THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS

ELECTRONIC T.M.

Servicing & Technology

January 1991/$3.00

TV servicing using an external power supply

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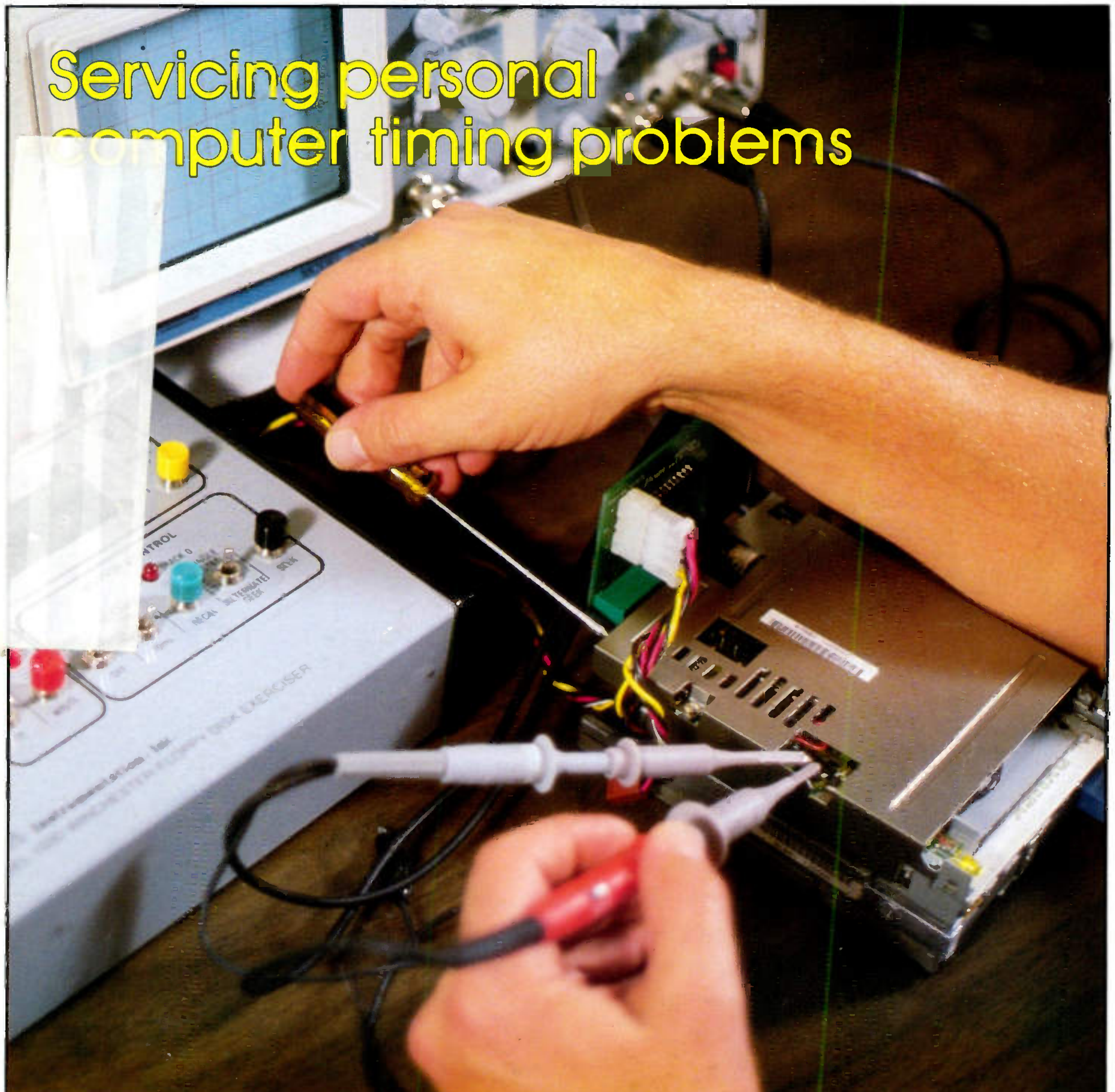

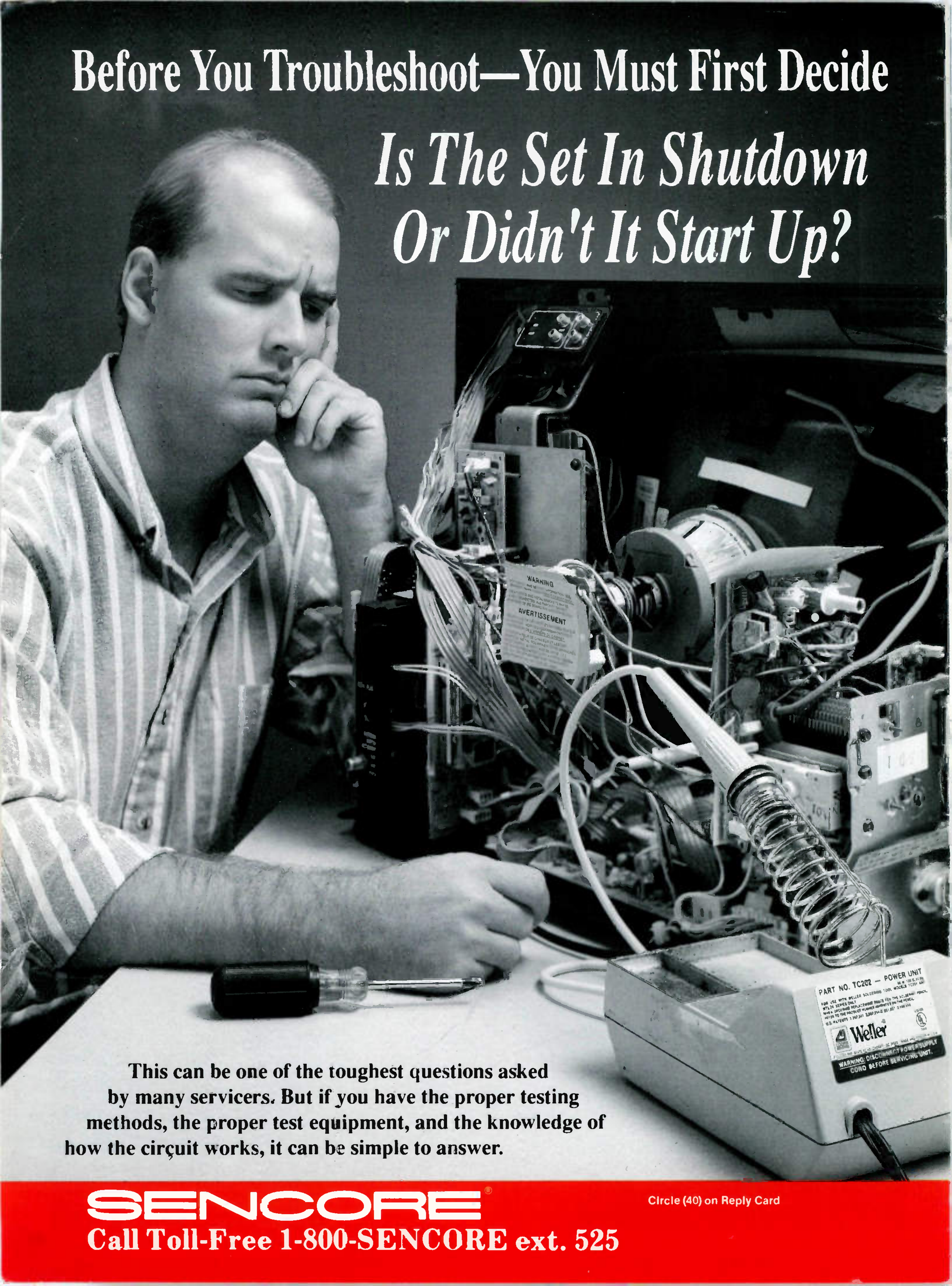
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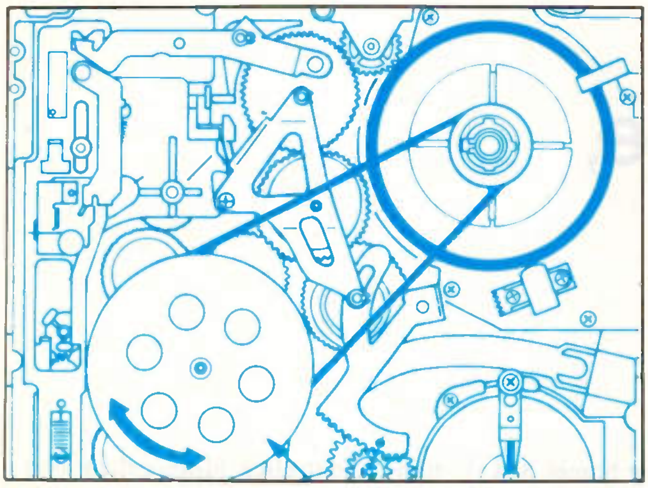

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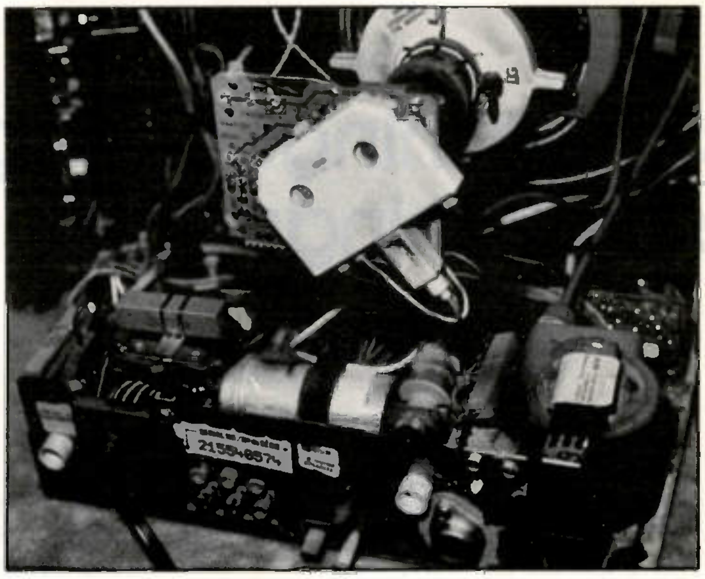

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FEATURES

1990 EDITORIAL INDEX

Here's our annual update on the articles, departments and Profax published in 1990. The Profax directory contains a special feature requested by many **ES&T** readers—a listing of Profax since the beginning, cross referenced by month, Profax number and company name.

DEPARTMENTS

ON THE COVER

Servicing personal computers can be difficult and frustrating because there are so many things that can go wrong. Software problems can masquerade as hardware problems and vice versa. An awareness that such problems may exist, and availability of the correct performance information and test equipment, will help determine where the problem lies. *(Photo courtesy of National Advancement Corporation).*

THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS
ELECTRONIC Servicing & Technology

Some things change, some things don't

It's the start of a new year, and the temptation is strong to look back and try to make sense of the previous twelve months (or more) from the perpesctive of time, and to look forward to see what we think the future might bring. So why not give in to the temptation?

1990 was a very eventful year for **ES&T**. It started out the year owned by Intertec Publishing in Overland Park, KS a suburb of Kansas City, MO and on April 1, was in the hands of CQ Communications, Hicksville (Long Island), NY. We promised you at the time, nothing about the magazine: editorial content, look, subject matter covered would change. It hasn't.

And of course, the editor hasn't changed either. And I'm still in Kansas. I've been with **ES&T** for almost nine years. In fact, In February of this year, just next month, it will be nine years. And looking ahead just a little, I hope to be editor for at least nine more years. Becasue of the nature of the magazine, editing it is a constant challenge because of the need to keep up with the changes not only in technology, but in the fortunes of the consumer electronic servicing community. But because of all the feedback we get that the information we publish is helping service centers cope with those changes, it's very rewarding.

In fact looking back at all of the changes that have taken place during those nine years it's really staggering. Compact discs, just beginning to emerge in 1982 have become the standard source for recorded music, making the turntable practically obsolete. Home video was in its infancy in 1982, and only a few homes had VCRs, hardly anyone had a video camera and only a relative handful of movies had been recorded on 1/2-inch tape.

Personal computers of 1982 were interesting and fun, but not really very useful, compared to the information processing powerhouses that can today be purchased by almost any household.

In the video game arena, the fortunes of Atari and producers of software for their products grew and then waned, and Nintendo has become the standard. For now. And don't forget what an impact that the introduction of cellular telephone technology has made on personal communications.

I can hardly wait to see what further changes, waiting in the wings right now, will come about in the decade of the nineties. Here are just a few of the changes that we might see in the next few years: HDTV, home automation, delivery of audio/video/data to the home via fiber optics from your friendly telephone company and/or electric power company, direct broadcast satellite. Are you ready for these things?

Please make note of these changes. Starting in April of 1990 as a result of the purchase of **ES&T**, a few things *have* changed around here: addresses and phone numbers, among other things. There still seems to be a little confusion as to who to call or who to write to on specific subjects. Here's a rundown again.

For all matters that require the attention of the editor, such as press releases, article queries, technical questions, and the like, please call or send mail to:
Conrad Persson - Editor
Electronic Servicing & Technology
PO Box 12487
Overland Park, KS 66212

For routine mail, like Reader's Exchange, and other editorial-directed mail that doesn't require the editor's attention, send it to:
Jeff Uschok
Assistant Editor
Electronic Servicing & Technology
CQ Communications
76 N. Broadway
Hicksville, NY 11801

There has been a flurry of questions regarding subscriptions, and many of the readers with questions regarding their subscriptions have called the Kansas office. This just causes delays because I either have to refer the individual to the Hicksville office or relay the information. For any subscription-related problems, please direct your mail or call to:
Customer Service
Electronic Servicing & Technology
CQ Communications
76 N. Broadway
Hicksville, NY 11801
516-681-2922
Fax: 516-681-2926

If readers would keep these addresses and phone numbers in mind, and direct mail and phone calls to the appropriate destination, any questions or problems can be addressed and corrected in the most expeditious manner.

Nils Conrad Persson

Service dealers increase service business at the expense of sales

The ratio of service-only businesses participating in the National Professional Electronics Convention compared to sales and service businesses increased an outstanding 13% in 1990 over the previous year. This reflected a tendency of smaller electronics sales and service departments. The figures were part of a survey conducted by the National Electronics Sales and Service Dealers Association (NESDA) of dealers participating in the 1990 National Professional Electronics Convention (NPEC).

This trend away from retail is substantiated by a decrease in the median number of employees with no change in the number of technicians per business. The average number of technicians was six, the same number listed in the economic census of the US Department of Commerce.

Another big change uncovered by the survey was the upsurge of rental business. 21% of the businesses surveyed had significant rental business. The median rental revenue more than doubled during the year to the $100,000 -$199,000 category. Total annual revenue remained about the same: under $500,000 for service only businesses and $500,000 - $999,000 for sales, service, and rental businesses. 23% of the businesses surveyed had an annual revenue of more than $1,000,000.

There was also a change in the way the service businesses operate. Daily outside service calls decreased 33% from an avergage of six per business to an average of four. This probably had an effect on technician productivity, which increased from five completions per day to 5.5 completions. Technician wages also rose an average of 65 cents per hour to $14.43 for top technicians.

Product mix reflected the same trends. Those servicing TV and video remained unchanged at 94%. Dealers who sell video products decreased from 29% to 18%, while those renting these products increased from 10% to 17%. Fax machines, which were listed on the survey for the first time this year, are serviced by 31% of the dealers.

Heavy investment in test equipment was apparent in the survey. 56% purchased new equipment in 1990, and half of their test equipment is less than five years old. 30% of the dealers own over $30,000 worth of test equipment; 14% have an investment of over $100,000.

Payment for warranty service by the manufacturers appears to be moving toward an average. Best paying dropped from 82% to 80% of carry-in rate; lowest paying rose from 43% to 49%. Average reimbursement was 65% of the servicer's normal COD rate.

For a copy of the survey results, send a stamped, self-addressed envelope to the NESDA office, 2708 West Berry, Fort Worth, TX 76109. Information about the 1991 NPEC Convention and Trade Show, August 5-10, 1991, in Reno, NV, will be included with your reply.

EDS manufacturer participation advances

The Electronic Distribution Show and Conference (EDS) continues to live up to the dual roles of trade show and conference, as implied in its name, based on first-round space assignments for EDS '91. The 168 companies enrolled to date as "exhibitors" will participate in 141 exhibit floor spaces, 93 hotel suites, and 20 conference rooms.

EDS '91 takes place at the Las Vegas Hilton Hotel April 30th - May 2nd. More than 7,000 industry personnel are expected, including delegations from close to 90% of the nation's electronic distributorships.

David L. Fisher, executive vice president of the Electronic Industry Show Corporation, announced that the Space drawing - the first space assignment event since the close of EDS '90 last April - showed that manufacuters are not being scared away by the economy; exhibitor registration is clearly holding pace with last year at this time. Typically, 40 percent of EDS exhibitors are enrolled by the time of the Space Drawing, an equivalent number sign up after the first of the year, and EDS "sells out" by mid-March. ■

NAC announces component level PS/2 repair class

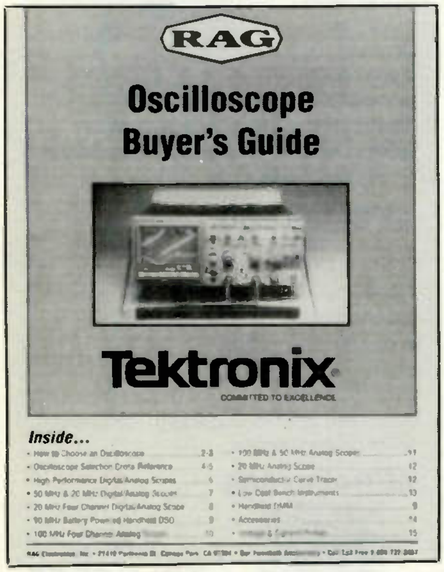
The National Advancement Corporation schedules their advanced PS/2 repair class for major cities across the country.

The National Advancement Corp PS/2 repair class focuses on chip level failures and repairs of PS/2 systems. This class contains the information technicians need to service PS/2 systems including where to find parts (including proprietary parts), rework centers, diagnostic boards and software, schematics, SMD soldering and test equipment, and how to service 3.5 inch drives. This class is backed by NAC's documentation; and one year of toll-free support, technical update and bulletin board services. The classes are on an intensive two-day, 8am-5pm schedule and the cost is $1075.

Circle (1) on Reply Card

Buyer's guide for Tektronix oscilloscopes

RAG electronics recently announced the availability of a free 16-page buyer's guide featuring Tektronix oscilloscopes and accessories. Also included are Tek's new low cost bench



instruments. Guide simplifies choosing an ocsilloscope, plus describes special features and terminology. Selection tables enable quick and easy comparison of both analog and digital models. Oscilloscopes are discussed in detail with differences between similar models clearly highlighted.

Circle (2) on Reply Card

Pace, Incorporated announces training schedule for U.S. training centers

Pacenter training teaches the skill and process control development techniques to perform high quality, non-destructive assembly and repair on all types of electronic modules and assemblies. Spanish language and bi-lingual classes can be arranged. Open enrollment for classes through June 1991 has been scheduled. Such classes include: Universal repair for electronics (PCT-200) an in-depth, hands-on, program covering Hi-Rel soldering, component removal, circuitry repair and ESD control. Other courses include multilayer and flexible circuit repair (PCT-300) an advanced, hands-on program covering the latest techniques needed for excavations, interfacial connections and internal conductor repairs, as well as the latest repair technology for broken conductors and land areas. Surface mount technology is also another course offered. Classroom reservations and tuition schedules may be obtained from Jane Gazaway at (301) 490-9860 or (301) 498-3252.

Circle (3) on Reply Card

Power newsletter

The new Power Monitor newsletter written by (BMI) Basic Measuring Instruments, is for field service engineers and managers who are concerned about reducing power cost and maintaining reliable operation of personal computers and other electronic devices. It includes articles on power quality and energy management applications and products, industrial topics such as harmonic distortion and power shortages, questions and answers about power-related issues, and power applications group meetings around the country. The monthly letter is free.

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Plan now for a successful 1991

By William J. Lynott

The first year of the nineties is over . . . and you made it. Now that 1990 has blended into history, why not take a hard look back. Was it a good year for your business? Did you meet your sales goals? Is the profit on your year-end P&L up to those projections you made a year ago? Did you hold the increase in your operating expenses within the 6% limit you set at the beginning of the year? Does your balance sheet reflect a healthier glow than it did when your year began?

What's that you're saying? You didn't set any specific sales goals for the year. You don't make profit projections. There's no sense in budgeting expenses because you can't do anything about them anyway. You don't have a balance sheet because your accountant wants to charge you extra for it. Thank heavens we found you in time.

Be assured that your malady is not unique—not even unusual. I know many technicians, turned entrepreneur who would rather have a root canal than fill out a report. Hands-on management is what interests many electronics service dealers. In fact, my experience leads me to believe that the average service dealer would rather use an oscilloscope than a calculator.

The trouble is that the average electronics service dealer is not as successful as he would like to be—and too often doesn't really understand why. After all, he's a good technician, perhaps even an outstanding one. He's honest. He tries to give his customers a fair shake. He treats his employees well. That ought to be enough. But it isn't.

At the risk of repeating what I've written in this column before, I'm going to remind you that service is a business. If yours is to provide you and your family with the kind of living to which you are entitled, it must be operated as a business.

If you already know these things, and if you are already providing your business with advantages of sound technical skills PLUS a grounding in business fundamentals, you may as well skip this month's column. Please accept my best wishes for another happy and prosperous new year.

On the other hand, if those opening paragraphs caused a slight twinge of conscience, why not take a moment to consider this: The relationship between financial success and sound business planning is not all theoretical. The two have been traveling comfortably hand-in-hand for years. They thrive in each other's company. The truth in this statement is so all pervasive that you would have a difficult time trying to find a truly successful, growing business that is not being guided by some sort of organized planning.

The trouble is that planning sounds too complicated for some entrepreneurs—not all that kind of work that people in the service business are most comfortable with.

Well, it may sound unpleasant, but it isn't that way at all. In a small business, planning is as natural as a smile, and almost as easy. Planning in your business can be as simple or as complex as you decide to make it and—this is important, any plan is better than no plan at all.

If business planning is new to you, just think of it this way. Your business can be broken down into two basic financial parts: income and expense. Planning is nothing more than preparing realistic (and sometimes inspiring) projections of expense and advanced goals for income. Along with the figures that you set to paper should be brief descriptions of how you expect to achieve your goals.

In practice, the most effective plans further divide income and expenses into categories. Income, for example, may be made up of labor sales, parts sales, warranty payments and service contract sales. Expenses can be broken down into categories such as technician payroll, other payroll, rent, utilities, supplies, etc. Your accountant can be a big help in deciding the number and type of categories best suited for your business plan.

In its most basic form, that's all there is to it. But don't be fooled by its simplicity. The planning process owes its success to a powerful instinct that lurks deep within most of us. For most people, a specific goal if it is realistic, acts as a driving force capable of producing results far beyond those we might normally regard as possible.

In other words, the creation of a specific goal helps in the attainment of that goal. Notice the word specific. It's very important here. Generalities just won't do the trick.

Until Roger Bannister crashed into the record books in 1954, the four minute mile was regarded by many to be beyond the capacity of human effort. Some medical experts, in fact, declared flatly that no human could ever run an elapsed distance of one mile in four minutes or less because of biological limitations. Once the barrier was broken, however, the four minute mile became almost as common as apples in autumn.

And there you have it: A specific goal and a plan for achieving it.

This time next year will you be resolving to prepare your first business plan, or will you be reviewing the results of your 1991 plan? The right answer to that question now might make a big difference to you next year.

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

Servicing personal computer timing problems

By Eric Nay

Many everyday problems with personal computers are the result of timing problems introduced by untrained people working inside the PC.

One problem that's commonly encountered is difficulty with system timing. To describe the nature of the problem, first let's do a bit of math (Don't worry, it'll be brief): For example, in a 10 MHz computer, the system clock pulses 10 million times a second. That means each clock pulse takes 0.0000001 seconds, or more recognizably 0.0001 milliseconds, 0.1 microseconds, or 100 nanoseconds. Every operation in this system will take place 100ns apart.

Now for a little bit about integrated circuits (chips). When a manufacturer produces chips, the plant does not have separate production lines for 20MHz chips and for 10MHz chips. Most chip makers only have one production line. They take a newly produced chip and try it at 20 MHz. If it fails at that speed they try it at 16MHz, 12MHz, 10MHz, and 8MHz until it passes. Once it passes (at any speed) the chip is labelled with that figure as its speed rating. The chip will function at that speed or slower. For most chips such as central processor units (CPUs) and direct memory access (DMAs) the label is in MHz (80286-8 for an 8MHz CPU chip). Dynamic Random Access Memory (D-RAM) chips, however, are labeled in tens of nanoseconds (41256-12 for a 120ns RAM chip).

Nay is a Senior Instructor with National Advancement Corporation. He has worked on PC systems as a bench technician, a field service engineer, a application programmer, and a network consultant since 1978.

SYSTEM CHIP SPEEDS

4.77MHz	209ns
6MHz	166ns
8MHz	125ns
10MHz	100ns
12MHz	83ns
16MHz	62ns

NOTE: Systems 16MHz and faster may use some form of Cache RAM or Interleaving of RAM, so may not fit this profile.

Because the manufacturer has already rated these chips based on the speed at which they will actually operate, if you try to run them faster than rated you are asking for trouble. I refer to this as relying on the "Fudge Factor." If you encounter problems such as Parity Check messages, NMI Interrupt messages, random lockups, Stack Overflow or Divide Overflow messages when you're servicing a personal computer, suspect that the RAM chips may be slower than the speed at which the clock is trying to operate them. Many small retailers of IBM compatible computers will try to convince you that several brands of RAM chips are rated below their capability and that therefore you can use them in a higher speed system. Don't believe them. If you try to use slower RAM chips (or any other speed rated chips) than what your system requires you're relying on a nonexistent fudge factor to get you by.

There are several chips in the system which are speed- dependent. These chips include the CPU, the Math Coprocessor, the RAM chips, the clock generation chip (8284 or 82284), and the Bus Control chip (8288 or 82288).

A note on RAM chips: Because each chip stores one bit of a given data word and the machine accesses information 8 bits at a time (16 bits for ATs), all 8 chips must be rated at the same speed. Actually, IBM-type machines use an extra chip for watching over the other 8 data chips. This process using a 9th chip is called parity checking. It is important to note that not only should all 9 chips be the same speed rating but should also be made by the same manufacturer, since different manufacturers rate their chips by different methods.

One method that will allow use of different manufacturers' chips is to test their speeds yourself using a RAM tester such as Computer Doctors' RamStar. Different banks of RAM in the system may be rated at different speeds, as long as each bank's speed is fast enough for the system clock.

Now that we have a handle on how to set up a system, let's throw a monkey wrench into the mess.

IBM created the AT in a cloud of dispute between the engineers and the manufacturers. Engineering wanted to make a 6MHz machine, and manufacturing wanted to make the machine cheaper per unit. Since RAM was one of the most expensive single pieces in the system, a decision was made to use a "wait-state" in the machine. Each time the CPU accesses RAM, the clock signal to the system is suspended for a period of time roughly equal to a 20% reduction in performance.

RAM CHIP SPEEDS WITH ONE WAIT STATE

6MHz 200ns or faster
8MHz 150ns or faster
10MHz 120ns or faster
12MHz 100ns or faster
16MHz 75ns or faster

This allows usage of slower RAM chips in the system. In fairness to IBM however, some method of speed control must be achieved because the RAM chips required in a system faster than 12MHz (80ns) are not commercially available in quantities required for the PC market. Wait states are one method of handling fast CPU chips, but two others have emerged in compatible machines.

The most prevalent approach to handling fast CPU chips with slower RAM chips is to use a very small amount (usually 16kb) of high speed RAM controlled by a Cache Controller such as Intel's 82385. The cache acts as a buffer between the high speed CPU and the relatively slow RAM. This cache controller monitors the CPU's actions and before the CPU can ask for information from memory the Cache controller has copied the information into the high speed cache RAM.

In cases where the cache RAM does not contain the needed information the Cache controller will put the CPU on "hold" until the information can be loaded into the cache controller. This "hold" is similar to a wait state, but typically 95% of the time this hold is not necessary. The third approach to RAM speed problems is to interleave the banks of RAM so that sequential reading of or writing to RAM will never access the same bank of memory twice. The only problem to this method is that you must have a lot of memory chips in your system to use this method, for example in an 80386 machine you must have 72 chips minimum.

A note on benchmark programs such as Norton's SI, Landmark's Speed, Golden Bow's VSpeed and others: Most of these programs can't distinguish whether a system has a wait state or not. Consequently, if you have a benchmark that assumes your machine has one wait state and the machine is actually 10MHz with zero wait states, it will say the system performs as a 12.7 MHz machine. Some of the more unscrupulous small retailers then say their system "runs with 12.7 MHz performance."

TV servicing using an external power supply

By Homer L. Davidson

One way to determine if a particular overloaded circuit is shutting down the chassis is to connect an external voltage source to that circuit. Because many of today's voltage sources are derived from the secondary voltages of the flyback transformer (scan derived), a defective component in these voltage sources may prevent the chassis from functioning.

For example, an RCA Variable Frequency Switching Power Supply, V1PUR, (see Figure 1) with an overloaded secondary voltage may remain dead when the switch is turned on. In the case of Sylvania's C9 series, the manufacturer recommends injecting a 24V external voltage source to service this section or make sure it's operating before trying to troubleshoot the Switched Mode Power Supply (SMPS).

In the chopper or converter type power supply circuits, an overload on the secondary of the chopper or converter transformer may shut down the chassis, destroy the converter or chopper output transistor, and never allow the set to start up. By injecting an external voltage source, these complicated power supplies can easily be repaired.

Hot and cold grounds

Beware of the TV chassis with separate "hot" and "cold" grounding systems used in many of today's television receivers. If you measure all voltages with respect to chassis ground, you'll get erroneous readings. In the Sylvania C9 chassis, the cold ground is in the secondary of the switched-mode power supply circuits. You should use the IF shield area as a ground (signal) reference

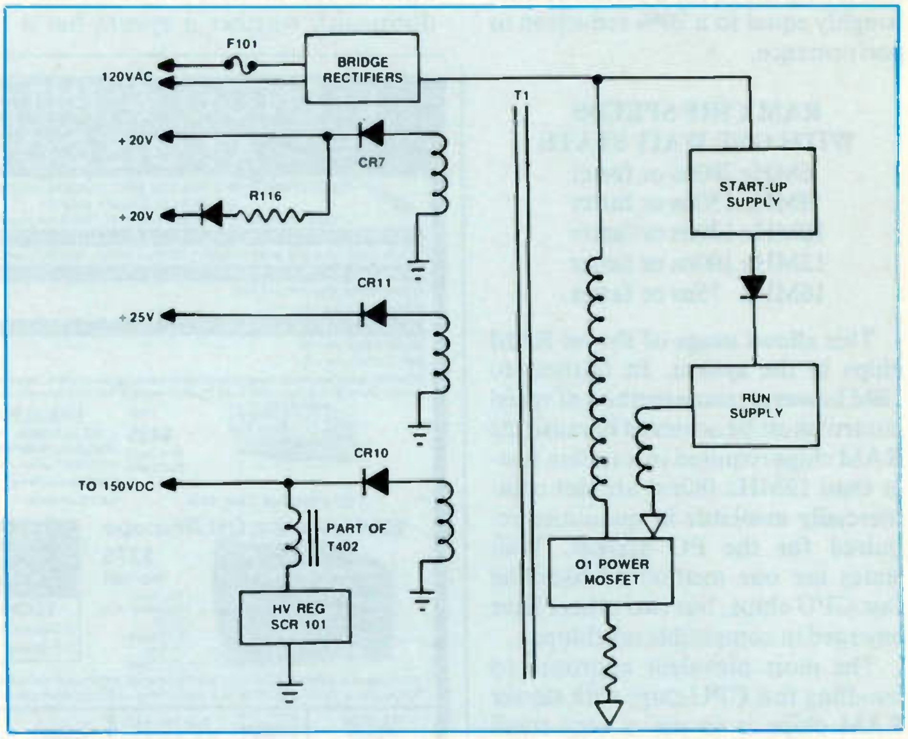

Figure 1. The block diagram of the RCA CTC130C (V1PUR) power supply circuits.

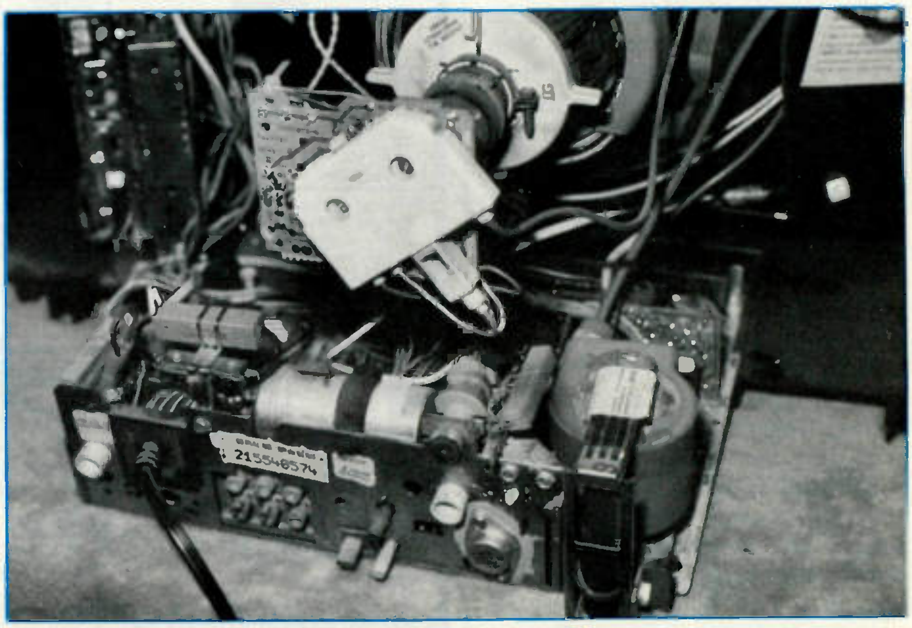

Figure 2. In today's solid-state chassis, scan derived voltages to operate many circuits in the TV set may come from the flyback transformer secondary winding.

Davidson is a TV security consultant for ES&T.

when taking readings in the "cold" circuitry of this unit.

The hot ground of the C9 chassis is on the primary side of the switched mode transformer (T401). When taking voltages in this section, use test point (TP19) as the hot ground. Do not use heat sinks for any ground connections.

In the RCA (V1PUR) power supply, the reason for employing the dual grounding system is to isolate the primary TV power supply, which uses a bridge rectifier, and consequently has a common point that is above earth ground potential, from the video/audio circuits cold ground. The hot ground circuit (150Vdc) supply develops the cold 150Vdc supply which is routed back to the main chassis. All voltages measured in the primary of transformer (T1) are hot, while the secondary voltages are common, cold, ground.

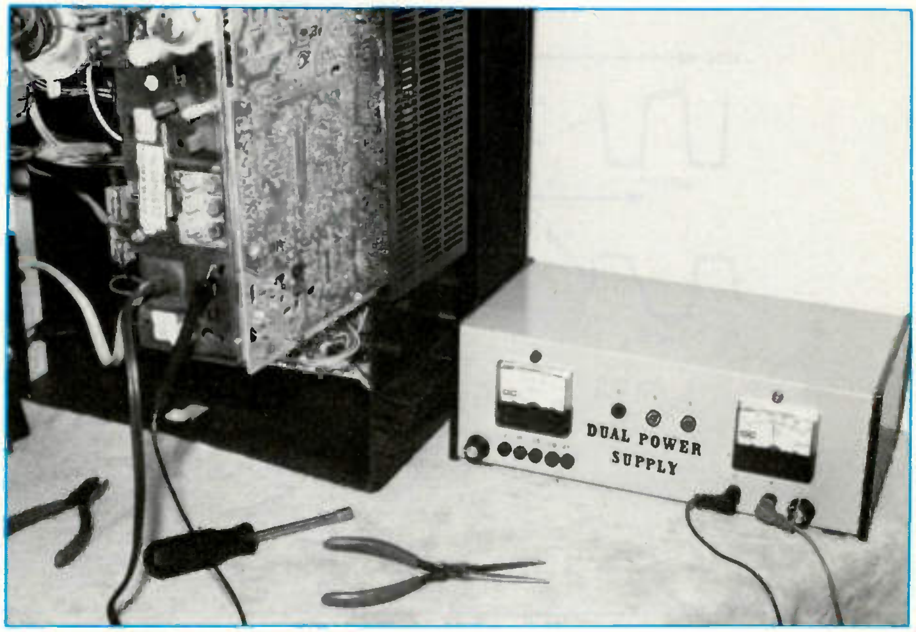

Figure 3. Select a power supply with a set of fixed voltages and another variable power supply, or two different variable voltage sources.

Connecting the external power supply

Locate the suspected defective circuit on the schematic and TV chassis. In most cases, the external voltage can be hooked into the circuit without clipping or separating the PC wiring. The voltage may be injected right at the cathode terminal of the silicon rectifier which supplies voltage to the defective circuit. Other times, you may want to inject the voltage right at the IC or transistor voltage supply terminal (V_{cc}). Remove one end of the diode to isolate the circuitry that you're servicing from the rest of the set.

Very small IC or transistor mini-hook or clip test leads are required to connect directly to the IC pin or transistor from the external power supply. Some technicians solder a short bare piece of hookup wire to the pc wiring where it connects to the defective voltage source, then connect the meter to the bare wire and common ground. This method of connection reduces the likelihood of shorting out the IC pins or transistor terminals.

The TV should be disconnected from the ac power supply while you're injecting external voltages. Use only the external power supply, DMM and scope. But don't forget to use the variable isolation transformer between the TV chassis and the ac line before attaching test equipment when testing out the circuits.

Sylvania's C9 (SMPS)

Always disconnect resistor R513 when servicing the Sylvania C9 switched mode power supply. This 10Ω, 7W resistor removes the + 130V applied to the flyback and horizontal output transistor, to prevent high voltage at the high voltage anode cable.

In many cases, a blown fuse (F400) will indicate a defective switched mode regulator transistor (Q400). When Q400 shorts, check the bridge

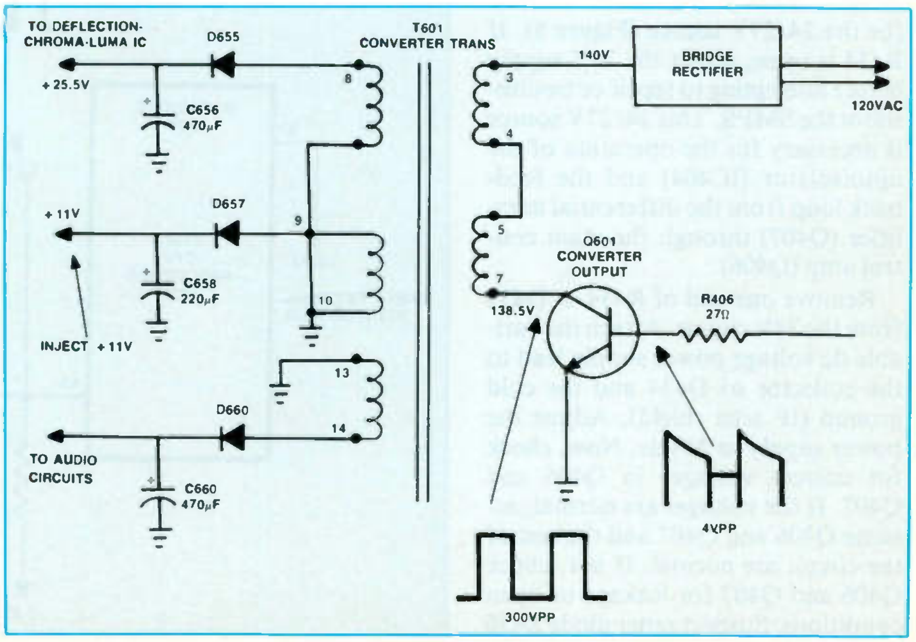

Figure 4. The converter output transistor (Q601) and transformer circuits in Realistic TC-1011 model waveform indicate if the converter power supply is working.

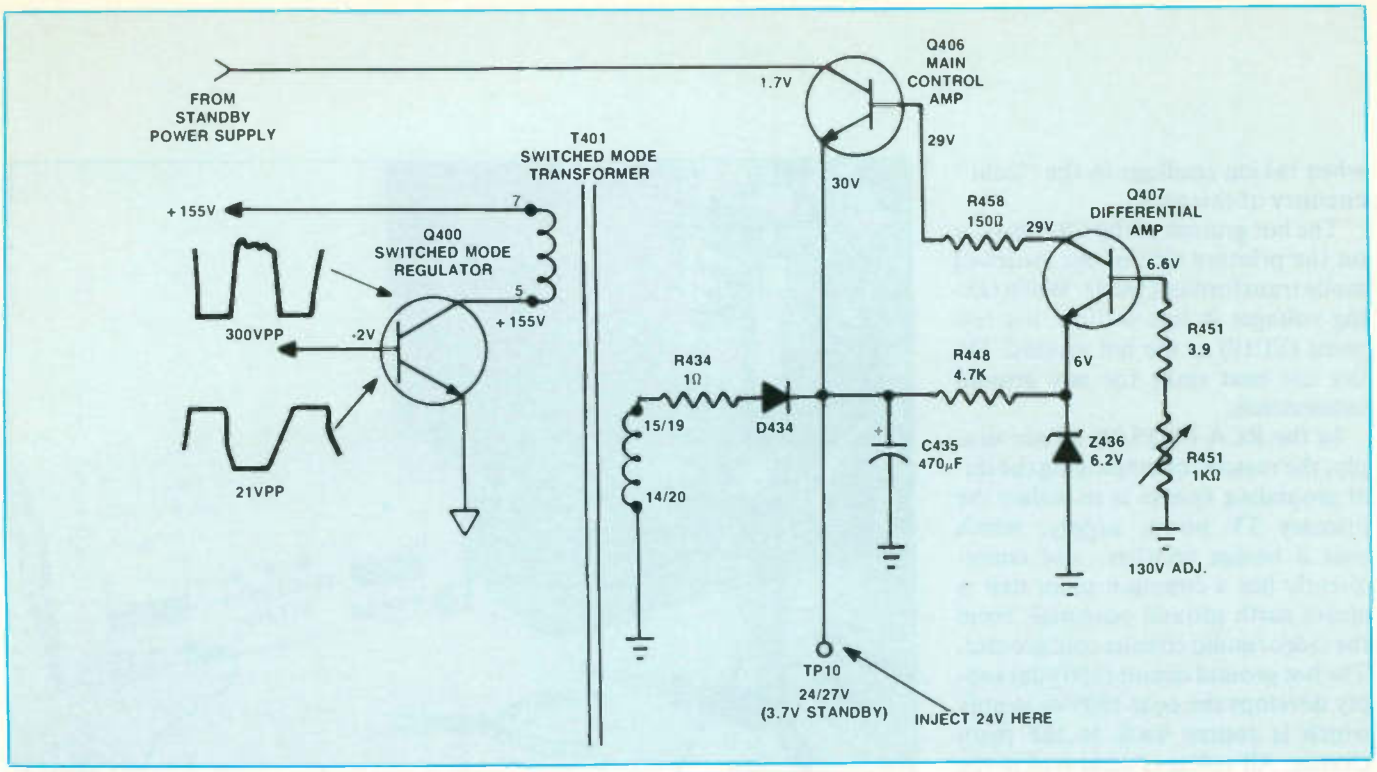

Figure 5. Inject an external 24V source at TP10 to see if the main control amp (Q406) and differential amp are functioning.

diodes D404 through D407. The shorted switched mode regulator transistor may destroy Q403 and Q402 in the feedback circuits. Always, check Q402 and Q403 when you encounter a shorted or leaky regulator transistor. Replace Q402 and Q403 if they are open or leaky. If not, the new Q400 will be destroyed when the chassis if powered up.

Also check R434 (1Ω) ahead of diode D434 for burned or open conditions. R434 is the fusible resistor for the 24/27V source (Figure 5). If R434 is open, repair the 24V supply before attempting to repair or troubleshoot the SMPS. This 24/27V source is necessary for the operation of the optoisolator (IC404) and the feedback loop from the differential amplifier (Q407) through the main control amp (Q406).

Remove one end of R434 or D434 from the 24V circuit. Attach the variable dc voltage power supply lead to the collector of D434 and the cold ground (IF area shield). Adjust the power supply to 24Vdc. Now, check for correct voltages in Q406 and Q407. If the voltages are normal, assume Q406 and Q407 and the rest of the circuit are normal. If not, check Q406 and Q407 for leakage or open conditions. Suspect zener diode Z436 (6.2V) if the 6 volts is low on the emitter terminal of Q407. Double check filter capacitor C435 (470μF) when the 24/27V source is low. Check TP10 for 24/27V source.

RCA's CTC157 horizontal IC deflection circuits

In most TV chassis with scan derived secondary voltages powering the horizontal oscillator IC or transistors, the horizontal and flyback circuits must operate before the chassis will run. The secondary voltage from the flyback transformer supplies the supply voltage to the horizontal oscillator. If the startup - deflection - regulator power supply will not start

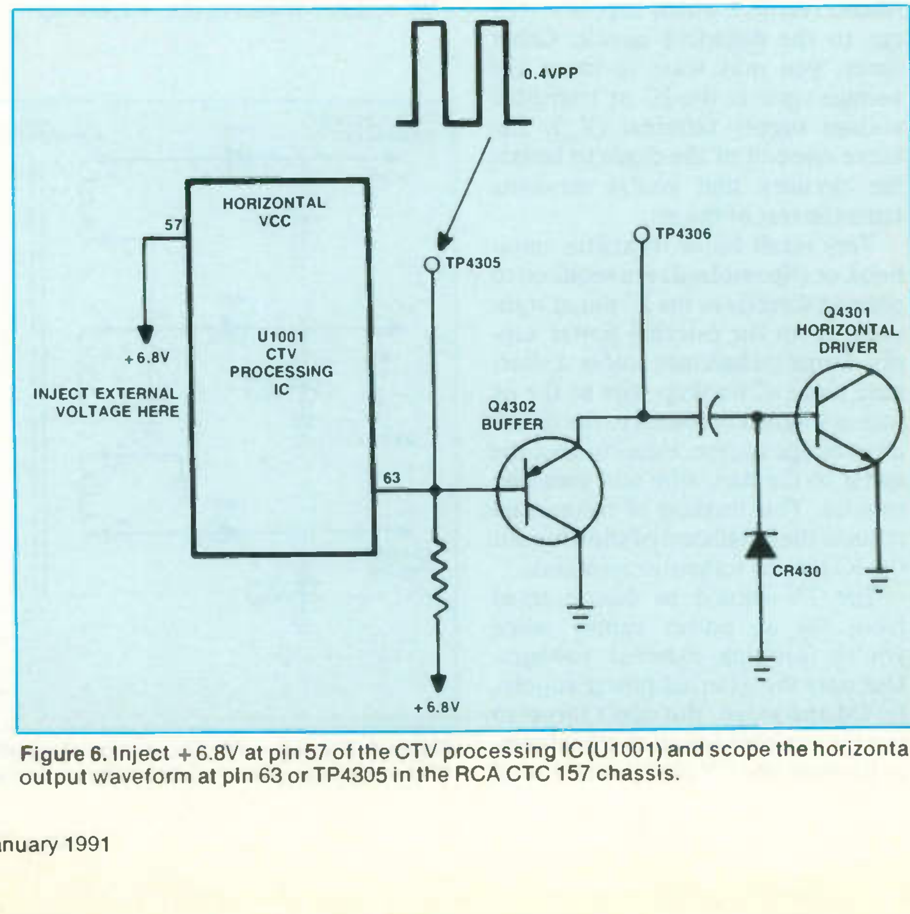

Figure 6. Inject +6.8V at pin 57 of the CTV processing IC (U1001) and scope the horizontal output waveform at pin 63 or TP4305 in the RCA CTC 157 chassis.

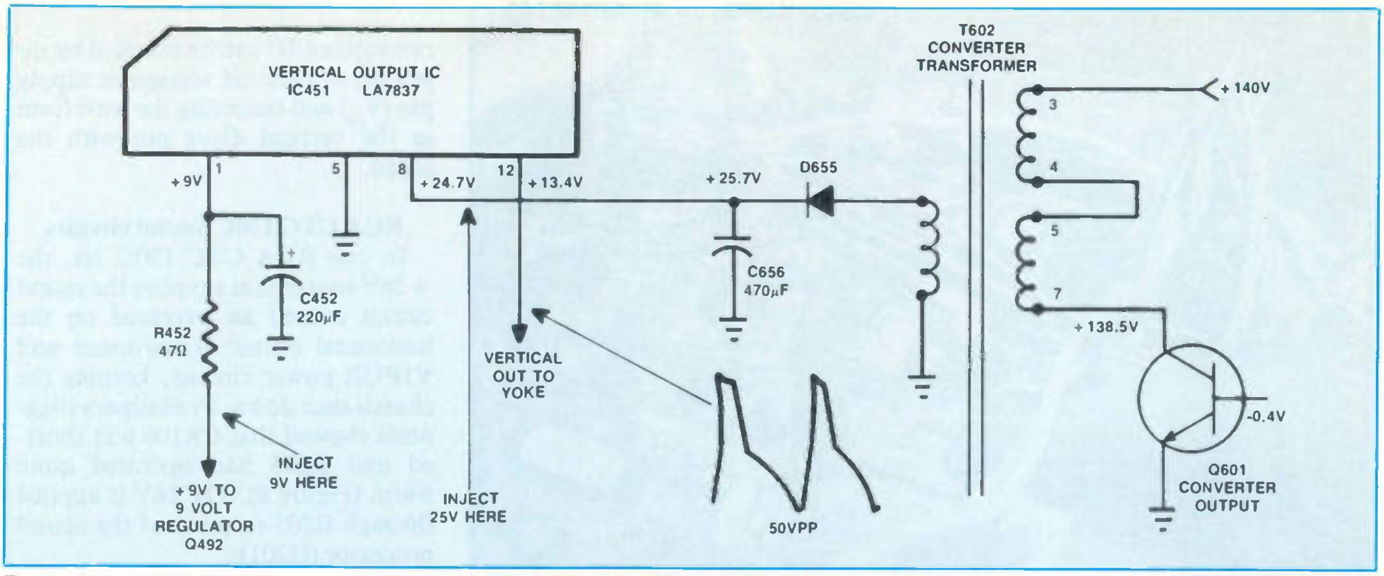

Figure 7. The vertical oscillator and output circuits may be checked by injecting a 9V and +25.7V into IC 451 and scoping the output waveform at pin 12 in the Realistic TV-10 mode.

up in the RCA CTC157 chassis, you can determine if the horizontal oscillator section is working using external voltage injection (Figure 6). Just about any horizontal oscillator section can be checked with this method.

Inject +6.8V at supply pin 57 of CTV processing IC (U1001) and observe the horizontal output waveform at pin 63 or TP4305. You should have a square wave on the scope. Since the buffer amp is also connected to the +6.8V source, waveforms can be traced right up to the base terminal of the horizontal driver transistor (Q4301). If the power supply voltage drops when attached to pin 57, or if you don't see a square waveform, suspect a leaky deflection IC. Leaky U1001 may cause T4401 to shut down and never start up.

In some cases the waveform will appear at the horizontal oscillator pin for just an instant, when the chassis is turned on and may not start up. This may indicate that the problem is somewhere other than in the horizontal oscillator circuits.

Radio Shack TC-1011 19 inch vertical circuits

After replacing the shorted converter output transistor (Q601) in the primary circuit of the converter transformer (T602) and checking components in the start-up circuits, it was determined a defective component in one of the voltage sources was shutting the chassis down. After removing one lead of D655 from the circuit, the converter power supply began to operate without any vertical deflection. The 25.7V source fed directly to the vertical output IC451 (Figure 7).

When I connected the external supply to Pin 8 of IC 451, the problem in this circuit caused enough of an overload to shut down the external power supply. Checking the schematic a little closer revealed that two different voltage sources feed the vertical IC circuits: +9.1V and +25.7V. Applying an external +9V at pin 1 did not cause the vertical cir-

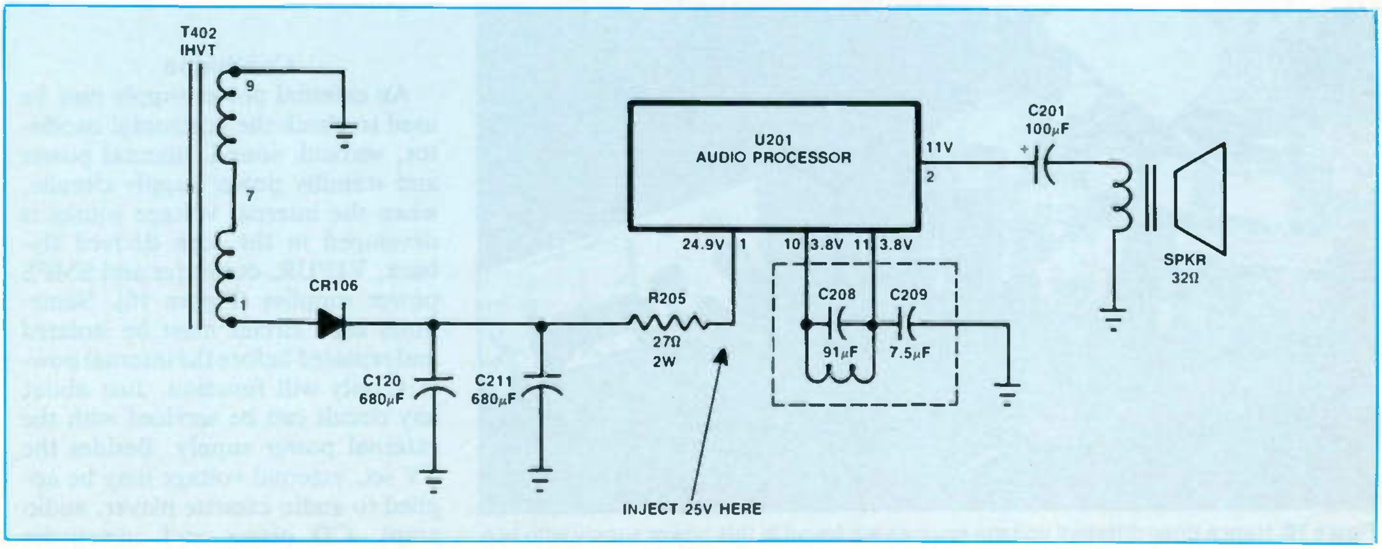

Figure 8. The RCA CTC130C sound IC was checked by injecting 25V at pin 1. R205 and CR106 were replaced.

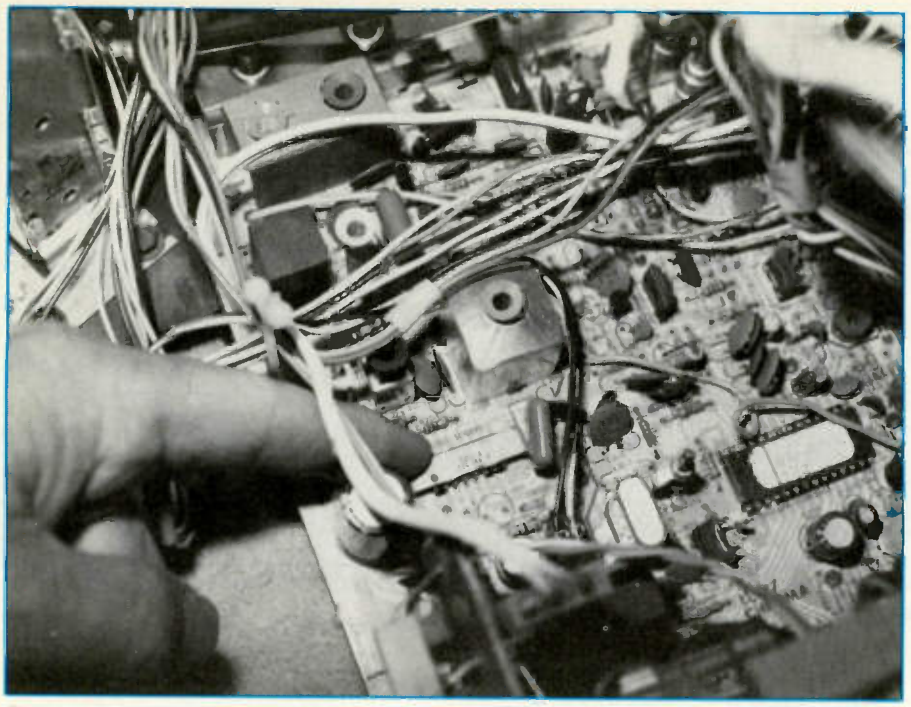

Figure 9. The finger points at the audio output IC within RCA's CTC 108C chassis.

cuits to operate. This combination of events pointed to IC451 (LA 7837) as the cause of the problem, so I replaced it.

After I replaced IC451, both external voltage sources returned to normal. When I injected a sawtooth waveform at pin 2, the scope waveform at pin 12 of IC451 indicated a normal vertical output pulse. After I reconnected the cathode lead of D655, the converter power supply operated properly.

Sometimes when the set is working and the chassis goes into a horizontal white line before shut down, suspect a defective component in the vertical circuits. The vertical oscillator or countdown IC can be checked by injection of external voltage at supply pin (V_{cc}) and observing the waveform at the vertical drive pin with the scope.

Figure 10. Here a three different voltage sources are found in this power supply with two variable sources and three fixed voltages.

RCA CTC 130C Sound circuits

In one RCA CTC 130C set, the +26V source that supplies the sound circuit caused an overload on the horizontal output transformer and V1PUR power circuits, keeping the chassis shut down. Preliminary diagnosis showed that CR106 was shorted and R205 had operated quite warm (Figure 8). The 26V is applied through R205 to pin 1 of the sound processor (U201).

I disconnected R205 from the circuit and applied 25V to pin 1 of U201. The voltage of the external power source went clear down, indicating an overloaded IC. Pin 1 measured 45.7Ω to common ground. I replaced U201 with the exact manufacturer's replacement audio output IC (175722).

I connected the 26V external supply to the cathode of CR106 and when I touched the center top of the volume control (R4201) the circuit produced audio. I replaced the shorted CR106 and R205, which had been overheated. The CTC 130C chassis was alive once again.

Although some of the earlier sound output transistors and IC components used higher voltage than may be available on a typical bench/lab power supply, most of today' sound circuits are below 30Vdc (Figure 9). Besides checking the sound stages in the TV, external voltage may be applied to audio circuits in stereo audio amplifiers.

Conclusion

An external power supply may be used to check the horizontal oscillator, vertical, sound, internal power and standby power supply circuits, when the internal voltage source is developed in the scan derived flyback, V1PUR, converter and SMPS power supplies (Figure 10). Sometimes each circuit must be isolated and repaired before the internal power supply will function. Just about any circuit can be serviced with the external power supply. Besides the TV set, external voltage may be applied to audio cassette player, audio amps, CD player and camcorder motor drive circuits. ■

Test your electronics knowledge

By Sam Wilson

Once again I am indebted to Mr. Thomas V. Vlazny of Milwaukee, WI for pointing out an error in the September TYEK. Motorola's name for Universal Asynchronous Receive/Transmit (UART) is Asynchronous Computer Interface Adapter (ACIA). The Peripheral Interface Adapter (PIA) is Motorola's name for Peripheral Input/Output). In the near future I will repeat some of the related questions to clear up any confusion that may have arisen.

1. A certain transducer has a specific dc output voltage that corresponds to a given temperature input. To use this transducer for a computer input you need

A. An A/D converter
B. A D/A converter

2. Which of the following transducers produces a dc output voltage related to a given temperature input?

A. Thermistor
B. Hall Device
C. Thermocouple
D. (None of these choices is correct.)

3. Hexadecimal MNEMONICS can be converted into machine language in

A. A PIO.
B. An assembler.
C. A PIA
D. An ACIA

4. Which of the following can be missing in a phase-locked loop?

A. An amplifier
B. A high-pass filter
C. Both choices are correct
D. Neither choice is correct.

5. Which of the following can be the output of a passive transducer?

A. Inductance
B. Capacitance
C. Resistance
D. All of the choices are correct.

6. A loudspeaker

A. Is an example of a transducer
B. Is not an example of a transducer

7. Which of the following is a type of motor used in clocks operated from the ac power line?

A. Synchronous
B. Brushless dc motor
C. Induction motor
D. All of these choices are correct.

8. In a superheterodyne radio receiver, heterodyning takes place in the mixer (or converter) stage. Name another section of a radio receiver where heterodyning takes place. ____________.

9. Refer to Figure 1. Which of the phasors is in the correct position to represent a series RC circuit?

A. The one marked (a).
B. The one marked (b).
C. Both choices are correct.
D. Neither choice is correct.

10. To save money, you and a friend divide a pie equally. You only eat one-fourth of your part, but you generously give your friend a fourth of your total share. Therefore, your friend got ____________ of the original pie.

(Answers on page 54)

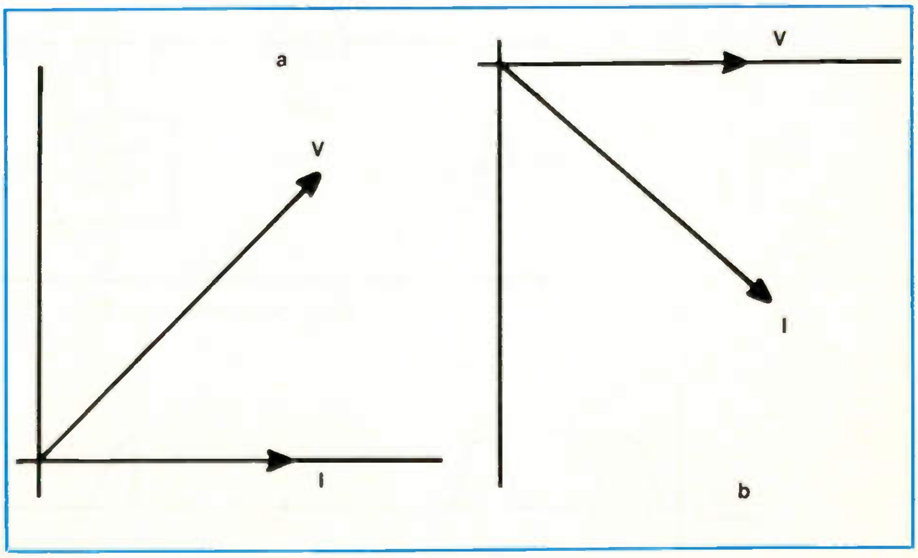

Figure 1.

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

Thyristors from A to Z

Part IV: Triacs, SCSs, PUTs and GTOs

By Bert Huneault, CET

The first three parts of this series discussed SCR theory and applications. This concluding article takes a look at four other types of thyristors: the triac, silicon controlled switch (SCS), programmable unijunction transistor (PUT); and gate turn-off thyristor (GTO) also known as gate controlled switch (GCS).

SCRs aren't always the answer

The fact that the SCR is a rectifier can be a disadvantage in certain applications. For example, in an ac operated SCR lamp dimmer, the current flowing through the lamp is half-wave current at best. This is illustrated in Figure 1; the unidirectional thyristor allows current to flow only one way through the lamp.

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If the control in the timing or phase control circuit is adjusted for maximum brightness, the SCR fires at the beginning of each positive alternation of applied voltage, resulting in maximum duty cycle and maximum average current through the lamp; see Figure 1(B). But note that the duty cycle cannot exceed 50% because of the rectification performed by the SCR; no current flows during the negative alternation of line voltage. Obviously the lamp can never glow with its full rated brightness. Reducing the brightness control setting would delay SCR triggering, resulting in a lower duty cycle, as in Figure 1(C); the lower average current would reduce brightness even further.

Is there no way around that problem? Can we not come up with a lamp dimmer circuit that would allow, say a 100W light bulb to glow with the full brightness expected from such a lamp at maximum setting of the brightness control? The answer is yes indeed. One way would be to connect two SCRs in an inverse-parallel configuration, as in Figure 2.

This way, lamp current would flow during both alternations of input voltage. But that would be doing it the expensive way. A more practical approach is to rely on a different member of the thyristor family.

Triac to the rescue

As its name suggests, the triac is a three-terminal thyristor designed for switching ac loads. Because it is a bidirectional device, it can solve our light dimmer problem, as we'll see shortly. But first, a word about the device itself.

The triac is a five-layer device that functions like two SCRs in inverse-parallel connection. Figure 3(A) shows that when terminal two (T2) is

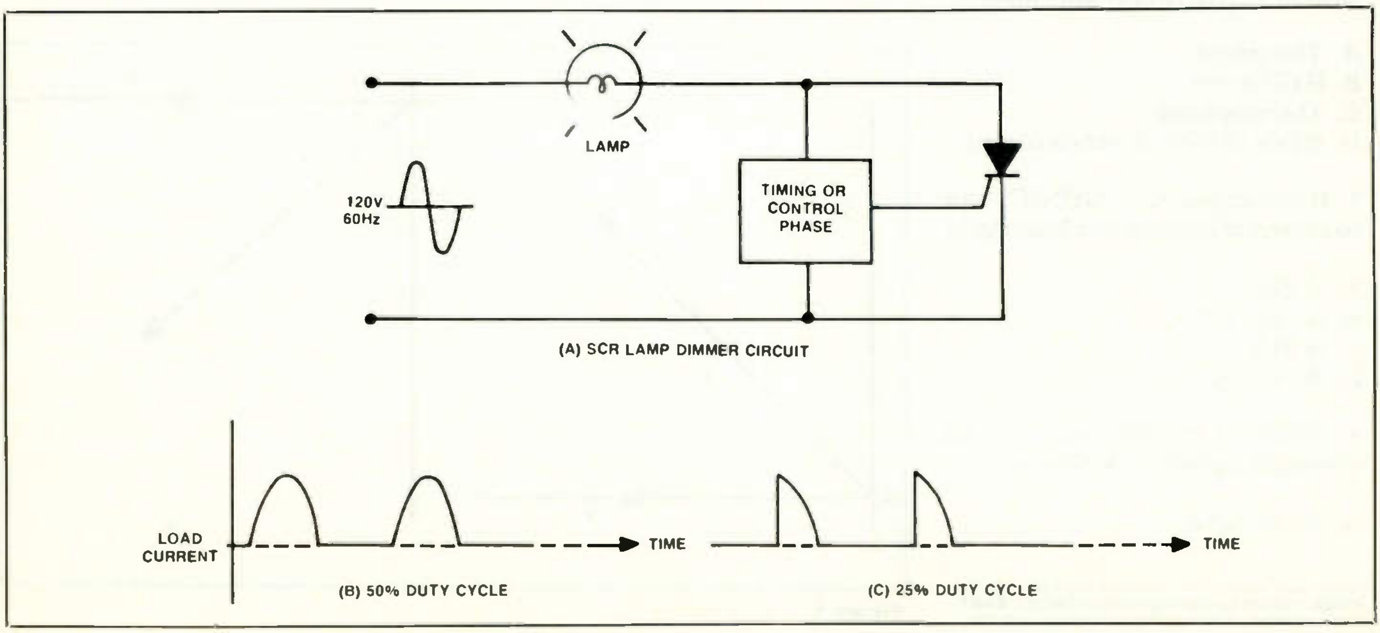

Figure 1.

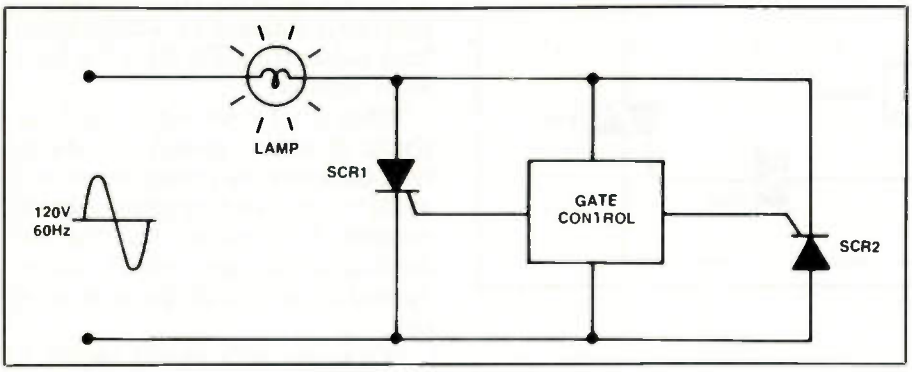

Figure 2.

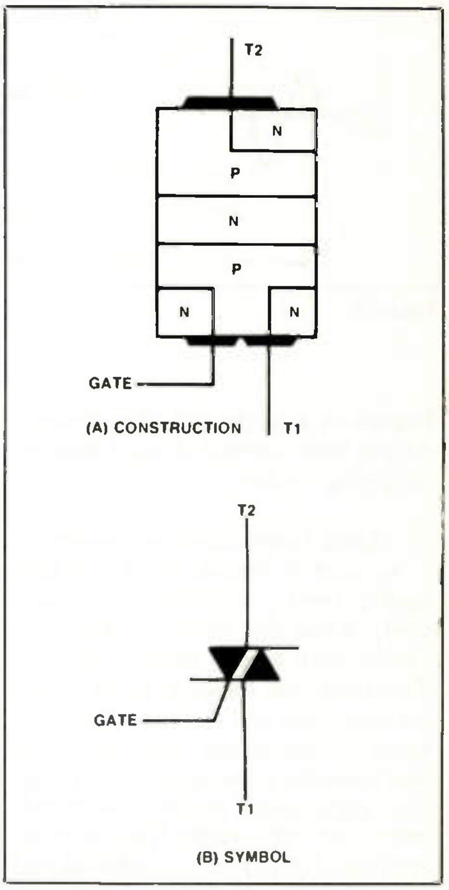

Figure 3.

positive in relation to terminal one (T1), the thyristor is essentially a PNPN device whose top P layer acts as the anode, and whose N section of the T1 bottom layer acts as the cathode. Electrons can flow from T1 to T2, just as in an SCR.

When applied voltage makes T2 negative relative to T1, the thyristor is essentially a NPNP device whose top N layer acts as the cathode and whose P section of the T1 bottom layer acts as the anode. Electrons can then flow from T2 to T1. Note that the gate is common to both "SCRs." Figure 3(B) shows the standard triac symbol.

Because the triac can block voltages of either polarity, or conduct current in either direction, it is used for switching and/or controlling ac current.

The triac will conduct when T2 is positive in relation to T1 and the gate is made positive relative to T1. When T2 is negative relative to T1, the triac will conduct if the gate is negative with respect to T1.

Actually, the triac can even be triggered with either polarity of gate voltage, during either polarity of T1-T2 voltage, but its sensitivity to gate voltage is greatest for the aforementioned conditions.

As is the case in the SCR, the triac is triggered on when sufficient gate current flows. When the thyristor latches on, the gate loses control; we can then remove the gate voltage and the triac remains in the on state. The only way to switch off a triac is to allow the T1-T2 current to drop below the minimum "holding" value (I_H). Of course, in 60Hz ac circuits, the condition is met automatically at the end of every alternation, when applied voltage drops to zero.

Triac light dimmer

We can now get back to the lamp dimmer and solve our problem by replacing the SCR of Figure 1(A) with a triac, as in Figure 4.

Because current flows in both directions through the triac, full-wave (ac) current flows through the lamp; the latter can therefore operate at its full brightness rating. Note that the load could just as easily be a heater, or a universal motor, instead of a lamp or a parallel bank of light bulbs.

Figure 5 shows the complete circuitry of a lamp dimmer featuring phase control. R1, R2 and C1 form a phase shift network whose time constant determines the exact moment when the diac breaks over, allowing a sudden pulse of gate current to flow in the triac and firing the latter into conduction. The conduction angle (duty cycle) of the triac — and therefore the power in the load (lamp brightness) — can be varied by adjusting R1. Figure 6 shows the waveforms of load current resulting from three different settings of R1.

In (b), the triac turns on very early in each alternation (time t1), so that the load current is virtually sinusoidal. In (c) triggering is delayed until time t2 in each alternation, reducing the average current through the load. In (d) triggering is delayed even further, until t3, so that average load current is reduced considerably (lamp very dim). The waveforms also show that, once triggered, the triac

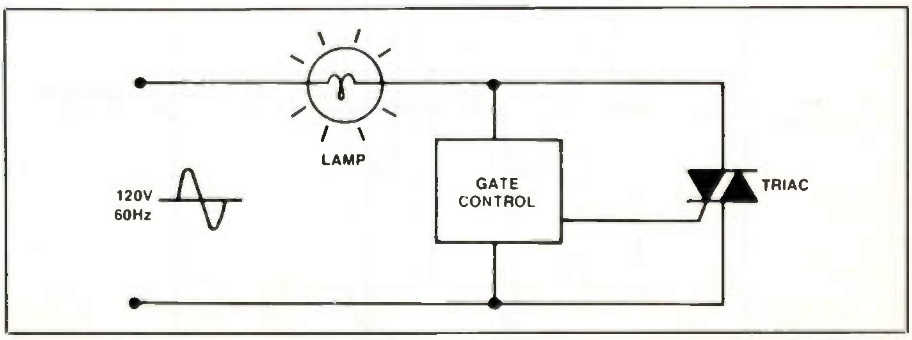

Figure 4.

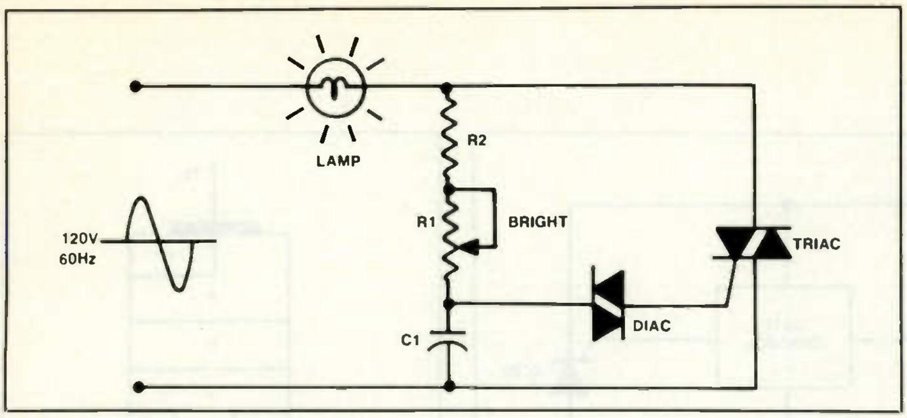

Figure 5.

latches on until the end of each alternation when current drops below its "holding" value.

Radio frequency interference

As seen in Figures 6(C) and (D), load current can increase very suddenly when the triac switches into conduction, e.g. at times t2 and t3. This rapid rise tends to shock-excite the inductive and capacitive components of the circuit into resonance and generate noise at radio frequencies, particularly in the AM broadcast band. This radio frequency interference (RFI) can be radiated and picked up directly by nearby radios, or carried through the power line to radios, TV sets, computers, etc. The same problem exists in SCR phase control applications. Metal enclosures, RF chokes and bypass capacitors are commonly used to reduce or eliminate the RFI, as shown in Figure 7. The capacitors are ceramic, rated at 200V or more.

Triac circuits in TV sets

Triacs can be used to control load power in ac circuits, such as in the light dimmer application just discussed; or to electronically switch ac power as described in the TV receiver examples which follow.

Automatic degaussing

Figure 8 is a simplified version of the automatic degaussing circuitry found in some color receivers. 120V ac is permanently applied to the degaussing coil, thermistor and triac connected in series. Gate voltage for the triac is obtained by rectifying flyback pulses from T1; D1 is the half-wave rectifier.

When the TV set is off, the horizontal deflection system is inoperative; therefore, no pulses are present at D1's input, and no gate voltage is available for the triac. The thyristor is effectively an open switch, and no current flows through the degaussing coil.

When the set's on-off switch is turned on, B+ is applied to the various circuits, and horizontal deflection starts up. D1 rectifies the flyback pulses and applies dc voltage to the triac, via gate limiting resistor R1. The thyristor switches on and current flows through L1, initiating degaussing action.

The triac switches off at the end of each 60Hz alternation because current falls below its I_H value when voltage drops to zero; but it turns right back on again in each subsequent alternation because gate voltage continues to be present.

As ac current flows through the degaussing coil, positive temperature coefficient thermistor R2 heats up. Its resistance gradually increases, causing the current to gradually decrease. Eventually the resistance of R2 becomes high enough to limit the current to a negligible trickle, and degaussing effectively stops. This action is repeated each time the set is turned on from a cold start.

Remote controlled ac power

Figure 9 shows part of the remote control circuitry of a TV receiver. Here the triac is used to switch ac power to the power supply rectifiers on the main chassis.

The remote receiver has its own power supply that is on permanently. When the on button is depressed on the remote transmitter unit an infrared digital signal is transmitted, and picked up by a photo sensor in the remote receiver. The output of the remote receiver is fed to the microprocessor which responds by applying a potential difference across its lines A and B. This potential difference energizes the LED which is optically coupled to a light dependent resistor (LDR) in the opto-isolator. The light photons cause the LDR's resistance

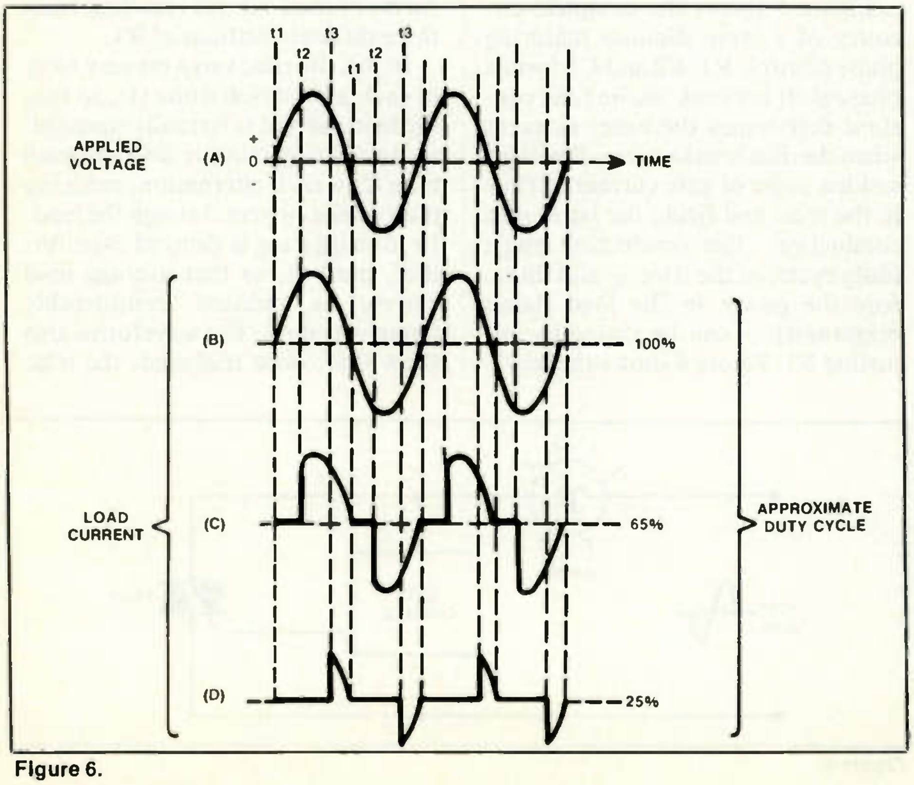

Figure 6.

to drop substantially, allowing sufficient gate current to turn on the triac; ac power is therefore applied to the B+ rectifiers on the main chassis.

When the off button is depressed, the microprocessor disables the dc voltage across lines A – B, causing the LED to turn off. With no light, the LDR's resistance increases dramatically, virtually cutting off gate current. The triac opens, switching off the ac to the power supply.

Like SCRs, triacs can be triggered by dc, ac, or pulses provided by diacs, neon bulbs or UJTs. Also like SCRs, triacs come in small, medium and large packages, with current ratings ranging from one or two amps to several hundred amps, and voltage ratings up to 1000V or so. The triac is also similar to its SCR cousin in another respect: its on-state voltage (across the main terminals) is very low — about 1 or 2 volts; in other words, it's a good switch, but not a perfect one.

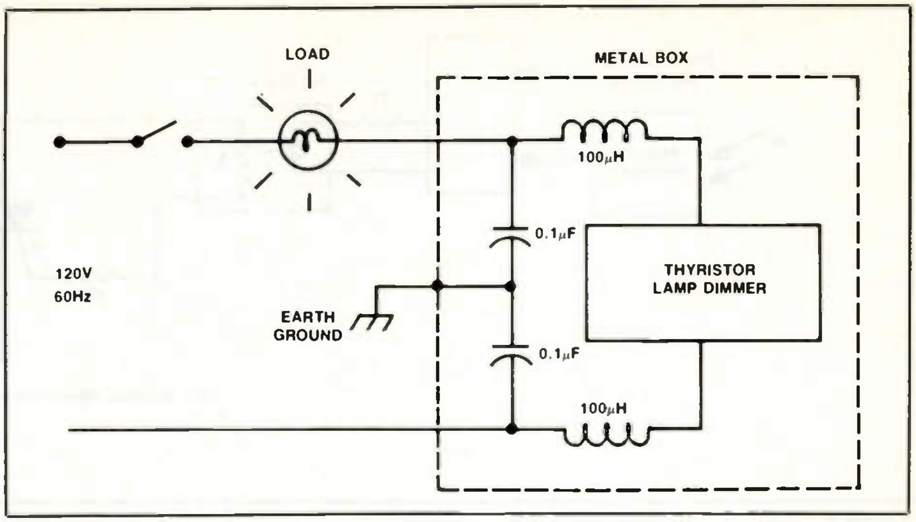

Figure 7.

Silicon controlled switch

The silicon controlled switch (SCS) is another four-layer PNPN thyristor encountered in some applications. It's like a small SCR (maximum current rating under 1A) but with two gates, as illustrated in Figure 10.

Like the SCR, the SCS can only conduct when its anode is positive in relation to its cathode. But since access to all four semiconductor layers is provided, the SCS is more versatile in switching characteristics and circuit configurations.

The SCS can be turned ON with a positive pulse applied to the cathode gate (just like an SCR), or with a negative pulse on the anode gate. Either way, a p-n junction gets forward biased, initiating internal regeneration just as in the SCR. The regeneration sustains the on state, and the SCS effectively becomes a closed switch.

The SCS can be turned OFF by a number of different methods, including the following:

1. allowing the cathode current to drop below the minimum "holding" value;
2. reversing the polarity of anode-to-cathode voltage (e.g. in ac circuits);
3. applying a negative pulse to the cathode gate;
4. applying a positive pulse to the anode gate.

Note that 3 and 4 represent a distinct advantage, compared to the SCR which doesn't feature gate turn-off capabilities.

SCSs normally feature greater triggering sensitivity than SCRs, i.e. they require less gate current. Thus a higher impedance triggering source can be used, with minimum gate loading of the source. They also feature shorter turn-off times than SCRs. Other interesting characteristics of the SCS are: the load resistor may be located in the anode circuit, cathode circuit or anode gate circuit; and if the anode gate isn't connected to any external circuitry, the SCS behaves much like an ordinary SCR. See Figure 11.

Note that if a gate is left open-circuited, it may be considered forward biased so that it is generally necessary

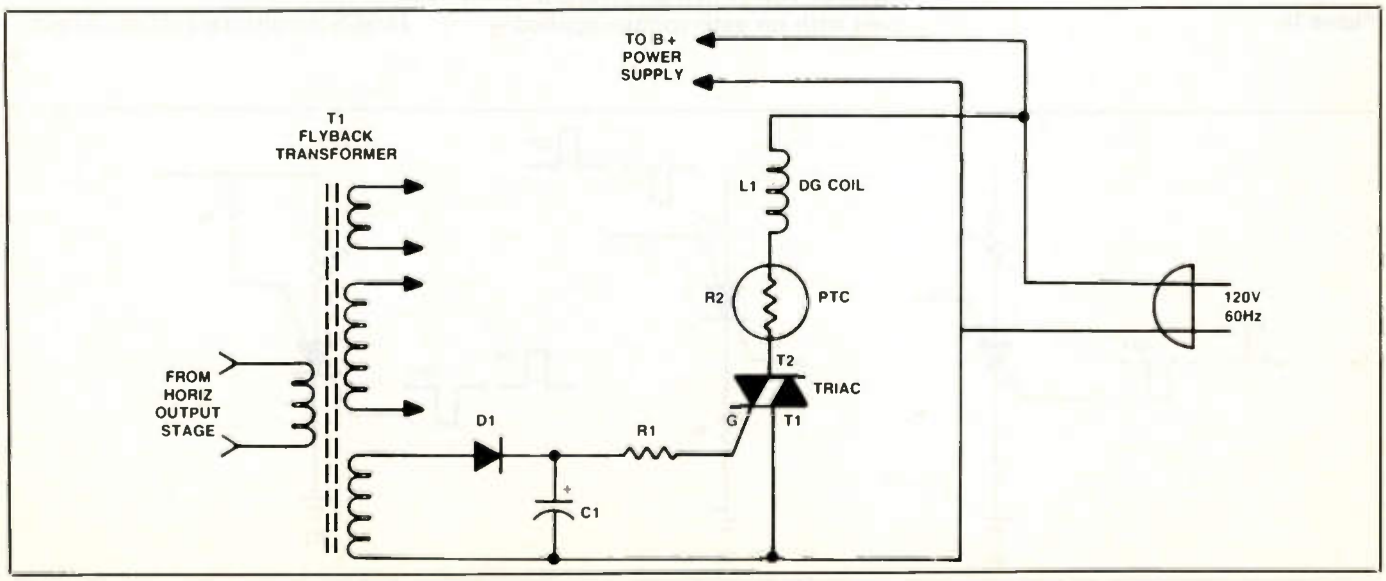

Figure 8.

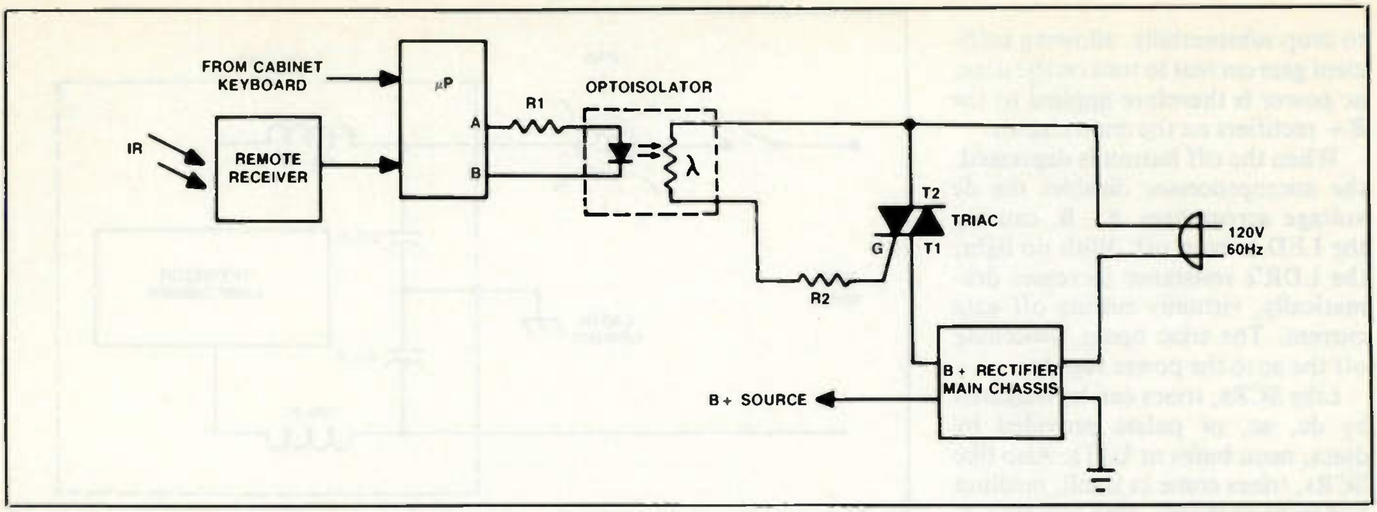

Figure 9.

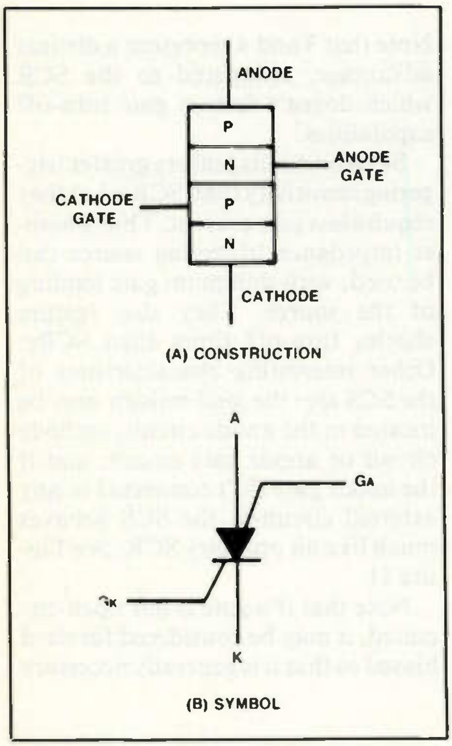

Figure 10.

to actually forward bias only one junction in order to turn on the SCS, the second junction automatically becoming forward biased by the resulting transistor action (regeneration) within the device. In applications where the load is located in the anode gate circuit, a resistor (R_A) is generally connected between the anode and the supply, to give the thyristor the proper gate turn-off characteristics, as in Figure 11(C).

SCSs are found in a variety of computer circuits, pulse circuits, voltage sensors, alarms, timing circuits; and even in the vertical deflection circuitry of some TV sets, where they function as sawtooth generators.

Rate effect

An important thyristor consideration not mentioned so far is "rate effect," also known as dV/dt. This phenomenon refers to the fact that a thyristor can switch on erratically—even with no gate voltage applied—if, for any reason, the rate of anode voltage change (dV/dt) is too high. For example, if anode voltage is suddenly applied or if there are voltage transients in the supply, an SCR can trigger unexpectedly. This is due to junction capacitances within the thyristor; if the rate of rise of anode voltage is high enough, capacitive charging current can initiate the internal regeneration which triggers the device on.

To avoid this false triggering, the rate of anode voltage change should not exceed the critical rate of voltage rise as published in data sheets. For example, a particular SCR might have a critical rate of 100V/µs.

One solution to the problem is to use an R-C snubber in the anode circuit of the SCR, as shown in Figure 12. If a high-speed switching transient appears on the voltage supply, the R1-C1 snubber circuit reduces its rate of rise.

In SCS circuits, rate effect can gen-

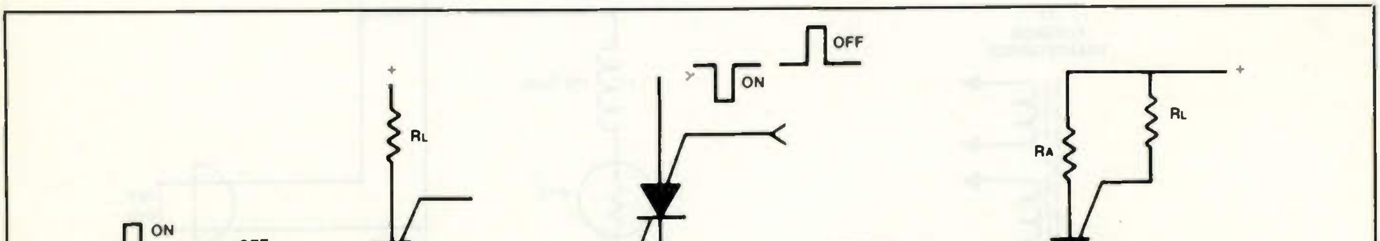

Figure 11.

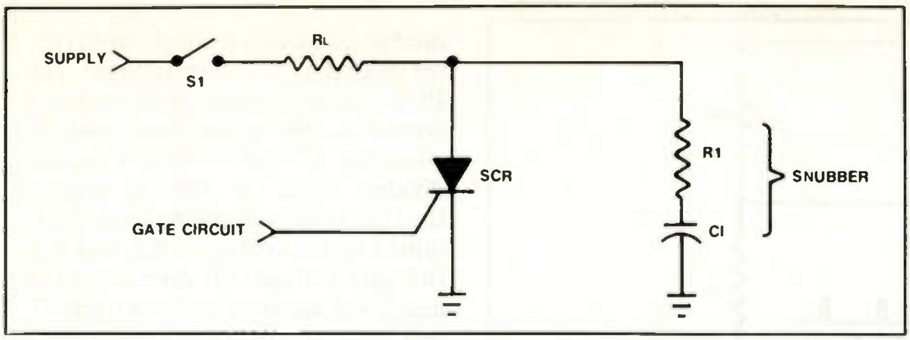

Figure 12.

erally be suppressed quite easily, e.g. with a 100K resistor connected between the anode gate and the supply (R1 in Figure 13). This allows the center junction capacitance to charge up when the anode circuit is open. As a result, rate effect does not occur when S1 is closed.

Programmable unijunction transistor

The programmable unijunction transistor (PUT) is, in reality, not a unijunction transistor at all; as a matter of fact, it contains three junctions! It's a thyristor (switching device) designed to simulate the UJT which it can replace; that's why it's called a unijunction transistor.

Because some of the device's characteristics such as internal resistance and firing voltage can be programmed (i.e. preselected or changed) by means of an associated voltage divider circuit, the thyristor is said to be programmable; hence the name "programmable unijunction transistor."

Figure 14 shows that the PUT is a four-layer PNPN device similar in structure to the SCR, but with the gate terminal connected to the N-layer near the anode rather than the P-layer adjacent to the cathode. The cathode corresponds to the base-1 terminal of a UJT, the anode to the UJT's emitter, and the gate to base-2 of the UJT.

Recall that a UJT switches into conduction when its P-type emitter becomes at least 0.6V more positive than the adjacent interbase N-type silicon. Likewise, the PUT fires when its P-type anode becomes at least 0.6V more positive than its N-type gate. When this happens, the internal regenerative dual-transistor feedback action (reinforcing action similar to that in the SCR) makes the thyristor suddenly switch into its low-resistance state. This switching action is very fast, the turn-on time of a PUT being about one-tenth that of a UJT.

In circuit applications, both the anode and the gate are kept positive in relation to the cathode. For the PUT to trigger, however, a certain amount of gate current must flow through the anode-gate junction. For this to happen, the gate must be negative with respect to the anode. If the anode-gate junction is not forward biased sufficiently (at least 0.6V), or if it is reverse biased (gate positive with respect to anode), the PUT remains in its blocking state. When the PUT triggers, its anode-to-cathode voltage drops to a very low level (e.g. one volt), just like the SCR's.

PUT relaxation oscillator

Figure 15 shows a basic PUT relaxation oscillator. Note that the gate is connected to the junction of R2 and R3. The R2/R3 resistance ratio determines the positive voltage at the gate. Just as in a UJT relaxation oscillator, capacitor C1 charges through variable resistor R1. The RC time constant determines the rate of charge. When power is applied, C1 begins charging, and as soon as its voltage makes the anode 0.6V more positive than the gate, the thyristor fires. For example, let's assume that the resistance ratio of the R2 – R3 voltage divider establishes a gate voltage of +4.0V. As soon as the charging capacitor attains a voltage of 4.6V, the N – type gate becomes negative in relation to the P-type anode, and the PUT switches into its low-resistance state. C1 discharges rapidly through the very low resistance of the thyristor and the low resistance of the cathode load, producing brief, high energy current pulses through R_L. The pulses can be used to trigger higher power thyristors such as SCRs and triacs.

Once C1 has discharged to a sufficiently low voltage and the discharge current drops below the PUT's "holding" value, conduction can no longer be maintained through the thyristor; the PUT reverts back to its blocking state. C1 then begins charging again, i.e. a new cycle begins. The R1 – C1 time constant determines the pulse repetition rate (frequency) of

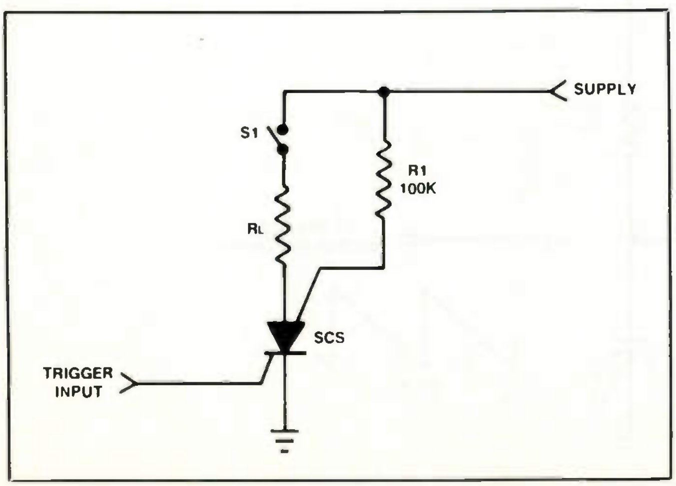

Figure 13.

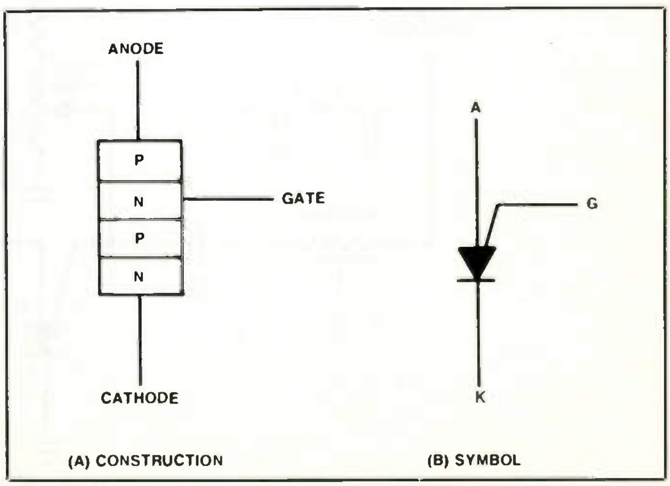

Figure 14.

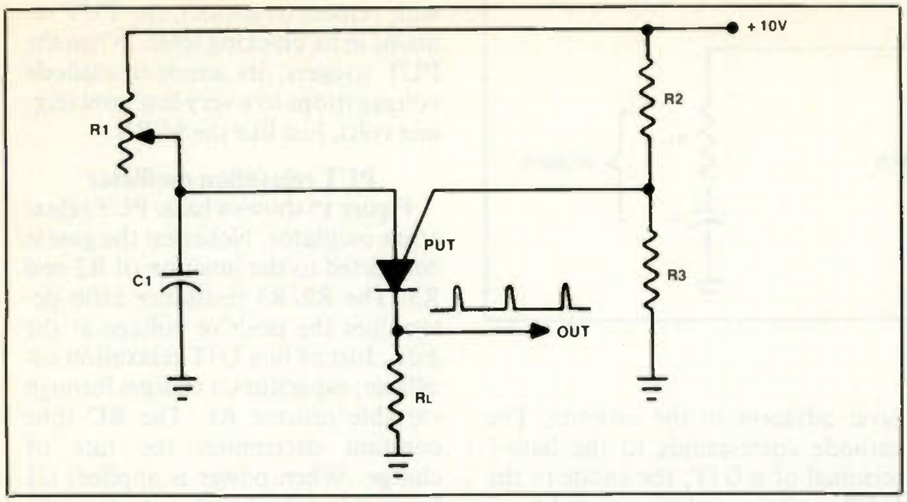

Figure 15.

the oscillator by controlling the time it takes the anode voltage to rise above the gate voltage sufficiently to trigger the device. Note that selecting a different R2/R3 resistance ratio would establish a different dc voltage at the gate and thus provide an additional way of controlling the oscillator frequency because either more or less time would be needed for the anode voltage to exceed that higher or lower gate voltage.

Note that because C1 charges gradually through R1 and discharges very rapidly through the PUT, the voltage waveform across the capacitor is a sawtooth which can be another useful output of the relaxation oscillator.

So we see that the PUT performs very much like the UJT which it can replace. PUTs produce excellent frequency stability in oscillators because their characteristics are more constant and dependable over a wide temperature range, than those of the UJT. Also, PUTs are able to operate with very low supply voltages. In addition to generating triggering pulses for other thyristors, PUT applications include timers, counters, sawtooth generators, relay drivers, voltage controlled oscillators (VCO), ramp generators in servomechanisms, etc.

PUT vertical oscillator

A PUT is sometimes featured in the vertical oscillator circuits of TV receivers, particularly in imported brands. Figure 16 is a simplified version of such a circuit. Quite similar to that of Figure 15, it features a relaxation oscillator in which C2 charges gradually through R4 while the PUT is off (sawtooth trace interval), and discharges quickly through the thyristor when the PUT is on (retrace). The PUT is programmed by the manual setting of the vertical hold control. Note that R2 and R3 form a voltage divider across the 20V dc supply; thus the dc voltage at the gate is determined by the setting of R3, and it is this gate voltage that determines the anode voltage level at which the PUT will fire.

Negative-going sync from the sync separator is coupled through the vertical integrator and coupling capacitor C1, to the gate of the PUT. The vertical hold control is normally adjusted in such a way that the relaxation oscillator free-runs at a frequency slightly lower than 60Hz. Therefore, by the time a negative-going 60Hz sync pulse arrives at the gate, C2 has already charged up considerably, making the anode several volts positive. The sync pulse forces the gate voltage down, making the gate suddenly more negative (less positive) than the anode. This forward biases the anode-gate junction and triggers the PUT; retrace is initiated, and a new cycle starts.

The sawtooth voltage waveform generated by C2 is usually applied to a vertical buffer amplifier and then to the vertical driver and output circuits. The circuit of Figure 16 was simplified by omitting a few components such as the vertical size control as well as the vertical linearity control and negative feedback circuitry often found between the oscillator and the vertical amplifier. But it is typical of vertical oscillator circuits fea-

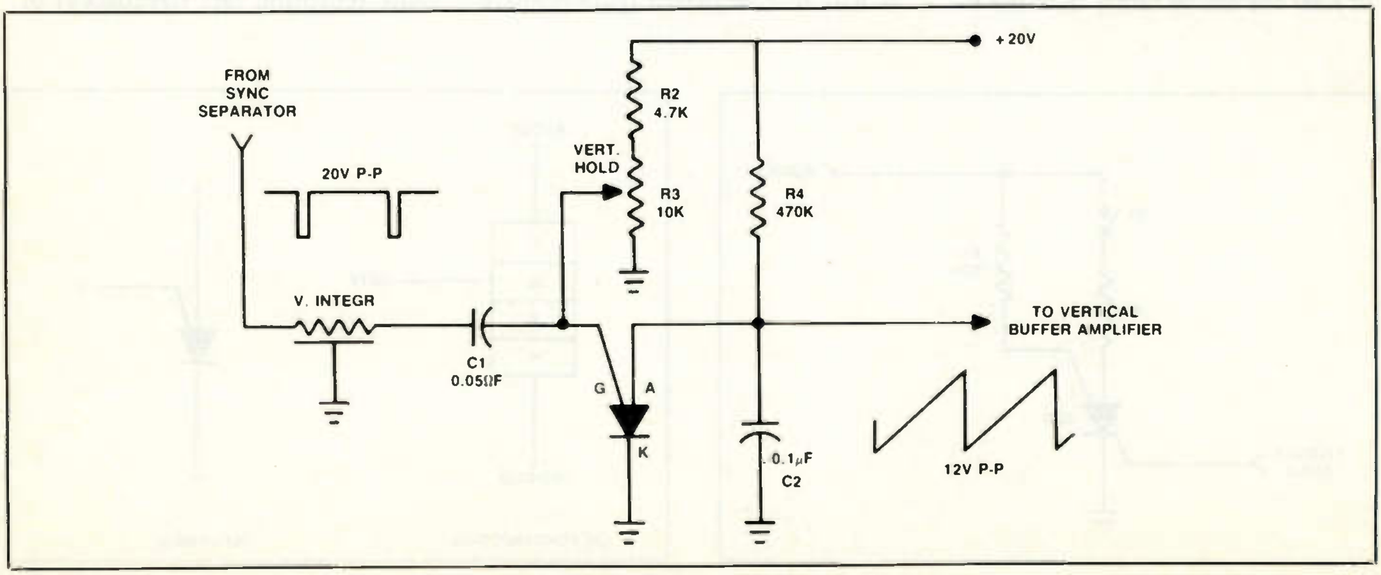

Figure 16.

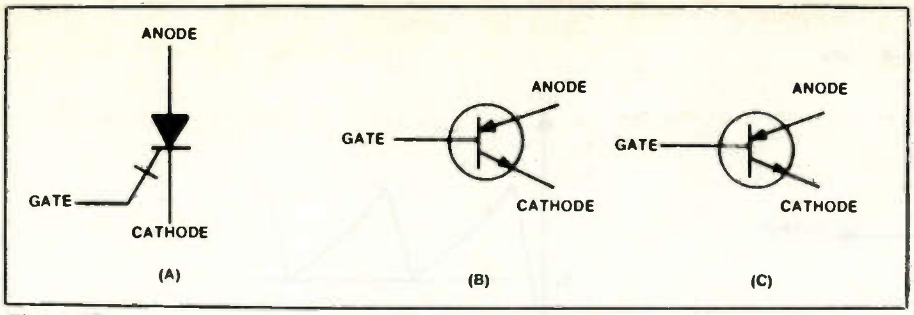

Figure 17.

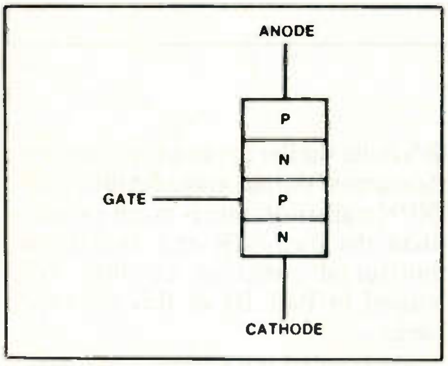

Figure 18.

turing programmable unijunction transistors.

Gate turn-off thyristor

The final switching device to be introduced in this series is the gate turn-off thyristor (GTO), also called gate controlled switch (GCS), gate turn-off switch or gate turn-off SCR. This three-terminal PNPN device is very similar to the SCR in construction, characteristics and operation, but with one main difference: it can be turned off by applying a negative voltage to its gate, i.e. by making the gate negative with respect to the cathode.

Of course, the GTO also possesses the usual SCR characteristics, namely:

1. it can be turned on with positive gate voltage;
2. once turned on, it latches on, even when the gate voltage is removed;
3. it reverts back to the blocking state when the polarity of anode voltage is reversed or when anode current is reduced below its holding value (I_H);
4. it features low anode-to-cathode voltage while conducting.

You should think of the GTO simply as a special type of SCR with gate turn-off capabilities. Three different GTO symbols are in common use, as seen in Figure 17. The arrows in (B) and (C) remind us that the anode consists of P-type silicon, while the cathode is N-type, as shown in the construction diagram of Figure 18. For example, the Figure 17(B) symbol is the one used by the Sony Corporation for the GTOs featured in the power supply regulator and horizontal output circuitry of their color TV sets. Sony calls these thyristors gate controlled switches (GCS).

In addition to its gate turn-off advantage, the GTO also features a faster turn-off time than the SCR (about 1μs) and is thus well suited to high-speed switching applications.

Does it have any disadvantages? Unfortunately so: a significant increase in the amount of gate current required for triggering the thyristor into conduction. For an SCR and a GTO of similar low-power ratings, for example, the gate triggering current of the SCR might be about 300μA while the GTO might need 20mA. In the case of high-power SCRs and GTOs, the difference can be even more dramatic; for example, an SCR might need 40mA to 150 mA of gate current while a corresponding GTO might need between 1A and 5A. This whopping gate current requirement can be a disadvantage because the driving circuitry which feeds the triggering pulses to the gate must be able to supply that current. And the turn-off gate current of GTOs is even slightly higher than the required trigger current. Nevertheless, the GTO can be very useful and its popularity is on the increase.

Some GTOs feature symmetrical forward and reverse blocking, i.e. their peak anode voltage rating (e.g. 1000V) is the same whether the anode is positive or negative in relation to the cathode; but others have asymmetrical blocking properties, their maximum anode voltage rating (in the blocking state) being much higher with positive anode voltage than with negative. Like SCRs, GTOs come in a wide variety of voltage, current and power ratings. For example, the relatively low-power ECG276 horizontal output GTO has the following maximum ratings: on-state anode current: 5A; off-state anode voltage: 1200V; gate trigger voltage: 1.5V; gate trigger current: 120mA; and a typical holding current (I_H) of 300mA. It comes in a TO-66 type of metal case. On the other hand, high-power GTOs used in some industrial applications may have ratings of around 1500A and 2500V and come in large "hockey puck" packages.

GTO applications

Because of their desirable switching characteristics, GTOs are found in a variety of applications, including

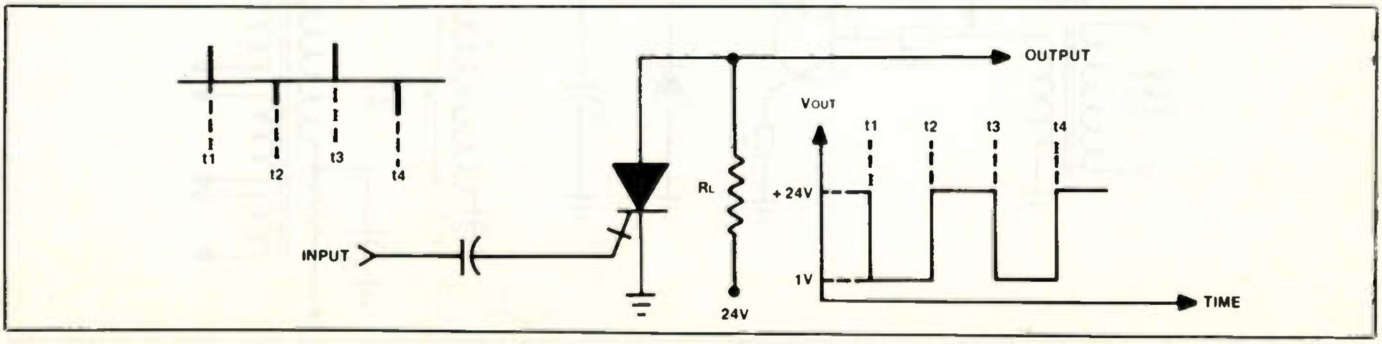

Figure 19.

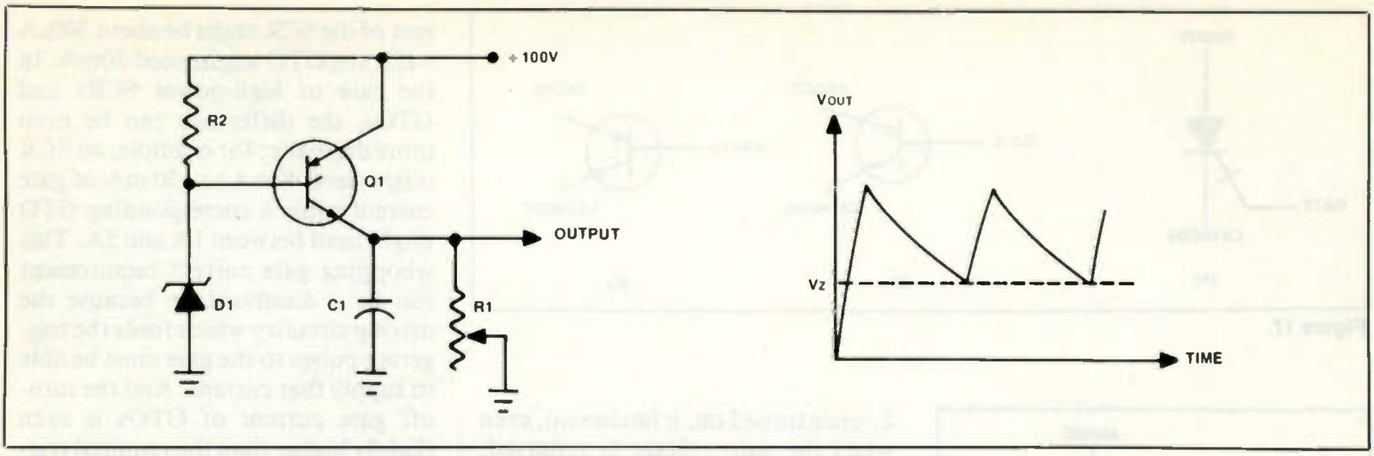

Figure 20.

pulse generators, multivibrators, digital counters, voltage regulators and television sweep circuits.

As an example, Figure 19 shows a switching circuit that changes short trigger pulses into a square wave output. Each positive pulse at the input (at times t1 and t3) triggers the GTO into conduction, causing the anode voltage to drop to a very low value (about 1V); and each negative input pulse (at times t2 and t4) switches the thyristor off, allowing the anode voltage to rise to the full Vcc value. Therefore the output consists of a square wave.

Figure 20 shows a GTO and a zener diode configured into a sawtooth generator circuit. When the 100V dc supply is turned on, positive voltage is applied through R2 to the gate; the resulting gate current causes the GTO to switch on, allowing current to flow through C1 and the thyristor to the + Vcc terminal. The capacitor charges rapidly, eventually allowing the GTO's cathode voltage to rise above the zener voltage (Vz) of diode D1; the gate then becomes negative in relation to the cathode, causing a reversal in gate current. When the reverse gate current becomes sufficiently large, the GTO switches off, allowing C1 to begin discharging through R1; discharge time is determined by the relatively long R1-C1 time constant. Once the output voltage (GTO's cathode voltage) drops below Vz, forward gate current begins flowing again, the thyristor switches back on, and the process is repeated. Thus a sawtooth voltage waveform is generated at the oscillator's output. The period (and frequency) of the oscillator can be varied by adjusting R1.

GTO horizontal output stage

Our final GTO application is that of horizontal output switching in TV receivers. Figure 21 is a simplified schematic of such a circuit. Note that it's quite similar to the more common horizontal output stage featuring an NPN transistor, and is much simpler than the dual-SCR and dual-diode horizontal switching circuitry discussed in Part III of this thyristor series.

As pointed out earlier, the thyristor is called a gate controlled switch (GCS) by some manufacturers. Driver transformer T1 provides impedance matching and couples a square wave signal to the gate of Q1. C1 resonates with the yoke and determines the speed of retrace as well as the amount of high voltage available from the flyback transformer. D1 is the usual damper diode.

The square wave at Q1's input alternately switches the GTO on and off, just like a switching transistor; the duty cycle is roughly 50%, allowing the thyristor to run reasonably cool.

Technicians should note one important difference, however. Losing

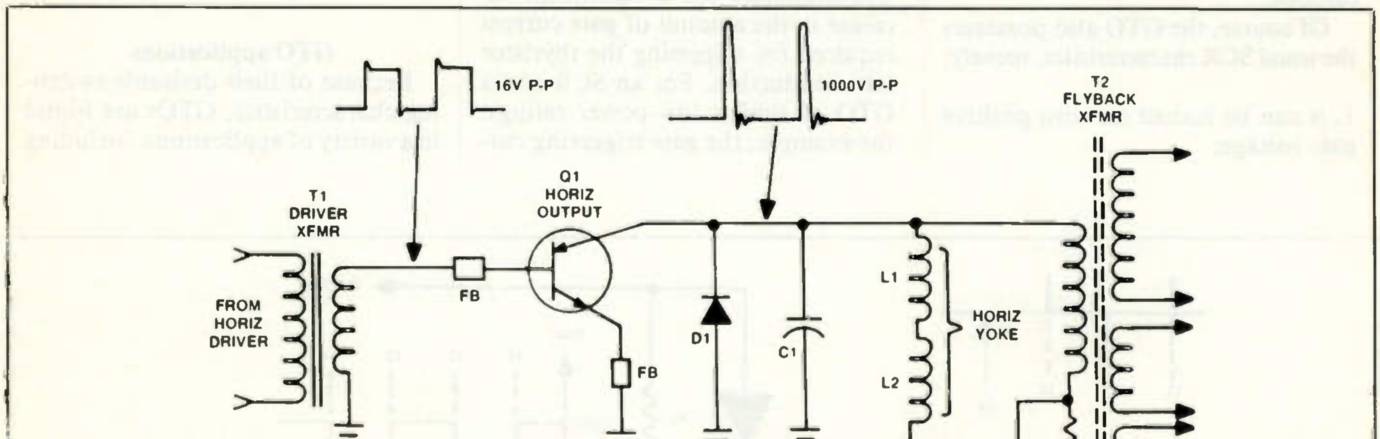

Figure 21.

horizontal drive in a transistor circuit is of no serious consequence; the transistor switches off and the raster disappears, but no damage results. Not so with a GTO; a loss of drive is likely to leave the thyristor conducting maximum current continuously and burn it out, possibly damaging the flyback transformer as well. Old-timers undoubtedly remember a similar situation in vacuum tube receivers. When the horizontal oscillator failed, the horizontal output tube would glow—its plate turning a bright cherry red — and the wax in the flyback transformer would end up at the bottom of the TV cabinet or on the customer's floor! The moral of the story is: don't kill the horizontal drive when you're troubleshooting a GTO type of horizontal output stage.

Our final comment concerns something we can all relate to: dollars and cents. Aside from gate drive requirements and physical considerations, current and voltage ratings should be carefully considered when choosing a replacement thyristor. Otherwise $$$ will get you! The net prices quoted here are Canadian; they're undoubtedly a bit lower in the U.S.A., but the comparisons are valid.

Suppose you need to replace a 5A/50V SCR. An ECG5470, rated at 5A/50V costs $11.59; but if you select an ECG5476 instead, rated at 5A/600V, the price goes up to $24.03. Percentage-wise, that may be quite a jump, but it's just chicken feed compared to high power thyristors. Take a 1200A SCR, for example. An ECG5598, rated at 600V, will cost you $538.00, but an ECG5599, rated at 1200V, will set you back $851.00! And if you don't know what gift to buy for a friend who has everything, consider giving a 4800A/2000V phase control thyristor, such as the International Rectifier S77R20A featuring an A-36 'hockey puck' case . . . it'll cost you $1,157.63, but it might make a lasting impression!

Well, there you have it . . . thyristors from A to Z. It is hoped that the information was of interest to experienced technicians as well as novices, and that the fundamentals, circuit descriptions and servicing hints presented in the series will make the devices a little better understood and your troubleshooting work a little easier as a result. ■

DC motor control simplified

By John Shepler

Most electronic devices should really be called electromechanical devices. Think about VCR's, cassette, reel, and DAT tape recorders, CD players, computer disk drives, printers, typewriters, and camcorders. All of these have one or more electromechanical components.

The permanent magnet dc motor, or PMDC motor, is a common electromechanical component. It is used everywhere, from toys to computer drives. How these motors work and how they are controlled electronically is the subject of this article.

How does a PMDC motor work?

Magnetism. That's what makes a motor spin. All electric motors are based on the principle that opposite magnetic poles repel, or force each other away. The major differences in motors are whether the magnetic fields are generated by permanent magnets, dc currents, or ac currents. If a permanent magnet creates one field, the other must be generated by dc or ac power.

Figure 1 shows what goes into the construction of a PMDC motor. The part that rotates is called the armature. It starts with a soft iron core, generally built up from a stack of punched sheet metal laminations. The stack of laminations is pressed onto a metal shaft. Insulated copper wire is wound in the slots of the lamination stack to form electrical coils.

To complete the armature, a rotary switch called a commutator is pressed on the shaft and connected to the armature coils. As the armature turns, the copper commutator bars make contact with a pair of carbon brushes that are fixed in place. The commutator slides over the brushes, connecting one coil after another to the power source. While a coil is energized, it will become an electromagnet with a north and south pole. The force generated by the electromagnetic field interacting with the field of the stationary permanent magnets is what causes the motor to rotate.

You can make a simple electromagnet by wrapping a few dozen turns of hookup wire around a nail and connecting to a lantern battery. Try this and see that the electromagnet attracts iron and steel objects, like paper clips, but repels one pole of a bar magnet. If you don't have a bar magnet, use a cylinder magnet from a torn loudspeaker. Next, try reversing the battery and see that the magnets now attract.

In a motor, the commutator is wired so that the coil that has just turned past the north pole of the permanent magnet is energized to repel. This force makes the armature turn, disconnecting the coil through the commutator and connecting the next one. This way, the permanent magnet and one of the electromagnet coils will always be pushing against each other.

Magnets have two poles, north and south. If the north poles are repelling, the south poles are also repelling, giving the motor a push from both sets of permanent magnets.

It is also possible to arrange the commutator switching so that the permanent magnet and electromagnet attract each other. The force of attraction is just as powerful as the force of repulsion. In fact, to switch from magnetic attraction to magnetic repulsion, all you need do is reverse the polarity of the current into the motor armature. Reverse the power supply polarity and the motor will run in reverse.

The complete motor assembly consists of the armature, permanent magnets and a few other parts. There is an outer shell with end caps to hold the armature shaft bearings in align-

(Continued on page 37)

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

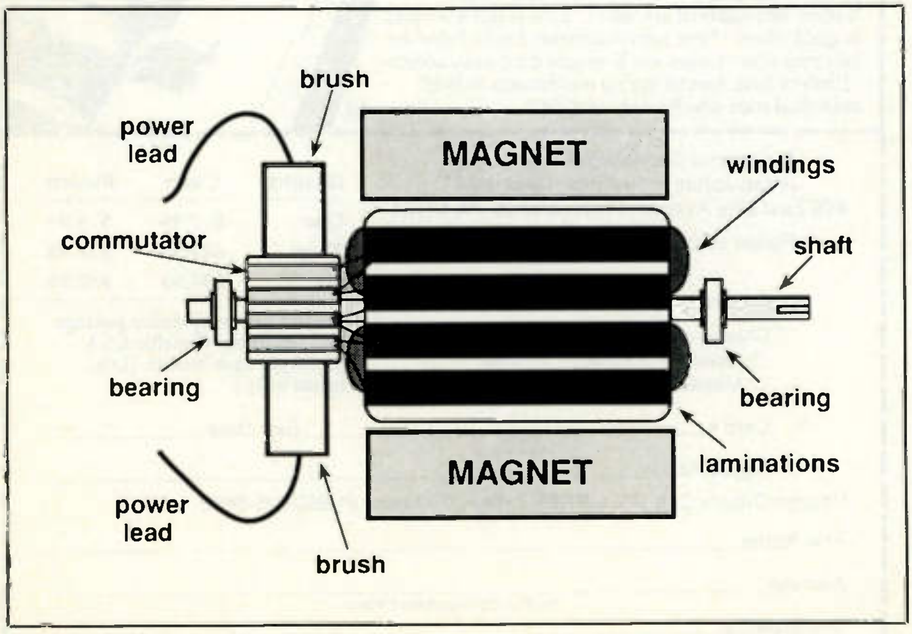

Figure 1. PMDC motor construction.

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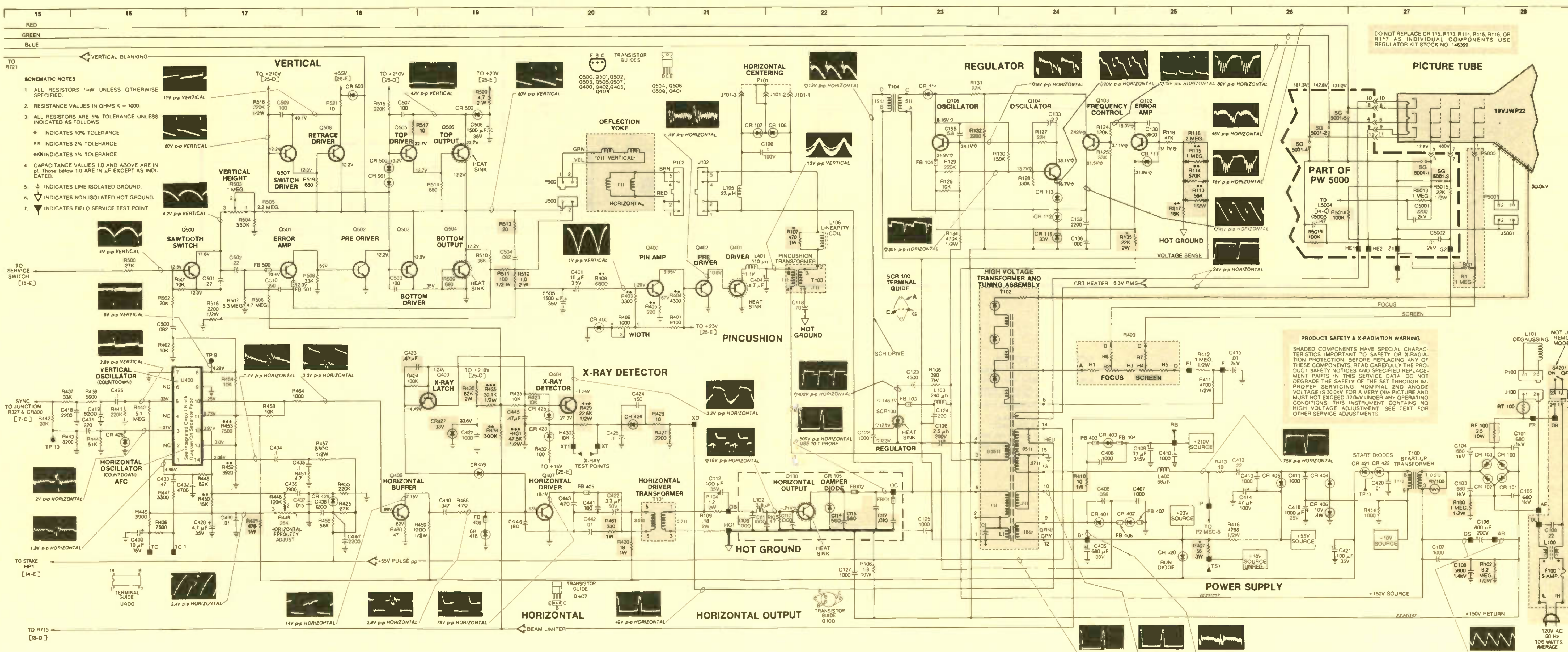

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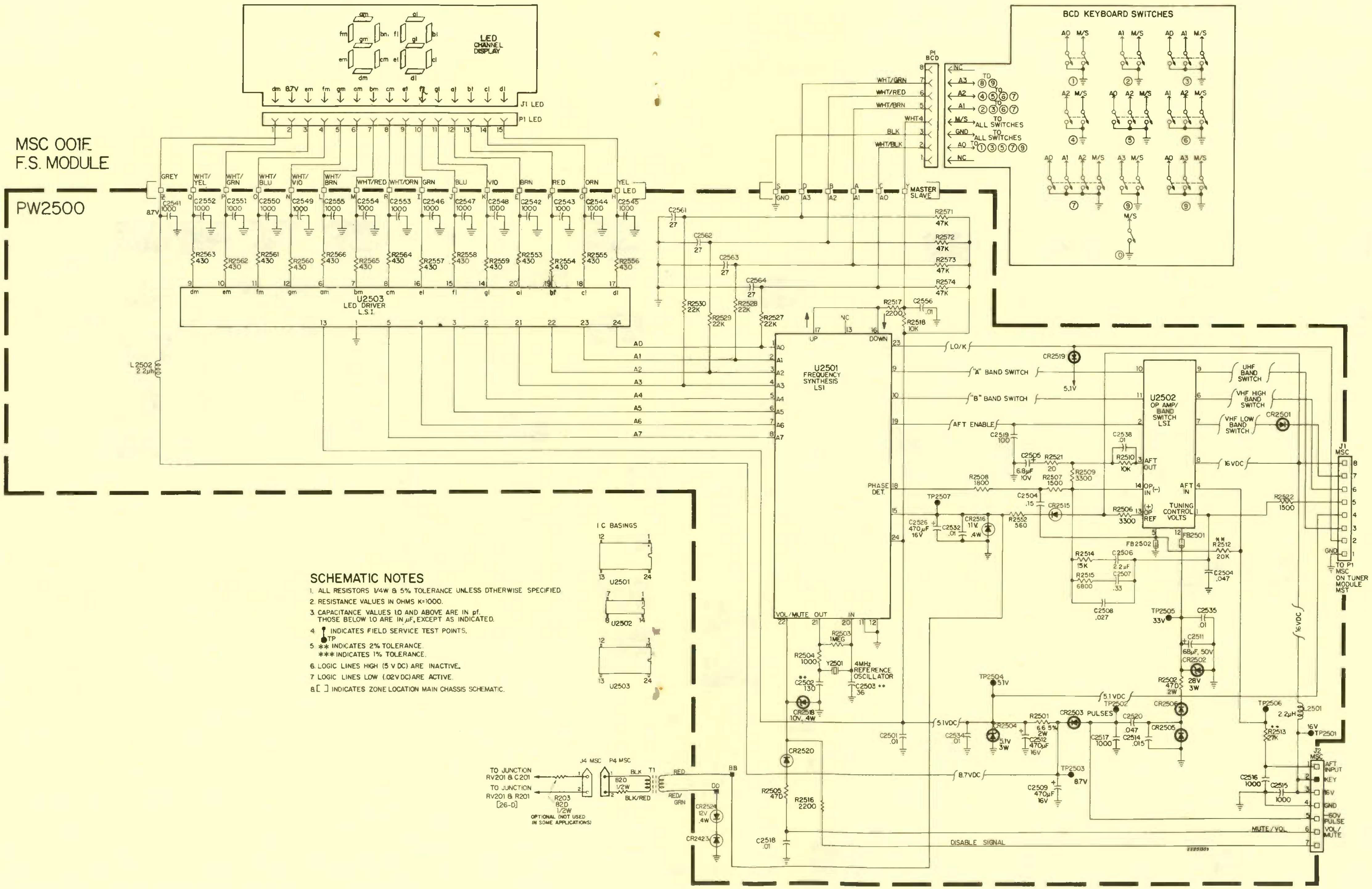

SCHEMATIC NOTES

1. ALL RESISTORS 1/4W & 5% TOLERANCE UNLESS OTHERWISE SPECIFIED
2. RESISTANCE VALUES IN OHMS K=1000.
3. CAPACITANCE VALUES 1.0 AND ABOVE ARE IN pf. THOSE BELOW 1.0 ARE IN µF, EXCEPT AS INDICATED.
4. INDICATES FIELD SERVICE TEST POINTS. TP
5. ** INDICATES 2% TOLERANCE. *** INDICATES 1% TOLERANCE.
6. LOGIC LINES HIGH (5 V DC) ARE INACTIVE.
7. LOGIC LINES LOW (.02V DC) ARE ACTIVE.
8. [ ] INDICATES ZONE LOCATION MAIN CHASSIS SCHEMATIC.

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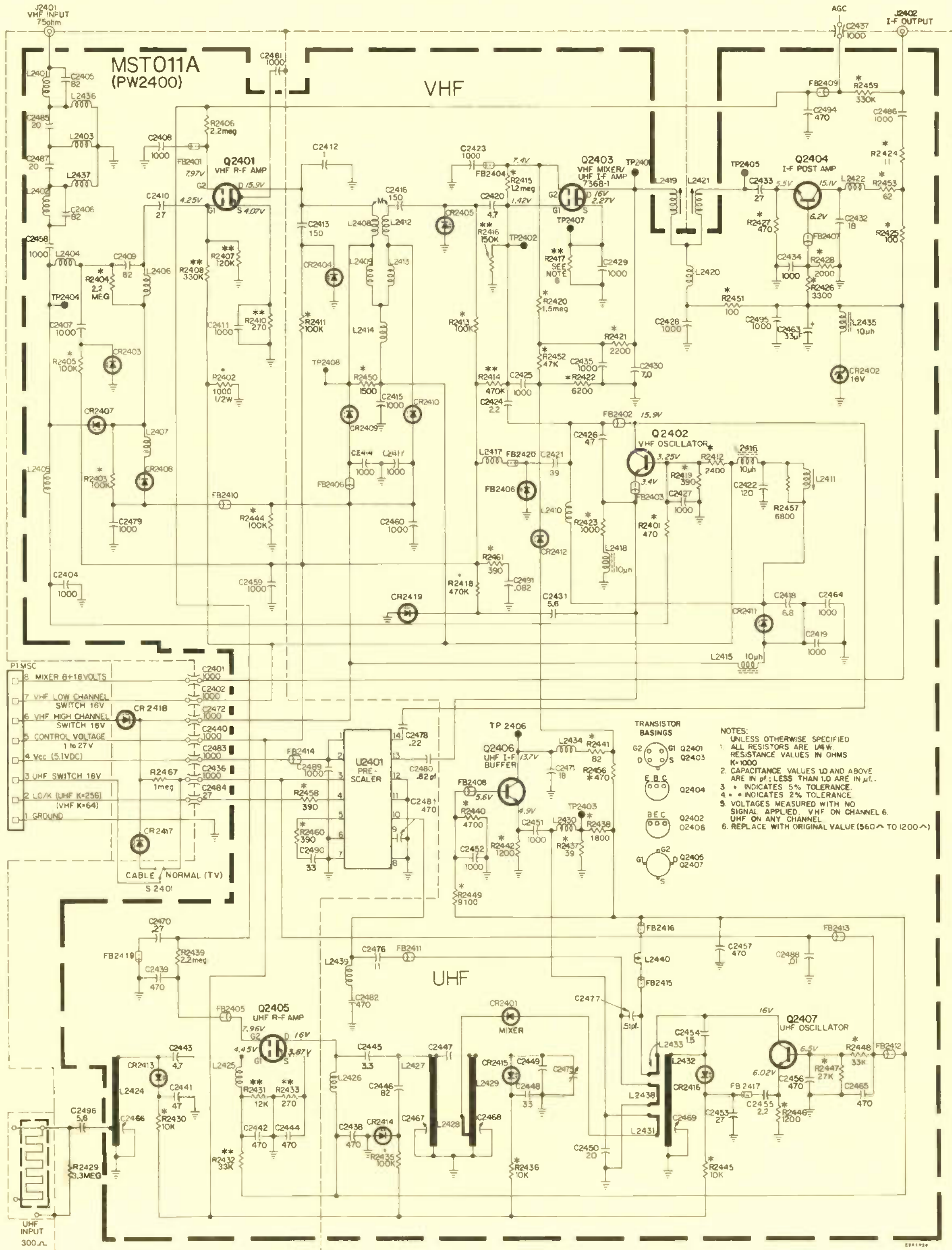

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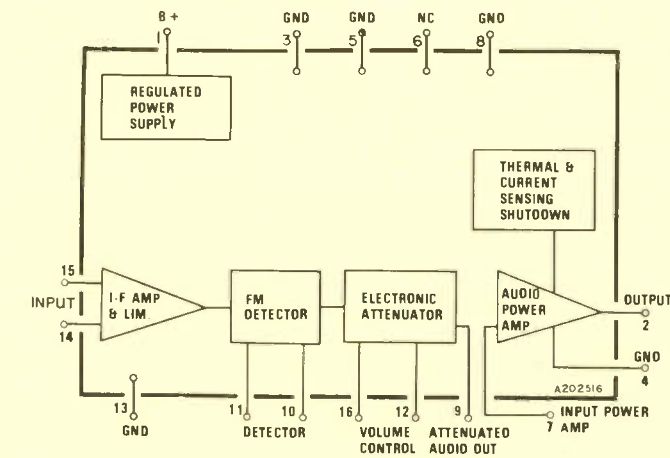

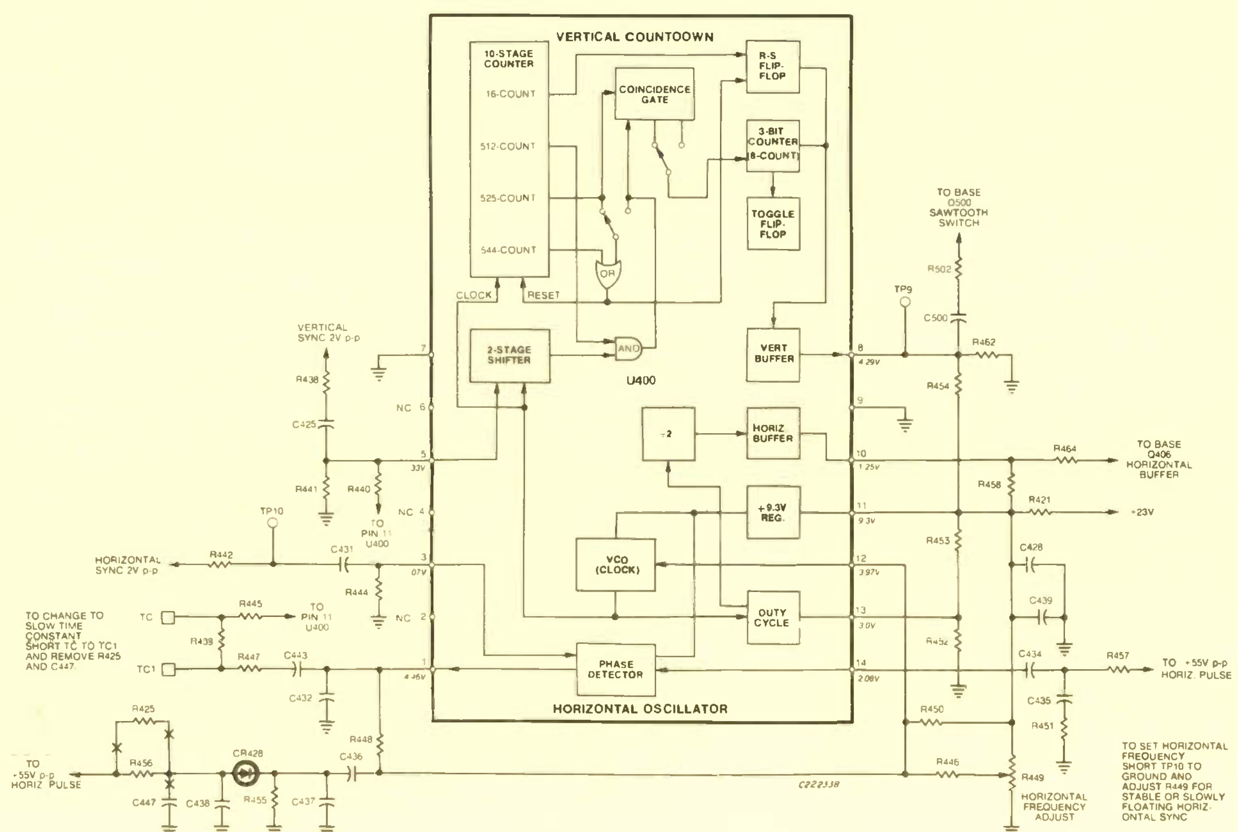

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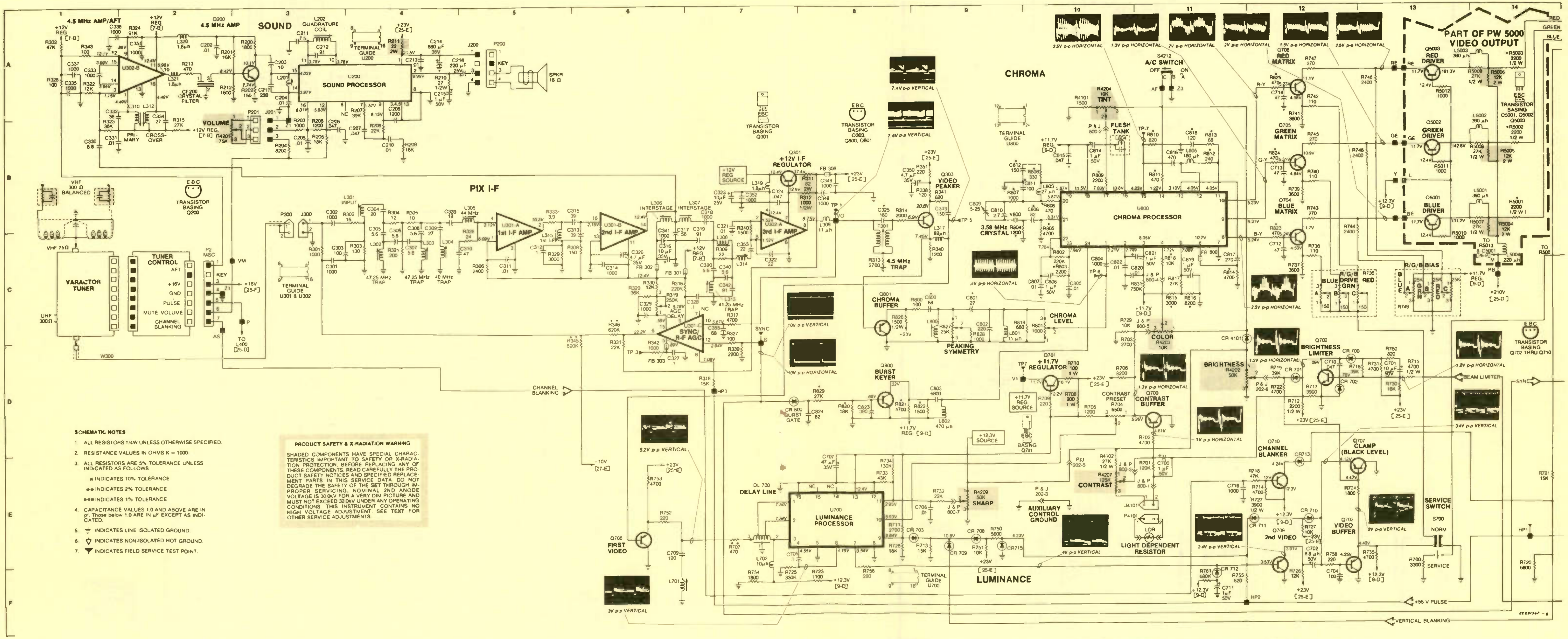

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2. RESISTANCE VALUES IN OHMS K = 1000
3. ALL RESISTORS ARE 5% TOLERANCE UNLESS INDICATED AS FOLLOWS
   - * INDICATES 10% TOLERANCE
   - ** INDICATES 2% TOLERANCE
   - *** INDICATES 1% TOLERANCE
4. CAPACITANCE VALUES 1.0 AND ABOVE ARE IN pf. Those below 1.0 ARE IN μF EXCEPT AS INDICATED.
5. ⏚ INDICATES LINE ISOLATED GROUND.
6. ▽ INDICATES NON-ISOLATED HOT GROUND.
7. ▼ INDICATES FIELD SERVICE TEST POINT.

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ment. On more expensive motors these are ball bearings. On less expensive and many small motors a bronze bushing pressed into each end cap holds the shaft.

The permanent magnets are shaped as arcs to conform to the shape of the round armature. They are mounted within an iron ring that completes the magnetic path. Sometimes the shell itself is thick enough to provide the magnetic path and an extra iron ring is not needed.

The brushes form the electrical connection between the power supply and the rotating electromagnet by way of the commutator. They are held in insulated holders with springs to push them against the bars of the armature. Flexible leads are connected to wires or terminal posts on the shell of the motor.

Electronic motor control

Some applications simply use a mechanical switch to turn the motor on and off. Many portable cassette players are built this way. More sophisticated electronics applications require a solid state interface for electronic control.

Figure 3 shows the simplest way to turn the motor on and off electronically. This is the same arrangement used to control relays and solenoids. The transistor ratings are determined by the voltage and current required by the motor, including the high inrush current when the motor starts. The flyback diode is needed to protect the transistor from high voltage spikes induced when the armature field is turned off.

Most dc motors are designed to run equally well in both directions. This is a big advantage over ac motors which run in one direction only. This is of little concern in applications like fans, but very useful for reversing tape direction in cassette recorders.

Figure 4 shows a circuit for bi-directional control. The control lines are labeled FWD (foward) and REV (reverse). Four transistors are needed to switch the two motor leads to the single polarity power supply. If plus and minus supplies are available, only two transistors are needed.

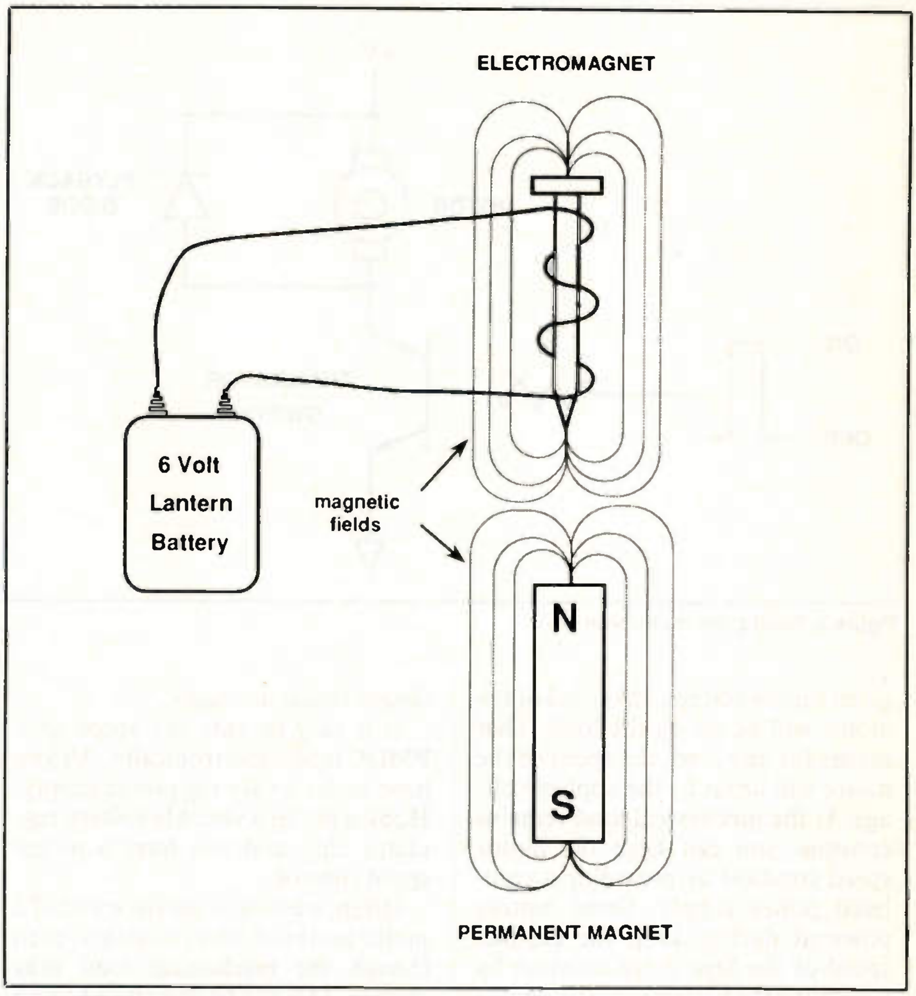

Figure 2. Experiment in motor magnetics.

Here's how the bridge works. When the foward line is energized, transistors Q1 and Q4 are energized. The power flows from the supply through Q1 to the left motor terminal, through the motor, and from the right motor terminal through Q4 to ground. Q2 and Q3 are off. To reverse the motor, activate the reverse line, which puts the plus supply to the right motor terminal through Q2 and connects the left motor terminal to ground through Q3. In this case, Q1 and Q4 are off. Not shown in this diagram are flyback diodes to protect the transistors.

It is important that only the forward or reverse line is turned on at any time. If both lines should go high, all 4 transistors would switch on, shorting the power supply to ground. Switching logic within the electronic motor control circuit is designed to prevent this from happening.

Variable speed control

What sets the speed of a motor? Every motor design has a no-load speed that is set by the strength of the magnets, the number of turns in the armature coils, and the applied voltage. This is the speed that the motor will run without any load being connected to its shaft.

The characteristic of PMDC motors is that the speed decreases as load is applied. There is a curve for every motor, called the speed-torque curve, that shows what the speed will be for a given load. A typical speed torque curve is shown in Figure 5. If you buy a new motor you may get a copy with the data sheet. Torque is a measure of mechanical loading.

What's important is that for a

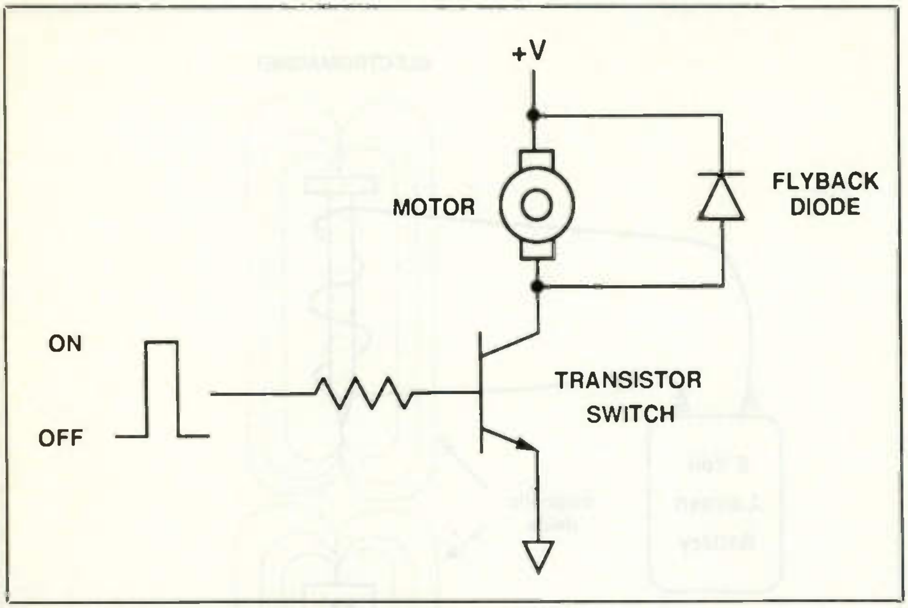

Figure 3. Solid state motor switch.

given supply voltage, the speed of the motor will be set by the load. That means for any load, the speed of the motor will be set by the applied voltage. If the mechanical load remains constant you can keep the motor speed constant by providing a regulated power supply. Some battery powered devices keep the capstan speed of the tape drive constant by regulating the battery voltage. Motor current increases linearly as motor torque (load) increases.

It is easy to vary the speed of a PMDC motor electronically. All you have to do is vary the power supply. Hook a pot to a variable voltage regulator chip and you have a motor speed control.

Often, we want to set the speed of a motor and have it stay constant, even though the mechanical load may change. This can be done by adding a feedback loop to the circuit.

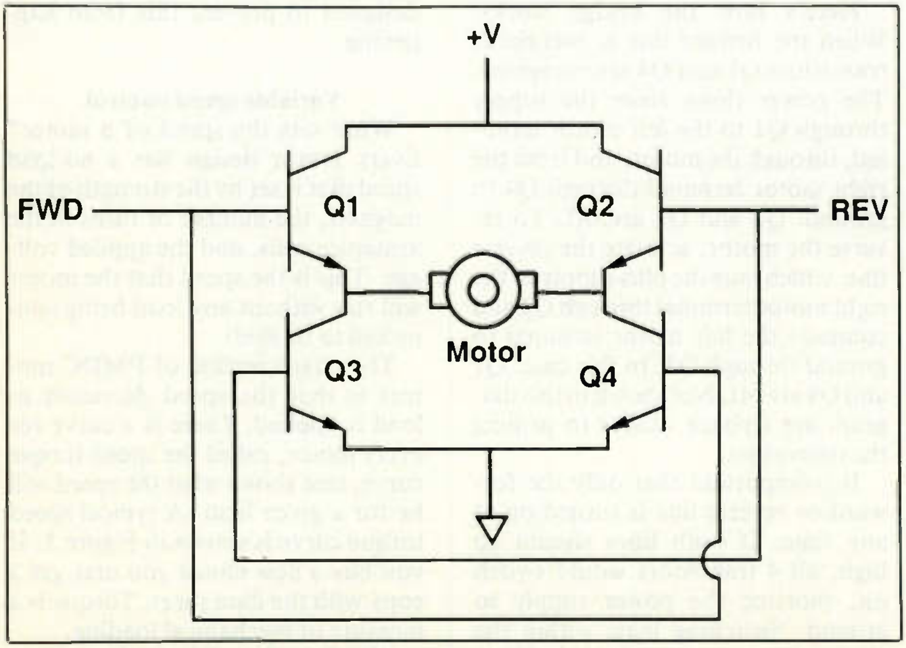

Figure 4. Bi-directional control.

Figure 6 shows a new component, a tachometer, added to the motor. A tachometer, or tach, is any device that gives a voltage or current output proportional to speed. A small generator will produce a voltage that increases as speed increases. In fact, any PMDC motor can be used as a generator by simply turning its shaft and measuring the terminal voltage. Small dc motors make tachometers. Optical sensors are also commonly used as tachs, although they need additional electronic interfacing.

Here's how the feedback loop works. The speed pot provides the plus input of the op amp with a voltage that represents the desired speed of the motor. This is sometimes called the set point. The op amp output will jump high and turn on the transistor switch. This energizes the motor, which then speeds up, rotating the tachometer shaft. The tach output voltage increases with motor speed and is fed to the negative input of the op-amp. When the tach voltage is equal to the speed setpoint voltage, the transistor is turned on just enough to keep the motor running at that speed.

If the speed falls, the drive will increase because the setpoint is greater than the tach voltage. If the speed increases, due to less load, the drive will decrease because the tach voltage is greater than the set point.

You can see that the feedback loop from the tachometer is used to regulate the amount of drive to the motor. The difference between tach and setpoint voltages at the op amp inputs determines the motor voltage and current.

Feedback control is also called servo control. Servos are used in any application that requires speed to be controlled automatically. Servos are used to control position and velocity in other types of systems.

Advances in motor control

Motion control is so commonly applied that special integrated circuits have been developed as speed loop controllers or power drivers.

Microprocessors are also used to provide this function along with on/off control and digital clock/

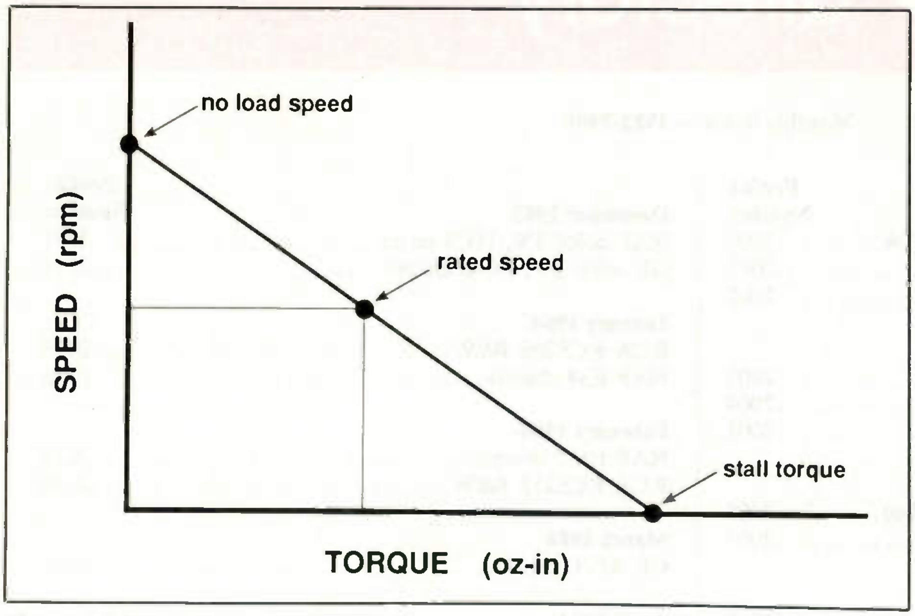

Figure 5. DC motor speed-torque curve.

timer displays. Microprocessors are especially suited to this application because they can count pulses from a simple optical or magnetic pickup tach and determine whether to increase or decrease motor speed. They can also do more complex functions, like slowly ramping the speed up or down and detecting when a jam has occured. A jam would be detected as the absence of tach input when the motor is energized. With new functions being added to home and business equipment every day, it is important to stay abreast of advances in dc motors and motor controls. You may even want to purchase some inexpensive motors and control chips and experiment with closed loop control. Understanding servos and motor controls will certainly come in handy when you need to service equipment that is both electronic and electromechanical.

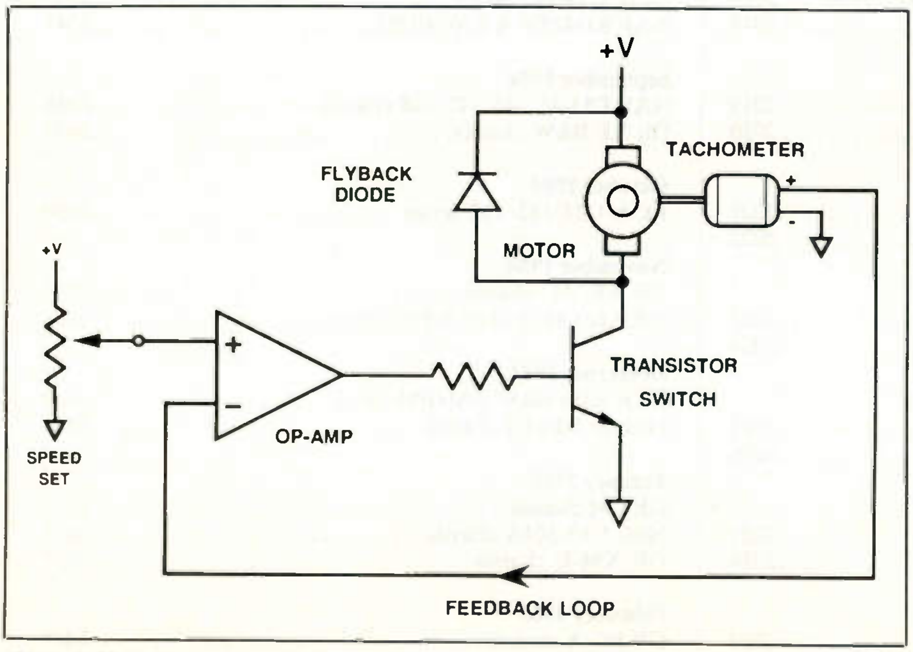

Figure 6. Variable speed control.

1990 Profax directory

Monthly index — 1982-1990

1990 Profax Directory

	Profax Number
March 1985	
GE GK chassis	2060
Hitachi CQ4X chassis	2061
April 1985	
RCA CTC117 chassis	2062
NAP UXC chassis	2063
May 1985	
GE EC-A chassis	2064
NEC DJ-60EN(R) chassis	2065
June 1985	
GE EP-B chassis	2066
July 1985	
GE 19PC-F/H chassis	2067
August 1985	
GE PM-B chassis	2068
September 1985	
NAP EC-31-52, -56 & -58 chassis	2069
RCA CTC118 chassis	2070
October 1985	
NAP E-34-18, -32 & -33 chassis	2071
RCA CTC121 chassis	2072
November 1985	
GE BC-N chassis	2073
GE EP chassis	2074
December 1985	
GE PC-J chassis	2075
RCA CTC126 chassis	2076
January 1986	
RCA MMC 100, video monitor	2077
GE PM-A chassis	2078
February 1986	
GE BC-A chassis	2079
RCA 117 chassis	2080
March 1986	
RCA CTC133 chassis	2081
April 1986	
GE 25 PC(J) chassis	2082
RCA CTC120 chassis	2083
May 1986	
GE HP chassis, tuning & control systems	2084A
GE HP chassis, chroma	2084B
June 1986	
RCA CTC125 chassis	2085
RCA 207 series weather clock	2086
July 1986	
GE NF chassis	2087
GE PM-C chassis	2088
August 1986	
RCA CTC136 chassis	2089
September 1986	
RCA CTC130-S1 chassis	2090
October 1986	
GE X110 chassis, B&W TV	2091
GE TV/AM/FM clock radio	2092
November 1986	
RCA B&W TV basic service data, UVM chassis	2093
GE 14-inch portable color TV, RS-A chassis	2094
December 1986	
GE X110 chassis (cont.)	2095
RCA UWJ chassis	2096
January 1987	
GE color TV, MK-2 chassis	2097
February 1987	
RCA color TV supplement, CTC117-S2	2098
GE color TV, MK-1 chassis	2099
April 1987	
Hitachi color TV, CT2250B, CT2250W chassis	3000
May 1987	
RCA color TV, VDM140 chassis	3002
GE color TV, NF chassis update	3003
GE 5-inch B&W TV, 7-7130A chassis	3004
June 1987	
Hitachi color TV, CT1358 chassis	3005
RCA color TV, CTC135 chassis	3006
July 1987	
Zenith color TV, D13085/D1910B chassis	3007
GE color TV, MK-1 chassis, model 8-1938	3008
August 1987	
Zenith color TV, D2500W chassis	3009
Hitachi color TV, CT2020W, CT2020B chassis	3010
September 1987	
Zenith color TV, SD2501W chassis	3011
Hitachi color TV, CT2250B, CT2250W chassis	3012
October 1987	
RCA color TV, CTC134 chassis	3013
November 1987	
GE color TV, CTC140 chassis	3014
December 1987	
Hitachi color TV, chassis CT0911	3015
Zenith color TV, chassis SD2097S	3016
January 1988	
Zenith PV800 color monitor	3017
Hitachi color TV, CT1358 chassis	3018
February 1988	
GE VCR, 1VCR2018W model	3019
March 1988	
GE 8-4500 projection TV	3020

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Profax Number	Month	Year
2000-2002	Oct	82
2003-2005	Nov	82
2006-2007	Dec	82
2008-2010	Jan	83
2011-2012	Feb	83
2013-2014	Mar	83
2015-2016	Apr	83
2017-2018	May	83
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2027-2028	Oct	83
2029-2030	Nov	83
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2033-2034	Jan	84
2035-2036	Feb	84
2037	Mar	84
2038-2040	Apr	84
2041	May	84
2042-2043	Jun	84
2044-2045	Jul	84
2046-2047	Aug	84
2048-2049	Sep	84
2050	Oct	84
2051-2052	Nov	84
2053-2054	Dec	84
2055-2057	Jan	85
2058-2059	Feb	85
2060-2061	Mar	85
2062-2063	Apr	85
2064-2065	May	85
2066	Jun	85
2067	Jul	85
2068	Aug	85
2069-2070	Sep	85
2071-2072	Oct	85
2073-2074	Nov	85
2075-2076	Dec	85
2077-2078	Jan	86
2079-2080	Feb	86
2081	Mar	86
2082-2083	Apr	86
2084A-2084B	May	86
2085-2086	Jun	86
2087-2088	Jul	86
2089	Aug	86
2090	Sep	86
2091-2092	Oct	86
2093-2094	Nov	86
2095-2096	Dec	86
2097	Jan	87
2098-2099	Feb	87
(Note: numbers 2100-2999 were skipped)		
3000	Apr	87
3002-3003	May	87
3005-3006	Jun	87
3007-3008	Jul	87
3009-3010	Aug	87
3011-3012	Sep	87
3013	Oct	87
3014	Nov	87
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3017-3018	Jan	88
3019	Feb	88
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3029-3030	Aug	88
3031-3032	Sep	88
3033-3034	Oct	88
3035-3036	Nov	88
3037	Dec	88
3038-3039	Jan	89
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3044-3045	Apr	89
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3048-3049	Jun	89
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3055-3056	Oct	89
3057-3058	Nov	89
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3060	Jan	90
3061	Feb	90
3062	Mar	90
3063	Apr	90
3064	May	90
3065	Jun	90
3066	Jul	90
3067	Aug	90
3068	Sep	90
3069	Oct	90
3070	Nov	90
3071	Dec	90

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GENERAL ELECTRIC		
Color TV, AC-D AC-E	2015	Apr 83
B&W TV, XE chassis	2018	May 83
Color TV, EM chassis	2023	Aug 83
Color TV, PM-A chassis	2028	Oct 83
Color TV, PC-B chassis	2832	Dec 83
AF/C chassis	2037	Mar 84
GL/X chassis	2038	Apr 84
XK B&W chassis	2039	Apr 84
XJ B&W chassis	2042	Jun 84
EC/K chassis	2044	Jul 84
XE B&W chassis	2049	Sep 84
AB/AC chassis	2051	Nov 84
CM chassis	2055	Jan 85
XM-E chassis	2057	Jan 85
PC-A chassis	2058	Feb 85
GK chassis	2060	Mar 85
EC-A chassis	2064	May 85

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GENERAL ELECTRIC

	Profax Number	Month and year
EP-B chassis	2066	Jun 85
19PC-F/H chassis	2067	Jul 85
PM-B chassis	2068	Aug 85
BC-N chassis	2073	Nov 85
EP chassis	2074	Nov 85
PC-J chassis	2075	Dec 85
PM-A chassis	2078	Jan 86
BC-A chassis	2079	Feb 86
25 PC(J) chassis	2082	Apr 86
HP chassis, tuning control systems	2084A	May 86
HP chassis, chroma	2084B	May 86
NF chassis	2087	Jul 86
PM-C chassis	2088	Jul 86
X110 chassis, B&W TV	2091	Oct 86
TV/AM/FM clock radio	2092	Oct 86
14-inch portable color TV	2094	Nov 86
X110 chassis (cont.)	2095	Dec 86
CTC140 chassis, color TV	3014	Nov 87
MK-1 chassis, model 8-1938	3008	Jul 87
MK-1 chassis	2099	Feb 87
MK-2 chassis	2097	Jan 87
NF chassis update, color TV	3003	May 87
7-7130A chassis, 5-inch B&W	3004	May 87
1VCR2006W model, VCR	3027	Jul 88
1VCR2018W model, VCR	3019	Feb 88
NC-05X3/06X1 chassis, color TV	3032	Sep 88
Projection TV 8-4500	3020	Mar 88
PW chassis, model 40PW3000KA01 TV	3037	Dec 88
VHS VCR, model 1VCR2002X	3044	Apr 89
Color TV, 1987 CTC136	3047	May 89
CTC135-S1 color TV	3052	Aug 89

HITACHI

	Profax Number	Month and year
Color TV, chassis NP80SX	2003	Nov 82
Color TV, GTX chassis No. 615	2008	Jan 83
Color TV, NP9X chassis	2011	Feb 83
Projection color TV, CT5011	2014	Mar 83
NP81X chassis	2054	Dec 84
CT2516 chassis	2059	Feb 85
CQ4X chassis	2061	Mar 85
CT1358 chassis, color TV	3005	Jun 87
CT2020W, CT2020B chassis	3010	Aug 87
CT2250B, CT2250W chassis	3000	Apr 87
CT2250B, CT2250W chassis	3012	Sep 87
CT1344 chassis color TV	3029	Aug 88
CT1358 chassis color TV	3018	Jan 88
CT2647/CT2648/CT2649 color TVs	3025	Jun 88
CT2652, CT2653 color TVs	3024	May 88
CT3020W/CT3020B	3033	Oct 88
VHS VCR, model VT-63A	3035	Nov 88
CT1955 color TV, NP85XA chassis	3038	Jan 89
Color TV, chassis CT1941/CT19A2	3043	Mar 89
CT1955 color TV	3045	Apr 89
CT2066 color TV	3050	Jul 89
CT2086 B/W chassis G7NU3 color TV	3055	Oct 89
CT1395W G7NSU2 color TV	3060	Jan 90
G7XU2/3 chassis color TV	3062	Apr 90
G7XU2 models CT2087B/W, A087 (MT2870 through MT2878)		
G7XU3 Models CT2088B/W, A088 (MT2880, MT2886, MT2887)		
CT4580K, VP7X2 chassis proj. TV	3065	Jun 90
VP9X1 chassis color TV	3069	Oct 90

MAGNAVOX

	Profax Number	Month and year
B&W TV chassis 09M101	2010	Jan 83
Color TV, chassis E31-38	2021	Jul 83

NAP

	Profax Number	Month and year
Color TV, chassis 09C201 CQ4X	2002	Oct 82
B&W TV, model MQA014GY (w/radio)	2006	Dec 82
B&W TV, AM/FM radio UVG-1	2016	Apr 83
Color TV, E34-18, -19, -32, -33	2017	May 83
B&W TV, model B386QWA01	2020	Jun 83
B&W TV, chassis 12M101	2024	Aug 83
B&W TV, chassis 12M101 (duplicate)	2026	Sep 83
Color TV, 13C3 series	2030	Nov 83
Color TV, 19C3 series	2031	Dec 83
E34 chassis	2034	Jan 84
19C2 chassis	2035	Feb 84
E32 chassis	2040	Apr 84
E32-58, -59 chassis	2043	Jun 84
K10 chassis	2045	Jul 84
RD 425S1 & RXC 192SL chassis	2047	Aug 84
E53-45, -46, -47, -48 chassis	2048	Sep 84
BD3911 SL01 B&W chassis	2051	Nov 84
UXC chassis	2063	Apr 85
EC-31-52, -56 & -58 chassis	2069	Sep 85
E-34-18, -32 & -33 chassis	2071	Oct 85
E51-56 chassis, color TV	3030	Aug 88
E54-10 chassis, projection TV	3021	Apr 88
E54-15 chassis, projection TV	3026	Jun 88
RD4502SL/RLC312SL color TV	3036	Nov 88
Color TV, series 19C2 chassis	3039	Jan 89
Color TV, chassis E34-11	3042	Mar 89
Color TV, chassis E54-15	3049	Jun 89
(Magnavox RD8518 and RD8520; Philco model P8190S; Sylvania PSC410 and PSC420,		

NEC

	Profax Number	Month and year
Color video monitor, chassis Z7A	2000	Oct 82
Video projector, chassis W2A-1	2005	Nov 82
C13-304A chassis	2056	Jan 85
DJ-60EN(R) chassis	2065	May 85

PHILCO

	Profax Number	Month and year
Color TV, chassis K-20	2022	Jul 83

RCA

	Profax Number	Month and year
B&W TV, chassis KCS207B	2001	Oct 82
Color TV, chassis CTC115	2004	Nov 82
Color TV, chassis CTC108	2007	Dec 82
Projection TV, model PGR200/300	2009	Jan 83
Color TV, CTC118 series	2012	Feb 83
B&W TV, chassis KCS 206C	2013	Mar 83
Color TV, CTC117 series	2019	Jun 83
Color TV, chassis CTC120	2025	Sep 83
B&W TV KCS205 series	2027	Oct 83
B&W TV KCS204 series	2029	Nov 83
KCS206 B&W	2033	Jan 84
KCS213 B&W	2036	Feb 84
CTC111 series	2041	Mar 84
CTC123 series	2046	Apr 84
CTC131/132 series	2050	Oct 84
KCS B&W AM/FM clock	2053	Dec 84
CTC117 chassis	2062	Apr 85
CTC118 chassis	2070	Sep 85
CTC121 chassis	2072	Oct 85
CTC126 chassis	2076	Dec 85

	Profax Number	Month and year
RCA		
MMC100, video monitor	2077	Jan 86
CTC117 chassis	2080	Feb 86
CTC133 chassis	2081	Mar 86
CTC120 chassis	2083	Apr 86
CTC125 chassis	2085	Jun 86
207 series weather clock	2086	Jun 86
CTC136 chassis	2089	Aug 86
CTC130-S1 chassis	2090	Sep 86
B&W TV basic service data	2093	Nov 86
UWJ chassis	2096	Dec 86
CTC117-S2 color TV supplement	2098	Feb 87
CTC134 chassis, color TV	3013	Oct 87
CTC135 chassis, color TV	3006	Jun 87
VDM140 chassis, color TV	3002	May 87
PVM035 chassis color TV	3031	Sep 88
PVM050 color TV	3023	May 88
P42000-S1 projection TV (additional models: RVM46700, 46GW700, P46000)	3048	Jun 89
CTC135 color TV	3051	Jul 89
CSM055 color TV/AM/FM/clock radio	3054	Sep 89
CTC91 chassis	3071	Dec 90
RCA/GE		
Color TV, CTC145/146 chassis	3040	Feb 89
CTC145/146 color TV	3058	Nov 89
CTC148/149-S2 chassis color TV	3062	Mar 90
TX81 color TV	3067	Aug 90

	Profax Number	Month and year
RCA/GE		
CTC156 color TV	3068	Sep 90
CTC169 (PV) color TV	3070	Nov 90
ZENITH		
D2500W chassis, color TV	3009	Aug 87
D13085/D1910B chassis, color TV	3007	Jul 87
SD2501W chassis, color TV	3011	Sep 87
CM-139/B-0 (B) chassis color TV	3028	Jul 88
CM-139/B-3 (I) SD2511G/SD2581H	3034	Oct 88
C2020H chassis color TV	3022	Apr 88
PV800 color monitor	3017	Jan 88
Color TV, CM-140/b-2(G) chassis	3041	Feb 89
CM-14-0/B-3(1) color TV (models SE2721H/SE2725R/SE2727H)	3046	May 89
CM-140/B-2(I) color TV	3053	Aug 89
PV4661H rear-projector color TV	3056	Oct 89
CM-140/DIGITAL(C) chassis color TV Models SE3135P/E3191H/SE353H/ ZB2771/ZB771H2/ ZB277H/ ZB2772/ZB27/B2797P2/ZB2797Y/ ZB2797Y2/ZB313H/ZB193Y/ ZB3539T/ZB3539Y)	3059	Dec 89
CM-139/B1 (Y) and (K) TV receivers Models SD2097S Y and SD1327W3, SD1327Y, SD1327Y3 K	3061	Feb 90
PV-140/Digital G Rear Proj. TV receiver, Zenith surround stereo system	3064	May 90
Zenith PV454-1P color TV	3066	Jul 90

Graphical analysis of capacitor characteristics

By Sam Wilson

In order to prove a point, I have discussed capacitor characteristics at length using mathematical analysis. I told you the true meaning of capacitor ESR, and I have explained parallel-tuned circuits.

I sent, to anyone who asked, mathematical proofs of the statements. I never said that the math was absolutely necessary to prove those things. The fact is you can do it with a compass, ruler and protractor. (You also need paper and pencil).

If I had given you this very simple approach at the start you would have said "Wilson is afraid of math!" But my heart is pure and my strength is as the strength of ten. I fear no math!

I just happen to think the math solution is the long way around for technicians who are trying to analyze capacitance. The graphical approach shown here provides an adequate analysis of capacitor characteristics. In this analysis, two kinds of phasor diagrams will be discussed: current/voltage and impedance.

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

Definitions

Here are a few basic definitions: A *phasor* is a line that represents a magnitude (which means an amount) at an angle. Figure 1 shows a phasor marked *phasor V*. It represents five volts at 45°. This is often expressed as *5 V/45°*.

The horizontal phasor, marked *phasor I*, is in the standard zero position. Angles are often measured with respect to this position.

The conventional direction of rotation for phasors in the United States is counterclockwise.

Think of the V and I phasors as being two hands of a clock that are welded together and rotating counterclockwise.

As shown in Figure 1, phasor V is ahead of of phasor I. Another way of saying that is phasor I is lagging behind phasor V. Phasors like this are used to represent the voltage and current in a series RL circuit.

With this information, we can build a very simple graphic solution for the ESR and for the parallel resonant circuit. You need a protractor and ruler. If you are familiar with geometric constructions, a compass will be useful. Also, the paper and a sharp pencil are needed.

Simple circuits

Figure 2 shows a series RC circuit. Shown beside it is a phasor diagram that represents the circuit resistance and capacitive reactance.

Figure 3 shows another type of phasor diagram for the series circuit in Figure 2. Current is the same in all parts of a series circuit, so it is usually used as a reference in series circuits. Note that the phasor representing the circuit RMS current (I) is in the conventional zero position. All other phasors in this diagram are referenced to that current phasor.

The voltage across the resistor, V_R, is in phase with the current, and the voltage across the capacitor, V_C, is 90° behind the current. The two volt-

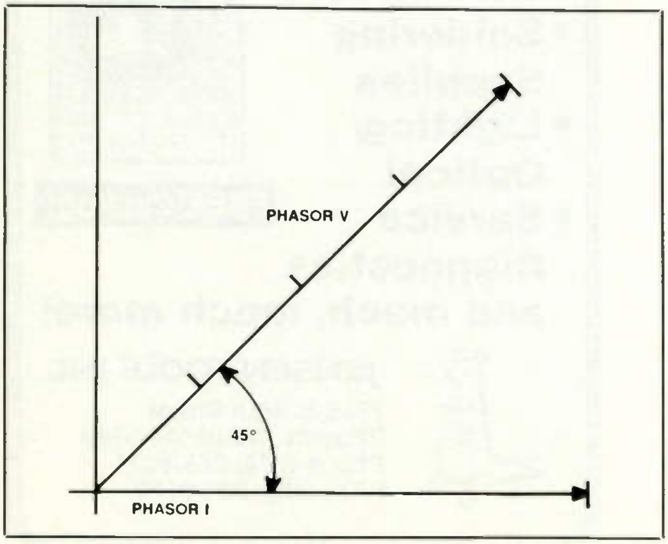
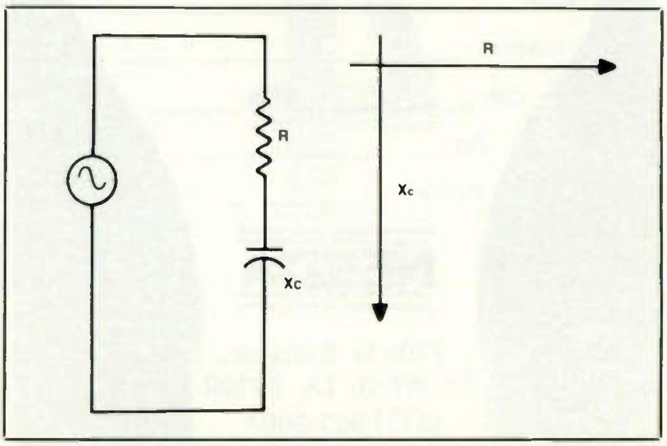


Figure 1.

Figure 2.



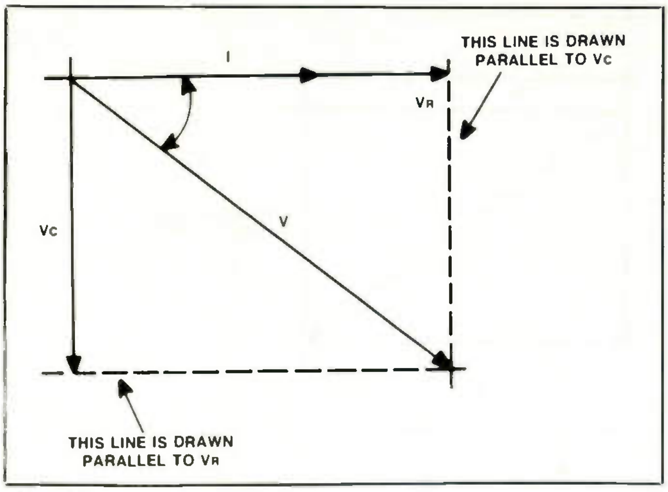


Figure 3.

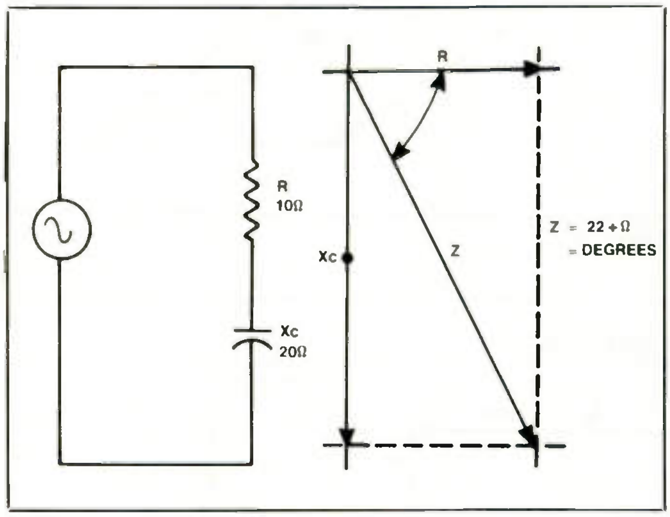


Figure 4.

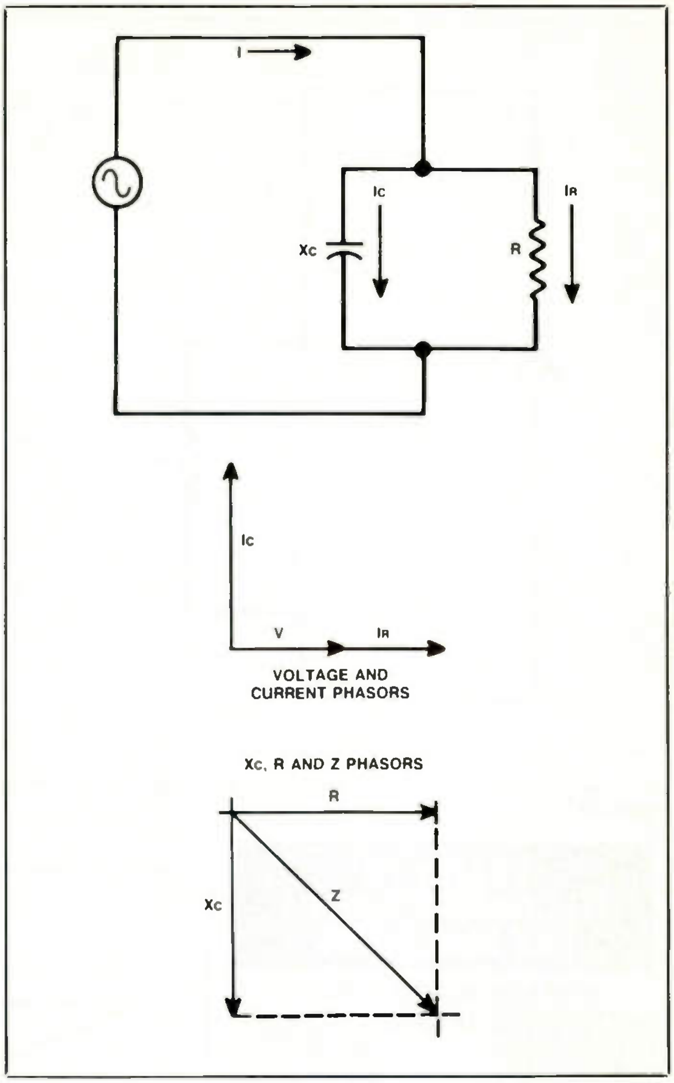


Figure 5.

ages, V_R and V_C, are added by the "parallelogram method." To do that, the broken lines are added to the ends of phasors V_R and V_C. Those broken lines are parallel to the phasors. The *resultant* is V. It is the vector or phasor sum of V_R and V_C shown by arrow V in the rectangle. It shows that the voltage across the circuit lags the circuit current. A very close approximation to the exact value of the voltage could be determined if the phasors were drawn to scale. Moreover, the phase angle between the voltage and current could be measured by a protractor.

Try this problem

Take a look at Figure 4. What is the impedance of this RC circuit? To solve it, draw phasors that represent X_C and R. Draw the parallelogram and measure the length of the impedance phasor.

Using the same scale as used for X_C and R, you can find Z in ohms. Using a protractor you can measure the phase angle. The solution is shown in Figure 4.

Figure 5 shows a capacitor in parallel with a resistor. The current and voltage phasor diagram is shown for this circuit. Note that the phasor for I_C is drawn in the direction opposite to the one in Figure 3. The reason is that the voltage is now the reference. The current phasors represent the ac currents through the capacitor and resistor.

The phasors for X_C and R are also shown in Figure 5. The procedure for finding the parallel impedance is the same as for finding the series impedance.

Now consider the series-parallel circuit of Figure 6. This is the simplified equivalent circuit of a capacitor. Draw the impedance phasor diagram for the R_C parallel circuit. This was shown in Figure 5. The impedance phasor for the parallel circuit is Z'. Next, combine the resultant (Z') phasor with the phasor for the series resistance (R_S). Find the resultant by the parallelogram method as shown. This is the resultant phasor (Z) that represents the impedance of the complete circuit.

The circuit resultant phasor is shown again in Figure 7. Now grab

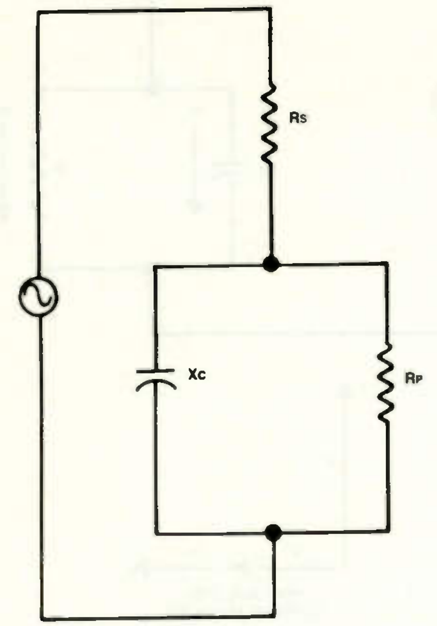


Figure 6A.

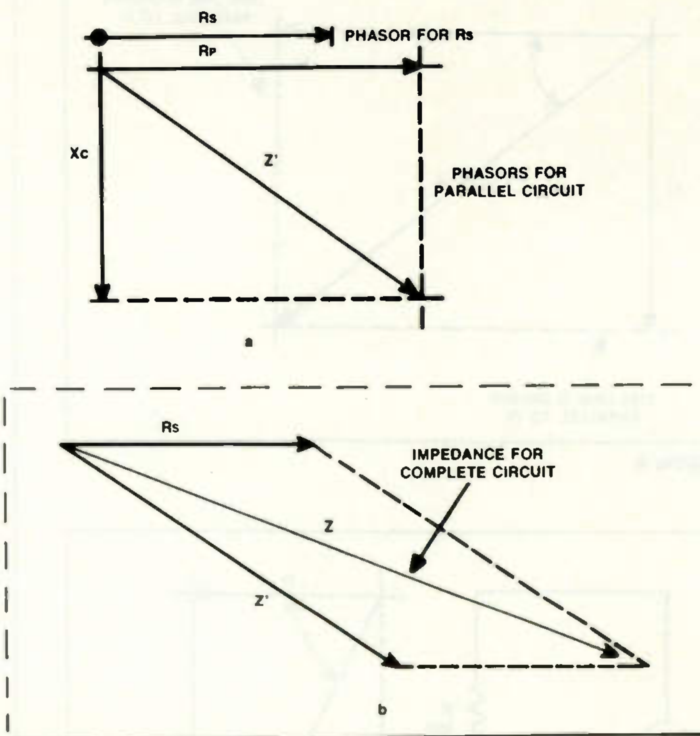


Figure 6B.

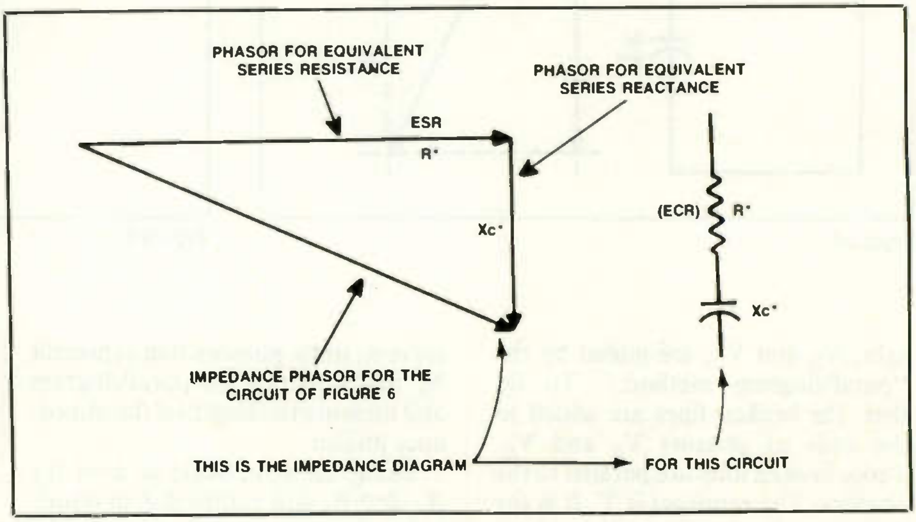


Figure 7.

onto your hat!!! You can make a single RC circuit that has that same resultant phasor. All you have to do is connect the correct resistor (R*) in series with the correct capacitance (C*). (The * means that the value is the equivalent resistance or capacitance). The graphical procedure for determining the values of R* and C* is called *resolving* a phasor into its component parts (see Figure 7).

It doesn't matter how complicated an RLC circuit, you can always replace it with a single resistor in series with an inductor or capacitor that gives the same impedance. When you do that, the generator voltage and current will be unchanged.

In a future issue, I will show the parallel resonant circuit phasors for parallel tuned circuits that have variable resistance tuning.

The DOS PATH command

By Conrad Persson

One complaint that you might get from an individual whose computer you're servicing is that he has difficulty navigating among the directories and subdirectories on the hard disk. This is especially true if he has built a lot of subdirectories and subsubdirectories. Actually, it's probably not necessary or good pratice to have too many sub-sub and sub-sub-subdirectories, but that's a subject for another time.

For example, the complaint might be that when the person tries to invoke a program, he has a hard time remembering exactly what path he needs to specify to get to that problem. Even if he remembers how to get to the program, the syntax needed to specify that path gets cumbersome and it's easy to make a slight error in keying it in, producing the message "CAN'T RUN PROGRAM," and making it necessary to start all over again. The DOS PATH command can help to alleviate such problems and save time and frustration for both you and your client.

Here's how the computer searches

Let's say you have a program file called Database in a directory called PROGRAMS, but at the moment you're in another directory called WP (for word processor). If you want to start Database operating, you might type in "DATABASE" and wait for the program to start. What you'll get for your trouble is the message "CAN'T RUN COMMAND." Here's why.

Persson is editor of **ES&T**.

When you enter the name of the program, the first thing that the COMMAND.COM program does is to see if it's one of its internal commands: a command like COPY, DIR, and the like. The programmers of DOS designed COMMAND.COM so that it has a list of those commands. If it doesn't find what you've typed in its list, it then looks for a program or a batch file: one with an extension of COM, EXE, or BAT. There are two important things about this; 1. it searches for these *in the current directory* and 2. it searches for files with the extensions COM, EXE or BAT in that order.

If the computer still doesn't find a program or file with the name you've typed in, it looks to see if there's a PATH statement that tells it where else to look. If it doesn't find anything that tells it where to look, it will give you a message of "CAN'T RUN COMMAND" if what you typed in was in a form that would invoke an executable (COM or EXE) command.

Giving the computer a PATH

You can avoid problems such as this by simply including PATH information for the computer in the AUTOEXEC.BAT file. If there's no AUTOEXEC file on the disk, you should probably write one, to include at least a PATH statement if nothing else. You can write a batch file using either the COPY.CON utility in DOS (if you like to do things the hard way, or don't have any other choice), or a word processor that creates files that are in pure ASCII.

Let's assume for the moment that you have only the two directories we mentioned previously "PROGRAMS" and "WP", in addition to your DOS directory. To establish a path for the computer to follow when you type in a command, you would write the statement:

```
SET PATH =
C:\;C:\DOS;C:\PROGRAMS;C:\WP
```

This command tells the computer that if you call for a program or a file that it doesn't find in the current directory that it should first go back and search in the root directory. If it doesn't find the named program in the root directory it will then search the DOS directory, the PROGRAMS directory then the WP directory, in that order. If it still doesn't find what you called for, it isn't there.

What PATH won't do

Unfortunately, the PATH feature isn't able to find all of your programs or files. It will only find those with a COM or EXE extension. For example, if you're using a word processor and you're in the word processor directory and would like to call a file from another directory, you'll have to specify the path. Otherwise you'll get a "FILE NOT FOUND" message.

Still, in spite of it's limitations, PATH can be very helpful, and save you and/or your client time and frustration in everyday computer operation. It's worthwhile to experiment with it, preferably with a copy of the DOS manual or a good book such as "Peter Norton's DOS Guide," or PC Magazine's "DOS Power Tools" in your hand. ■

The Benchtop Electronics Reference Manual: Second Edition, by Victor F.C. Veley; Tab Books; 784 pp; $29.95.

The Benchtop Electronics Reference Manual is written for electronics and communications technicians, as well as students and hobbyists, who need information and equations at their fingertips. A source of information on a wide variety of topics such as direct current, alternating current, electronics math, tube circuits, radio communications, digital electronics and solid-state devices and circuits. It offers detailed facts and figures on more than 200 of the most common electronic topics. The two new sections alone—mathematics for electronics and digital electronics each include 20 chapters.

Tab Books, Blue Ridge Summit, PA 17294.

Fiber Optic Communications Handbook: Second Edition, by the Technical Staff of CSELT; Tab Books; 1184 pp; $89.98 - Hard Only

This is an in-depth, up-to-date coverage of the fiber optic communications field. This second edition takes readers through an in-depth study of the newest developments in this revolutionary field.

Students, systems engineers, physicists, computer scientists, electronics hobbyists, technicians, or telecommunication managers anyone who needs a complete reference tool or practical applications guide will be impressed by the scope and detail of this book's coverage of the rapidly growing field of fiber optic communications. A sampling of the topics include: Sources and detectors, Optical cable and passive devices, The transmission medium, Optical systems, Integrated optics, Advanced topics in optical communications.

This revised, updated and expanded edition has been prepared by 35 engineers and technicians at Centro Studi E Laboratori Telecomunicazioni (CSELT), the Italy based central research laboratory for one of the most active communications manufacturing and operations organizations in Europe. The authors are specialists in different areas of fiber optics and are well-known in the international scientific community.

TAB Books, Blue Ridge Summit, PA 17294.

Lenk's Video Handbook: Operation and Troubleshooting, by John D. Lenk; 416 pp; illustrated; 6''x 9''; $39.95.

Lenk's Video Handbook by John D. Lenk presents advice and suggestions on ways to troubleshoot consumer video equipment—TVs and monitors, digital TVs, VCRs, and camcorders. Explaining not only how video equipment works, but also how to service it, this handbook features guidelines that serve to fill the gap between complex works on the theory of video and the simplified instructions in service manuals. It concentrates on troubleshooting techniques, rather than technical details that quickly become obsolete because of technological advances, and gives step-by-step examples based on actual troubleshooting problems.

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

Microcomputer LANs - 2nd Edition, by Michael Hordeski; Tab Books; 384 pp; $39.95 Hardbound.

This is a complete, applications-oriented guide that shows managers, planners, and systems analysts how to determine networking requirements, evaluate available LAN hardware and software, set up networks that allow for future growth. Also included is how to design and build a private user network, how to achieve optimum signal flow and routing with switching techniques plus a whole lot more.

The options for creating or upgrading local area networks (LANS) have grown dramatically in the last year alone, with a greater variety of products, lower component and software prices, and the arrival of computer equipment designed especially for network applications. Most busi-

Causing a VCR to operate without a cassette in it

By the ES&T staff

When you're in the process of diagnosing a problem in a VCR, it's frequently important to be able to get the mechanism to operate without a tape in the machine. Of course it's possible to insert a specially prepared tape cassette from which the tape has been removed or cut and taped off. It's possible even to buy or prepare a cassette that has a portion of the cassette cut away to observe what's going on and make adjustments.

Sometimes, though, even this degree of access isn't enough, and a technician would like to get the cassette holder into the down position and get the unit operating with nothing at all in the cassette holder.

The following procedure, adapted from the service manual for the Panasonic Omnivision VCR line (Model numbers PV-2015S, PV-4016, PV-4002-K, PV-4025S, PV-4005K, PV-4009-K) describes how to get the cassette holder in those models down and get the VCR playing, without a cassette inserted.

How to place the cassette holder in the down position without a cassette tape

In the cassette holder up condition, the VCR can not be operated even if service test point TP6001 is grounded. To place the cassette holder in the down position without a cassette, use the following procedure: Note: When the power switch is turned on while the cassette holder is in the down position, the VCR will load to the STOP (fully loaded) position when the service test point, TP6001 is grounded.

Method 1 - Refer to Figure 1.

1. Disconnect the ac plug.
2. Remove the bottom cover, top case and front panel.
3. Turn the center pulley clockwise (See Figure 2: bottom view) while pushing the change lever until the top of the reject lever is locked by the first locking tab -Left.
4. Clear the first locking tab -Left by pressing the lower portion of the reject lever down.
5. Turn the center pulley clockwise (Figure 2) until the Pin of the cassette Opener is locked by the FIrst Locking Tab -Right.
6. Clear the first locking tab -Right by raising the Pin of the cassette opener.
7. Turn the center pulley clockwise (Figure 2) until the Pin of the cassette opener is locked by the second locking tab-right.
8. Clear the second locking tab-Right by raising the Pin of the Cassette Opener.
9. Turn the center pulley clockwise (Figure 2) until the Pin of the Cassette Opener is locked by the second tab -left.
10. Clear the second locking tab - left

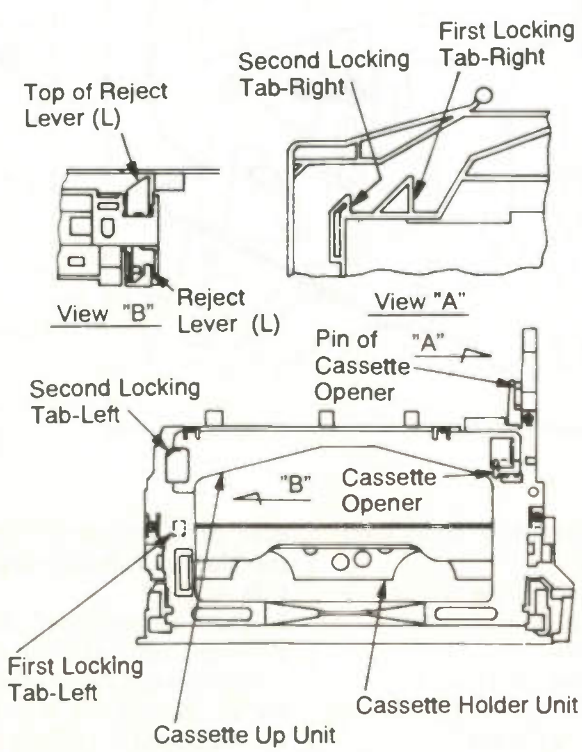


Figure 1.

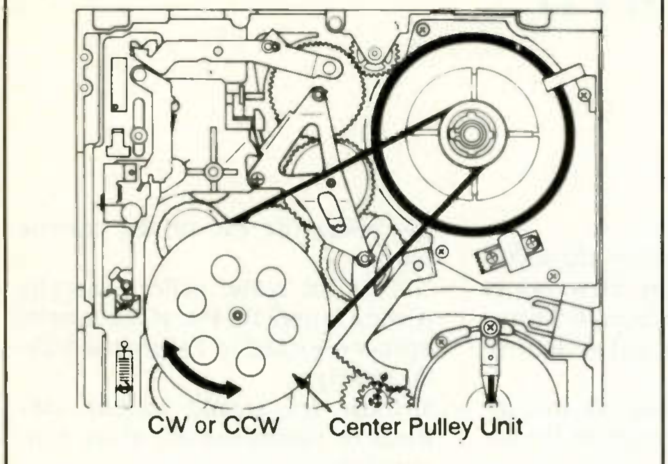


Figure 2A.

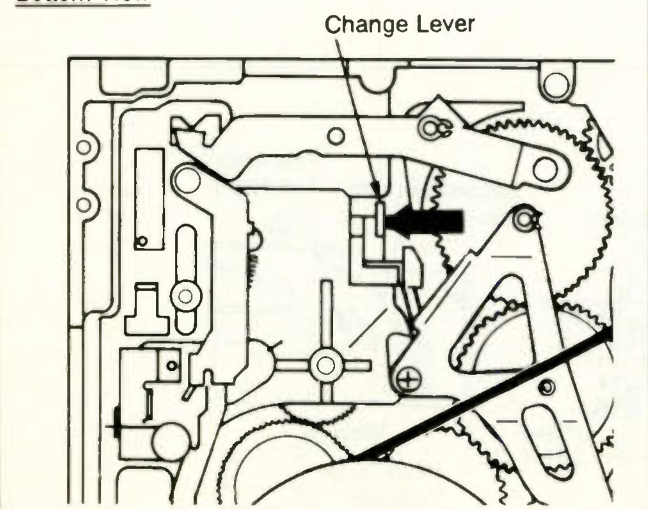


Figure 2B.

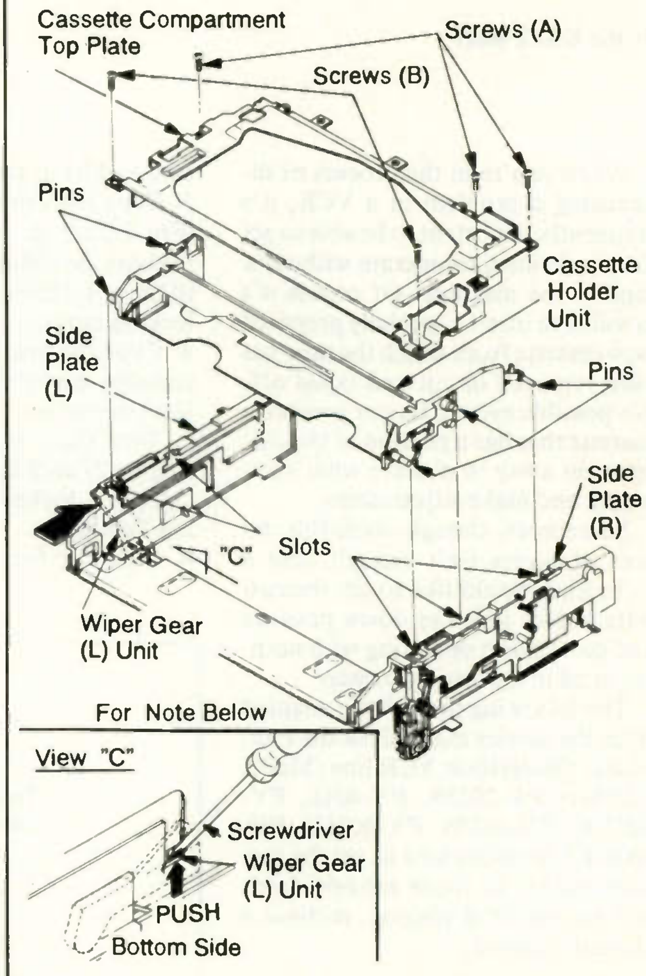


Figure 3.

by pressing the top of the reject lever down.

11. Continue to turn the center pulley to the cassette down position.

Method 2. (An alternate method for loading with no cassette in the machine. Refer to Figure 3.

1. Route the two supply side photo transistor leads so they are at the area edge of the Cassette Compartment top plate and slightly open the Main C.B.A.

2. Then remove the cassette compartment top plate by removing 3 screws (A) and 2 screws (B). Remove the cassette holder unit by pushing the wiper gear (L) unit until the 5 pins of cassette holder unit clear the slots of the side plates (L) and (R) as shown in box in Fig. 3.

3. Connect ac plug

4. Push the wiper gear (L) unit to place the unit in the cassette down position (no tape) as shown in Fig. 3.

Note: If the cassette mechanism can not be placed in the Cassette-Up position when the STOP button is pressed, push the wiper gear (L) unit up using a screwdriver as shown in box Figure 3. Now push the Stop button to eject. ■

HI-Z lines must stay short

By John Shepler

Connecting cables are always too short. If we're talking about speaker lead, the solution is easy. Simply add a little more wire. But what if the audio leads to a turntable, tape head, or microphone are too short. Is it still ok to simply add a jumper cable?

Most of the time the answer, unfortunately, has to be NO. You have probably seen warnings taped to some audio cables that say: DO NOT EXTEND THE LENGTH OF THIS WIRE. This is usually a sure giveaway that the circuits involve tape heads, magnetic phono cartridges, and microphones.

Why is impedance such an issue? You might conclude that it has to do with noise pickup, since high impedance circuits do tend to be noisier than low impedance circuits with the same gain. This is an important consideration, but is not the main reason. The problem is not with the impedance of the circuit, but with the characteristics of the connecting cable.

Figure 1 shows a typical HI-Z circuit. The transducer, such as a ceramic microphone or magnetic phono cartridge, is connected via shielded cable to a preamplifier with an input impedance of 47KΩ. In fact, there is normally a load resistor at the input of the preamp.

The cable also has a characteristic impedance. There is resistance from the copper wire, inductance from the length, and capacitance between the center conductor and the shield.

Let's say the cable is 10 feet long. The resistance isn't much of a factor since it is less than an ohm. Compared to 47K, you'll never measure the voltage drop. Inductance, too, tends to be negligible at audio frequencies. That leaves capacitance.

Ten feet of microphone cable with a typical capacitance of 30 pf per foot is 300 pf. That doesn't sound like much, does it? However, this capacitance in parallel with the resistance of the preamp input forms a low pass RC filter.

We can calculate the effect from the formula:

$$F = 1/(2 \times \pi \times R \times C)$$

Substitute 3.14 for PI, 47K for R, and 300 pf (or .0003 uf) for C and the cutoff frequency (F) calculates to be about 11 kHz.

The cutoff frequency is the frequency where the level drops by 3dB. It continues to drop as you increase the frequency above this cutoff point. In effect, the highs get filtered just like turning down the treble control.

Now consider that many cables have more like 100 pf per foot. This results in a cutoff frequency of only about 3.4 kHz. Certainly this is not acceptable for quality audio.

You might have noticed that the transducer is also in parallel with the capacitance. Its impedance has to be factored into the equation also. Tape heads and phono cartridges are really highly inductive coils. They are designed to have a flat frequency response only when driving a known impedance, which includes a value of capacitance and resistance. If there is not enough capacitance in the cable, some is added in the preamp. If there is too much capacitance . . . well, there is no way to take it out, so frequency response suffers.

The toughest elements to deal with are ceramic and crystal microphones. These have an impedance in the megohms. You can't change the cables by even a foot without causing audible response effects.

What's the solution? Resist the urge to lengthen cables for turntables and tape decks that don't have preamps. If you need a longer hookup, add a preamp to drive the extra cable length. For microphones, use a low impedance mic setting wherever possible. The same 10 ft., 100 pf cable connected to a standard low impedance mic amplifier of 150 Ω, has a cutoff frequency over 1 MHz. An added advantage of lower impedance is that these lines are also less susceptible to noise and hum. ■

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

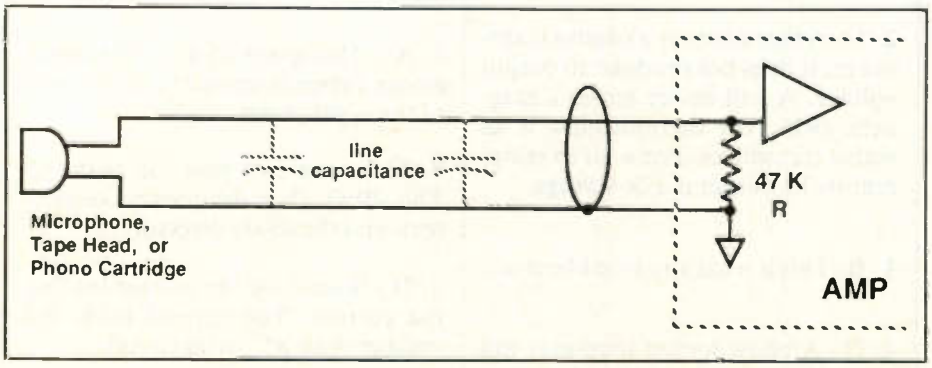


Figure 1. High impedance circuit

Books

(from page 50)

nesses and organizations recognize that quick and reliable access to information is the key to productivity, but only if it means for achieving it are well planned and closely monitored.

The book is also designed for anyone who wants to apply computer networks to office automation and factory control problems, this updated and expanded edition provides hands-on information necessary to design and implement cost-effective network configurations that will be compatible with future LAN products and techniques.

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Test your electronics knowledge

Answers to the Quiz *(from page 13)*

1. None of these choices is correct. The diode is used primarily in high-voltage circuits, and is there to protect the regulator in case of loss of input voltage.

2. C - A thermistor is a passive transducer. It does not produce an output voltage. A hall device senses a magnetic field. The thermocouple is an active transducer. For a given temperature its output is a dc voltage.

3. B - This is what an assembler does.

4. C - A phase locked loop may not have an amplifier. It has a low-pass filter but not a high-pass filter.

5. D - Passive transducers are made for each of the outputs listed.

6. A - The loudspeaker input is electrical energy and the output is sound energy.

7. A - The speed of a synchronous motor depends upon the frequency of the input power.

8. There are two possible answers: The BFO (beat-frequency oscillator), and the diode detector.

9. D - Both show the voltage leading the current. The current leads the voltage in an RC series circuit.

10. 5/8 of the original pie.

Coax adapter connector kit

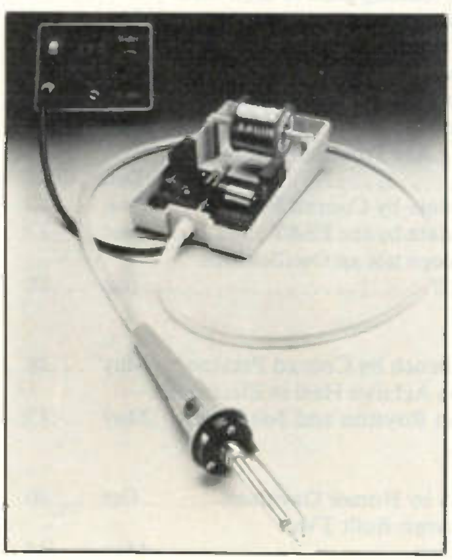
New from *Test Probes* is the TPI 3000A Kit, a coax adapter connector kit that makes all combinations of BNC, TNC, SMA, N, UHF, Mini-UHF, F and RCA adapters.

No soldering is required, simply screw any combination of two connectors from the 24 available to one of the six universal interfaces. The TPI 3000A kit features eight types of male and female connectors with: gold plated contacts, machine brass, silver plated connector bodies, Teflon insulation and each TPI 3000A kit contains two male and female connectors of the BNC, N, UHF and TNC adapters. Universal adapter cables are available separately. The TPI 3000A comes with a zippered, soft leather case that protects and organizes the collection.

Circle (12) on Reply Card

Electronic-feed soldering iron

New Methods is now offering the Solbest line of electronic-feed, temperature-controlled soldering irons for precision soldering of SMD's, components, wires, harness and other industrial applications. With Solbest, hand soldering operations, using one hand only, are able to precisely feed solder electronically through the soldering iron itself to the solder joint, by simply depressing a microswitch on the handle of the iron.



Circle (13) on Reply Card

AC gaussmeter

Integrity Research introduces for monitoring powerline and appliance magnetic fields a new 60Hz ac gaussmeter, model #IRC-27. It has an audible clicking sound that varies as the field reading increases and is light weight with a reusable LCD display. Its sensitivity is 0.1 milligauss with a maximum range of 200 milligauss.

Less than half the price of Intergrity's professional model -IRC-109, the 60Hz ac gaussmeter still retains many of the popular features of its brother. It is frequency-specific for 60Hz, eliminating harmonic distortion, with a separate model (IRC-28) available for European 50Hz measurements. A 200 mV strip chart recorder output is standard.

Circle (14) on Reply Card

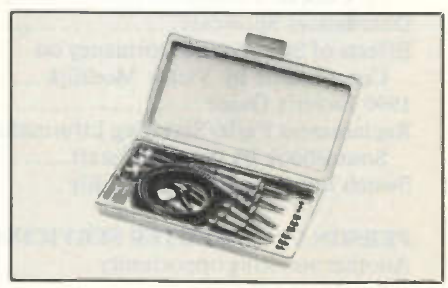
Soldering iron controller

An inexpensive adapter that makes any fixed temperature soldering iron fully adjustable from 150F to full heat is available from *M.M. Newman*. The Dial-Temp soldering iron controller is a compact device that plugs into a 115 Vac wall outlet and accepts any 3-prong fixed temperature soldering iron. Featuring a dial on top, it lets users adjust tip temperatures from 150F to full heat. Compatible with any soldering iron ranging from 15w to 1600w, the Dial-Temp Soldering Iron controller is ideal for precision assembly electronic work on heat sensitive components and fits neatly into a tool kit for field service applications.

Circle (15) on Reply Card

Oscilloscope probe master kit

Probe Master has developed a master kit containing 3 complete heavy duty probes and accessories. The 20-piece kit contains a 1x 25 MHz, 10x 200 MHz and a 1x/10x switchable 15/200 MHz probe in a high impact protective case. The 4ft probes use new soft molded strain relief techniques providing longer cable life. Accessories feature a fully enclosed rotating snap-on ground lead, "screw in" replaceable tips and repairable spring hooks for ease of operation and maintenance. Tip insulators, IC test tips and trimmer tools round out the kit.



Circle (16) on Reply Card

1990 Article Index

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1990 Department Index

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Sencore sweep and marker generator, or sencore speed aligner. *F. Lurry 6738 Ahmerst St., San Diego, CA 92115. (619) 462-7445.*

Leader dual millivoltmeter LMV 185A or equivalent. *John Butler Phoenix Electronics, 1400 Inverness Ave, Balt, MD 21230.*

Repair parts manual for an Alpha coder, AC-1, MFG by Autovolt. A schematic would be helpful. *Charles Mann 106 Sonny Dr., Warner Robins, GA 31093.*

Schematic diagram for Cobra 67LTD CB radio. Sams does not print this model. Schematic for Realistic Pro 2020 scanner. *R.Jacobs, 6610 Bunker Rd. North Royalton, OH 44133.*

Admiral part no. 56A49-2 or 56C49-2 if sound/AGC I.C. used in model KC1301. ECG equivalent ECG 854. Both numbers discontinued. *John Phipps 1412 Navaho Trail, St. Charles, Missouri 63303.*

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