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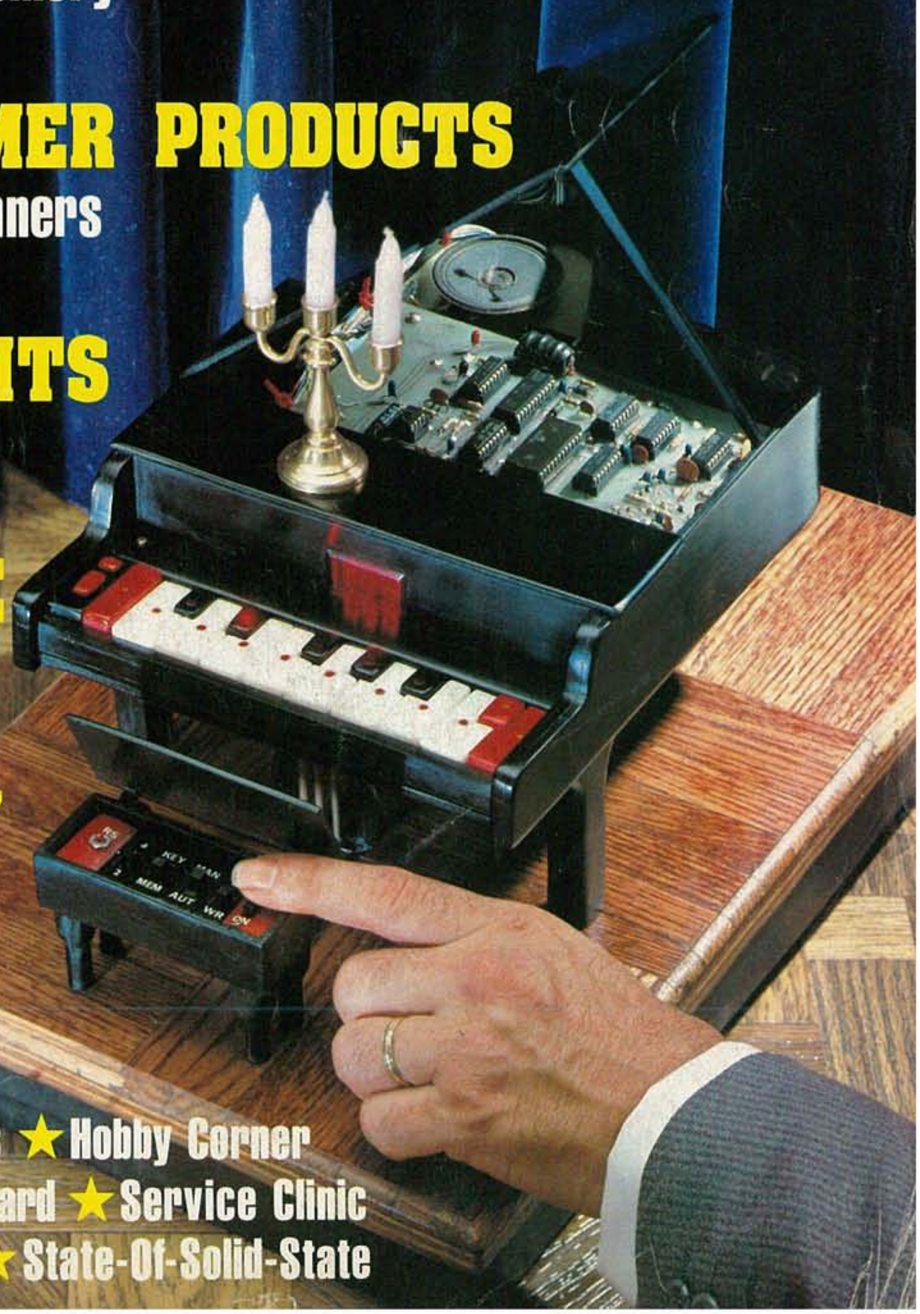

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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

SEPTEMBER 1983 Vol. 54 No. 9

ON THE COVER

Projects that are built just for fun are sometimes enjoyed most of all. But what's even better is a fun project that can teach you something new. The Pianomatic mini player-piano does just that. Sure to be an entertaining conversation piece when it is finished, building it will introduce you to such topics as computer memory organization and retention, digital logic, keyboard encoding and decoding, and the like. As a bonus, the techniques you'll pick up here can easily be adapted for use in your own designs. The story begins on page 43.

THE KOALAPAD from Koala Technology, Inc., allows you to control your computer's cursor movement by just tracing on the touch-sensitive pad. It's just one of the most innovative products of the past year as honored at the Summer CES. Turn to page 49 to find out more about it, and others similarly honored.

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Our special supplement: Your Own Computer. Among the things we'll look at are:

- **Hardware**—a comprehensive look at systems, and their cost!
- **Word-processing software**
- **Software and hardware compatibility**
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VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

FLAT PANEL COLOR

The first giant-screen flat-panel color display has been developed—and is being offered for sale—by Mitsubishi. As demonstrated at the Chicago Summer Consumer Electronics Show, the screen was about 1-⅓ inches thick. The diagonal measurement can range from 5.3 to 17.6 feet, and even larger.

The panel contains a matrix of LCD's. Each is about two square inches and contains an 8 × 8 array of individually addressable red, green, and blue elements. The size of the panel of determined by the number of the LCD squares that are used. Thin fluorescent tubes illuminate the panel from the rear, providing a surface brightness of 120 footlamberts—about the same as a direct-view color picture tube.

Before you run out and try to buy one, there are a few things you should know about Mitsubishi's *Crystal Color*. First, the minimum cost is $100,000. Second, because of the coarseness of the picture, the minimum viewing distance is about 12 feet. Initially the computer-controlled viewing system will be used for advertising and informational purposes in airport terminals, hotel lobbies, and other places people gather. However, Mitsubishi says that it is developing a home version—there's no estimate on when it will be ready.

POCKET COLOR TV

Seiko has succeeded in making a prototype of a pocket color-TV with a liquid crystal screen that measures 2-inches diagonally. It could be on the market in about a year for less than $500. The 240 × 240 pixel display uses nematic liquid-crystal technology. Like Mitsubishi's giant flat-panel screen, Seiko's midget uses a diffused fluorescent backlight with individual red, green, or blue filters above each pixel electrode.

TELETEXT LAG

Although, CBS, NBC and some major cable groups plan to begin teletext "magazine" transmissions using TV's vertical blanking interval this year, most set manufacturers have adopted a policy of watchful waiting before committing themselves to producing receiving equipment for the mass-consumer market. An exception is Zenith, which says that its entire 1984 model line will be equipped for teletext adaptors, which it plans to have on the market this year. General Electric and the Matsushita group (Panasonic, Quasar) also say they'll have adaptors, but haven't specified when.

Teletext adaptors are expected to be quite expensive, at first, figures mentioned varying from $150 to $250; but they're expected to drop rapidly if the new medium wins consumer-market acceptance. ITT, developer of the digital TV signal-processing circuit, claims that it will have a low-cost teletext adaptor IC for sets which use its digital IC's. That IC, it estimates, will add about $21 to manufacturers' costs—meaning that it probably will increase the cost of a set by about $60—still an appreciable expense. The networks' teletext systems are expected to use the NABTS system, a variation of the French Antiope technique, and each will have about 100 pages.

SOLID-STATE LASER PICKUP

A major improvement is in sight for the *LaserVision* videodisc system. After years of promises and speculation, the solid-state laser pickup is virtually here, thanks at least partly to the mass production of the CD digital-audio-disc system, which has generated methods of producing semiconductor lasers in volume. Although the videodisc laser pickup is different from that used in the audio disc, production methods for the two pickups are similar. Hitachi has introduced two industrial-model laser disc players with solid-state pickups, one of which will sell in Japan for as little as $800; that is not much more than Pioneer's consumer model with the helium-neon laser.

Among the immediate advantages of the semiconductor laser is elimination of the bulky and costly power supply required by the helium-neon version and consequent reduction in size and cost of the player. In addition, random access—one of the major features of the optical disc—can be speeded up, perhaps to three seconds from the current six. And the life of the pickup is increased (at least in the Hitachi version) to 5,000 hours from 2,000 claimed by conventional laser players. It wouldn't be surprising to see new consumer *LaserVision* players soon adding the advantages of solid-state pickups. In fact, Pioneer hints that it is considering development of a player that will play both optical-video and CD-audio discs. **R-E**

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WHAT'S NEWS

Capt. Inman receives Gold Medal Award

Capt. Bryce D. Inman, USN (ret.), Manager of Advanced Radar Development at RCA Missile and Surface Radar, has received the Gold Medal of the American Society of Naval Engineers. He was cited for visionary leadership, engineering excellence, and initiative in defining and directing the integration of the first AEGIS Combat System. AEGIS is a radar-based, computer-controlled air-defense system developed for the Navy by RCA.

A pioneer in the areas of the phased-array radar and the guidance-system computer while in the Navy, Capt. Inman directed his design team through the difficult task of successfully integrating the first AEGIS Combat System into the first AEGIS Guided Missile Cruiser, *USS Ticonderoga,* which was commissioned in January.

In 1978, Capt. Inman organized the first efforts to develop enhanced-capability versions of the AEGIS Weapons System and the AN/SPY-1 radar in a smaller, lighter mode. The AN/SPY radar is used to detect air targets in the AEGIS Weapons System.

He also promoted vigorously the concept of a combat system "grooming site." As a result of his efforts, the AEGIS Production Test Center, dedicated in 1979 to provide a site for testing and evaluating the integrated AEGIS Combat System, has reduced the cost, time, and risk of shipboard testing.

Six-legged robot

"A MAJOR TECHNICAL ADVANCEMENT in the field of Robotics" is how Odetics, Inc. describes its new walking robot, or "functionoid." Odetics claims that it is the first mobile exploratory multifunction robot combining electronics, mechanical engineering, and computer science.

The robot, Odex I, can carry a load of 860 pounds at ordinary walking speed (or about a ton with all six legs down) can step up or down 33 inches, can go through a 21-inch door, and can be maneuvered through very tight places. (It doesn't have to turn around to change direction.) It is controlled with seven computers, six for the legs and one handling all other controls, and receives commands via radio link from the teleoperator, who works with two joysticks and six leg-control knobs.

The robot weighs 370 pounds and is powered by a 369-watt hour, 24-volt battery. The cameras shown are currently not operable—they are intended for experiments in vision sensing.

Atari gives computers to train teachers

Atari, Inc. has donated 20 Atari 800 home-computer systems, including peripherals and software, to the Graduate School of Education at Fordham University's Lincoln Center Campus in New York City. They are to be used to instruct teachers in methods of computer use and classroom instruction.

Since about half the high schools in the country have computers, says an Atari spokesman, it is crucial that teachers be familiar with basic computer concepts.

The Fordham-Atari Center will offer courses in computer programming as well as in the use of computers for research and educational applications. It will become a major center for the development of teacher-training materials in computer literacy and also for the testing of educational software.

Satellite services for individuals?

Geostar Corp of Princeton, NJ, proposes a satellite-communications system that would permit persons to send messages via satellite, using devices no bigger than pocket pagers. The system will locate the exact position of the sender, and handle messages of up to 36 characters.

In its application to the FCC. Geostar states that a person confronted by a mugger could press a single button on his communicator. That would send out a signal that would go to three satellites in geostationary orbit over the Equator, and from them back to a computer on Earth. The computer would determine instantly the exact location of the sender by noting the difference in the time it takes for signals to reach the computer from the different satellites. It would then notify the nearest police car or station.

The system would also be valuable to hunters and others lost in the woods, and would be of great value to trucking companies, who would make large savings if they could determine the location of—and communicate with—their trucks at all times.

The proposal has not found favor in all quarters. The cellular radio services—some of whose alloted frequencies Geostar proposes to use—are particularly unhappy. AT&T and Motorola Inc., both of whom are heavily involved in cellular radio, have opposed plans of Geostar's type, stating that such systems would waste frequencies in serving remote areas; such frequencies could be used better in urban areas.

FM car radio supplies traffic information to drivers

Blaupunkt Car Radio Division has initiated its Automatic Radio Information (ARI) system in the New York metropolitan area. Designed to improve and speed up traffic flow, ARI gives timely traffic information to motorists via a special FM broadcast signal.

THE AREAS COVERED BY ARI, each with automobile traffic reports for its own zone, around New York City. Zone 2 is covered by WALK-FM. Zone 3 by WNEW-FM, Zone 4 by WVNJ-FM, and Zone 5 by WZFM. ARI follows television practice (there is no Zone 1).

Four stations in the New York area broadcast signals that activate special car radios to draw traffic reports for their zones to the driver's attention. With the commuter's ARI-equipped FM radio tuned on and tuned to his zone's ARI station, the traffic reports he needs will be boosted in volume to stand out over the regular programming. The station will come in loud and clear even if volume is low, or a cassette is playing.

Drivers in Nassau and Suffolk counties will get their ARI traffic reports from WALK-FM on Long Island; WNEW-FM serves New York City; residents of New Jersey will tune their ARI-equipped radios

continued on page 8

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WHAT'S NEWS

continued from page 6

to WVNJ-FM in Newark, and the northern suburbs are served by WZFM.

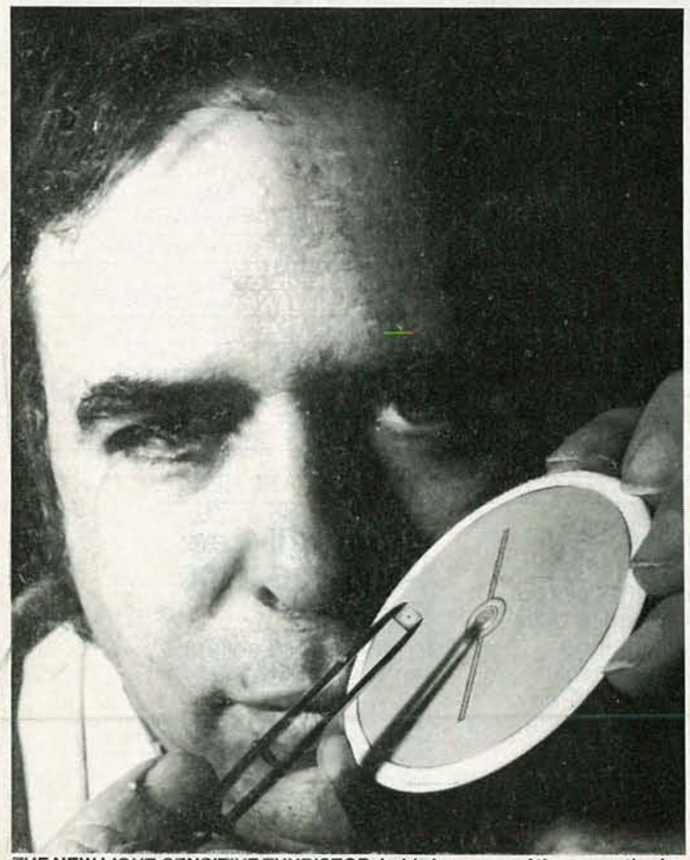
Only FM car radios with built-in ARI decoders will respond to the control signal (that will cause the volume of the station to be increased). At present, those radios are available exclusively from Blaupunkt, who plans, however, to license the technology, as has already been done in Europe. (West Germany has been covered nationwide since 1974. P. 47, R-E March 1982.)

Thyristor turns on bigger thyristor

Scientists of the General Electric Research Development center, Schenectady, NY, have developed a light-sensitive thyristor that will turn on larger power thyristors—normally activated by an electric signal—to convert them into light-triggered devices.

In addition, the new device will be welcomed by the electric-utility industry, which uses thyristors to convert high-voltage AC into DC for long-distance transmission, and back again to AC for distribution to consumers. The new device would be less expensive and more reliable than systems using electrical triggering. It would also improve immunity to electrical interference.

GE's new light-triggered thyristor is supplied in a hermetically-sealed, ready-to-use package. That package is smaller than a stick of chewing gum, and has leads for anode and cathode as well as a standard coupling for an optical fiber from the light source.



THE NEW LIGHT-SENSITIVE THYRISTOR, held above one of the power thyristors it turns on by its developer, Dr. Victor A.K. Temple. Working something like a pilot light on a gas stove, it is activated by pulses of light, and emits pulses of electricity that operate the bigger thyristor to which it is attached.

International carriers need safeguarding

Testifying before the Senate Subcommittee on Communications, Eugene F. Murphy, President of RCA Communications, Inc., called for Congressional action to assure competing carriers of cost-based access to Intelsat facilities.

Recent FCC action permits Comsat to serve end-users direct, putting it in direct competition with the international carriers. "If Comsat is to act both as wholesaler and retailer," said Mr. Murphy, "legislation must allow the other international carriers to compete with Comsat on a relatively equal footing."

He went on to say that, because of AT&T's continuing monopoly of international voice communications (which accounts for two-thirds of the total U.S. international communications market) AT&T's expansion into other markets should be accompanied by such safeguards as may be necessary to permit and insure full and fair competition.

Any legislation regarding the use and resale of international communications circuits would have to take the concerns of our overseas operating partners into account, Mr. Murphy said. "The role of our overseas correspondents, without whose cooperation there cannot be effective international telecommunications service, is critical."

Bankers get food tips from talking computer

A talking computer was used to help bankers find a good place to eat while attending the American Bankers Association conference in Miami Beach last May.

The computer, manufactured by Periphonics of Bohemia, NY, spoke by telephone to visitors who stopped at the Periphonics booth. Among the questions asked of the visitors were how much they wanted to spend, what kind of food they preferred, and what part of the town they'd like to eat in.

The computer provided a printout of restaurants to choose from that met specifications of each respondent. **R-E**

Radio-Electronics

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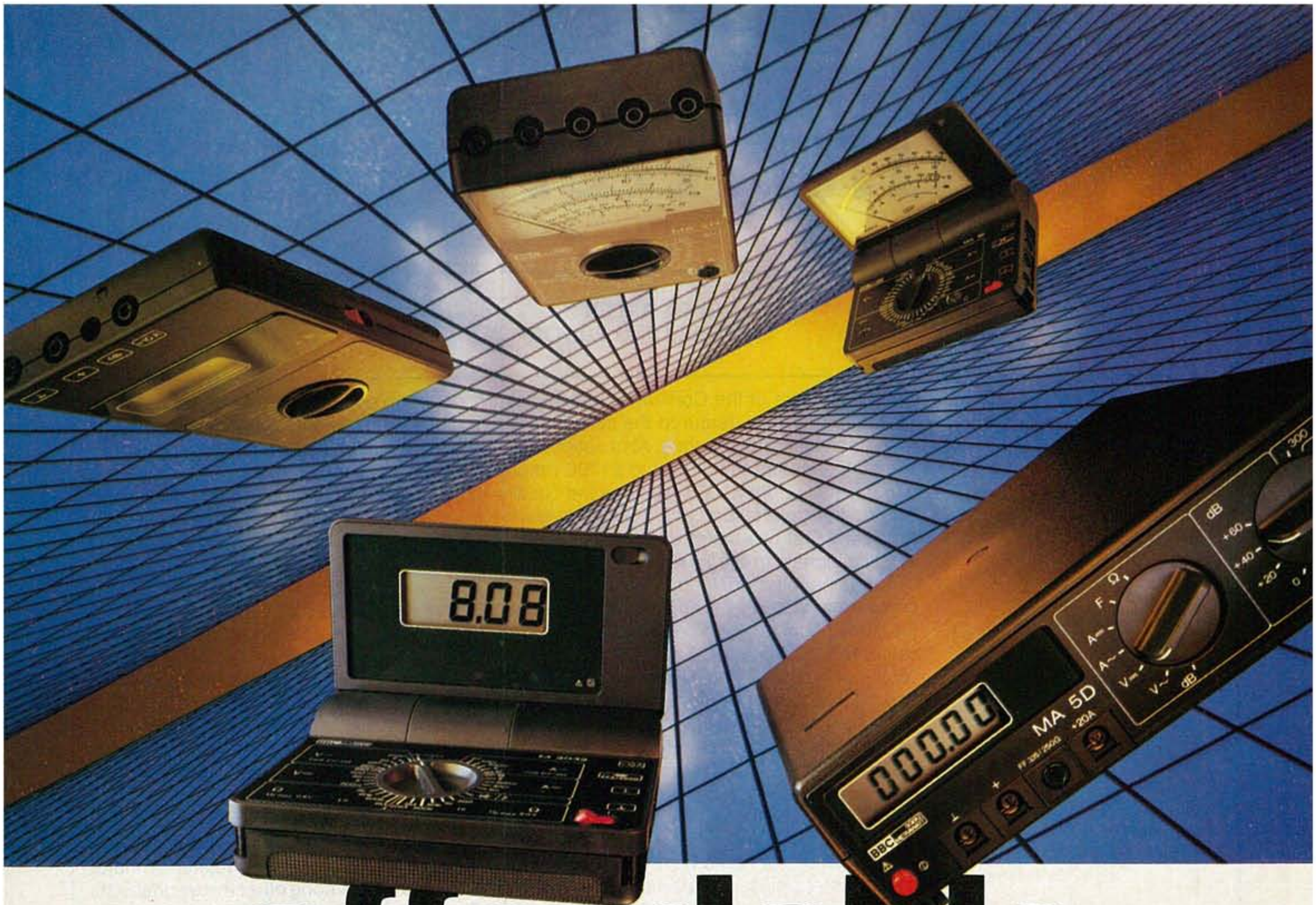

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SATELLITE/TELETEXT NEWS

GARY ARLEN
CONTRIBUTING EDITOR

LOWER PRICES, MORE DISHES

Trend-watchers at the Consumer Electronics Show got an eyefull when it came to satellite systems. The show featured the most impressive display yet of home equipment, including more than four dozen dishes. Also noticeable was the continuing decline in prices, with many systems priced in the $1400 to $1700 range, and most now under $2000. A few systems came in just under $1000 (such as the Galaxy Video system, which features a 7-foot dish). Among the trends seen at CES was a move toward smaller antennas, with some experts predicting that two-meter dishes will become commonplace for home reception of C-band satellite signals in the next few years.

The impending arrival of DBS is on many experts' minds—as is how Ku-band DBS will compare to existing C-band service. Although DBS has been touted as a low-priced service (under $500 for reception equipment), some are now predicting that the price may actually be closer to $1500 per site. That would mean conventional satellite service would have a better "cost-per-channel" than DBS—a conclusion that is reached when you compare the three to five channels proposed for DBS to the two dozen or so signals available on current satellites.

There was also speculation at CES that the Japanese are ready to unveil their home satellite-equipment, probably for DBS service. (As we've reported in the past, Sony and other major Japanese manufacturers are working with NHK and other TV broadcasters to develop new satellite facilities for home reception.)

Another indicator that home satellite-service has come of age is that the business is being analyzed and studied. One company reported a tripling of its business from 1981 to 1982, with expectations that home-dish users would triple again this year. Channel Master, a major equipment supplier, revealed its research findings that showed, among other things, that 90% of home satellite-users live in small towns or rural areas and that about 40% of dish-owners also have a videocassette recorder (about ten times the national average for VCR use).

Quite a variety of ancillary satellite equipment was also introduced at the CES. Among the add-on products were a receiver made by Intersat that features a two-year programmable memory, and an antenna-control unit that will allow a dish to cover up to 50 birds. (That, by the way, is far more than will be in place over North America in the foreseeable future.)

NEW TECHNOLOGY

Sat-Trol, an actuator and control system for satellite earth stations, includes "touch-label" switches with selectable fast and slow travel rates for pinpoint location of satellites. The new $400 unit was developed by Burr Engineering, of Battle Creek, MI, and features a self-contained power supply and "over-travel" protection to prevent a dish from going beyond the signal reach of a bird.

Satellite Television Corp. will test "multiplexed analog components," a system created by England's Independent Broadcast Authority to increase video resolution on the direct broadcast satellite service it is developing. The MAC technique transmits luminance and chrominance in time succession rather than simultaneously, a process that may improve definition of video images compared to the current NTSC technique. Satellite Television Corp. has not committed to using the system, nor has it made any other specific plans for high-definition video on its DBS signal.

Antenna Technology Corp. now offers a Tri-Sat dish that allows the signals from three adjacent satellites to be received simultaneously. The four-meter version costs $1390 and a five-meter version sells for just under $6400. The Las Vegas-based company already offers other multi-beam dishes in sizes ranging from three to seven meters.

ABC Radio has started digital transmissions via Satcom I, and the network hopes to have all 1850 of its radio affiliates on satellite by the end of the year. CBS, RKO and NBC also plan to inaugurate digital-audio networks via satellite this year.

DIRECT-TO-THEATRE MOVIES

Direct-to-theater video is being considered by several companies. Greater StarLink wants to use the 14/12 GHz band on the upcoming SpaceNet bird (to be launched by Southern Pacific Satellite Co.) to send high-definition TV to movie theaters for display on a 40- × 100-foot screen. Several movie studios have expressed interest in the project, which is several years away. In another development, United States Satellite Systems plans to test a similar HDTV transmission, beaming signals to about 50 video centers around the country. USSS may use local facilities operated by the Campus Entertainment Network.

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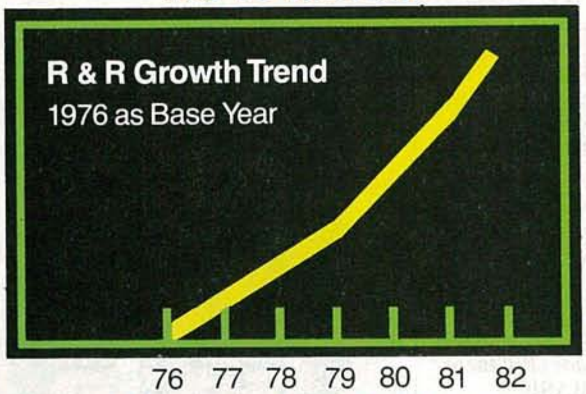

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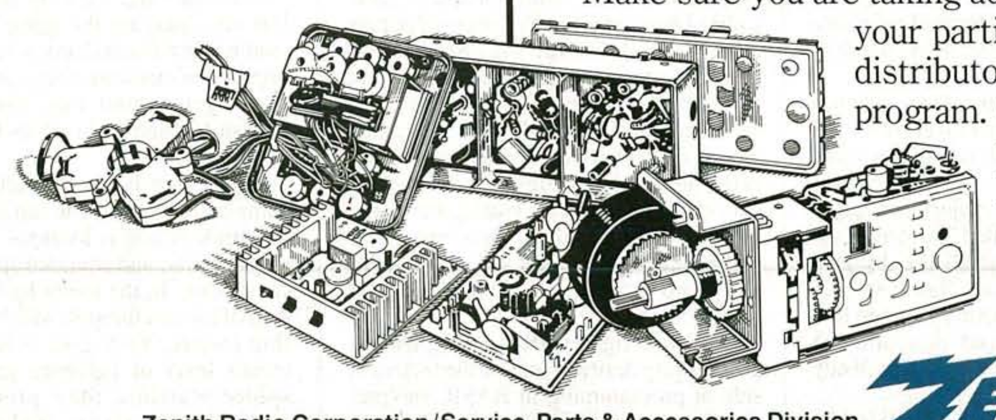

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VIDEOGAMES

Rolling your own

DANNY GOODMAN, CONTRIBUTING EDITOR

LAST MONTH, WE SAW HOW AN APPLE computer, a working knowledge of 6502 microprocessor assembly-language, and a special development system can help you design your own games for the Atari *2600* and *5200* systems. But for those who like to program their own games, there is another game system—and a darn good one at that—that has been open to user programming for years. And you don't need assembly language or a computer to get anywhere. I'm talking about the unit that started out as the Bally *Professional Arcade*, more recently known as the *Astrocade* (shown in Fig. 1).

FIG. 1

The system has had a long and checkered career in the volatile videogame industry. As we go to press, the future of Astrocade is unsure as they attempt to extricate themselves from Chapter XI. But that's not what this story is about.

As a good many of the estimated 120,000 *Astrocade* owners know, the *Astrocade*, in addition to playing some of the graphically and sonically best videogame cartridges ever, is programmable in BASIC with the help of the BASIC language/cassette-interface adapter. In recent times, this accessory and well-prepared BASIC tutorial/reference manual has been included as standard equipment with the unit.

The open access to the *Astrocade* has caused a closely knit and loyal following of *Astrocade* enthusiasts to band together in users groups and in an open exchange of information via the major news pipeline for Astrocaders called *The Arcadian*, a monthly newsletter published by Bob Fabris (3626 Morrie Dr., San Jose, CA 95127). Each issue contains program listings and more advanced programming tips from experienced users like Andy Guevera.

Andy has taken his interest in the *Astrocade* up to the assembly-language level (Z80 microprocessor). But in so doing, he left tracks for others to follow. He now produces a plug-in cartridge called the *Machine Language Manager* (The Bit Fiddlers, P.O. Box 11023, San Diego, CA 92111-0010), which guides the way for novice programmers. You'll still need to know Z80 machine language, but in the manual that comes with the cartridge, Andy recommends some introductory books. Machine language allows you to program faster action within the limited built-in RAM of the *Astrocade*. But there is still plenty going on in BASIC.

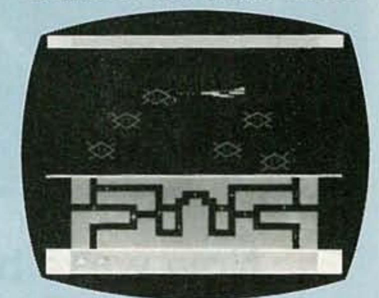
The 114-page *Astrocade Sourcebook* (635 Los Alamos Ave., Livermore, CA 94450), produced semi-annually by Richard Houser, lists practically every one of the hundreds of third-party programs available—a large percentage of them in BASIC on cassette. Most of these tapes have been designed by dedicated hobbyists with a love for the capabilities of the *Astrocade* system. Every once in a while, one of these hobbyists finds a programming specialty.

George Moses, for example, has unlocked the secrets to the three-voice music synthesizer of the *Astrocade*. His company (George Moses Co., P.O. Box 686, Brighton, MI 48116) offers several cassettes of straight music (Scott Joplin rags, Christmas carols, Bach, and more) playable through the console's synthesizer. For the musically creative, he also has a music-assembler program to let you try your hand at it.

George, by the way, produced the continuously running musical score for one of the first third-party game cartridges for the *Astrocade*, a family-oriented game called *Treasure Cove* by Spectre Systems (Box 1741 Dearborn, MI 48121). Bret Bilbrey, one of the principals at Spectre was attracted to the Bally system back in 1977 (in the days of the Fairchild *Channel F* and dedicated Atari videogames) because he could do things with the BASIC cartridge that no other videogame could let him do. Since then, Bret and a few others have turned what was a hobby interest into a career, designing games for the *Astrocade*.

With the right system, imagination, and a strong desire to master the technical side of programming in BASIC or (preferably) machine language, rolling your own videogames is certainly within almost everyone's reach.

Fox Video Games' Flash Gordon for Atari 2600



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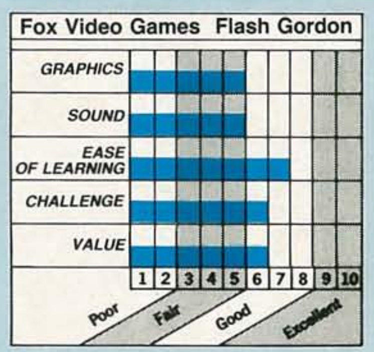


I'd hate to be in the shoes of the videogame designer who steps into the boss' office to receive an order to develop a game around a popular theme. It can't be easy to force a game to fit a particular mold. That's what I expected to find when I plugged Fox Video Game's *Flash Gordon* cartridge into my 2600 console. But after playing the game for a while (and being a Flash Gordon fan), I got the impression that somebody came up with a space game, and Fox simply pulled "Flash Gordon" out of its list of space movie titles.

The screen is divided into two main game-action areas. The top half is where the prime action is located—your rocket ship, targets, and stranded spacemen you can rescue. In the lower half is an aerial map of tunnels through which your rocket ship travels. Your goal is to clear each tunnel level of hatching pods and the spider warriors they produce. Two amorphous alien fields, called Disrupters, pursue your every step, trying

continued on page 14

VIDEOGAMES

continued from page 12

to enshroud your ship in deadly debris. Every time you successfully shoot five spider warriors from a hatching pod, you have the added power of a temporary shield. Floating through the tunnels at random are your fellow spacemen whom you must pick up by touching them with your ship.

Hatching pods are distributed unequally through the maze of tunnels. When they are grouped together, there is a likelihood that the sluggish Disrupters will catch up to you. Unless your shields are intact while you escape from the Disrupter's field, you'll have a tough battle on your hands trying to survive the onslaught of debris. Occasionally, however, a Disrupter Generator flies across the screen. If you can shoot one, the Disrupter is stalled momentarily, giving you a head start away from it.

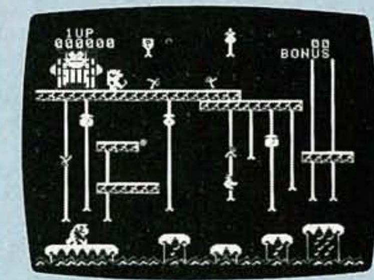
The joystick control in this game is a bit odd at first. When you want to move your rocket ship to the left on the tunnel map, for example, the rocket ship on the screen glides toward the left margin. But if a spaceman comes into view on the right, and you push your joystick to the right, your blip on the map immediately reverses direction while your rocket ship slowly glides over to the right of the screen. I suppose that it is the two speeds (instant on the lower map, gradual on the top screen) that makes it feel awkward. I'm sure it was designed that way, too, so that the lure of the spacemen would perhaps draw you backwards toward an oncoming Disrupter.

But after being tricked into retrieving spacemen for bonus points a few times, only to be annihilated by a disrupter, you lose interest in rescuing spacemen. Even though you're passing up extra bonus points, you'll gather more points in the long run if you simply ignore the men and go after the next hatching pod as planned. That takes away from the urgency of rescuing spacemen. If the game play required you to pick up spacemen by penalizing you if you didn't, then you'd have a more interesting game on your hands.

But with the same screen images reappearing wave after wave, the game doesn't hold interest for long. That's true even though the waves rapidly become more difficult. There is little in the way of discovery in this cartridge—it becomes a simple durability contest from the first wave.

And if this game action has some connection with Flash Gordon, it eludes me. At least there should be *some* reference to Ming, Dale, and Dr. Zarkhov.

Coleco Donkey Kong Junior for Colecovision



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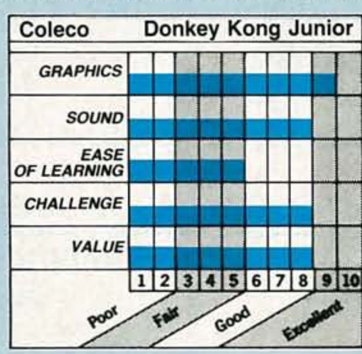

If you have ever followed the exploits of Mario and his efforts to rescue his girl from the clutches of the fierce Donkey Kong, then you'll better understand the story behind *Donkey Kong Junior*, another stunning arcade translation by Coleco for their *Colecovision* system.

The story goes that Mario finally captured Kong. Now the tables are turned. Mario is the bad guy, as jailor of Kong. Kong's pint-sized protege, Kong Junior, is on the trail of his father, trying to reach the key that unlocks cages and chains.

With the typical *Colecovision* high-resolution graphics, *Junior* is certainly one of the cutest games available for a home videogame, yet the cuteness doesn't get in the way of sincerely challenging game play.

The game features three completely different game screens, each with its own particular challenge. The first screen makes Junior swing from vine to vine while eluding the harmful Snapjaws (they like to climb vines at random). Swinging Junior from vine to vine is accomplished by moving the joystick to one side, unless he needs to leap from a platform to a vine, in which case you need to use a side action-button to make him jump.

On to the second screen, which has Kong's cage chained down. Junior must swing to six dangling chains. As he pushes each lock to the platform, the chain holding the cage is released. All six locks need to be pushed to the top while avoiding both Snapjaws and flying Nitpicker birds.

The third screen is a repetition of the first screen, but the fourth screen features a unique jump board (a precisely timed bounce buys Junior some extra time and bonus points), moving platforms and chains, and egg-dropping Stookybirds, which Junior must swing amidst on his way to the key for dad's cage.

I find the game graphically interesting for longer periods than the excellent-looking *Donkey Kong*. For instance, the graphic depiction of this little diapered chimp character swinging from vine to vine is clever.

Each screen has its own background music or sound, and the tune played at the end of a successful screen is catchy. Moreover, as Junior makes his way through a screen, the sound he makes is believably ape like.

I wasn't sure whether the greater ease of attaining higher levels was a result of playing so many dozens of hours of *Donkey Kong* or whether it was because *Junior* is actually a little easier to control. It may just be that I have become accustomed to *Colecovision*'s controllers and response-time characteristics. But whatever the reason, you will probably find that you can progress through at least one shot at all the screens within a couple of hours of dedicated play.

Unlike most spin offs (Ms. Pac-Man, most noticeably), *Donkey Kong Junior* is a far differently playing game from its predecessor. It's different enough to warrant placing *Junior* high on your "to buy" list for the *Colecovision*. **R-E**

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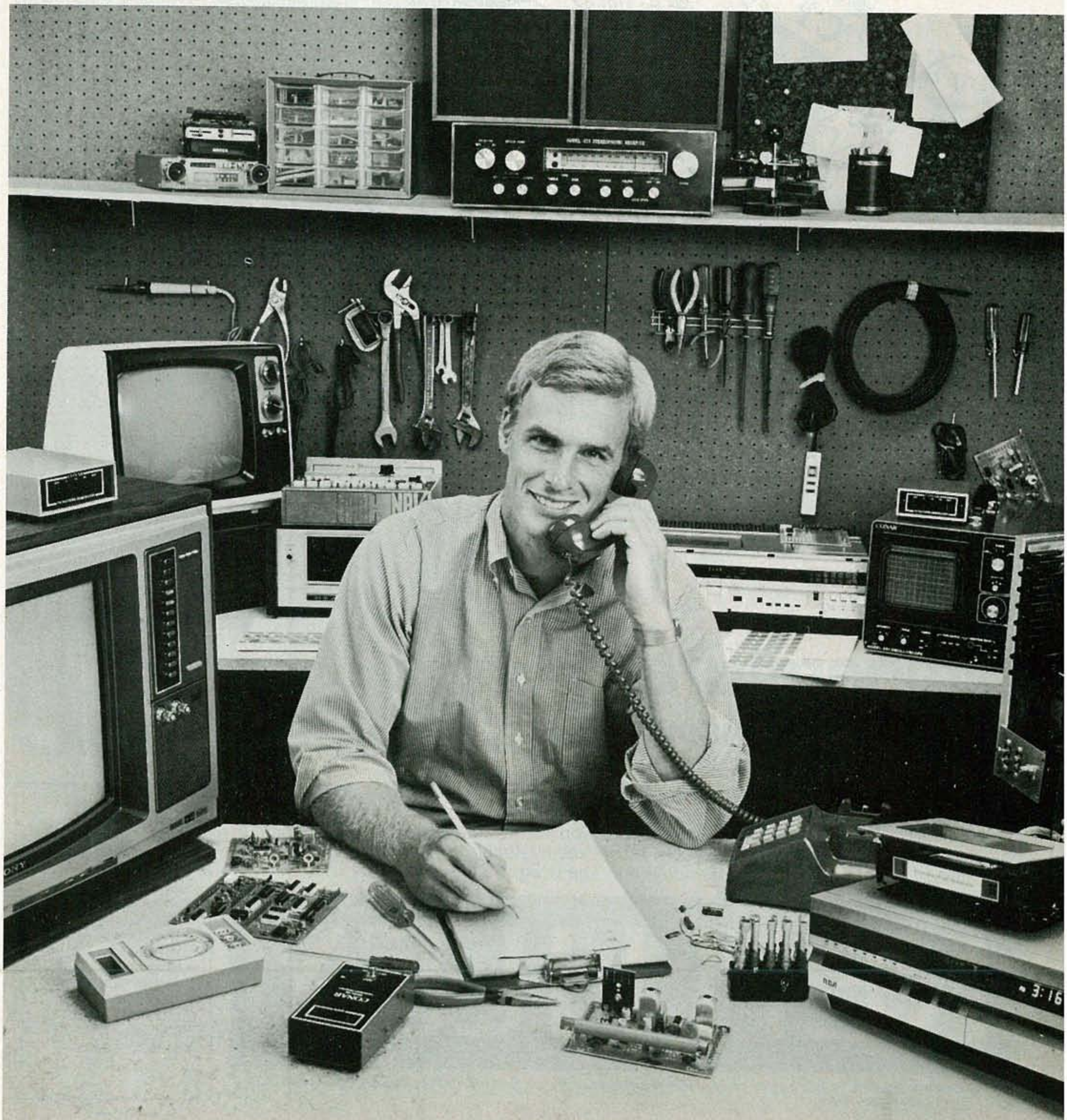

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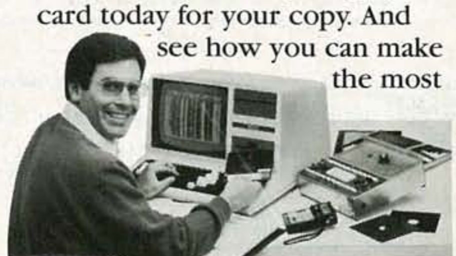

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NONVOLATILE-MEMORY NOTES

When reading my article on the 8K nonvolatile memory expansion for the Timex/Sinclair computers (**Radio-Electronics,** July 1983) I noticed an error that potentially could confuse some readers. The memory map in Fig. 1 says that the "System variable 'D_File' can appear ..." There are two things wrong with that. First, it's not the variable D_File but rather the actual display file that is echoed in the 48K to 64K region. Second, how do 64K RAM packs work then? Since an op-code fetch cannot be made with A15 high, simply gating A15 with M1 through an AND gate for the upper 32K will prevent a clash between the echo of the display file and any data stored in the 48K to 64K region.

In Fig. 7, the parts-placement diagram, capacitor C3 is missing. It should be installed from the empty pad at R5 to the pad directly below it.

One further note: The RAM board is compatible with the new Timex/Sinclair 1500, but not with the *Spectrum* or the Timex/Sinclair 2000.

PAUL W. W. HUNTER

HELP NEEDED

I need some help in locating some information. Back in 1968, I built a Delco-designed 160-watt stereo amplifier from one of their application notes. Instead of using the Delco-designed pre-amp, I used a design from a G.E. transistor manual. After I had built it, I encountered some personal problems and had to shelve the whole unit. Unfortunately, all my design layouts and schematics got lost, and the unit is just collecting dust.

Now, my problem is this: I have just received the application note from Delco. What I need now is some information on the pre-amp and its power supply. I've tried the library, but they do not have the manual; and I don't know how to get in touch with G.E. even to see if the manual is still available. Could any of your readers help me?

The pre-amp uses 3 2N508A transistors per channel, 1 volume control, 2 tone controls, has a phono (RIAA) input, and tuner input with a future tape input. The circuit is supplied with −22 volts and is shielded from the main amplifier. The power supply delivers −44 volts, using 4 1N91 diodes with 2 1N91 diodes for regulation along with 3 1500-µF 50-volt capacitors.

I would appreciate any information anyone can send me on the pre-amp.

B.E. BROSKI
5912 West Clinton,
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DRIVERS' BEHAVIOR

In the March 1983 issue of **Radio-Electronics,** Mr. Kolasinski tells about his attempt to check on drivers' behavior by motoring at the speed limit and observing

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how many drivers passed him when the police weren't around. But his simple test is inherently faulty.

Fact: Nobody also going at the speed limit can pass him or be passed by him. Two bodies going at the same speed in the same direction can only keep station with each other. And so, all exactly law-abiding citizens are eliminated from his count. In fact, the more closely other drivers match his speed, the less likely that he will encounter them. But the faster (or slower) they drive relative to Mr. Kolasinski, the more likely that he will observe them. Not exactly a fair test of drivers' general behavior, is it?

That is not to say that he is wrong in thinking that people do tend to speed when not in the presence of the police. Or that the average speed is higher than the posted speed in most circumstances. It's just that he'll need a more objective test in order to satisfactorily prove his point.

Some Purdue University studies suggest the majority of drivers move at a speed that they find comfortable and efficient, with only small regard for the posted speed. It is not their intent to break the law, but to get where they are going at a rate they perceive as safe and efficient, based on traffic, road conditions, and other factors. That speed is often marginally above the posted speed. Indeed, some communities set the posted speeds by observing general speeds in practice, and then posting a rate that agrees with (typically) 85% of the drivers using that road. That's a pragmatic approach, which also guarantees a constant supply of "speeders."

BRUCE LOGAN
South Bend, IN

OOOOOPS

I want to thank you for the excellent job of editing you did on my recent articles in **Radio-Electronics.** The end results were simply beautiful!

I did notice one error in each article, though, and those should really be pointed out to the readers. In the article, "Music Synthesizer IC's," (May 1983), on page 67, Fig. 3, the control-voltage reject trim (R7) was altered from my original artwork. While it is shown in the article as a rheostat, it should actually be set up as a potentiometer, with one side going to +15 volts and the other side to −15 volts. So, break the rheostat connection (on the left-hand side) from the wiper, and send it to −15 volts.

A more serious error occurs in the article, "How to Use Transconductance Operational Amplifiers" (July 1983), on page 57, Fig. 5. On my original artwork, R5 is shown as being 15K, and that suitably restricts the current into the 3080. However, it is shown in the magazine as being 1.2K. That value is far too low, and will lead to excessive current flow that will destroy the chip! As stated in the text, that current should be restricted to a value between 0.5 μA and 0.5 mA. With the 1.2K resistor, the current will exceed 10mA! Thermal runaway is almost guaranteed. The solution is simple: Change the value of resistor R5 to 15K.

I hope those corrections will save your readers some blown chips and blown tempers. Once again, let me say that I was very pleased with the fine way in which you presented my articles. I feel very honored that **Radio-Electronics** picked them up.

THOMAS HENRY

EQUIPMENT REPORTS

Microbuffer In-Line Printer Buffer

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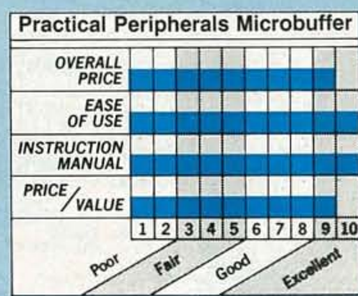

A COMPUTER CAN RUN NO FASTER THAN its printer. While even the least expensive, unsophisticated computer can process data at a nominal rate of 20,000 characters per second (cps), the typical low cost daisy-wheel printer loafs along at 12 cps, while the average matrix printer speeds along at 80 cps. Translated into real time, it means your system is tied up for anywhere from 20 seconds to 2 minutes when printing a standard double-spaced page of 250 words. A ten page report can easily tie up your system upwards of 20 minutes, while a longer report would still be printing when you returned from an extended lunch.

One of the most convenient ways to release your computer from the strings that tie it to the printer—and have the computer available for use even when printing a long report—is to use a *Microbuffer In-Line* (Practical Peripherals, Inc., 31245 La Baya Drive, Westlake Village, CA 91362) between your computer and your printer.

Basically, the *Microbuffer In-Line* is a cabinet that houses 32K or 64K of RAM (user expandable to 258K) that substitutes for the computer's RAM during a

continued on page 28

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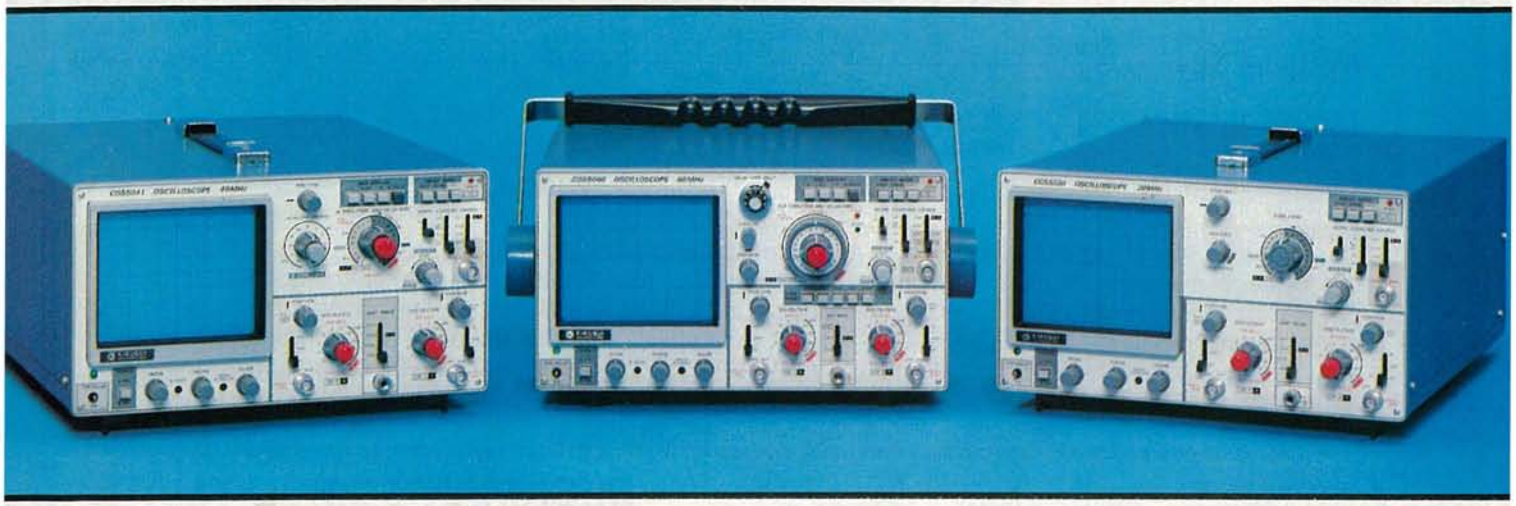

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Each scope in our 5000 Series is crafted so that it can be used for production, field service, consumer electronics servicing, or even personal use. The 5060 is a 60MHz scope with 3 channels, eight traces, delayed sweep, delay line and alternate sweep, and priced at $1100. Models 5040 and 5041 are 40MHz, dual channel scopes, featuring peak-to-peak automatic triggering, automatic focus control and a delay line. If you're interested in a 20MHz scope, we have our 5020 and 5021 models with features similar to our 40MHz scopes. Both the 5041 and 5021 also have delayed sweep. Prices at $920 for the 5041, $795 for the 5040, $690 for the 5021 and $595 for the 5020. So, whatever model suits you best, you can't get a better scope for the money.

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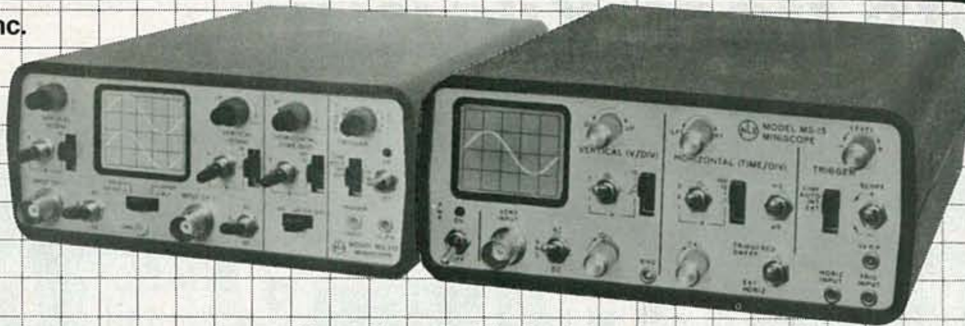

MS15 15 MHz Single Trace
MS215 15 MHz Dual Trace
MS230 30 MHz Dual Trace

Non-Linear Systems' trio of miniscopes are accurate, affordable, portable. And there's one to match nearly every budget and need. Standard features on all models include an input impedance of 1 megohm with 50 pF; maximum input voltage of 350 V; trigger modes in auto, internal, external and line; slope that's + or − selectable; graticule (4×5 division of 0.25″ each); dual power sources operating either internally from rechargable lead acid batteries or externally from 115 VAC or 230 VAC (50-60 Hz) via plug-in transformer; handy size (2.9″H×6.4″W×8.0″D) and weighs just 3 lbs.*

*(Exception: model MS-230 is slightly deeper, at 8.6″, and heavier, at 3.6 lbs.).

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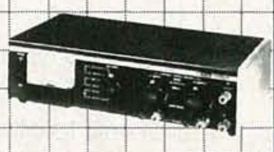

MODEL 1650

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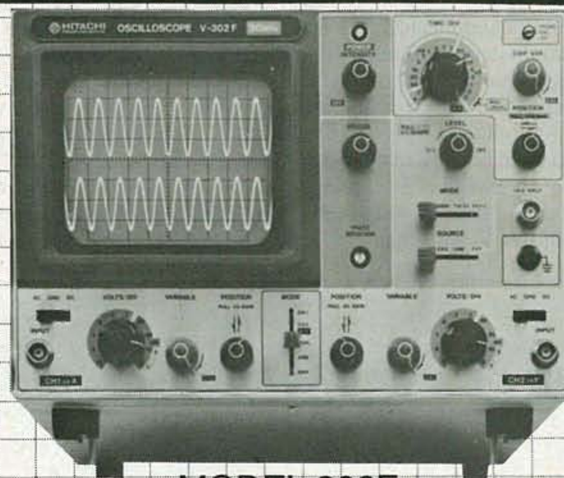

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EQUIPMENT REPORTS

continued from page 24

printing job. The input to the *Microbuffer*'s RAM comes from the computer's printer output connection; the *Microbuffer*'s output connects to the printer. When the computer is commanded to PRINT, it dumps what is to be printed from its RAM directly into the *Microbuffer*'s RAM at almost lightning speed. For example, a 4000 word document dumps to the *Microbuffer* in less that 3 seconds.

If the number of bytes being dumped to the buffer is less than, or equal to, the capacity of the buffer, the computer itself is free and ready for use within seconds. If the length of the document exceeds the capacity of the buffer, the computer holds the remainder in its RAM. As the document prints, the data in the buffer slides forward, producing free RAM at the tail end. Eventually , the computer will dump into the free RAM. Then, the computer is free for use—as far as it is concerned, it is finished printing and ready for another job. The task of driving the printer is now controlled entirely by the *Microbuffer*.

The word "controlled" is appropriate because the buffer is more than just a storage memory for driving the printer; it also determines the various ways in which the printer is driven. On the front panel are three membrane button switches labeled CLEAR, COPY, and PAUSE, along with matching LED indicators to show the selected mode(s). The PAUSE switch does exactly what its name implies: it pauses the output to the printer so that the user can make adjustment or alignment tests or anything else you can do when the printer drive is halted. The computer can dump to the buffer while the PAUSE is set.

The COPY switch programs the *Microbuffer* for up to 255 repeat copies of the document. Normally, the buffer provides a single copy. If the copy switch is depressed, say, three times, three additional copies will be automatically printed. To print a copy, the entire document must be in the buffer. If the document is larger than the buffer it will overrun the first part of the document. If the buffer receives a document larger than its RAM, the LED above the CLEAR switch goes on to indicate that the complete document cannot be held in the buffer's memory. Normally that is not a major difficulty because the buffer is matched to the available memory in the computer.

If the user is reasonably certain of the document size and can be certain that there is RAM available for a new document, he can dump additional documents into the buffer even while the printer is running. That's because the buffer provides a form-feed command for the printer between documents.

For example, assume you are preparing four form letters and you will print two copies of each. As the first letter is printing, you prepare the second letter and dump it into the buffer, then perhaps a third letter, and a forth. As long as you are certain there is RAM available in the buffer, you can continuously dump additional documents or even pages of a manuscript. Just keep in mind that the buffer issues a form feed to the printer after each complete dump, so each document starts on a fresh page.

The CLEAR switch instantly clears the buffer's RAM so you can go on with other printing jobs.

The *Microbuffer* works exceptionally well and fuss-free. Its only limitation appears to be that it does not respond to a page stop. For example, if the word processor, such as *Scripsit* or *Typit*, is instructed to stop after each page is printed, the instruction is ignored when printing through the buffer; the buffer simply provides the standard form feed at the end of each page. For documents or listings greater than one page in length, the paper should be tractor-fed.

The *Microbuffer In-Line* is housed in a cabinet 5⅜ by 7½ by 1⅝ inches. It is AC powered through a wall transformer. The parallel-printer model is supplied with a standard Centronics-type input connector and a 3-foot output cable terminated in a Centronics-type connector. In the serial-printer version, RS-232 connectors are

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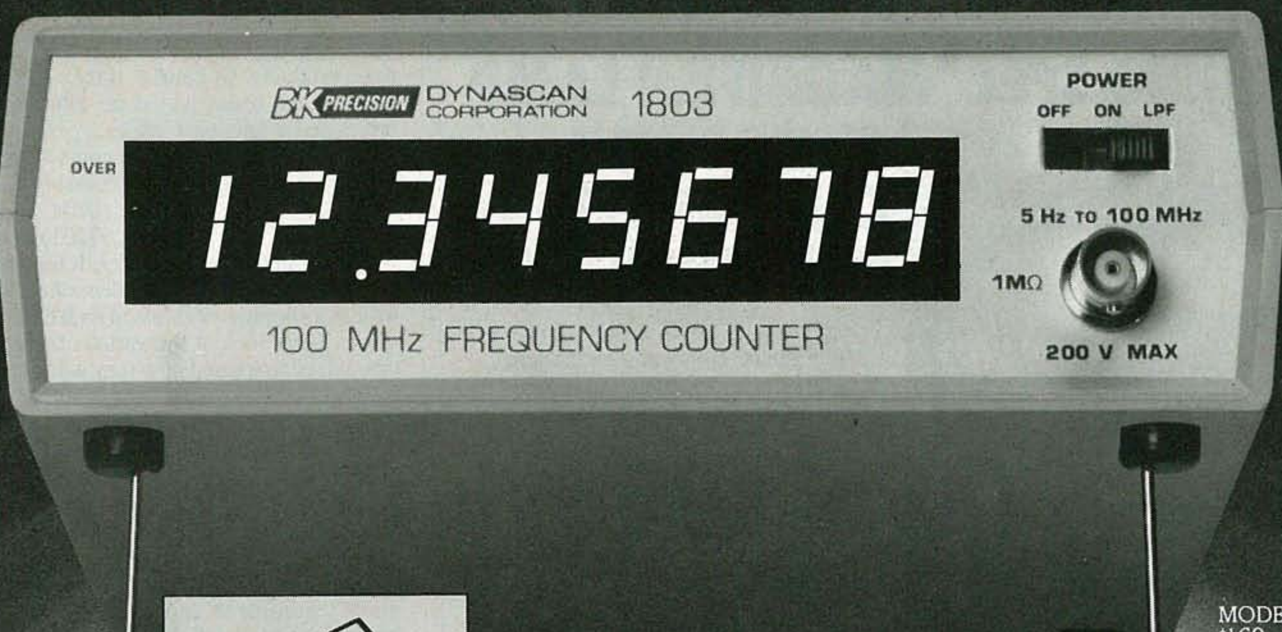

MODEL 1803
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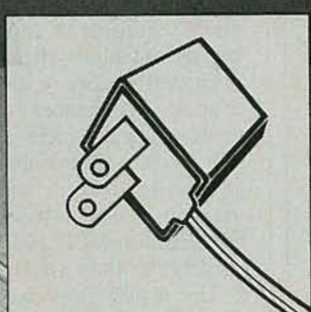

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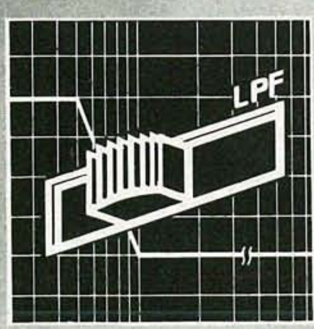

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used. The input and output baud rates and assorted handshaking protocols are individually programmable. Both the serial and parallel versions are priced at $299 (32K model) and $349 (64K model). User-installed 64K add-ons are $179. Specially configured models (without housings) of the *Microbuffer* are available for direct installation in the Epson printers (with and without *Graftrax*) and the Apple computers.

While the price might appear to be somewhat high at first glance, consider that it frees some expensive computer hardware for more productive use. What is high for home and family use can be a real buy for business use. **R-E**

Vidicraft Model-IVE 100 Integrated Video Enhancer

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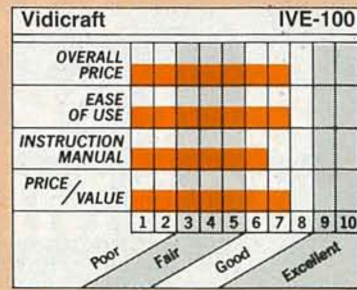

IT'S QUITE AN UNDERSTATEMENT TO SAY that the video marketplace has changed dramatically in the past few years. For one thing, products that once were only used by video professionals, and others that had never even been thought of, are now commonplace in the home. Those products include such things as image enhancers, sync stabilizers, video distribution amplifiers, and commercial-elimination systems. There are few video enthusiasts that, at one time or another, have not wished they had one or more of those products. Of course, if they had all of them the result would be four more boxes and a tangle of cables.

There is an alternative, of course—one of the new all-in-one video accessory systems such as the Vidicraft (0704 S.W. Bancroft St., Portland, OR 97201) *IVE-100* integrated video enhancer. It features all of the systems we've mentioned, as well as a simple switcher and an RF modulator. Let's look at the various features this unit contains and how they work, and then look at the system as a whole.

An image enhancer

Anyone who's ever recorded a TV program while watching it and then later viewed the tape, is sure to have noticed that the recording is of inferior quality. Granted, the quality improves with top-notch equipment and high recording speeds, but there will always be some loss of overall quality or detail. The purpose of an image enhancer is to restore that lost quality. The enhancer incorporated in the unit can be used to enhance the quality of pre-recorded tapes and off-the-air TV viewing, as well as to improve the quality of camera-to-VCR and VCR-to-VCR recordings as they are being made.

The results provided by the unit are dramatic, but vary according to the quality of the original source. Video enhancers work by amplifying the high-frequency video information, which in turn increases the detail and sharpness of the picture. But if that high-frequency information is for the most part missing, as is often the case with multi-generation tape recorded at slow speeds, there is nothing to amplify. Needless to say, the enhancer can not bring out detail that has been lost forever.

There is a drawback with all video enhancers; when you amplify the high-frequency video you also amplify the high-frequency video noise. That noise shows up on the screen as snow. The Vidicraft unit compensates for that problem with their *VNX* noise-reduction circuit. That circuit suppresses certain low-amplitude, high-frequency signals. Thus,

its purpose is the exact opposite of the enhancement, but it operates only on low-amplitude signals. The result is the removal of much of the increased snow, but at the expense of some of the recovered detail. Even so, the overall quality of the picture will be much improved.

Stabilizer

By now, most VCR owners know about the various anti-piracy schemes used by tape distributors, and the havoc even authorized copies can play with some older sets. The purpose of the stabilizer, then, is to eliminate the roll and jitter caused by those anti-piracy schemes. It is also useful in the dubbing of home tapes because it reduces the chances of roll and breakup (due to drop-outs) during that process.

Commerical alert

There are various schemes for automatically removing commercials from programs for taping. They all have one thing in common—the don't work very well. The ones that search for a color burst are fine for old black-and-white movies and shows, but are useless for color. The ones that search for a fade to black are fouled up by multiple commercials and by the fact that such fades are often found in the middle of movies.

The *IVE-100* gets around the problem by not removing the commercials—instead it warns you about them. It searches for a fade-to-black, and when it finds one it emits a rather loud beep.

The feature is, of course, only useful for attended recording of programs as it does not actually remove the commercials. What it does is give you enough warning so that you can hit the pause button.

The manufacturer states that it is also possible to use the feature for recording one program while watching another, but to do that would require you to switch channels to the one being recorded to check for a commercial. If one were found, the tape would have to be rewound slightly, played up to the beginning of the first commercial, paused, and then taping restarted when the program resumed. Only then would you be able to return to the program you were watching.

The unit incorporates two additional features. An RF amplifier for connecting units with video outputs to your TV, and a distribution amplifier that allows three separate outputs without a loss in apparent picture quality.

Installation and operation

Installing the unit is a snap; it should take no more than five minutes from box to use. Three installation diagrams, complete with clearly written descriptions, cover the most common setups.

Turning to the front panel, the unit is turned on and off, and the inputs and the functions are selected using a row of pushbutton switches located at the left. On the right are three controls that are used to adjust the enhancement, noise reduction, and the stabilizer circuit.

Operation is fairly straightforward; the only thing that is the least bit tricky is the setting of the enhancement level. That level is a matter of personal preference and you'll have to play around with the controls a bit until you are satisfied. The effect of all of the controls can be seen by simply switching a particular function in and out; that makes comparisons easy.

One thing that was a little annoying was the fact that once the unit was wired into a video system, it had to be turned on any time the system was used, even if none of the features were needed. A bypass provision would have been nice.

The instruction booklet was well written, clear, and certainly better than some we've seen for this type of equipment. Of course it still leaves a lot to be desired for those technically inclined (no schematics, etc.), but that is typical.

If you take your video seriously, and are in the market for a versatile accessory to upgrade the performance of your video system, the *IVE-100* deserves your attention. It is well made, as witnessed by the limited two-year warranty on parts and labor it carries, and works as claimed. The unit lists for $229.00. **R-E**

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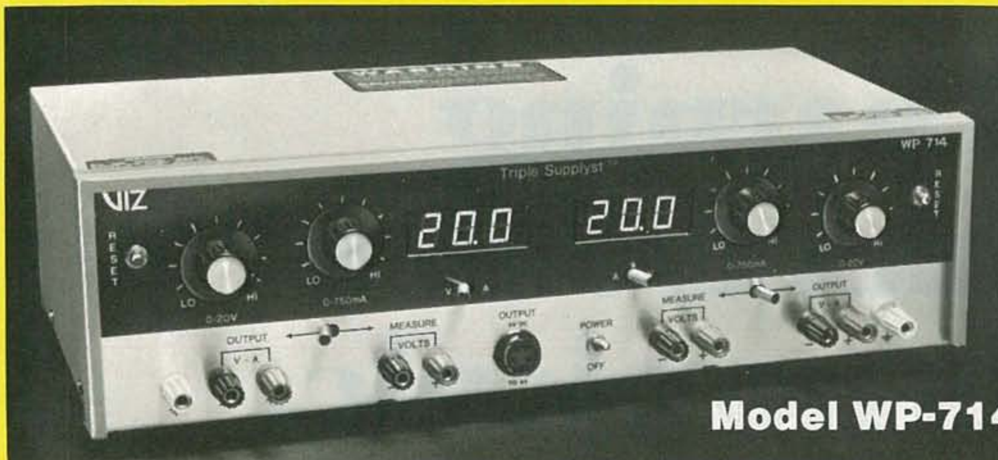

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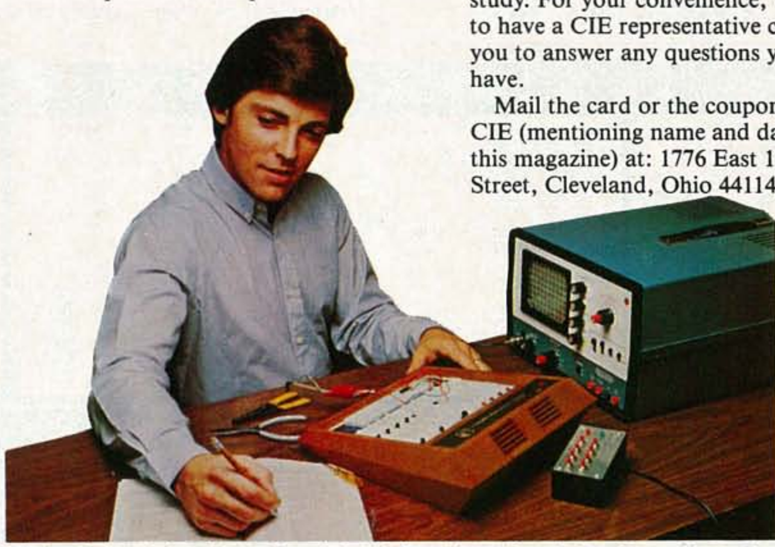

Pattern shown on oscilloscope screen is simulated.

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EQUIPMENT REPORTS

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Tektronix Model 212 Dual-Trace Oscilloscope

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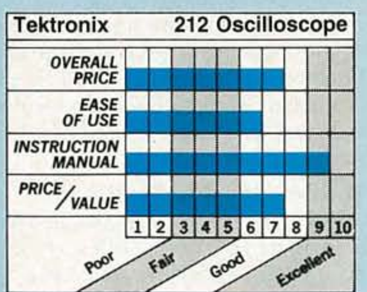

IT WASN'T TOO LONG AGO THAT OSCILLOscopes were huge and heavy, and they doubled as the primary source of heat for the test-bench area. But nothing will make you forget those days faster than the model *212* oscilloscope will. That dual-trace scope from Tektronix (PO Box 500, Beaverton, OR 97077) measures approximately 3 × 5¼ × 9 inches—so you might even be tempted to call it a pocket oscilloscope (especially if you're wearing a bulky winter coat). The lack of air vents alone indicates that the *212* is a cool-running unit. Let's take a look at the features that Tektronix managed to fit in such a small package.

The CRT screen, as you might expect, is rather small (approximately 1¼ × 2 inches). But even so, it dominates the front panel of the scope. It's graticule is an internal 6 × 10 division grid. It is not illuminated; we presume that's to ensure as long a life as possible from the 10 internal, rechargeable, nickel-cadmium "A" cells.

Those batteries can run the scope for 3–5 hours on a full charge (even longer if maximum trace intensity is not used). While they are meant to be the primary power source for scope operation, the *212* can also be operated from line voltages between 104 and 126 volts. (However, when the unit is operated below 110 volts, the internal batteries will be slowly discharged.)

The *212* incorporates an internal battery charger, but the scope must be turned off for it to work.

A protection circuit in the scope protects against excessive discharge. The scope automatically shuts down if the battery charge drops below 10 volts. A front-panel LED labeled POWER, that normally lights whenever the scope is turned on, will not light when there is less than 10 minutes of scope-operating time left in the batteries.

Controls

All of the operating controls are located on the side panel of the scope. But that's not an entirely fair statement. The two VOLTS/DIV controls, though located on the side panel, are read from the front panel. And the SEC/DIV, while located on the side, near the rear, can be read reasonably conveniently by viewing the scope from a slight angle. All the other controls are in a recess on the side. Until you become familiar with them, you pretty much have to turn the scope 90° so that you can read the labels.

The POWER switch is particularly hard to find without turning the scope to look for it. It is a slide switch that is located at the center of 4 larger rotary switches. That's not really a disadvantage, though. The 4 rotary controls "protect" the POWER switch from being turned ON accidentally. That's especially important for portable battery operation, and shows that Tektronix gave its panel layout a little

bit of thought.

Other controls include an INPUT COUPLING switch for each channel (AC, GND, and DC); a POSITION control for each channel (with a click-stop OFF position), and a variable VOLTS/DIV control for each channel (with a clik-stop CAL position).

A three-position TRIG SOURCE slide switch is used to choose the appropriate trigger signal source. In the EXTernal mode, the sweep is triggered from the signal applied to the EXT TRIG banana jack. In the COMP position the sweep is triggered from a sample of the vertical deflection signal after the vertical switching, while in the CH-2 position the sweep is triggered from a sample of the vertical deflection signal before the vertical switching and only from Channel 2.

There are also seven screwdriver adjustments. They can be used to balance the vertical-amplifier system (for minimum trace shifts when the deflection multiplier is changed); to set the gain of the vertical-amplifier system; to set the trigger point for automatic trigger operation; to focus the display; to calibrate the horizontal gain and to calibrate the horizontal sweep timing.

You might have noticed that we never mentioned the probe-input jacks. That's because there are none. Two probes are included, but they are hard-wired to the scope. They are neatly stored at the rear of the cabinet, as is the power cord.

Using the scope

Until you get used to the side-panel layout, the *212* can be a chore to use. However, to be fair, the *212* is meant to be portable and its side-panel controls help to keep its size to a minimum.

The oscilloscope that we received came with both an operator's manual and a service manual. The operator's manual is a 37-page, shirtpocket-sized booklet. Amazingly enough, however, it does a creditable job in describing the fundamentals of using the scope. The service manual fills in the details that the operator's manual leaves out. It includes a description of the scope as well as sections on preventive maintenance, calibration, troubleshooting, circuit description, and corrective maintenance. Lists of all parts, both electrical and mechanical, are included as are schematics, circuit-board photos, and exploded drawings.

Tektronix's *212* is a great portable oscilloscope. But we would not recommend using this scope for a bench-top unit (although we are sure that some people will try). Because of its small CRT, it can be tiring to use. And its $1775 price is certainly not cheap for a scope with its bandwidth. (When the input is DC coupled, the bandwidth is at best DC to 500 kHz. That decreases to 100 kHz when the vertical sensitivity is increased to 1mV/division.) But if you're in the field and in need of a dual-trace scope, then it's hard to find fault with this unit. **R-E**

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SPECIFICATIONS

Ranges:	8 automatically selected ranges from 1999 pF to 19.99 mF (full scale)
Resolution:	1 pF in lowest range, 0.05% of full scale on all other ranges
Accuracy:	0.2% of reading ±1 count ±1 pF from 1 pF to 199.9 μF; 1.0% of reading ±1 count from 200.0 μF to 19.99 mF
Display:	3½ digit, 0.5 inch LCD, low battery (LOBAT), over compensation indication (−), and 4 LEDs to indicate pF, nF, μF, and mF
Reading UpDate Time:	350 ms to 19.99 μF, 200 ms to 1.25 s from 20 μF to 20 mF
Controls:	POWER (ON/OFF) switch, ZERO calibration adjustment to null out stray capacitance up to 100 pF
Test Technique:	Measures ΔT/ΔV (Dual Threshold slope integration)
Power:	6 AA Alkaline or Nicad batteries or optional AC Adapter/Charger, 16 hours continuous use
Dimensions:	(LxWxH) 7.6x3.75x1.72 inches (193x95x44mm)
Weight:	12 oz. (340 grams) without batteries

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CIRCLE 31 ON FREE INFORMATION CARD

ONE OF THE FIELDS THAT HAS BENEFITED MOST FROM THE revolution in digital electronics is electronic music. That's because the relationships between notes can be expressed mathematically, making music the perfect candidate for digital logic. These days, the use of electronically generated music is limited only by imagination and the demands of the marketplace, and common applications include everything from doorbells to watches.

Anyone who has dabbled in electronics knows that there are an infinite number of sounds that can be produced electronically. Unfortunately, the majority of them are the squeals and yowls of wayward circuitry. Producing music electronically means being able to control not only what sounds you produce, but the order in which you produce them. This project, the Pianomatic, is a good beginning for anyone who is interested in designing control circuitry for electronically generated music. The unit has a keyboard that will play a full

mini player-piano

Build the Pianomatic and make beautiful music—electronically.

ROBERT GROSSBLATT

octave, and a memory section that will remember as many as four tunes even when it is turned off. The notes are entered into the memory from the keyboard and either a half or full rest between notes can be programmed.

Although a full-blown electronic piano has a much wider range of notes and features, the principles used by the Pianomatic are exactly the same. Once you understand how it works, we'll show you how it can be expanded to provide as many features as you want. The keyboard can be extended to cover a range of several octaves and much more attention can focussed on refining the sound. But we're getting ahead of ourselves. Let's first look at Fig. 1, a block diagram of the device. Then, we'll examine each section in detail.

An overview

The keyboard encoder translates the pressing of each key into a unique binary four-bit word. At the same time, it generates an "any key pressed" signal that the Pianomatic uses to increment its counters and to control several of its automatic functions. If we're writing a tune into memory, that signal is also used to generate the "write" pulse.

The memory of the Pianomatic can be organized into either two or four pages at the throw of a switch. That means you have the choice of programming either two longer tunes or four shorter ones. Addressing is controlled by the note counter and the tune selector.

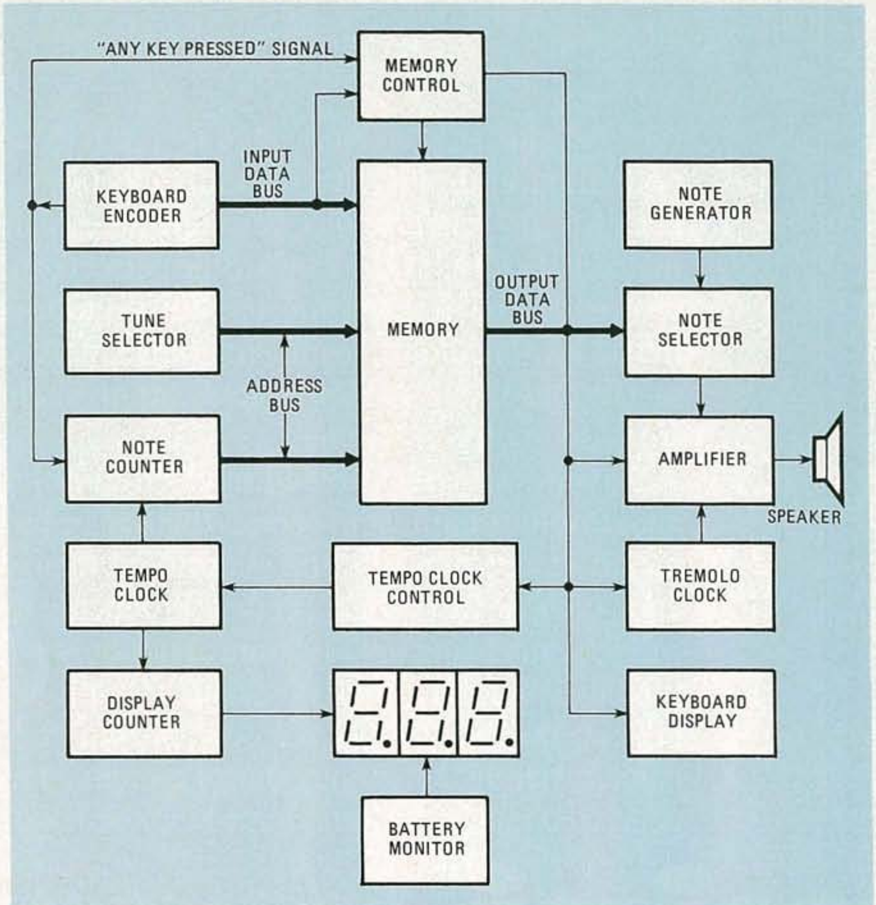


FIG. 1—THIS BLOCK DIAGRAM shows how the various functions of the Pianomatic are interrelated.

What we mean by "paging" is that some of the address lines are used to select which part of the memory is going to be accessed. That technique of memory management is frequently used whenever lots of information is stored in system memory—the more extensive the memory, the more useful the technique. Let's suppose, for example, that you had a system that used an address bus that was ten bits wide. That would mean you could address 1K words of memory (2^{10} = 1024 = 1K). (A word is a group of bits that are considered as a whole. In a personal computer, for example, a word might be 8 or 16 bits long, depending on the machine.) If you wanted to organize that memory into two pages, you would have to break the memory down and think of it as being made of two parts, each being a page that was 512 words long. The most significant address line would then be used to select the page of memory you wanted to access. That system is shown in Fig. 2. In that example, address line A9 is switched between +V and ground, and is used to select the page of memory that will be accessed. Address lines A0 to A8 are used to select a memory location on that page. Once the memory location is selected, the data is stored.

The data bus of the Pianomatic is four bits wide, so we can select 16 separate four bit words (2^4 = 16). Thirteen of those are used for individual note selection, one is for a full rest, and the remaining two words are decoded by the tempo clock control to, logically enough, control the tempo clock during playback from memory. One of the two words causes the tempo clock to speed up and create a half rest and the other disables the clock at the end of a tune.

The tempo clock increments both the note counter and the display counter. The former addresses the memory and the latter controls a three-digit display that allows you to easily keep track of which note is being played.

The note generator is composed of two parts—an oscillator, and a top-octave generator, shown in Fig. 3; that IC performs the frequency division necessary to produce thirteen notes of the equally tempered scale. Each note is related to the others by some multiple of $\sqrt[12]{2}$. In other words, since the frequency of a middle A is 440 Hz, an A-sharp would be 440 × $\sqrt[12]{2}$, or about 466 Hz.

The outputs of the top-octave generator are connected to the note selector—a one-of-sixteen analog switch that is controlled by the output data bus. Once the note is selected, it is passed on to the amplifier and speaker; the sound is given a bit of coloring by having the tremolo clock rapidly vary the gain of the amplifier.

Each key on the keyboard has a small LED in it, and whenever a note is played the corresponding LED lights up. That makes it easy to keep track of which note is being played and provides a bit of visual appeal when you are playing a tune back from memory.

As you can see by now, the organization and operation of the Pianomatic are logical and straightforward. When you're writing a tune into memory, a key is pressed and the corresponding word is latched onto the data bus. The "any-key-pressed" signal generates a write pulse

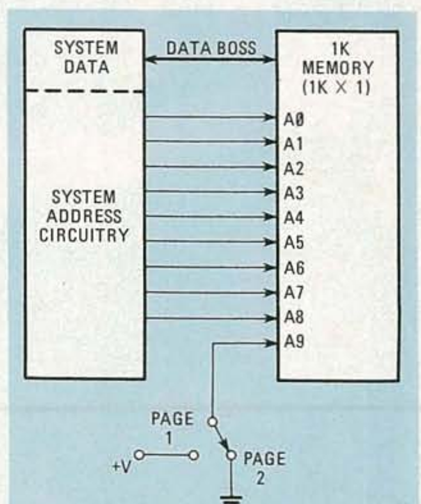


FIG. 2—HOW A 1K MEMORY can be organized into two pages, each 512 words long. In this simplified circuit, the most-significant-address line is switched to choose between two pages of memory.

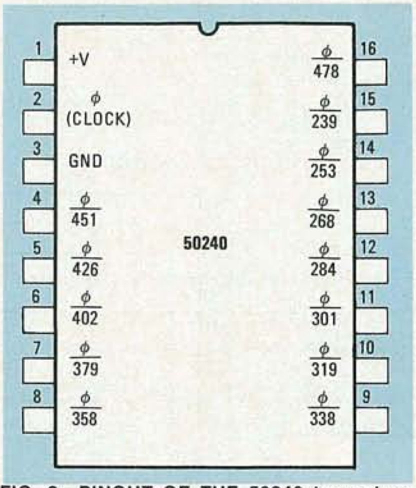


FIG. 3—PINOUT OF THE 50240 top-octave generator. Although the specifications for that IC call for a supply voltage of between 11 and 16 volts, the device will operate reliably at the Pianomatic's 7.3 volts.

PARTS LIST

All resistors ¼ watt, 5%, unless otherwise noted
R1, R7, R10, R17—8200 ohms
R2—6800 ohms
R3, R8, R29—1 megohm
R4, R38—10,000 ohms
R5—3000 ohms
R6, R12, R30—1000 ohms
R9—150,000 ohms
R11, R15—100,000 ohms
R13—470 ohms
R14, R19–R28, R36, R40—160 ohms
R16—1500 ohms
R18—82,000 ohms
R31—22,000 ohms
R32, R33—560,000 ohms
R34—390 ohms, ½ watt
R35—15,000 ohms
R37, R39—2200 ohms
R41—500,000 ohms, multi-turn potentiometer, PC mount

Capacitors
C1, C4, C6, C8, C9, C13, C15, C18, C20, C23, C28—0.47 μF, 35 volts, tantalum
C2—0.5 μF, ceramic disc
C3, C22—100 pF, ceramic disc
C5, C16—0.22 μF, 35 volts, tantalum
C7, C19—2.2 μF, 35 volts, tantalum
C10, C11, C14, C25, C26, C29—0.01 μF, ceramic disc
C12—47 pF, ceramic disc
C17—.001 μF, ceramic disc
C21—10 μF, 16 volts, electrolytic
C24—500 μF, 25 volts, electrolytic
C27—100 μF, 16 volts, electrolytic

Semiconductors
IC1—4514 1-of-16 data selector
IC2—4520 dual binary counter
IC3—4040 12-stage binary ripple counter
IC4—5101L-1 256 × 4 static RAM
IC5—4066 quad analog switch
IC6—4515 1-of-16 data selector
IC7—50240 top-octave generator (AMI, Mostek)
IC8—4067 1-of-16 analog switch
IC9—4082 dual 4-input AND gate
IC10—386 ½-watt audio amplifier
IC11—4511 BCD-to-7-segment-display decoder/driver
IC12—4553 3-digit counter
IC13—7805 five-volt positive regulator
IC14—4093 quad 2-input NAND Schmitt trigger
IC15—4049 hex inverter
SCR1—ECG 5400 or equivalent
Q1—2N2222A or equivalent NPN silicon transistor
D1–D3, D5–D7, D9, D11, D13, D17, D18—1N34A germanium diode
D4, D8, D10, D12—1N914 silicon diode
D14, D15—1N4001 silicon diode
D16—1N4003 silicon diode
DISP1–DISP3—FND 359, common cathode 7-segment displays with decimal point
LED1–LED13—miniature red LED
LED14–LED16—miniature green LED
S1–S3, S7—DPDT miniature switch
S4–S6—SPST normally open momentary switch
S8—SPDT miniature switch
S9–S24—SPDT miniature lever-type switch, Radio Shack 275-016, or equivalent
J1—miniature N.C. chassis-mount phone jack, Radio-Shack 274-253 or equivalent
SO1, SO2—female header strips, AP Products 929974 or equivalent
PL1–PL5—male header strips, right-angle, AP Products 929835 or equivalent
PL6—male header-strip, AP Products 929834 or equivalent
B1–B8—1.5-volt alkaline "AA" cell
B9–B11—nickle-cadmium "button" cell, 20 mAh, or larger
Miscellaneous: PC boards, IC sockets, female header-strips (AP Products 929974 or equivalent) for interconnections (see text), solder, wire, case, etc.
A set of the five PC boards, etched and drilled, but not plated through, is available from Hal-Tronix, PO Box 1101, Southgate, MI 48195. The price is $39.95. Please add $2.00 for shipping and handling. MI residents add 4% tax.

and the note is written into memory. It appears on the output data bus and the note selector connects the chosen note to the amplifier. When you release the key, the keyboard encoder starts scanning again and the note counter is automatically incremented by one. In playback, the note counter is advanced by the tempo clock and addresses the memory. The stored binary information is sequentially put on the output data bus and the note selector connects the note to the amplifier.

Let's next look at each of the sections in detail and see how they work. The schematic diagram for the Pianomatic is shown in Fig. 4. You'll probably want to refer to it now and then as we discuss the various sections.

Keyboard encoder

The keyboard encoder is of the scanning type and is made up of a clock (IC14-c), a binary counter (IC2-a), and a one-of-sixteen data selector (IC1). The keyboard itself is a series of normally-open, momentary SPST switches connected to the outputs of the data selector. As long as no key is pressed, the clock is enabled and causes the binary counter to count at about 1.5 kHz. That makes the outputs of the data selector go high in sequence. When a switch is closed, nothing happens immediately because the unselected outputs of the data selector, IC1, are low. When the binary counter causes the chosen output to go high, D11 is forward biased and disables the clock input of the counter. The same signal is inverted by IC15-c and disables the clock. The effect of all that activity is to stop the scanning dead in its tracks and latch a binary word on the input data bus corresponding to whichever switch was closed. Diode D9 is also forward biased and increments both IC3, a 4040 binary ripple counter that serves as our note counter, and IC12, a 4553 three-digit counter that is our display counter. The inverted version of the "any-key-pressed" signal, available at the output of IC15-c and through C12, is used to generate the "write" pulse for the RAM IC, IC4. Since keyboard switches S9–S24 are mechanical, R8 and C10 are used to debounce them.

Pin 23 of IC1 is the inhibit input of that device and it gives us a simple way of disabling the entire keyboard. If we make that pin positive, we force all the outputs to remain at ground, so closing a switch on the keyboard will have no effect on the rest of the keyboard encoder. That's handy because there are times when we don't need or want the keyboard to be working. If we're playing a tune back from memory, for example, there's no need for the keyboard to be operating. If it were, and you pressed a key during playback, a write pulse would be generated causing a glitch in the memory.

Memory

As we mentioned before, the memory of the Pianomatic can be organized into either two or four pages. The addressing of the memory is done by the note counter, IC3, and the tune selector, IC2-b. Since the memory, IC4, is a 1K memory organized into 256 words by 4 bits, it has eight address lines, ($2^8 = 256$) labelled A0 through A7 (pins 4, 3, 2, 1, 21, 5, 7, and 6 respectively). The six least-significant address lines are connected directly to the corresponding outputs of the note counter. One of the two most significant address lines, A6, is connected to the least significant ("A") output of the tune selector (pin 11 of IC2-b). The ability to select either two or four pages of memory is made possible by how we handle address line A7. If we want to organize the memory into four pages, the seventh output of the note counter, (pin 4 of IC3), is

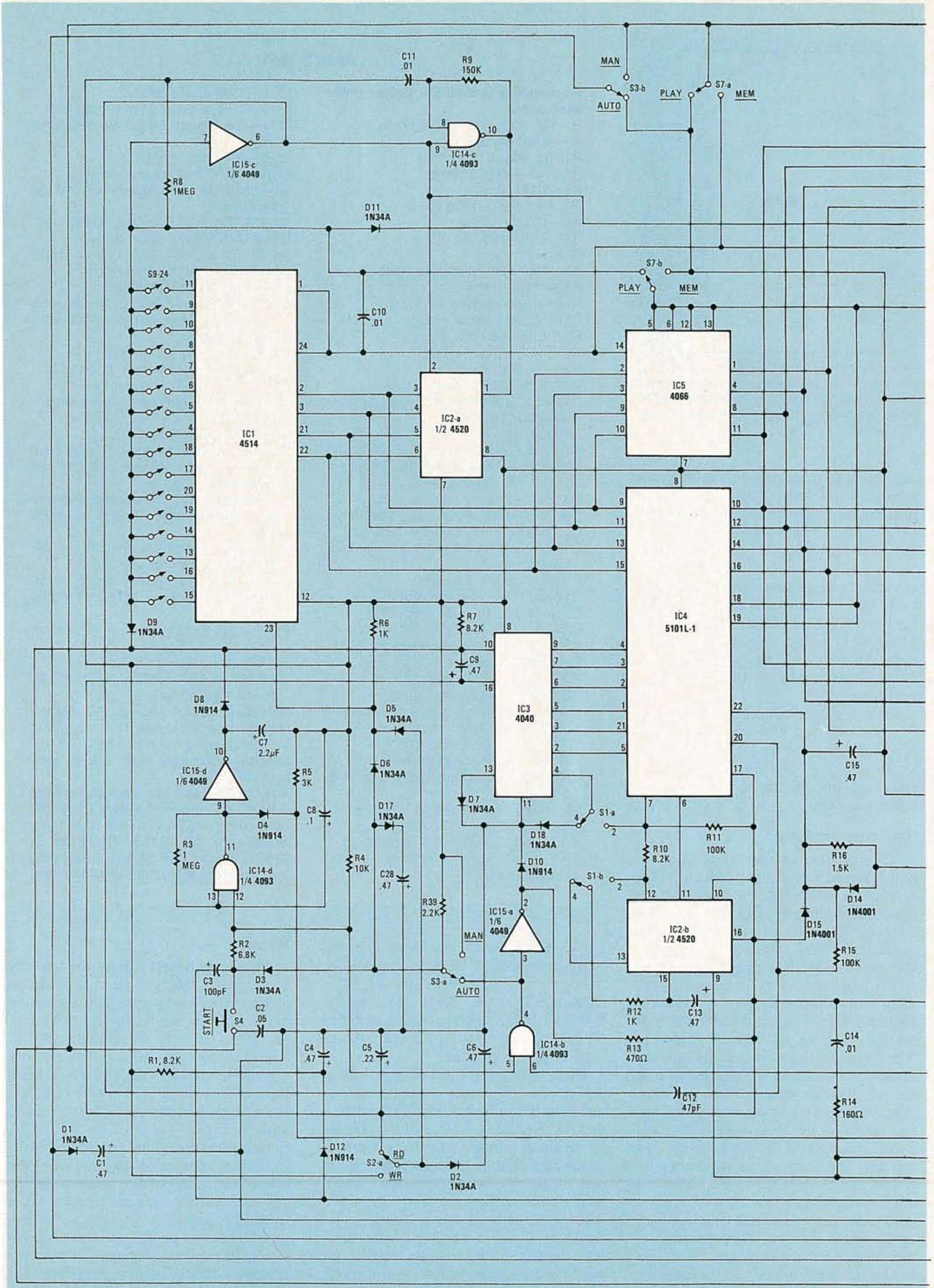


FIG. 4—SCHEMATIC DIAGRAM OF THE PIANOMATIC. This circuit can store either two long tunes or four shorter ones.

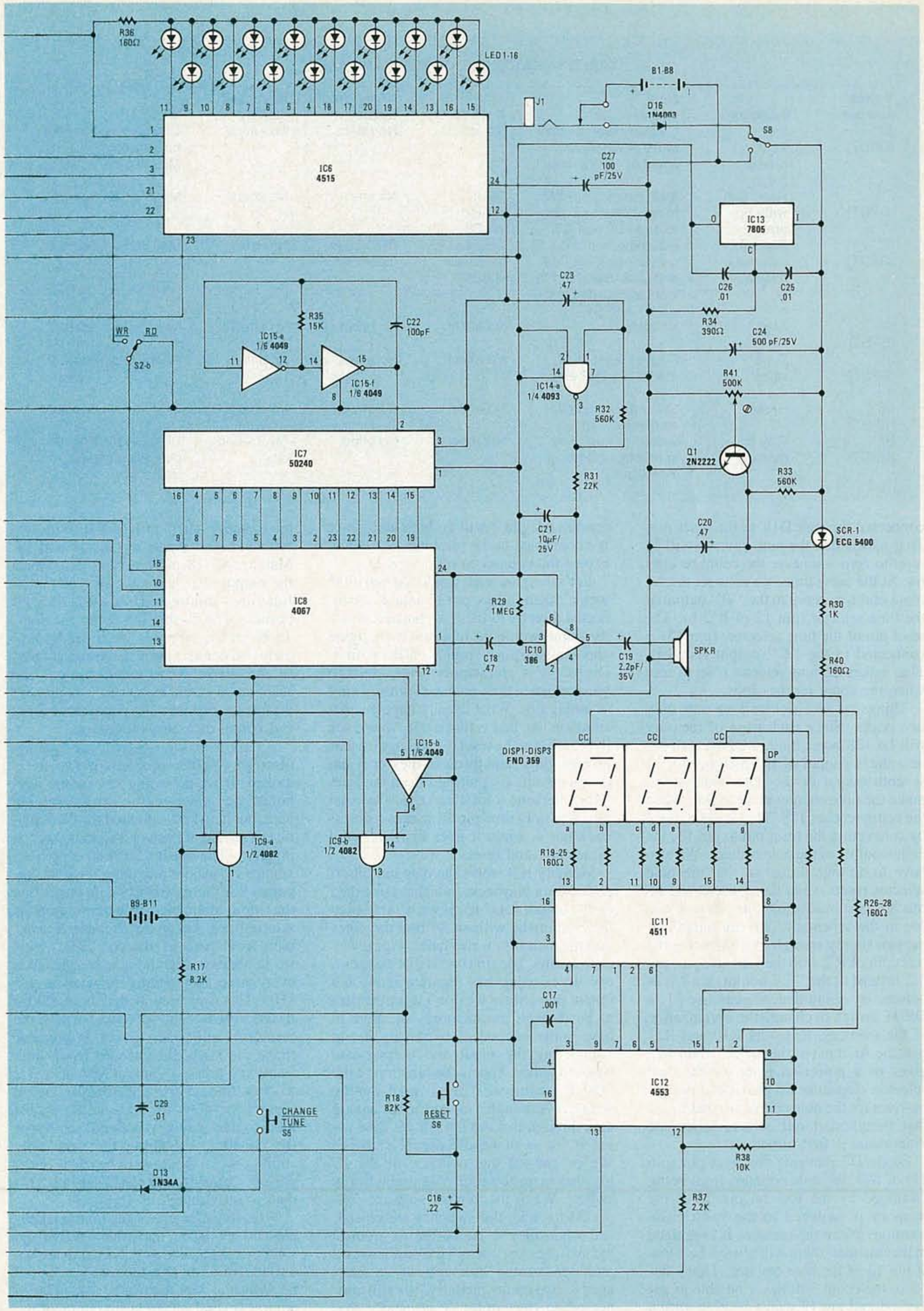

R36
160Ω
LED1-16
IC6
4515
B1-B8
J1
D16
1N4003
S8
C27
100
pF/25V
IC13
7805
C26
.01
C25
.01
R34
390Ω
C24
500 pF/25V
R41
500K
Q1
2N2222
R33
560K
C23
.47
R35
15K
C22
100pF
IC15-e
1/6 4049
IC15-f
1/6 4049
WR
RD
S2-b
IC14-a
1/4 4093
R32
560K
R31
22K
IC7
50240
C21
10μF/
25V
C20
.47
SCR-1
ECG 5400
IC8
4067
R29
1MEG
C18
.47
IC10
386
C19
2.2pF/
35V
SPKR
R30
1K
R40
160Ω
IC15-b
1/6 4049
DISP1-DISP3
FND 359
CC
DP
IC9-a
1/2 4082
IC9-b
1/2 4082
R19-25
160Ω
R26-28
160Ω
IC11
4511
B9-B11
R17
8.2K
C17
.001
IC12
4553
C29
.01
CHANGE
TUNE
S5
R18
82K
RESET
S6
R38
10K
D13
1N34A
C16
.22
R37
2.2K

TABLE 1—SWITCHING OF THE PIANOMATIC

Switch number	Function	Note counter	Keyboard	Note counter display	Keyboard display	Misc.
S1 (DPDT)	2 or 4 tune memory paging	Causes reset at count of 64 (4 tunes) or count of 128 (2 tunes).	No effect	No effect	No effect	Changes resetting of tune selector, IC2-b. Mounted on Board 3.
S2 (DPDT)	Read and write operation	Switching from write to read causes reset through D2 and C6.	Disabled in read via D5.	No effect	No effect	Mounted on Board 3.
S3 (DPDT)	Manual or automatic playback	Switching from manual causes reset via D17 and C28. Switching to manual causes reset via D1 and C1.	Disabled in automatic via D6.	Blanked in automatic	No effect	Mounted on Board 3.
S4 (SPST)	Start	No effect	No effect	No effect	No effect	Mounted on Board 2.
S5 (SPST)	Tune select	Causes reset in all modes via D12 and C4.	No effect	No effect	No effect	Mounted on Board 2.
S6 (SPST)	Reset	Causes reset in all modes via C16.	No effect	No effect	No effect	Mounted on Board 3.
S7 (DPDT)	Play or memory	Switching from Play to Memory causes a reset via C2.	No effect	No effect	Disabled in play	Disables memory in play. Mounted on Board 3.

connected through D18 to the reset pin. That means that the note counter will be reset to zero whenever the count reaches 64. At the same time, we connect the A7 input of the memory to the "B" output of the tune selector (pin 12 of IC2-b). The reset pin of the tune selector, (pin 15) is connected to the "C" output (pin 13). That makes the tune selector reset to zero when the count reaches four.

Things get a bit trickier if we want only two pages. Since each page of memory will be 128 notes long, we have to connect the A7 input of the memory to the seventh output of the note counter and make the note counter reset to zero when the count reaches 128. That is easily done by connecting the reset pin to pin 13, the eighth output of the note counter. We also have to arrange things so that the tune selector resets when the count in the IC reaches two instead of four. As you can see in the schematic, we can make that happen simply enough by connecting the reset pin of IC2-b to the "B" output, pin 12, instead of the "C" output, pin 13, as before. By doing that, we can use S1, a DPDT switch to change the organization of the memory. Resistors R10 and R11 bias the A6 input of the memory and C13 gives us a power-on reset for the tune selector. Capacitor C5 provides a power-on-reset for the note counter to make sure that things start out at zero when the Pianomatic is first turned on.

Diode D7 prevents the reset pin (pin 11) of IC3, the note counter, from being swamped by the low on pin 13 if the memory is switched to the FOUR PAGE position. When the memory is organized in that manner, there will always be a low at pin 13 of the note counter. That's because the count will never be able to get past 64 and pin 13 won't go high until a count of 128 is reached. When the count reaches 64, pin 4 will go high and, since it's connected to the reset bus, we would expect the counter to reset to zero.

Let's imagine what would happen if D7 weren't there. Since pin 13 would be connected directly to the reset pin and, since its output would be low, the high signal appearing on pin 4 would conflict with it. Digital IC's are tempermental and go bananas when they're faced with any kind of ambiguity. What usually happens in a situation like that is that the IC would see the conflict at the reset pin, recognize it as an ambiguity, and throw in the towel and destroy itself. By putting D7 on the line, things become a lot clearer for the reset pin. The only time pin 13 makes its presence felt is when it goes high, forward biases D7, and resets IC3.

Memory IC4 stores the data put into it and, during playback, puts that same data on the output data bus. If we want to play the Pianomatic without writing the notes into the memory, we're faced with several problems. The first one is that the memory we're using has separate input and output pins. Since we don't want the data to go through the memory, we have to have some method of bypassing it and connecting the input and output data buses together. That is the function of the memory control, IC5, a quad analog switch. (Although you can route analog data through that device, all we'll be using it for is to handle digital signals.) We've ganged the switches in the IC together to make a four-pole single-throw switch. When the control pins are connected to +V, the switches are closed, and when they're connected to ground, the switches are open. That still leaves a problem because although we've managed to bypass the memory, it's still connected to the circuit. Fortunately that problem was forseen by the designer of the memory—he's provided us with two enable-control inputs at pins 18 and 19. Making pin 18 positive will disconnect the outputs but leave the rest of the IC functions unaffected. Making pin 19 positive will disable the entire memory. To be on the safe side we'll use both of them and connect them to the control pins of the 4066. Now when we put the Pianomatic in the PLAY ONLY mode, we disable the memory and connect the input and output data buses together.

As soon as we do that, we quickly discover another problem we've overlooked. If we press any key on the keyboard we generate the corresponding note, but if no key is pressed the Pianomatic makes one of the worst sounds you can imagine. The reason for that is obvious when we consider one thing—we've forgotten that there's always data present on the input data bus. When no note is selected, the keyboard encoder is scanning from zero to fifteen. Thus, what we're hearing when no note is selected is every note sequentially selected at 1.5 kHz. The way around that is to find a means to enable the 4066 (and disable the memory) only when a key is pressed. Since the keyboard encoder has a high "any-key-pressed" output, our answer is evident. Instead of connecting the control pins of the 4066 to +V, we'll connect them to the "any-key-pressed" output of the encoder. By doing that, the only sounds we'll hear will be, to coin a phrase, "music to our ears." Switch S7-b does exactly that.

When the memory of the Pianomatic is enabled by S7-b, the other half of the switch, S7-a, puts +V on the MANUAL terminal of S3-b. One look at the schematic will show you that we're using that to control several different functions of the

continued on page 81

Innovative Consumer Products of 1983

At each Summer Consumer Electronics Show the outstanding designs of the past year are honored. Here are some of the highlights of this year's exhibition.

ONE OF THE MOST EXCITING DISPLAYS AT every summer consumer electronics show in Chicago is a special exhibit of design and engineering accomplishments of the past year. Sponsored by the Consumer Electronics Group of the Electronic Industries Association (EIA), that event is the only place at the vast show where the entire industry—manufacturers of everything from hand-held games to esoteric audio—comes together to honor innovative design and the application of state-of-the-art technology. This year, the eighth time that the special exhibit has appeared, judges from the consumer-electronics press honored more than 125 individual products and, in a separate event, over 60 computer, game, videodisc, and videocassette software titles as the most innovative products in their categories. Let's take a look at some of the highlights.

DANNY GOODMAN

Audio

There is little question that the compact disc (CD) in general won the hearts of judges. Several new players were on display. But to see all those machines together, it is apparent that the only "compact" thing about most CD players is the disc; practically all of the first-generation players are rather large. The exception is the Magnavox (I-40 and Straw Plains Pike, Knoxville, TN 37914) *FD 1000SL*, which may be the smallest CD player in production.

Controls are kept at a minimum on that low-profile player, shown in Fig. 1, yet with the nine front-panel function buttons and the LED track indicators, the audiophile has full programmability for setting up any sequence of tracks on the disk, as well as forward and reverse search. For that premium design there is fortunately not a premium in price, at least not when compared to other CD players. The *FD 1000SL* has a suggested retail price of $800.

One hi-fi technology that's getting off to a slow start is AM stereo. With the lack of a standard or recommended AM-stereo transmission method, broadcasters are free to select whichever system they want, even though each is incompatible

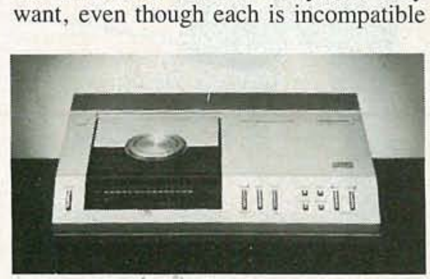


FIG. 1—THE MODEL *FD1000* from Magnavox; a truly compact, compact-disc player.

with all others. Needless to say, that creates quite a dilemma for receiver and tuner manufacturers. But with the Sansui (1259 Valley Brook Ave., Lyndhurst, NJ 07071) *TU-S77AMX* tuner, the listener doesn't have to worry about which systems the various stations in his area are using. That's because that new tuner (see Fig. 2) automatically detects which of the four AM-stereo methods is received and adjusts to the proper decoding circuitry automatically. All of that operates invisibly to the listener, without any indication as to which stereo method is in use. The tuner also features a few other state-of-the-art listener features. Up to eight preset stations can be stored for both AM and FM, and the memories can be scanned.

FIG 2—BILLED AS A UNIVERSAL RECEIVER, the model *TU-S77AMX* is capable of receiving all of the four AM-stereo systems.

Video

While *M*etal-*O*xide *S*emiconductor (MOS) cameras for VCR recording have been more or less a novelty item for the last year-and-a-half, the technology of that solid-state image sensor has improved. Hitachi (401 W. Artesia Blvd., Compton, CA 90220) now feels confident enough about it to package a full-featured portable camera using the tiny sensor instead of a pickup tube. The compact, five-pound *VKC3400* camera, shown in Fig. 3, is one of the first cameras to include a color viewfinder as well. Thus, the video-camera operator will see that all settings are accurate before shooting, and can play back any segment of tape, in full color, to double check. Also built into the small unit are automatic focus, even in macro (closeup) settings; a character generator for titles; a date timer; a time-lapse counter; negative/positive reverse, and VCR transport controls. As

FIG. 3—HITACHI'S *VKC3400* boasts an MOS image sensor, a full-color electronic viewfinder, and a range of special-effects features.

far as optics go, the camera uses an *f*1.2 lens and a six times power-zoom lens. Iris and white balance adjustments can be set automatically or manually. Surprisingly, the camera lists at about the same price as the first, rather featureless MOS camera of about a year ago: $1995.

High-quality, stereo sound for videocassette recordings was the big announcement last January by a consortium of Beta-format VCR manufacturers. They had agreed on a standard for the Beta format to put two audio channels on the tape (with rotating drum heads) with more impressive specifications than traditional analog audio. Those specifications included a dynamic range of 80dB and a frequency response of 20hz–20kHz with less than 0.3% harmonic distortion. Now the products are starting to appear, and the Sanyo (1200 W. Artesia Blvd., Compton, CA 90220) *VCR 7300* is one of the first "portables" to include Beta Hi-Fi. The unit features separate audio inputs (as from a stereo tuner for use during a simulcast) and outputs (for playing through a stereo system), and claims a dynamic range greater than 80dB. A separate, stationary audio-head makes all Beta-format tapes playable on the *VCR 7300*; and all tapes recorded on the deck will play back (in mono) on other Beta decks. Other features include: 105-channel cable-ready tuner with 12 pushbutton channel selectors; one week, one event programmable timer; 8-function wired remote control, and Betascan picture search. It weighs 15 pounds including the rechargeable battery. It operates from that battery, or from AC or a 12-volt car battery. The price of the unit, (see Fig. 4) is $1000.

As more television manufacturers join in the move toward component TV, Proton (19600 Magellan Dr., Torrance, CA

FIG. 4—THE SANYO *VCR 7300* is the first portable unit to make used of Beta Hi-Fi.

90502) is taking a different tack by building component-quality video, audio, tuning, and switching sections into their model *619* 19-inch receiver/monitor (see Fig. 5). The video-monitor section limits overscan to 5%. Horizontal resolution is rated to be in excess of 370 lines. Built into the receiver is an automatic flesh-tone adjustment, which can be manually

FIG. 5—A 19-INCH RECEIVER/MONITOR, the Proton model *619* features component-quality video, audio, tuning, and switching sections in a single cabinet.

overridden. Picture brightness also automatically adjusts to ambient lighting conditions. There are four video inputs; two for RF and two for composite video. Front-panel pushbuttons select the input. There are also provisions to handle stereo-audio inputs from such sources as stereo-videodisc players and VCR's (the set has only a mono speaker, however). Outputs include one for video (for recording) and two for two-channel audio.

With the proliferation of home audio and video equipment, the cable and cable-switching mess gets increasingly more complex. To combat that problem, what may be the ultimate home-electronics switcher was introduced by Video Interface Products (1930 Ecorse Rd., Allen Park, MI 48101). The *From-To* routing computer, shown in Fig. 6, not only accommodates 10 inputs and 8 outputs, but also has a number of microprocessor-controlled features that allow it to be used as a control board for a small-scale television production. For simple selection of inputs and outputs, all the user needs to do is press the appropriate FROM and TO squares on the grid. More complex combinations involving multiple audio and

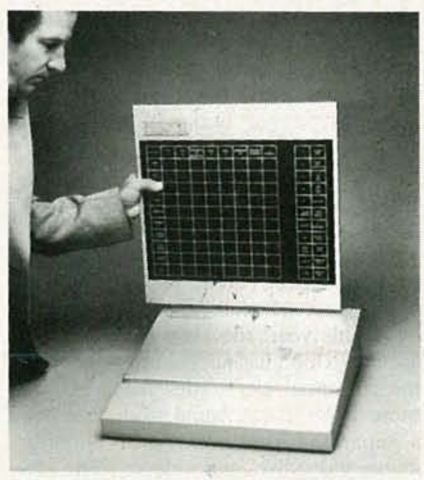


FIG. 6—THE ULTIMATE in convenience and flexibility, the microprocessor-controlled *From-To* switcher from Video Interface Products can handle 10 inputs and eight outputs.

video gear can be stored in up to 5 memories. Two outputs can be RF modulated (built-in) in case you want to display a composite video signal on a standard TV-set. A scan mode automatically switches through up to ten video inputs at infinitely selectable scan rates. The unit was engineered with extensive internal shielding. Crosstalk is less than −60dB. Of the three RF inputs, one features a VHF input amp, while the other two use broadband input amplifiers capable of handling frequencies through 900 MHz. The control-pad of the two-piece unit can be wall hung, if desired, with a 5-conductor cable linking it to the central console. The suggested retail price is $999.

Games and computers

A relatively new company, Koala Technologies Corp. (4962 El Camino Real, Suite 125, Los Altos, CA 94022), has developed a low-cost touch panel for use on Apple, Atari, Commodore, and IBM personal computers. The *Koalapad*, shown in Fig. 7, may eventually be used as a 40-function controller for some rather sophisticated software, in addition to its obvious applications in computer graphics. The unit's four-inch-square touch-sensitive surface can be used with either a stylus or a finger to move a screen pointer (cursor). In conjunction with the graphics software included with the pad, the neophyte computer artist can have the computer draw straight lines between two points, fill segments with various colors, magnify a segment to rearrange pixels, and create free-form drawings on the screen in response to the tracing on the pad.

From Xonox (11311 K-tel Dr., Minnetonka, MN 55343), a division of K-Tel (the same people who bring us 50 original hits on two LP's or cassettes), comes a new brand of videogame cartridge with something really different: *Double-Enders*, a cartridge that is actually two

FIG. 7—THE KOALAPAD, from Koala Technologies Inc., is a low-cost touch panel for use with microcomputers.

cartridges. Not just two games—that's been done years ago—but two separate cartridges packaged as if they were glued end-to-end, with their edge connectors facing away from each other; see Fig. 8. While that is certainly clever packaging, a sneak preview of the actual games at the Consumer Electronics Show revealed some interesting play in these 8K (per game) cartridges. Most of the cartridges have from three to five game screens.

One of the smallest direct-connect, RS-232 compatible telephone modems is the *J-CAT* by Novation (18664 Oxnard St., Tarzana, CA 91356). That 300-baud modem, shown in Fig. 9, can be set for auto answer/originate, as well as manual

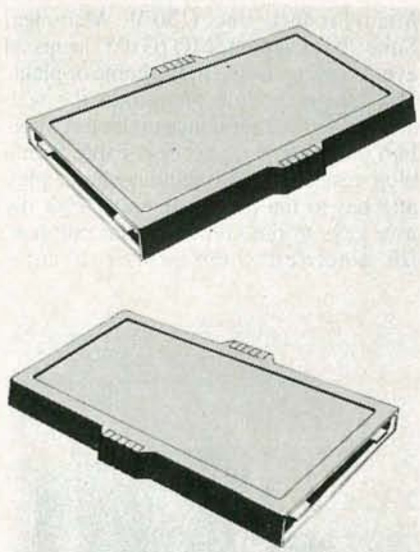


FIG. 8—TWO FOR ONE. The *Double Ender* cartridges from Xonox feature two separate 8K games in a single, two-ended cartridge.

answer/originate. An audio indicator gives the operator the status of the phone line (dial tone, busy signal, etc.). It features full-duplex operation only and carries a suggested retail price of $149.

Personal Electronics

In use in Europe for some time, and now available in the New York metropolitan area, a new traffic-conditions alert system is being introduced by Blaupunkt (2800 S. 25th St., Broadview, IL 60153). Called *A*utomatic *R*adio *I*nformation, or ARI, the system uses existing selected FM-broadcast stations to bring timely, localized traffic data to commuters. With an ARI-equipped car stereo, a driver can turn down the radio volume or turn on the tape player without missing traffic reports. When the report comes on, a subcarrier signal sent by the broadcaster activates the car radio to a pre-set volume, making sure the driver hears it. If the tape player is going, it is paused during the report. Participating broadcasters each have limited geographic zones, thus making sure the driver tuned into that local

FIG. 9—THE J-CAT from Novation, one of the smallest direct-connect RS-232 modems available.

station hears only about relevant road information. Blaupunkt is offering ARI adapters for some of its auto-stereo models (see Fig. 10), and is building ARI capability into some of its stereo radio/cassette decks. The company is currently licensing the technology to other manufacturers and plans to bring this system to more cities in the U.S.

Although automatic dialers aren't new, the shirtpocket-sized *Dial-It*, shown in Fig. 11, from Dictograph (3573 Warden Ave., Buffalo, NY 14086) packs an impressive roster of features in its tiny case. The unit stores up to 100 telephone numbers and then audibly tone-dials them

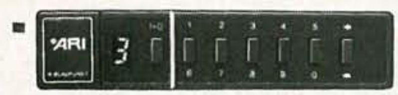


FIG 10—IN THE ARI SYSTEM, special signals keep a driver informed of traffic reports in his area. The adapter shown here will adapt a Blaupunkt car stereo to receive those ARI signals.

through a small speaker at the back of the case. Each memory can store up to 32 digits, leaving plenty of room for MCI, Sprint, or other budget long-distance-service access codes. An LCD display shows the number being dialed. For dialing numbers not stored in memory, the keypad can be used just as a pushbutton dialer. Also included is a clock (programmable in 12 or 24-hour time), alarm, memory calculator, and low-battery warning. The circuit lets you change batteries without losing what is in memory. The suggested retail price is $65.

As frequent users of walkman-type tape players know, batteries are an expensive habit. Clear Electronics (5362 Bolsa "B", Huntington Beach, CA

FIG. 11—THIS TINY AUTOMATIC DIALER, the *Dial-it* from Dictagraph, can store up to 100 numbers.

92649) has combined an AM/FM stereo tape-player and a slide-on rechargeable battery pack that will stop the endless purchases of batteries in their *818* AM/FM stereo tape-player shown in Fig. 12. The power pack has its own retractable AC power-plug; it plugs directly into the wall receptacle for recharging. Each charge keeps the player going for 6 to 10 hours. Packaged with the player and power pack are two pair of lightweight headphones and carrying case; it all sells for a suggested retail price of $140.

What makes the Regency Electronics Inc. (7707 Records St., Indianapolis, IN 46226) *MX 7000* noteworthy is the fact that it covers more of the frequency spectrum than any other consumer-oriented programmable scanner ever has. In addition to the standard VHF and UHF commercial bands, the unit, shown in Fig. 13, has continuous coverage from 27-1250 MHz (that's 1.25 GHz). Services covered in that range include Citizen's Band, FM broadcast, aircraft, 800-MHz public service, and cellular telephone. Front-panel selection is available for three receive modes: narrow-band FM, wide-band FM, and AM. The scanning interval is selectable; the intervals available are 5, 12.5, and 25 kHz. Up to 20 frequencies can be stored. Availability is scheduled for late 1983 and the suggested retail price will be $599.

FIG. 12—NEVER NEEDS BATTERIES. This personal stereo, the *818* from Clear Electronics, is powered from a rechargeable battery pack.

It may look at first like an electric flyswatter, but it's really a new design for a microphone for use in recording sound in noisy rooms or in rooms with a lot of hard surfaces. The *Sound Grabber*, from Crown International (1718 West Mishawak Rd, Elkhart, IN 46517) lies inconspicuously face-down on a table. The microphone element is set in place about one-quarter inch above its large, flat, plastic surface. The element captures sound in front of it such that all sound reaching the element is in phase. In a demonstration we had of the device, the improvement in recording quality, especially the quality of voices, over a built-in condenser microphone was considerable. The suggested retail price is $99.

The *Energy$Teller* from Advanced Micro Products, Inc. (150 W. Meramec, Suite 205, Clayton, MO 63105) keeps an eye on energy usage in the home or plant. The sensor module plugs into the wall socket, and the appliance under test plugs into the module. A six-foot cable with a plug resembling a modular-phone plug attaches to the processor unit. After the user keys in the killowatt-hour rate paid for electricity, the processor automatically keeps track of how much the electricity used by that appliance costs. A log book, called the *Energy$Checkbook*, is included to record the interval between readings. Tracking actual cost can help isolate wasteful appliances or equipment. The 120-volt module handles up to 25 amps. A 240-volt module will also be available. Suggested retail price for system shown in Fig. 14, is $80.

FIG. 13—THE REGENCY *MX 7000* offers continuous coverage from 27–1250 MHz.

American Bell (5 Wood Hollow Rd., Parsippany, NJ 07054), one of the companies created in the break up of AT&T, has introduced a line of telephones for sale to the general public. Of interest here is their *Genesis* system, a microprocessor-controlled, modular telephone that takes on powerful attributes with the addition of plug-in cartridges and modules. The alphanumeric display on the main console, for example, shows names and numbers stored in the electronic directory module shown in Fig. 15. By itself, the main console can store seven numbers plus three emergency numbers; the emergency numbers stand out on the console in red. Also built in is a call timer and alarm. Plug-in cartridges feature additional memories or custom-calling functions such as 3-way calling, call forwarding, and call waiting. Each cartridge redefines the keys on the console; slide in cards rename the keys.

FIG. 14—THE *ENERGY$TELLER*, sensor module, and log book help keep track of electricity consumption. The system is manufactured by Advanced Micro Products, Inc.

Sound Plus from Controlonics (5 Lyberty Rd., Westford, MA 01886) is about the only device singled out for recognition for using electronics to aid the handicapped—in this case, the hard-of-hearing. When a roomful of TV watchers contains one or more people who are hard of hearing, the volume almost always goes up to accommodate the one with the worst hearing, perhaps to the discomfort of the others. But *Sound Plus* lets the hard-of-hearing in the audience hear as loudly as they want, while the rest of can have the speaker volume at a lower level. The principle is quite simple. Each listener who needs one has an individually controlled amplifier-headphone combination. The device picks up the sound from the TV speaker with its microphone (plugging any device into the external speaker or earphone jack would cut off the internal speaker for the others in the room). Then the sound is transmitted via infrared up to 50 feet to all wearers of the headset/receiver, a stethoscope-like device. **R-E**

FIG. 15—THE *GENESIS* from American Bell, a modular, microprocessor-controlled telephone.

ECL LOGIC CIRCUITS

Emitter-coupled logic, though not as popular as other logic families, is by far the fastest available commercially. Let's take a look at some ECL basics.

TJ BYERS

WHAT WOULD YOU SAY IF I TOLD YOU that there are IC's available that can process data at the rate of 500 million bits per second? Some new laboratory discovery, you ask? Hardly. I'm talking about ECL (*E*mitter *C*oupled *L*ogic) circuits. Although ECL IC's became commercially available in 1962, they are still not very popular with hobbyists. However, due to their ultra-high-speed switching properties, they are popular in the data-processing, test-equipment, and digital-communications industries.

ECL IC's can be purchased today for about the same price as you're paying for TTL IC's. Does all this sound too good to be true? Well, before you rush out to replace your "antiquated" designs with ECL, first let me tell you that the average ECL circuit is nothing at all like the standard TTL format you've grown to love and understand.

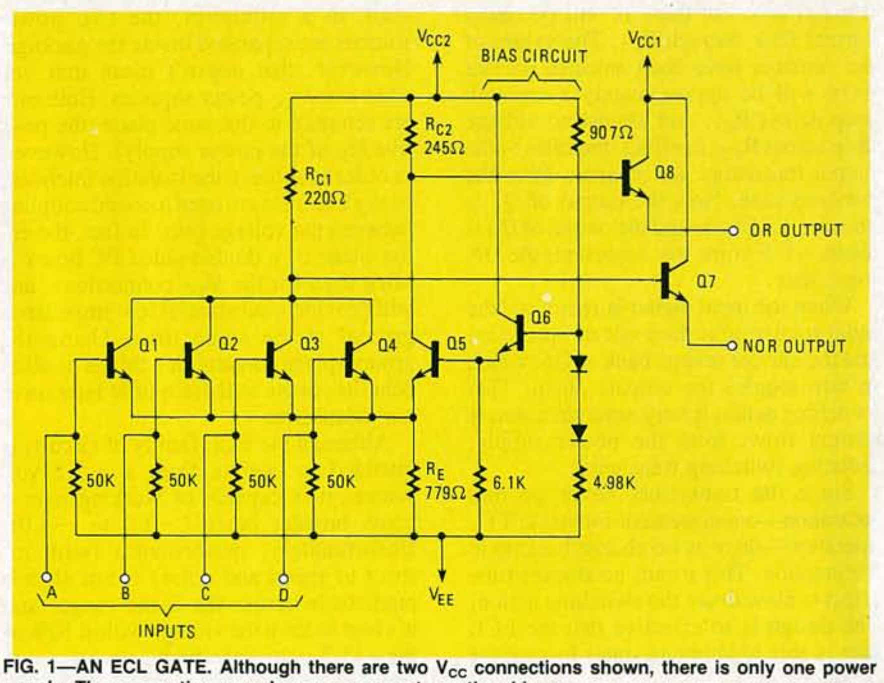


FIG. 1—AN ECL GATE. Although there are two V_{CC} connections shown, there is only one power supply. The connections are, however, separate on the chip.

ECL theory

Unlike the popular TTL-style logic, which exploits the two states of a transistor (either on or off), ECL is biased so that the transistors are in the active region at all times. (That is why ECL is often called nonsaturated logic.) Because the transistor does not go into saturation, there is no stored-base-charge problem; so propagation-delay times are very small. The IC's have speed capabilities a full order of magnitude faster than other existing technologies.

Figure 1 shows a complete ECL gate. If you look at it closely, you'll recognize the input section as being a slightly modified differential amplifier—similar in design to the input of an operational amplifier. However, also notice that one side of the differential "pair" includes four transistors, all in parallel. Each represents a separate gate input.

To the right of the differential amplifier is a biasing network that provides a stable, temperature-compensated voltage source. That voltage is input to differential-transistor Q5, establishing a reference level for differential operations. With no signal present on any of the inputs, Q5 conducts, resulting in a voltage drop across R_{C2}. Output transistors Q7 and Q8, whose base circuits are coupled directly to the collector resistors R_{C1} and R_{C2} respectively, monitor the status of the differential amplifier. Let's see what that means.

With no inputs, Q5 conducts, and little current flows in the other leg of the differential amplifier; there is no appreciable voltage drop across resistor R_{C1}. Thus the voltage at the base of Q7 is V_{CC}. Because the output circuit is being operated as an emitter follower, the voltage developed at the emitter (output) of Q7 will be V_{CC} plus the voltage drop across the base-emitter junction—or approximately 0.9 volts less than V_{CC}.

Unlike R_{C1}, there *is* a voltage drop across R_{C2} when Q5 is conducting. In fact, with the resistor values shown, the voltage drop is very nearly 1 volt. As before, the voltage developed at the emitter of Q8 will be the base voltage plus the voltage drop across the base emitter junction. The emitter voltage of Q8 will be about 1.75 volts less than V_{CC}. With the outputs configured this way ($V_{E7} = -0.9$, and $V_{E8} = -1.75$). We define it as our OFF state.

If we now apply a voltage—which is in excess of the reference voltage established by the bias network—to the base of one of the input transistors, it will conduct. That increases the current flow through the emitter resistor R_E.

The increase in current raises the voltage drop across the R_E, causing a proportional decrease in the current flowing through Q5—as is the nature of a differential circuit. Very little current will flow through R_{C2}, but there is will be heavy current flow through R_{C1}. The values of the resistors have been selected so that there will be approximately a one-volt drop across R_{C1}, and almost no voltage drop across R_{C2}. In effect, the roles of the output transistors are reversed from the previous case. Now the output of Q7 is about -1.75 volts and the output of Q8 is about -0.9 volts; that represents the ON logic state.

When the input signal is removed, the input transistor(s) drop out of operation, and the current reverts back to Q5, which in turn toggles the outputs again. That switching action is very smooth; a steady current flows from the power supply, reducing switching transients.

Since the transistors never go into saturation—a requirement for stable TTL operation—there is no charge buildup at the junction. That means no storage-time effect to slow down the switching action. The design is so effective that the ECL gate is able to alternate states in a matter of *picoseconds*.

Power supply

In order to effectively use these fast switching times, which are equivalent to 1 GHz in some IC's, other parts of the circuit take on a different look. One of the changes you'll see is in the power supply.

Characteristic to ECL circuits, the V_{CC} voltage—which is our positive line—is grounded. That means that our V_{EE} line must therefore assume a negative potential (usually -5.2 volts). Although any voltage source of the ECL family can be designated as ground, there is a valid reason for selecting the V_{CC} source.

To better understand the reasoning behind this, again think of an ECL gate as a differential amplifier (which it is, basically). Differential amps have the capacity for very high common-mode rejection, allowing the input circuit to ignore many sources of noise and interference that are inherent in switching circuits. However, noise generated on the V_{CC} line is not canceled out by the differential circuit. However, by referring V_{CC} to ground, good noise suppression can be accomplished.

That changes our way of thinking somewhat, because a "1" level is now represented by ground potential. Consequently, the "0" logic assumes a negative value, which is consistent with our new thinking.

That brings up another point about the V_{CC} voltage. If you look again at the schematic in Fig. 1, you'll notice that there are *two* V_{CC} connections to the gate. That is quite intentional. The output transistors drive the load using emitter followers, and the currents (particularly surge currents) are at times very heavy. That is reflected back into the V_{CC} line as a voltage spike, or a glitch. At the speeds involved, crosstalk inside the integrated circuit is a real problem. To keep crosstalk to a minimum, the two power sources are separated inside the package. However, that doesn't mean that you need two V_{CC} power supplies. Both pins are returned to the same place (the positive leg of the power supply). However, in order to achieve the isolation intended, heavy bus lines are used to avoid coupling between the voltage pins. In fact, the entire plane of a double-sided PC board is often used for the V_{CC} connections, and will provide a substantial low-impedance ground at the same time. Using the ground-plane construction brings us other benefits, as we will see a little later on in our discussion.

Although the ECL family of circuits is intended to operate from a -5.2 volt source, it is capable of working over a much broader range (-3.0 to -8.0). Unfortunately, performance (with respect to speed and noise) is not always predictable across the entire range, and it's best to keep the voltage within 10% of the -5.2 volts specified.

Power dissipation

One of the major complaints that has been lodged against the ECL family is that of excessive power dissipation. Since the transistors operate in their active region, it is naturally assumed they will dissipate more power than other, saturation-type logic families. However, that is not always the case. If you look at the power-dissipation curve in Fig. 2, you will see that although the TTL-style logic does use less power initially, the condition soon changes as the input frequency increases. As a matter of fact, even the power-miserly CMOS gate (operating with a 10-volt source) soon dissipates more power than what is dissipated by an ECL gate—and before the operating frequency even reaches 10 MHz!

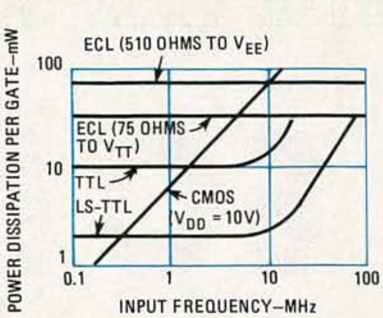


FIG. 2—POWER-DISSIPATION CURVES for various logic families shows that while ECL is often considered to be a power waster, at high frequencies it is quite miserly.

Even though TTL and LS-TTL seem to fare better at first, at high frequencies they, too, end up wasting as much power as an ECL gate. The ECL gate, on the other hand, keeps right on switching along, maintaining the same level of power regardless of the input frequency. In fact, in many situations the ECL design becomes a strong watt-for-watt competitor at frequencies as low as 20 MHz.

Logic levels

Since differential currents are used to represent the logic states, the logic voltages center around a threshold voltage that is established by the bias network. That can be seen from the transfer characteristics of the ECL gate, shown in Fig. 3. The "1" level is defined as -0.9 volts and the "0" level is -1.75 volts. Notice the use of negative values when expressing the logic levels, keeping consistent with our earlier observations.

The reference voltage for Q5 is set at approximately -1.3 volts. You'll see that the levels defined for our logic states pivot about the reference by just about 0.4 volts. By keeping the voltage levels confined to a narrow voltage band, rather than setting them at V_{CC} and V_{EE}, the *slew* effect is minimized. Slew is best defined as the amount of time it takes a pulse voltage to travel from one level to another. You probably know it better as rise time.

The greater the voltage transition, the more time it takes for the gate to switch. In other words, you can increase the op-

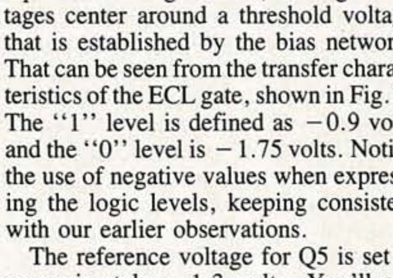


FIG. 3—TRANSFER CHARACTERISTICS of an ECL gate.

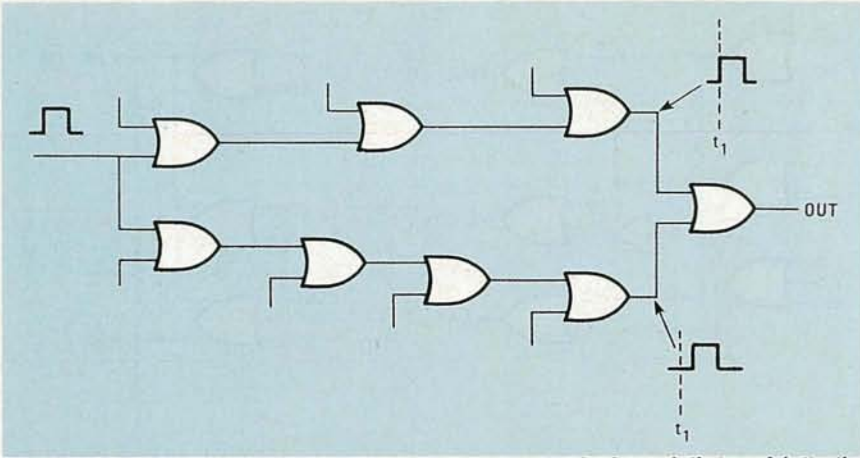


FIG. 4—THE EXTREMELY HIGH clocking speed used with ECL circuits demands that careful attention be paid to design.

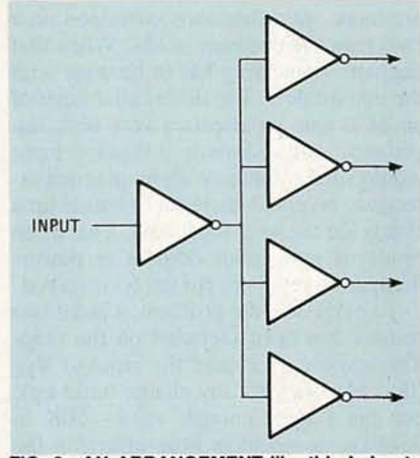


FIG. 6—AN ARRANGEMENT like this helps to minimize clock-skewing problems.

erating speed by limiting the voltage swing. That is not to say that the devices won't accept voltage levels beyond those defined as the logic states. They will. In fact, the situation often occurs at lower operating speeds. It is quite acceptable for the input pulse to run the entire gamut from V_{EE} to nearly V_{CC}.

High-speed logic

Basically, designing with ECL logic is pretty much like using standard logic IC's—if you remember that V_{CC} is ground. Because of the higher speeds involved, though, certain parameters require some important consideration. It's not unusual to find ECL gates operating comfortably at 500 MHz. At that speed, restrictions are frequently placed on pulse timing to a degree unimaginable with other forms of logic.

Assuming for the moment that the pulse width is 3 ns and that the delay per gate is 1.5 ns, the circuit in Fig. 4 will demonstrate our point. When a pulse is input to this configuration, it is split, with the signal traveling two different paths. (To simplify our example, only the actual signal paths are shown, but bear in mind that other inputs are present along the way, influencing the logical decisions.)

The pulse travels through the circuit and finally arrives at the last logic gate. However, the bottom signal arrives exactly 1.5 ns later than the top one. Now, one and one-half nanoseconds is not a very long time, and it would be ignored using standard logic practices. However, at the clocking speed we have set for ourselves in this circuit, it amounts to a full 25% of the clock cycle—and 50% of the pulse width!

At the beginning of the clock cycle, the final gate senses the inputs and makes its decision. However, 1.5 ns later the logic pulse from the lower path arrives at the input. Now, depending upon the logic states involved, the later signal could abruptly alter the status of the output. Furthermore, if there were a total of five gates involved in the lower path, the pulses would never coincide because they would be separated by 3 ns.

ECL clock skewing

Lead lengths must also be considered because of the high operating frequencies. A mere 12 inches of wire will delay a signal by about the same amount as one gate does. To emphasize that, let's take the circuit layout in Fig. 5, depicting, more or less, the physical positioning of several ECL gates on a PC board. The clock pulse is tied into the board at the top, and distributed to the IC's as shown. I'll bet you can see the problem already.

By the time the pulse reaches the fifth IC, the timing signal is skewed by a full 2.0 ns; on the back swing, the entire bottom row of chips is off by nearly 3 ns. As a matter of fact, the last chip is clocking more than 4 ns late; that is an intolerable situation!

To minimize such clock skewing problems, line delays must be matched to each other by better than 1 ns. A practical way to accomplish that is to use a logic-tree arrangement, such as is shown in Fig. 6. The timing signal is fed to one centrally located IC. From there, lines of matched length carry the timing pulses to the individual gates.

NOR logic should always be used when developing clock trees, and OR and NOR outputs should never be mixed within the chain. Due to lumped capacitance and other factors, loading of the outputs causes the gates to respond more slowly. So for high-speed performance, it is recommended that no more than four to six loads be applied to any one driver. Furthermore, when more than one gate is driven by a single output, it's better to run separate lines—of equal length—to each input rather than lump the loads at the end of a signal line. It is sometimes necessary (and usually desirable) to include an extra gate in a line to match delayed pulses from longer runs.

Parallel gates can be used to increase the bandwidth of an ECL driving gate when clock repetition rates are high, or when large capacitive loads are involved. Bandwidths can be extended by 40 or 50 MHz just by paralleling both halves of a dual gate.

As you may suspect, the timing problem becomes even more critical when more than one circuit card is involved in a system. Since the master clock is normally located on just one card, with output lines sent to the other cards in the system, it becomes imperative that all the feedlines be identical in composition (all coax, for example) and of *exactly the same length!*

Unused inputs

There always comes a time when there

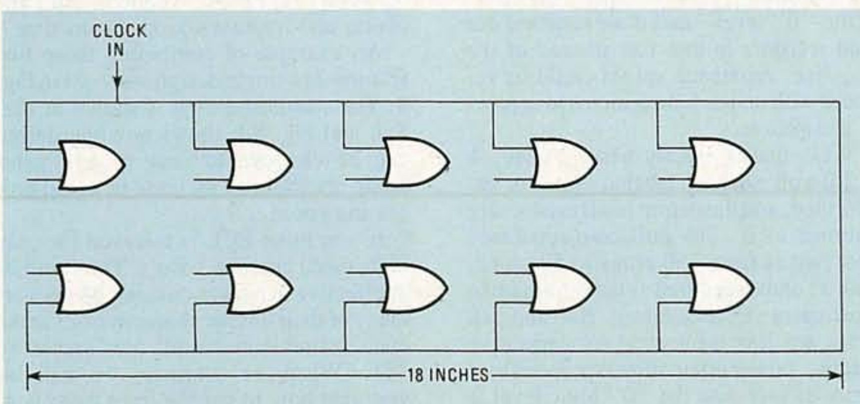


FIG. 5—LEAD LENGTHS become critical in ECL circuits.

are more logic functions contained on a chip than the designer needs. When that happens, something has to be done with the unused pins. The differential input of an ECL gate represents a very high impedance, and ordinarily a floating input would spell trouble. With no planned direction, reverse-bias leakage builds up a charge on the base-input lead. That often produces ambiguous outputs or power-dissipation problems for the IC involved.

To overcome the problem, a pulldown resistor has been included on the chip. The resistor references the input to V_{EE} (thus bleeding off any charge build-up), but has a large enough value—50K in most cases—to have little effect on the signal. As a result, all unused inputs can be left unconnected.

Be that as it may, there are exceptions. Several ECL devices don't have internal pulldown resistors; an example is a line receiver. In the case of a line receiver, one input must be tied to the V_{BB} pin (V_{BB} is a reference source used for Schmitt trigger applications) and the other returned to V_{EE} when the receiver is unused.

It frequently occurs during the analysis of a logic design that one of the inputs must assume a constant state. You see this configuration all the time in decision-making circuits that compare the input pulse to a fixed frame of reference. And, as has been the practice with standard logic, the inputs are hard-wired to either V_{CC} for a fixed HIGH, or V_{EE} for a LOW.

Although it is acceptable to tie the input to the V_{EE} line to simulate a low input with ECL gates, the reverse should not be attempted. Tying the input to V_{CC}—or ground, as is the case—to imitate a high input is not recommended. Due to their design, many of the ECL IC's won't operate properly when that method is used.

The proper way to force a logic "1" is to provide −0.9 volts at the input. You can use a resistor voltage-divider but most manufacturers recommend you use the forward voltage drop across a diode junction, as shown in Fig. 7, to provide the voltage required.

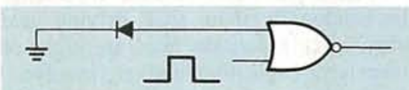


FIG. 7—A DIODE IS USED to imitate a "high" input for an ECL gate.

Outputs

Since the ECL output is an open emitter, an external load resistor is required to provide a current path for the output transistor. Normally, a resistance between 270 and 510 ohms is selected.

We should note that almost no dedicated driver circuits exist in the ECL family. That is because every gate is capable of becoming a driver. In fact, with the values so far specified, each output is capable of driving approximately 20 gate loads. The maximum fanout, however, is not limited by the gate's DC driving capacity as you may think.

While DC loading, such as the pulldown resistors in the input circuits, can produce a shift in output voltage levels, it does little to alter processing times. AC loading, on the other hand, increases as the capacitance across the output circuit increases. The AC considerations are what determine the maximum fanout. If not for those considerations, the fanout drive capability would be greater than that which is required for most any practical application.

Driven through a typical output impedance of 7 ohms, the output transistor is able to force current through the capacitance, hastening the charge time and leaving the rise time less affected. Fall time, however, must depend on the discharge rate through the load resistor. Therefore, it is beneficial to keep the load resistance as small as practical. Unfortunately, as the load resistance decreases, power dissipation (in both the IC and resistor) increases. For that reason, 200 ohms to V_{EE} is suggested as the smallest value you should use. However, the gate input doesn't require that the logic voltage swing all the way to V_{EE}, remember? Any level in excess of −1.65 volts is all that's really necessary. Therefore, if we were to provide another power supply—one nearer the "0" level—and if we returned our load resistors to that line instead of the V_{EE} line, resistance values could be reduced with no burdening increase in power dissipation.

Well, that is exactly what is done. A −2.0-volt source, labeled V_{TT}, is established, and the output load resistors are returned to it. The pulldown-resistance now ranges from 150 ohms to 50 ohms, with 35 ohms specified as the minimum in most cases. Consequently, rise and fall times are less influenced by capacitive loading, power dissipation is reduced by a factor of four, and the "0" logic level is still within limits.

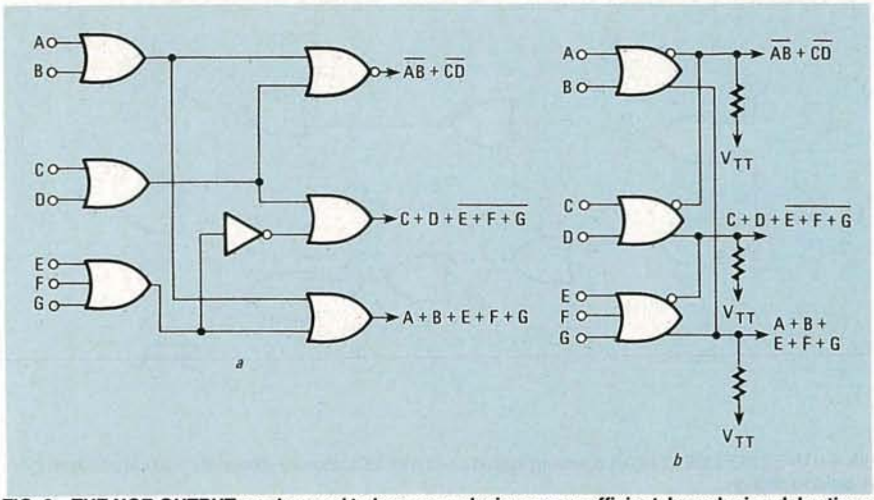


FIG. 8—THE NOR OUTPUT can be used to keep your designs more efficient, by reducing delay times and the number of gates required.

Of course, it must be decided during the course of design whether or not the cost and distribution of a −2.0-volt power supply is warranted. In many small systems, it isn't—in which case a resistor to V_{EE} is preferable.

Design shortcuts

The open-emitter drive makes it possible to engineer logic shortcuts into your designs. In particular is the wired-OR function. Wired-OR is the process of combining two (or more) outputs and OR-ing the results—without the use of a separate gate.

In general, it is recommended that the equivalent of only one pulldown resistor be used for the wired-OR design; although two resistors will improve fall times, it does so at the expense of added power dissipation. Due to LOW level current flow through the resistor, the number of gates paralleled in the wired-OR fashion should be limited to six in order to maintain a suitable level for LOW logic.

It is important that you keep the outputs involved physically close (from the same IC when possible). Anything else only aggravates the timing problems.

Another convenience of the ECL family is the inclusion of the complementary NOR output on most chips. Use of the NOR function eliminates the need for time-delaying inverters, reduces package count, and improves propagation time.

An example of combining these two features in a single design is shown in Fig. 8. The standard design is shown in Fig. 8-a, and Fig. 8-b shows how the design can be changed to save several gates while obtaining an increase in signal processing speed.

If you think ECL is reserved for only high-speed circuits...don't. They are just as effective in slower circuits. Moreover, many of their unique characteristics make them desirable in circuits now served by TTL. When we continue, we will investigate how to get the most from your ECL IC's. **R-E**

Powerline Transient Suppressor

All it takes is a single glitch, transient, or surge on a power line to wipe out hours of work on a personal computer. Here's a simple yet effective device that helps eliminate those three serious power-line-related problems.

HERB FRIEDMAN

THERE ARE THREE DIFFERENT TYPES OF power-line disturbances that can affect the operation of small computers: RF interference, line transients, and power-line surges. Each can affect different computers in different ways. Also, some computers are more easily affected than others. For example, short of a direct lightning hit, no power-line disturbance will disrupt a Heathkit/Zenith *H8* or *Z/19* computer. One *H8* we know of was running when the opposite wire of a 120/120 (240 volt) power line took a direct lightning hit only 100 feet away; the *H8* just kept on working. On the other hand, simply turning on one of the most popular printers will cause an equally popular personal computer to re-boot—and wipe the program you've been writing for three hours right out of memory.

Let's look at the three types of disturbances and some of their causes. Turning first to RF interference, we were asked to cure such a problem plaguing a *TRS-80 Model III* used for demonstrations in a Radio Shack store. It turned out that the source of the interference was a *Color Computer* that was also being used for demonstrations. All that was needed for a quick and inexpensive fix was a $12 RF filter that Radio Shack itself sold.

Line transients are another simple-to-cure but nevertheless bothersome problem. They are generated by power transformers and inductors when the current through them is turned on or off (although it's most severe when turned off.) Consider this case involving an Epson Printer and a *TRS-80 Model I* computer. If *scripsit* text-editing software was running, simply turning the printer on caused a line transient that scrambled the memory but not the video display. Everything looked just fine on the video screen, but what was saved to disk or sent to the printer came from memory, and that was pure garbage.

Transient "ride-through" was the reason for the scrambled memory. It's not unusual for line transients caused by inductors and even lightning discharges in the neighborhood to range as high as 1000 volts; and those transients can ride right through the power-supply regulators and into the five-volt computer power supply. The result can be scrambled memory or "blown" ICs. The cure for the problem is a General Electric MOV (*M*etal *O*xide *V*aristor) that more or less clips instantaneous line-transients at about 180 volts, a safe value that is generally handled (as far as we can tell) by all personal computers.

Finally, we can come to the third disturbance, one that causes the "silent death" of software, and sometimes of hardware: power-line surges caused by the local electric company's trying to maintain service after a power interruption. As a general rule, if a power line fails, the utility company will attempt to maintain service; often, the line may surge several times before failing completely, or the line may "hold," and power will be restored. The first interruption will probably wipe out or scramble whatever is in the computer's memory. The transients caused by the surges that follow as the utility tries to maintain power are quite capable of zapping your IC's and disks. If the first failure takes your disk drives out of service, you want to keep them out of service until things are safe for them once more. Applying power again and again—particularly in the case of start-up transients—to a disk drive with the door closed is an odds-on bet to wipe out a disk. For software protection, a good rule of thumb for personal computers is that when the power takes the computer down even for an instant, keep the computer and all its peripheral equipment out of service until you are absolutely certain that steady, reliable power has been restored.

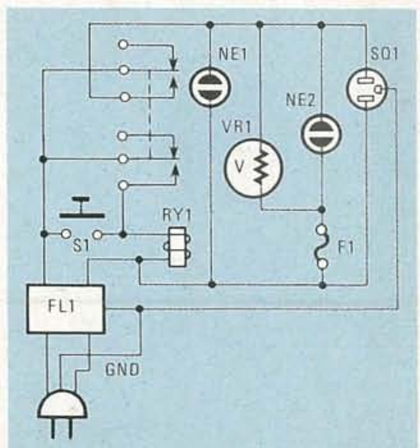


FIG. 1—THIS EASY-TO-BUILD CIRCUIT can provide better power-line protection for a personal computer than many commercial devices costing as much as $150.

Three in one

One way to eliminate, or at least sharply reduce, the problems caused by the unusual power-line conditions we've discussed is with the simple yet effective device described by this article. A schematic diagram of that device is shown in Fig. 1.

Although relatively unsophisticated, it does protect your computer against the three most common forms of power-line disturbances. First, there's FL1, an RF filter that keeps RF from entering into your computer through the power line, and RF from your own computer from getting into the power line (see Fig. 2).

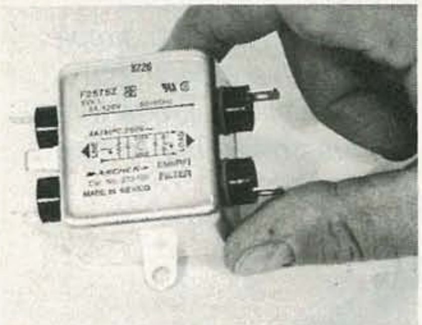


FIG. 2—THIS RF FILTER keeps RF power-line interference from leaking into your computer, and keeps your computer from interfering with other devices. It is particularly good at keeping two computers on the same power line from interfering with each other.

Second, it has a General Electric MOV, VR1, across the outlet receptacle to reduce the effects of line transients (see Fig. 3). Finally, relay RY1 is wired so that it drops out and *stays out* after the first power-line interruption until deliberately reset by the user. If the power fails at night, and in the darkness you forget to turn off your computer system, hours later—when the utility restores power—your disk drives won't start by themselves. Also, if the utility creates surges on the line while trying to maintain power, your computer will be safely disconnected from any consequences of that surging.

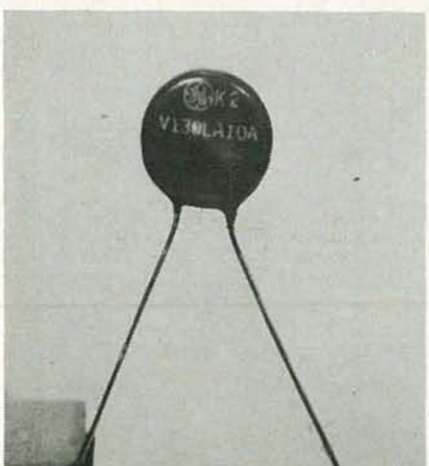


FIG. 3.—IT LOOKS LIKE A DISC CAPACITOR, but it's really a metal oxide varistor that limits transient line-voltage surges to about 180 volts.

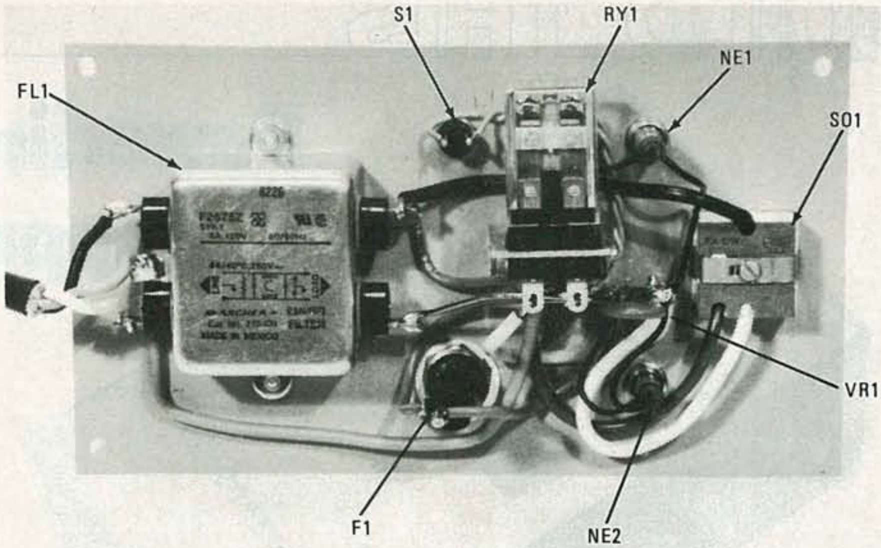


FIG. 4—ALL OF THE COMPONENTS mount on the metal front panel of a plastic utility cabinet.

Two neon indicator lamps show the condition of the power line and of VR1. Lamp NE1, an amber-colored POWER indicator, will always be lit if there was no interruption of the power source. If NE1 is out it means there was a power-line interruption and the power to receptacle SO1 is locked out (RY1 dropped out). Power is restored by pressing RESET switch S1, which causes RY1 to pull in and latch, and apply power to SO1.

Lamp NE2, a green LIMIT indicator, shows that the safety fuse in series with VR1 is intact and the power line is protected against transients. Lamp NE2 must always be on when NE1 is on. If NE2 is out it means there was an excessive transient that caused fuse F1 to blow, or—more seriously—that VR1 is damaged. Replace fuse F1. If it blows again (as indicated by failure of NE2 to light), simply replace the varistor. It is rare for a varistor to be damaged by a transient, but it can happen.

No provision is made for an on-off switch because the unit is intended always to be on; it is simply a safety device. If you want to use the device as a master power-control for your computer system, you can install an on-off switch in series with either power-line connection to the RF-filter input. Keep in mind, however, the fact that S1 must still be depressed to turn the power on.

Construction

The unit described was built on the metal panel supplied with a $7\frac{5}{8} \times 2\frac{3}{8} \times 4\frac{5}{16}$ plastic utility-cabinet. There are two versions of that cabinet around: the U.S.-made Bakelite cabinet with a sturdy metal panel, and the "imported" model made of soft plastic with a relatively thin metal panel. If the thin panel is all you can get and you want something more sturdy, you can cut a duplicate from a sheet of a heavier grade aircraft-quality aluminum.

PARTS LIST

FL1—EMI/RF filter (Radio Shack 273-100 or equivalent)
VR1— V130LA10A metal-oxide varistor (General Electric)
RY1—DPDT plug-in relay, 125-volts AC (Radio Shack 275-217 or equivalent)
S1—pushbutton switch, normally open
NE1—neon lamp assembly with built in resistor, 120 volts, amber
NE2—neon lamp assembly with built in resistor, 120 volts, green
F1—fuse, 3AG, 10 or 12 amps (see text)
SO1—AC receptacle, three-pronged, grounded type
Miscellaneous—cabinet, fuseholder, 3-wire line cord, relay socket (Radio Shack 275-220 or equivalent), No. 14 solid wire, etc.

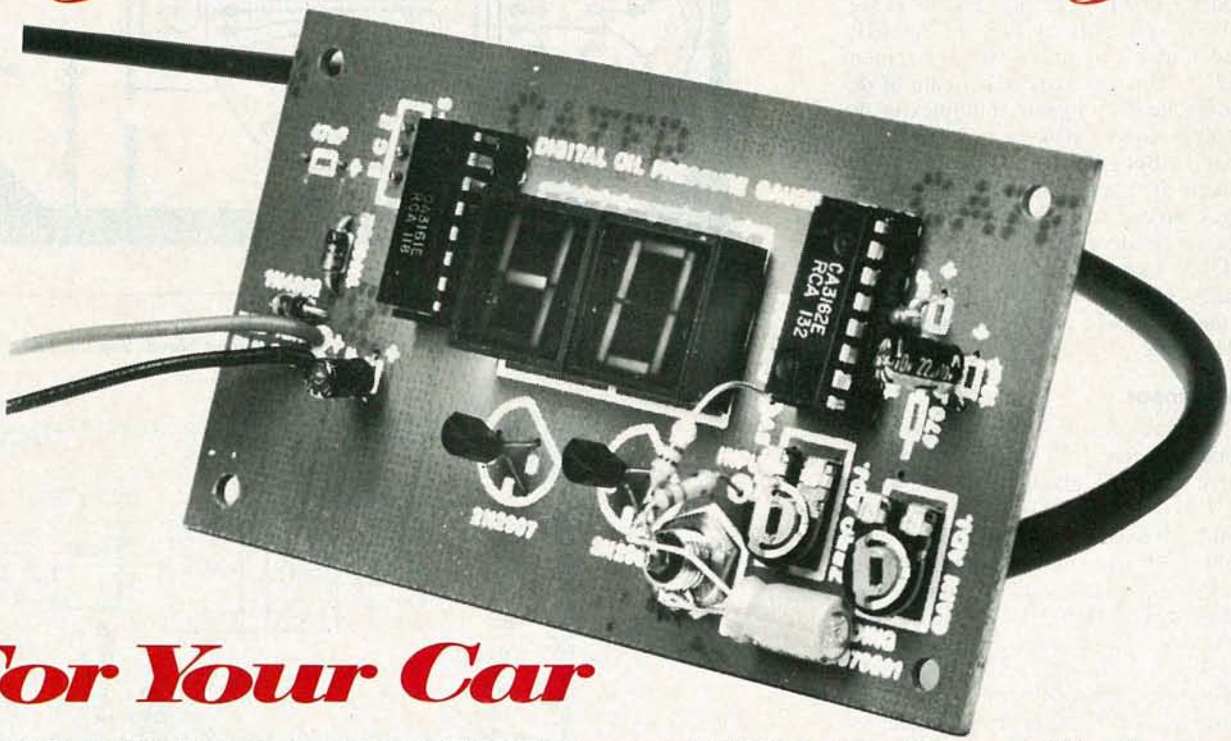
As shown in Fig. 4, all components except RY1 mount directly on the metal panel. Relay RY1 is mounted on a small L-bracket fashioned from scrap aluminum. (See Fig. 5.) Form the bracket to the shape required to mount the particular relay you use. The relay specified in the Parts List is easy to obtain, and mounts in a socket that is similarly easy to obtain and install. Its use is recommended.

When you form the L-bracket, make certain there will be clearance for the small terminal-strip used to mount the VR1—that terminal strip is secured by one of the rivets or screws used to mount the bracket on the panel; alternatively, you can leave room for the terminal strip next to the bracket. Take note that the power line for a computer must be 100% free of interruptions. Make sure that all components are tied down and expertly soldered; leave no connections hanging in space even if they are soldered and taped (see Fig. 6).

continued on page 78

BUILD THIS

Digital Pressure Gauge



For Your Car

Those "idiot lights" on your car's dashboard are great for telling you when something has gone wrong...but by then it's usually too late. This digital gauge will constantly monitor your oil pressure and warn you of problems long before they become critical.

FRED L. YOUNG, SR. and FRED L. YOUNG, JR.

A READING OF THE OIL PRESSURE IN YOUR car can tell you many things about what's going on in the engine—whether there's enough oil, whether a component (such as the oil pump) is beginning to fail, or whether there's a leak. The digital pressure gauge described here provides a two-digit display of the oil pressure—between 25 and 75 psi (*P*ounds/*S*quare *I*nch)—updated four times a second. It's easy to build, and can save you a lot of trouble and expense.

Before you begin, a word of advice: Despite the fact that the digital gauge provides a lot more information than the idiot-light indicator you presently have, don't get rid of that indicator. It will act as a backup device should the digital gauge fail for some reason, and should you be unfamiliar with low oil-pressure warning signs, will give a definite indication that something is wrong.

How it works

The circuit is similar in operation to the digital voltage and temperature meters described in recent issues of **Radio-Electronics** (July and August 1983, respectively). Its schematic is shown in Fig. 1. A regulated five-volts DC is derived

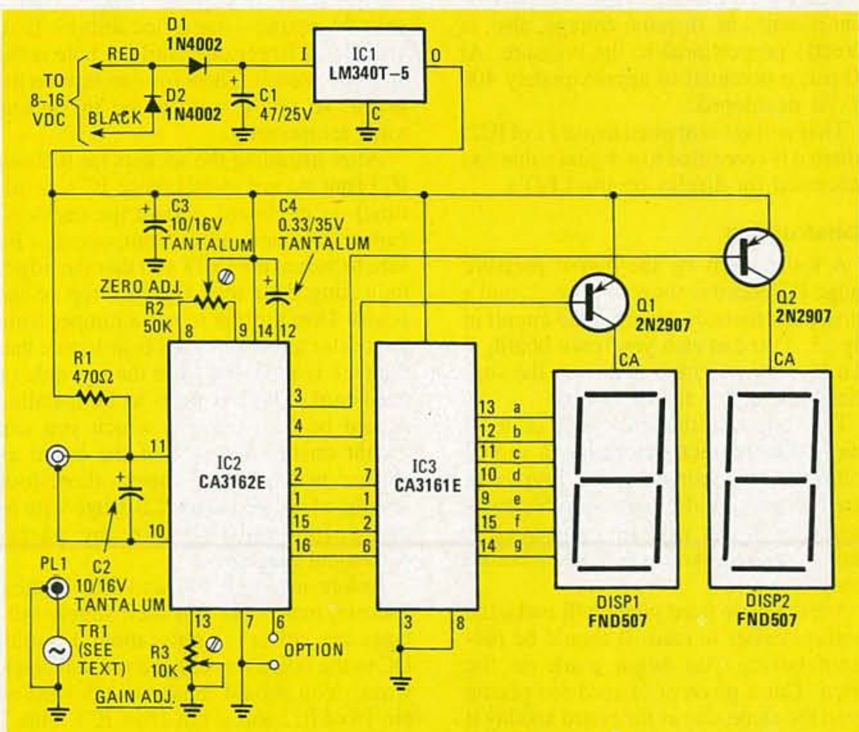


FIG. 1—TWO IC's, a CA3161E and a CA3162E do the whole job—from converting the analog voltage from the sensor to digital form to driving the display LED's.

from IC1, an LM340T-5 regulator, and supplies power for the rest of the circuit. The voltage coming from the pressure sensor (see below) is applied to IC2, a CA3162E dual-slope, dual-speed analog-to-digital converter with BCD (*B*inary *C*oded *D*ecimal) outputs. The BCD signals are converted by IC3, a CA3161E, into signals to drive two 7-segment LED's. The CA3161E takes care of decoding the BCD signals, multiplexing the displays (to save power), and driving the LED's. Because that IC controls the amount of current supplied to the displays, no external current-limiting resistors are needed.

Only two adjustments have to be made—one (R2) to set the "zero-point" of the conversion circuit, and one (R3) to scale it; i.e., to match it to the sensor.

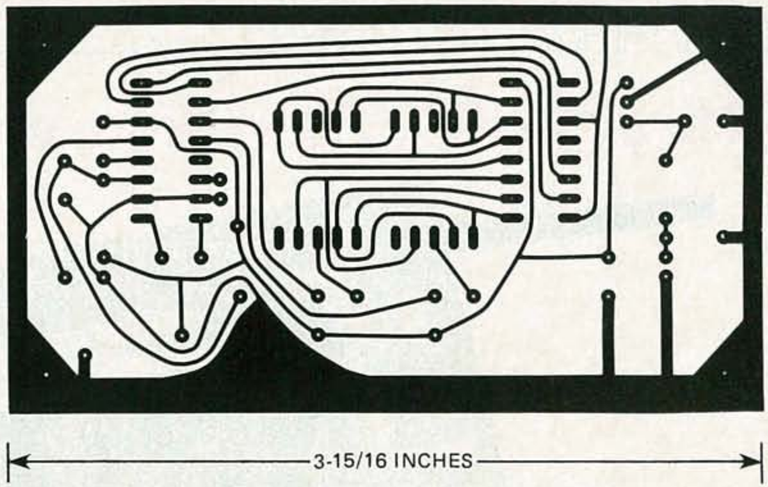


FIG. 2—FULL-SIZE FOIL PATTERN for etching the printed-circuit board. See the Parts List for a supplier of ready-to-use boards.

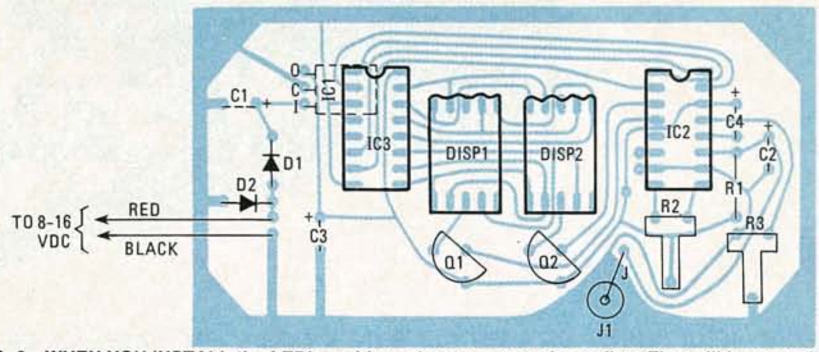


FIG. 3—WHEN YOU INSTALL the LED's, solder only two corner pins at first. That will let you adjust their positions easily should they not be in straight.

The sensor

Many oil-pressure sensor units will not work properly with the digital gauge. There are three, though, that we know *will* work: the General Motors GM370801, GM547034, and GM14039612. One or more of them should be available at a local automotive-parts supply house or GM dealer.

As (oil) pressure is applied to the sensor, its electrical characteristics change almost linearly; each pound of pressure causes a corresponding change in the resistance of the unit. At 40 psi, the resistance is approximately 40 ohms.

To convert that resistance into the voltage required by the meter circuit, a current is passed through R1 (470 ohms) to the sensor. As the resistance of the sensor changes with the pressure applied to it, so, then, does the voltage across it. Since the resistance varies linearly, and the current is constant, then the voltage, also, is directly proportional to the pressure. At 40 psi, a potential of approximately 400 mV is developed.

That voltage is applied to pin 11 of IC2, where it is converted to a digital value and processed for display on the LED's.

Construction

A foil pattern for the digital pressure gauge PC board is shown in Fig. 2, and a parts-placement diagram for the circuit in Fig. 3. You can etch your own board, if you like, or purchase one from the supplier indicated in the Parts List.

The article in the July 1983 issue of **Radio-Electronics** describing a digital voltmeter for your car goes into great detail about circuit-board assembly techniques; if this is your first construction project, we suggest that you read it before going to work.

A red plastic front panel will make the displays easier to read. It should be prepared before you begin work on the board. Cut a piece of ⅛-inch red plastic about the same size as the board and lay it on a clean soft cloth. Then position the PC board on it, component-side down, and mark the plastic with the positions of the board's four corner holes. Then carefully drill holes at the four positions marked on the plastic to accept 4-40 bolts. Don't split the plastic—use a fine drill-bit first, and then a larger one until the hole is the size you want it. Then you can start on the board, so you'll want to set the plastic aside temporarily.

After installing the sockets for IC2 and IC3 (but do not install those IC's at this time) on the board, mount the resistors, capacitors, and other components. Be sure to mount the LED's so that the ridges indicating their tops face the top of the board. Don't forget to run a jumper from the center lug of J1 to the board; note that the jack is mounted from the foil side of the board. The last parts to be installed should be IC1 and C1, which you can mount on the foil side of the board as shown in Fig. 4. Connect three-foot lengths of red and black 22-gauge wire to the points indicated in the parts-placement diagram.

Before inserting IC1 and IC2 in their sockets, make sure that their supply voltages are correct. Apply about 12-volts DC to the board through the red and black wires. You should measure +5 volts at pin 14 of IC2 and at pin 16 of IC3. Pins 7 and 8, respectively, should be at ground potential.

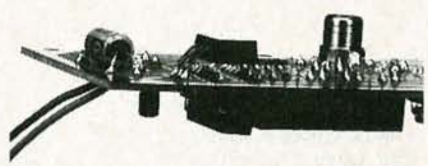


FIG. 4—INSTALL IC1 and C1 on the foil-side of the board. Make sure that the body of the regulator does not come into contact with the board.

If the voltages you measure are correct, you can remove power and install the two IC's. If they are not, recheck your work carefully for solder bridges and other errors.

A completed board—modified for noise reduction (we'll talk about that a little later) is shown in Fig. 5.

Calibration

To calibrate the pressure gauge, first apply between 10 and 16 volts DC to the red and black wires; 13.8 volts is ideal (it's the voltage that would normally be supplied by the car's electrical system). Then, with the sensor unit *not* connected, temporarily ground pins 10 and 11 of IC2 and adjust the 50K ZERO ADJUST potentiometer (R2) until the display reads "00."

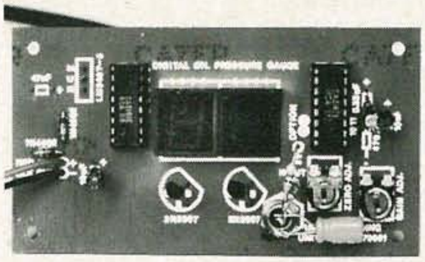


FIG. 5—THE COMPLETED oil-pressure gauge board. This version has been modified to incorporate noise reduction (see Fig. 7).

PARTS LIST

All resistors ¼-watt, 5%, unless otherwise specified
R1, R4—470 ohms (R4: see text)
R2—50,000 ohms, trimmer potentiometer
R3—10,000 ohms, trimmer potentiometer
R5—150,000 ohms (see text)

Capacitors
C1, C5—47 µF, 25 volts, electrolytic (C5: see text)
C2, C3—10 µF, 16 volts, tantalum
C4—0.33 µF, 35 volts, tantalum
C6—22 µF, 16 volts, tantalum (see text)

Semiconductors
IC1—LM340T-5 (7805) five-volt positive regulator
IC2—CA3162E dual-slope, dual-speed, A/D converter (RCA)
IC3—CA3161E BCD-to-seven-segment decoder/driver/multiplexer (RCA)
Q1, Q2—2N2907 or equivalent PNP-type
DISP1, DISP2—FND507 (FND510) 0.5-inch common-anode display LED
D1, D2—1N4002
TR1—GM370708, GM547034, or GM14039612 oil-pressure sending unit
J1—RCA phono jack
PL1—RCA phono plug

Miscellaneous: PC board, RG58A/U coax, red plastic, wire, solder, hardware for sensor mounting, etc.

The following are available from Digital World, PO Box 5508, Augusta, GA 30906: Pressure gauge PC-board only, $7.50; pressure gauge PC-board with schematics and diagrams, $8.50; IC2 and IC3, $12.50; pressure gauge PC-board with IC1–IC3, $20.00; kit of all parts (excluding plastic panel, solder, chassis, sensor, and sensor mounting-hardware), $32.50. The PC board, and PC board with schematics and diagrams are shipped postpaid within the U.S. and Canada. For all other items add $2.00 within the continental U.S., and $3.00 for APO, FPO, other U.S., and Canada. Canadians please use U.S. dollar postal money order. For shipment to other areas, write for prices and shipping costs. Please allow 4–6 weeks for delivery.

You'll need a fine screwdriver—and some patience—to do this. When you're satisfied with your work, remove the ground connection.

Next, temporarily connect a 47-ohm resistor across J1 to simulate the presence of the sensor unit and adjust the 10K GAIN ADJUST potentiometer (R3) until "47" is displayed. Again, work slowly and be patient until you have it just right. When you're done, remove the resistor.

If you are using either the GM370801 or GM547034 unit for pressure sensing, you're done with the calibration. If, however, you have a GM14039612 unit, you *must* also carry out the additional step that follows.

Because of its characteristics, the GM14039612 sensor tends to give readings about 10 psi too high if used with the pressure gauge as calibrated above. To compensate for that, connect the sensor (see below for installation instructions) and, with the vehicle's motor *off*, apply power to the circuit board. Adjust the ZERO ADJUST potentiometer, R2, for a reading of "–9" or "– –." The final setting of the potentiometer should be so that it is midway between the positions that give those readings. With that, the board is correctly adjusted for the GM14039612 sensor.

When you've finished the calibration procedures, install the red plastic faceplate over the board with 4-40 hardware. Use either spacers, or standoffs made from nuts threaded on bolts.

Installation

Since you want to retain your original oil-pressure sensor, it will have to be connected physically in parallel with the new one. Figure 6 shows how that can be done. You'll require a ¼-inch, 3-input "T" adaptor, which should be available at a local plumbing or hardware-supply outlet. You will also need a one- or two-inch piece of standard ¼-inch brass tubing, threaded at both ends, to act as an extender. It should be long enough to allow the sensor to clear the engine block and other parts in the area in which the sensor is mounted; it's better to have the tubing a little too long, than too short.

Screw one end of the extender tube into the center hole of the "T" adaptor, and the other end into the engine block where the original pressure sensor (which you've removed, of course) had been installed. Then attach the original sensor to one arm of the "T," and the new one to the other. Be careful when working with the brass tubing—it's rather fragile. Don't use too much force when you tighten the fittings, or the tubing may break.

When you assemble the fittings, use pipe cement or plumber's tape to prevent oil leaks.

If you have a foreign car that uses metric fittings, you may have to use an adaptor for the extender tubing, or secure a length of unthreaded tubing and have a machine shop thread it to metric specifications.

Use RG58A/U coaxial cable to connect the sensor to the circuit board. You can get an idea of how long the cable will have to be by running a piece of string from the sensor position through the firewall to where the circuit board will be mounted. Allow enough slack to keep the cable away from hot parts of the engine, and be sure to allow an extra 18 inches so the board can be installed (and removed) conveniently.

After cutting it to size, strip one end of the cable and connect it to the sensor. Tape the cable securely to the sensor unit to keep it from breaking loose. Connect

continued on page 134

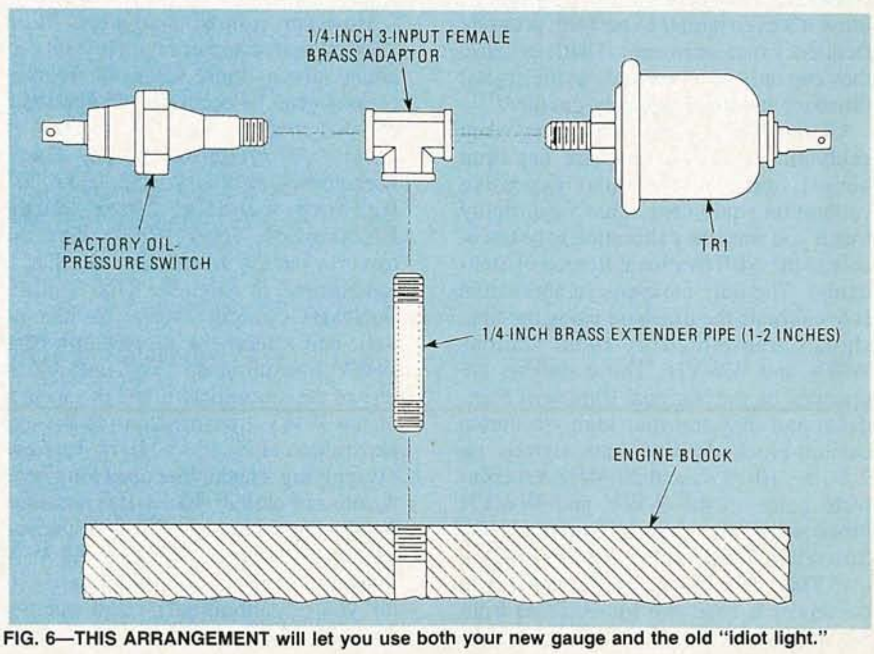


FIG. 6—THIS ARRANGEMENT will let you use both your new gauge and the old "idiot light."

HOW TO

FREQUENCY CALIBRATION USING WWV

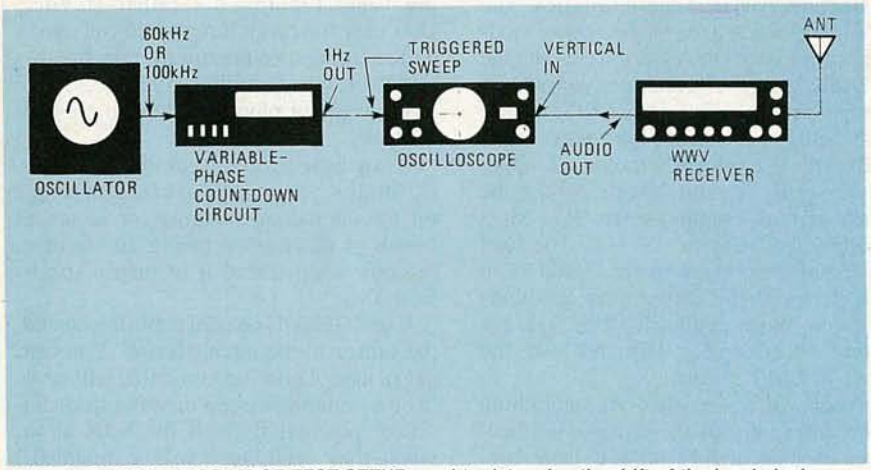


FIG. 1—BLOCK DIAGRAM OF TEST SETUP used to determine the drift of the local clock.

R.W. BURHANS

WWV is a source of highly accurate time- and frequency-signals. Here's a method that lets you use those signals to calibrate your own frequency standards.

AS ELECTRONIC CIRCUITS GET MORE COMplex, the level of accuracy needed to test those circuits also increases. While accurate measurement of voltage, current, and resistance present their own problems, often it's even harder to perform accurate frequency measurements. That's because they can only be as accurate as the crystal timebase in your frequency counter.

Getting a high degree of accuracy when calibrating a crystal timebase has been almost impossible without expensive calibration equipment. That's especially true if you want the calibration to be traceable to the NBS (*N*ational *B*ureau of *S*tandards). The only inexpensive alternative is to calibrate the timebase using the time signals transmitted by radio stations WWV and WWVH. Those stations are operated by the National Bureau of Standards and they transmit highly-accurate cesium-clock derived time signals on 2.5-, 5-, 10-, 15-, and 20-MHz. (A complete guide to the WWV and WWVH broadcast services can be found in NBS Special Publication 432, *NBS Frequency and Time Dissemination Services*. The document is available for 60 cents from the Superintendent of Documents, U.S. Printing Office, Washington, DC 20402.) The commonly accepted method for calibrating an oscillator using WWV transmissions is to zero-beat the oscillator against the WWV carrier frequency.

However, a small controversy has developed as to whether or not crystal oscillators such as those found in frequency counters can be accurately calibrated using that method. (See "Equipment Reports," *Sabtronics 8610A*, **Radio-Electronics,** February 1982, and John H. Hennings rebuttal letter, **Radio-Electronics,** June 1982). The controversy arises from the fact that the ionosphere is unstable (its condition fluctuates cyclicly over a 24-hour period), and affects the propagation of the WWV transmissions. The unstable nature of the ionosphere limits the accuracy of the WWV transmissions to 0.1 part-per-million (1 Hz in 10 MHz). However, by applying a technique used long before the days of atomic clocks, it is possible to obtain an accuracy of 0.001 part-per-million (1 Hz in 10 GHZ) using WWV transmissions, provided that the oscillator you're calibrating is kept operating continuously for long periods of time.

The calibration technique

Rather than calibrate the oscillator against the WWV carrier frequency, the technique outlined here uses the audible ticks that are transmitted by WWV and WWVH to identify the seconds. Each tick transmitted by those services consists of a 1000-Hz, 5-ms tone. The actual tick, therefore is composed of five cycles of a 1000-Hz sinewave.

The technique is illustrated in the block diagram in Fig. 1. The received time tick from WWV is displayed on the vertical axis of an oscilloscope. The output of the crystal oscillator is connected to a variable-phase countdown circuit that divides the oscillator frequency down to one pulse per second. Thumbwheel switches in the countdown circuit vary the phase of that 1-pulse-per-second waveform, which is used to trigger the oscilloscope. The sweep rate is set to 1-ms-per-division and the thumbwheel switches on the countdown circuit are adjusted until a sinewave appears. Since the 1000-Hz tone from WWV occurs only once each second and lasts for only 5 ms, the thumbwheel switches may have to be adjusted almost through their entire range before

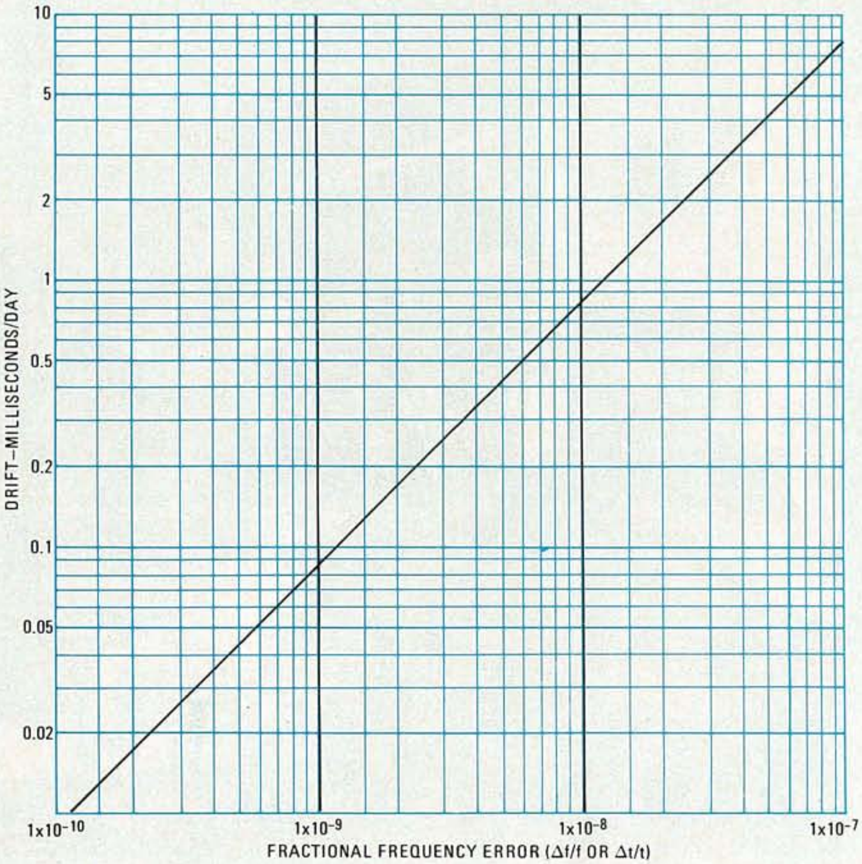


FIG. 2—THE FRACTIONAL FREQUENCY ERROR of the local clock can be determined from this graph once the drift is known.

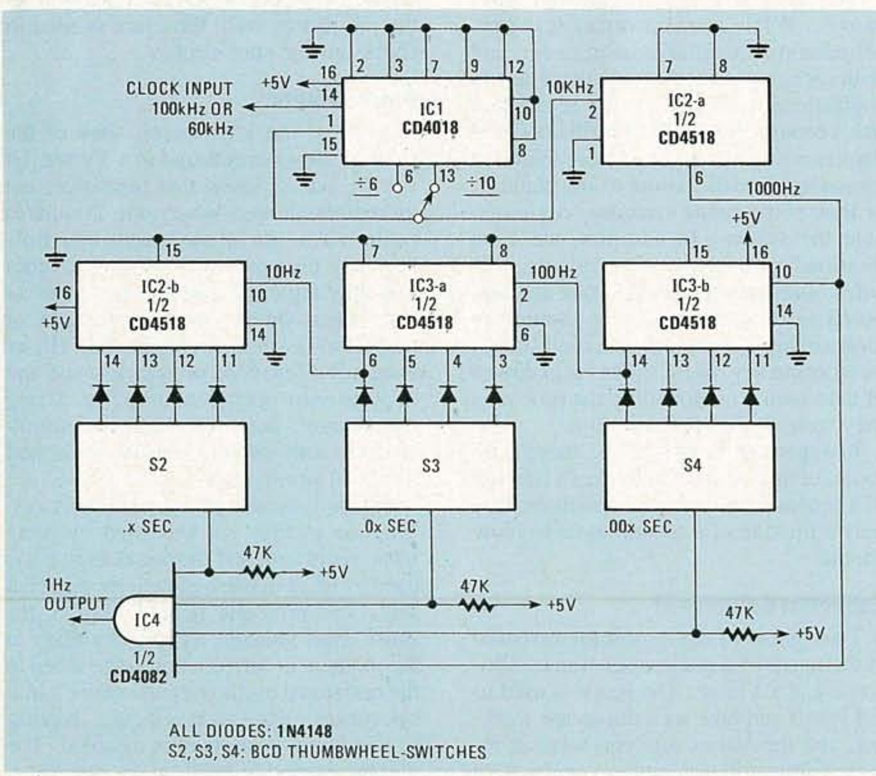


FIG. 3—VARIABLE PHASE COUNTDOWN CIRCUIT. The thumbwheels are adjusted until the sinewave is aligned with the beginning of the tick trace.

the sinewave can be seen. Remember, it lasts for only 1/200 second.

After the sinewave does appear, the thumbwheel switches are again adjusted until the leading edge of the first cycle of the sinewave aligns with the start of the oscilloscope trace. The drift of that trace determines the frequency error of the crystal oscillator. If the sinewave drifts one full cycle in about a minute, then the crystal oscillator is set to within only ± 10 parts-per-million. If the sinewave drifts one cycle in 15 minutes then the frequency stability is about 1 part-per-million. The rate of change of that drift is called the aging rate of the crystal.

To obtain higher accuracies, it is necessary to measure the drift over several days. The ionosphere will indeed affect the accuracy of the results, but its effect will be minimized if the measurements are always made at the same time of day. The change in the settings of the thumbwheel switches required to align the sinewave with the beginning of the trace is recorded every day at the same time each day. The drift can be estimated to within perhaps 0.1 millisecond by observing where the leading edge of the first cycle of the sinewave is with respect to the starting point of the trace. The drift (in milliseconds) over a 24-hour period of time can be used to determine the fractional frequency error of the clock by using the graph shown in Fig. 2. Although that may be a lot more trouble than the average observer is willing to take to determine his clock error, the point is that if accuracy is necessary, it *can* be obtained using WWV time signals.

The aging rate of a crystal itself changes with time, so it is necessary to reset the fine trim on the local clock-oscillator about once a month to maintain accuracy. An additional problem with temperature-compensated and oven-controlled crystal oscillators is that when they are shut off and then turned back on again, the aging rate starts at a new point. However, that problem is eliminated if the oscillator is kept running continuously, as in the frequency counters now sold that have standby operation, in those, an oven-stabilized crystal oscillator is always on.

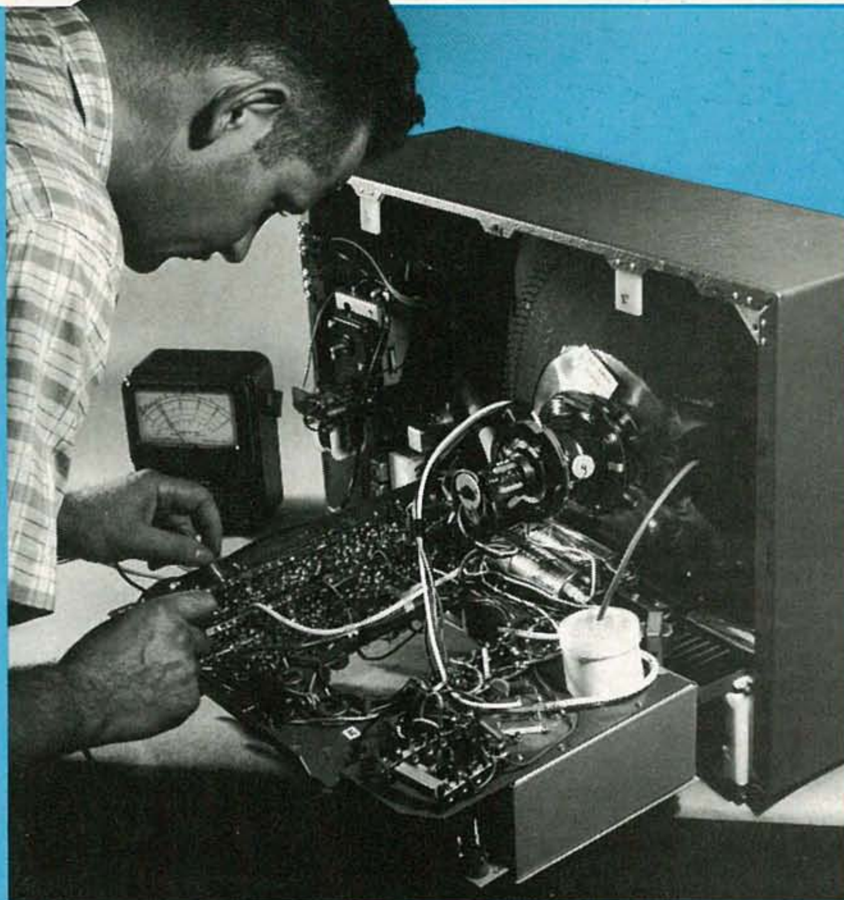
The countdown circuit

The variable-phase countdown circuit is shown in Fig. 3. This circuit is intended to be driven from a 100-kHz or 60-kHz source, but it can easily be driven from a 1-MHz or 10-MHz source with the addition of a couple of decade dividers using Schottky TTL or even some CMOS IC's. The thumbwheels can be adjusted to provide any phase of a 1-second tick from 0 to 999 milliseconds in one-millisecond increments. **R-E**

SERVICING HORIZONTAL SWEEP CIRCUITS

FRANK A. SALERNO

Here are some hints and tricks that may help you out the next time you run across that tough one.



TV SETS ARE GETTING TOUGHER TO FIX every day. Nowhere is that truer than in the horizontal-sweep circuit sections. Gone forever are the days when a simple multivibrator fed an output tube that drove a flyback transformer, which in turn energized the deflection yoke and the high-voltage rectifier. That was the basic sequence, with only slight variations, which was followed by just about all the manufacturers.

There were, to be sure, peripheral circuits that varied from system to system, and those could and did cause problems, but those problems were minor compared to what we face now. For openers, there's the switch from tube to solid-state stages. Even with a severely overloaded circuit, and the output tube glowing red, you could usually pull the plug in time to prevent any great damage. In modern, solid-state sets, however, it takes no time at all to lose a couple of expensive transistors to a sudden short.

Early solid-state sets tended to follow the design pattern of the tube models. The advent of modular sets made things even more simple, with many manufacturers putting the oscillator on one tiny plug-in board and keeping the output uncomplicated. A classic design was the Zenith EC/FC chassis of a decade ago. That set was so easy to service that few ever required shop repair.

That kind of a set just isn't made anymore. With most manufacturers abandoning modular construction, and with each one trying to outdo the others in sophistication, it's the home repair that has become the rarity. Oscillators and drivers now can consist of more than five transistors, and the failure of any of those, or their surrounding circuitry, could disable the system. In addition, we have overload protectors, shut downs, fail safes, and what-have you's that are supposed to disable the system should the high voltage go beyond specified limits. Needless to say, those suffer breakdowns of their own, compounding the problems they were designed to prevent.

In repairing modern sets, there's no room, or time, for error. It takes a fraction of a second to blow a $12 transistor, and only a fraction of a second more to blow another.

Essential equipment

Two pieces of equipment are essential in the repair of a modern set—an oscilloscope and a Variac. The scope is used to tell you if and how well things are working, and the Variac lets you work at relatively low voltage, giving you the time required to make some measurements before blowing things out. A variable DC supply is also nice to have, but a few six-volt dry-cell lantern batteries will do the job just as well; those are needed to check out the start circuits.

Start circuits

Oh yes, the start circuit, one of the nastiest things ever found in a TV set. Of course, we all know that transistors are incredible things; when one compares them with the slow-warming, hot-running, energy-wasting vacuum tubes that they replaced, one can really get to love them. One of the nice features of transistors is that give them 20, 10, or even just a few volts on which to run and they go into operation instantly. Using that feature, however, someone originated the start circuit, and like most bad habits, it proliferated.

Figure 1 shows two such start circuits. The one in Fig. 1-a was used by Sony some years ago, and the one in Fig. 1-b is used by RCA in some of their more recent sets. The principle behind both is the same. They generate a pulse of voltage at the moment of turn on; that pulse is fed to the horizontal oscillator and excites it into operation. The start circuit, having served its purpose, is then disabled. The voltage needed to keep things running—called, naturally enough, the run voltage—is taken from the flyback, recti-

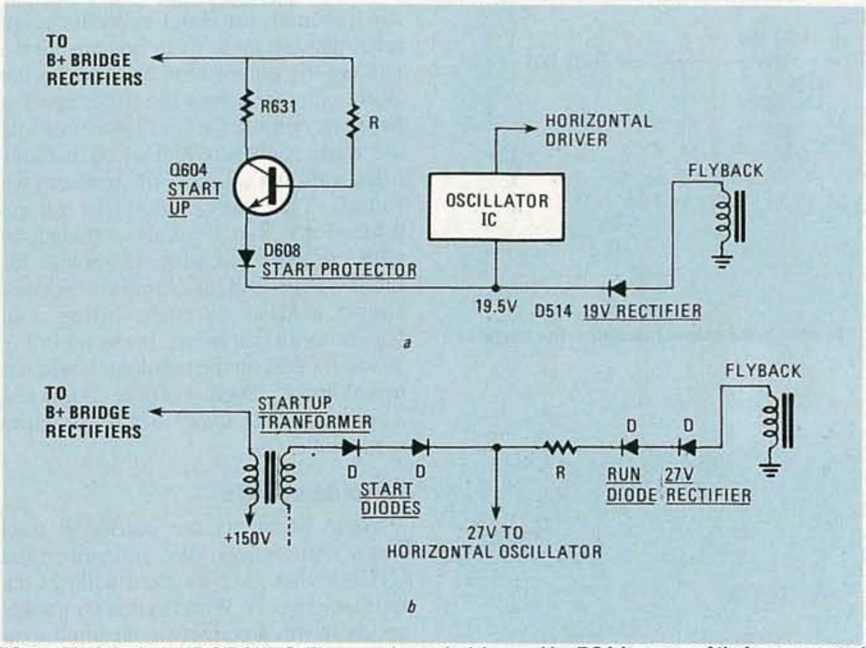


FIG. 1—TWO START-UP CIRCUITS. The one shown in *b* is used by RCA in many of their more recent sets.

fied, and fed to the oscillator at the same point in the circuit as the start pulse.

Now, that's all very nice, but it certainly has complicated life. If there is anything wrong on the output side of the circuit, loading it down, the run voltage will be affected, cutting off the oscillator. That can be quite a problem all around, but especially in those Sony receivers that used an SCR in the output. Sony called that SCR a GCS (*G*ate *C*ontrolled *S*witch). The nature of that particular device is that if it fails to receive its input signal, it self-destructs—instantly; it has no patience with a lazy oscillator. We have a "Catch 22" here. If the start circuit fails and/or the oscillator does not take off, the GCS shorts out. If the oscillator does in fact start up but is unable to keep running, due to some malfunction in the output side, the GCS shorts out. Either way, you lose.

When you come across a Sony with a shorted GCS (along with an open four-amp fuse and a shorted regulator transistor), the first step to take is to check out the oscillator. Using the start-up circuit for the Sony KV1920, shown in Fig. 1-a, we can see that the 19.5-volt bus supplies the power to the oscillator. The oscillator, however, can run on far less power than that, a fact that works to our advantage when troubleshooting the chassis.

We start by examining the collector of the driver transistor with the oscilloscope. Without plugging the set in, feed six volts DC to the circuit (positive to the 19.5-volt bus, negative to chassis); use either the variable DC supply or the batteries we talked about earlier. You should get a rock-solid signal at the horizontal frequency. It will be less than the 70 volts called for in the schematic, and it will be distorted, but this is not an operational set; all we are interested in now is whether or not the signal is there. If the signal is missing, find out why by working backwards. If it is there, tap the PC board in and around the oscillator. If you see any movement in the waveform when you do that, look for a poor solder joint, or other mechanical problem, somewhere. Even a slight flutter could be what caused the GCS to blow in the first place, so the importance in making sure that the signal you see is rock steady can not be overemphasized.

If you are satisfied with things to this point, it's time to get up your courage and install a new GCS. Once that's done, apply power to the circuit slowly, using the Variac. Start with 50 volts, and keep the oscillator running with the DC supply (or battery). As you increase the voltage, you should hear a rush of noise through the speaker at 75 volts, and at 80 volts a small raster should begin to appear.

If you do not hear that sound, stop! It means that the sound section is not getting its scan-derived voltage because the sweep system is not working. Increasing the applied voltage any farther is tempting fate.

The place to look for trouble now is on the output side of the GCS. Keeping the voltage at 75 volts will minimize the danger of destroying the GCS while using conventional troubleshooting techniques to track down the culprit: defective tripler, shorted scan rectifier, etc.

On the other hand, if sound and picture appear, back the voltage down to 75 and remove the battery; leave the scope attached, however. Check to see if the oscillator starts when the set is turned on. If it doesn't, the start circuit is probably bad. Check Q604, D608, and R631; that resistor will frequently be burned open. The cause of that can often be traced to a shorted 200-volt scan rectifier, or anything else that might knock out the run voltage forcing the start circuit to do more than was intended.

It's much easier to service a set in which the output is separated from the oscillator. A Philco 5CY81 that we recently came across is a perfect example (see Fig. 2).

The circuit breaker in that set was tripping. When the screws holding down the output transistor were removed, however, the breaker held. When the output of the oscillator module was scoped it turned out to be normal. Reinstalling the screws, the Variac was used to slowly apply power. When the voltage got to about 70, the breaker tripped. Troubleshooting was done by simply lifting each component in turn and reinstalling it until the culprit was found. In this case, when the pincushion transformer was unsoldered the breaker held. It turned out that the transformer had shorted turns.

That troubleshooting process was simple and straightforward in that instance because the oscillator module depended solely on the regular power supply for its operating voltage. By keeping the Variac at 75 volts, we were able to protect the transistor. Otherwise, at full AC voltage, each turn-on might have been its last.

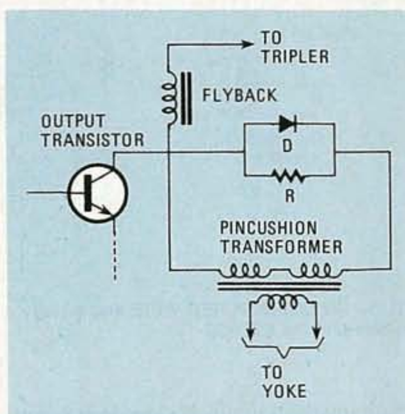


FIG. 2—A SIMPLE REPAIR. A shorted pincushion transformer was the cause of the excessive current drain in this Philco circuit.

Regulator outputs

In addition to run-start circuits, the newest RCA sets, such as the CTC97 (see Figs. 3 and 4), have another wrinkle to worry about: a regulator output. That is an SCR that supplies a regulated 114 volts to the output transistor.

Here's how to troubleshoot problems

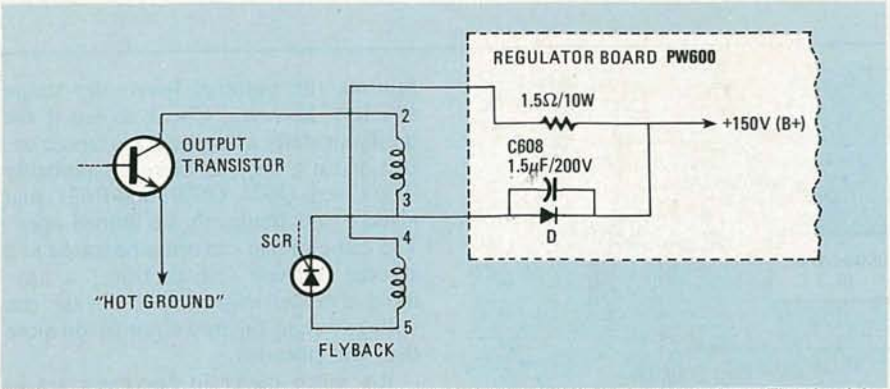


FIG. 3—THE SCR IN THIS CIRCUIT supplies a regulated 114 volts to the output transistor. The circuit is from an RCA CTC97.

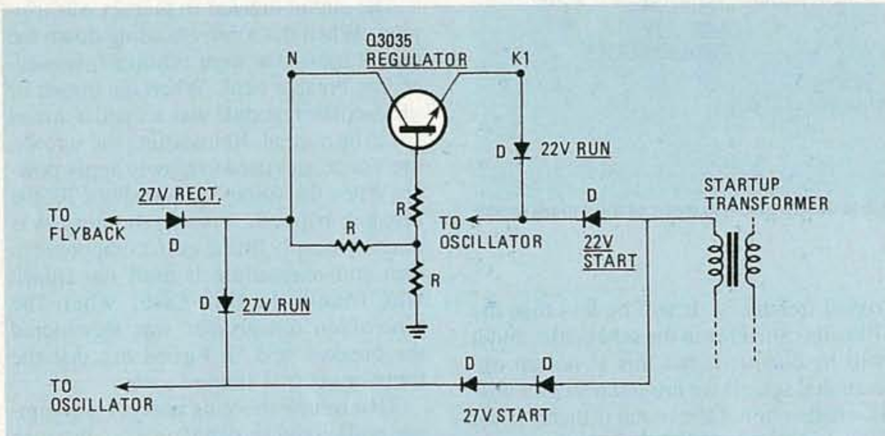


FIG. 4—ONLY THE 27-VOLT run voltage, applied to terminal N, need be supplied for testing. The 22-volt run voltage is taken from the regulator transistor, Q3035.

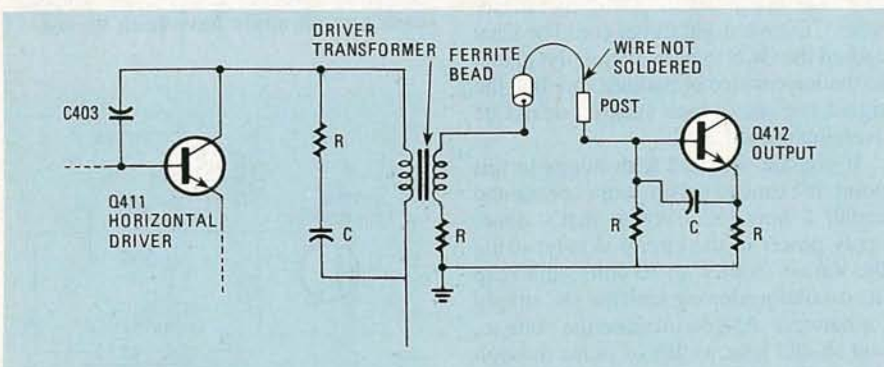


FIG. 5—AN UNSOLDERED WIRE and a leaky capacitor caused two unusual and hard-to-diagnose problems in the CTC108

involving that circuit. If a dead set has no output collector voltage (reading to a hot ground, not the chassis), and the B + is OK, remove the SCR as a precaution and install a jumper between the anode and cathode connections in the circuit. Again using the Variac, bring the voltage to 90. Using the scope, keep an eye on the output transistor's collector voltage and make sure that it does not exceed 114. If the set comes on, that means that there is trouble somewhere in the regulator circuit that is preventing the SCR from being gated on. Check all components on PW600, the regulator board.

If, on the other hand, there is collector voltage, we have to troubleshoot the oscillator/output system shown in Fig. 4. Looking at that figure, we see that the oscillator depends on two run voltages—27 and 22. But we need only to supply the 27 volts at terminal N; the other voltage is supplied by Q3035. That 27 volts is supplied once again either with the DC supply or four six-volt lantern batteries in series; the negative connection from the supply or batteries is made to the chassis.

Once more we use the Variac and scope to go through the system. One CTC97 we saw required just about every technique mentioned so far to track down what was making the output transistor run so hot. With a jumper across the SCR, and four batteries running the oscillator, one after the other each part had to be patiently lifted until the cause of the problem was found. That may seem like an unprofessional way to go about things, but with complex closed-loop circuits like those, scope measurements become almost useless; as such, lifting components is all that is left. In the set in Fig. 3, when C608 on the regulator board was unsoldered, high voltage crackled. Replacing that leaky capacitor cured everything.

Unsoldered wire

Some problems are harder to track down than others. We remember one CTC108 that gave us a particularly bad time (see Fig. 5). With the battery hooked up, there was a perfect signal coming out of the driver transformer. With no signs of anything being shorted, we decided to temporarily clip a new output transistor into the circuit. Happily, that seemed to cure the problem as the set came on.

Changing that transistor on that particular set was no easy matter as it was soldered in and mounted in a difficult position. You can understand the dismay, then, when the set didn't respond with the new transistor installed. The funny thing was that when the old transistor, the one that was thought to be bad, was clipped into the circuit along with the new one, everything worked once again.

If you've ever been stuck with an oddball situation like this one, you know how time can melt away. You also know that sometimes, after spending hours looking at the underside of the chassis, the answer suddenly becomes obvious.

That was the case here. We knew there was an oscillator signal, but was it reaching the transistor? Being mounted on the rear apron, both the base and the collector were returned to the chassis by wires (the emitter was grounded to the apron). The base wire went to the bottom of a hollow metal post that served as a test point. A loop of bare wire came out of the top of that post, passed through a ferrite bead, and then was soldered to the foil connecting the driver transformer. As it turned out, the looped wire was just sitting inside the metal post—it had never been soldered—so the base was getting no signal. Had the transistor been more accessible, and had the signal been traced through, that would have been just a routine repair. Instead, confusion reigned as it appeared as if two transistors were needed. Of course, that was not the case because the one soldered on the apron was never really in the circuit.

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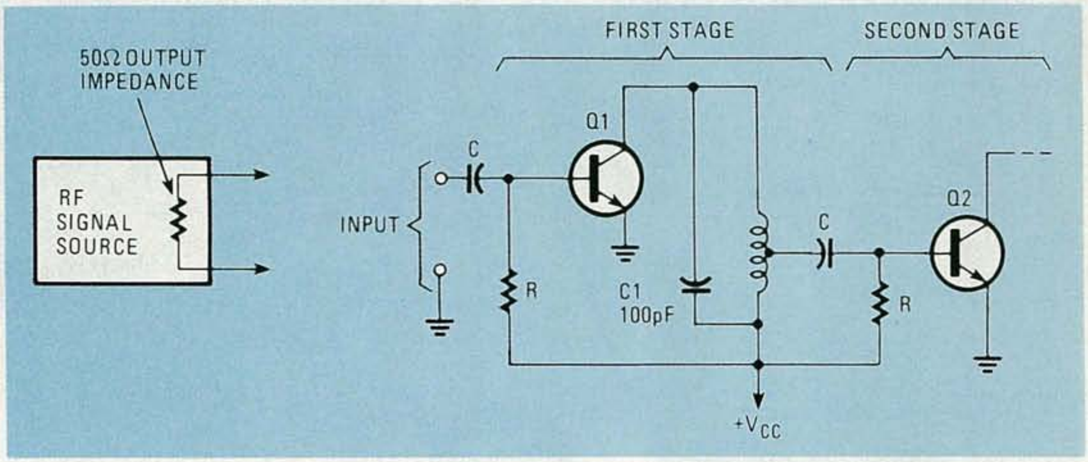

How to Design High Frequency Analog Circuits

MANNY HOROWITZ

Many factors that up to now could be ignored when designing a circuit become critical at high frequencies. This month, we'll look at those factors and the role they play in designing a successful circuit.

UP TO NOW, WE'VE BEEN DISCUSSING CIRcuits that operate at fairly low frequencies. As operating frequencies become higher, however, factors that were previously unimportant become critical. That's because the effects of stray capacitance, both of the components and the circuit itself, become more pronounced as the frequency increases. Thus, any successful design must take into consideration the selection of the components as well as their placement in the circuit.

Before we begin, let's review a couple of points. It was previously stated that a resonant circuit in an oscillator consists of a capacitor and an inductor. The capacitor in that circuit has a reactance, X_C, equal to $1/2\pi fC = 1/6.28fC$, where f is the frequency of the signal applied to the component and C is its capacitance in farads. Obviously then, as frequency increases the reactance of the capacitor is reduced. In the case of an inductor, however, its reactance, X_L, is equal to $6.28fL$, where L is the inductance in henrys; thus, the reactance increases with increasing frequency.

Figure of merit

Inductors and capacitors store energy. That energy is applied to those components when a voltage is placed across their terminals and a current is fed through them. If the capacitor or inductor were ideal, all of the energy stored in them would be returned to the circuit eventually regardless of the operating frequencies. Of course, the components we are dealing with are real, not ideal. They all have some element of resistance associated with them that causes losses. Consider, for instance, a capacitor. Under DC conditions that component is considered an open circuit with infinite resistance. That being the case, no current should get through. We all know, however, that some small leakage current almost always exists. The effect is the same as if a large valued resistor were in parallel with the capacitor as shown in Fig. 1. That figure illustrates the model used when analyzing the behavior of a real capacitor.

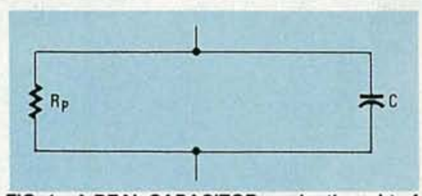

FIG. 1—A REAL CAPACITOR can be thought of as an ideal capacitor in parallel with a very large resistance.

Inductors, on the other hand, are treated as short circuits under DC conditions. Since they theoretically present no resistance, there should be no voltage drop across them. Of course, that is not

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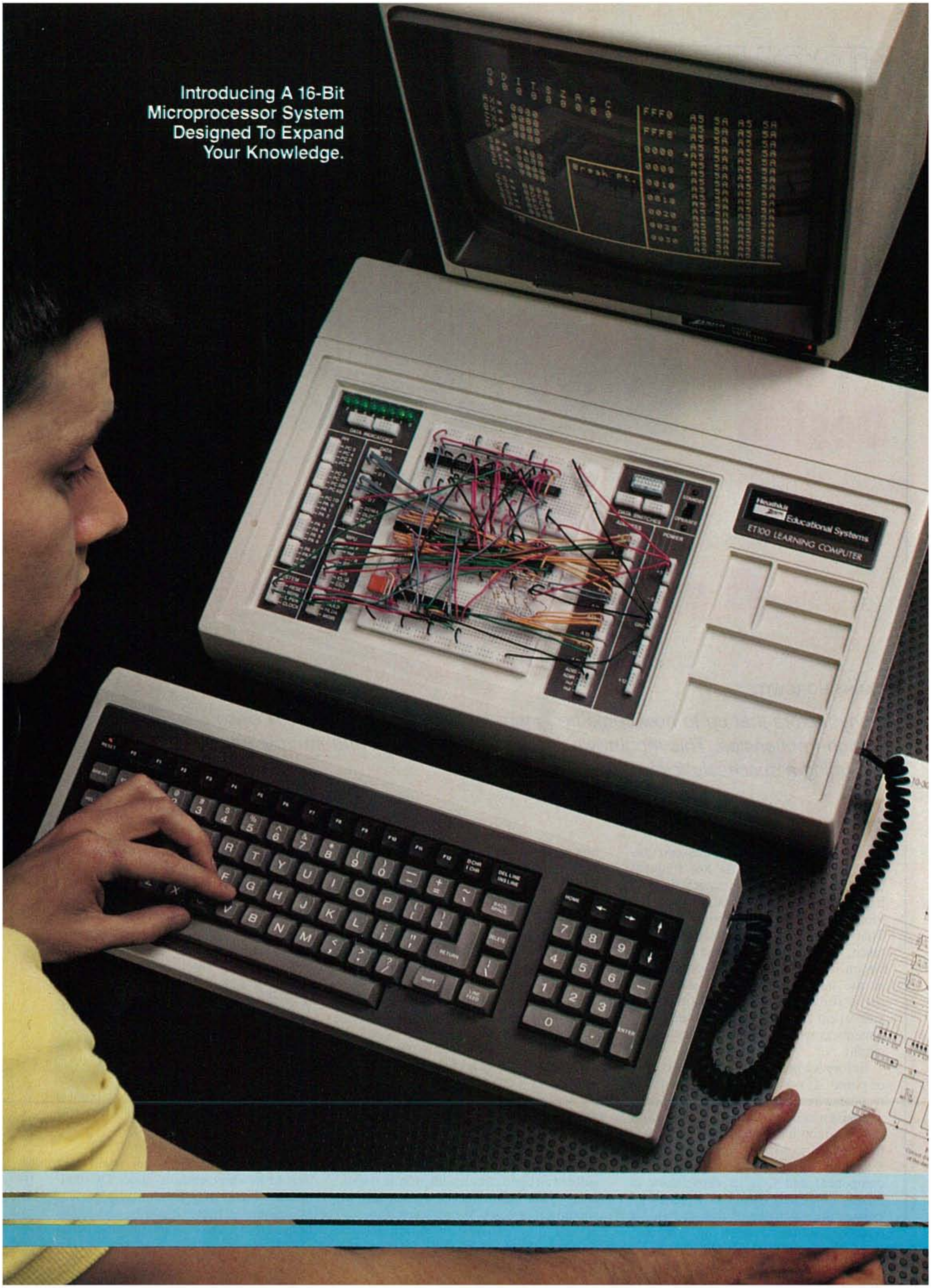

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what happens. There is a voltage drop that is caused by the resistance of the wire that makes up the inductor. Although that resistance is distributed along the length of the wire, the effect is the same as if that resistance were in series with an ideal inductor. That is the model used in analyzing the behavior of a real inductor and is shown in Fig. 2.

FIG. 2—A REAL INDUCTOR can be represented as an ideal inductor in series with a resistor.

When discussing such components, it is useful to know how close to ideal they are. To do that, a value Q, called the figure of merit, can be determined for each component. That value relates the amount of energy returned to the circuit to the amount of energy lost in the component due to its inherent resistance. A high value of Q indicates a more ideal component, and hence less loss than one with a low Q rating.

The Q of an indicator or capacitor is related to the reactance and series resistance of the component through the equation $Q = X/R_S$; and is related to the reactance and parallel resistance by $Q = R_P/S$. Thus (using the equivalent circuits shown), for an indicator, $Q = 6.28fL/R_S$, while for a capacitor it equals $6.28fCR_P$.

While we represented a real inductor as an inductance in series with a resistance, and a real capacitor as a capacitance in parallel with a resistance, those are not necessarily the only ways those components can be shown. For instance, there is no reason why an inductor could not be shown as an inductance in parallel with a resistance. After all, it is the same component so the impedance and the Q will be the same. When the way that the component is shown changes, the only thing that changes is the way in which Q is calculated. Instead of $6.28fL/R_S$, it is now found from $R_P/6.28fL$. But since the value of Q is identical, $6.28fL/R_S = R_P/6.28fL$. After rearranging the terms and simplifying, that equation yields the relationship $R_P = Q^2R_S$. That relationship also holds true for capacitors.

Dissipation factor

Instead of Q, the quality of a capacitor is frequently described by the dissipation factor, or DF. That is a quantity indicating a loss of energy, usually due to the conversion of that energy to heat and is equal to 1/Q. Thus, the quality of a capacitor is best when the dissipation factor is at a minimum.

Although most frequently used when specifying the quality of a capacitor, the dissipation factor can also be used to describe the quality of an inductor. Such use is rare, however.

Resonance

Inductors and capacitors are used to tune a circuit so that it is resonant at a specific frequency such that $X_L = X_C$. By substituting and rearranging terms it can be shown that that frequency, f_O, is equal to $1/6.28\sqrt{LC}$. Resonant circuits can take one of two forms: series or parallel. If the inductor and capacitor are in series, the circuit presents a low impedance at resonance. If the inductor and capacitor are in parallel, the circuit presents a high impedance at resonance.

Let's first consider a series L-C circuit, such as the one shown in Fig. 3. The current in any series circuit is the same through all the components in the circuit. In a series L-C circuit, however, the phase of the voltage across the capacitor is 90° ahead of the current through it, while the voltage across the inductor is 90° behind the current through that component. Thus, the voltages across those components are 180° out of phase. What that means is that when the reactive voltages are equal, the voltage across the capacitor will completely cancel the voltage across the inductor. That happens when $X_L = X_C$, which is the condition at resonance.

If the circuit were ideal, at resonance it would present zero inductance, zero reactance, and zero impedance. Real capacitors generally do resemble the ideal model and have negligible series resistance associated with them, but that is not the case with inductors. As previously mentioned, those components are coils of wire and as such generally have a substantial series resistance associated with them. Thus, since the resistance of the inductor can be drawn as a discrete component in series with it, Fig. 3 can be redrawn as shown in Fig. 4, where R_S is the series resistance of the inductor.

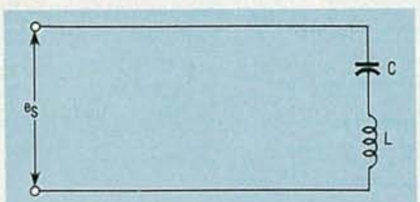

FIG. 3—A SERIES L-C CIRCUIT presents, in theory, zero impedance at resonance.

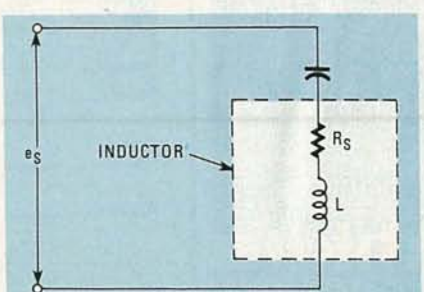

FIG. 4—TO ANALYZE a series L-C circuit's behavior, redraw the circuit as shown.

A parallel L-C circuit is shown in Fig. 5. In all parallel circuits, the voltage across each branch is identical. In a parallel L-C circuit however, the phase of the current leads the voltage by 90° in the capacitor, while the current lags the voltage by 90° in the inductor. At resonance, since the reactances are equal, whatever current is flowing upward in the capacitive branch of the circuit, is flowing downward in the inductive branch, and vice versa.

Let's examine what the importance of that is a little more closely. From Kirchoff's current law we know that the sum of the currents flowing into a junction of circuit branches must equal zero. Looking at the point labeled A in Fig. 5, we see that at resonance the same current flowing into it from one of the reactive elements is flowing out of it into the other. That means that there is no current drawn from the source, which means that the impedance presented by the circuit is infinite ($Z = e_S/I_S = e_S/0 = \infty$).

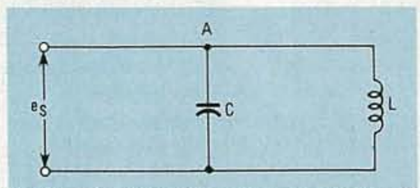

FIG. 5—AN IDEAL PARALLEL L-C CIRCUIT will present an infinite impedance at resonance.

That, of course, assumes ideal components. If those components were indeed ideal, and the source were disconnected, the current would flow back and forth between the reactive elements indefinitely. Of course, that never would happen because of the losses introduced by the series resistances of the components. Here, we once again can consider the series resistance of the capacitor to be negligible and concern ourselves just with the series resistance of the inductor. Thus, Fig. 5 can be redrawn as shown in Fig. 6, where R_S is the series resistance of the inductor.

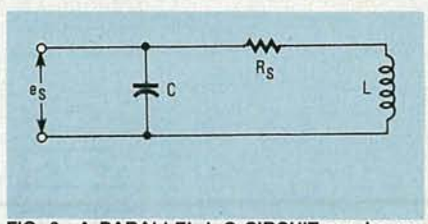

FIG. 6—A PARALLEL L-C CIRCUIT can be redrawn as shown here.

Before we go any farther, let's look at one other aspect of inductors that's important, especially when dealing with higher frequencies. As inductors are composed of turns of wire, stray capacitances can form between turns, whether or not they are adjacent; between the coil and ground; between the leads connected to the terminals of the coil, and so on. Thus, any inductor is in essence a large inductor in parallel with a very small capacitor. At lower frequencies, those *distributed capacitances* are rarely important, but at higher frequencies, they can make the inductor self resonant. That effect must be considered in high-frequency designs because if the signal frequency exceeds the inductors self-resonant frequency, that device will behave like a capacitor rather than an inductor. Thus, those distributed capacitances place an upper limit on the frequencies at which the inductor can be used. Self-resonance can also occur if the self-resonant frequency is a harmonic of the signal frequency.

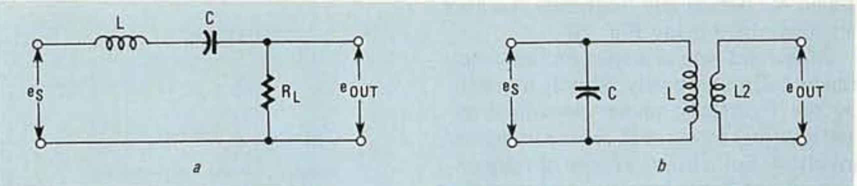

FIG. 7—TWO BANDPASS FILTERS. The one in *a* uses a series L-C circuit and presents a high impedance at all frequencies except the resonant one. The one in *b* uses a parallel L-C circuit; at resonance, only the resonant frequency appears across L.

Filters

Since series L-C circuits present a low impedance at the resonant frequency, but high impedance at others, they make excellent bandpass filters. Such an application is shown in Fig. 7-a. In it, the input signal e_S, is fed to a series L-C circuit. Assuming that the circuit is designed to be resonant at e_S's fundamental frequency, only that frequency will be passed; all other frequencies will be sharply attenuated. Finally, the signal appears across R_L as e_{OUT}.

In the circuit shown in Fig. 7-b, all frequencies except the resonant frequency are shorted by the L-C circuit. The resonant frequency, however, appears across L. From there it is coupled into L2 and on to the output. Ideally, only the resonant frequency should pass through those L-C circuits to the output. In most cases, however, a band of frequencies is passed. The width of that band can be determined from the circuit Q, and through use of a graph of the frequency response of a circuit similar to the one shown in Fig. 8. Looking at that curve, the maximum output of a circuit is e_{OUT}, and f_H and f_L are the −3-dB points. The bandwidth of the circuit, $f_H - f_L$, is equal to the resonant frequency divided by Q. Thus the bandwidth is inversely proportional to Q.

As an example, assume a circuit where C = 10pF, L = 25.4μH, and Q = 20. Using the equation for the resonant frequency, we find that f_O = 10 MHz. If Q = 20, $f_H - f_L$ = (10 MHz)/20 = 500 kHz. Because f_L should be the same distance below f_O as f_H is above that resonant frequency, f_L = 10 MHz − 250 kHz = 9.75 MHz, and f_H = 10 MHz + 250 kHz = 10.25 MHz. Signals with frequencies between 9.75 MHz and 10.25 MHz are passed rather easily by that circuit.

In many applications it is desirable to attenuate signals at frequencies below and above the active band. To achieve that, L-C circuits can be placed in series with the signal. The circuit shown in Fig. 9-a is a simple *low-pass filter*. It is called that because it will only pass frequencies less than a certain cut-off frequency, f_C. The values of L and C can be found from $L = R/4\pi f_C$ and $C = 1/4\pi f_C R$, where R is the impedance of the source and the load.

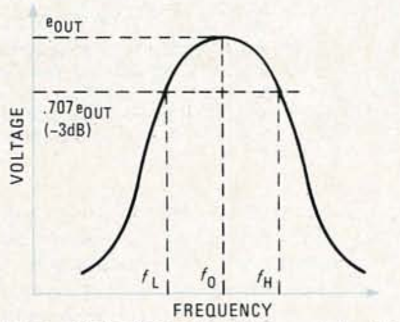

FIG. 8—THE LIMITS OF A BAND are defined by its upper and lower −3-dB points. Those are the frequencies at which the signal has dropped 3 dB from its level at resonance.

The circuit shown in Fig. 9-b is a simple *high-pass filter*. It will only pass frequencies that are higher than the cut-off frequency. The appropriate values of L and C can be found from $L = R/\pi f_C$ and $C = 1/\pi f_C R$.

Bipolar transistors

Inductors, capacitors, and resistors are not perfect components at high frequencies. We saw that an inductor has stray capacitances associated with it. Similarly, a capacitor has stray inductances. Resistors also exhibit some capacitance and inductance; some types of resistors cannot be used at high frequencies.

Such imperfections are not limited to passive components alone; transistors, for instance, exhibit stray capacitance between their terminals. Those capacitances are their primary imperfections when they are used at high frequencies. Because of that, many types of transistors can only be used in low-frequency circuits. On the other hand, some devices have been developed that are capable of operating in the high GHz range. We will start this part of our discussion by describing the use of bipolar devices in RF circuits and by noting how those devices limit the performance of those circuits. The discussion continues by describing how FET's behave under similar situations.

Alpha and beta

When describing a transistor's characteristics, and the effect of those characteristics on a circuit, the alpha and beta of the transistor were treated as constant values. The only deviation from the stated constants was to note how they varied with collector current. But alpha and beta also vary with frequency; they become smaller as the frequency becomes higher. As a result, the input impedance of a particular transistor circuit, equal approximately to βR_E, is much higher at low frequencies than at high ones.

If we consider α_O as the low-frequency current gain between the collector and emitter, α decreases 3 dB to .707 of α_O at what is referred to as the *alpha cutoff frequency*. Several symbols are used to denote that frequency, including f_α, f_{hbo}, and $f_{\alpha b}$. Once the frequency is determined from the transistor's specifications, α at any frequency can be determined using the curve in Fig. 10. At f_O, alpha is 1/1.4 of its specified low-frequency value; at $2f_O$, alpha is 1/2.24 of α_O, and at $4f_O$, alpha drops to ¼ of its low-frequency figure. From that frequency on, every time the frequency doubles, alpha drops by one-half. Thus at $8f_O$, or double the $4f_O$ frequency, alpha dropped from ¼ of α_O to ⅛ of α_O. That relationship remains constant on up to extremely high frequencies.

Since beta decreases at the same rate as

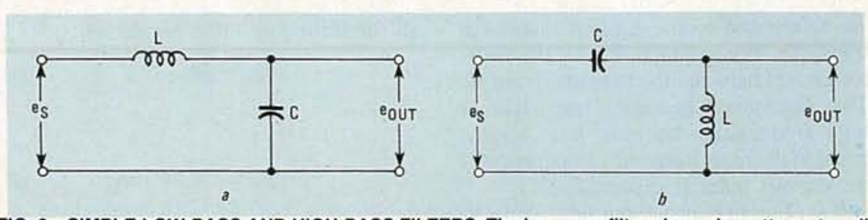

FIG. 9—SIMPLE LOW-PASS AND HIGH-PASS FILTERS. The low-pass filter shown in *a* attenuates all frequencies below the resonant one while the high-pass filter in *b* attenuates all frequencies below resonance.

alpha, the beta at any frequency can also be determined using Fig. 10.

Alpha and beta at a specific frequency can be calculated easily. Simply divide f_O by the frequency under consideration, and multiply by α_O or β_O of the transistor involved. For a limited range of frequencies, α and β can be estimated from the curve in Fig. 10.

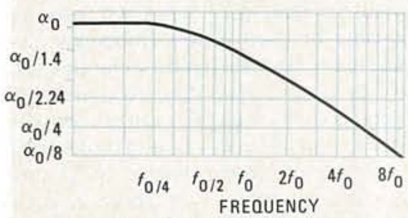

FIG. 10—HOW ALPHA VARIES with frequency. The value of beta varies in an identical manner.

Finally, the *gain-bandwidth product*, f_T, a value found on most transistor spec sheets, is useful in determining β at any operating frequency. That quantity, f_T, is defined as the product of beta and the upper 3-dB limit of a band. By simply considering the band here to stretch from 0 Hz to the operating frequency, it is possible to find beta by dividing f_T by the operating frequency. For example, if the f_T for a transistor is specified as 100 MHz, and you want to find the beta at 10 MHz, it is 100/10 = 10.

Equivalent circuits

At low frequencies, the equivalent circuit of a transistor was considered to be composed of two diodes. One diode, located between the base and collector terminals, was reverse biased. The second one, located between the base and emitter terminals, was forward biased. That circuit can be simplified farther by replacing the diodes with their internal on- and off-state resistances. The forward-biased diode could be replaced with a low value resistor connected from the base to the emitter, r_{be}, and the reverse-biased diode could be replaced with a large resistor connected between the base and collector, r_{ce}. There are, of course, also capacitances between the various terminals of the equivalent circuit. At low frequencies, those can be ignored; that, of course, is not true at high frequencies. An equivalent circuit including those capacitances, is shown in Fig. 11.

In that circuit, almost all components are referenced to b′, a point inside the transistor. For instance, $R_{bb'}$ is the resistor located between the base and point b′. That resistance becomes important at high frequencies because it is almost equal to the high-frequency impedance of the various internal capacitances.

It is obviously just about impossible to measure the various resistances and capacitances in the equivalent circuit be-

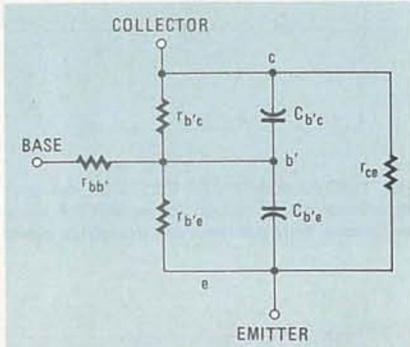

FIG. 11—EQUIVALENT CIRCUIT for a transistor in a common-collector configuration. The values of all the resistances and capacitances can be found using data on the device's specification sheet and readily measurable quantities.

cause those are all referred to a point inside the transistor. But their values can be estimated using either measurable or specified quantities. Those are g_m, β, h_{oe}, h_{re}, h_{ie}, and C_{ob}. All those factors, with the exception of g_m, can be found on most complete specification sheets. Let's look at them briefly.

The transconductance of a transistor, g_m, relates the collector current to the base-emitter voltage; in an FET it relates drain current to gate voltage. Transconductance is roughly equal to the quiescent collector current, in amperes, divided by 0.026.

Beta, of course, is the low-frequency current gain as specified by the manufacturer of the device. The no-load admittance seen when looking back into a transistor is h_{oe}. Since admittance is the inverse of resistance, the output resistance of the transistor is given by $1/h_{oe}$.

Consider two voltages. One, V1, is the voltage at the input due to voltage present at the output of the transistor. The other, V2, is the voltage at the output. The ratio V1/V2 is equal to h_{re}. That again assumes no load at the output. The impedance seen by looking into the input when the output is short circuited is called h_{ie}. The collector-to-base capacitance of a transistor's common-base equivalent circuit is C_{ob}.

All of the above parameters, with the exception of C_{ob}, are for a common-emitter circuit. If the specification sheets should list the h-factors for the common-base circuit, h_{ob}, h_{rb} and h_{ib}, rather than the h-factors for the common-emitter circuit as noted above, the common-base factors can be converted back to common-emitter parameters through use of the following three equations:

$$h_{oe} = \beta h_{ob} \quad (1)$$

$$h_{re} = \frac{h_{ie}h_{oe}}{\beta} + h_{rb} \quad (2)$$

$$h_{ie} = \beta h_{ib} \quad (3)$$

In each case, all factors should be altered to conform with the emitter current and collector-emitter voltage conditions under which the transistor is being used. Curves are usually supplied by the manufacturer of the device to help in that task. If no such curves are available, the data can be used as supplied but the circuit will have to be tweaked up once it is built. (More on that later.)

Using the h-factors, the values of the resistances and capacitances in the high-frequency equivalent circuit can be found from the following:

$$r_{bb}' = h_{ie} \quad (4)$$

$$r_{b'e} = \frac{\beta}{g_m} \quad (5)$$

$$r_{b'c} = \frac{r_{b'e}}{h_{re}} \quad (6)$$

$$r_{ce} = \frac{1}{(h_{oe} - g_m h_{re})} \quad (7)$$

$$C_{b'e} = \frac{g_m}{2\pi f_T} \quad (8)$$

$$C_{b'c} = C_{ob} \quad (9)$$

At low frequencies, the voltage gain can be found without resorting to complex mathematics. But like α and β, voltage gain drops at higher frequencies. The frequency at which the voltage gain has dropped to 1/1.414 of its low-frequency level (3 dB) is:

$$f_O = \frac{\beta + g_m(\beta R_E + r_{b'b} + R_S)}{2\pi\beta(C_T)(R_T)} \quad (10)$$

where:

$$C_T = (C_{b'e} + C_{b'c}g_mR_L + C_{b'c}g_mR_E)$$

$$R_T = (R_E + r_{bb'} + R_S)$$

In that equation, all factors, with the exception of R_E, R_L, and R_S, are found as shown above. As for the exceptions, R_E is the emitter resistor, R_L is the load resistance, and R_S is the resistance of the signal source. The gain of the device varies as shown in Fig. 10.

The above details apply to a common-emitter circuit. To find the high-frequency voltage gain of a transistor in a common-base or common-collector circuit, proceed as you would in a low-frequency situation, except use the values of α and β, and the effective load on the transistor, at the frequency in question.

Let's now apply what we've learned. Assume you have a 10-MHz signal source with an output impedance of 50 ohms.

That source is feeding a transistor in a common-emitter circuit. In order to get good gain, a transistor with a high f_T should be used. Use a 2N5354; it has an f_T of 250 MHz. In that transistor, C_{ob} = 8 pF, beta at low frequencies is 100, h_{ie} = 1300, $h_{oe} = 24 \times 10^{-6}$, and $h_{re} = 1.5 \times 10^{-4}$. If we assume that the idling current, I_E, is 2 mA (.002 amperes), then $g_m = 0.002/0.026 = 0.077$ mhos. We can use the common-emitter h-factors as supplied by the manufacturer without modification. The various components in the high-frequency equivalent circuit of the transistor are found by substituting into equations 4 through 9:

$r_{bb'}$ = 1300 ohms

$r_{b'e}$ = 100/0.077 = 1300 ohms

$r_{b'c} = 1300/1.5 \times 10^{-4}$
$= 870 \times 10^{-4}$ ohms

$r_{ce} = 1/[24 \times 10^{-6} - 0.077(1.5 \times 10^{-4})]$
= 28000 ohms

$C_{b'e} = 0.077/6.28(250 \times 10^6) = 49$ pF

$C_{b'c}$ = 8 pF

As for the load, assume there is a parallel resonant circuit in the collector circuit consisting of a 100-pF capacitor and a 2.5-μH inductor. The series resistance of the inductor is 0.2 ohms. That circuit resonates at 10 MHz. The Q is primarily equal to that of the inductor, which is $6.28fL/R_S = (6.28 \times 10^7)(2.5 \times 10^{-6})/2 = 80$. Thus the series resistor, when converted to the parallel resistance across the L-C circuit, is equal to $Q^2R_S = 80^2 \times 0.2 = 1280$ ohms. Because the impedance of the inductor cancels the impedance of the capacitor at resonance, R_L is equal to that parallel resistance. Use 1300 ohms as a close approximation.

This transistor performs well without a resistor in its emitter circuit so one will not be used here. Substituting all necessary information into equation 10 to determine f_O while letting R_E equal 0 gives us f_O = 283,419 Hz.

Use f_O = 250,000 Hz as an approximation for the calculated frequency. That means that the gain at 250 kHz is 1/1.414 of what it is at low frequencies (3 dB below the low frequency gain). At 500 kHz, the gain drops another 4 dB, and at 1 MHz the gain is another 5 dB down for a total drop in gain of 12 dB. From that frequency on, the voltage gain drops an additional 6 dB each time the frequency doubles, so that it is 18 dB down at 2 MHz, 24 dB down at 4 MHz, 30 dB down at 8 MHz, and a little more, about 32 dB, down at the 10 MHz we are concerned with. The 32 dB figure indicates that the gain at 10 Mhz is about 1/40 of the gain at low frequencies.

Considering that the only resistor in the emitter circuit is the r_e of the transistor, and that r_e is equal to 26/2 = 13 ohms when 2 mA of current flows through the device, the gain at low frequencies is R_L/13 = 1300/13 = 100. Because gain dropped to 1/40 of that at 10 MHz, the voltage gain of the overall circuit is 1/40 of that 100, or 2.5.

As the gain-bandwidth product equals 250 MHz, β at 10 MHz is equal to 250 MHz/10 MHz = 25. That is approximately equal to the current gain of the device at 10 MHz. Power gain is the product of the current and voltage gains at 10 MHz, or $2.5 \times 25 = 62.5$.

Those results must be tweaked-up in the amplifier after it has been built. There are many reasons for that. For one, approximations have be used in the design. Also, the various stray capacitances in the equivalent circuits of Q1 and Q2 were not considered. Although not shown in the equation, they do affect the resonant frequency and must be compensated for in the final design.

A basic schematic using two transistors and the components we've described here is shown in Fig. 12. In our design example, Q2 was not in the circuit, so that the complete load on the transistor was the L-C resonant tank. Should the L-C circuit feed another transistor as shown, its load should be considered to be in parallel with the calculated R_P of the tank. In the figure, the tap on the transformer is used to match the impedance of the resonant circuit to the impedance at the input of Q2. That is done to maximize the transfer of power from the first stage to the second stage.

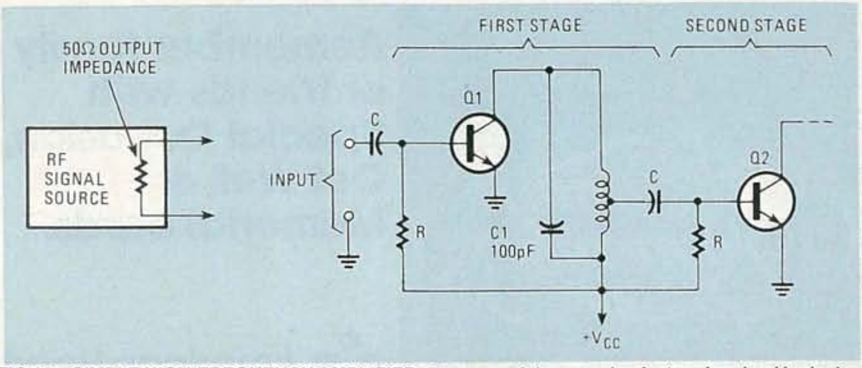

FIG 12—SIMPLE HIGH-FREQUENCY AMPLIFIER. Because of the complex factors involved in designing such a circuit, the values used for the various components will always differ from those initially calculated.

FET's

Practical circuits involving FET's do not differ radically from those using bipolar devices. There are differences, however. Because of an FET's high input impedance, the transistor does not contribute substantially to the load on a preceding stage but the various capacitances in the FET's equivalent circuit can effect the load. As for those loads, they are almost always resonant tank circuits so it's clear that those capacitances will change the tank's resonant frequency.

As an example, consider the circuit drawn in Fig. 13. For simplicity, we'll use the same values for L and C that were used in the previous example. Thus, L1 = 2.5 μH, C1 = 100 pF, and the parallel resistance is 1300 ohms; the tank, then, resonates at 10 MHz. The impedance of the source has no effect at high frequencies and is thus ignored.

We'll use a 2N5397 transistor here; it has excellent characteristics even at 450 MHz. That transistor's capacitance from the gate to the drain, C_{rss}, is specified as 1.3 pF. That capacitance added to the gate-to-source capacitance of the FET is specified as 5.5 pF. That sum is the C_{iss} of the device. The g_m of the transistor is about 7.5×10^{-3} ohms.

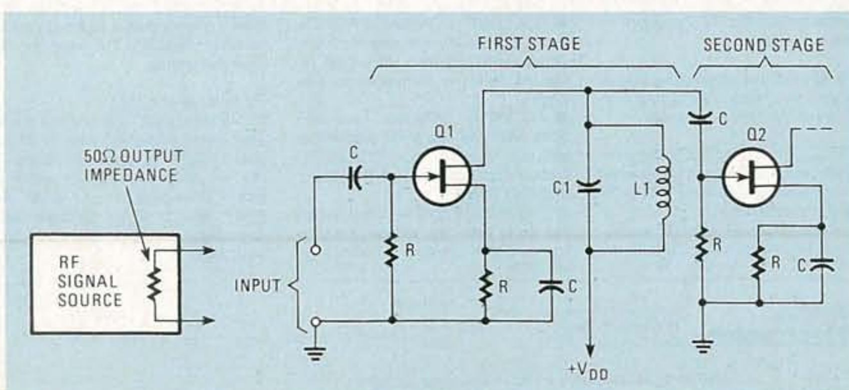

FIG. 13—PRACTICAL FET HIGH-FREQUENCY AMPLIFIER CIRCUITS do not differ greatly from those using bipolar devices.

Using this data, gain at low frequencies is g_mR_D or $(7.5 \times 10^{-3})(1300) = 9.75$. Voltage gain is 3 dB down at:

$$f_O = \frac{1}{6.28\,(R_D)(C_{ds} + C_{gd})}$$

In that equation, C_{gs}, the gate-to-drain capacitance, is equal to C_{rss}. Because C_{ds} is insignificant in JFET transistors, that factor can be ignored and:

$$f_O = \frac{1}{6.28\,(1300)(0 + 1.3 \times 10^{-12})} = 94\text{ MHz}$$

Because of that high cut-off frequency, voltage gain at 10 MHz is not reduced noticeably from its low-frequency value of 9.75. If the impedance of the signal source were comparable to the impedance of the circuit (which it is not), f_o would differ from the frequency just calculated. It would be

$$f_O = \frac{1}{6.28\,(R_S)\,(C_{iss} + g_m + R_DC_{gd})} = 175\text{ MHz}$$

Because f_O is at a much higher frequency in that case, the effect of the transistor on voltage gain would be even less then when the source was ignored. As for the effect of Q2 on the load of Q1, it is negligible because of its extremely high input impedance as previously noted.

Stability

RF circuits have a tendency to be unstable because of undesirable positive feedback from the output back to the input of a transistor. Oscillation caused by such feedback is eliminated through a technique called neutralization. In that, a capacitor feeds a signal from a circuit at the output of an amplifier stage back to its input. The signal through the capacitor is adjusted so that it is 180° out of phase with the feedback and at the same level. When that is done, the effects of the positive feedback are cancelled.

Filters

When working at high frequencies, a considerable number of factors in the circuit must be calculated. Even so, due to stray capacitances and inductances, as well as the fact that approximations are used in some steps in the design, the values of most of the capacitors and inductors must be adjusted after the circuit has been built. The same factors occur in high-frequency filter design. There, however, the technique of approximation and trimming is not satisfactory. Therefore, more precision is required. In the next part of this series, we'll look at what's involved, as well as at the design of different types of high-pass, low-pass, bandpass, and band-rejection filters. **R-E**

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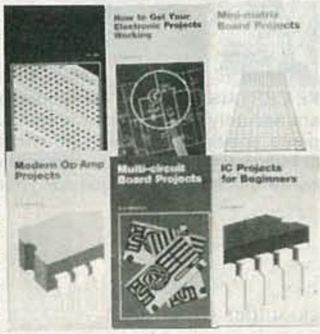

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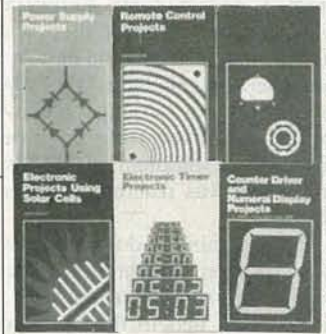

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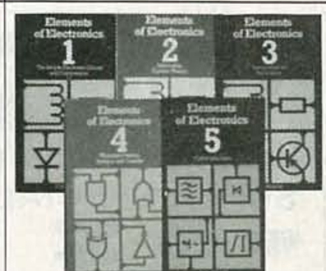

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continued from page 66

Of course, you don't just get one type of problem in a particular set. Consider another CTC108 with a completely different set of symptoms. In this instance, with the battery in place there was a signal, but a poor one that in no way resembled what was called for. Thus, there was obviously some sort of problem with the oscillator. But was it the circuit itself or was it some problem in the shutdown circuit that was reacting with the oscillator?

The first thing to do was to isolate the oscillator from the shutdown circuit. To do that, the shutdown transistor, which was directly tied to the oscillator, was lifted. But that had no effect and the signal was unchanged. All the oscillator/driver transisitors checked out as OK, so the next step was to take some resistance measurements. An unstable reading between the driver collector and ground finally led to the answer—a leaky 27-pF capacitor, C403, across the driver.

It's enough to make one wish for the "good old days!" **R-E**

TRANSIENT SUPPRESSOR

continued from page 58

The relay specified handles 10 amps, and all circuit wiring should, similarly, be capable of handling 10 amps. This means No. 14 wiring for all circuits associated with receptacle SO1. (The wires to the relay coil and the lamps can be No. 20, or No. 18.) Solid wire is recommended. You can obtain No.14 solid wire by purchasing a few feet of No. 14 Romex electrical-wire at your local hardware store and stripping off the outer skin. Under the skin will be two (or three) insulated No. 14 solid wires and a bare ground-wire. Save the bare wire for some future project.

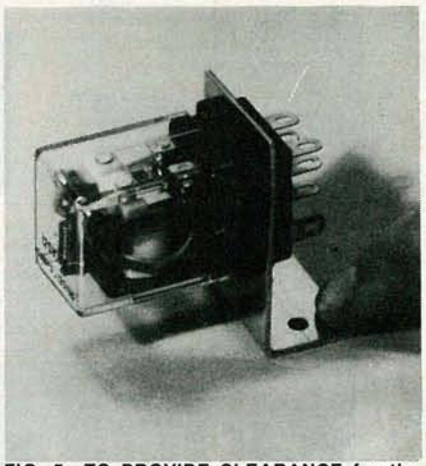

FIG. 5—TO PROVIDE CLEARANCE for the power-drop-out relay, mount it on an L-bracket made from scrap aluminum.

Receptacle SO1 must be of the three-pronged, grounded type. The particular unit you get may have screw or solder terminals, or may be prewired. If there are screw or solder terminals use your No. 14 wire. If the receptacle is prewired the wire is probably No. 12 stranded. Simply twist the free strands together tightly and tin them with solder. Take care to be sure you locate the correct "ground" terminal on SO1. If SO1 is prewired the wires will be color-coded red, black, and green. The green one is the ground wire, and is soldered to the ground lug on FL1. The power-line ground, also green, must be soldered to the filter's ground terminal, as well.

Neatness doesn't count

Insulated No. 14 wire is not the easiest material to work with. Usually, forming "square corner" bends will put undue strain on the associated components. Don't try to be extremely neat; bend the power wires in gentle arcs. There's plenty of room on the panel, so don't crowd the wiring. Bending No. 14 wire around a relay socket's solder lug is a sure way to break the lug, so lay the wire on the lug (use a clamp if necessary) and make a secure tack-solder connection.

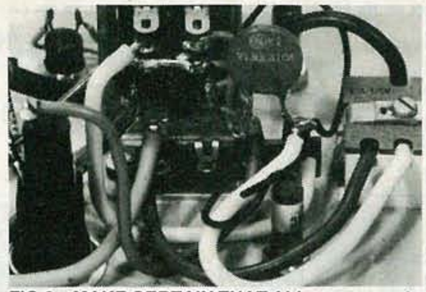

FIG 6—MAKE CERTAIN THAT ALL components and wires are securely soldered to a terminal. No components should "float," and no wires should have in-line splices. Such construction will help ensure glitch-free operation for your computer.

Use a 3AG fuse rated at 12 amps (*not* the "Slo-Blo" type) for F1. If you can't get a 12-amp one, a 10-amp fuse will do. We have never run across a varistor's protection fuse that opened, or a "shorted" varistor, but since the possibility exists that it can happen, don't eliminate F1.

Checkout

Measure the resistance across the line cord's terminals with an ohmmeter. It should be "infinite," even though the RF filter's schematic, printed on the filter's case, shows a resistance across the input terminals.

Check the resistance across SO1's output connections; it should also be "infinite." If not, check the connections to the varistor.

Check the resistance from both sides of the line-cord plug's prongs, and SO1 to ground. It too should be "infinite;" if not, there is a wiring error.

If everything checks out up to this point, connect the unit to the power line. Nothing should happen. Next, press RESET switch S1. You should hear RY1 switch in and both NE1 and NE2 should light. If NE1 does not turn on, check RY1 for a wiring error. If NE1 turns on but NE2 does not, check the wiring of F1 and the varistor.

If both lamps turn on, the device should be OK. As a final check of the device's latching function, simply remove then restore power. To do that, simply plug a load such as a table lamp into SO1 and then cut power either by throwing a circuit breaker or pulling the device's plug. Restore power and if the lamp will not light the device is ready for use. Connect your computer system's main power-cord to SO1, or better yet, connect a power strip to the socket, and the computer and the disk drives to the strip. Your printer should then be plugged into the same socket that's used by the protection device. That ensures that any RF or glitch generated by turning the printer on must feed through the RF filter before reaching the varistor. That provides double protection, and you can never be too safe. **R-E**

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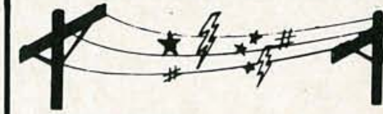

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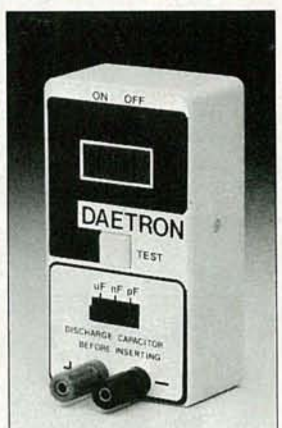

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VIC-20

NEW IDEAS

Protecting your car

HERE IS AN ALARM CIRCUIT FOR YOUR car that uses only one IC and is rather easy to build. But it still has many desirable features, including entrance- and exit-delay times, an auto reset control, automatic shutoff, and low power consumption. The schematic of the alarm is shown in Fig. 1.

First we'll look at the two switches, S1 and S2. Opening switch S1, which is a normally-open door-mounted switch, activates the alarm after an 8-second delay. However, if S2—a hidden switch inside the car—is closed within that 8-second delay time, the alarm will not be activated. That switch always takes priority over S1. Whenever it is closed, the alarm is off. Even when S2 is opened again, it still inhibits the alarm activation—but only for an additional 20 seconds. (That delay is determined by the combination of R4 and C3.) That's enough time to get out of the car and close the doors. Switch S2 can be a momentary normally-open switch, but you may prefer using a toggle switch. That way you can disable the alarm if you have to keep your car open for more than 20 seconds, such as when you are loading it with luggage.

Integrated circuit IC1 is a quad 2-input NAND Schmitt trigger. The output of IC1-c latches IC1-b to a high output state once switch S1 is opened. After that, only S2 can stop the alarm oscillator, IC1-d, from being triggered after the 8-second delay (determined by R9 and C6). That drives transistors Q1 and Q2, which switch the load (the coil of the horn relay, RY1) to ground. Thus the horn sounds intermittently. The maximum current that transistor Q2 can sink safely is about one amp.

After about 2 ½ minutes (controlled by the R7-C4 combination), which is called the alarm cycle time, IC1-b is unlatched when pin 6 goes high via C4. If S1 at that time is not open, pin 4 of IC1-b goes low and the alarm stops and is once again ready to receive triggering signals from S1. If S1 is still open, the alarm will continue to sound. Remember though, that S2 inhibits both the detection and activation of the alarm at any point of the cycle.

I used RCA IC's when building my alarm. If you substitute those of another manufacturer, you may have to adjust the values of the timing resistors and capacitors. Some experimentation may be required before everything works as it should.—*Ronald Ham-Pong*

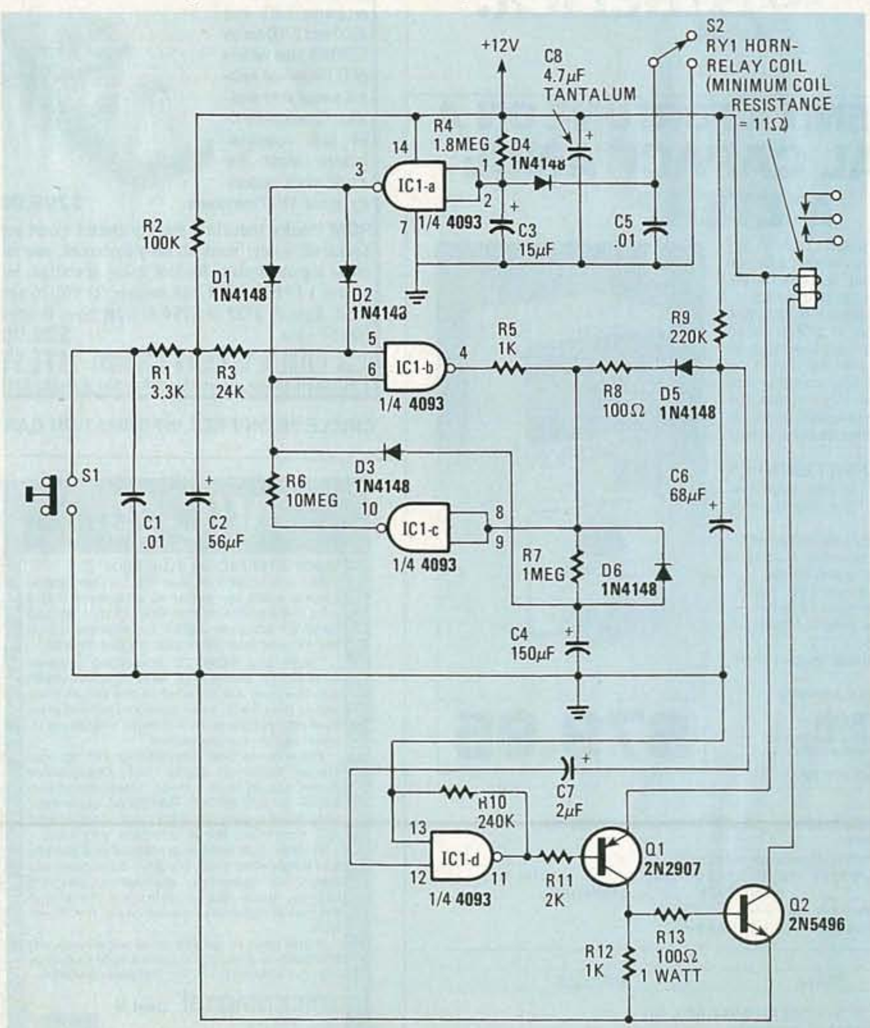

FIG. 1

NEW IDEAS

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MINI PLAYER-PIANO

continued from page 48

Pianomatic—the enabling of the keyboard display, IC6, the display counter, IC11, the TUNE SELECTOR switch, S5, and finally, the START switch, S4. Let's take a look at the last of those first and see how the Pianomatic operates when it plays a tune back from memory.

Playback

The circuit consisting of IC14-d, R3, and C-8 is a gated oscillator. By "gated oscillator" we mean that a high logic level turns it on, and a low turns it off. The Pianomatic has two modes of playback—AUTOMATIC and MANUAL. In MANUAL, switch S3-b puts +V on one side of the START switch, S4. The other side of the START switch is connected through resistor R2 to the control pin, pin 12, of the tempo clock, IC14-d. As long as the START switch is kept closed, the tempo clock will operate, be inverted by IC15-d, and, through D18, increment the note counter, IC3. That will sequentially address the memory in binary form, causing the tune to be played. When S4 is open, resistor R2 pulls pin 12 (IC14-d) low and the tempo clock stops.

The AUTOMATIC PLAYBACK mode is one of the nicest features of the Pianomatic. When the START switch, S4, is pressed, the Pianomatic reads out the data on the selected page of memory and stops. The interesting point of that is that it doesn't stop at the end of the page; it stops wherever you've programmed it to stop. We accomplish that piece of magical business by some creative gating and selective decoding. Let's now see exactly how that is done.

As we've seen before, when we're playing back from memory in MANUAL, S3-b puts +V on the C2 side of S4. As long as S4 is kept closed, IC14-d is enabled and the tune plays. In order to have the tune continue playing after S4 is released, we need some way of keeping IC14-d enabled. We do that by using the *b* half of the MANUAL/AUTOMATIC switch, S3-a. In the MANUAL position, the switch is connected to ground, but in the AUTOMATIC position it's connected to the output of IC14-b. The operation of that gate is the key to the automatic-playback feature of the Pianomatic.

The output of IC14-b is controlled by the voltages on pin 12 of IC14-d, the enabling pin of the tempo clock, and the output of AND gate IC9-a. That gate monitors the output-data bus and is set to decode a binary 15 (1111). In other words, the output of IC9-a will be low unless a binary 15 appears on the output-data bus. Let's assume that S3 is set on AUTOMATIC, the START switch, S4 hasn't been pressed, and that any number but 15 is on the output-data bus. Since the output of IC9-a is a low and pin 12 of IC14-d is low, the output of IC14-b will be high. That will bias D6 and disable the keyboard by making pin 23 of IC1 high. It will also forward bias D3 and slightly raise the voltage at pin 12 of IC14-d.

When S4 is pressed, IC14-d is enabled just as it was in MANUAL playback. In AUTOMATIC, however, releasing the switch won't disable the clock because the output of IC14-b remains high and doesn't let R2 pull the enabling pin low enough to stop the clock. Remember that IC14 is a Schmitt trigger, so there is a certain amount of hysteresis inherent in the device. Because of that, it takes more than a 50% voltage swing to make the gate change state. By choosing appropriate values for R2 and R4, we can take advantage of the "dead band" area of the Schmitt trigger. As long as we don't allow pin 12 of IC14 to drop below the trip voltage point, it will remain high and the clock will remain enabled. In manual playback, R2 was able to pull pin 12 low, but in AUTOMATIC, the high output of IC14-b raises the voltage just enough to prevent that from happening.

Even though pin 12 remains high, the output of IC14-b doesn't change because IC9-a is still presenting a low to the other input leg of the gate at pin 6. Let's suppose that a binary 15 appears on the output-data bus. That will be detected and decoded by IC9-a, and the output state of that IC will change to a high. Since a high signal is being presented to both legs of IC14-b, its output will change and it will go low. That will put a low at pin 12 of IC14-d, lower the voltage past the trip point, and disable the clock. Thus, when we are writing a tune into memory the last thing to put in the program is a binary 15. By doing that, playback will stop at that point in memory. A low at the output of IC14-b will be inverted by IC15-a and present a high to the reset pins of the note counter IC3. When a "stop" signal is present on the output data bus, therefore, not only will the Pianomatic stop playing, but the device will also reset itself to zero again.

In order to make the Pianomatic easier to use, there are several things that will make the note counter, IC3 reset to zero. A glance at the schematic will show you that there is a whole bunch of "Mickey Mouse logic" (M^2L) tied to the reset pin of IC3. That takes the form of diode-capacitor combinations that cause various switching of the Pianomatic's controls to put a positive pulse on the reset bus. Rather than go through all of it here, it's much easier to put it in table form; we've done that in Table 1. That table shows the actions and effects of the switches in the Pianomatic. In general, the only action that won't reset IC3 is going from READ to WRITE. That was done to make it easier to correct mistakes in programming a tune. If you single-step through a tune in MANUAL and come across a mistake, it's a simple matter to move the READ/WRITE switch, S2, to the WRITE position and program in the correct note...but we're getting ahead of ourselves. We'll completely discuss how to program the Pionomatic later in this article.

The other half of IC9 is used to decode a binary 14 (1110) when it appears on the output-data bus. That is done by using IC15-b to invert the least-significant line on the output-data bus. When a 14 appears on the bus, the output of IC9-b goes high, reverse biases D4, and force feeds a clock pulse to pin 9 of inverter IC15-d. That has the effect of speeding up the clock for as long as the 14 remains on the output-data bus. Since the clock increments the note counter, IC3, immediately, the next note is put on the bus and the output of IC9-b goes low again. That lets you program a temporary speedup in the clock and is used when you want a definite attack on a note or a half rest between notes.

Next time

When we continue, we'll finish up our look at how the Pianomatic works and then begin the construction. By the way, the project is built on five PC boards, two of which are double-sided. While the board patterns will appear in the next part of this article, you can order the boards from the source listed in the Parts List.

R-E

HOBBY CORNER

A few quick answers

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

THIS MONTH I WANT TO REDUCE THE SIZE of the pile of letters here. I'm going to try to look at as many of your comments, and try to answer as many questions, as possible. Of course, to do that, I'll answer only those questions that don't require going into too much detail.

We'll start with a letter from Tom Talley (OH). He included a couple of suggestions for improving the performance of the high-voltage generator we discussed in the February 1983 column. First, the relay coil and the transformer primary should be in parallel to give more punch to the output. Second, a small capacitor (around .001 μf) across the relay contacts will suppress arcing and make the contacts last longer. Tom knows whereof he speaks. As a lad of 10, he made and sold a couple of dozen to neighborhood farmers for use as cattle prods.

George Ovat (IA) wants to know how to build a negative-ion generator and he questions some of the claims about their benefits. Well, George, take a look at the "Hobby Corner" in the May 1981 issue of **Radio-Electronics**. Another ion generator was discussed in a feature article in the July 1981 issue. As far as their benefits go, why not build one and see if it does anything for you!

We discussed cassette-speed modifications in the May column. Dick Furnas (NY) offers a very simple method to slow the speed on most cassette recorders—a method that doesn't even require tearing into the machine. He points out that because the remote-control (on/off) jack is in series with the motor, it can be used for ready access to that circuit. So, without even opening the case, you can put a resistor or a potentiometer across a spare plug and simply insert it when you need it! The resistance value will be determined by the characteristics of the machine and, of course, the speed you want. Here again, experimentation is the key to finding the correct value for your needs.

Anthony Maunuis (CA) wants to know how to build a "Jacob's Ladder." That's the rising arc that you sometimes see in science fiction movies. Well, Tony, I don't want to get too specific because (1) those things can cause a nasty burn if you aren't very careful and (2) the radio and TV interference problems that they cause are no joke.

You mentioned the use of a flyback transformer and some tubes. Perhaps. I'll just point you in a couple of other possible directions and let you take it from there. Give a bit of thought to Tesla coils and to ignition transformers (the kind used in oil furnaces).

AN INVITATION

To better meet your needs, "Hobby Corner" has undergone a change in direction. It has been changed to a question-and-answer form. You are invited to send us questions about general electronics and its applications. We'll do what we can to come up with an answer or, at least, suggest where you might find one.

If you need a basic circuit for some purpose, or want to know how or why one works, let us know. We'll print those of greatest interest here in "Hobby Corner." Please keep in mind that we cannot become a circuit-design service for esoteric applications; circuits must be as general and as simple as possible. Please address your correspondence to:

Hobby Corner
Radio-Electronics
200 Park Ave. South
New York, NY 10003

Where's the zero?

The tricky question for this month is from Robert Bainbridge (NY). He asks how to determine the "zero" or base line in relation to voltages of various wave shapes. Well Bob, there are probably as many answers (or more) than there are types of waves!

In practice, the base or zero line can be anywhere you want it to. Rather than use the words "base" or "zero," let's call it the reference line. Using that name gives you an entirely new perspective on the question.

In Fig. 1 you see a single cell and a voltage divider. If you make your measurements in relation to point A, then both B and C will be negative *as far as the point-A reference is concerned.* Here, then, A is called the zero or base line. Relative to point C, A and B are positive and C is the zero line. Thus, the base line is *your choice*. If you chose A, then B is negative. If you chose C, then B is positive. It's up to you.

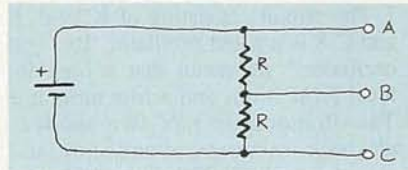

FIG. 1

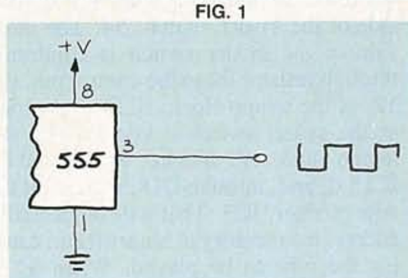

FIG. 2

The same logic applies in the case of waveforms. It all depends upon your reference point. For example, look at Fig. 2, which is a fragment of a 555 squarewave-oscillator circuit. When measured with respect to pin 8, the waveform varies from approximately zero to a negative value. Measured from pin 1, however, it varies from zero to a positive value. Asking which is which is like asking whether the chicken or the egg came first!

Of course, the accepted convention is to measure voltages from circuit ground but this is not always best.

Bob's second question had to do with how to determine whether or not a wave is inverted. Here, again, the answer is the same: it all depends upon your reference point, which would be another wave in this case. When measured against itself, it is not inverted, obviously. When measured against another wave, it can be inverted, non-inverted, or at any phase-angle. Take your choice, Bob.

Timer problems

William Schreiber (HI) is dissatisfied with the performance of the AC-powered timer he uses to control his nightlights. When he is away for a week or more, he frequently finds that the power company had problems in his absence. Of course, that causes his timer to be off schedule—even as much as having his lights turn on during the day and turn off at night!

Bill, you may have seen the versatile digital clock timer in the April "Hobby

Corner." There is no reason to assume that the clock must run from the AC line. The use of a battery operated clock would make the timing cycle completely independent of the power company's problems. Certainly, the AC lights would not come on during an power outage (neither would anyone else's) but, when power is restored, you would be on your schedule rather than on theirs.

Incidentally, it has always appeared to me that there is a fundamental inequity in my relationship with the power company. Actually, there are several, but Bill's problem relates to one of them. If, without notice, they cut my power in order to make some adjustment in their equipment, it's tough luck that I may have been inconvenienced. Example: such action can cause the loss of hours of computer work—especially when it causes part or all of a disk to "go west." On the other hand, just let me interfere with them and see what happens.

Gene Fisher (AR) wants to build a strong electromagnet for retrieving items that have been dropped overboard. There are several considerations in the design of such a magnet. For one thing, it should be waterproof. Even though it is safe to assume there is no salt water in Arizona, other chemicals in the water can have an effect.

The strength of an electromagnet is determined partially by its core but primarily by the number of turns of wire and the amount of current flowing through those turns. Because of that, an increase in the number of turns and/or in the amount of current will obviously create a stronger magnetic field.

The resistance of various types and sizes of wire can be found in any standard reference book. For example, 39 feet of 24-gauge copper wire has a resistance of one ohm, and one pound of it has a resistance of 21 ohms. Most reference books will also give you the approximate length of a wire that is wound on a core of given dimensions. With the information for the type of wire you are using and good old Ohm's law ($E = IR$), you can determine how much current will flow in a given coil.

So, Gene, you see that there is a kind of balancing act involved here: turns, current, and wire size. Of course, you must be concerned with overall weight and the current capability of the power supply you will be using. Unfortunately, I have been unable to find the relationship for all these factors and the number of pounds that a magnet will lift. Once again, it is a matter of experimentation to determine the optimum factors for your particular use.

Thanks for the interesting questions, gang. Be sure to keep them coming and don't forget that although we are especially glad to receive questions from you, suggestions and comments are also always appreciated. **R-E**

THE DRAWING BOARD

Successful designing and breadboarding

ROBERT GROSSBLATT

JUST ABOUT EVERYONE IS FAMILIAR WITH Zeno's story about Achilles' race with the tortoise. But for those of you out there who *don't* remember the story, it goes something like this: Achilles and a tortoise decided to have a race. Since Achilles was the Jesse Owens of his day and the tortoise even slower than an apology, they gave Achilles a handicap by letting the tortoise have a fifty-foot head start. (It was only fifty feet because even ancient bookies didn't like to take chances.) On the day of the race, the tortoise moved up fifty feet, Achilles laced up his sneakers, the gun went off, and so did Achilles.

Here's the twist: Every time Achilles covered half the distance to the tortoise, he still had half the remaining distance to go. And, according to Zeno, since time and space are infinitely divisible, Achilles never even passed the tortoise, much less got to the finish line. What Zeno didn't tell us was that even though Achilles never passed the tortoise, when he got close to him, he caught him, cooked him, and ate him.

Believe it or not, there's a valuable lesson to be learned from that story for all of us who like to design our own equipment. Culinary tastes aside, the moral of the story is really that even though you may not be able to get there, you can get close enough for all practical purposes—never mind what the mathematicians tell you!

Paper and the real world

In a nutshell (which is where all valuable lessons are to be found), there's a big difference between brainwork and boardwork. Things that work out perfectly well on paper have a nasty habit of blowing up when you build them. Sometimes it's because you overlooked something in designing them, and sometimes it's because you messed up in building them, but most of the time it's just because we live in the real world. Formulas, graphs, and tables of values stretched out to endless significant figures can lull you into thinking that the same sort of precision exists here in the real world. It doesn't.

Not only do unexpected things crop up when you start breadboarding, but even before that. The final paperwork often turns out to be the result of compromises and approximations. The difference between the words "standard value" and "calculated value" is what keeps the variable-resistor and -capacitor manufacturers prosperous and smiling. I challenge you to take any design problem and solve it using only standard-value components. That's only one example of how things on paper differ from things in the real world.

One of the magic moments in life comes when power is first applied to the first breadboard version of an original circuit design. Since it never works the first time around, the first thing to do, obviously, is to check the breadboard against the paperwork. Let's assume everything checks out. Now, the problem can only be in one of two places: the physical devices or the original design. I'm going to show you how you can cut the amount of your troubleshooting by as much as fifty percent, and maybe even more.

Using the right parts

Creating a completely workable electronic system is a difficult job any way you look at it—no matter what you want it to do. Even a fairly simple design-goal can involve some rather complicated circuit parameters. What you should be aiming for is a method that makes your life as simple as possible. One way to do that is to make sure that the components you're using in the breadboard circuit are all 100% functional.

Anyone who breadboards circuits using "junkbox" parts is asking for trouble. Those components are available all over the place—unmarked IC's ("you test 'em...we don't have the time") and surplus boards loaded with everything imaginable except an explanation. As far as the former is concerned, if their time is too valuable why should yours be any less so? And surplus boards hardly ever have socketed IC's. Removing one of those non-socketed packages safely is something like trying to fix a lightbulb. I suppose it's possible, but since you can get a new one for thirty-nine cents, why bother? Anyway, the chances are that you're going to destroy the IC as you remove it.

In a circuit design that calls for loads of IC's I don't think you'll save more than a

TABLE 1

American Microsystems 3800 Homestead Rd. Santa Clara, CA 95051	**Motorola Semiconductor** Box 20912 Phoenix, AZ 85036
Exar Integrated Systems, Inc. 750 Palomar Avenue, PO Box 62229 Sunnyvale, CA 94088	**National Semiconductor** 2900 Semiconductor Drive Santa Clara, CA 95051
Fairchild Semiconductor 313 Fairchild Avenue Mountainview, CA 94040	**RCA** Box 3200 Somerville, NJ 08876
General Instrument Corporation 600 W. John Street Hicksville, NY 11802	**Signetics** 811 East Arques Avenue Sunnyvale, CA 94086
Gould Batteries 931 Vandalia St. Paul, MN 55114	**Solid State Scientific** Montgomeryville Industrial Park Montgomeryville, PA 18936
Intel Corporation 3065 Bowers Avenue Santa Clara, CA 95051	**Sprague Electric Company** Semiconductor Division 115 Northeast Cutoff Worchester, MA 01606
Intersil, Inc. 10710 N. Tantau Avenue Cupertino, CA 95014	**Texas Instruments** Box 5012 Dallas, TX 75222

few dollars by using surplus ones. Considering the price of IC's today, salvaging surplus ones isn't worth the bother unless you put a really low value on your time. I don't mean the time it will take to find and remove the components, either. You're going to spend a lot of time troubleshooting your circuit when it doesn't work. And that's to say nothing of the damage a bad IC can do to the more expensive parts of your circuit. Blowing up a twenty-dollar memory because you used a bad surplus twenty-cent gate is, to say the least, ridiculous.

One of the least discussed linear qualities of digital IC's is their degree of "goodness." Although they basically operate with only high and low states, they can be 100-percent functional, pretty good, OK, pretty bad, or any degree in between. A surplus IC that tests OK may blow up in your circuit. That's because your testing probably won't make the exact demands on the IC that your circuit will. Internal diodes may be marginal, pass transistors may be degraded, and so on.

Another problem with surplus parts: A manufacturer may have made a seemingly standard part with different specifications to meet the particular requirements of a customer. For example, Radio Shack used what looked like a quad OR gate in the early version of the *TRS-80*. One of the gates wasn't used—because the chip had only three functional gates on it!

As I've said before, when you design your own equipment, you're the one responsible for the warranty. The key to making your bench time as productive as possible is to eliminate any possible source of error. Breadboarding with anything other than brand-new components is the best way I know to grow gray hair. As far as prototyping is concerned, junkbox components are just that—junk.

Data books

Successful original design is the result of three things: a clear bench, a clear mind, and a clear understanding. The first you get with a broom, the second with a brain, and the third with a stamp (your brain will help here too). Major component-manufacturers publish data sheets, application notes, and data books. (Figure 1 shows one such data manual from Signetics.) Those not only provide you with the operating parameters of the various devices, but they are loaded with suggestions and hints that can make your design work a lot easier.

Once you've decided what components you're likely to need in your design, find out who makes them and drop them a note requesting information. Chances are you'll get back a listing of the data sheets and application notes they have available. There's usually a nominal charge for those things, but the information that you'll get will save you all sorts of bench time. The application notes are

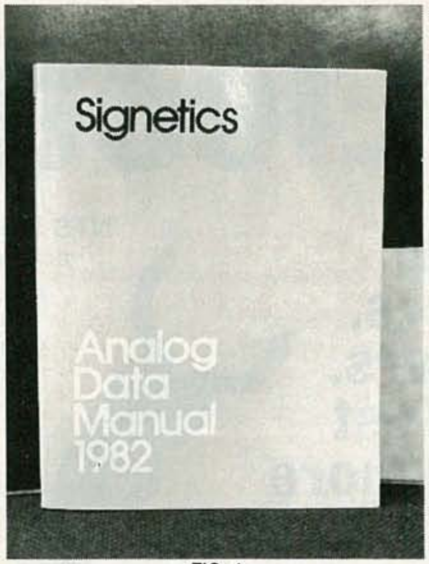

FIG. 1

particularly useful because they can give you ideas about how to begin your design. More often than not they'll suggest an approach to the problem that never occurred to you.

In Table 1 I've given you a list of some of the major manufacturers who publish data books. It's by no means an exhaustive list, but it's a good beginning.

Next month we'll be jumping into a discussion of counters—what kinds are available, how they differ, and, how and when to use them.

I should point out that I learn as much by writing these columns as you (I hope) learn by reading them. Since we both profit from them it's only fair to let you have a say in what we talk about. If you have a particular area of interest, let me know. If it's possible, we'll spend some time on it.

One final note: All the circuits we develop here are ones that I've at least breadboarded. If you take them farther or find problems, let me know. I'll pass the information along. **R-E**

"Next time you check resistance ranges around here, leave me out of it!"

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STATE OF SOLID STATE

Thermometer circuits and more

ROBERT F. SCOTT SEMICONDUCTOR EDITOR

IN THE AUGUST ISSUE OF **RADIO-ELECTRONICS,** we looked at the REF-01 and the REF-02 from PMI (1500 Space Park Drive, Santa Clara, CA 95050). Accurate thermometers, reading directly in °C or °F can be built using either device, a few external parts, and a voltmeter. Scales can be based on references such as 10 mV/°C, 100 mV/°C, or 10 mV/°F, and direct voltage-readings such as −0.55 volts at −55°C, 0 volts at 0°C, and +1.25 volts at +125°C.

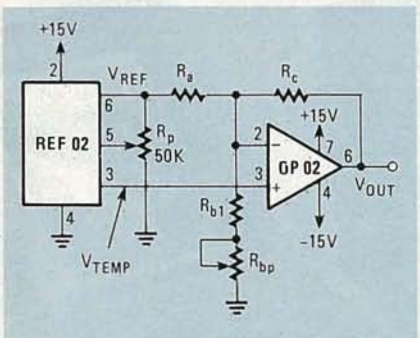


FIG. 1

Figure 1 shows a simple thermometer circuit that is built around the REF-02. The only additional components are an op-amp and three resistors. Those components, and the 5-volt output of the REF-02, scale and amplify the temperature-dependent V_{TEMP} to produce a usable V_{OUT} at the op-amp's output. That voltage output is determined from the equation:

$$V_{OUT} = \left(1 + \frac{R_c}{R_a \parallel R_b}\right) V_{TEMP} - \frac{R_c}{R_a}\left(V_{REF}\right)$$

where $R_a \parallel R_b$ is the parallel combination of R_a and R_b. The term enclosed in the parentheses is the circuit gain when V_{REF} equals zero. The term to the right of the parentheses is the circuit gain when V_{TEMP} equals zero. The slope, S, of the temperature-versus-output curve (TCV_{OUT}) is a factor of the value of the three resistors and is determined from:

$$S = 2.1 \text{ mV/°C} \left(1 + \frac{R_C}{R_a \parallel R_b}\right)$$

From the above equation, we can see that the ratio of R_c to $R_a \parallel R_b$ determines the slope of V_{OUT} and the ratio of R_c to R_a and V_{REF} determines the level of V_{OUT} at 25°C. Table 1 shows typical scaling-ratios for different values of V_{OUT}.

TABLE 1—TEMPERATURE SCALING RATIOS

V_{OUT} at 25°C (77°F)	TCV_{OUT} (Slope)	R_c/R_a	$R_c/R_a \parallel R_b$
250mV	10mV/°C	0.55	3.76
2.5V	100mV/°C	5.50	46.6
770mV	10mV/°F	0.926	7.57

V_{REF} = 5.000V, V_{TEMP} = 630mV at 25°C, TCV_{TEMP} = 2.1mV/°C

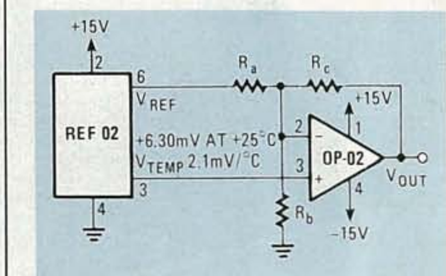


FIG. 2

TABLE 2—RESISTOR VALUES

TCV_{OUT} slope (S)	10mV/°C	100mV/°C	10mV/°F
Temperature range	−55° to +125°C	−55° to +125°C	−67°F to +257°F
Output voltage range	−0.55V to −1.25V	−5.5V to −12.5V*	−0.67V to +2.57V
Zero scale	0V at 0°C	0V at 0°C	0V at 0°F
R_a (±1% resistor)	9.09K	15K	8.25K
R_{b1} (±1% resistor)	1.5K	1.82K	1.0K
R_{bp} (potentiometer)	200Ω	500Ω	200Ω
R_c (±1% resistor)	5.11K	84.5K	7.5K

*For 125°C operation, the op amp output must be able to swing to +12.5V; increase V_{IN} to +18V from +15V if this is a problem.

A practical circuit—ready to drive a suitably calibrated voltmeter—is shown in Fig. 2. The 50K potentiometer, R_p, is used to adjust V_{REF} over a range of 5 volts ±300 mV to compensate for any error introduced by the circuit, and to permit precise calibration using 1% resistors. Resistor values are given in Table 2.

Detailed calibration instructions and performance specifications for the REF-02 when it is used as a temperature transducer can be found in PMI'S Application Note AN-18, "Temperature Applications of the REF-02."

Low-drain voltage-regulator IC's

The new Intersil (10710 Tantau Ave., Cupertino, CA 95014) ICL7663 and ICL7664 monolithic voltage regulators feature a maximum quiescent current (I_Q) of only 4 μA—1000 times better than a typical bipolar voltage-regulator. With a 1-mA load, the V_{IN}/V_{OUT} differential is only 50 mV. The low I_Q and low voltage differential make possible the use of smaller batteries and possibly allow longer battery life.

The devices handle operating loads ranging from 1 μA to 40 mA at from 1.6 to 16 volts. Output voltage is set by a two-resistor voltage divider—the only external components required. The ICL7663 is for positive voltages and the ICL7664 for negative voltages.

Slotted optocouplers

A series of six new slotted optocoupler/interrupter devices has been introduced by Motorola that are drop-in replacements for the GE H21 and H22 series. The devices, encapsulated in a molded plastic housing, consist of a gallium-arsenide infrared-emitting diode facing a silicon NPN phototransistor. The housing has a slot so that an opaque material such as a card, tape, or disc can be placed between the emitter and detector.

The Motorola MOC7811, -7812, and 7813 are flanged drop-in replacements for the H21A1, HA21A2, and HA21A3., respectively. Similarly, the MOC7821, -7822 and 7823 are non-flanged replacements for the H22A1, H22A2, and H22A3, respectively. Those devices are available through Motorola distributors.—**Motorola Semiconductor Products**, Opto Marketing, PO Box 20912, Phoenix, AZ 85036. **R-E**

NEW LITERATURE

For more details use the free information card inside the back cover

BROCHURE is 4-color, letter size, six pages and features three 4½-digit low-cost multimeters—two handheld and one benchtop unit.

The brochure contains full product descriptions, full specifications, and pricing and ordering information for all three instruments. Included are the model *8060A* and model *8062A* handheld DMM's—and the model *8050A* benchtop unit. The brochure is free upon request.—**John Fluke Mfg. Co., Inc.,** PO Box C9090, Everett WA 98206.

CIRCLE 111 ON FREE INFORMATION CARD

CATALOG, 2-color, 40 pages letter-size, describes a wide range of electronics components and supplies from AC adaptors to Zeners. Included are books, cases, drafting aids, enclosures, IC inserters, generators, jumpers, keyboards, LED displays, matrix program boards, meters, PC boards and breadboards, power supplies, resistors, sockets, switches, templates, terminal blocks, test clips, transistors, voltage regulators, and many others. Free upon request.—**Sintec Company,** Drawer Q, Milford, NJ 08848-9990.

CIRCLE 112 ON FREE INFORMATION CARD

AUDIO-ACCESSORIES CATALOG is 16 pages, 5½ × 8½ inches, glossy, listing many hard-to-find accessories. Included are stereo phones, anti-static mats, record and head cleaners, speaker mounts, low-mass cartridges, protective alarms, remote headphone controls, and cassette cabinets. Free upon request.—**Herrington,** 7265 Shadowbrook Dr., Kirtland, OH 44094.

CIRCLE 113 ON FREE INFORMATION CARD

PRODUCT-INFORMATION CATALOG is 38 pages, letter-size, on glossy paper, and deals with mobile top-loaded antennas, cordless-telephone antenna systems, CB base antennas, antenna-installation accessories, miniature speakers, monitor-scanning base antennas, complete antenna kits, and much more. Fully illustrated, it includes camera-ready advertising copy for use in catalogs, newspaper advertisements, etc. Free upon request.—**Firestick Antenna Company,** 2614 East Adams, Phoenix, AZ 85034-1495.

CIRCLE 114 ON FREE INFORMATION CARD

BROCHURE, 2 pages, describes a new "intermediate" line of wire cutters for the electronics industry. The wire cutters include such features as chrome vanadium tool steel, two types of cut (semi-flush and ultra-fine flush) color-coded handles, and precision screw joints.

All of the specifications describing sizes and cutting capacities, as well as a wide selection of handles (including static-dissipative) are included in this glossy technical brochure, free upon request.—**EREM Corporation,** PO Box 2909, Torrance, CA 90509.

CIRCLE 115 ON FREE INFORMATION CARD

CIRCLE 38 ON FREE INFORMATION CARD

COMPUTER CORNER

Shopping for a word processor

LES SPINDLE*

WORD PROCESSING IS ONE OF THE MOST widespread—and most misunderstood—computer applications. Writers, secretaries, research reporters, scientists, doctors, lawyers—people in all types of professional endeavors—depend on processing text in one form or another as a part of their daily routines. Yet, those accustomed to old-fashioned typewriters are often skeptical about just how a word processor is better than their familiar IBM *Selectric*—at least until they try one.

Once they've been introduced to the flexibility, the ease-of-use, and the versatility of a good word-processing program, they are apt to have second thoughts. When they discover that many modern word-processing programs also serve as grammarians, spelling experts, and synonym and antonym authorities—even reference sources—they are likely to junk the old typewriter for good.

Word processing allows more than simply editing and revising text. It also makes possible the quick recall of stored text, manipulation of text from various files, and integration of office records with letters or other important documents. Professional writers probably stand to benefit the most from this versatile tool, but its value for a multitude of personal and business applications can't be overstated.

TABLE 1—SOME SAMPLE WORD-PROCESSING PROGRAMS

Manufacturer	Product name	Price*	System Requirements
Aspen Software Box 339-A Tijeras, NM 87059	Grammatik (grammar checker)	$75	TRS-80 I, II, III; CP/M; IBM PC
C.E. Software 238 Exchange St. Chicopee, MA 01013	Letter Writer II	$20	Atari 400 and 800
Hayden Software 600 Suffolk St. Lowell, MA 01853	Pie Writer	$150	Apple II
Howe Software 14 Lexington Road New City, NY 10956	TYPITALL	$129.95	TRS-80 Model I and III
Liftetree Software 177 Webster, Ste. 342 Monterey, CA 93940	Volkswriter	$195	IBM PC
MicroPro 33 San Pablo Ave. San Rafael, CA 93940	WordStar	$495 (spelling option is extra)	CP/M, IBM PC
Oasis Systems 2765 Reynard Way San Diego, CA 92103	The Word+ (proofreader)	$150	CP/M
On Line Systems 36575 Mudge Ranch Road Coarsegold, CA 93614	Screen Writer II	$130	Apple II Plus
Peachtree Software 3445 Peachtree Rd., N.E. Altanta, GA 30326	PeachText (formerly Magic Wand)	$500	CP/M

*Accurate at press time; check with manufacturer for most up-to-date information.

FIG. 1

What to look for

What are the primary features that you should look for in a word-processing program? First of all, let's assume that you have decided against investing $12,000 or more for a dedicated word-processing hardware/software system (such as a Xerox *860*, or a Wang or Lanier system), and want a program that will run on your desktop computer—the same computer that you use daily for accounting, filing, and other purposes. For large offices, or highly demanding word-processing applications, the dedicated units are feasible but many users will want to invest in a microcomputer that can perform many tasks besides word processing. Let's take a look at some of the criteria to keep in mind when seeking the package most appropriate for your needs.

A good place to start your evaluation is with the instructions provided with the program. Many word processors, such as *Select* (Select Information Systems, 919 Sir Francis Drake Blvd., Kentfield, CA 94904), are extremely user-friendly, with extensive on-screen tutorials to guide the novice until he is familiar enough to use the program without assistance. *WordStar* (MicroPro, 33 San Pablo Ave., San Rafael, CA 93940) offers the user a choice of several levels of "help" menus, depending upon his level of experience with the program.

If the program will be used by beginners, it would be wise to ask a salesperson to demonstrate for you the thoroughness of its menus and tutorial sections. If that form of prompting is not particularly important to you, it is still a good idea to check the manuals supplied with the program to make sure that a comprehensive run-down is provided of the various commands and modes of operation available.

*Managing Editor, *Interface Age* magazine

Even an experienced word-processor user will have difficulties working with a program if its workings are not clearly spelled out.

Another important selection criterion is the relationship between what you see on the terminal screen and what will ultimately appear on the printed page. Some users only feel comfortable with programs that attempt to make the text on the screen resemble the final output. Several programs are designed with such users in mind. The other school of thought seems to feel that this method is ultimately more confusing, since such subtleties as boldface type and proportional spacing cannot be depicted accurately on the screen. Test a variety of programs as you shop to discover what type of display is most comfortable for you to work with.

Another useful feature for those who need to visualize page formats is a marker that sits at the top of the screen indicating where you are on the page (by line and column) and/or tab settings. That will be helpful in manipulating text if you need to place copy at various spots on the page. An additional feature found on many programs is an automatic-centering command that makes the placement of subheads, titles, etc. very simple.

One function to keep in mind is the program's ability to append or insert text to the document you are preparing from other files on the disk. If you are printing out late-payment notices, for example, and wish to insert the same standard wording in every one, along with other data that will differ on each statement, you want to be able to retrieve that data easily and be able to incorporate it where it belongs.

You will also want to check the "delete" functions that are included. Can you delete a word at a time? A paragraph? A line? How much flexibility is there for removing various portions of the text?

If you are creating a document that requires multiple columns to be printed out, look for a word processor that permits that to be done. Standard business forms or newsletters might require such a format.

For accounting or scientific functions, some programs integrate computational functions with word processing. Columns and rows of figures can be automatically calculated and the result printed out after the figures are placed using normal text-entry procedures.

The flexibility in margin setting is one feature that will vary significantly from program to program. Can you set more than one margin for various sections within a single page? Can you have more than one setting that can be easily called forth at various times during the preparation of the document? Can you set tab positions? Those are key questions to ask in ascertaining whether or not the program will meet your requirements.

Does the program include automatic indexing or table-of-contents features? Some word processors do, or have compatible indexing programs that work with them. This is handy for writers.

The newest, most sophisticated capabilities, as mentioned earlier (spelling and grammar checkers, thesauruses, etc.) are often available only in separately-purchased programs (see Fig. 1). Some can be integrated with existing word processing programs; some not. Try to decide what you're going to want beforehand, and determine whether the auxilliary program(s) will work with the word processors that appeal to you.

Table 1 lists just a few of the many word-processing packages on the market. The wise shopper will examine a number of offerings until he finds the one that includes the greatest number of features he needs in his application. One word of caution: while the prices of seemingly similar products vary widely, so do their capabilities. The inclusion of some features that seem highly sophisticated at first glance may mean the lack of other features too important to be without. Before being tempted by what seems like a bargain, make sure that the program offers sufficient versatility to handle your needs. Take your time to pick the product that you find easiest to work with. **R-E**

COMMUNICATIONS CORNER

Phones are for more than talking.

HERB FRIEDMAN, COMMUNICATIONS EDITOR

ONE OF THE LATEST BUZZWORDS IS "high-tech"—meaning high technology. I dislike the term because it connotes snobbery, as in "if it ain't high tech it ain't no good 'cause it ain't up to date."

Actually, high technology is a relative term. For example, schools don't even teach spark-gap transmitters any more ...who wants to know about that old stuff? In Marconi's day, however, spark gap was high tech. So was the Marconi antenna, and skip. (Did you ever stop to consider that if Marconi had picked some other month for his transatlantic experiments, or the frequency he'd used was closed at that hour, it might have taken the world some 20 years to stop laughing at someone silly enough to think he could transmit across the "big pond"?)

But high technology does tend to sneak up on us, and because the field of electronics is so fragmented, we often have little idea of, or can't keep up with, the spectacular developments in specific areas of interest. We're going to talk about one such rapidly developing area—that of signalling telephone-equipment.

Telephone control

It seems that almost weekly some new service is announced that uses *Touch-Tone* or DTMF (*D*ual-*T*one *M*ulti-*F*requency) signals to make it work. We have recently covered the special low-cost telephone services (such as Sprint and MCI—see the July 1983 issue of **Radio-Electronics**) that provide reasonably inexpensive long-distance service from your local phone—providing you have some form of *Touch-Tone* signalling device to control their computer(s).

Well, the same signalling methods can be used to control the computer or telephone-answering machine back at the office. They can also be used to turn on the air conditioner before you get home, to key a sensitive telephone amplifier to check the kids while you're away for the evening, or to do any of a hundred other things. Combine a microprocessor (computer) with the *Touch-Tone* signaling and you can accomplish just about anything using the telephone system.

However, not everyone has *Touch-Tone* service—mainly because that service usually is more expensive. And why pay for it just to key your gadgets?

Up until very recently, the standard way to be certain you had *Touch-Tones* available when you needed them was to carry around a small keypad device that generated the tones directly into a telephone handset. You dialed on the rotary (dial) telephone, held the tone device over the mouthpiece (transmitter), and when you heard the answer signal you beeped the keypad.

FIG. 1

Now, all that is great for a few tones, but what do you do when it can take up to 26 individual tones to place a Sprint call, turn on an air conditioner, or access a computer? Right! You use a computerized keypad "dialer," one with lots of non-volatile (permanent) memory; the kind of device just starting to make its way into the local general stores. Who needs them, you ask? Isn't that the same question you asked last year about personal computers?

To date, the most convenient way I've seen to provide relatively massive memory, automatic dialing, and a host of other computerized telephone functions is the *SoftTouch* auto dialer, a device that substitutes for the existing telephone

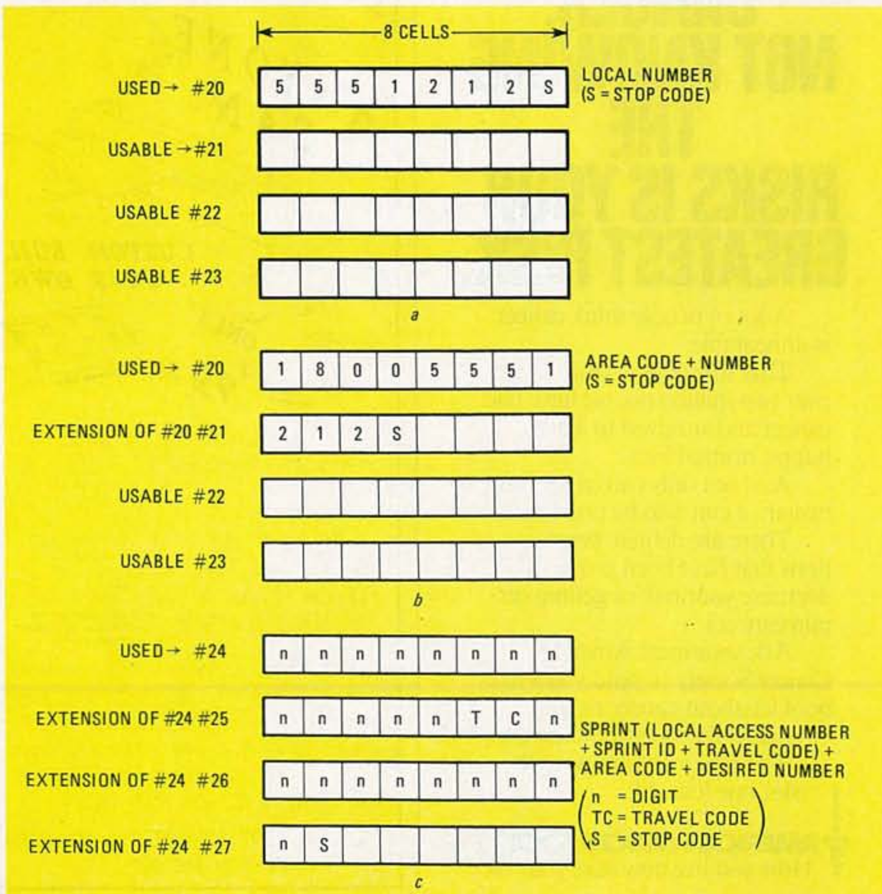


FIG. 2

transmitter (mouthpiece). We've had devices in the past that replaced the transmitter with a combination microphone and tone pad, but adding memory is a different ballgame. We looked at that auto dialer briefly in July's column. Now, we'll take a closer look.

The *SoftTouch 83* from Buscom Systems, Inc. (4700 Patrick Henry Drive, Santa Clara, CA 95050) is shown in Fig. 1. (It sells for about $90, but there are models with less memory that are less expensive.) It is powered by the telephone line but it is backed up by lithium batteries. (There is nothing more frustrating than losing the contents of a device's memory because of an interruption in power.) What happens when you have to replace the batteries? Do you lose all the memory programming? No! When the handset is off the hook the telephone line voltage is applied to the memory; if that's when you change the batteries, you'll save the programming.

But the most important feature of the *83* is its flexibility. When you make a local call, a long distance call, or a call using a service such as Sprint, you are going to be using tone-groups of different lengths. The *Soft-Touch* AutoDialer, uses a convenient and practical technique—one that is certain to be copied by others.

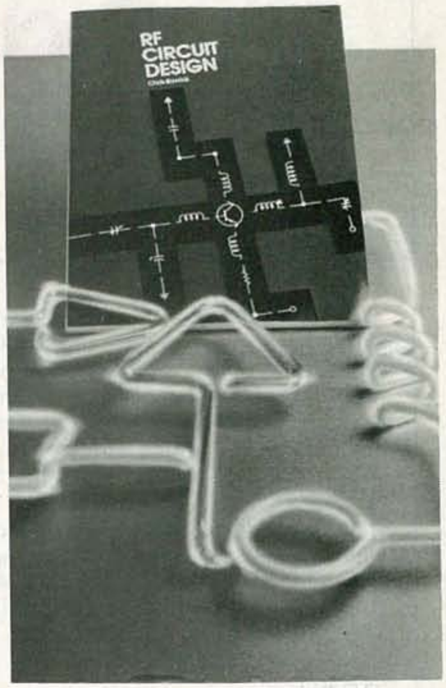
Figure 2 shows how it's done. The autodialer has 80 stackable memories numbered from 20 through 99. Each memory holds 8 characters, but they can be strung together to hold any size number (up to 640 characters). Two additional memories of 16 characters (which can also be strung together) are also included. Keying any memory number causes a complete tone-sequence of any needed length to be transmitted.

Each numbered memory has 8 cells, and each entry must be terminated by a "stop" command. If your number plus the stop fits into the 8 cells, the single memory is used for the information. For example, if memory no. 20 uses 8 or less cells, the no. 21 memory can be used for a different entry. But if the number plus the stop require more than 8 cells, you can simply get the required number of cells—the number automatically spills into the next memory. For example, one call might require a dialing sequence of 1-800-555-1212S (S for stop). That's 12 digits. When you enter the sequence it simply uses as much memory as it needs. When you punch up the no. 20 memory, the correct tone sequence will be transmitted. But the next usable memory is now 22 because 21 has been linked to 20.

Let's carry this further. We'll examine a Sprint call using *Touch-Tone* for local telephone access. The local access number could, of course, be rotary-dialed, but we'll make the whole dialing procedure automatic. Also, we'll presume that the two 16-digit memories are already full. Under the most favorable conditions the dialing sequence for the Sprint call will be: nnn-nnnn-nnnnnn-nnn-nnn-nnnnS. That's 24 digits; it will just fit into 3 memories. But assume you're out of your local area and are using a travel code (TC). That adds two more units and the sequence becomes: nnn-nnnn-nnnnnnTC-nnn-nnn-nnnnS. Because that's 26 digits, 4 memories will be required. If the starting memory is no. 24, the next available memory will be no. 28. Memories 24 through 27 are used for one single (but long) sequence.

Of course, sequences can also be manually keyed. For example, assume that after you dial the 26 digits your computer answers and needs an 8-frequency access command. Well, you can place that sequence in another memory that you key when you hear your call answered by the computer. Or, you can use the standard keypad built into the device.

If you think you can handle it all manually, keep that 26-digit dialing sequence in the back of your mind. It's even more difficult than it sounds, particularly if you get a busy signal from the other end. As we are forced to memorize seemingly endless digit sequences to communicate with computers, etc., the pocket-sized telephone autodialer is certain to become as commonplace for business people as the ballpoint pen and car keys. **R-E**



SERVICE CLINIC

Opening your own shop

JACK DARR, SERVICE EDITOR

WE'VE BEEN GETTING QUITE A FEW LETters from young men who are learning electronics in the Armed Services and want to open their own shops when they get out. So, we decided to run a column dealing with it. I'm the staff expert on one-man shops (I've been running one for the last 50 years!), so I get to write it. There are a lot of things, all of them important, about opening your shop, and a lot of mistakes you can make. (I know, I've made them.) So, I may sound like the Dutch Uncle at times, but it's all based on actual experience! Let's start out with the shop itself

Location

Whether you settle in a small town or city, you should follow the same rules when trying to find a suitable location. Don't try to find one on the main street; rents are much higher there, and you really don't need "store traffic." Look for the secondary streets; a block or so off the main one. Rents are lower, and you are a service industry—people will look you up when they need you.

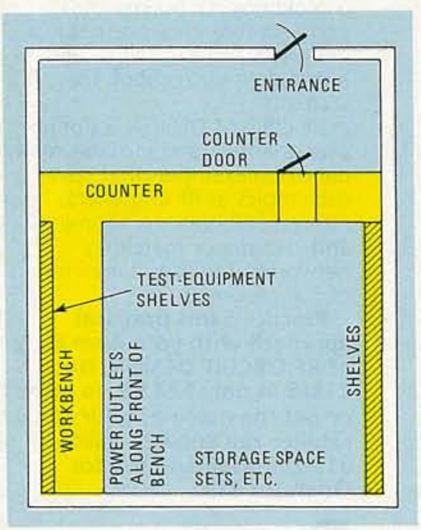


FIG. 1

Look for a fairly large room, with parking space in front or back. That will give you room to make a workbench, and a small place with a counter or railing to keep the customers off your neck while you're working (see Fig. 1). A back door on an alley is very handy; you can drive up there and unload sets quickly. Check the roof of the building, too; nothing's worse than a leaky roof!

The bench

Your bench is important. It should be big enough to hold the largest TV set you plan to service. Mine is four feet wide, with a shelf along the back to hold test equipment. Wire a string of outlets along the front of your bench, *not* the back. On the other side of the shop, build shelves for parts storage. That gives you the fastest way to operate; when you need a part, just turn around and get it. Parts should not be on the bench itself; they'll just get covered up. Make a small set of drawers under the middle of the bench for hand tools and other things. (I keep the most-used hand tools, long-nose, screwdriver, soldering iron, nut driver etc., at the right end of my bench. I'm right handed—they're right there when I need them.)

Test equipment

Now we come to the subject of the most-asked question: what test equipment you'll need. To me, the essential instruments are a good VOM (digital or analog), a scope (which doesn't have to be a triggered-sweep type—a good recurrent-sweep scope can do a good job). Next is a color-bar generator, with both RF and IF outputs. With the IF output, it becomes a tuner subber. With those, you can read any voltage or current, feed test signals into the set, and trace them through it with the scope. A transistor tester, preferably one with a good leakage test, can be very handy. Leaky transistors are responsible for a lot of problems. Other instruments can be added later as the need arises, but I think these are the essential ones, and will be the most-used.

Service data

Now we come to one really essential thing: service data on the TV sets. You've got to have that; modern TV sets simply can't be fixed without it. For one thing, you can't even find the parts! The two major sources for data are Sams *Photofacts* (Howard W. Sams & Co., Inc., Indianapolis, IN 46206), and the factory data from the maker. Personally, I like to have both. With the factory data, you usually get a newsletter, etc. which often has valuable hints on certain models.

The Sams folders come in small boxes each month; these can be stacked on shelves with the edge out, and you can locate any folder quickly; the numbers of the folders are printed on the edge. Filing cabinets can be added later. The Sams Index is an invaluable source of data. Keep it handy.

Parts data, on transistors, IC's, etc is another handy thing. All of the replacement-transistor makers put out big guides, with many, many types listed with their substitutes. Companies like RCA, GE, Sylvania, and many others have them; get all you can. I've had no problems at all in using such parts in place of originals, and in some cases they're better. You can get a starter stock of the most popular types and fix quite a number of sets out of it.

Getting the parts

I hate to tell you how easy it used to be to get parts! Many sets used standard parts, and you could stock them. Nowadays, it isn't easy at all. There are so many specialized parts that it gets rough at times. There are two major sources; the radio-TV supply houses, and the factory distributor for the make. Universal replacement parts come from the supply houses, and in many cases they stock factory parts for popular makes, as well. The distributor will have parts on hand; call him and introduce yourself, and make arrangements to get parts at discounts. They often have catalogues, etc. that are useful.

Several makers have hotlines, with a toll-free number, if you have problems getting parts. GE's number is 1-800-241-6696; Admiral's is 1-800-447-8361; Thordarson's (for flybacks and transformers) is 1-800-851-3583. Those numbers can be useful in emergencies.

If you're in a small town, there will be a radio-TV supply house in the nearest small city. They often have a salesman who calls on you once a week. If you need a part fast, you can call them and have them put it on the bus—you'll get it in a few hours. (Be sure to charge the customer for the long distance call and the freight!)

Here's a useful hint: Try to do most of your parts buying from only one firm. That will make your account much bigger, and they'll be very polite to you!

Spraying small orders all around won't get it. If you buy open-account you can often get a 2% cash discount by paying the bill before the 10th of the month. Check up on that. It doesn't sound like much but it really does help. R-E

SERVICE QUESTIONS

LOOSE YOKE

The deflection yoke on this Admiral 4M10 chassis is permanently bonded to the neck of the CRT—or at least it was until it became unbonded. The customer didn't want to spring for a new CRT/yoke. I am wondering if I should try to cement it back. What will happen to the convergence if I do?—W.L., Ozone Park, NY

Yes, you *should* try to cement it back on. An old trick I used to use on old CRT replacements is to put a cross-hatch pattern on the set and hold the yoke (carefully!) in place. Watch the pattern and move the yoke around until it's converged, and mark the places where the mounting pads are. Then move the yoke back and put cement where the pads were. Put the yoke into position again, watching the pattern, and hold it until the cement sets. (Any fast-setting epoxy will work well, probably better than the original "permanent" cement.) For temporary adjustments, put a bit of double-sided tape under each pad. That will hold everything while you fiddle with the adjustments.

HOT RESISTOR

In this Sears 529.72940, the color and the convergence are a little bit off. Resistor R26 on the convergence board is hot as a firecracker, but opening the coupling capacitor, C160, cools it down. My old instructors said that some heat should be expected here, but I don't think that the smoke should be! Any advice?—D.M., Huntsville, TX

I think I know what's wrong: a misadjustment of the blue shape coil. If you look at page 29 of the Sam's folder, you'll find the adjustment procedure. It's really quite simple. Adjust the coil until the waveform "hump" is where it should be and things will get much better.

POSITIVE GRID VOLTAGE

In this Philco 19FT00B, I not only have no high voltage, but the screen grid of the 6JS6 reads full B+ (294 volts) while the control grid is +50 volts instead of −74 volts. I've checked everything I can think of and I'm stuck.—J.J., Farmington, IA

Instant analysis: you're not going to get *anything* until you get that +50 volts off the 6JS6 grid! The tube is being driven far above its normal current. The B+ on the screen shows that the tube is drawing no current at all. It's evidently completely exhausted.

The positive grid-voltage could be due to a shorted coupling capacitor between the oscillator and the grid. I seem to remember other letters on this same chassis with the same complaint. Check to see if the oscillator is running. The oscillator grid should read −34 volts if it is running, and the plate should read +180 volts.

LOOK AT THOSE WAVEFORMS!

I wrote to you a while back asking for help with a Panasonic with a sync problem. After that I again looked at the signal at the video amplifier with a scope and found that I'd made a mistake. Now I could see white compression! The collector of the first video transistor had only two volts on it. Resistor R323 was wide open. Replacing the resistor fixed everything up. I'm puzzled as to how the thing made a picture at all!

Thanks to W.J. McClain of Phoenix, AZ. That is something we should all (including a certain guy I know very well) keep in mind. Look at those waveforms very carefully.

VERTICAL PROBLEMS

The vertical linearity is bad on this Magnavox T939, and the top of the picture is distorted. I tried a new 6LR8 with no improvement. I was using a scope, and when I touched the probe on the pentode grid, the screen filled out! In desperation, I "shotgunned" (that's what you once called it) the set: I checked out every part one at a time, out of the circuit. Of course, all of them checked out good. And when I put them back, the story was the same. Any ideas on what's going on?—G.Y., West Yellowstone, MT

I had the same symptoms on a horizontal output tube! It worked fine if I held the VTVM probe on it. A big resistor in the grid was open. I think you have the same problem. Try replacing some of those high-value resistors in the pentode grid circuit. Some of them may be breaking down under load.

(Feedback: Both of the 4.7 megohm resistors had checked out OK. I replaced them anyway and that solved the problem!)

SUBSTITUTE FILTER

The complaint about this Quasar TS-951 was that the line fuse would open intermittently when it was turned on. I had no service data, so I went at the problem blind. I found a few leaky diodes, but new ones didn't help any. I also checked the main filter capacitor and found that it took too long to charge on a leakage test. I got an exact replacement from Quasar and it was bad too! Other parts also turned out to be bad. Finally, though, I used a Cornell-Dublier CC0129.7 along with a Sprague PC-8 PC-board adapter. The set's worked fine ever since.

Thanks much to Dave Horning of Mole Electronics, Westlake, OH for that one. Dave, you're just like the namesake of your shop—you just keep digging until you find what you're after. Keep up the good work.

BURNING CAPACITOR

This Admiral K-1904-1 had a very small raster. I found that capacitor C111 had burned up. When I replaced it, I got a full raster back. But the new capacitor gets too hot to touch. What's up?—J.T. Delanson, NY

Capacitor C111 in that set is the boost capacitor, from boost to B+. It normally has quite a high spike-voltage on it from the flyback. For that purpose (and any other capacitors used in flyback circuits) you need a capacitor with a special dielectric that can withstand high spike-voltages (which most of us refer to as "RF"). Sprague and others have those in many sizes. Ordinary types won't stand up too long, as you found. Your set was suffering from a bad case of dielectric heating.

SUGGESTIONS

If you have a loss of color sync in a GE KC chassis, look at the little neon bulb in the middle of the chassis. If it's blackened or not glowing, replace it; the color sync is fed through it.

In a Panasonic CT925 chassis with no sound or picture except for a flash when it's turned off, the problem is probably a defective video/sound-IF IC.

In a Magnavox T982-12 with a high voltage that's about 4KV higher than it should be, check transistor Q2 on the regulator pincushion-board. The base and collector are reversed! They apparently came out of the factory that way. The board is marked right, but the transistor is in wrong.

Thanks to John Osborne of Winthrop Electronics, Winthrop, ME.

THREE HINTS AND A QUESTION

On a Magnavox T995 series set, the lack of vertical deflection can be due to open coils, L1 or L2, on the vertical module. They open very easily, usually when the output transistors go out, but sometimes they do it all by themselves! You can get the parts from N.A.P. (North American Philips) Consumer Parts.

On the same set, the 300-megohm bleeder resistor coming from the tripler burns out about every year and a half. Transistor Q4 in the power-supply module shorts out. That causes the high voltage to go up to 37KV. It also keeps the 24-volt supply from adjusting properly. After replacing Q4, I've had no further problems.

Loss of video and weak distorted sound in an Admiral 1M30B can be due to a bad third-IF transistor. Rockwell International developed a special heat sink (part No. 90A66-1) that should help solve the problem. You can order it through Admiral National Parts. The newer video-IF modules have the heat sink, but the older ones don't.

Now, here's the question: This Magnavox T991 has a narrow picture with wavy lines on the edges. Also, the picture is cut in half, with the left half on the right side and the right half on the left side. After a few tests, the base and collector of the horizontal output transistor shorted, which also shorted the switching regulator, Q6. I replaced both of those but still get no raster. Any ideas?

Before I answer the question let me say thanks to Terry Erickson of Las Animas Electronics, Las Animas, CO for the helpful hints.

Now for the problem: Something is surely messed up in the horizontal-oscillator/AFC circuit. Check all the parts around that IC to make sure that none of them are bad. If everything checks out OK, then try a new horizontal module. All of the frequency-determining parts are inside that IC. Also check the 4-legged capacitor, C220. A couple of parts on the regulator seem to give trouble. Check the string of three diodes in series in the base circuit of the regulator; those set the bias on the regulator-driver. Also check the 50 µF electrolytic on the +88-volt line and the pulse-regulator diode, D11, on the power supply board. If that shorts, you've got trouble.

SOUND PROBLEM

I finally fixed the "no sound" problem in this B/W Panasonic 429B set. Transistor TR53 was bad, so I replaced it with a GE-63 PNP-type. That promptly burned up. I checked the schematic again and found that TR53 should be an NPN! I substituted a GE-67, replaced TR54 with a GE-63 and also replaced R510. Now everything works fine. I hope this information can help some others.

Thanks to Terry Dick of Corbin, KY for that bit. Yep, it helps to use the right type transistor. But sometimes it's almost impossible to find out what's what with the minute schematics we get with some sets. For a quick check, note the polarity of the collector voltage. If it's positive, the transistor should be NPN (and vice versa.)

SOME BIG-AMPLIFIER ADVICE

Here's a problem that I came across when working on a 100-watt guitar amplifier—but you could find a similar problem anywhere. The amp contained a full-wave bridge rectifier with four separate diodes, marked 3 amps, 300 volts. Someone had replaced bad diodes with the familiar 1-KV, 2.5-amp types that we always use. I put in two more; they promptly shorted out. I checked for shorts, put in two more and ran the line voltage up slowly with a Variac. It worked fine.

I turned the amp off, and then back on. The new diodes blew again. I sat and thought. Then I checked the RCA SK substitution manual. Those diodes have a *peak* rating of 50 amps. With one exception, 3-amp diodes will have a peak rating of 200–300 amps. The amplifier had a very large input capacitor and a low-resistance power-transformer winding. The surge current charging that huge capacitor was simply too great, and the diodes blew from the overload. Finally, I replaced all the diodes with a SK3987 encapsulated bridge rated for eight amps and 400 PIV/300-amp surge. Now the unit can be turned on safely.

Thanks go out to Bill Styles of Hillsboro, MO (The Sage of the Ozarks). I hope that helps a few people out.

LINE FORMS ON THE LEFT

I asked you for help on a problem in a Quasar TS934. It had a black line on the left side of the screen, about one inch wide. You told me to check the coil-resistor gadget on the plate cap of the 6LF6. I took it off and the line was still there. I tried several other things with no results. I noticed that the bias was low on the 6LF6 grid and the waveform had "fuzz" on top. I took off the violet wire from the flyback and the line went away! Also, the bias jumped to normal (59 VDC) and the current went down. What hap-

pened here?—H.A., Baltimore, MD

I think you hit it! The violet lead from the flyback feeds pulses through an RC network (R506/C501) to the VDR (*V*oltage-*D*ependent *R*esistor)in the 6LF6 grid. That is supposed to control the bias. I'd suspect the VDR. It could be arcing at the peak of the pulse, which would not only cause the "fuzz" on the pulse, but also reduce its amplitude by flattening the peak (causing cathode current to go up). But the "fuzz" is HF oscillation and that causes the line.

BAD CAPACITOR

I asked a little while ago about a problem in a Quasar TS929. You told me to check some capacitors. Capacitor C2 on the BA panel was open. That let horizontal pulses get into the IF. Also, I had an intermittent convergence problem, which was traced to a jumper wire on the convergence yoke plug. (The way it was traced was very scientific—an arc happened to catch my eye.)

THAT'S A GOOD QUESTION!

I'm looking at a CTC-108C (RCA) schematic. The block diagram shows a sandcastle generator. What is that and where did they get the name? None of the local TV shops seem to know.—S.C., Mentone, CA

Unfortunately, no one around here knows either. (Neither does RCA!) Maybe some of our readers do?

MORE HINTS

If you come across a B/W 19EB12 that loses horizontal sync when changing channels, check R715, a 10K, ½-watt resistor. It's probably open.

If you have no raster after a few minutes on a Zenith 19HC48, the 24-volt regulator is probably opening up.

Now here's a problem I had with a Sears 563.51170701. It had bottom foldover and not enough sweep. Cool-spraying transistor Q502, the vertical driver, brought the sweep back. A new transistor did not change symptoms. Replacing C504, a leaky 1-μF coupling capacitor didn't help either. I then looked at the two vertical-output transistors, Q505 and Q506. I noticed that the case of the Q506 was much cooler than that of Q505. I put in a new ELM153 for Q506 and full sweep returned.

Thanks to Mike Danish, Danish TV, Aberdeen Proving Ground, MD.

VERTICAL PROBLEM

I've got a Sears set, chassis number 529-72912, that is giving me fits. The problem is in the vertical stages. I replaced a capacitor four months ago, and everything seemed fine, at least for a while. The set recently came back with the same problem, however. I replaced the same capacitor, and this time the set played for just 20 minutes before it went out again. I'm baffled.—D.P., Sacramento, CA

That all sounds very familiar. Some years ago we had an RCA chassis that had continual vertical problems. We finally got to where if one came in we simply replaced all of the capacitors in the vertical stage. It really was not that big a job as there were only five of them in all. That nearly always cleared up the problem. Be sure to use good-quality capacitors with a high enough voltage rating when you do that job; after all, you don't want to do it twice.

MANY SYMPTOMS

I had a GE 16JA come in with multiple symptoms. They were a herringbone pattern on the screen, odd results when using the brightness control, brightness varying with the channel, and a buzz in the sound. When I checked the B+, it measured only 13 volts instead of 22. I checked the regulator board and replaced the regulator transistor, Q400, with no results. I finally found that R414, Q400's emitter resistor, read 4.5 ohms; it should have read 2.2. Replaced it with a 2.2-ohm, 5% resistor and everything seemed fine except that the brightness was still low. After quite a bit of head-scratching,, I finally realized that someone had turned the brightness centering control all the way down. Once that control was reset everything was fine again. Thanks for teaching me the method.—*Don Wainwright, Taos, NM*

R-E

NEW PRODUCTS

For more details use the free information card inside the back cover

POWER SUPPLY, the *LIFELINE,* is an uninterruptible AC power supply that was designed specifically to furnish the microcomputer market with true UPS (*Un*interruptible *P*ower *S*upply) protection at an affordable cost. The "no-break" power feature provides voltage regulation and line filtering at all times, plus an inverter that supplies power only during power outages. There is no interruption to the critical load.

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A maintenance-free internal battery handles the full power of the system for 5 to 10 minutes. Recharge to 95% of the full charge requires less than 40 minutes. A larger bank of batteries may be used to extend operation to several hours.

The *LIFELINE* plugs into a normal 120-volt AC wall outlet; the critical load is simply plugged into the dual-convenience outlet on the UPS. The many applications include telephone PBX and PABX's, communications systems, microcomputers, and instrumentation. The 200VA *LIFELINE* unit is priced at $1042.00. (600- and 1200VA units are also available.)—**ICS,** Electro-Pac Division, 520 Interstate Rd., Addison, IL 60101.

KEYBOARD, the *PRO-100,* is an intelligent, detachable, capacitance keyboard with enclosure for use with the *Apple II* and *Apple II+* personal computers. It offers 100 keys supporting all existing Apple functions, plus horizontal and vertical cursor movement, separate number pad with enter key, autorepeat, relocated RESET key, CAPS LOCK key, power-ON indicator, upper/lower case, 22 *VisiCalc* keys, 25 Apple BASIC keys, and 18 programmable keys.

The *VisiCalc* keys assist the user to access all *VisiCalc* commands through the use of one key. That reduces the user-training time and creates a friendlier program for novices

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as well as dedicated programmers. The Apple BASIC keys help the user to access BASIC commands that were otherwise confusing to remember or to use into one key function, speeding up computer use. Supplied with the *PRO-100* keyboard is a preboot diskette containing BASIC disk utilities, user-friendly menu, keyboard information, and a useful word-processor and graphics program that demonstrates the programming flexibility at the function keys. The detached *PRO-100* keyboard make the *Apple II* and *Apple II+* a user-friendly computer. It is priced at $265.00, including shipping and handling.—**AMKEY, Inc.,** 200 Ballardvale Street, Wilmington, MA 01887.

AMPLIFIERS, the model *ML-11* Power Amplifier (shown) and the model *ML-12* preamplifier, are designed to be used together, but the model *ML-11* may be used with any other preamplifier.

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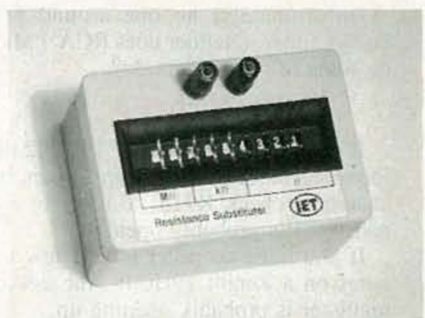
The model *ML-11* is a universal stereo power amplifier, providing accuracy and reliability where relatively low power is required; it is rated at 50 watts per channel. It can elicit from many loudspeakers the same clear, clean, and alive quality of music reproduction that larger amplifiers have established. It is priced at $1700.00.

The model *ML-12* is designed to be used *only* with the model *ML-11.* Line amplification and power-supply redundancies have been eliminated by using the model *ML-11* power amplifier for those functions. That design allows for an optimum match of preamplifier and power amplifier, while offering the advantages of discrete circuits and external preamplifier power supply. The model *ML-12* is priced at $1200.00.—**Mark Levinson Audio Systems, Ltd.,** 2081 South Main St., Route 17, Middletown, CT 06457.

RESISTANCE SUBSTITUTERS, model *RS-200W* and model *RS-201W* use nine side-by-side thumbwheel switches. The desired resistance is simply dialed in, and they are ready for use. Both are error-proof, because the resistance is set and read directly as an unambiguous number on color-coded switches. Unlike the case with conventional decade boxes with rotary or slide switches, there is no need to examine or sum a whole group of



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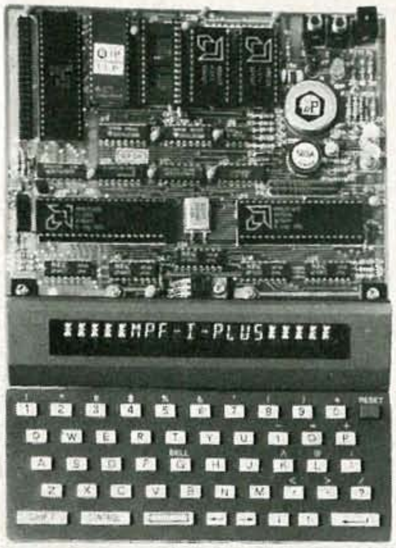
separate numbers. These are laboratory tools for a variety of uses in engineering, design, troubleshooting, or service.

The model *RS-200W* is the economy version, using 1%, 0.5-watt metal film resistors; it is priced at $189.00. The model *RS-201W* is the high-precision version with 0.1% tolerance; it is priced at $379.00.—**IET Labs, Inc.,** 534 Main Street, Westbury, NY 11590.

MICROCOMPUTER, the *MPF-IP,* has for its brain a Z80 microprocessor, which features a 158-command instruction set. The 8K monitor ROM also supports the functions of a text editor, two-pass assembler, and line assembler. The optional thermal printer (20 characters per line, 0.8 lines per second) incorporates a memory-dump utility, and a Z80 disassembler-listing utility. The user's RAM of the *MPF-IP* is 4K, but can be expanded using the optional input/output and memory board (IOM-MPF-IP).

A standard ASCII keyboard is provided, enabling a user to enter programs in assembly language, machine code, BASIC, or FORTH. A 20-digit, 14-segment alphanumeric green tube display, together with the line-scrolling ability, allows the *MPF-IP* to accept or display an input line of 40 characters. There is also a built-in speaker, audio cassette tape interface for program storage and reading, battery-operated memory back-up



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circuit, and many useful optional boards. The *MPF-IP* comes with detailed instructional self-learning manuals, enabling a user to get familiar with microcomputer hardware and software step-by-step. Its suggested retail price is $199.00.—**Multitech Electronics, Inc.,** 195 W. El Camino Real, Sunnyvale, CA 94086.

VIDEO PROCESSOR, the model *V-1880,* has a stabilizer (video guard remover), image enhancer, video-to-RF converter, video fade in/out, and a dual-output distribution amplifier. All five functions are contained in one compact tabletop box that features easy dial operation.

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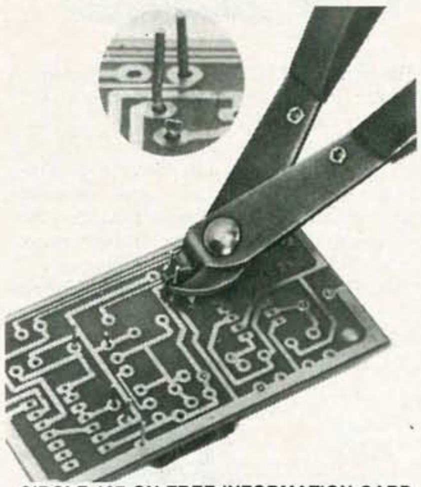
The stabilizer LOCK control corrects the entire range of "copy guard" distortion such as jitter, vertical roll, or traveling black bar, and ensures a continued stable picture. An enhancer, regulated by the DETAIL control reduces grain and gives the user the opportunity to select the best picture, according to preference.

The RF converter allows the TV set to receive video and audio signals from the image enhancer, guard stabilizer, video camera, computer, and VCR. It does that by converting direct video signals from any video component to usable RF signals that can go into the TV antenna terminals. The video fader produces a gradual transition from full video to black and back to full video, just as if it were done in a professional studio.

The model *V-1880* is priced at $250.00.—**BP Electronics, Inc.,** 260 Motor Parkway, Hauppauge, NY 11787.

TOOL, the *TP-1,* will cut and crimp component leads flush to the PC board with one motion. Designed to permit maximum operation visibility, the *TP-1* is used for lead trimming before soldering; it's ideal for laboratory, production, or personal projects. Rated for up to 20 AWG (0.8mm) soft wire leads, the tool is constructed of high carbon steel with a



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black oxide finish, a double coil spring, and cushioned plastic grips. The *TP-1* is priced at $10.75.—**OK Industries, Inc.,** 3455 Conner Street, Bronx, NY 10475. **R-E**

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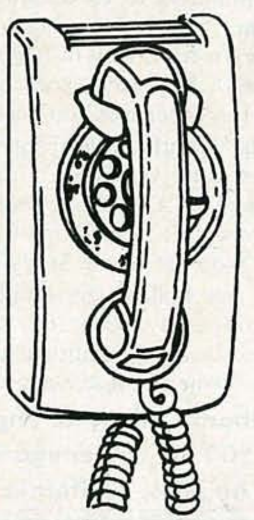

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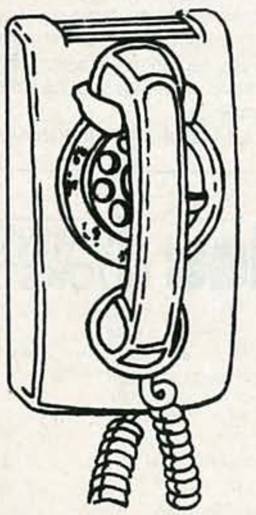

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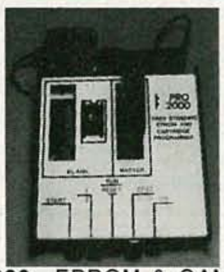

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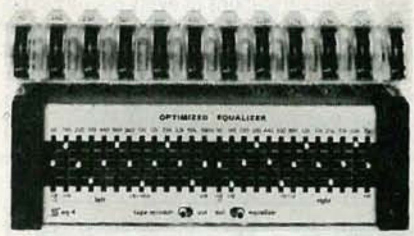

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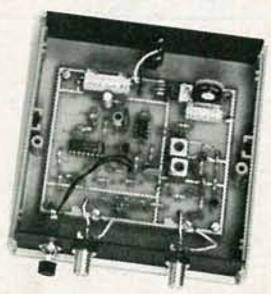

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NEW BOOKS

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WORLD RADIO TV HANDBOOK, The Authoritative Directory of International Radio and Television; World Radio TV Handbook, 1515 Broadway, NY 10036; 608 pages; 9 × 5¾ inches; $17.50.

This 37th edition, celebrating the World Communications Year (1983) is a complete almanac of radio and TV broadcast sources in every country on earth. It is designed to help the international radio listener obtain maximum enjoyment from his receiver.

The first section of the Handbook contains instructive articles relating to broadcasting, and information about broadcasting organizations.

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There is also a listing by frequency of the shortwave stations of the world, and long- and mediumwave stations by regions, to assist in the identification of stations.

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PRACTICAL REPAIR AND MAINTENANCE OF COMMUNICATIONS EQUIPMENT, by Albert D. Helfrick; Prentice-Hall, Inc., Engelwood Cliffs, NJ 07632; 308 pages, including index; 9¼ × 6 inches; hardcover; $29.95.

This book is for technicians who repair and maintain radio-communications equipment, and is particularly suited to radio amateurs. It covers all the popular forms of radio-communications equipment from the low end of the high-frequency spectrum through the UHF spectrum, AM and SSB to FM and tone signaling. Special emphasis is placed on the most-used modes of transmission for the frequency range covered.

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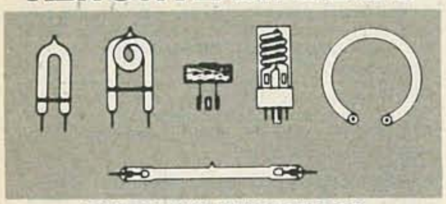

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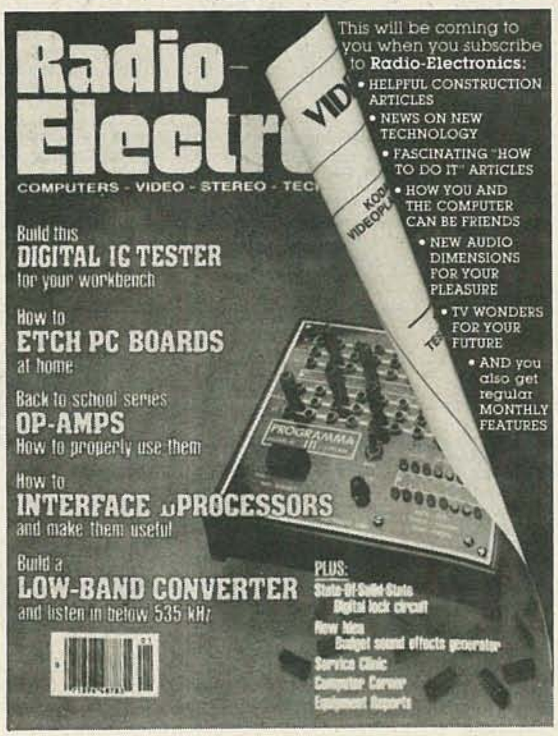

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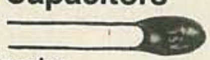
Std.	6.3	1.2A	273-050	3.79
Std.	12.6 CT	1.2A	273-1505	3.99
Std.	25.2	1.2A	273-1480	4.39
H-D	12.6 CT	3.0A	273-1511	5.99
H-D	25.2 CT	2.0A	273-1512	6.29
H-D	18.0 CT	2.0A	273-1515	6.99

Tantalum Capacitors



- 20% Tolerance
- Standard IC Pin Spacing

µF	WVDC	Cat. No.	Each
0.1	35	272-1432	.49
0.47	35	272-1433	.49
1.0	35	272-1434	.49
2.2	35	272-1435	.59
10	16	272-1436	.69
22	16	272-1437	.79

Electrolytic Capacitors

Axial Leads

µF	WVDC	Cat. No.	Each
4.7	35	272-1012	.49
10	35	272-1013	.59
22	35	272-1014	.69
47	35	272-1015	.69
100	35	272-1016	.79
220	35	272-1017	.89
470	35	272-1018	.99
1000	35	272-1019	1.59
2200	35	272-1020	2.49
3300	35	272-1021	2.99
4700	35	272-1022	3.59
470	50	272-1046	1.59
1000	50	272-1047	1.99
2200	50	272-1048	3.49

PC-Mount Leads

µF	WVDC	Cat. No.	Each
220	16	272-956	.79
470	16	272-957	.89
1000	16	272-958	.99
4.7	35	272-1024	.49
10	35	272-1025	.59
22	35	272-1026	.69
47	35	272-1027	.69
100	35	272-1028	.79
220	35	272-1029	.89
470	35	272-1030	.99
1000	35	272-1032	1.59
100	50	272-1044	.89

1/4-Watt, 5% Resistors

39¢ **Pkg. of 5**

Ohms	Cat. No.	Ohms	Cat. No.
10	271-1301	10k	271-1335
100	271-1311	15k	271-1337
150	271-1312	22k	271-1339
220	271-1313	27k	271-1340
270	271-1314	33k	271-1341
330	271-1315	47k	271-1342
470	271-1317	68k	271-1345
1k	271-1321	100k	271-1347
1.8k	271-1324	220k	271-1350
2.2k	271-1325	470k	271-1354
3.3k	271-1328	1 meg	271-1356
4.7k	271-1330	10 meg	271-1365
6.8k	271-1333	—	—

Miniature PC-Mount Pots
1/8-Watt, Horizontal-Mount Type

Ohms	Cat. No.	Each
1k	271-333	.49
10k	271-335	.49
25k	271-336	.49
100k	271-338	.49
500k	271-339	.49

1/4-Watt, Vertical-Mount Type

Ohms	Cat. No.	Each
500	271-226	.59
1k	271-227	.59
5k	271-217	.59
10k	271-218	.59
50k	271-219	.59
100k	271-220	.59
500k	271-221	.59
1 meg	271-229	.59

Submini Toggle Switches

10A at 125VAC. Each includes 4 colored handle covers. 1/4″ mounting holes.

Type	Cat. No.	Each
SPST	275-324	1.89
SPDT	275-326	1.99
SPDT Center-Off	275-325	2.19
DPDT	275-1546	2.39
DPDT Center-Off	275-1545	2.59

RF/IF Components

MC1330 Video Detector IC. 8-pin DIP with data. **276-1757** **2.29**

MC1350 Universal IF Amp IC With AGC. 8-pin DIP with data. **276-1758** **1.99**

MC1358/CA3065 FM Detector. 14-pin DIP with data. **276-1759** **1.79**

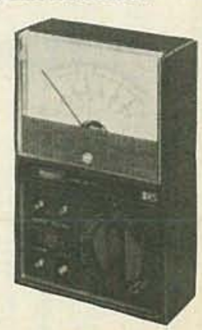
SFE4.5MB. 4.5 MHz Ceramic TV-Sound Filter. 272-1304 .... **69¢**

CDA4.5MD3 4.5 MHz Ceramic Discriminator. 274-1305 .... **79¢**

18-Range Multitester

19.95

Big 3″ Meter With Color-Coded And Mirrored Scale



Measures 0 to 1000 volts, AC and DC. 0 to 250 milliamps DC current. 0 to 2 megohms resistance. −20 to +62 decibels. 5 1/8 × 3 1/2 × 1 7/16″. With test leads and manual. Requires "AA" battery. **22-201** **19.95**

OVER 8800 LOCATIONS WORLDWIDE **Radio Shack**® A DIVISION OF TANDY CORPORATION

Prices apply at participating Radio Shack stores and dealers.

CIRCLE 86 ON FREE INFORMATION CARD

7400

**Number of Pins of each I.C. for easy Socket purchase

Part No.	**Pins	Price
SN7400N	14	.19
SN7401N	14	.19
SN7402N	14	.25
SN7403N	14	.25
SN7404N	14	.25
SN7405N	14	.25
SN7406N	14	.29
SN7407N	14	.29
SN7408N	14	.25
SN7409N	14	.25
SN7410N	14	.25
SN7411N	14	.25
SN7412N	14	.35
SN7413N	14	.35
SN7414N	14	.49
SN7416N	14	.25
SN7417N	14	.25
SN7420N	14	.19
SN7421N	14	.35
SN7422N	14	.45
SN7423N	16	.59
SN7425N	14	.29
SN7426N	14	.29
SN7427N	14	.25
SN7428N	14	.49
SN7430N	14	.25
SN7432N	14	.29
SN7437N	14	.25
SN7438N	14	.29
SN7439N	14	.59
SN7440N	14	.19
SN7441N	16	.89
SN7442N	16	.45
SN7443N	16	.99
SN7444N	16	.99
SN7445N	16	.69
SN7446N	16	.69
SN7447N	16	.69
SN7448N	16	.69
SN7450N	14	.19
SN7451N	14	.19
SN7453N	14	.19
SN7454N	14	.19
SN7459A	14	.25
SN7460N	14	.19
SN7470N	14	.29
SN7472N	14	.29
SN7473N	14	.35
SN7474N	14	.35
SN7475N	16	.45
SN7476N	16	.35
SN7479N	14	4.95
SN7480N	14	.69
SN7482N	14	1.19
SN7483N	16	.59
SN7485N	16	.59
SN7486N	14	.35
SN7489N	16	2.25
SN7490N	14	.39
SN7491N	14	.59
SN7492N	14	.39
SN7493N	14	.39
SN7494N	14	.69
SN7495N	14	.49
SN7496N	16	.49
SN7497N	16	2.75
SN74100N	24	1.49
SN74104N	14	.89
SN74105N	14	.89
SN74107N	**14**	**.29**
SN74109N	**16**	**.39**
SN74116N	24	1.49
SN74121N	14	.39
SN74122N	14	.55
SN74123N	16	.49
SN74125N	14	.45
SN74126N	14	.45
SN74132N	14	.49
SN74136N	14	.69
SN74141N	16	.69
SN74142N	16	2.95
SN74143N	24	2.95
SN74144N	24	2.95
SN74145N	16	.59
SN74147N	16	1.49
SN74148N	16	1.19
SN74150N	24	1.19
SN74151N	16	.59
SN74152N	14	.59
SN74153N	16	.59
SN74154N	24	1.25
SN74155N	16	.59
SN74156N	16	.59
SN74157N	**16**	**.59**
SN74160N	16	.69
SN74161N	16	.69
SN74162N	16	.69
SN74163N	16	.69
SN74164N	14	.69
SN74165N	16	.69
SN74166N	16	.89
SN74167N	16	2.79
SN74170N	16	1.29
SN74172N	24	4.95
SN74173N	16	.69
SN74174N	16	.69
SN74175N	16	.69
SN74176N	14	.69
SN74177N	14	.69
SN74179N	16	1.49
SN74180N	14	.69
SN74181N	24	1.95
SN74182N	16	.89
SN74184N	16	1.95
SN74185N	16	1.95
SN74190N	16	.69
SN74191N	16	.69
SN74192N	16	.69
SN74193N	16	.69
SN74194N	16	.69
SN74195N	16	.69
SN74196N	14	.89
SN74197N	14	.89
SN74198N	24	1.19
SN74199N	24	1.19
SN74221N	16	1.19
SN74251N	16	.79
SN74276N	20	1.95
SN74279N	16	.79
SN74283N	16	1.49
SN74284N	16	2.95
SN74285N	16	2.95
SN74365N	16	.55
SN74366N	16	.55
SN74367N	16	.55
SN74368N	16	.55
SN74390N	16	1.49
SN74393N	14	1.49

74LS

Part No.	**Pins	Price
74LS00	14	.25
74LS01	14	.25
74LS02	14	.25
74LS03	14	.25
74LS04	14	.29
74LS05	14	.29
74LS08	14	.29
74LS09	14	.29
74LS10	14	.29
74LS11	14	.35
74LS12	14	.35
74LS13	14	.39
74LS14	14	.59
74LS15	14	.35
74LS20	14	.29
74LS21	14	.29
74LS22	**14**	**.29**
74LS26	14	.29
74LS27	14	.29
74LS28	14	.29
74LS30	14	.29
74LS32	14	.29
74LS33	14	.55
74LS37	14	.35
74LS38	14	.35
74LS40	14	.29
74LS42	16	.55
74LS47	16	.75
74LS48	16	.75
74LS49	16	.75
74LS51	14	.25
74LS54	14	.29
74LS55	14	.29
74LS73	14	.39
74LS74	14	.39
74LS75	16	.39
74LS76	16	.39
74LS78	16	.39
74LS83	16	.65
74LS85	16	.69
74LS86	14	.39
74LS90	14	.55
74LS92	14	.55
74LS93	14	.55
74LS95	14	.79
74LS96	16	.89
74LS107	14	.39
74LS109	16	.39
74LS112	16	.39
74LS113	14	.39
74LS114	14	.39
74LS122	14	.49
74LS123	16	.79
74LS125	14	.49
74LS126	14	.49
74LS132	14	.59
74LS133	16	.59
74LS136	14	.39
74LS138	16	.59
74LS139	16	.59
74LS151	16	.59
74LS153	16	.59
74LS154	24	.99
74LS155	16	.69
74LS156	16	.69
74LS157	16	.69
74LS158	16	.59
74LS160	16	.69
74LS161	16	.69
74LS162	16	.69
74LS163	16	.69
74LS164	14	.69
74LS165	16	1.19
74LS166	16	1.19
74LS168	16	1.19
74LS169	16	1.19
74LS170	16	1.49
74LS173	16	.69
74LS174	16	.69
74LS175	16	.69
74LS181	24	2.49
74LS190	16	.89
74LS191	16	.89
74LS192	16	.79
74LS193	16	.79
74LS194	16	.69
74LS195	16	.69
74LS197	14	.79
74LS221	16	.89
74LS240	20	1.09
74LS241	20	1.09
74LS242	14	1.09
74LS243	14	1.09
74LS244	20	1.09
74LS245	20	1.49
74LS247	16	.79
74LS248	16	1.09
74LS249	16	1.09
74LS251	16	.59
74LS253	16	.59
74LS257	16	.59
74LS258	16	.59
74LS259	16	2.75
74LS260	14	.59
74LS266	14	.55
74LS273	20	1.49
74LS279	16	.49
74LS283	16	.69
74LS290	14	.89
74LS293	14	.89
74LS298	16	.89
74LS352	16	1.29
74LS353	16	1.29
74LS365	16	.49
74LS366	16	.49
74LS367	16	.49
74LS368	16	.49
74LS373	20	1.29
74LS374	20	1.29
74LS375	16	.69
74LS377	20	1.29
74LS386	14	.45
74LS393	14	1.19
74LS399	16	1.49
74LS670	16	1.49
81LS95	20	1.49
81LS97	20	1.49

74S/PROMS*

Part No.	**Pins	Price
74S00	14	.35
74S02	14	.35
74S03	14	.35
74S04	14	.45
74S05	14	.35
74S08	14	.35
74S09	14	.39
74S10	14	.35
74S11	14	.35
74S15	14	.35
74S20	14	.35
74S22	14	.35
74S30	14	.35
74S32	14	.45
74S38	14	.89
74S40	14	.39
74S51	14	.35
74S64	14	.39
74S65	14	.39
74S74	14	.55
74S86	14	.55
74S112	16	.55
74S113	14	.55
74S114	14	.55
74S124	16	2.95
74S133	16	.45
74S134	16	.50
74S135	16	.89
74S136	16	1.39
74S138	16	.89
74S139	16	.89
74S140	14	.55
74S151	16	.99
74S153	16	.99
74S157	16	.99
74S158	16	.99
74S160	16	2.49
74S174	16	.99
74S175	16	.99
74S188*	16	1.95
74S194	16	1.49
74S195	16	1.49
74S196	16	1.49
74S240	20	2.25
74S241	20	2.25
74S242	14	2.49
74S243	14	2.49
74S244	20	2.49
74S251	16	1.19
74S253	16	1.19
74S257	16	1.19
74S258	16	1.19
74S260	14	.79
74S280	14	1.95
74S287*	16	1.95
74S288*	16	1.95
74S373	20	2.49
74S374	20	2.49
74S387*	16	1.95
74S471*	20	5.95
74S472*	20	4.95
74S473*	20	4.95
74S474*	24	4.95
74S475*	24	4.95
74S570*	16	2.95
74S571*	16	2.95
74S572*	18	4.95
74S573*	18	4.95
74S940	20	2.49
74S941	20	2.49

CA—LINEAR

Part No.	**Pins	Price
CA3010H		.99
CA3013H		2.15
CA3023H		3.25
CA3035H		5.95
CA3039H		1.35
CA3046N	14	.89
CA3059N	14	3.25
CA3060N	16	3.25
CA3080E	8	.89
CA3081N	16	1.49
CA3082N	16	1.49
CA3083N	16	1.49
CA3086N	14	.69
CA3089N	16	1.69
CA3096N	16	1.19
CA3130E	8	1.49
CA3140E	8	.99
CA3160H		1.95
CA3401N	14	.59
CA3600N	14	3.95

CD—CMOS

Part No.	**Pins	Price
CD4000	14	.29
CD4001	**14**	**.29**
CD4002	14	.29
CD4006	14	.89
CD4007	14	.29
CD4009	**16**	**.39**
CD4010	16	.39
CD4011	14	.29
CD4012	**14**	**.15**
CD4013	14	.39
CD4014	16	.79
CD4015	**16**	**.39**
CD4016	14	.39
CD4017	16	.69
CD4018	16	.79
CD4019	16	.39
CD4020	16	.75
CD4021	16	.79
CD4022	16	.79
CD4023	14	.29
CD4024	14	.69
CD4025	14	.23
CD4026	16	2.49
CD4027	16	.45
CD4028	16	.69
CD4029	16	.79
CD4030	14	.39
CD4034	24	1.95
CD4035	16	.89
CD4040	16	.79
CD4041	14	.79
CD4042	16	.69
CD4043	16	.79
CD4044	16	.79
CD4046	16	.89
CD4047	14	.89
CD4048	16	.39
CD4049	**16**	**.39**
CD4050	16	.39
CD4051	16	.79
CD4052	16	.79
CD4053	16	.79
CD4056	16	2.95
CD4059	24	7.95
CD4060	16	.89
CD4066	14	.39
CD4068	14	.39
CD4069	14	.29
CD4070	14	.39
CD4071	14	.29
CD4072	14	.29
CD4073	14	.29
CD4075	14	.29
CD4076	16	.79
CD4078	14	.49
CD4081	**14**	**.29**
CD4082	14	.29
CD4093	14	.49
CD4098	16	1.95
CD4506	16	1.19
CD4507	14	.99
CD4508	24	3.95
CD4510	16	.89
CD4511	16	.89
CD4512	16	.89
CD4514	24	1.79
CD4515	24	1.79
CD4516	16	.99
CD4518	16	.99
CD4519	16	.39
CD4520	16	.79
CD4526	16	1.19
CD4528	16	1.19
CD4529	16	1.19
CD4543	16	1.19
CD4562	14	6.95
CD4566	16	1.39
CD4583	16	2.49
CD4584	14	.59
CD4723	16	1.19
CD4724	16	1.19
MC14409	16	13.95
MC14410	16	13.95
MC14411	24	11.95
MC14412	16	13.95
MC14419	16	7.95
MC14433	24	13.95
MC14538	16	1.19
MC14541	14	1.19

(More in Catalog)

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	**Pins	Function	Price
CDP1802	40	CPU	$9.95
2650	40	MPU	14.95
IDM2901ADC	40	CPU—4-bit slice (Com. Temp. Gr.)	19.95
MCS6502	40	MPU w/Clock	9.95
MCS6502B	40	MPU w/Clock at 3MHz	13.95
MC6802CP	40	MPU w/Clock and RAM	7.95
INS8035N-6	40	MPU—8-bit (6MHz)	5.95
INS8039N-6	40	CPU-Sgl. chip 8-bit (128 bts. Ram)	5.95
INS8040N-6	40	CPU (256 bytes RAM)	5.95
INS8070N	40	CPU (64 bytes RAM)	11.95
INS8073N	40	CPU w/Basic Micro Interpreter	14.95
P8085A	40	CPU	5.95
8155	40	HMOS RAM I/O Port-Timer	7.95
8748	40	HMOS EPROM MPU	24.95

Z80, Z80A, Z80B, Z8000 SERIES

Part No.	**Pins	Function	Price
Z80	40	CPU (MK3880N)(780C) 2MHz	$4.95
Z80-CTC	28	Counter Timer Circuit	5.95
Z80-DART	40	Dual Asynchronous Rec./Trans.	11.95
Z80-DMA	40	Direct Memory Access Circuit	15.95
Z80-P10	40	Parallel I/O Interface Controller	5.95
Z80-S10/0	40	Serial I/O (TxCB and RxCB Bonded)	15.95
Z80-S10/1	40	Serial I/O (Lacks DTRB)	15.95
Z80-S10/2	40	Serial I/O (Lacks SYNCB)	15.95
Z80-S10/9	40	Serial I/O	15.95
Z80A	40	CPU (MK3880N-4)(780C-1) 4MHz	5.95
Z80A-CTC	28	Counter Timer Circuit	5.95
Z80A-DART	40	Dual Asynchronous Rec./Trans.	11.95
Z80A-DMA	40	Direct Memory Access Circuit	17.95
Z80A-P10	40	Parallel I/O Interface Controller	5.95
Z80A-S10/0	40	Serial I/O (TxCB and RxCB bonded)	16.95
Z80A-S10/1	40	Serial I/O (Lacks DTRB)	16.95
Z80A-S10/2	40	Serial I/O (Lacks SYNCB)	16.95
Z80A-S10/9	40	Serial I/O	16.95
Z80B	40	CPU (MK3880N-6) 6MHz	11.95
Z80B-CTC	28	Counter Timer Circuit	13.95
Z80B-P10	40	Parallel I/O Interface Controller	13.95
Z8001	48	CPU Segmented	51.95
Z8002	40	CPU Non-Segmented	55.95
Z8030	40	Serial Comm. Controller	44.95
Z8036	40	Counter/Timer & Parallel I/O Unit	29.95

6800/68000 SERIES

Part No.	**Pins	Function	Price
MC6800	40	MPU	4.95
MC6802CP	40	MPU with clock and RAM	7.95
MC6810API	24	128x8 Static RAM	3.95
MC6821	40	Peripheral Inter. Adapt (MC6820)	4.95
MC6828	24	Priority Interrupt Controller	15.95
MC6830L8	24	1024x8-bit ROM (MC68A30-8)	10.95
MC6850	24	Asynchronous Comm. Adapter	4.95
MC6852	24	Synchronous Serial Data Adapter	5.75
MC6860	24	0-600bps Digital MODEM	9.95
MC6862	24	2400bps Modulator	12.95
MC6880A	16	Quad 3-state bus. trans. (MC8T26)	2.25
MC68000L8	64	MPU 16-Bit (8MHz)	69.95
MC68488P	40	General Purpose Int. Adapter	8.95
MC68652P2	40	Multi. Protocol Comm. Controller	24.95
MC68661PB	28	Enhanced Prog. Comm. Int.	8.95
MCM68764	24	64K EPROM (450ns)	39.95
SY6522	40	Peripheral Inter. Adapter	7.95

8080A SERIES

Part No.	**Pins	Function	Price
INS8080A	40	CPU	3.95
TMS5501	40	Synchronous Data Interface (SIRC)	14.95
INS8154	40	128 Byte RAM 16-Bit I/O	13.95
INS82C06	20	Octal D Flip Flop Tri-State (74C374)	2.49
DP8212	24	8-bit Input/Output (74S412)	2.25
DP8214	24	Priority Interrupt Control	3.95
DP8216	16	Bi-Directional Bus Driver	2.25
DP8224	16	Clock Generator/Driver	2.25
DP8226	16	Bus Driver	2.25
DP8228	28	System Cont./Bus Driver (74S428)	3.49
DP8238	28	System Controller (74S438)	4.49
INS8243	24	I/O Expander for 48 Series	5.95
*INS8245	18	16-Key Keyboard Encoder (74C922)	4.49
INS8246	20	20-Key Keyboard Encoder (74C923)	4.95
DP8247	28	Display Controller (74C911)	8.95
DP8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element	10.95
INS8251	28	Prog. Comm. I/O (USART)	4.49
DP8253	24	Prog. Interval Timer	6.95
DP8255	40	Prog. Peripheral I/O (PPI)	4.49
DP8257	40	Prog. DMA Control	7.95
DP8259	28	Prog. Interrupt Control	6.95
DP8275	40	Prog. CRT Controller	29.95
DP8279	40	Prog. Keyboard/Display Interface	8.95
DP8303	20	8-Bit Tri-State Bi-Directional Trans.	3.95
DP8304	20	8-bit Bi-Directional Receiver	2.49
DP8307	20	8-bit Bi-Directional Receiver	2.49
DP8308	20	8-bit Bi-Directional Receiver	2.49
DP8310	20	Octal Latched Peripheral Driver	4.95
DP8311	20	Octal Latched Peripheral Driver	4.95

DISK CONTROLLERS

Part No.	**Pins	Function	Price
INS1771-1	40	Single Density	16.95
FD1791	40	Single/Dual Density (Inv.)	24.95
FD1793	40	Single Density Inverted	26.95
FD1795	40	Dual Density/Side Select (Inv.)	49.95
FD1797	40	Dual Density/Side Select True	49.95

SPECIAL FUNCTION

Part No.	**Pins	Function	Price
DS0025CN	8	Dual MOS Clock Driver (5MZ)	2.49
DS0026CN	8	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	40	Floppy Disk Controller	16.95
INS2651N	28	Communication Chip	8.95
MM58167N	24	Microprocessor Real Time Clock	8.95
MM58174N	16	Micro. Compatible Time Clock	7.95
COP402N	40	Microcontroller w/64-digit RAM and Direct LED Drive	5.95
COP402MN	40	Microprocessor w/64-digit RAM & Direct LED Drive w/N Buss Int.	5.95
COP470N	20	32-seg. VAC Fluor. Drvr. (20-pin pkg.)	3.25
MM5369EST	8	Prog. Oscillator/Divider (100Hz)	1.19

DYNAMIC RAMS

Part No.	**Pins			Price
1103	18	1024x1	(300ns)	.99
4027	**16**	**4096x1**	**(250ns)**	**2.49**
4116N-2	16	16,384x1	(150ns)	1.89 - 8/14.95
4116N-3	16	16,384x1	(200ns)	1.69 - 8/12.95
4116N-4	16	16,384x1	(250ns)	1.49 - 8/10.95
4164N-150	16	65,536x1	(150ns)	7.95 - 8/59.95
4164N-200	16	65,536x1	(200ns)	7.49 - 8/54.95
MM5261	18	1024x1	(300ns)	.49 - 8/1.95
MM5262	**22**	**2048x1**	**(365ns)**	**.49 — 8/1.95**
MM5270	18	4096x1	(250ns) MK4096	4.95
MM5280	22	4096x1	(200ns) 2107	3.95
MM5290-2	16	16,384x1	(150ns)	1.89 - 8/14.95
MM5290-3	16	16,384x1	(200ns)	1.69 - 8/12.95
MM5290-4	16	16,384x1	(250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1	(200ns)	1.69

STATIC RAMS

Part No.	**Pins			Price
1101	16	256x1	(650ns)	1.49
2101	22	256x4	(450ns) 8101	2.49
2102	16	1024x1	(350ns)	.89
21L02	16	1024x1	(450ns) L.P.	1.49
2111	18	256x4	(450ns) 8111	2.95
2112	16	256x4	(450ns) MOS	2.95
2114	18	1024x4	(450ns)	1.95 - 8/13.95
2114L	18	1024x4	(450ns) L.P.	2.25 - 8/15.95
2114-2	18	1024x4	(200ns)	2.25 - 8/15.95
2114L-2	18	1024x4	(200ns) L.P.	2.49 - 8/17.95
2147	18	4096x1	(70ns)	4.95
2148	18	1024x4	(70ns)	8.95
TMS4044	18	4096x1	(450ns)	3.95
TMS4045	18	1024x4	(450ns)	3.95
5101	22	256x4	(450ns) CMOS	4.95
MM5257	18	4096x1	(450ns) 4044	4.95
HM6116P-3	24	2048x8	(150ns) CMOS	7.95
HM6116-4	24	2048x8	(200ns) CMOS	6.95
HM6116LP-4	24	2048x8	(200ns) L.P. CMOS	7.95
7489	16	16x4	(50ns)	2.25
74C921	18	256x4	(250ns) CMOS	3.95
74C929	16	1024x1	(250ns) CMOS (6501)	3.95
74C930	16	1024x1	(250ns) CMOS (6518)	3.95
74S189	16	16x4	(35ns) 93405	1.95
74S200	16	256x1	(80ns) 93410	3.95
74S206	16	256x1	(60ns) 93411	3.95
74S289	16	16x4	(35ns) 3101	2.25
82S10	16	1024x1	(50ns) O.C. (93415)	3.95
82S25	16	16x4	(50ns) O.C. (74S289)	2.25

EPROMS

Part No.	**Pins			Price
1702A	24	256x8	(1us)	4.95
2708	24	1024x8	(450ns)	3.95
2708-5	24	1024x8	(550ns) SM00246	2.95
TMS2516	24	2048x8	(450ns) 2716	6.95
TMS2532	24	4096x8	(450ns) NMC2532	9.95
TMS2564	28	8192x8	(450ns)	19.95
TMS2716	24	2048x8	(450ns) 3 voltage	7.95
2716	24	2048x8	(450ns)	4.95
2716-1	24	2048x8	(350ns)	6.95
2732	24	4096x8	(450ns)	9.95
2758D	24	1024x8	(450ns) single +5V	2.95
MM2764	28	8192x8	(450ns)	16.95
MM2764-3	28	8192x8	(300ns)	19.95
MCM68764	24	8192x8	(450ns)	39.95
74S188	16	32x8	PROM O.C. (6330-1)	1.49
74S287	16	256x4	PROM T.S. (6301-1)	1.95
74S288	16	32x8	PROM T.S. (6331-1)	1.95
74S387	16	256x4	PROM O.C. (6300-1)	1.95
74S471	20	256x8	PROM T.S. (6309-1)	5.95
74S472	20	512x8	PROM T.S. (6349-1)	4.95
74S473	20	512x8	PROM O.C. (6348)	4.95
74S474	24	512x8	PROM T.S. (DM87S296N)	4.95
74S475	24	512x8	PROM O.C. (6340)	4.95
74S478	24	1024x8	PROM T.S. (TBP28S86)	8.95
74S570	16	512x4	PROM O.C. (6305)	2.95
74S571	16	512x4	PROM T.S. (6306)	2.95
74S572	18	1024x4	PROM O.C. (6352)	4.95
74S573	18	1024x4	PROM T.S. (82S137)	4.95
82S23	16	32x8	PROM O.C. (27S18)	2.95
82S115	24	512x8	PROM T.S. (27S15)	9.95
82S123	16	32x8	PROM T.S. (27S19)	2.95
82S126	16	256x4	PROM O.C. (27S20)	3.95
82S129	16	256x4	PROM T.S. (27S21)	3.95
82S130	16	512x4	PROM O.C. (27S12)	5.95
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DM87S180N	24	1024x8	PROM O.C. (82S180)	9.95
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Part No.	**Pins	Function	Price
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MC3470P	18	Floppy Disk Read AMP System	4.95
MC1408L7	16	7-bit D/A Converter (DAC0807LCN)	2.49
MC1408L8	16	8-bit D/A Converter (DAC0808LCN)	2.95
ADC0804	20	8-bit A/D Converter (1 LSB)	3.49
DAC0806	16	8-bit D/A Converter (0.78% Lin.)	1.95
ADC0809	28	8-bit A/D Converter (8-Ch. Multi.)	4.49
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DAC1006	20	10-bit D/A Conv. Micro. Comp. (0.20%)	7.95
DAC1020	16	10-bit D/A Conv. (0.05% Lin.)	8.49
DAC1022	16	10-bit D/A Conv. (0.20% Lin.)	5.95
DAC1222	18	12-bit D/A Conv. (0.20% Lin.)	6.95
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7206CEV/Kit*	16	Tone Generator Chip, XTL	7.95
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74HCU04	14	.75
74HC08	14	.75
74HC10	14	.75
74HC11	14	.69
74HC14	14	.85
74HC20	14	.75
74HC27	14	.75
74HC32	14	.75
74HC42	16	1.39
74HC51	14	.75
74HC58	14	.75
74HC73	14	.75
74HC74	14	.99
74HC75	16	.99
74HC76	16	.75
74HC85	16	2.19
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74HC109	16	1.39
74HC112	16	.75
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74HC132	14	.89
74HC137	16	2.95
74HC138	16	1.49
74HC139	16	1.49
74HC147	16	1.19
74HC151	16	1.19
74HC153	16	.99
74HC154	24	2.69
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74HC158	16	1.59
74HC160	16	1.79
74HC161	16	1.79
74HC162	16	2.39
74HC163	16	2.39
74HC164	14	1.79
74HC165	16	2.39
74HC173	16	1.59
74HC174	16	1.39
74HC175	16	1.39
74HC192	16	1.39
74HC193	16	1.39
74HC194	16	1.59
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74C10	14	.35
74C14	14	.59
74C20	14	.35
74C30	14	.35
74C32	14	.39
74C42	16	1.39
74C48	16	1.95
74C73	14	.79
74C74	14	.69
74C85	16	1.95
74C86	14	.39
74C89	16	5.95
74C90	14	1.19
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74C95	14	1.39
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74C151	16	2.49
74C154	24	3.49
74C157	16	2.25
74C160	16	1.19
74C161	16	1.19
74C162	16	1.19
74C163	16	1.19
74C164	14	1.49
74C173	16	.79
74C174	16	1.19
74C175	16	1.19
74C192	16	1.49
74C193	16	1.69
74C195	16	1.39
74C221	16	1.95
74C240	20	1.95
74C244	20	1.95
74C373	20	2.49
74C374	20	2.49
74C901	14	.59
74C903	14	.59
74C906	14	.59
74C911	28	8.95
74C912	28	8.95
74C915	18	1.19
74C917	28	8.95
74C922	18	4.49
74C923	20	4.95
74C925	16	5.95
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80C97	16	.39

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TL084CN	14	1.95
LM301CN	8	.35
LM302H		1.95
LM304H		1.95
LM305H		.99
LM307CN	8	.45
LM308CN	8	.69
LM309K		1.25
LM310CN	8	1.75
LM311CN	8	.69
LM312H		2.49
LM317T		1.19
LM317K		3.95
LM318CN	8	1.95
LM319N	14	1.95
LM320K-5		1.35
LM320K-12		1.35
LM320K-15		1.35
LM320T-5		.89
LM320T-12		.89
LM320T-15		.89
LM323K		5.95
LM324N	14	.59
LM337T		1.95
LM338K		6.95
LM339N	14	.69
LM340K-5		1.35
LM340K-12		1.35
LM340K-15		1.35
LM340T-5		.79
LM340T-12		.79
LM340T-15		.79
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LM350K		4.95
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LF356N	8	1.10
LM370N	14	4.49
LM373N	14	3.95
LM377N	14	1.95
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LM381N	14	1.79
LM382N	14	1.39
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NE544N	14	2.95
NE550A	14	1.95
NE555V	8	.35
LM556N	14	.69
LM565N	14	1.19
LM566CN	8	1.49
LM567V	8	.89
NE570N	16	3.95
LM703CN	8	1.19
LM709N	14	.49
LM710N	14	.69
LM711N	14	.79
LM723N	14	.55
LM733N	14	1.00
LM739N	14	1.95
LM741CN	8	.35
LM747N	14	.69
LM748N	8	.59
LM1310N	14	1.49
LM1458CN	8	.59
LM1488N	14	.69
LM1489N	14	.69
LM1496N	14	1.95
LM1800N	16	1.49
LM1889N	18	1.95
LM1896N	14	2.95
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LM3900N	14	.59
LM3905CN	8	1.19
LM3909N	8	.99
LM3914N	18	3.49
LM3915N	18	3.49
LM3916N	18	3.49
RC4136N	**14**	**1.25**
RC4151NB	8	1.95
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Connect any number of peripherals to a single I/O port — use a single printer to support several microcomputers — use two or more printers to support a single microcomputer — access a modem from any of several microcomputers — ideal for demonstrating or comparing equipment. The Selecto-Switches are designed to eliminate the unnecessary plugging & unplugging of cables which connect printers, terminals, or modems to various computers. By using a Selecto-Switch, you achieve more efficient system operation, better utilization of peripherals & computer ports, eliminate redundant hardware & reduce service calls. 5 yr. limited warranty on all Selecto-Switches. No power required. Size (inches): 10L x 7W x 3H, 2½ lbs.

RS232 SERIAL SELECTO-SWITCH

• Switches all lines of asynchronous data • Easy expansion of serial ports • Connectors are female DB25 type

PART NO.	DESCRIPTION	PRICE
GRS232-AB	2-Way Switch	$139.95
GRS232-ABC	3-Way Switch	$179.95

DB25 PARALLEL SELECTO-SWITCH

• TRS-80, Apple, and IBM compatible • Switches 24 lines (line 1 is ground) • Connectors are female DB25 type

PART NO.	DESCRIPTION	PRICE
GP24-AB	2-Way Switch	$139.95
GP24-ABC	3-Way Switch	$179.95

CENTRONICS-STYLE SELECTO-SWITCH

• Switches all 36 lines • Connectors are female Centronics

PART NO.	DESCRIPTION	PRICE
GCENT-AB	2-Way Switch	$199.95
GCENT-ABC	3-Way Switch	$229.95

Micro-Logic Corp. MICRO-CHARTS

• Fully decoded data • Instant access • 2-sided, totally comprehensive • Compact 8½ x 11 in. durable credit card plastic • Perfect for programmers & engineers • Clear & concise tables for: full instruction set, disassembly, ASCII, base conversion, effect of flags, compare vs. jump, interrupt structure, pinout, cycle times, diagrams, bug notes, & much more...

PART NO.	REFERENCE	PRICE
ML-Z80	Z80 CPU	$5.95
ML-8080A	8080A/8085A	$5.95
ML-6502	6502 (65XX)	$5.95
ML-8048	8048, Relatives, Algorithms	$5.95
ML-7400	5400/7400 TTL	$5.95

BOOKS

30001	National CMOS Data Book (1981) (640 pages) 74C, CD4000, and A/D Converters	$6.95
30003	National Linear Data Book (1982) (1376 pages) LM, LF, ADC, DAC, LH Series	$11.95
30008	National Memory Data Book (1980) (464 pages) RAMs, ROMs, PROMs, EPROMs Series	$6.95
30009	Intersil Data Book (1983) (1356 pages) Complete line.	$9.95
30010	National Audio/Radio Handbook (1980) (240 pages) Pre-Amps, AM, FM & FM Stereo, Power Amps	$5.95
30011	National Linear Application Handbook (1980) (736 pages) Application Notes, Linear Briefs, etc.	$15.95
30012	National PAL Data Book (1982) (176 pages) Application Notes, Linear Briefs, etc.	$5.95
30013	Zilog Data Book (1983) (641 pages) Microprocessors and Support Chips	$7.95
210830	Intel Memory Components Handbook (1983) (798 pages) Contains all Application Notes, Article Reprints, Data Sheets, and other design information on Intel's RAMs, EPROMs, E²PROMs & Bubble Memories.	$14.95
210844	Intel Microprocessor & Peripheral Handbook (1983) (1027 pages) Contains Data Sheets on all of Intel's Microprocessors and Peripherals.	$14.95

ATARI

ATARI PADDLES

JSP (2) . . . . $2.95 pair

ATARI DRIVER

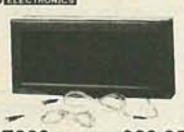
JSD (1) . . . . $2.95 ea.

TV GAME SWITCH

Used on Atari. Cosmetically blemished. 100% functional.

TGS-1 . . . $1.95 ea.

Jameco Electronics Digital Thermometer Kit



Dual sensors — switch controls for indoor/outdoor or dual monitoring — can be extended to 500 feet. Continu s LED .8" ht. display. R je: -40°F to 199°F, -40°C to 100°C. Accuracy ±1° nominal. Calibrate for Fahrenheit/Celsius. Simulated inut case. AC wall adapte cluded. Size: 6⅞"L x 3⅞"H x 1⅞"D.

JE300 . . . . . . $39.95

Universal Computer Keyboard Enclosures

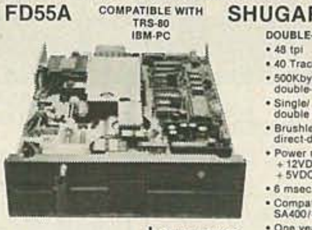
"DTE" Blank Desk-Top Enclosures are designed for easy modification. High strength epoxy molded end pieces in mocha brown finish. Sliding rear/bottom panel for service/component access. Top/bott. panels .080" thick alum. alodine type 1200 finish (gold tint color) for best paint adhesion after modification. Vented top & bottom panels for cooling efficiency. Rigid construction provides unlimited applications. Assembly instructions included.

DTE-8	Panel Width 7.5"	$24.95
DTE-11	Panel Width 10.13"	$27.95
DTE-14	Panel Width 13.5"	$29.95
DTE-20	Panel Width 19.25"	$34.95

5¼" HALF-HEIGHT DISK DRIVES

FIT TWO DRIVES IN THE SAME SPACE AS ONE CONVENTIONAL 5¼" DRIVE

TEAC FD55A — COMPATIBLE WITH TRS-80, IBM-PC — SHUGART SA455



TEAC FD55A — SINGLE-SIDED:
- 48 tpi
- 40 Tracks
- 250Kbytes single-sided
- Single/double density
- Brushless DC direct-drive motor
- Low 5W power consumption
- Power req.: +12VDC @ .3A, +5VDC @ .55A
- 6 msec. track to track
- One year warranty
- Size: 5¾"W x 1⅝"H x 8"D
- Weight: 3 lbs. 5 oz.

FD55A $249.95

Shugart SA455 — DOUBLE-SIDED:
- 48 tpi
- 40 Tracks
- 500Kbytes double-sided
- Single/double density
- Brushless DC direct-drive motor
- Power req.: +12VDC @ .75A, +5VDC @ .7A
- 6 msec. track to track
- Compatible with SA400/450
- One year warranty
- Size: 5.75"W x 1.63"H x 8"D
- Weight: 3.3 lbs.

SA455 . . . . $259.95

Keyboard Mask for Your ZX81/1000* Computer

BRAND NEW!!

FEATURES:
- Install in seconds. Remove adhesive backing from mask and place over keyboard.
- All characters and symbols reproduced on mask.
- Durable — formed with polycarbonite sheet-satin finish.

The JE681 Keyboard Mask provides users of the ZX81/1000 series computer the individual feel of each keypad on the keyboard. The mask has a raised outline around each keypad allowing the user to feel and correctly position their fingers onto the keyboard.

JE681 KEYBOARD MASK . . . . . $9.95 each

Jameco Electronics ZX81/1000* Keyboard Conversion Kit

JE682-AK KEYBOARD KIT MOUNTED IN DTE-AK ENCLOSURE. LIGHT TAN PANELS WITH MOLDED DARK BROWN END PIECES. SIZE: 14¼"W x 3½"D x 3½"H

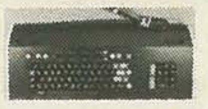
The JE682 Kit provides users of the ZX81/1000 series computers a full-size industrial keyboard hook up to their computer. The JE682 Kit allows the use of either the full-size keyboard or the Sinclair/Timex Keyboard. The Kit also permits the simple disconnection of the Sinclair/Timex Keyboard for portable use. The JE682 Kit consists of a full-size industrial grade keyboard with 62 keys, 2 p.c. boards, 24" ribbon cable, DIP socket and 4 rubber feet. The keyboard conversion kit can easily be mounted into the DTE-AK enclosure. This enclosure is large enough to contain the ZX81/1000 computer and the full-size keyboard together. A handy label representing the ZX81/1000 keyboard layout is placed on the enclosure.

JE682-AK Keyboard Conversion Kit . . . . . . $99.95 ea.
(WITH DTE-AK CASE - AS PICTURED)

JE682 Keyboard Conversion Kit . . . . $59.95 ea.
(WITHOUT DTE-AK CASE)

*ZX81/1000 is a trademark of Sinclair/Timex

80-Key Keyboard



CA150C $69.95

95-Key Keyboard

CA154A $79.95

CONTROL DATA KEYBOARDS

Limited Quantities!

- ★ 7-bit Parallel ASCII
- ★ SPST Switching
- ★ FTZ Shielded Base
- ★ N-Key Rollover
- ★ 128 Character ASCII
- ★ Non-Slip, Non-Glare Keycaps
- ★ CDC752 Terminal Keyboards
- ★ Attractive Case

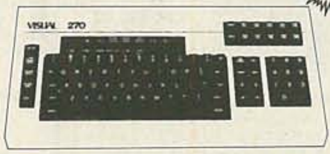
These Control Data Keyboards consist of a base, cover, the keyboard assembly, and an interface cable. Color (case): Harvest gold and black. Color (keycaps): Black, blue, and red. Electrical requirements: +5V @ 600mA, -12V @ 50mA. Size: 21½"W x 9"D x 3½"H. Weight: 6 lbs. All units brand new in original boxes, specifications included.

Keytronics 90-Key Soft-Programmable Keyboard

WITH SECURITY KEYLOCK SWITCH

250 Available! BRAND NEW!!

- RFI shielded
- Cursor controls
- Numeric keyboard
- 8-bit Parallel
- Solid state switches
- 10 user-programmable keys
- Positive TTL Logic
- Size: 17"L x 8¼"W x 2¼"H



Made for Visual Technology, this keyboard features: a security keylock (includes two keys) to guard against unauthorized use; an 11-key numeric keypad; cursor controls; and 10 user-programmable keys. Electrical requirements: +5VDC. Color (case): White. Color (keycaps): Black. Complete with case, keyboard assembly, 40-inch interface cable, and schematics. Weight: 7 lbs.

Part No. KB270 . . . . $79.95 each

23"L x 5¾"W x 1-3/8"H

MICRO SWITCH 85-KEY KEYBOARD
Word Processing Keyboard, 26 Pin Edge Card Connection. Supply Voltage +5VDC. Main Keyboard is QWERTY. Additional Key Pads for Cursor and word processing functions.
Part No. 85SD18-1 . . . . $29.95 each

3"L x 3"W x 1½"H

HI-TEK 14-KEY NUMERIC KEYPAD
SPST switching. Charcoal grey keycaps. Mounted on printed circuit board.
Part No. K-14 . . . . $9.95 each

POWER SUPPLY +5VDC @ 1 AMP REGULATED — *Transaction Tech*
Output +5VDC @ 1A (also +30VDC) reg. Input 115VAC 60Hz. 2-tone (black/beige) self-enclosed case. 6 ft., 3 cond. black power cord. 6½"W x 7"D x 2¼"H. Wt. 3 lbs. Data sheet incl.
Part No. PS51194S . . . . $14.95 each

POWER SUPPLY +5VDC @ 3 AMP REGULATED — *Deltron*
Input: 115VAC, 47-440Hz. Output: 5VDC Adjustable @ 3 amp, 6VDC @ 2.5 amp. Adjustable current limit, Ripple & Noise: 1MV rms, 5MV p-p — 2 mounting surfaces. UL recognized. Size: 4"W x 4½"L x 2-7/16"H - wt. 2 lbs. Data sheet included.
Part No. QPS-1 . . . . $29.95 each

POWER SUPPLY +5VDC @ 7.5 AMP, 12VDC @ 1.5 AMP SWITCHING
Input: 115VAC, 50-60Hz @ 3 amp/230VAC, 50Hz @ 1.6 amp. Fan volt./power supply select switches (115/230VAC). Output: 5VDC @ 7.6 amp. 12VDC @ 1.6 amp. 8 ft. blk. pow. cord. 11½"W x 13¾"D x 3¾"H. Wt. 6 lbs.
Part No. PS94VOS . . . . $39.95 each

POWER SUPPLY 4-Channel Switching - Apple Compatible
FOR USE AS AN EXTERNAL POWER SUPPLY FOR APPLE
Microprocessor, mini-computer, terminal, medical equipment and process control applications. Input: 90-130VAC 47-440Hz. Output: +5VDC @ 5A, -5VDC @ 1A; +12VDC @ 1A, -12VDC @ 1A. Line reg.: ±0.2%. Ripple: 30mV p-p. Load reg.: ±1%. Overcurrent protection. Adj: 5V main output ±10%. 6-3/8"L x 1-7/8"W x 4-15/16"H. Wt. 1½ lbs.
Part No. FCS-604A . . . . $69.95 each

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6½% Sales Tax
Shipping — Add 5% plus $1.50 Insurance
Send S.A.S.E. for Monthly Sales Flyer!

Spec Sheets — 30¢ each
Send $1.00 Postage for your
FREE 1983 JAMECO CATALOG
Prices Subject to Change

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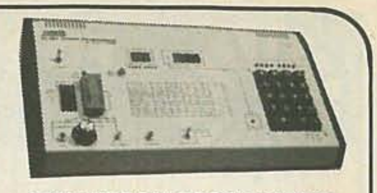

JE664 EPROM PROGRAMMER

8K TO 64K EPROMS — 24 AND 28 PIN PACKAGES

— PROGRAMS 2716's IN 16 SECONDS —
— PROGRAMS 2764's IN 64 SECONDS —

• Programs, validates, and checks for properly erased EPROMs • Emulates PROMs or EPROMs • RS232C Computer Interface for editing/program loading • Loads data into RAM by keyboard • Changes data in RAM by keyboard • Loads RAM from an EPROM • Compares EPROMs for content differences • Copies EPROMs • Power input: 115VAC, 60Hz, ◄ 10W power consumption • Enclosure: Color-coordinated, light tan panels w/molded mocha brown end pieces • Size: 15-5/8"L x 8¾"D x 3½"H • Weight: 5¾ lbs.

JE664-A EPROM Programmer $995.00
Assembled & Tested (Includes JM16A Module)

JE665 — RS232C INTERFACE OPTION — The JE665 RS232C Interface Option implements computer access to the JE664's RAM. Sample software written in BASIC provided for TRS-80® Model I, Level II Computer. Baud rate: 9600. Word lgth: 8 bits - odd parity. Stop bits: 2. Option may be adapted to other computers. The JE665 can be interfaced to any computer with an RS232 port. Information is also provided for interfacing to any CP/M system with an RS232 port.

JE664-ARS EPROM Prog. w/JE665 Option $1195.00
Assembled and Tested (Includes JM16A Module)

EPROM JUMPER MODULES — The JE664's JUMPER MODULE (Personality Module) is a plug-in Module that pre-sets JE664 for proper programming pulses to the EPROM & configures EPROM socket connections for that particular EPROM.

P/N	EPROM	EPROM MANUFACTURER	PRICE
JM08A	2708	AMD, Motorola, National, Intel, TI	$14.95
JM16A	2716, TMS2516	Intel, Motorola, National, NEC, TI	$14.95
JM16B	TMS2716	Motorola, TI (+5, -12, +12)	$14.95
JM32A	TMS2532	Motorola, TI	$14.95
JM32B	2732	AMD, Fujitsu, NEC, Hitachi, Intel	$14.95
JM32C	2732A (21V)	Fujitsu, Intel	$14.95
JM64A	MCM68764, MCM68L764	Motorola	$14.95
JM64B	2764	Intel	$14.95
JM64C	TMS2564	TI	$14.95
JM64D	HN482764G-4	Hitachi (21V)	$14.95

iii's Black Hole EPROM Eraser

9 Chips — 8 Minutes

The Black Hole EPROM Eraser will completely and safely erase 9 EPROMs in less than 8 minutes. The Black Hole is a fully automatic cassette loading eraser featuring U-shaped 4000 hr. UV lamps mounted in a special ALZAK (UV reflectivity of .9) parabolic light tunnel. In operation, the user slips in an anti-static Bug Box (3 ea. incl.) containing the EPROMs to be erased into the loading slot on the front panel of Black Hole. The rest is fully automatic. The Black Hole latches the Bug Box into place, turns on the UV lamps and starts its fully solid state (CMOS) UV integration dose timer. The percentage erasure time is monitored and displayed on a front panel LED readout. At the end of the erase cycle, the Black Hole ejects the Bug Box containing the 9 erased EPROMs and turns off power.

PART NO.		PRICE
ULV-008	Replacement Lamp for ERS-008	$29.95
ERS-008	Eraser, Auto Eject & LED Readout	$249.95

IBM MEMORY EXPANSION KIT

SAVE HUNDREDS OF $$$ BY UPGRADING MEMORY BOARDS YOURSELF!

Most of the popular memory boards allow you to add an additional 64K, 128K, 192K, or 256K. The IBM64K Kit will populate these boards in 64K byte increments. The kit is simple to install — just insert the nine 64K RAM chips in the provided sockets and set the two groups of switches. Directions are included.

IBM64K (Nine 200ns 64K RAMs) $59.95

EXPAND YOUR MEMORY

TRS-80 to 16K, 32K, or 48K

**Model 1 = From 4K to 16K Requires (1) One Kit
Model 3 = From 4K to 48K Requires (3) Three Kits
Color = From 4K to 16K Requires (1) One Kit

**Model 1 equipped with Expansion Board up to 48K Two Kits Required — One Kit Required for each 16K of Expansion —

TRS-16K3 *200ns for Color & Model III $12.95
TRS-16K4 *250ns for Model I $10.95

TRS-80 Color 32K or 64K Conversion Kit

Easy to install kit comes complete with 8 ea. 4164-2 (200ns) 64K dynamic RAMs & conversion documentation. Converts TRS-80 color computers with E circuit boards, & all new color computers to 32K. Minor modifications of 32K memory will allow the use of all the 64K of the dynamic RAM providing you have a FLEX DOS operating system.

TRS-64K2 . . . . $54.95

5¼" Mini-Floppy Disk Drive

FOR TRS-80 MODEL I - COLOR COMPUTER

Pertec Computer Corp.

Features single or double density. Recording mode: FM single, MFM double density. Seek time: 25msec. track to track. Power: +12VDC (±0.6V) 1.6A max., +5VDC (±0.25V) 0.8A max. Unit as pic. at right does not incl. case, power supply, cables). 30-pg. data book incl. Wt. 3½ lbs. Size: 5¾"W x 8"D x 3¼"H.

Part No.	*Limited Quantity!*	Price
FD200	Single-sided, 40 tracks, 250K bytes capacity	$179.95
FD250	Double-sided, 35 tracks, 438K bytes capacity	$199.95

8" FLOPPY DISK DRIVE

- Shugart 801R compatible
- Single-Sided
- 77 Tracks
- 400/800K Bytes Capacity
- Industry Standard

The FDD100-8 8" Floppy Disk Drive (Industry Standard) features single or double density. Recording mode: FM single, MFM double density. Transfer rate: 250K bits/sec. single density; 500K bits/sec. double density. The FDD100-8 is designed to work with the single-sided soft sectored IBM Diskette I, or eq. disk cartridge. Power: 115VAC @ 50-60Hz, +24VDC @ 1.7 amps max., +5VDC @ 1.2 amps max. Unit as pictured above (does not include case, power supply, or cables). Size: 8.55"W x 14"L x 4.5"H. Weighs 12 lbs. Incl. 96-pg. manual.

Part No. — Price

FDD100-8 . . $169.95 ea.

CIRCLE 20 ON FREE INFORMATION CARD

WE HAVE QUALITY PARTS, DISCOUNT PRICES AND *FAST* SHIPPING!

TRANSFORMERS

120 volt primaries

5.6 VOLTS at 750 MA	$3.00
6 VOLTS at 150 MA	$1.25
16.5 V. at 3 AMPS	$6.50
18 V at 650 MA	$3.50
18 VOLTS at 1 AMP	$4.50
18 V.C.T. at 2 AMP	$5.50
24 VOLTS at 250 MA	$2.50
24 VCT at 1 AMP	$4.50
42 V.C.T. at 1.2 AMP	$4.50

WALL TRANSFORMER

ALL ARE 115 VAC PLUG IN

4 VDC at 70 MA	$2.50
9 VDC at 225 MA	$3.00
16.5 VAC at 10 VA	$3.50
17 VAC at 500 MA	$4.00
22 VDC at 60 MA	$2.50

2K 10 TURN

MULTI-TURN POT
SPECTROL #MOD 534-7161
$5.00 EACH

VARACTOR DIODE

BB-103 3 for $1.00
33 PF 100 FOR $30.00

HELPING HAND

WILL HOLD P.C. BOARD OR OTHER SMALL ITEMS AND ALLOW BOTH YOUR HANDS FREEDOM TO WORK.
$6.50 EACH

BLACK PLASTIC CASE

PAC-TEC SERIES C

BLACK PLASTIC ENCLOSURE ADJUSTABLE HEIGHT FROM 1.63" TO 2.93"; WIDTH 6.85"; DEPTH 8". BUILT-IN STAND OFFS FOR P.C. BOARDS . . FRONT AND BACK PANELS NOT INCLUDED . .
$5.25 PER CASE

MIKE CONNECTOR

5 CONDUCTOR IN-LINE PLUG AND CHASSIS MOUNT JACK. TWIST LOCK STYLE, SAME AS SWITCHCRAFT 12CL5M.
$2.50 PER SET

CRYSTAL

CASE STYLE HC33/U
2 MHZ **$3.50 EACH**

S.C.R.

0.8 AMPS 30 VOLTS
5 for $1.00
4 AMPS 200 VOLTS
65¢ EACH
4 AMPS 400 VOLTS
75¢ EACH
12 AMPS 400 VOLTS
$1.00 EACH

TRIAC

6 AMPS 400 VOLTS
75¢ EACH

TRANSISTORS

2N706	5 for $1.00
2N2222A	4 for $1.00
PN2222	8 for $1.00
2N2904	4 for $1.00
2N2905	4 for $1.00
2N2907	4 for $1.00
MJ3030	$2.50
2N3055	$1.00
2N3585	$1.00
2N3904	5 for $1.00
2N3906	5 for $1.00
2N4401	5 for $1.00
2N4403	5 for $1.00
2N4898	$1.50
D43C8	2 for $1.00
D44C2	.75
TIP 31	.75
TIP 32	.75
TIP 121	.75
TIP 126	.75

MICROWAVE TRANSISTOR

MRF 901 REDUCED TO
N.P.N. SILICON **$2.00 EACH**

LIGHTS

GRAIN OF WHEAT

T1 SIZE
.125" DIA. (3.15mm)

3 to 6 VOLTS 3 for $1.00
Rated: 55ma @ 5 VOLTS
6 to 12 VOLTS 3 for $1.00
Rated: 55ma @ 8 VOLTS
12 to 24 VOLTS 3 for $1.00
Rated: 45ma @ 14 VOLTS

T1 SIZE WITH WIRE LEADS

3 to 6 VOLTS 2 for $1.00
Rated: 55ma @ 5 VOLTS
6 to 12 VOLTS 2 for $1.00
Rated: 55ma @ 8 VOLTS
12 to 24 VOLTS 2 for $1.00
Rated: 45ma @ 14 VOLTS

T1- 3/4 SIZE WITH WIRE LEADS

.163" DIA. (4.14mm)

3 to 6 VOLTS 2 for $1.00
Rated: 45ma @ 6 VOLTS
6 to 12 VOLTS 2 for $1.00
Rated: 55ma @ 8 VOLTS
12 to 24 VOLTS 2 for $1.00
Rated: 45ma @ 14 VOLTS

NEON W/ RESISTOR

DIRECT OPERATION FROM 120 VOLT
7 for $1.00

120V INDICATOR

NEON INDICATOR, RATED 120 V 1/3 W. MOUNTS IN 5/16" HOLE . . . RED LENS.
75¢ EACH
10 FOR $7.00
100 FOR $65.00

SOLDERING IRON STAND

SPRING STEEL IRON HOLDER ON WEIGHTED BASE.
$5.00 EACH

12 VOLT A.C. POWER UNIT

THIS UNIT CONSISTS OF A 12 VOLT 2 AMP TRANSFORMER, 1 AMP CIRCUIT BREAKER, 4 PRONG CINCH JONES SOCKET AND A 3 WIRE A.C. CORD ALL MOUNTED IN AN ATTRACTIVE 4½" x 5½" x 3" CHASSIS BOX. GOOD FOR PARTS OR A NICE START FOR D.C. POWER SUPPLY. **$8.50 PER UNIT**

METERS

0 - 20 V.D.C.

0 -20 VDC FULL SCALE FACEPLATE BATTERY TEST SET-UP AS INDICATOR
$5.50 EACH

1 MA

2 5/16" SQUARE PANEL METER MOUNTS IN 2 1/8" HOLE
$5.50 EACH

0 - 15 V.D.C.

THIS 2-1/4" SQUARE METER MEASURES 0-15 VDC.
$4.50 EACH

METAL OXIDE VARISTOR

2 FOR $1.50
G.E. # V82ZA12
50 VOLTS, NOMINAL D.C. VOLTAGE. 5/8" DIAMETER.

SWITCHES

MINI-PUSH BUTTON

S.P.S.T. MOMENTARY NORMALLY OPEN 1/4" BUSHING
35¢ EACH
10 FOR $3.25
100 FOR $30.00
SPECIFY COLOR: RED, BLACK, WHITE, GREEN, YELLOW

KEY SWITCH

S.P.S.T.
4 AMPS @ 125 VAC
KEY REMOVES BOTH POSITIONS
$3.50 EA

LIGHTED PUSH BUTTON

RED LIGHTED 120 VAC 10 AMP S.P.S.T.
"POWER" PRINTED ON FACE. MOUNTS IN 7/8" SQUARE HOLE . .
$1.50 EA 10 FOR $13.50

2 CHANNEL LIGHT ORGAN

EASILY HOOKS INTO STEREO SPEAKERS AND ALLOWS 110 VAC LIGHTS TO DANCE WITH MUSIC. TWO SEPARATE 110 VAC OUTPUTS FOR HIGH AND LOW FREQUENCY AUDIO SIGNALS. USE TWO ORGANS FOR STEREO . . .
$6.50 PER UNIT
COLOR LIGHT STRING AVAILABLE **$1.75 EA**

FREE! FREE! FREE! *SEND FOR* NEW LARGER! *48 PAGE CATALOG* FREE! FREE! FREE!

POWER SUPPLY

REGULATED FULLY ADJUSTABLE 5 VDC AT 3 AMPS.
$18.50 EACH

LINE CORDS

TWO WIRE

6' 18ga TWO WIRE
3 FOR $1.00

THREE WIRE

18 INCH 18ga THREE WIRE
2 for $1.00
8 FOOT 18ga THREE WIRE
$2.00 EACH

KEY ASSEMBLY

5 KEY

$1.00 EACH
CONTAINS 5 SINGLE-POLE NORMALLY OPEN SWITCHES. MEASURES 3 3/4" LONG.

6 KEY

$1.25 EACH
CONTAINS 6 SINGLE-POLE NORMALLY OPEN SWITCHES. MEASURES 4 1/4" LONG.

SLIDE POTS

100K linear tape
2" LONG
1 5/8" TRAVEL **75¢ EACH**

500K linear taper
2 7/8" LONG
1 3/4" TRAVEL **75¢ EACH**

DUAL 100K audio taper
3 1/2" LONG
2 1/2" TRAVEL. **$1.50 EACH**

RELAYS

6 VDC RELAY

MINIATURE D.P.D.T.
3 AMP CONTACTS
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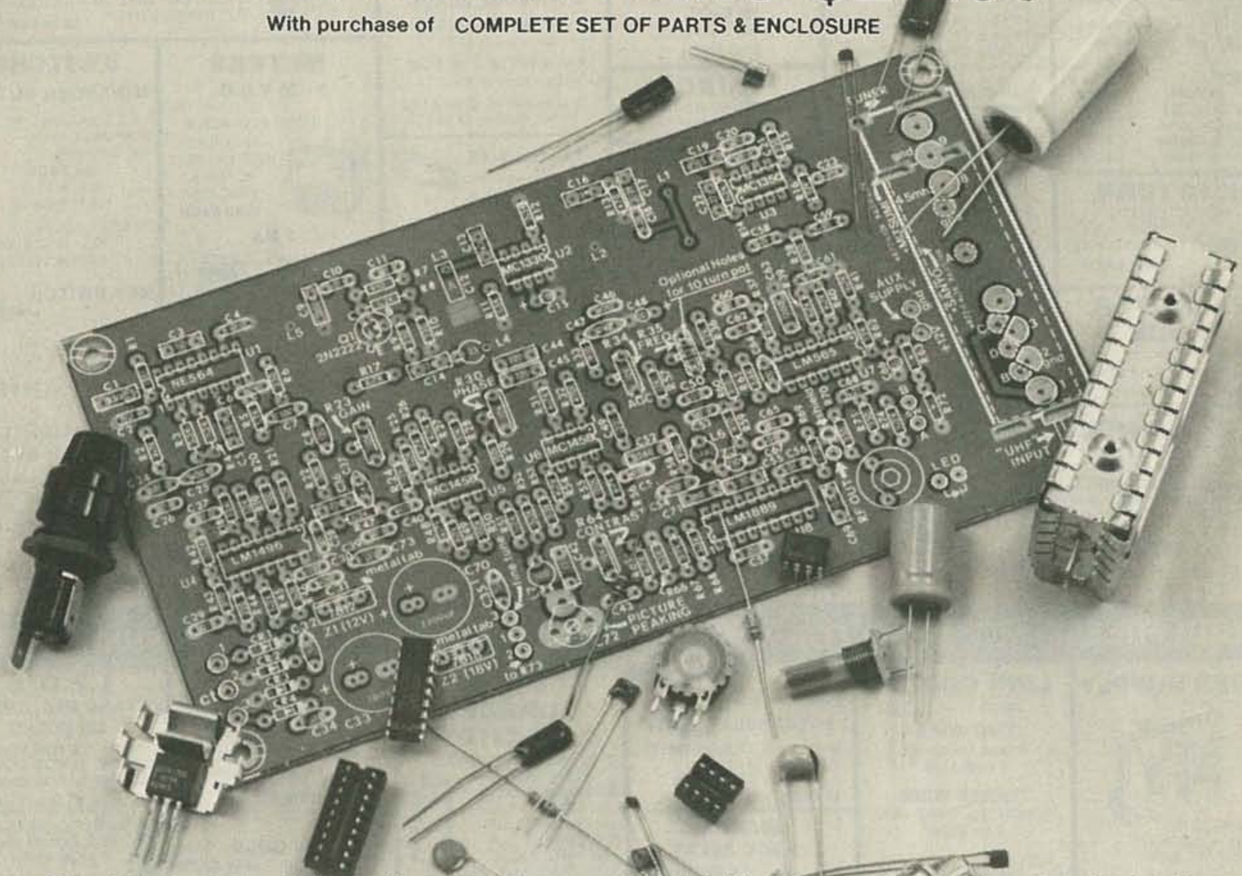

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74LS10	.23	74LS138	.53	74LS275	3.33
74LS11	.25	74LS139	.53	74LS279	.47
74LS12	.25	74LS145	1.18	74LS280	1.96
74LS13	.39	74LS147	2.47	74LS283	.67
74LS14	.39	74LS148	1.33	74LS290	.87
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74S08	.40	74S135	1.10	74S194	1.10
74S10	.30	74S138	1.25	74S240	1.00
74S11	.35	74S139	1.10	74S241	1.50
74S15	.40	74S140	1.70	74S257	1.30
74S20	.40	74S151	1.25	74S258	1.30
74S30	.40	74S153	.95	74S260	1.50
74S32	.40	74S157	1.25	74S280	1.75
74S74	.70	74S158	1.25	74S373	2.25
		74S161	1.75	74S374	1.75

TTL IC SERIES

7400	.24	7472	.30	74612	.60
7401	.24	7473	.35	74163	.60
7402	.24	7474	.32	74164	.60
7403	.24	7475	.40	74165	.60
7404	.24	7476	.35	74166	.70
7405	.24	7480	.45	74170	1.60
7406	.45	7483	.50	74173	.75
7407	.55	7485	.55	74174	.65
7408	.24	7486	.35	74175	.60
7409	.18	7489	1.90	74176	.75
7410	.24	7490	.35	74180	1.90
7411	.24	7491	.45	74182	.45
7412	.30	7492	.45	74190	.70
7413	.35	7493	.35	74191	.75
7414	.45	7494	.60	74193	.79
7416	.25	7495	.55	74194	.85
7417	.25	7496	.60	74195	.45
7420	.24	74107	.30	74196	.75
7425	.25	74116	1.50	74221	1.00
7426	.25	74121	.29	74273	.85
7427	.25	74122	.39	74279	.60
7430	.24	74123	.42	74298	.65
7432	.32	74126	.45	74365	.65
7437	.32	74145	.60	74367	.65
7438	.32	74148	1.10	74390	.90
7440	.24	74150	1.10	75324	1.75
7441	.75	74151	.50	75325	1.50
7442	.45	74153	.40	75492	1.05
7445	.65	75154	1.10	9601	.75
7446	.65	74155	.50	9602	.75
7447	.65	74157	.50	8T26	1.00
7448	.65	74160	.85	8T28	1.25
7450	.24	74161	.65	8T97	.90
				8T98	.90

4164-2 — $5.50
4164-2 — 100/$500.00
4116-2 — 100/$90.00
2114-2 — 100/$100.00

2N3820 P FET	$ .45
2N 5457 N FET	$ .45
2N2646 UJT	$ .45
ER 900 TRIGGER DIODES	4/$1.00
2N 6028 PROG. UJT	$ .65

LINEAR CIRCUITS

DAQ08EQ — 3.75	LF356 — 1.00	747 — .50
TL062 CP — .96	LM358 — .50	CA758 — 1.75
TL064 CN — 1.50	LM361 — 1.75	LM1310 — 1.60
TL084 — 1.50	LM370 — 1.60	1456 — .80
LM201 — .75	LM377 — 1.60	1458 — .50
LM301/748 — .30	LM380 — .85	LM1808 — 1.75
LM307 — .30	LM386 — .85	LM2901 — .95
LM308 — .65	LM387 — 1.25	CA3018 — 1.95
LM310 — 1.10	LM393 — .75	CA3078AT — 1.50
LM311 — .50	LM555 — .34	CA3086 — .75
LM318 — .75	LM556 — .65	CA3089E — 1.75
LM324 — .55	565 — .95	AD2700LD — 4.95
LM339 — .65	566 — 1.25	CA3140 — 1.00
LM348 — .90	567 — .85	3900 — .45
LF351 — .55	709C — .35	4136 — .85
LF353 — .90	711CH — .40	N5596A — 1.50
LF355 — .90	741CV — .40	D6303B — 1.75
		8038CC — 3.90
		LM13080 — .95
		8700CJ — 5.95

DISC CAPACITORS

.1UF 16V	10/$1.00	100/$8.00
.01UF 35V	16/$1.00	100/$5.00

PRINTED CIRCUIT BOARD
4" × 6" DOUBLE SIDED EPOXY BOARDED 1/16" THICK
$.60 ea. .... 5/$2.60

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106D — SPDT — .80
206D — DPDT — 1.20
206P — DPDT — CENTER OFF $1.40

IN4148 (IN914) 15/1.00

L1411-IR DETECTOR	3/$1.00
FP 100 PHOTO TRANS	$ .50
RED LED's .2"	8/$1.00
YEL, GREEN or AMBER LARGE LED's .2"	6/$1.00
RED-GREEN BIPOLAR LED	$ .90
RED-YELLOW BIPOLAR LED	$ .90
MLED92 IR LED	$ .40
MRD14B PHOTO DARL. XTOR	$ .50
MCT2 OPTO ISOLATORS	$ .60
4N26 OPTO ISOLATOR	$ .40
1 WATT ZENERS: 3.3, 4.7, 5.1, 5.6, 6.8, 8.2, 9.1, 10, 12, 15, 18, or 22V	6/$1.00

FULL WAVE BRIDGE

PRV	2A	6A	25A
100			1.40
200	.80	1.30	2.20
400	1.00	1.65	3.30
600	1.30	1.90	4.40

12V DC RELAYS TTL SIZE
S.P. 1200 ohm coil .75
D.P. 400 ohm coil .95

SILICON POWER RECTIFIERS

PRV	1A	3A	12A	50A	125A	240A
100	.05	.14	.35	.90	4.25	6.00
200	.06	.17	.50	1.30	5.25	9.00
400	.09	.25	.65	1.50	6.50	12.00
600	.11	.30	.80	2.00	8.50	15.00
800	.13	.35	1.00	2.50	10.50	18.00
1000	.20	.45	1.25	3.00	12.50	26.00

74LS SERIES

74LS00	.35	74LS109	.55	74LS240	1.10
74LS01	.35	74LS112	.50	74LS241	1.10
74LS02	.33	74LS113	.60	74LS242	1.10
74LS03	.33	74LS114	.65	74LS243	1.10
74LS04	.40	74LS123	.85	74LS244	1.30
74LS05	.38	74LS125	.60	74LS245	1.75
74LS08	.40	74LS126	.60	74LS446	.95
74LS09	.40	74LS132	.75	74LS247	.90
74LS10	.40	74LS136	.55	74LS248	1.10
74LS11	.40	74LS137	.95	74LS251	.70
74LS12	.40	74LS138	.70	74LS253	.70
74LS13	.55	74LS139	.70	74LS257	.70
74LS14	.50	74LS147	1.95	74LS258	.80
74LS15	.50	74LS151	.70	74LS259	1.00
74LS20	.40	74LS153	.70	74LS266	.70
74LS21	.40	74LS154	2.40	74LS273	1.15
74LS22	.40	74LS155	.80	74LS279	.80
74LS26	.55	74LS156	.80	74LS280	1.80
74LS27	.40	74LS157	.80	74LS283	.80
74LS28	.50	74LS158	.80	74LS290	.90
74LS30	.40	74LS160	.90	74LS293	.90
74LS32	.40	74LS161	.90	74LS298	.90
74LS37	.40	74LS162	.90	74LS320	2.00
74LS38	.40	74LS163	.90	74LS323	3.50
74LS40	.40	74LS164	.90	74LS365	.70
74LS42	.55	74LS165	.90	74LS366	.70
74LS47	.80	74LS166	1.90	74LS367	.70
74LS51	.40	74LS169	2.50	74LS368	.70
74LS54	.40	74LS170	1.90	74LS373	1.20
74LS73	.55	74LS173	.90	74LS374	1.20
74LS74	.55	74LS174	.90	74LS377	1.50
74LS75	.55	74LS175	.90	74LS386	.60
74LS76	.55	74LS181	1.95	74LS390	1.10
74LS83	.80	74LS190	.90	74LS393	1.10
74LS85	.90	74LS191	.90	74LS398	2.50
74LS86	.60	74LS192	.90	74LS625	1.75
74LS90	.55	74LS193	.90	74LS668	1.50
74LS92	.70	74LS194	.90	74LS670	1.20
74LS93	.70	74LS195	.90	81LS97	1.20
74LS96	.80	74LS196	.90	81LS98	1.20
74LS107	.55	74LS197	.90		
		74LS221	1.10		

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GRAY
28 gauge
26 conductor .60/ft
40 conductor .90/ft
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CTS 206-4	4 POSITION	.75
CTS 206-7	7 POSITION	.95
CTS 206-8	8 POSITION	.95
CTS 206-10	10 POSITION	1.25

DIP SOCKETS

8 PIN	.10	20 PIN	.25
14 PIN	.12	22 PIN	.25
16 PIN	.15	24 PIN	.25
18 PIN	.20	28 PIN	.35
		40 PIN	.40

REGULATORS

LM338K $5.75	323K (LA1406) $1.75
LM317T $1.35	LM305G .... $ .75
78L05, 78L12 ..... $ .40	340T-5, 6, 8, 9, 12, 15, 18 or 24V ... $ .75
723 .... $ .50	LAS1412 + 12V 3A $3.95
320T 5, 12, 15 or 24 $ .85	
LM 337T $1.95	

TANTALUM CAPACITORS

.22UF 35V	5/$1.00	15UF 16V	3/$1.00
.47UF 35V	5/$1.00	30UF 6V	5/$1.00
.68UF 35V	5/$1.00	33UF 15V	$ .50
1UF 20V	5/$1.00	47UF 20V	$ .85
2.2UF 20V	5/$1.00	68UF 16V	$1.00
3.3UF 20V	4/$1.00	120UF 6V	$ .75
4.7UF 35V	4/$1.00	200UF 20V	$1.75
6.8UF 20V	4/$1.00	150UF 16V	$1.30
10UF 20V	— $ .40	330UF 10V	$1.75
22UF 10V	— $ .30		

MULTI TURN TRIM POTS
50 OHM, 100 OHM, 500 OHM, 1000 OHM, 5K, 10K, 500K — 3/$2.00

WIRE WRAP SOCKETS

14 PIN	.45
16 PIN	.50
18 PIN	.65
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24 PIN	1.10
28 PIN	1.25
40 PIN	1.50

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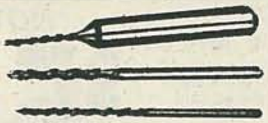

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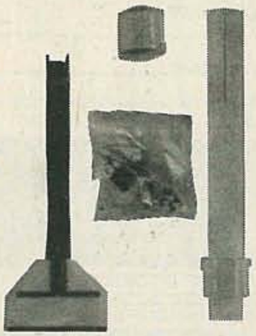
COMPLETE



- P.V.C.
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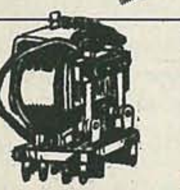
10" FIBERGLASS SCREW DRIVER

with Plastic Handle

3/$1.00

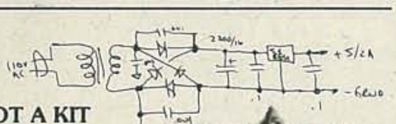


Latching Relay

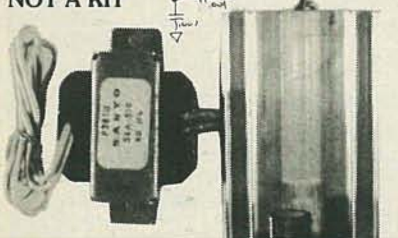
$4.95

24V Coil

110V @ 15A D.P.S.T.



NOT A KIT



Regulated Supply 5V, 2A

w/Transformer and 4" x 2.3" Heat Sink

$5.50 each -or- 2/$10.00

Items MC, VISA, COD via UPS

(Plus Shipping/Handling)

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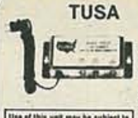

Use of this unit may be subject to rules by your local cable TV Co.

A WHOLE NEW WORLD OF TV VIEWING WITH TUSA'S NEW MODEL CVU-40, 40 CHANNEL CABLE TV CONVERTER

Receive all the EXTRA CABLE TV "MIDBAND" & SUPERBAND CHANNELS on your UHF DIAL.

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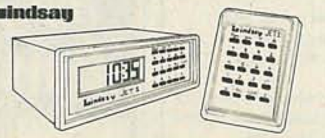

52 CHANNEL WIRELESS REMOTE CATV CONVERTER

• Micro computer technology locks in picture and prevents drift • 52 channel selections • Programmable time on & off • 24 hour LED digital clock • Favorite channel memory & recall plus scan • Wireless hand held "infra-red" transmitter system • Automatic fine tune • Adaptable to any brand of television •

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SPECIAL PRICE! $94.00 ea.

B+K PRECISION

COLORMAX

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2 pc. REMOTE CONTROL MODEL CM35-2P

UHF TUNERS

45 MHz Output

Click Stop Detent Tune model. Excellent for replacement use or experimental work building UHF receivers for ham or TV.

WHILE THEY LAST

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TOP QUALITY
NO SECONDS

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NE-564N	Digital Phase Locked Loop	3.50	2.69
LM-565N	Phase Locked Loop	1.49	.99
LM-733N	Video Amp	1.69	.98
MC-1330	Video Detector	2.29	1.69
MC-1349	Video If Amp	2.06	1.55
MC-1350	Video If Amp	1.75	1.19
MC-1352	Video If Amp AGC	2.69	2.09
MC-1358	Audio If Amp	1.95	1.64
MC-1374P	R.F. Modulator	3.19	2.39
MC-1458	Dual Comp. Op Amp	.88	.59
MC-1496N	Balanced Mod/Demod	1.79	1.34
LM-1800	PLL Stereo Decoder	2.29	1.99
LM-1889	Video Modulator	2.79	1.95
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LM-7805	5 Volt Positive Volt. Reg.	1.19	.89
LM-7808	8 Volt Positive Volt. Reg.	1.19	.89
LM-7812	12 Volt Positive Volt. Reg.	1.19	.89
LM-7815	15 Volt Positive Volt. Reg.	1.19	.89
LM-7818	18 Volt Positive Volt. Reg.	1.19	.89
LM-7824	24 Volt Positive Volt. Reg.	1.19	.89

WINEGARD 75 OHM UHF YAGI ANTENNAS

12 db GAIN

Specify Channel $8.95 EA.

6 OR MORE $6.95 EA.

OPTIONAL Winegard UHF Antenna Preamp 18db Gain $39.95 ea.

Now Back in Stock! SANYO UHF VARACTOR TUNERS

MODEL 115-B-403A

45 MHz Output

$19.95 EACH

Call for Quantity Price

AC LINE CORDS

18 gauge wire
6 ft. long cable
Prestripped and tinned ends for easy installation.

49¢ ea.

AC-6G 12-Up 39¢ ea.

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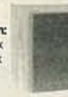

Dimension: 7¾" wide x 9½" high x 5½" deep. Removable 1/8" thick back cover.

Popular speaker cabinets for those famous homebrew TV circuits. Speakers included.

SC001 $10.95 ea.

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VCR-TV 10db VHF/ CABLE/FM SIGNAL AMPLIFIER

#401 50-400 MHz. This one really works! Boosting those weak VHF/ FM, midband & superband cable channels. Standard F connectors for 75 ohm input/output. $9.95 ea.

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Special Purchase MV-2109

33pf Tuning Diode

1-9 ... $.69 ea.
10-Up . .39 ea.

5% MICA CAPS 5%

Price Each

10pf...42¢ 560pf..66¢
43pf...36¢ 1200pf..89¢
110pf...36¢ 3000pf .1.39

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75 OHM CORD SETS

75 ohm RG-59 low loss foam coaxial cable with heavy duty F59 fittings installed on both ends. Specify color — black, white or tan. Special lengths available. Made in U.S.A.

FOR SIMPLE HOOK-UP OF VIDEO RECORDERS, TV SETS, ANTENNA SYSTEMS, ETC.

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(Quantity discounts available)

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24V CT, 500 mA.

$3.19 ea.
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75 OHM CHASSIS MOUNT CONNECTOR

F-61 Female connector. Rear chassis mount with nut. Mates with male "F" connectors.

NOW! 4 for $1.00

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MRF-911 .... 3.46
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(Formerly MRF-902)

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$12.50 ea.

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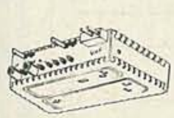
Model PM-1030
75 Ohm
40-900 MHz

Low Loss 3.5-4 db
Low VSWR
Waterproof Housing

1-9 $1.98 ea.
10-Up $1.59 ea.

SONY SURPLUS UHF-VHF VARACTOR TUNERS

These tuners receive all channels 2-83, plus midband cable channels and are perfect for home-brew TV circuits etc. Output Freq. 45 MHz. Hookup data included. Name Brand.



Actual unit may differ from that shown.

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Handles up to 15 watts. 4 Ohms. 3 oz. Ceramic Magnet

$1.89 ea.

10 up $1.49 ea.

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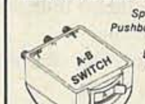
Specify Pushbutton Or Lever Type



For CATV - MATV - VCR
75 ohm - 90 db Isolation

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Toroids - T30-12 .... .46
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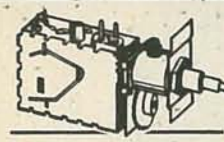

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Frequency Range 470-899 MHz Channels 14-83. Output Channel 3. Ch 2 or 4 Avail.

PART #B20 .... $15.00

WHAT'S IN IT?

To make a regular UHF tuner into a **GILCO HIGH GAIN TUNER**, each and every one of the following steps is painstakingly taken by a certified technician:

1. The first thing GILCO does is change the standard diode to a **hot carrier diode**.
2. The tuner's output is then measured on our JERROLD field strength meter and compared to a computer derived chart from which we determine the correct value coil to add across the IF output for ***maximum pre-peaked gain***.
3. The tuner is then fed a standard 10db 300 ohm antenna input and while monitoring the output on our HEWLETT PACKARD spectrum analyzer, the tuner is tuned to the desired channel and its oscillator is offset for the desired output frequency as follows:

Channel 2: 58 Mhz, Channel 3: 63 Mhz, Channel 4: 68 Hhz

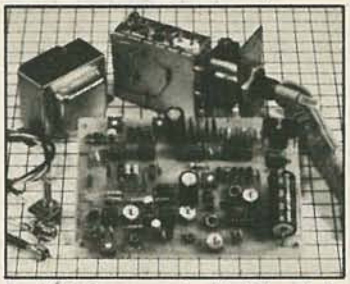
We call this step peaking because the tuner's output looks like a peak on our spectrum analyzer and the highest point of that peak is actually adjusted for the desired output.

4. The last step is one more measurement on the field strength meter which is again compared to our performance chart to calculate the correct value of the second coil which is added to the tuners internal connections.

This procedure was developed by GILCO and it is our computer derived performance charts that make our tuner better, that's because ***almost every tuner gets a different value coil*** before it's peaked and again a different value coil after it's peaked. The combinations are endless and ***the way we determine the values is our secret...***

GILCO PARTS KIT & PRINTED CIRCUIT BOARD

- **Use with GILCO High Gain Tuner**
- **Requires NO Modification to Your Television**
- ***Individually Packaged and Labeled Parts Save Guesswork***



Pre-drilled, pre-screened, plated through the holes P/C board. All hardware, connectors, 22 page illustrated instruction manual, & Gilco Hy-Gain tuner. Kit assembles in just 4 hours.

- The only tools required for assembly are: screwdriver, soldering iron, voltmeter. No drilling is required to the P/C board.
- This kit was designed to take advantage of the GILCO high gain tuner which means its circuitry is ***simpler and more efficient*** than those circuits that require inferior varactor tuners.

FREE 22 Page Instruction Book included with each P/C Board or Parts Kit. This instruction book will guide the builder through every step of the assembly. ***Nearly every page is illustrated***. With this Instruction Book, estimated assembly time is 4 hours.

HERE'S WHAT YOU GET FROM GILCO

Part No. B21 Printed Circuit Board $17.00

1. This Printed Circuit Board uses ***only one jumper, others use nine.***
2. ***The component layout is screen printed*** on the component side of the P/C board.
3. The solder side of the P/C board is covered with high temperature solder resist. This prevents solder bridges.
4. ***Newest Addition:* the P/C board is plated through the holes**. This allows for easier and more positive soldered contact between the parts and the P/C board.

Part No. B22 Complete Electronic Parts Kit $80.00

All resistors (30), Potentiometers (1-5K, 3-10K), Panel Mount Potentiometer (10K), Electrolytic Capacitors (6), Ceramic and Mylar Disc Capacitors (35), Variable Capacitors (4), All Integrated Circuits (7), Voltage Regulator, Heat Sink, Diodes (4), IC Sockets (4-8 pin, 3-14 pin), Power Transformer (24V, 1A), Coil Kit with No. 26 wire (4), Speaker (4", 3oz.), Standoffs, Coaxial Cable, All Miscellaneous Harware, Etc. All parts are individually packaged and labeled.

All components including the Wire, Hardware, Coaxial Cable and Heat Sinks are included in the parts kit. This means your assembly time from start to finish is just 4 hours.

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#A02 New 2 stage, low noise, 28db gain, RF Amplifier Kit.................. Kit $18.00

#A03 New 1 stage, low noise, 14db gain, RF Amplifier Kit.................. Kit $10.50

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PRICES

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CT-90 Kit, 90 day parts warranty	109.95
AC-1 AC adapter	3.95
BP-1 Nicad pack +AC Adapter/Charger	12.95
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External time base input	14.95

The CT-90 is the most versatile, feature packed counter available for less than $300.00! Advanced design features include; three selectable gate times, nine digits, gate indicator and a unique display hold function which holds the displayed count after the input signal is removed! Also, a 10mHz TCXO time base is used which enables easy zero beat calibration checks against WWV. Optionally, an internal nicad battery pack, external time base input and Micro-power high stability crystal oven time base are available. The CT-90, performance you can count on!

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 10 MV to 150 MHz Less than 50 MV to 500 MHz
Resolution:	0.1 Hz (10 MHz range) 1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	9 digits 0.4" LED
Time base:	Standard-10.000 mHz, 1.0 ppm 20-40°C. Optional Micro-power oven-0.1 ppm 20-40°C
Power:	8-15 VAC @ 250 ma

7 DIGITS 525 MHz $99.95 WIRED

SPECIFICATIONS:

Range:	20 Hz to 525 MHz
Sensitivity:	Less than 50 MV to 150 MHz Less than 150 MV to 500 MHz
Resolution:	1.0 Hz (5 MHz range) 10.0 Hz (50 MHz range) 100.0 Hz (500 MHz range)
Display:	7 digits 0.4" LED
Time base:	1.0 ppm TCXO 20-40°C
Power:	12 VAC @ 250 ma

The CT-70 breaks the price barrier on lab quality frequency counters. Deluxe features such as; three frequency ranges - each with pre-amplification, dual selectable gate times, and gate activity indication make measurements a snap. The wide frequency range enables you to accurately measure signals from audio thru UHF with 1.0 ppm accuracy - that's .0001%! The CT-70 is the answer to all your measurement needs, in the field, lab or ham shack.

PRICES:

CT-70 wired, 1 year warranty	$99.95
CT-70 Kit, 90 day parts warranty	84.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC adapter/charger	12.95

7 DIGITS 500 MHz $79.95 WIRED

PRICES:

MINI-100 wired, 1 year warranty	$79.95
AC-Z Ac adapter for MINI-100	3.95
BP-Z Nicad pack and AC adapter/charger	12.95

Here's a handy, general purpose counter that provides most counter functions at an unbelievable price. The MINI-100 doesn't have the full frequency range or input impedance qualities found in higher price units, but for basic RF signal measurements, it can't be beat! Accurate measurements can be made from 1 MHz all the way up to 500 MHz with excellent sensitivity throughout the range, and the two gate times let you select the resolution desired. Add the nicad pack option and the MINI-100 makes an ideal addition to your tool box for "in-the-field" frequency checks and repairs.

SPECIFICATIONS:

Range:	1 MHz to 500 MHz
Sensitivity:	Less than 25 MV
Resolution:	100 Hz (slow gate) 1.0 KHz (fast gate)
Display:	7 digits, 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	5 VDC @ 200 ma

8 DIGITS 600 MHz $159.95 WIRED

NEW READ RECEIVER FREQUENCY

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 25 mv to 150 MHz Less than 150 mv to 600 MHz
Resolution:	1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	8 digits 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	110 VAC or 12 VDC

The CT-50 is a versatile lab bench counter that will measure up to 600 MHz with 8 digit precision. And, one of its best features is the Receive Frequency Adapter, which turns the CT-50 into a digital readout for any receiver. The adapter is easily programmed for any receiver and a simple connection to the receiver's VFO is all that is required for use. Adding the receiver adapter in no way limits the operation of the CT-50, the adapter can be conveniently switched on or off. The CT-50, a counter that can work double-duty!

PRICES:

CT-50 wired, 1 year warranty	$159.95
CT-50 Kit, 90 day parts warranty	119.95
RA-1, receiver adapter kit	14.95
RA-1 wired and pre-programmed (send copy of receiver schematic)	29.95

DIGITAL MULTIMETER $99.95 WIRED

PRICES:

DM-700 wired, 1 year warranty	$99.95
DM-700 Kit, 90 day parts warranty	79.95
AC-1, AC adaptor	3.95
BP-3, Nicad pack +AC adapter/charger	19.95
MP-1, Probe kit	2.95

The DM-700 offers professional quality performance at a hobbyist price. Features include; 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch LED readout with automatic decimal placement, automatic polarity, overrange indication and overload protection up to 1250 volts on all ranges, making it virtually goof-proof! The DM-700 looks great, a handsome, jet black, rugged ABS case with convenient retractable tilt bail makes it an ideal addition to any shop.

SPECIFICATIONS:

DC/AC volts:	100uV to 1 KV, 5 ranges
DC/AC current	0.1uA to 2.0 Amps, 5 ranges
Resistance:	0.1 ohms to 20 Megohms, 6 ranges
Input impedance:	10 Megohms, DC/AC volts
Accuracy:	0.1% basic DC volts
Power:	4 'C' cells

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CIRCLE 55 ON FREE INFORMATION CARD

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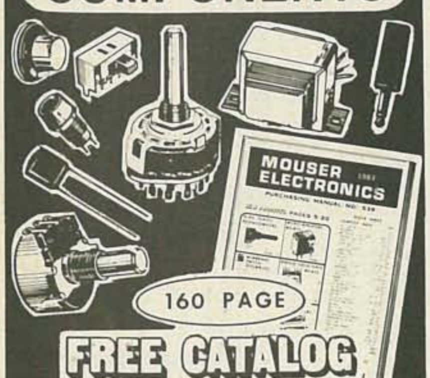

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LP = Low Power Qstat = Quasi-Static

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MC68764	8192 x 8 (450ns) (5v)(24 pin)	39.95
27128	16384x8 Call	Call

5v = Single 5 Volt Supply

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	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320	X	32	15,000	595.00

Z-80

2.5 Mhz	
Z80-CPU	3.95
Z80-CTC	4.49
Z80-DART	10.95
Z80-DMA	14.95
Z80-PIO	4.49
Z80-SIO/0	16.95
Z80-SIO/1	16.95
Z80-SIO/2	16.95
Z80-SIO/9	16.95
4.0 Mhz	
Z80A-CPU	4.95
Z80A-CTC	4.95
Z80A-DART	11.95
Z80A-DMA	16.95
Z80A-PIO	4.95
Z80A-SIO/0	16.95
Z80A-SIO/1	16.95
Z80A-SIO/2	16.95
Z80A-SIO/9	16.95
6.0 Mhz	
Z80B-CPU	11.95
Z80B-CTC	13.95
Z80B-PIO	13.95
Z80B-DART	19.95

ZILOG

Z6132	34.95
Z8671	39.95

CRYSTALS

32.768 khz	1.95
1.0 mhz	4.95
1.8432	4.95
2.0	3.95
2.097152	3.95
2.4576	3.95
3.2768	3.95
3.579535	3.95
4.0	3.95
5.0	3.95
5.0688	3.95
5.185	3.95
5.7143	3.95
6.0	3.95
6.144	3.95
6.5536	3.95
8.0	3.95
10.0	3.95
10.738635	3.95
14.31818	3.95
15.0	3.95
16.0	3.95
17.430	3.95
18.0	3.95
18.432	3.95
20.0	3.95
22.1184	3.95
32.0	3.95

CRT CONTROLLERS

6845	14.95
68B45	19.95
HD46505SP	15.95
6847	11.95
MC1372	6.95
68047	24.95
8275	29.95
7220	99.95
CRT5027	39.95
CRT5037	49.95
TMS9918A	39.95
DP8350	49.95

KEYBOARD CHIPS

AY5-2376	11.95
AY5-3600	11.95
AY5-3600 PRO	11.95

8000

8035	5.95
8039	6.95
INS-8060	17.95
INS-8073	24.95
8080	3.95
8085	5.95
8085A-2	11.95
8086	29.95
8087	CALL
8088	39.95
8089	89.95
8155	6.95
8155-2	7.95
8156	6.95
8185	29.95
8185-2	39.95
8741	39.95
8748	24.95
8755	24.95

8200

8202	24.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	19.95
8237-5	21.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	39.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
8288	25.00
8289	49.95

DISC CONTROLLERS

1771	16.95
1791	24.95
1793	26.95
1795	49.95
1797	49.95
2791	54.95
2793	54.95
2795	59.95
2797	59.95
6843	34.95
8272	39.95
UPD765	39.95
MB8876	29.95
MB8877	34.95
1691	17.95
2143	18.95

CONNECTORS

RS232 MALE	2.50
RS232 FEMALE	3.25
RS232 HOOD	1.25
S-100 ST	3.95

6800

68000	59.95
6800	3.95
6802	7.95
6808	13.90
6809E	19.95
6809	11.95
6810	2.95
6820	4.35
6821	3.25
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	11.95
6850	3.25
6852	5.75
6860	9.95
6862	11.95
6875	6.95
6880	2.25
6883	22.95
68047	24.95
68488	19.95
6800 1MHZ	
68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	6.95
68B21	6.95
68B45	19.95
68B50	5.95

68B00 = 2 MHZ

6500

1 MHZ	
6502	4.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	7.95
6532	9.95
6545	22.50
6551	11.85
2 MHZ	
6502A	6.95
6522A	9.95
6532A	11.95
6545A	27.95
6551A	11.95
3 MHZ	
6502B	14.95

UARTS

AY3-1014	6.95
AY5-1013	3.95
AY3-1015	6.95
PT1472	9.95
TR1602	3.95
2350	9.95
2651	8.95
TMS6011	5.95
IM6402	7.95
IM6403	8.95
INS8250	10.95

GENERATORS

BIT-RATE	
MC14411	11.95
BR1941	11.95
4702	12.95
COM5016	16.95
COM8116	10.95
MM5307	10.95
FUNCTION	
MC4024	3.95
LM566	1.49
XR2206	3.75
8038	3.95

74LS00

74LS00	.24	74LS173	.69
74LS01	.25	74LS174	.55
74LS02	.25	74LS175	.55
74LS03	.25	74LS181	2.15
74LS04	.24	74LS189	8.95
74LS05	.25	74LS190	.89
74LS08	.28	74LS191	.89
74LS09	.29	74LS192	.79
74LS10	.25	74LS193	.79
74LS11	.35	74LS194	.69
74LS12	.35	74LS195	.69
74LS13	.45	74LS196	.79
74LS14	.59	74LS197	.79
74LS15	.35	74LS221	.89
74LS20	.25	74LS240	.95
74LS21	.29	74LS241	.99
74LS22	.25	74LS242	.99
74LS26	.29	74LS243	.99
74LS27	.29	74LS244	1.29
74LS28	.35	74LS245	1.49
74LS30	.25	74LS247	.75
74LS32	.29	74LS248	.99
74LS33	.55	74LS249	.99
74LS37	.35	74LS251	.59
74LS38	.35	74LS253	.59
74LS40	.25	74LS257	.59
74LS42	.49	74LS258	.59
74LS47	.75	74LS259	2.75
74LS48	.75	74LS260	.59
74LS49	.75	74LS266	.55
74LS51	.25	74LS273	1.49
74LS54	.29	74LS275	3.35
74LS55	.29	74LS279	.49
74LS63	1.25	74LS280	1.98
74LS73	.39	74LS283	.69
74LS74	.35	74LS290	.89
74LS75	.39	74LS293	.89
74LS76	.39	74LS295	.99
74LS78	.49	74LS298	.89
74LS83	.60	74LS299	1.75
74LS85	.69	74LS323	3.50
74LS86	.39	74LS324	1.75
74LS90	.55	74LS352	1.29
74LS91	.89	74LS353	1.29
74LS92	.55	74LS363	1.35
74LS93	.55	74LS364	1.95
74LS95	.75	74LS365	.49
74LS96	.89	74LS366	.49
74LS107	.39	74LS367	.45
74LS109	.39	74LS368	.45
74LS112	.39	74LS373	1.39
74LS113	.39	74LS374	1.39
74LS114	.39	74LS377	1.39
74LS122	.45	74LS378	1.18
74LS123	.79	74LS379	1.35
74LS124	2.90	74LS385	1.90
74LS125	.49	74LS386	.45
74LS126	.49	74LS390	1.19
74LS132	.59	74LS393	1.19
74LS133	.59	74LS395	1.19
74LS136	.39	74LS399	1.49
74LS137	.99	74LS424	2.95
74LS138	.55	74LS447	.37
74LS139	.55	74LS490	1.95
74LS145	1.20	74LS624	3.99
74LS147	2.49	74LS640	2.20
74LS148	1.35	74LS645	2.20
74LS151	.55	74LS668	1.69
74LS153	.55	74LS669	1.89
74LS154	1.90	74LS670	1.49
74LS155	.69	74LS674	9.65
74LS156	.69	74LS682	3.20
74LS157	.65	74LS683	3.20
74LS158	.59	74LS684	3.20
74LS160	.69	74LS685	3.20
74LS161	.65	74LS688	2.40
74LS162	.69	74LS689	3.20
74LS163	.65	74LS783	24.95
74LS164	.69	81LS95	1.49
74LS165	.95	81LS96	1.49
74LS166	1.95	81LS97	1.49
74LS168	1.75	81LS98	1.49
74LS169	1.75	25LS2521	2.80
74LS170	1.49	25LS2569	4.25

JDR Microdevices

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7400

7400	.19	74132	.45
7401	.19	74136	.50
7402	.19	74141	.65
7403	.19	74142	2.95
7404	.19	74143	2.95
7405	.25	74145	.60
7406	.29	74147	1.75
7407	.29	74148	1.20
7408	.24	74150	1.35
7409	.19	74151	.55
7410	.19	74152	.65
7411	.25	74153	.55
7412	.30	74154	1.25
7413	.35	74155	.75
7414	.49	74156	.65
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7422	.35	74162	.85
7423	.29	74163	.69
7425	.29	74164	.85
7426	.29	74165	.85
7427	.29	74166	1.00
7428	.45	74167	2.95
7430	.19	74170	1.65
7432	.29	74172	5.95
7433	.45	74173	.75
7437	.29	74174	.89
7438	.29	74175	.89
7440	.19	74176	.89
7442	.49	74177	.75
7443	.65	74178	1.15
7444	.69	74179	1.75
7445	.69	74180	.75
7446	.69	74181	2.25
7447	.69	74182	.75
7448	.69	74184	2.00
7450	.19	74185	2.00
7451	.23	74190	1.15
7453	.23	74191	1.15
7454	.23	74192	.79
7460	.23	74193	.79
7470	.35	74194	.85
7472	.29	74195	.85
7473	.34	74196	.79
7474	.33	74197	.75
7475	.45	74198	1.35
7476	.35	74199	1.35
7480	.59	74221	1.35
7481	1.10	74246	1.35
7482	.95	74247	1.25
7483	.50	74248	1.85
7485	.59	74249	1.95
7486	.35	74251	.75
7489	2.15	74259	2.25
7490	.35	74265	1.35
7491	.40	74273	1.95
7492	.50	74276	1.25
7493	.35	74279	.75
7494	.65	74283	2.00
7495	.55	74284	3.75
7496	.70	74285	3.75
7497	2.75	74290	.95
74100	1.75	74293	.75
74107	.30	74298	.85
74109	.45	74351	2.25
74110	.45	74365	.65
74111	.55	74366	.65
74116	1.55	74367	.65
74120	1.20	74368	.65
74121	.29	74376	2.20
74122	.45	74390	1.75
74123	.49	74393	1.35
74125	.45	74425	3.15
74126	.45	74426	.85
74128	.55	74490	2.55

LINEAR

LM301	.34	LM340 (see 7800)		LM566	1.49	LM1800	2.37
LM301H	.79	LM348	.99	LM567	.89	LM1812	8.25
LM307	.45	LM350K	4.95	NE570	3.95	LM1830	3.50
LM308	.69	LM350T	4.60	NE571	2.95	LM1871	5.49
LM308H	1.15	LM358	.69	NE592	2.75	LM1872	5.49
LM309H	1.95	LM359	1.79	LM709	.59	LM1877	3.25
LM309K	1.25	LM376	3.75	LM710	.75	LM1889	1.95
LM310	1.75	LM377	1.95	LM711	.79	LM1896	1.75
LM311	.64	LM378	2.50	LM723	.49	ULN2003	2.49
LM311H	.89	LM379	4.50	LM723H	.55	LM2877	2.05
LM312H	1.75	LM380	.89	LM733	.98	LM2878	2.25
LM317K	3.95	LM380N-8	1.10	LM741	.35	LM2900	.85
LM317T	1.19	LM381	1.60	LM741N-14	.35	LM2901	1.00
LM318	1.49	LM382	1.60	LM741H	.40	LM3900	.59
LM318H	1.59	LM383	1.95	LM747	.69	LM3905	1.25
LM319H	1.90	LM384	1.95	LM748	.59	LM3909	.98
LM319	1.25	LM386	.89	LM1014	1.19	LM3911	2.25
LM320 (see 7900)		LM387	1.40	LM1303	1.95	LM3914	3.95
LM322	1.65	LM389	1.35	LM1310	1.49	LM3915	3.95
LM323K	4.95	LM390	1.95	MC1330	1.69	LM3916	3.95
LM324	.59	LM392	.69	MC1349	1.89	MC4024	3.95
LM329	.65	LM394H	4.60	MC1350	1.19	MC4044	4.50
LM331	3.95	LM399H	5.00	MC1358	1.69	RC4136	1.25
LM334	1.19	NE531	2.95	MC1372	6.95	RC4151	3.95
LM335	1.40	NE555	.34	LM1414	1.59	LM4250	1.75
LM336	1.75	NE556	.65	LM1458	.59	LM4500	3.25
LM337K	3.95	NE558	1.50	LM1488	.69	RC4558	.69
LM337T	1.95	NE561	24.95	LM1489	.69	LM13080	1.29
LM338K	6.95	NE564	2.95	LM1496	.85	LM13600	1.49
LM339	.99	LM565	.99	LM1558H	3.10	LM13700	1.49

H = TO-5 CAN T = TO-220 K = TO-3

RCA

CA 3023	2.75	CA 3082	1.65
CA 3039	1.29	CA 3083	1.55
CA 3046	1.25	CA 3086	.80
CA 3059	2.90	CA 3089	2.99
CA 3060	2.90	CA 3096	3.49
CA 3065	1.75	CA 3130	1.30
CA 3080	1.10	CA 3140	1.15
CA 3081	1.65	CA 3146	1.85
CA 3160	1.19		

TI

TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75110	1.95	75453	.39
75150	1.95	75454	.39
75154	1.95	75491	.79
75188	1.25	75492	.79
75189	1.25	75493	.89
75494	.89		

BI FET

TL071	.79	TL084	2.19
TL072	1.19	LF347	2.19
TL074	2.19	LF351	.60
TL081	.79	LF353	1.00
TL082	1.19	LF355	1.10
TL083	1.19	LF356	1.10
LF357	1.40		

CMOS

4000	.29	4527	1.95
4001	.25	4528	1.19
4002	.25	4531	.95
4006	.89	4532	1.95
4007	.29	4538	1.95
4008	.95	4539	1.95
4009	.39	4541	2.64
4010	.45	4543	1.19
4011	.25	4553	5.79
4012	.25	4555	.95
4013	.38	4556	.95
4014	.79	4581	1.95
4015	.39	4582	1.95
4016	.39	4584	.75
4017	.69	4585	.75
4018	.79	4702	12.95
4019	.39	74C00	.35
4020	.75	74C02	.35
4021	.79	74C04	.35
4022	.79	74C08	.35
4023	.29	74C10	.35
4024	.65	74C14	.59
4025	.29	74C20	.35
4026	1.65	74C30	.35
4027	.45	74C32	.39
4028	.69	74C42	1.29
4029	.79	74C48	1.99
4030	.39	74C73	.65
4034	1.95	74C74	.65
4035	.85	74C76	.80
4040	.75	74C83	1.95
4041	.75	74C85	1.95
4042	.69	74C86	.39
4043	.85	74C89	4.50
4044	.79	74C90	1.19
4046	.85	74C93	1.75
4047	.95	74C95	.99
4049	.35	74C107	.89
4050	.35	74C150	5.75
4051	.79	74C151	2.25
4053	.79	74C154	3.25
4060	.89	74C157	1.75
4066	.39	74C160	1.19
4068	.39	74C161	1.19
4069	.29	74C162	1.19
4070	.35	74C163	1.19
4071	.29	74C164	1.39
4072	.29	74C165	2.00
4073	.29	74C173	.79
4075	.29	74C174	1.19
4076	.79	74C175	1.19
4078	.29	74C192	1.49
4081	.29	74C193	1.49
4082	.29	74C195	1.39
4085	.95	74C200	5.75
4086	.95	74C221	1.75
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
14409	12.95	74C902	.85
14410	12.95	74C903	.85
14411	11.95	74C905	10.95
14412	12.95	74C906	.95
14419	7.95	74C907	1.00
14433	4.18	74C908	2.00
4502	.95	74C909	2.75
4503	.65	74C910	9.95
4508	1.95	74C911	8.95
4510	.85	74C912	8.95
4511	.85	74C914	1.95
4512	.85	74C915	1.19
4514	1.25	74C918	2.75
4515	1.79	74C920	17.95
4516	1.55	74C921	15.95
4518	.89	74C922	4.49
4519	.39	74C923	4.95
4520	.79	74C925	5.95
4522	1.25	74C926	7.95
4526	1.25	74C928	7.95
		74C929	19.95

74S00

74S00	.32	74S163	1.95
74S02	.35	74S168	3.95
74S03	.35	74S169	3.95
74S04	.35	74S174	.95
74S05	.35	74S175	.95
74S08	.35	74S181	3.95
74S09	.40	74S182	2.95
74S10	.35	74S188	1.95
74S11	.35	74S189	6.95
74S15	.35	74S194	1.49
74S20	.35	74S195	1.49
74S22	.35	74S196	1.49
74S30	.35	74S197	1.49
74S32	.40	74S201	6.95
74S37	.88	74S225	7.95
74S38	.85	74S240	2.20
74S40	.35	74S241	2.20
74S51	.35	74S244	2.20
74S64	.40	74S251	.95
74S65	.40	74S253	.95
74S74	.50	74S257	.95
74S85	1.99	74S258	.95
74S86	.50	74S260	.79
74S112	.50	74S274	19.95
74S113	.50	74S275	19.95
74S114	.55	74S280	1.95
74S124	2.75	74S287	1.90
74S132	1.24	74S288	1.90
74S133	.45	74S289	6.89
74S134	.50	74S301	6.95
74S135	.89	74S373	2.45
74S138	.85	74S374	2.45
74S139	.85	74S381	7.95
74S140	.55	74S387	1.95
74S151	.95	74S412	2.98
74S153	.95	74S471	4.95
74S157	.95	74S472	4.95
74S158	.95	74S474	4.95
74S161	1.95	74S482	15.25
74S162	1.95	74S570	2.95
		74S571	2.95

IC SOCKETS

	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call
ST = SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW = WIREWRAP		
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7824T	.75		
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C, T = TO-220 K = TO-3
L = TO-92

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ORDER BY	DBxxP	DBxxS	DBxxPR	DBxxSR	IDBxxP	IDBxxS	HOOD-B	HOOD
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15	2.69	3.63	2.20	3.03	4.70	5.13	---	1.60
25	2.50	3.25	3.00	4.42	6.23	6.84	1.25	1.25
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ORDER BY	IDHxxS	IDHxxSR	IDHxxW	IDHxxWR	IDSxx	IDMxx	IDExx
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ORDERING INSTRUCTIONS: Insert the number of contacts in the position marked "**xx**" of the "order by" part number listed. **Example:** A 10 pin right angle solder style header would be IDH**10**SR.

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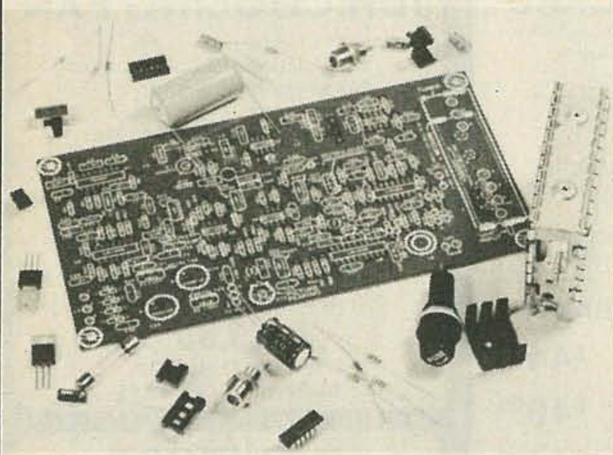

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TMS2716; 5V, 12V	17.95	MM5204Q	9.95
2758, 5V, (450nS)	3.50		

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2513-001 (5V) Upper	$9.50	DAC08	$9.95
2513-005 (5V) Lower	10.95	DAC100	9.95
2513-ADM3 (5V) Lower	14.95	8038 Function Generator	4.50
MCM66710 ASCII Shifted	12.95	MC4024 VCO	2.95
MCM66740 Math Symbol	13.95	LM566 VCO	1.95
MCM66750 Alpha Control	13.45	XR2206 Function Generator	5.25
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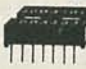
SOCKETS



LOW PROFILE SOCKETS (TIN)

	1-24	25-49	50-100
8 pin LP	.16	.15	.14
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.29	.27	.24
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
40 pin LP	.60	.59	.58

3L WIREWRAP SOCKETS (GOLD)

	1-24	25-49	50-100
8 pin WW	.55	.54	.49
10 pin WW (Tin)	.65	.63	.58
14 pin WW	.75	.73	.67
16 pin WW	.80	.77	.70
18 pin WW	.95	.90	.81
20 pin WW	1.15	1.08	.99
22 pin WW	1.45	1.35	1.23
24 pin WW	1.35	1.26	1.14
28 pin WW	1.60	1.53	1.38
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78M.G.	1.49	MC1488N	.99
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LM308CN	.98	LM2900N	.99
LM309K	1.49	LM2901N	2.50
LM310CN	1.25	LM2917N	2.95
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LM320T-XX*	1.39	CA3046N	1.29
LM320H-XX*	1.25	LM3053N	1.49
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LM340K-XX*	1.25	CA3081N	1.69
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LM344H	1.95	CA3086N	.80
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LM376N	3.75	CA3146N	2.49
LM377N	2.75	CA3160T	1.19
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LM381N	1.79	CA3410N	.59
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LM733N/H	.98	SN75451N	.35
LM739N	1.15	SN75452N	.49
LM741CN/H	.33	SN75453N	.49
LM741CN-14	.19	SN75454N	.49
LM747N/H	.75	SN75491N	.89
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74S04	.52	74S135	1.15	74S257	1.29
74S05	.52	74S136	1.69	74S258	1.29
74S08	.49	74S138	1.29	74S260	.75
74S09	.49	74S139	1.29	74S280	2.79
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74S11	.42	74S151	1.29	74S288	2.55
74S15	.42	74S153	1.29	74S373	3.10
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74S22	.42	74S158	1.29	74S387	2.75
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74S64	.46	74S195	1.89	74S570	5.75
74S65	.46	74S196	1.89	74S571	5.75
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74S112	.72	74S242	2.99	74S940	2.90
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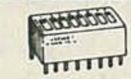
DIP SWITCHES



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7407	.35	7486	.35	74170	1.69
7408	.26	7489	1.75	74172	4.75
7409	.23	7490	.39	74173	.79
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7411	.29	7492	.45	74175	.85
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7413	.39	7494	.69	74177	.75
7414	.59	7495	.65	74179	1.34
7416	.29	7496	.69	74180	.75
7417	.29	7497	2.90	74181	1.75
7420	.22	74100	2.90	74182	.75
7421	.35	74107	.32	74184	2.25
7422	.29	74109	.37	74185	2.25
7423	.29	74116	1.95	74186	9.95
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7427	.25	74123	.59	74191	1.15
7429	.45	74125	.39	74192	.85
7430	.23	74126	.44	74193	.85
7432	.29	74128	.59	74194	.85
7437	.25	74132	.69	74195	.68
7438	.29	74136	.75	74196	.85
7439	.29	74139	.95	74197	.85
7440	.19	74141	.79	74198	1.39
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7444	.95	74145	.62	74273	1.05
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74LS04	.35	74LS124	1.35	74LS251	1.40
74LS05	.28	74LS125	.89	74LS253	1.40
74LS08	.28	74LS126	.52	74LS257	.85
74LS09	.35	74LS132	.79	74LS258	.98
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74LS48	.95	74LS169	1.15	74LS367	.69
74LS51	.26	74LS170	1.99	74LS368	.69
74LS54	.29	74LS173	.89	74LS373	1.89
74LS55	.29	74LS174	.89	74LS374	1.89
74LS73	.45	74LS175	.89	74LS375	.69
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74LS76	.45	74LS191	1.15	74LS386	.65
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74LS85	1.19	74LS194	1.15	74LS395	1.70
74LS86	.45	74LS195	.95	74LS399	2.35
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74LS93	.75	74LS221	1.15	74LS670	2.29
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74LS96	.98	74LS242	1.69	81LS96	1.69
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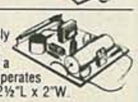

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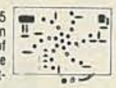

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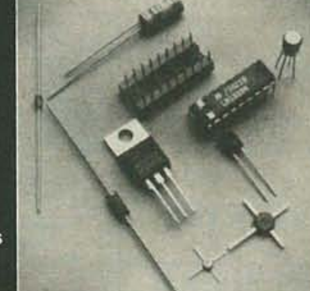

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10/8.70	18	10/1.80
10/9.70	20	10/2.70
10/12.70	22	10/2.70
10/13.70	24	10/2.70
10/14.70	28	10/3.00
10/17.70	40	10/3.90
wirewrap		solder

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74LS03	.26	74LS74	.45	74LS147	2.10	74LS196	.75	74LS352	1.25
74LS04	.32	74LS75	.38	74LS148	1.35	74LS197	.75	74LS353	1.25
74LS05	.28	74LS76	.38	74LS151	.55	74LS221	.95	74LS365	.45
74LS08	.28	74LS78	.45	74LS153	.50	74LS240	.95	74LS366	.45
74LS09	.28	74LS83	.55	74LS154	1.90	74LS241	.95	74LS367	.75
74LS10	.26	74LS85	.60	74LS155	.75	74LS242	.95	74LS368	.55
74LS11	.35	74LS86	.35	74LS156	.75	74LS243	1.25	74LS373	1.10
74LS12	.35	74LS90	.50	74LS157	.65	74LS244	.95	74LS374	1.10
74LS13	.45	74LS91	.85	74LS158	.65	74LS245	1.85	74LS375	.85
74LS14	.55	74LS92	.50	74LS160	.69	74LS247	1.10	74LS377	1.25
74LS15	.35	74LS93	.50	74LS161	.85	74LS248	1.10	74LS378	1.15
74LS20	.24	74LS95	.70	74LS162	.69	74LS249	1.10	74LS379	1.25
74LS21	.25	74LS96	.89	74LS163	.85	74LS251	.55	74LS386	.45
74LS22	.24	74LS107	.38	74LS164	.65	74LS253	.55	74LS390	1.20
74LS26	.26	74LS109	.38	74LS165	.85	74LS257	.50	74LS393	1.20
74LS27	.28	74LS112	.38	74LS166	1.75	74LS258	.55	74LS395	1.20
74LS28	.35	74LS113	.38	74LS168	1.55	74LS259	1.75	74LS399	1.40
74LS30	.24	74LS114	.38	74LS169	1.55	74LS260	.55	74LS490	1.90
74LS32	.27	74LS122	.45	74LS170	1.35	74LS266	.55	74LS623	1.90
74LS33	.50	74LS123	.85	74LS173	.65	74LS273	1.45	74LS668	1.65
74LS37	.35	74LS125	.45	74LS174	.65	74LS279	.45	74LS669	1.80
74LS38	.32	74LS126	.48	74LS175	.85	74LS280	1.85	74LS670	1.45
74LS42	.55	74LS132	.58	74LS181	1.95	74LS283	.95	74LS683	2.95
74LS48	.75	74LS133	.55	74LS190	.89	74LS290	.95	74LS685	2.95
74LS49	.75	74LS136	.38	74LS191	.89	74LS293	.85	74LS687	3.50
74LS51	.24	74LS137	.85	74LS192	.75	74LS295	.95	74LS783	15.95
74LS54	.25	74LS138	.50	73LS193	.75	74LS298	.85		

74S

74S00	.30	74S32	.40	74S138	.85	74S194	1.35	74S280	1.85
74S02	.30	74S37	.85	74S140	.40	74S195	1.35	74S287	1.85
74S03	.30	74S38	.85	74S151	.95	74S201	6.50	74S288	1.85
74S04	.35	74S50	.25	74S157	.95	74S240	2.25	74S289	6.75
74S05	.30	74S51	.25	74S158	.95	74S241	2.25	74S299	6.75
74S08	.30	74S64	.40	74S161	1.85	74S244	2.75	74S373	2.45
74S09	.35	74S65	.40	74S163	3.75	74S251	.85	74S374	2.45
74S10	.35	74S74	.50	74S174	.95	74S253	.85	74S387	1.90
74S11	.35	74S85	1.75	74S175	.95	74S257	.85	74S454	4.50
74S15	.35	74S86	.50	74S182	2.50	74S258	.85	74S470	6.50
74S20	.35	74S112	.50	74S188	1.85	74S260	.75	74S471	9.50
74S22	.35	74S124	2.50	74S189	5.95	74S275	15.85	74S472	9.50
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LM709	.40
LM710	.75
LM711	.49
LM720	.75
LM723	.75
LM733	.95
LM741-8	.45
LM741N-14	.45
LM741H	.45
LM747	.65
LM775	.25
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1349	1.75
1350	1.15
1358	1.35
1372	4.95
1458	.55
1488	.85
1489	.85
1496	.85
1889	1.55
4501	1.50
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6522	6.95	6809	12.50	6840	10.50	6850	3.25		
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2101	1.95	4116-200NS	8/12.95	6116-200NS	6.95
		4164-150NS	7.95	6116-150NS	7.95
		5290	1.75	5101-800NS	4.50

CIRCLE 61 ON FREE INFORMATION CARD

DIGITAL PRESSURE GAUGE

continued from page 61

both the center conductor and the shield to the sensor—don't rely on the automobile chassis for a ground. Attach an RCA plug (PL1) to the other end of the cable.

The circuit board can be mounted in or under the dashboard. Connect the red wire coming from the board to a source of 12 volts—the point on the fuse block that powers the radio is a good place. (Wherever you take the supply voltage from, make sure that, when the ignition is off, the power is off, too.) Connect the black wire to a point that goes to the negative pole of the car battery. Finally, with the board in place, connect the cable coming from the sensor to J1.

Noise reduction

There are two types of electrical noise that may give you problems. First, the conversion and display-multiplexing circuitry on the board may cause interference with your AM radio. If that happens first try taking the supply voltage from a point other than the radio fuse. Make sure, though, that the point you choose is active only when the ignition switch is on. Next, move the digital unit away from the radio. Finally, you can enclose the board in a grounded metal case. Just make sure that the board is adequately ventilated.

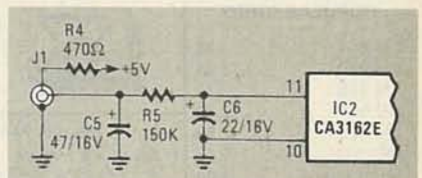
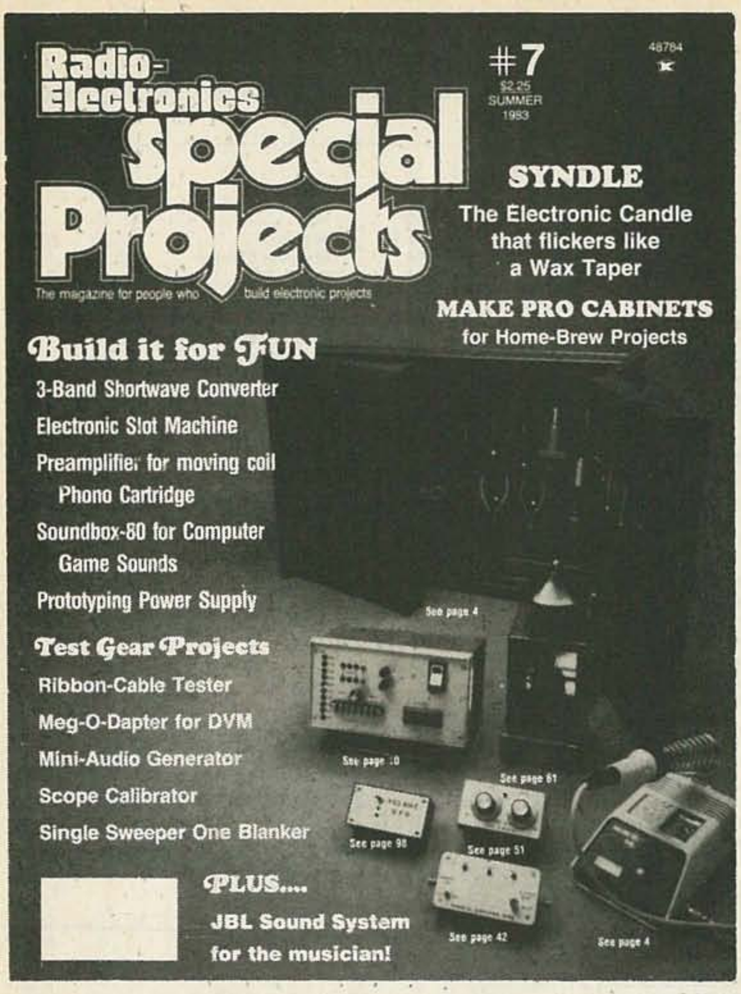


FIG. 7—SOME PRESSURE SENSORS may create electrical noise. This modification will help get rid of it (see text).

The other type of noise can be caused by the sensor unit, particularly the GM547034 or GM14039612 models. That noise can cause the pressure gauge to function erratically. A noise-reduction "fix" is shown in Fig. 7. It consists of first removing R1, C2, and the wire that runs from the center lug of J1 to the board. (These part numbers are the ones shown in Figs. 1 and 3). Then, referring to Fig. 7, install a new 470-ohm resistor (R4) from the five-volt line (there's a trace provided on the board to the left of pin 8 of IC2) to the center lug of J1. Also connect to that lug a 150K resistor (R5). The other end of that resistor goes to the hole in the board that was occupied by the old R1. Connect a 47-μF electrolytic capacitor (C5) between the center lug of J1 and the ground foil on the board. That's done either by soldering the capacitor lead to the shell of the jack, or by running it over the edge of the board to the foil side. Finally, connect a 22-μF electrolytic capacitor (C6) in place of the old C2. **R-E**



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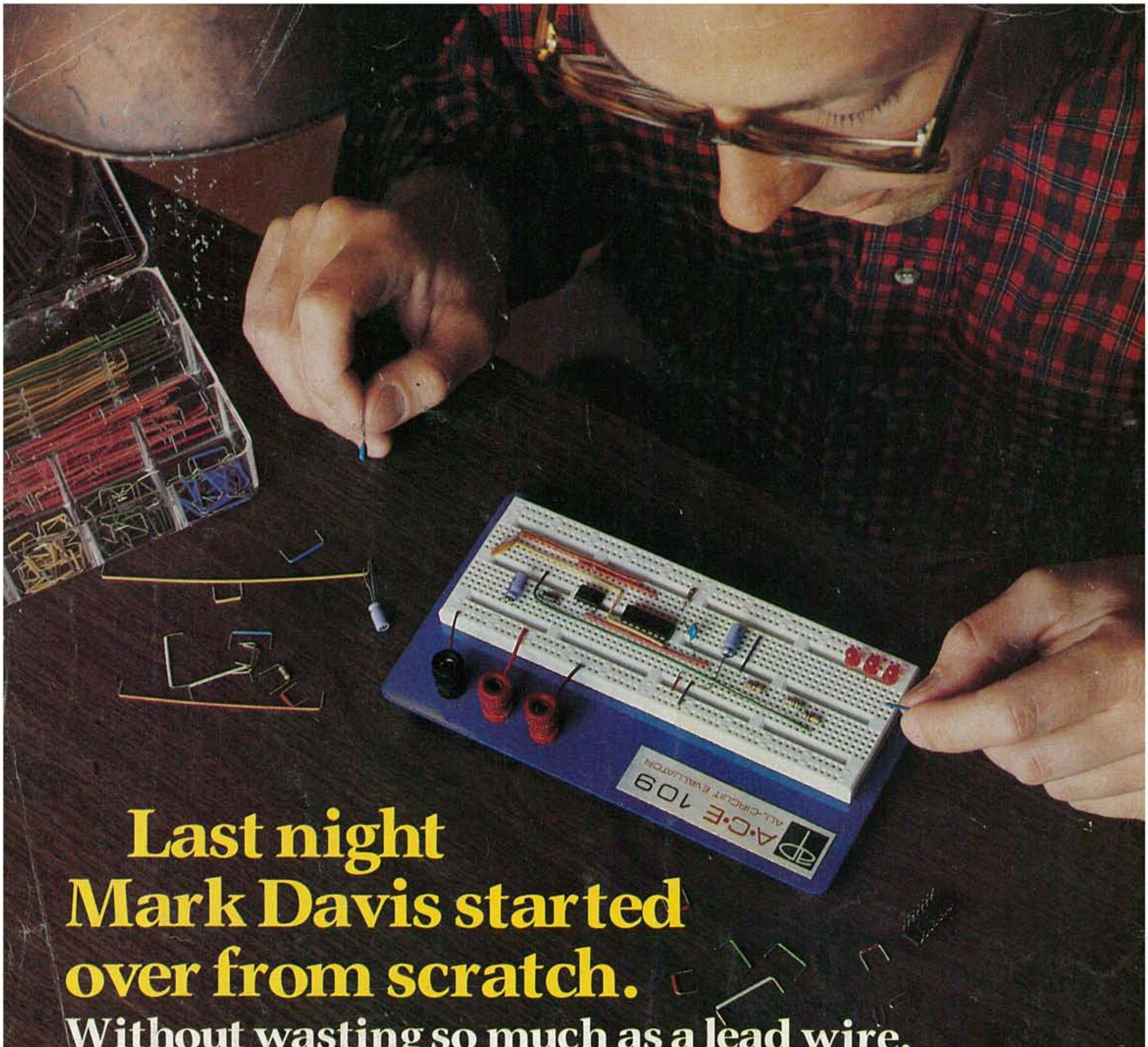

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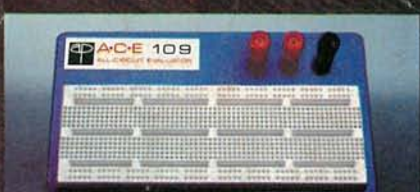

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