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August 1996

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ELECTRONIC

Servicing & Technology

Volume 16, No. 8 August 1996

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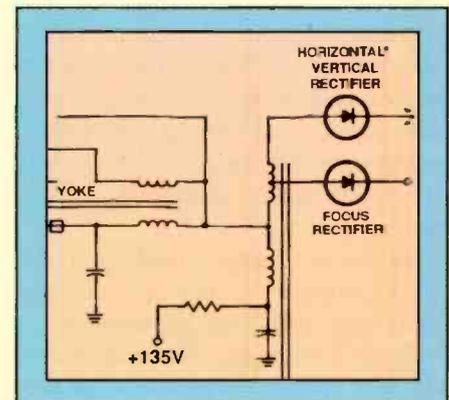
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With electronics today coming from a variety of manufacturers, it is often difficult for a servicer to keep abreast of all of them. But, whether you are dealing with an established company or a relatively unknown one it is still important to deal with a reputable company. The companies featured in the month's showcase will help you to make an informed decision about buying replacement parts you can feel confident about.



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ON THE COVER

No matter how good a technician is at diagnosing the cause of a malfunction in a consumer electronics product, unless a replacement part is available the product won't be restored to proper operation. The right distributor may make a big difference in getting the right part to the service center when it's needed. The Replacement Parts Showcase in this issue provides some useful information on what the various distributors have to offer. (Photo courtesy Herman Electronics)

ES&T editorial policies and procedures

Every once in a while we receive letters from readers that inform us that we haven't done enough to make our editorial policies and procedures clear. Since this department is at the front of the magazine and seems to be fairly well read, it would seem to be a logical place to restate some of those policies and procedures.

Policies and procedures

1. *Readers' Exchange.* Readers' Exchange is a free service that is provided for the convenience of readers. It is intended to be a forum where individual readers can buy and sell items related to consumer electronics servicing, and where they can arrange for exchanges of information. If a reader has a DMM, oscilloscope, or other piece of test equipment, tool, service literature, or replacement part that he no longer needs, he may advertise it to other readers in this department at no charge.

On the other hand, if a reader is in need of such an item he may advertise that need, at no cost, in this department.

This is not the place for companies to advertise products or services that they regularly offer as part of their business. Those items should be advertised in our classified or display advertising.

Keep in mind that items submitted to Readers' Exchange will take at least two months from the time they are received to the time they are published, and we make no guarantees that they will be published at all. If you feel that your item must absolutely be published by a certain date, paid advertising is the proper place in the magazine for it.

2. *Letters.* We receive a fair number of letters. Answering letters takes time and effort, and our editors are already overextended. If you send us a letter and would like a personal reply, it's only

common courtesy to include a self-addressed, stamped, envelope. That saves the editor the time to address a reply envelope.

Please keep in mind though, that many of the requests for information that we receive can be answered easily by looking in the Electronic Industry Telephone Directory, the Consumer Electronics Show Guide, or some other readily available resource. Please don't waste our time or your time with those questions. Have those resources available for yourselves. Just send us the tough challenges.

If you have a request for information about a company, product, etc., please state what you're looking for clearly and in some detail.

Please keep in mind, too, that except for articles credited to the ES&T Staff, the authors who write for ES&T are not employees of the magazine or the company that owns the magazine. They are for the most part independent consumer electronics technicians. A few are technical employees of companies that supply products to the service market.

So if you read an article by an author on a subject about which you desire further information and want to write a letter to that person, it would be better instead to send your letter to the editorial department and let them decide who should handle your request.

3. *Profax schematics.* **Electronic Servicing & Technology** is a monthly magazine. We publish technical articles that are aimed at assisting technicians, service managers and service center owners in the technical and business aspects of consumer electronics servicing.

We do not create any schematic diagrams of consumer electronics products for sale to our readers. The Profax schematics that we publish are reprints of schematic diagrams that are provided to

us through the courtesy of the manufacturers, as a service to ES&T readers. These schematics are available only as a part of the monthly issue in which they are bound.

Each year in the January issue we publish an index of Profax schematics that we have published in the past ten years. If the schematic diagram you're looking for is not on that list, either we have never published it, or it is more than ten years old, and is therefore most likely not available. If a Profax schematic is on that list and you wish to obtain it, it will be available only as part of that back issue of the magazine, if it is available.

Other possible ways to obtain the same service information are:

- Manufacturers' service literature (usually available through electronics distributors).
- Howard W. Sams & Company Photo-fact (available from Sams Company or a distributor).
- An item in the Readers' Exchange section of ES&T requesting this information from other readers.

In general, we wish to state that we love to get calls, cards and letters from readers. It's a great way for us to learn what's going on in the world of consumer electronics service and to keep us on our toes. We especially enjoy the complimentary letters that tell us that we're doing a great job. But we also appreciate the critical letters that tell us where we're failing to get the job done, because those letters help us to make necessary improvements.

So keep those cards, letters, and phone calls, coming!

Nils Conrad Penam

Camcorders and projection TV post double digit sales increases for March

Camcorders and projection TVs posted double digit sales increases in March 1995, according to the Consumer Electronics Manufacturers Association (CEMA). While the overall video hardware category declined seven percent in March, CEMA expects the video category to do well for the year, reaching approximately \$16 billion in sales.

Camcorder sales rose 12 percent in March. Dealers opted for compact models (up 22 percent) over full-sized units (down 31 percent).

Projection TVs rose a solid 28 percent in March. The market was strong across all screen sizes with 55 inch and larger models accounting for 14 percent of sales. Color TV sales fell nine percent, however, sales of sets 25 inches edged four percent and 10 percent gains for March 1995 respectively. Large screen TV sales totaled \$2.2 million.

Stereo VCRs proved loyal winners in March with sales increasing 19 percent to 494,000 Monaural decks dropped 19 percent on volume of 691,000.

The Consumer Electronics Manufacturers Association is a sector of the Electronic Industries Association (EIA), the 72-year-old Arlington, Virginia-based trade association representing all facets of electronics manufacturing. CEMA is the new name of EIA's Consumer Electronics Group (CEG). CEMA represents US manufacturers of audio, video, consumer information, accessories, mobile electronics and multimedia products.

Camcorders sales increase

As consumers prepare for upcoming summer weddings and graduations, camcorders sales are taking the high road, posting a four percent increase in the first four months of 1996 over the same time period in 1995, and an eight percent increase for April alone, according to the Consumer Electronics Manufacturers Association (CEMA). Overall video sales were down 10 percent in April compared

to April 1995 numbers.

"Videotaping with camcorders is one of the best ways for consumers to capture memories," said Robert Scaglione, director of product planning, Audio/Video Division, Sharp Electronics Corp. "Today's more advanced camcorders are easier to handle and operate.

They can take truly exceptional, crystal clear pictures."

Camcorder sales were up for the second straight month, rising eight percent in April. Full-size and compact sales registered gains of nine and eight percent, respectively. Full-size models accounted for 14 percent of overall sales.

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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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VCR sales slipped 12 percent in April, but were up one percent in the first four months of the year. Monaural decks accounted for most of the decline, falling 24 percent. Stereo VCR sales were up 15 percent in the month and 20 percent in the year-to-date on sales of 1.42 million units.

Color TV sales fell 11 percent in the month and were off nine percent in the year-to-date. Larger screen sets (25 inches and larger) outperformed the TV market as a whole, rising five percent over April 1995, and climbing four percent in the year-to-date to 2.84 million units. Sales in the 13 inches and smaller category were down sharply in the month and eight percent in the year-to-date. The slowest area continues to be mid-range 19-inch and 20-inch sets where sales fell 24 percent through the first four months of the year, totaling 1.97 million.

Projection TV sales were flat compared to April of last year due entirely to a 26 percent drop in sales of models 49 inches and smaller. Total sales maintained a 15 percent edge in the year-to-date. Sales of projection models 50 inches and larger jumped 27 percent in the month and were up 25 percent in the year-to-date.

TV/VCR combination sales were down 13 percent in April, including a 21 percent fall in the 13 inch and smaller category and a three percent dip in dealer purchases of 19 inch and larger models.

Audio hardware shows renewed strength, posting half billion in sales for February

Audio hardware sales totaled more than a half a billion dollars in February, according to the Consumer Electronics Manufacturers Association (CEMA). While February 1996 audio sales still fell almost 13 percent compared to February 1995's numbers, the sluggishness seen in overall US retail sales during the end of 1995 and the beginning of 1996 seems to be relenting based on recent reports. The Commerce Department reported retail sales at household appliance, stereo, TV and computer stores rose 10 percent in

February, and total US retail sales were up five percent in March.

"A more confident consumer is helping retailers trim inventories to levels which should spur a faster pace of dealer purchases," commented Todd Thibodeaux, CEMA's senior economist.

Separate components posted increasing sales, rising seven percent in February. Receiver sales rose 16 percent in the month to \$46 million. Power amplifiers scored with sales of \$3.4 million, up 44 percent from February 1995. Sales of CD players were off 19 percent to \$26 million.

Segments of the audio systems market regrouped in February, recording solid increases such as compact CD changer systems with sales of \$67 million, a gain of nine percent. Compact systems with a single CD player or no CD player dropped by more than half from February 1995. Rack system sales totaled \$20 million, down 32 percent.

Aftermarket autosound sales fell 14 percent in February. However, dealers increased their purchases of CD changers by nine percent to \$20 million and speakers by 30 percent to \$29 million. Sales of in-dash CD head units totaled \$36 million for a loss of five percent.

The portable market fell 18 percent due to drops in the sales of personal portable (down 10 percent to \$35 million) and boombox CD players (down 25 percent to \$50 million).

Separate component sales boost 1995 audio volume

The Consumer Electronics Manufacturers Association (CEMA) announced that sales of home, portable and car audio products rounded out 1995 with a three percent overall gain, posting combined volumes of more than \$8.3 billion. Audio equipment sales for 1996 should close in on \$9 billion.

"As our industry has developed more and more high-quality product innovations, placing ever increasing expectations for higher performance, our growth has been fueled by our customers' appreciation of the value our products bring to



the market at very competitive prices. We expect this trend to continue as we introduce even more advanced products to the market," said Ed Mims, director of sales and marketing for Cerwin-Vega, Inc.

Separate component sales were up 21 percent during the holiday season, ending the year with a 13 percent gain. CEMA expects this category to fare even better in 1996 with more than \$2 billion in sales. Surround sound processors (A/V amps and receivers) recorded sales of \$503 million in 1995, up 23 percent. CD player shipments were flat at \$440 million. High-capacity CD players (10 or more) saw sales double in 1995 to \$65 million. Cassette deck volume was down sharply to \$149 million, while home theater speakers posted sales of \$266 million, up 137 percent over 1994.

With almost \$2.8 billion in sales, portable audio equipment sales were down less than one percent from record sales in 1994. Table, clock and portable radio sales were off seven percent for the year to \$284 million. Weak sales of CD boomboxes, throughout 1995, was the primary reason for the overall decline. Despite a seven percent drop, however, CD boomboxes still recorded sales of more than \$1 billion.

Total sales of cassette boomboxes fell 13 percent to \$215 million, despite a three percent sales gain for three-piece models. Cassette tape recorders, and especially microcassette formats, posted solid numbers in 1995, rising eight percent of volume of \$218 million.

Aftermarket autosound sales rose three percent, totaling \$1.9 billion in 1995. Sales were erratic for most of the year, rising sharply one month only to fall sharply the next. The speaker side of the market finished the year strongly with sales of \$353 million, up one percent over 1994 and posting the first annual gain since 1992. Head units, CD player and amp sales were up two percent overall. Shipments of head units dropped an abrupt 12 percent in 1995 but were offset by a 23 percent gain in CD head dollar volume. CEMA projects aftermarket

autosound to hold steady overall in 1996, posting sales of nearly \$2 billion.

Dollar sales of compact audio systems were up five percent in 1995, including a 21 percent increase in shipments of multi-play CD models and an eight percent gain in units equipped with surround sound. Rack system sales totaled \$294 million in 1995, down 13 percent from 1994.

Consumers want CD-quality radio according to latest CEMA survey

Nearly one-third of Americans are interested in having a car radio which could receive Digital Audio Radio (DAR) signals, according to a recent survey by the Consumer Electronics Manufacturers Association (CEMA). And, more importantly, almost half of those surveyed would be willing to pay up to \$100 above the price of a car radio for one equipped with DAR capabilities.

In a survey of 400 randomly chosen consumers in Florida and another 400 randomly chosen consumers from across the US, 13 percent of respondents were interested in DAR for their car radios. DAR interest was slightly higher among males than females (35 percent for male vs. 28 percent for females). DAR interest was highest among younger consumers (25 and younger) and declined with age.

Fifty-seven percent of younger consumers would pay up to \$100 extra for DAR capabilities compared to 25 percent of older consumers (age 56 and over). A larger number of Florida consumers on the whole were willing to pay extra for such a radio.

In a 1994 survey by CEMA, 33 percent of 1,000 nationwide respondents had said they were interested in having a home radio with CD-quality sound, with 47 percent of the 25-and-under crowd interested in DAR for their home radios. In the same 1994 survey, 21 percent of respondents wanted DAR capabilities for their portable radios.

The 1996 survey was formulated by the EIA market research staff and fielded by

the Verity Group of Fullerton, CA during the month of March. All results have a margin error of +/-4 percentage points.

Comparative evaluations of nine DAR systems from five proponents currently are being undertaken by CEMA's DAR subcommittee and the National Radio Systems Committee's (NRSC) Digital Audio Broadcast (DAB) subcommittee. Laboratory results from the testing were released in August 1995. CEMA expects field testing of the systems to begin this spring in San Francisco. The overall objective of this testing process has been to help insure that the US adopts a new CD-quality radio service that will meet the needs of the public to the greatest extent technically possible and that this service will be available in the near term.

TIA debuts world wide web site

The Telecommunications Industry Association (TIA) announced the debut of Communications OnLine, the organization's new World Wide Web site. TIA's home page will allow Internet users to become better informed of TIA, its activities and communications industry. The web site located at <http://www.industry.net/tia> will offer information to the general public and for members only.

Web browsers can now access information on the standards setting activities of TIA's engineering committees, association newsletters, press releases, buyer's guide and membership directory, industry calendar of events and points of contact in the international telecommunications arena. Communications OnLine also features information on upcoming TIA-sponsored trade shows, including SUPERCOMM '96 and Americas TELECOM '96. Position papers and telecom legislative updates will be placed online regularly as well as global telecom market information. TIA's home page will also provide links to relevant web sites such as those of the Federal Communications Commission, World Bank, US Congress, Asia Development Bank and TIA member companies. ■

An introduction to logical troubleshooting

By William L. Call

As working technicians know, "time is money" is a true adage in servicing. The successful servicer is one who is able to quickly and efficiently diagnose and repair a failed product. Experience is a wonderful teacher, but even an experienced troubleshooter works best if the diagnosing is done in a logical manner.

The purpose of this article is to describe a logical approach to troubleshooting. The experienced technician will recognize (and, it is hoped, agree with) the suggestions given. The novice should benefit by becoming more organized and capable in his approach.

I take no credit for originating these suggestions, I've learned them from others, but have confirmed the value of the logical approach through years of my own experience. Perhaps seeing these suggestions named and described will help technicians with future work.

The shotgun approach

My favorite way of describing an inefficient approach to troubleshooting is to use the example of a service center where I used to take my car. The mechanic didn't take any notes when I described to him what was wrong with my car. He would just catch a key word or two and say, "O.K., we'll replace this part, and if this doesn't fix it we'll replace that part, and if that doesn't fix it we'll replace...." Of course, he would leave all of the new parts in and charge me for them even if they weren't needed!

We call this method the "substitution" method, preceded with a little bit of "symptom-function analysis". This approach is valid and even appropriate in some circumstances, but it seemed to be the only approach this service center knew. Eventually the problem would be fixed, but often it takes longer and presents a much higher cost to the customer. I now use service centers that take a more



logical approach. They only replace the part that was causing the problem.

The orderly approach

It's the same with electronic work. Troubleshooting shouldn't be just dumb luck, or a "shotgun" approach of trial and error. The more you understand a circuit or product, the easier it is to fix.

Training and experience become important factors in your speed and success. But good logical troubleshooting techniques increase your speed, and make it possible to fix many things that you haven't seen or been trained on before, and in some cases even without diagrams or powerful instruments. (This is not to lessen the importance of any of these things, but to state how significant the

proper troubleshooting techniques are.)

There are several basic techniques that are used when troubleshooting electronic equipment. Which one you use depends on the circumstances. It is possible to begin work on something by measuring dc voltages, or by swapping parts; but we need to find the best technique to use for the problem at hand. (Advanced techniques requiring specialized equipment are not discussed in this article.)

Step one: get all the information about a unit's failure that you can

It's important to ask the customer questions about a unit's failure so that you can begin formulating ideas of how to begin work. Realize, of course, that the customer isn't (usually) an expert on electronic

Call is an associate professor of electrical engineering technology at Murray State University.

systems; they may not describe symptoms accurately or completely, and may be reluctant to admit doing something foolish to the equipment. Any information you do get can be a big help. Write down all significant facts, especially if you're not going to be working on the equipment right away.

There are two areas where troubleshooting is very difficult without customer observations: when the failure is intermittent, or when it is caused by external interference. Unless you have data to correlate circumstances and failure symptoms, you may not be able to duplicate the failure in the service center, or know when you have fixed it. So if a problem is not continuous, make sure you get full details about the circumstances of failure.

Suggested questions to ask:

1. What is really wrong, and how is this defect apparent? (Describe fully what isn't working properly—a statement of "it's broke" isn't very helpful.)

2. Is it always this way, or if it's intermittent, under what conditions? (For instance, if failure is related to movement you might have a mechanical failure to look for, such as a loose connection or dirty contact in the set. If external circumstances are indicated, the set might be good, and the cause of the problem may be elsewhere.)

3. Was there any abuse? (A vibration or sudden shock that might have broken connections. Was it exposed to extreme heat or a nearby lightning strike that could have burned out semiconductors?)

4. Did the defect occur suddenly or gradually? (Gradual failure may indicate adjustments are needed to correct for aging. Sudden failure usually means a part is defective.)

5. Did the defect occur during equipment operation? (If a set worked before being stored but now has trouble operating, components such as electrolytic capacitors might have deteriorated, or control contacts might have oxidized.)

6. Any additional details? (Look for anything related, such as other functions that don't work, or other circumstances that might have contributed to the failure of the product.)

7. Has anyone tried to fix it? (If they have, realize that the first effort may have produced additional problems that you will have to find and fix, perhaps unusu-

al problems such as parts in backwards, or wires connected wrong.)

8. Is there any service literature available? (Not many systems these days come with service manuals or schematic diagrams, but it's worth asking for.)

Step two: preliminary observations

Before actually starting to work on the unit with instruments, take time to perform two preliminary steps:

1. Try to duplicate the failure yourself, to improve and refine the reported symptoms, as well as confirm them. Particularly in the case of intermittence, try to make the failure symptoms come and go with pushing, shaking, twisting, etc., of the set, circuit boards and cables. Check the operation of panel controls.

2. Use your eyes, ears, nose, etc. to physically inspect the set. Take time to look for burned or broken components, wire leads or PC foil, bad solder joints, foreign objects, or anything abnormal.

Often during this examination you can locate a problem with little thought or instrumentation work, or a need for diagrams. Several times when I have skipped this step, I have eventually tracked a problem to a bad component which was visibly bad and something I could have spotted with a quick inspection if I had just taken the time to do it.

It is helpful to power the set up and use your senses to look for abnormal behaviors such as smoking, components that are too hot, popping or arcing noises, etc.

A rough test for excessive temperature is the "five-second rule": you should be able to hold your fingers on most electronic components comfortably for five seconds or more. Be careful when performing this test, both for electrical hazards and for being burned: keep the other hand behind your back, and touch gingerly. Moreover, some components are designed to operate normally at temperatures that will cause burns to human skin, so be aware of such situations.

Step three: apply the most efficient troubleshooting technique

There are five basic troubleshooting techniques. Several will probably be utilized during the course of the job. They are, 1) symptom-function analysis, 2) signal-tracing and/or signal injecting, 3) voltage-resistance measurements, 4) sub-

stitution of components, and the 5) statistical or historical method.

Symptom-Function analysis

Symptom-function analysis analyzes the failure symptoms, considering the function of each stage of the system while doing so and how a failure of that stage would be evident in symptoms. Usually this technique is used first to narrow the scope of the problem and to decide which technique to use next. The "input" to this analysis comes from the reported failure symptoms, preliminary observations, and your knowledge of the system (the only "instrument" used is your mind).

For an easy illustration of what is meant by symptom analysis, consider a home stereo receiver with no output from the left speaker, but good output and normal radio reception from the right speaker.

The observed failure symptoms point to a defective left-channel audio amplifier, since all other stages are apparently working properly and only that stage's failure would produce this set of symptoms. In other words, your analysis of the failure symptoms would lead you to perform additional testing on the left-channel audio amp, bypassing other sections.

In this example, symptom-function analysis quickly narrows the scope of troubleshooting. It's not always that easy. Suppose a similar receiver produces output on both speakers, and the AM reception is normal but in FM mode only a few nearby stations are weakly heard.

Symptom-function analysis would tell you that all stages used for AM reception are probably good, and the problem is probably in a stage only used for FM, and is likely a "low gain" situation somewhere. There are quite a few stages and components with this function. The scope of your troubleshooting is narrowed, but not to one stage yet.

Signal-tracing and/or signal injecting

Either start at one end and follow the signal path to the other, using suitable signal-monitoring and signal-injecting instruments; or start in the middle to sectionalize, which is called "half-splitting" or the "divide and conquer" approach.

The customer's answers to your questions, and what you found in symptom-function analysis, will help you to know

where to start. As you are tracing, when the signal disappears or has an improper change in level you have located the area of the failure. Additional testing or substitution is often used to find the actual defective component.

For audio or low-frequency ac circuits, an oscilloscope is usually the best instrument for signal tracing, since voltage level and signal quality are both quickly known. Sometimes a "signal tracer", which combines an ac voltmeter with an audio amplifier and monitoring speaker, is a good choice. RF signal tracing is more difficult, and often signal injection with a modulated signal generator coupled through a dc-blocking capacitor, and monitoring the output of the set, is easier.

Well-equipped service centers find a spectrum analyzer with a high-impedance probe a powerful instrument for RF signal tracing. While measuring ac amplitudes through cascaded stages, keep in mind that impedance level changes produced by transformers or transistors may produce level variations that are normal.

Digital signal tracing is done either with a dc-coupled oscilloscope, a "logic probe", or in advanced service centers, a logic analyzer. Signal-tracing through systems with feedback loops calls for careful consideration; a failure anywhere in the loop causes all measurements in the loop to be abnormal.

Signal tracing feedback circuits

There are two approaches to signal-tracing feedback circuits: (1) if possible, disable the feedback so the circuit can be treated as an open-loop system, keeping in mind that this may raise the gain or alter operation significantly; (2) break the circuit into small subcircuits so you can predict the behavior of and check each subcircuit's output for a known input (which you may need to inject).

Circuits with feedback are really quite common: audio amplifiers use negative feedback to reduce distortion, radio receivers use AGC to hold the output level constant, frequency synthesizers use feedback to reference the output frequency to a master standard, etc., and these circuits can be challenging to troubleshoot.

Voltage-resistance measurements

For this technique make measurements

of dc voltages or ac signal levels, or resistances in the circuit, and compare them to service data or to another set. Testing power-supply voltages (including the outputs of any low-voltage regulators) should be among the first measurements made. Use the results of symptom-function analysis and/or signal tracing to narrow the search for abnormal voltages or resistances to a particular stage, as this testing can be tedious.

Resistance testing can be tricky since different sets (assuming solid-state) often respond differently to different ohmmeters (their excitation voltage and current levels differ). It's possible to make rough tests on capacitors and inductors, as well as resistors and transistors and diode junctions, if correct procedures are adopted to test components individually. Remember that the set power must be OFF for resistance testing! I've found that a productive method in many cases is to use a DMM set on the "diode test" range, and to quickly test diode and transistor junctions in a suspect stage, connecting probes to forward-bias the junctions.

A normal reading for a good silicon forward-biased junction is 0.5V to 0.9V (also $k\Omega$), if your meter sets up a diode test properly), and any readings significantly different than this should be investigated. Components in the circuit, such as transformer windings or low-value resistors, can mask the true value of a junction's resistance, so desoldering of a lead may be required for a final test.

If you are trying to repair a set without a service manual, junction-testing to find an open or shorted semiconductor junction may be one of the only ways to proceed. For bipolar transistors, you should also test the collector-emitter path to make sure that a "punch-through short" hasn't occurred; you might miss this if only the base-emitter and base-collector junctions were checked.

Components substitution

Try swapping questionable parts with new (or known good ones). This is easy for plug-in parts (tubes, socketed IC's, daughter-boards), but harder for soldered-in components, so use this method only if you're almost sure, or stumped and resorting to shotgun-swapping. Remember to note the component orientation,

and observe good static-electricity control measures when trying the procedure.

Statistical or historical method

This method uses symptoms as a start, consider likely failures from a historical database, and jump to component testing and/or substitution. It's a particularly valuable technique when you work on a given product often, or have access to a historical database. One of the factors that make an experienced troubleshooter so much faster at repairing equipment is that he has a historical database in his mind of failures he has tracked down in the past. Some technicians even compile their own written database.

If you get stumped

If you get stumped trying to repair a product you are unfamiliar with, it can be very helpful to consult someone more experienced, or, if available, call the manufacturer's technical support department.

For some products (VCR's, for example), "case history" databases of symptoms/ cures are available for purchase. Another way that the statistical method is useful is to remember that those components that are highly stressed are the most likely to fail. Components most likely to be stressed are PA (Power Amplifier) devices or power-handling circuits like voltage-regulators, or any input/output devices, since their external connection wiring exposes them to external voltage transients or load shorts. Audio PA's in receivers are therefore doubly suspect, as are many power-supply components; also, RF PA's in transmitters.

Applying this logical approach should make troubleshooting more efficient. There are a number of full-length books on the market which discuss these techniques and others in detail, and give numerous helpful examples. You may find these useful for further study. Here is a list of some of the books that I have found most valuable:

Tested Electronics Troubleshooting Methods, second edition, by Walter H. Buchsbaum; Prentice-Hall, 1983.

The Complete Guide to Electronics Troubleshooting, by James Perozzo; Delmar Publishers, 1994.

Electronic Troubleshooting Procedures and Servicing Techniques, by J. A. Sam Wilson; Prentice-Hall, 1990. ■

Manufacturers on the network

By Victor Meeldijk

The growth in the past few years of the number of entities that have home pages on the Internet has been phenomenal. If you log onto the Internet and look around you'll find newspapers, magazines, television stations, cities, movies, schools and a lot more with their own sites. Some of these sites have a great deal of useful information, some are relatively useless.

Many companies of interest to readers of this magazine have their own web site. Some readers have already found many of them. The following is a partial list of websites operated by manufacturers that are of interest to consumer electronics servicing. Also included are e-mail addresses. We hope you find it useful.

Manufacturers on the Internet

Actel Corporation

Internet: <http://www.actel.com>
E-mail: tech@actel.com

Advanced Hardware Architectures, Inc. (AHA)

<http://www.aha.com>

Advanced Micro Devices, Inc. (AMD)

<http://www.amd.com>
<http://www.amd.com/html/locations/hq.html>
<http://www.amd.com/html/locations/locations.html>

Advanced RISC Machines (ARM)

<http://www.systemv.com/armidtd.index.html>

AITech International, Inc.

Internet: info@aitech.com
sales@aitech.com
<http://www.altech.com>

Allegro MicroSystems, Inc.

(prior to 12/90, was Sprague Semiconductor, now owned by Sanken Electric Co. Ltd.)
<http://www.allegrosys.com>

Altera Corporation

BSDL (boundary scan) files on BBS
408-954-0104
<http://www.altera.com/html/products/>

American Precision Industries

Delevan/SMD Divisions
<http://www.delevan.com>
E-mail: apisales@delevan.com

AMP, Inc.

<http://www.amp.com>
<http://connect.amp.com>

Analog Devices

Internet: [ftp ftp.analog.com](ftp://ftp.analog.com) or <ftp://137.71.23.11>, log in as anonymous then use your Email address for your password.

Applied Laser Systems (ALS)

Email: ALS@cdsnet.net

Applied Micro Circuits Corporation (AMCC)

E-mail: pciinfo@amcc.com
<http://www.amcc.com>

Applied Microsystems Corp.

<http://amc.com>

Aptix Corp.

sales@aptix.com

Ariel Corporation

E-mail: ariel@ariel.com
<http://www.ariel.corp>

Aries Electronics

<http://www.arieselec.com>

Astec America, Inc.

<http://www.wwww.astec.com>

Atlanta Signal Processors, Inc. (ASPI)

BBS: 404-892-3200 (8,N,1)
Internet: info@aspi.com

Benchmark Microelectronics, Inc.

<http://synapse-group.com/Benchmarkq/>
<http://synapse.onramp.net/benchmarkq>

Berg Electronics, Inc.

<http://www.bergelect.com>

Blue Sky Research

BlueSky@ix.netcom.com

Brooktree Corp.

<http://www.brooktree.com>

Butterfly DSP, Inc.

email: mflemin@pacifier.com (to Mike Fleming VP Eng)

Caig Laboratories, Inc.

<http://www.caig.com>
caig123@aol.com

Cardinal Components

BBS: 201-812-7082
<http://cardinalxtal.com/home/cardinal>
E-mail: cardinal@cardinalxtal.com

Carroll Touch, Inc

BBS: 512-388-5668 (300, 1200, 2400 Baud N81)

Cherry Semiconductor Corp.

Internet: info@cherry-semi.com

Chip Express Corporation

email: moreinfo@Chipx.com
<http://www.elron.net/chipx/>

Circuit Repair Corp.

<http://www.circuitnet.com>

Cirrus Logic Inc.

<http://www.cirrus.com/>

CN Software Inc.

<http://www.cns-nj.com/cnsoft>

Comlinear Corp.

<http://www.compdist.com/cdi>
Internet: clc_apps@cc.com

Corcom

<http://www.cor.com/home.html>

Crosspoint Solutions, Inc.

E-mail: info@xpoint.com

Meeldijk is the Reliability/Maintainability Engineering Manager Diagnostic/Retrieval Systems, Inc. Oakland, NJ.

Crystaloid
E-mail: crystaloid@aol.com

CTS Resistor Networks
<http://www.fwi.com/cts>

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Cypress Online (quarterly Newsletter)
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Cyrix Corp.
Internet: tech_support@cyrix.com
BBS: 214-994-8610 (2400, 9600, 14.4K, 28.8K baud)

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<http://www.industry.net/data.instruments>

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<http://www.dec.com> or
<http://www.digital.com> (PCs)
<http://www.digital.com/info/semiconductor>
e-mail: semiconductor@digital.com or moreinfo@digital.com

DSP Development Corporation
<http://www.dadisp.com>

DY 4 Systems, Ltd.
Email: sales@dy4.com (sales support)
support@dy4.com (product support)

Ecliptek Corp.
ecsales@ecliptek.com
WWW: <http://www.ecliptek.com/ecliptek/>

EIA
Electronic Industries Association
<http://www.eia.com>

Electron Tubes, Inc.
Email: phototubes@aol.com
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Harris Semiconductor
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Home Page: <http://www.semi.harris.com>
Technical Assistance E-mail: centapp@harris.com

Hewlett Packard
<http://www.hp.com>

Hitachi America, Ltd.
Semiconductor and I.C. Division
<http://www.hitachi.co.jp/>

Honeywell Solid State Electronics Center (SSEC)
<http://www.ssec.honeywell.com/>

Huntsville Microsystems
<http://www.hmi.com>

IAC Industries
e-mail: iacind@earthlink.net
<http://www.marketlink.com/iac/index.html>

IBM Corp.
<http://www.chips.ibm.com>

I-Cube, Inc.
BBS: 408-986-1652
Internet: marketing@icube.com

ImageNation
Email: info@ImageNation.com
<http://www.ImageNation.com/~image>

IMP, Inc. - International Microelectronic Products
<http://www.impweb.com>

Integrated Circuit Systems, Inc. (ICS)
<http://www.icsinc.com>

Integrated Device Technology, Inc. (IDT)
<http://www.idt.com>
FTP Server: Acrobat index:
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Text Index: <ftp:ftp.idt.com/pub/index>
E-mail: info@idt.com

Integrated Systems
<http://www.isi.com>

Integrated Telecom Technology, Inc. (IGT)
<http://www.igt.com>

Intel Corp.
Internet: <http://www.intel.com>
<http://www.intel.com/embedded/i960/>
(for the i960 processor)

Intellon Corporation
BBS: 904-237-8841 (9600,8,N,1)

International Power Devices, Inc. (IPD)
ipdsales@ipd-hq.ccmail.compuserve.com

Interpoint Corp.
E-mail: power@intp.com

Iomega Corporation
<http://www.iomega.com>

Ironwood Electronics
<http://www.cera.com/ironwwwx.htm>

Jerome Industries Corporation
E-mail: jeromeIND@aol.com

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<http://www.kepecopower.com>

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Maxtek Components Corporation
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www.mchip.com/microchip

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E-mail: prodmtkg@micron.com
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<http://www.mei.micron.com>

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E-mail: micrnet@aol.com

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<http://www.molex.com>

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<http://www.moselvitellic.com>

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E-mail: mosis-help@misis.edu

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<http://www.powertrends.com/isr/>

Programmable Logic Performance Corporation

<http://www.prep.org>

Projects Unlimited, Inc.

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Protek

<http://www.techexpo.com/www/hcprotek>

Pulse (formerly Pulse Engineering)

<http://www.pulseeng.com>

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<http://www.qualcomm.com/>

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<http://www.xmission.com/~qsi>

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MCI Mail ID: 4286653

QuestLink Technology, Inc.

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web server: <http://www.csn.net/ramtron>

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RCA

<http://www.nipper.com>

RdF Corporation

E-mail: sensor@rdfcorp.com

Real Time Devices, Inc. (rtd)

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<http://www.rell.com>

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(formerly called Rockwell Telecommunications)
<http://www.nb.rockwell.com>

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<http://www.ross.com>

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E-mail: sales@rtg.com

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<http://www.sbsdirect.com>

Semtech Corpus Christie

(formerly Lambda Semiconductor)
e-mail: NPSMTCHAD@AOL.COM

Siemens

<http://www.siemens.de/ec/ecb/ecb.htm>
(connectors and interconnect systems)

Sierra Research & Technology, Inc.

E-mail: cores@srti.com

Silicon Systems, Inc. (SSI)

A TDK Group Company
BBS: 714-544-6525 (14.4k BPS, if trouble call 714-573-6226)
E-mail: spd@ssil.com
<http://www.ssil.com>

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SPARC International
<http://sparc.com>

Spire Coropration
spire.corp@channell.com

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Components Products Division
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FTP: info.smc.com
Internet: chipinfo@smc.com
<http://www.smc.com/>

Sun Microsystems, Inc.
Internet: <http://www.sun.com/stb/>
<http://www.sun.com/sparc/Net.Engine>
<http://www.DACafe.com> (design automation cafe)

Supertex Inc.
e-Mail: prodinfo@supx.com

Symbios Logic, Inc.
E-Mail: symbios@saligent.com

Synergy Semiconductor Corp.
<http://www.synergysemi.com>
Internet: info@synergysemi.com

TDK
<http://www.tdk.com>

Tektronix
<http://www@tek.com>

Teradyne
<http://www.teradyne.com/icd>

Texas Instruments, Inc. (TI)
Semiconductor Group
<http://www.ti.com> (to get customized E-mail and product information, click on "Register Now")
<http://www.ti.com/sc/docs>
TMS320 Hotline: BBS: 713-274-2323.
email:
4389750@mcimail.com, Internet BBS
via anonymous ftp to
[ftp.ti.com\(192.94.94.3\)](ftp.ti.com(192.94.94.3))

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34223248

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DSP Internet via anonymous ftp to
(140.111.1.10) in
directory/vendors/TI/tms320bbs

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Email: info@2Dlabs.com

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<http://www.toshiba.com>

TriQuint Semiconductor, Inc.
Computing and Networking Division
E Mail: cust.serv@tqs.com

Valor Electronics, Inc.
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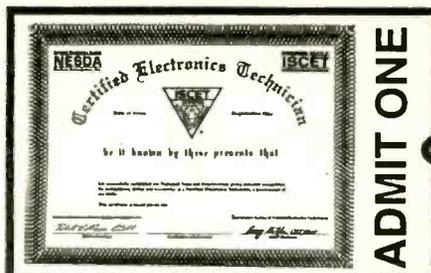
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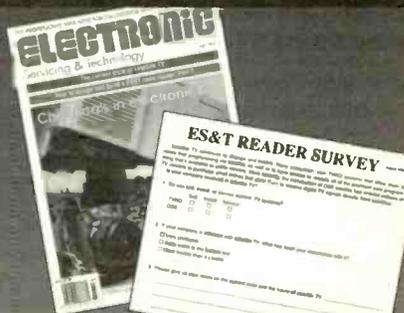
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A brief look at color television circuits - Part 4

By Lamarr Ritchie

Three earlier articles in this series have described most of the circuits in a typical color TV set. This fourth article wraps things up with a discussion of deflection circuits and the high-voltage section.

Deflection circuits

The deflection circuits, both horizontal and vertical, develop the scanning currents for the electron beam. The end device for both vertical and horizontal deflection circuits is the deflection yoke, which is situated around the neck of the picture tube.

The deflection currents are produced by oscillators. The two most popular types of oscillators used as deflection oscillators are the *blocking oscillator* and the *multivibrator*.

In transistor type deflection circuits, an emitter follower driver amp is often used to prevent loading of the sawtooth forming circuitry of the vertical oscillator.

Vertical deflection

The vertical deflection circuit example shown in Figure 1 illustrates two adjustments commonly found in the circuits. The vertical height control adjusts for the correct amount of vertical sweep. This example is adjusting the amplitude of the oscillator output voltage to do this. The vertical linearity control adjusts the linearity of the sawtooth, making sure the top or bottom of the raster is not stretched or compressed.

The vertical output stage may be followed by a vertical output transformer to match the impedance to the yoke. Most transistor vertical outputs do not employ a transformer, instead they use an amplifier arrangement such as the complementary symmetry amplifier that has a low inherent output impedance.

To separate vertical and horizontal sync, integrators and differentiators are used. The operation of these devices is

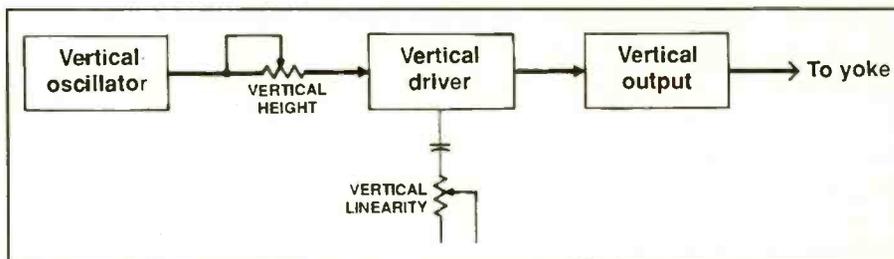


Figure 1. In this circuitry, the vertical height control adjusts for the correct amplitude of vertical sweep, and the vertical linearity control adjusts the linearity of the sweep sawtooth, insuring that the top and bottom of the raster are not stretched or compressed.

illustrated in Figure 2. The vertical integrator may have more RC sections than the one shown, and may be in packaged component form, having three leads; input, output and ground.

The output of the vertical integrator is sufficient to lock in the vertical oscillator because, being essentially a low pass filter, it does not produce an output for fast-acting or high frequency noise.

The horizontal oscillator

The horizontal oscillator, however, needs a better way to control its frequency since high frequency noise will be present at the differentiator's output. It is essentially a high-pass filter.

The horizontal circuit uses a phase-locked loop called the horizontal AFC circuit to control the oscillator's frequency.

Figure 3 shows the basic configuration of the horizontal sweep section. The hor-

izontal oscillator is locked in by a dc control voltage developed by the AFC. The control voltage developed by the AFC's phase lock circuit can be a smoother, slower moving voltage with low pass filtering to remove the effects of high frequency noise spikes.

Automatic frequency control (AFC)

Figure 4 is an example of an AFC circuit. The input transistor in this circuit acts as a phase inverter to provide two equal pulse inputs of the correct phase to make both diodes conduct.

The phase inversion at the collector provides the cathode of the top diode with negative pulses. The signal at the emitter is not phase shifted, so the anode of the bottom diode is provided with positive pulses. If the voltage at the other end where the diodes join is at 0V, both diodes will conduct equally. The divider resis-

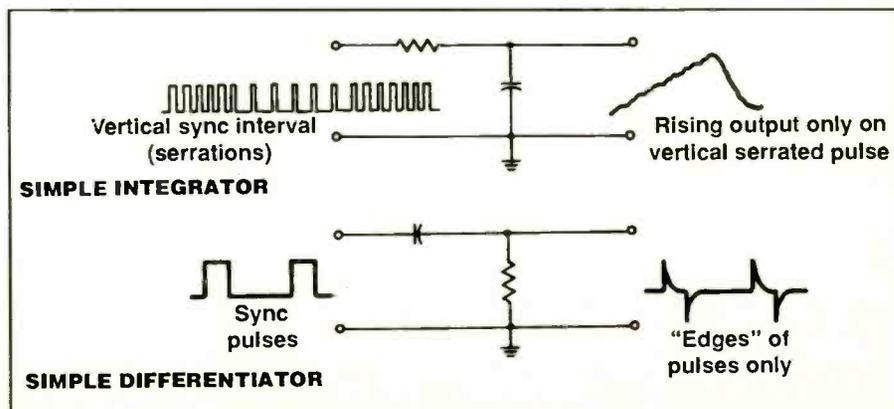


Figure 2. Integrators and differentiators are used to separate vertical and horizontal sweep.

Ritchie is an electronics instructor at Kentucky Tech, Hazard Campus.

tors for the control voltage will then have equal voltage drops, and being opposite in phase, will cancel and the control voltage will be 0V.

This situation occurs if the sawtooth derived from the flyback is at the 0V point, as shown by the slashed line, at the same time as the input sync pulses occur. If however, the sawtooth arrives earlier or later than the sync pulses, it will not be at the 0V point.

If the frequency of the oscillator is high, the pulses will arrive early and will be on the positive part of the slope when the sync pulses arrive. This will cause more forward bias for the top diode, and less for the bottom diode. The two resistor currents will then be unequal and will not cancel. A control voltage will be generated that, in this case, will be negative.

If the frequency of the oscillator is too low, the reverse of the above situation will occur and a positive control voltage will develop. The control voltage is connected to the oscillator to cause its frequency to vary in the proper direction until the control voltage falls to zero. The oscillator stays phase locked to the sync signal.

Multivibrator characteristics

Multivibrators are very sensitive to voltage changes. The control voltage could possibly vary the frequency of the multivibrator too much to be used as is, so a tank circuit can be added to the mul-

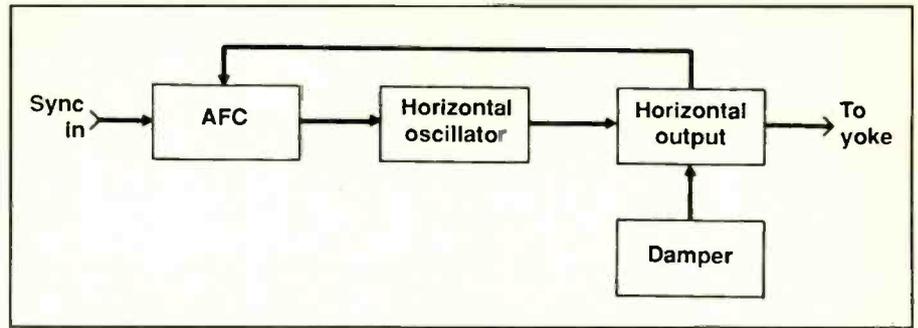


Figure 3. The horizontal sweep section of a modern TV is generally based on a scheme such as this.

tivibrator to stabilize the circuit. Changes in voltage do not affect the LC oscillator to a great degree.

In the circuit of Figure 5, Q1, the horizontal oscillator, and Q2, the horizontal driver, form a multivibrator. There is a feedback path from the collector of Q2 to the base of Q1. This is used in combination with the Hartley oscillator arrangement to provide the proper stability. In this circuit the horizontal hold control adjusts the core of the coil to change the free-running frequency of the oscillator.

Transistor Q2 will in most cases be an intermediate power transistor, since this stage must drive the relatively high-powered horizontal output stage. An interstage transformer, called the horizontal driver transformer, is usually used to match the driver output impedance to the horizontal output's input impedance.

The input pulses to the horizontal output transistor will not be a sawtooth wave, they will be rather narrow rectangular pulses. Capacitors at the collector will give a small sawtooth component to the output voltage, but the signal will still consist mainly of rectangular pulses.

The time constant of the flyback transformer and yoke, being a relatively high Q, will generate a sawtooth current when a rectangular pulse is applied. The small amount of sawtooth voltage will provide a sawtooth current for the small amount of circuit resistance. Most modern television receivers now have the entire sync and deflection circuits, except for the power stages, within a single integrated circuit (Figure 6).

In these circuits, there is no vertical integrator or oscillator and therefore no vertical hold control. The vertical fre-

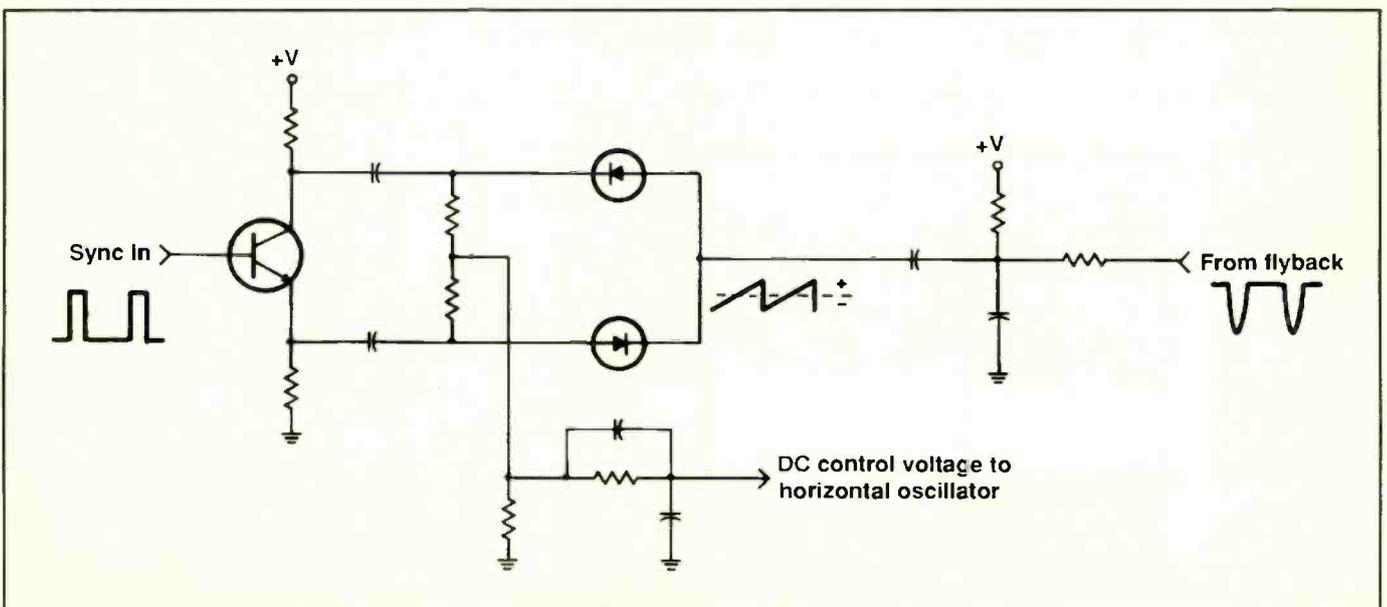


Figure 4. The AFC circuit keeps the picture synchronized by comparing the arrival times of the horizontal sync pulses with the time of occurrence of the 0V point in the horizontal sawtooth waveform and automatically adjusting them so that they occur at the same time.

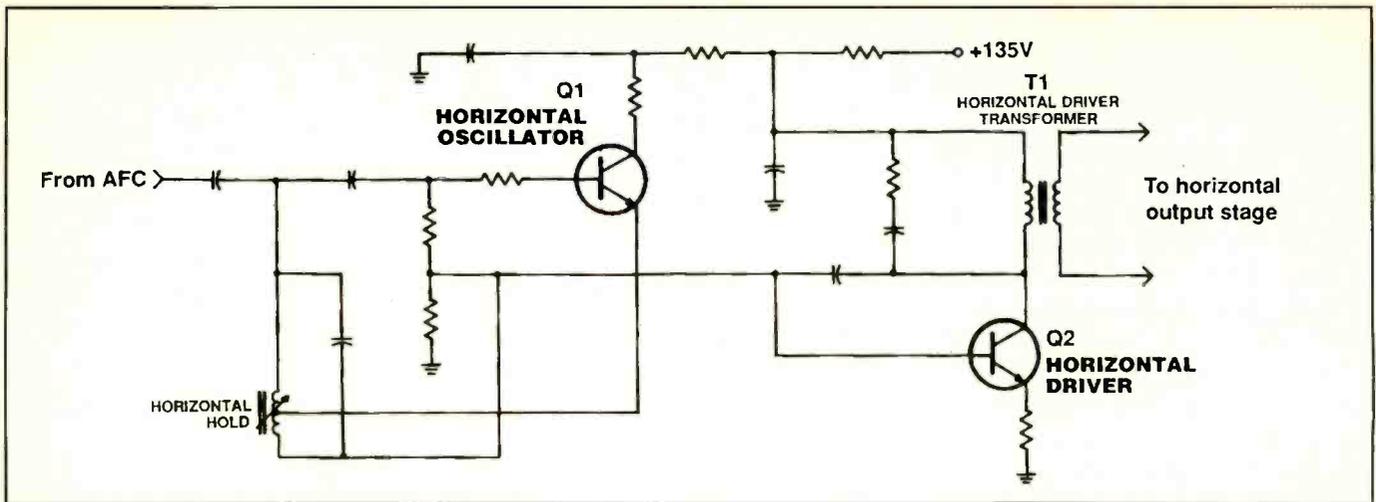


Figure 5. The horizontal oscillator generates the sawtooth waveform.

quency is derived by digital circuits that divide the horizontal oscillator's phase-locked signal by a factor of 262.5.

There are some modern hybrid ICs that also contain the vertical output stages and horizontal driver stage, but they all still have a discrete horizontal output stage using a transistor.

The horizontal output transistor (HOT)

The horizontal output transistor is a high voltage, high current switching transistor. The HOT will usually be rated at 1500V to 2500V at 5A to 15A, and are almost invariably NPN transistors.

Take special note of Figure 7. It is important to be aware that there are special horizontal output transistors that con-

tain an integral damper diode. Some also contain one or two circuit resistors within the package. If you try to test one of these HOTS as you would an ordinary transistor and are not aware that there are other devices in the package, the transistor might appear defective. If in doubt you must obtain the information from a substitution guide or the service manual.

The horizontal output stage is generally a high power, high frequency amp. The sawtooth wave has many harmonics starting with the fundamental frequency of 15.75Khz. The horizontal output stage is biased class C for best efficiency.

The damper diode

Because of the high inductance and inter-winding capacitance of the yoke and

flyback transformer, the circuit must be damped out during retrace to prevent ringing. The damper diode does this. The damper diode is placed in parallel with the high inductance flyback, in most cases directly across the horizontal output transistor. As shown previously, the damper may be within the package of the horizontal output transistor.

During flyback time, the reverse voltage (sometimes called counter EMF, or CEMF) drives the collector of the horizontal output negative, so it stops conducting and will be of relatively high impedance. This would allow the L and C of the circuit to be shock excited and begin to ring. The high CEMF would also destroy the horizontal output transistor. The damper diode is connected in such a

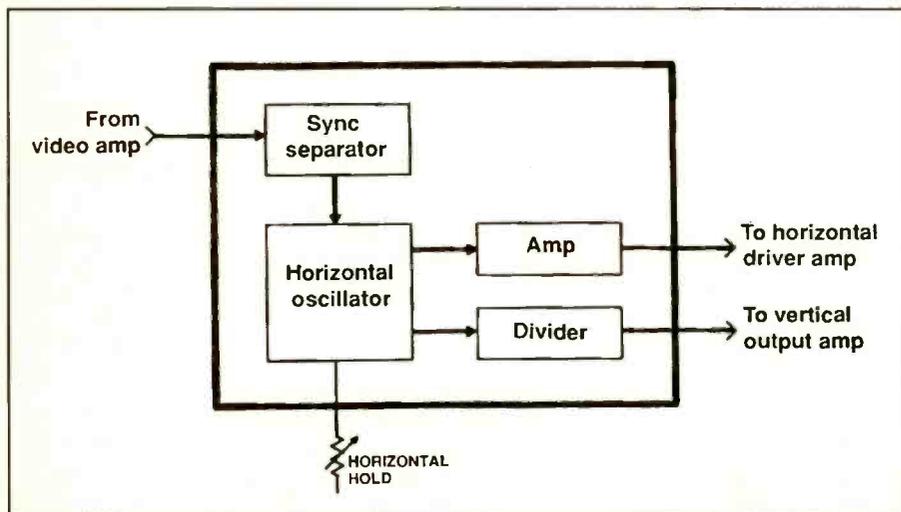


Figure 6. Most modern television receivers have all of the sync and deflection circuitry, except for the power stages, in a single integrated circuit package.

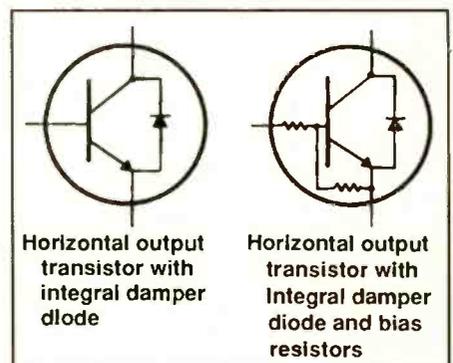


Figure 7. Many horizontal output transistors (HOTS) contain a damper diode, and sometimes bias resistors, within the same package. If you try to test one of these devices as if it were a standard transistor you might get a reading that would lead you to the conclusion that it's defective even though it is in perfect shape.

Regulation

All color receivers require that the high voltage be well regulated. Some older models regulated the high voltage directly, but most receivers today regulate it indirectly by regulating the dc supply voltage for the horizontal output stage, which will normally be in the range of 80V to 120V.

Supply voltages derived from the flyback

Most TV's obtain their dc power supply voltages by using additional secondary windings on the flyback transformer. This eliminates an additional power transformer that would add weight and cost to the repair.

The voltages from the flyback transformer are easier to filter because of the higher frequency of the horizontal puls-

es. A disadvantage of deriving supply voltages from the flyback—in addition to added complexity—is the possibility of costly damage to the flyback, horizontal output, and other horizontal sweep components if any other circuit fails, drawing too much current. Moreover, a failure in the horizontal circuit causing the horizontal output voltage to increase, or the frequency to change, could cause the voltage to all other circuits to increase and cause major damage.

Hold-down and shut-down circuits

Most receivers have additional protection circuits. These may be called "hold down", or "shut down" circuits that will sense if the horizontal pulse changes in amplitude too much, and will disable the circuits if this happens.

Many receivers also have a related type of circuit called an "X-ray protection" circuit that either holds the high voltage down to a safe level or disables it if it should go too high. The reason for this circuit is that if the high voltage is excessive, the electrons may bombard the screen too hard, producing dangerous X-rays.

Focus voltage

Focus voltage, as mentioned earlier, is derived from the flyback transformer. Some use a tap, or separate secondary winding in the flyback transformer to provide the appropriate voltage, and a focus rectifier to convert to dc. The voltage can be adjustable using a high voltage pot and high voltage resistors.

Note here that ordinary carbon resistors *cannot* be used for high voltages. The voltage will cause ionization and the resistors could literally explode. Special high voltage resistors are used in this type of circuit.

The focus voltage can also be varied using a variable inductor. A variable coil resonates with the capacitor at the fundamental frequency of 15.75KHz. Tuning the coil to resonance then decreases the amplitude of the pulse applied to the focus rectifier because the impedance of the circuit will be higher.

A tuned transformer may also be used to vary the focus voltage. Varying the coupling of the transformer varies the amplitude of the pulse applied to the focus rectifier, thereby adjusting the output voltage.

In most modern receivers, the same

high voltage that supplies the CRT is applied to a special voltage divider made of high voltage resistors and sealed in high voltage insulation. This device is often referred to as a focus block, as shown in Figure 9. Often, the focus block also contains additional resistors to divide the voltage to a lower value needed by the CRT screen grids. A second potentiometer is used to adjust the screen voltage.

Reducing the incidence of failure

To improve the failure rate of the high voltage and focus circuits, many receivers manufactured in the 1970's began to use lower voltage flyback transformers, followed by a solid state *tripler*. The output of the flyback might be 10KV or so, and the tripler produces around 30KV at its output for the CRT. The tripler usually had a tap within it at a lower voltage to use as the focus voltage.

The solid state tripler was found to have a high failure rate. Manufacturing quality control improved dramatically in the 80's, and now most receivers no longer use a tripler. The flyback transformers produce the full output voltage and have a solid-state high voltage rectifier built in to them.

These units are sometimes referred to as *integrated* flyback transformers, or IFTs. Some even have the voltage divider for the focus voltage and the focus control built into them.

Also in the 1970's, some receivers began to use SCRs, GCSs or SCSs in an effort to improve the efficiency of the horizontal output stage and reduce the failure rate. Once again, this has been abandoned and modern receivers are using bipolar transistors as the horizontal output.

It's a marvel

Modern television sets are the culmination of decades of advances in electronics components and innovations in circuit design. They provide a high-quality picture and are exceptionally reliable.

Nevertheless, even the most modern of TV sets do malfunction, and because of their complexity they frequently present a stimulating challenge to the technicians who are called upon to service them. An understanding of the individual circuits and their interactions in one of today's TV sets, can help make the service process more efficient. ■

ES&T Calendar

National Professional Service
Convention and Professional Service
Trade Show
August 5-10, 1996
St. Louis, MO
817-921-9061

ServiceTech '96: Fourth Annual
Conference of Innovation in Services
Technology
September 9-12, 1996
Boston, MA
800-333-9786 or 941-275-7887

Eighth Annual Digital Audio & Video
Workshop
October 1-4, 1996
Philadelphia, PA
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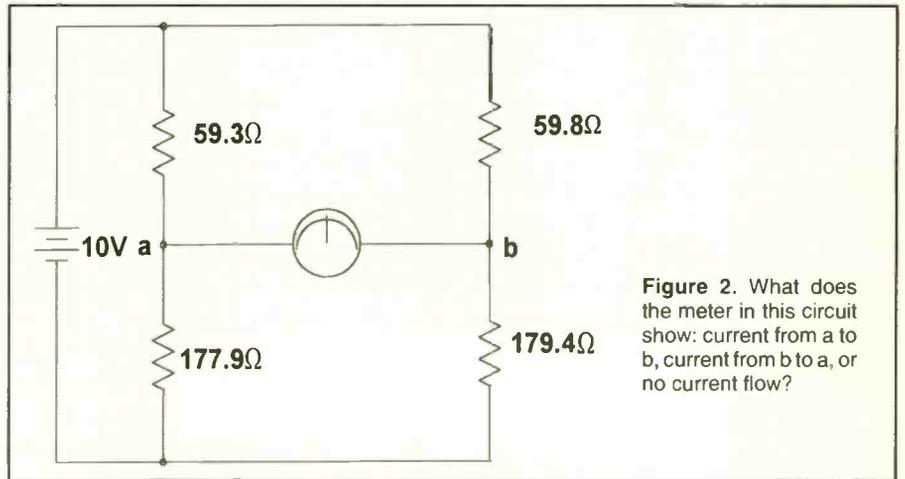
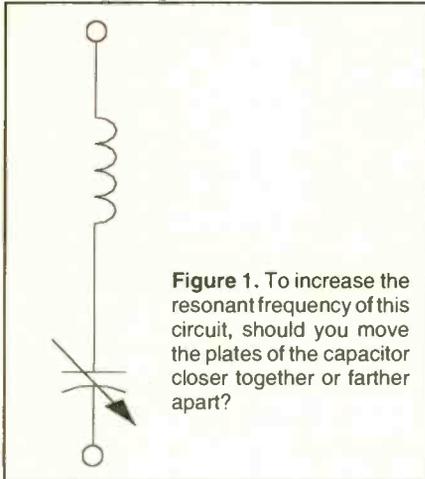
International Winter Consumer
Electronics Show
January 9-12, 1997
Las Vegas, NV
703-907-7674

CES Mobile Electronics - The 12-Volt
Educational Forum
April 4-6, 1997
Atlanta, GA
703-907-7674

Test Your Electronics Knowledge

A few electronics math problems

By Sam Wilson



1. $2 = 4\log(1/x)$. Find the value of x .
2. The expression di/dx means
 - A. take the average value of i .
 - B. the time it takes for i to reach its maximum value.
 - C. the time it takes i to reach 70.7% of its maximum value.
 - D. the rate of change of the variable i with respect to x .
3. Your measurement is 13.2V and you are supposed to get 15V. What is the percent error?
4. The circuit in Figure 1 is tuned by "knifing the capacitor plates." The LC combi-

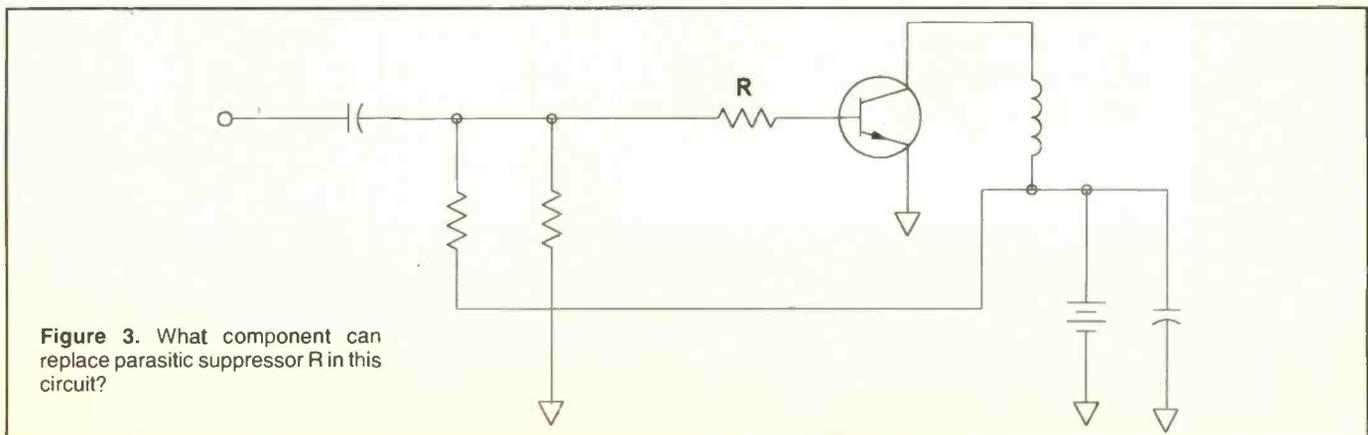
- nation is supposed to tune to 1500kHz, but it is resonant to 1495kHz. You should correct the frequency error by moving the capacitor plates
- A. farther apart.
 - B. closer together.
5. In the circuit of Figure 2, the meter should indicate that
 - A. current is flowing from a to b.
 - B. current is flowing from b to a.
 - C. there is no current flow.

6. You are designing a flashlight for TV technicians to keep in their toolbox. It will use a 9V dry cell battery that has an internal resistance of 37Ω . Is the following statement correct? The flashlight should use a light bulb that has a resistance of 37Ω .

- A. Correct
 - B. Not correct
7. Convert 0.000027 to a number in scientific notation.
 8. Convert 0.000027 to a number in engineering notation.
 9. Which of the following is a component that can replace the parasitic suppressor R in Figure 3?
 - A. Ferrite bead.
 - B. Bead ledge.
 - C. Ceramic bead.
 10. What decimal number is represented by BCD 0101 0101?

Wilson is the electronics theory consultant for ES&T.

(Answers on page 65)



Examine your ratios to improve your business

By Charles Varble, Jr.

Management today is confronted with many problems. They need to use every tool at their command to produce a growing profitable business. Most large businesses have a team of MBAs who are schooled in the latest and most effective methods to manage a business for growth and profit. They use data from comput-

ers to make decisions and changes to improve the business. They analyze the current figures and compare them to the budget and originate changes early so that they will meet their goals.

Consumer electronics service companies normally do not have the luxury of a staff of people, or even a single person, who devotes their full time to managing the company. Frequently the person responsible is the owner or manager and

there are so many areas that urgently require his time that there is little time left to devote to the analysis of the business and planning for the future.

Analyzing ratios can help

A *ratio* as applied to business analysis, is the contribution of an item to the total gross income, or the cost of an item against the total gross income, expressed as a percentage. You might find, for ex-

Varble is a retired consumer electronics service business owner.

Acme TV & Electronics Inc.					
07/04/96	Profit & Loss For June 1996			4 Weeks	
Acct#	Account	Third Period		Year to Date	
0	Gross Receipts	\$45,231.42	100.00%	\$271,388.52	100.00%
1	Materials	\$3,245.87	7.18%	\$25,301.78	9.32%
2	Accounting & Legal	\$100.00	0.22%	\$350.00	0.13%
3	Advertising	\$1,234.00	2.73%	\$2,385.19	0.88%
4	Truck Expense	\$259.40	0.57%	\$3,944.86	1.45%
5	Auto Expense	\$83.72	0.19%	\$532.28	0.20%
11	Utilities	\$359.45	0.79%	\$2,372.33	0.87%
12	Insurance	\$1,021.20	2.26%	\$6,852.35	2.52%
16	Licenses	\$0.00	0.00%	\$630.07	0.23%
18	Office Expense	\$121.35	0.27%	\$486.16	0.18%
20	Rent	\$1,300.00	2.87%	\$9,100.00	3.35%
21	Shop Expense	\$211.45	0.47%	\$1,925.79	0.71%
22	Sales Tax	\$307.57	0.68%	\$1,199.41	0.44%
23	Social Security Taxes	\$1,017.71	2.25%	\$3,725.68	1.37%
24	Unemployment Taxes	\$0.00	0.00%	\$17.88	0.01%
28	Telephone	\$456.20	1.01%	\$2,928.27	1.08%
29	Trade Dues-Manuals	\$74.30	0.16%	\$466.54	0.17%
31	Wages & Bonus	\$21,456.70	47.44%	\$150,196.90	55.34%
34	Employee Retirement	\$3,642.00	8.05%	9,784.32	3.61%
36	Operating Expenses	\$34,891.12	77.14%	\$222,199.81	81.88%
56	Net Profit	\$10,340.30	22.86%	\$49,188.71	18.12%

Figure 1. This is an example of a profit and loss statement.



ample, that parts income is 21.4% of the total gross, or that advertisement uses 4.53% of the gross. There is no standard or correct ratio for every item of each type of business.

Comparing ratios

One of the best uses of ratios is to compare your business using the ratios from two different periods. You might, for example, compare a period that was very profitable to one that was poor and see what ratios changed the most during that period. You can take a profit and loss statement from a long time ago and compute the ratios and compare them to your business today. See Figure 1 for an example of the profit and loss statement with the ratios printed on it.

Increasing cost ratios are not always a bad sign. If, for example, you double your advertising budget, it will also increase that ratio in the short run, but it will cause you to have a greater profit by expanding your business. The ratio of your parts purchases may increase significantly, but this may be a good sign if the increase is caused by more sales at the counter created by increased emphasis on accessories. You may elect to move to a new, higher-rent, location, which will increase your rent ratio, but this could result in increased business, thus boosting your sales because of the favorable location.

Income per employee

Income per employee, while strictly speaking is not a ratio, is a very significant factor and greatly reflects the efficiency, growth and profit of a firm. To determine the income per employee you divide the gross receipts by the number of employees. If you have people who work part time, you can convert their hours worked to an equivalent number of full-time employees. To perform this conversion, add up the hours worked by part-time employees and divide by 40. Add this number to the number of full-time employees to determine the divisor.

Many very successful companies have incomes of hundreds of thousands of dollars a year per employee. Take any large

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company and use public records from stockholder reports and you will find that as their income per employee increases so does their profit. The inverse is also true. This ratio can serve as an early warning indicator when a company hits a plateau or declines.

Comparing ratios

Compare your ratios during a given period to the ratios that you calculated for the same period in the previous year. Many items will be high for one month, but will gradually decrease each month as the income increases. Your business license would be an example.

Because you pay for your license once a year, that cost ratio will be high during the month in which it first appears. By the end of the year the ratio will have dropped to normal. This happens because when you first pay an annual cost, it will be compared with your income for one month, but at the end of the year it will be compared with twelve months.

When you find a ratio that is significantly outside the normal range for your business or similar businesses, determine the reason. If you were to increase your gross income while your rent stayed the same, you would be pleased to note that your ratio for rent had decreased. This would increase your profit if all other ratios stayed the same.

You may have a low ratio for advertisement and a higher one for rent if you have a location of high visibility that produces more business and reduces your advertisement budget. If your service income ratio decreased, this might be because you started selling more accessories.

Making decisions based on ratios

You should make changes immediately if you think that they will change the ratios and improve your profitability. Remember that some changes will initially decrease your profit but will increase it over the long run. An example of this would be an increase in your advertising budget for the Yellow Pages. This will result in an immediate increase in your advertising cost ratio. It usually takes sev-

eral months before increased advertising results in an increase in business. Once the increase in business occurs the advertising cost ratio begins to decrease back toward normal.

Examine only one item at a time and take the time to explore it thoroughly. You are probably very busy but you will have time each month to study your profit and loss statement and pick out one ratio to try to improve. First get a detailed printout of all of the items that were in that account and examine them in detail to determine what changes can be made to produce the desired effects. If you take more time to examine the situation, you may be rewarded with greater savings for being thorough.

Analyze any work that you send out of the service center to be done and see if you could reduce your costs by doing it internally. In addition, look for areas where you can save on products and services. You might, for example, examine your electric bill, and the power consuming devices in your service center. You may find that some lights are on all of the time but they only need to be on a short time to serve the needs of people in the stockroom. You can install an automatic light sensor that turns the lights on when someone comes in and turns them off when they leave the room. Careful analysis might show that you have a large electric sign on outside that is on all night but after midnight none of your customers see it. You can install an automatic timer that will turn it off at any time you select.

Salaries and payroll

Salaries and payroll will represent your highest ratio. When you calculate this figure, be sure that you include all the fringe benefits including medical insurance and any retirement or profit sharing that you pay. In addition, be sure to include unemployment insurance, workman's compensation, and FICA taxes that you pay. A good way to determine if you should include the expense is ask "if I did not have the employees would I have this expense?"

Compare your final ratios to industry standards and also to your own business

in past periods. If you did not compute ratios in the past you can easily take the old figures and compute the ratios. Be very careful if the salary ratio exceeds 50% of your gross business. This is a warning signal. If your salary ratio is this high, it will be difficult to make a profit after including the other expenses. Your own salary should be included if you are active in the daily management and operations of the business. Your profit should not be included in this category.

Improving the payroll ratio

If your payroll ratio is higher than industry standards, decreasing this ratio will be your first objective in a well managed business. It would be very difficult to achieve this goal by reducing salaries because your employees want more pay and are not likely to be happy with a decrease in salary. Your job here is to increase income without hiring more people. If you attract more business you might have to hire more help, but ordinarily you will be able to handle additional business with your current staff.

Using incentives to improve efficiency

Greater efficiency will be the easiest way to reduce the payroll ratio and keep your technicians happy. One of the easiest ways to increase your productivity is to offer an incentive for your technicians to produce more by letting them earn a bonus. You may have some type of bonus or profit sharing program in effect now, but you need to examine it to see if it is producing the desired results. See the March "Business Corner" for a detailed article on a bonus plan for technicians.

Have you systematically replaced test equipment so that the technicians are using modern equipment in order to speed up the analysis of the equipment? Have you visited other modern shops to see what techniques they are using to increase their efficiency? You are not stealing ideas, but increasing efficiency, by sharing operating techniques with others in the same business. Do you have an adequate supply of parts so that they can complete most repairs without waiting for



parts? Do the technicians have common parts close by so that they do not have to get them from a parts person? Do you have the schematics and manuals for the units that they service?

How does the incentive plan work

If you have an incentive plan in effect in your business, you should ask yourself several questions. Does it reward the individual technician or does it put them all in a group and then split the amount among them? Each of your technicians will think that they are doing more than their share of the work and not receiving their proper share of the bonus.

A lead technician that only works on the more difficult units, and the ones that others can not repair, deserves more of a bonus even though he completes fewer units. A lead technician should get some credit for a repair that he helps another technician complete.

Do you assign the work to the technicians or do they choose the units from a waiting pile? Do they only get one unit until it is completed or do they "cherry pick" and take several units that they know will be easy to repair? Are they paid monthly, or do they have to wait three months to a year, to share in the bonus? Do they work on their own recalls and get zero, or a minus amount, to complete the repair? If someone else has to service the recall does he get the full credit with this amount charged back to the original technician as a minus amount? Once you establish an incentive plan do not change the terms or the plan will be self defeating.

Electronic service is labor intensive; you cannot use machines or computers to troubleshoot the products. There are programs for computers, called diagnostics, that will tell you where the problem is and what to replace. Consumer electronics products are less expensive and unless the manufacturer has a good reason you will not find plugs or connectors to connect automated test equipment that will troubleshoot it. When it was an advantage for the manufacturer consumer electronics products were modular, but now most units have PC boards that require troubleshooting to the component level.

Where to start

Start with the higher ratio items and examine each expense in detail. Sometimes you can reduce expenses by some simple changes.

We used to have a soft drink company deliver the soft drinks that we provided for employees to drink. We found out that we could save an appreciable amount by purchasing it on sale from the discount stores. Toilet paper and hand soap purchases can be reduced by purchasing in quantity when they are on sale.

If your business is licensed in the incorrect category, you may be able to reduce the cost of your license by requesting that you be licensed in the correct category. The state may have you listed as a regular sales business, but many states have a service only category, that you may qualify for, that has a sharply reduced annual cost.

Get several quotes on your insurance and see if your trade association offers an advantage in this area. Your credit card fees, for accepting credit cards, may be sharply reduced by shopping around. Frequently your own bank will reduce the charges if you tell them you can obtain a lower rate elsewhere.

Watching ratios may help you remain in business

Some companies, by making changes and finding new products to service and new ways to serve the customers, will still provide competent profitable service in the future. You will remain in business if you watch the ratios, make changes as needed and practice good management. Many companies will go out of business and only the most efficient and well managed will survive. ■



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AK240P	.75	BA4403	.75	HA1197	1.65	LA1264	1.35	MS270L56	1.60	MSM58301RS	2.85	STR5326	5.45	TAB210AH	4.25	TDAB198	2.95	UPC1353C	1.35	221-246-02	3.95
AK241PO	1.25	BA4412	1.60	HA1199	2.75	LA1266	1.55	HA7020	2.45	MTD14AS	4.45	STR5332	4.45	TAB218AH	3.95	TDAB305A	6.95	UPC1363C	2.25	221-249	5.95
AK262	1.25	BA5101	1.55	HA1389R	3.05	LA1816	1.55	MS017AP	4.40	MUR610	.75	STR5431E	5.95	TAB410L	4.45	TDAB350G	3.25	UPC1363CA	2.25	221-261	4.10
AK277	1.75	BA5102A	1.85	HA1392	2.45	LA2000	1.50	MS0198P	7.95	MUR3005PT	1.75	STR5471	4.95	TAB654AN	6.95	TDAB351	5.95	UPC1371C	4.25	221-285-02	1.75
AK301	1.60	BA5115	2.05	HA1406	1.75	LA2120	2.50	MS0512AS	27.95	NASU3000	4.95	STR5474	4.95	TAB655AN	7.95	TDAB326E	7.95	UPC1373M	.95	221-289-09	1.75
AK305	1.95	BA6104	2.25	HA11107	1.45	LA2770	4.95	MS0743FP	7.95	NE5532P	1.50	STR5479	4.40	TAB677N	5.95	TDAB425	4.95	UPC1373MA	.95	221-289-38	2.95
AK321	2.45	BA6109	1.10	HA11211	2.75	LA3115	1.35	MS1102L	2.85	NE5534N	3.75	STR5481	8.95	TAB6808N	7.95	TDAB426	6.25	UPC1378M	1.55	221-301	1.75
AK335F	1.95	BA6146	1.70	HA11219	1.65	LA3155	1.25	MS1172P	1.50	NI57264E2	2.95	STR5482	6.95	TAB6809N	5.99	TDAB444	4.95	UPC1382C	.85	221-365-01	3.25
AK362	1.25	BA6209	1.35	HA11221	2.35	LA3160	.60	MS14085P	6.95	NJM072D	.65	STR5490	8.45	TAB6922N	5.95	TDAB233	1.50	UPC1391	1.40	221-369	3.95
AK2253FA	5.95	BA6219B	1.35	HA11227	1.85	LA3161	.65	MS1531L	1.50	NJM7810BA	1.50	STR5492H	6.50	TAB825AN	7.95	TEA2114	.75	UPC1393CA	2.95	221-379	2.00
AK3230NK	4.95	BA6238A	1.35	HA11235	1.50	LA3220	1.90	MS1721L	12.99	NJM2043S	1.30	STR7309	6.95	TAB8845AN	12.99	TEA2261	3.45	UPC1394C	2.45	221-418	5.95
AK3311K	2.95	BA6302A	1.65	HA11423	2.25	LA3320	.65	MS1724P	2.95	NJM2063A	2.95	STR7310	5.25	TAB8850N	7.95	TEA5562	2.50	UPC1397C	2.45	221-463	4.95
AK3313	2.95	BA6993	1.20	HA11510M	3.30	LA3350	1.75	MS1782AS	8.95	NJM2065	1.60	STR451	7.95	TAB8864AN	4.95	TEA5562	3.95	UPC1470	1.10	221-467	7.95
AK5015K	2.95	BA7001	.75	HA11714	5.50	LA3361	.75	MS1901L	8.00	NJM2065S	1.80	STR73125	5.95	TAB8879N	8.00	NJ2019A	.45	UPC1473MA	1.45	221-485	6.25
AK5020	1.35	BA7025L	1.35	HA12005	2.40	LA3365	1.25	MS1995P	5.95	NJM2073D	1.50	STR73130	5.95	TAB7536P	.65	TP131C	.50	UPC1474MA	2.20	221-498	2.95
AK5111	3.75	BA899	.25	HA12026	1.25	LA3376	1.35	MS2025SP	2.95	NJM4556S	.55	STR73135	5.95	TAA621A11	2.95	TP132A	.50	UPC1486C	2.75	221-528	2.60
AK5151M	2.95	BF960	.55	HA12411	2.35	LA3376	1.35	MS2030ASP	5.45	NJM4562D	1.50	STR73220	5.95	TAB4530	1.95	TP132C	.50	UPC1504C	2.45	221-545	2.75
AK5265	3.50	BF964S	.75	HA12413	2.25	LA3400M	2.30	MS2032AP	4.95	NJM4562D	1.50	STR8210	5.95	TAB4540	2.50	TP132A	.50	UPC1514CA	2.35	221-547-50	4.15
AK5301NK	5.40	BF990	.70	HA17456	.55	LA3401	1.95	MS23035P	6.65	NMC9306	2.95	STR10006	4.35	TAB4950	2.75	TP1300	.75	UPC1525C	2.95	221-657-63	4.15
AK5316N	2.45	BF991G	.70	HA17901P	.75	LA3600	.95	MS2666AP	3.95	NSD3440T	1.25	STR13006	5.95	TC5080P	1.90	TP1302	.54	UPC1870CA-1	5.95	221-908	9.95
AK5352	4.25	BF992A	1.25	HA17904S	.45	LA3605	2.20	MS2679C	4.95	OE00018	5.50	STR13015	2.95	TC9130P	2.25	TP1305	.65	UPC1870CA-2	5.95	612042-2	2.75
AK5436NK	2.75	BF992G	1.25	HA21001WS	6.95	LA4182	2.45	MS26925P	5.99	OE10020	5.80	STR30120	2.95	TC9145P	2.55	TP1801CP	.55	UPD612C	.95	612059-1	2.35
AK5512	1.25	BT138-000	1.20	MD6301V1PEB4	4.95	LA4260	1.35	MS4406P	5.99	OE20003	5.75	STR30125	2.95	TC9303AN-014	5.95	TP1272CP	.75	UPD620C	2.95	612071-1	1.80
AK5515	1.65	BT151-500R	1.25	MD6305V1D23F	7.50	LA4261	1.90	MS4450L	1.90	OE30006	6.10	STR30125	2.95	TC9311	1.90	TP12610	1.75	UPD5471L	2.75	612072-1	1.95
AK5521	1.60	BU126	2.45	MD140138P	.90	LA4265	1.40	MS46145L	1.90	OE30006	5.50	STR30130	2.95	TC93500AP	1.55	TP1960G	1.50	UPD554C-036	5.95	612076-7	2.85
AK5700	1.10	BUD208A	1.95	MD140278P	.40	LA4270	1.75	MS4516P	1.60	OFM1962	4.95	STR30135	2.95	TC9350M	.85	TP16216	1.25	UPD605C	1.75	612094	2.15
AK5703	2.25	BUD208D	2.30	MD38941	.375	LA4422	1.35	MS4521P	1.45	OFM1963	3.95	STR40090	4.95	TC94500A	.95	TP1631	.85	UPD65C	3.95	612120	3.80
AK5710	1.25	BU508A	1.95	MD42851	1.50	LA4510	1.95	MS4533P	2.10	OFM3251	4.25	STR50041A	5.25	TC94621-9081	2.95	TP10C73AN	3.40	UPD946	5.50	612130-3	2.95
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AK5750	1.35	BU508DF1	1.65	HEF40168P	.25	LA5521D	1.25	MS4770P	3.95	PD0494N	4.95	STR50115	5.95	TP47C63AN4042	1.80	UPD1203C1111	4.95	612332-3	5.10		
AK5760	1.60	BU806	1.25	HEF40408T	.25	LA6358	.75	MS4873P	1.90	PD748H	3.95	STR51041	5.95	TP47C63AN4043	5.25	UPD1708A023	5.25	612342-1	6.95		
AK6250	1.75	BUD444-06	2.95	HE6104040P	4.50	LA6393S	1.50	MS5818-83P	2.95	PC74HC123P	.65	STR53041	5.95	TMS10458L	5.60	UPD171C-524	4.35	612347-2	1.95		
AK6306	2.75	BUD508A	1.95	HE61101P-4	2.50	LA6458S	.45	MS6826-002P	2.65	PC74HC138P	.65	STR53041	5.75	TP47C63AN	.95	UPD19436	2.50	612351-1	1.10		
AK6307	1.40	BUD508AF	2.25	HE623257FC44	3.95	LA6510	1.85	MS60025-100SP	5.95	PC74HC161P	.35	STR59041	6.75	TP47C63AN	2.85	TMS19432L	2.50	UPD40538C	3.55	612364-1	1.55
AK6326	1.95	BUD508DF	1.95	HE64510	3.95	LA7016	1.50	MS66075P	16.95	PC74HC245P	.65	STR6001	6.25	TP47C63AN	2.20	TMS19432L	2.50	UPD5104C	2.95	612405-1	2.50
AK6327	1.95	BUD520AF	2.45	ICM7555	.45	LA7031	1.75	HA2778	.20	PC74HC574T	.20	STR10005T	4.95	TP4440	1.25	TMS19442L	3.55	UPD6111	6.45	612412-2	5.50
AK6328	2.25	BUD527AF	2.75	IR2E01	1.50	LA7032	4.95	HA2778A	.20	PC74HC4046AT	.47	STR1002	6.25	TP4402	2.65	TMS3450N	2.45	UPD6336C	3.95	612463-1	1.25
AK6337	1.95	BUH413	2.95	IR2E02	1.50	LA7033	4.45	HA3031	2.45	PC74HC4053P	.25	STR10106	4.95	TP4403A	2.95	TMS3451N	2.45	UPD6360C	1.95	612469-1	.95
AK6341	2.95	BUH417	2.10	IR2E05	1.50	LA7034	3.25	HA38841PFO47	6.00	PC74HC4066T	.44	STR10106	5.65	TP44010A	1.20	TS45515TD	3.75	UPD8039M3LC	2.85	612479-4	.35
AK6342	1.99	BTU11AF	1.55	IR2E19	1.50	LA7213	3.30	HA38841PFO38	7.50	PC74HC4315P	.65	STR10310	4.95	TP44010B	2.25	TP42007X	1.80	UPD75106M16	5.45	612480	1.55
AK6343	2.25	BTU21C	1.95	IR3P06	1.75	LA7221	1.50	HA38841PFO36	9.50	PC74HC4358P	.35	STR10315	4.95	TP44017N	2.25	TP42007X	1.80	TP42444P	4.75	612500-1	6.10
AK6344	1.85	BU2901	4.95	IR3P07	1.50	LA7505	1.95	HA36660	1.50	PC74HC4613P	.35	STR10330	4.95	TP441208	.75	U4168	3.10	IR35242P	1.55	612552-1	4.95
AK6350	3.95	BY203-20	.35	IR3P08	2.95	LA7520	2.95	PC8571P	4.50	PCF8571P	4.50	STR10305	4.95	TP44107X	1.95	TP30	1.75	TP30	1.75	612553-1	4.50
AK6359	2.90	BYN6	.35	IR8C54H7	.15	LA7530	2.10	MC3761	1.85	PCF8583P	9.75	STR06602	5.45	TP44152	3.25	U4208	2.75	LA66102-02A	6.95	612554-1	17.95
AK6360	1.75	BZ120	.15	IR2403	1.80	LA7571	3.75	MC4204	1.25	PCMS44P	4.95	STR55041G	5.95	TP44152A	3.25	U4208	2.75	LA66102-02D	6.95	612565-1	4.50
AK6361	1.90	CA1523E	3.45	IR2410	1.50	LA7610	10.99	MB4844ABDLSL	5.45	PH302	3.90	STR55141G	5.95	TP44154A	3.95	U4208	4.5	LA66102-06B	6.95	612566-1	1.25
AK6362	2.75	CA3012T	2.95	IR6C5	1.95	LA7652	5.95	MC8076	2.45	PH309	3.95	STR55241	5.95	TP441580	2.95	U4A170	1.80	LA66103-04A	6.95	612584-7	12.45
AK6366NK	2.45	CA3053T	1.75	IRF730	1.99	LA7653M	5.65	MC86530	6.95	RP5C01	3.95	STR55241G	5.95	TP441584Q	4.95	U4A180	1.80	LA66103-04B	6.95	612624-1	12.75
AK6367	2.95	CA3065E	.65	IRF830	1.99	LA7670	7.75	MC7812ACP	.35	RS403L	1.95	STR56301	5.95	TP441675A	3.95	U4A1008A-DP	6.5	LA66107-02E	6.95	612658-3	12.00
AK6650	3.90	CA3072E	1.75	IRFP450	1.95	LA7674	7.95	MC1309P	1.25	SO42P	1.10	STR56301A	7.95	TP442005M	1.75	UC3A240N	1.50	LA66107-07E	6.95	612668-2	3.95
AK6686	3.05	CA3078E	.95	JA101Q	1.70	LA7696</															

Choosing a replacement parts supplier

The question of which aspect of servicing one of today's consumer electronics products is the most difficult depends upon the manufacturer and the particular chassis. In some cases, the most difficult part of the service process is obtaining the service literature. In other cases, the toughest aspect of servicing a product is isolating the cause of the problem. In some products with their fine, closely-spaced circuit traces, the most difficult part of servicing is removing a component from the PC board without causing any damage. Sometimes the biggest problem is finding a replacement for the defective part. Consumer electronics servicing is almost never easy.

Correspondence from readers overwhelmingly tells us that two of the most common problems facing service technicians and managers are locating replacement parts and finding service literature.

Large numbers of consumer electronics products being sold today are made by companies that are not well known. In many cases the products have venerable old names on them, but are actually made by some no-name company on the Pacific rim; the name was sold to them by the original company.

In spite of their questionable parentage, much of the circuitry in these products is highly sophisticated, featuring unique components for which no one but the manufacturer has the replacement. This compounds the problem because many service centers don't have the faintest idea where they can go to find service information or replacement parts. What can a service center do when faced with this increasingly common problem?

Part of the answer is to deal with a good replacement parts distributor, the kind that will make an extra effort to meet the service center's needs.

Consumer electronics products are complex

Many so-called consumer electronic

products of today are in fact complex systems. Moreover, electronics engineers and scientists continue to create an ever broadening variety of components with unique characteristics. With this increasing variety of available components and characteristics, designers of today's sophisticated consumer electronics products have increasing freedom in the way in which they design the circuits for the product they want to build.

If the designers should want to achieve a function but don't want to do it with the components available, they can go to an integrated circuit manufacturer, or in some cases the IC division of their own company, and have a new, proprietary IC designed and fabricated.

All of this leads to a huge variety of components that the technician will encounter any time he services a product. The problem is compounded by the fact that manufacturers' part numbering systems are all different.

In some cases, when a technician has identified a particular faulty component, he can find a cross reference that will allow him to determine if he has an equivalent in stock. Unfortunately, in many cases, there is no cross reference, and even if the service center has a needed part on hand, no one is aware of it. And in the case of complex ICs, there probably is no equivalent anyway.

The role of the distributor

Once the faulty component has been identified, the next step is obtaining a replacement part. Some distributors offer the service technician a variety of aids in finding the needed replacement. Others are less helpful.

The distributors who have advertised in this special advertising supplement have done so because they would like to tell you more about themselves than they can in an ad. They want service centers to know what kind of facilities they have, what kinds of people work for the com-

pany, the efforts they are making at customer satisfaction, and how to contact them when you need a replacement component.

Here are some of the questions we asked the manufacturers and distributors to address in their articles:

- How many locations do they have?
- How often are they able to fill orders from stock?
- What payment options do they offer - open order account, credit card?
- How soon after receipt of an order to they ship?
- Do they add a shipping surcharge?
- Do they have a toll free number?
- What ordering options do they offer?
- What is their return policy?
- Do they offer a warranty?
- Is there a minimum order amount?
- What shipping options do they offer?
- What special services do they offer?
- Do they have a research department to help technicians find a specific part?

Food for thought

Keep some of these questions in mind when you're looking for a supplier of replacement components. You want to find someone you can count on for reliability, convenience and service. Merely locating someone who stocks the part isn't the only consideration. For example, if you have to wait until you fill a large minimum order amount before you order, or if you have to wait weeks for the part to arrive, you'll have that defective product sitting around the service center for a long time without earning you any profit, and the customer will not be pleased with the wait.

It might be tempting to order from the first distributor that comes to mind, but if you will take the time to ask a few questions it might save time, money and aggravation. The following section will give you a head start in answering some of those questions. ■

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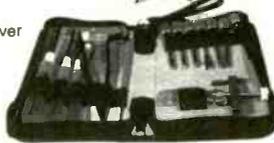
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Your success is our number one priority at Philips Service Company. We listen to servicer needs and respond! That's why more and more servicers are turning to Philips Service Company for their replacement needs.

When you turn to Philips, you're met with real people who care about your concerns. Joe Kucan, our new Marketing Manager for Philips' replacement parts, has reemphasized the value of **treating our customers as top priority.** Our goal is to maintain lifelong relationships with all of our customers.

How do we do that? By listening to your requests and responding to your needs. When you call Philips, we respond with:

Same-day shipping

95% Order fill rate

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When you turn to Philips, you can relax. **We find what you need and ship it when you need it.** There's no second guessing. For your **maximum convenience**, we have also added KPINS warranty filing.

Locating the right part isn't a problem with our software support. *Parts Pricing* and *Cross-Reference* gives you instant access to over 260,000 part numbers. *PartSeeker* locates your part number through a model or chassis number and interacts with *Parts Pricing* and *Cross-Reference*. *SmartTips* helps you solve difficult repair challenges at the click of a button. Finally, we've developed a software manual operating system that connects all the above programs, while providing fast access to boards, circuits, components, and faults. This program not only links the other programs, it allows you to insert your own notes and tips.

At Philips Service Company we're not content to rest as #1 in parts and service support. We continue to **listen to your concerns and respond to your requests.** You deserve nothing less than total support. And with a comprehensive line of over 45,000 replacement parts, service aids, tools, and test equipment, **Philips remains your one-stop-shop for all servicing needs.**

Philips goes beyond quality OEM replacement parts by offering **comprehensive solutions** to all electronic servicing needs. For more information on Philips *SmartParts*, call 1-800-851-8885. ■

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PHILIPS

PTS Corporation

5233 Highway 37 South • PO Box 272
 Bloomington, IN 47402-0272
 Phone: 800-844-7871 • Fax: 800-844-3291

For over thirty years PTS has been providing television replacement tuners and mainboards to the electronic service industry. PTS is the nation's largest single source for all major brands of replacement Television Tuners, Mainboards, Projection Set Modules and Complete Chassis. Brands such as RCA, Zenith, Philips and GE are available at substantial savings when compared to manufacturers pricing. PTS employs over 275 technical and support staff with a 85,000 square foot facility and branch locations in California, Texas and Colorado.

Thousands in stock

PTS maintains an extensive inven-

tory on most major brands of Television Replacement Tuners and Mainboards. Thousands of tuners and mainboards are readily available - just call in your order. If the item you need is not currently in stock, PTS has a service support system to rebuild your non-working tuner or mainboard.

In recent years, PTS has expanded its available service to include Computer Products such as Monitors, Printers and Motherboards.

Our primary objectives

PTS has been supporting the independent service dealer since 1967. If you're a one man operation, multiple location service center or a manufac-

turer, PTS can help increase profits utilizing four primary objectives. **REDUCE PARTS INVENTORY.** There is no need to stock expensive, unnecessary parts for repair when you can rely on PTS for thousands of rebuilt tuners and mainboards. **PROVIDE FASTER SERVICE.** You'll minimize having to wait for backordered parts, schematics or technical information including high failure history of individual components. In most cases we'll process your order long before you could have obtained special ordered parts or schematics. **MINIMIZE LABOR COST.** Knowing that PTS provides an excellent source for repair assistance, your technicians will no longer have to agonize over "dog" units which results in a high labor cost per unit. Your output per man hour and work flow will improve dramatically. **INCREASE PROFITS.** Call PTS today and order your free catalog of replacement parts. ■

PTS Electronics

Supplying the World of Electronics

PTS Support

PTS has been supporting the electronic service industry for over three decades. By providing quality TV replacement Tuners and Mainboards, PTS has become a source you can rely on. Thousands of TV Tuners, Chassis, Mainboards, and Modules are in stock and available for immediate delivery. PTS stocks and services over 40 brands of direct replacements. PTS is a valuable resource which will keep you competitive in today's electronics industry.

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 Complete Chassis



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Abingdon, MD 21009-2334

Phone: 1-800-638-3328 (MD) • 1-800-365-8030 (FL)

Fax: 1-800-888-3293 (MD) • 1-800-999-3293 (FL)



Tritronics, Inc. recently celebrated its twentieth year in business, and pledges to the industry that it will continue to serve the independent servicers for more generations to come.

Our family owned and operated business provides fast, professional service to the independent service industry. For example, orders received by 4:00 PM EST are shipped the same day; we average an overall 85% fill on initial shipments; we offer an on-line ordering system (DRAGNET).

EFFICIENCY is great, but how can we save our customers' time and money? Tritronics offers toll-free pricing and availability for common parts by description and by part number. Our headquarters can be reached at (800) 638-3328 and

our Florida branch at (800) 365-8030. The order desk is staffed by an experienced sales force. We also offer toll-free fax numbers for pricing and availability; headquarters (800) 888-FAXD and Florida (800) 999-FAXD. Faxed in research is usually returned in four hours.

The rising cost of replacement parts brought Tritronics to the conclusion that high-quality, low cost replacement parts are needed by our customers. We recently introduced our sixth catalog, which is full of such items.

The catalog has more pages of products and cross-references, and now includes test and soldering equipment, optical pick-ups and many new products. Please call (800) 638-3328 if you have not received our latest edition. If you are

located in Florida, please call (800) 365-8030.

Tritronics has fully staffed parts research and sales departments that are knowledgeable and efficient. In an effort to improve our level of service, Tritronics has employed Doug Maris, CSM, formally the service manager of Home Electronics of Englewood, Colorado, to run the Miami branch. Doug has been in the service industry for eleven years and his goal is to bring the servicers' perspective to Tritronics, Inc.

In our travels to the various industry meetings, Tritronics officers often have the pleasure of meeting other people who work their business with family members. The Tritronics family looks forward to serving your business now and in the future. ■



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Matsushita Services Company

20421 84th Avenue South
 Kent, Washington 98021
 Phone: 800-833-9626
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For 35 years, the Panasonic, Quasar, and Technics brand names have appeared throughout American homes and industries. In that time, our company's commitment to total customer satisfaction has manifested itself in many ways. Our approach to post sales support has evolved to include programs that encompass qualitative human resource training, as well as ones that stress the development of automated processes that allow us to offer timely, accurate solutions to our end users' service needs.

The engine behind MSC's ability to ensure timely repairs is our ability to deliver parts, accessories, and service literature to our network of factory service centers, independent servicers, and dealers in a timely manner. We are now seeing the results of over a decade of continued investment in the modernization of our facilities. The primary point of support for all replacement parts and service literature is the National Parts Center in Kent, Washington. From here, and with further support from sales & marketing staff and field staff throughout our U.S. regions, we handle a wide variety of inquiries and fill just about any request made of us.

Customer Contact

Generally, the first line of customer support is provided by our order offices located in Kent, Washington. This office handles a wide variety of customer calls ranging from simple parts orders to requests to do research on unique model numbers. Currently, the order office handles an average of 1,400 calls a day just for taking orders, as well as take an average of 250 calls from customers requesting such things as estimated shipping time, return authorizations, processing credits, and special orders. Also, the office receives over 500 faxes daily. In addition to all of this, we offer retail customers toll-free phone and fax numbers to call and order literature, parts, or any of our comprehensive line of accessories.

One of our recent changes was the consolidations of our Kent, WA and Suwanee,

GA order offices. The single order office allows us to process customer orders more quickly and efficiently. In order to further improve our level of service, we've made significant investments in phone management systems to improve our efficiency. Data gathered from these systems will graphically depict work load volume, peak times, and average call length on a daily basis, and give management a true picture of where additional improvements are needed.

Our staff includes representatives which reach out to the field as well. Regional parts accessory representatives call on distributors, independent servicers, dealers, and even end users, to assess their needs. With a comprehensive portfolio of sales programs and promotional items, they are able to keep in touch with the ever changing needs of all, and make the necessary recommendations to our market developmental personnel.

Our commitment doesn't stop with our internal efforts. We also maintain a network of over 40 authorized independent parts and accessory distributors who are well positioned to support our wide range of customers in various markets throughout the country.

Parts and Service Literature Distribution

Once we've established what our customer needs, we have to get it to them. That's the job of over 80 employees that staff our parts and service literature warehouse in Kent. The building is a quarter mile long, and encompasses 228,000 square feet, which houses over 125,000 line items and 3 1/2 million pieces.

The warehouse day begins at 6:00 A.M. There are nearly 2,000 parts orders being processed at any given time. In order to manage such an overwhelming task, procedures have been created that allow us to meet our goal of having all orders shipped within 24 hours. By the end of the day, the facility will have shipped approximately 3,000 parts and literature orders, which consist of over 10,000 line items,

and over 40,000 pieces!

Through the use of bar coding, and a RF (radio frequency) based receiving system, we are able to reduce the turn around time for receiving and stocking, making goods available to the customer even sooner.

In August of this year, we will have completed our investment in the modernization of our warehouse operations. This will include the expanded use of RF and bar codes throughout the facility, conveyors, carousels and a new software system. Designed to create a paperless environment, this comprehensive, state of the art installation will enable us to provide faster, error free service to our customers as well as positioning Matsushita for the next decade.

Finally, in our effort to be earth friendly, the warehouse has been a leader in the effort to recycle. It all started four years ago when we began to use biodegradable packing material. Today, we have a comprehensive program to recycle all paper, cardboard, aluminum cans, and pallets. We make an effort to purchase recycled product when it is available. In recognition of our efforts, we were designated a "Distinguished Business in the Green" by King County.

The Future

There will be a continued emphasis on expansion of our customers' ability to go "on line" with MSC, not just for order entry and order inquiry, but also for credit and return procedures.

Internally, with systems that our customers don't directly see, we move further into the information age. Not only do our purchasing agents continue to employ CD-ROM information systems, we are now on line with our factories in Japan for inquiry purposes, a capability we plan expand to selected aspects of our market. The use of bar coding will continue to expand.

Our goal for the future is customer satisfaction, not just for our direct customer, but anyone who comes in contact with Panasonic, Technics, or Quasar. ■

Matsushita Original Replacement Parts and Accessories

A Guarantee of Quality

Nothing less than total satisfaction is expected by today's customers. The only way to live up to this standard is by using Matsushita Original Replacement Parts and Accessories. The source of this quality is The Matsushita Services Company and your Authorized Replacement Parts Distributor. Consult the list below, or call **1-800-545-2672** for the location nearest you.

CALIFORNIA

Andrews Electronics (C/V/M/A) * 25158 Avenue Stanford, Valencia 91355 * 800-289-0300 * FAX 800-289-0301
Cass Electronics (C/V/M/A) * 801 Seventh Ave., Oakland 94606 * 510-839-2277 * FAX 510-465-5927
E and K Parts (C/V/M/A) * 2115 Westwood Blvd., Los Angeles 90025 * 310-475-6848 * FAX 310-474-0846
Pacific Coast Parts (C/V/M/A) * 15024 Staff Court, Gardena 92048 * 800-421-5080 * FAX 800-782-5747
Star For Parts (V) * 10727 Commerce Way, Suite B, Fontana 92335 * 909-428-1404 * FAX 909-428-3213
Blakeman Wholesale/Tacony (V) * 1800 E. Walnut St., Fullerton 92631 * 714-680-6800 * FAX 714-680-8700

COLORADO

Star For Parts (V) * 2350 Arapahoe St., Denver 80205 * 303-296-2117 * FAX 303-296-2120

CONNECTICUT

Signal Electronics Supply, Inc. (C/M/A) * 589 New Park Ave., West Hartford 06110 * 203-233-8551 * FAX 203-233-8554

FLORIDA

Herman Electronics (C/V/M/A) * 7350 N.W. 35th Terrace, Miami 33122 * 800-938-4376 * 305-477-0063 * FAX 800-938-4377 * 305-477-8087
Layco, Inc. (C/V/M/A) * 501 South Main St., Crestview 32536 * 904-682-0321 * FAX 904-682-8820
Vance Baldwin (C/A/M) * 2701 West McNab Road, Pompano Beach, 33069 * 800-432-8542 or 305-969-1811 * FAX 800-552-1431 or 305-969-0226
Vance Baldwin (C/M/A) * 1801 NE 2nd Ave., Miami 33132 * 305-379-4794 * FAX 305-373-8855
Vance Baldwin (C/V/M/A) * 1007 N. Himes Ave., Tampa 33607 * 800-299-1007 * FAX 813-870-1088

GEORGIA

Buckeye Vacuum Cleaner (V) * 2870 Plant Atkinson Rd., Smyrna 30080 * 770-351-7300 * FAX 770-351-7307
Wholesale Industrial (C/M/A) * 5925 Peachtree Corners East, Norcross 30071 * 770-447-8436 * FAX 770-447-1078

ILLINOIS

B-B & W, Inc. (C/V/M) * 2137 S Euclid Ave., Berwyn 60402 708-749-1710 * FAX 708-749-0325
Hesco Inc. (V) * 6633 North Milwaukee Ave., Niles 60714 * 847-647-6700 * FAX 847-647-0534
Joseph Electronics (C/M/A) * 8830 N. Milwaukee Ave., Niles 60714 * 847-297-4208 * FAX 847-297-6923
Union Electronic Dist. (C/V/M/A) * 311 E. Corning Road, Beecher, IL 60401 * 708-946-9500 * 708-946-9200

INDIANA

Electronic Service Parts (C/V/M) * 2901 E. Washington St., Indianapolis 46201 * 317-269-1527 * FAX 800-899-1220

KANSAS

G & A Distributors, Inc. (C/V/M/A) * 635 N. Hydraulic St., Wichita 67214 * 316-262-3707 * FAX 316-262-6494

MARYLAND

Fairway Electronics (C/V/M/A) * 4210 Howard Ave., Kensington 20895 * 301-564-1440 * FAX 800-955-1358
Tritronics (C/V/M/A) * 1306 Continental Dr., Abingdon 21009-2334 * 410-676-7300 * FAX 800-888-FAXD

MASSACHUSETTS

Signal Electronics Supply, Inc. (C) * 484 Worthington St., Springfield 01105 * 413-739-3893 * FAX 203-233-8554
Tee Vee Supply Co. (C/V/M/A) * 407 R. Mystic Avenue, P.O. Box 649, Medford 02155 * 617-395-9440 * FAX 617-391-8020

MICHIGAN

G. M. Popkey Co. (C/V/M/A) * 5000 W. Greenbrooke Dr. S.E., Grand Rapids 49512 * 800-444-3920 or 616-698-2390 * FAX 616-698-0794
Remcor Electronics (C/V/M/A) * 10670 W. Nine Mile Rd., Oak Park 48237 * 810-541-5666 * FAX 810-398-1016

MINNESOTA

AVAC Corporation (V) * 666 University Ave., St. Paul 55104 * 612-222-0763 * FAX 612-224-2674
Ness Electronics, Inc. (C/V/M/A) * 441 Stinson Blvd. NE, Minneapolis 55413 * 612-623-9505 * FAX 612-623-9540

MISSOURI

Cititronix, Inc. (C/V/M/A) * 1641 Dielman Rd., St. Louis 63132 * 314-427-3420 or 800-846-2484

* FAX 314-427-3360

Tacony Corp. (V) * 1760 Gilsinn Lane, Fenton 63026 * 314-349-3000 * FAX 314-349-2333

NEVADA

MCM Electronics (C/V/M/A) * 205 Vista Blvd., Suite 103, Sparks 89434 * 702-355-1000 * FAX 702-355-1092

NEW JERSEY

Panson Electronics (C/V/M/A) * I-80 and New Maple Ave., Pine Brook 07058 * 800-255-5229 * FAX 800-332-3922

NEW YORK

Dale Electronics (C/V/M/A) * 7 E. 20th St., New York City 10003 * 212-475-1124 * FAX 212-475-1963
Fox International, Inc. (C/V/M/A) * 241-A Central Ave., Farmingdale 11735 * 516-694-1354 or 800-321-6993 * FAX 516-694-0595

Radio Equipment Corp. (C/A) * 196 Vulca St., Buffalo 14207 * 716-874-2690 * FAX 716-874-2698

Star For Parts (V) * 250 Rabro Drive East, Hauppauge 11788-0255 * 800-525-6046 * FAX 516-348-7160

OHIO

Fox International, Inc. (C/V/M/A) * 23600 Aurora Rd., Bedford Heights 44146 * 216-439-8500 * FAX 800-445-7991

MCM Electronics (C/V/M/A) * 650 Congress Park Drive, Centerville 45459-4072 * 513-434-0031 or 800-543-4330 * FAX 513-434-6959

OREGON

Diversified Parts (C/V/M/A) * 2114 S.E. 9th Ave., Portland 97214-4615 * 800-338-6342 * FAX 800-962-0602

Northwest Wholesale (V) * 426 NE Davis St., Portland 97232 * 800-234-8227 or 503-232-7114 * FAX 503-232-7115

The Moore Co. (C/V/M) * 333 SE 2nd, Portland 97214 * 800-487-0500 or 503-731-0100 * FAX 503-731-0105

PENNSYLVANIA

CRS Electronics (C/M) * 818 Brownsville Rd., Pittsburgh 15210 * 412-431-7700 * FAX 412-431-5666
Steel City Vacuum Co., Inc. (V) * 919 Penn Ave., Pittsburgh 15221 * 800-822-1199 or 412-731-0300 * FAX 412-731-3205

TENNESSEE

Shields Electronics Supply, Inc. (C/V/M/A) * 4722 Middlebrook Pike, Knoxville 37921 * 615-588-2421 * FAX 615-588-3431

TEXAS

Fox International (C/V/M) * 752 So. Sherman, Richardson 75081 * 800-321-6993 * FAX 800-445-7991

Interstate Electric Co. (C/V/M/A) * 11292 Leo Lane, Dallas 75229 * 214-247-1567 or 800-527-4029 * FAX 214-247-2137

M-Tronics (C/V/M/A) * 3201 West Ave., San Antonio 78213 * 210-340-4069 * FAX 210-340-4569

VCP International, Inc. (V) * 2285 Merritt Dr., Garland 75040 * 214-271-7474 * FAX 214-278-5981

VIRGINIA

Avec Electronics Corp. (C/M) * 711 Granby St., Norfolk 23510 * 804-627-3502 * FAX 804-627-1710

Avec Electronics Corp. (C/M) * 2002 Staples Mill Rd., Richmond 23230 * 804-359-6071 * FAX 804-359-5609

Avec Electronics Corp. (C/M) * 2009 Williamson Rd., Roanoke 24012 * 703-344-6288 * FAX 703-344-0081

WISCONSIN

G. M. Popkey Company (C/V/M/A) * 2035 Larsen Ave., Green Bay 54307-2237 * 414-497-0400 * FAX 414-497-4894

G. M. Popkey Company (C/V/M/A) * 2355 S. Calhoun Rd., New Berlin 53151 * 414-786-5887 * FAX 414-786-9031

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Matsushita Services Company

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Howard W. Sams & Company is proud to be celebrating 50 years as the nation's leading technical publisher. Since its inception in 1946, Sams has seen its product offerings expand and diversify, so that today, Sams boasts the most complete lineup of technical documentation, services, and publications found anywhere.

Over 50 years ago, Howard Sams was the first company to recognize that the increasing popularity of home entertainment electronics meant a corresponding demand for reliable service documentation. This insight gave birth to the first PHOTOFACT®, which presented concise technical information to help service technicians repair specific makes and models of radios. Televisions soon were added to the product line, followed by computer equipment and then VCRs, further enhancing Sams' ability to provide complete, consistent, high-quality repair information to service technicians.

Today, Howard Sams is the nation's largest provider of after-market service data for the television and VCR repair industry in the form of the PHOTOFACT® and VCRfacts® subscription services, as well as through such retail outlets as Radio Shack. Research shows that 95 percent of the companies providing after-market repair service for color televisions use Sams technical data.

The most useful features of Sams service data products for technicians are our featured parts lists and component replacement parts lists. We strive to provide our customers the most extensive replacement lists available in the industry today; eliminating the need to spend painstaking hours searching through manufacturers' data for one replacement code.

Another major part of the Sams technical products line, PROMPT® Publications has grown to become one

of the top technical imprints in the nation and one of Sams' brightest stars. Concentrating its efforts on technical books designed both for the novice and the experienced electronics technician, PROMPT® published over 40 books in its first five years, with another 20 scheduled to go to press this year.

With books such as *The Semiconductor Cross Reference*, which lists over 500,000 semiconductor replacements, and the *IC Cross Reference Book*, PROMPT makes every technician's job easier by eliminating the need to look through large volumes of data books for replacement information.

Each and every PROMPT® book provides a clear understanding of the principles involved in the installation, maintenance, and performance of electronic devices that have become such a large part of our everyday lives. Some of PROMPT's most recent best-selling titles include *Digital Electronics*, *Surface-Mount Technology for PC Boards*, and *Advanced Speaker Designs*.

Sams' photocopy service is another element of the company's business that provides invaluable information to its customers. With a library of hundreds of manufacturers covering a wide range of product lines and thousands of models, Sams can provide service documentation on most any product, including TVs, VCRs, FAX machines, computers, microwave ovens, antique radios, plus much more.

Last year marked another historic period for Howard Sams as it was acquired by Bell Atlantic Directory Graphics, a member of the Bell Atlantic family. Based in Valley Forge, Pa., Directory Graphics provides complete graphics services, database design, typesetting, pagination and state-of-the-art electronic database publishing,

multimedia, and CD-ROM applications for Bell Atlantic and other Yellow Pages and catalog publishers. The acquisition was a result of a successful strategic teaming agreement that started in 1994, when Directory Graphics and Sams began working together to develop DATAVIEW® an industry-leading on-line catalog delivery system. The teaming agreement demonstrated that Directory Graphics' technological skills combined with Sams' content-rich database and technical catalog expertise would lead to next-generation business-to-business information products for both print and electronic delivery.

Presently, Sams' five-million item database is being converted to a relational database platform, coined DATAHOST®. The information contained in DATAHOST® can be extracted from the database and delivered to distributor customers through not only traditional print catalogs and niche catalogs, but also CD-ROMs and electronic on-line applications. While the acquisition has had the most profound effect on Sams' catalog division, it brings increased potential and expansion opportunities to all elements of the business. This includes preliminary plans to make PHOTOFACT® service documentation and PROMPT® books available on-line via the Internet.

Since its very creation, Howard W. Sams & Company has been setting the standard by which every other technical publisher is judged. Many have tried, but few have succeeded in matching the level of quality and customer satisfaction that Sams provides with every one of its products. Sams is now taking its half-century of technical expertise into the next generation, once again forging the path that other publishers will try to follow.

To receive more information on any of Sams' products or services, please call 1-800-428-7267. ■

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Where the best service centers turn for replacement parts information.

Howard Sams offers a complete line of products to assist technicians in determining and locating recommended replacement parts.

PHOTOFACT®

Surveyed technicians say the comprehensive lists of parts and components is one of the main reasons they buy Sams' PHOTOFACT® service documentation. Replacement parts listed in every PHOTOFACT® include special or unusual items, safety items, and substitution items. Noted manufacturers include NTE Electronics, Philips ECG Company, and Thomson Consumer Electronics. These replacement manufacturers directly supply all the recommended parts information listed, so their accuracy and reliability is guaranteed.

Monthly Subscription: \$49.95
Individual Set: \$11.95



VCRfacts®

Sams' newly re-engineered VCRfacts® service documentation for VCRs includes comprehensive OEM parts replacement information. All semiconductors and mechanical parts are listed, and safety and special passive components are supplied with part numbers given for replacements. VCRfacts® is designed to provide service dealers and technicians with the reasonably priced repair information that is needed for timely and cost-effective VCR repairs. After 50 years in the business, Sams knows how to produce outstanding service documentation.

Monthly Subscription: \$19.95
Individual Set: \$24.95



Semiconductor Cross Reference Book

This newly revised and updated reference book is the most comprehensive guide to replacement data available. With more than 490,000 part numbers, type numbers, and other identifying numbers listed, technicians will have no problem locating the replacement of substitution information they need.

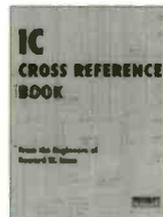
\$24.95
0-7906-1080-9
688 pages



IC Cross Reference Book

The engineering staff of Sams assembled this book to help technicians find replacements or substitutions for more than 35,000 ICs and modules. The IC Cross Reference Book was compiled from manufacturers' data as well as from the analysis of consumer electronics devices for PHOTOFACT®.

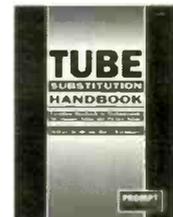
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0-7906-1049-3
168 pages



Tube Substitution Handbook

The most accurate, up-to-date guide available, the Tube Substitution Handbook is useful to antique radio buffs, old car enthusiasts, and collectors of ham radio equipment. In addition, marine operators, microwave repair technicians, and TV and radio technicians will find it to be an invaluable reference.

\$16.95
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As this free offer is designed to familiarize technicians with the PHOTOFACT® style and layout, Sams will be selecting the PHOTOFACT® folder which best represents the product. Requests for specific folders will not be honored in conjunction with this offer.

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Premium Parts+
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 Fax: 800-887-2727

It's New Catalog time again for...Premium Parts+ Electronics Company! The free catalog showcases over 10,000 popular items at competitive prices. Quantity discounts are also available for those who like to buy "Lots".

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Of course, Premium Parts+ carries the

incredible Chip Quik® SMD systems. In just 4 easy steps you can easily remove an SMD with our Chip Quik SMD Removal Kit (CQ123). You can complete the entire rework process of removal and replacement with the Chip Quik SMD Bench Rework System (CQ1000). The Chip Quik System is *safe, easy and recommended by Sony!*

HR Flybacks! We have them too! Premium Parts+ is currently stocking over 350 HR® flybacks for both TV and computer monitors. Not just your ordinary generic flybacks, HR flybacks are manufactured by an ISO 9001 quality certified company from Barcelona, Spain. This is a new product line for us so we will be expanding to meet your needs.

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vice. By requesting PREMIUM DELIVERY, your parts will be delivered within 48 hours via UPS 2nd Day Air anywhere in the 48 states for just \$6.75*. Or we'll send your order via UPS Overnight Air with guaranteed noon delivery anywhere in the 48 states for just \$16.75, regardless of its weight.* All orders placed by 2:00 PM Central Time are normally shipped the same day via UPS ground, unless you request our PREMIUM DELIVERY Service.

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PREMIUM PARTS+ strives to be your one source for innovative and high quality electronic replacement products. Call us at 800-558-9572 toll free OR call our 24 hour toll free fax line at 800-887-2727 for your FREE copy of our catalog! ■

* Plus the regular handling charge. Based on UPS 1# rate. Subject to change if UPS raises rate. Excluded from this offer are: shipments to Alaska and Hawaii; chemicals; literature including, reference books; and all back orders.

**Note: Reference materials and video tapes are non-returnable, unless defective.



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Herman Electronics

Phone: 800-938-4376

Fax: 800-938-4377



**7350 Herman Way
Miami, FL 33122**

Herman Electronics is a diverse, full-line distributor of everything in electronics, committed to offering only the best in original replacement parts, tools, test equipment, and most importantly, customer service to their customers. In business for over 40 years, Herman Electronics has clearly established itself as one of the leaders in the industry by providing only quality products and superb customer service to all facets of the electronics industry.

1996 is a very special year for Herman Electronics. After 35 years, they are celebrating their first anniversary in their new state of the art distribution facility.

Herman Electronics' product base varies from original replacement parts and accessories to test equipment and everything in between including tools, soldering & desoldering equipment, chemicals, cable, connectors, microphones, line conditioners and virtually everything to fulfill a servicer/technician's needs.

The heartbeat of the company lies in the OEM parts department. While servicing the industry for over three decades, Herman Electronics has many of the major OEM parts lines, enabling them to provide more efficient and cost effective service to you, their valued customers. Herman is one of the largest original replacement parts and accessory distributors in the country and is factory authorized for

SONY, PANASONIC, RCA (premier), SAMSUNG, QUASAR, KENWOOD, GE, TECHNICS, ONKYO, and TOSHIBA. Stocking one of the largest and most comprehensive inventories enables the company to fill over 80% of their orders from their 50,000 stocking items and guarantees TWO-DAY service (at no additional charge) to you on all in stock orders placed before 4:30 P.M. (EST).

Herman Electronics is able to provide a variety of customer support services as a result of the company's commitment to customer service excellence. They have several customer service representatives to serve all your needs from 8:30 A.M. to 6:00 P.M. Monday thru Friday.

The company prides itself on being accommodating to its customers in order to deliver total customer satisfaction. "We realize there are many good distributors throughout the country" says Jeffrey A. Wolf, Vice-President and son of one of

the company's founders. "It is our job to be better by taking that extra step in giving our customers professional personalized service. This industry has quickly become service driven. Therefore, we are dedicated to maintaining a standard of excellence in customer service."

Herman Electronics makes ordering easy and provides several benefits to insure customer satisfaction. All orders are shipped according to individual needs. Several methods of payment are available including a net 30 day open account, COD, Mastercard/Visa or American Express. To accommodate the west coast and after hours requests and orders, Herman Electronics has an electronic telephone and fax ordering system to insure service 24 hours a day, seven days a week.

If you haven't given Herman Electronics a try, please do so now - you'll be glad you did! Herman Electronics - with only ONE call you get it all. ■

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Vance Baldwin Electronics

2701 McNab Road
 Pompano Beach, FL 33069
 Phone: 1-800-432-8542
 Fax: 1-800-552-1431

Vance Baldwin Electronics is one of the leading OEM electronic parts distributors in the country...and it didn't happen by accident! Consistent attention to customer service and a commitment to keeping pace with technology has positioned them as leaders of their industry. A family owned and operated business, Florida based Vance Baldwin has three warehouses carrying well over 100,000 SKU's. From original replacement parts, accessories and test equipment, to chemicals and a full line of generic replacement parts, Vance Baldwin has it all! Whether you're a professional electronic service technician or a do-it-yourselfer, Vance

Baldwin has the people and parts to help you get the job done.

With over fifty employees, Vance Baldwin is able to provide their customers with the most complete and knowledgeable service in the industry. When an order comes in via phone, it's handled by one of our customer service representatives, right from the first "Hello". From any of our branch locations, our service people have access to Vance Baldwin's complete inventory. You'll know what we have, where we have it, and when you'll receive it...all while you're on the line! At Vance Baldwin Electronics it is our goal to get the product to you within two days, and

at no extra cost to you. Your success is our success! We can also complete most research requests immediately.

For customers with modems, Vance Baldwin has a proprietary on-line ordering software system. Customers are able to access the computer system, check inventory and product availability, place orders, and find out about new products. This information is available in both English as well as Spanish. Computerization plays a key role in all facets of the operation except one...the phones. At Vance Baldwin Electronics, your call will be answered by customer service people who, in many cases, know the customers personally and have been doing business with them for years. You get the best of both worlds at Vance Baldwin, personal service with computerized speed and accuracy! If you would like to contact us at our E-mail address; VBPARTS@ AOL.com you can leave a request, or call 1-800-432-8542 to order your electronic products today!

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I.C.M. Components

1226 Third Street Promenade , Suite 206
 Santa Monica, CA 90401, U.S.A.
 Phone: 310-260-1444; 800-748-6232
 Fax: 310-451-8727

I.C.M. Components is an importer and distributor of high quality computer monitor flybacks, computer monitor testers, schematics and service manuals. Flybacks for televisions are also available.

Offering the highest level of service, I.C.M. processes and ships most orders the same day from an inventory of over 600 different types of flybacks and 620 different types of schematics/service manuals. There are no minimum orders and most major credit cards are accepted.

Helping the repair technician is I.C.M.'s top priority. In addition to schematics we offer several types of software designed to assist the tech. One such software program is our Tech-Tip Repair Program for Windows; the program contains over 850 Monitor, CPU, and Power Supply failures listed by symptom and solution. The program is updated once a month and upgrades can be purchased for a small

charge plus S&H at any time during the first year after the initial purchase. A DOS version of the program that covers over 400 different failures listed by symptom & solution is available for only \$99.95 and can be upgraded to the Windows version during the first year for just the difference in price plus S&H.

To help identify who made the different brands of monitors, I.C.M. offers a FCC-ID software program for \$50.00. The FCC-ID database contains over 60 pages of monitor manufacturer names and addresses. The software is easy to install and operate; no long instruction texts are ever required. Considering the many off-brands of monitors being sold now, this program is a must to easily identify the O.E.M.

Our line of Computer Monitor Testers are affordable and easy to operate. Starting at only \$99.00 plus S&H our testers can test most of the IBM compat-

ible monitors including MDA, CGA, EGA, VGA, SVGA. There is no need to use a computer or to change video cards; the ease of operation, reliability and low price has made our testers a very popular choice with repair depots that already own the top names in testing equipment in the repair industry.

A new TV tester will be introduced in August 1996; price and specifications are available upon request.

I.C.M. sales people are dedicated to complete customer satisfaction. Our staff is knowledgeable, dependable and friendly. To obtain the latest availability and pricing call our toll-free telephone line between 7:00 AM - 5:00 PM (Pacific) Monday through Friday. During off hours and days use our voice mail to leave detailed parts request information; all calls will be promptly returned with price and availability.

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Andrews Electronics

**PO Box 914
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Phone: 800-289-0300
Fax: 800-289-0301**



Andrews Electronics is housed in 50,000 square feet of warehousing and office space. Miles of shelving are arranged for immediate identification and easy accessibility for over 250,000 different parts that we carry.

Andrews is the largest supplier in America for the majority of the manufacturers we represent. Our average fill rate is over 90%, and our dealer order desk has 30 available sales representatives available to take care of all your ordering needs.

We've built our reputation on a very simple philosophy.....service. Not very fancy, but very effective. Our constant growth attests to it. You see, all of our policies that have been developed over the years have been based on that one simple thought: "How may we better serve the industry?" How about:

- 14 major brands to save you time, frustration, and money with "one-stop shopping."
- Orders placed before 2:30 PST are routinely shipped the same day.
- A freight program that offers free or discounted shipping.
- No minimum orders or handling charges.
- Automatic backorder reports with ETA's mailed bi-weekly.
- A fast, highly-efficient research department, second to none.

- A program that converts make/model descriptions to part numbers instantly for the majority of research requests.

- 24-hour toll-free phone and fax order lines.
- Over 80 full-time employees waiting to serve your needs.

Our newest feature is an online system that allows select customers to directly access our computer! This program offers the widest possible range of servicing including:

Placing orders that are automatically prioritized and will accept multiple purchase order numbers, research, etc., viewing previous orders, access to our model file, will enable customers to perform the majority of their research immediately.

You'll be able to view backorders with ETA's, part inquiry for pricing and availability on a system that also provides information on substitutes and allows partial part numbers to be entered.

This is just one more reason to make us your "one-stop shopping" distributor.

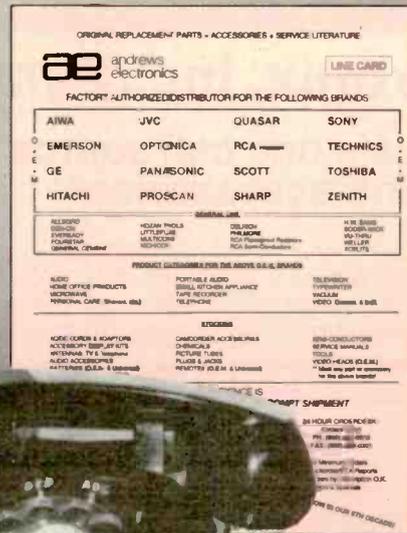
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before, now's the time to let us prove it to you. By investing a mere two minutes of your time, you can discover what thousands of others have: that there is a difference. When you place your next order with your local supplier, check the availability of all the items. Then call or fax Andrews and check our stock levels. We believe you'll be pleasantly surprised! Wouldn't getting those extra units repaired a week or two sooner be good for your reputation? Sure it would! And we can help! After all is said and done, it is performance that counts. We know that your ability to perform your job depends on how well we perform ours. Our regular office hours are from 8:15 to 4:45 PST and we're closed for lunch between 12:00 and 12:30. When you think of electronic parts...think of Andrews. ■



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CitiTronix, Inc./Panson Electronics

America's one call source for brand name electronic parts and accessories®

CitiTronix/Panson's affiliation is based on 90 years of combined parts distribution experience. Serving North America's servicers and customers by distributing high quality exact replacement parts and accessories for most major consumer electronic manufacturers.

In January, 1994 CitiTronix, Inc. and Panson Electronics formed an alliance which operates under the name CitiTronix/Panson.

Benefits for you from this alliance are:

- More product lines - by combining resources the alliance offers more lines than ever.
- More Inventory - With multiple warehouse facilities the "in-stock" parts inventories are larger than ever.
- Faster shipping - Multiple warehouse facilities allows your order to be filled and shipped from the most efficient location.
- State-of-the-Art/Computerized Phone System - allowing for immediate access to the customer service department, research help desk, fax and Dial-In/On-Line access (P.A.R.T.S.®).

The company maintains an experienced staff dedicated to serving you and providing exact replacement parts for your servicing needs. Parts research is provided via the On-Line system, or by calling 1-800-846-2484. This research includes helping you determine the correct parts and recommending alternates when parts are no longer available. A large collection of manufacturer's literature, microfiche and computer data is maintained for the sole purpose of assisting you.

The company maintains a state-of-the-art computerized telephone system, Fax, and one-line computer system for communicating with you. The remote customer access system (P.A.R.T.S.®) is continually updated and provides research capabilities as well as access to the complete combined company inventories.

Warehouses are located in Pine Brook, New Jersey, St. Louis, Missouri and the Chicago area.

In 1994 JCPenney named CitiTronix/Panson as their exclusive authorized repair parts distributor.

Both CitiTronix, Inc. and Panson Electronics are long-time parts distributors and have interesting histories.

CitiTronix was founded on June 1, 1936 and was called City Refrigeration Company. It began as a service company servicing washers, dryers, ranges and refrigeration products.

A dramatic change came to CitiTronix in 1977 when the first electronic lines were added to the existing appliance lines. Following are the brands of exact replacement parts offered:

- Sony
- Philips, Magnavox, Sylvania, Philco
- Matsushita (Panasonic, Quasar, Technics)
- Sanyo & Fisher
- Thomson Consumer Electronics (RCA Premier, GE, ProScan)
- Kenwood
- JCPenney

On January 8, 1988, the name City Refrigeration Co., Inc. was changed to CitiTronix, Inc. and a 13,800 sq. ft. facility was established.

Panson Electronics was established in 1965 as a supplier of electronic repair parts and was authorized as the first Panasonic repair parts distributor in the U.S.

Responding to the ongoing changes and needs of the consumer and repair industry, Panson began expanding its services so that today it distributes exact replacement parts for such well-known electronic products as:

- Sharp
- Hitachi
- JVC
- Zenith
- Thomson Consumer Electronics (RCA Premier, GE, ProScan)

- Matsushita (Panasonic, Quasar, Technics)
- JCPenney

In August 1993, Panson relocated from Greenpoint, N.Y. to the present 20,000 sq. ft. facility in Pine Brook, N.J. in order to provide the fastest parts delivery available.

CitiTronix/Panson features:

- A consistent high level of service.
- A knowledgeable customer service department that is available from 8:00 AM to 4:30 PM CST.
- Free freight on back orders.
- On-line remote access system with extensive data base, parts price/availability, model number to part number research, open order status and order entry (P.A.R.T.S.®).
- Open line of credit available.
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CitiTronix • 1641 Dielman Rd. • St. Louis, MO 63132-1597 • Office: 314-427-3420

Panson • I-80 & New Maple Ave. • P.O. Box 2003 • Pine Brook, NJ 07058 • Office: 201-244-2440

Circle (118) on Reply Card

Thomson Consumer Electronics, Inc.

1-800-336-1900

(Call for the distributor nearest you!)



Thomson Consumer Electronics believes that you should have a choice. We realize that you rely on our genuine replacement parts not only during the required warranty period, but also when you want the highest level of quality and performance. We also realize that not every estimate can be converted to a repair using original parts. That's our difference, we give *you* the choice!

Original Parts

RCA and GE genuine replacement parts provide today's service professional with the reliability you need when completing warranty repairs. And they are delivered to you by parts distributors who provide an outstanding level of service. In fact, our most recent survey of the service industry shows that three out of four servicers believe that **no other manufacturer** provided a *consistently better* parts fulfillment system than the Thomson Consumer Electronics' parts distributors.

Thomson Premier Distributors can fill your warranty part orders either off their shelves on all in-stock products, or by placing a Direct Drop Shipment (DDS) order via computer directly into the TCE national parts depot. Either way, you receive the part you need to complete the repair quickly and you get the highest possible fill rate for warranty parts to service RCA, GE and ProScan products. This computer link also allows the Premier Distributor access to all the information needed to provide you with the high level of service you require in today's fast paced business.

SK Series Universal Parts

You know that lower estimates equal more repairs and more business for you. To help you turn more of those COD estimates into repairs, Thomson has broadened it's line of SK Series products to include Universal Replacement parts. These quality parts let you reduce the repair estimate by lowering your replacement parts cost, and that's good news for you!

SK Series Universal Parts cover a wide range of high wear, high usage parts.

Whether you need video heads, idlers, gears, pulleys, tires, belts, pinch rollers, laser pickups, RF modulators, exact semi-conductors, tool kits or other servicer aids you can look to SK Series.

TCE Literature

Thomson also provides a number of publications which makes finding the right part for the repair even easier. In addition to TCE service data, the "Television Components Quick Reference Guide" contains key part numbers for recent RCA, GE and ProScan chassis. It's ideal for the technician on the road - it folds to fit in your pocket. The Quick Reference Guide also contains a section dedicated to the EPROM's associated with chassis CTC-168 through CTC187.

Another hard copy publication is the TCE "Source Book" which contains a wide variety of information. The extensive main section contains VCR/Camcorder Key Items, with a look-up by brand and model. Another section contains an OEM manufacturer number look-up for SK Universal Parts, belts and other wear items along with photos, as well as a complete Camcorder Battery cross reference. The "Source Book" also contains information on TCE Tools and Fixtures by model number, Flameproof Resistors, IC Protectors, and Axial Lead Zener Diodes.

These publications are available from your Authorized Thomson Parts Distributor. For the *Quick Reference Guide* order publication 1J9548, for the *VCR/Camcorder Source Book* order publication number 1J9780.

The Thomson "Tech Aid" Family

The first three members of Thomson's "Tech Aid" family have recently been introduced. This involvement of new technology in the Consumer Electronics service business represents a trend which will help improve Quality, Productivity, and Customer Satisfaction in our business as well as yours.

A PC software package called Chipper Check™ will be used to perform diagnostics and alignments on models containing chassis CTC178, 179, 188, and 189. With

a click of a mouse button the Servicer's Personal Computer will "talk to" TCE models containing the CTC178, 179, 188, and 189 chassis via a communications interface. In addition to the service features, the Help Screens and point-and-click references serve as excellent training supplements, and provide troubleshooting assistance for your technicians.

Thomson also offers other software subscriptions in the "Tech Aid" software family. PartsFinder™ serves as a fast look-up tool for needed replacement parts and Service data information. Nipper Net™ is an on-line system that allows subscribers to download important, up-to-date information like Service Bulletins to their PC's rather than wait for periodic mailings of diskettes or printed materials.

These "Tech Aid" family members are all available from Thomson Consumer Electronics Publications. Call (502) 491-8110 for more information.

Accessories and Components Business

The Thomson Consumer Electronics, Accessories and Components Business provides service from a 358,000 square foot facility located in Deptford, New Jersey. All business functions—customer service, sales and marketing, quality assurance, product analysis, administrative departments and warehousing operate under one roof. Some parts are stocked in satellite warehouse facilities in El Paso TX, Asheville NC, and Indianapolis IN.

A full line of RCA brand Consumer Electronics Accessories is marketed from this facility as well. The business is managed by Larry R. McKinney, General Manager. Thomson Consumer Electronics corporate headquarters is in Indianapolis.

One Call is All You Need to Make

Whether you need original RCA and GE parts or SK Series products, your Thomson distributor is your one stop source. A single call to a Thomson Distributor gives you the choice you deserve, making your business more profitable. To locate a nearby Thomson Authorized Distributor simply call (800) 336-1900 today. ■

Sometimes There's No Substitute For The Genuine Article...

As a member of today's professional electronics repair industry, we realize that you rely on our genuine replacement parts not only during the required warranty period, but also when you want the highest level of quality and performance.

Thomson Consumer Electronics' Authorized Parts Distributors can provide you with the replacement part which meets original specifications for RCA, GE and ProScan brand products.

Not only is Thomson a leader in producing quality Home Consumer Electronic products, but our most recent survey of the service industry shows the majority of you believe that **no other manufacturer** provided a consistently better parts fulfillment system than Thomson. We thank you very much.

As a result, quality parts and quality service combine to protect your reputation with your customers. Is anything more important to you?

RCA
PROSCAN



**Genuine
Replacement
Parts**

Sometimes There is



We also realize that not every estimate can be converted to a repair using original parts, especially VCRs. Our growing line of low cost, high quality SK Series universal parts can help you convert more of those jobs and increase your profits. Whether you need video heads, idlers, gears, pulleys, tires, belts, pinch rollers, laser pickups, tool kits or exact semiconductors, you can look to SK Series.

We have parts for Panasonic, JVC, Sony, Zenith, Magnavox and most other brands...and you can get all these parts with one call to your Authorized Thomson SK Series Parts Distributor. What could be easier or more convenient?

For more information on the SK Series line of universal parts contact your Thomson Parts Distributor.

 **THOMSON CONSUMER ELECTRONICS**

2000 Clements Bridge Road Deptford, NJ 08096-2088

Circle (107) on Reply Card

RNJ Electronics, Inc.

805 Albany, Ave., PO Box 528
Lindenhurst, NY 11757
Phone: 800-645-5833
Fax: 800-RNJ-FAX1

RNJ Electronics, Inc. is now entering its 16th year as a full-line discount distributor, servicing the TV, VCR, computer, stereo, and microwave repair industries. In addition, RNJ Electronics is a leading supplier of background sound products including PA amplifiers, microphones, speakers, wire, etc. RNJ is also your source for all home theater products including Dolby Pro-logic receivers, in wall speakers, subwoofers, center channel speakers, as well as Decora volume controls. RNJ electronics can now fill your DSS satellite needs including both the basic and deluxe systems. The company has also become a leading distributor in an industry experiencing tremendous growth: the security industry, stocking products such as cameras, monitors, sequential switchers, quad splitters, multiplexers, lenses, modulators, etc.

The company publishes a semi-annual,

136-page catalog containing thousands of items all at discounted prices. Product categories in our catalog include test equipment by B&K Precision, EMCO, Global Specialties, Fluke, Wavetek, and AVCOM. In addition, the company also stocks a full line of audio video and antenna accessories, universal remotes, TV and VCR wall mounts, mobile carts, service chemicals, an extensive line of VCR parts, camcorder accessories, TV and monitor flybacks, Japanese semi-conductors, microwave oven parts, educational kits, tools and soldering equipment and computer accessories. RNJ is also one of the largest stocking distributors of Panasonic cable converters.

RNJ Electronics prides itself on its ability to stay current with the ever changing needs of its customers. Customer service is a top priority for the company. All orders are processed in a timely manner with



shipping via UPS. The company has added additional phone lines as well as an 800 fax line.

The company offers volume discounts for large orders. It also ships all over the world. RNJ Electronics, Inc. can meet all of your needs. Call toll free and see. ■

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Fax: 702-434-7509

"The On Time Electronic Distributor" is our motto at MAT Electronics and we have proudly served the electronic repair industry for over ten years. Over the past several years, MAT Electronics has strived to constantly improve their product lines, customer service and competitive pricing.

MAT Electronics has two locations to better serve our customers—our original location in Pennsylvania and our newest location in Las Vegas, Nevada. The growth of MAT Electronics has been due to the following: quality product, competitive prices and fast reliable service. The company's products are used by manufacturers, engineers, hospitals, technical training schools, hobbyists, and technicians.

MAT Electronics stocks an extensive line of flybacks (TV and monitor), Japanese semiconductors, capacitor and MATV accessories. Recently, MAT Electronics has start-

ed to distribute original parts from Hitachi, NEC, Panasonic and Sony at very competitive pricing. The company publishes an easy-to-read 100-page catalog filled with thousands of inventoried items, which can be accessed immediately on their state-of-the-art computer system.

MAT Electronics is always current with market trends in the repair industry—always emphasizing what is new in electronic parts and components—for VCR's, TVs, computer monitors, stereos, microwaves and surveillance equipment. MAT Electronics sources its products from around the world as well as domestically to offer the best product at a true savings.

MAT Electronics is proud to be a prominent distributor in the surveillance industry and is an authorized Sony, Philips, Provideo distributor.

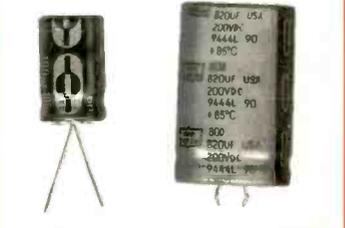
MAT Electronics takes great pride in its abil-

ity to accommodate the various needs of all their valued customers—both in the US and worldwide. The company normally ships orders within 24-hours of receipt of your order, but UPS red and blue label service is also available to ensure even faster delivery service if necessary.

The company takes pride in our friendly and knowledgeable telephone operators on both coasts, who are waiting to take your phone call and deal courteously with any questions you may have about any electronic part. If you don't see it in the catalogue—just ask for it.

Mat Electronics takes the risk out of ordering from a catalog, offering a 90-day 100% guarantee on all purchases. Large volume discounts are also available. The company's toll-free lines are open weekdays 8:30 A.M. to 7 P.M. EST, and Saturdays from 8:30 A.M. EST until 2:00 P.M. The toll-free FAX number available 24 hours a day.

VCR REPLACEMENT PARTS		POPULAR SEMICONDUCTORS		FLYBACK REPLACEMENTS		CAPACITORS	
VXP0521 Panasonic Idler	\$2.99ea (10 min)	BU208A	\$2.50ea (10 min)	154-040A	\$19.95ea	4.7M/160V	Radial \$.45ea (10 min)
164113 RCA Idler Original	\$1.89ea (10 min)	2SC1172B	\$2.50ea (10 min)	154-074E	\$19.95ea	4.7M/250V	Radial \$.45ea (10 min)
NPLY0111GEZZ Idler Original	\$7.95ea (10 min)	2SD869	\$2.50ea (10 min)	2434391	\$24.95ea	4.7M/350V	Radial \$.55ea (10 min)
613-022-2534 Sanyo/Fisher Gear	\$.29ea (10 min)	2SD1397	\$1.99ea (10 min)	2434651	\$24.95ea	10M/160V	Radial \$.55ea (10 min)
199347 RCA Belt Kit	\$1.99ea	2SD1398	\$1.99ea (10 min)	3214003	\$24.50ea	10M/250V	Radial \$.65ea (10 min)
VTK-1 Video Tool Kit	\$29.95ea	2SD1426	\$1.99ea (10 min)	043220011	\$26.50ea	10M/350V	Radial \$.75ea (10 min)
198522 Audio Bias Oscillator	\$2.25ea	2SD1427	\$1.99ea (10 min)	79A307-1	\$24.95ea	100M/50V	Radial \$.50ea (10 min)
VSJS0018 Orig. Panasonic Solenoid	\$5.95ea	2SD1650	\$1.99ea (10 min)	1-439-357-11	\$19.95ea	100M/63V	Radial \$.50ea (10 min)
VEMS0099 Panasonic Motor	\$9.50ea	2SD1651	\$1.89ea (10 min)	F0014	\$19.95ea	100M/100V	Radial \$1.00ea (10 min)
143-0-7504-01000 Fisher Belt	\$.85ea (10 min)	2SD1879	\$2.50ea (10 min)	F0015	\$19.95ea	100M/160V	Radial \$1.00ea (10 min)
157061 RCA Belt	\$.85ea (10 min)	SDA-3202-3	\$6.50ea (10 min)	F0016	\$19.95ea	100M/200V	Snap-in \$1.00ea (10 min)
157062 RCA Belt	\$.85ea (10 min)	STK4273	\$8.50ea (10 min)	F1588	\$26.50ea	100M/250V	Radial \$1.25ea (10 min)
MSU911 Toshiba RF Mod	\$13.95ea	STK4274	\$6.95ea	TLF14401F	\$28.50ea	330M/200V	Snap-in 10/for \$19.90
MSU951 Toshiba RF Mod	\$13.95ea	STK0080	\$13.00ea (10 min)	TLF14423F	\$29.95ea	470M/200V	Snap-in \$1.99ea (5 min)
VA3409 Emerson RF Mod	\$13.95ea	STK5481	\$12.25ea (10 min)	TLF14530	\$24.95ea	680M/200V	Snap-in \$2.99ea (5 min)
VA3422 Emerson RF Mod	\$13.95ea	TA7777	\$9.50ea (10 min)	TLF14515F	\$26.95ea	800M/200V	Snap-in \$2.50ea (5 min)
RTU006GEZZ Sharp RF Mod	\$13.95ea	TDA4505A	\$8.95ea	TLF14561F	\$26.95ea		
RTU0035GEZZ Sharp RF Mod	\$13.95ea	TDA8305	\$9.50ea (10 min)	TLF14801F	\$24.50ea		
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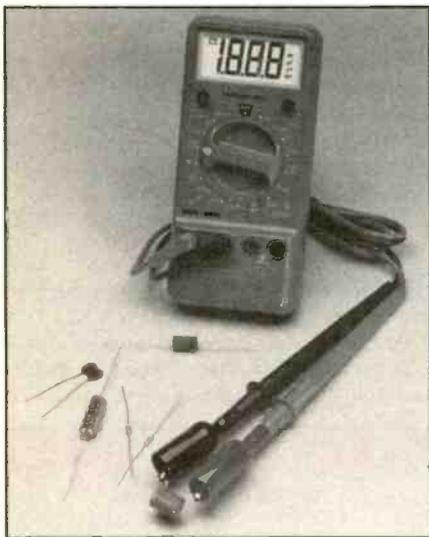
Circle (57) on Reply Card

PRODUCTS

Capacitance/resistance meter

Wavetek Corporation announces a new capacitance/resistance meter.

The unit is a full range capacitance meter, measuring capacitance in nine ranges, from 200pF to 20mF, with 0.1pF resolution. The meter features a CAP zero adjust button to compensate for test lead and stray capacitance. The meter measures resistance in seven ranges, from 20Ω to 20MΩ, with a 0.01Ω resolution in the



20Ω range. The 20Ω range (Low Ohms) also features the zero adjust button to compensate for test lead resistance.

The product has large display characters and includes enunciators to echo the specific range selected.

Circle (16) on Reply Card

DMM with frequency counter

American Reliance offers the Model 700T, 4 1/2 digit multimeter with true RMS and frequency counter.

The meter features dc and ac voltage measurement, dc and ac current measurement up to 20A, diode check, audible continuity check, and data hold. Frequency counter measures frequencies up to 200KHz. This instrument is also drop-proof up to four feet. The display is 0.43 inches high with "Lo Bat" and decimal annunciators.

Circle (17) on Reply Card

Benchtop fiber tool kit

A benchtop Fiber Tool Kit is offered by Jensen Tools, Inc. for those who need a



complete kit of tools to put connectors on fiber, but don't require the portability and durability of a fiber optic field service kit. The benchtop kit features a six-drawer Flambeau case with everything needed to terminate AMP's Light Crimp fiber connectors, except the connectors, polishing pucks, and epoxy.

Included are an AMP crimp tool, 125μ cable stripper, sapphire scribe, 100X inspection microscope, plexiglass polishing plate, 20 sheets each of 0.33, and 12 micron polishing film, safety glasses, three syringes, plastic bottle, mixing cups, and miniwipes.

The company offers to modify the Benchtop Fiber Tool Kit to meet individual connector requirements.

Circle (18) on Reply Card

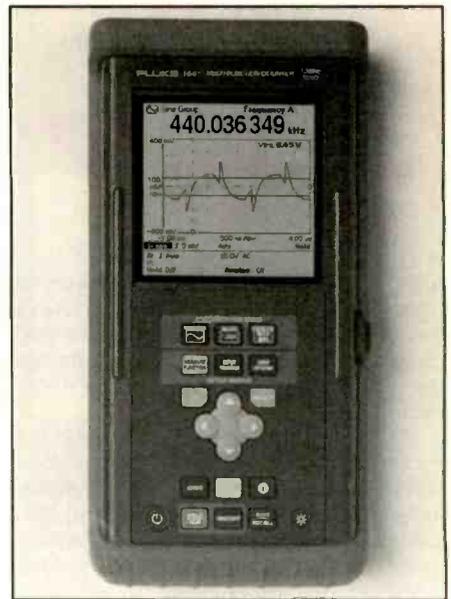
Synthesized function generator

The Model 1010 from Videospectra operates not only as a synthesized function generator, but also as a sweep and pulse generator. Communications functions such as AM and FM are also incorporated. That's the equivalent of more than three instruments, all utilizing multiple DDS (direct digital synthesized) sources for timebase, rate and modulation generation. Any frequency, rate or time interval can be specified to resolutions greater than 9 decimal digits - over 4 billion frequencies.

Circle (19) on Reply Card

Handheld counter-timer

Fluke Corporation offers a new class of frequency counter/timers. Called the 160 Series Multi-Function Counters,



these battery or line powered instruments offer powerful measurement capabilities in a rugged handheld product. Two models, the Models 163 and 164, offer major design innovations that will overcome the difficulties users experience with conventional counters and counter/timers.

The instruments can handle virtually all the precision, high-speed time and frequency measurements needed in today's engineering and maintenance applications. The 10-digit display provides nine digits of resolution in one second. Two optional higher stability oscillators are also available for Model 164; the 5x10⁻⁷ temperature compensated oscillator and the 1.5x10⁻⁹ ovenized oscillator.

Circle (20) on Reply Card

Virtual electronics lab

CircuitMaker for Windows from Micro-Code Engineering, a schematic capture, circuit simulation program has been upgraded to a 32 bit application. It also includes a built in symbol editor that allows a user to draw a schematic symbol and associate functionality with the symbol, an interactive run time display of analog waveforms and simulation progress, component value stepping and comparison and 500 plus new devices, bringing the total to more than 1500.

The software allows users to transform digital, analog and mixed-mode circuit designs into functional circuits.

Circle (21) on Reply Card

BOOKS

Simplified Design of Linear Power Supplies, By John Lenk, Butterworth-Heinemann, \$29.95, 246 pp

Butterworth-Heinemann is pleased to announce that their Simplified Design of Linear Power Supplies, by John Lenk, is now available in paperback. Part of the EDN Series for Design Engineers, this book is a one-stop guide to linear power-supply design, using step-by-step instructions and diagrams.

Well suited for the beginner/student/experimenter as well as for the professional, this book requires no design experience to understand and utilize the techniques described. Lenk concentrates on the use of commercial IC regulators by discussing a selection of external components that modify the IC-package characteristics. A chapter is devoted to heat sinks and other temperature-regulated design problems. Another chapter concentrates on testing the linear supplies in

both experimental and final form, and illustrates the connection of the completed supplies.

The thoroughly detailed operation of all circuits provides a basis for those totally unfamiliar with linear supplies and a refresher for the design professional. All popular forms of linear supplies, including zener, three-terminal, feedback, current foldback, op-amp, series, shunt, and IC package are covered in detail. In addition, the design examples may be put to immediate use, as is, or can be modified to meet a specific design goal.

Butterworth-Heinemann, 313 Washington Street, Newton, MA
02158-1626

Op Amps: Design, Application, and Troubleshooting, Second Edition, by David L. Terrell, Butterworth-Heinemann, \$49.95 hardcover, 512 pp

Op Amps: Design, Application, and Troubleshooting, Second Edition is new

from Butterworth-Heinemann. David L. Terrell's new edition deliberately straddles that imaginary line between the technical and engineering worlds. Topics are carefully addressed on three levels: operational overview, numerical analysis, and design procedures.

Troubleshooting techniques are presented that rely on the application of fundamental electronics principles. Systematic methods are shown that can be used to diagnose defects in many kinds of circuits that employ operational amplifiers.

The book is written in an easy-to-read, conversational writing style. The author speaks directly to the student in a manner that encourages learning. This book explains the technical details of operational amplifier circuits in clear and understandable language without sacrificing technical depth.

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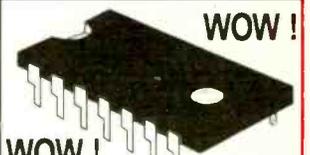
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CTC175 K, K2, L, L2	ROM7523	3.39
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CTC176 L2	ROM7699	5.65
CTC176 N2	ROM7632	3.35
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CTC177AA2, AK2	ROM7779	3.35
CTC177 AA3	ROM7715	3.31
CTC177 AC	ROM7742	3.39
CTC177 AD, AG	ROM7701	3.39
CTC177 AE, AH	ROM7703	3.39
CTC177 AF	ROM7702	3.39
CTC177 AF2	ROM7735	3.35
CTC177 AH2, BH2, BH3, BM2	ROM7781	3.35
CTC177 AJ2	ROM7795	5.65
CTC177 AM2, AF3	ROM7787	3.65
CTC177 AR2	ROM7716	3.31
CTC177 BB	ROM7761	3.39
CTC177 BD, BF	ROM7797	3.39
CTC177 BE, BG	ROM7798	3.39
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CTC186 A, D	ROM8667	3.35
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CTC187 BC, BD, BF, BD2, BF2	ROM8788	3.35
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CTC187 CH, CN, CN2, CN3	ROM8705	5.05
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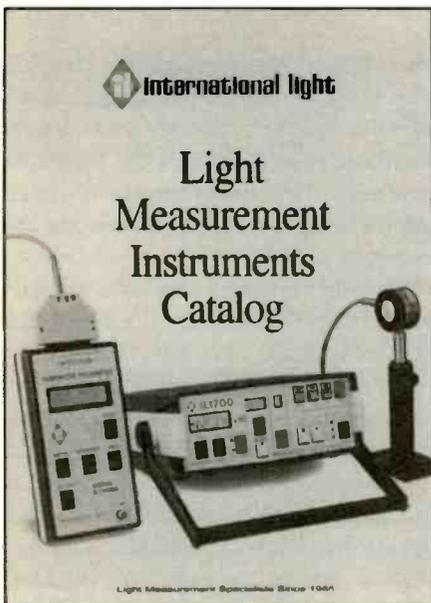
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221-87-01	2.15	221-285-02	1.75
221-92	.95	221-301	1.75
221-96	1.75	221-365-01	3.25
221-97	1.75	221-369	3.95
221-97-02	1.75	221-379	2.00
221-104	1.95	221-418	5.95
221-105	2.95	221-463	4.95
221-106	2.95	221-467	7.95
221-121	1.75	221-485	6.25
221-157-02	1.65	221-498	2.95
221-158-03	1.65	221-528	2.60
221-160-01	3.25	221-545	2.75

**SEE OUR
FULL PAGE AD ON
PAGE 26 !!!**

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Light measurement instruments catalog

A new catalog featuring tutorials describing power measurements, wave effects, hardware considerations, and other factors involved with light measurement is offered by International Light, Inc.

The catalog features tutorials describing basic light measurement concepts along with descriptions of instruments, detectors, filters, input optics, and accessories. In addition, turnkey system configurations for photometry, radiometry, phototherapy, UV curing, photoresist, germicidal, UV hazard, plant growth, laser power, LED, and flash measurement applications are provided.

A resource for everyone involved with light measurements, regardless of their level of expertise, the 36-page catalog is organized by instruments and applications. Featured are the IL1400A Radiometer/Photometer which uses "smart" pre-programmed detectors, the IL1700 Research Radiometer, and the IL1800 Lock-In Radiometer for precise low light level measurements.

Circle (32) on Reply Card

LCR meter

American Reliance announces a two-page data sheet on the 470D handheld LCR meter. The sheet describes how users can test capacitance or resistance of SMD or chip type components with the

meter. Optional SMD test probes enable measurement of capacitance from the 200pf to 20µf ranges and resistance measurements from 2 to 20Ω.

Further descriptions discuss capacitance ranges from 200pf to 20µf in the parallel mode at 1KHz, 0.5 rms. Utilization of this mode ensures the highest accuracy. Measurement in the series mode is also provided for at 120Hz, 10mA rms.

Circle (33) on Reply Card

Chemical manufacturer web site

CAIG Laboratories, manufacturer of environmentally safe manufacturing and service products, announces its home page featuring product information, pictures, technical information, material safety data sheets, and the most frequently asked technical questions and answers from its customer service department. The web site includes a quick e-mail access to send/receive information. The site address is <http://www.caig.com>.

Switches catalog on the Internet

To provide better service to customers and all users of switching products, Switches Plus now offers complete product information via the World Wide Web. The Internet site was introduced concurrent with release of the company's most recent mail order catalog.

Internet users can reach the home page on the Web at <http://www.switchesplus.com/>. They can immediately access information about all of the company's products including prices, illustrations, specifications, and ordering procedures. Net users can also questions to technical representatives. A "specials" page features selected items at extremely attractive prices and presents information about new product introductions.

Evaluation software and brochure

National Instruments announced today the free, new LabVIEW evaluation software for Windows 3.1/95/NT PCs, Macintosh/Power Macintosh computers, Sun SPARCstations, and Hewlett-Packard 9000 Series 700 workstations. The company also announced a new 16-page, full-



color brochure filled with screen captures and descriptions of virtual instrumentation applications. The evaluation CD, based on the recently announced 4.0 version of the graphical instrumentation software package, features tutorial-style online documents as well as a menu-based system so users can access a variety of information, including details about add-on toolkits, technical support, customer education, and the Alliance Program. With the evaluation copy on the CD, users can also build custom applications. Windows users who do not have access to a CD-ROM can use the Overview disks.

Circle (34) on Reply Card

Computer/instrument 1996 supplement catalog

L-com announces its 64-page supplement catalog containing thousands of its most popular and newest components that are used to interface with computer and instrumentation related needs.

In keeping with the latest technology the company has introduced some unusual product categories including SCSI-1, 2 and 3 cables, terminators and adaptors. A wide variety of VGA cables and adaptors is offered to mate with a variety of cable monitors and adaptations.

Typically, the company specializes in a wide variety of ready-made cables including coaxial, data, modular, DIN, IEEE-488, V.35 etc. along with a selection of adaptors and adaptor kits and rack panels of all kinds and descriptions. Besides its standard listings, the company will also quote any custom related products found in this category.

Circle (35) on Reply Card



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CT-20G10T3684
CT-20G10T-13684
CT-31G30UT3680
CT-31G30T3680
PV-4603VCR-278
PV-4609VCR-278

QUASAR
AUEDC2243685

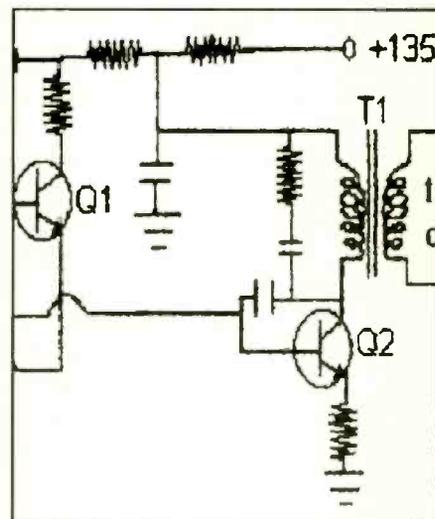
SP2736K3685
VHQ650(sim to) VCR-278

SHARP
13TG303689
19TF303691
19TG303691
31H-X10003682
31H-X1000/C3682

SYLVANIA
SRA253043678
SSC273843687
SSP476043687
25Y1003678
27Y1003687

TOSHIBA
CF27E303688
CL29E363688
TAC95123688

ZENITH
SR2053S3686
SR2053SM3686
SR2768S3683
SR2789DT3679



Test Your Electronics Knowledge

Answers to the Quiz

(from page 19)

1. $2 = 4 \log(1/x)$
(Divide both sides of the equation by 4)
 $0.5 = \log(1/x)$
(Take the antilog of both sides of the equation)
 $\log^{-1}(0.5) = \log^{-1}(\log(1/x))$
(Look up, or use a calculator to find the antilog of 0.5)
 $3.16 = 1/x$
(Take the reciprocal of both sides)
 $x = 0.316$

2. D. di/dx is a calculus expression that means the rate of change of the variable i with respect to x .

3. % error =
 $\frac{(\text{what you have} \pm \text{what you want})}{(\text{what you want})} \times 100$

In this case:
 $\frac{(13.2-15)}{(15)} \times 100 = -12\% \text{ error}$

4. A. Moving the plates farther apart lowers the capacitance value. Since C is in the denominator of the resonant frequency equation, reducing C will increase f_r .

5. C. The bridge is balanced, so there is no current through the center leg. $57.3/177.9 = 59.8/179.4$

6. B. If you make the value of the bulb resistance equal to the internal resistance of the battery, you will get maximum power and the brightest light. However, the bulb won't last very long. Choose a bulb with a higher resistance.

7. $0.000027 = 2.7 \times 10^{-5}$
In scientific notation, the number in question is written as a number between 1 and 10 multiplied by a power of 10.

8. $0.000027 = 27 \times 10^{-6}$. In engineering notation the power of 10 must be equal to an engineering term. Examples are: pico (10^{-9}), micro (10^{-6}), milli (10^{-3}), mega (10^6). The answer to this question is 27 microunits.

9. A. When a ferrite bead surrounds a wire it acts like there is an inductor in series with the wire. Inductors can be used to stop parasitic oscillation.

10. BCD 0101 0101 = 55_{10} .

What Do You Know About Electronics?

Teaching with experiments

By Sam Wilson

One of the most important things I learned from teaching is that students are (sometimes) capable of original, and sometimes brilliant, solutions to problems. To balance that, some are capable of working out elaborate schemes for cheating. According to Sam Wilson's Law, the more difficult the subject, and the more important it is to the student's career, the more elaborate the techniques for cheating. Students are especially clever when it is necessary for them to remember equations.

In the early days of my teaching career I had to watch for equations written in ink on the palm of a hand, on an arm covered with a sleeve, on the tops of shoes, and on the back of the student sitting in front of the cheater. In fact, they would do almost anything to avoid memorizing the equation for the test.

In modern times, students employ the very latest advances in electronics. They store equations in very small computers (also known as calculators). They use two-way radios to get information from an accomplice outside the classroom.

Hand signals, coded coughs, equations written on paper towels in the rest room and other methods supplement the electronics. It is an on-going test of the professor's ability to try to keep up with this.

The reciprocity theorem

My lecture on the mathematics and applications of the Reciprocity Theorem always started with a basic dc circuit like the one shown in Figure 1. Since this was not an exam, a few students took this opportunity to take a nap. I never objected to that because it reduced the time it took to grade papers later.

In the circuit of Figure 1, V and I are at any two different points in the circuit. As you know, you can interchange V and I in the circuit and I will not be changed.

In a better statement, *transfer resistance* (R_X) is defined as $R_X = V/I$.

When V and I are interchanged, the transfer resistance is not changed in value.

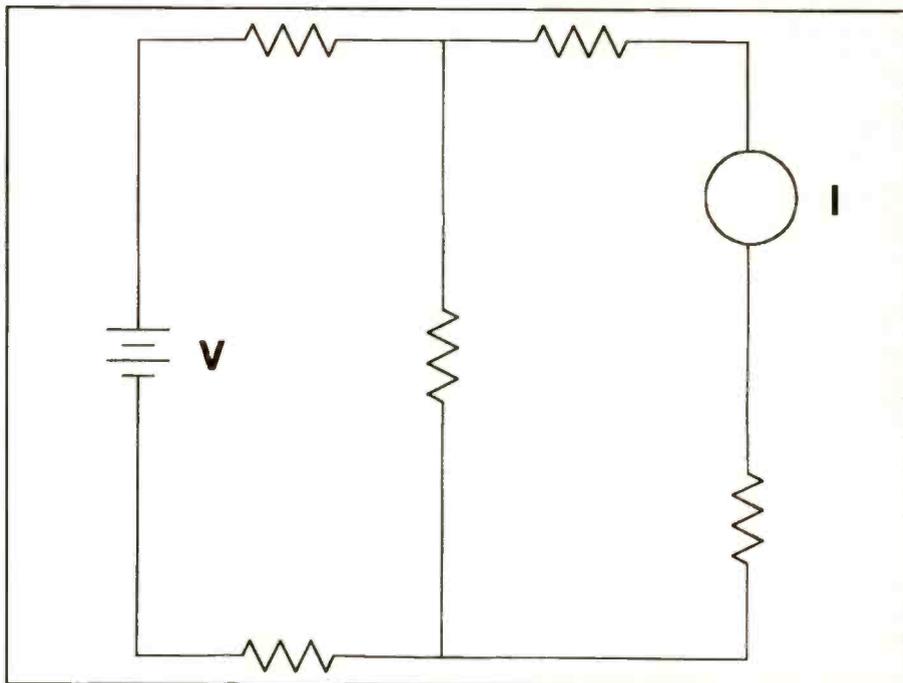


Figure 1. According to the reciprocity theorem, in this circuit V and I can be interchanged and I will not be changed. In a better statement of the theorem, the transfer resistance (R_X) is defined as $R_X = V/I$. When V and I are interchanged, the transfer resistance is not changed.

You will recognize the term transfer resistance in the study of four-terminal networks such as filters and attenuators. Discussing the next step is to switch to an ac circuit and work with transfer impedances.

I include this theory because there are students who are trying to get a foothold. They squeeze every bit of theory they can get out of WDYKAE?

But I digress. Right in the middle of my dynamic and informative lecture I hear "Number 36, this is a code 3 alert! I repeat, this is a code 3 alert!" One of my students in the lower third of the class (in every way) got up and turned his radio off. As he headed for the door I gave him one of my "what?" stares. "Company business," he explained.

Another student came forward and volunteered in a low voice, "He doesn't even have a job," and he also left the room.

Alarmed, I dismissed the class and went to a room with a window overlooking the parking lot. Sure enough, there was a bright new Lincoln with several students standing around it. I called the po-

lice and within minutes they came and arrested the driver. His drug-dealing days were over—at least for a long time. Actually, another professor had seen the same thing and he had already called the police. To complete the story, the student with the radio flunked the final exam.

Experiments

I have been a voice in the wilderness with my objections to the exclusive use of canned experiments in school labs. You know the type: "connect the green wire to terminal number three. The light should blink. If it does not blink, turn the equipment off and call the instructor for help."

In my last teaching experience, I was hired to teach medical electronics. We couldn't get into the lab for three weeks. There was no lab manual, so I decided to have the students design and build a radon detector. I asked for questions. Every student raised a hand.

I picked one of the more alert looking students. He asked, "Is this going to be on the final exam?" I explained that it would

Wilson is the electronics theory consultant for ES&T.

be final for some of them if they didn't study for the exam.

From that point things got worse. The first step in the experiment was for the students to build a neon oscillator. There are three components. These students were going to graduate soon, and not one of them could construct the oscillator. Finally, one of the students asked his dad (who works at Cape Kennedy) to build the circuit. He brought the design to class and every student copied it wire-for-wire. Only 30% of the circuits worked.

I tried to teach the class how the new electronic blood pressure devices worked. They went to the front office and complained "he's teaching stuff that's not in the book." I was told to teach only what was in their text book, which had a copyright date of 1970. But I digress.

Finding a way to observe the VITS signal

I was teaching in a university where the students really wanted to learn. What an experience. I was allowed to give innovative experiments that supplemented their lab work for the subject in this particular class. They had already completed their courses in analog electronics. One of the teams in lab had completed the experiments in the lab manual, so they were ready to tackle one of my innovative experiments. In my office I explained what I wanted them to do.

"You know about the VITS signal that is sent on the horizontal blanking pedestal. I want you to make a circuit that will trigger the scope to display the start of the VITS signal. I don't want to see anything else on the scope screen but the VITS signal. That's all. I'm not going to tell you anything else."

In my mind, I was sure I knew what they would do. They would make a counter that could count the number of lines needed and trigger the scope on. I was feeling that I had given them a good two or three day project. Thirty minutes later they asked if I'd like to see it.

I looked at the tangle of wires and parts. I used the normal escape route for professors: "Explain it."

"We remembered that you said that the propagation delay of FETs depended directly upon the power-supply voltage. We copied a FET amplifier out of the book and used a variable-voltage power supply. After trimming the circuit we were

able to get right onto the VITS signal."

Two of these students wound up patenting their projects.

An electronic combination lock

At the same university I selected a very bright student for another project. "I want you to design a combination lock with three code numbers. It must have only one button. Use your knowledge of electronics." It only took him two lab sessions to complete the design of this project. I published his circuit in a publication I generated called "Technical Notebook."

Later that year I was attending another IS CET convention. A man from a large electronics company said to me, "That one-button combination lock really came in handy. Our representatives fly their own planes and they often get back to our field after dark. We needed a way for the pilot to turn on the landing lights. So we set up that circuit with a radio so he could key his microphone in the code. It works great. I'd like to talk to that student when he graduates." Unfortunately, that student dropped out of the university and went into truck driving school.

Of all the sad words of tongue or pen, the saddest are these: "It might have been." — Whittier

The heart (beat) of the matter

If you want to teach innovative experiments, you have to be careful not to give the student too much information. However, you must also be sure that you give them the experiment you want them to do.

A young man and woman had teamed up as lab partners. I gave them the project of building a device that displayed the heart beat on an oscilloscope. When they were ready to demonstrate their project I was surprised that they had decided to display the heart beat of a mouse. I had meant for them to show the heart beat of a human. They used a bright light to shine through the tail and used a light-sensitive circuit to pick up the light from the other side of the tail. It worked. The pulses were clearly visible on the scope screen.

A biology professor found some use for it, but the young man would not let him have the mouse. He carried it around for the remainder of his time in the school.

A papers about paper

When I started teaching at the university I got the job of teaching technical

writing. I always tried to assign class term papers that would give the students the experience they needed for gathering information. I was surprised at the high level of the papers I got. Here are a few:

- the design of landing gear for blimps,
- the design of concrete landing strips at airports,
- automatic transmissions used in the propulsion of farm tractors,
- how electric eels generate their dangerous voltage.

I assigned "Paper Airplanes" to a student in aeronautics. He complained and threatened to drop out. He explained that he wanted a subject that was useful. So I gave him a different subject.

A few months later, the TV program "60 Minutes" ran a story about a professor who designed a paper airplane that wouldn't stall. When a paper airplane stalls it goes into a climb and slows to a stop, then it recovers and flies until the next climb and stall. The story on "60 Minutes" explained that the Air Force was greatly interested in the design.

Perhaps I should have quoted that line of poetry here. ■

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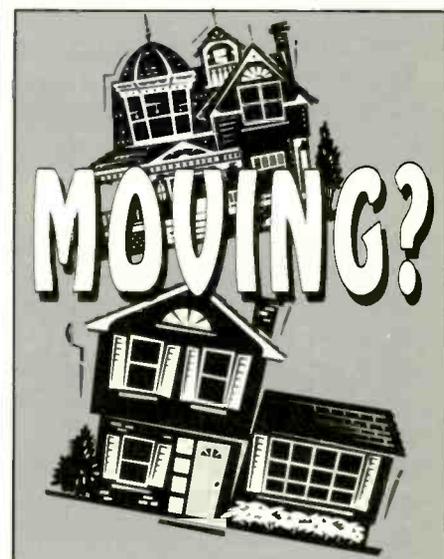
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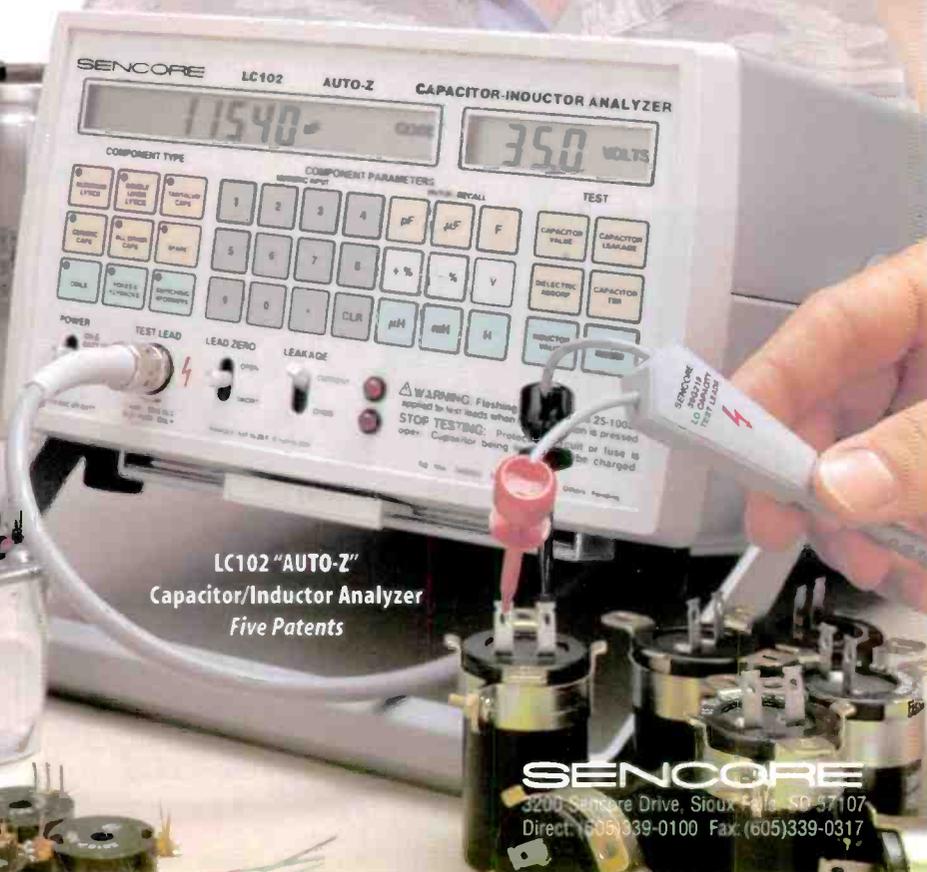
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