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November 1995

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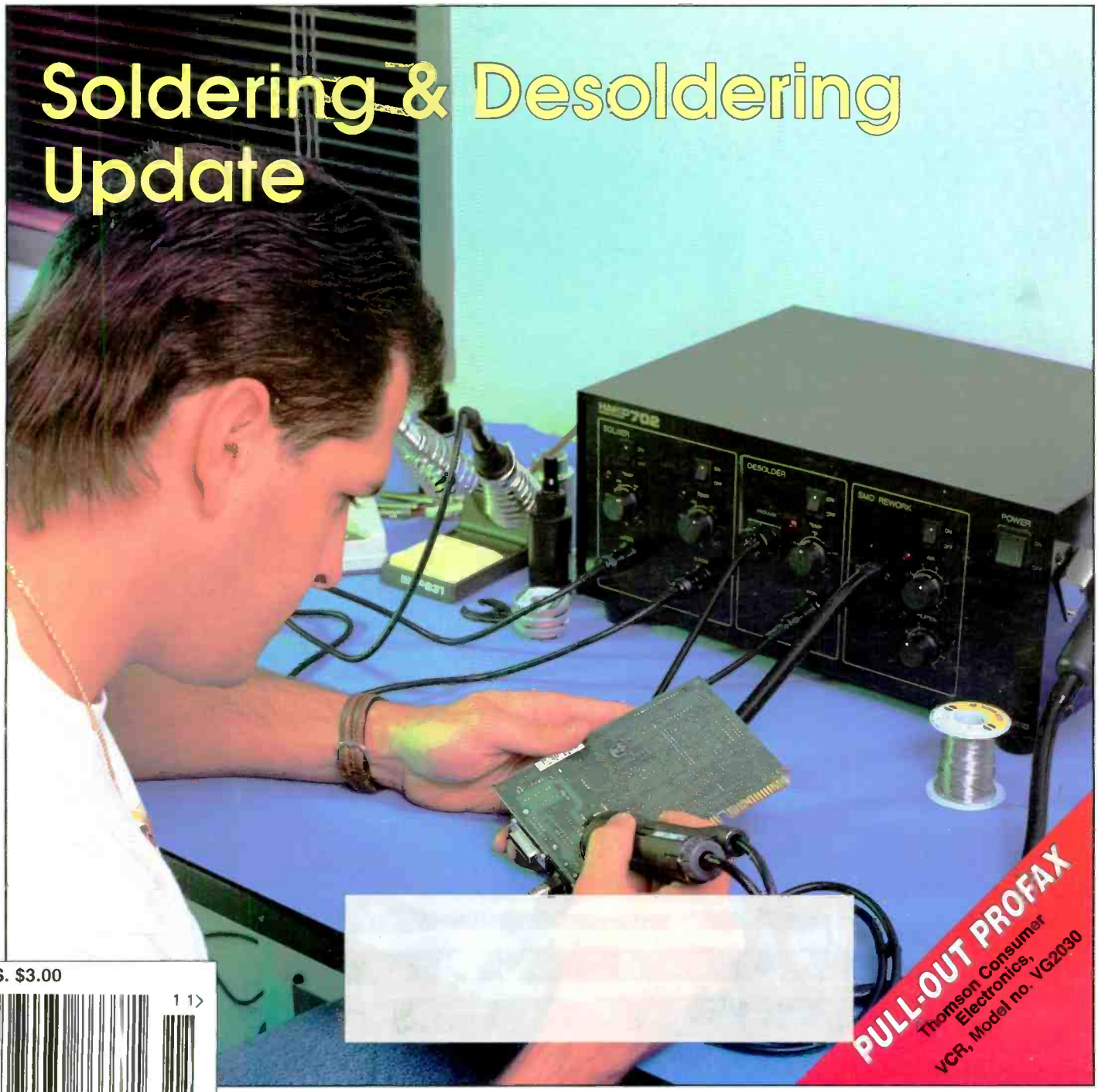

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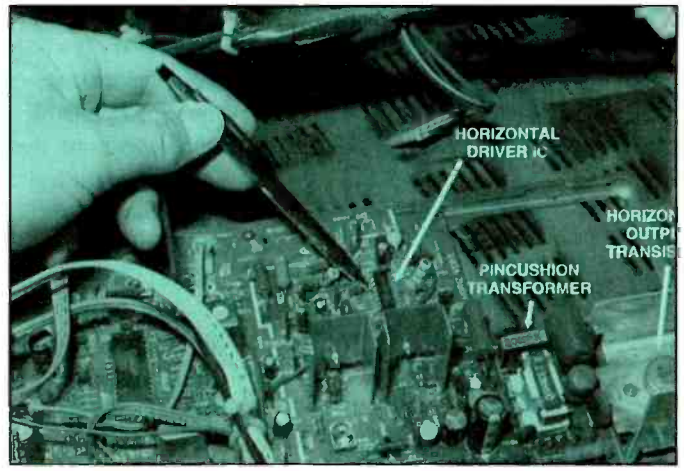

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FEATURES

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING
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DEPARTMENTS

ON THE COVER

Minuscule electronic components such as SMDs leave consumer electronics service centers with few soldering/desoldering options. The service center should have available soldering equipment that is capable of removing devices without damage to the circuit board or surrounding components, and soldering in replacement devices without damage. (Photo courtesy American Hakko)

Editorial

The more things change.....

There's an interesting juxtaposition of articles in this issue. There are two articles that discuss one of the oldest technologies available to electronics: vacuum tubes, and one that discusses one of the most modern technologies that has been incorporated into consumer electronics products: the SAW (surface acoustic wave) filter.

This is one of the aspects of the study of electronics that keeps it endlessly fascinating, as well a little frustrating. It's interesting to learn about the new technology, and at some point you feel as though you can go ahead and forget about the older technology, like tubes, but then like the Glenn Close character in Fatal Attraction they keep coming back, just when you thought they were dead.

For example, as Arthur Flavell points out in "Vacuum tubes revisited," in this issue, "while obsolete in many current applications, vacuum tube technology has not disappeared entirely. Some types of equipment, such as radio transmitters and musical instrument amplifiers still use tubes. The cathode ray tube displays in televisions and computer monitors are vacuum tubes, while magnetrons are vacuum tubes that are used in radar and microwave ovens."

Coincidentally, in the "What Do You Know About Electronics" in this issue, entitled "Vacuum tubes," Sam Wilson discusses vacuum tubes that are used in broadcasting and in audio systems and decries the fact that vacuum tubes are completely ignored in the FCC General Radio Operator License (GROL) test. Sam also resurrects the running argument over whether tube-based audio systems sound better than their solid-state counterparts.

On the other side of the coin, in the article "SAW filters: Whatever happened to if transformers" Steve Babbert talks about one of the more recent, less well understood components used in consumer electronics: the surface acoustic wave filter.

In this article, Babbert states that in most cases of innovation in electronics technology, such as the incorporation of thousands of devices into a single IC, the theory of operation of the devices remains the same. "Occasionally, however," Babbert continues, "a new device will be developed that will take the place of one or more components by utilizing a totally different concept."

"The SAW (surface acoustic wave) filter is one device that employs an entirely new technological concept when it comes to providing filtering. A simple SAW filter can eliminate the need for most of the interstage coupling transformers, and traps used in video *if* (intermediate frequency) strips. These transformers and traps are the components that were used for signal coupling and waveshaping." The article goes on to describe how SAW filters are designed and constructed and how they work.

While it's unlikely that a technician will find both vacuum tube technology and SAW filter technology in the same product, it's not beyond the realm of possibility that he might encounter both technologies in a single day.

It will be interesting to see how some of the innovations in technology that are being introduced today will be thought of in the future. For example, some of the more recent developments in video display technology are sure to be compared with each other down the line.

Will LCD displays, for example, ever be able to replace CRTs? How about some of the more advanced technologies that are still under development such as plasma displays or the digital mirror device?

I can't help but wonder if sometime in the future a couple of video enthusiasts will be sitting down watching an LCD display or a DMD display, or even some kind of display technology that hasn't even been dreamed of yet, and one of them will comment that, yes, it looks good, and crisp and sharp, but it just doesn't have the warmth, the realism of a CRT. And then the whole argument about the qualities of one technology vs another will start up, just as it has over the sound of tubes vs transistors in audio systems.

Nils Conrad Persson

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

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

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News

Home theater sales keep up fast pace for second quarter of 1995

Keeping pace with the records set in the beginning of the year, factory sales of home theater products rose 8 percent in the second quarter of 1995, according to the Consumer Electronics Group of the Electronic Industries Association (EIA/CEG). Sales of all home theater products* totaled $1.7 billion for the quarter, and $3.4 billion for the first six months of the year. EIA/CEG estimates there will be more than 10 million home theater households in the U.S. by the end of the year.

"These sales gains show home theater to be one of the hottest consumer electronics trends for 1995," said Joyce Fleming, president of McCormack Audio Corp. "As evidenced by the huge sales growth of audio products, consumers are moving beyond the video requirements of home theater and are realizing the enormous advantages high-quality speakers and surround sound processors bring."

Pushing past the $500 million mark, sales of home theater audio equipment increased 40 percent for the first half of the year. Home theater speaker sales for the second quarter jumped a whopping 155 percent with a volume of $56 million. Speaker sales rose 139 percent for the first half of the year to $105 million. Sales of surround sound processors (receivers, amps and stand-alone units) were up strongly again, rising 37 percent to a second quarter record of $210 million and to $396 million for the year to date. Overall, sales of home theater audio products rose 52 percent in the second quarter to a total of $266 million.

Hi-fi VCR sales carried the quarter in the video home theater side, topping 27 percent on factory sales volume of $251 million. Large screen TV sales (including projection models) were off two percent in the quarter, while total home theater video sales edged up three percent to $1.4 billion. For the year-to-date, home theater video components rose seven percent over 1994 sales and reached $2.88 billion in volume sales.

* Home theater products for these calculations include direct-view color televisions 25 inches or larger; laserdisc players; projection televisions; hi-fi stereo VCRs; surround sound processors; amps and receivers; subwoofers; center channel speakers; and satellite surround speakers sold as separate units or as multi-speaker packages.

EIA/CEG research finds careful shopping, use of manuals and towering satisfaction

When it comes to consumer electronics products, Americans are careful shoppers who read product reviews before they go to the store, talk with knowledgeable sales personnel before they buy, and then read the instruction manual as they set up and begin using their purchases, according to a national survey conducted by the Consumer Electronics Industries Association (EIA/CEG).

One dividend of this diligence is a tremendously high level of satisfaction with recently-purchased consumer electronics products, the research found.

Specifically, according to the national survey of a representative sample of 750 households, 91 percent are satisfied—including 71 percent who said they were very satisfied—with a television set purchased in the last year.

Similarly, 88 percent are satisfied with a recently purchased CD player, 84 percent with a VCR, 81 percent with a cassette tape recorder, 79 percent with a telephone answering machine and 78 percent with a cordless phone.

These make two points, said Gary Shapiro, EIA/CEG group vice president. One is that the consumer electronics industry is bringing high quality products to market. The other is that the consumers are shopping carefully and then doing all they can to ensure their purchase is set up and operating properly.

For example, nearly two-thirds of the respondents said they do research before purchasing TVs, VCRs, CD players, telephones, computers and similar products.

The two most frequently named sources of information were published product reviews, which were cited by 80 percent, and talks with friends or family, the choice of 74 percent. Consumers frequently named multiple sources of information and added contacting the store, the manufacturer and other organizations to the list provided in the survey.

One consequence of this information-gathering is that 41 percent of consumers said they always know the exact brand and model they want to purchase before they go to the store, and 16 percent said they know some of the time.

Once they have made their purchase, 86 percent reported they read the instruction manual at some point during the first month of ownership. Half read the manual while they set up the product and 38 percent read the entire manual before beginning the set up process. Ninety-seven percent say they keep the manual after the product has been set up.

When the EIA researchers asked how manuals could be improved, consumers named more diagrams, more detailed descriptions of features and functions, easier to understand language, and a glossary of technical terms as their top choices.

If there is a problem with the product, 35 percent of respondents said they would first try to solve it themselves. Twenty-seven percent would contact the store, 15 percent would ask a friend or family member for help, and 20 percent would call the manufacturer.

In fact, nearly four in ten said they had called a manufacturer's toll-free number for assistance or other information, and those who called expressed high levels of satisfaction with the service they received via telephone.

Specifically 72 percent were satisfied with the representative knowledge, 85 percent were satisfied with politeness, 72 percent with the speed and 81 percent with the overall effectiveness in solving the problem. Not surprisingly, 66 percent said the treatment they received would influence future decisions to buy a product from the manufacturer.

The research was conducted through the EIA/CEG Consumer Research Service in cooperation with the EIA Marketing Services Department. The telephone survey, administered by the Verity Group, Inc., has a margin of error of plus or minus 4 percentage points.

The research included questions on where consumer electronics products are purchased, impact of instruction manuals on future buying decisions, reaction to toll-free number experiences, evaluation of automated menus on service lines, judgments about warranties and other purchasing issues. A full report for the study can be purchased from the EIA Market Research Department. For information call: 703-907-7752. ■

Literature

PC-based test catalog

The 1995/1996 PC-Based Test Solutions Source Book is now available from Geotest Inc. This 40-page products catalog features more than 100 products including hardware, software and systems for PC-Based ATE, data acquisition and test and measurement applications. This catalog contains complete specifications, selection charts and block diagrams.

Products include the GTXI instrumentation chassis for simple, clean and quick configurations of virtually any PC-Based ATE, Data Acquisition or Test and Measurement configuration, and the GTPC series of embedded computer modules in 80486 and Pentium configurations.

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Electronic testing and prototyping equipment catalog

Global Specialties introduces a 48-page catalog which includes an instrument selection guide and table of contents. This full line catalog features complete product descriptions and specifications for ac and dc power supplies, function and pulse generators, frequency counters, capacitance meters, logic probes and logic analysis test kits, protolab design work station, project kits, test clips, data acquisition products and other global accessories items. The company's complete line of prototyping breadboard equipment which includes, solderless quick test and experimentor sockets, proto-board systems, powered proto-boards and the famous PB-503 and PB-503C total breadboard design work stations are also featured.

Circle (81) on Reply Card

Site on the world wide web offering technical information of fiber optics

Fotec has established a web site on the World Wide Web (WWW) as a simple electronic way for those involved in fiber optics to get applications assistance and product information.

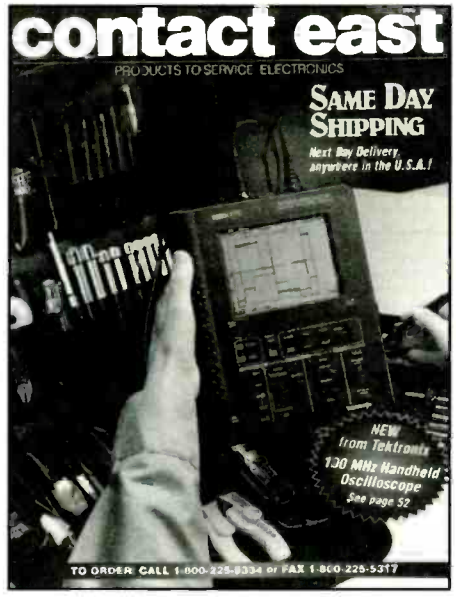
The World Wide Web (WWW) is an Internet-based graphical communications system that allows any user with Internet access to find, view and even download information. Many companies are putting their technical information on the Web to facilitate customer access from anywhere in the world 24 hours a day.

This Web Site includes the company's "Guide to Fiber Optic Testing," which shows the standard test methods used for testing fiber optic components and networks, materials and testing product information. Future plans include adding the Fotec Fiber Optic Testing textbook to the site in its entirety. This Web site URL is http://www.std.com/fotec.

Circle (82) on Reply Card

Catalog featuring test equipment, tools, and supplies

A 48-page supplement catalog from Contact East comes packed with hundreds of new test instruments and tools for engineers, managers, technicians, and hobbyists. Featured are quality products from brand-name manufacturers for testing, repairing, and assembling electronic equipment. Product highlights include new DMMs and accessories, soldering



tools, custom tool kits, EPROM programmers, power supplies, "create your own tool kit," ELF meters, helpful reference books, millammeters, megohmmeters, wavemeters, breadboards.

Also included are lines of communication test equipment, scope meters, datacom tools and testers, adhesives, measuring tools, precision hand tools, portable and bench top digital storage scopes, soldering/desoldering systems, static protection products, ozone safe cleaners, magnifiers, inspection equipment, tool kits and tool bags, workbenches, cases and more. Some brand names include Tektronix, Fluke, B&K Precision, Weller, Loctite, 3M, Pace, Hitachi, Microcare and many more.

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Electronics products catalog

Herman Electronics presents the first edition of the Herman Catalog. This 350-page buyers guide contains everything in electronics including test equipment, tools, soldering equipment, consumer and industrial original replacement parts, audio, video and telephone accessories, connectors, computer accessories, batteries, telephone headsets, power products.

Circle (83) on Reply Card

Industrial electronics product digest

Galco Industrial Electronics announces a new In-Stock Product Digest featuring items that are on the shelf and ready for immediate delivery. The digest contains part numbers, quantity-break pricing, product descriptions, technical specifications and a fax back order form.

The digest features items that customers purchase on a frequent or regular basis. The objective of this guide is to provide engineering, maintenance and purchasing professionals with all the information they will need when specifying or procuring a product, including pricing and technical information, in one concise and easy-to-use format. This new guide provides quick and easy access to electronic control components and will reduce the amount of time customers spend sourcing parts. The company will update the digest once a quarter.

The In-Stock Product Digest is intended to be used in conjunction with the company's full-line product catalog which is published yearly. The full-line product catalog is over 1,300 pages and features more than 300,000 items.

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Soldering & Desoldering Update:

Process control of SMT repair

By Ed Zamborsky

Process control of SMD (surface mount device) repair involves rate of heating, component alignment and avoidance of lead damage. As in all manufacturing procedures, process control is critical in achieving consistently good results. With repair of SMD components, two functions must be controlled; heating and component handling.

The "three challenges" of PCB repair involve these functions:

• *Rate of heating*. During removal and replacement, the rate of heating must be controlled. Heating in excess of 4C to 5C/second increases the probability of component damage due to differing thermal coefficients of expansion (TCE) of the component materials. Moreover, rapid heating (>5C/second) has been shown to promote substrate delamination. Finally, controlled heating of the connections (2C to 3C/second) prevents rapid outgassing of solvents, which can create solder balls when reflowing solder paste.

• *Component alignment*. During placement, what differentiates rework equipment more than any other feature is the ability of that equipment to repeatably and accurately place components. When dealing with placement, there are three areas of equipment that should be considered: basic tools that should be used for component removal only, not placement, tools/equipment for removal and placement limited to components with lead pitches of 0.032 inch or larger, and equipment for removal and placement of components, including fine pitch devices 0.025 inch or smaller.

• *Lands/lead damage*. Damage to lands and leads can occur, usually as a result of operator pressure or rework processes utilizing hand tools.

Tools for the repair area

There are no generalizations that can be made with regard to "ideal" tools for an SMD repair station (Figure 1). The component package and PCB configuration will determine the selection of tools. Here are a few tools that should be considered.

Zamborsky is engineering manager at OK Industries, Yonkers, NY

Resistor/capacitor "chip" components

These components are usually removed and replaced with new components because of their low cost. In this case the preferred approach is to remove with a contact heating device (for speed), i.e. tweezer-type handpiece; remove old solder using a solder braid and a soldering iron; deposit new solder paste with a

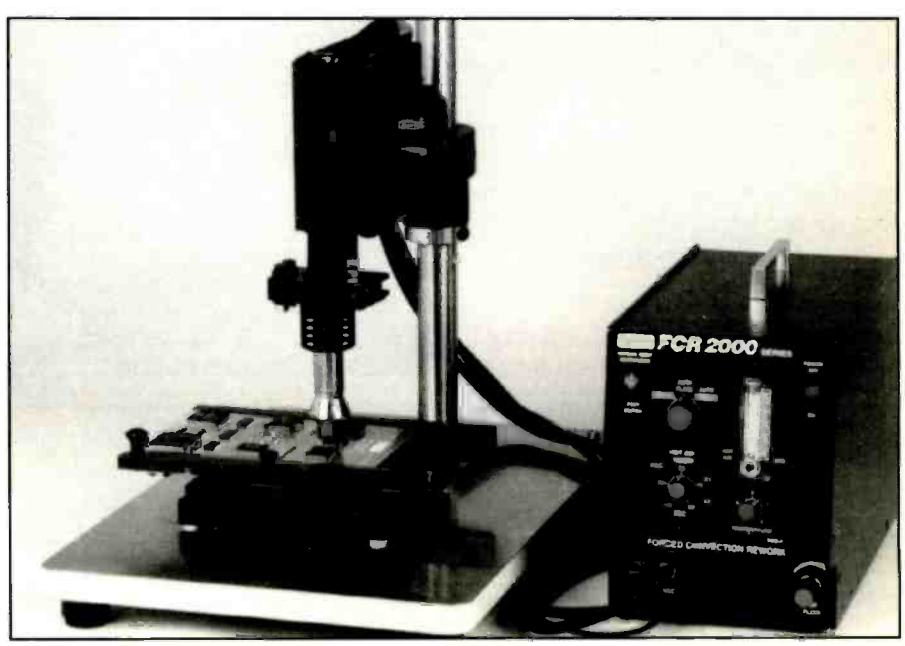


Figure 1. This re-work system features process control to assure proper solder joints.

Figure 2. Tweezer tip soldering tool.

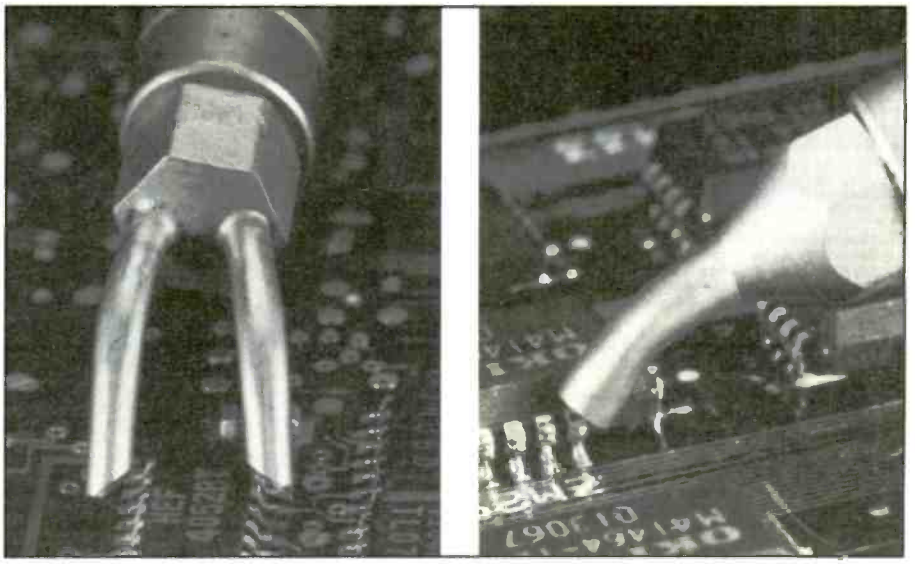


Figure 3. Hot air pencil for touch up.

dispenser; place the component with a vacuum pencil; and reflow the solder paste with a hot air tool.

Whereas with each task there is flexibility in the type of tool that can be used, use of hot air with solder reflow should be thought of as an absolute. Hot air reflow will have a slower rate of temperature rise than a soldering iron (contact heating). Slower heating is required to control problems of differential TCE with the component, which can induce cracking. Slower convection (hot air) heating will also eliminate boiling the solder paste volatiles too rapidly, which can create solder balls.

Therefore, the ideal tools for this process include a soldering iron (perhaps dual output where a tweezer handpiece (Figure 2), and a standard iron can operate simultaneously), a dispenser for paste, a tweezer or vacuum pencil, and a focused hot air pencil (Figure 3).

SOIC/PLCC components

There is more debate over the repair process of SOIC (small outline integrated circuit) and PLCC (plastic leaded chip carrier) components. Perhaps the greatest point of contention is the question of which type of heat source is appropriate for removal. Manufacturers of contact heating devices claim that rapid, isolated heating of the leads does not cause any risk of damage to the component. However, contact heating devices, which are usually hand-held, can damage leads through excessive mechanical stress and have been shown to lift pads causing additional unnecessary repair.

Forced convection heating devices eliminate the mechanical stresses caused by contact heating devices. Furthermore, the rate of temperature rise with equipment or tools that use a closed-loop temperature-controlled system falls within component manufacturers' specifications. Limitations to using convection heating include its relative inefficiency vs. contact heating where removal may take up to 50 seconds; five times longer than contact heating.

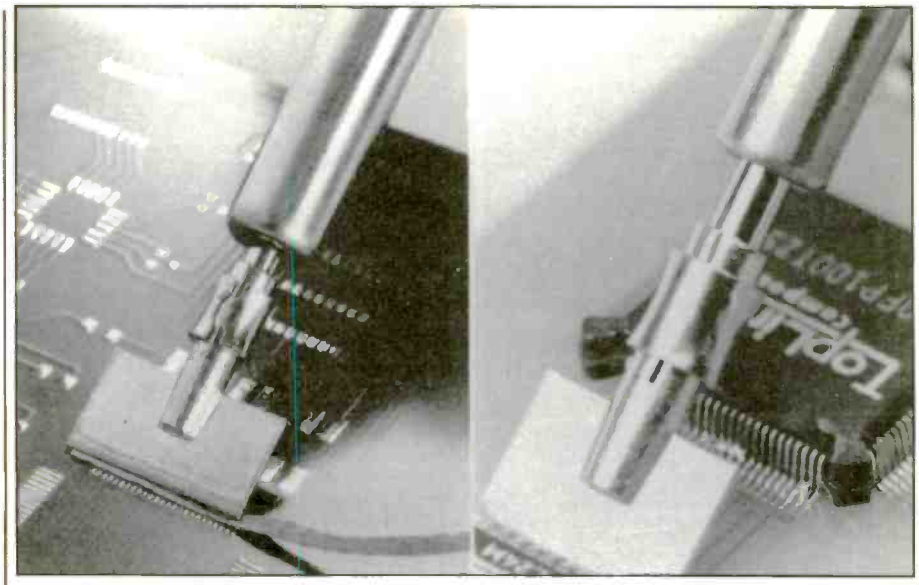


Figure 4. Desoldering tool with wick.

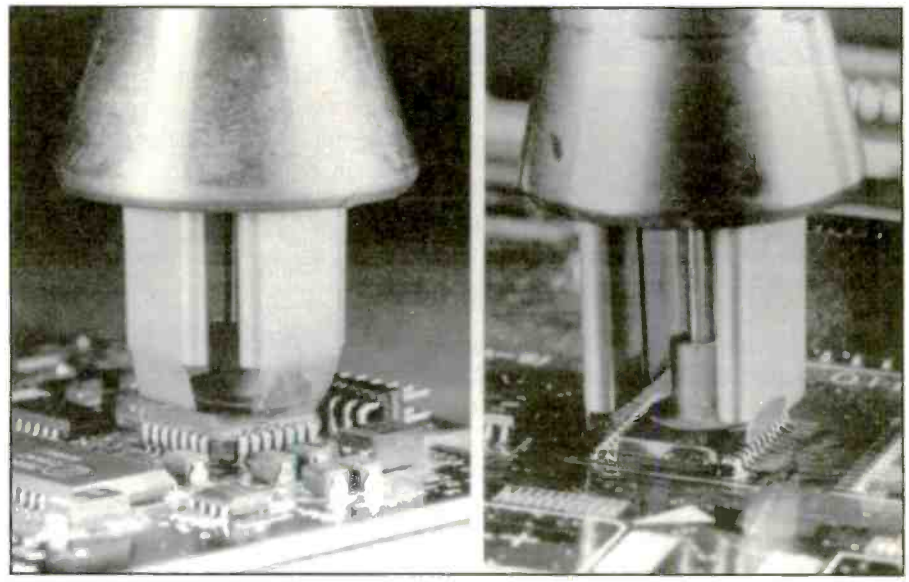


Figure 5. A focused convection tool.

Criticism has been leveled against forced convection heating for its potential to heat adjacent components. However, those forced convection systems that focus the hot air on the component leads virtually eliminate the potential for unacceptable levels of heating of adjacent components.

Finally, concerns that forced air heating causes component body heating have been raised. It should be noted that surface mount components are designed to allow component body heating. The issue here is not necessarily component body heating, but the rate at which it occurs.

Ideal equipment for removal of SOIC and PLCC therefore, depends on the philosophy (or vested interest) being proven. In a vast majority of cases, the recommended heating method for removal of SOIC and PLCC packages is hot air. If the budget for soldering/desoldering tools is limited, contact heating is an option.

The same procedures as those used with chip components may be followed after removal, and therefore, a similar list of equipment can be used. Forced convection tools are also able to simultaneously reflow all leads upon replacement, unlike contact (tweezer type) tips, which can only be used for removal but not for replacement.

Quad Flat Pack (QFP) components

The same debate over conduction vs. convection will exist when addressing the

issue of a preferred heating method for removal of QFPs. Again, after weighing the advantages and limitations of each method, forced air convection is preferred.

Another important issue with QFP components is that the leads, usually fine pitch, are quite sensitive to damage, such as bending. In the cases where they are being reused, straightening the lead(s) can be very difficult if they are damaged during removal. Therefore, a non-contact method of removal becomes more critical.

The process after removal will be different for QFPs. With chip components, SOIC and PLCC packages it is generally recommended that the old solder be removed and new paste be dispensed. With QFP, dispensing is not recommended. Instead, there are two options you can choose from.

You can remove the QFP with a focused forced air convection tool, apply flux and gently use hot air to level the solder on the pads, and then place and align the QFP in molten solder (after leveling).

Another option is to remove the QFP with a focused forced air convection tool, use hot air to level the solder on the pads or level the solder with specialized blade-type soldering iron tips, place the QFP and tack-solder leads on two opposite corners, re-apply flux and solder with a focused forced air convection tool.

Therefore, the ideal tools for QFP should include a focused forced air convection tool and a soldering station.

LCCC

The LCCC (leadless ceramic chip carrier) is a leadless package that requires forced air convection for removal, since there are no leads to conduct heat, and the ceramic package is sensitive to rapid heating. Following removal, the pads should be cleaned of solder with wick or a vacuum desoldering tool (Figure 4), re-pasted with a dispensing tool and reflowed with a focused hot air tool.

BGA

BGA (ball grid array) components are square or rectangular packages with their connections formed by solder balls underneath the component. Having no perimeter leads to contact will cause additional complications to the repair process and possibly some confusion to the repair technician. The BGA was developed to allow a high number of component leads (like a QFP) at a higher pitch (like a PLCC), to reduce the handling problems (lead bending/alignment) normally associated with high lead count devices.

Here there is no debate over the required heating technology. Focused convection tools (Figure 5) are the only possible heating technique available. The component to be removed must be heated through the component body, while the PCB is heated from the bottom. Like all SMD components, BGA's are designed to withstand high reflow temperatures.

Controlling the heating cycle is an absolute requirement when soldering ball grid array components. The focused convection tool you select for your BGA repairs *must* provide, bottom side preheating to a maximum temperature of 125C, focused convection heating at a controlled rate of 2C to 3C/ second with soak zone to provide thorough component heating, and a peak zone where the temperature is spiked allowing reflow of the solder balls under the component.

The final stage of the repair profile is the forced cooling of the component being soldered. In this step of the process air bypasses the heating element to cool the BGA and solidify the solder at an accelerated rate. This forced cooling will promote a much higher quality solder joint with the reliability of the original manufactured PCB assembly.

Removing solder from a printed circuit board

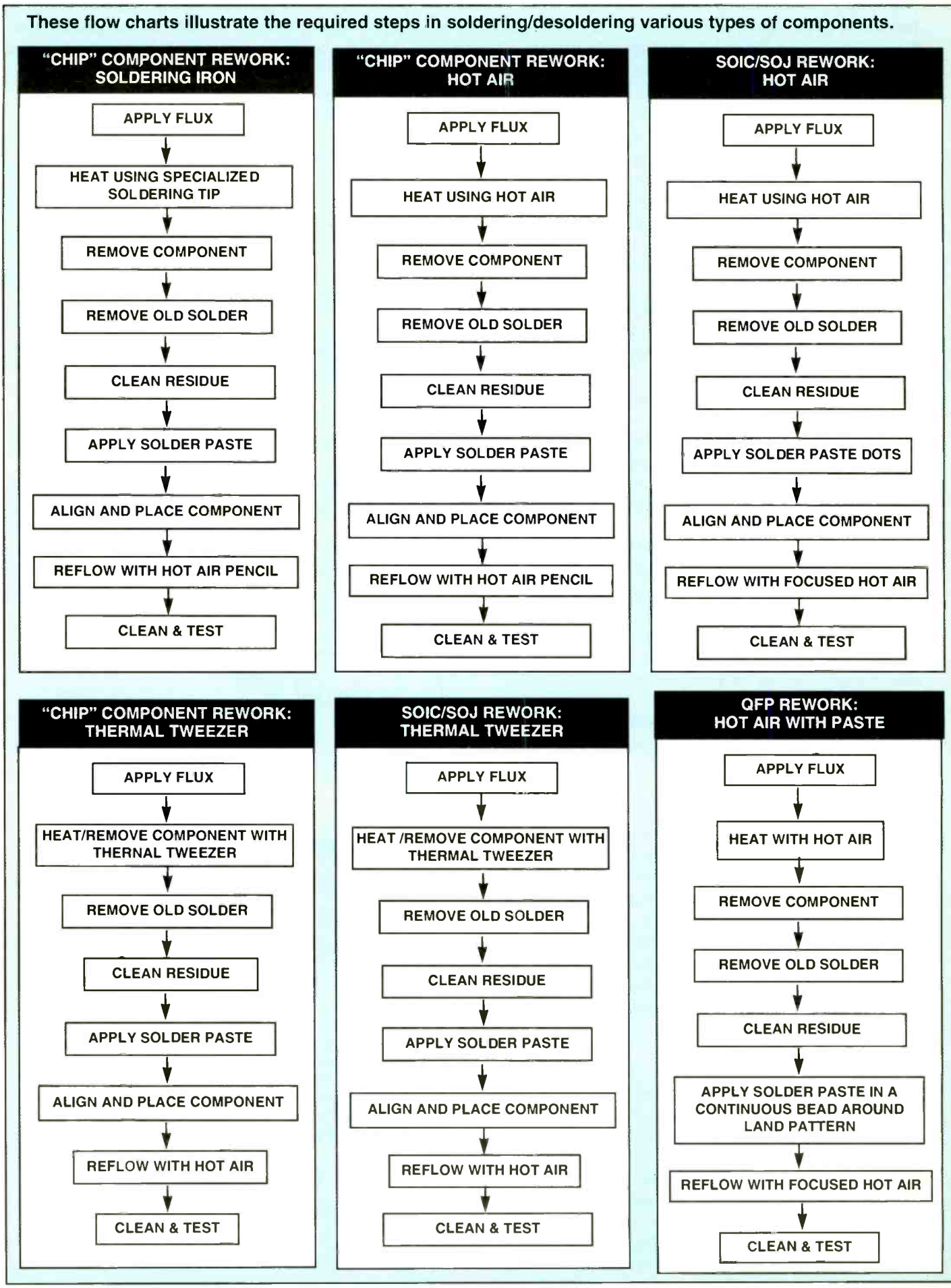
There are two accepted methods for removing solder. The first method utilizes copper braid for wicking in conjunction with a soldering iron. Specialized soldering iron blade tips are available designed to contact a linear array of lands, facilitating faster removal.

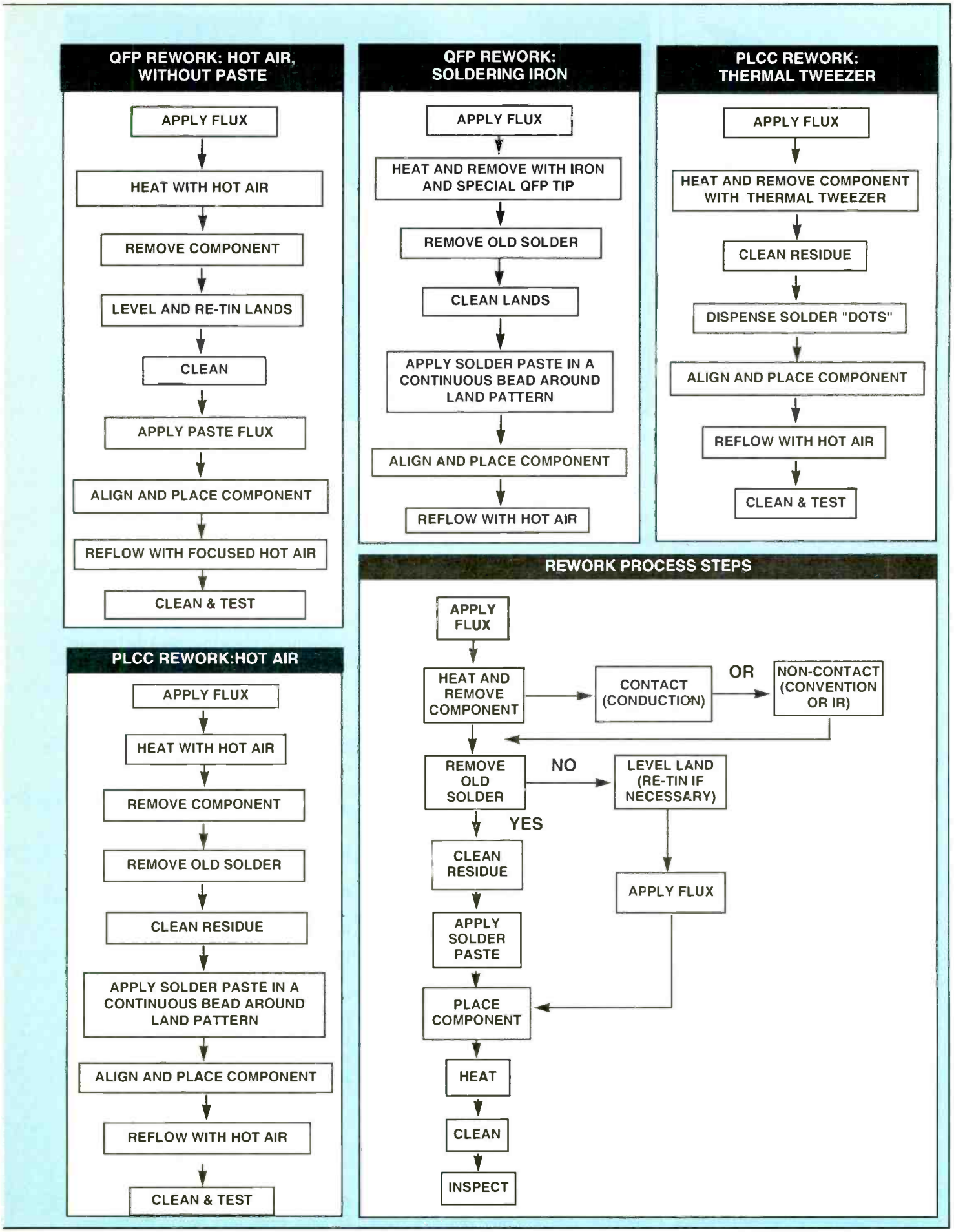
A second method is use of a vacuum desoldering tool. In both cases a temperature-controlled heat source should be used to prevent thermal stress.

Replacing the solder on a printed circuit board

There are three techniques that are usually used for replacing solder during an SMD component repair. The most basic method would re-use the existing solder. Here the technician uses a soldering iron and wire solder to re-tin the component pads prior to re-placing the SMT component. You should keep in mind that the

These flow charts illustrate the required steps in soldering/desoldering various types of components.

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REMOVE COMPONENT
LEVEL AND RE-TIN LANDS
CLEAN
APPLY PASTE FLUX
ALIGN AND PLACE COMPONENT
REFLOW WITH FOCUSED HOT AIR
CLEAN & TEST
QFP REWORK: SOLDERING IRON
APPLY FLUX
HEAT AND REMOVE WITH IRON AND SPECIAL QFP TIP
REMOVE OLD SOLDER
CLEAN LANDS
APPLY SOLDER PASTE IN A CONTINUOUS BEAD AROUND LAND PATTERN
ALIGN AND PLACE COMPONENT
REFLOW WITH HOT AIR
PLCC REWORK: THERMAL TWEEZER
APPLY FLUX
HEAT AND REMOVE COMPONENT WITH THERMAL TWEEZER
CLEAN RESIDUE
DISPENSE SOLDER "DOTS"
ALIGN AND PLACE COMPONENT
REFLOW WITH HOT AIR
CLEAN & TEST
PLCC REWORK:HOT AIR
APPLY FLUX
HEAT WITH HOT AIR
REMOVE COMPONENT
REMOVE OLD SOLDER
CLEAN RESIDUE
APPLY SOLDER PASTE IN A CONTINUOUS BEAD AROUND LAND PATTERN
ALIGN AND PLACE COMPONENT
REFLOW WITH HOT AIR
CLEAN & TEST
REWORK PROCESS STEPS
APPLY FLUX
HEAT AND REMOVE COMPONENT
CONTACT (CONDUCTION)
OR
NON-CONTACT (CONVENTION OR IR)
REMOVE OLD SOLDER
NO
LEVEL LAND (RE-TIN IF NECESSARY)
YES
CLEAN RESIDUE
APPLY FLUX
APPLY SOLDER PASTE
PLACE COMPONENT
HEAT
CLEAN
INSPECT

Figure 6. Fluid dispenser for solder paste.

tech will be placing the component onto hard smooth solder, this may make realignment difficult as the part may slide off the solder bumps. The application of a high viscosity paste flux will help stabilize the part and promote proper wetting and fillet formation.

A more advanced technique that is especially popular when repairing fine-pitch QFPs is hot air leveling of the solder prior to replacing the QFP. After the defective component is removed with a focused convection tool, the technician will apply flux to the pad array, lower the convection nozzle and apply heat. This heating operation will smooth out any solder spikes left on the pads and facilitate component alignment. Apply paste flux to help stabilize the part and promote proper wetting and fillet formation.

Some facilities will elect to completely remove the existing solder, clean the solder pads and replace them with new solder paste. There are two types of solder paste dispensing tools commonly used in the repair area.

The most basic is a hand powered mechanical dispenser. This tool is like a miniature caulking gun. The technician attaches his solder paste syringe and manually squeezes the solder paste from the tube through a dispensing needle onto the pads (Figure 6). This technique is suitable for applying solder paste to large pads, paste flux during reflow and with practice, solder paste on 0.050 pitch component pads.

For improved control of the volume of paste being dispensed, a pneumatic dispenser is recommended. This type of dispenser uses air pressure controlled by an electronic timer to control the burst of air that drives the solder paste from the syringe. This controlled air supply will increase process control and provide a more uniform solder dot size while reducing the technician's hand fatigue and increasing solder paste placement accuracy. In addition most pneumatic dispensers incorporate a provision for a vacuum pencil to assist in component placement.

The final solder paste deposition method utilizes miniature stencils to carefully control the alignment and volume of the solder paste during the repair process. These miniature stencils are fixtured over the pad array and the operator uses a miniature squeegee to apply solder paste through the stencil onto the pads. This is the method of choice during the repair of fine-pitch QFPs and BGA components.

The affect of fine pitch leads on repair

The drive for finer pitches has affected repair by placing a stronger emphasis on tools, equipment, and techniques that

aid in the placement process. Standard pitch components, i.e. 0.050 inch lead spacing, can be placed with relatively simple and inexpensive hand tools. For components with a 0.025 inch pitch, placement requires greater mechanical and sometimes visual aids.

Repair systems with micrometer or fine lead-screw type adjustments in concert with vision systems are an advantage when repairing fine pitch components with 0.025 inch lead spacing, and an absolute requirement with component pitches of 0.020 inches or less. In addition BGA components with a pitch less than 0.040 inches requires vision systems with simultaneous viewing of the top side of the PCB and bottom of the BGA. Alignment is accomplished under high magnification with micrometers for fine movement.

Because of this requirement for tight control of component replacement the trend among manufacturers of soldering/desoldering equipment is to offer improved vision and manipulation of components in their products.

Trends in repair.

There appear to be two trends in repair today. First, equipment manufacturers are offering products that provide the user with greater control of the process. As evidenced above, high-end machines must provide fine movement and vision to address the challenges of fine pitch and BGA components. For standard component repair, lower cost systems and tools are also trying to meet the need for improved process control. A recent development in this area is the OK Industries FCR-2000 repair system in which the concept of a basic hot air tool has been enhanced to incorporate focused heating, heater cycle control, component lift-off with automatic vacuum and "hands-free" operation with handpiece fixturing.

Another emerging trend in repair is the compound or multi-function repair system. Especially with hand tools, at least two companies, Pace and OK Industries, have introduced repair stations that provide simultaneous operation of a variety of handpieces. These systems combine the equipment required for both SMT and through-hole assemblies.

Tool selection

The key to selecting equipment for your repair facility is to identify the components you need to repair today. Talk to the manufacturers you have service contracts with to identify the components they will be using in their future products, then select a repair system that will grow with your needs.

Contact the soldering equipment manufacturers for catalogs, training manuals and video tapes. Get the equipment in-house for evaluation on the boards you need to repair, not a dummy board. Accept any training that the manufacturers will provide on their equipment and make an informed decision. ■

SAW filters Whatever happened to *if* transformers

By Steve Babbert

In the trend toward miniaturization, engineers have found numerous ways to conserve circuit board space. Sometimes components were just made smaller, and sometimes a number of components were formed into a "hybrid" device or module. IC technology has enabled us to fabricate hundreds or thousands of devices into a single "chip." In these cases, the theory of operation hasn't changed.

Occasionally, however, a new device will be developed that will take the place of one or more components by utilizing a totally different concept.

The SAW filter

The SAW (surface acoustic wave) filter is one device that employs an entirely new technological concept when it comes to providing filtering. A single SAW filter can eliminate the need for most of the interstage coupling transformers and traps used in video *if* (intermediate frequency) strips. These transformers and traps are the components that were used for signal coupling and waveshaping.

Besides taking up space, these components had other inherent problems. Not only did they require adjustment during manufacturing, but they sometimes needed additional adjustment during the life of the set. This need for adjustment could arise when components in the *if* section were replaced, or drifted in value because of age or heat.

The distributed capacitance of the circuit surrounding the inductive transformers and traps plays a role in determining their tuned resonant frequency. Any change in capacitance will require a change in inductance in order to maintain this frequency. The adjustment or alignment procedure could be a tedious and time consuming process requiring service literature, sweep and marker generators, oscilloscope, etc. Moreover, components in the *if* circuits were known to fail because of open windings.

Then there's the "human error" factor which must be taken into account. Screws are made for turning, and some humans just can't resist turning screws. Most older techs have had to deal with receivers that were grossly misaligned by someone's brother-in-law who was attempting to bring a weak station to crystal clarity. His attempt to compensate for a reception problem by "tweaking the *if* cans" often led to the customer's complaint of snow on all channels. In these cases, it wasn't uncommon to find broken ferrite slugs. This breakage was usually caused by using improper alignment tools.

Babbert is an independent consumer electronics servicing technician.

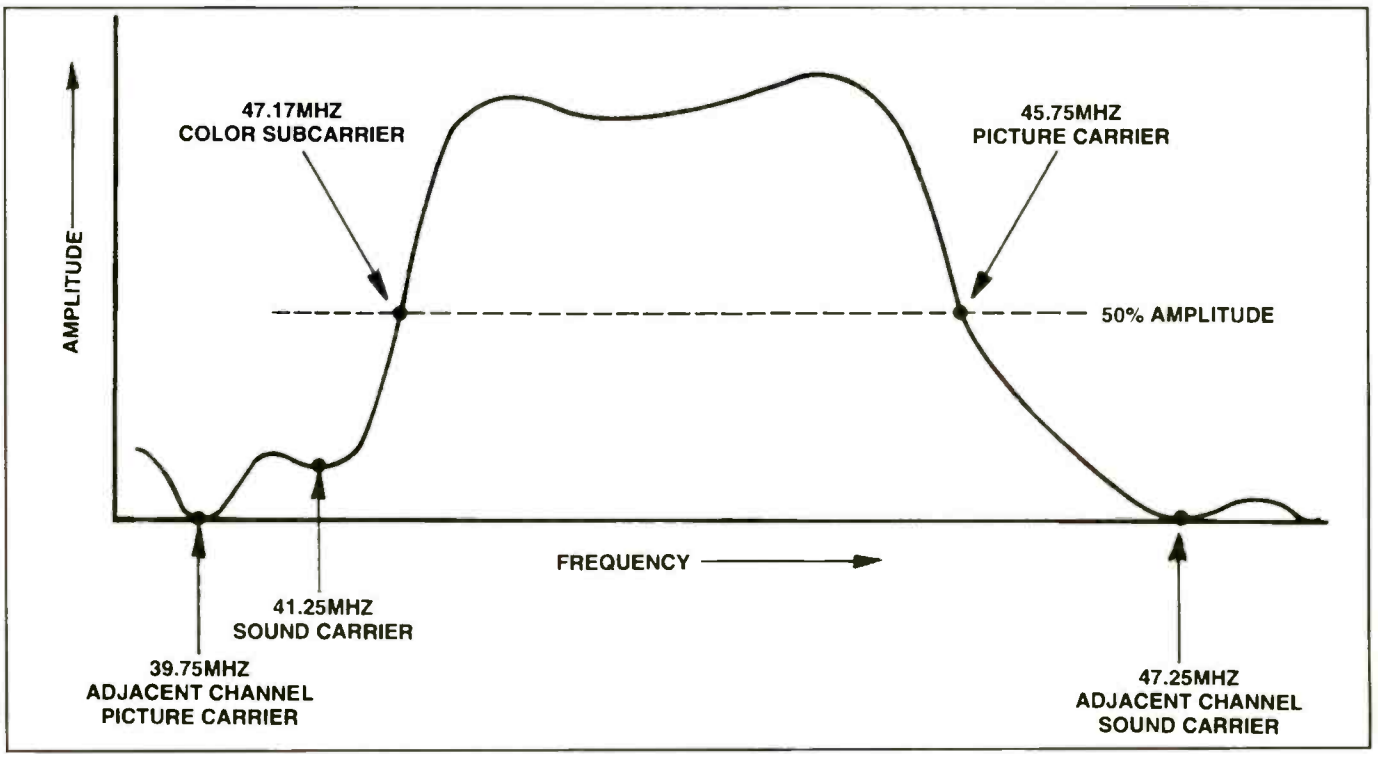


Figure 1. The *if* response curve for a typical color television (NTSC system).

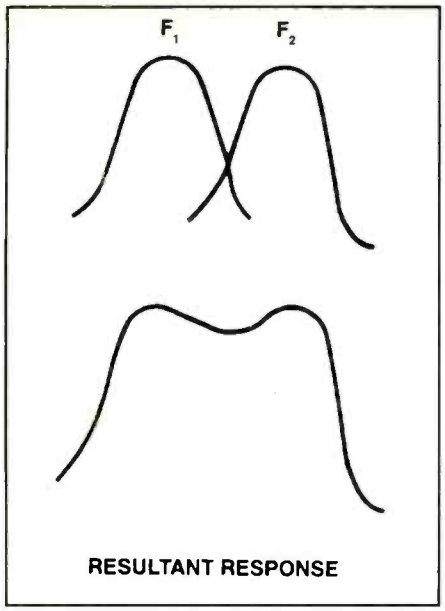


Figure 2. The basic waveshape for the TV *if* response curve was obtained by "stagger" tuning two or more stages.

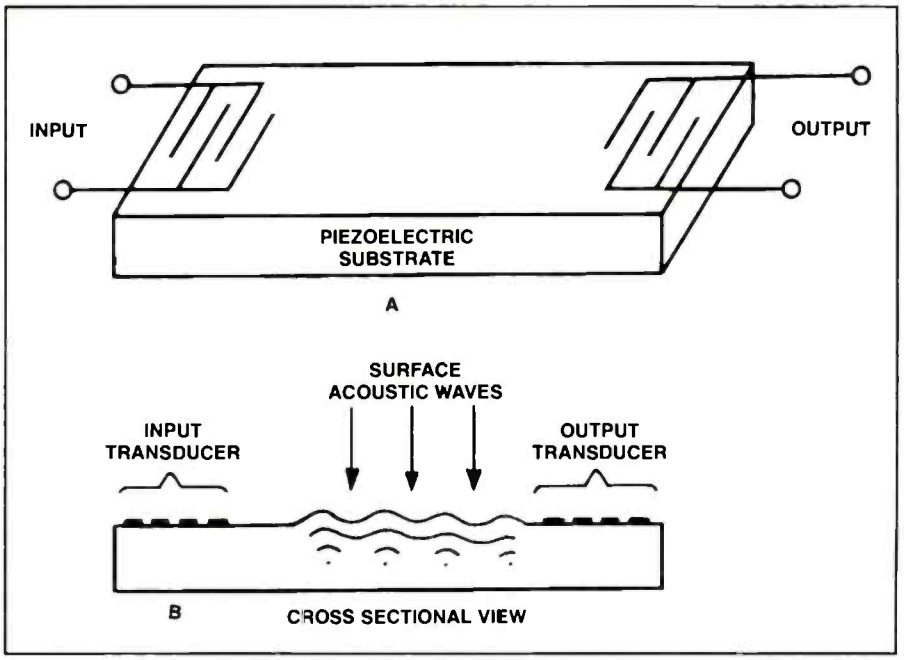


Figure 3. A. A simplified model of a SAW filter. B. A cross sectional view of a working filter.

The *if* response curve

The *if* response curve for a typical color TV receiver is shown in Figure 1. It has a relatively flat top with steeply sloping skirts. The color *if* subcarrier frequency of 42.17MHz and the video *if* carrier frequency of 45.75MHz are at points that are 50% of the maximum amplitude on opposite sides of the curve. The upper adjacent channel picture carrier of 39.75MHz and the lower adjacent channel sound carrier of 47.25MHz are at zero amplitude. The in-channel sound carrier of 41.25MHz is reduced to avoid 920KHz beat with the color subcarrier, but not eliminated, as it is needed by the sound section. The shape of this waveform is critical for accurate video, chroma and sound reproduction.

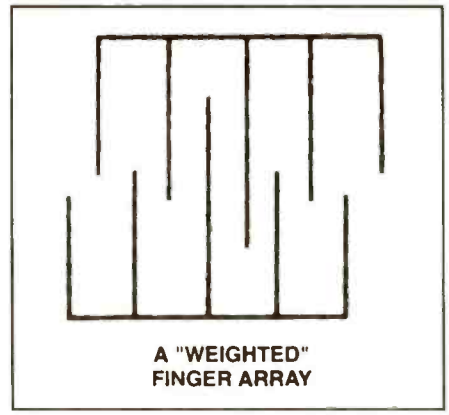


Figure 4. A simplified "weighted" finger array.

Since LC resonant circuits peak at a single frequency, a method known as "stagger tuning" was often used to obtain the basic response curve. In this method, individual stages were tuned to different frequencies within the passband. The result was an overall response wider than that which could be obtained with a single stage (Figure 2). LC traps were employed and tuned as needed to notch out unwanted frequencies.

How SAW filters work

SAW filters function by converting an electrical signal into a mechanical vibration or "acoustic wave." After this wave passes along the surface of the crystal in which it is induced, it is converted back into an electrical signal. Essentially, the SAW filter is a double transducer, since the energy conversion takes place twice.

The energy conversion is made possible by the piezoelectric effect. If a voltage is applied across a substance exhibiting the piezoelectric effect, the substance will twist or bend. Conversely, if this substance is twisted or bent, it will produce a voltage. This effect has been widely used in crystal oscillators, ceramic phono pickups and in cigarette lighters to generate an electric spark to ignite the lighter fuel.

Some materials used for the SAW filter substrate are silicon oxide, thin film zinc oxide, lithium tantalate, lithium niobate, bismuth, germanium oxide and quartz. This material is formed into a slab and its surface is highly polished. Next, metallic electrode arrays are formed on its surface using a photolithographic process (Figure 3).

Signal applied

When an ac signal is applied across the input section of the crystal via the two halves of the input array, the crystal's surface vibrates at the signal frequency. These vibrations create waves which traverse the surface of the crystal to the output section (Figure 3b). The corresponding voltage variations on the surface are picked up by the output array. During this process, specific bandwidth and frequency characteristics have been established.

SAW filters are tailored to particular applications by selecting specific geometric structures for the input and output arrays. Low frequency components of a signal are transmitted and received by wide spread fingers, while closely-spaced fingers favor high-frequency components. Devices can be made to work even in the gigahertz range.

A large number of uniform fingers restricts bandwidth. A uniform array with

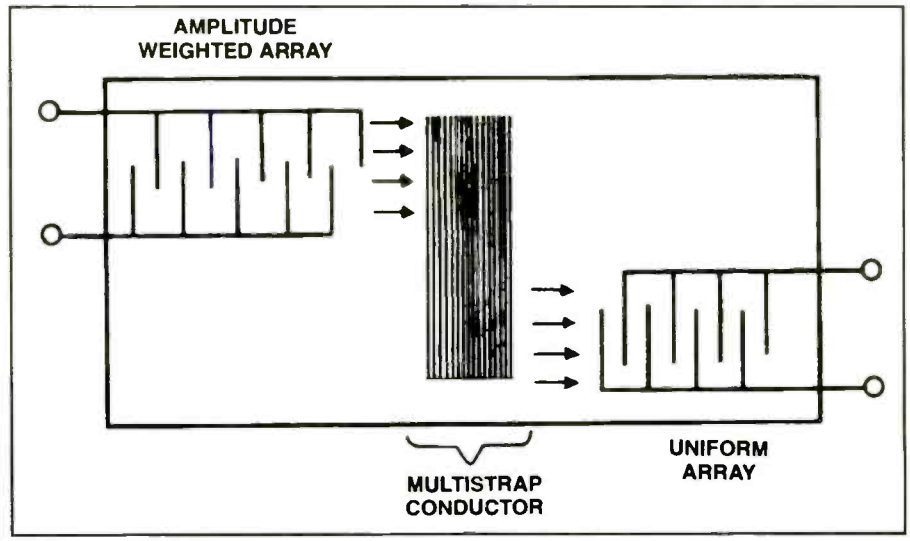


Figure 5. A simplified view of an actual device designed to tailor the *if* response.

only a few fingers will have a broad frequency response. For a specific response with sharp cutoffs, "amplitude weighted" finger arrays are used (Figure 4). In amplitude weighting, the amount of overlap is varied throughout the array.

Problems in SAW filters

It is possible for reflections to pass from the output to the input and then back. These waves would then have three times the delay of the direct wave. This can cause ghosts in the picture, similar to those caused by multipath antenna reception. Split finger arrays double the incident wave frequency, pushing it outside of the passband.

Reflections from the bottom to the top of the crystal, known as bulk wave reflections, sometimes occur. These can be eliminated by placing a multi-strap coupler between the input and the output. Multi-strap couplers consist of a number of "dummy" fingers which are formed with the input and output arrays. Other forms of distortion can be dealt with by modifying the array configurations. The many designs are too numerous to be included in this discussion.

Wave propagation

In SAW filters, the acoustic wave travels slowly (about 10^{-5} times that of an electromagnetic wave) much as soundwaves do, yet they maintain the frequency of the source. This propagation delay makes these devices useful as delay lines. Older television receivers used long inductive delay lines to delay the video signal by about 1µs. This was required to keep it in phase with the chroma signal which encountered the same delay in the chroma processing circuitry.

A simplified model

A simplified model of a SAW filter providing complete *if* shaping for a Zenith color TV is shown in Figure 5. This device consists of input and output interdigital arrays which are offset and separated by a multi-strap coupler. The substrate is made of lithium niobate.

The input array is weighted for selectivity. It has a very low signal loss at 44MHz (the center of the *if* passband). It provides the required 41.25 MHz sound carrier attenuation and traps the unwanted 39.75MHz and 47.25MHz carriers. Frequencies outside the passband are sharply attenuated. The output array consists of a few uniform fingers for a broadband response.

The substrate is mounted on the inside bottom of a ceramic package, the bottom of which has a conductive coating. This acts as a shield when grounded. The device is hermetically sealed with epoxy. Newer devices are mounted in dime-sized metal cans that resemble button cell batteries. The symbol for the SAW filter is shown in Figure 6. Some earlier schematics show them as five-pin ICs.

A device in circuit

The *if* output from the tuner is terminated in an LR network which provides the correct match to the SAW filter (Figure 7). The double-ended output of the filter is applied to pins 2 and 14 of a three-stage *if* amp IC. Direct coupling is used between the three stages since the proper waveform has already been established.

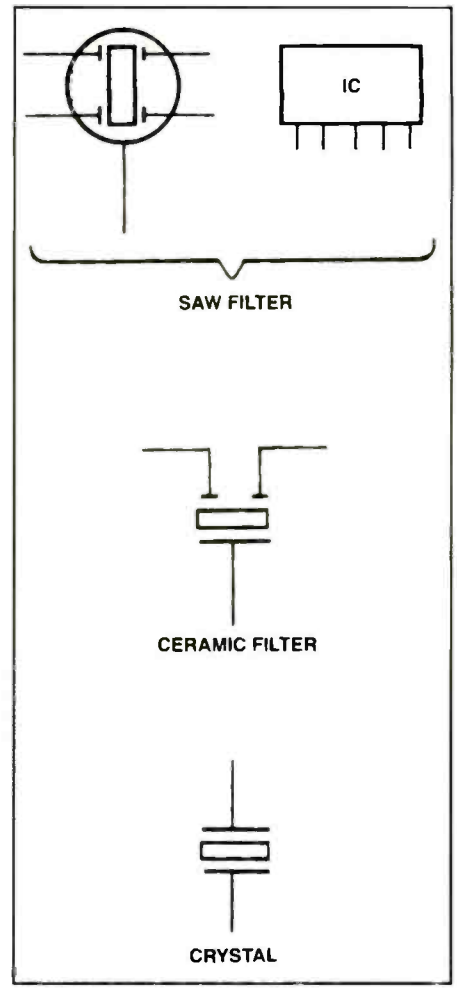


Figure 6. Commonly used symbols for a SAW filter, a ceramic filter (the smaller relative of the SAW filter), and a standard crystal (notice the resemblance to the symbols for the SAW and ceramic filters).

Contrast this with a typical design using conventional LC circuits (Figure 8).

A smaller relative of the SAW filter is the ceramic filter. The symbol for this device is shown in Figure 6. This three-terminal device uses the same principle, but

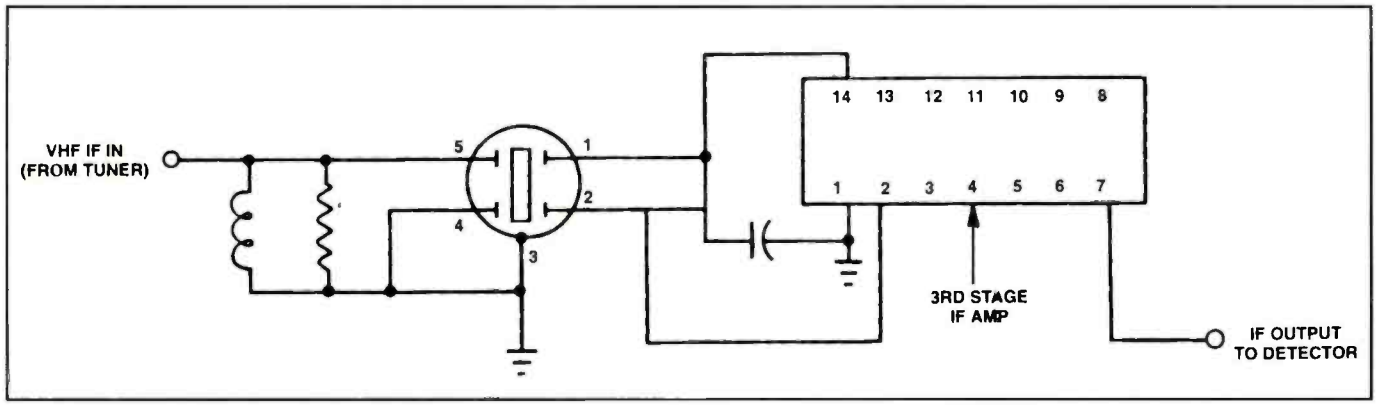


Figure 7. The *if* output from the tuner is terminated in an LR network which provides the correct match to the SAW filter. The double-ended output of the filter is applied to pins 2 and 14 of a three-stage *if* amp IC. Direct coupling is used between the three stages since the proper waveform has already been established.

Figure 8. Contrast this typical design using conventional LC circuits with the design of Figure 7 which uses a SAW filter. ➤

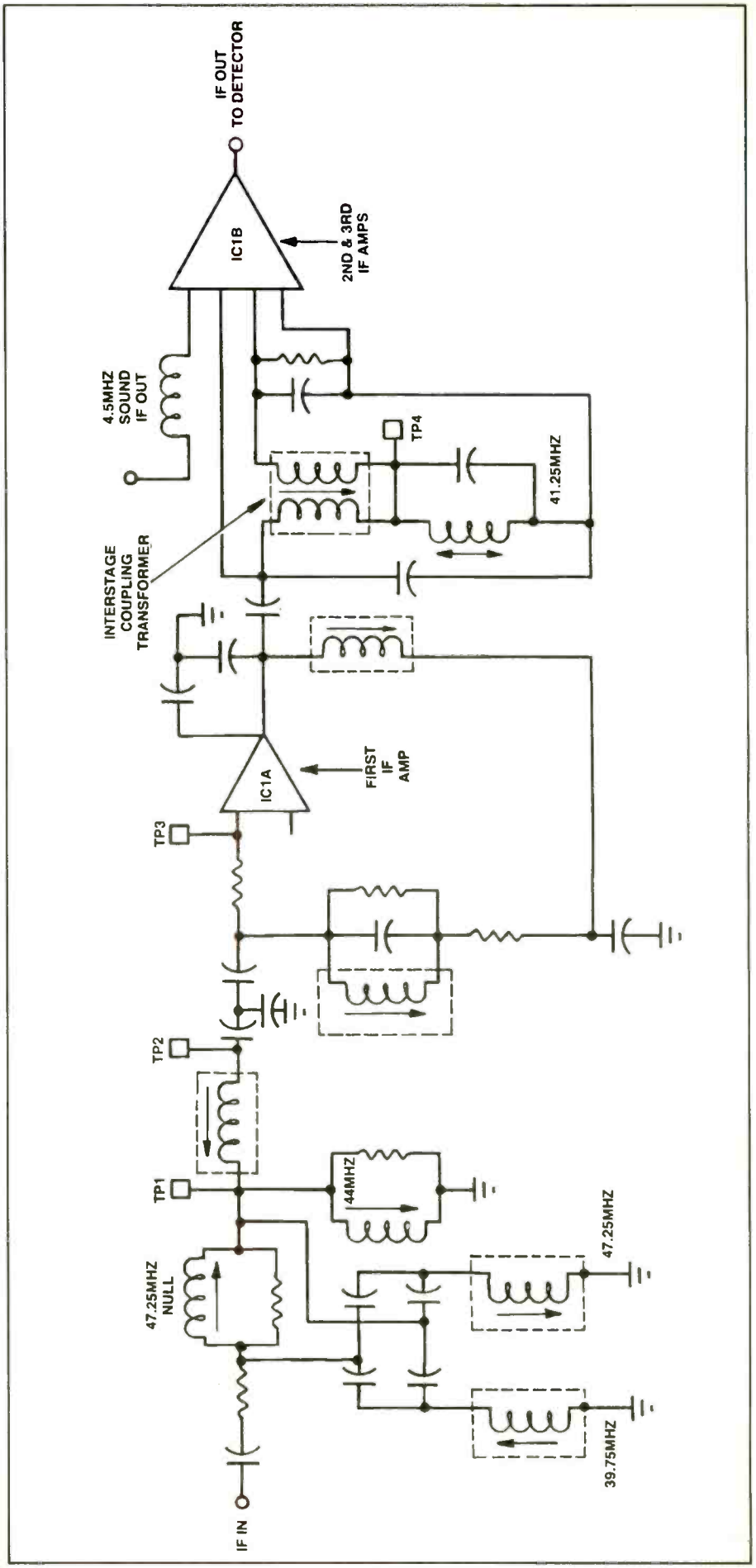
has a much narrower bandpass characteristic. For this reason, the design is simpler and the elaborate input and output arrays are omitted.

These are used almost exclusively for interstage coupling in fm receivers and other audio communications equipment. The center frequency is usually stamped on the case. They resemble ceramic capacitors except that they are rectangular and have flat leads.

Summary

The SAW filter has simplified the *if* section of TV sets, and eliminated much of the alignment that was associated with the early television receiver. Some older technicians who took pride in their mastery of the art of alignment may well wonder what will be done away with next.

Remember though, not all breakthroughs and improvements result in decreased complexity: just look at any switched-mode power supply. At least for the time being it is safe to assume that as one challenge passes a new one will emerge. ■



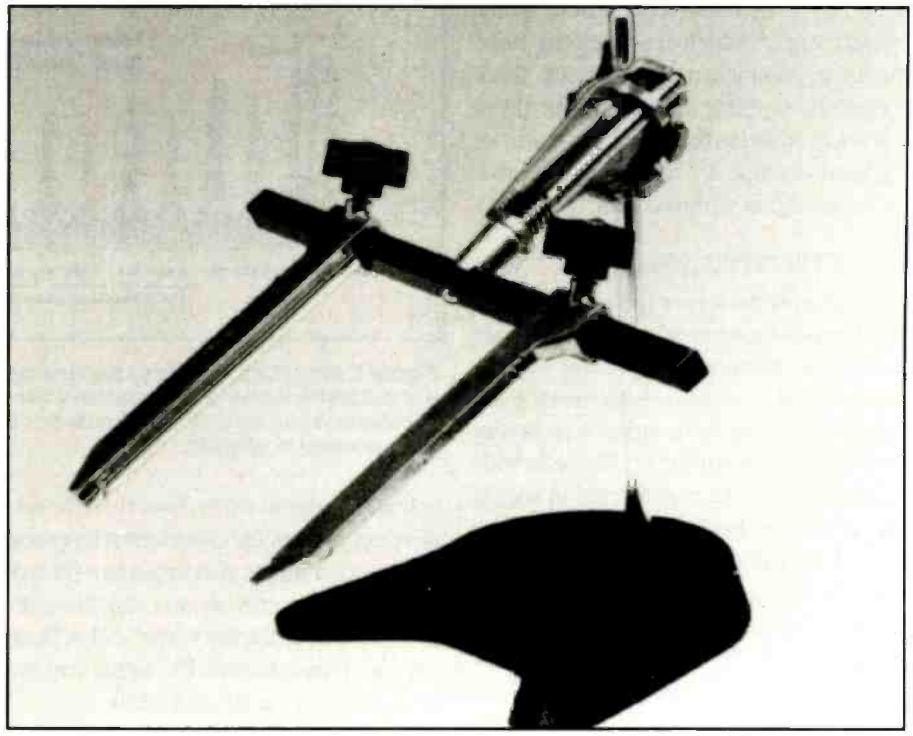
Pick and place and holding fixtures

By The ES&T Staff

There was a time when most components in consumer electronics products were as big as your finger, and just plugged in. Even if the technician was unlucky and the problem was a bad resistor, a fix usually meant bending the leads to fit, and soldering the replacement into the circuit using an 100W soldering tool.

Now, things have changed dramatically. Most components are so tiny that they border on being invisible. Even mutileaded ICs are so tiny that a healthy sneeze can blow them across the room. And because they're multileaded it's important to get the ICs properly lined up on the PC board tracer.

But that brings up yet another problem concerning these tiny components and the PC boards they're mounted on. For those of us who have only two hands, it's hard to hold the PC board to keep it from moving while you're trying to place the component on the board and solder it.



A circuit board holder such as this allows the technician to place the PC board at a convenient angle for soldering/desoldering. (Photo courtesy Panavise)

Pick and place tools

Fortunately for the harried and overworked technician, there are tools that allow him to pick up the smallest component, transfer it to the PC board, and place it in precisely the correct position.

One example of such a pick and place device consists of a bent metal or plastic tube with a hole in it. One end of the tube ends in a tiny suction-cup-type device. The other end of the tube connects to a vacuum source.

To use this device, the technician places the suction-cup end of the tube on the component that is to be picked up, leaving the hole in the tube uncovered. As long as the hole in the tube is open, the vacuum can pull in air at that point rather than at the suction-cup end.

Once the suction-cup end of the tube is in the right location the technician covers the hole with a finger. Now a vacuum is created and the component can be neatly lifted. Now using the tube, or wand, the technician can transfer the tiny component to its precise location and orientation on the PC board. Once it's in position he merely has to remove his finger from the hole releasing the vacuum and the component stays in position on the board unitl it is soldered in place.

At least one manufacturer offers a similar device that doesn't require an outside source of vacuum. With this manual device, the user merely has to place the suction-cup end of the device or the component to be lifted then manipulate a button or lever, which creates the vacuum. Then, once he has placed the component where it needs to go he releases the vacuum, and then proceeds with soldering.

Holding the PC board in place

But, picking up the component and placing it on the PC Board is only part of the problem. How do you hold the PC board at a convenient angle and keep it from moving? And, how do you keep from damaging components on the board, or some of those delicate traces?

In many cases that question is answered for the technician. The PC board remains within the product being serviced and he gets to the location where the component belongs as best he can.

But then there are cases in which the PC board is completely removed from the unit in order to desolder the defective component and solder in the replacement. In such cases the technician may have to resort to propping the board up on a couple of pieces of wood, or leaning it against something to set it at the desired angle.

Of course when the replacement of components is done this way it's rarely possible to get the PC into just the position you want. Even worse is when the board slips just as you apply the soldering iron to the connection.

Holding fixtures

Fortunately, there are devices that make all that messing around unnecessary, and allow the technician to put the PC board exactly where he wants it, and at exactly the right angle. This way, there's no chance that any components or tracer will be damaged during servicing.

These holding fixtures are available in a variety of sizes and styles, from a number of manufacturers and distributors. With these the technician simply clamps the PC board into the fixture, places it just where he wants it, adjusts it to the desired angle, and goes to work. ■

The TV color signal

By Lamar Ritchie

The July issue featured an article "Television theory," which described the basic theory of monochrome television. This continuation of that article describes how color was added to the signal while allowing monochrome TV receivers to receive the same signal without color.

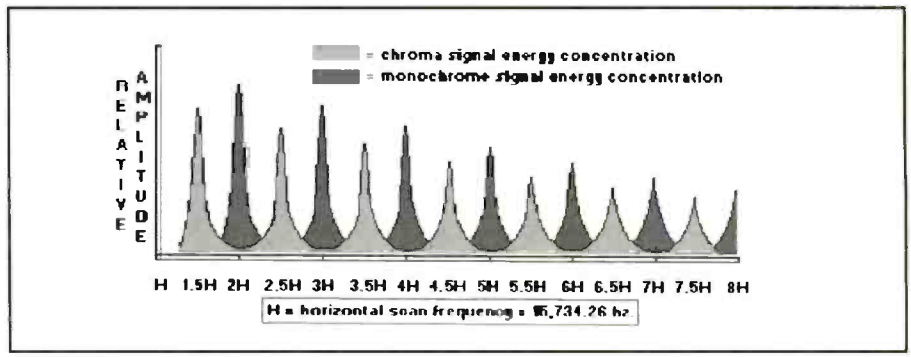


Figure 1. Most of the frequency spectrum used by the monochrome video is clustered in "packets" that are harmonics of the horizontal scanning frequency: 15.75Khz. The color signal is placed in between these areas, in the frequencies that are little used by the monochrome video in a process called interleaving.

The NTSC color system

Many systems were experimented with for the transmission of color TV signals before the present NTSC color system was adopted. The main obstacle to the development of the color video system was the need for compatibility. The color video signal had to be constructed in such a way that the monochrome video would be essentially unchanged. Existing receivers must be able to reproduce the signal as a black and white image and the signal must occupy nearly the same bandwidth that the monochrome signal did. These are severe limitations which produced several compromises in the color system.

There are, of course, an infinite number of colors. What we call color is nothing more than the different frequencies of light that we can see. The lowest visible light frequency that we can see is the frequency corresponding to the color red and the highest is that of the color violet. There is a large number of frequencies between these extremes.

Fooling the eye

We can produce the illusion of having all colors by using varying mixtures of the three primary colors of light—red, green and blue. Transmission of color television, therefore, requires that three video signals be recovered at the receiver; the red, green and blue video signals. These are referred to as the R, G and B video signals. The monochrome signal containing only the relative brightness information is called the Y signal.

The derivation of the color video signal parameters is exceedingly complex. As an example, white light is actually a mixture of all colors, and thus can be considered as a mixture of all three primary colors. To appear white, however, the relative amounts of the colors must be exact.

The color mix is also important for any objects that are gray, as gray could be considered to be a "darker white" color. Note that the monochrome TV signal can reproduce black, grays and white.

To appear a neutral gray or white color, the same as the monochrome image, the color signals must have this proportion:

$Y = 0.3R + 0.59G + 0.11B$

If the colors are in the proportion of 30% red, 59% green and 11% blue, the image should appear as a gray to white shade to us. To do this electronically, any signal that we are using to convey color must "disappear" when this ratio exists.

Still too many signals for TV transmission

Thus far, we have managed to reduce the number of signals needed to convey color, and signals conveying the primary colors to three. These signals are still too many, however. In order to further reduce the information that needs to be transmitted, TV engineers developed a system that has been used in trigonometry for a long time: "vectors."

A vector is a quantity with both a magnitude and a direction. If these vectors are assigned an origin at the intersection of two axes (the X and Y axes), an infinite number of locations and directions can be assigned by using only two rectangular

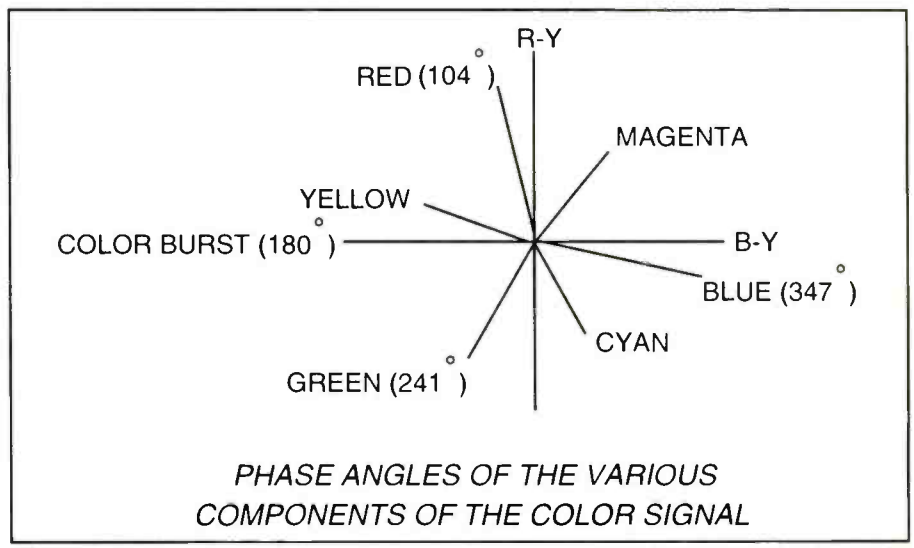


Figure 2. The two sideband signals are created by subtracting the luminance value from both the red and blue signals. These are called the R-Y and B-Y signals. These are used in a quadrature modulator and are essentially the rectangular coordinates that produce the various phase angles for the individual colors.

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coordinates, providing both positive and negative numbers can be used.

This is the scheme that was used to develop the color signal. Using this scheme, all of the color information can be transmitted using only two signals. These signals can represent rectangular coordinates with the colors assigned as vectors having various phase angles.

Furthermore, these two signals can be assigned as independent sidebands of a single am signal. It is possible to produce a color signal, then, as a single am signal with two independent sidebands. It was necessary to place this modulated signal on the existing baseband video signal. This entire signal is then used to modulate a carrier in the video transmitter, so instead of being called a carrier, it is actually called a subcarrier.

The color subcarrier

The color information is placed in the existing monochrome video as a color subcarrier or chrominance subcarrier, to use its accurate name. I must point out now that the subcarrier is not actually transmitted. It is suppressed after the subcarrier modulation process that produces the two sidebands, in order to reduce interference with the monochrome video.

This means that to demodulate the color signal, this color subcarrier must be reinserted by the television receiver circuits. The receiver uses a crystal oscillator for this purpose, but even a crystal oscillator is not stable enough to free-run at the exact frequency needed.

To "lock" in the crystal oscillator, eight to ten cycles of the original color subcarrier frequency are placed on the "back porch," or trailing edge of the horizontal blanking to be used as reference pulses to which the color oscillator in the receiver can lock. These will be easy to gate through to the oscillator by using a delayed horizontal sync signal in the receiver.

Color frequencies

Because the color signal must use the existing bandwidth allowed for the monochrome signal, and therefore must be placed in the same frequencies, it will appear visible on the TV screen. Note that I am saying the color signal will be visible. The colors that are the result of demodulating this signal will also be visible, of course. We want to see the colors. We do not want to see the color signal.

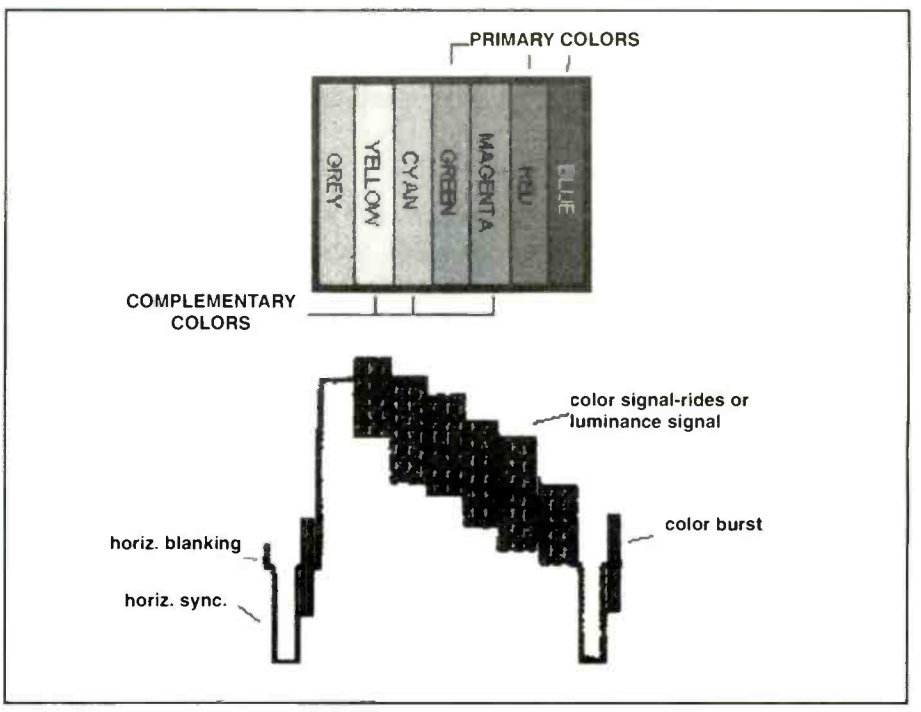

Figure 3. The phase of the chroma signal compared to the burst determines the particular color (hue) of an object , and the amplitude of this signal determines the saturation (amount of color) for an object. This illustration shows how the color signal might appear for the indicated televised scene.

Because the color signal is essentially a sine wave that varies in phase, it would appear on the screen as a series of light and dark colored pixels as the sine wave alternated between its positive and negative peaks. The trick here is to place these pixels in areas that are not used much for the monochrome image so that they will interfere as little as possible with it.

Because the picture information is scanned one horizontal line at a time, and the spacing between lines is very small, most of the video information is repetitive at the horizontal scan rate. This means that most of the frequency spectrum used by the monochrome video is clustered in "packets" that are harmonics of the horizontal scanning frequency: 15.75Khz. The color signal is placed in between these areas, in the frequencies used by the monochrome video in a process called interleaving (Figure 1).

Interleaving

For interleaving to take place, the color subcarrier frequency must be an odd multiple of one-half the horizontal scan rate. There are other things to consider, however, before this frequency is chosen.

The frequency of the color subcarrier should be as high as possible so that the resulting interference pattern that it creates on the screen will be as small and unnoticeable as possible. We have up to about 4MHz as the upper end of the video spectrum. It should be obvious at this point that the chroma signal cannot produce as much detail as the monochrome signal, which has the full 4MHz.

Although the eye is not as sensitive to detail for colors, the color subcarrier must be placed far enough down from the upper frequency limit to allow a reasonable bandwidth for it—at least 500KHz. This would put it's frequency somewhere in the vicinity of 3.5MHz.

Avoiding audio interference

Another problem arises in that the frequency of this signal is very close to the sound carrier frequency of the transmitter. This transmitter is operating at a frequency that is 4.5MHz above the video carrier frequency and the color signal can "beat" with it to produce different frequencies that are 1MHz or below, and would produce an objectionable interference pattern on the screen. This is one reason why the chrominance (color) subcarrier was suppressed and only the sidebands of the chroma signal used.

To minimize deterioration of the picture quality that might be caused by the heterodyning of the sound carrier and

quadrature. The I signal is placed at +123 degrees and the Q signal at +33 degrees, hence they are still 90 degrees apart as were the R-Y and B-Y signals and can be used to derive any of the other colors by vector addition. The difference is that the I signal can produce reddish-orange and blue-green colors by itself (look at the +I and -I vectors on the previous diagram). These are the colors for which the eye is most sensitive to detail.

For these colors, the Q signal drops out, since it is not needed anyway, and the I signal uses the entire color signal bandwidth itself. It was decided to allow 1.5-MHz of bandwidth for the I signal. This gives approximately three times the color detail that R-Y, B-Y encoding has. Considering the upper and lower sidebands of the I signal, this means that it would need frequencies of 3.58MHz - 1.5MHz. to 3.58MHz + 1.5MHz. The lower sideband of the I signal is used as is, but the upper sideband is filtered and limited to a frequency around 4.2MHz.

As far as the receiver and the video signal are concerned, the results of I - Q, and

IC's have reduced the size and cost of circuitry to the point where consumer video equipment (camcorders) now use the better system. A modern S-VHS cam-

occurs in a system, some knowledge of the principles of operation of the system always enhances the ability of the service technician to determine the cause. ■

ES&T Calendar

International Winter Consumer Electronics Show
January 5-8, 1996
Las Vegas, NV

Mobile Electronics Show
April 19-21, 1996
Orlando, FL

CES Orlando '96—The Digital Destination
May 23-25, 1996
Orlando, FL
703-907-7500

CES Habitech
May 23-25, 1996
Orlando, FL
703-907-7500

1996 CES Specialty Audio and Home Theater Show
May 23-25, 1996
Orlando, FL
703-907-7500

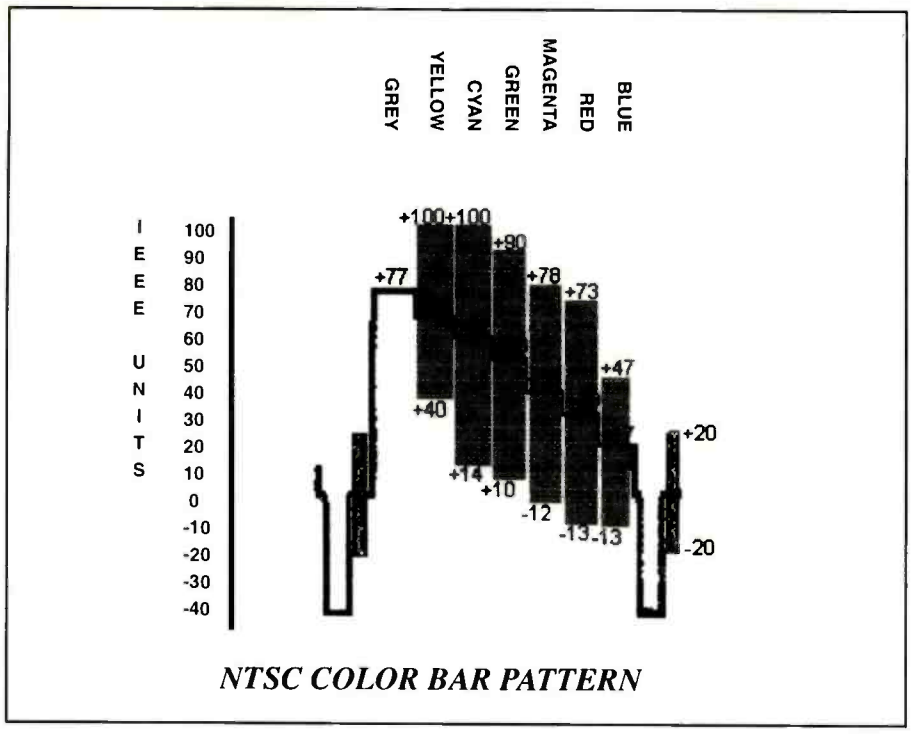

Figure 4. For 100% saturated colors (for example, as deep a blue that you can get) the amplitude of the signals would be higher. The amplitudes standardized for 100% saturated colors are shown here.

color signals, this beat difference fre-

The color subcarrier frequency

color. It is the amplitude of the color signal that determines the saturation of the color. It is the instantaneous phase of the color signal, compared to the burst, that determines the hue of the color.

Refer to Figure 2. The two sideband signals are created by subtracting the luminance value from both the red and blue signals. These are called the R-Y and B-Y signals. These are used in a quadrature modulator (which creates sidebands 90 degrees apart) and are essentially the rectangular coordinates that produce the various phase angles for the individual colors. Note that the phase of the burst is not 0 degrees, but is placed at 180 degrees. This is to prevent interference with the B-Y signal. The burst is restored to 0 degrees in the receiver by a simple process of phase reversal.

After modulation, then, the composite color video signal consists of all the parts that existed in the monochrome signal (called the Y signal), with minor changes to the sync frequencies, plus a chroma signal (referred to as the C signal) that rides on the luminance. A color burst or color sync signal is used as a reference to indicate the 0 degree axis.

Vacuum tubes revisited

By Arthur Flavell

Since the introduction of transistors and integrated circuitry, vacuum tube applications have declined dramatically. While obsolete in many current applications, vacuum tube technology has not disappeared entirely.

Some types of equipment, such as radio transmitters and musical instrument amplifiers, still use tubes. The cathode ray tube displays in televisions and computer monitors are vacuum tubes, while magnetrons are vacuum tubes that are used in radar and microwave ovens. A growing interest in restoration of vintage equipment may present an opportunity to work on Uncle Fred's old tube-type table radio. The well-rounded technician should be familiar with the basics of vacuum tube operation as well as the techniques and hazards of troubleshooting tube circuits.

Basic vacuum tube theory

In simplest terms, a vacuum tube is a device that controls a flow of electrons. It is used in a variety of electronic circuits such as rectifiers, amplifiers, oscillators and switches. The elements of a vacuum tube are enclosed in an evacuated envelope made of glass, ceramic or metal.

Each vacuum tube contains elements for carrying electrical current into and out of the device. The element connected to the lower (less positive) voltage point is called the *cathode*. The element connected to the higher (more positive) point is called the *anode* or *plate*.

The cathode is coated with a material which enhances the generation of free electrons. The release of electrons is enhanced by heating the cathode material with a filament or heater element. When the filaments are energized, a "cloud" of electrons is produced around the cathode by a process known as *thermionic emission*. Internal current flow is in the form of an electron stream from the cathode, through the vacuum, to the plate.

The positive potential of the plate attracts electrons from the cathode. When the tube is connected in a complete circuit, current will flow. Electron current will not flow in the reverse direction (from anode to cathode).

Vacuum tube types

A two-element vacuum tube is known as a diode and performs the same functions as its solid-state cousin. Figure 1 shows the schematic symbol for a diode.

With a diode, only two operating conditions exist. If the plate is positive with respect to the cathode, current will flow through the tube. If the plate is negative with respect to the cathode, no current will flow. The amplitude of current flow is a function of the applied voltage and the total resistance in the circuit.

For more complex circuit applications, current flow through the tube must be varied between the full off and full on conditions. This is accomplished by adding a control element to the basic diode configuration called a grid. The control grid is located between the cathode and the anode. This three element tube is known as a triode. Figure 2 shows the schematic symbol for a triode.

In most circuits, the control grid is negative with respect to the cathode and does not carry current. This provides a repelling effect to the electrons released from the cathode, reducing current flow through the tube. Relatively small voltage variations on the control grid produce large changes in plate current and voltage. The variations in plate voltage are amplified versions of the control grid voltage and are 180° out of phase with the voltage at the input. Some circuits, such as RF power amplifiers, allow the grid to go positive for a portion of the input waveform, and grid current will flow.

While the triode is useful in many applications, it does have some limitations. Performance in the RF region suffers from inter-electrode capacitance

Flavell is owner of an independent consumer electronics service center in Alaska.

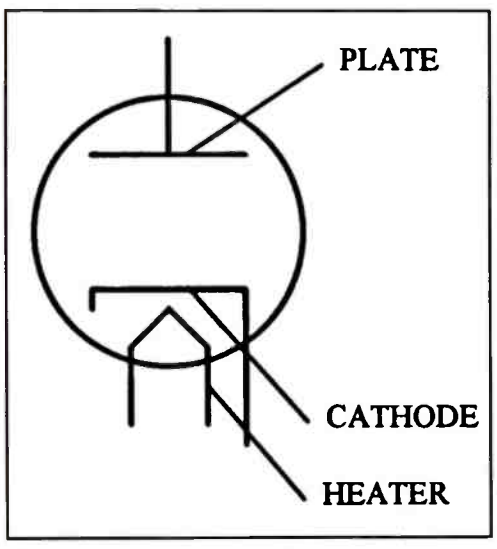

Figure 1. The schematic symbol for a diode.

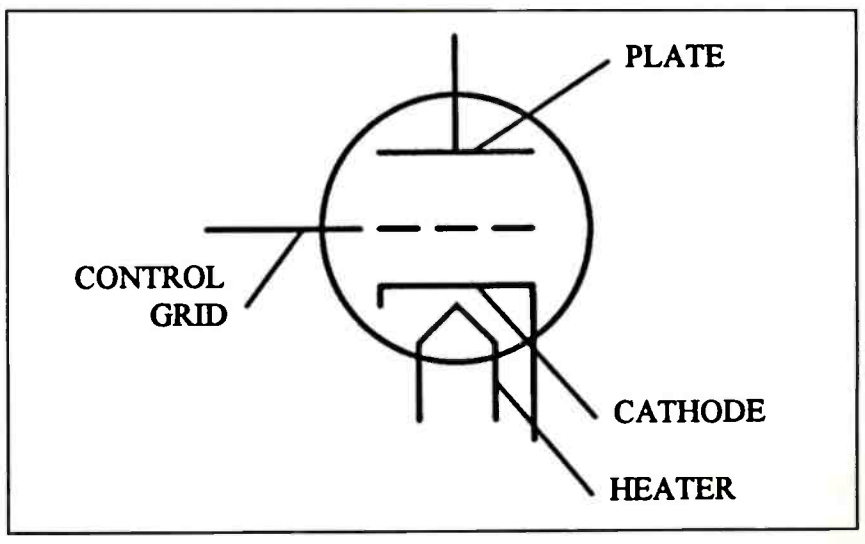

Figure 2. The schematic symbol for a triode.

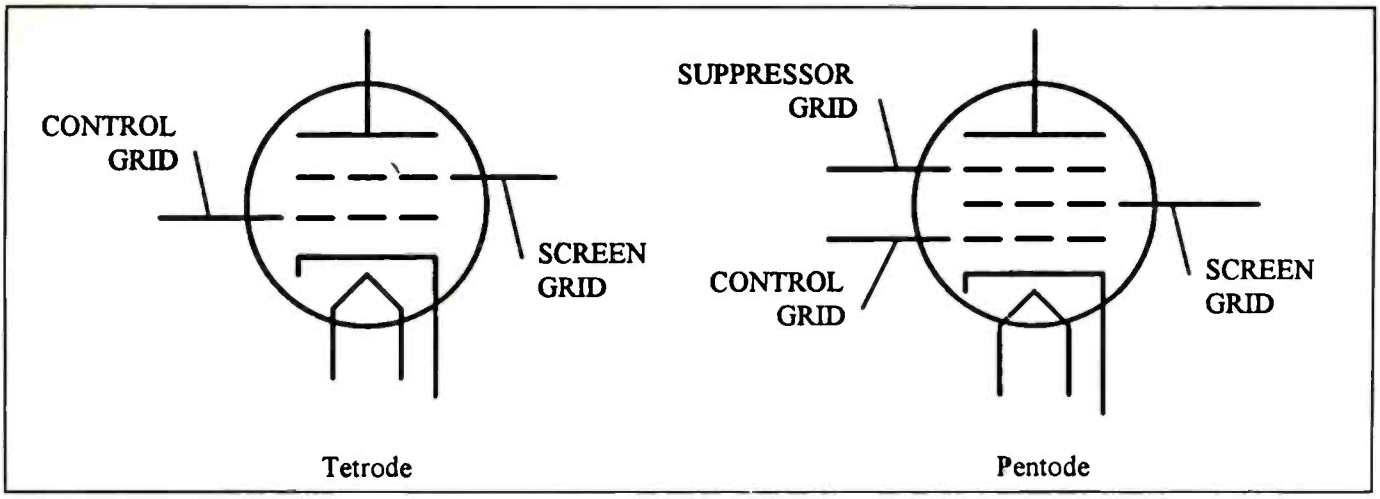

Figure 3. The schematic symbols for tetrode and pentode tubes.

which causes internal feedback and self-oscillation. To overcome these limitations, tubes were developed with additional elements. Examples of these are the tetrode and pentode tubes shown schematically in Figure 3.

Vacuum tube numbering

There are a number of electrical and physical characteristics of vacuum tubes that apply to a variety of types. Here are a few practical topics that may be useful.

Vacuum tubes used in consumer products are often identified with an alpha-numeric designation. Typically, it is a number-letter-number combination, such as 5U4, 6GH8, 12AU7, etc. For tubes with this type of identifier, the number at the beginning of the designator indicates the filament voltage. In the previous examples, the filament voltages are 5V, 6V and 12V respectively. This system does not apply to industrial or military tubes with four-digit designations.

Tube envelopes are made of glass, metal or ceramic materials, with glass being the most common. The tube type is printed on the outside of the envelope. Identifiers on older tubes may be faint or badly faded. When the tube is cold, wipe it gen-

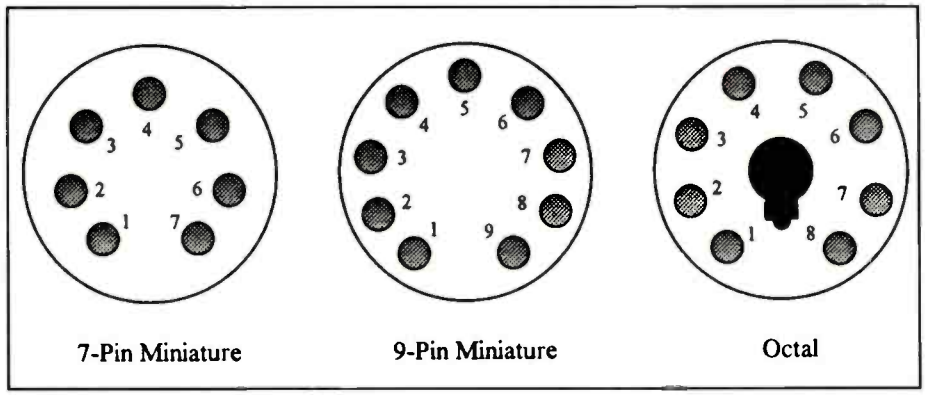

Figure 4. Pin arrangements for 7-pin, 9-pin miniature types and octal bases.

tly with a damp cloth to remove any dust or dirt. Then breathe on the envelope as if you were cleaning a pair of eye glasses. In many cases, this makes the markings readable.

A couple of publications are helpful when working on tube circuits. A tube manual contains technical information for each tube type, including normal and maximum operating voltages and currents, characteristic operating curves, element pin arrangements, and other data. A tube substitution manual is also handy when exact replacements are not available.

Gassy tubes

To function properly, tubes must maintain a high degree of vacuum inside the envelope. Tubes may accumulate gas, either from molecules released from the tube elements or through leaks in the envelope seal. Such tubes are said to be "gassy" or "soft."

One indication of a gassy tube may be a bluish glow inside the tube when operating. Another indicator is the condition of the getter material. The getter is a small ring inside the envelope which is loaded with a gunpowder-like material. When the envelope is evacuated during manufacture, the getter is fired to help drive out gas, creating a shiny silver deposit in the interior surface. When the tube becomes gassy, the getter material turns a dull brown and may be surrounded by a grayish film.

Pin arrangements

Individual elements in vacuum tubes are connected to metal pins which penetrate the envelope. Different tubes have different numbers of pins. The 7- and 9-pin miniature types and octal bases are the most common. Figure 4 illustrates pin arrangements for these tubes.

Schematic diagrams or a tube manual will illustrate which tube element is connected to each pin. Some tubes have connections at positions other than the base. Tubes used in high-power circuits, such as RF amplifiers, sweep tubes in televisions and some rectifiers have plate connections at a cap on top of the tube. Circuit connection is made with a friction-fit socket. Corrosion can make these connectors difficult to remove. Care should be used to prevent the cap from breaking off or the tube envelope from cracking.

Troubleshooting vacuum tube circuits

The function of vacuum tube circuits is similar to the function of solid state circuits. However, there are some important differences. Vacuum tube circuits operate with potentially lethal voltages and currents! The plate voltage supply or B+ voltage may run from several hundred to several thousand volts. A good practice to follow while taking live circuit measurements is to keep one hand tucked in your hip pocket to avoid the possibilty of a shock across your chest.

In many cases, equipment failure is the result of tube failure. It's a good idea to check if the tube filaments are lit. With glass envelope tubes, a red glow should be visible. With metal or ceramic tubes, resistance checks out of circuit will pinpoint an open filament.

In some older equipment, tubes are selected so that the individual filament voltages add up to 120V. This allows the filaments to be connected in series and operated directly across the ac line. Like a string of Christmas lights, if one unit fails, the whole string goes out. Voltage checks along the series string will reveal which filament is the culprit.

Newer equipment uses 6V or 12V filaments fed by a low voltage secondary of the power transformer. In this case, the filaments are connected in parallel and the failure of one will not affect the operation of other tubes. To simplify schematic diagrams in some cases, the filaments of all tubes may be grouped together rather than shown individually.

A tube tester will give a quick go/no-go indication and can reveal internal shorts. If a tester is not available, conventional signal tracing and signal injection techniques may be used (again, remember that tube circuits have high voltages present). A dc blocking capacitor should be used on signal generator leads to prevent any overloading of the generator output.

Problems in other areas of tube circuits

If the tubes check out okay, look for the problem in other areas. The power supply is high on the list of trouble sources. A voltage check will reveal problems in this area. Electrolytic capacitors are common problem makers, particularly in older equipment where they may have dried out and become leaky. Check for excessive ripple on the B+ and other dc supplies. Electrolytics can cause problems in other areas, too. Figure 5 shows a simple vacuum tube audio amplifier. C2 is an interstage coupling capacitor. A faulty coupling capacitor can prevent or reduce signal transfer from one stage to the next.

Many tube circuits are self-biased with a resistor between the cathode and the ground (R2 and R4). Current flow through this resistor creates a small positive voltage at the cathode. With the control grid at ground potential, a dc bias is developed, with the control grid negative with respect to the cathode.

To allow the cathode to operate at ground potential for the ac signal, an electrolytic capacitor is used to bypass the cathode resistor (C3 and C4). Failure of this capacitor causes reduced stage gain by degenerative feedback or "swamping."

When the problem has been narrowed down to a specific stage, voltage checks on the tube's elements can help isolate defective components. The B+ voltage may be supplied to the tube plate through

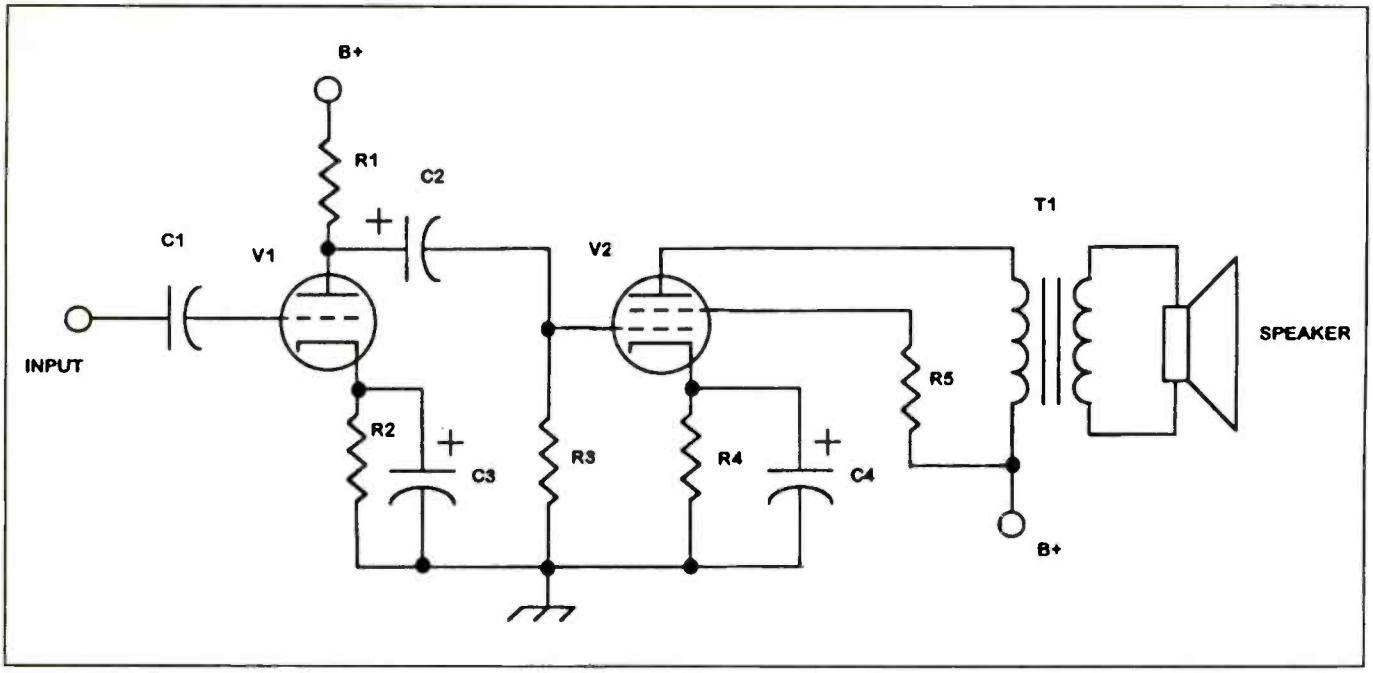

Figure 5. A simple vacuum tube audio amplifier circuit.

a plate load resistor (R1) or through an interstage transformer (T1), such as an audio output transformer. If B+ is present at the power supply but is missing at the plate, suspect an open plate load. The same analysis holds true for the screen voltage supply in a tetrode or pentode-vacuum tube circuit (R5).

Vacuum tubes may be the dinosaurs of the electronics age, but they are not extinct yet. An understanding of basic theory and an awareness of the safety hazards inherent with vacuum tube equipment can help expand your service base and generate more profits. ■

Interrupted again! Installing adapter cards in a microcomputer

By John A. Ross

Recently, one of my employees attempted to install an internal modem and a sound card into a customer's microcomputer system. The system was an IBM-compatible, 486-based microcomputer running MS-DOS version 6.22 and Microsoft Windows 3.11. After an hour on the job, Joe called back to the office and complained that the modem would not send or receive data and that the sound card only worked part of the time. When the modem did work, the mouse would not. A job that had seemed like a simple matter of inserting cards into a computer had now become a frustrating experience.

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The problems that Joe encountered during the installation of the modem and the sound card are fairly common problems. Any time a technician installs additional adapters into a microcomputer, those adapters require system resources. The additional adaptors then compete for those resources which other attached devices are already using. If two adapters compete for the same resources, a device conflict occurs. With that conflict, neither device will work.

Watch those resources

Microcomputer systems offer four basic types of resources for use by those pesky adapters. Those resources are:

- Interrupt Request Lines (IRQ's)
- Input/Output Addresses (I/Os)
- Direct Memory Access Channels (DMAs)
- Upper Memory Blocks (UMB's).

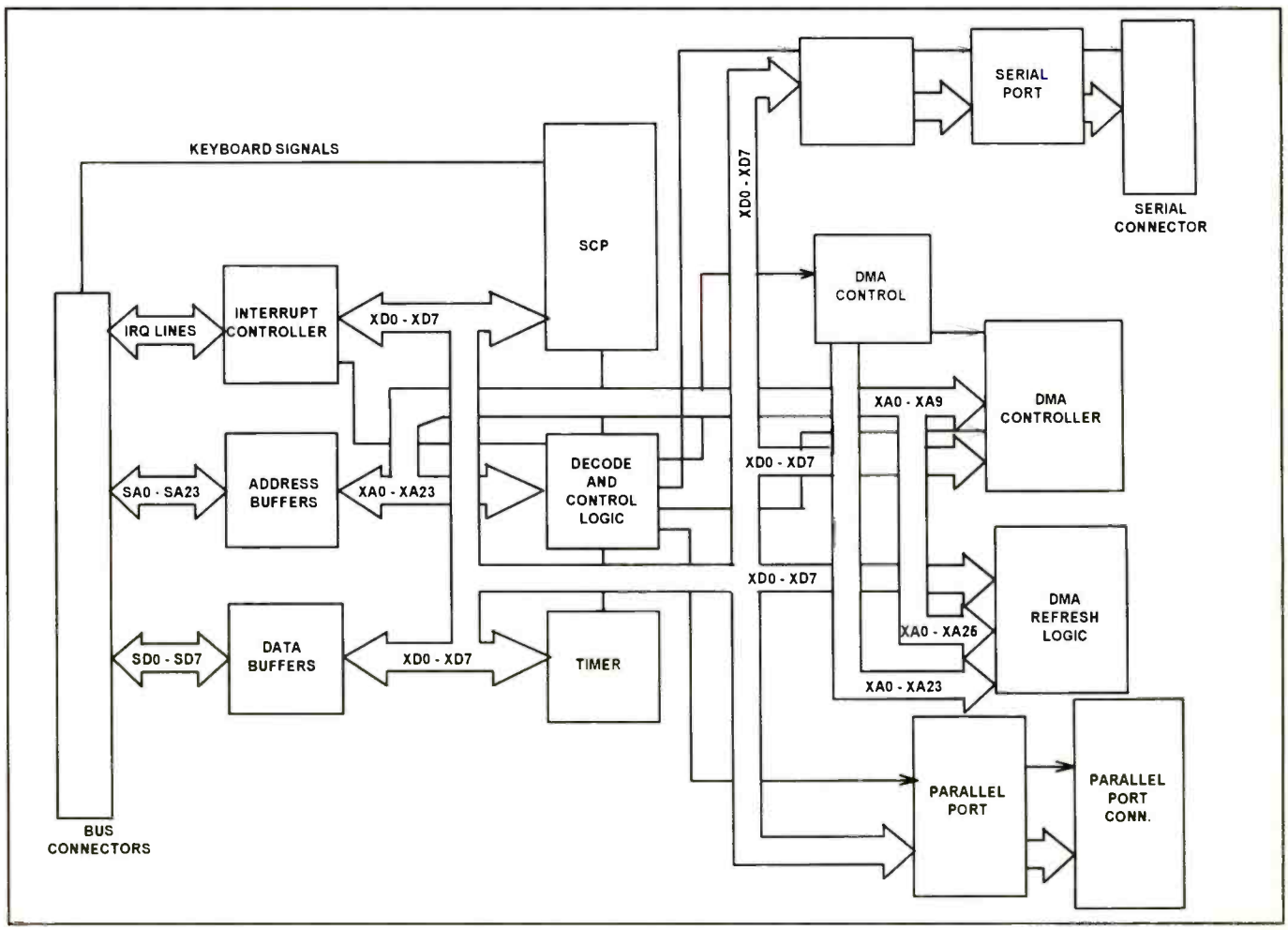

Figure 1. The upper left-hand corner of Figure 1 schematically shows the relationship between the interrupt controller, the IRQ lines, and the remainder of the system. The relationship between DMA control and the remainder of the system is shown as a schematic representation. The DMA circuitry is shown towards the right side of the figure. During direct memory addressing, the CPU is put into a hold state while the DMA controllers drive the address and control lines.

IRQ's

Adapters communicate with the central processing unit of the system through interrupt request lines. Interrupt requests are special signals that stop the current operation of the microprocessor. When a specific interrupt signal is received by the CPU, the microprocessor interrupts its routine and begins a special programmed routine. When the microprocessor completes this special program, it goes back to the prior task.

Peripheral devices attached to the microcomputer—such as scanners, modems, printers, and SCSI adapters—utilize interrupt request lines that are numbered from 0 through 15. If two adapters or devices generate interrupts at the same time, an Integrated Circuit called the *Interrupt Controller* determines which signal is processed first. While IRQ 0 usually receives the highest priority, non-maskable interrupts or NMI's have priority over all other interrupts.

The upper left-hand corner of Figure 1 shows schematically the relationship between the interrupt controller, the IRQ lines, and the remainder of the system. The interrupt controller prioritizes up to 15 incoming interrupt signals. When an interrupt input signal goes high, the interrupt controller resets and checks the interrupt register. If an interrupt is in progress, the controller waits until the current interrupt is completed before sending the next interrupt to the CPU. The CPU responds to the interrupt request with a signal on the interrupt acknowledge line after it completes its current instruction.

DMA channels

DMA channels allow the adapters and their accompanying software to communicate with the system memory. As an example, operator instructions may tell the CPU to read data from a hard disk drive and then store the data into the system memory. When the microprocessor needs to move the large blocks of data, another IC called the DMA controller takes control over the address and data buses. As the data transfer begins, the DMA controller tells the microprocessor to momentarily halt its current operation while the data transfer takes place through the DMA controller.

The use of DMA channels and the DMA controller speeds the data transfer and frees the CPU for other operations. Although serial and parallel ports do not utilize DMA channels, adapters such as network cards and tape backup interfaces often use DMA transfers. Each adapter can use the same DMA channel but only if the other device is not functioning. Two devices may share DMA channel 7, but not simultaneously.

Take another look at Figure 1. The relationship between DMA control and the remainder of the system is shown as a schematic representation. The DMA circuitry is shown toward the right side of the figure. During direct memory addressing, the CPU is put into a hold state while the DMA controllers drive the address and control lines.

Upper memory blocks

The upper memory block is the area between the top of the conventional memory or 640K and the bottom of the extended or expanded memory or 1,024K. The addresses of the upper memory block range from A0000 to F0000 and are reserved for various purposes. For example, the video adapter may use some, if not all of its allocated 128K of memory in this area. Other adapters may use segments of the upper memory blocks; a token ring network adapter will use 8K at address CC000 for ROM and 16K at address D8000 for RAM.

Uses of upper memory block segments cannot overlap. If two adapters are set to request the same segments, neither will work properly. If the modem and sound card installed by Joe request the same block segment, one will work only when the other is disabled. Some adapter cards have switches or jumpers that allow technicians to change the requested memory segments to different areas. Other adapter cards rely on driver software for such changes. Documentation for the adapters should specify the area of the upper memory block needed so that the adapter can function properly.

I/O addresses

The input/output address of a device is the physical location on the system's bus or RAM where intelligence that allows the adapter to function is located. Unlike memory addresses, the 1,024 I/O addresses are not designed for data storage. With the I/O addresses, the microprocessor can communicate directly with adapters and other attached peripheral devices. Each adapter or device has a unique, hexadecimal I/O address. Because of this, there is a chance that a conflict could occur. Examples of I/O addresses are 2F8 to 2FF for the serial port two or COM 2 and 3F8 to 3FF for COM 1.

Making a plan

What does all this mean for the technician? Here's an example: a modem may be assigned to a base address of 02F8 and use COM 3 while a mouse is assigned to a base address of 03F8 and uses COM 1. Both will use IRQ 4. Unfortunately, the interrupt controller cannot determine which signal should be processed first when the signals arrive on the same interrupt request line.

If the modem is accessed first, the mouse won't function correctly. If the mouse is used for a Windows application, the modem won't send or receive data. As you can readily see, the simple installation of an adapter card suddenly becomes more complex. Solving interrupt and device conflicts requires a logical process rather than the shotgun approach.

Start over

To consider that logical approach, let's go back to Joe's problem and see if we can find a solution. First, we should remove the just-installed internal modem and sound card from the system. This allows us to reset the system back to its original condition and provides a working base for our troubleshooting. As we remove the two devices, we can also check for disconnected cables or other adapters, such as a video card that may not be locked into place. The object of this step is to take the system back to its original condition; not to create more problems.

Check jumpers, switches

Second, we'll take a look at any switch or jumper settings that could affect the performance of the adapters. Check both the adapter and the system for the location of the switches and jumpers. Now, double-check your settings against the switch or jumper positions shown in the manuals that accompany both the system and the adapter. Usually, the manuals will show default settings for switches or

jumpers and will suggest settings for specific IRQ and address needs.

Often, because of poor print quality or poor graphics it is easy to misinterpret those settings. The default settings provide a reference point as you troubleshoot the problems. Sometimes though, those default settings shown by the manuals will not match the actual default settings of the adapter.

Document

For your third step, document which devices are installed or attached to the system. Set up a cross-reference form that lists the adapters or devices, the designated IRQ's, and the base addresses. List the slot number occupied by the adapter and, if possible, the DMA channel utilized by the adapter. Most manufacturers of IBM compatible computers and third-party card manufacturers include this type of information with their products, but some do not. If you encounter a problem and cannot find reference material, there are several references that contain information on many brands of boards, drives, controllers, network interface cards, I/O cards, etc.

Use diagnostics

Still unsure about the quality of information? Use diagnostic software to find which addresses are used or available. Microsoft includes the MSD or Microsoft Diagnostic Software with its MS-DOS operating systems for version six and above. Diagnostic software also provides easy access to those settings. Performing this type of inventory allows you to identify which adapters or devices are attempting to use the same IRQ lines, base addresses, or DMA channels.

Set jumpers, switches

Step four in this process is obvious. Using the manuals or the diagnostic software, find available IRQ, base memory addresses, and DMA channels and then set the adapter switches or jumpers to the new settings. Some adapter cards may not contain switches or jumpers. Instead, these adapters have settings that are encoded into IC's located on the card. Because of this, you may need to consider changing settings on other adapters.

Because of newer software technologies, this step may also require adjustments to several points that involve software configuration. Sometimes, the installation software that accompanies an adapter will add lines to the CONFIG.SYS file, which resides in the root directory of MS-DOS. The CONFIG.SYS file is a text file that lists a series of commands that allow a user to configure the system as needed. When the system starts, the CONFIG.SYS file controls how MS-DOS starts and configures the hardware components such as the memory, keyboard, and printer. See Figure 2 for an example of a typical CONFIG.SYS file.

Lines in the file refer to the device driver software that initializes the mouse, the SCSI controller card, and the external CD-ROM reader. Device driver commands in the CONFIG.SYS file install the driver into the system memory. As long as the system stays on the current CONFIG.SYS file, the driver works as part of the system software. The driver software sets the operating parameters for the attached devices.

AUTOEXEC.BAT

Like the CONFIG.SYS, the AUTOEXEC.BAT file is an unformatted text file and may be changed by using the line editor command that is available through MS-DOS or the Notepad software included with Windows. Versions 5 through 6.22 of MS-DOS utilize the EDIT command; older versions use the EDLIN command. To use the edit command, change to the DOS directory and type EDIT at the prompt (C:\DOS). The edit software is menu-driven and easy-to-use. Manuals that arrive with the MS-DOS operating software provide a complete set of instructions for using the edit command. Before editing the CONFIG.SYS file, screen print the original as a reference point. Re-booting the system will initialize the newly-changed CONFIG.SYS file.

The AUTOEXEC.BAT file is a simple batch program that MS-DOS runs immediately after following the commands listed in the CONFIG.SYS FILE. An example of an AUTOEXEC.BAT file is shown in Figure 3.

INI files

In addition to the CONFIG.SYS file and AUTOEXEC.BAT file, installation software often modifies the SYSTEM.INI and WIN.INI files that reside in the Windows directory. Both files initialize the Microsoft Windows software and list settings that customize that software for specific hardware applications. As with the CONFIG.SYS file, the SYSTEM.INI and WIN.INI files may be edited through the edit command. As before, screen print the original as a reference point. Errors in either the CONFIG.SYS or the SYSTEM.INI file may cause the system to lock during its initialization process.

Along with considering those important DOS files, also remember to check the version and type of the driver software that arrives with the card or peripheral device. Some lower versions of device driver software may not work with the intended card or device. When a mismatch of this type occurs, an error message that says something like "device not recognized" may appear on the screen. Most manufacturers offer bulletin board services with listings of device drivers and device driver definitions. Technicians can download those files from the manufacturer server computer through a modem.

Try again

Now that you've changed the jumper or switch settings and have configured the system software, reinstall the adapter into its slot and test its performance. The testing of performance should include not only the adapter but all parts of the computer system. Many technicians will conclude that the problem is resolved and then later find that they've created new ones. If the first adapter or other adapters fail to operate, look for other available IRQ, memory address, or DMA channel settings. As mentioned, solving the problem may require changes to other already-installed adapters.

Occasionally, the only option is removing other adapters and attempting to modify those IRQ, memory address, and DMA channel requirements. This option also means that you would need to go back to the starting point of our procedures. Briefly, that involves:

- Removing the adapter and resetting the system to its original settings.
- Verifying the settings on the adapter selected for modification along with checking adapter and system manuals.
- Making a list of installed adapters and devices and checking for possible conflicting demands on system resources.

```
DEVICE=C:\DOS\HIMEM.SYS
DEVICE=C:\DOS\EMM386.EXE NOEMS
FILES=30
BUFFERS=30
DEVICE=C:\DEVICE\SMARTDRV.EXE
DEVICE=C:\MOUSE\MOUSE.SYS
DEVICEHIGH=C:\PIONEER\SCSI.SYS /D:
LASTDRIVE=Z
DOS=HIGH,UMB
```

Figure 2. CONFIG.SYS file is a text file that lists a series of commands that allow a user to configure the system as needed. When the system starts, the CONFIG.SYS file controls how MS-DOS starts and configures the hardware components such as the memory, keyboard, and printer. This is an example of a typical CONFIG.SYS file.

```
TIME
DATE
PATH=C:\;C:\DOS;C:\WINDOWS;C:\PIONEER
PROMPT $P$G
DOSKEY
SMARTDRV
WIN
```

Figure 3. The AUTOEXEC.BAT file, an example of which is shown here, is a simple batch program that MS-DOS runs immediately after following the commands listed in the CONFIG.SYS FILE.

After finding available resources, change the selected adapter so that it uses those resources that are available.

• Reinstall the selected adapter and check the performance of all of the adapters or attached devices.

Following this procedure should allow you to solve most problems encountered when installing new adapters into a microcomputer system. There is, however, a small portion of adapter installations that will fall outside of these procedures. Working with these cases may require some phone calls to the technical support teams that support the individual adapters or devices. As you prepare to talk with support personnel, remember to keep a printout of the original CONFIG.SYS and AUTOEXEC.BAT files handy. Also, check for any model or serial numbers that may be silk-screened onto the adapter card. Record both the default settings and the modified settings for use during your conversations with technical support.

Some recommended books

Aside from the technical reference manuals, several books are also excellent sources of information for technicians working with microcomputer upgrades. Scott Mueller's "Upgrading and Repairing PC's" (published by the QUE Corporation) provides charts and information that cover IRQ's, DMA's, and I/O addresses. In addition, Mueller's text lists phone numbers and addresses for a large number of system and adapter manufacturers.

For beginning technicians, an older text in the Howard W. Sams library, "Microcomputer Troubleshooting and Repair" by John Stephenson and Bob Cahill, provides easy-to-interpret information about microcomputer systems.

Two new texts from WEKA Publishing, "How to Repair and Upgrade Computers and Peripherals" and "How to Maximize Your PC" also provide up-to-date reference charts about adapter cards, DMA channel requirements, I/O port addresses, and hardware interrupts. ■

Servicing TV horizontal foldover problems

By Homer L. Davidson

Horizontal foldover problems in TV sets are not as common as vertical foldover, but when it occurs you must be able to recognize the symptoms and know the possible defective components. Horizontal foldover can be caused by a defective damper diode, safety or hold down capacitors in the horizontal output collector circuits or capacitors in pincushion transformer circuits (Figure 1). Horizontal foldover often occurs at the extreme right side of the TV raster.

When you encounter a set that has horizontal foldover, inspect the horizontal output circuits. A leaky horizontal output transistor, trace or retrace SCR, or a leaky flyback can cause some form of foldover. Open bypass capacitors in the high voltage regulator or SCR horizontal circuits can cause some type of horizontal linearity problem, or foldover. Defective safety capacitors in the horizontal output circuits produce foldover. Open or poor soldered terminals of reactors and regulation transformers can cause horizontal foldover (Figure 2).

Figure 1. Horizontal foldover in the TV chassis may occur on the right hand side and center of the TV picture or raster.

Defective safety capacitors

Safety capacitors in the horizontal output circuits can cause horizontal foldover and poor linearity. I have seen cases in which the horizontal output transformer is replaced but the foldover problem persists. Often when safety or hold down capacitors become open or change value the high voltage at the picture tube will increase. If one of the safety capacitors in series with another capacitor becomes open, the voltage may increase accompanied by horizontal foldover.

A change in the value of the safety capacitor can result in improper horizontal linearity and foldover, accompanied by incorrect HV at the picture tube (HV may be either too high or too low). A leaky safety capacitor may damage the horizontal transistor, and/or blow line and secondary fuses.

Replace safety capacitors with the manufacturer's original part number or an exact universal replacement. When original ones are not available, replace with 2KV voltage rating safety capacitors. Remember the safety capacitor is a critical safety component.

Check carefully for burned resistors and shorted turns of windings in pincushion transformers when horizontal

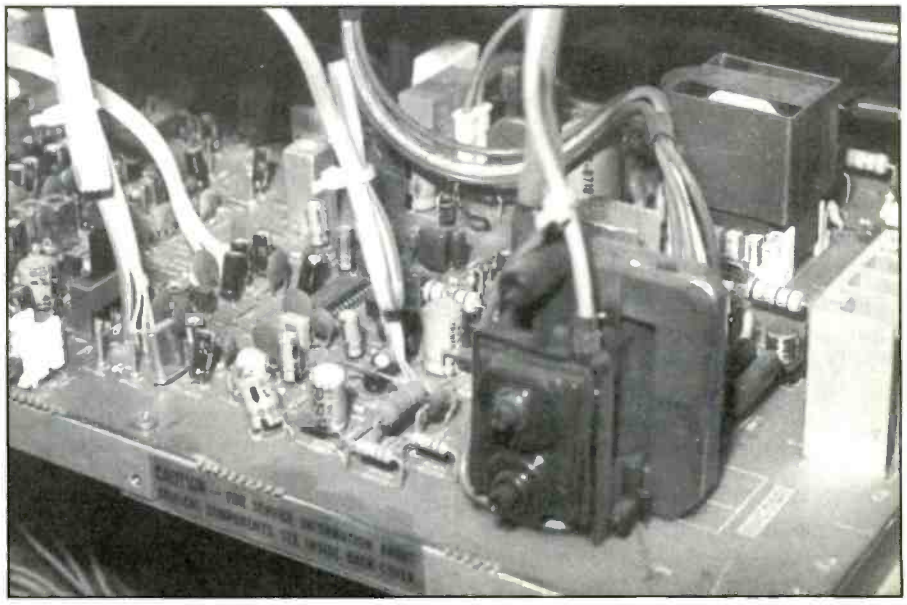

Figure 2. Check the pincushion and regulator transformer for poor terminal connections when the symptom is vertical foldover.

Davidson is a TV servicing consultant for ES&T.

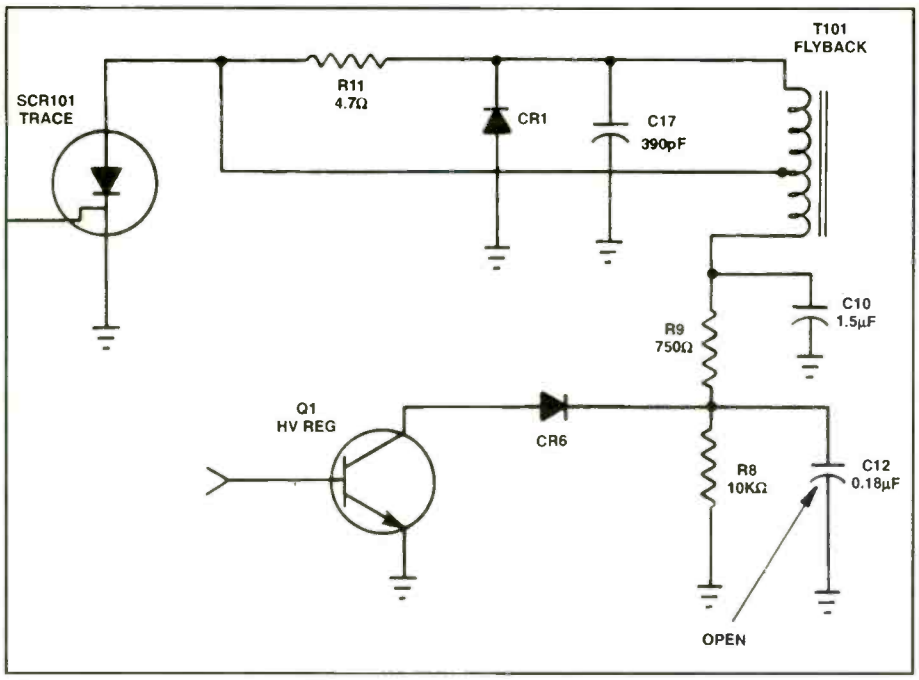

Figure 3. Capacitor C12 (0.18µF) bypass capacitor in the high voltage and flyback circuits of the RCA CTC44A chassis can produce horizontal foldover.

foldover is caused by problems in the pincushion circuits.

Foldover problems in older sets

If you encounter foldover problems in older TV chassis that have trace and retrace SCR's, suspect a leaky SCR, open gate input coil, or bypass capacitors. Check all bypass and coupling capacitors in the SCR horizontal output. Use a capacitance meter to try to locate the defective capacitor, or shunt each capacitor with a known-good capacitor until the problem is corrected. The capacitor you

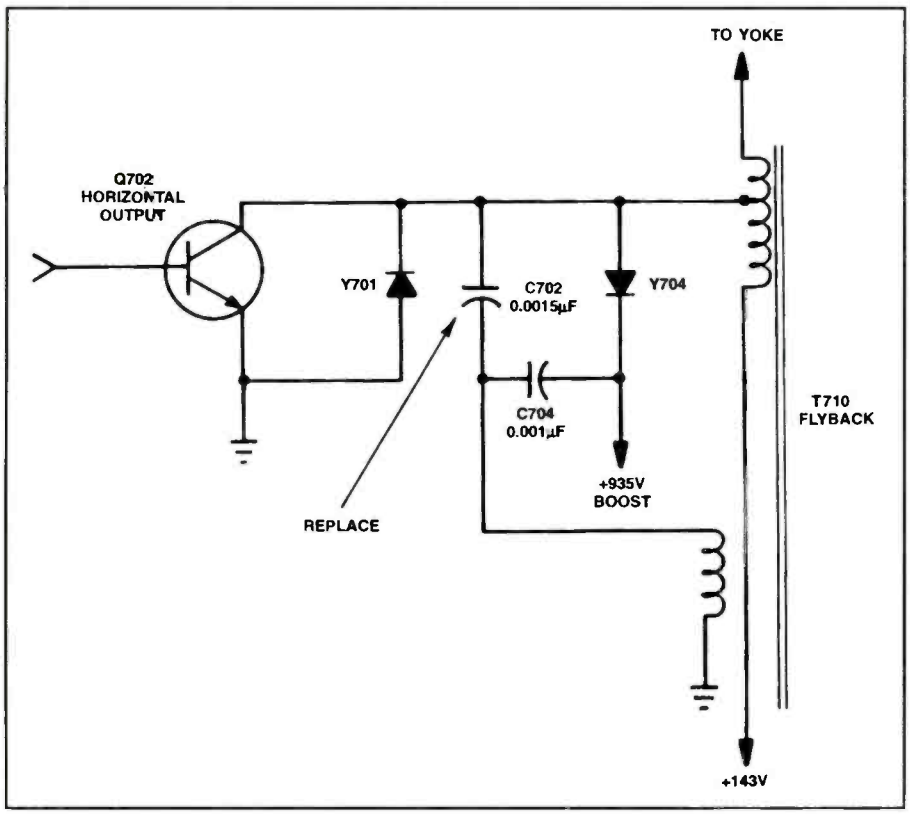

Figure 4. Capacitor C702 in a General Electric YME chassis was the cause of foldover.

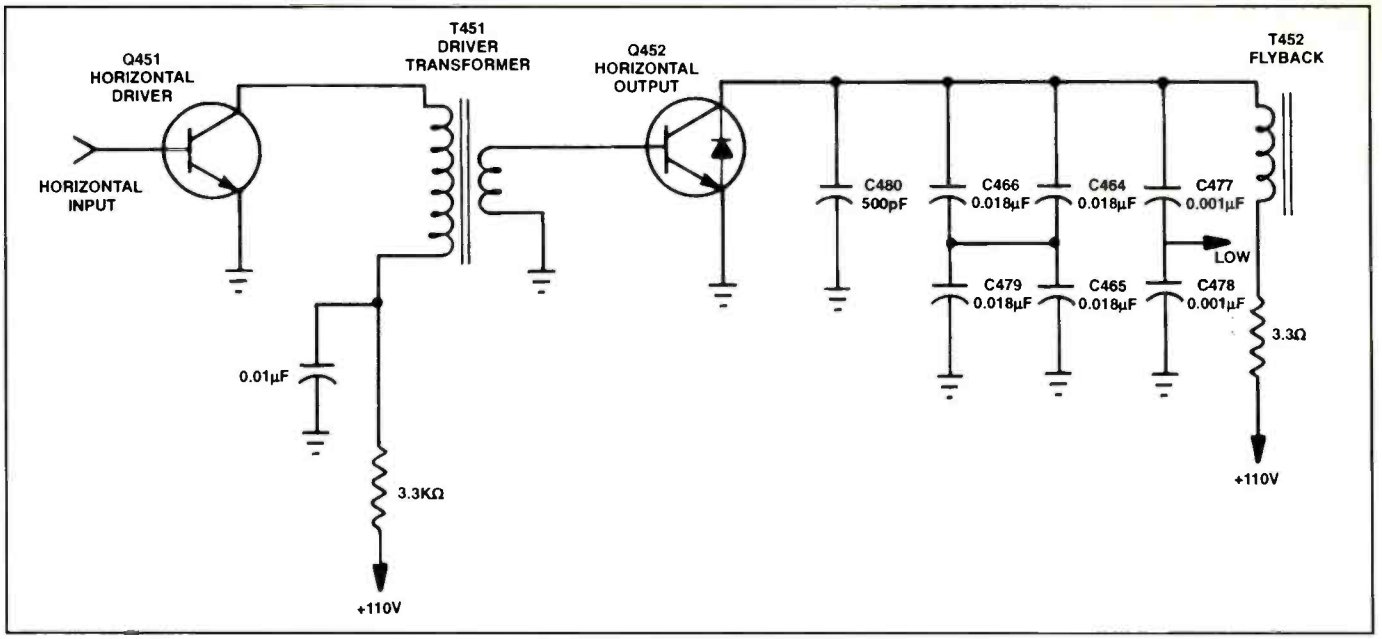

Figure 5. Check all capacitors in the collector output circuits of Q452 when the problem is poor linearity and foldover problems.

shunted when the problem disappeared is the bad one; replace it.

Check each capacitor for open or leaky conditions. In one RCA CTC44 chassis, I found C12 (0.18µF) open to chassis ground (Figure 3). You ordinarily expect bypass capacitors to become leaky. They seldom open. It is best to replace these odd capacitors with the exact part number.

Intermittent conditions were noted in an early RCA CTC74 chassis with the sides pulled inward, and horizontal foldover in the center of the picture. A common cause of this symptom was a blown fusible resistor RF401. I replaced the horizontal oscillator but the problem remained. After several other corrective steps were taken with no improvement, I replaced the C507 (0.18µF) bypass capacitor. The foldover problem disappeared. Another possible cause of horizontal foldover in this set is poor input reactor transformer (T402) board connections.

General Electric YME chassis foldover

When the horizontal output circuit is unfamiliar it may take more time for the technician to troubleshoot a foldover problem. When the picture came on in a General Electric YME chassis, horizontal foldover at the right side occurred accompanied by a black area at the edge of the picture tube.

After checking the horizontal output transistor, the drive waveform and the supply voltage, I disconnected the yoke from the circuit. With the red-yellow lead disconnected, the raster was still folded over. Damper diode Y201 and boost diode Y704 tested normal.

When I checked safety capacitor C702 in the circuit, the 0.0015µF capacitor appeared open. When I tested it out of the circuit, however, it tested normal. C704 tested normal with one lead disconnected from the circuit.

The only other component in the circuit was the horizontal output transformer (T710). I presumed that it had to be the culprit. I ordered a replacement for T710 and installed it when it came in. Unfortunately, replacing T710 did not solve the foldover problem. The foldover was still there but now there was no black line at the side of the raster.

Because many foldover problems are caused by defective safety capacitors, I replaced C702 and C704. I replaced C702 with a 0.0015µF 1.5KV original replace-

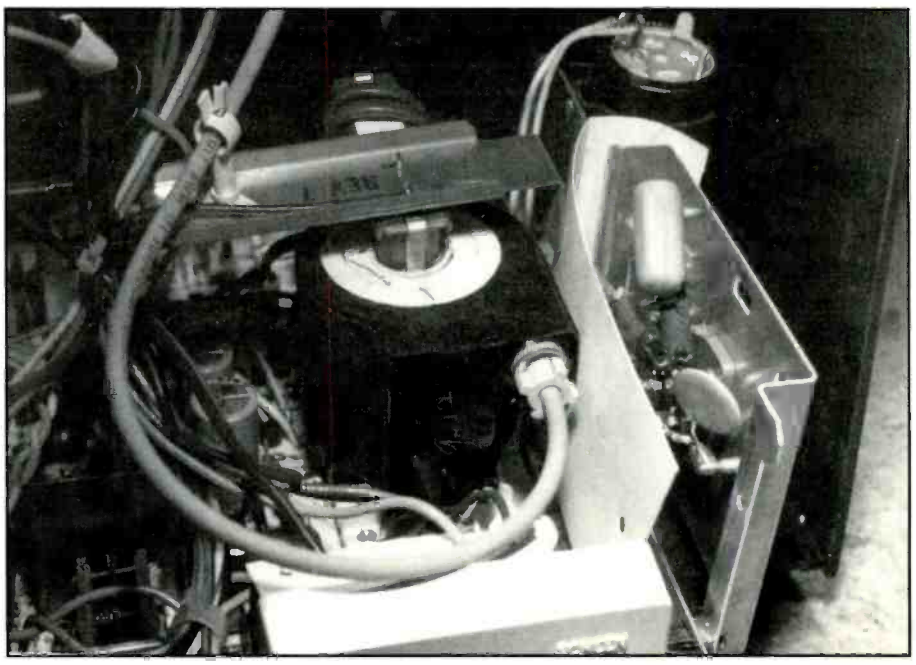

Figure 6. Make sure all components in the horizontal output circuits are normal before removing and replacing the output transformer.

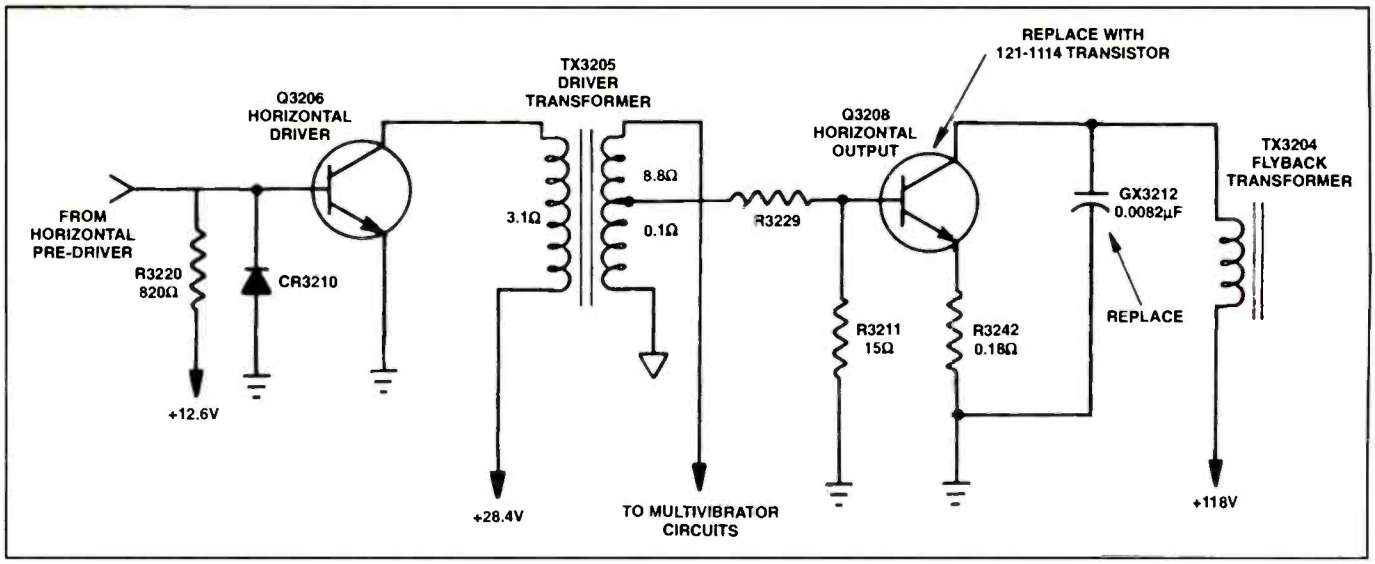

Figure 7. Replacing leaky Q3208, R3242, and GX3212 restored the dead set to life and corrected the horizontal foldover condition in this Zenith television set.

ment. Victory appeared in sight. When the chassis was fired up again, the foldover problem was eliminated. I have since found this safety capacitor to be the cause of foldover in many similar sets.

Foldover follows horizontal circuit problems

The main fuse in a Sanyo AVM255 TV set was blown. I replaced the fuse but it blew again as soon as power was applied. A voltage measurement at the main filter capacitor in the low-voltage power supply indicated leakage somewhere. I checked all silicon diodes and found them to be normal. The low-voltage source feeding the +110V source indicated an overloaded component.

A resistance check between the collector of horizontal output transistor (Q452) and the chassis ground showed a 0.17Ω short (Figure 5). A look at the schematic revealed that the damper diode was located in the same package with the horizontal output transistor. I removed Q452 from the heat sink and checked it with the DMM. This component was shorted between the emitter and collector terminals.

After replacing Q452 with a universal replacement, I plugged the set into a variable line transformer. I connected a voltmeter at the 3.3Ω isolation resistor to monitor low voltage to the horizontal output transistor. As I slowly raised the voltage to the set, I noted that the voltage at the flyback was lower than it should be and Q452 was beginning to run quite warm. I shut the set down in order to perform some other tests.

After checking the various components against the specified values on the schematic, I decided to advance the line voltage with the scope connected to the base of the horizontal driver transistor (Q451). The drive voltage at this point was low. This condition meant that either the horizontal oscillator drive waveform was missing or one of the components in the horizontal output circuits was leaky.

I checked all safety capacitors in the output circuit using in-circuit resistance tests. None of these capacitors were leaky. I disconnected the yoke lead from the flyback circuit but the situation didn't change. The primary winding of T452 seemed normal. However, because experience has shown that a defective flyback can be the reason for destruction of the horizontal output transistor, I ordered an exact manufacturer's replacement for the flyback (Figure 6).

After several weeks, the replacement flyback transformer arrived. I installed it, reconnected the yoke, and the high voltage came up, as did the raster and picture. Although replacement of the defective flyback solved the horizontal output problems, there was horizontal foldover at the right edge of the picture. No doubt

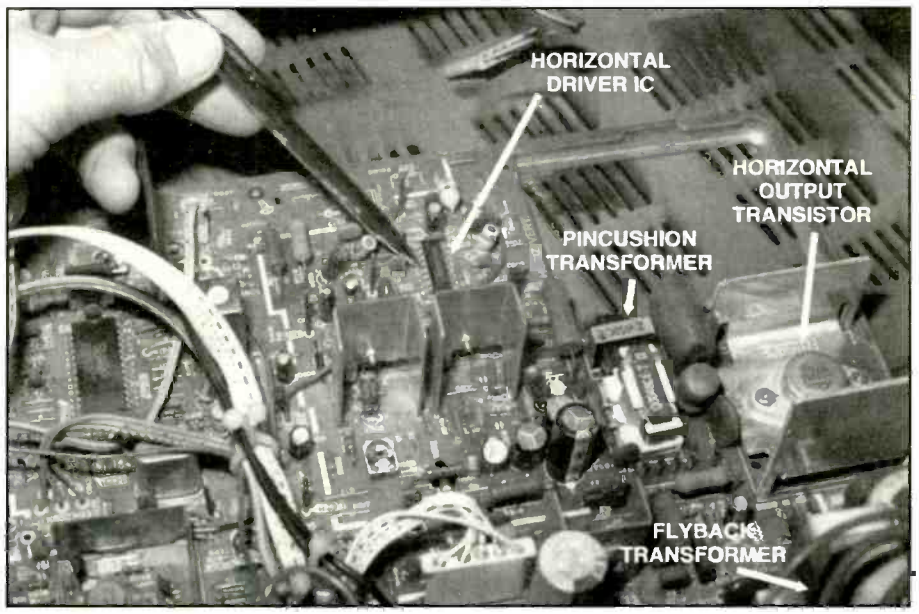

Figure 8. If you locate the flyback, horizontal output, and pincushion transformer, you will find the safety capacitors nearby.

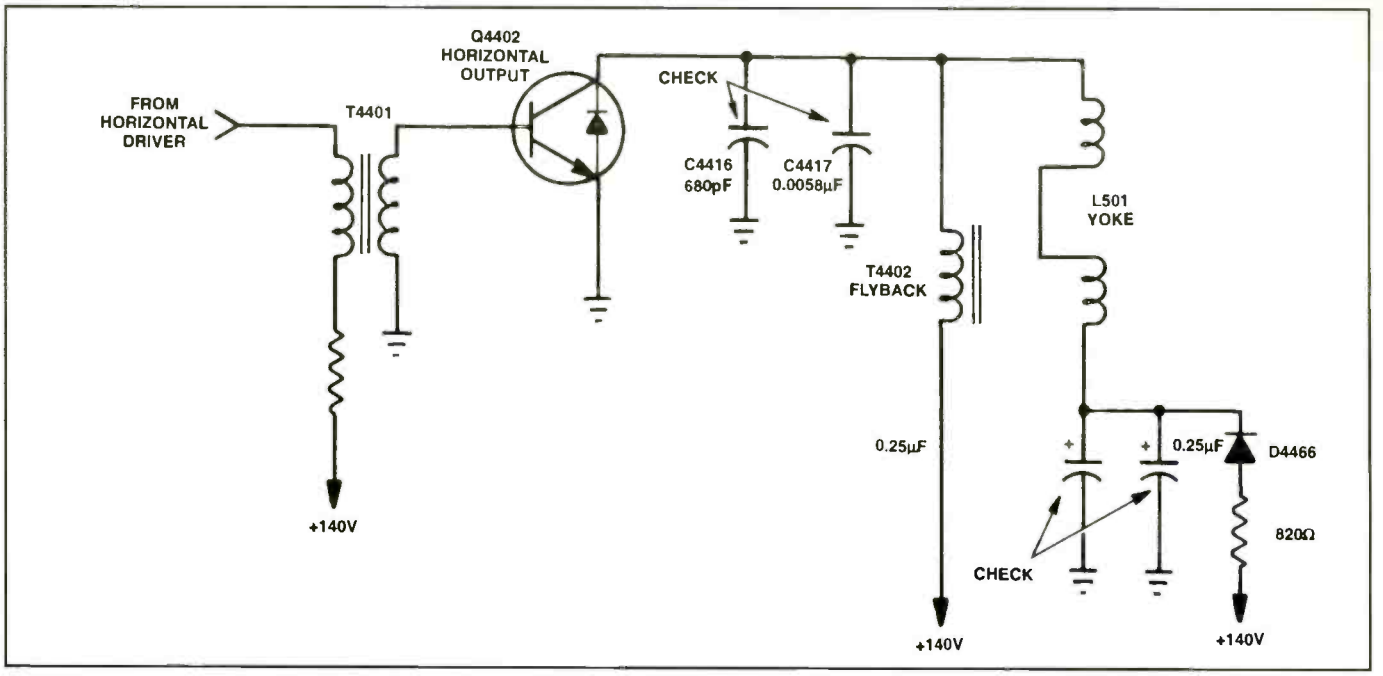

Figure 9. Horizontal foldover may remain after a shorted horizontal output transistor has been replaced with a good component.

one of the safety capacitors was defective.

I again checked each safety capacitor in the circuit. None of them appeared to be open or leaky. Possibly one of the capacitors was opening up under load. Since there were four safety capacitors, all of the same value, I decided to shunt each one with a 0.018µF 2KV safety capacitor. When I shunted C464 with another capacitor the foldover problem disappeared. I replaced both C464 and C465, finalizing the solution to the horizontal foldover.

Dead Zenith SA-1927W chassis

The chassis of a Zenith SA-1927 TV set was completely dead. The main fuse was blown and there was no +118V supply from the low voltage power supply. A resistance measurement from the collector (metal) to common ground indicated a leaky output transistor (Q3208) or damper diode. I removed Q3208 from the heat sink and checked it with the ohmmeter. It was shorted (Figure 7).

Transistor Q3208 can be replaced with the original 121-1114 part number or a universal RCA SK9119 output transistor. After I replaced the transistor and again applied power to the set there was a motorboating sound from the speaker. I again checked Q3208 and Q3206 in the circuit and they tested good. Resistance tests at the base and emitter terminals of the horizontal output transistor revealed that emitter resistor R3242 (0.18Ω) was open. No doubt when the output of the transistor shorted, the excessive current destroyed R3242.

With both Q3208 and R3242 replaced I plugged the set into a variable isolation transformer and connected the scope to the base of Q3208. I slowly raised the line voltage until the set produced a raster and picture. At the right side of the picture a slight foldover and a drive line was found. At first I suspected the flyback since the output transistor had been shorted. I checked all parts in the horizontal output circuits. They appeared normal.

Because I know that safety capacitors can cause foldover problems and an increase in HV, I replaced capacitor CX-3212 (.0082µF 1.8KV). When I again applied power to the set, a small foldover line near the edge of the picture remained. I replaced Q3208 with another universal replacement, but the horizontal foldover problem remained.

I picked up a replacement for the horizontal output transistor (121-1114) from a local Zenith dealer, and installed it. This time when I applied power the picture returned to normal. This Zenith chassis was restored to normal when the defective horizontal output transmitter was replaced with an exact manufacturer's replacement component, a new 0.18Ω resistor and 0.0082µF safety capacitor. In some cases there is no substitute for an exact manufacturers replacement component.

Poor horizontal linearity with foldover

Whenever you encounter a set with poor horizontal linearity accompanied by foldover, try to locate the horizontal output transistor and flyback transformer. (Figure 8). You should be able to locate safety capacitors nearby. Often safety capacitors, in this case, C446 and C447, can also cause excessive high voltage and horizontal foldover. Electrolytic and bypass capacitors in the yoke circuits can cause poor horizontal linearity and horizontal foldover problems.

If the symptom is horizontal foldover and a safety capacitor appears to be open, put a known-good capacitor in parallel with the suspect capacitor to see if that corrects the problem. Clip or tack in bypass and electrolytic capacitors in parallel with suspected capacitors in the yoke and horizontal circuits if the symptom is vertical lines and poor horizontal linearity. Disconnect one end of the safety capacitor to test it for leakage, and measure its capacitance. Often, a leaky capacitor in the B+ voltage circuits of the horizontal output transistor, yoke, and flyback circuits may cause the line and secondary fuses to open (Figure 9). Sometimes the horizontal output transistor may be damaged with a shorted or leaky capacitor in the output circuits. Remember, horizontal foldover may remain after you replace a leaky horizontal output transistor. ■

Constructing a pencil probe

By Roger D. Redden

Sometimes, making a simple connection is an exercise in frustration. Does this sound familiar? You want to make a connection to a component lead, but it is surrounded by a badland of other components that prevent your fingers from operating a typical grabber device. Or, you can get to it, but the lead is flat against the board, and the hook of the grabber won't slip under it.

If you've fought these villains, then build this trusty probe to defeat them both. The long barrel allows access to recessed areas, and the pincher jaws will grasp a lead lying flat against a circuit board. As a final bonus, if you have the needed items on hand, which is very possible, it's really inexpensive to construct.

The lower drawing of Figure 1 shows the completed probe and should give you an idea of how it's used. When you press the eraser, the pincher jaws extend and open so they can straddle the component lead, and when the eraser is released, the jaws clamp on the lead. I'm confident you can envision how this probe can make your connection easier.

Redden is owner and operator of a consumer electronics service center.

Material and costs

Undoubtedly, you've surmised that this probe is made from a pencil. Specifically, it's a Bic, nonrefillable, mechanical pencil containing three 0.7mm leads. The upper drawing of Figure 1 depicts the pencil, which usually has a black body while the clip and eraser holder is of a contrasting color. This is the common pencil substitute usually sold in a bag containing 5 or 10 of them. The bag usually costs about $1 to $3 and is available in most places where school supplies are sold.

The primary item needed to make the pencil a probe is the springwire used to make the jaws, or pinchers, of the probe. The source of this springwire is a pigtail adapter for a 1/4 inch fuse, sometimes called a springtail fuse holder, or a springwire clip. Figure 2B is a drawing of one. Two of these clips allow a pigtail fuse to be replaced with a plug-in type fuse.

This item is still found in may service centers. If you have one lying around, you can figure it probably cost you about $.35. If you don't have one, you might be able to get a single one from another service center, If you have to buy a package of 12, it may cost you $5 or $6. Cheaper by the dozen can be a drawback when you need just one. As you can see, the total cost of materials can vary from under $1 if you have these items on hand, to over $9 if you don't.

You'll also need about a foot of stranded, insulated, hookup wire of about #20 or #22 size, one inch of 1/4 inch heat shrink tubing or spaghetti, masking or other tape, a drop of superglue gel or other glue for plastic, and 13/32 inch length of #2 desoldering braid.

For tools, you'll need a sharp utility knife or razor, a drill, a drill bit slightly larger than the outside diameter (OD) of the insulated wire you use (I used a 5/64 inch bit), needlenosed pliers, wirecutters, a small jeweler's screwdriver, a ruler or

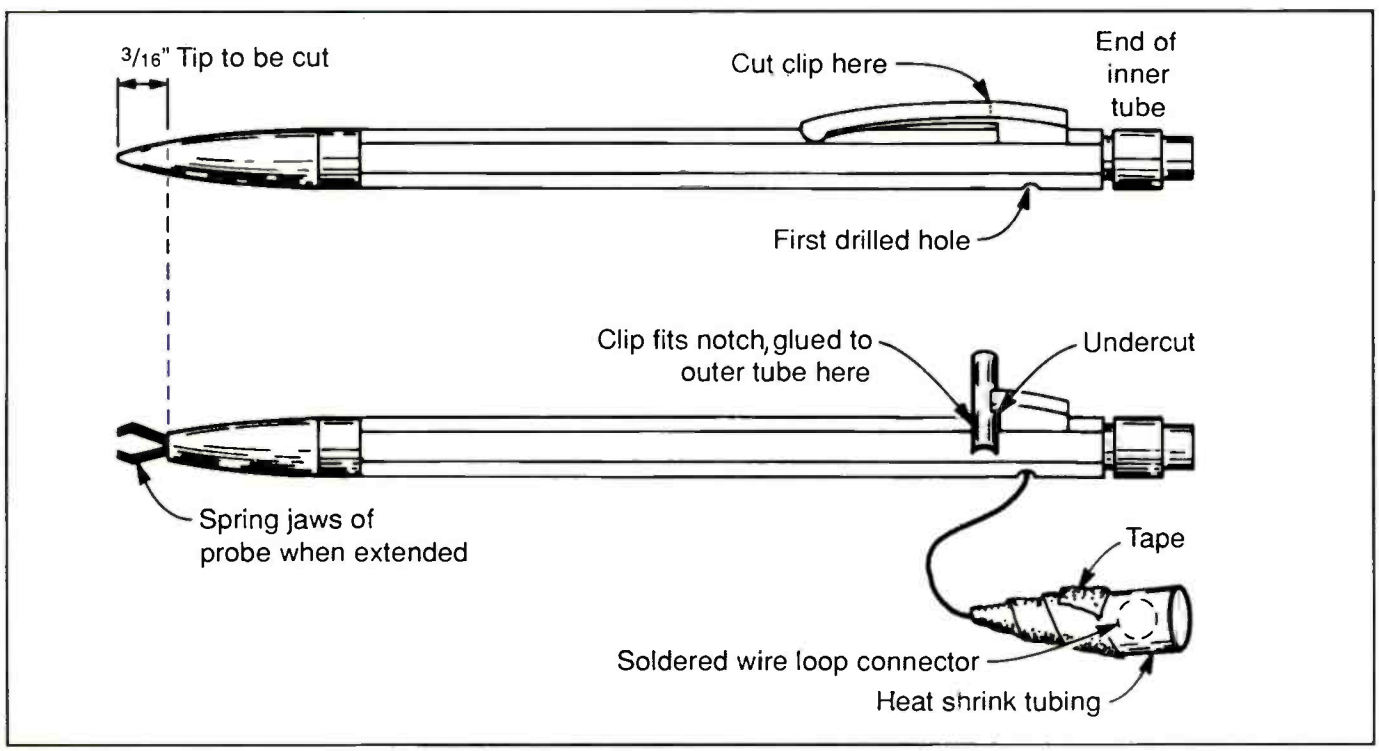

Figure 1. The upper drawing shows the mechanical pencil before it is altered, and the lower drawing shows the completed probe with the jaws extended.

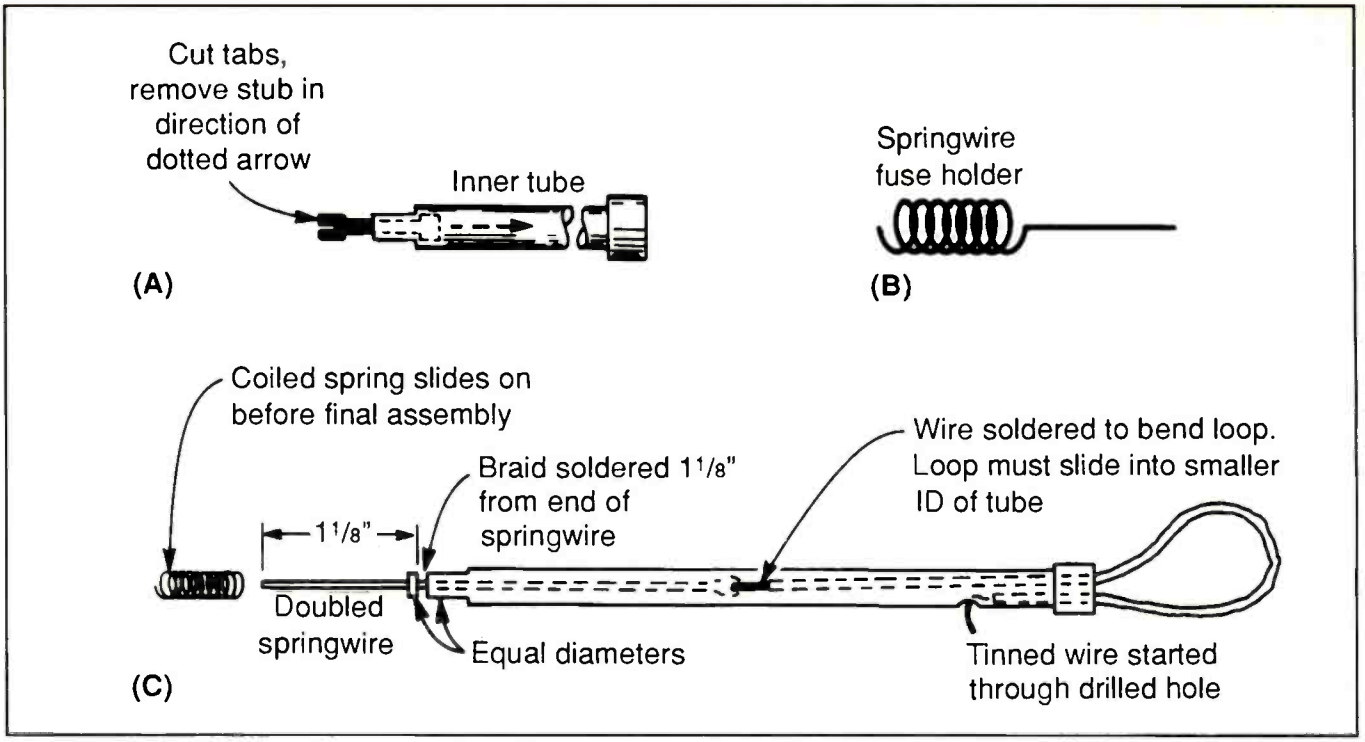

Figure 2. A. After the inner tube is withdrawn from the pencil, the tabs are cut and the stub removed. B, is a drawing of a springwire fuseholder. In C, the springwire assembly is slid into the inner tube until the braid touches the tube's end. The tinned end of the hookup wire is pushed through the drilled hole.

other scale with 1/32 inch divisions, and a file (optional). It takes about one hour to build the probe.

Preparing the springwire

From now on, I'll refer to the springwire fuse holder as the springwire. The first step in building the probe is to unroll the spiral part of the springwire. The easiest way I've found to do this, is to hold the straight part of the springwire with one hand, and, in the other hand, use the needlenosed pliers to repeatedly grasp and unroll the spiral. When the spiral is unrolled, leave the 90 degree bend at the end of the straight section so the springwire is in an L shape. This bend will help you prevent the wire from revolving while you continue to straighten the unwound spiral.

The springwire must be relatively straight. Use the pliers to overbend it slightly about every 1/4 inch along its length to compensate for its spring action. Clamp it in the pliers to help remove small kinks and use your fingers to straighten longer curves. You can combine these and any other methods intended. I usually spend about ten minutes on it before I'm satisfied. When the former spiral seems straight enough, straighten the 90 degree angle as well.

Shaping the springwire

Having done all of this straightening, it's time to bend the springwire again. Fold it in the middle so the result is similar in shape to a cotter pin, or a bobby pin. Figure 2C shows (partly inside the inner tube) the desired shape. For clarity in the drawing, the two sides of the springwire are shown slightly separated, but it's better if they touch, except for the loop where the wire is soldered.

After the springwire is bent in the middle, the two ends will cross each other and have to be corrected by overbending in the opposite direction to get the right shape. Hold the back of the bend in the pliers to prevent twisting while you bend the sides. It requires patience and persistence, and you probably can't prevent minor crossing or separating of the ends, but this can be partly corrected later as the braid is soldered on, and the correction completed afterwards.

Don't worry if the two sides of the springwire are not exactly the same length; the ends will be cut later. Bend and adjust the two sides of the springwire as needed so that they lie closely parallel. The small loop formed by the bend should be large enough for the hookup wire to go through, but small enough, about 3/32 inches, to slide into the small end of the inner tube. Now, set the springwire aside temporarily while you begin to work on the pencil.

Getting the lead out

The lead needs to be removed from the pencil. Doing lots of writing with the pencil is the thrifty way to empty it. But if you just want to get the lead out—and fast—here's how:

- Remove the eraser, which must be done anyway, by pulling, rocking, and twisting it while holding the socket it sits in. Don't lose the eraser. Turn the pencil tip up, and the lead will fall out.
- Push the eraser socket a few times to start the last lead out of the tip of the pencil. Press the socket and hold it, and the third lead can now easily be pulled out of the tip of the pencil.

Drilling for the wire exit

You need to drill a hole through both the outer and inner tubes of the pencil, opposite the middle of the clip as shown at the top of Figure 1. Use a drill bit slightly larger than the OD of your hookup wire. Twisting the point of the utility knife on the spot the hole will be drilled can help start the bit in the right place. Stop drilling when the drill reaches the hollow space of the inner tube, and remove the drill bit.

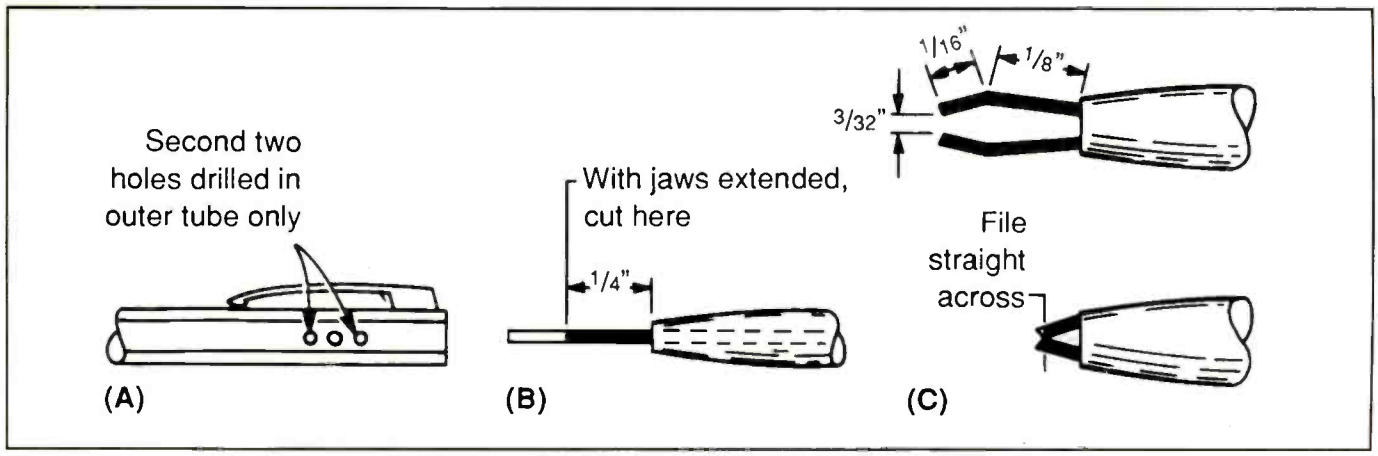

Figure 3. A. A rectangular slot is formed in the outer tube by drilling two additional holes and trimming away the remnants. In B, the ends of the extended springwire are cut 1/4 inch from the end of the outer tube. C. Bend the jaws as shown in the upper drawing. The jaws should close before entering the barrel of the pencil as shown in the lower drawing. Both drawings are about 3 times the actual size.

Press the eraser socket a couple of times to break loose any drilling chips lodged between the tubes, and allow them to fall out the open end of the tube.

Separating and preparing the tubes

Removing the inner tube from the outer tube, or barrel of the pencil requires little force. Hold the barrel in one hand and pull straight out on the eraser socket with the other hand (a quick, but controlled jerk helps). When the tubes separate and you pull the inner one out, be sure to save the coiled spring at the end.

After you remove the coiled spring, you'll find two plastic tabs. Cut these tabs just below where they come together, as shown in Figure 2A. Press the protruding end of the stub against the bench until it breaks loose and recedes into the tube, and then use the jeweler's screwdriver to press it farther into the tube. Tap the back of the tube on the bench so the stub falls out, and lay the tube aside.

The outer tube needs a rectangular slot just behind the mounting shoulder of the clip. My method was to drill two more holes, one on each side of the one already drilled, and cut out the remnants with a sharp utility knife. The slot should be the same approximate length as the shoulder of the clip, and as wide as the diameter of the drilled hole, as shown in Figure 3A.

Next, cut off the end of the outer tube 3/16 inches from the tip, as shown in the upper part of Figure 1. A good way to keep the cut the same distance from the tip all of the way around the tube is to lay the side of the pencil tip against the bench and spin it slowly while holding the utility knife in one place.The cut will probably leave burrs or a plastic lip inside the tube. Remove this with the jeweler's screwdriver or, being careful not to cut the barrel, with the tip of the utility knife.

Now cut the clip of the pencil about 1/16 inches before the front of the mounting shoulder as shown in the upper part of Figure 1. Smooth the sharp corners of the cut ends. Undercut the shoulder overhang so the clip will fit under it as shown in the lower part of Figure 1. Glue the middle of the clip to the barrel of the tube as shown. Hanging two fingers over this crossbar makes it easier to squeeze the eraser when using the probe. Lay the outer tube aside for now.

Completing the springwire assembly

For the steps in this section, refer to Figure 2C. Strip 1/4 inch of insulation off one end of the hookup wire and solder it to the loop of the springwire. Strip 1/2 inch of insulation from the other end of the hookup wire and tin the bare wire.

Roll the 13/32 inch length of desoldering braid between your fingers to round it, then wrap it around the springwire leads about 1-1/8 inches from their ends, as shown. After it's in place, use needlenosed pliers to flatten it into the approximate shape of a washer or thin doughnut. The desired result is to have the thin doughnut of braid the same diameter as the end of the inner tube, allowing for some slight swelling caused by filling it with solder.

Check that the braid is 1-1/8 inches from the shortest end of the springwire, then align the two springwire sides so they are as parallel and as close fitting as possible, holding them in the needlenosed pliers, which are placed on the side of the braid that gives the best results. This is the partial correction referred to earlier for the problem of the springwire ends crossing over each other.

With the soldering iron lying on the bench, touch the braid to the iron and supply just enough solder to fill the braid and make a good connection to the springwire. Excess solder could cause a bulge that would prevent proper sliding action between the two tubes.

After soldering, do any further needed aligning (final corrections) to the ends of the springwire extending past the braid. Insert the hookup wire into the small end of the inner tube and push it out the eraser holder end, continuing until the braid doughnut is flush against the small end of the tube. Form a loose loop in the hookup wire, bend a gentle curve in the tinned end, and using the jeweler's screwdriver if needed, start the tip out of the drilled hole as shown.

Final assembly

To reassemble the two tubes, place the coiled spring over the springwire ends, and begin sliding the inner tube into the outer tube. When the tinned wire protruding through the side of the inner tube reaches the rim of the outer tube, make sure it's aligned with the slot in the outer tube. Press the tinned wire back into the inner tube just enough to allow the inner tube to slip into the outer tube.

Press the eraser holder with enough pressure that the drilled hole in the inner tube is visible in the slot of the outer tube. Work the tip of the hookup wire out through the slot, using the jeweler's

screwdriver and needlenosed pliers if needed, and pull the wire out through the slot. Continue to pull the wire through the slot until the loop goes inside the inner tube and just clears the bottom of the eraser holder socket. Reinstall the eraser by twisting it back into the holder.

The wire exiting through the slot prevents the inner tube from falling out when it's released. If everything is working correctly so far, pressing the eraser holder should cause the inner tube to move forward about 1/4 inch, and it should spring back when you release the holder.

Forming the jaws

Now that the probe is assembled, it's time to partially cut, break, and bend the springwire to make the jaws. There are two reasons for only partially cutting the springwire. First, the brittle wire flies when cut, and could cause eye injury. Because of this, you should wear safety glasses in case you inadvertently cut through the wire. Second, the pressure required to cut through the springwire could damage the edge of precision cutters.

So that you won't need three hands, set the rear of the eraser on the top of the bench and press down on the outer tube, or barrel, so that the springwire is fully extended. Measure 1/4 inch from the cut end of the outer tube and clamp the jaws of the sidecutters across both springwire ends at that point. Squeeze the cutters until the springwire end closest to the cutters' pivot pin is cut about halfway through (1/4 through on the front and back sides).

Release the cutters and rotate the pencil 180 degrees so the other springwire is next to the cutters' pivot pin and repeat the partial cut. Using the pliers, bend each end of the springwires back and forth at the partial cut, about 30 degrees from its straight line, until it breaks off.

With the springwire fully extended, bend the jaws as shown in the upper drawing of Figure 3C. First bend the two sides of the springwire out so the tips are about 3/16 inches apart. Then, about 1/16 inches back from the tips, and making the bends as identical as possible, bend the ends back toward the center. The tips should now be open about 3/32 inches. As the eraser is released, the inner corners of the jaws should come together shortly before going inside the barrel, as in the lower drawing of Figure 3C. When the jaws are bent correctly, the friction from the mouth of the barrel will cause the jaws to slow before going inside the barrel, possibly with a slight snapping action. Some trial and error adjustments may be required to get it right.

An optional improvement to the jaws is to flatten the tips by filing straight across them, this allows the pinching inner part of the tips to approach closer to a circuit board. For the filing, extend the jaws about 1/16 inches with the tips still together, and use light strokes of the file to avoid misaligning the jaws. Stop filing when about half of the outer tips are removed, as shown in the lower part of 3C.

Connecting to the hookup wire

Numerous ways can be devised to connect to the probe's hookup wire, such as adding a small alligator clip, or making a permanent soldered connection to a test equipment lead. I chose to use a simple insulated loop which can be clamped in the hook of a scope probe or the jaws of a small alligator clip. Many DMM test probes have an alligator clip adapter which will clamp to this loop. Clamping one alligator clip from a jumper lead to the probe can give a different and useful jumper. Depending on your needs, you may want to shorten the hookup wire before doing this step.

As shown in the lower part of Figure 1, the loop is just a small circle made of the hookup wire soldered to itself, then enclosed in an inch long piece of heat shrink tubing or spaghetti, which is then taped to the insulation of the wire.

A pinch of caution

Certainly this probe will not solve all of your connection problems. It's ineffective at clamping to short leads protruding from the bottom of a circuit board. And though I've noticed no effect on waveforms at video frequencies, it's only reasonable that higher frequency waveforms would be degraded. Also, there's no shielding to prevent pickup of strong unwanted signals. Other potential shortcomings are possible. But, since I've made this probe, few items to be tested have made it through my shop without feeling the nip of its little pinchers. ■

Photofacts

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FVH-960 . . . . . VCR-268
PC-3013 3548

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GCT 2505M 3541
NC-44A 3541

JVC
AV-31BM5 3549

MITSUBISHI
CS-27200A 3547
CS-27200 3547
XM-0 3547

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AEDP212 3539
ALDP231 3544
AMDP233 3542
ANDP233 3542
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CT-13R13T 3540
CT-13R22T 3544
CT-20R12T 3542
CT-20R3T 3542
CTN-3176S 3539

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What do you know about electronics?

Vacuum tubes

By Sam Wilson

Television is being blamed for everything these days. But, I say, if you watch TV over a very long period of time you will pick up gems of wisdom. You may not agree with the philosophical viewpoints, but you will agree that they provoke thought. Here are two examples:

Regarding success: "The hardest thing about getting to the top is to get through the crowd at the bottom." (Rockford Files)

By a confirmed bachelor: "A man needs a woman like a fish needs a bicycle." (For the women who read this column: interchange the words man and woman.)

Don't throw away your 6SN7s

A company called George Kaye Audio Labs is making a new tube tester that costs over $500. Don't confuse this tube tester with your favorite old Hickock tester. That old favorite did a fine job of separating good and bad, but, it was never intended to give an in-depth analysis of a tube's condition.

I have to be very careful how I word the following, but, I feel it must be said. At the very mention of the word "vacuum tube" or "relay" there are some people who go into hold. Those people are not technicians. They call themselves "administrators." They are people who have worked their way into positions where they control what is being taught and what information is being used in tests.

To paraphrase the late President, Harry Truman—they know as much about what is happening in electronics as a pig knows about Sunday.

Who uses vacuum tubes in this day and age? Well, for one example, people in the broadcast industry. Despite the fact that certain administrators have announced that tubes and relays are dead, there are people who still use them!

Not too long ago I quoted the Wall Street Journal article that told about some manufacturers who make vacuum-tube audio equipment. Who buys this type of equipment? People who claim that transistor audio systems just don't sound as good as tube equipment.

I have a zinc ear. I can't tell the difference between the sounds made from a bass drum from those made by a tuba. I am not even qualified to make a guess as to which type of equipment sounds best. However, when professional musicians say tube equipment sounds better I am not dumb enough to argue with them. I do know that there has never been any test equipment that can identify that difference in sound quality, but I'm not sure that proves anything.

If you don't believe tubes are being used today find a way to get into a 50,000 watt broadcast station and start counting.

The GROL

Now listen carefully—the "new" FCC licenses are called GROL (General Radio Operator License). Every question on the FCC test has been released to the public along with the answers. I am a co-author (with Joe Risse) of two books on the FCC GROL tests. I have been through every question and every answer. Joe Risse also went through every question and answer.

There isn't any coverage on tubes in any part of the new FCC test. The test is supposed to be a method of determining whether a technician is qualified to work in the broadcast industry today. If a broadcast technician is likely to be involved with tubes why don't they have anything about tubes in the FCC license?

We're back to those administrators again. To them, tube is a four-letter word. You still don't believe me? Take a look at the latest textbooks for technicians. Look at the trade school curricula.

Before you send me a nasty letter asking why I don't have tube theory in *my* books, let me tell you something about writing books. One reason for writing technical books is to (hopefully) get a few pennies in royalty money. I hope that doesn't spoil an image.

If a book doesn't sell there are no royalties. So, the people who buy books make the final decision on whether a book will be used for training. I was born on Friday, but, not last Friday!

(Incidentally, if you are an administrator you should disregard all of the bad things said about administrators. It's really not my fault. Norma wrote it!)

The lifetime of batteries

You and I both know that a battery is a combination of cells. However, the public seems to have trouble with that distinction. We see ads in newspapers about a sale of flashlight batteries. Here in Florida we are warned that we must always make sure that we have a good supply of flashlight "batteries" on hand when the big wind descends upon us. If you buy cells every time you get a warning you would have to build an extra room to house them.

When the last hurricane was about to hit our town the radio and TV announcers had old people half scared out of their minds. In one instruction that was passed out people were to seek shelter in local school auditoriums, and, in another instruction people were warned to stay away from the auditoriums.

After the big wind, people start counting up their supplies. You never know when the next breeze will come roaring down the street.

One announcer said to keep your cells in your refrigerator and they will last longer. That is true. Another announcer said to get everything out of the refrigerator because the electricity was sure to go OFF. That was also true.

If you do store cells in the refrigerator (but never in the freezer!) you must handle them very carefully until they get back to room temperature. The seals in cold cells become very brittle! Allow the cells to get back to room temperature gradually in order to avoid condensation and a leakage problem.

How long should you keep those batteries? A battery has a shelf life, according to manufacturers, that is equal to *the*

Wilson is the electronics theory consultant for ES&T.

amount of time it takes for its terminal voltage to drop to 90% of its rated value when it is stored at a temperature of 70F.

For example, alkaline and mercury cells have shelf lives up to two years. Carbon-zinc (LeClanche) cells have slightly shorter lives.

The lifetime of electrolytic capacitors

Note: tantalum capacitors are hermetically sealed and have a longer shelf life than the aluminum types. This is a discussion about aluminum electrolytics.

If you are going to make a capacitor with a high capacitance value in a small package your best choice is to use a very thin dielectric material. That is the theory behind the operation of electrolytic capacitors. Their dielectrics are a thin coating of oxide material.

Electrolytic capacitors do not last forever. The thin dielectric material in electrolytics breaks down over time. Their shelf life is shortened when electrolytics are stored in hot and/or damp places.

Aluminum electrolytics can be stored in dry, cool places for up to two years. During that time you need to reform the dielectric material every two months. You reform the dielectric by connecting a DC voltage across the capacitor. Use a current-limiting resistor.

Other types of capacitors (ceramic discs, mica, plastic, etc.) have a shelf life of about five years. That's assuming you store them in a dry place. Also, as with electrolytics, you will hasten their deterioration if you put them where the temperature swings.

Important notice

Did you purchase either (or both) of the following books by Sam Wilson and Joseph A. Risse:

Communications Licensing and Certification Examinations—The Complete TAB Reference.

Practice Tests for Communications Licensing and Certification Examinations - The Complete TAB Reference.

As often happens, some errors got into the first editions. For a free copy of corrections write to me in care of ES&T. Enclose a self-addressed, stamped, business envelope. It would be a good idea to write "corrections" on a piece of paper and enclose it with your mail. Otherwise, it might get mixed in with my contest for a free can of Florida air. ■

Test Your Electronics Knowledge

A mixed bag

By Sam Wilson

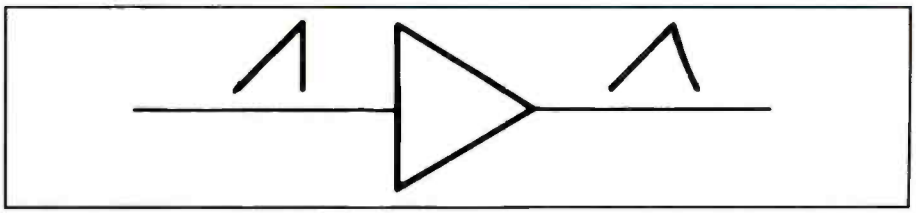


Figure 1. Result of a sawtooth waveform test performed on an amplifier.

1. In what field of technology would you expect to find an "end effector?"

2. Regarding a SAW filter, what do the letters SAW stand for?

3. In what type of thyristor circuit would you expect to find a snubber?

4. Which of the following statements is correct?

A. When you stress a material you get strain.

B. When you strain a material you get stress.

5. A Kelvin Bridge is used to measure _____.

A. capacitance.
B. inductance.
C. resistance.
D. frequency.

6. A technician performs a sawtooth waveform test on an amplifier and gets the result shown in Figure 1. What does the result tell about the amplifier?

7. You can measure a voltage with a _____.

A. variable capacitor.
B. gyrator.
C. potentiometer.
D. None of these choices is correct.

8. A voltage doubler is connected to an ac power line frequency of 60 Hz and an ac voltage of 120V. The output voltage should be in the range of _____.

A. 175V to 250V.
B. 300V to 350V.
C. 400V to 450V.
D. None of these choices is correct.

9. What is the reciprocal of reactance?

10. In the circuit of Figure 2, what is the voltage between point A and ground?

(Answers on page 64)

Wilson is the electronics theory consultant for ES&T.

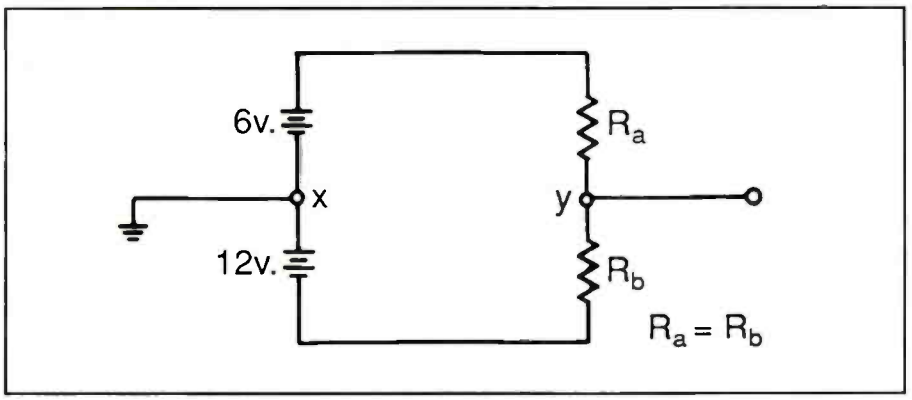


Figure 2. Diagram of a circuit.

Is computer service in your future?

By Sheldon Fingerman

Unfortunately, the cost of replacing many consumer electronic products is getting about as inexpensive as servicing them. This fact has left many servicers scratching their heads wondering about what the future will bring. Obviously, the more expensive the product, the more inclined the consumer will be to repair the item rather than heaving the item into a dumpster and heading off to Wal-Mart. Computers easily fit into the category of repairable items...so far.

The computer service business

This magazine, as well as others, have had some excellent articles dealing with computer servicing. But, what they have not dealt with are the realities of actually being in the business, and whether being in the computer servicing business might be a viable option for you.

There are many reasons computer service is desirable: parts are relatively easy to obtain. Hourly rates range from $60 to $90 per hour. The entire operation can be carried out in your living room, (although you probably wouldn't want to). And in most cases, you can yank a part out of one brand name computer and stick it into another of a different brand.

There is another side to this, however. If you are used to sitting at a bench, solving problems at your own pace, computer service definitely offers some surprises. Most repairs are done on site, with a very nervous customer watching your every move. This alone can be unnerving to the average bench technician who, during a normal house call, may only have to deal with a few kids wanting to know when the set will be fixed. As irate as some customers can be with regard to the speed at which a television is being repaired, their business is rarely brought to a halt because their TV doesn't work.

Fingerman is an electronics and computer consultant and servicing technician.

Technician and customer communication

To begin with, the customer can be part of the problem. Many computer users know just enough to be dangerous, and it can be difficult to get the proper information in what I call the initial "interrogation." They tend to be afraid to admit they may have done something wrong, even though the problem may merely have been a coincidence rather than anything they were doing at the time of the failure. Gathering as much information as possible before starting a repair or consultation, can save hours in the long run. It's imperative that you find out what, if anything, happened between the time the computer was working fine and the time that it failed.

A related problem is a lack of communication between the technician and the customer. The customer may use terms that are in the technician's computer vocabulary, but may actually mean something completely different. If an office has two computers linked together, and the customer claims they want a new, larger hard drive installed in the "server," but they actually meant the "client" computer, you may find yourself doing the same job twice. And who's fault is it?

Maybe I'm wrong, but I tend to blame myself in these instances. I'm supposed to be the expert here, and I've learned to ask the same questions more than once, point to peripherals and say, "You mean that?," and draw a lot of pictures. Not unlike a customer who brings in a TV with nothing but a line on the screen from left to right. Yes, it is a "horizontal" line, but you know the problem is actually in the vertical circuit. The object is not to make the customer feel stupid, but to make sure your definitions are the same.

Common problems

A major headache for me, and a lot of other servicers as well, is trying to figure out whether a problem is hardware or software related. A serious knowledge of computer operating systems, and little bit of knowledge about a lot of different kinds of software can help here, but there are so many new programs being released all the time—many full of "bugs" that mimic hardware problems—you might find yourself joining the Hair Club For Men a lot sooner than you expected. Experience will soon tell you which software titles tend to cause problems. And, believe it or not, many software publishers will confess pretty quickly when it is regarding a problem. I can't tell you how many times I've heard, "Oh yes. Give us your address and we'll send out the 'latest' version of the software."

Another common problem is trying to upgrade a system, only to find that the customer has no documentation, the computer has no known brand name, and the motherboard has no identification of any kind. Usually, consumer electronic prod-

ucts have some kind of label. A Sony is a Sony, and a JVC is a JVC. You need a part, you make a call.

But what happens when the product has no identification and the customer wants to upgrade the RAM on her computer from 4 MBs to 8? Will the computer accept a 4MB SIMM? If the computer has 8 SIMM slots, are they set up as two banks of 4 slots? Does each bank have to be filled completely? And will the computer even accept the amount of RAM the customer wants? Most computers have a limit as to how much upgrading can be done, and you would be surprised at how limited some of the older computers are.

Keeping up with what's new

In the world of consumer electronics it's important to keep up with what's new. In most cases these changes have come in stages: transistors, ICs, surface mount components, stereo TV, etc. In the computer world, if you understand it, it's probably obsolete. And the industry won't give us much of a break. I spend more time reading now than I did when I was in school. And, my mailbox is filled every day with more publications then Ed McMahon has down at The Publishers Clearing House. I have to read them all, or I will fall behind.

Recently, magazines like *PC Magazine* have started releasing back issues on CD-ROM. This has enabled me to purge some files and free up space on my bookshelves. This new technology also makes searching for articles a snap. Magazines like *ES&T* also offer a wealth of timely information, but in the computer world things change very quickly. You probably have television schematics that are years old but get lots of use. Computer literature that old makes good kindling.

Books make good reference material, but by the time they get the books published new products have already been introduced. Sometimes these products couldn't have even been imagined by the books authors. It's pretty unnerving to see the latest copy of a book on DOS sitting on the shelf that reads, "Now includes DOS 6.0," when you know that Microsoft has already released DOS 6.22.

Tools and test equipment are always a concern when it comes to servicing new products, except when it comes to computer repair. With computer service the most valuable tool you possess is right between your ears. You'll find no matter how many pieces of fancy test equipment you own, there is no substitute for good, sound logic; especially when dealing with computers. To fix a computer, sometimes you have to think like a computer. Taking this to a Zen level, I guess you would have to "be" the computer.

Tools

Although a plethora of hand tools jammed in a custom case is always a luxury, and sometimes a necessity, a minimum of hand tools are actually needed to service most computers. An assortment of screwdrivers, basic hand tools, some specialty tools like IC pullers, and lots of small screws and washers will make up the bulk of your tool kit. In the vast majority of repairs, a piece of equipment, like a scope would be excess baggage, but never leave your DMM behind.

Diagnostic software is a necessity, and is readily available from many sources. You may have to experiment with a few to find the ones that work best for you. The latest versions of Microsoft DOS now include some diagnostic programs, and they're not bad. Diagnostic hardware is a luxury that's nice to have in your bag of tricks. To be honest, I haven't had a lot of experience with diagnostic hardware, but many technicians swear by it.

Replace modules

Assuming the problem is hardware related, determining which part is defective and simply replacing it is usually the best route to take. I know very few technicians who would attempt to repair an internal modem that's "gone south," or open a hard drive without any instruction. You should always look for problems a simple solder repair, or something similar might rectify. I've actually come across a few poorly soldered power switches.

One of the few exceptions to simply replacing a component would be a "flaky" hard drive that just needs to be brought back from the dead. A lot of the diagnostic software that's available can actually "repair" hard drives that simply have defects in the magnetic material which store data, or may have shifted slightly over time causing what are called seek errors.

Taking into account the age of the drive, and the customer's needs, once the data has been resurrected it still may be a good idea to transfer the data to a new hard drive. Remember, prices keep falling while reliability keeps improving.

Having an extra computer on hand can be an invaluable diagnostic tool. And, as long as you are honest about selling used parts, it's pretty easy to sell the parts off of your "test" computer, allowing you the luxury of upgrading that computer, while getting your customer back in the saddle quickly.

Inventory

With computer prices falling all the time, keeping a large inventory of parts can be a detriment. However, it's always a good idea to keep an assortment of common items on hand.

With everyone getting on-line these days, having a few modems around couldn't hurt. But, you still have to be careful. As with other computer peripherals, a 2400 baud modem, that may have cost $250 when it was state of the art, may be worth almost nothing as your customers clamor for 14,400 and 28,800 baud modems, which probably cost less now than that old 2400 baud modem you have sitting on your shelf.

Unlike a TV, where you would simply replace a defective part with an exact replacement, many computer components can be easily upgraded to the latest technology by simply substituting the part, like the modem mentioned above.

Other parts to keep on hand are adapters; lots of them. It's an awful feeling to get to a job with a new CD-ROM drive, only to find that the computer's power supply doesn't have enough power cables. A simple Y adapter would have saved the day, if you had one.

An extra keyboard is always a good item to have around, but considering the fact that you may only have a 50/50 chance the keyboard DIN plug will fit the computer—there are two standards now—once again an adapter can be a real time saver. You can't have too many adapters.

Profits and possibilities

Another rarely thought of tool is a notebook computer. Even a relatively inexpensive monochrome model has an external port that will drive virtually any color VGA monitor well enough to evaluate it. It's also a great place to store programs, tons of information, a service database, take lots of notes, and even contact bulletin boards and on-line services right from the repair site.

Add a portable printer and you can even crank out an invoice on the spot. Not inexpensive, but if you use a little imagination there are lots of possibilities here.

Now, before you get too excited about all the big bucks you are going to make in this business, remember that good salaries usually go hand and hand with some degree of aggravation. Recently, the community I live in started up a nonprofit, low cost access to the Internet. I agreed to act as a volunteer "mentor." Soon, people who were having problems getting on-line were calling me at all hours. You'd think they were dialling 911.

Many people called asking for "free" advice over the phone. I tend to be very lenient with my time when dealing with established customers. With a prospective client you have to be a bit more careful. When working in a consulting capacity all you have to sell is knowledge. How much of that you are willing to give away is up to you.

So, how do you get started? If you've been maintaining your own computer(s), and/or been solving some tough problems on other machines, you might want to dive right in. If the "innards" of a computer are new to you, see if there are any computer service seminars in your area. You can always look under the hood of your own, but just knowing where all the parts are won't nearly be enough to start a computer service business.

On the other hand, if you've been "surfing the Net" for years, one of the hottest professions right now is getting individuals and businesses hooked up to the Internet. Except for installing a modem here and there, you may never have to touch a screwdriver or a DMM to make a very good living.

Liability

One often overlooked issue that deals with any type of repair business is that of liability. When you remove a hard drive you could be holding years worth of data in your hands. Even an electrostatic discharge could bring a thriving business to a complete halt.

Check with your insurance company, and always try to get the customer to do a complete backup of any valuable data before you show up. Be right up front about the possibility of data loss and other problems that might occur during a repair, and put some type of disclaimer on your invoice. In other words, cover yourself.

In many ways, I'd rather be faced with a tough computer problem than a "dog" of a VCR that's been sitting on my bench for a week. But that's me. If you feel profits slipping away as more and more consumer products become throw away items, servicing computers could be just the boost your business needs. And don't think you can't do it. Anyone possessing the skills necessary to fix a television or VCR certainly has what it takes to diagnose and repair a computer. ■

Books

***Surface-Mount Technology for PC Boards*, PROMPT Publications, 528 pages, illus., $26.95**

SMT holds great promise for manufacturing technology, and the race to adopt it has been described as the latest revolution in electronics. *Surface-Mount Technology for PC Boards* will give everyone from the engineer, to the interested layman, the inside track on this pace-setting technology. Since its introduction, the largest roadblock from the complete acceptance and efficiency of SMT has been a lack of communication. The how-to knowledge of SMT comes from the factory floor, but the exchange of ideas and demands between the electronics designers and manufacturing personnel has been either nonexistent or, at best, ineffective. *Surface-Mount Technology for PC Boards* provides a two-way street for communication between the manufacturing technology and the layout considerations for SMT.

The subjects covered in the book include, benefits and limitations of SMT, surface-mount components, SMT manufacturing methods, practical applications and standards, a glossary of SMT terms, and more.

Prompt Publications, 2647 Waterfront Parkway E. Drive, Indianapolis, IN 46214

***Easy Laser Printer Maintenance and Repair*, Stephen J. Bigelow, Professional Book Group, 224 pages, 200 illus, $28.95 hardcover, $18.95 paperback**

Laser and LED printers have become indispensable fixtures in most of today's offices and, like other office equipment that usually performs reliably, are taken for granted—until they break down. *Easy Laser Printer Maintenance and Repair* is written to address these problems.

Written especially for those with modest technical skills, this easy-to-use guide will have readers handling common problems such as poor image quality, paper jams, and misfeeds with ease. Step-by-step instructions and illustrations aid in solving more complex problems too. And, just as important, this book teaches how to extend a printer's life by performing adjustments, cleaning, and other routine maintenance.

Chapters are included on, components, power supplies, image formation systems, soldering and test instruments, service guidelines and precautions, mechanical systems, electronic controls, and service guidelines.

The book also includes an index of printer manufacturers and supply sources and a "quick-reference" index of troubleshooting procedures.

McGraw-Hill, Inc., Blue Ridge Summit, PA 17294-0850

***The Information Broker's Handbook*, Sue Rugge and Alfred Glossbrenner, Professional Book Group, 528 pages, $49.95 hardcover, $34.95 paperback.**

The first edition of *The Information Broker's Handbook* was a bestseller. Co-written by the woman who pioneered the field of information brokering and an expert in PC telecommunications and online services, it helped launch the careers of thousands of information professionals. Not content to rest on their laurels, authors Sue Rugge and Alfred Glossbrenner now deliver a completely up-to-date revision of their masterwork with new coverage of the Internet and its enormous potential for information-gathering.

There is also a new chapter on how to profit from the burgeoning field of public records-searching, including the authors' insightful tips on techniques and markets. In addition, they include new or expanded coverage reflecting other advances in technology, including the fast-growing array of CD-ROM databases, modem and CD-ROM hardware, and database graphical front-end software.

All of the helpful information from the first edition is still there too; how to handle the business end, including how to price your information brokering services, get more out of clients, project a strong image, and more. Appendices provide resources and reference works, contact names and telephone numbers, as well as information on how to benefit from the resources, expertise, and mentoring offered by the Association of Independent Information Professionals (AIIP).

McGraw-Hill, Inc., Blue Ridge Summit, PA 17294-0850

***Online Resources for Business: Getting the Information Your Business Needs to Stay Competitive*, By Alfred Glossbrenner & John Rosenberg, John Wiley &Sons, Inc., 385 pages, $24.95 paperback**

Online Resources for Business: Getting the Information Your Business Needs to Stay Competitive, describes today's online service, the type of information they provide, and how much it costs to obtain that information. Written by online experts Alfred Glossbrenner and John Rosenberg, this compendium shows businesses how to save time and money when conducting research online.

A complete revision of the 1987 best-seller, How to Look it up Online, Online Resources for Business, provides the key to using the two general types of online services: *Business Services*: Lexis/Nexis (Law), Dow Jones (Financial), DIALOG (Corporate),*Consumer Services* such as Internet, CompuServe, America Online, Prodigy, access to dozens of little-known information sources, like marketing studies and government statistics, sophisticated search strategies, tools, and techniques, information on third-party research firms, rates for accessing, downloading, and printing information from online searches.

John Wiley & Sons, Inc., 605 Third Avenue, New York , NY 10158-0012

***PSMA Standardized Handbook of Terminology for the Power Sources Industry*, Power Source Manufacturers Association, $35.00**

The second edition of the *PSMA Standardized Handbook of Terminology for the Power Sources Industry* has been published by the Power Sources Manufacturers Association and is available to power professionals

This "dictionary" of definitions has been updated and expanded from an original version produced eight years ago. It addresses new state-of-the-art activities, long-established technology and regulatory issues. The new edition was edited by Joe Stockert of The NJ Power Group, Morristown, NJ, and reviewed by 18 power electronics specialists from the PSMA and the IEEE Power Electronics Society.

The handbook includes definitions and explanations of more than 700 terms in the power industry, along with information on testing and standards agencies, international power components standards and publications, world voltages and frequencies, military specifications, standards and handbooks.

"It is intriguing," Stockert said, "to see how much has changed in the last eight years and how much has stayed the same. The influence of new global technologies

Test Your Electronics Knowledge

Answers to the quiz

(from page 59)

1. Robotics—it is the gripper at the end of a robotic arm that enables the robot to pick things up.

2. Surface Acoustic Wave—the filter acts by sending acoustic waves across the surface of a piezoelectric material.

3. An SCR circuit—the snubber prevents undesired turn-on.

4. A - Strain (deformation) is the result of stress (force).

5. C - It measures very low resistance values.

6. The amplifier has a poor high-frequency response. It cannot follow the rapid change from high to low amplitude.

7. C - There are two meanings to the word potentiometer. It is a variable resistor, and, it is a special instrument for measuring voltage.

8. B - The peak voltage is 120V X 1.414 = about 170V. The doubler multiplies that value (approximately) by 22 X 170V = 340V

9. Susceptance—susceptance is a measure of the ease with which an ac current can pass through a reactance.

10. The same amount of current flows through Ra and Rb so the voltage across Ra equals the voltage across R2. The total drop across the two resistors is 18V, so, there must be 9V drop across each resistor.

Using conventional current flow and going clockwise from x to y:

+6-9 = -3V (answer).

As a double check, going counterclockwise from x to y:

12+9 = -3V (answer).

and marketing programs have revised power capabilities and strategies and the new edition reflects these developments."

PSMA, 3685 Motor Ave., Los Angeles, CA 90034-5750

Introduction to Microprocessor Theory & Operation, By J.A. Sam Wilson & Joseph Risse, PROMPT Publications, 232pp, illus., $16.95 paperback

PROMPT Publications announces the release of Introduction to Microprocessor Theory & Operation—a book that explores the microprocessor. This book explains how microprocessors work with their associated circuitry to provide basic core energy to the entire system.

Since the introduction of microprocessor theory, a great gap has existed between its principles of operation and those attributed to the more universally accepted ideas revealed in digital electronics theory. The authors set out to eliminate the myths and inform the reader on the circuits, specifications, and general ins-and-outs of microprocessor systems.

Subjects covered in Introduction to Microprocessor Theory & Operation include, features of the Microprocessor, basic Microprocessor systems, ALU, mass memories, binary components, and transducers as data sources.

PROMPT Publications, Howard W. Sams & Company, Indianapolis, IN 46214

***Giecks' Engineering Formulas Released on CD-ROM*, By Kurt and Reiner Gieck, McGraw-Hill, Inc., $79.95 CD-ROM, $89.95 diskette**

McGraw-Hill announces the electronic edition of the classic Engineering Formulas, 6th Edition by Kurt and Reiner Gieck. *The Electronic Gieck's Engineering Formulas* is a CD-ROM that uses the technical data and mathematical formulas from the Gieck's Engineering Formulas to generate instant solutions for engineering and scientific equations.

The best-selling Gieck's - first published in 1967 and now in its sixth edition - is an invaluable resource of fundamental formulas and data for engineers. With a fully interactive interface powered by MathSoft, Inc.'s MathCad engine, the new Electronic Gieck's is a complete engineering reference that solves the most time-consuming technical calculations instantly.

Indispensable for engineers, engineering students, and other professionals, the Electronic Gieck's provides powerful navigational tools for full-text searching. It allows access to information through multiple paths, including the table of contents, index, and hypertext linking. In addition, interactive math allows the user to perform calculations and test results with different input variables.

With over 500 live formulas and more than 400 graphic images, the Electronic Giecks' provides instant problem solving for, electrical engineering, areas, dynamics, machine parts, strength, solid bodies, radiation physics, statics, hydraulics, kinematics, heat, and production engineering.

The Electronic Giecks' Engineering Formulas is a time-saving tool that simplifies all kinds of technical calculations, from simple geometry to radiation physics.

McGraw-Hill, Inc., 11 West 19th Street, New York, NY 10011

***Troubleshooting and Repairing Computer Monitors*, Stephen J. Bigelow, Professional Book Group, 320 pages, 150 illus., $36.95 hardcover**

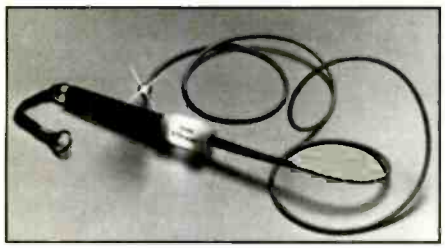
With the enormous variety of monitor types and configurations on the market today, the time is ripe for a comprehensive guide to the essential diagnostic and repair tools and techniques. That's exactly what *Troubleshooting and Repairing Computer Monitors* delivers.

Electronics technicians and intermediate to advanced-level hobbyists who want to take advantage of the ever-expanding market for monitor repair technicians will need the critical information presented in this authoritative, A-to-Z guide. Readers will learn how to tackle virtually any monitor problem with either CRT-based monitors or the growing number of LCD varieties.

After beginning with an overview of concepts, components, technologies, and test equipment, author Stephen J. Bigelow presents details about: CRT alignment and degaussing, specifications and architectures of monochrome, CGA, EGA, and VGA monitors, state-of-the-art plasma displays, linear, switching, and high-voltage power supplies, logic and drivers supporting both CRT and LCD monitors, major graphics standards used in today's monitors, and many other important topics.

McGraw-Hill, Inc., Blue Ridge Summit, PA 17294-0850

Products



Fiber optic tool

Fotec has introduced a new, inexpensive tool that simplifies fiber optic network installation and troubleshooting. The FOtracer is a visible light source that makes it possible to visually test fiber optic cables for continuity and trace fibers throughout the network.

Most connection problems in fiber optic networks can be diagnosed with a visual check of continuity. A visible light source is needed for visual testing, since the actual network sources are in the infrared region and are invisible. The tracer can test multimode cables up to 4 km (2.5 miles) long, making it useful for all fiber optic LAN applications.

Circle (100) on Reply Card

VCR instructional cassette

An instructional videocassette from *Electronix* presents practical repair techniques for servicing the G Chassis VCR. The G Chassis is found in most VCRs manufactured from 1992 to the present. It is a much smaller chassis, which in turn allows the physical size of the VCR to be dramatically reduced.

Along with this reduction comes a variety of new servicing problems, especially ones which involve alignment between the top and bottom of the chassis. These alignments can be a nightmare for someone not familiar with the proper methods and procedures to perform them. A Layperson's Guide to G Chassis VCR Repair will take the fear out of servicing the G Chassis. The video displays many common failures of the chassis and easy ways to repair them.

Circle (101) on Reply Card

Telephone transfer unit

Electronic Design Specialists introduces a product that will allow callers to get hold of a person easier, while simultaneously eliminating unnecessary calls and wasted cellular time. There is only one phone number required for contacting the owner of the cellular phone .

The selective teletransfer unit (STU) connects to an office or home phone line and answering machine, and will selectively transfer the caller by their command to a cellphone, or pager, or voice mail, or any other number, or by your command, can tell callers to leave a message on the answering machine. The level and ability to transfer can be made from anywhere by simply calling STU and entering the proper functions. Because cellular or pager phone numbers are programmed into STU, they remain secret. STU combines the features of "call forwarding," "no-answer transfer," and "ProLink," and adds the ability to filter the caller selectivity instead of simply transferring everything.

Circle (102) on Reply Card

Curve tracer

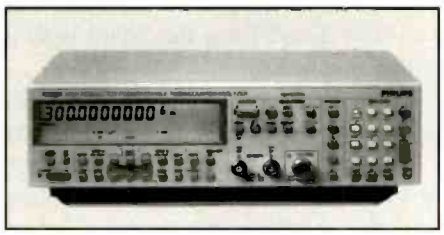
Hameg Instruments, Inc. introduces the HM8042 Curve Tracer. This is a module that plugs into the company's HM8001-2 Mainframe Power Supply and is used in conjunction with any oscilloscope that has X-Y display capabilities. It can test diodes, transistors, FETs and thyristors.

The instrument is microprocessor based, has a well designed front panel and measures and displays characteristic curves of semiconductor devices. Digitized data is used to generate a 5-curve, flicker-free X-Y oscilloscope display. A 4-digit LED numeric readout indicates parametric data. On-screen cursors define the curve areas of interest and the internal processor calculates dynamic "h" parameters. Single measurement data can be stored for a match of two devices or as a test reference.

Circle (103) on Reply Card

Timer/counter

Fluke Corporation announces two new additions to the PM 6680 family of timer/counter/analyzers. The new PM 6681 timer/counter has a high time-interval resolution of 50ps single-shot and 1ps averaged, plus a speed of up to 8000 measurements per second. This allows the unit to make universal timer/counter measurements, such as time interval, frequency, phase and jitter, at accuracies higher than currently possible.



Also available from Fluke is the PM-6680B, which is an improved version of the PM 6680 instrument.

The products have built-in hardware features for fast data capture. When the timer/counters are linked to a PC running the TimeView software package, they are turned into highly accurate modulation domain analyzers. TimeView handles time and frequency analysis and advanced statistical and FFT processing.

These capabilities give users extra facilities, such as analyzing frequency stability, and revealing and qualifying signal anomalies (jitter, noise or modulation artifacts, for example) that would otherwise remain hidden. Other examples include analyzing frequency modulation, locating hidden noise sources, plotting frequency agile signal sources (frequency vs. time), analyzing VCO transient response and viewing frequency locked loop dynamics.

Circle (104) on Reply Card

Removal Kit

Premium Parts+ offers the Chip Quik Removal Kit, which contains a special alloy solder, liquid flux, solder removal braid, and complete instructions.

The removal process is simple. The only tools required are a soldering iron and a dental pick. The technician applies special liquid flux to all leads of the SMD to be removed. Then, with a soldering iron, melts the special alloy solder uniformly on all pins. The iron temperature recommended is just over 200F. The iron is used to keep the special alloy solder in a molten state long enough to react with

the existing solder. Now the SMD can easily be lifted from the board with a puller or dental pick.

To clean the PC board, the technician uses a cotton-tipped swab dipped in flux and a soldering iron to push large globs to an unused section of the board where it is left to solidify and be removed. Solder braid and flux can be used for any additional clean up that may be needed.

Circle (105) on Reply Card

Test accessories kit

ITT Pomona Electronics' new Model 6003 Electronics Lab Test Kit is an all-in-one combination of the most popular test accessories used in the laboratory. It is a versatile kit for users of digital multimeters and oscilloscopes.

The kit contains a combination of features and accessories for specific test requirements, including operator-safe insulation, interchangeable test points, and interfaces. The 6003 includes a x1 - x10 oscilloscope probe, an assortment of interchangeable tips, handy leads and clips, BNC female-to-double banana plug adapter, as well as a multi-use DMM test lead with accessories for testing ICs, board and components circuitry.

Circle (106) on Reply Card

Monitor diagnostic and video display utilities

Tech Assist, Inc. is shipping Display Mate Professional with DisplayMate for Windows. This is the leading utility for monitor and video board service, maintenance and/or repair. The utilities allow the user to use the setup display test series to properly adjust the user controls. The user can measure the resolution, test and measure the color registration and/or color convergence error and measure the geometric distortion. In the testing features, you can perform any or all 300 tests to determine if the video system is working properly. It can generate more than 200 test patterns and determine the strengths, weaknesses, quality, performance, and compatibility of all video system hardware. In the compatibility section, DisplayMate Professional will use video adapter BIOS function and register, to probe for hidden flaws and limitations in the hardware. Another feature is the speed performance testing. This will report on the performance of the video accelerator.

The user may also write scripts to customize the testing to their preferred routines and when finished, print a report for their client of all testing completed and the results.

Circle (107) on Reply Card

Credit card size DMM

Wavetek Corporation announces a new DMM, the DM78A. The shirt pocket size makes the meter easy to use and carry. The multimeter comes in a vinyl carrying case, with test leads and probes attached.

The credit-card sized DMM offers a 3200 count display with a 32 segment baragraph, useful for measuring peaking and nulling circuits and locating bad diodes, and features a Data Hold, which freezes a reading on the display for later evaluation, and provides safer operation when in a dangerous area. Auto Shut-off, is designed to UL and EN (IEC) Agency Safety standards.

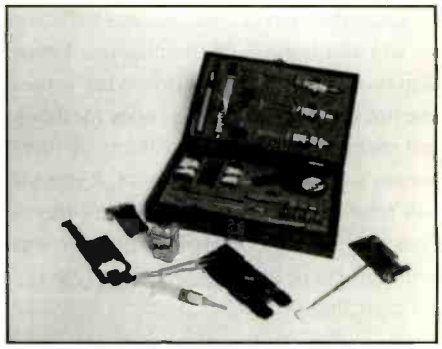
Circle (108) on Reply Card

Electrical cleaner and degreaser

CRC Industries announces a new formula for its Lectra Clean electrical cleaner and degreaser. Absent in the new formula, in order to meet Clean Air Act standards, is the primary ingredient 1, 1, 1 Trichlorethane.

The new formulation contains no CFCs, 1, 1, 1-Trichlorethane, or Perchlorethylene, but according to the company has retained all of its desirable characteristics including non-flammability, non-corrosiveness and freedom from residue. The product can be used in a wide variety of electrical applications to increase the life and efficiency of motors, parts, relays, switches and other equipment by effectively removing grease, oil, dirt and sludge.

Circle (109) on Reply Card



SMD tool kit

Automated Production Equipment's SMD Tool Kit contains all of the components necessary to quickly remove and replace Ball Grid Arrays and all surface mounted components or printed circuit boards, when used with the SMD-1000

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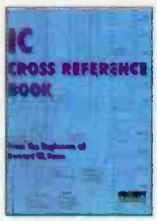
By Howard W. Sams & Company

The IC Cross Reference Book, compiled from manufacturers' data and from the analysis of consumer electronics devices for Photofact service data, will help you find replacements or substitutions for more than 35,000 ICs or modules. **Order# 61049 ····· $19.95.**



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By J.A. Sam Wilson and Joseph Risse

Industrial Electronics for Technicians provides an overview of the topics covered in the Industrial Electronics for Technicians CET test, and is also a valuable reference on industrial electronics in general. **Order# IET ····· $16.95.**

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By Gordon McComb

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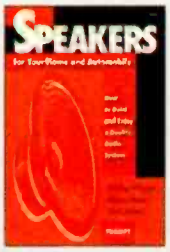
Speakers for Your Home and Automobile

How to Build a Quality Audio System

By Gordon McComb, Alvis J. Evans and Eric J. Evans



Build quality home speaker systems that will complement the sound available from your other components using the instructions in this book.

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By Irving M. Gottlieb

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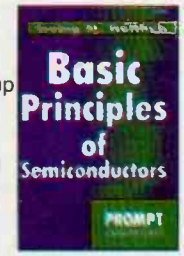

Semiconductor Cross Reference Book

By Howard W. Sams & Company

From the makers of Photofact service documentation, the Semiconductor Cross Reference Book is the most comprehensive guide to replacement data for all major types of semiconductors. This volume contains over 475,000 part numbers and other identifying numbers. **Order# 61050 ····· $24.95.**

Tube Substitution Guide

Complete Guide to Replacements for Vacuum Tubes and Picture Tubes

By William Smith and Barry Buchanan

The Tube Substitution Handbook will help antique radio buffs, consumer electronics technicians and other interested individuals find the right replacement tube when servicing older electronics products. **Order# 61036 ····· $16.95.**

Electronic Control Projects for the Hobbyist and Technician

By Henry C. Smith and Craig B. Foster

Electronic Control Projects for the Hobbyist and Technician helps the reader know how and why an electronic circuit works, then applies that knowledge to building practical and dependable projects that solve real, everyday problems. **Order# 61044 ····· $16.95.**

Schematic Diagrams

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Chipmaster. The Chipmaster is a hot air-based complete communications rework and repair station for rework and repair of pagers, 2-way radios, cellular telephone electronics, and other communications equipment.

The SMD Tool Kit contains an SMD pad prep cleaner that gently removes oxidation and contamination to restore pads to optimum solderability. The cleaner removes the coating from the pager or circuit and is non-toxic to workers. The kit also contains an assortment of dental-quality probe tools, "no-clean" soldering flux, syringes for flux application BGA "no-clean" removal prep solution, a vacuum handling tool, a wick gun for wicking away old solder, assorted dispensing needles for the syringes, and tweezers.

Circle (111) on Reply Card

DMM

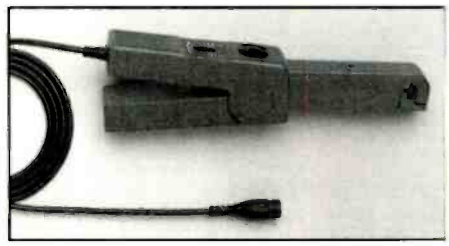
Fieldpiece Instruments has introduced the LT6 handheld digital multimeter. It measures volts, ohms, amps, indicates continuity with a beep, and tests power semiconductors for catastrophic failure.

The meter works with all the accessory heads and other accessories offered by the manufacturer for their Heavy Duty line of meters. The optional deluxe test leads (model ADL2) fit the LT6 and can be used to connect the accessory heads to the meter. Currently available accessory heads include converters for current, MA relative humidity, and dual temperature.

Circle (110) on Reply Card

Current probe

Fluke Corporation, introduces its new 80q-110s probe, which offers high-accuracy current measurements for a wide range of oscilloscope and multimeter applications. The new probe is compatible with other of the company's products.



The probe accurately reproduces current waveforms as they occur. Users simply connect the clamp to a waveform recording device to clearly view distorted waveforms that result from nonlinear loads, such as computers, adjustable speed motor drives, and electronic ballasts for fluorescent lighting.

Circle (112) on Reply Card

Circuit software

Interactive Image Technologies Ltd., announces the Electronics Workbench Engineer's Pack. This pack offers design engineers the ability to design and verify complex circuits using the company's mixed-mode simulation and then integrate these circuits into SPICE and PCB design automation software—speeding up the entire design process.

The product comes with over 2,450 models, which allow users to design more complex circuits. The models correspond to actual parts that users would select from popular databooks. The models are made of four specialized library sets: 500 Transistors, 600 FETs, 500 Diodes and Thyristors, and 500 Opamps.

Circle (113) on Reply Card

Swiveling robotics

Robotic machines from *Inca Corporation* can move TVs, video displays, projectors or computers in every direction. They are available in four standard models for lifting loads of 100 to 450 pounds. Modular panel movers can move up to 250 pound panels 3 feet wide. All are equipped to take a radio remote or switch controller and can be fixed to work with a pullout and swivel as well.

Circle (114) on Reply Card

Hand tools

Cooper Tools offers a premium line of cutters and pliers under the Erem name designed for those who specialize in state-of-the-art technology.

Each tool is machine process made from high-grade tool steel and is selectively heat treated at cutting edges. A precision double-screw joint system prevents lateral blade movement. Other features include lead catchers, anti-glare finish, serrated tips, and conductive molded grips. Ergonomically designed grips are also available.

Circle (115) on Reply Card

Rework system

American Hakko, Inc. introduces The Model 702 Rework System; a fully integrated rework system for all PCB repairs.

This new system incorporates the latest designs with a straight handle desoldering tool, a medium style soldering iron, an extra slim style soldering iron, and a complete hot air SMD rework station.

The Model 702 incorporates an ESD design for static free performance and safety. Calibration can be performed in house, and its compact design uses a minimum of bench space.

Circle (116) on Reply Card

Alternate source directory

Hearst Business Publishing/UTP Division announces release of the 1995 IC Master Alternate Source Directory (ICMASD) on floppy disk. This electronic version of the Alternate Source Directory from the IC Master catalog is an industry wide cross-reference listing of 127,000 current and discontinued devices. It includes complete manufacturer contact information.

The all-new 1995 ICMASD has been enhanced with the addition of device category information such as Linear-Telecommunications, or Memory - EPROM. A new, more powerful interface makes accessing the expanded and enhanced data faster and more efficient. ICMASD cuts hours of searching for functional equivalents and second sources.

Circle (117) on Reply Card

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Earn $$$ Repair Zenith TV modules found in over 1000 models, 1983-1993. Symcure manual shows you how. $89.95 or send SASE for **FREE** samples. **ZMEX**, 807 Queen Palm Lane, Sarasota, FL 34243.

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• Readers' Exchange items must be restricted to no more than three items each for wanted and for sale, and may be no more than approximately four magazine column lines in length (about 20 words).

• All submissions must be typed or printed clearly!

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Photofacts from 1980, '83, and '84. Call with best offer. *Contact: Diana, 407-677-7030, early morning or Wed. and Thurs. evenings after 6 P.M.*

Sencore equipment, PR57, CR70, TVA92, VC93, VG91. Complete with modules and manuals, $9000.00 total package, like new. *Contact: 412-329-4658.*

Sencore VC93 VCR analyzer. Two years old, hardly used. All accessories and original box, $1700.00. *Contact: 718-654-6022, after 6 PM EST. Ask for Barry.*

Closed my shop. Will completely outfit shop. Sencore: SC61, DM56A, ST66, CR70, PR57. B&K 1250 NTSC, 1601 power supply, 520B transistor tester, 820 capacitor tester, 1822 counter. Have other items. Best offer. *Contact: V. Knight, 912-764-4866 anytime, or fax 912-489-6773.*

Sencore CM2000, SC61, PA81, PR57. All original boxes, cables, probes, adapters, and manuals. Excellent condition, $3500.00. Separate prices available. *Contact: Mike, 503-839-6609.*

Sencore VA62, $850.00, SC61 $750.00 or both for $1500.00. All leads in excellent condition. *Contact: 207-872-2504.*

NR1 VCR training videotapes. $55.00. MTI Mobile Radio training course, 40 lessons, $165.00. *Contact: B.J. Jett, Farmers Telephone Cooperative, PO Box 217, Rainsville, AL 35986, 205-638-2144 x 203.*

Sencore equipment like new. SC3100, VG91/TVA92, CR70. Going out of business. All for $6000.00, or best offer. *Contact: 901-986-0410.*

Sams Photofacts, 1275 folders, numbered 205 through 1675. Will sell for $250.00, or sell in small lots for $.75 per folder plus shipping. Send SASE for listing. *Contact: Willy at 707-864-8237.*

Sencore VA62 and VC63, $1700.00. Marconi 2018 synthesized frequency generator 80 KHz to 520 MHz, $2200.00. Tektronix 475 scope 200MHz with probes, $950.00. Leader LCG 396, NTSC generator, $425.00. *Contact: Alex Torok, 814-337-2348.*

Weller soldering stations EC2001 ESD, $150.00, EC2000 ESD $100.00. Both like new. Ungar 4624 solder/desolder, $400 new. Plus more, just ask. *Contact: Jimmy 310-815-9090.*

Sencore VG91 and TVA92. Like new, all manuals, cables and boxes, $4500.00 or take over payments (contract). Also a PR-57 isolation unit $350.00, oscilloscope 20 MHz B&K model 4667 picture tube checker and rev, $300.00. Plus more. Will pay shipping. *Contact: Gordon E. Lane, 239 Jacksonian Drive, Hermitage, TN 37076, 615-889-6195.*

Sencore VC93 VCR analyzer, excellent condition, $1500.00. *Contact: Len, Len's VCR & Electronics Repair, 1-800-241-2393.*

FOR SALE

Hickok signal generator 615. Jackson cathode ray oscilloscope, CR03. Sencore color generator, G141. *Contact: Ann Bichanich, 15 1/2 West Lake Street, Chisholm, MN 55719, 218-254-4421.*

SC61 - less than 500 hours. Used once since Sencore calibrated it. Comes with 2 direct probes, 2 10-1 probes, and high voltage probe, $1800.00. *Contact: 704-544-0628, leave message or call after 6 PM EST.*

Sencore VA62, NT64, VC63, excellent condition, with probes and manuals in original box $2000.00, shipping included. *Contact: Keith Conroy, 10310 Woods Road, Utica, NY 13502, 315-735-1554.*

Tenma, 60 MHz oscilloscope 3 channel, 8 trace, $600.00, or best offer. *Contact: Michael, 516-997-5372, AM's.*

Sencore 100 MHz waveform and circuit analyzer, model SC3100. Purchased in 1994. New, excellent condition, cart included, $2900.00. *Contact: Route 2 Box 232D, Williston, SC 29853, 803-266-5000 ext.365.*

Simpson 380M microwave leakage tester, $400.00, 260-6xlm-analog tester $120.00. B&K 467 CRT tester, $400.00. Excellent condition, complete with manuals and cables. *Contact: Vitaly, 913-492-5189.*

Tenma 72-1070 monitor tester, like new. List for $389.00 in MCM's Catalog. I need to get $195.00 for it. *Contact: RFM Sales & Service, 208-233-9249, fax 234-0091.*

Partial set of Sams Photofacts, #800-#2000. Some missing, $150.00. *Contact: 503-484-1551(days), 503-343-2184(evenings), ask for Gloria.*

Hickok tube tester, model 532 dynamic mutual conductance, electronic volt-ohm-capacity milliameter, model 203. Philco, dynamic tester, model 7030. *Contact: Ed H. Rauchfuss, 946 Santa Clara Place, Los Alamos, NM 87544-3209, 505-662-2277.*

New Sencore VG91 video generator and VC93 VCR analyzer, in original cartons, never turned on. $3,000.00 firm. *Contact: Bob, 217-423-5700.*

Howard W. Sams Photofacts from early 1940 to 1970. Make an offer. *Contact: Freddie, 214-231-4520.*

Sencore, Tentel, Fluke, Tektronix, Philips, Heath test equipment, office equipment, parts, and more. Retired from business. SASE. *Contact: Bob Kovaleski, 55 Edgewood Avenue, Clifton, NJ 07012.*

Tenma 20 MHz oscilloscope, dual trace with probes, $200.00. Fluke 83 DMM with leads, $130.00. B&K CRT analyzer model 480 with many adapters, $380.00. *Contact: Bruce, 508-977-3154.*

Like new Sencore test equipment SC60 dual trace scope, FC51 1 GHz counter, PR57 Isol transformer, DVM 56 multimeter, and more. Cost minus 70% OBO. Also, CATV taps, splitters, Jerrold SJ5 2W amp, WWV receiver FM mod, connectors. *Contact: 813-784-2271.*

Superior variable transformer, 0-135Vac, 7Amp $60.00. Heathkit IG-57A, RF/IF sweep generator, $165.00. *Contact: Walt, 616-599-3220.*

WANTED

Main power transformer and schematic for Rock-Ola Juke Box, model #452 serial #522321. *Contact: J. Harris, 76 Lillian, Yorkville, IL 60560.*

RCA stereo receiver MSR 140, tuner pack assembly, part # 174252. *Contact: Richard Zabell, 202-638-7900 ext. 105, daytime.*

Sanyo JV688 stereo integrated amplifier, need service manual or schematic. Will pay for copy or will copy and return. *Contact: George Columbo, 4185 Louisiana St. #3, San Diego, CA 92104, 619-296-7577, or gcolumbo@ix.netcom.com.*

New A.A or quality rebuilt A. Sony 470DLB22 picture tube. *Contact: Ron's Electronic Service, 345 High Avenue. Jefferson, IN, 53549, 414-674-2029.*

Hitachi flyback, 2431913, or model CK-200 (GTX chassis) with good flyback. *Contact: Garbis Saatjian, 5612 Marburn Ave., Los Angeles, CA 90043.*

JVC model RX-9 computer controlled receiver, need access to service manual. JVC advises manual no longer available. Will pay for loan or copy, (your terms), postage and phone call. *Contact: Charles W. Morgan, 646 Devon Drive, Nashville, TN 37220-1911, 615-834-2628.*

Panasonic C-2600 satellite receiver in good working condition. *Contact: Ron Tsubota, 130 Douglas Road, Ontario, OR 97914, 503-262-3422.*

Good used CRTS - 510YT-B22A, CPJ 370 BV B&K TV-TC. *Contact: Samuel Pearlman, 7513 E. Camino De Querabi, Tucson, AZ 85715-4265.*

Shell/cartridge mount dual turntable model 128. ZB-17 EVG replacement. *Contact: Dan Palmer, 3438 Alvin Kirby Rd., Timmonsville, SC 29161, 803-346-5107.*

Spilsbury SBX-11A and Marconi CP24, CP34 HF SSB radios for parts, SMATV Modulators and single channel bandpass filters, #20 stranded Teflon wire, Motorola HT-1000 software. *Contact: Rejean Mathieu, 1823 3rd Avenue, Val D'or, Quebec J9P 4N7, 819-874-1049, fax 819-874-0704.*

Sylvania CK3000 test jig or high voltage focus divider for this jig. State price. *Contact: Happy Valley TV, 501 Rossevelt Street, Exeter, PA 18643.*

Toshiba type - channel selector switch (Sears - part # 46-69657-3) for model #56242060801. Fiche viewer/projector Micro-Corp model #760 or any make of fiche viewer. *Contact: M. Fischer, 2947 N. Spruce Road, Pulaski, WI 54162, 414-822-5458 (after 8P.M. central time zone).*

Sencore test equipment of all types. Will pay cash for quality test equipment. Must be in good condition. *Contact: Lance, 605-361-6386.*

SciTech SEG-21 need service manual or schematic. Magnavox AR9160BK special effects generator/Genlock system. *Contact: Jack, 5262 US RT. 50, Fayetteville, OH 45118, 513-875-2909.*

RCA CTC 72N, model ET396W, need VHF tuner KRK 199. *Contact: George T. Fogelman, 1201 Idlewilde, El Paso, TX 79925, 915-778-0997.*

Technics power unit model SH-10E for a Technics direct drive turntable model SP10 MKII. The manufacturer claimed this to be a discontinued 1978 model. *Contact: McDonald Pinder, 1-800-524-8884 Ext. 268.*

Multitech model MP-020 VHS videocassette player, service information needed. *Contact: T. Gratkowski, 5 Gross Lane, Easthampton, MA 01027, 413-527-2894.*

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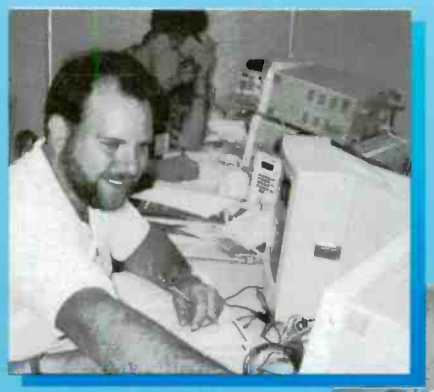

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- What video patterns to use to accurately identify failures

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