

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONICTM

Servicing & Technology

August 1997

Continuing education servicing

Troubleshooting transmitter circuits

Replacement Parts Showcase



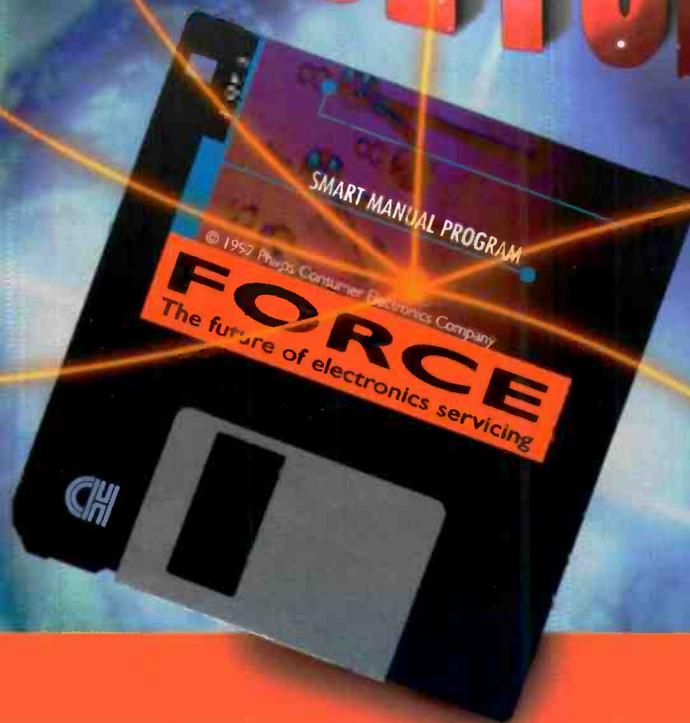
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Servicing & Technology

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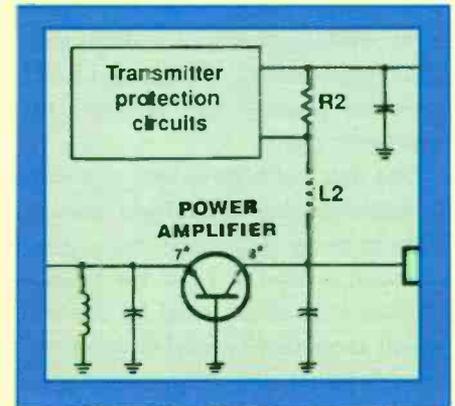
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ON THE COVER

As replacement parts become harder to locate, it becomes more important to deal with a vendor who can fulfill your needs for parts to get those critical repairs completed and out the door. (Photo courtesy Herman Electronics.)

Are you ready for the millennium?

By now, most of you have probably heard about the "millennium bug." Simply put, when the year changes from 1999 to 2000, many computers will not know what year it is. They may operate improperly or not at all, and the functions they perform, from keeping track of peoples' bank accounts to operating a power grid, might be performed improperly or cease to function at all.

The reason for this problem is also quite simple. Back in the early years of computing, computer memories and storage devices could only store a limited amount of information; very limited compared to today's capacious memories and magnetic or optical storage media. So programmers, working mostly in COBOL (computer business oriented language), looked for every possible way in which they could save space.

One way that leapt to their minds was to reduce the date to six digits instead of eight by using only the last two digits of the year. Instead of 1957, for example, programmers simply used 57. After all, we all know that 57 used to designate a year, without any other information, would represent a year in the century in which we live, so it means 1957. So when someone says that they were a member of the class of 57', we know that they graduated in 1957. If someone says that she owns a 57' Chevy, we know that it's a car that was manufactured in the year 1957.

By extension, as we approach the year 2000 (the new century actually will start on January 1, 2001, by the way, not 2000), when people begin to talk about someone who will be in the graduating class of 08', or 13', it will be clear that they're talking about 2008, or 2013. Unfortunately, computers don't have the ability that humans do to evaluate information on the basis of context. To a computer that is pro-

grammed using years of two digits, the year 2000 will be the year 00.

As a side issue here, as my son Carl pointed out to me several months ago, this is not really a millennium problem. It is a centenary problem. Had computers been invented in, say, the 1850s, and programmed with the year as a two-digit number, then as the year 1900 approached, the two-digit year would be rapidly moving toward 00. There will be enough foolish people predicting that dire things will happen because one century is ending and a new one beginning. Let's not add this computer bug to the list of things that people will blame on the millennium.

What computers are affected?

The "millennium bug" probably wouldn't have become the huge problem that it now is, if it weren't for the fact that computer professionals appear to have emulated their counterparts in the legal profession and performed their work based on precedent. Even as the memory and storage capacity of computers grew by leaps and bounds, programmers retained the standard of representing a year by the rightmost two digits.

Therefore, computers of all kinds: those operated by electric companies, airlines, banks, communications companies, manufacturers, air-traffic controllers, and more, will experience this problem in the year 2000, unless the programs on which they operate are rewritten to accommodate a four-digit year, and tested to make sure they work. This huge problem is made even more difficult as a consequence of two factors: 1. each one of the computers has a two-digit date field many times in the body of the program, and each one of these dates has to be changed, and 2. these fields may be difficult to locate, because the source code, the English-like

COBOL statements that were written by the programmers and then converted to machine language (compiled), has been destroyed or lost, or for some other reason no longer exists.

The cost of fixing all of these programs is expected to run into the billions of dollars, and experts predict that many computer programs will not be corrected by midnight on December 31, 1999, and many functions controlled by computers will experience some glitches. Some computers may fail entirely.

For example, one electric utility ran an experiment and concluded that unless they addressed the problem at least part of their system would have shut down, and some customers would have been without power.

What about personal computers?

Consumer electronics service centers may be concerned as to how this problem will affect personal computers: their own, and those of their clients. Most likely the year 2000 will cause little or no problem for these computers. Some more recent computers will not experience any difficulties at all, and turning them on the morning of January 1, 2000 will be just like turning them on any day in the 1900s. Some computers will experience a minor glitch such that the date will have to be reset. Some older machines; 386s and 486s may require that the ROM BIOS be upgraded. It wouldn't hurt to check with the manufacturer of your computer, and those of any regular computer servicing clients, to find out.

Happy New Year!

Nile Conrad Penam

Video equipment sales surge in April, as projection TVs, camcorders, VCRs and TV/VCRs post record numbers

Showing strength virtually across the board, video equipment sales to dealers scored impressive results during April, the Consumer Electronics Manufacturers Association (CEMA) reported today. Last month's numbers included double-digit growth in four major products: projection TVs, camcorders, VCRs and TV/VCR combinations, lifting most video categories into positive territory on a year-to-date basis.

Due in part to a 17 percent gain relative to April 1996, some 12.4 million pieces of consumer video hardware were sold to dealers during the first four months of 1997, a seven percent increase over the same period a year ago.

"We take a great deal of encouragement from the April sales rise," said Fred Towns, vice president of sales and marketing for Panasonic Consumer Electronics Company. "For us, it is a sure sign of the resilience of the consumer electronics industry - an industry capable of creating exciting new products which can excite consumers and spark retail sales."

More than 1.4 million color TV receivers were shipped in April, a solid one percent improvement over April 1996's 1.3 million units. On a year-to-date basis, color TV sales now exceed 5.8 million units, off fractionally but essentially what they were during the January-April period last year. Stimulating color sales last month was a 16 percent increase in shipments of large-screen, direct-view models, defined as those with screens measuring 25 inches and larger.

If color TV enjoyed an uptake in April, the results posted by four other video products were nothing less than record-breaking. Color TV/VCR combos jumped 34 percent to more than 173,000 units, their best April ever, and for the first four months are running nearly 35 percent ahead of last year's pace.

The monthly increases for projection TVs and VCR decks are identical: 22 percent. With stereo models accounting for 44 percent of April's 1.1 million units, nearly 4.4 million VCRs have been sold to dealers year-to-date, a 17 percent

improvement. April sales of projection TVs boosted their year-to-date total to 225,000, a slight gain over the 222,000 sold at a comparable stage last year. For both projection TVs and VCRs, last month's unit sales were an April record.

Not to be outdone, camcorders registered their best April as well, posting monthly sales of more than 330,000 units, a 28 percent increase. For the first four months, camcorder sales topped one million units, 17 percent ahead of last year.

The continuing decline in laserdisc players, which dropped 63 percent in April, was more than offset by encouraging sales of a new category: DVD players. Nearly 35,000 DVD players were sold to dealers last month, bringing their cumulative total to approximately 69,000. Since DVD has been available only a few months, there are no 1996 results by which to measure sales experience believed to be contributing to the surge in larger TV set sales.

CEMA and SBCA announce satellite education partnership at '98 winter CES

The Consumer Electronics Manufacturers Association (CEMA) and the Satellite Broadcasting and Communications Association (SBCA) announced that they have agreed to jointly sponsor the satellite education and conference programming at the 1998 International Winter Consumer Electronics Show® (WCES). Under an agreement announced today by the two organizations, SBCA will be responsible for coordinating and developing the content for the sessions held at the WCES January 8-11, 1998, in Las Vegas, NV.

"The joining of these two organizations represents a turning point in the satellite industry efforts to broaden its impact on the consumer marketplace," said Gary Shapiro, CEMA's president. "We respect the SBCA and our pooling of resources will strengthen our mutual interest in providing dealers with the best possible information. SBCA's sponsorship instantly enhances the depth and value of the satellite conference program at the Winter CES. These sessions will provide manufacturers, retailers and press an

opportunity to learn about the latest developments the industry has to offer."

SBCA will be responsible for selecting and coordinating moderators and panelists for 12 marketing and business sessions targeted to the satellite retailer. Each session will be 90 minutes in duration and in the Las Vegas Convention Center.

"This partnership will be a cost-effective educational forum for attendees and exhibitors," said Charles Hewitt, SBCA's president. "It is another way to provide opportunities for our mutual constituencies and our members. Winter CES is the most recognized trade show in the consumer electronics industry and will naturally complement our National Show in Nashville. We're confident this partnership will help grow our members' businesses as they continue to identify new ways to communicate with one another."

Systems and autosound drive year-to-date audio sales

Sales of systems and autosound products reported solid increases during 1997's first quarter, according to the Consumer Electronics Manufacturers Association (CEMA). Despite advances in these two categories, however, quarterly audio equipment factory sales to U.S. dealers slipped two percent to \$1.58 billion, compared with a year ago.

In terms of quarterly growth, audio systems led the sector, jumping 15 percent to nearly \$362 million in factory sales. Autosound products, the leading performer in dollar volume, accounted for \$464 million, a respectable four percent improvement over \$445 million in factory sales during January-March 1996.

Reporting quarterly declines were both portable audio and components. Sales of portable equipment declined eight percent to \$408 million, while separate components dropped 16 percent relative to the same period a year ago.

March sales were buffeted by cross currents as well, with portable audio and systems posting gains but components and autosound having negative numbers. Monthly sales totaled \$618 million, off four percent compared with the \$643 million in dollar volume during March 1996.



Portables broke out of their slump with an increase in March to \$164 million. Within that category, home radio and CD boombox sales grew four percent and 22 percent, respectively. With 3 percent growth, systems outpaced the other categories and accounted for approximately \$131 million in factory sales.

Even though autosound sales receded 2 percent in March, it was a banner month for in-dash compact disc (CD) players. With 406,000 units sold to dealers, in-dash CD players not only broke any monthly sales record but, with sales of \$75 million - a 39 percent increase over March 1996, exceeded it by \$20 million.

Separate components continued to struggle in March, falling 16 percent to \$347 million. Providing an upbeat note, however were left/right speaker pairs (non-surround usage), which typically account for some 20 percent of all component sales. March sales of these speaker sets expanded four percent, CEMA's market analysis said.

Certified Network Systems Technician program initiated in joint effort between ETA and Texas Engineering Extension Service, Texas A&M University System

Beta Testing is being completed in ETA's newest certification program; The Certified Network Systems Technician (C.N.S.T). Following closely on the heels of the ETA's Fiber Optics Installer Certification program and division of the C.S.I. (Certified Satellite Installer), into two separate programs (C.S.I., and RSDI - Registered Small Dish Installer), the C.N.S.T testing and registration program brings to 15 the number of areas in which ETA provides credentials and testing.

Dick Glass, CETsr, President of ETA, indicated that the C.N.S.T promises to be one of the most important testing programs administered by the 19 year old professional association of electronics technicians, teachers and businesses. Responses from technical colleges wanting to participate in the beta testing, and to follow that up with computer networking courses, has been remarkable.

Unlike other C.E.T. programs in ETA (the first started in 1966), the C.N.S.T certification does not require minimum accrued time in schooling or on-the-job training as a pre-requisite for attempting the exams or receiving C.N.S.T credentials. It does require that the applicant hold either an ETA C.E.T in Computers, or an A+ certification by CTIA. Thus, even an applicant for the Associate C.N.S.T (A.C.N.S.T with less than 4 years combined schooling and on-the-job experience) will have accrued some job and/or training experience. A C.N.S.T applicant with at least 4 years experience, qualifies as a Journeyman. With 6 years and passage of ETA's basic electronics Associate Examination, the C.N.S.T can be recognized as a Senior C.N.S.T.

The major segments of the 100 question C.N.S.T examination (and thus the recommended course subjects) are as follows: Computer Network Terminology, Understanding Network Types, Network Services, Network Operations, Network Administration, Wide Area Networks and Devices, Network Architectures, Open System Interconnection (OSI), Troubleshooting, Network Server and Workstation Hardware (Netware, Windows NT, UNIX Operating Systems), and Disaster Planning for Networks - File Backup.

Study materials recommended by Texas A&M's Engineering Extension are: Networking Essentials Self Paced Training Kit (Includes CD-ROM), by Microsoft Press; and Upgrading and Repairing Networks, By Que. MarCraft's DataCom is also suggested as an excellent addition to the study materials.

ETA administers CET (as well as FCC Commercial License) exams through its network of 400 technical schools, as well as U.S. Military Education offices. Information is available regarding test sites by faxing 317-653-8262, e-mail at: eya@indy.tdsnet.com, or voice phone at: 317-653-4301.

The 180 subheading topics for the C.N.S.T course outline are available from ETA for schools interested in initiating a Networking Course similar to that in progress at Texas A&M University's Engineering Extension Service ■

ELECTRONIC

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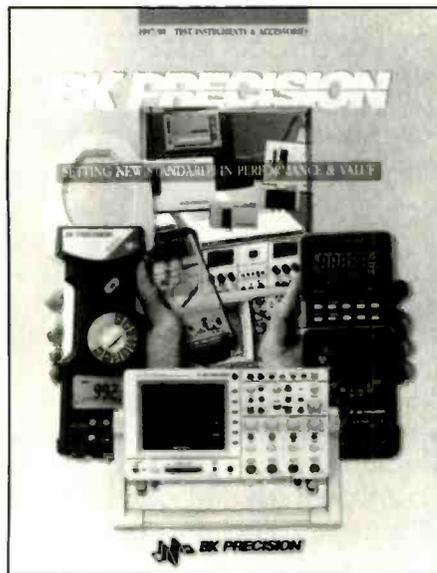
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Summertime special catalog

Herman Electronics announces the release of their summer catalog. The catalog contains over 500 specially priced items for the service industry including: tools, test equipment, parts and accessories, chemicals, power products, technicians aids and more.

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Test equipment catalog

B&K Precision's 1997/98 full line product catalog highlights the company's new line of high performance oscilloscopes, digital multimeters and power clamp-on meters. The 72-page catalog features an index and product guide for quick reference, as well as detailed spec-

ifications on each product category: oscilloscopes, DMMs, power supplies, function generators, spectrum analyzers, and a wide variety of component testers, test leads and accessories.

Circle (21) on Reply Card



Coaxial connector catalog

RF Connectors, a division of RF Industries, new 100-page catalog features a full range of standard and RF custom coaxial connectors, including 300 new items. Extensive coverage of BNC, TNC, N, UHF, MINI-UHF, MB, SMB, SMA, MCX, 7/16 DIN, FMR, LMR series, and 1 5/8", 1 1/4", 1/2", and 7/8" corrugated cable connectors that fit Andrew, Cable-wave and Eupen cables.

The catalog includes over 1500 coax products, including cable assemblies, connector kits, Unidapt and Celludapt universal adapter products, cellular products and hand tools. Product specifications and photographs are included.

Circle (22) on Reply Card

Full line catalog

Specialized Products has released its Summer '97 Catalog. The 378-page publication features an assortment of over 5000 specialized products including everything needed for basic cable installation to board level component repair.

Over 100 standard tool kits designed for installation, field service and repair



applications are listed. Tool cases and tool pallets in assorted styles and materials are stocked with selected assortments of high-quality, name-brand tools. Any standard tool kit may be modified to suit a customer's specific application or budget. Custom tool kits can be built from scratch to exacting specifications.

SPC offers a selection of high-density, reusable shipping containers. Over 100 configurations plus various other styles for many additional uses are available. Choose from an extensive selection of stock cases carrying, storing, protecting and shipping tools, instruments, laptop and notebook computers, sensitive and expensive equipment, circuit boards, catalogs and more.

Also included is a complete assortment of electronic test equipment featuring component testers, digital multimeters, frequency counters, function generators, oscilloscopes, power supplies and much more. The computer testing selection includes benchtop test equipment, EPROM testers and SIMM testers. LAN test equipment choices include analyzers, Category 5 testers, continuity testers and fiber optic test equipment. The telecom selection features bit error rate testers, digit grabbers, digital butt sets and transmission test sets. For fiber optic test equipment, choose from cleavers, light sources, optical time domain reflectometers, power meters, strippers and more.

Circle (23) on Reply Card

Continuing education in servicing

By The ES&T Staff

Have you ever stopped to think about the elements in the basic and continuing education of a consumer electronics servicing technician, or the skills that a technician must possess in order to do his job effectively? It's one of the things that we at ES&T do every day, because we feel that continuing of technicians is a large part of the definition of what we do.

Skills and attributes of an effective technician

For what it's worth, here's our idea of the set of skills and attributes that technicians must possess in order to get the job done. If any readers have any other ideas, or suggestions about technicians' qualifications, we'd love to hear from you.

- Basic language skills in order to be able to communicate with customers, other people in the service center, manufacturers, distributors, etc.

- Good reading skills in order to be able to gain information from textbooks, service manuals, service bulletins, etc.

- An even temper, tact and diplomacy as needed to handle difficult customers, difficult service jobs, etc.

- Good math skills. A technician should be able to perform all of the calculations necessary to interpret readings from meters, oscilloscopes, etc. He should have at least a passing familiarity with electronics math, such as Ohm's Law, Kirchhoff's Law, etc. He should be able to perform all of the financial math in order to be able to prepare an invoice.

- A technician should have a reasonably broad background in electronics circuit theory. He should have some kind of picture in his mind of how the basic electronics components work, and how they interact in a circuit.

- A technician needs to have a basic background in the use of test instruments such as DMMs, oscilloscopes, signal generators, signal analyzers and more, including how to use them safely.

- A technician needs to be reasonably skilled in the use of small hand tools and soldering/desoldering equipment in order

to be able to disassemble a product to the extent necessary to identify and replace a defective component and to reassemble the product once it has been repaired without causing any damage.

The need for continuing education

A good two-year or four-year technical education provides many of the skills that a technician needs in order to be adept at the duties of a service technician. But two years, or even four years, is a relatively short space of time in which to absorb all of the knowledge and hone all of the skills needed to develop a skilled technician. Moreover, as time goes on, we tend to lose some of the knowledge we gained while going to school; sometimes quite a great deal. For those reasons, it is important for a technician to continue his or her technical education for life.

But the greatest reason for continuing education is to keep up with developments in the field. This is especially true in a pursuit such as consumer electronics servicing which seems to be undergoing a continuous revolution.

Take, for example, someone who became a technician in the 1950s. Now, 40 some years later, and maybe getting ready to retire, how useful would a technician be if he hadn't updated his skills several times. Most servicing in the '50s still emphasized vacuum tubes. Transistors were just being introduced and ICs hadn't been heard of yet. Everything was still entirely analog. All TV signals were received via a broadcast antenna; there was no cable TV, no VCRs, laser disks, etc. A technician who allowed himself/herself to stagnate at that period would be helpless with today's technology.

Interestingly, the paradigm shift from analog to digital has caused some educational problems on the other side of the coin. Most technicians graduating from technical schools today have specialized in digital electronics, because that's what industry wants, and besides, it's much more glamorous than analog. So technicians today who want to work in consumer electronics servicing must contin-

ue their educations beyond technical school simply to learn some of the "old" stuff in electronics.

There is help

Fortunately for service centers and technicians, everyone from the manufacturers and the manufacturers' associations, to service associations and technical schools, as well as publishers, have recognized that technicians need a lot of training for this new technology, and are making that training available.

And depending on the amount of money available to the technician, the amount of time he has for school, and the travel budget, the technician has a choice of resident schools, hands-on schools, self-study courses, videotapes, books, test equipment manuals and user instructions, association meetings and seminars.

The ES&T staff continually remains tuned in to the educational opportunities available to technicians. We like to think that we're a valuable source of technical/servicing information, but we recognize that a 70-or-so-page magazine once a month can't begin to fulfill the information needs of electronics servicing technicians, so we try to make you aware of every other avenue of education that we can find.

Training from EIA/CEMA

One of the best, and least expensive sources of training for servicing of consumer electronics products is the Electronics Industries Association/Consumer Electronics Manufacturers Association (EIA/CEMA) Product Services Department. This organization, in conjunction with state and national service organizations, offers three-day and five-day on-site workshops for technicians who are actively working in consumer electronics servicing (Table I). There is a nominal fee of \$50.00 (\$150.00 for monitor classes) for these classes.

EIA/CEMA is the association to which manufacturers of TVs, VCRs, stereo equipment, etc. belong. They recognize that it is in their best interests to attract and train technicians to service all of the

products that they manufacture and sell. Every service center that can do so should take advantage of this superb training resource whenever possible.

In addition to the workshops, EIA/CEMA also offers video cassettes, manuals and the like on a wide range of subjects from "Troubleshooting with modern electronic test equipment" to high-tech soldering and microprocessor troubleshooting, and more. These tapes are inexpensive, just costing enough to offset the cost of producing them.

If you, or someone in your service facility is in need of training, you should at least explore what EIA/CEMA has to offer. See their name and address in the listing in this article.

Currently available from EIA

For example, the EIA currently offers several courses in servicing of color TV, VCR, personal computer, microprocessor/pc, and monitors. These courses will be presented in cities throughout the U.S., throughout the current year.

Five-day workshops for electronics instructors in vocational education are also available from EIA/CEMA.

Anyone interested in attending any of these courses should contact:

Consumer Electronics Manufacturers Association

2500 Wilson Blvd
Arlington VA 22201
703-907-7656
Fax: 703-907-7968

You can also learn more about CEMA by visiting their Internet website at <http://www.cemacity.org>.

Considering the high quality and timelines of these programs and the materials the attendees retain, EIA believes that the practical nature of these workshops will provide the attendees with new skills of immediate benefit.

These course have an estimated value of several hundred dollars, but EIA/CEMA offers them at minimal cost to qualified technicians. Attendees must provide their own transportation and lodgings while at the workshops.

Identifying the need for education

For the technician, identifying the need to further his education usually isn't difficult. One day a customer brings in a TV set for service and when the technician opens up the set to perform a technical evaluation of the nature of the problem he

finds components and circuitry he's never seen before. Or one day a customer brings in a digital compact cassette or a DVD, a product that the technician has only seen in photographs before.

Once the need to get further education has been established, it's important to pin down exactly what type and level of education is needed. There are usually two questions that the technician must answer: "What training do I need?" and "How do I get that training?"

It's important to examine these questions in detail to determine beforehand exactly what it is you need to study. It's not enough to just say "I need to learn about DVD servicing," and then to look for a correspondence school or a local school that might offer a course on DVD.

It's important to examine the situation precisely, and determine what aspects of the subject that need to be covered. Do you just want an overview on DVD technology? Or do you really have a pretty good idea of how DVD works and really need a course in nuts and bolts DVD servicing?

Once the specific goals are set, the question becomes how to achieve them. One simple but effective method might be to contact other technicians in your area. If you have a skill that they lack and vice versa, you might be able to arrange for a session, or a series of sessions, in which you educate each other.

Technical books

Technical books provide a good way to fill in the gaps in your service education. Many technicians are able to learn enough through reading books to enter into a whole new area of servicing. If the book is well written, and the technician has a lot of self discipline. He just might be able to add a whole new product to the scope of his technical education. If the book is poorly researched or written (there are probably a lot more of these than there should be), or if the technician doesn't have the self-discipline to study on his own, the whole thing might turn out to be a waste of time.

Home study courses

Home-study courses are a step up from simply studying from a book on one's own, and they generally make learning easier and lead to better results. In a home study course, the material is divided into logical study units, an instructor tells the student what is expected, and there is feed-

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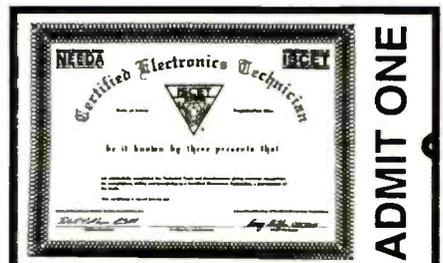


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back through regular tests. Some schools assign an instructor to the student with whom he can correspond by telephone and mail when there is a problem.

Schools and seminars

If the technician or service center can afford the time and money, structured class and lab courses provide a more effective way to learn. There are many options available for a technician who can attend such classes. Technical schools throughout the country offer anything from the most elementary introductory courses to detailed theory, design and servicing courses.

For anyone who has the time and the budget to travel, consumer electronics equipment manufacturers offer seminars on the operation and servicing of specific products to servicing technicians.

There are also many organizations, especially in the computer area, that offer seminars of a few days to a week or so, usually in a number of locations throughout the country.

Other good sources of technical education are manufacturers of test equipment and tools such as multimeters, oscilloscopes, soldering tools, etc. Many of them offer instruction in using their products. Some offer books and pamphlets, and some even have videotaped instructions, that help the technicians understand how to most effectively use their products. Some companies offer formal courses for home study, and others offer courses and seminars that travel to different areas of the country so you can take a formal course taught by the experts near home. Some of the instruction is free, and some will cost a substantial amount, so check before you proceed.

Finding the knowledge

We wish we could provide a complete list of all of the technical educational resources available to technicians today, but such a list would no doubt fill several thick volumes. Some of the educational resources, in no particular order, are: local vocational technical schools, both public and private, a large handful of national technical correspondence schools, associations such as ETA, NESDA/ISCET, PSA, manufacturers' training, thousands of technical books. Anyone who wishes to stay abreast of modern electronics technology, would do well to simply maintain an awareness of what the educational resources are and how to take advantage of them.

Along with this article we present several lists of companies and other organizations that offer some kind of training and/or training materials. Unfortunately, space doesn't permit a comprehensive list. There are a number of detailed lists available that will provide someone who is serious about training many avenues to explore. One such list is the **ES&T** March Buyers' guide. That issue contains a large list of consumer electronics manufacturers, tool and test equipment manufacturers and associations with addresses and telephone numbers.

Why not experiment

A time-tested way to get an education is to "learn by doing." Sitting in a class with an instructor is a great way to learn about the theory of technology, but to really gain a knowledge of how something works, there's nothing like taking a piece of equipment in your hands, pressing the buttons, turning the knobs, watching what happens, poking and probing, and taking DMM and oscilloscope readings.

This might not be a great way to learn if the unit is a \$1,000.00 hi-fi VCR, but some of the low-end units cost in the neighborhood of \$200.00. If you take a look at the cost of books these days, or the cost of seminars, or even just the cost of travel, lodging and meals to attend a seminar, \$200 is pretty cheap for a unit to take apart, observe, and check with test equipment. And you're likely to get a pretty good education from it.

Try the product manufacturers

Many of the manufacturers of consumer electronics equipment provide training in a number of ways. Some of the manufacturers restrict the training they provide to technicians from their own authorized servicing facilities. Others not only offer courses to anyone who is interested, they make it a point to make their courses universally applicable.

Test equipment manufacturers

Test equipment manufacturers not only know a great deal about the test equipment they sell. Moreover, they are familiar with applications of their products. They talk to the engineers and technicians who buy and use their products and learn what their problems and needs are.

They also recognize that the more their customer knows how to apply their products, the more likely they will be to buy their product in the first place, to be happy with it once they've bought it, to recommend the company's products to a friend, and to buy that same brand the next time they need a piece of test equipment. In order to enhance the customer's or potential customer's understanding of the testing/diagnosing function in general and the company's product in particular, many manufacturers of test equipment offer courses, manuals, videotape courses, and other training opportunities.

For example, B&K Precision offers booklets such as a "Guidebook to Function Generators," a "Guidebook to Test Instruments," and a "Guidebook to Oscilloscopes." Sencore offers seminars throughout the country as well as their "Tech Tips" binder, the periodical "Sencore News" and other training materials.

Tektronix Oscilloscope Division puts out booklets such as "The XYZs of using a scope" and "Basic Oscilloscope Operation." They even sell a training kit that allows an oscilloscope user who needs to learn more about use of an oscilloscope



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to practice on circuitry for which the oscilloscope traces are known. The Tektronix Television Business Division offers application notes such as "Basic NTSC Video Testing" and "Checking VCR Performance."

Hewlett-Packard offers manuals such as "The fundamentals of signal analysis" and "Feeling comfortable with digitizing oscilloscopes," that provide in depth information about the state of the art in circuits and signals, and the test equipment and techniques needed to study and understand it.

You should also check with any of the other well known manufacturers of test equipment to determine what kinds of training materials they have, or that they may recommend.

Office equipment

Personal computers now constitute a large segment of what is considered consumer electronics products. The increasing availability of useful, user-friendly low-cost software such as word processing, spread sheet, data base, desk-top publishing, accounting, on line data bases, and the huge information sources available on the internet are making personal

computers more and more attractive to more and more people.

More people are establishing offices at home. Along with fax machines and answering machines, personal computers are essential tools for the home office.

With the increase of personal computers in homes, consumers are looking to their traditional service centers to service their computers. And while making the transition from servicing TVs and VCRs to servicing computers does take something of a mental adjustment, it's usually far easier than it first seems, especially for someone who has made a lifetime study and a business of understanding and servicing electronics circuits.

Trade associations

Organizations such as ETA, NARDA/NASD and NESDA/ISCET (see the "Associations" listing below for the meaning of these abbreviations, and the and addresses and telephone numbers of these associations) and their state and local affiliates offer many opportunities for education both technical and management oriented.

For example, state and local chapters of these associations frequently invite a

technical training instructor from a consumer electronics manufacturer to their monthly meetings to lead seminars on servicing the company's new products.

Some of the most successful service center owners and managers belong to these trade associations, and attend the meetings, seminars and annual conventions religiously. Most, if not all of them attribute a great deal of their success to their membership in the organization and their participation in these training activities. If you don't belong to such an association, you should at least look into it.

Just do it

If a technician hasn't taken a course, read a technical book, or otherwise made an attempt at learning about some of the new technology in some time, he may be in danger of joining the dinosaurs in extinction. The resources to develop new skills to catch up with the new technology may be as near as the local library, the local association meeting place, the mailbox, or the nearest computer with internet access. The information is there. The listings that accompany this article will help you get started in finding it. ■



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Here's a technical college program that might be of interest to readers who are interested in becoming electronic music technicians, or service managers who are interested in recruiting someone to service electronic musical instruments.

The school is:

Red Wing Technical College
215 Pioneer Rd
Red Wing, MN 55066
1-612-388-8271
1-800-657-4849
Fax: 612-388-6368

Graduates can earn a diploma or Associate in Applied Science degree, in as few as two traditional school years.

The course includes technical writing, computers and basic electricity. Technical courses include circuitry, semiconductors, MIDI concepts, vacuum tube and solid-state amplifiers, electronic assembly and digital music devices.

Graduates can pursue careers as manufacturer's technicians, music store technicians, consumer electronics technicians, band roadies, amplifier design and sales, factory bench servicing, organ servicing, studio engineer for sound systems or sound system maintenance for entertainment complexes.

Some of the sources

The accompanying text lists a number of correspondence schools, book publishers, associations, and test equipment manufacturers whom you might want to contact for further information on what technical or management educational opportunities they have to offer.

Trade Associations

Consumer Electronics Manufacturers Association

2500 Wilson Blvd
Arlington VA 22201
703-907-7656
Fax: 703-907-7968

Electronics Representatives Association

444 N. Michigan
Chicago, IL 60611
312-527-3050

Electronic Technicians Association

604 North Jackson St.
Greencastle, IN 46135
765-653-8262

Musical Instrument Technicians Association, International

8216 Audrain Drive
St. Louis, MO 63121-4504
314-389-3290

National Association of Business and Educational Radio

NABER
500 Montgomery
Alexandria, VA 22314
703-739-0300

NARDA (National Association of Retail Dealers of America)

NASD (National Association of Service Dealers)

10 East 22nd Street
Lombard, IL 60148
630-953-8950

National Association of Service Managers

650 W. Algonquin Road, Suite 204
Des Plaines, IL 60016
847-640-8133

National Computer Association

1355 Automobile Blvd.
Suite 240
Clearwater, FL 34622
800-615-6224

National Electronic Distributors Association

35 East Wacker Drive
Suite 3202
Chicago, IL 60601
312-558-9114

National Electronic Servicing Dealers Association

2708 W. Berry Street
Ft. Worth, TX 76109
817-921-9062

Professional Service Association

71 Columbia Street
Cohoes, NY 12047
518-237-7777

Technical Book Publishers

CRC Press, Inc.

2000 Corporate Blvd., N.W.
Boca Raton, FL 33431
561-994-0555

Hayden Book Company

Rochelle Park, NJ 07662

McGraw-Hill Book Company

1221 Avenue of the Americas
New York, NY 10020

MacMillan Publishing

Front and Brown Streets
Riverside, NJ 08075
800-257-5755

PCS Publications

PO Box 10492
Clearwater, FL 34617-8492

Prentice-Hall, Inc.

Rte. 9W
Englewood Cliffs, NJ 07632
201-592-2455

Howard W. Sams & Company

2647 Waterfront Parkway, East Drive
Suite 300
Indianapolis, IN 46214-2041
800-428-7267

Tab Books

PO Box 40
Blue Ridge Summit, PA 17214
717-794-2191

Van Nostrand Reinhold Company

135 W. 50th St.
New York, NY 10020

Publishers of Schematic Diagrams (other than manufacturers)

Eagan Technical Services, Inc.

1408 Northland Drive
Suite 107
Saint Paul, MN 55120
612-688-0098

MI Technologies

3310 E. Peterson Rd
Troy OH, 45373
937-335-4560
Fax: 937-339-6344

Howard W. Sams & Company
2647 Waterfront Parkway East Drive
Indianapolis, IN 46214
317-298-5400

Schematic Solutions, Inc.
11120 Wurzburg Rd., #206
San Antonio, TX 78230

Software Sources

Service Tips programs

AnaTek Corporation
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Electronic Software Developers
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South Farmingdale, NY 11735
516-221-6403
800-621-8477

FixFinder
TCE Publications
10003 Bunsen Way
Louisville, KY 40299

High Tech Electronics
1623 Aviation Blvd.
Redondo Beach, CA 90278
310-379-2026

Higher Intelligence Software
60 Farmington Lane
Melville, NY 11747
516-643-7740
800-215-5081

**Technical Information
Procurement Service (TIPS)**
PO Box 1681
Forest Park, GA 30051-1681
770-968-3715

Home Study

Cleveland Institute of Electronics
1776 E. 17th St.
Cleveland, OH 44114
216-781-9400
Fax: 216-781-0331

**Cook's Institute of Electronics
Engineering**
Desk 15
PO Box 20345
Jackson, MS 39209
601-371-1351

Electronic Institute of Brooklyn
4823 Avenue N
Brooklyn, NY 11234

Grantham College of Engineering
2500 S. La Cienega Blvd.
Los Angeles, CA 90034

Heath/Zenith
PO Box 167
Hilltop Rd.
St. Joseph, MI 49085
616-925-6000

National Institute of Technology
1701 W. Euless Blvd.
Euless, TX 76039

National Technical Schools
456 W. Santa Barbara Ave
Los Angeles, CA 90037

NRI Training for Professionals
McGraw-Hill
Continuing Education Center
3939 Wisconsin Ave.
Washington, DC 20016

Private Trade Schools

**Accrediting Commission of Career
Schools and Colleges of Technology
ACCSC**
(Formerly NATTS)
2101 Wilson Blvd Suite 302
Arlington VA 22201
703-247-4142
Fax: 703-247-4533

Other Training Programs

Computer Training

American Institute
Institute for International Research
437 Madison Ave., 23rd Floor
New York, NY 10022

Learning Tree International
6053 West Century Boulevard
PO Box 45028
Los Angeles, CA 90045-0028
310-417-9700
Fax: 310-645-4762

National Advancement Corp.
2730-J South Harbor
Santa Ana, CA 92704
714-754-7110

Test Equipment Manufacturers

B&K Precision
Maxtec International Corp.
6470 West Cortland Street
Chicago, IL 60635
312-889-1448
Fax: 312-794-9740

John Fluke Mfg. Co., Inc.
PO Box C9090
Everett, WA 98206
206-347-6100

Hewlett-Packard
3000 Hanover St.
Palo Alto, CA 94304
415-694-2000

Sencore
3200 Sencore Drive
Sioux Falls, SD 57107
605-339-0100

Tektronix
Oscilloscope Division
PO Box 500, MS 39710
Beaverton, OR 97077
503-627-2010
Fax: 503-627-5593

Tentel
4475 Golden Foothill Parkway
El Dorado Hills, CA 95630
916-939-4005
800-538-6894



Hitachi VCR repairs

By Victor Meeldijk

A Hitachi Model VT-M241A that I was called on to service exhibited a wavy looking picture (Figure 1) and low sound level. The sound level would increase then fade out when the machine was put into Fast Reverse then Play mode. When I opened the unit, I found that it was relatively clean inside and seemed to be loading tape properly. Minor adjustments to the audio head stack alignment improved the audio level.

A close examination of the chassis revealed that the right tape arm was not fully seated in the stopper (Figure 2). Lubricating the tape loading arm tracks and then the gear assembly did not fix the problem, the arm still would stick just before seating. I remembered that the owner said that it had jammed once and he had had to manually extract the tape.

Checking both tape loading arm paths, I found that by pressing on the metal of the right loading arm chassis path (Figure 3) the metal moved down, this did not occur on the left side. Bending the metal into its proper position fixed the video problem. However, on system check-out the VCR hung-up, just as the owner described, and the machine went out of alignment. I traced the problem to an intermittent mode switch (pin one lost continuity). Hitachi does not sell the switch, so I ordered a complete loading block assembly (p/n 7468854). After I installed the new loading block I set about to realign the VCR.

Realigning the VCR

The technical manual for this model is no longer available, so to realign the machine I used a Hitachi Model VT-M250A, which has a similar chassis, for visual reference, and a manual obtained from some helpful readers through a Reader's Exchange item in this magazine. Thanks again to Kevin Wood and Dave Garber of Pyxis Technical Services of Halifax, Nova Scotia for their help.

To keep this article short, I will not go



Figure 1. When I first operated the Hitachi model VT-M241A to evaluate its condition, it produced this wavy picture.

into detail on another problem that I encountered during this service procedure: the cylinder head motor did not operate. In brief, however, by using sig-

nal tracing, I found that the clock signal from the system microprocessor (IC901) was not getting to servo IC601, pin 53. The cause of this problem was a damaged

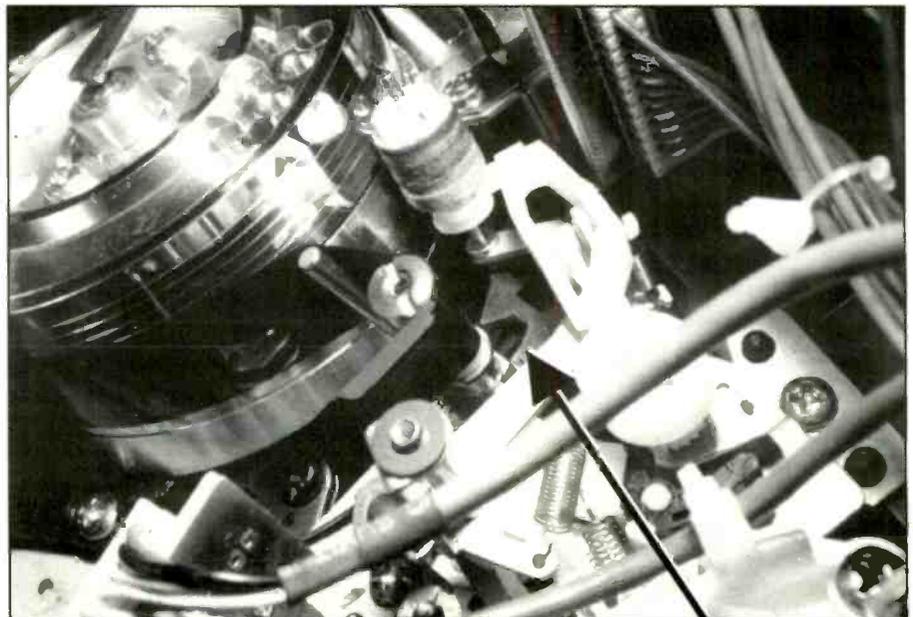


Figure 2. The picture of Figure 1 was wavy because the right tape arm was not fully seated in the stopper (easily missed when looking at the chassis from the front of the machine).

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

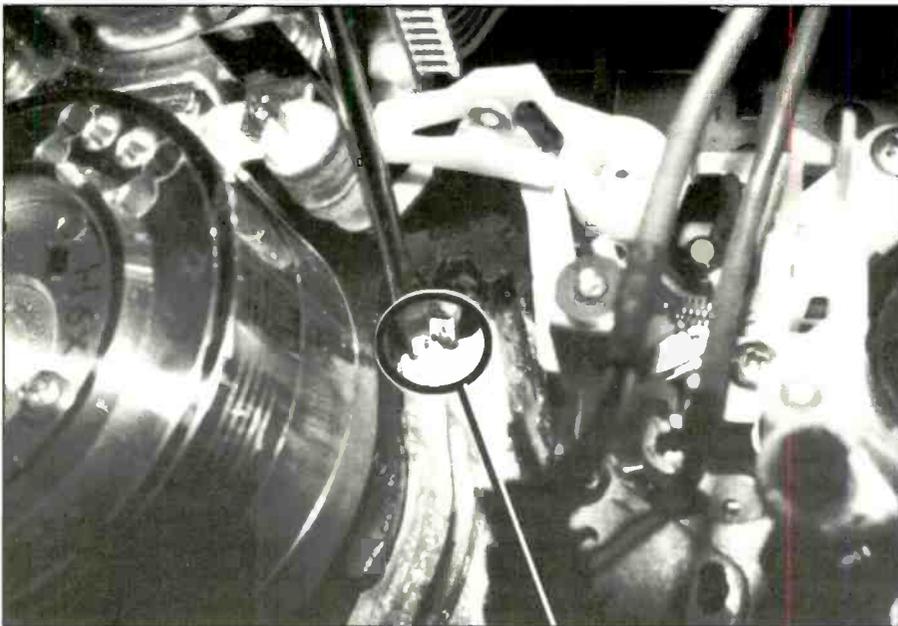


Figure 3. Pressing on the metal of the right loading arm guide revealed that it was slightly raised, causing the arm to bind.

printed circuit board trace, that occurred during the handling and troubleshooting process. This can happen to you, especially with some of the thin traces in high density areas of circuit cards.

Repairing a Hitachi Model VT-M250A

At the same time as I was servicing the Hitachi Model VT-M241A, I was also working on another VCR, a Hitachi Model VT-M250A that was "eating" tape. The problem was that the tape was not being drawn into the cassette because

the take-up reel was not turning. The machine would also not work in Fast Forward, Fast Reverse or Review mode.

In disassembling the drive gears I found that the fix washer had spread apart and was no longer holding the gears in place (Figure 4). After I replaced the washer the machine operated normally. However, a few weeks later the machine was back with the same problem. The new washer had spread open. To make sure that this failure did not happen again, I replaced the washer with a metal E-clip (Figure 5). ■

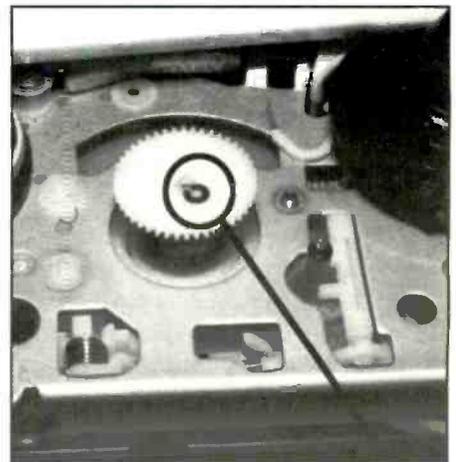


Figure 4. The Model VT-M250A was eating tape because the fix washer had spread apart and was no longer holding the gears in place.

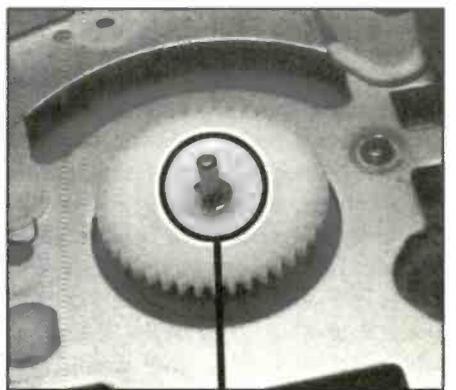


Figure 5. After the VCR returned with the same problem a few weeks after the initial repair I replaced the fixed washer with a metal E-clip to hold the gears in place.

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Troubleshooting transmitter circuits

By Thomas Jones

Technicians who service consumer electronics other than the traditional entertainment products will discover that fairly complex radio frequency (rf) transmitting systems are available for purchase by consumers. The simple garage door opener using an oscillator and small signal transistor as a final amplifier shares the spectrum with sophisticated video signal repeaters, closed circuit and rf camera systems, baby monitors, personal locators, cellular equipment, etc. An understanding of a generic radio transmitter will enable technicians to service most transmitters as they all share similar characteristics.

To provide a background which will be useful when repairing the next transmitter system that comes into your shop, we will look at the theory of operation and methods of troubleshooting actual transmitter circuits. The circuits will include those found in the VHF/UHF region, which include stripline and transmission line technology.

Jones is electronics applications engineer at Enercon Industries, Menomonee Falls, WI.

Frequency generation

The frequency synthesizer is becoming more economical and easy to implement as specialized microchips become available, so they are being designed into more and more consumer products. This article, will, therefore include a list of steps that a technician should take to isolate problems in a semi-discrete synthesizer. You will still find plenty of single channel crystal or tuned circuit controlled systems, and so the reference oscillator is also discussed. Additionally, steps that are recommended to isolate problems in the synthesizer will be reviewed.

Figure 1 illustrates the components of a modern synthesizer system. In simple systems, the microprocessor (μ p) will be replaced by switches to change channels. The transmitter radio frequency is generated in the voltage controlled oscillator (VCO). The VCO frequency is changed by the phase lock loop integrated circuit (PLL IC) in conjunction with channel select information from the μ p and a steady reference frequency (1MHz in our example) from the reference oscillator.

The μ p loads the PLL IC counters with

a division ratio such that they will output 1MHz when the VCO is on the desired frequency. The comparator inside the PLL IC will always generate a constant control voltage when the input from the internal PLL IC counters and the reference oscillator are both at exactly 1MHz.

When the radio operator changes frequencies, two things happen in the PLL integrated circuit. First, the up loads a (divide by X) command into the counters in the PLL IC. The radio was on a different channel, so the output from the counters will not be 1MHz since we just selected a new division ratio. Secondly, this signal which is not quite 1MHz, is compared by the comparator to the 1MHz crystal controlled reference oscillator signal and a resultant difference voltage (control voltage) begins to drive the VCO frequency in a direction which results in 1MHz from the counters inside the PLL IC.

Just as the new frequency selected by the operator is reached, the output of the counters will be exactly 1MHz, and when compared to the reference 1MHz, the PLL IC will stop varying the control volt-

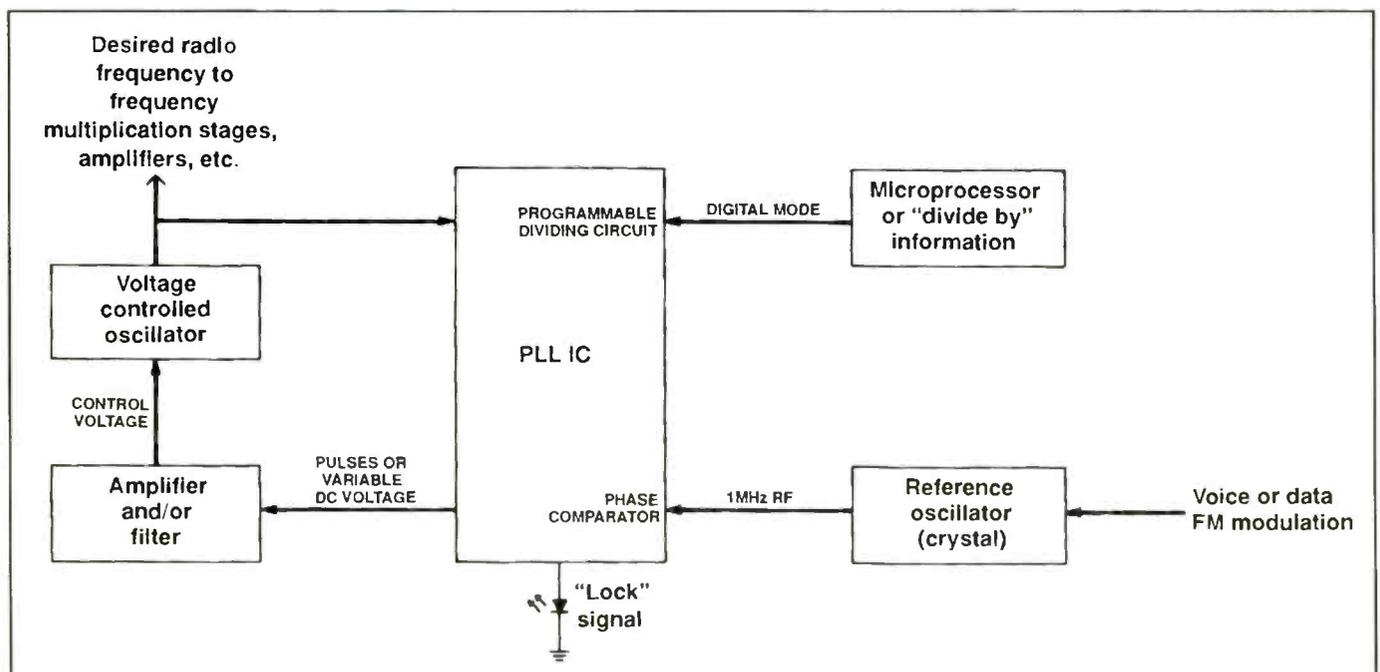
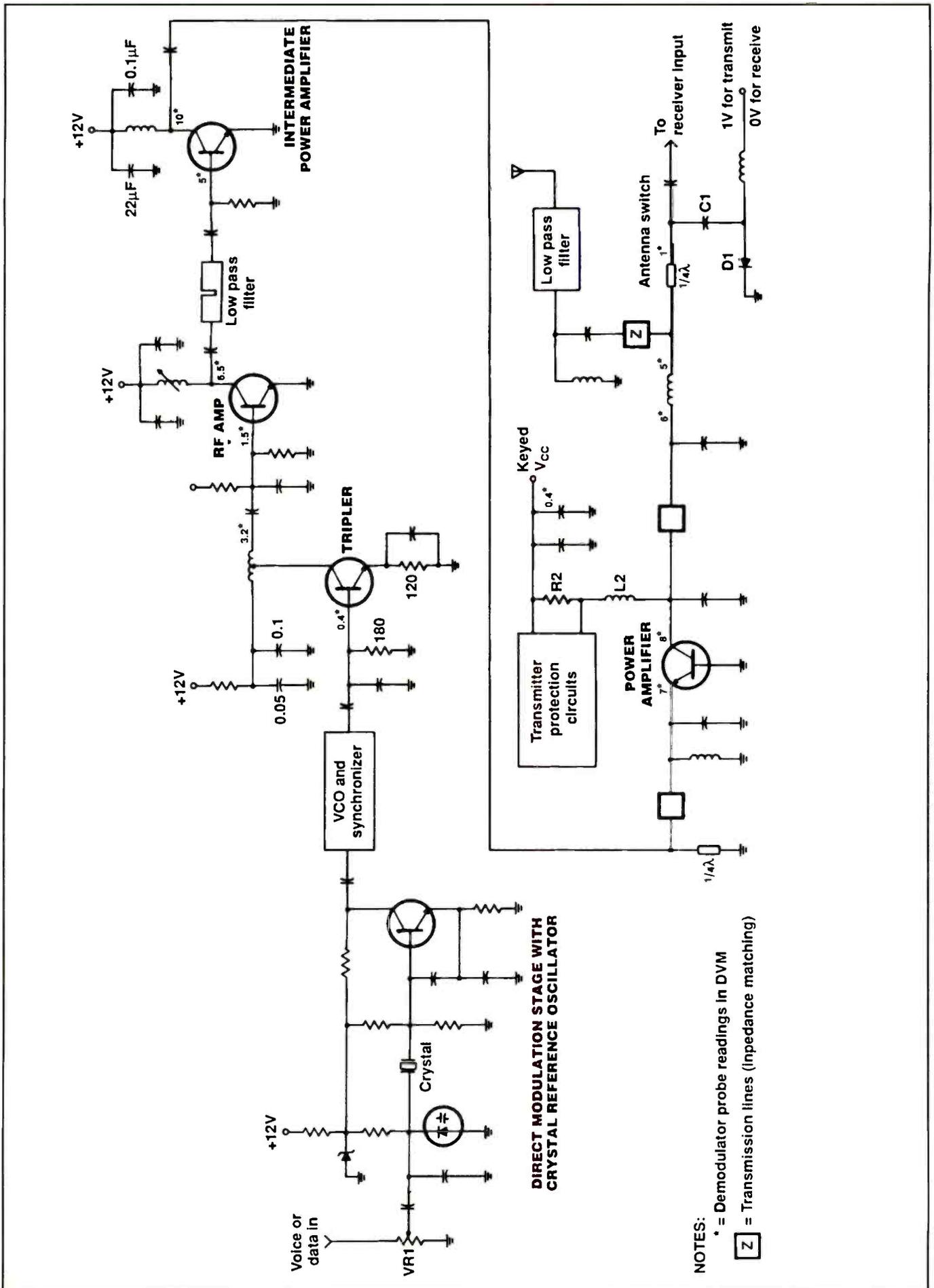


Figure 1. The basic components of a modern synthesizer system.



◀ **Figure 2.** These circuits form an FM transmitter. The data on the drawing show the major stages and voltage readings measured with a demodulator probe connected to a common DVM or DMM.

age so the VCO will stay locked on the new frequency or channel. Of course, any drifting by the VCO will result in an error from the comparator circuit inside the PLL IC, and a resulting correction to the control voltage will be fed to the VCO.

Troubleshooting synthesizers

In advanced systems, we have to assume the μ p and memory are working in order to troubleshoot the synthesizer. If the PLL IC has a lock signal and it is correct, it is occasionally possible for the control voltage to have some noise on it, or be varying quite a bit. The lock signal indicates that the PLL IC is able to follow the signals it is receiving.

Tapping on the unit (gently) should not cause noise on the control line. If tapping does cause noise on the control line, check for loose screws that provide grounds, loose screws or cold solder welds on VCO RF covers, or cold solder joints on components. Noise can also be caused by leads of components touching other circuit parts, for example, a capacitor lead touching another part of the circuitry, which is aggravated by disturbances, such as tapping on the unit.

A control voltage at ground or V_{CC} indicates that the problem could be almost anywhere in the synthesizer. The following troubleshooting routine works well in general synthesizer repair. Verify that the unit is out of lock by checking the lock signal. Next, check the reference oscillator signal. Use the oscilloscope and frequency counter to check for stability in amplitude and frequency, as well as being on the correct frequency.

In some instances, a VCO trim capacitor can become dirty and shut down the oscillator. If you suspect this to be the case, blow the area out with compressed air. Adjust the trim capacitor throughout its range, returning to nearly the position you started at and recheck the lock signal just in case the VCO has restarted.

Next, measure the control voltage. If this voltage is at either extreme, the VCO probably will not work. In that case, open the control line and use an external supply to clamp the control line fed to the VCO

at about one fourth the PLL IC supply voltage. You may need to use a potentiometer to vary the clamped control voltage a bit. The main thing to observe is an output frequency from the VCO. If you get an output in the correct frequency range (considering any frequency multiplying downstream), the VCO is probably good.

Sometimes defective components around the VCO tuned circuit (coils and capacitors) cause the VCO to stop oscillating. If you cannot coax the VCO into operation with the clamped line, try replacing the active device, then the frequency determining passive components.

If the unit still doesn't operate, by process of elimination, the PLL IC and any amplifier/filter circuits in series with the control line after the PLL IC are now left as possible causes of the problem. The output of a normal PLL IC may be a series of pulses, or a steady control voltage, depending on the type of PLL IC used. In either case, when you change the channel, the output should change in some manner. If it does not, the PLL IC is probably defective.

Frequency synthesizers are the heart of modern wireless equipment. Always ensure that the synthesizer is working before making any attempt to repair other parts of the system.

Transmitter circuits

Transmitter circuits are required to increase the power of the radio signal and do so without distorting the modulation, regardless of whether it is AM, FM, PCM, video, etc. The circuits collected in Figure 2 to form the FM transmitter show the major stages and voltage readings mea-

sured with a demodulator probe connected to a common DVM or DMM. Notice that the reading does not necessarily increase on the output of a power amplifier. The reason that there is no increase is that the demodulator probe simply measures voltage, not the product of voltage and current, i.e., power.

Reference oscillator and frequency synthesizer

In some FM systems, the reference oscillator frequency is shifted at the audio rate as the voice signal modulates the varactor diode. The capacitance of the diode varies with applied voltage, and warps or shifts the crystal frequency to produce FM modulation. Moreover, modulation is often applied to the VCO at the same time for a linear modulation response. VRI sets the deviation level. If the oscillator is found to be working, by measuring with a frequency counter at the collector of the transistor, yet there is no deviation, then a quick check with an oscilloscope at the varactor should show if modulation is reaching the circuit.

The capacitors from the base of the transistor to ground set the feedback ratio and also determine whether or not the oscillator will start. The Synthesizer and VCO are shown as a block diagram and operate as previously discussed.

Tripler and rf amplifier

The function of the tripler is to multiply the frequency by a factor of three. This is accomplished by adding a tuned circuit which is resonant at the third harmonic of the frequency from the synthesizer. The tapped coil and tapped capacitors are

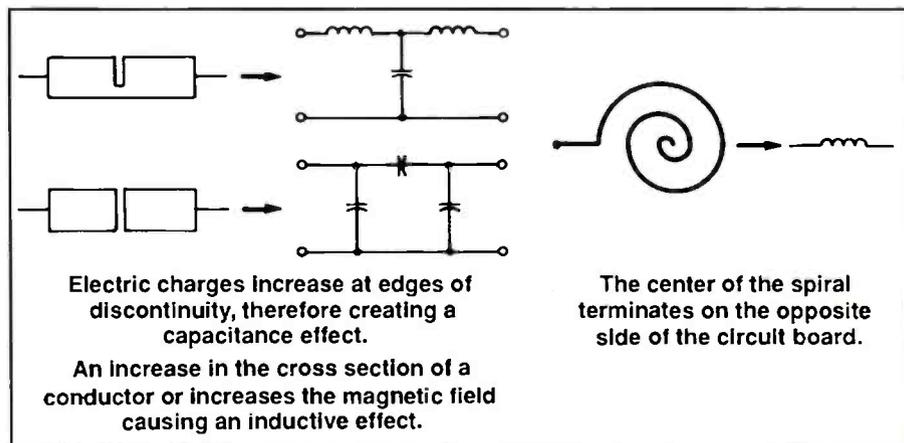


Figure 3. The rectangular strip with a notch cut out of the middle between the rf amplifier and the IPA amplifier in Figure 2 is a microstrip low pass filter, and physically appears just as it is drawn on the schematic. This filter attenuates higher order harmonics produced by the rf amplifier.

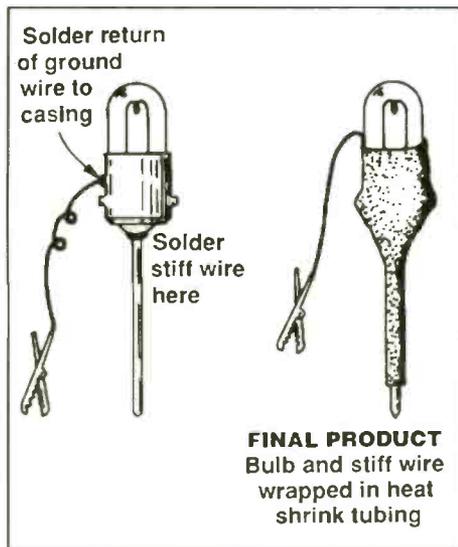


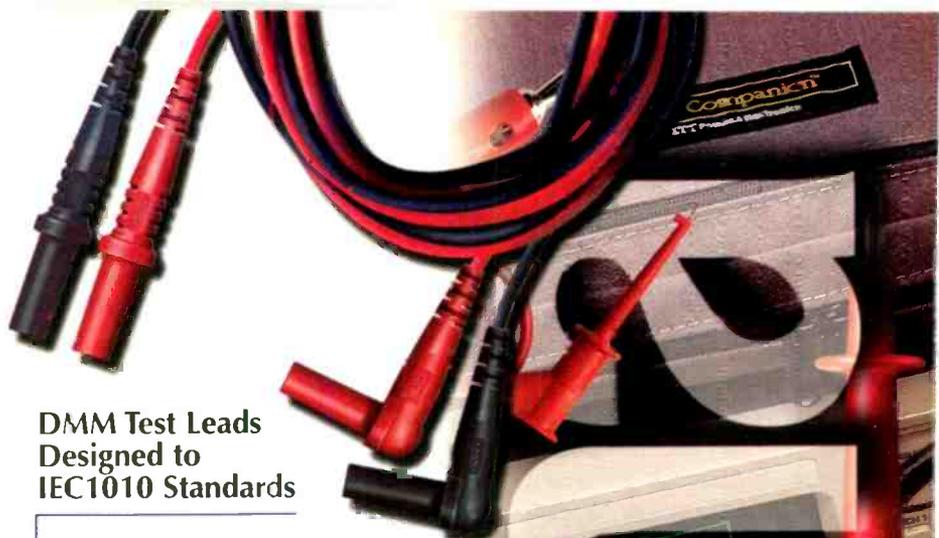
Figure 4. An old trick, used since the early days of radio, is to use a light bulb as shown here as a piece of test equipment during the troubleshooting process on power stages. The rf alternating currents will light the lamp with an intensity related to the rf power level. At higher power and frequency levels, it is not even necessary to connect the ground or return lead in order for the lamp to light.

broadly tuned to the third harmonic over the frequency range at which this transmitter is designed to operate. The absence of forward bias indicates a class B dc operating point, and you would expect full V_{CC} to appear on the collector. The demodulator probe (DMP) indicates voltage gain, although this stage is designed for frequency multiplication. The point to be made here is if the dc conditions are correct and rf is making its way through the stage, we can consider it operating normally. The key measurement parameter in this stage is frequency, not signal amplitude. For example, when troubleshooting a decrease in rf output power, we would not normally suspect a frequency multiplier stage to be at fault.

However, the following stage is an rf amplifier, and we would expect to see a voltage gain of at least two from this type of low level stage. The coil in the collector circuit allows maximum dc voltage on the collector, yet acts as a high impedance to develop the rf signal. Tune the coil for maximum power out of the transmitter.

Microstrip filter and intermediate power amplifier (IPA)

The rectangular strip with a notch cut out of the middle between the rf amplifier and the IPA amplifier is a microstrip low pass filter, and appears just as it is



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drawn on the schematic. This filter attenuates higher order harmonics produced by the rf amplifier (Figure 3). The 0.1 μ F and 22 μ F capacitors in the collector circuit bypass the IPA for high and low frequencies, respectively. RF amplifiers have high gain at low frequencies and can break into oscillations or sometimes saturate if the low frequencies are not bypassed.

The shorted (grounded) quarter wave line on the output of the IPA acts as a parallel resonant circuit or high impedance to the fundamental frequency, and as a series resonant or low impedance circuit to the second harmonic, and thus attenuates the second harmonics generated in the IPA stage. The microstrip line between the IPA and the PA is used for impedance matching, that is, to transfer as much electrical power as possible between stages.

Troubleshooting transmission or microstrip lines

It is possible for problems to appear on transmission or microstrip lines, even though they are essentially pieces of copper foil over a ground plane. The printed circuit board will be double-sided, and any defects in the circuit board material will also affect the impedance of the transmission line.

The impedance of stripline is determined by the stripline width, height above ground plane, and the dielectric constant of the board material. Therefore, any cracks in the circuit board or in the copper foil will reduce the effectiveness of the line. Carefully observe these lines with a magnifying glass to ensure there are not any discontinuities. A careful touch-up with solder will often repair a cracked transmission line. Keep the solder connection as smooth as possible to avoid creating unwanted surface wave reflections on the line.

Power amplifier (PA) stage

Power stages consume most of the current in a transmitter; usually more than 60 percent. If you have a means of monitoring the current from the power supply, the value of current drawn can give you an idea of the location of a fault in transmitter power stages, assuming the unit is properly tuned to start with. For example, if current draw is normally 10A for 20W output, and you have a transmitter with

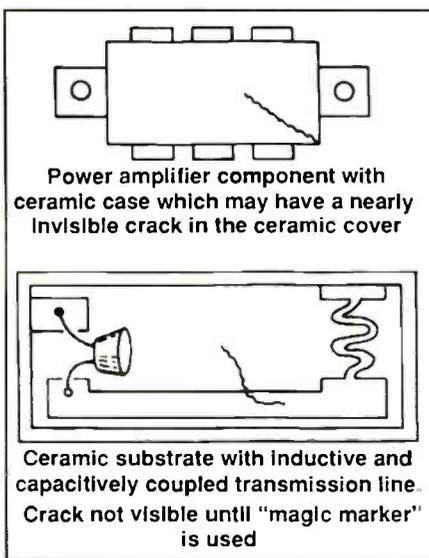


Figure 5. This is the diagram of a common type of power amplifier module or component. The insulator of this component can sometimes develop a hairline crack which will affect operation of the component by letting moisture or other contaminants seep into the circuitry. Moreover, some of the high-power amplifiers use ceramic substrates as "circuit board" on which to lay down microstrip lines, etc. A hairline crack on these materials can also allow in moisture or cause breaks in the strip itself. Sometimes, the substrates are just used as insulators, and cracks can then cause paths for leakage currents.

low power output, say 5W, and a current of 3A, this would point you to the power amplifier as a possible problem.

Along with the current measurement method of troubleshooting, don't forget the technique of placing a finger near, or almost touching, the power amplifier. To use this method, turn off power and quickly feel near or on the PA module. An extremely hot power amplifier module that is not generating the required power is probably defective. Conversely, a relatively cool power amplifier transistor or module that is not producing power is probably also defective. The PA's job is to divert as much power supply energy to the antenna as possible, and to do that it must get somewhat warm or hot, but not end up at either temperature extreme.

Power amplifier stages are very finicky about grounding, especially under and around any supporting capacitors in the emitter and base circuits. This is one area in electronics where it pays not to be stingy with the solder. Make sure it flows under the contact points and makes a good bond with the trace. Don't worry too much about overheating the PA, it is designed to handle the heat. On that note,

never run a PA without a heat sink. The device can be destroyed in less than a millisecond if keyed without proper heat sinking in place. If the unit is mounted with heat transfer (thermal compound) grease, don't forget to apply a thin coat any time you install one of these. The purpose is simply to fill in the small irregularities between the two surfaces. Excess grease will actually impede heat transfer.

PA protection circuits

Most PA circuits have some sort of V_{CC} control. These can be quite sophisticated, detecting abnormal phase conditions across the PA (voltage standing wave ratio, abbreviated VSWR), as well as temperature or current draw abnormalities. Needless to say, always check these circuits when troubleshooting PA stages.

During troubleshooting, it is often helpful to isolate problems with these circuits by bypassing them. In this transmitter, we would jump around the keyed V_{CC} stage by connecting V_{CC} directly to the junction of L2 and R2. Bypassing circuits is a very powerful troubleshooting technique as long as you understand the circuit and carefully think through the consequences before connecting the jumper wire.

PA stages need sufficient drive to work properly. For example a 10W amplifier will develop ten watts into the proper load impedance when it is driven at the minimum rated input rf power level. The same can be said for most rf stages, which is the reason impedance matching is so important in rf circuitry.

Antenna switch and output filter

Most of the components tied to the PA collector are there to provide an impedance match between the collector and the antenna load. Additionally, unless there is an odd electrolytic capacitor in there somewhere, these PA components are very rugged and seldom fail without visible charring or evidence of overheating.

The antenna switch rejects, from the receiver front end, most of the power the PA is attempting to force into the antenna. Diode D1 is forward biased during transmission, which provides an rf short through the dc blocking capacitor (C1) to one side of a quarter-wave line, therefore the other side presents a high impedance to the power signal from the PA collector, thus preventing most of the power from entering into the receiver circuit where it

could damage sensitive components.

The output low-pass filter attenuates high-frequency harmonics generated in the PA. Filter stages in line with the antenna usually have identical input and output impedances, therefore if the filter is suspect, bypass it and see if power output increases. You will probably notice an increase in output power because the harmonics are now transmitted instead of being attenuated by the filter.

A bright idea

An old trick, used since the early days of radio, is to use a light bulb as a piece of test equipment during the troubleshooting process on power stages (Figure 4). Basically, the rf alternating currents will light the lamp with an intensity related to the rf power level. At higher power and frequency levels, it is not necessary to connect the ground or return lead in order for the lamp to light.

Be careful using this technique. A 12V transceiver can generate rf voltages in excess of 100V, which could burn out the lamp, or draw an arc. Using the test lamp on this transmitter, we should see a brighter glow on the collector then on the base of the RF amp; and subsequently the

bulb will glow brightly on the IPA and the PA stages.

The light bulb is also a good tool to use when troubleshooting power splitters/combiners. Additionally, low level dc voltages on identical stages can be quickly compared as well.

Checking for defects in substrates

Figure 5 is the diagram of a common type of power amplifier module or component. The insulator of this component can sometimes develop a hairline crack which will affect operation of the component by letting moisture or other contaminants seep into the circuitry. Moreover, some of the high-power amplifiers use ceramic substrates as a "circuit board" on which to lay down microstrip lines, etc. A hairline crack on these materials can also allow in moisture or cause breaks in the stripline itself. Sometimes, the substrates are just used as insulators, and cracks can then cause paths for leakage currents.

One method to check material of this nature for cracks is to use a marker that uses water-soluble ink to mark across the substrate. Then wipe quickly with a damp cloth to spread the ink along the surface

of the substrate. The ink will accumulate in the cracks and pinpoint the defect.

General transmitter troubleshooting

Once the oscillator or synthesizer section is operating, trace the signal through the rest of the transmitter. The only stage that can cause frequency drift is in the frequency generators. Suspect poor solder joints, defective temperature compensation components, or varying V_{CC} supplies if frequency drift is a problem. Crystals that drift in frequency on their own accord are rare. They are more likely to shift to another frequency due to breakage, or to totally stop oscillating.

Active devices, as well as feedthrough type filters and other components can be cooled with freeze spray to help find intermittents. Tapping on a radio should not cause change in operation. If it does, this indicates a loose connection. Use further tapping to isolate the area, then use freeze spray or a magnifying glass to help find the loose part. Always perform a close visual inspection, especially inside cavities, under RF covers, etc. In my experience, 70% of transmitter problems are associated with heat generating components, including power amplifiers and voltage regulators. ■

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Troubleshooting Tip

No raster, no sound: Zenith Model SB5563GC

By Dudley Overton

A Zenith Model SB5563GC TV was brought to the service center with the complaint that there was no raster and no sound. The remote control and the channel display were working. The fuses were intact, and the horizontal output transistor (HOT) had the required 153V on the collector. I checked the HOT using the beeper on the DMM; it was ok.

Since this set uses a one-shot multivibrator to start the HOT, I connected the scope to the base of the HOT to check for the start-up pulse. The pulse was not there.

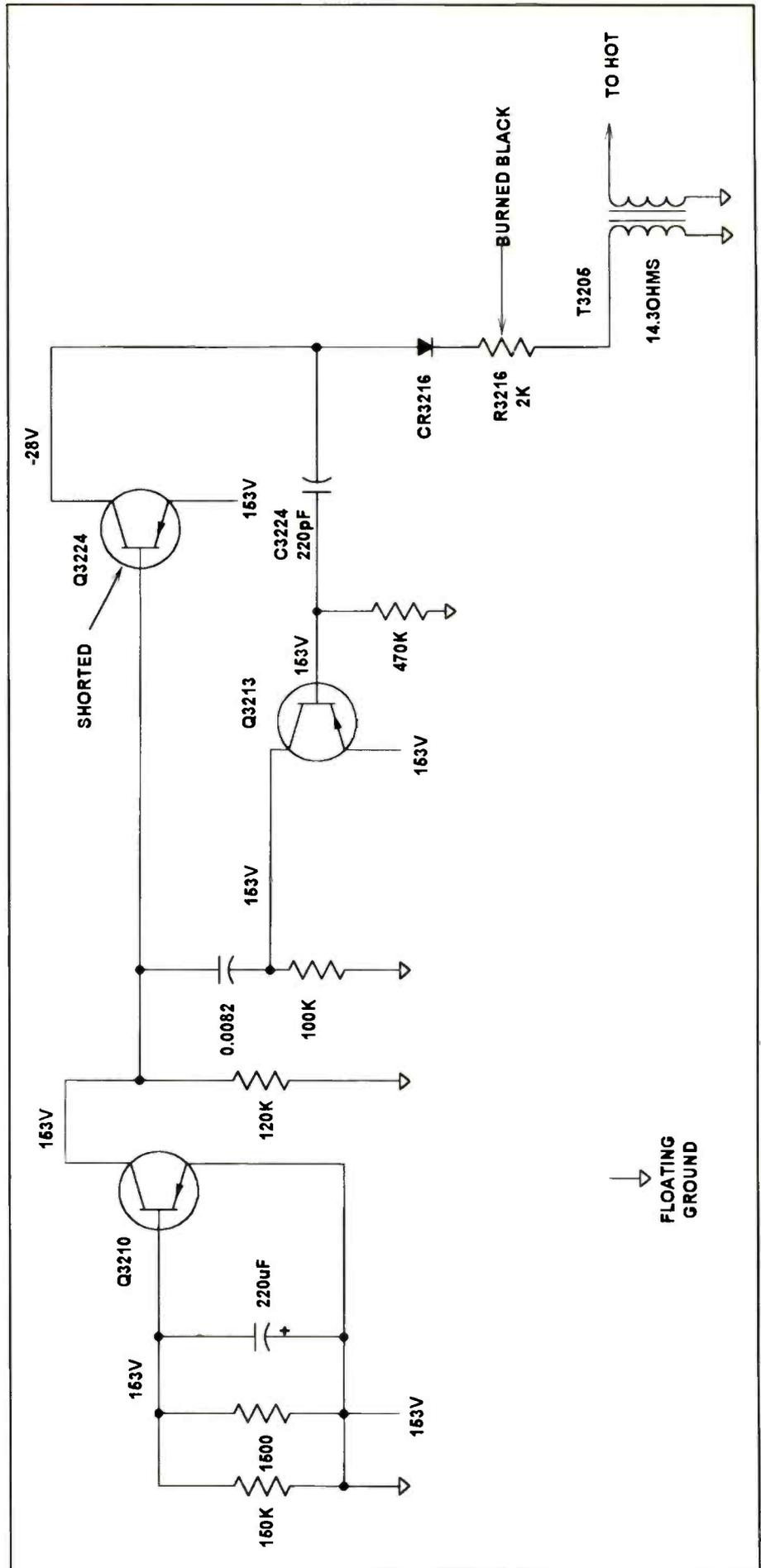
I removed the horizontal chassis from the set and looked it over carefully. Resistor R3216 was burned black. Either C3224 or Q3224 was shorted allowing 153V to pass through R3216 to ground via the 14.3Ω primary of transformer T3205. Since small ceramic capacitors seldom become short-circuited, I decided to check the transistor. I removed transistor Q3224 from the circuit and tested the junctions. It was defective.

Transistors Q3224 and Q3213 were both marked with the Zenith part number 121-1101. Several documents I referred to list SK3466/159 as a replacement. This transistor will not withstand 153V.

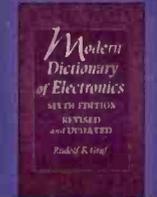
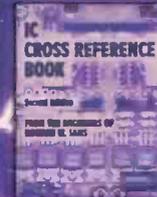
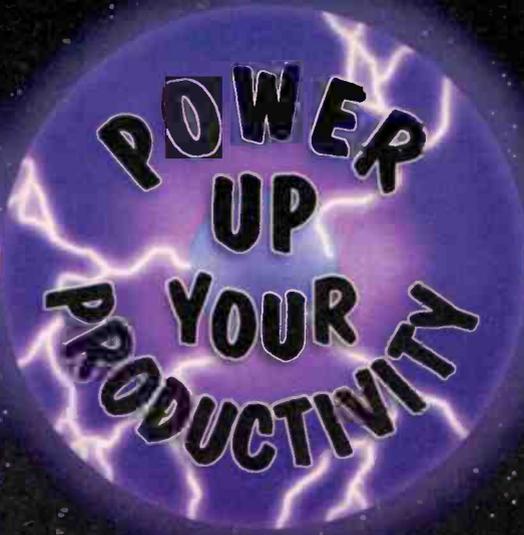
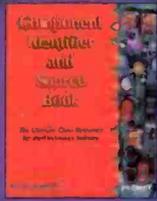
I checked a recent edition of the *ECG Master Replacement Guide*, and it shows that SK3434/288, rated at 300V, is the correct replacement.

I replaced both Q3213 and Q3224, because both transistors in this circuit should be identical. I also replaced the burned resistor and installed a new diode. This restored the set to normal operation.

Overton is an independent servicing technician.



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Choosing a replacement parts supplier

The whole is greater than the sum of its parts. The origin of that expression, and the "whole" to which it refers is obscured at the moment, but it is an expression that certainly applies to consumer electronics products. Take a television set for example, and examine each of its parts.

You'll find resistors in there whose functions include limiting current and establishing proper voltages. You'll find capacitors whose functions include blocking dc current and passing ac, as well as establishing a virtual short circuit for higher frequency signals. You'll find inductors whose functions include adjusting the frequency of a tuned circuit or acting as a virtual open circuit for higher frequency signals.

Sprinkled throughout you'll find a sampling of silicon components and integrated circuits whose functions include amplification, rectification, data storage, control, and emission of light.

Take all of those parts and a few more and you have a television set that is capable of bringing the great wide world into your living room.

Complexity meets absence of standardization

At one time the components that an engineer had to select from in designing a consumer electronics product, and the ways in which they were interconnected, were relatively few and pretty much standardized. And most of the circuits were relatively simple. A technician who needed a replacement part looked through a standardized catalog, selected the replacement, installed it, and restored the product to operation. Actually, in many cases the parts were so standardized and so readily identified that it wasn't even necessary to consult any documentation.

Those days are long gone. Today's consumer electronics products are more sophisticated, contain far more complex circuitry, and circuit design varies great-

ly from manufacturer to manufacturer. As if that weren't bad enough, many products contain proprietary parts that can't be obtained from anyone but the manufacturer. In some cases, those proprietary parts may not be available at all to servicers who are not authorized to service that manufacturer's products. And if the product is more than seven years old, replacement parts may no longer be available, at all, to anyone, at any price. What's a service center to do?

Identifying components

Service centers can do a number of things to make obtaining replacement components easier. One step is to obtain copies of every available cross reference and become familiar with them so that when a part is needed it can be identified.

Some cross references are available free from manufacturers through distributors. Other cross references cost a considerable amount of money. However, if a service center adds up all the long distance calls, and all the time spent on the phone, to say nothing of the toll charges for those long distance calls, any cost for cross references might be found to be money well spent.

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 company, the efforts they are making when it comes to customer satisfaction, and how

to contact them when you need a replacement component.

Helpful questions

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

- How many locations do they have?
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- 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 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.

It might be tempting to order from the first distributor that comes to mind, but if you 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 the questions you may have regarding replacement parts. ■

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The engine behind PASC'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 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 1,000 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 con-

solidations 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 125 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 3¹/₂ 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 approx-

imately 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.

We have completed our investment in the modernization of our warehouse operations. This includes 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 enables 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 five 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 Country.

The Future

There will be a continued emphasis on expansion of our customers' ability to go "on line" with PASC 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 Panasonic 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, Santa Clarita 91355 * 800-289-0300 * FAX 800-289-0301
AVAC Corp. (V) * 3746 Bradway Dr., Sacramento 95827 * 916-361-7491 * FAX: 916-361-5480
Cass Electronics (C/V/M/A) * 801 Seventh Ave., Oakland 94606 * 510-839-2493 or 800-289-0300 (outside 510) * FAX 510-465-5927
E and K Parts, Inc. (C/V/M/A) * 2115 Westwood Blvd., Los Angeles 90025 * 800-331-8263 or 310-475-6848 * FAX 800-826-0890 or 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 (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 * 860-233-8551 * FAX 860-233-8554

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/M/A) * 2701 West McNab Road, Pompano Beach, 33069 * 800-432-8542 or 954-969-1811 * FAX 800-552-1431 or 954-969-0226
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 * 404-351-7300 * FAX 404-351-7307
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, Inc. (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. Coming Road, Beecher, IL 60401 * 800-648-6657 or 708-946-9500 * FAX 800-43-UNION or 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 * 800-247-1439 or 316-262-3707 * FAX 316-262-6494

MARYLAND

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 413-739-3895
Tee Vee Supply Co. (C/V/M/A) * 407 R Mystic Avenue, P.O. Box 649, Medford 02155 * 617-395-9440 * FAX 413-739-3895

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
Rencor 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 Gilsian Lane, Fenton 63026 * 314-349-3000 * FAX 314-349-2333

NEVADA

MCM Electronics (C/V/M/A) * 495 East Parr Blvd., Reno 89512 * 800-543-4330 * FAX 513-434-6959 (OH)

NEW JERSEY

AVAC Corp. (V) * 66 Ethel Rd., Edison 08818 * 908-287-3300 * FAX 908-287-3331
Panion Electronics (C/V/M/A) * 1-60 and New Maple Ave., P.O. Box 2003, Pine Brook 07058 * 800-255-5229 or 201-244-2400 * 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 Vulcan 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 * 937-434-0031 or 800-543-4330 * FAX 937-434-6959

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

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

AVAC Corp. (V) * 236-B Space Park South Dr., Nashville 37211 * 615-834-8800 * FAX 615-831-1051
Electrotex, Inc. (C/V/M/A) * 6122 Macon Rd., Memphis 38134 * 901-383-9300 * FAX 901-388-0258
Shields Electronics Supply, Inc. (C/V/M/A) * 4722 Middlebrook Pike, Knoxville 37921 * 423-588-2421 * FAX 615-588-3431

TEXAS

Electrotex, Inc. (C/V/M/A) * 813 Morrow, Austin 78757 * 512-454-0318 * FAX 512-454-0859
Electrotex, Inc. (C/V/M/A) * 555 S. 23rd St., Beaumont 77707 * 409-842-3456 * FAX 409-842-5262
Electrotex, Inc. (C/V/M/A) * 1410 Crescent, Corpus Christi 78412 * 512-993-9697 * FAX 512-993-9699
Electrotex, Inc. (C/V/M/A) * 2300 Richmond Ave., Houston 77098-3299 * 713-526-3456 * Fax 713-639-6400
Electrotex, Inc. (C/V/M/A) * 1200 W. Hildebrand, San Antonio * 78201 * 210-735-9271 * FAX 210-737-2642
Fox International (C/V/M) * 752 So. Sherman, Richardson 75081 * 800-321-6993 or 214-439-8500 * 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
VCP International, Inc. (V) * 2285 Merritt Dr., Garland 75040 * 214-271-7474 * FAX 214-278-5981

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

(C) Consumer Electronics Parts/(V) Vacuum Cleaner Parts Distributor/(M) Major Appliance Parts/(A) Accessories (as of 3/97)

Panasonic Services Company

20421 84th Avenue South, Kent, Washington 98032

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Technics

Quasar®

PC ServiceSource

**2350 Valley View Lane
Dallas, TX 75234
Phone: 1-800-PCPARTS
Fax: 972-406-9081
Web site: www.pcservice.com**



Approximately 85.5 million installed-based personal computers are at work in the United States. That's 85.5 million reasons why Service Providers should know PC ServiceSource. By the year 2000, the worldwide total is projected to reach 350 million. Sooner or later, these computers will need service and replacement parts. PC ServiceSource, the leading independent source for PC and printer parts as well as service logistics, was founded to serve this growing market.

PC ServiceSource is strategically placed in the supply chain between PC industry OEMs and Service Providers. The OEMs utilize PC ServiceSource to reduce the total cost of providing service logistics programs and achieve higher customer service levels. The Service Providers utilize PC ServiceSource for a single source for parts from over 30 leading industry manufacturers.

When PC ServiceSource was established in 1990, it wasn't meant to be just another parts supply company. The aim was to define the service logistics marketplace by creating nothing less than a new operational model for the business. The company's mission statement makes this plain: *"To become the processing hub for all service transactions in the computer service industry."*

Now, with more than 750,000 spare parts in stock from over 30 computer and printer OEMs, as well as hard-to-find diagnostic software, computer repair tools and cleaning supplies, we manage one of the largest inventories in the industry.

If you need it, PC ServiceSource can get it to you, fast. And by knowing you can depend on PC ServiceSource to have what you need, when you need it - for purchase or exchange - you can all but eliminate your own parts inventory, thereby dramatically reducing the costs and headaches of owning and managing it.

PC ServiceSource maintains strong vendor relationships with the manufacturers of the lines distributed. Currently, parts for the following lines are available :

Acer	Exabyte	Overland Data
Apple	Fujitsu	Packard Bell
AST	Genicom	QMS
Brother	Grid	Ricoh
Canon	Hewlett-Packard	Simple Technology
Citizen	IBM	TekWare
C.ltoh	Kingston	Texas Instruments
Compaq	Lexmark	Toshiba
Dataproducts	NEC	Viking
Digital Equipment	Okidata	Western Digital
Epson	Output Technology	

PC ServiceSource never closes. They're a one-stop source - at your service 24 hours a day, 365 days a year. No other service logistics company provides similar non-stop service. The company will also ship the same day all in-stock parts ordered before 9:00pm CST. PC ServiceSource can also offer Service Providers an exclusive Volume Purchase Agreement with lower prices, reduced service fees, private sales and more. Working through a channel of international service logistics providers assures you receive global coverage and consistent levels of service and effectiveness - wherever your business takes you. And of course, the international sales services representatives have multi-lingual capabilities.

PC ServiceSource also offers expanded programs including detailed inventory management services and customized spare parts outsourcing programs for machine manufacturers as well as service organizations, an on-line order entry system, a convenient selection of innovative and hard-to-find diagnostic software, technician tools and cleaning supplies, a world class call center and a world class spare parts distribution center as well as convenient 24-hour a day ordering options.

PC ServiceSource is often recognized as the world's leading independent service logistics company in the PC spare parts industry, and an expert in advance-exchange services. To further expand the array of service logistics and inventory management capabilities, a subsidiary company was introduced in 1995: Cyclix Engineering Corporation, a remanufacturing services firm oriented to the unique needs of OEMs. Cyclix provides complementary remanufacturing and repair services and helps complete the range of services required by computer OEMs.

Customer service begins with convenient access to inventory. There are three ordering alternatives: phone (**1-800-PCPARTS**), fax (**972-406-9081**) or directly on the Internet (**www.pcservice.com**). PC ServiceSource launched the industry's first real-time online ordering system, which allows customers to not only order parts, but also check inventory and availability and to track the status of orders.

There's much more to computer support service than technicians and parts. Cost effective user satisfaction demands a complete service logistics solution...well planned in anticipation of the inevitable. Whether a customer needs a mission-critical system board or hard-to-find bezel, an occasional requirement or a complete outsourcing solution, PC ServiceSource delivers. ■

Whatever computers look like in the future,
you know we'll carry their parts.

call 1.800.PCPARTS

fax 972.406.9081

www.pcservice.com

We're already re-shaping the future of parts logistics. We use technology that lets you order from over 750,000 parts in stock from over 30 different product lines 24 hours a day, 365 days a year. So whatever you need, wherever you need it, you can order by phone, fax or via pc service net on our website. Looks like the future may already be here.

 **PC ServiceSource**
right parts. right now.®



Photo from James Balog's
Techno Sapient series ©1997

Circle (135) on Reply Card

Dalbani Corporation

The Ultimate Saving Source

4225 N.W. 72nd Avenue

Miami, FL 33166

Phone: 305-716-1016, 1-800-325-2264

Fax: 305-594-6588 (24 hours)

The Corporation

Dalbani is a national and international distributor and manufacturer of electronic parts and accessories servicing the wholesale, retail and manufacturing industry.

The Stock

We maintain a huge inventory of over 30,000 different items which include over 20,000 original ICs and Transistors. This reflects our commitment to our customers because it shows how we anticipate their needs.

The Prices

We offer the lowest prices in the industry, as well as quantity discounts. Just ask to speak to the.....

Sales Department

Dalbani has equipped their multilingual sales department with the latest in state-of-the-art com-

puterized order processing systems to promptly and efficiently handle your order.

Technical Support/Customer Service

No matter what your needs are, whether it be a technical question regarding something you are ordering or a situation needing servicing, Dalbani is fully staffed to answer any questions you may have.

The Catalogs

Dalbani Corporation keeps customers informed of the latest introductions of new items by publishing 2 full line catalogs per year including catalog supplements, seasonal brochures, and notifications of sales promotions and specials.

Business Hours

Monday through Friday 9:00 AM to 7:00 PM Eastern Time. A toll-free number (1-800-DAL-



Free Catalog (248 Pages) With Your First Order.

BANI/1-800-325-2264) for U.S.A. is available, in addition to a 24-hour fax line (305-594-6588).

Shipping Options

Dalbani Corporation offers many shipping options (UPS Red, Blue, Orange & Ground, FedEx, etc.). Orders received by 2:00 PM Eastern Time will be shipped the same day, and most other orders are shipped within 24 hours. CODs, company checks and cash, and most major credit cards (Visa, Mastercard, Amex, & Discover) are accepted. There is a \$20.00 minimum order. ■

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\$20.00 Min Order

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BU-208/O	TOSHIBA	3	2.99
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2N-3773	TESLA	5	1.20

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Low Frequency Power Transistors



19¢ Minimum 10 pieces per item

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(Voltage Regulators) Repl. ECG No

7805 (Pos VR, 5V, 1A)	960
7806 (Pos VR, 6V, 1A)	962
7809 (Pos VR, 9V, 1A)	1910
7812 (Pos VR, 12V, 1A)	966
7818 (Pos VR, 18V, 1A)	958
7824 (Pos VR, 24V, 1A)	972
7905 (Neg VR, 5V, 1A)	961
7906 (Neg VR, 6V, 1A)	963
7915 (Neg VR, 15V, 1A)	969
7918 (Neg VR, 18V, 1A)	959

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SONY

• SONY PART# 8-746-371-10 SBX1637-11

\$29.95



Order No 03-195

ORIGINAL SONY OPTICAL PICK-UP

SONY

KSS# SONY# KSS210A 8-848-062-11 KSS210A 8-848-127-11

\$25.95



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ONE YEAR WARRANTY Made in Japan

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24-2550	JVC	PDM2008F5	10.40
24-1750	ORION	1590D00002	10.92
24-0775	PANASONIC	VEHS-0095	9.58
24-0800	PANASONIC	VEHS-0115	9.31
24-0900	PANASONIC	VEHS-0385/0191	10.91
24-1200	PANASONIC	VEHS-0077	19.50
24-1375	PANASONIC	VEHS-0146	20.61
24-2000	SAMSUNG	6900-370-011	9.95
24-2625	SHARP	DDRMU0004E10	26.00

ORIGINAL JVC OPTICAL PICK-UP ASSEMBLY

• Optima-6s Order No 46-2705

JVC

• Optima-5s Order No 46-2755

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63-0189	GOLDSTAR	154-074R	11.68
63-460	GOLDSTAR	154-122E	9.95
62-850	HITACHI	243-4391	11.75
63-0475	RCA (original)	1455864-501	17.61
63-0203	SAMSUNG	FCK-1415AL	10.68
63-810	SHARP	RTRNF-0003PEZZ	14.87
63-840	SHARP	RTRNF-0015PEZZ	13.81
63-850	SHARP	RTRNF-0016PEZZ	14.06
63-0106	SHARP	RTRNF-1588CEZZ	19.37
63-0112	SONY	1-439-254-13	13.75
63-0170	SONY	1-439-254-00	12.75
63-0113	SONY	1-439-273-00	13.06
63-0346	SONY	1-439-235-00	11.18
63-0346	SONY	1-439-235-11	11.18
63-0346	SONY	1-439-235-21	11.18

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MAT Electronics

(East Coast)
 400 Pike Road
 Huntingdon, PA 19006-1118
 Phone: 800-628-1118
 Fax: 800-628-1005

(West Coast)
 Phone: 800-811-5177
 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 started to distribute original parts from Hitachi, NEC, Panasonic and Sony at very competitive pricing. The company publishes an easy-to-read 116-page catalog filled with thousands of inven-

toried 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 VCRs, 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 authorized Sony, Philips, Provideo distributor.

MAT Electronics takes great pride in its ability to accommodate the various needs of all their valued customers—both in the U.S. 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.

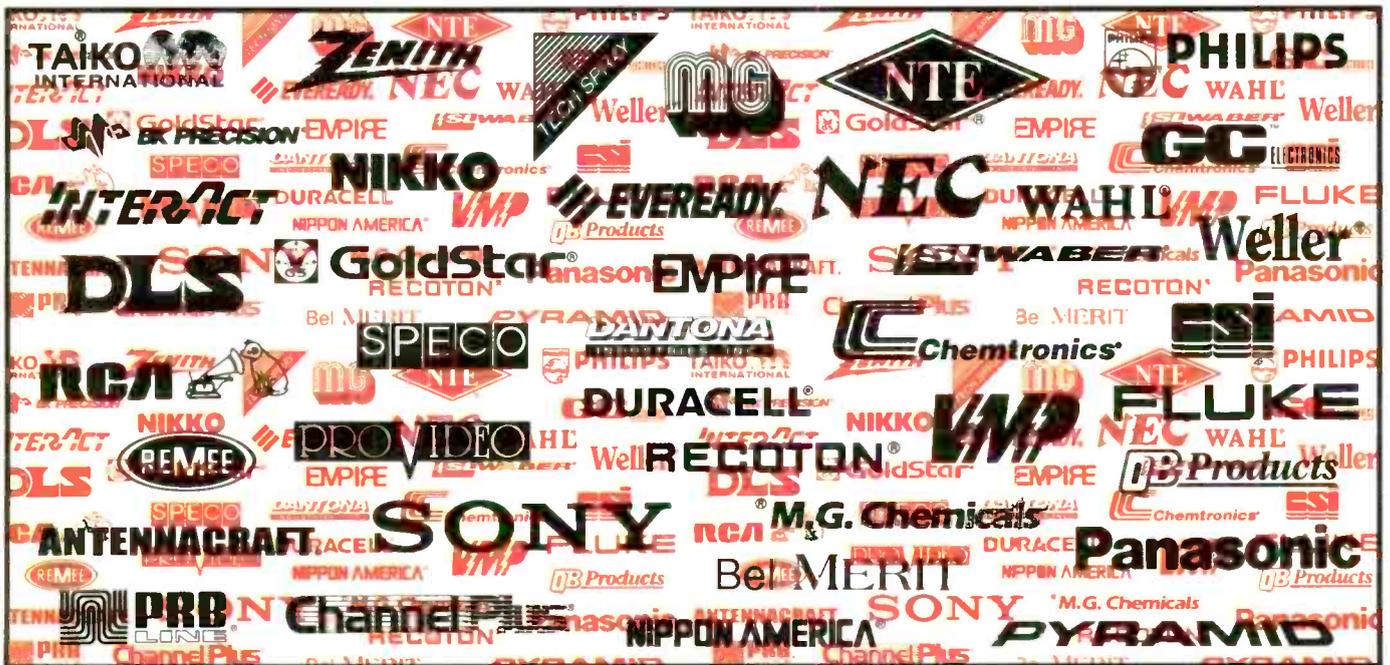
The company takes pride in our friendly and knowledgeable telephone operators on both coasts, who are waiting to take your phone call



Keep on the lookout for our upcoming website www.matelectronics.com

and deal courteously with any questions you may have about any electronic part. If you don't see it in the catalog—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 is available 24 hours a day.





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MCM Electronics

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Phone: 800-543-4330
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Your Source For Service Parts and Accessories

For over 20 years, MCM has been a leading supplier to the electronics service industry. Stocked is a wide variety of original OEM repair parts used in all aspects of consumer electronics repair. As authorized distributors for RCA/GE, Panasonic, Technics, Quasar and now ECG, Philips and Magnavox, we have the exact replacement items you need.

Your Source For All of Your Benchtop Requirements Tools

MCM stocks a broad selection of tools and technician aids specifically designed for the consumer electronics service industry. Trusted names such as Xcelite, Crescent, Ideal, Klein, Weller and Hakko are just a few of the popular tool lines stocked at MCM. Additionally, MCM works directly with tool manufacturers all over the world to bring you the best values in generic and application specific tools.

Technicians Chemicals

MCM stocks the highest quality technicians chemicals. Commonly used dusters, freeze sprays, defluxers, contact cleaners, plastic and glass cleaners and adhesives are all stocked. Brand names include Chemtronics, Tech Spray, Caig, Rite Off, Rawn, LPS, 3M, and Loctite/Permatex.

Test Equipment

MCM can meet your test equipment needs. From simple pocket multimeters, to oscilloscopes, spectrum analyzers, cable testers and more are available from Tenma, Fluke, BK Precision, Hitachi, Sencore, Leader, Triplet, Simpson and Tektronix.

Discover The MCM Electronics Difference

MCM publishes two full-sized catalogs annually. The latest issue boasts over 6500 new products, and features over 100 pages devoted solely to semiconductors, repair parts and accessories. In all, MCM stocks over

36,000 items essential to the service industry. Sales flyers are mailed regularly featuring specially priced items and new product additions keeping the customers up to date on the latest available products.

Superior Customer Service

The MCM staff is trained to answer all calls fast, friendly and efficiently. All sales representatives are professionals who are available on toll-free lines to provide immediate information on stock availability and pricing. They are available Monday through Friday 7:00 a.m. to 9:00 p.m. EST, and Saturday 9:00 a.m. to 6:00 p.m. EST. Faxed orders are also accepted 24 hours a day, seven days a week. MCM also provides highly trained electronics technicians to answer customers product questions. With a separate toll-free "Tech Line," customers receive prompt answers to their questions by calling 1-800-824-TECH (8324).

Fast Delivery From Two Distribution Facilities

MCM is committed to providing superior customer service. Distribution centers are strategically located near Reno, NV and Dayton, OH. This enables fast delivery at ground rates throughout the U.S. In addition, with over 36,000 items stocked, 99% of all orders are shipped within 24 hours. In fact, all in stock orders received by 5:00 p.m. (your time) are shipped the SAME DAY!

For more information and a free catalog, call 1-800-543-4330, in Dayton, OH, call 937-434-0031.

Leading Supplier to the Consumer Electronics Repair Industry

MCM Electronics

Technicians have come to know MCM Electronics as the undisputed leader in supplying the service industry. Our 20+ years experience, selection of over 36,000 stocked items and same day shipping have set the standards for our industry nationwide.



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MCM Electronics
is now ISO 9002
Certified
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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 available. We also realize that not every estimate you give 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 they need when completing in-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 continues to show that three out of four servicers believe that no other manufacturer provided a consistently better part 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 continues to broaden it's line of SK Series Universal Products. These quality parts let you reduce the repair estimate by lowering your replacement

parts cost, and that's good news for you!

The SK Series product line grows daily. Some recent additions to the line include switch mode power supply repair kits, module repair kits, several hundred exact semiconductors and many new video replacement parts. The most recent additions to the line include a single and dual SK Series LNB as well as the very popular *Chip Quick* SMD removal system. You can count on SK Series to continue adding new products that satisfy your needs.

SK Series Universal Products cover a wide range of high wear, high usage parts. Whether you need video heads, flyback transformers, video replacement parts, belts, tires, pinch rollers, laser pickups, RF modulators, exact semiconductors, servicer aids and more, you can look to SK Series First.

TCE Literature

Thomson also provides a number of publications which makes finding the right part for the repair even easier. Our latest "SK Series Product Guide" (Catalog #201) serves as a quick reference tool to the SK Series Universal Product line. Photographs, text and graphic illustrations all help guide you to the right stock number very quickly and easily.

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 CTC168 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. Also included is a complete Camcorder Battery cross-reference along with information on TCE

tools and fixtures by model number, flameproof resistors, IC protectors, and axial lead zener diodes.

And there is of course, our well known and widely accepted "OEM Remote Control" book. This book is printed once a year and no one that repairs TCE products should be without one!

These publications are available from your Authorized Thomson Parts Distributor. For the "SK Series Product Guide" order publication 1J1226, for the "Quick Reference Guide" order publication 1J9548, for the "VCR/Camcorder Source Book" order publication number 1J9780 and for the "Remote Control" book order 1F5790.

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 Jack Nick, Vice President. Thomson Consumer Electronics corporate headquarters is in Indianapolis.

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2SC1383	2SC2240	2SC3157	2SC3
2SC1384	2SC2271	2SC3158	2SC3
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2SC1413	2SC2291	2SC3175	2SC3
2SC1413A	2SC2309	2SC3180	2SC3
2SC1417	2SC2310	2SC3180N	2SC3
2SC1445	2SC2314	2SC3181	2SC3
2SC1475	2SC2328	2SC3181N	2SC3
2SC1507	2SC2336	2SC3182	2SC3
2SC1509	2SC2344	2SC3198	2SC3
2SC1583	2SC2362	2SC3203	2SC3
2SC1623L5	2SC2362	2SC3203	2SC3
2SC1627	2SC2362	2SC3203	2SC3
2SC1678	2SC2362	2SC3203	2SC3
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Herman Electronics is a diverse and multi-faceted full-line distributor of everything in electronics, committed to offering only the best in original replacement parts, tools, test equipment, cable, connectors, chemicals, and most importantly, customer service to their customers. In business for over 40 years and having recently moved to their new state-of-the-art corporate offices and distribution facility, 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.

The heartbeat of the company lies in the OEM parts department. While serving the industry for over 3 decades, Herman has many of the major OEM parts lines enabling them to provide more efficient and cost effective service to you, their

valued customer. The company prides itself on being a SINGLE source to the service trade.

Herman Electronics is one of the largest original replacement parts and accessory distributors in the country and is factory authorized for SONY, PANASONIC, THOMSON-Premier (RCA-GE-PROSCAN), SAMSUNG, QUASAR, ONKYO, TECHNICS, TOSHIBA, and KENWOOD. Stocking one of the largest and most comprehensive parts inventories in the country enables the company to fill over 80% of their orders from their inventory and guarantees SAME DAY shipment of all in-stock orders placed before 4:30 P.M. (EST).

Herman Electronics provides a variety of customer support services as a result of their commitment to customer service excellence. They have several professional customer service representatives

to serve all your needs from 8:30 A.M. to 6:00 P.M. (EST) Monday thru Friday.

The company prides itself on being accommodating to its customers in order to provide complete customer satisfaction. "We realize there are many good distributors throughout the country," says Jeffrey A. Wolf, 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 and therefore it is our focus and dedication to maintain a standard of excellence in customer service. As the year 2000 rapidly approaches we must continue to develop innovative ideas and fresh approaches to meet and exceed the demands that lie ahead." And the company is doing just that. On-line computer services, 24 hour electronic ordering, EDI, on-line parts research just to name a few. To accommodate the west coast and after hours requests, Herman has an electronic telephone and fax ordering system available 24 hours a day, seven days a week.

If you haven't given Herman Electronics a try, please do so now. Experience the HERMAN ADVANTAGE where with ONE call you truly can get it all! ■



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Business, by nature is a cyclical process. It requires a constant focus on the evolution of the marketplace, reevaluating current strategies and redirecting this focus for continued success. As marketplace advancements occur in technological and service capabilities your business must be ready to respond to customer needs by anticipating future demands.

Electro Dynamics, Inc., since its inception in 1984, has always kept responding to new demands in the marketplace. Each time the marketplace demanded a new solution to a problem Electro Dynamics, Inc. rose to the challenge. Whether importing OEM parts, creating a new line of semiconductors, or engineering a flyback series, Electro Dynamics, Inc. has been consistently dedicating all of its faculties to properly servicing its customer base.

Maintaining and servicing its customer base is the bedrock that has sustained Electro Dynamics, Inc.'s growth for the last 13 years. Whether through establishing global partnerships or conducting regional seminars Electro Dynamics, Inc. spends its time developing fundamentally sound relationships with its customer base and suppliers alike. Through this strength and foresight Electro Dynamics, Inc. has grown during the tenure of its corporate progress with milestones such as its introduction of an original product line, semiconductors, tires & belts and becoming the first independent distributor to directly import special regulator series (STR) from Sanken for the replacement market. In 1987 Electro Dynamics, Inc. became the first in the United States to carry a variety of replacement gears, and idlers, and a full line of replacement end sen-

sors and photo interrupters for distribution. In 1989 Electro Dynamics, Inc. and its sister company, Computer Component Source, initiated the development of its own custom manufactured flyback line and specific semiconductors. In 1990 success spawned the company's relocation to Syosset, where the company further progressed, with joint ventures involving Taiwanese factories to develop a line of replacement signal cables thus becoming the only company in the United States to feature these items. In 1992 Electro Dynamics, Inc. also became the first distributor to offer toll-free incoming fax line and direct dial in access.

Establishing further global relations Electro Dynamics, Inc. initiated importing of original parts and semiconductors, resulting in becoming the first independent distributor to directly import and offer OEM replacement parts for the consumer electronics market. In the interest of the ever expanding global marketplace Electro Dynamics, Inc. next established a joint venture with Richardson Electronics in Europe. Further broadening its base, Electro Dynamics, Inc. introduced a series of TV/VCR repair and upgrade kits. Expansion into the semiconductor business increased inventory line items from 7,200 SKU's to over 60,000 SKU's.

Once these global alliances and targeted marketing concepts were in place, Electro Dynamics, Inc. then redirected its focus internally to place its corporate emphasis on customer satisfaction. This kind of progress did not always come easily however. It required an openness to change and a willingness to evolve. When existing suppliers could not facilitate the needs

of Electro Dynamics, Inc.'s customer base, Electro Dynamics, Inc. sought out new sources of supply. This resulted in a watershed of new product availabilities and engaging the common practices of competition and free enterprise. Using its breadth of purchasing leverage Electro Dynamics, Inc. has dedicated series of procurement teams trained in new emerging technologies to constantly challenge these venues to bring about proper and competitive pricing structures.

Price may be the heartbeat of business, but the lifeblood is keeping an eye on the proper servicing of your current client's demands and needs. Although Electro Dynamics, Inc. is primarily an electronic parts company its inherent product is service. Great emphasis is placed on making sure the client is properly serviced thus ensuring that Electro Dynamics, Inc. remains ahead of industry standards. This is being accomplished through a variety of means. An example is the internal training and progress meetings that are conducted regularly between purchasing, sales, customer service and warehouse management. Our new headquarters will encompass a fully automated order picking carousel that is tied directly into inventory and product availability reports to help facilitate these decisions.

Starting from a 1,000 square foot office in East Norwich, Long Island, Electro Dynamics, Inc. has successfully progressed to the opening of its fully automated, 60,000 square foot corporate headquarters in Hauppauge, New York. Success creates progress, creating the catalyst for further success and the cycle of business broadens. ■

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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 800 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 and service manuals, we offer several types of software designed to assist the tech. One such software program is our Tech-Tip Repair Program for Windows that we

sell for \$199.95 plus S&H; the program contains over 1,400 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. As a bonus, the FCC-ID Database program described below is included at no extra charge with the new WINDOWS Tech Tips program (a \$50.00 value if purchased separately).

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 manufacturers names and addresses. The software is easy to install and operate; no long instruction texts are

ever required. With so 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 \$129.00 plus S&H our testers can test most of the IBM compatible 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. For 1997 we have introduced two new testers that will test Apple Mac monitors in addition to the IBM compatibles; one of the new models is also capable to test up to five different IBM compatible monitors simultaneously for long term burn-in. A new TV tester is now also available; price and specifications on all testers 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 us between 7:30AM - 5:00 PM (Pacific) Monday through Friday. Fax or e-mail us at anytime and we'll respond promptly.

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

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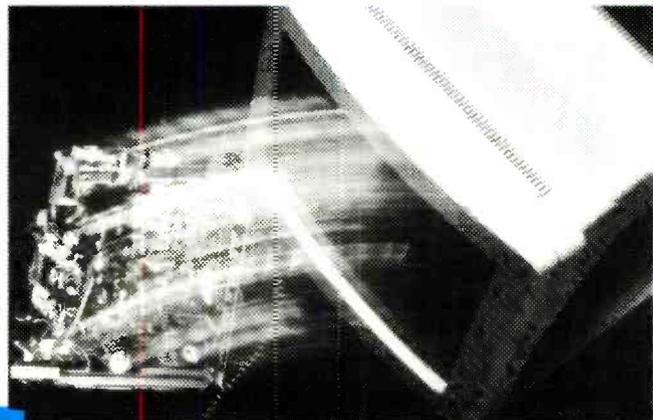
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Andrews Electronics is housed in 50,000 square feet of warehousing and office space. Miles of shelving are arranged for immediate identification and easy accessibility for over 250,000 different parts that we carry.

Maintaining an inventory of this size has been the cornerstone of our success as the O.E.M. parts distribution industry leader. It provides us with an average first pass fill rate of above 90% and makes us the largest supplier in America for the manufacturers that we represent. Our fill rate is calculated on not only everything that is ordered but also on every call or fax that we receive for availability, even if it isn't ordered! Our dealer order desk has 32 available sales representatives to handle all of 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:

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Software Development is a new department in Philips. We grew out of an effort to create the best electronic service manual program possible. From this effort we have embraced the goal to **"Develop the most user friendly software products for the service industry"**.

We were the first to develop a parts cross reference program covering all 250,000 of our parts with substitutes, prices, dud allowance, and availability. It was in this project that we started to develop methods to reduce the size of our data which makes it practical to load on a hard drive.

Our next big effort was to take all of our TV/PTV models going back to 1985 and put them into a program that allows fast access to any component in those sets with a link back to the pricing program. This combination was very fast and powerful, allowing access to all parts including hand units by typing the model number. Substitutions, price, and availability are then only a keystroke away.

In 1994 we began to research how we could create an electronic service manual. We insisted that it meet certain criteria:

1. An electronic service manual program had to be FAST in order to bring up diagrams and move through them without delay.

2. It had to be COMPATIBLE with all other manufacturers. In order to prevent servicers from having to have multiple systems, our program is designed to be flexible to accommodate any manufacturer's service manual data.

3. The most challenging and important is that our program had to OVERCOME EVERY COMPLAINT we could imagine concerning the use of paper manuals.

Overcoming every complaint was the most difficult. There are so many problems and as we talked to technicians the list grew even longer. This is a short list of problems to overcome:

- Manuals get lost on the bench under other manuals as they do not get refilled.
- Tracing signals through a manual is

too time consuming and difficult.

- Finding any information in a manual takes too long.
- The diagrams are printed too small for most people.
- It takes too long to order and receive a manual when it is needed.
- Paper manual files take up too much floor space in the shop.
- Paper manuals take up too much bench space when opened to view the diagram.
- Keeping paper manuals updated in a timely manner is difficult.
- In most cases paper manuals lack a history of known fixes and troubleshooting techniques.
- Paper manuals cost too much.
- Every company makes their manual in a different style.

We have listened to every one of these complaints and designed FORCE to overcome these and so many more. The program was initially called SmartMan. Regrettably there was a trademark already issued for that name so we have changed the name to FORCE (FOR Consumer Electronics).

We have designed FORCE to make every manual available to every technician. It includes HotSpot signal tracing to quickly jump from one diagram to another. Location information for components, circuits, diagram name, and all Known Faults are included. We can deliver our manuals via the Internet as well as update it at any time. We allow you to make notes about any fix you find. We are also soliciting consumer electronics companies wishing to make manuals in this style to join us.

We designed our program, FORCE, to be user friendly and can improve productivity so much that every technician will soon have his own computer. We see productivity improving by 10% to 30%, depending on the technician's use and the kind of jobs done. It costs only 2% of that productivity improvement to put a computer in the hands of every tech.

Some have considered CD-ROMs to be



the way to go with a program like this. The problem is a CD-ROM style manual would be impractical to deliver via the Internet. Most of our manuals are under one floppy disk in size. If our manuals required a CD-ROM, we would not be able to easily deliver them by Internet and only one technician could access a manual at a time. Updating would have been much more difficult and adding your own information, impossible.

The FUTURE of FORCE is growth and expansion. We are going to add many more features:

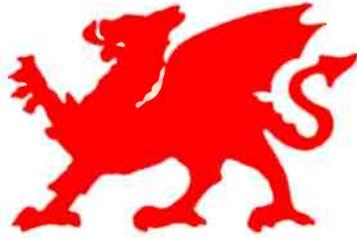
- The ability to annotate a diagram with your notes.
- Cause voltage measurements to appear on-screen and remain there while you diagnose a problem.
- Draw or write on a diagram, save it and FAX it to a help line.
- Link via modem to any compatible help line to exchange ideas on a repair.
- Tie to any company's service programs and record the results.
- Allow NARDA claims to be generated and electronically filed right from the job.

There are more features being planned and we expect technicians will be making suggestions that will turn into even more new features.

The Software Development Department hopes to overcome years of everyone doing their own thing. We stand ready to help any company that wants to join a unified standard for the industry. We want to overcome the last complaint about paper manuals and finally produce manuals that are easy and **intuitive** to use.

Tritronics, Inc.

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WHAT DO WE HAVE TO DO TO GET AND KEEP YOUR BUSINESS??? That's a question we are asking ourselves at Tritronics all the time. So here are some of the ideas we have come up with. Saving our customer's both time and money is the key to improving your bottom line.

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 Southeastern branch at (800) 365-8030. Our customer service departments are staffed by experienced and friendly people. We also offer twenty-four hour toll-free fax numbers for ordering and price availability, (headquarters 800-888-FAXD and Southeastern branch 800-999-FAXD). Faxed in research is usually returned in four hours.

Many of our customers are looking for ways to cut costs and Tritronics is commit-

ted to helping the service industry do so. Our upcoming catalog, due out in late August, includes several pages of cross-references and product description for universal replacement parts. New products included in Catalog 7 will be 12-volt accessories and a sampling of the SK UNIVERSAL line including flybacks for TVs and computer monitors, power supply repair kits, Zenith module repair kits and mechanical parts for VCRs. Tritronics is one of the largest premier distributors of SK UNIVERSAL parts in the country.

Tritronics, a stocking distributor for B&K Precision Instruments, consistently sells test equipment below the published dealer price. We are also holding the line on shipping and handling charges for all of our servicers - big or small, open account or COD.

There has been no increase in shipping and handling charges by Tritronics for

almost four years, despite annual increases and zone-based pricing by FedEx, UPS and RPS. For COD and account customers, there is a flat shipping and handling charge regardless of any backorders. In other words, all backorders ride free.

Tritronics has a fully staffed research and sales departments that are knowledgeable. The majority of the staff has been with Tritronics for a minimum of three years. Orders received by 4:00 pm EST are shipped the same day. Tritronics averages an overall 85% fill rate on initial shipments.

We have a branch located in Miami at 1952 NW 93rd Ave. The branch manager, Doug Maris, used to manage a large service company in Colorado. Although he is enjoying the warmer climate of Florida now, he is still in touch with servicers' needs. Doug has recently created a counter area with about 1,500 square feet of tools, services aids, accessories, antenna/DSS supplies and parts. If you are in the area, stop by for a visit. The branch is located within minutes of Miami's International Airport.

You can also visit us at our website, www.tritronicsinc.com. The site is currently interactive to request free literature and catalogs, and to leave a message requesting price and availability. A response will be sent by 5:00 pm the same day. The Tritronics family looks forward to serving your business now and in the future. ■



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Parts Express is a full line distributor of electronic parts, tools, test equipment, and accessories geared toward the consumer electronics industry and the technical hobbyist. In business since 1986, Parts Express has quickly established itself as a leader in the industry by consistently providing quality products, first rate customer service, low prices, and toll-free technical support.

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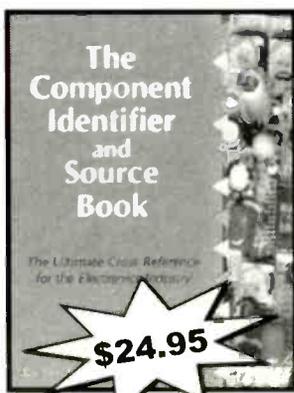
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Circle (30) on Reply Card



Smoke-free, non-toxic chemicals for rework, repair

Motorola Aftermarket Products Division now supplies materials and chemicals for rework, assembly, and repair of electronics circuits. These materials include "no-clean" soldering paste

and flux (products that do not require cleaning from an assembly after soldering), organic cleaner and wetting solution in a dispensing pen, wetting solution for C-5 chip removal/replacement, and a dispensing pen with coating remover for pager repairs. All of these products are non-toxic, CFC and HCFC-free, non-smoking, and are said to be easy to use.

Circle (31) on Reply Card

Business management software

The Service Assistant program from Sencore is a fully integrated business management tool for today's electronic service center. It offers a complete tracking system that provides instantaneous status reports on work in progress, from customer drop off to customer pick-up.

With the software, a business manager can monitor technician productivity allowing him to track total time spent on any invoice, as well as daily productivity. This in turn allows pinpoint accuracy of knowing where revenues are coming from. An integrated accounts payable and accounts receivable provides answers on business profitability.

The software supplies a purchasing and check printing package for financial management, and a complete inventory system with full parts ordering and parts receiving functions. For instantaneous parts information.

NARDA and NESDA warranty claims filing are also included. The product is a secure business system with three levels of accessibility, as defined by service center management. If you're currently using a software system, the software provides data transmission for import and export of business information.

The program is compatible with Windows 95, Windows 3.11, and Windows NT. And it's available in a 16 bit, 32 bit, and network version.

Circle (32) on Reply Card

True RMS DMM offers dual display

True RMS and Signal Injection are among the features available in the HC Protek Model 505 DMM.

This DMM provides auto ranging, dual display readout of frequency, acV and temperature, a 10 location memory, ana-



log bargraph, backlit LCD display, full annunciators, as well as a 4000 count, 3 3/4 digit readout. The meter measures decibels, inductance, and capacitance, and features a time mode (with alarm clock) and a stop watch function, in addition to min/max, average and relative mode functions. Continuity, diode test, auto power off, data hold, low battery indication, a fused 20A input with warning beeper and overload protection are some of the unit's other features.

The companion Model 506, available at a higher price incorporates an RS-232 interface and personal computer software for data transfer.

Circle (33) on Reply Card

Computer monitor checker software

A Windows compatible software program, the Teknix Monitor Adjustment Software program, available from Electronix, produces a variety of high quality test patterns which allow technicians to adjust computer monitors. Included are full field color and gray bars, aspect ratio, and convergence grid dot patterns. The user can customize patterns by changing the steps, line counts, pixels, and more. The software can be installed to a hard disk or run directly from the floppy on your computer.

Circle (34) on Reply Card

***The Network Maintenance and Troubleshooting Guide*, Fluke Corporation, 176 pages, \$29.95**

Fluke Corporation now has available a 176-page reference guide for troubleshooting and maintaining local-area networks (LANs).

The Network Maintenance and Troubleshooting Guide, covers how to anticipate, prevent and solve problems; how to operate a healthy network; and how to put into practice five key steps to successful troubleshooting. This guide is written as a reference for networking professionals as well as an educational text for novices interested in learning more about network operation.

The Network Maintenance and Troubleshooting Guide is now available for a U.S. list price of \$29.95. To obtain a copy of the guide (literature #J0644UEN) or for more information, contact Fluke Corporation, PO Box 9090, Everett, WA USA 98206, call (800) 44-Fluke, Fax (800) FLUKE-FAX, or e-mail: fluke-info@tc.fluke.com. Visit Fluke Corporation's Web site at: <http://www.fluke.com/nettools>.

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***Modern Dictionary of Electronics, Sixth Edition*, By Rudolf Graf, Newnes, 1152 pages, paperback \$49.95**

The Modern Dictionary of Electronics is a classic, comprehensive reference book for engineers, technicians, students, and hobbyists. It includes practical terminology for consumer electronics, optics, microelectronics, communications, medical electronics, and packaging and production. Where appropriate, abbreviations and letter symbols are represented, and tables of SI units and schematic symbols are included in the back of the text.

Rudolf Graf is an author whose name is familiar to electronics professionals and hobbyists alike. His many books offer a practical approach to complex material. Mr. Graf is a graduate electronics engineer, and received his MBA at New York University. He is a senior member of the IEEE, a licensed amateur radio operator, and holder of a first-class radiotelephone operator's license.

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***Basic Electronics Math*, By Clyde Herrick, Newnes, 200 pages, paperback \$24.95**

Most students entering an electronics technician program have an understanding of mathematics. What *Basic Electronics Math* provides is a practical application of these basics to electronic theory and circuits.

The first half of *Basic Electronics Math* provides a refresher of mathematical concepts. These chapters can be taught separately from or in combination with the rest of the book, as needed by the students. The second half of the book covers applications to electronics.

The book contains: Arithmetic Fractions, Operations With Powers and Roots of Numbers, Division of Monomials and Polynomials, Fundamentals of Trigonometry, Network Theorems and much more.

Clyde Herrick is a former instructor with San Jose City College California.

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***Crash Course in Electronics Technology, Second Edition*, By Louis E. Frenzel, Jr., Newnes, 392 pages, paperback w/disk \$36.95**

Crash Course in Electronics Technology teaches the basics of electronics, components, and circuits in an easy-to-understand format. Each chapter includes learning objectives, clear explanations and examples, and an end-of-chapter self-quiz. The drill-and-review software included with the book allows the learners to test themselves on the contents of each chapter, providing a second way to reinforce the material. A final chapter teaches the basics of troubleshooting circuits.

The contents include: Introduction to Electronics, Principles of Magnetism and Electricity, Resistors and Resistive Circuits, Inductance and Transformers, Capacitance and Capacitors, Resonance and Filters, Diodes and Transistors, Amplifiers, Operational Amplifiers, Oscillators, Pulse Techniques, Power Supplies, Amplitude and Frequency Modulation, Industrial Control and Test Equipment and Troubleshooting.

Louis Frenzel is an experienced electronics engineer and educator, as well as

the author of many magazine articles and texts. He is currently based in Texas.

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***Cellular Telephones & Pagers: An Overview*, By Stephen W. Gibson, Newnes, 176 pages, paperback \$19.95**

Cellular Telephones and Pagers is an overview of the basics of mobile telephone and paging technology and related issues. It is written for the interested layman as well as the professional for basic information.

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***Programmable Logic Controllers*, By W. Bolton, Newnes, 192 pages, paperback \$28.95**

Rapid technological advances have made the PLC (Programmable Logic Controller) an important part of many industries, from petrochemicals to food production. At the same time, the study of PLCs has moved into lower academic levels. This book provides an accessible introduction for all students on introductory courses in PLCs, with plenty of worked examples and programming problems designed to cover technology from a range of manufacturers. It has been written specifically for current courses. It is also designed as an introduction to the topic for degree students, and engineers seeking to gain a working knowledge of PLCs.

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Test Your Electronics Knowledge

By J.A. Sam Wilson

Sam Wilson is currently busy with other urgent projects, and was therefore unable to prepare What Do You Know About Electronics/Test Your Electronics Knowledge for this issue. This is a reprise of articles that appeared in a previous issue.

1. What is the value of the input voltage (V) in Figure 1?

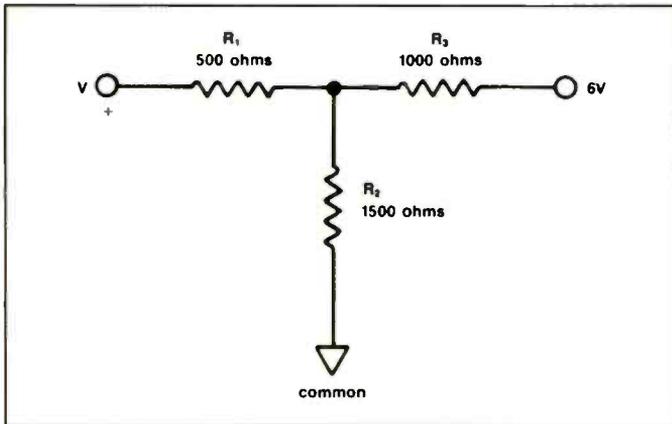


Figure 1. What is the value of the input voltage (V) in this circuit?

2. For the 500 Hertz sinewave voltage shown in Figure 2 the time marked (t) is _____.

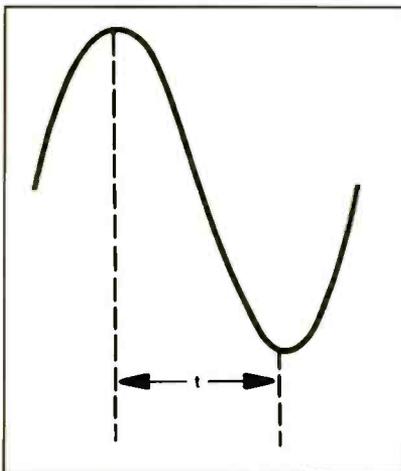


Figure 2. For this 500Hz sinewave voltage, what is the value of the time marked (t)?

3. Convert 230_{10} to a binary number _____.

4. A signal that indicates a hardware condition or the program status is called a _____.

5. 10 decibels = _____ neper.

6. Each capacitor in Figure 3 has a reactance of 10Ω . The capacitive reactance of the combination is

- A. 5Ω
- B. 20Ω
- c. 7.5Ω
- d. (Cannot be determined from information given.)

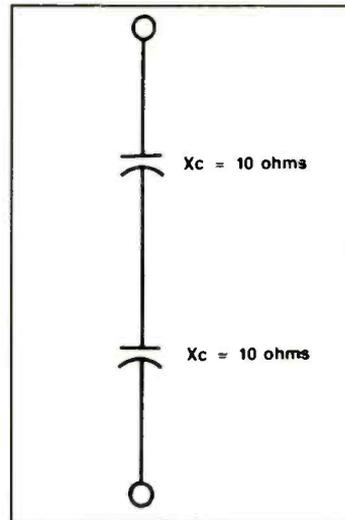


Figure 3. Each of the capacitors in this circuit has a reactance of 10V. What is the capacitive reactance of the combination?

7. With a 10kHz sinewave, 10V input signal in the circuit of Figure 4, the VOM should read

- A. about 10V
- B. about 5V
- C. about 0V
- d. (none of these choices is correct.)

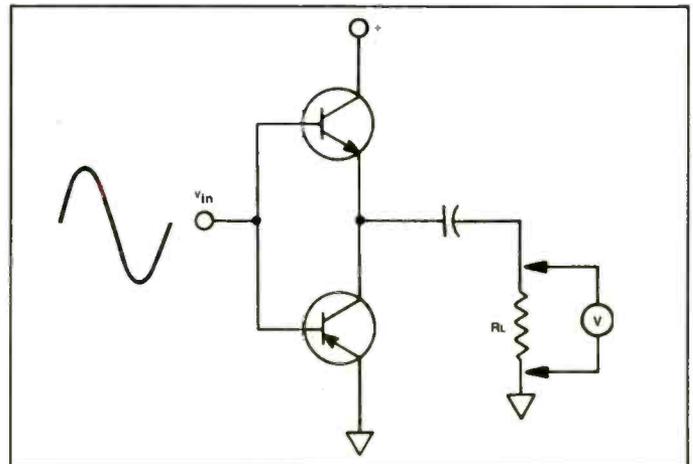


Figure 4. If the input to this circuit is a 10V, 10kHz sinewave, what would be the reading on the VOM?

8. Apparent power in an R-L circuit is measured in

- A. VARs
- B. watts
- C. volt-amperes
- D. darafs

9. Two insulated wires twisted together make a "gimmick." It is used as

- A. an inductor.
- B. a capacitor.
- C. a resistor.
- D. a gyrator.

10. Using two or more interconnected processors to simultaneously perform different parts of an application is called _____.

BONUS QUESTION: Morse Code was invented by

- A. Samuel Morse
- C. Alfred Vail
- B. Sam Wilson
- D. Morison Trapp

(Answers on page 69)

What Do You Know About Electronics?

The ASIC

By J.A. Sam Wilson

Sam Wilson is currently busy with other urgent projects, and was therefore unable to prepare What Do You Know About Electronics/Test Your Electronics Knowledge for this issue. This is a reprise of articles that appeared in a previous issue.

The letters ASIC stand for Application Specific Integrated Circuit. It is a method of making an integrated circuit. This type of component/circuit design is accomplished by using a computer.

The designer has a library of basic circuits available at the touch of the proper computer keys. The circuits are called standard cells. That is an unfortunate selection of terms because, now we have two standard cells. The original meaning of the term standard cell is a voltage source made with a specific construction and chemicals. See Figure 1. The terminal voltage of a standard cell is provided by the manufacturer and is accurate to five decimal places.

Standard cells are used as very accurate voltage references.

Incidentally, if you happen to run across one don't touch the leads! These cells cannot provide any current above 0.0001A. If a standard cell is subjected to any greater current flow they can be destroyed. That's expensive!

The standard cell in ASICs is a self-contained analog circuit or digital circuit, (or, some other basic unit of electronics). Using a computer, the designer selects the desired standard cell and moves it on the screen into the system.

The library of standard cells available to the designer may consist of any number of basic units - depending upon the manufacturer. In one example, the library consists of about 100 standard cells. It has both analog and digital standard cells.

An important advantage of the ASIC design is that the designer doesn't need to know anything about how integrated circuits are fabricated. The design procedure

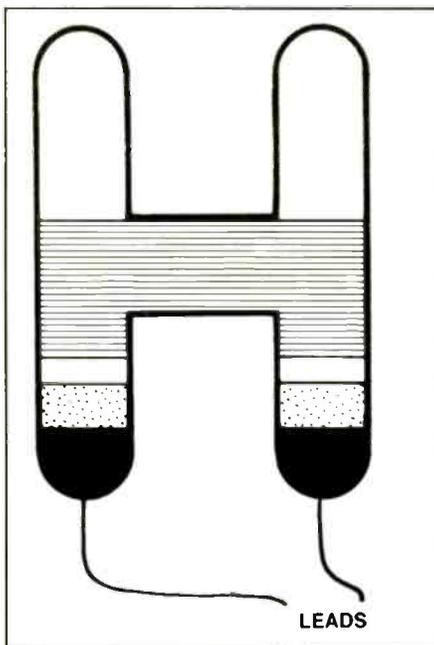


Figure 1. The original meaning of a "standard cell" is a voltage source made with a specific construction and chemicals, and having a precise voltage output.

is given clearly by the computer software.

Another advantage is the very fast turnaround between an idea and the final product. The cost is low - even for small quantities. Also, competing companies will find it difficult to copy a design. Many ASIC designs have more than ten thousand transistors.

When integrated circuits were first introduced, some technicians were reluctant to give up the idea of analyzing circuits by chasing electrons through individual components. That idea has now been out of favor for a long time. (However, it is still an important method of understanding the theory of operation of electronic circuits. This theory is taught in basic electronics courses.)

Chasing electrons through an ASIC design could turn out to be a lifetime job in a design with over 10,000 transistors. Even if you could do it, you wouldn't get any useful troubleshooting information. You can't replace individual transistors in any integrated circuit.

At the manufacturer's location the approach is to use ATE (Automatic Test Equipment) to test ASICs.

In the field you have to troubleshoot by chasing signals not electrons. Quality test equipment and knowledge of how to use it are important parts of your future troubleshooting. There will still be outboard circuits - especially those that handle high currents and/or voltages.

Where is the battery?

You know that the pumping action of the heart is created by an electrical signal. Electrical signals cause the heart muscles to contract and squeeze out the blood with each heartbeat. The question is: How is the electricity generated?

There is no doubt that the human body is fearfully and wonderfully made. Humans have spent lifetimes trying to fathom the depths of this complicated organism. Many of the mysteries of life have been solved by equating them to the electrical and chemical systems. However, the meaning of life is still elusive and has been left to the mental gymnastics performed by philosophers. We are not interested in that for this article.

A chemist might look at the human body as a chemical manufacturing plant. The complicated chemical manufacturing plant. The complicated chemical structures of the blood, tissues and cells have been well documented by chemists. The chemist may see the electrical activity in the human body as being incidental to the chemical activity.

An electrical engineer may look at the human body as being a very complicated system of feedback networks, electrical conductors and electric generators. A complete electrical analysis of the human body has not been accomplished because of the staggering number of cells, transport systems, feedback networks and generators present.

The fact is that neither a complete chemical or electrical analysis is possible, at least at the present time. Each cell

Wilson is the electronics theory consultant for ES&T.

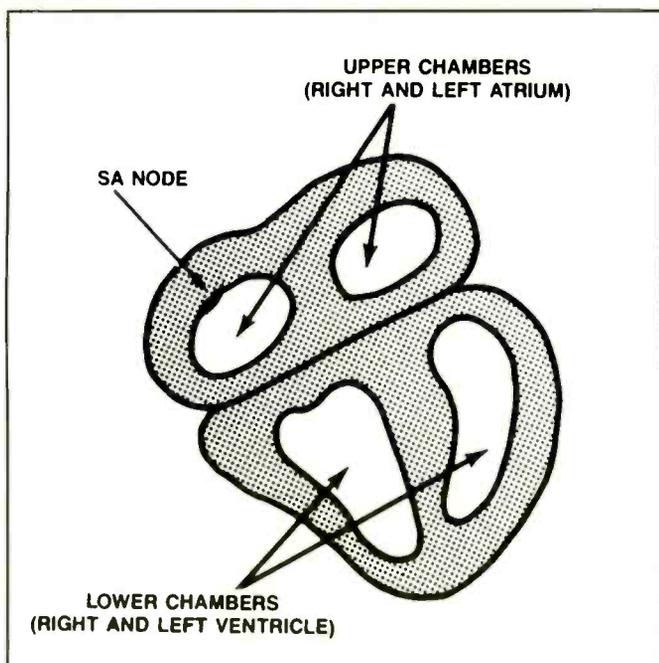


Figure 2. A rough drawing of the heart and its chambers.

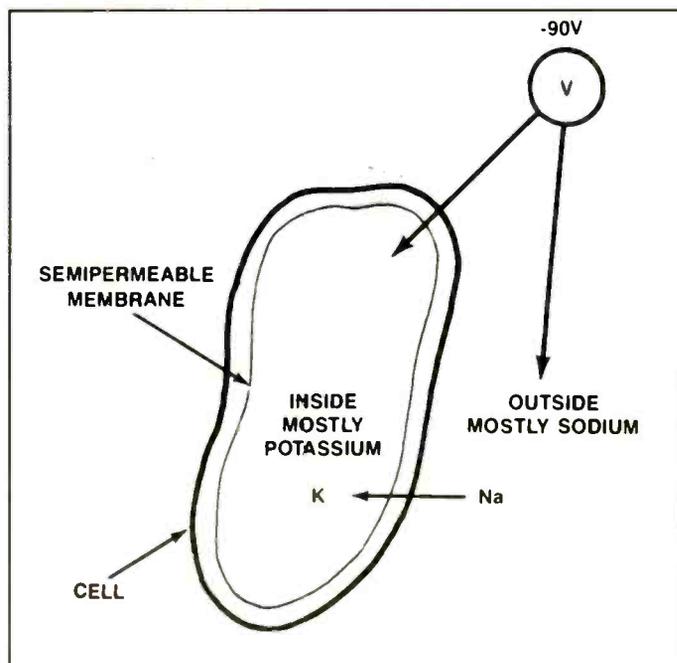


Figure 3. The cells that make up the SA node are constructed similar to those shown in this simplified drawing.

in the body exhibits both electrical and chemical activity.

When you stop to think that there are over 60 trillion cells in the human body you begin to realize the complication. Add to that the fact that each of these cells is interacting with other cells in ways that are not always fully understood.

In this article we are interested in where the electric signal comes from that causes the heart to beat. More important at this time, how is that signal generated? Let me say this at the start - I am going to make full use of some models that enable us to picture what is happening. I do this because I don't believe electronics technicians are really interested in a detailed study of chemical activities involved in producing a heartbeat. However, the models are quite accurate and give a good concept of what is happening.

A good place to start is to review some of the basic ideas related to the heart and its activity. The heart is a pump. In the human adult the heart is divided into four chambers - two upper chambers and two lower chambers. These chambers hold blood and they are used to pump the blood through the 60,000 miles of blood vessels. In one single day the equivalent of approximately 4,000 gallons of blood is pumped by this remarkable organ.

Figure 2 is a rough drawing of the heart and the chambers. The blood goes out from the lower chambers of the heart by

way of the arteries. The blood returns to the heart through veins into the upper chambers. In the upper right chamber, called the right atrium, there is a very small region where the heart beat begins. If you are a name dropper you might want to remember that this small region is called the central (SA) node. It is the pacemaker that generates pulses of 60 to 80 beats per minute. Signals from the brain can increase that frequency to as high as 150 beats per minute under conditions of hysteria and shock.

OK, so we know where the voltage that controls the heart is generated, but how is that voltage generated? To understand this, we have to go to the basic construction of the cells of a SA node.

This discussion does not include the common activities of all cells. The cells we are interested in are constructed somewhat like the simplified illustration in Figure 3. There is an inside chamber and a semi-permeable membrane that separates it from the outside world surrounding the cell. The semi-permeable membrane consists of very, very tiny holes which permit certain ions to pass through.

At our first glance at the cell it will be considered to be in the resting condition. There are two concentrations of ions. (see Figure 3). When the cell is in the resting state there is approximately a 90 millivolt difference of potential between the inside of the cell and the outside. This difference

in potential occurs because of the ionic imbalance between two points.

You may think of it as being a battery. The resting state just described is called the polarized state. In this state the difference in the chemical makeup of the inside and outside of the cell, and also the difference in potential is shown in Figure 3. The combination of these chemical and electrical signals is called a gradient.

That gradient affects the passage of tiny potassium ions through the membrane. The larger sodium atoms are not able to pass readily through the membrane, but the potassium ions can pass. You can think of it this way - the potassium ions are smaller than the sodium ions so they can pass through the very tiny holes in the membrane of the cell.

Starting from the resting state the potassium atoms pass through the membrane. That eventually causes the different concentration of sodium and potassium ions inside and outside of the cell shown in Figure 4. Observe the difference in potential compared with the voltage in the resting state. Under this condition the cell is considered to be depolarized.

To summarize, in the polarized state there is a -90 millivolt potential between the inside and outside of the cell. In the depolarized state the potential changes to +20 millivolts. Figure 5 shows a graph of the potential difference as it would appear on an oscilloscope.

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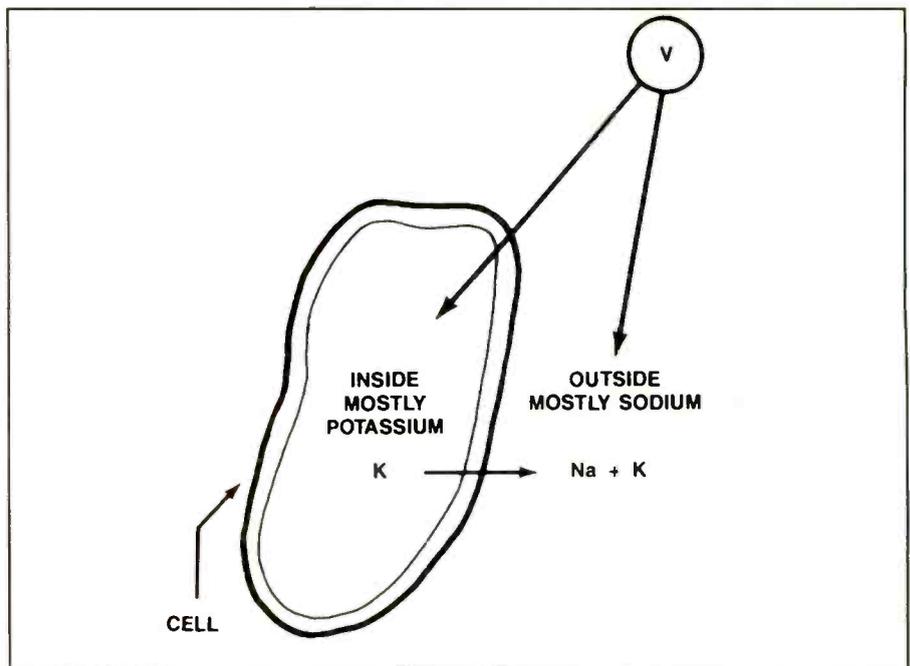


Figure 4. When potassium ions pass through the membrane of a cell of the SA node, leaving sodium ions on the other side of the membrane, the concentration of sodium and potassium is different inside the cell than it is on the outside.

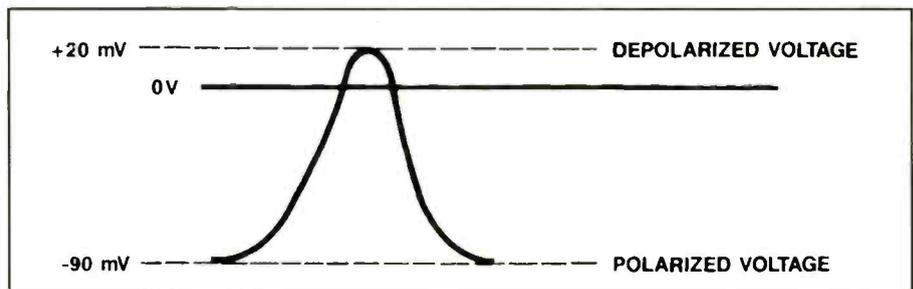


Figure 5. When a cell of the heart's SA node is polarized, there is a -90mV potential difference between the inside and the outside of the cell. In the depolarized state, the potential difference changes to +20mV. An oscilloscope would show that potential something like in this drawing.

The potential difference occurs because of motion of ions through the semi-permeable membrane. Once the voltage is generated it produces a motion of ions in the reverse direction to return the cell to the polarized state. If you have a large number of these cells in a small region, as in the SA node, there is some kind of mysterious signal that occurs between the cells. They all become polarized at nearly the same instant and all become depolarized at the same time.

The electric impulse flows first into the upper chambers and later into the lower chambers. That way, the return blood from the veins is first squeezed into the lower chambers, then out of the lower chambers into the arteries.

Let me summarize the action

The cell has two states of electrical potential, in the polarized or resting state

the potential between the inside and outside of the cell is -90V. In the depolarized state the difference in potential between the inside and outside of the cell is 20V. You can think of the cell as being a very tiny battery that switches between the two voltages. The reason it turns on and off is that ions are able to pass through the cell surface membrane in such a way that the voltages are generated.

The rate at which the polarization-depolarization-polarization pulse occurs is dependent upon a number of factors. One is the membrane construction itself. Another is the electrical potential between the inside and outside of the cell. Not to be denied is the fact that the human brain can cause chemicals to be delivered to the cell to speed up their activity - that is, to change the rate of ion migration. That ion migration, in turn, changes the rate of the heartbeat. ■

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Test Your Electronics Knowledge

Answers to the quiz (from page 65)

1. Answer: 8V - Current through R_2
 $= I = V/R = 6/1500$
 Voltage across $R_1 = V_1 = IR_1 = 6/1500$
 $\times 500 = 2V$
 $V = V_1 + V_2 = 2V + V = 8V$ (answer)

2. Answer: 1 millisecond - The period of the wave is:
 $T = 1/f = 1/500 = 0.002$ second
 $t = 1/2T = 0.001$ second
 $= 1$ millisecond

3. Answer : 11100110

Proof:

1	1	1	0	0	1	1	0
0 ⁰	2 ¹	2 ²	0 ³	0 ⁴	2 ⁵	2 ⁶	2 ⁷
0	2	4	0	0	32	64	128

4. Answer: flag (by definition)

5. Answer: 1.151 nepers
 Number of dB $\times 0.1151 =$ number of nepers (a neper is the foreign equivalent of decibels.)

6. Answer: B - Capacitors in series combine as reciprocals the same way as resistors in parallel. However, the reactances combine in simple addition.

7. Answer: C The meter deflects to the average value of the sinewave voltage across the load resistor (R_L). The average value of a sinewave voltage is zero volts. This is true even though there is crossover distortion.

8. Answer: C - Apparent power = volts \times amps

9. Answer: B - The capacitance is, of course, a very low value. If you have a capacitor meter or bridge you can trim this capacitor to the desired number of picofarads.

10. Answer: parallel processing (by definition)

* * * *

Answer to the Bonus Question
 C- Alfred Vail

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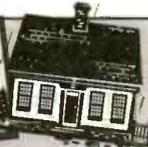
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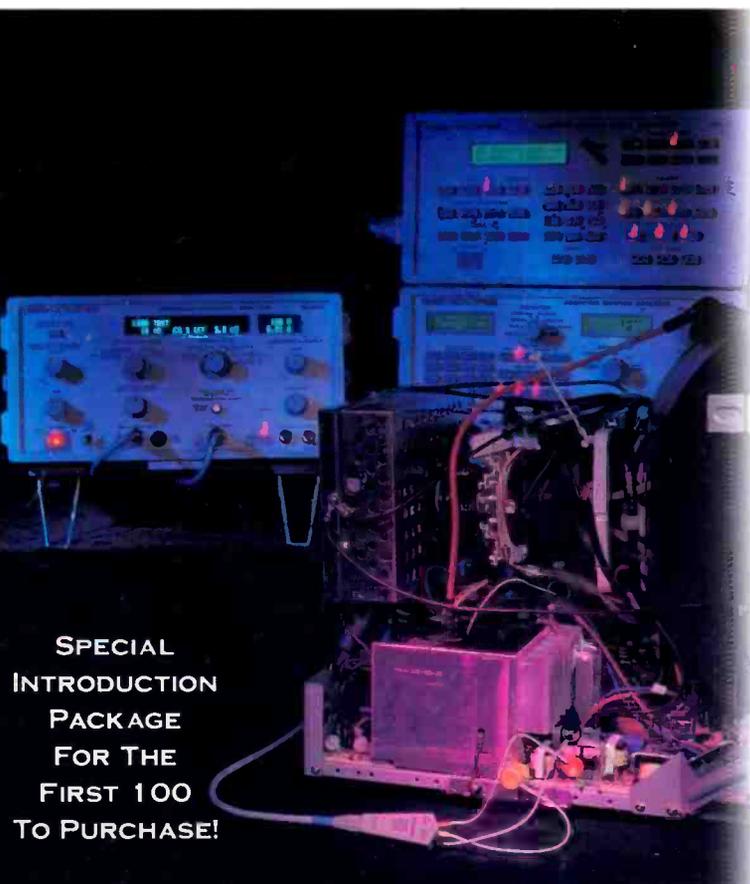


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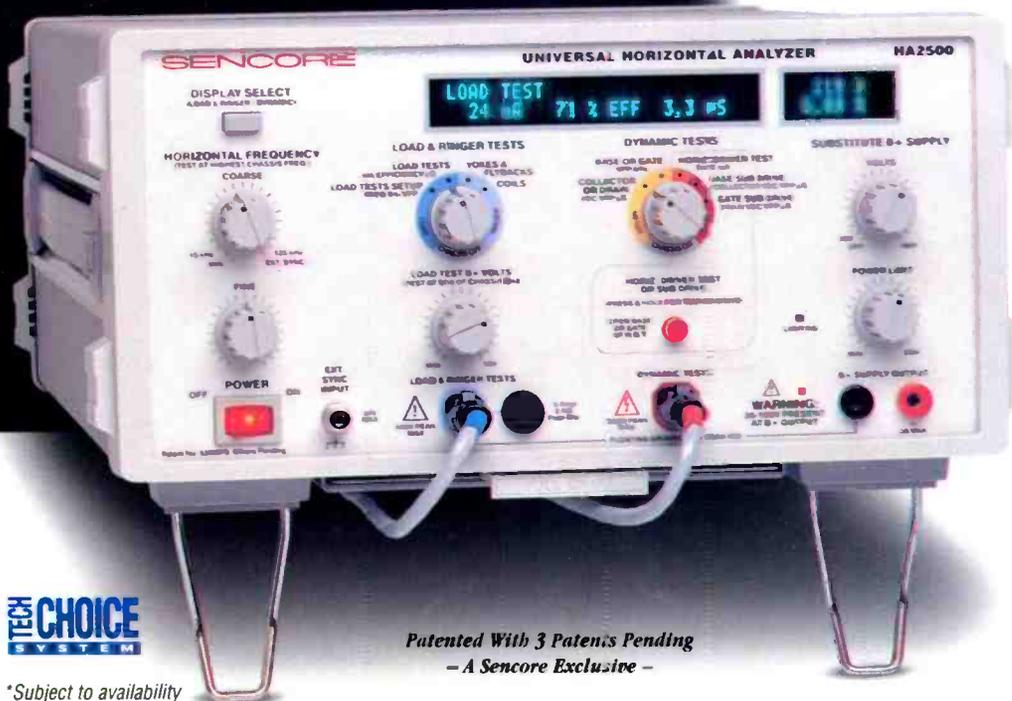


Now everything you need to localize horizontal and B+ supply defects in computer monitors in less time and more profitably than ever before!

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