Position Control) must be maintained in both the drum and capstan servos in both playback and record. In playback, phase control of the drum motor is necessary to insure accurate alignment of the video heads with the video tracks recorded on the tape. In record, phase control is necessary to insure that vertical sync is recorded at the same point in each video track. If phase control is not maintained in the capstan motor proper tracking is impossible, resulting in noise in the reproduced picture.

Video drum phase control

The basic drum servo diagram shown in Figure 1 was derived from the HS-230UR, but is similar to other Mitsubishi VCRs. The reference signal for the drum servo phase control is a 59.95Hz signal, applied to the drum servo IC411 at pin 26. In playback the reference signal is derived from a stable 3.58MHz oscillator in IC6A0. The output of the 3.58MHz oscillator is divided by 59,712 in IC6A1, resulting in a 59.95Hz output at pin 1, IC6A1. The 59.95Hz signal is directed to pin 26 of IC411 via the analog switch in IC405. In record, the reference signal is the incoming vertical sync from the program source, applied to pin 26, IC411 via Q603 and the analog switch in IC405.

In both playback and record the 59.95Hz reference signal is compared to a pulse generator (PG and -PG signal), which is representative of the position of the video heads. The flywheel on the bottom of the video drum shaft contains two magnets of opposite polarity mounted 180 degrees apart. A PG pick-up head is mounted near the flywheel, so that when the flywheel rotates the fields of the permanent magnets cut across that of PG pick-up head. Since the magnets are of opposite polarity, one positive pulse and one negative pulse are generated by the PG pick-up head

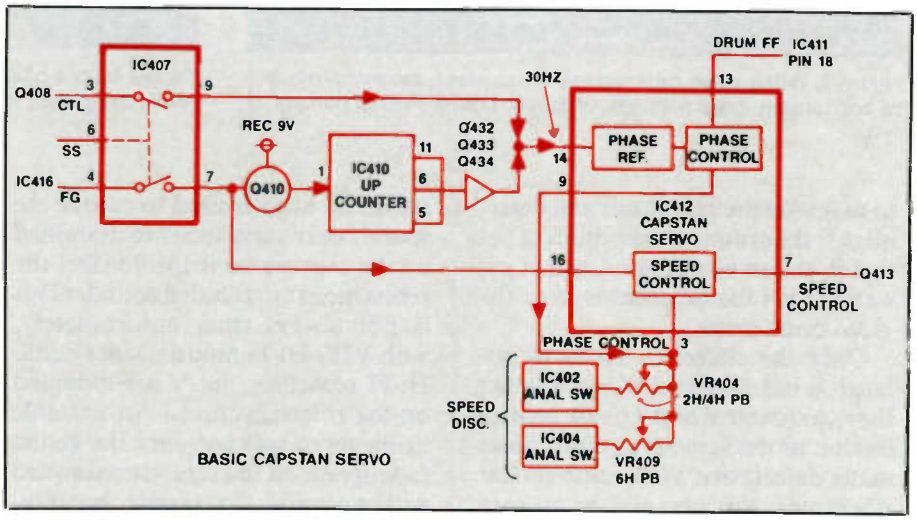


Figure 2. The capstan servo controls the speed and phase of the capstan motor, and consequently the speed and position of the videotape.

for each revolution of the drum flywheel. Consequently, the PG pulses also represent the relative speed of the drum motor. A phase difference between the reference signal and the PG signals will result in the generation of a phase correction voltage at pin 15, IC411, which is directed to the drum speed control circuit at pin 13, IC411, resulting in the required adjustment to the motor speed to assure an in-phase condition. A drum flip-flop (FF) signal is developed by IC411, available at pin 18, and will be used later as a reference signal for capstan phase control. Since the PG (position) pulses were used to form the drum FF signal, the phase of the FF signal also coincides with the position of the video heads; as such, the drum FF signals are utilized as video head switching signals.

Capstan phase control

Phase control of the capstan motor is achieved by comparing the 30Hz drum FF signal, applied to pin 13, IC412, to the 30Hz reference signal at pin 14, as illustrated in Figure 2. In record, the 30Hz reference is derived by dividing the capstan FG signal to produce a 30Hz reference signal. In playback, CTL (control track) pulses previously recorded on the tape serve as the 30Hz reference.

A difference in phase between the 80Hz reference signal and the drum FF signal results in the development of a capstan phase correction voltage output at pin 9 of IC412. The correction voltage is applied to the capstan speed control circuit at pin 3, slightly jogging the capstan motor to achieve an in-phase condition.

Troubleshooting servo systems

In VCR servicing, one of the more common problem areas has been the servo circuitry. The advent of digital servos used in the latest model VCRs has greatly reduced the number of servo problems. Many VCRs using analog servos are still in use, however, so the technician must be able

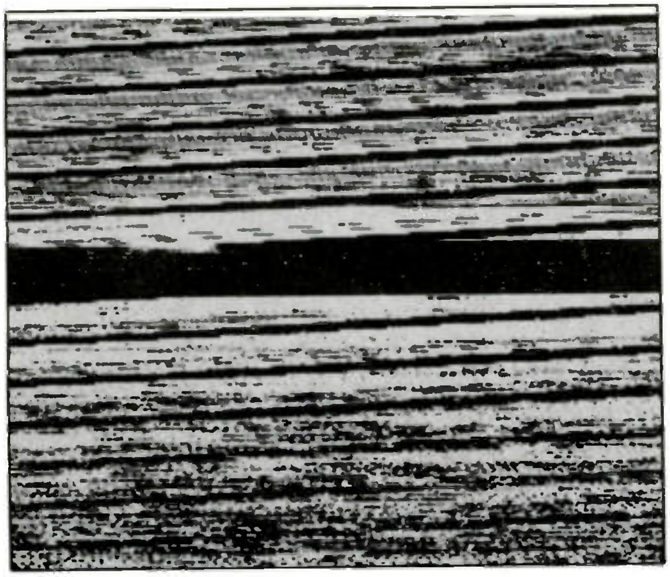


Figure 3. When video drum speed is incorrect, the symptom will be horizontally diagonal lines, characteristic of loss of horizontal sync.

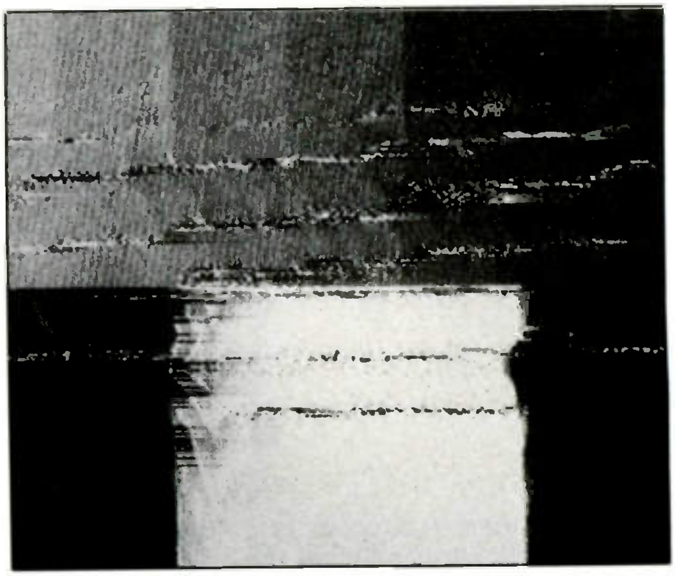


Figure 4. Loss of drum phase control usually results in a single noise bar in the picture.

to diagnose the symptoms and determine if the symptoms are due to a defect in the servo circuitry, and if so, whether it's the capstan servo or the video drum servo.

Once the defective servo is isolated, it must be determined whether the speed control or the phase control section of the servo is at fault. Since many defects in a VCR cause similar symptoms, this may not be an easy task. The following descriptions and illustrations should aid the technician in diagnosing servo problems.

Incorrect motor speed or a loss of phase control in either the capstan servo or the drum servo can produce similar symptoms in the reproduced picture in PLAYBACK. A substantial error in drum motor speed will usually cause a loss of horizontal and vertical synchronization, while smaller errors in the speed of either motor can cause noise in the playback picture.

A loss of phase control results in smaller speed errors, producing the associated noise or noise bars in the picture. Similar symptoms can be caused by other sections of the VCR, such as dirty or defective video heads, incorrect interchangeability adjustments, incorrect head switching, etc. Usually, when a phase control problem exists in a servo system, good tracking (a noise free picture) can be obtained momentarily but will not hold. If noise is due to other circuitry, it is usually there all the time.

When a servo problem is encountered, one key indicator that can be used to determine which servo system is at fault is the sound. Since a separate audio head is used to record the sound, only tape speed (determined by the capstan servo) will affect the reproduced or recorded sound. (This is not always true, unfortunately, with VHS Hi-Fi models, since audio Hi-Fi recording heads are mounted on the rotating drum.) An unstable drum servo will not vary the actual tape speed, so the reproduced sound will be normal. Conversely, instabilities in the capstan servo will affect tape speed, which is audible in the sound, a slow tape speed producing wow, and a fast tape speed producing high pitched sound.

Noise in playback

When the video drum is rotating at the correct speed (1800 RPM), the sync pulses picked up from the tape are at the normal NTSC frequencies, 15,734 Hertz for horizontal and approximately 60 Hertz vertical.

Drum speed errors

If the drum speed is incorrect, the horizontal and vertical sync picked up from the tape will not appear at the normal NTSC frequencies. The frequencies increase if the drum is fast and decrease if the drum is slow. Because of the incorrect sync pulse rate, the predominant symptom resulting from incorrect drum speed is horizontally diagonal lines as illustrated in Figure 3.

Drum phase errors

Should the drum phase control be lost, the video heads may not contact the tape at the correct point in time, or may be activated when the head is not in contact with the tape. This usually causes a single noise bar in the picture, as shown in Figure 4. Usually if drum phase control is lost, the noise in the picture is not constant, but comes and goes.

Capstan speed errors

The capstan servo determines tape speed and phase. If the capstan speed control servo is defective, the tape runs at an incorrect speed and the effect is audible in the sound. An incorrect tape speed will cause a series of noise bars in the picture as shown in Figure 5. The number of noise bars varies with how far the tape speed has changed.

Capstan phase errors

If capstan phase control is lost, the video heads may traverse opposing azimuth video tracks producing a noise bar in the picture area, as illustrated in Figure 6. Usually the noise will come and go as the phase varies, and slight variation in the sound may be audible. If the customer Tracking Control has to be constantly readjusted to move noise from the picture, it is usually caused by a defect in the capstan phase servo.

Servo basic troubleshooting procedure

When it is determined which servo system is at fault the following servo basic troubleshooting procedure, in conjunction with the appropriate VCR training manual and service manual, should help the technician in

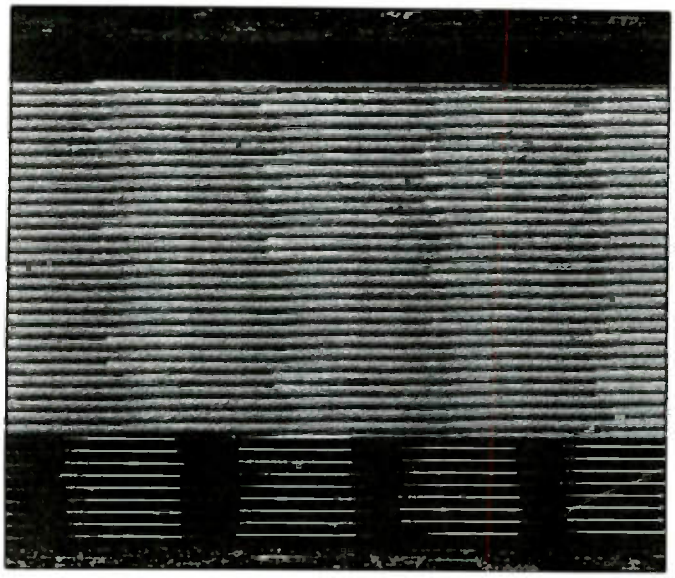


Figure 5. Incorrect tape speed, the consequence of incorrect cap stan speed control, will result in a symptom consisting of a number of noise bars in the picture.

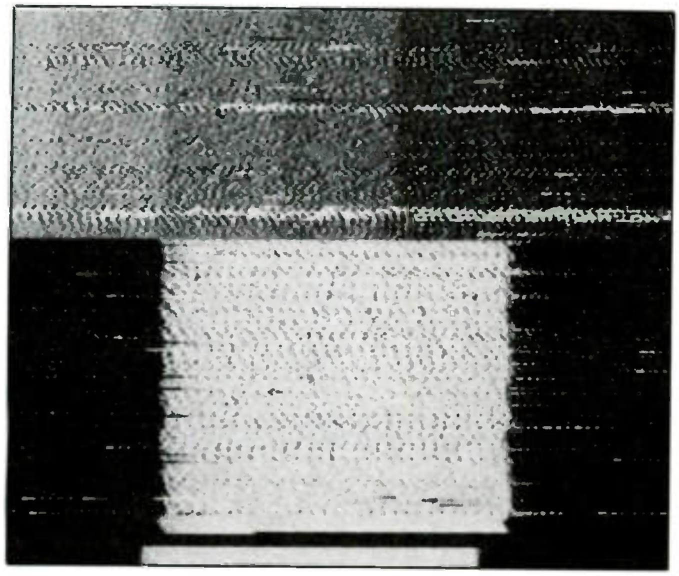


Figure 6. Loss of capstan phase control will be a noise bar in the picture that comes and goes as the phase varies.

solving servo problems. Although the nomenclature in the following procedure is derived from the HS-320UR, the basic principles can be applied to servo circuitry in other VCRs.

Symptom: Playback picture is out of sync (speed).
Noise bars in the picture (phase).

I. Capstan or drum?
A. Sound normal—Troubleshoot the video drum servo
B. Sound abnormal—Troubleshoot the capstan drum servo

II. Servo speed adjustment
Perform the servo speed adjustment as in the service manual.
A. Motor speed does NOT change. Proceed to Step III.
B. Motor speed varies but will not hold. Proceed to Step IV.

III. Determine effect of servo potentiometer
Measure the dcV at the servo speed control input, while varying the servo potentiometer.

Drum	Capstan
Pin 13 IC411	Pin 3 IC412

A. Speed control input voltage does NOT vary.
1. Check the operation of the servo potentiometer.

Drum	Capstan
VR401	VR404 (2H/4H)

2. Check the analog switch for proper operation.

Drum	Capstan
IC401	IC402 and IC404

B. Speed control input DOES vary. Check for dcV variation at the speed control output of the servo IC as the servo potentiometer is turned.
1. Varies—troubleshoot the motor drive circuit.
2. No variation—servo IC is probably defective

Drum	Capstan
IC411	IC412

IV. Servo input signals
A. Check for all input signals to the servo IC. Troubleshoot the signal path of any missing signals.

Drum	Capstan
IC411	IC412
FG—pin 14	FG-pin 16
59.95Hz-pin 26	CTL-pin 14
PG-pin 23	Drum FF-pin 13
– PG-pin 24	

B. If all signals are present—proceed to Step V.

V. Servo IC or motor drive circuit?
Connect the dc input of an oscilloscope to the speed control output of the servo IC.

Drum	Capstan
Pin 8	Pin 7

A. Voltage varies—servo is trying

		PIN 8 MODE	PIN 5 SV-REC	PIN 16 VSCO	PIN 17 VSC1	PIN 18 C-REV	PIN 20 REC 9V
RECORD	2H	L	H	L	H	L	H
	4H	M					
	6H	H					
PLAYBACK		..	L	H	L	L	L
FORWARD SEARCH		..	L	H	H	L	L
REVERSE SEARCH		..	L	H	H	H	L
FAST FORWARDING		..		H	H	L	H
REWIND		..	L	H	H	H	H

MODE SELECTOR TRUTH TABLE

Table 1. Although digital servo circuits seldom cause problems, this truth table may make diagnosis of problems easier when they do occur.

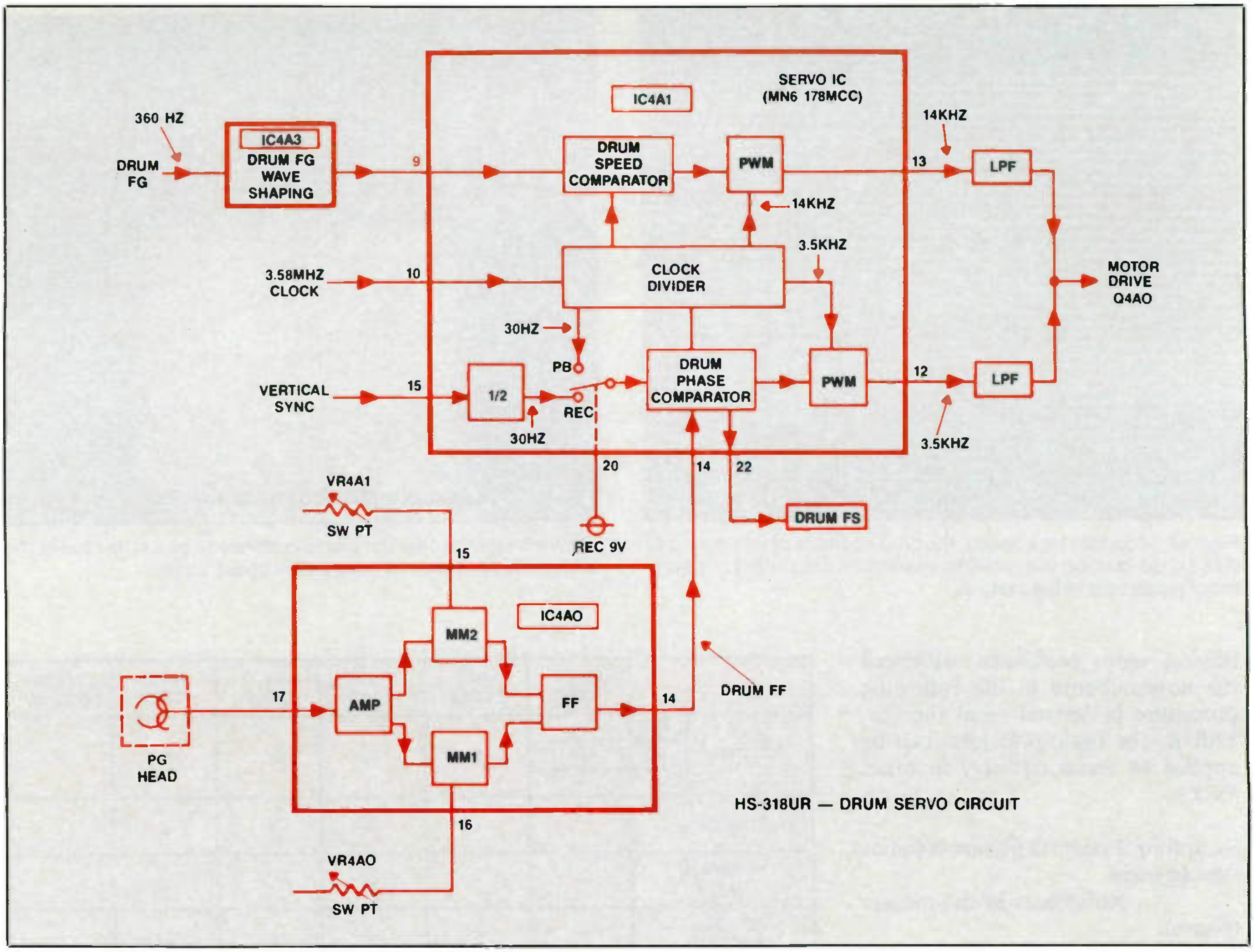


Figure 7. In this VCR both the drum servo circuitry and the capstan servo circuitry are contained in a single large-scale integrated circuit (LSI). Only the drum servo portion is shown here to avoid confusion.

to correct motor speed. Troubleshoot motor drive circuit/motor.

B. Voltage is constant—servo IC is probably defective.

Digital servo circuits

The following analysis uses the HS-318UR for illustrative purposes. The analysis also applies to other Mitsubishi VCR models.

The HS-318UR utilizes a digital servo system with a new servo IC. This large-scale integration (LSI) device, identified as MN6178MCC, was designed specifically for the NTSC television format. Both capstan and drum servos are internal to the same LSI, however, for simplification each servo system will be described individually.

Drum servo

A simplified diagram of the drum servo is illustrated in Figure 7, showing only those sections of the LSI directly related to the drum servo. Timing for all the servo LSI operations is derived from an external 3.58MHz clock oscillator, directed to the LSI (IC4A1) at pin 10. An internal clock divider generates the timing signals required by the internal digital comparators and pulse width modulators.

As in all servos used in VCRs, the servos in the HS-318UR are divided into 2 major sections, speed control and phase control. The drum speed servo sets and maintains the drum rotational speed at 1800 RPM.

During record, the drum phase servo insures that the video heads come into contact with the tape just prior to vertical sync, and assures the recording of vertical sync at the beginning of each video track, as required by the VHS format. In playback, the drum phase servo maintains a constant head-to-tape phase relationship. Any error between the video head paths and the video tracks on the tape is corrected by the capstan servo.

The frequency of the drum FG signal generated by the Hall elements in the drum motor assembly represents the drum motor speed, and is directed to the drum speed servo at pin 9 of IC4A1. The internal drum speed servo generates a variable duty cycle 14KHz PWM (pulse-width modulated) signal at pin 13. The duty cycle of the PWM signal is determined by the speed of the motor.

The 14KHz PWM signal is filtered by a discrete component low pass filter (LPF) and the resultant dc voltage is directed to Q4A0 in the drum motor drive circuit. If the motor is slow, the 14KHz PWM signal has a less positive duty cycle which, when filtered, results in a lower dc level and, via the drum motor drive circuit, increases the motor speed. Conversely, if the motor is fast, the 14KHz duty cycle is more positive, resulting in a higher filtered dc voltage, reducing the motor drive.

The drum phase servo compares

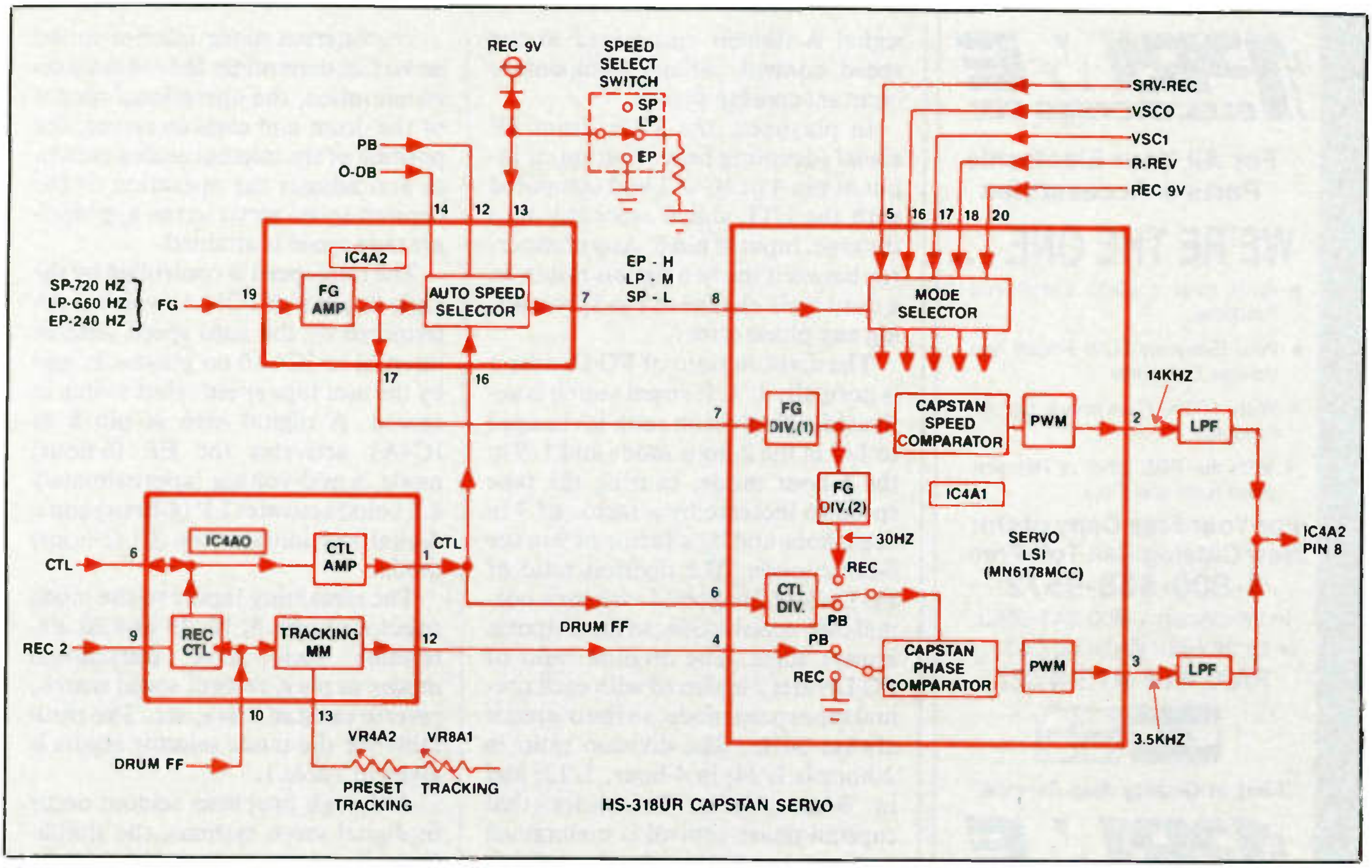


Figure 8. The capstan circuitry of this VCR shares a single LSI IC with the drum servo circuitry.

the drum FF (representing the relative head position) against a stable reference. In record, the stable reference is incoming vertical sync, directed to pin 15 of IC4A1, and in playback the reference is a 30Hz signal derived by repeatedly dividing the 3.58MHz clock signal. The drum phase servo generates a variable duty cycle 3.5KHz PWM signal at pin 12, which is filtered by a LPF and added to the speed control voltage to correct any error in the drum phase.

Capstan servo

The capstan servo, illustrated in Figure 8, operates basically the same as the drum servo, with the exception of the signals directed to the circuitry. The capstan FG signal is directed, via IC4A2, to the capstan speed servo input at pin 7 of IC4A1. The capstan speed servo generates a 14KHz PWM signal at pin 2, which is filtered and directed to the capstan motor drive circuitry at pin 8 of IC4A2.

In record, the capstan phase servo maintains a constant capstan phase by monitoring the capstan FG signal divided down to 30Hz. Any change in the phase of the divided 30Hz signal results in a duty cycle change in the 3.5KHz PWM signal output from pin 3 of the LSI. The 3.5KHz PWM signal is filtered and added to the speed control voltage to maintain constant capstan phase.

In playback, the 30Hz drum FF signal (denoting head position) is input at pin 4 of IC4A1 and compared with the CTL signal recorded onto the tape, input at pin 6. Any phase error between the two signals results in a duty cycle change at pin 3, correcting any phase error.

The division ratio of FG Divider 1 is normally 1/1. If speed search is activated, the division ratio is changed to 1/7 in the 2-hour mode and 1/9 in the 6-hour mode, causing the tape speed to increase by a factor of 7 in the 2-hour and by a factor of 9 in the 6-hour mode. The division ratio of FG Divider 2 is altered with each normal tape speed mode, so the output is always 30Hz. The division ratio of FG Divider 2 is altered with each normal tape speed mode, so the output is always 30Hz. The division ratio in 2-hour is 1/24; in 4-hour, 1/12; and in 6-hour, 1/8. To insure that capstan phase control is maintained in a speed search mode, the division ratio of the CTL divider corresponds to that of FG Divider 1 . . . 1/7 in 2-hour and 1/9 in 6-hour.

The internal mode selector in the servo LSI determines the required division ratios, the operational modes of the drum and capstan servos, the position of the internal analog switches and adjusts the operation of the capstan speed servo so the appropriate tape speed is attained.

The tape speed is controlled by the logic at pin 8 of IC4A1, which is determined by the auto speed selector internal to IC4A0 on playback, and by the user tape speed select switch in record. A digital high at pin 8 of IC4A1 activates the EP (6-hour) mode, a mid-voltage (approximately 2.5 volts) activates LP (4-hour) and a digital low initiates the SP (2-hour) mode.

The remaining inputs to the mode selector at pins 5, 16, 18 and 20, determine such servo operational modes as play, record, speed search, reverse capstan drive, etc. The truth table for the mode selector inputs is given in Table 1.

Although problems seldom occur in digital servo systems, the simplified diagrams and mode selector truth table presented in this article should be of assistance in localizing a defect should one arise. ■

JVC
2729-1 .... C-2019/29/39

Panasonic
2730-1 .... CTK-2061S (CH. AMEDP165/GL7H)
2732-1 .... CTK-1350R/1R/2R (CH. ALDP153)

Philco
2732-2 .... C5820BAK01, C5823BPN01, C5824BPE01, R5051BWA01, R5075BWA02, R5860BAK01, R5861BAK01, R5862BPE01, R5863BHP01, R5865BPE01, R5880BPE01, R5882BPE01, R5883BPE01, R5960BAK01, R5962BPE01,

Philco continued
R6862BPC01, R6862BPE01, (CH. 25B107/8/9, 26B105/6/7)

Quasar
2726-1 .... SL2534DK, SL2536DD, SL2538DP, SL2539DP, (CH. AEDC160/GL7S2)
2727-1 .... SP2730DE (CH. AMEDC148/GL7S)
2728-1 .... TP1920DW (CH. ADC179/GL7H2)
2729-2 .... SP2030DW (CH. AEDC177/GL7H2)
2731-1 .... TP2520DW (CH. ADC144/GL7S)

RCA
2731-2 .... F26100AKF01, F26101NGF01, F26103EGF01,

RCA continued
F26105MKF01, F26150BHF01, F26155AKF01, G26330TNC01, G26331TNC01, G26335TKC01, G26339HPC01, G26341TNC01, G26343TNC01, G26345TKC01, X26025EBF01, X26027WNF01 (CH. CTC149B/E/Q)

Sears
2726-2. 564.42355950, 564.42455950

Sony
2727-2 .... KV27TS23/24/25/26 (CH. SCC-B55K-A/P-A/Q-A/U-A)

Sylvania
2728-2 .... RKZ119BK01/02

Series vs parallel, and measuring rms voltage

By Sam Wilson, CET

Whether a circuit is series or parallel can sometimes be tricky to determine. A question, published in this department in the February 1990 issue, generated a great deal of controversy. Here's that question, the answer, and an explanation of why the answer given is the correct answer.

5. Refer to the crystal radio in Figure X. The radio is tuned by the combination of L and C. In this circuit, L and C are in

A. series
B. parallel

Answer: B

This letter was only one of many questioning that answer:

"I must take issue with Sam Wilson's column 'Test Your Electronics Knowledge.' I refer specifically to Mr. Wilson's answer to question 5. My view is that L and C are in parallel. I can illustrate this by the series-resonant, parallel-connected trap and the parallel-connected, series resonant trap. Perhaps the question was not stated properly."

Sincerely,
Gene Vinson

Sam Wilson Answers:

Thanks for taking the time to write. Your illustrations have been redrawn because it is difficult to print pencil sketches. The connections are exactly the same as on your drawings. However, for my discussion of the circuit in Figure 3, I have changed the position of point A [your symbol for the antenna terminal] to a position I have called X. My reason is that I am discussing antenna voltage. Point X is the location of that source of voltage.

Your illustrations of parallel and series traps do not demonstrate that L and C of the receiver tuned circuit are in parallel. Refer to Figure 1. In order to determine if a circuit is series- or parallel-connected, start with the location of the generated voltage, then trace the generator current. In Figure 1, the generated voltage is between the antenna and ground. A popular way of showing that is given in Figure 2.

The series trap is a series circuit because the antenna voltage is directly across it. Also, the generator ac current must flow through the inductor and through the capacitor. The transformer primary in that illustration is in parallel with the trap. That follows because the generator current can flow through the trap or through the transformer winding.

Your parallel-connected trap of Figure 3 has been redrawn in Figure 4. The generator current has a choice of flowing through the inductor or capacitor, so those components are in parallel. The transformer primary winding is in series with the trap because current flows through the trap connection AND the transformer winding.

Components are not in series just because they are drawn with one above the other. Likewise, they are not in parallel just because the are drawn side by side. Remember that the generator current [and, indirectly, the generator voltage] are used to

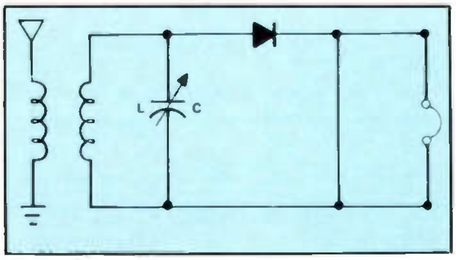


Figure X

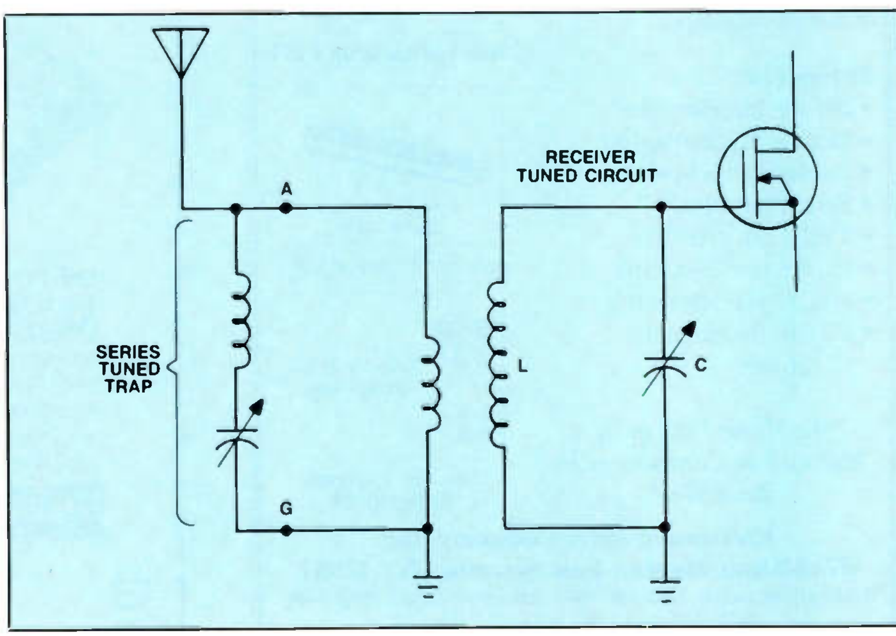


Figure 1

Wilson is the electronics theory consultant for ES&T.

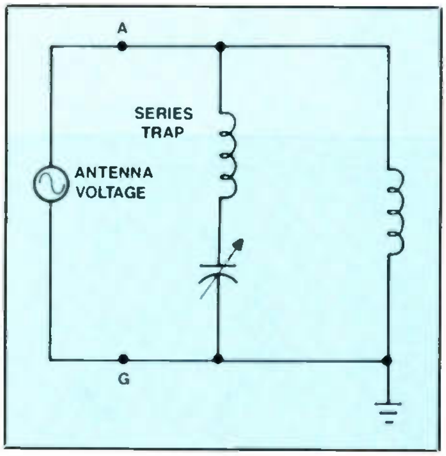


Figure 2

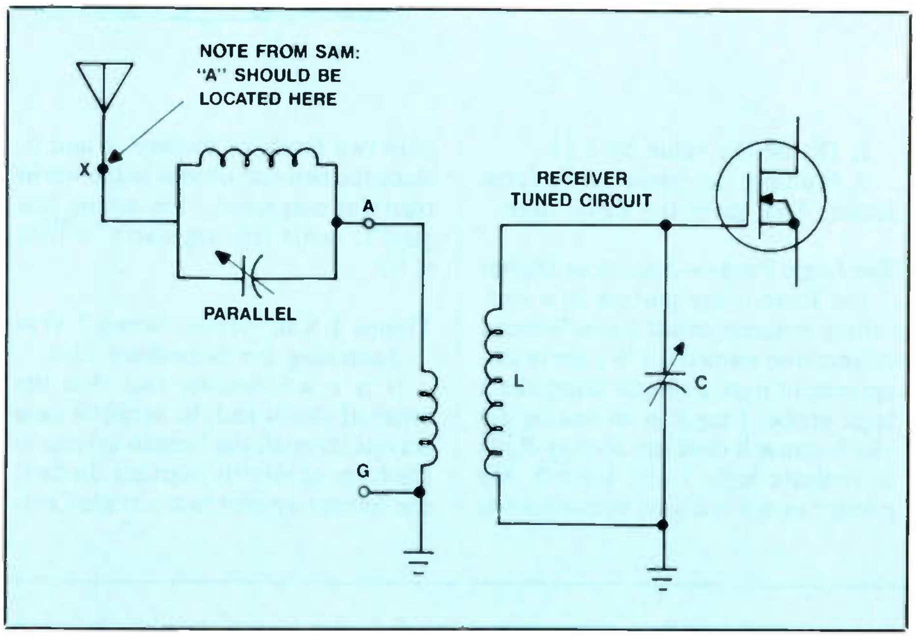


Figure 3

determine if components are in series or parallel. Always locate the generator first before deciding if components are connected in series or parallel.

Now look at the receiver LC tuned circuit in Figure 5. The secondary voltage is generated in the windings. As shown in the illustration, the generated voltage is considered to be is series with the transformer secondary. The MOSFET gate is an open circuit so no current is flowing in that branch. The generated current must flow through the inductor and capacitor. There is no choice of L or C as in the parallel trap.

In the question, a crystal radio was shown at the output of the tuned circuit. The answer is still the same. The crystal circuit is in parallel with the capacitor. An argument could be made about a series-parallel combination. However, that was not one of the choices because the question addresses the configuration of series and parallel tuned circuits.

Even without the above discussion, it should be obvious that this is a series LC circuit. Its purpose is to select one frequency [and sidebands] and reject all other frequencies. That is the characteristic of series-tuned circuits.

The voltage across the series combination is minimum at resonance. However, the voltage across the capacitor is determined by the equation:

$$V_c = (I)(X_c)$$

Since the current in the circuit is maximum at resonance, it follows that the voltage across the capacitor is also maximum. The result is that the maximum signal is delivered to the RF amplifier, or crystal circuit, when the circuit is resonant with the station frequency. A parallel tuned circuit

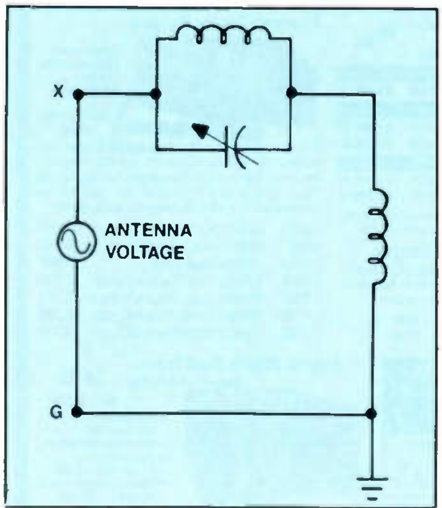


Figure 4

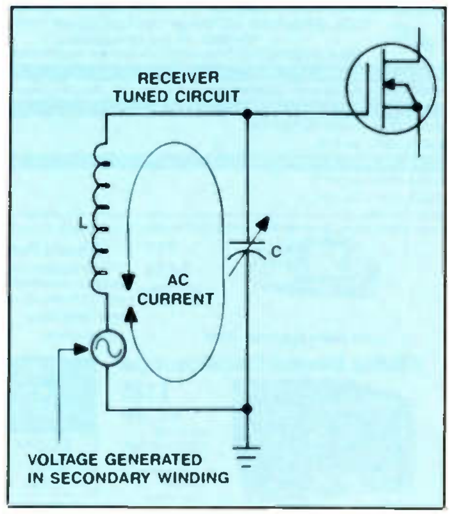


Figure 5

rejects the resonant frequency and passes all other frequencies.

Your letter brings to mind an important problem in teaching electronics. Unless the instructor makes a move to prevent it, a student will try to identify circuits only by the way they are drawn. A good example of this is shown in Figure 6. Both circuits are bridge rectifiers, but students will not recognize that unless they learn to trace—not just memorize—circuits.

Measuring rms voltage and current

I have a very classy engineering book with a genuine imitation leather cover. It gives the equation for form factor:

$$\text{form factor} = \frac{\text{RMS value}}{\text{average value}}$$

Then it goes on to say that the form factor has no practical value because it does not really give any information about the waveform. That is like saying that hamburgers are not really food because they don't contain any ham. So what?

My point is that form factor has some uses even though it is true that it does not tell you about waveform. There are books that claim that it is a measure of how closely a waveform approaches a sine wave. That just is not true. However, there are ways of using form factor. In the previous issue, it was shown that the RMS value of a nonsinusoidal wave can be measured with a VOM if you know the form factor.

Here are the steps that were given:

1. Measure the voltage as if it was a sine wave.

2. Divide the value by 1.11.

3. Multiply the result by the form factor. That gives the RMS value.

The Logic Probe—Analog or Digital

Joe Risse is my partner in a consulting business called Risse/Wilson. (Guess who named it.) We are in disagreement over a simple thing like a logic probe. I say it is an analog device because it does not display digits to indicate logic 1 and logic 0. My partner says it is digital because it has only two levels of display: 1 and 0. Since the best technicians in the world read this magazine, I am asking you guys to settle this argument. Which is it?

Things I Ran Across When I Was Searching for Something Else

It is a well-known fact that the sense of touch and the sense of pain travels through the human system in the form of electric currents. In fact, the human system is a complex network of currents and voltages. What is not so well known is the fact that trees and plants also have electric systems that correspond—roughly—to the human system.

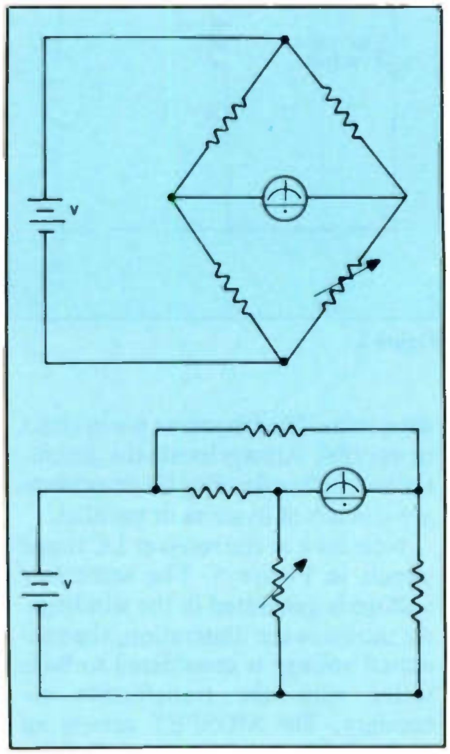


Figure 6

One difference is that the human connectors have synapses that connect shorter conductors. In plants there has not been any evidence of the synapses. Instead, the electric signals pass along longer conductors. The amount of electricity (voltage and/or current) varies from one type of plant to another. The same is true for trees. Experiments show that the electricity increases when a leaf of the plant is touched.

No practical use of this information has come forth so far. I would like to suggest that a large plant be placed near a door. An electronic transducer could be used to sense when leaves have been disturbed as an interloper brushes past—and touches—the plant. The sensed electric signals would then set off an alarm.

Remember, if you make millions with this idea, you wouldn't miss a few hundred thousand for my favorite charity.

Usually when I bring some dynamic technology to the attention of readers, I get letters from non-believers. ■

VCR vertical sync

By Stephen J. Miller

Digital technology can often throw us a curve. Last month we looked at a deceptive headswitching circuit. This month we will explore another area where digital technology can trick us, the vertical sync signal.

In the record mode, the vertical sync signal is used both to produce the record control pulse, CTL, and as a reference signal to the drum phase control servo. In earlier machines, loss of the vertical sync signal would mean no record CTL signal and no drum phase reference signal. However, in recent designs, the vertical sync signal does not directly produce these signals. Rather, the vertical sync signal is used to reset a down-counter inside the servo IC.

CTL without vertical sync

Figure 1 shows a typical circuit. The 3.58MHz master clock is divided by 119,320 to produce a 30Hz signal. Vertical sync is divided by 2 and used to reset this down-counter. Resetting the counter in this fashion insures that no phase error exists between the down-counted 30Hz and vertical sync.

Miller is a senior bench technician for a Lancaster, PA, repair company

This is very similar to the headswitching circuitry described last month. As with last month's circuitry, loss of vertical sync will not cause the loss of the 30Hz reference signal. Instead, it will cause a phase error to exist between vertical sync and this 30Hz reference signal.

If you're skeptical, try this little test. Take a late model Matsushita machine and, without attaching an antenna, enter the SP record mode. Next zero the counter and, after ten counts, switch the speed to LP. After ten more counts switch to the SLP speed. Finally, after an additional ten counts, rewind and playback the tape. You will find that the VCR plays back each section of tape at the same speed it was recorded in. A CTL signal is needed to perform playback speed selection, so a CTL track must have been recorded. Yet, with no antenna connected, vertical sync was not present. Therefore, in the absence of vertical sync, the machine produced its own 30Hz reference signal. Machines of many other manufacturers will produce the same results.

Record mode problems

Loss of vertical sync to the servo section affects the record mode. The usual symptom is a line in the playback picture of tapes recorded on the defective machine. This thin noise line can appear anywhere on the screen, but will remain stationary throughout a particular recording session. Playing the tape on a good machine will display the same line. Often the line is mistaken for a scratch or crease in the video tape itself. However, when recording over that tape on a good machine, the line will disappear. This line is actually the headswitching points appearing on the screen.

Figure 2 helps explain why the headswitching points appear on the TV screen. Section A shows a normal recording, while section B shows an abnormal recording. Because of the overscan, the TV viewer sees only about 90% of the vertical field or the shaded areas in Figure 2. Since there is no switching point within the shaded area of section A, no switching point will be visible to the viewer. Because of the phase error in Section B, a switching point is present in the shaded area and it will be visible to the viewer.

This type of phase problem has been a common failure in the Toshiba M-5100 series machines. The usual complaint is that pre-recorded tapes play fine, but the picture produced by self-recorded tapes has a thin blue horizontal line. In these machines, the most likely cause is servo IC, IC501 (TD6360P). To troubleshoot, enter the record mode, and using the video output signal as a reference, scope the vertical sync input, pin 25 of IC501. Positive-going sync pulses at 0.75 volts peak-to-peak should be present at pin 25. Make

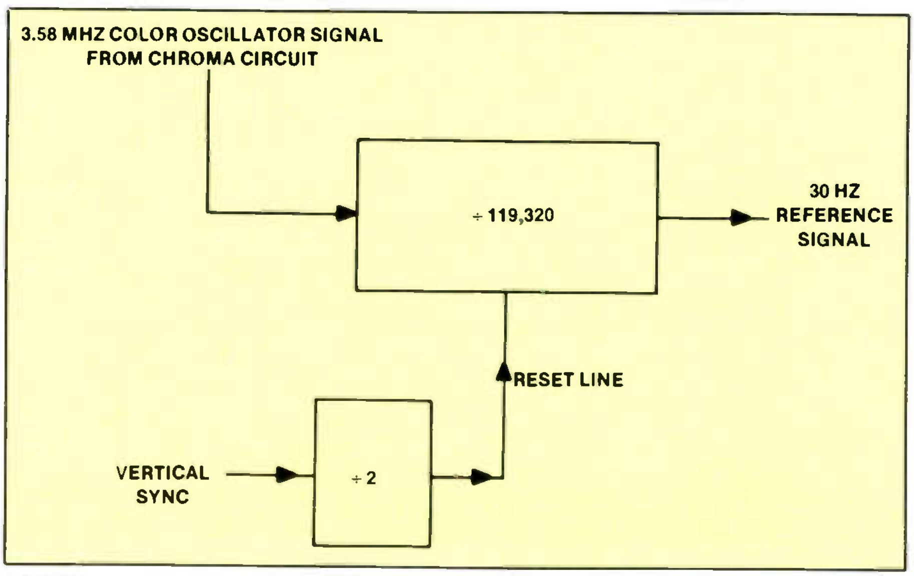


Figure 1

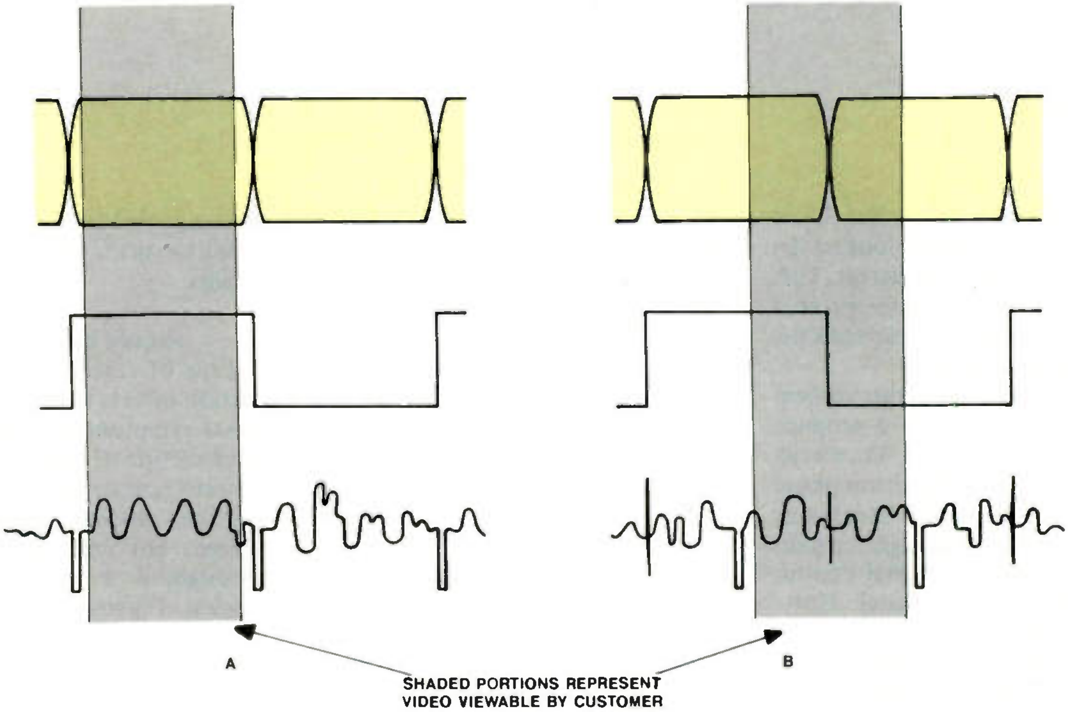
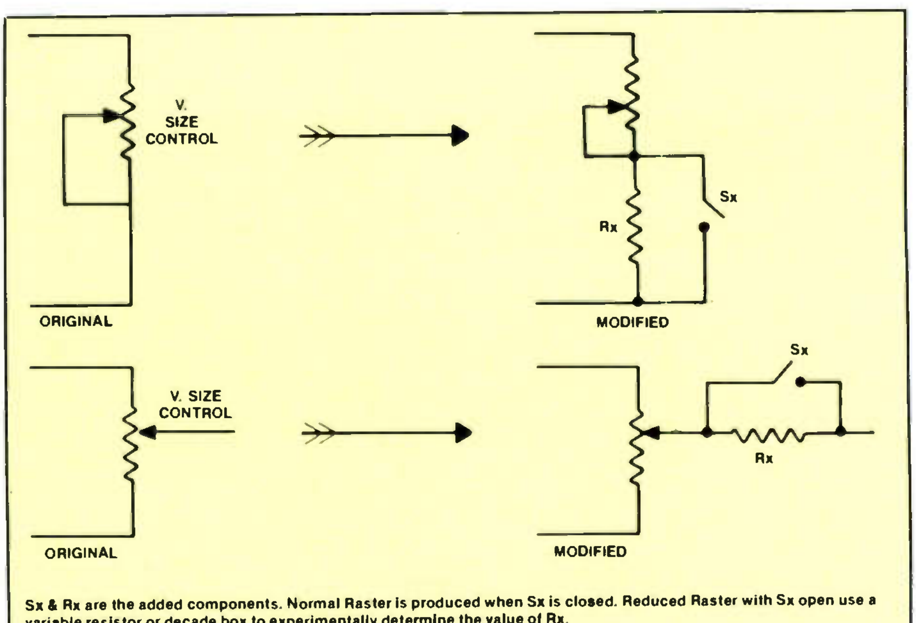


Figure 2

sure this signal is present and is in phase with the video signal. The headswitching signal at pin 29 should lead the video signal very slightly (approximately 0.4 ms in the SP mode). If this headswitching signal is out of phase with the video signal, yet the vertical sync input is present, then IC501 is defective and must be replaced. To insure continued reliability in these Toshiba machines, always check that the ground screw to the reel motor is both present and tight.

Sync separator is problem

In an Emerson VCR755, this type of phase error became a useful troubleshooting aid. The complaint was no color and bad recording. Often, color problems are time-consuming to track down as there are a great number of defects which can kill color. On the test bench, playback was in black and white. However, when playing back a recording made on this Emerson, I was pleased to see a black and white picture and a headswitching line near the center of the screen. This symptom allowed me to isolate the problem to one small area, the sync separator, without lifting a test probe. One of the numerous signals necessary to produce color is horizontal sync, while vertical sync in necessary during recording to prevent the headswitching line from appearing on the screen. Thus, a sync separator fault would explain all the symptoms. Going to the sync separator of IC4001, pin 17, I found no signal. After making the standard volt-



Sx & Rx are the added components. Normal Raster is produced when Sx is closed. Reduced Raster with Sx open use a variable resistor or decade box to experimentally determine the value of Rx.

Figure 3

age checks, IC4001 was proved defective. A new chip cured all the symptoms.

Reducing height aids diagnosis

Failures involving the headswitching points can be difficult to troubleshoot because they closely resemble other faults. One thing that speeds up troubleshooting is to be able to view the area of the TV screen where the headswitching points should be. Special video monitors are available with this feature. Reducing the vertical height of your test bench TV is a less expensive method. With a moderately underscanned raster, the headswitching points of a normal machine will be visible at the bottom of the screen. I chose to install a resistor and switch combination in series with the TV's vertical height control. This modification allows me to select either normal or reduced raster (see Figure 3). Make sure to mount the switch on an insulated surface of the TV's cabinet and perform the standard AC leakage checks on the external portions of the switch before placing the set back into service.

The reduced height position is used when symptoms of incorrect headswitching points are encountered. Vertical roll or an unexplained line in the picture are two examples. If, with the switch in the reduced height position, the head switching points are not observed at their usual position at the bottom of the screen, then a defect in the headswitching circuit should be suspected. This is a quick check, as the VCR doesn't even have to be disassembled.

A test for headswitching problems

To prove whether an unexplained line on the screen is the headswitching points, perform the following test. First make a recording at the SLP speed. Next playback the tape and, while watching the unexplained line, enter the pause mode. If the line expands to a horizontal bar or if the playback picture breaks into two disconnected parts, then the line is definitely the headswitching points. Figure 4 gives some examples. Section A is the playback picture before entering pause, while sections B and C are examples of the picture while in pause.

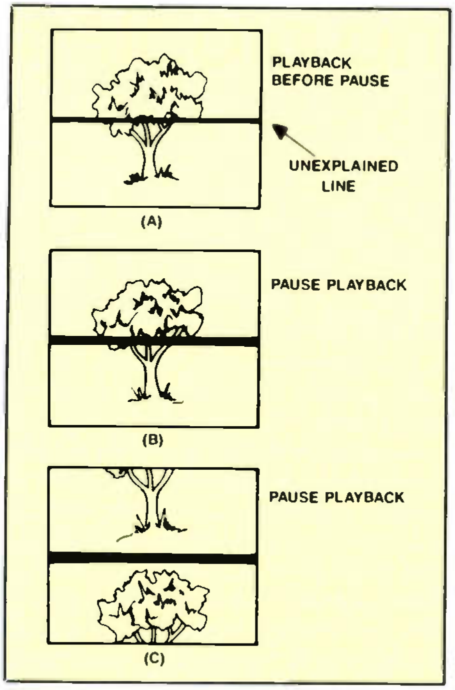


Figure 4

To understand why pause has this effect, recall that when in pause, the FM envelope often has one or more nulls or dropouts. Should a dropout occur in the vertical sync interval, the pause picture will lose vertical sync and may either shake or roll. To prevent this, the headswitching signal is used to generate a false vertical sync signal. During pause, the false vertical sync signal is mixed with the video output signal. False vertical sync is a wider pulse than normal vertical sync and therefore overrides normal vertical sync. This feature helps keep the pause picture stable, regardless of the location of any nulls in the FM envelope. Should the headswitching signal and the video signal be out of phase, then each field of pause video will contain two vertical sync pulses. One of these pulses will be visible in the screen. Depending on which pulse the TV's vertical circuits choose to lock onto, the TV display will resemble either B or C of Figure 4. Again, this is an extremely quick test to perform on any VCR as no disassembly is required. ■

Stereo phasing problems–part two

By John Shepler

Last month Audio corner talked about some of the characteristics of stereo audio, and some of the problems that can occur in stereo audio systems. This second and final installment describes how to use your oscilloscope to diagnose and correct stereo problems.

Telltale scope patterns

The most effective way to see phasing problems in an operating stereo system is with an XY scope pattern. Most scopes can be set to do this. It doesn't matter which channel feeds which input since the combined pattern is all that's important.

Figure 1. shows the important patterns. Pattern A is a pure monophonic signal. The X and Y axes of the scope are being driven in the same polarity at the same time so the pattern is a straight line at a 45 degree angle. If the line is straight, but not 45 degrees exactly, the balance of the channels is not exact.

Pattern B shows an out of phase mono signal. it is the exact reverse of the in-phase signal as you would expect. For tape sources, these lines may not be exactly straight. Tape jitter causes a fuzzy line.

Pattern C shows a normal full separation stereo signal. Expect to see a fuzzy ball on the scope. If the ball is constrained and tends to be more like pattern A, then you have stereo with poor separation. It is possible that one channel may be leaking into the other or the source material may be poor.

Pattern D shows a mono signal that is nearly 90 degrees out of phase. This indicates a phase problem in the system. Perhaps a capacitor has gone bad in a filter circuit. Another possibility is when long lines, such as phone lines, are used to carry a stereo signal. Both circuits should be the same length or the phase of the channels won't line up exactly.

Troubleshooting a system

A scope set on the XY pattern and an oscillator are about all you need to find most major stereo problems. A noise generator or mono program source can be used instead of an oscillator.

Connect the scope to the output of the system, and feed the oscillator into both left and right inputs at various points in the system. You should see pattern A even when you vary the

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

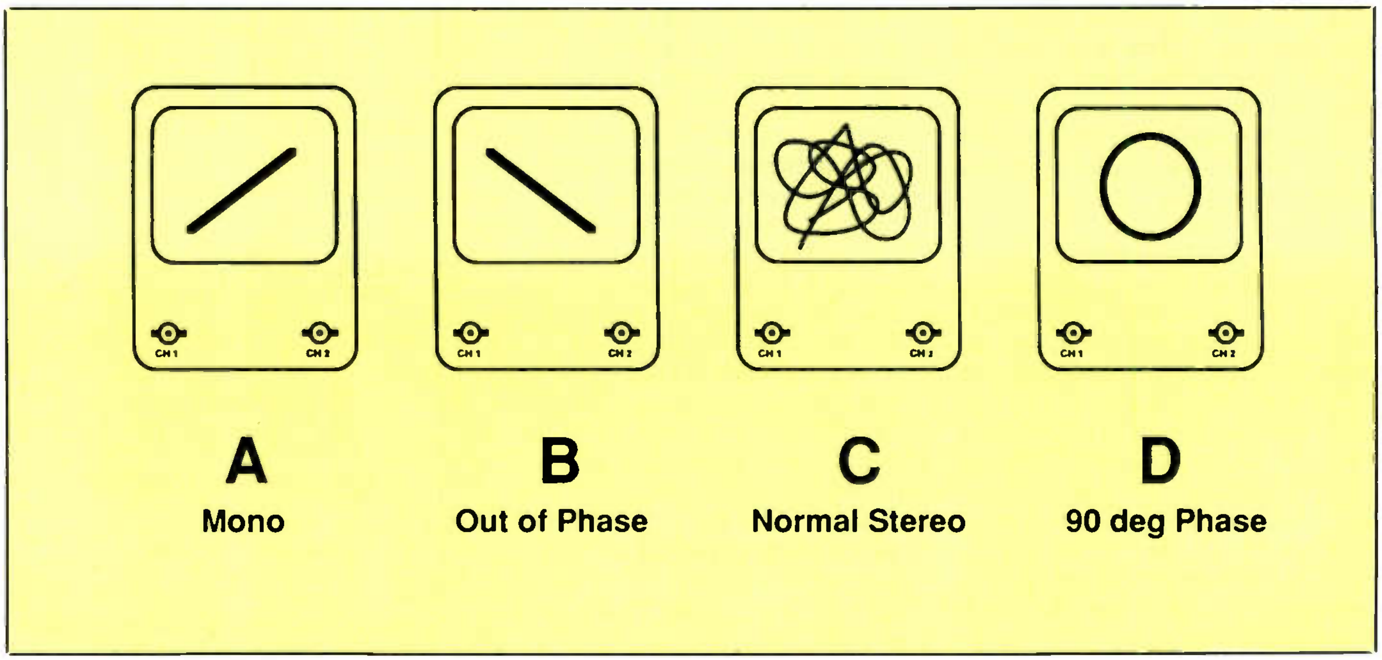


Figure 1.

frequency of the oscillator. Note that if you are going to connect the scope across speaker leads, it's possible to short out an amplifier if the hot lead gets connected to the scope chassis. Use transformer isolation or a balanced circuit input to the scope to prevent this.

If you find a phase reversal or degraded phasing, you can move the scope to the outputs of various pieces of gear, such as receivers, pre-amps, equalizers, and so on until the culprit is found. The scope can be used in the same manner inside the boxes when troubleshooting faulty circuits.

There is some unique audio circuitry in the field today, such as time delays, that may not look right on a scope depending on how they are adjusted. Equalizers, too, must have the same adjustment on both channels or they will appear out of phase. Dealing with this equipment requires some judgment as to whether it is working or not. Phasing problems are probably due to improper adjustment or wiring reversals.

Be especially careful around balanced audio systems. An unbalanced circuit usually won't work if the leads are reversed. A balanced circuit works just fine electrically. Any meters will read correctly and sound will come out of the speakers with no quality loss. However, the phase can just as easily be correct or reversed. This is especially true with microphones. Most are balanced with XLR connectors. It's too easy to reverse pins when connecting extension cables, so be aware of this weak point in the system.

Another common culprit is speaker leads. The reason one speaker wire is silver and the other copper colored is to help prevent phasing errors. When zip cord or some other wire is substituted, it is easy to reverse the signal and common leads.

Preventing phasing problems

The easiest way to prevent phasing problems is to use a color coding scheme for hookup. Even with this, though, mistakes are made at the factory and some equipment will show up new with one channel reversed. A quick bench check with your scope before installing any new equipment will prevent later troubleshooting headaches. You should also run quick phase checks whenever you install a new audio system. Even a mono system can have multiple microphones with reversed phases. This causes sound problems that are hard to isolate since they seem to come and go.

Become familiar with the scope patterns associated with stereo sound. You will develop a valuable troubleshooting tool and will be able to solve problems that baffle others. This will translate into fewer callbacks on your own installations and additional income fixing errors in other systems. ■

The importance of good housekeeping

By William J. Lynott

As a small electronics service dealer, you have several distinct advantages over the corporate bureaucracies that form some of your competition. For one, it is far easier for you to stay in tune with your customers—to be more responsive to their needs. Still, there are some important lessons to be learned from the big boys. Housekeeping for example.

If there is a universal trait in large corporations catering to the retail trade, it is in their meticulous attention to housekeeping. Retail professionals learned long ago that a sparkling clean environment is a positive influence on sales. Conversely, poor housekeeping makes a negative impression on customers—has a detrimental effect on sales.

In addition to its obvious effect on customers, I believe that housekeeping has a strong impact on both the productivity and the morale of those who are employed in the business.

Of course, few people would be inclined to argue with such simple logic; the problem is the difficulty of defining the standards that separate good housekeeping from poor housekeeping.

Working conditions

I remember visiting a friend some years ago who operates a sales and service business in New York state. I was dismayed at the working conditions I found in his operation.

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

Discretion dictated that I keep my observations to myself, but it was difficult to hold back. In showing me the shop area, my friend commented as to how shops are "always too small." But one look around revealed junk of every description stacked in total disarray around the room. Some of the old cartons, boxes and assorted trash had been around long enough to develop a heavy coating of dust.

In a quick estimate while still in the shop, I calculated that the productive area of that shop could have been doubled through no bigger an investment than one day's determined housecleaning and reorganization.

My friend's office was a tangled jumble of papers and work orders. While proudly pointing out what he considered to be the accuracy and completeness of this business records, he was struggling to put his hands on the ones he wanted to show me.

Instill the urge to buy

The sales floor, while more than adequate in size, was without pattern and lacked that squeaky-clean look that experts know helps to instill that urge to buy—a look that is virtually universal in the large retail chains.

Back in the shop, there was no attempt whatever to separate incoming goods from repaired goods, and both from goods awaiting parts or estimate approvals. All of this was evident from a visit in the shop of no more than five minutes or so. There was no question in my mind that a thorough look would have revealed a dozen specific ways in which efficiency—and therefore profitability—could be improved.

To be sure, that business is located in what might be described as a "blue collar" area. No doubt the majority of his customers are of moderate means. However, it is a serious mistake for any business person to assume that standards of cleanliness, quality of service, and the other things that a customer looks for are any less acute for the person of modest means than for his more affluent counterparts.

To get back to my original point, the small service dealer has a special set of advantages that his larger competitors would dearly love to share: personal relationships with customers, the ability to react quickly to changes in the marketplace, and a strong identification with the community.

Some service dealers instinctively know how to exploit these advantages; some do not. Even those who do, however, often fail to grasp the importance of taking a page out of Big Brother's book by muscling in on some of the ideas he has developed.

Cost-effective business technique

The concept of good housekeeping as a cost-effective business technique has been raised almost to the point of science by the large retail chains. A simple technique such as clean floors, they have learned, can actually help create an atmosphere conducive to a spending mood.

If you haven't noticed, take a look at the floors the next time you visit one of the chain department stores.

If they are tiled, chances are you will find them spotlessly clean and buffed to a high gloss. If the floors are carpeted, the vacuum cleaner will have recently been put to use.

Up to now, you may not have noticed this basic item on the full housekeeping agenda. You can be sure, though, that you have been impressed on a subconscious level.

These lessons have been put to use in the service centers of national chains as well. Most, as you may have noticed, are neatly laid out, with special attention given to those areas visible to the customer. Shops are functional, with careful attention to work flow and neatness. Some chain service centers have been designed so that repair shops, including the benches and the technicians are in full view of the customer.

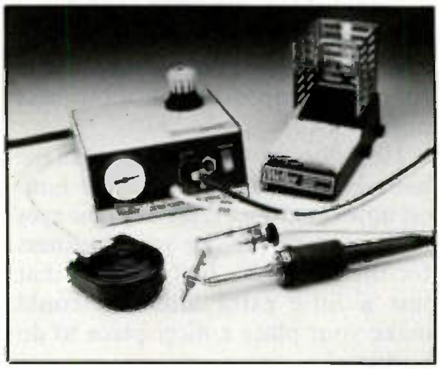
The physical appearance of a service operation is at least as important as that of a retail store when it comes to establishing customer confidence and trust. Yet many servicers fail to take advantage of this easy technique for overall improvement of business operations.

How does your business rate in the housekeeping department? Be honest now. Try to see it through the eyes of a customer seeing your business for the first time. Is it possible that just a little extra attention could make your place a nicer place to do business?

Products

Desoldering station

Controlled desoldering is enhanced with the new *Weller* DS500E "user-friendly" desoldering station. The table top unit features interchangeable "keys" that deliver precise temperature control to the iron tip to within 10°F. Switching transients that may damage voltage sensitive components are eliminated with zero



voltage circuits. A foot-activated switch controls vacuum from an exterior air system, while a cabinet-mounted gauge shows vacuum level. The easy-to-maintain station is equipped with an easy-to-clean collecting tube and optimal tiplet temperature control that meets MilSPEC DOD-STD-2000-1 specifications.

Circle (31) on Reply Card

Portable frequency counter

CG Instruments Corp. offers the Soar Model FC-863 battery powered frequency counter with a measurement range from 10Hz to 1.3GHz for

communications, telecommunications, maintenance and production line applications. The compact, portable 6-digit LED readout unit has two input channels and uses a prescaler measuring method to enable high accuracy measurements up to 15MHz (Ch A) and 1.3GHz (Ch B). Sensitivity is 15mV between 30 and 800 Mhz, and 25mV for the other frequency ranges. Through standard BNC connectors, the input is 1MΩ for channel A and 50j for channel B.

Circle (32) on Reply Card

Heavy duty DMM

A hand-held DMM, designed to survive the rigors of field service or general industrial applications has been introduced by *B&K Precision*.

The Model 2860, called the Survivor, which comes with a five-year limited performance warranty, is a is a 26-range, drop-, water- and overload resistant digital multimeter. The unit, featuring oversized 0.8-inch digits and a safety yellow case, is designed to withstand a five-foot drop and is sealed to keep out rain, grease, dirt and other contaminants. The meter features high-energy fusing and overload protection. Accuracy is within 0.5% dc, within 1.25% ac from 40Hz to 500Hz. Additional features are dc and ac measurements to 20A, resistance measurement to 20MΩ, audible continuity check, and diode junction test. ■

Circle (33) on Reply Card

Test your electronic knowledge

By Sam Wilson, CET

In each of the following questions, you are asked to test your recognition of basic equations used in electronics. You are also asked to identify the resulting unit of measurement when the units in the equation are given.

Only a super technician can get three or more correct.

Samples:

When V is in volts and I is in milliamperes, V × I will give the (a)__________in (b)__________.
Answer: (a) power; (b) milliwatts

When V is in kilovolts and I is in milliamperes, V × I will give the (a)__________in (b)__________.
Answer: (a) power; (b) watts

Wilson is the electronics theory consultant for ES&T

1. When C is in microfarads and R is in ohms, RC will give the (a)__________in (b)__________.

2. When L is in Henries and C is in microfarads, $1/2\pi\sqrt{LC}$ will give the (a)__________in (b)__________.

3. When f is in Hertz, 1/f will give the (a)__________in (b)__________.

4. When V is in volts and I is in amperes, V × I × sin θ gives the (a)__________ __________in (b)__________.

5. When f and bandwidth (BW) are both in Hertz, F/BW will give the__________. It has no units of measurement.

6. When the angular velocity is in radians per second and L is in Henries, angular velocity × L will give the inductive (a)__________in (b)__________.

7. When C is in farads and V is in volts, C × V will give the (a)__________in (b)__________.

8. When θ is in degrees, cos θ will give the __________. It has no units of measurement.

9. If you know R in ohms, then 1/R will give the (a)__________in (b)__________.

10. The reciprocal of X_C or X_L is called (a)__________, and the reciprocal of Z is called (b)__________.

Answers are on page 58.

Accessing ICs

(from page 13)

and ease of use then become important. Quality clips and adapters outperform alligator clips and hand-soldered wire, measured by any of these criteria. It is possible in some cases to access IC leads with fine tweezers and probes, provided you're able to hold them in place. However, doing this for several leads is time consuming and can be unreliable.

A good contact can be assured with a "wipe" connection. The "snap ring" design that slips over all four sides of an IC "wipes" as it is pushed down into position, wedging for a tight fit. These are designed to provide a 40-50 gram normal force against the contact, assuring a tight joint. When using a clothes-pin type clip, it's a good practice to "wiggle" it a little, providing the "wiping" action for a good contact.

Clip design counts, too

There is no doubt that gold plating makes the best contact. Most quality clips and adapters use gold-plated beryllium copper contacts or pins. Lower quality pins, perhaps nickel-silver, cost less and provide an adequate contact for many applications. Some clips now offer a roughened stainless steel coating on the contacts to penetrate oxide coatings on DIP ICs exposed to contaminated environments.

Test clips require some space for installation. If you're in a position to influence the design of the board as well as test it, get the manufacturer to leave some real estate around those vital chips you're likely to want to reach. Also, they should keep in mind when they're mounting the board that there is some height to test clips. Many test clip manufacturers provide this "footprint" information in their catalogs.

Keeping an inventory of test clips on hand, to match each of the package types you're testing, can save you time and money. They allow you to perform hands-free testing. They also can help you be more accurate. And doing a better testing job, quicker, at less cost, is what it's all about. ■

Answers to the quiz

Questions are on page 57.

1. (a) time constant
   (b) microseconds
2. (a) resonant frequency
   (b) kilohertz
3. (a) period
   (b) seconds
4. (a) reactive volt amperes
   (b) VARS
5. Q
6. (a) reactance
   (b) ohms
7. (a) charge
   (b) coulombs
8. power factor
9. (a) conductance
   (b) siemens
10. (a) susceptance
    (b) admittance

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Send your Readers' Exchange submissions to:

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

WANTED

Sams MHF (Modular High Fidelity) series books, the higher numbers preferred. *Bob Kramer, 919 Grove St., Aurora, IL 60505.*

Service manual for Emerson color TV, Model EC-131A. *Mitchell Electronics, 803 Sanders Rd., Port Orange, FL 32127.*

Sams Photofact folders, numbers 2299 through 2347, and number 2453 and higher. *H. Sievers, 2715 Rogge Ln., Austin, TX 78723; 512-928-4925.*

Heath 10A-4200 Time voltage module, either kit or assembled. *Sidney R. Creacey, 1358 Turquoise Ave., Mentone, CA 92359.*

Sams Photofact folders. Have some to sell or trade. Send a list of what you have to sell or trade and prices. *Johnnie Goggatt, R#2, Marshall, IL 62441; 217-826-5122.*

Schematic/service manual for Fieldmaster TR-16M and Lafayette HE-20D CB radios. Happily pay any charges. *Duff Campbell, Box 4371, Panorama City, CA 91412.*

$$$$ paid for very old scanning disk TVs by Jenkins, Baird, Western, others. Finder's fee available. *Mr. Hauff, Box 16351, Minneapolis, MN 55416.*

Sencore SC61, and/or any accessories. Also need Sams Photofact folders, numbers approximately 1500 through 2355. Also back issues of ES&T, years 1983/84/85/86/87, or any combination thereof. *Paul Carlson, 11201/2 W. Bristol St., Elkhart, IN 46514; 219-264-2147.*

Urgently require schematic and service info for 19" Hitachi color TV, Model CT-958, Serial No. T81001980, manufactured Sept. 1978. *Horace Pollack, 19923 Buhrstone Drive, Gaithersburg, MD 20879.*

VCR service manuals, new or used. Manufacturers' or Sams. Any quantity, all numbers. *Nancy Hauver, 34 Burlington Ave., Rochester, NY 14619.*

FOR SALE

Sencore VA62, VC63, EX231, original carton. Have 2, need only 1. Used very little. $2500. *405-623-8655. Ask for Verlen or George.*

B&K Precision 1248 Digital IC color bar generator, $110. Sencore CR 161 Auto-tracker picture tube tester & rejuvenator, $150. Sencore TC 162 Mighty Mite VII tube tester, $110 plus shipping. *Harry Young, 34 Appleton Dr., Brick, NJ 08723; 212-255-3193.*

B&K 415 sweep marker generator, cables and instruction book; $225 or best offer. Shipping extra. *Fred Sarg, 3306 First Road, Vero Beach, FL 407-778-0784.*

RCA dealer's stock of XL-100 and Color Trak modules, 1969-76; RCA service literature, RCA 10J103 color jig - all for $300, or will sell separately. *Heston, 1130 Dover St. NE, Cedar Rapids, IA 52402.*

Factory service data. Magnavox, 22 yrs., $500; Zenith, 10 yrs., $250; RCA, 11 yrs., $250; extra data free. *George Crouch, 4018 Lillian Dr., Concord, CA 94521; 414-682-8841.*

Beckman scope, model no. 9502, cursors and CRT readout, original carton, $800 plus shipping. B&K tube checker, model no. 667, all manuals, $50. ES&T magazines, back issues to 1981, $100 plus shipping. *L. Hypnar, 6408 E. Elis, Mesa, AZ 85205.*

Sencore TF46 "Super Cricket" transistor/FET tester, $95 plus shipping. RCA WV-500B solid state volt-ohmyst, $55 plus shipping. Both in excellent condition, and with manuals. *R.F.M. Service, 585 Marlu Drive, Pocatello, ID 83201. 208-233-9249.*

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

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