Radio-Electronics

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$1.50 MAY 1983

DGS

COMPUTERS - VIDEO - STEREO - TECHNOLOGY - SERVICE

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New IC's for MUSIC SYNTHESIZERS simplify design

Build a VLF ANTENNA TUNER for your receiver

How to REWIND TRANSFORMERS for custom applications

Back-to-school series: AUDIO POWER AMPLIFIERS How to design your own

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Six-digit readout: Automatically tracks every CRT test. We call it digital autotracking. It's patent pending.

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Delta PPV, Time, Freq: Measure any part of a waveform for PPV, time or frequency using Delta measurements. Just dial in the waveform section you want to measure and push.

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U.S. Patent Pending
Financing Available

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Wabash diskettes are packed 10 discs to a carton and 10 cartons to a case. The economy bulk pack is packaged 100 discs to a case without envelopes or labels. Please order only in increments of 100 units for quantity 100 pricing. With the exception of bulk pack, we are also willing to accommodate your smaller orders. Quantities less than 100 units are available in increments of 10 units at a 10% surcharge. **Quantity discounts** are also available. Order 500 or more discs at the same time and deduct 1%; 1,000 or more saves you 2%; 2,000 or more saves you 3%; 5,000 or more saves you 4%; 10,000 or more saves you 5%; 25,000 or more saves you 6%; 50,000 or more saves you 7% and 100,000 or more discs earns you an 8% discount off our super low quantity 100 price. Almost all Wabash diskettes are immediately available from CE. Our warehouse facilities are equipped to help us get you the quality product you need, when you need it. If you need further assistance to find the flexible disc that's right for you, call the Wabash diskette compatibility hotline. Dial toll-free 800-323-9868 and ask for your compatibility representative. In Illinois or outside the United States dial 312-593-6363 between 9 AM to 4 PM Central Time.

SAVE ON WABASH DISKETTES Product Description	Part #	CE quant. 100 price per disc ($)
8″ SSSD IBM Compatible (128 B/S, 26 Sectors)	F111	1.99
8″ Same as above, but bulk pack w/o envelope	F111B	1.79
8″ SSSD Shugart Compatible, 32 Hard Sector	F31A	1.99
8″ SSDD IBM Compatible (128 B/S, 26 Sectors)	F131	2.49
8″ DSDD Soft Sector (Unformatted)	F14A	3.19
8″ DSDD Soft Sector (256 B/S, 26 Sectors)	F144	3.19
3″ DSDD Soft Sector (512 B/S, 15 Sectors)	F145	3.19
8″ DSDD Soft Sector (1024 B/S, 8 Sectors)	F147	3.19
5¼″ SSSD Soft Sector w/Hub Ring	M11A	1.59
5¼″ Same as above, but bulk pack w/o envelope	M11AB	1.39
5¼″ SSSD 10 Hard Sector w/Hub Ring	M41A	1.59
5¼″ SSSD 16 Hard Sector w/Hub Ring	M51A	1.59
5¼″ SSDD Lanier No-problem compatible	M51F	2.99
5¼″ SSDD Soft Sector w/Hub Ring	M13A	1.89
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5¼″ SSDD Soft Sector Flippy Disk (use both sides)	M18A	2.79
5¼″ SSDD 10 Hard Sector w/Hub Ring	M43A	1.89
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5¼″ DSDD Soft Sector w/Hub Ring	M14A	2.79
5¼″ DSDD 10 Hard Sector w/Hub Ring	M44A	2.79
5¼″ DSDD 16 Hard Sector w/Hub Ring	M54A	2.79
5¼″ SSQD Soft Sector w/Hub Ring (96 TPI)	M15A	2.69
5¼″ DSQD Soft Sector w/Hub Ring (96 TPI)	M16A	3.79

SSSD = Single Sided Single Density; SSDD = Single Sided Double Density; DSDD = Double Sided Double Density; SSQD = Single Sided Quad Density; DSQD = Double Sided Quad Density; TPI = Tracks per inch.

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Radio-Electronics

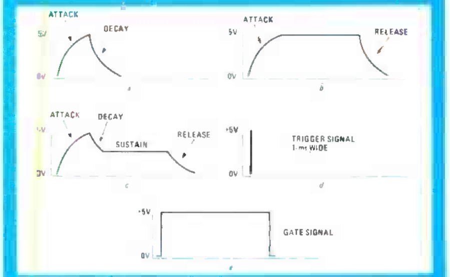
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

MAY 1983 Vol. 54 No. 5

ON THE COVER

Timepieces have come a tremendous way in the past few years—from wind-up and electric clocks to those with LED and LCD displays and—now—to clocks with no display at all! The talking alarm clock featured in this issue will announce the time either automatically or on request, and can also be set to *tell* you when it's time to get up. Modern speech-synthesis IC's make it extremely easy to build, as you'll find out starting on page 57.



THE MAINSTAY of today's popular music is the synthesizer. Once incredibly difficult and expensive to design and build, its current popularity is due in part to the versatility built into the LSI IC's that are found at its heart. The story of those IC's can be found on page 65.

COMING NEXT MONTH
On Sale May 19

- **Special Videogames Section:** What's new for 1983...and what's in store for the future.
- **Add-on RAM.** A non-volatile 8K memory expansion you can build for your Timex/Sinclair *1000*.
- **LF Loop Antennas.** The next installment on our continuing series on VLF-LF receiving techniques.
- **And lots more!**

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VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

CONVERTIBLE VCR

A new approach to portable VCR's is RCA's ultra-deluxe model *900* "convertible," (see photo above) the first product to be offered under the new contract in which Hitachi replaced Matsushita as the company's prime source of video recorders. The recorder resembles a normal high-end VCR when in home use. But for use as a portable, the hinged control drawer at the front is lowered and the deck unit slides out. When replaced for playback, the 7.9-pound portable automatically "docks" into a connector at the rear, eliminating cable connections.

The new VHS recorder has five heads, the fifth used for noiseless special effects exclusively. It has all high-end features, plus a few new ones, including a complete wireless remote control, 8-event 21-day programmability, liquid-crystal display showing elapsed recording time, sound-on-sound recording, "video dub" for insert edits, monitor earphone, digital keypad tuning, and a jack for a pay-TV cable converter.

UNIVERSAL REMOTE

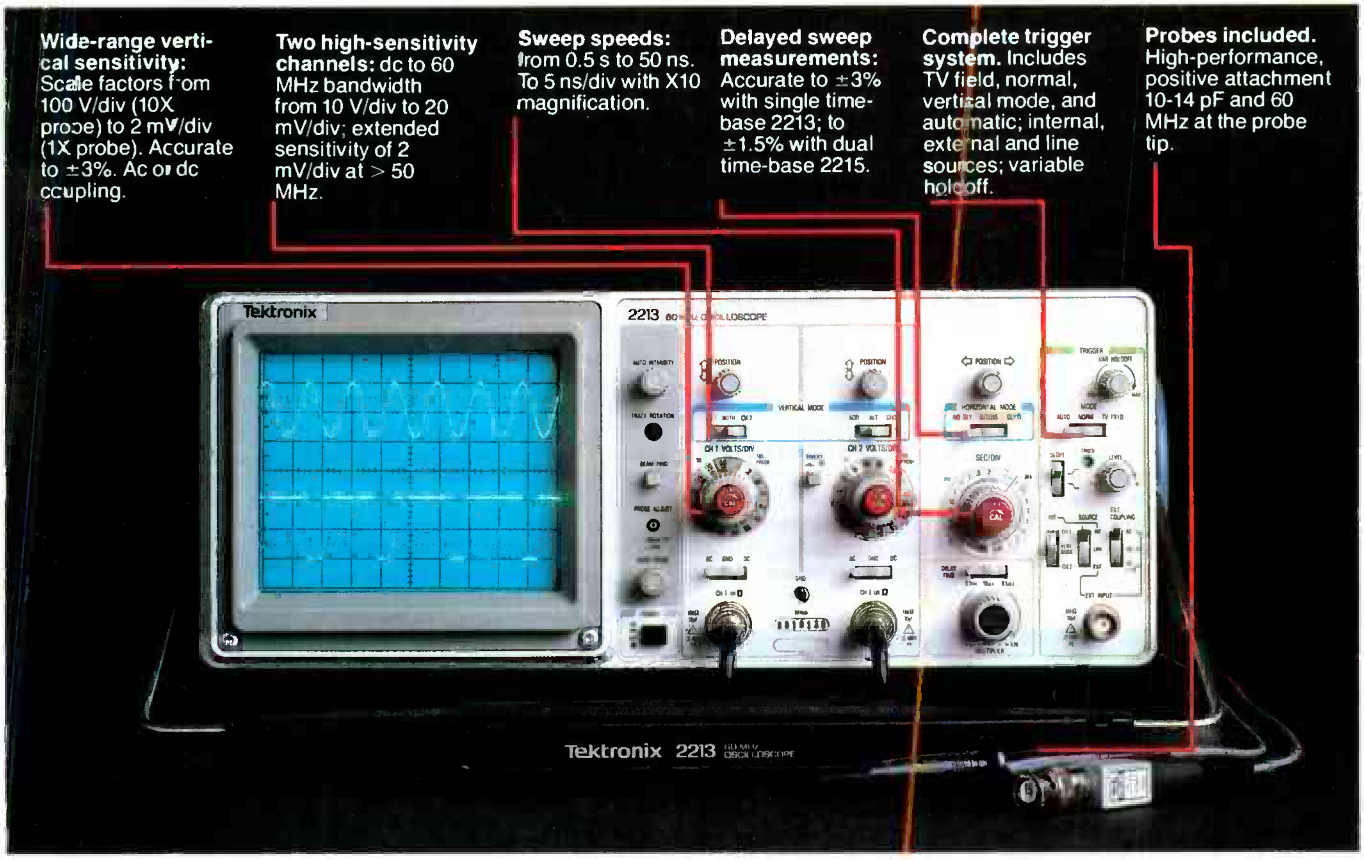
One of the annoyances of the video age is the profusion of controls and buttons to push. The owner of a TV, videodisc player, VCR, and stereo may be required to sit with four remote-control keypads on his lap in order to use the advantages of all the latest conveniences. Presumably that is about to change. Sony has already announced two *Unicontrol* systems, designed to work with both its TV sets and Betamax recorders, hinting that in the future they may control Sony stereos as well. This spring, RCA is expected to unveil its own universal remote control, which will operate its TV sets, VCR's, and videodisc players. Those devices will work only with equipment of the given brand. If you have, say, a Sony TV, an RCA VCR, and a Pioneer videodisc player, you'll presumably still need three remote controls. Is it possibly time for an allocation of the infrared-command frequencies for standardization of remote-control systems so that in the future any remote unit will work with any equipment?

NEW BETA

The Beta group of VCR manufacturers, seeking to improve their lagging market share, can be expected to introduce several innovations in the next few months. The imminence of the New Beta Hi-Fi sound system has already gained Beta three new adherents in the United States. Audio manufacturers Aiwa, Pioneer, and Nakamichi plan to introduce Beta Hi-Fi recorders, using the breathtaking new sound system being adopted for Beta recorders. As described in this column last September, Beta machines to be introduced this spring will feature high-fidelity stereo audio recording and playback via a frequency-modulated pair of soundtracks on the helical video track between the chrominance and luminance signals.

Compatible recorded programs—both musical tapes and movies—are already becoming available. They're playable on existing Beta VCR's because they have sound on both the longitudinal and helical tracks. The new recorders have no additional recording or playback heads, the standard video heads being used for the audio material; the sound is separated from the video in the machines' circuitry. Although Aiwa (owned by Sony) and Pioneer have long been Beta licensees, they plan to enter the American VCR market for the first time this year. Nakamichi is completely new to the video market and hopes to manufacture a video recorder compatible with its reputation for excellence in audio. It is considering adding video monitors as well. Although members of the VHS group have demonstrated audio systems similar to Beta Hi-Fi, they are undecided about marketing plans. R-E

Tek's most successful scope series ever: At $1200-$1450, it's easy to see why!



In 30 years of Tektronix oscilloscope leadership, no other scopes have recorded the immediate popular appeal of the Tek 2200 Series. The Tek 2213 and 2215 are unapproachable for the performance and reliability they offer at a surprisingly affordable price.

There's no compromise with Tektronix quality: The low cost is the result of a new design concept that cut mechanical parts by 65%. Cut cabling by 90%. Virtually eliminated board electrical connectors. And eliminated the need for a cooling fan.

Yet performance is written all over the front panels. There's the bandwidth for digital and analog circuits. The sensitivity for low signal measurements. The sweep speeds for fast logic families. And delayed sweep for fast, accurate timing measurements.

The cost: $1200* for the 2213. $1450* for the dual time base 2215. You can order, or obtain more information, through the Tektronix National Marketing Center, where technical personnel can answer your questions and expedite delivery. Your direct order includes probes, operating manuals, 15-day return policy and full Tektronix warranty.

For quantity purchases, please contact your local Tektronix sales representative.

Order toll free: 1-800-426-2200 Extension 53

In Oregon call collect: (503) 627-9000 Ext. 53

*Price F.O.B. Beaverton, OR. Price subject to change.

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WHAT'S NEWS

"Home computer/robot" is shown at Las Vegas

A robot especially designed for the home-computer enthusiast was exhibited at the International Winter Consumer Electronics Show in Las Vegas last January. The home robot was described by its manufacturer, Robotics International Corp. of Jackson, MI, as not only an adjunct to existing home computers, but also as a totally self-contained computerized system, with robotic hardware and software compatible with existing home microprocessors. It can be equipped for vacuuming, entertaining, or providing security, without human monitoring, says its developer.

The robot stands 4½-feet high and weighs about 120 pounds. Two 7-inch drive wheels and two casters allow it to negotiate hardwood floors or thick-pile carpets. It is powered by two 12-volt, 20 ampere-hour batteries. One charge is good for about four hours. When the battery is low, the robot can identify its own location, then go and connect to its personal recharging unit.

When the robot is first put into operation, it "walks" around the home, chirping ultrasonically as it maps wall distances and furniture location. It recalls that map each time it re-enters a room. Thus, it can vacuum a room full of furniture without damaging anything. Infrared obstacle-avoidance keeps it from bumping into pets, children, or new obstacles.

The head contains a cathode-ray tube that displays normal alphanumeric information, and has a pre-programmed video "mouth" with lips that mimic lip motion when it is synthesizing speech. The CRT operates normally when linked to the home computer, or to an optional computer package and software that eliminates the need for an external computer.

The robot can be equipped optionally with a security package, one or two arms, a vacuuming unit, a computer with keyboard and 48K or more of memory, and state-of-the-art voice recognition.

A FORMIDABLE SENTRY, THE ROBOT security monitor stands guard over the home. For that purpose it is equipped with microwave, passive infrared, and audio discrimination detectors. The robot is made by Robotics International Corp. of Jackson, MI.

IBM joins Japanese in research effort

International Business Machines (IBM) has informed the Japanese government that it would like to join a research project to develop a "fifth generation computer" that Japan started early in 1982. The proposed computer would think like a human being.

The Japanese Ministry of International Trade and Industry is subsidizing the project with an initial grant of 423 million yen (about 1.7 million dollars) for preliminary research.

Fujitsu, Hitachi, NEC, and five other Japanese companies are already taking part in the project. Several European computer makers have also shown interest. Thus, the 10-year project is on its way to become the world's largest international research effort in computer history.

New GE GaAs FET's improve power handling

General Electric Research and Development scientists have developed a novel high-voltage power field-effect transistor (FET) with switching speeds of less than five billionths of a second, and with resistance about one-tenth that of comparable silicon devices. The new FET's can block up to 150 volts—the best previous gallium arsenide FET's would not go beyond 85 volts.

Breaking with conventional horizontal layout (with the source, gate and drain closely aligned on the top of the chip), the new FET's have a large source contact on the top and a large drain contact on the bottom of the chip, with the fine gate regions running through the center.

By avoiding the close arrangement of tiny details on the surface of the wafer, the GE layout increases current-handling capability and reduces the possibility that a crystalline defect in the material can result in lines that touch, causing the devices to short out. That buried-gate design yields high quality and few defective chips.

GE'S NOVEL VERTICAL-CHANNEL gallium arsenide field-effect transistor that blocks up to 150 volts and switches in less than 5 billionths of a second. This photomicrograph shows its unusual construction. Most gallium-arsenide devices are horizontal, with the fine lines that form the source, gate, and drain closely aligned at the top of the chip. The GE design places a large source contact on top of the chip and a large drain contact on the bottom, with fine gate regions running through the center.

Larger-than-life video shown at Las Vegas

General Electric demonstrated a consumer-oriented system that projects bright, clear, color video images up to 25 feet wide at the Consumer Electronics Show at Las Vegas last January.

The *Talaria* Technology uses a single-gun, single-optical-path system and can accept video signals from off-the-air tuners, live TV cameras, tapes and discs, and computer terminals with standard video output. The system is already in use for industrial applications such as background display on TV weather broadcasts, magnification of minute details for display in large lecture halls, and large-screen CCTV broadcasts.

(continued on page 8)

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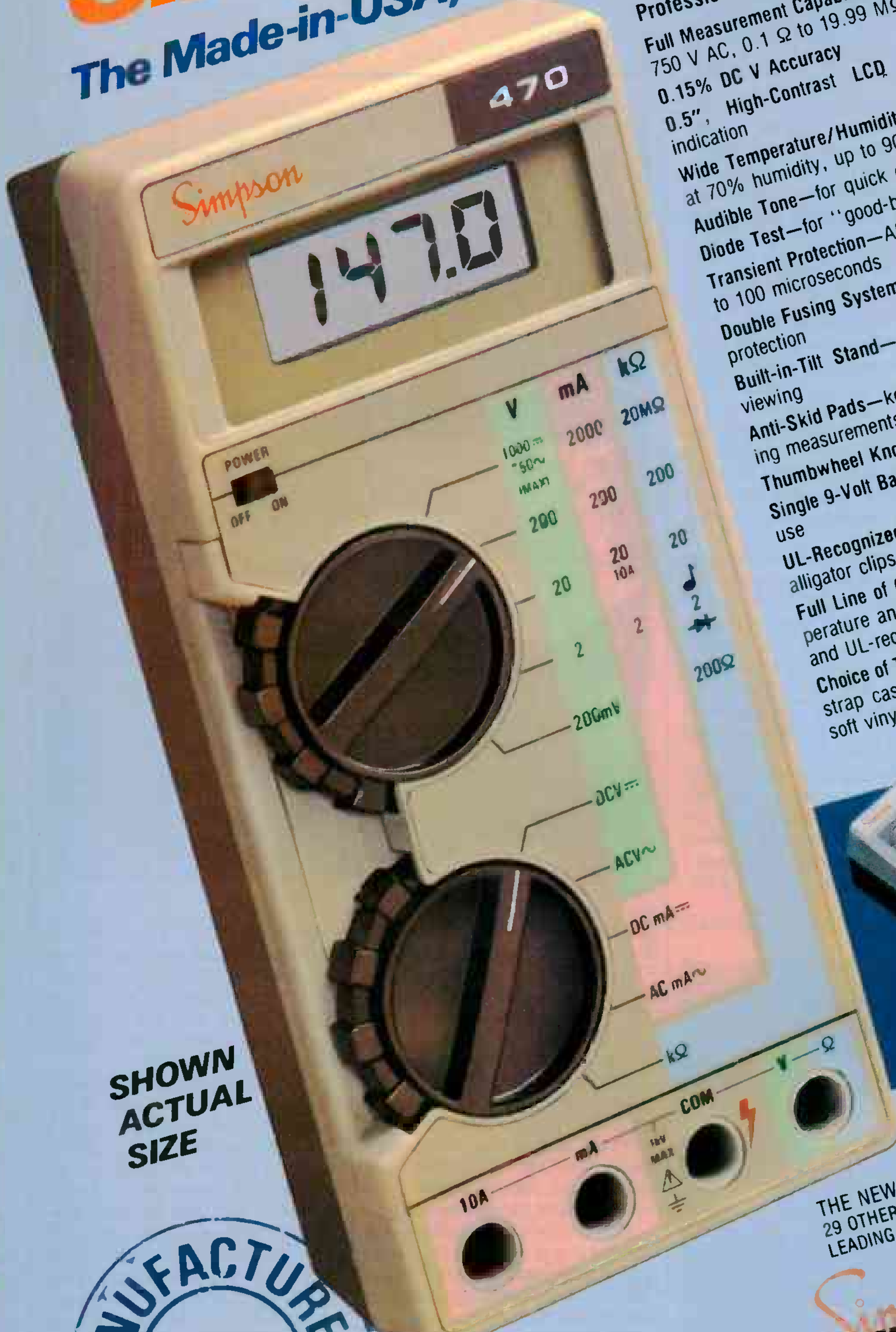
- **Choice of Two Optional Carrying Cases**—deluxe Ever-Ready neck strap case that provides 2-way hands-free/bench-top use, or soft vinyl-padded pouch with belt strap



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CIRCLE 23 ON FREE INFORMATION CARD

WHAT'S NEWS

(continued from page 6)

Sharp supplies "office in an attache case"

With three compact new pieces of equipment, Sharp claims: "Today's businessman can carry most of his office needs right in his attache case and still have room left for lunch."

The new *EL-6200* Planning Calculator (6⁵⁄₁₆ × ¹³⁄₁₆ × 3⅜ inches) acts as an ever-present secretary. It reminds him of all appointments, including business meetings and lunch dates, who and when to call, and the phone numbers. An interesting feature is the use of symbols in the display—a dinner date might be indicated by a knife and fork, for example. When it's not being used as a reminder of specific appointments, it serves as a standard clock and calendar.

The *EL-7100* Memowriter (7¹³⁄₃₂ × 1⁵⁄₁₆ × 3¾ inches) provides a miniature typewriter keyboard, a complete display, and a printer that makes hard copy on paper. (The memo may be written on the display and then immediately erased, or by pushing a PRINT button, turned into hard copy. The Memowriter has a memory of up to 40 words.)

The *7050* Graph Generator (10⁷⁄₁₆ × 1³¹⁄₃₂ × 5¾ inches) is designed for the sales engineer in the field. It generates a number of line or bar charts and ribbon or circle graphs—in four colors, complete with shading. It can make one drawing on top of another to compare the effects of different inputs, or enlarge or reduce any segment of a chart. (Both effects can be very useful in competitive sales situations.)

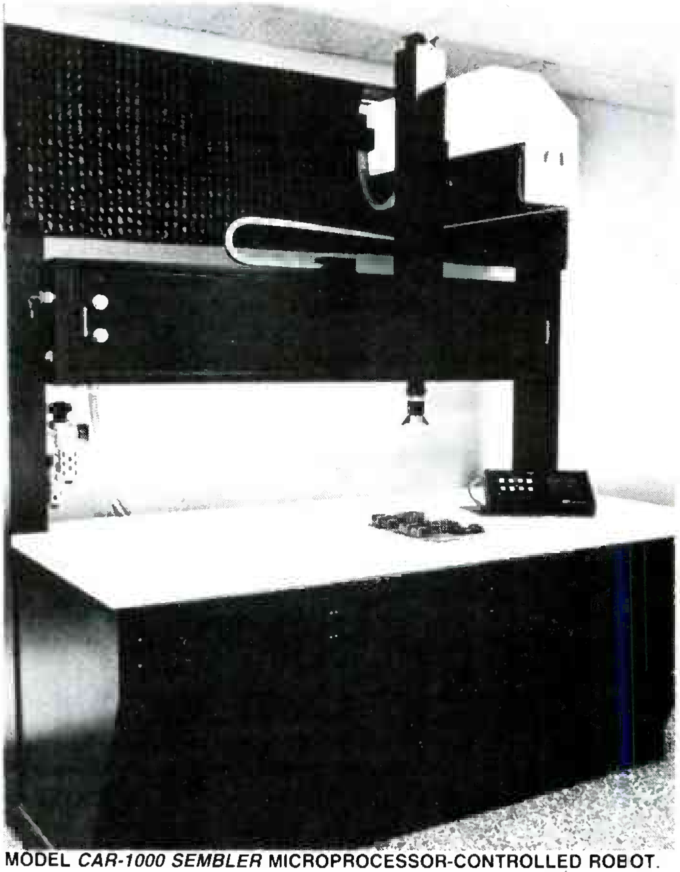
SHARP MEMOWRITER, PLANNER, AND GRAPH GENERATOR (clockwise from upper left) can indeed fit in an attache case, with room for some extra memo paper.

Three-armed robot makes printed-circuit boards

A new high-precision, microprocessor-controlled robot for use in printed-circuit manufacture is claimed to be the first robot on the market able to place non-standard parts automatically at high speed. Called the *Sembler* model *CAR-1000*, it is made by Control Automation, Inc. of Princeton, NJ.

The *Sembler* is available with one, two, or three arms, and is precise to 0.001 inch. Each arm is capable of coordinated motion in X, Y, or Z axes, plus wrist rotation (theta axis). The work envelope is 56 inches long, 20 inches deep, and 20 inches high. The robot wrist can rotate up to 180 degrees. Load capacity is 10 pounds.

The robot picks up the appropriate part (transformer, relay, IC, etc.) and places it precisely in the desired positon on the printed-circuit board. Its precision allows it to handle odd-shaped components.



MODEL *CAR-1000 SEMBLER* MICROPROCESSOR-CONTROLLED ROBOT.

With appropriate procedures, the *Sembler* can be controlled by any computer, in any language. The standard system includes an external computer *(SC 1000)* that the user programs in BASIC. That makes the robot literally plug-compatible with other assembly components.

All of the robot's motions are actuated by DC servo motors through lead screws with zero backlash. That eliminates belts and pulleys and results in a relatively maintenance-free robot.

The robot's chief application is assembling printed-circuit boards. Other applications include material handling and asembling computer peripherals (keyboards, etc.) and small electronic and automotive subassemblies.

Computer tracks down hit-and-run drivers

Tokyo police are now using a computer to catch drivers who leave the scene of an accident. In 1983 over 93 percent of the drivers in over 1,000 hit-and-run accidents in the metropolitan area were apprehended, and the police believe it possible to raise the figure to nearly 100 percent.

The computer analyzes paint particles left at the scene of the accident. A bit of paint as small as 0.2 mm (smaller than a pencil point) is all that the computer requires. The computer compares the paint with data on more than 10,000 finishes in its memory. It then tells the make, model, and year of all cars on which the finish was used. That information reduces tremendously the number of cars that might have been involved.

The work is done in five minutes, compared to the half day required for visual checking. Further, the older method requires a particle of 2 mm—ten times the size of the computer sample. R-E

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TM 500 means reliable, proven performance at an affordable price! Nothing else offers this kind of capability and convenience: over 35 compact plug-in modules spanning the total test and measurement instrument array. Compatible with each other and with TM 5000 Programmable Instruments. All of which configure easily in a variety of mainframes. TM 500 lets you create your own compact personalized instrument setup: manual, programmable or hybrid.

A TM 500 mainframe and plug-ins take less space than monolithic instruments. And less time to set up. The mainframe's rear panel interface connections reduce cable clutter and simplify operation. What's more, you can easily interface plug-ins with devices external to the mainframe.

Hundreds of customized systems are possible. The TM 500 family itself includes DMMs, Counters, Pulse Generators, Function Generators, Amplifiers, Oscillators, Power Supplies, Oscilloscopes, Calibration Instruments, even blank plug-in kits to build you own. Plus a choice of eight mainframes to house plug-ins: bench, rackmount and portable versions.

All modules are interchangeable among mainframe compartments, so you can set up a system for one test, then reconfigure for a completely different application.

Match your own requirements with TM 500! Get high performance for testing sophisticated equipment, without having to buy more capability than you need. There are several performance level choices within each instrument type for maximum cost-effectiveness.

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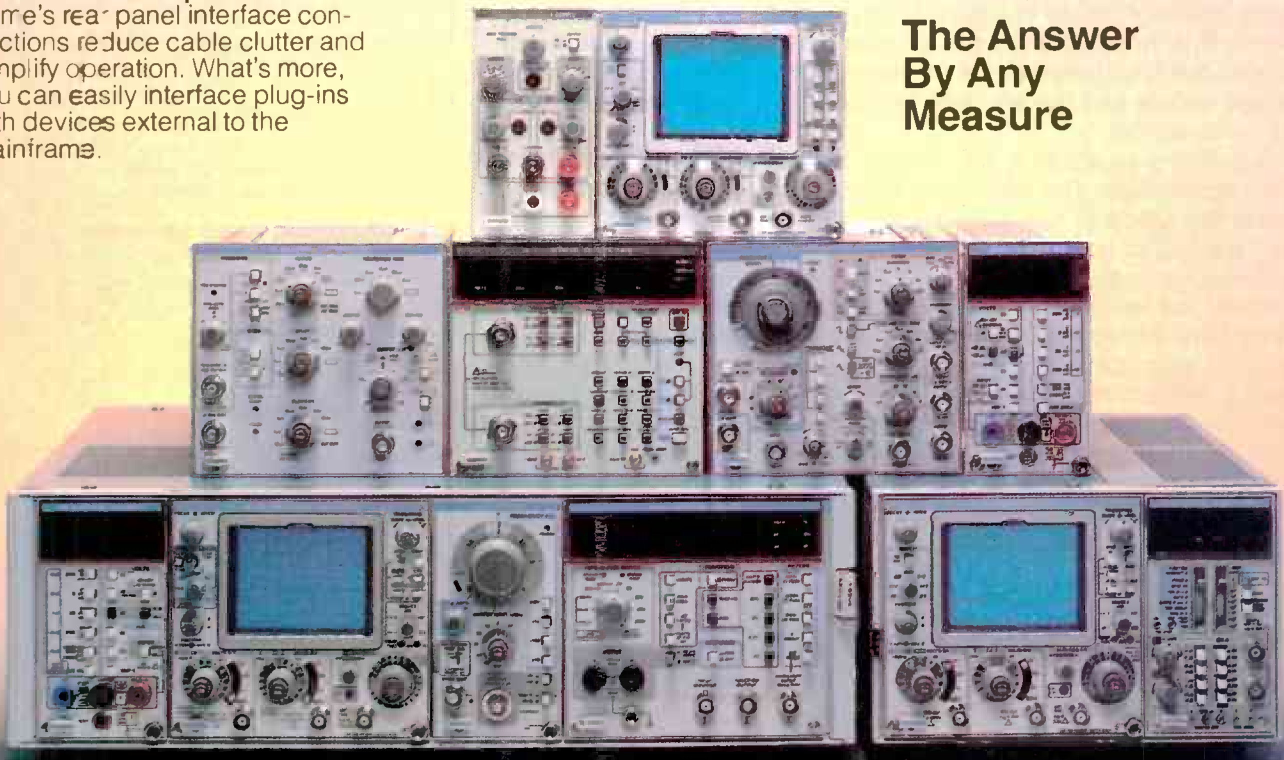

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EDITORIAL

Becoming An Author

Every year or two, I write an editorial devoted to our readers who yearn to become authors and write for **Radio-Electronics.** Based on the number of inquiries I've received on this subject lately, I've decided to repeat an editorial that was published almost two years ago:

Wherever I go, the most often asked question is: "How do I go about writing an article for **Radio-Electronics?**" I do not dismiss that question lightly. Our readers represent a vast untapped reservoir of knowledge. Each and every one of you has developed a special expertise in at least one particular area. Many of you have unique ideas and knowledge that is not widely known. The drive to acquire knowledge and share knowledge and ideas with others is immense. In fact, that is the main function of **Radio-Electronics.** It is a vehicle for the exchange of knowledge and ideas. For those reasons we encourage our readers to write articles.

What do you get out of writing an article? Aside from the extra income and recognition of having your name in print, there's the satisfaction of sharing your knowledge with others. In fact, you have advanced the knowledge of the members of this industry and have helped people just like yourself. Indeed, it is a rewarding and satisfying achievement.

Submitting an article is not difficult. It is simply a matter of sending it to my attention. The best first step, however, is to send me an outline of the article to see if we're interested in the subject. If we are, we'll tell you to go ahead and perhaps even make a few suggestions regarding your outline.

There are far too many steps involved in writing an article for us to cover here. However, we do have an Author's Guide that will answer many of your questions. If we've managed to stir your curiosity, then send a self-addressed stamped envelope to Author's Guide, **Radio-Electronics,** 200 Park Avenue South, New York, NY 10003, and we'll send you one.

Now what's your excuse for not writing an article?

Art Kleiman

ART KLEIMAN
Editor

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SATELLITE/TELETEXT NEWS

GARY ARLEN
CONTRIBUTING EDITOR

LOW-FLYING "SPACE MIRROR" COULD SUPPLEMENT SATELLITES

"Space Mirrors," which could bounce TV, audio, and data communications from orbiting positions about 100 miles high, are being developed by a University-of-Oregon professor in cooperation with Stanford Research Institute. The reflectors, two to five meters in diameter, would be made of ultra-fine wire and held stationary above Earth by the pressure of electronic radiation. Although the space mirrors would be passive reflectors, they could be adapted to transmit signals. The big attraction is that they could cost as little as $10 million—less than 20% of the price of a conventional communications satellite—and there would be lower launch costs.

Prof. Paul Csonka, who developed the space-mirror concept, foresees use of the low-flying dishes as particularly attractive in parts of the world which don't have the need or finances for full-scale satellite services. The reflective dishes could bounce signals between points up to 1000 miles apart—which is far less than the footprint covered by today's geostationary orbiting satellites. The space-mirror study was underwritten by equipment-maker EMCEE, which holds the patent rights to it. Further research, expected to continue through early 1984, is now under way to iron out some technical problems with the orbiting reflector.

SATELLITE TV CORP. OKAYED FOR DBS; 1986 TARGET DATE REMAINS

Satellite Television Corp. has received FCC approval to begin its first phase of construction for a national direct-broadcast satellite system. The FCC action gives STC a slight head start on the other eight companies which have received preliminary FCC approval to begin developing DBS services. If all goes according to plan, STC could put up its first DBS bird by early 1986, ready to serve viewers in the eastern time zone. The FCC was expected to begin action on the other DBS applications within a few weeks after okaying STC's plan. The DBS systems operate in the 12/14-GHz band.

The FCC authorization doesn't include launch go-ahead, frequency allocations or orbital slots for STC's direct broadcast birds. Those matters will be addressed after the June 1983 western hemisphere Regional Administrative Radio Conference, which will sort out DBS assignments for North and South American nations.

STC, a wholly owned subsidiary of Comsat, has already begun to make plans for its DBS service, which the company predicts will cost $680 million to build. By the end of the first year of operation, about 650,000 subscribers should be buying the service (for about $20 per month) which will offer three channels of pay-TV, education, and other programming.

In an unrelated development, Oak Industries has delayed its DBS plans. The company had hoped to get an early start on DBS sometime in 1984, using a Canadian satellite until its own bird could be launched in 1986. But further tests showed that the Canadian satellite wouldn't be strong enough to cover Oak's target audience, even using a higher-powered transmitter like those that are currently available on U.S. birds. Oak is still proceeding with its 1986 DBS plans.

PROMISING PREDICTIONS ABOUT SATELLITE USE, LOWER PRICES

Fearless forecasters continue to envision a bright future for satellite services, including lower prices for many facilities. For example, SPACE (The Society for Private and Commercial Earth Stations) foresees another $1,000 drop in prices for a typical earth station this year; SPACE estimates that the average home-satellite user now spends about $4,500 to set up equipment, which itself is a dramatic drop from a year ago when the typical start-up costs ran as high as $7,000. In all, that means a sophisticated 4/6-GHz private receiving system will cost about $3,500 bythe end of 1983—and, of course, many systems will be built for far less. Meanwhile, SPACE is also estimating that about 4000 new dishes are being installed each month, adding to the 60,000 or so units now in place. Moreoever, another 250,000 homes are seeing bird-fed programming via Satellite Master Antenna TV systems (SMATV) in apartments, condos and other multi-home dwelling units.

If the rapid growth of current satellite-reception technology seems staggering, there's an even bigger explosion ahead when Direct Broadcast Satellites are in full swing. By 1990, more than 15 million rooftop DBS receivers will be installed, according to a report from International Resource Development. The DBS facilities will make the present backyard terminals all but obsolete, IRD says. They also predict that the business of building and installing the small DBS dishes will be almost totally controlled by large satellite-industry firms such as Hughes, Harris, Scientific-Atlanta, and RCA. R-E

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VIDEOGAMES

A tale of two synthesizers

DANNY GOODMAN, CONTRIBUTING EDITOR

MATTEL AND ODYSSEY HAVE INtroduced us to a new technology that will add new excitement to home videogames: electronic speech synthesis. Both voice boxes are complementary add-ons to their respective consoles. They are attached to the game system through the cartridge slot, and game cartridges, in turn, plug into the voice add-ons. Both synthesizers use the same high quality speech technique from Texas Instruments, called Linear Predictive Coding (LPC). LPC allows different voices and accents to be stored digitally in ROM (*R*ead-*O*nly *M*emory) IC's that are packed inside the game cartridges.

Despite the similarities, the two companies have entirely different philosophies on how to approach videogames using voice. That diversity is not so much in hardware (although *Intellivoice* plays through the TV speaker and the *Odyssey 2* voice module, shown in Fig. 1, has its own built-in speaker) but in the specially coded software cartridges that make the modules move their electronic lips.

Odyssey's voice cartridges are initially aimed at educational applications, although one popular action cartridge, UFO, is reportedly being re-designed to incorporate voice. One of the educational cartridges, *Type and Tell*, lets the "player" type in any word, name, or jumble of letters, and the synthesizer attempts to speak the word—expletives not deleted.

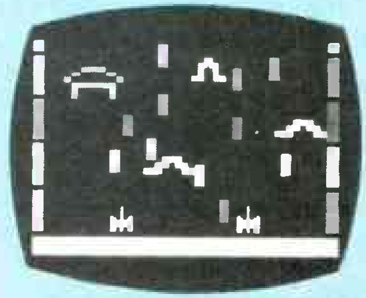
But most of the *Odyssey 2* voice cartridges for action games will be compatible with the same console without the voice module. That is, the cartridge will be playable without the module. That way, Odyssey believes, those without *The Voice* will still have the opportunity to play all the cartridges.

Mattel, on the other hand, seems to take the position that voice should be an integral part of the game play. In its voice cartridge *B-17*, for example, you're busy watching for ground targets below the plane when the plane's co-pilot alerts you that there are bandits at 3 o'clock. With that verbal alert, you know how to change your screen view to get the bandits in your gunsight. Some of the voices on that cartridge, however, are purely for decoration, like when the bombardier shouts "Bombs away!"

My initial reaction is that the Mattel approach will appeal to more *Intellivision* owners than the Odyssey idea will attract *Odyssey 2* owners. While it's "neat" to have a talking game, there is more incentive to go the voice route if the voice is integrated into the game play, instead of being put on only for extra trimming. One driving force behind all videogame development is the player's demand for more—more detailed graphics, greater strategic realism, and more challenges. If an electronic voice adds to those dimensions of the game, then there is a real incentive to invest in the voice add-on.

Atari is forecasting a speech add-on for the *5200* for 1983. I hope the software designers are doing more than just adding a Howard Cosell voice coming from the press box of a football game.

Fox Video Game's Worm War I for Atari 2600



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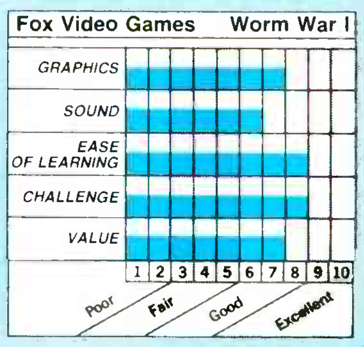

FIG. 1

You might expect games coming from Twentieth Century Fox to bear titles licensed from Fox's motion pictures. Not just yet, they tell me. In the meantime, Fox Video Games has jumped into the scene with four Atari *VCS*-compatible games designed by a respected personal-computer-software developer Sirius Software. *Worm War I* is a

(continued on page 2

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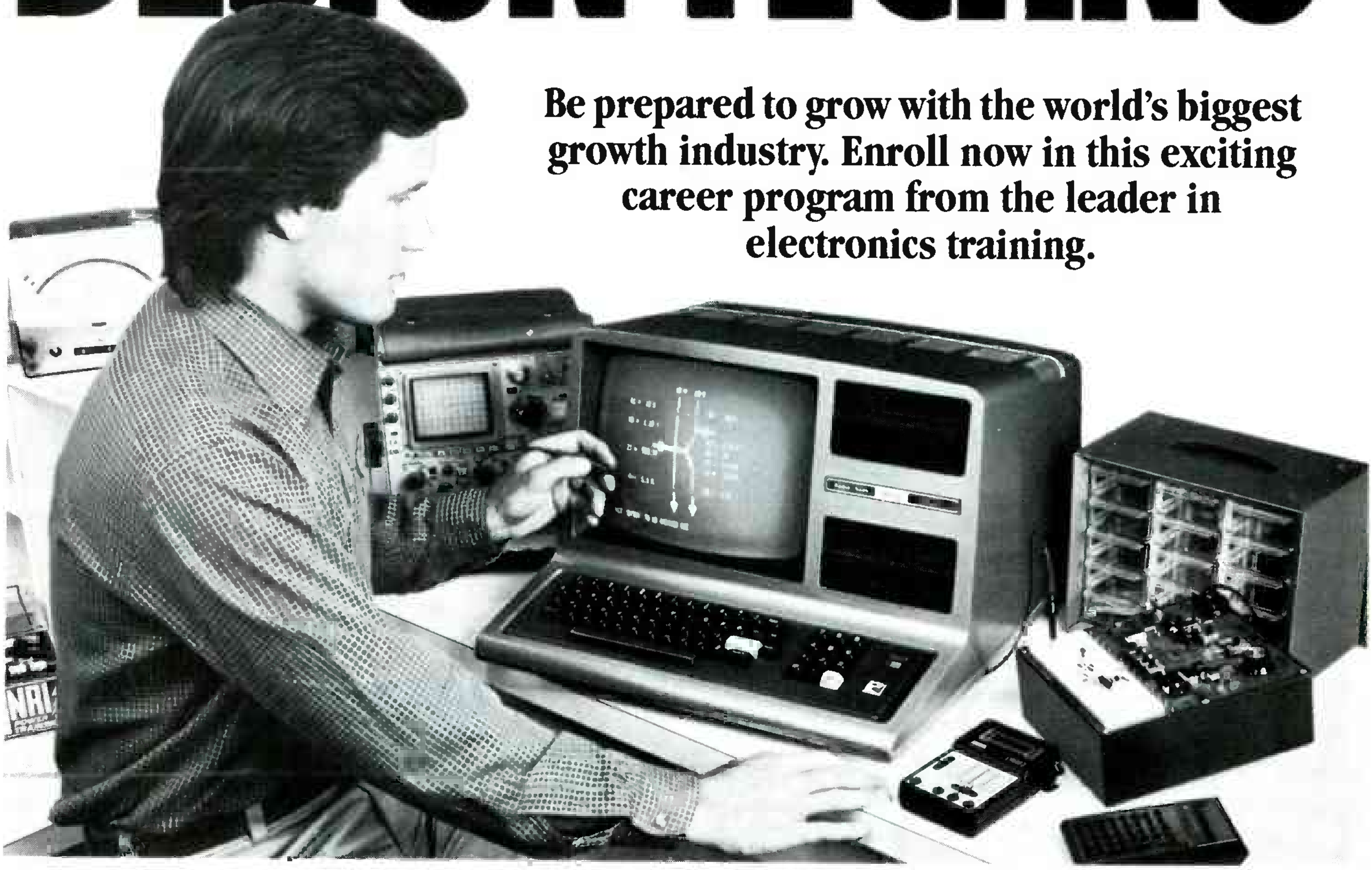

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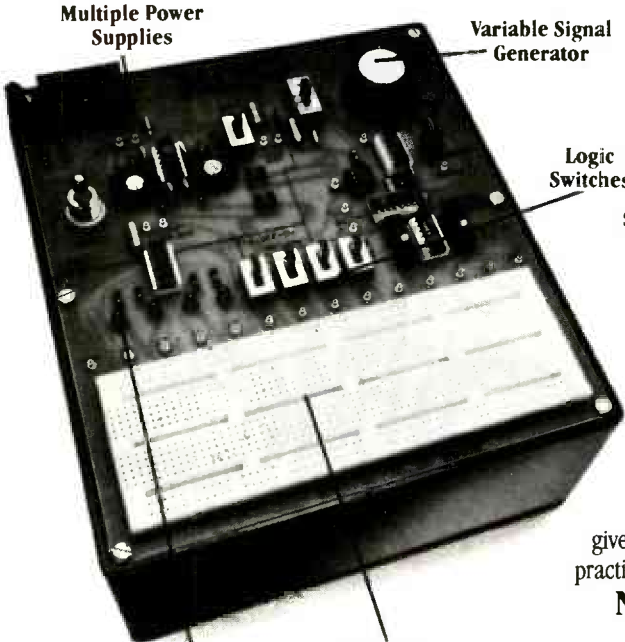

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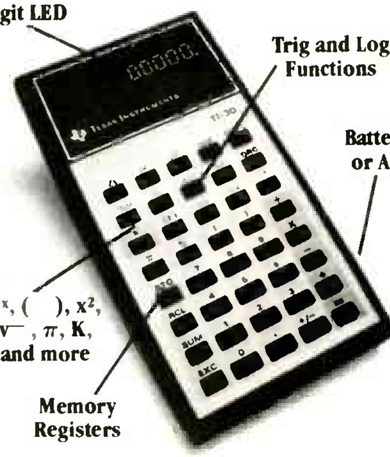

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BECKMAN

VIDEOGAMES

continued from page 14

unusual creation that pits a conventional tank against a horde of not-so-conventional giant worms that wiggle back and forth across the screen. The worms, plus other wall-like obstacles on higher levels, scroll from top to bottom, giving you the illusion of tank motion down a wide avenue. You control left-right movement of the tank and the scrolling speed.

The object is to clear off each successive wave of wriggly worms. If one scrolls off the bottom, it "wraps around" and re-appears at the top for another chance. Each wave materializes on the screen, along with an occasional gas station.

Gas station? Yes, your tank's fuel supply is limited, so you've got to pass though a station (more like a garage door) as quickly and as squarely in the center as possible to pick up the most fuel. As you soon learn, it's not so easy to hit a moving worm in the right spot on purpose, but it's all too easy to blast away a garage by accident.

The worm graphics are not greatly detailed, but the worms are unique in their movement. To some players, a fresh wave of worms will look like an oscilloscope pattern run amok. The sound consists of blaring barrages similar to the *Yar's Revenge* sequence after hitting the elusive *Qotile*.

Worm War I may not rank among the all-time great *VCS* cartridges, and inexperienced players may find the difficulty progression rather fast, but the original scenario and game play make it a worthy addition to larger libraries.

Parker Brothers' Frogger Jumps to the Atari 2600

Frogger was one of those non-combatant arcade games that helped draw quarters from the female audience once *Pac-Man* had whetted their appetites. The game's scenario was cute and simple: get the frog across a busy highway and a river in 30 seconds. Controlling the frog meant simply moving him forward, backward, left or right—just like a maze game. In spite of its simple scenario, and ease in picking up how the game works, the game advances rapidly into harrowing experiences for that homebound frog.

There is a lot going on on a *Frogger*

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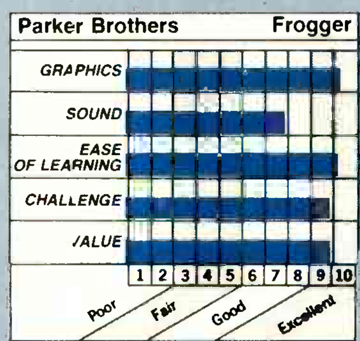

screen, especially in the river. That includes things like moving logs, turtles that dive (disappear) into the water, alligators, snakes, lady frogs, and flies (the last two account for bonus points). When Parker Bros. announced it had purchased the rights to *Frogger* from Sega/Gremlin, I had some doubts as to how much of the original could be convincingly transferred to an Atari *VCS* cartridge, given that system's limited memory and graphics-addressing capabilities. However, I was pleasantly surprised when I finally saw Parker's rendition. With the exception of one hazard (the otters), Parker's *Frogger* manages to capture most of the subtleties of the original graphics. More importantly, the game play is at least as challenging as the arcade version, with the difficulty increasing at a brisk but not frustrating pace.

One advantage of the home game over the arcade version is the number of game levels available. The cartridge contains 6 variations, three each for one and two players, called "easiest" (not that easy), "more difficult," and "speedy." In "speedy," *Frogger* continues to jump in one direction as long as you push the joystick that way. In other games, it's one push of the joystick per jump. *VCS* difficulty-switches also give you the option of letting the frog scroll around the screen on turtles or logs, instead of biting the algae when it reaches the screen edge. That's highly recommended for novice players.

Scoring is one-tenth that of the arcade version (e.g., 100 points for getting all five frogs home vs. 1000 at the arcade). Extra frogs are earned for every 1000 points, up to a maximum of four reserve frogs at any time. That may sound more generous than the arcade game (only one extra *Frogger* at 2,000 equivalent points), but it indicates the greater challenge that the Parker *Frogger* cartridge offers.

Players get a brief *Frogger* musical interlude between levels and the theme music at the game's outset. If you're intent on replaying the game, that intro music seems to take forever, but unlike Parker's *Empire Strikes Back*, you've got to wait for the music to stop before *Frogger* can start.

Even if you've never played the arcade original, you'll enjoy *Frogger*, as will the young and novice game players in your home. **R-E**

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LETTERS

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DMM ADD-ON

In reference to the "DMM Add-On" ("New Ideas," October 1982 issue), I must admit that, for me, the article does not compute. There was no rationale given for the "divide 4000 by the meter reading."

By my logic, I would consider the simplified circuit to be as you see it in Fig. 1.

Consider Rx to be 100 megs; then R total = 100 + 0.5025 = 100. 5025 megs. Total current =

$$\frac{E}{R} = \frac{8}{100{,}502{,}500} =$$

0.0000000796 amperes.

The DMM should read the voltage drop across 0.5025 megs. E = IR = 0.0000000796 × 502,500 = 0.039999005 volts; that rounds out to 0.04 volts (meter reading).

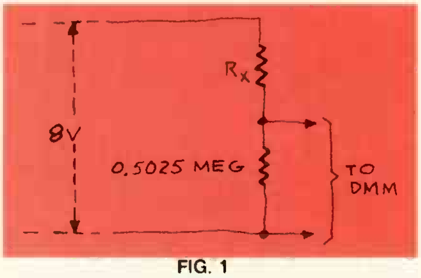

FIG. 1

According to the article,

$$Rx = \frac{4000}{0.04} = 100{,}000\ \Omega$$

That is not 100 megohms!

100 megohms can be derived by first determining the voltage drop across Rx = 8V − 0.040V = 7.96V. Then

$$R = \frac{E}{I} = \frac{7.96}{0.0000000796} = 100{,}000{,}000$$

or 100 megohms. Or the formula could be used:

$$Rx = \frac{E_{RX}}{E_{DMM}} \times \frac{0.5025 \text{ megs}}{1}$$

JOSEPH S. RIZK
Jacksonville, FL

In the 200-millivolt range, the meter reading is 40—not 0.04. To obtain the correct resistance in megohms, divide 4000 by the actual meter reading—not the voltage value.—Editor.

AGREEMENT

I agree with Mr. Joseph W. Miller's suggestion in the "Letters" section of the January

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1983 **Radio-Electronics** that you ease off computer articles.

I am not a subscriber, but the newsstand saves me a copy every month, and I have a **Radio-Electronics** file of several years' standing. I am a "hobbyist," retired (age 74), and have been in electronics and radio since 1923.

I have just refused to renew my subscription to another electronics magazine because they devote too much space to computers. There is not a single magazine (to my knowledge) that is for the hobbyist; all have gone to computers. There are still a lot of us, believe it or not, who are *not* interested in computers, *per se*.

GERALD HASSELL
Brookhaven, NY

FASTER THAN LIGHT

In your January 1983 issue, Dr. Harold W. Milnes presents three experiments. He interprets the first two (and particularly the second) as "leading to one conclusion: An electrical signal in a conductor, under suitable conditions of very low L and C values, can be made to pass through that conductor at a velocity considerably greater than that of light." He estimates it to be "greater than one hundred times the speed of light."

The problem with the experimental setup is that the wire is not a *straight* wire. In both experiments, the wire forms *loops* (a multitude of loops in the first experiement, and one in the second). Those loops allow for inductive magnetic coupling—or rather magnetic short-circuiting—of early parts of the wire with late parts of the wire.

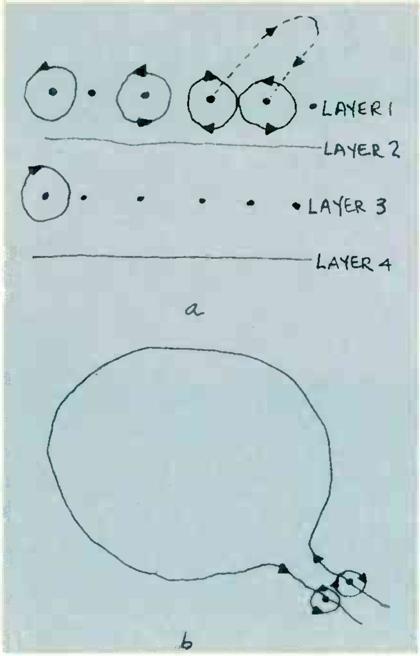

FIG. 2

Although the wire length is 400 meters, the magnetic length is only of the order of one meter or less (depending on the connecting wires). That can be seen in Figs. 2-a and 2-b below, which correspond respectively to the experiments. The magnetic lines show how the mutual magnetic inductive coupling occurs, and how a magnetic short-circuiting of the ends of the wire ensues. (Another way to examine that short-circuiting consists of considering the stepwise EMF induced in one end of the wire by the stepwise magnetic field of the stepwise current in the other end.) Using coaxial cable would remove the electromagnetic coupling of the early and late parts of the wire.

DR. MICHEL G. BOUGON
The Pennsylvania State University, University Park, PA

MICROPROCESSOR-BASED DEVICES

I have read the January issue of **Radio-Electronics,** and find it to be superb, as usual. I am always very interested in construction articles, and have been hoping to see some on how to design microprocessor-based devices. Your article, "How To Interface Microprocessors" was fine—but too short! I would very much like to see that article expanded into a multipart series, so that those of us who are not thoroughly familiar with micros can be enlightened as to the hardware aspects of those devices.

I am certainly *not* suggesting that **Radio-Electronics** become a computer magazine. Heaven forbid! I do, however think that a regular monthly series of construction articles based on the more common microprocessors would prove to be extremely valuable to your readers. After all, it is getting to the point where anyone working in the area of digital electronics must "know" micros. I have found the micro to be such a useful device that it would be a real loss not to continue to provide your readers with applications information.

DANIEL R. TAYLOR
Orlando, FL

"I built this 16-bit computer and saved money. Learned a lot, too."

Save now by building the Heathkit H-100 yourself. Save later because your computer investment won't become obsolete for many years to come.

Save by building it yourself. You can save hundreds of dollars over assembled prices when you choose the new H-100 16-Bit/8-Bit Computer Kit – money you can use to buy the peripherals and software of your choice.

H-100 SERIES COMPUTER SPECIFICATIONS:

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MICROPROCESSORS: 16-bit: 8088; 8-bit: 8085

DISK STORAGE: Built-in standard 5.25" disk drive, 320K bytes/disk

KEYBOARD: Typewriter-style, 108 keys, 13 function keys, 18-key numeric pad

GRAPHICS: Always in graphics mode. 640h/225v resolution; up to eight colors are available**

COMMUNICATIONS: Two RS-232C Serial Interface Ports and one parallel port

DIAGNOSTICS: Memory self-test on power-up

AVAILABLE SOFTWARE: Z-DOS (MS-DOS), CP/M-85, Z-BASIC Language, Microsoft BASIC, Multiplan, SuperCalc, WordStar, MailMerge, Data Base Manager, Most standard 8-bit CP/M Software

*128K bytes standard.
**Optional.

The H-100 is easy to build – the step-by-step Heathkit manual shows you how. And every step of the way, you have our pledge – "We won't let you fail." Help is as close as your phone, or the nearest Heathkit Electronic Center.†

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High-capacity disk storage, too. The H-100's 5.25" floppy disk drive can store 320K bytes on a single disk. The computer also supports an optional second 5.25" and external 8" floppy disk drives. And an optional internal Winchester disk drive will be available soon.

For more information, circle the reader service number below. Better yet, visit your Heathkit Electronic Center for a demonstration!

The H-100 gives me the most for my computer dollar!

CP-217

Heathkit
Heath Company

†Heathkit Electronic Centers are units of Veritechnology Electronics Corporation.
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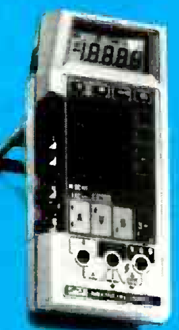
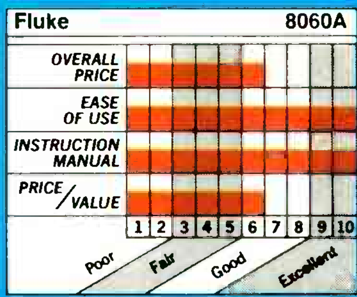
CIRCLE 16 ON FREE INFORMATION CARD

EQUIPMENT REPORTS

Fluke Model 8060A DMM





CIRCLE 103 ON FREE INFORMATION CARD

LONG A MANUFACTURER OF SMALL, high-quality, and useful digital multimeters, The John Fluke Co. (PO Box C9090, Everett, WA 98206) has outdone itself with its latest DMM, the model *8060*. Actually, rather than a DMM, we think this instrument should be called a DMPM, or a *D*igital *M*ulti-*P*urpose *M*eter, as it not only features the "standard" DMM functions, but also a few more that are definitely not standard. In fact, it will do so many things that we're going to concentrate on some of the more unusual ones.

Briefly, the unit is a hand-held, microprocessor-based, 4½ digit DMM, with a nice big LCD display. AC readings are true RMS up to a frequency limit of 100 kHz. Voltages, either AC or DC, can be displayed in dBm referenced to 600 ohms, or in relative dB. A relative reference (or offset) feature works with all of the meter's functions. When that feature is used, a reading is stored as a zero refer-

ence and all subsequent readings are displayed as ± deviations from that reading.

Resistance ranges are autoranging up to 300 megohms. Continuity tests can be made using either an audible or visual (on the display) indicator. A conductance range that is useful for measuring very high resistances (up to 10,000 megohms) is provided. While the reading is displayed in nanosiemens, a handy chart for converting that reading to ohms is provided. The 2000- and 20,000-ohm resistance ranges can be used for testing semiconductor junctions. Those provide a constant current that is high enough to turn on a junction. That function is clearly noted on the front panel as a reminder.

The range and standard-function switches are all located down one side of the meter for easy one-handed operation. The ON-OFF switch is also located on the side, but away from the rest and toward the top of the meter. The special-function switches are located in a row at the top of the front panel. Test leads plug into protected jacks at the bottom.

The meter performs a self-test procedure every time it is turned on. During that procedure, the entire display is activated, including all four digits (ones are displayed) as well as the function and low-battery annunciators.

The meter can be used for a wide variety of tests; let's take a look at some of them. You can find the bandwidth of any audio amplifier (as defined by its 3-dB points) using just the DMM and an audio generator, The generator need not be calibrated that accurately, as the meter can be used to determine the generator's output fairly precisely. The first thing to do is to connect the generator to the amplifier's input (you can set the input level to whatever you want by reading it out on the meter), connect the meter to the amplifer's output, and set the meter to read AC voltage. Next, determine a zero-dB level. To do that, set the generator to 1 KHz (that is the frequency most commonly used as a standard), and push DB and the REL (relative reference) buttons on the meter. Now, all readings will be referenced to that level and read out directly in dB. To make the test, start the generator at zero dB and slowly increase the frequency until the meter reads −3dB. That is the upper limit of the bandpass. To get the precise frequency, hit the HZ button on the meter and log the reading. To find the lower bandpass limit, repeat the procedure, except this time work downward from zero dB.

The results of that test can be used to find the Q of frequency-sensitive filters (such as bandpass, high- or low-pass filters, notch filters, etc.) as well as any other type of tuned audio-frequency circuit. To find the Q of such circuits, determine the circuit's passband from the procedure above and divide the center frequency of that passband by the passband's bandwidth.

The relative reference function can be used for very rapid signal tracing. For a 3-stage amplifier, for instance, connect the DMM across the first-stage input and feed the signal from an audio generator into that input. Set whatever level you want as 0 dB and use the dB and relative reference functions on the meter to store that as a reference. Now, move the meter to the output of that stage to see what the gain is. Do the same for the remaining stages. That one test should be invaluable for checking things like the 3-4 stage direct-coupled video and audio amplifiers, as well as many other types. Any defective stage can be found easily and quickly using that technique.

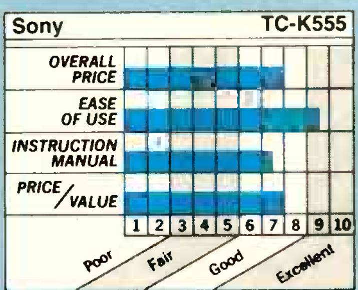
The meter can also be used to quickly find the frequency response of any amplifier, record player, tape deck, or the like. Let's see how that is done for a tape deck as an example. First of all, set the DMM to read AC voltage on the 200-mV range and connect it to the output of the deck. Now, play a frequency-test tape on the deck and set the relative reference function for some convenient value, say 1000 Hz, or whatever other value you wish. Now play the whole tape through and log the response to each frequency. The frequency "cuts" on the tape should play long enough for you to get a reading. The frequency response of the main amplifier can also be checked; just connect the meter across the output and be sure that the output is terminated into its rated load. Then, set the meter to a suitable range and play the frequency-test tape. Tests for stereo balance, head alignment, and many more things can be performed using that setup.

The instruction manual is very elaborate. Each function is described, and you're told how to set it up, as well as what it will do. It describes quite a few of the specialized tests that can be done using the meter, and a complete explanation of exactly how the instrument works is provided. Also provided are a parts list, schematics, a troubleshooting guide, and layout illustrations showing the location of all calibration adjustments, test points, etc. Finally, there's a list of the many accessory probes available for use with the DMM. Those include an RF probe that's used to extend the frequency range to 100 MHz, an HV probe, temperature probes, a clamp-on AC-current transformer, a current shunt, and a high-frequency probe for frequencies up to 500 MHz.

We've covered only a few of the things that the instrument can do and we're sure that you'll find quite a few more as you use it. The model *8060A* is an extremely versatile piece of test equipment, and one that should be well worth its suggested list price of $349.00. **R-E**

Sony TC-K555 Stereo Cassette Deck

CIRCLE 104 ON FREE INFORMATION CARD



IF YOU ARE AN AUDIO ENTHUSIAST LOOKing for a modestly priced, state-of-the-art stereo cassette deck, one unit you should consider is the *TC-K555* from the Sony Corporation (Sony Drive, Park Ridge, NJ 07656).

That deck, which is priced at $420.00, is packed with many features that a few years ago were seen only on much more expensive units.

Sony used a three-head design rather than using a two-head, sandwich design (where each head can affect the other magnetically). That head arrangement allows you to monitor your recording by listening to the signal that's actually on the tape, rather than the signal that's going to be on the tape. The record and playback heads are independently suspended and are separated by an air space of about 1.2 mm so that crosstalk is nil; there is a minimum of magnetic-flux leakage. The heads are mounted on one block, and each can be separately adjusted for precise azimuth alignment. The heads are made of both Sendust and Ferrite so that they can take advantage of metal tapes (which provide a wider dynamic range than do conventional tapes).

To reduce wow and flutter, the *TC-K555* uses two sets of capstans and pinch rollers that ensure uniform tape tension and stable tape-to-head contact. For the same reason, the capstans are driven by linear-torque motors. Wow and flutter of 0.04 percent wrms indicates the success of those measures to attain stability in the tape-transport system.

The *TC-K555* boasts some other impressive specifications. Total harmonic distortion is 0.8 percent when using high-performance tapes. (Although, as noted, the *K555* will handle normal tapes, chances are that most audio enthusiasts will use high-performance tapes to get the best performance from the deck.)

For normal tapes, the signal-to-noise ratios are 56 dB with Dolby off, 63 dB with Dolby-B, and 69 dB with Dolby-C. For chromium-oxide tapes, the S/N ratio is 57 dB with Dolby off, 64 dB with Dolby-B, and 70 dB with Dolby-C. Ferro-chromium tapes display markedly better performance characteristics and the system is able to make use of them, with a S/N ratio of 61 dB with Dolby off, 68 dB with Dolby-B, and 74 dB with Dolby-C. In fact, FeCr tapes outperform metal tapes (in terms of the signal-to-noise ratio), whose figures are 60 dB with Dolby off, 67 dB with Dolby-B, and 73 dB with Dolby-C.

The frequency response figures of the *TC-K555* are also impressive. With Dolby off, the figures are: 20 to 18,000 Hz with normal tapes and chromium oxide tapes, and 20 to 19,000 Hz for ferro-chromium and metal tapes. However, there are other things besides the specifications that make the Sony *TC-K555* an impressive stereo cassette deck. They are the many "human engineered" features that are included.

Features

The tape counter, usually taken for granted on cassette decks, is one feature that deserves close examination. That's because it's not simply a counter that counts arbitrary units (which seem to be different on every cassette deck) to indicate elapsed "time." Instead, it's a real-time counter. It provides you with a meaningful way to index your taped selections, and it can even tell you how much time is left on a cassette that you're recording. Let's take a closer look at how that feature is used.

One thing that you can use the counter for is simply to determine how much time is available on one side of a cassette. First you insert the tape and when you are at the beginning of it you press the COUNTER RESET button. That, as you might expect, sets the counter to zero. Next, fast-forward the tape to the end and the counter will show you the approximate available recording time. Using a slightly different procedure you can also use the counter to determine the time *remaining* on one side of a cassette.

Perhaps the most useful way to use the counter is to monitor the remaining recording time *while you are recording*. As before, you insert the tape, and fast-forward it to the end. Then you reset the counter and rewind the tape. The display will show how much time is available. As you record, the digits will decrease to zero. (Actually they increase to zero—the counter display shows a minus sign to indicate that it is in that mode.)

We should point out that the counter is not a digital clock. *The time that it displays is approximate*, and it will vary depending on the type of tape that you use. For best accuracy, you should use a C-60 tape. (That is what the counter is calibrated for.) Even so, the real-time tape counter is a definite improvement over the standard arbitrary counter. It's an improvement over many other real-time counters, too. It will show the tape time continuously and does not need to be adjusted when you change modes or tapes.

There is yet another feature that makes the *TC-K555* easy to use: auto play and memory play/stop. If you have a tape that has to be rewound before you can listen to it, you no longer have to sit by the deck so you can press PLAY after it finally rewinds. All you need to do is press REWIND and PLAY at the same time. When the tape is completely rewound, it will play automatically. You can also use that feature along with the MEMORY mode to start the tape (after rewinding) from any point on the tape.

The dual-meter VU display also deserves some attention. The display uses two rows of LED's to indicate the recording level. The saturation level (the highest recording-level setting that will not result in distortion) is also indicated on the meter. That saturation level is different for different types of tapes, and the *TC-K555* takes that into account. A row of red LED's indicates the range where saturation occurs depending on which TAPE button is pressed. (There is a choice of four, for normal, CrO_2, FeCr, and metal tapes.) You set the recording level by making sure that the meters deflect only to the lower edge of that line.

Setting the proper level is made easy because when the MONITOR switch is set to SOURCE, the VU meters show the peak input levels, and display them for four seconds. (A higher input will be immediately indicated and held for four seconds.)

The *TC-K555* includes Dolby B *and* Dolby C noise-reduction systems. (Dolby C, a recent development, is more effective than Dolby B. It begins to take effect at lower frequencies, and it reduces noise by 20 dB at 5 kHz as compared to 10 dB at 5 kHz for Dolby B).

Previously, we mentioned the saturation level of a tape (the level above which a recording will be distorted). At high frequencies, a tape will saturate more easily than at low frequencies. However, to reduce that problem, the Dolby C system includes a high-frequency anti-saturation network. That network reduces the level of high-frequency signals when you record. When you play back the recording, the system boosts them back to their original level.

Among the other features on the *TC-K555* is an MPX (multiplex) filter. That filter is used for recording FM stereo broadcasts from stations that are equipped with Dolby noise-reduction systems. The filter suppresses the 19-kHz pilot signal and 38-kHz subcarrier (if they have not been adequately suppressed by the tuner). If the tuner does suppress those signals adequately, then you can record with the filter switched off.

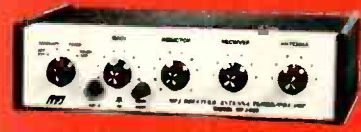
The *TC-K555* also has the usual tape-selection and bias controls found on just about all component-stereo recorders. The bias is set by pressing one of the four TAPE buttons (for normal, chromium dioxide, ferro-chromium, and metal tapes). When you are using normal tapes, you can also use the BIAS control to regulate the bias current by ± 20%. When bias is increased, it suppresses extremely high frequencies. High frequencies are boosted when bias is decreased.

The deck includes a timer switch, so it can be used with an external timer to record or play back at a predetermined time. A headphone jack is also included. The headphone output has its own volume control. That's a nice bit of "human engineering."

Yet another interesting function is the RECORD MUTING button. Pressing that button either inserts a blank space during a recording or eliminates unwanted material from a finished tape. It's an aid to editing. The *TC-K555* has a fast-forward and rewind time of 90 seconds for a C-60 cassette.

The owner's manual for this cassette deck is good, and is aimed at the nontechnical user. It features ample pictorial guides to help the user get started and explains some of the theory behind the various controls and features. However, it is very basic and will require the user to experiment for himself if he is to gain the fullest advantage from the recorder. **R-E**

MFJ Model 959 Shortwave Receiver Antenna Tuner



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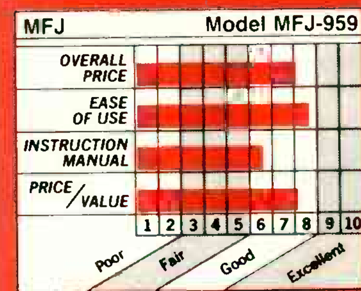


THE MOST IMPORTANT PART OF ANY radio setup—whether receiving or transmitting—is the antenna system. Of course it helps to have a good receiver or transmitter, but without a good antenna, excellent equipment can be useless.

One trouble with tuned antennas is that their performance is good only at the narrow frequency range for which the antenna was designed. While that problem is not as critical with a shortwave receiver as it is with a transmitter, it is a problem nevertheless.

The solution to that problem, used by radio amateurs for many years, is a tuned matching circuit that presents the correct load impedance to the radio. Granted, an antenna matching circuit will not make your antenna better—it will only allow the radio to see a correct load—but it will allow the receiver to make the best use it can of the off-resonance antenna. While transmitting tuners have been around for years, there have been few matching devices for shortwave receivers until the introduction of the MFJ model 959 receiver antenna tuner and preamp.

The *MFJ-959* is made by MFJ Enterprises, Inc., (P.O. Box 494, Mississippi State, MS 39762) and is 9¼ × 6 × 2⅜ inches and weighs about one pound. All the circuitry is contained in a 5 × 3 inch circuit-board. The tuner is powered by 9- to 18-volts DC that is supplied, through a subminiature jack on the back of the tuner, from a wall transformer that is included with the unit.

The unit is designed to allow the maximum possible signal transfer by presenting the proper match to the receiver. The tuner/preamp is broadband—designed to operate from 1.8 to 30 MHz. It has three built-in functions. Not only will it act as a straight impedance-matching network (a variation of a T-network) but it will also act as a signal attenuator and as a preamplifier. Those functions are controlled by a four-position, single-pole switch on the front of the tuner (the other position is OFF/BYPASS). Let's now look at the functions in greater detail.

When the switch is in the TUNER position, the signal is received at the antenna-input connector (either an SO-239 or RCA-type connector) and is then passed directly to the matching network which contains 10 inductances ranging from 0.47 μH to 47 μH. The inductors are selected by a single-pole, 10-position rotary switch. Capacitance is then added by using two 320-pF variable tuning capacitors. One is on the receiver side of the circuit, while the other is on the antenna side (those are labeled RECEIVER and ANTENNA on the front panel). Those controls are adjusted for maximum deflection on the receiver's signal meter or for maximum noise from the receiver if it has no S-meter.

When the function switch is in the TUNER-ATTENUATOR setting, an attenuation pad is placed in series with the antenna. That introduces enough resistance into the circuit to produce 20 dB of signal attenuation. That is especially useful if the receiver is being overloaded by nearby broadcast stations, amateur transmitters or CB radios. Indeed, that feature works well. It will null out almost all but the strongest signals.

In the TUNER-AMP mode, a common-collector amplifier circuit is switched in series wth the antenna, and weak signals are easier to copy. That helps, especially if the sensitivity and selectivity of the receiver itself falls short. The circuit, built around a 2N3904 transistor, can provide as much as 12 to 24 dB of gain to the receiver. It is that increase in gain which also helps, seemingly, to improve the sensitivity and selectivity of the radio. It works well enough to pull in barely-readable weak signals out of the noise and make them readable. However, one drawback is that that feature will also increase the noise level of the receiver. So, it is a trade-off, but in many cases a good one.

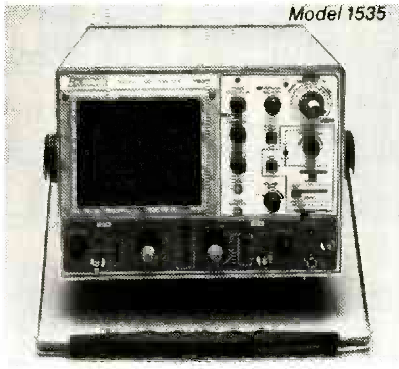
One interesting and convenient feature of this tuner is the inclusion of the two types of antenna connectors. That makes it easy to use antennas with either RCA-type or SO-239 connectors. There is a bypass setting for those times when you are using the antenna for the frequency range for which it was cut. There is also a provision for tying a second receiver into the circuit. That is convenient for the avid

continued on page 100

The trouble with most delayed-sweep scopes is the delay—not the electronic kind, but the delivery delay. B&K-PRECISION has solved that problem, so now you can have the delayed-sweep scope you need, when you need it.

The new model 1530 delayed-sweep scope from B&K-PRECISION is not only available at local distributors now, but it has all of the most frequently needed features. Thirty MHz response, 2mV division sensitivity and rectangular CRT assure that the 1530 will handle the requirements of most engineers involved in digital and microprocessor circuit development. High-triggering sensitivity and very-flat frequency response also allow the 1530 to be useful well beyond its rated bandwidth.

Five ranges of time-base delay from 1nS to 100mS highlight this new instrument. The delayed-sweep capability of the 1530 is a major advantage in the evaluation of digital pulse trains and other complex waveforms. Complex signals can be expanded by as much as 1000 times for examination of signal components and troublesome "glitches." The absolute minimum magnification is 5 times at frequencies to 30MHz. The delayed-sweep feature is also useful in the measurement of rise and fall times of pulse signals.


Model 1535

For highest display accuracy, the 1530 offers a variable hold-off function. This ensures triggering at the first pulse of a multi-pulse signal, preventing improper waveform display. The 1530 can also display two signals that are unrelated in frequency by alternately triggering on both the channel A and B signals.

Other convenient features include a FIX mode to eliminate trigger level adjustments, differential input capability, single sweep operation, selectable triggering filters and a built-in video sync separator.

If you're looking for the kind of features and performance found in the 1530, but without delayed-sweep capability, B&K-PRECISION offers the 35MHz model 1535. The 1535 is a high-performance instrument that doesn't sacrifice performance.

For immediate delivery, contact your local B&K-PRECISION distributor or call toll-free **1-800-621-4627.**

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*Please allow 6-8 weeks to receive your check from B&K-PRECISION. Sales receipts cannot be returned. Void where prohibited, taxed or otherwise restricted.

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If you have put off learning more electronics for any of these reasons, act now!

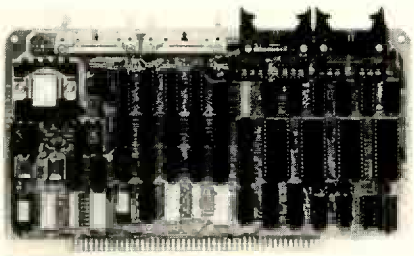
- ☐ I don't have the time.
- ☐ High school was hard for me and electronics sounds like it may be hard to learn.
- ☐ I can't afford any more education.
- ☐ I have a family now.
- ☐ I'm here. You're there. I've never learned that way before. I'm not sure it will work for me.

Read the opposite page and see how you can get started today!

NEW PRODUCTS

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

BOARD, model *4S/2P-ASM,* is a four-serial/two parallel port board. The four RS-232 serial input/output ports use four 8251's. The I/O ports use eight consecutive 8080 ports.



CIRCLE 141 ON FREE INFORMATION CARD

Features include full handshaking capability and four dip-switch-controlled baud-rate generators.

Two 8-bit parallel I/O ports include four 8-bit latches (74LS373's) and use four consecutive 8080 ports. There are separate handshaking lines, outputs that will drive up to 30 mA, and inputs that present less than a .4-mA load.

The board is S-100 compatible; all cables are included; it comes completely assembled and thoroughly tested, and there is a six-month, no-fault *full* warranty.

The model *4S/2P-ASM* is priced at $395.00.—**Tarbell Electronics,** 950 Dovlen Place, Suite B, Carson, CA 90746.

RADAR DETECTOR, the *Radar Intercept,* model *IN,* has a slim, solid-state design that allows it to be mounted easily into the automobile's visor. It is activated by lowering it into position; no complicated installation methods are needed. Using a swivel bracket, there will be no interference with the driver's vision.

The *Radar Intercept* detects police-radar

CIRCLE 142 ON FREE INFORMATION CARD

units on X and K bands, and its circuitry searches and selects signals on both bands. There is a two-stage warning system. When weak signals from distant radar units are en-

continued on page 44

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B+K PRECISION — 15 MHz TRIGGERED SWEEP SCOPE

MODEL 1477

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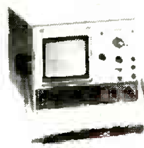
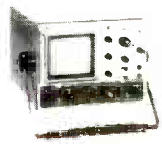
- Bright P31 blue phosphor
- Front-panel X-Y operation
- Differential input capability
- 19 calibrated sweeps—.5μSEC/cm to .5SEC/cm
- Sweep to .1μSEC/cm with 5x; 1.5SEC/cm with uncalibrated vernier

B+K PRECISION — 10 MHz SCOPES



1466 SINGLE TRACE



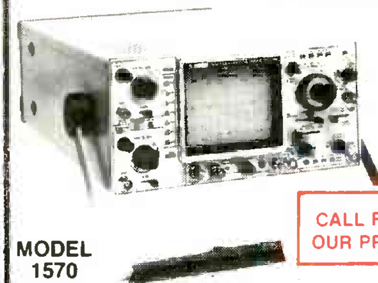
1476 DUAL TRACE

CALL FOR OUR PRICES

- Triggered and automatic sweep
- 18 calibrated sweeps
- On 1476 mode automatically shifts between CHOP and ALTERNATE
- Bright P31 blue phosphor
- Front panel X-Y operation using matched vertical amps
- Video sync separators
- Check most digital logic circuitry

PRICE DOES NOT INCLUDE PROBES

B+K PRECISION — 70 MHz. Dual Time BASE SCOPE

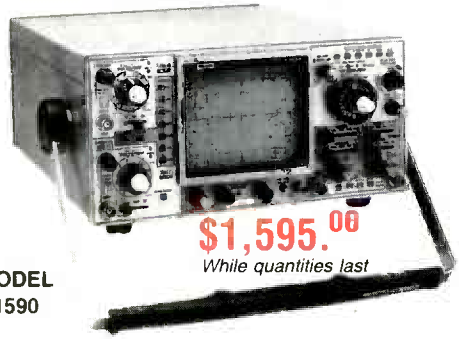


MODEL 1570

CALL FOR OUR PRICE

- 1 mV/division sensitivity to 70 MHz
- 500 μV/division cascade sensitivity
- Four-input operation provides trigger view on 4 separate inputs.
- Alternate time base operation
- Switching power supply delivers best efficiency and regulation at lowest weight

B+K PRECISION — 100MHz Dual Time BASE SCOPE



$1,595.00

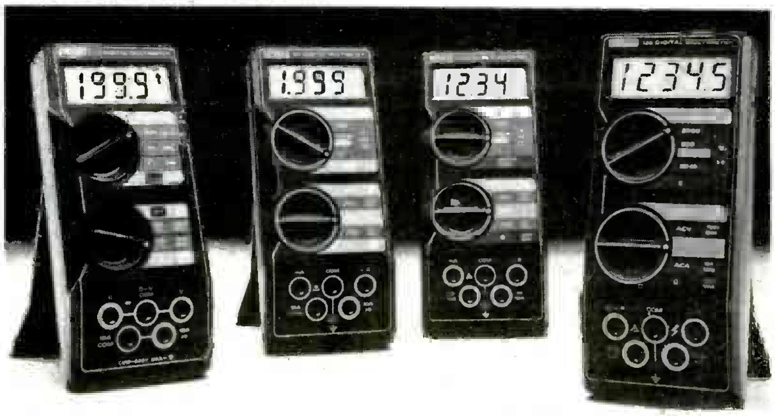
While quantities last

MODEL 1590

- 1mV/division sensitivity to 100MHz
- 500μ V/division cascade sensitivity
- 2ns/division sweep rate with 10× magnifier
- Four-input operation provides trigger views or four separate inputs
- Selectable 1MΩ or 50Ω inputs
- Alternate timebase operation
- 20MHz bandwidth limiter for best view of low frequency signals
- Lighted function pushbuttons employing electronic switching with non-volatile RAM memory
- Switching power supply delivers best efficiency and regulation at lowest weight
- Selectable frequencies for chop operation

PRICE DOES NOT INCLUDE PROBES

KEITHLEY — DIGITAL MULTIMETERS



Model 128: Beeper DMM designed to meet the tough specifications of a major computer manufacturer. See/hear display includes over/under arrow and on/off beeper.

Model 131: 0.25% accuracy added to the easiest to use handheld DMM. Color-coded front panels for maximum clarity, minimum confusion.

Model 130: Keithley user research led to unique DMM designs. Easy to read LCDs, largest DMM displays on the market.

Model 135: First 4½-digit handheld DMM, ideal for analytical/bio-medical service. 10A range standard on all Keithley handhelds.

Model 128: $139.00
Model 130: $124.00

Model 131: $139.00
Model 135: $235.00

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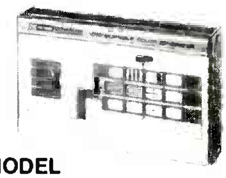
MODEL 1250

Professional studio quality generator. Ultra stable. Ideal for VTR work.

- Generates NTSC color bars with or without—IWQ signal
- Generates 5 step linear staircase; staircase with high or low chroma
- External video input—modulates rf or i-f carrier outputs



MODEL 1210

- Generates 10 stable patterns including crosshatch, 7 x 11 dot, gated rainbow and purity.
- Compact for convenient field service use

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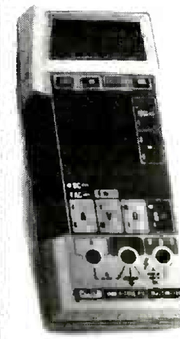
FLUKE 4½ DIGIT MULTIMETERS

MODEL 8060A



- Frequency measurements to 200KHz
- dB measurements
- Basic dc accuracy 0.04%; 10 µV, 10 nA and 10 mΩ sensitivity.
- Relative measurements
- True RMS
- High-speed Beeper

$349.00

MODEL 8062A

- Continuity and relative reference functions identical to 8060A.
- True RMS measurements to 30 kHz.
- Basic dc accuracy 0.05%; 10 µV, 10 nA and 10 mΩ sensitivity.
- Beeper

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- Audibly and visually indicates GOOD transistor

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MODEL 1601

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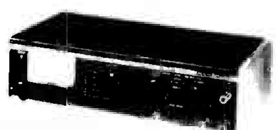
- Isolated 0-50VDC, continuously variable; 0-2A in four ranges
- Fully automatic shutdown, adjustable current limit
- Perfect for solid state servicing



MODEL 1650

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- Functions as three separate supplies
- Exclusive tracking circuit
- Fixed output 5VDC, 5A
- Two 0 to 25VDC outputs at 0.5A
- Fully automatic, current-limited overload protection

B+K PRECISION FUNCTION GENERATORS

MODEL 3010

- Sine, square and triangle output
- Variable and fixed TTL outputs
- 0.1 Hz to 1MHz in six ranges
- Push button range and function selection
- Typical sine wave distortion under 0.5% from 1 Hz to 100kHz

MODEL 3010 $179.95 was $220.

MODEL 3020 $299.95 was $379.

SWEEP FUNCTION MODEL 3020

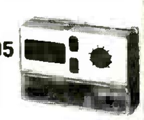
- Four instruments in one package—sweep generator, function generator, pulse generator, tone-burst generator
- Covers 0.02Hz-2MHz
- 1000:1 tuning range
- Low-distortion high-accuracy outputs

B+K PRECISION CAPACITANCE METERS

$179.95 was $229.

MODEL 830

- Automatically measures capacitance from 0.1pF to 200mF
- 0.1pF resolution
- 0.2% basic accuracy
- 3½ digit LCD display



$149.95 was $185.

MODEL 820

- Resolves to 0.1pF
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- Fuse protected against charged capacitors
- Overrange indication

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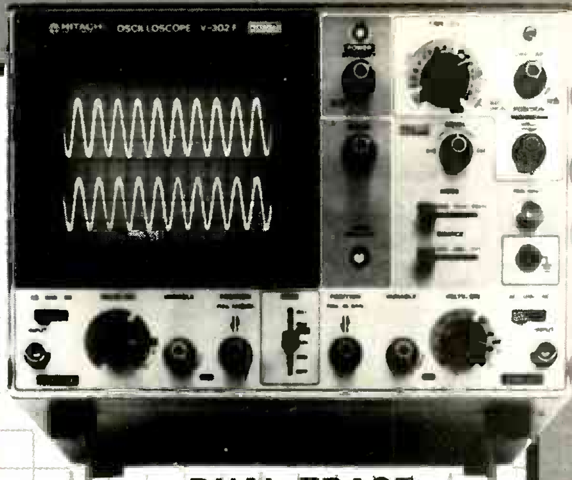

DUAL TRACE W/DELAY

QUANTITIES ARE LIMITED

V-302F 30MHz

SPECIFICATIONS

• Vertical Deflection	
Sensitivity	5mV/div to 5V/div ±5%, 10 calibrated steps 1mV/div to 1V/div ±6% (When using x5 amplifier) Uncalibrated continuous control between steps 1: < 2.5 (provide with click-positioning function)
Bandwidth	DC to 30MHz, −3dB (at 4 div) DC to 7MHz, −3dB (at 4 div) (When using x5 amplifier)
Rise Time	12ns; (for x5) 70ns typ
Signal Delay Line	Permits viewing leading edge of displayed waveform
Max. Input Voltage	600Vp-p or 300V (DC + AC peak, at 1kHz)
Input Coupling	AC, GND, DC
Input Impedance	Direct 1M ohm, approx. 30pF
Operating Modes	CH1, CH2, DUAL, ADD, DIFF
X-Y Operation	CH1: X axis, CH2: Y axis
Sensitivity	5mV/div to 5V/div (when using x5 amplifier: 1mV/div)
• Horizontal Deflection	
Trigger Modes	AUTO, NORM, TV (+), TV (−)
Trigger Source	CH1, CH2, LINE, EXT
Trigger Coupling	AC
TV Sync	TV sync-separation circuit
Internal	1 div or more (V sync-signal)
External	1Vp-p or more (V sync-signal)
Trigger Sensitivity	Frequency / Internal / External: 20Hz to 5MHz — 0.5div — 200mV 5 to 30MHz — 1.5div — 800mV
AUTO Low Bandwidth	30Hz
Trigger Slope	±
External Trigger Input	Input impedance: approx. 1M ohm, 30pF or less Max. input voltage: 100V (DC + AC peak at 1kHz)
Sweep Time	0.2μs/div to 0.2s/div, ±5% 19 calibrated steps Uncalibrated continuous control between steps 1: < 2.5 (provided with click-positioning function)
Sweep Time Magnifier	10 times (±7%)
Max. Sweep Time	100ns/div (20ns/div and 50ns/div. not calibrated)
• Power Requirements	100/120/220/240V ±10% 50 to 60Hz, approx. 40W
• Dimensions	Approx. 275(W) x 190(H) x 400(D) mm
• Weight	Approx. 8.5kg

FEATURES

- 1 mV/div high sensitivity design. Effective for measurement of weak signals.
- Employs TV sync separator circuitry with one touch synchronization of both TV horizontal and vertical signals.
- Built-in signal delay line enables front observation of fast rising waves.
- X-Y operation convenient for measurement of phase difference between two signals.
- Delayed sweep function with one touch control 10X magnification.
- Trace rotation system for easily adjusting trace inclination caused by terrestrial magnetism.
- Fine adjusting click positioning function enhances measuring efficiency.
- Signal output: CHI output terminal to Frequency Counter, etc.
- Z axis input provided — possible to use as CRT display.
- One touch shifting of waveform slopes for easy observation of rise and fall of waves.

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NEW PRODUCTS

continued from page 38

countered, a non-rhythmic interrupted beeping is sounded. When radar signals of sufficient strength are encountered, a steady-alarm signal of two beeps per second is sounded, thus providing a "reminder" to drivers to stay within the speed limits.

The *Radar Intercept,* model *IN* has a suggested retail price of $299.95.—**Leisure Time Development Corporation,** 1931 Mott Avenue, Far Rockaway, NY 11691.

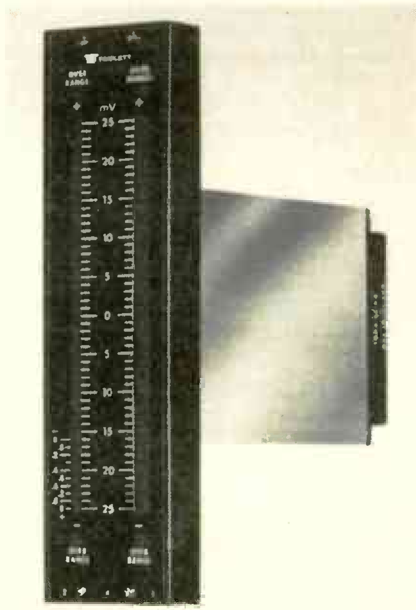
CONTROL CENTER, *Mr. Video Master Control Center* provides six video inputs and three outputs, which will accommodate two sets and a VCR input and output. A 13-pushbutton control panel provides complete and convenient video-system selection.

The *Mr. Video Master Control Center* is priced at $49.95.—**Jascon Products Co., Inc.,** 217 NE 46th, Oklahoma City, OK 73101.

CIRCLE 143 ON FREE INFORMATION CARD

PANEL METER, model *555,* is a microprocessor-based instrument offering many display, measuring, and monitoring features. This software-programmable bargraph meter provides up to ±0.2% digital accuracy with an analog display for process control, medical electronics, relay meter, quality control, and machine-tool and test-equipment applications.

Standard ranges are 0-50 mV, 0-1 mA and 4-20 mA with a dual channel (two separate inputs and outputs) standard-display mode. Other internal ranges are available from 50 millivolts to 200 volts, and 500 microamps to 100 millamps. The model *555* can be converted to single channel simply by removing a jumper wire, thus permitting the second channel to operate as an expanded scale for improved resolution, or for visual storage and display of set points.



CIRCLE 144 ON FREE INFORMATION CARD

Multiple (DIP switch selectable) readout provides 32 possible outputs on the 50-bar LED display. Displays include: negative full scale, positive full scale, suppressed zero for transducer interface, and zero center. Different displays may be shown on each channel of a dual channel if desired. Readout modes are also selectable and include 45 or 160-millisecond update, standard meter, or single/dual setpoint control.

The model *555* is priced at $199.00. —**Triplett Corp.,** One Triplett Drive, Bluffton, OH 45817.

TRANSCEIVER, model *TS-430S,* is an all solid-state SSB, CW, and AM transceiver, with FM optional. It is designed to cover the 160-10 meter amateur bands, including the new WARC bands, and also incorporates a 150kHz-30 MHz general-coverage receiver that has an exceptionally wide dynamic range.

Other features include dual digital VFO's, eight memories, memory scan, program-

CIRCLE 27 ON FREE INFORMATION CARD

mable band scan, fluorescent-tube digital display, and all-mode squelch. There is also VOX, a speech processor, IF shift, notch fil-

CIRCLE 145 ON FREE INFORMATION CARD

ter, and a NARROW-WIDE filter-selector switch for use with various optional filters.

The suggested retail price of the model *TS-430S* is $899.95. — **Trio-Kenwood Communications, Inc.,** 1111 West Walnut Street, Compton, CA 90220.

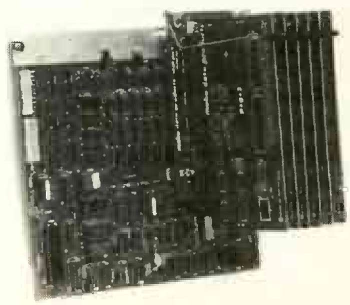
SURGE PROTECTORS, the *Transi-Traps,* are the first devices available in the electronics market that are designed with an "isolated ground" that keeps damaging arc-energy off the chassis of communications equipment and routes it directly to ground.

CIRCLE 146 ON FREE INFORMATION CARD

The *Transi-Trap* protector features a replaceable Arc-Plug cartridge that uses a special gas-filled ceramic tube that safely bypasses surges to ground and will fire thousands of times before requiring replacement. The *Transi-Trap* is connected in line between the receiver or transceiver and amplifier, or between the amplifier and the antenna. Configurations are available to accommodate UHF-type and N-type conductors, 200-watt and 2-kilowatt outputs, and in super low-loss models (0.1 dB at 500 MHz) for use through VHF and UHF.

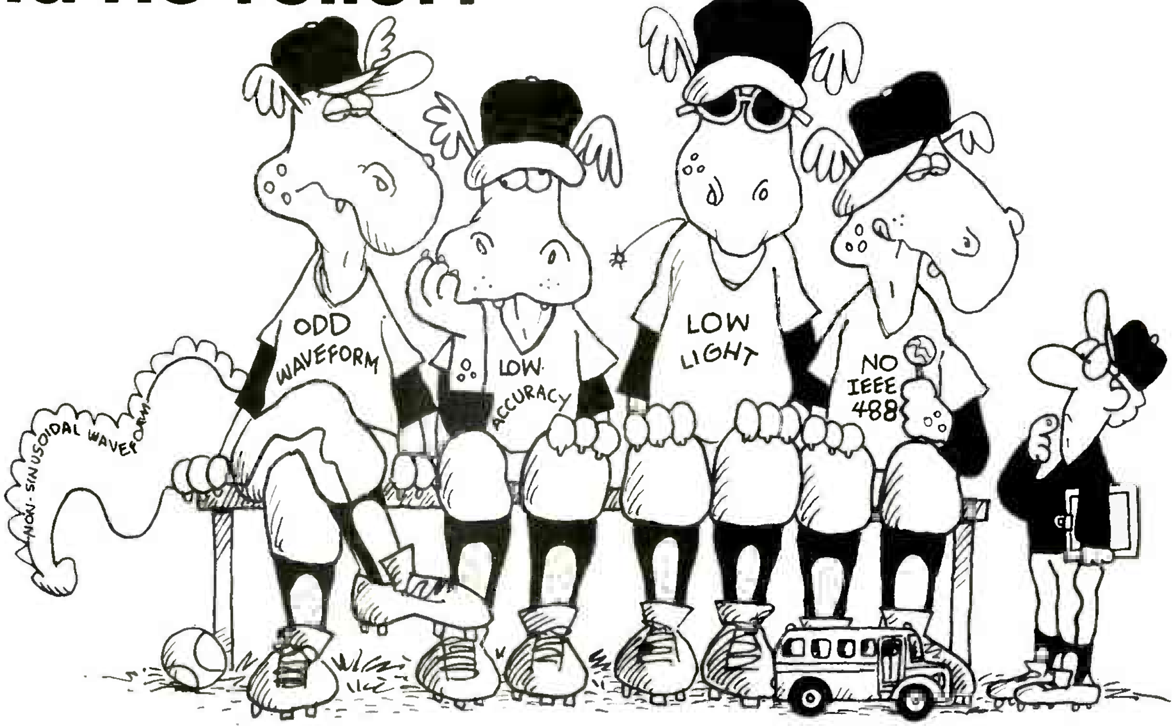
The *Transi-Trap* units range in price from $19.95 to $44.95. — **Alpha Delta Communications,** PO Box 571, Centerville, OH 45459.

EXPANDER, model *MH89 Plus 3,* is a bus expander for Heath/Zenith model *H89/Z90* computers. This accessory exactly doubles



CIRCLE 147 ON FREE INFORMATION CARD

A bench full of dragons and no relief?



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CIRCLE 22 ON FREE INFORMATION CARD

the I/O expansion capabilities of those machines, while keeping them all-in-one. The model *MH89 Plus 3* replaces the right-hand accessory area with a 6-slot mother board, creating 3 additional slots. That provides ample room for the many accessory and peripheral cards offered for those machines, without the need of external boxes or cables.

The design of the model *MH89 Plus 3* allows it to be installed in minutes, without soldering or cutting traces. In use, it is invisible to the user and requires no programming or system modification. The added slots occupy previously unused port addresses. Devices to be run off those slots should have their software configured for the new port number.

The model *MH89 Plus 3* keeps all accessory boards on the right side of the machine. It does not interefere with the left side memory-expansion area. All accessory cards remain vertical for best cooling.

The model *MH89 Plus 3* is priced at $150.00 plus a $5 shipping charge, comes with full documentation, and has a one-year warranty (CA residents add 6% tax). — **Mako Data Products,** 1441-#B N. Red Gum, Anaheim, CA 92806.

RECEIVER, model *R-2000,* is an all-mode communications receiver that covers 150kHz-30MHz in 30 bands. Designed to fill the needs of the short-wave listener as well as the radio amateur, this new radio is capable of receiving signals on AM, USB, LSB, CW, and FM.

The model *R-2000* has digital VFO's, 10 memories that store frequency, band, and mode data, memory scan, programmable band scan, and dual 24-hour quartz clocks with a timer that can be programmed to turn the radio on and off on a pre-selected schedule. Additional features include a built-in lithium-battery memory back-up (estimated

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5-year life), fluorescent-tube digital display, 3 built-in IF filters with switch, manual UP/DOWN band scan, squelch, "S" meter, noise-blanker, and RF step attenuator. It operates on 100/120/220/240 VAC, or may be operated on 13.8 VDC using an optional DCK-1 cable kit.

The model *R-2000* has a suggested retail price of $599.95. — **Trio-Kenwood Communications, Inc.,** 1111 West Walnut Street, Compton, CA 90220.

DMM, model *8026B,* is an eight-function handheld model that features true RMS AC capabilities while retaining all of the performance and versatility features of the earlier models in the *8026B* series. Like those others, the model *8026B* has an easy-to-read front panel; a heavy-duty 600-volt dual-fuse system on the current input to protect against high-energy inputs; non-skid rubber feet and a locking tilt bail, which keep the instrument

CIRCLE 119 ON FREE INFORMATION CARD

firmly in place; two-year parts and labor warranty, and a one-year calibration cycle. An audible continuity checker is also built in.

The model *8026B* is priced at $219.00. — **John Fluke Mfg. Co., Inc.,** PO Box C9090, Everett, WA 98206. R-E

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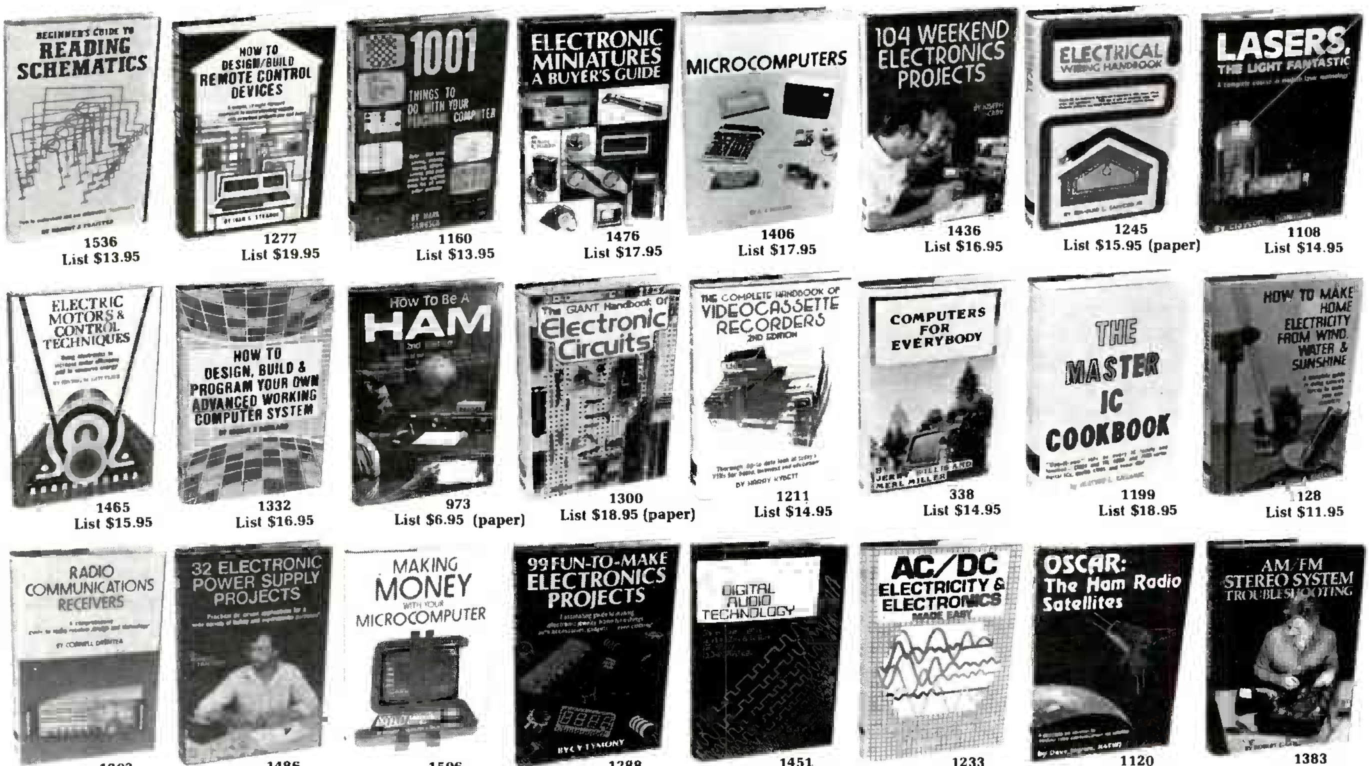

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CIRCLE 25 ON FREE INFORMATION CARD

COMPUTER CORNER

Selecting a terminal

LES SPINDLE*

MANY PEOPLE PURCHASE THEIR FIRST microcomputer system as a complete package that includes the computer, video display, printer, and software. There are those, however, who will want to buy the components separately. In doing so, they can put together a system tailored to their specific requirements.

Last month, we discussed the options available when purchasing a printer for your computer system. This month, we will explore data terminals.

A terminal consists of two main parts: the keyboard and the display screen. The terminal accepts data from the user (via the keyboard) and sends it to the computer where it is processed. The terminal then gives the processed data back to the user (via the display screen). Besides the CRT screen and keyboard, the terminal includes a built-in controller and communications port(s).

What to look for

Let's first look at a few design factors that should be considered when you shop for a terminal. Many studies have been conducted to explore possible health hazards connected to using inferior or imporperly-situated CRT screens. Eyestrain, neck-muscle stress, and headaches have all been traced to improperly used or poorly designed computer workstations. Terminals that have been designed to eliminate those strain factors are termed "ergonomic," and the right terminal can help you avoid such problems.

One feature you may want to consider is a detatchable keyboard—it gives you much more flexibility. If your terminal is made up of two sections (keyboard and display screen), then is it easier to place them where they will be more comfortable to use. For instance, if you need a lot of tabletop space when you are using your computer, you can put the display on a shelf above the table. (That's something you can't do if the keyboard is attatched to it—unless you have very long arms.) If you need still more space to lay out plans, papers, or what have you, then you can even put the keyboard in your lap. If you *do* decide on a detachable keyboard, I'd advise getting one with a coiled cord—it keeps things neater.

A further note on keyboards: If you will

*Managing Editor, *Interface Age* magazine

FIG. 1

be entering large amounts of numeric data, then a keyboard with a separate number-entry keypad will be almost a necessity. Entering numerical data on a standard keyboard can be very time consuming, frustrating, and inefficient.

Displays

There are some things that you'll want to look for—or should I say that there are some things that you'll want to avoid. First, you want the display to be stable. A display that flickers or jitters excessively can be an annoyance, a distraction, and fatiguing as well. You will also want to make sure that the size of the characters is adequate for legibility. If the screen is too small, the letters will be cramped together and eyestrain will occur. A 12-inch screen displaying a standard format of 1,920 characters (24 lines of 80 characters) is often considered a good size both for legibility and for its ability to display a reasonable amount of information on the screen at one time. Also, since a line on 8½ × 11 paper is generally about 66 characters long, the 80-column display can give you a good idea of what your final output will look like.

The size of the screen is not the only factor that determines the size of the characters. For example some terminals display fewer-but-larger characters than others—say, 40 per line instead of the more-or-less standard 80. Although you want the size of the characters to be reasonably large, you don't want them to be *too* large—it limits the usefulness of the terminal for many serious applications (such as word processing).

Another feature to consider in examining the terminal is variable brightness. A terminal should have a brightness control knob—much like the picture adjustments on a typical television—or some other means (such as software control) to allow you to set it for maximum readability.

Some terminals do not include the ability to highlight certain characters. Highlighting is accomplished by putting characters in *reverse video*. Reverse video is simply what its name implies. If your terminal normally displays light characters on a dark background, then reverse video would show dark characters on a light background. The highlighting can be used to make certain characters stand out. For example, in a word-processing application, a block of text that you want to delete, move, or change can be shown in reverse video so that it stands out.

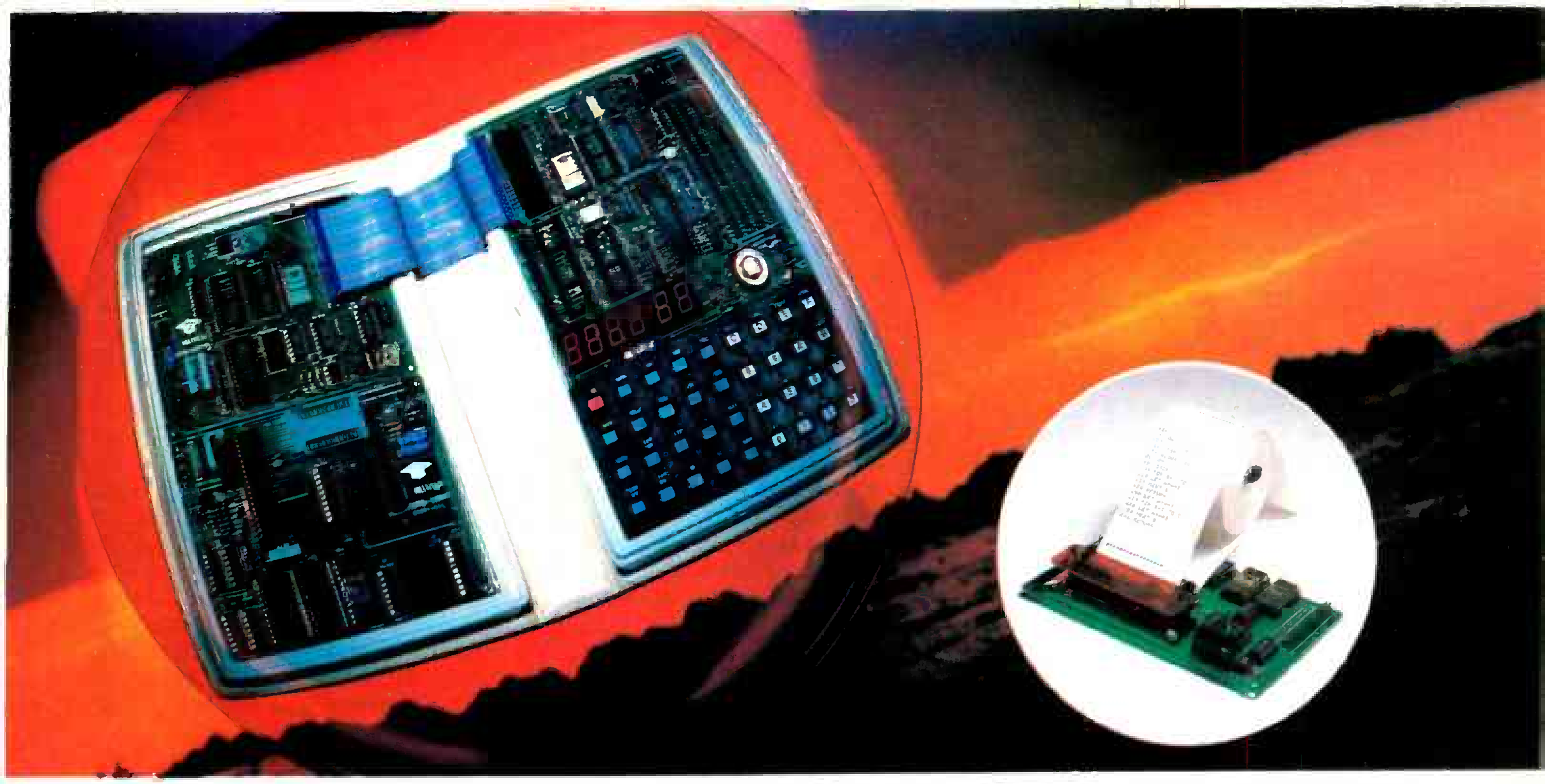
Some terminals use blinking characters instead of highlighting for the same purpose. Others use half-intensity characters. Still other terminals are capable of producing both reverse video and half-intensity characters (and may even include blinking ones).

While reverse video, etc. is normally controlled by the software that you're using with your computer, some terminals are not capable of producing certain types of displays, even if the software calls for them.

Scrolling is another feature that you should look for on a terminal. Some terminals allow you to scroll only line-by-line or only page-by-page. Others permit both line-by-line scrolling and page-by-page scrolling—a definate advantage. In many applications (but not all) scrolling, like reverse video, is controlled by the software. However, keep in mind that even if the software permits (or demands) scrolling, the terminal may not.

There is one point we should mention before moving on. When you are buying software, you should check it carefully and compare it with other similar packages to make sure that it takes advantage of the full range of features that you have on your own terminal.

Other factors to keep in mind are graphics capabilities and upper/lower



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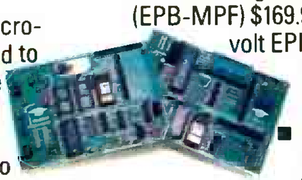

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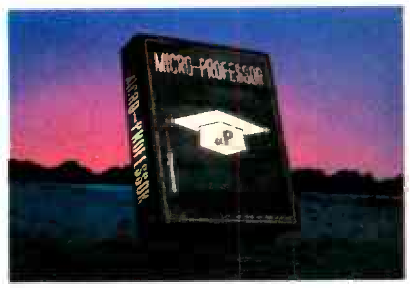

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case character capacities. If you plan to display charts, graphs, or other visual formats on your screen (like what is shown in Fig. 1 on the *MVI-100* terminal from Colorgraphic Communications Corp., Atlanta, GA), check the range of graphics capabilities available with the terminal. Some units may only be able to do block or straight-line graphics, but not curves. A few—usually inexpensive—terminals can display only upper-case letters. That won't be very useful for you if it is your plan to use the computer for word-processing applications.

We should not end this discussion of displays without mentioning color capability. Although many feel that color displays are not necessary (and in most business applications they really aren't), color can add emphasis when you need it. For example, they can be useful in any situation that requires the display of graphs, bar or pie charts, and the like.

Dumb and intelligent terminals

There are two types of terminals—*dumb* and *intelligent* (or *smart*). An intelligent terminal can be custom-programmed by the user, while a dumb terminal cannot. For example, many intelligent terminals, when coupled with the appropriate software, use special-function keys that add rapid and instantaneous commands to the standard data-manipulation functions. For instance, if you often use a particular function—moving blocks of text around, for example—the terminal can be programmed to accomplished that with one touch of a special-function key. A dumb terminal, on the other hand, may require many more steps or keystrokes—and much more time—to accomplish the same task. A dumb terminal, because it can do nothing more than act as a keyboard and display screen is often referred to as a "glass teletype."

There are two other factors should be considered in selecting a terminal—the baud rate and the operational modes (half-duplex or full-duplex).

The baud rate is the data-transmission rate. Most terminals have adjustable baud rates and you should be sure that the one you purchase also does—we'll explain why. Say, for example, that you are using your terminal to communicate over the phone lines (via a modem) with an informantion network or remote data base. Then you will have to send data at 300 baud. However, if the terminal is hard-wired to an in-house computer or another terminal, then you can use a much faster rate—typically up to 9600 baud. (Dividing the baud rate by 10 closely approximates the number of characters transmitted per second. For example, a baud rate of 75 would transmit about 7.5 characters per second.)

You may also want to be able to switch-select either half-duplex or full-duplex operation. Let's see what that means. In the half-duplex mode, any character that you type will be displayed on your screen at the same time that it is transmitted to the network or computer. In the full-duplex mode, however, the character you type is not displayed until the terminal receives an *echo* from the computer, data base, etc. Full-duplex manipulation will cause a bit of a time lag, although it's usually not serious. However, in a multi-user system, the process will sometimes slow things down considerably.

The biggest advantage to the full-duplex mode is verification of correct data transmission to the CPU. If there is a malfunction in this passage of information, you will not know about it in the half-duplex mode, as the character you entered will still be displayed on the screen. Meanwhile, the CPU will be receiving "garbage" (the commonly-used term for erroneous data), which you will not be aware of until you try to print out a document or otherwise extract some of the information.

For applications requiring frequent simultaneous use of many terminals, you may want to use the half-duplex mode for the sake of speed. The terminal should include a switch that will allow you to use either half- or full-duplex modes, so you'll be able to use it for the greatest variety of applications. **R-E**

NEW IDEAS

Liquid rosin flux

AFTER I RETIRED, MY INTEREST IN ELECTRONICS grew tremendously. Partly because of that, I joined the RSVP (*R*etired *S*enior *V*olunteer *P*rogram) and volunteered to help high-school electronics students in their electronics laboratory courses. Recently, the students began to make their own printed-circuit boards for their projects, and the instructor decided that the boards should be tinned (solder plated). What the students would do was to load the board with solder and then sop it up with *Solder Wick*. There had to be a better way to tin a board than that!

One improvement would have been to use some liquid rosin solder flux. However, that was not readily available, and an order would have taken months to fill. A solution was found, though—we made our own liquid flux. It's not very hard to do, and everything you need is shown in Fig. 1.

saw the price she paid for it I decided against it. However, I did manage to get my hands on an empty fingernail-polish remover bottle. That bottle was perfect for what I wanted to use it because it came with a handy applicator brush. A little acetone was used to clean both the bottle and the brush.

The next problem was to find the rosin. A violin-repair shop was the source for that. I mashed up a bit of the rosin—a piece about as big as the end of my finger—and coaxed it into the bottle that was half-filled with acetone. It was easy to tell how much rosin to put in—it dissolves very quickly, but little chunks of rosin form at the bottom of the bottle, when you've reached the saturation point. Then, no more will dissolve.

Now I had a little bottle of liquid rosin with its own applicator brush. It's a great way to put rosin flux on printed-circuit boards, to prime connections, to tin stranded wires, and so on. You can probably get by without it; but, believe me, liquid rosin can make many jobs a lot easier.—*Roger F. Sheldon*

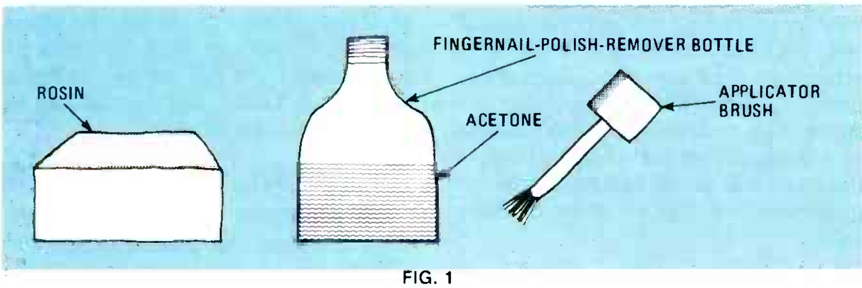
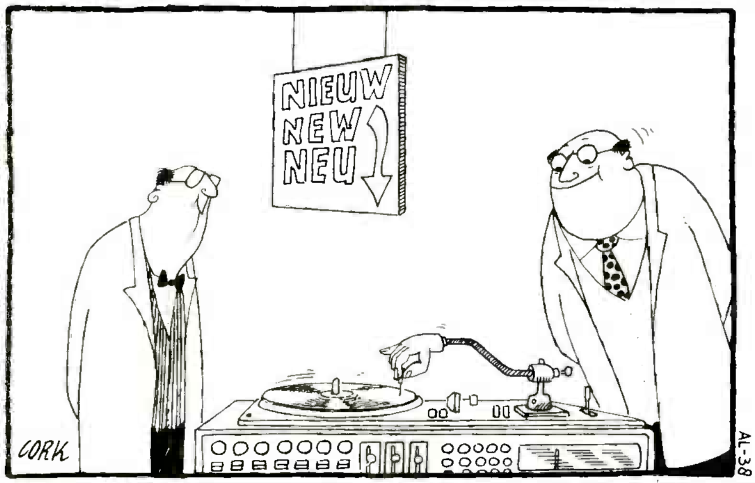


FIG. 1

I knew that the active ingredient in printed-circuit-board cleaners—acetone—dissolves rosin like crazy. So I went to raid my wife's acetone-based fingernail-polish remover—but when I



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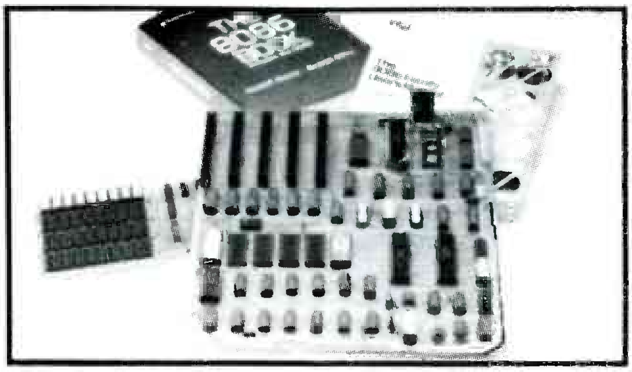

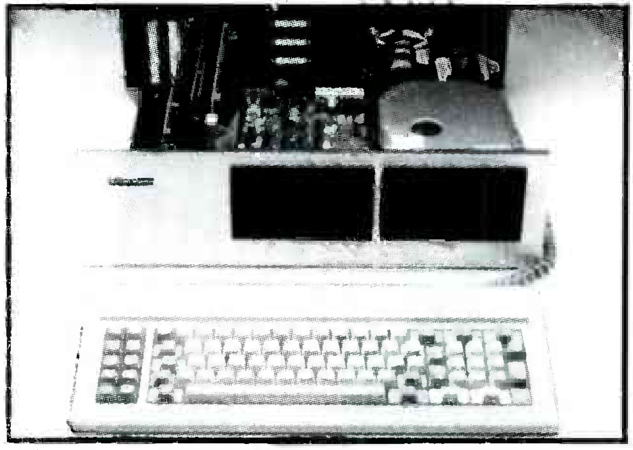

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The EXPLORER 88-PC STARTER'S KIT includes a mother board, memory/ I/O board, all components needed, sockets for IC's used, one 62-pin bus connector and complete assembly/test instructions. All you need is a soldering iron, solder, a +5 volt @ 3 amps & -5 & +/- 12 volt @.5 amp power supply, and a standard RS 232 terminal (Netronics has 2 low-cost ones to choose from).

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If you do not own a terminal you may want to consider using our IBM compatible keyboard (see photo) in conjunction with an IBM compatible color graphics board. This combination, although not necessary at the introductory level, may be desirable if you plan to expand the EXPLORER 88-PC to be fully IBM compatible. These items require additional power and are only available wired and tested as follows:

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The EXPLORER 88-PC can be expanded at any pace you decide. Invest and learn at a pace that is comfortable for you. Netronics is dedicated to supplying the finest hardware and software to make this a meaningful learning experience. Hard disks, built-in modem board, eprom burner, print buffer system plus more will be available shortly. The following items are available now:

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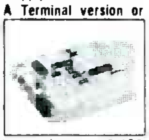

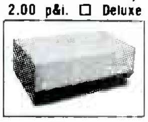

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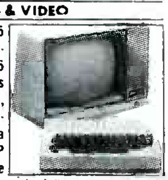

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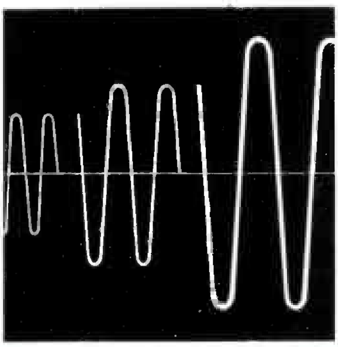

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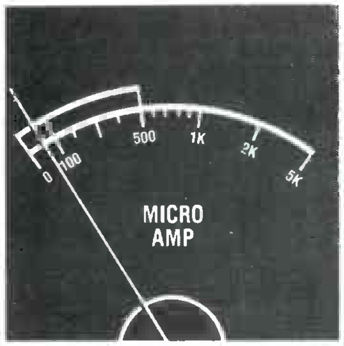

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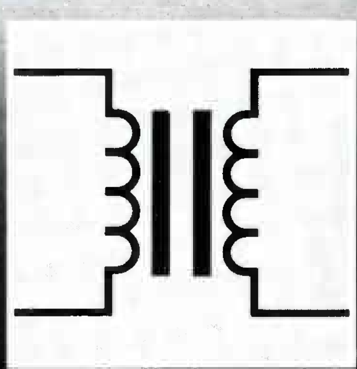

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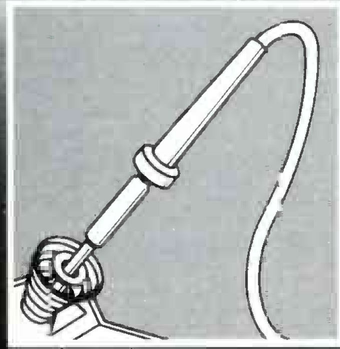

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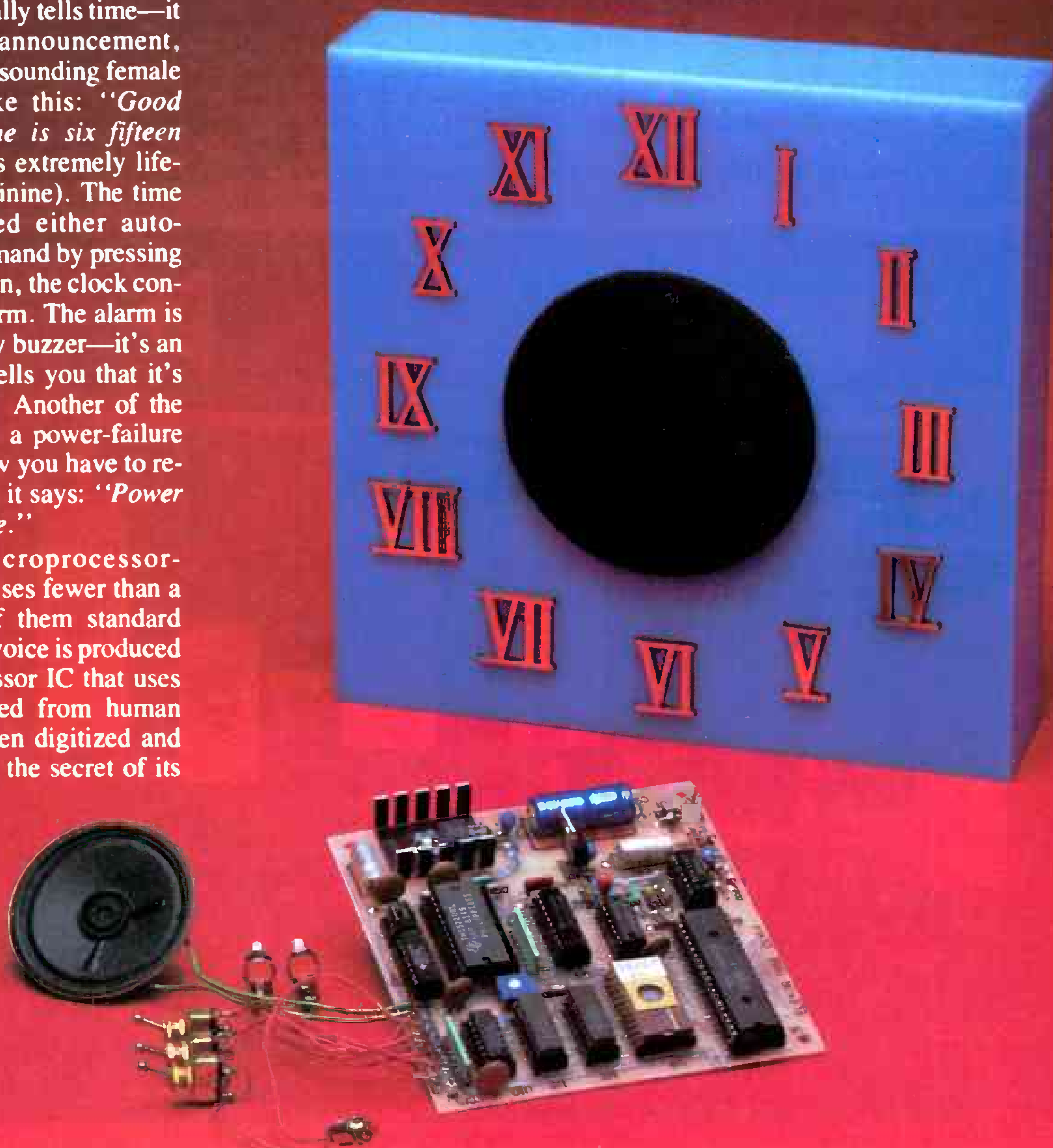
HERE'S A LOW-COST ELECTRONIC alarm clock that really tells time—it talks. The time announcement, made in a pleasant-sounding female voice, sounds like this: *"Good morning. The time is six fifteen AM."* The voice is extremely lifelike (and very feminine). The time can be announced either automatically or on demand by pressing a switch. In addition, the clock contains a 24-hour alarm. The alarm is not just an ordinary buzzer—it's an actual voice that tells you that it's *"time to get up."* Another of the clock's features is a power-failure alarm. You'll know you have to reset the clock when it says: *"Power failed. Set the time."*

The entire microprocessor-controlled device uses fewer than a dozen IC's, all of them standard parts. The clock's voice is produced by a speech-processor IC that uses speech data derived from human speech that has been digitized and compressed; that's the secret of its excellent sound.



Human speech

Before describing electronic speech-synthesis, it is first necessary to have an understanding of how human speech is generated. The voice-producing mechanism in human beings consists essentially of two parts—the sound source and the vocal tract. The speech process starts with air being pushed out from the lungs. The resulting air stream stimulates the vocal cords, and causes sounds to be produced. Those are called *voiced* sounds, examples of which are vowels like "U" and "A." If the vocal cords are held open so they don't vibrate, the sound produced will be *unvoiced*, like the consonants "S" and "F."

The basic sounds enter the vocal tract—made up of the mouth, nasal passages, and other resonant cavities inside the head, throat, and chest—where they are shaped into speech. Changing the shape characteristics of the vocal tract produces different sounds.

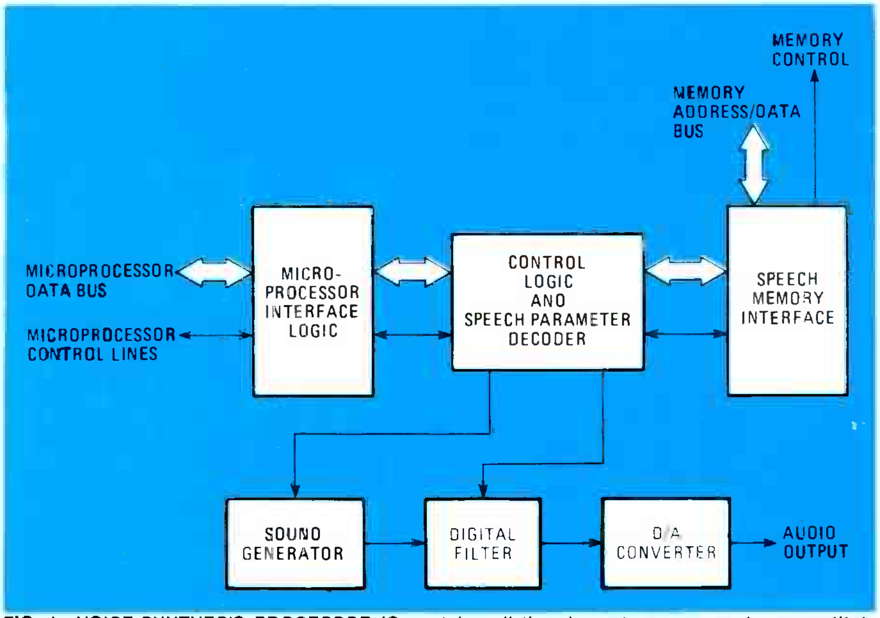


FIG. 1—VOICE-SYNTHESIS PROCESSOR IC contains all the elements necessary to reconstitute speech from compressed data stored in ROM.

Speech-synthesis theory

The voice of the talking clock is generated electronically by a speech-synthesis IC, the Texas Instruments TMS5220, that simulates the human voice-producing organs described above. The speech-generation technique used is called *linear predictive coding*.

Linear predictive coding, or LPC, uses a mathematical technique to model (simulate) the functions of the human vocal tract. Coherent speech is produced by stringing together many short speech-elements. Linear predictive coding determines how each of those elements is generated. Each speech element is generated by mathematical calculations, and a formula generates each new element, based on the previous ones plus some new data. Thus the term *predictive* coding—each new speech element is partially predicted from the previous ones.

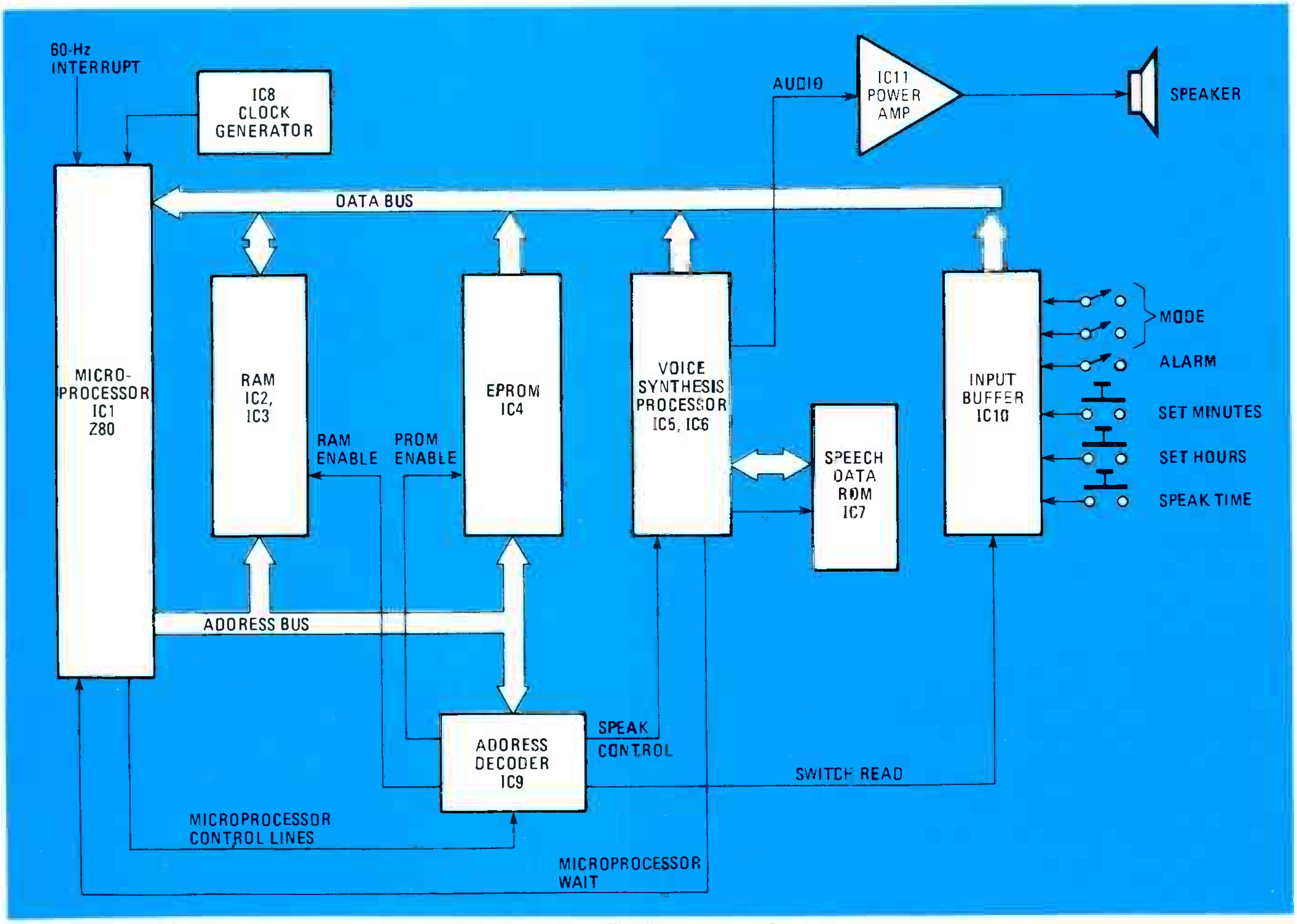


FIG. 2—SPEECH DATA IS STORED in two IC's: IC7 contains "time-telling" messages; IC4 holds messages for alarm and other functions.

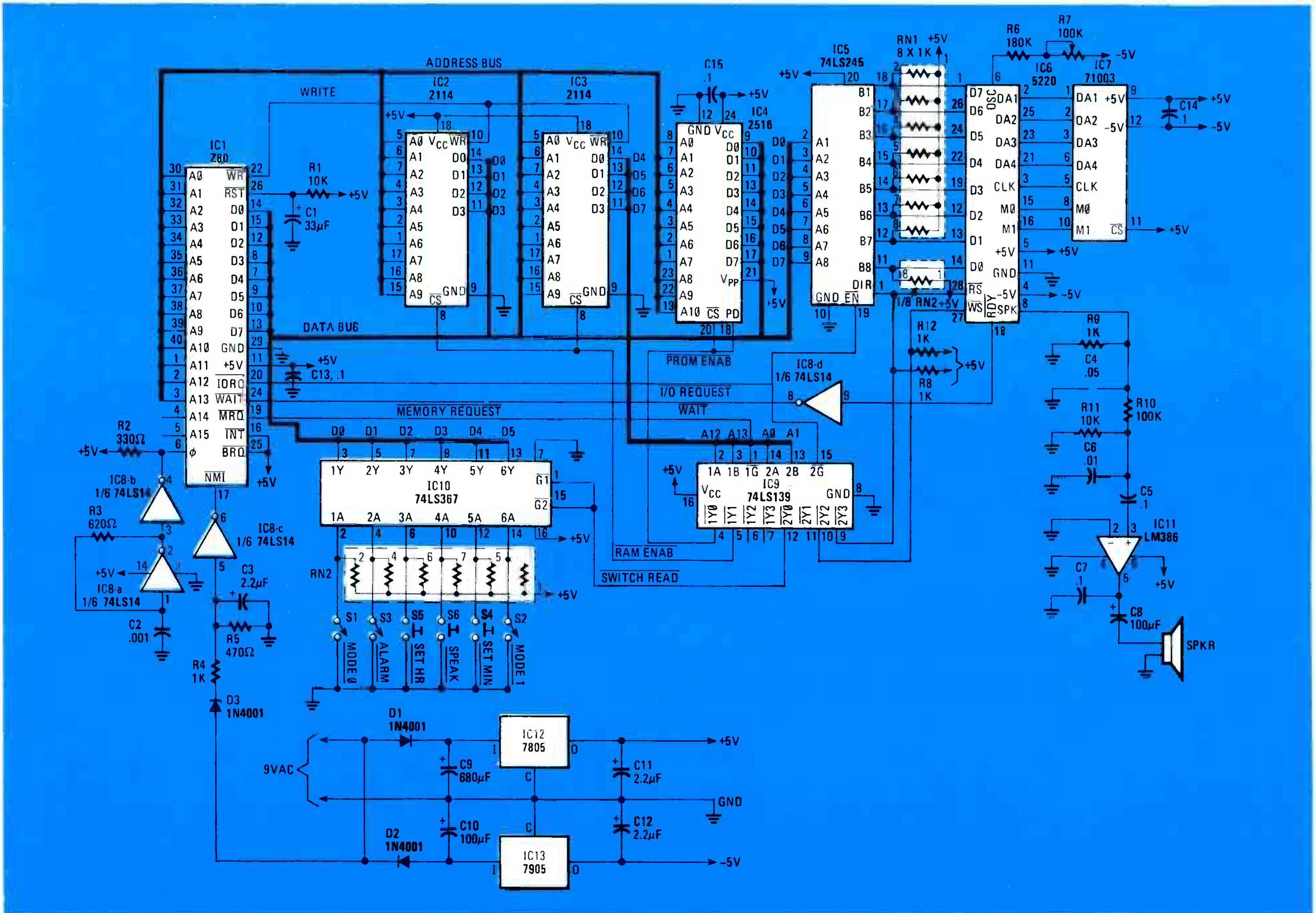


FIG. 3—BOLD LINES in schematic of talking clock represent multiple data and address lines.

The synthesizer simulates the human voice source and the vocal tract. As shown in Fig. 1, the voice is simulated by a sound generator, and the vocal tract is simulated by a digital filter. That digital filter is the mathematical model that performs the calculations to generate speech. Both the sound generator and the digital filter change their characteristics continuously as speech is produced.

There are two sound generators: a variable-frequency generator to simulate voiced sounds from the vocal cords, and a noise generator to simulate unvoiced noise-like speech sounds.

The digital filter shapes the signals from the sound generator to produce small time-samples of speech. Its characteristics can be altered to produce different sounds.

Each word produced by the synthesizer consists of many time-samples in sequence. During voice generation, one of the sound sources is selected, and the values of its pitch and loudness set. The sound source is then fed to the digital filter. The parameters of the filter are then programmed to shape the sound source into the desired speech pattern. The filter generates each speech sample from a calculated sum of the previous 10 samples. That is done to minimize the amount of data required to generate each new sample, and is the main characteristic of linear predictive coding.

The information that determines the characteristics of each sample is the *digital speech data*. That data is a description of certain parameters of the original spoken words. It contains parameters to describe the voice frequency, strength, and the filter characteristics required to create the synthetic speech. During speech generation the required data is fed to the speech synthesizer to control its operation.

A collection of speech data for a number of words makes up a speech synthesizer's vocabulary. To generate a vocabulary for the speech synthesizer, the words are first spoken and recorded on a high-quality master tape. Each word from the tape is sampled and digitized at an 8-kHz rate, and the resulting data is then fed to a computer for analysis. That's done to compress the data so that a minimum of memory is needed to store it. Typically, the data will be compressed by a factor of 100 or more.

Computer programs analyze the data using a mathematical model of the human speech-producing "mechanism." The computer extracts parameters from the data that describe the speech in terms of vocal-tract qualities, pitch, and energy level as a function of time. Once those values have been extracted, other computer programs further analyze and compress the data. That will produce speech data that can be used by the synthesizer for voice generation.

The compressed speech-data is coded in a way that the voice synthesizer can read and use effectively, and is stored in a ROM (*R*ead *O*nly *M*emory). The voice synthesizer reads the data contained by the ROM, performs the mathematical calculations to simulate the vocal tract, and produces synthetic speech.

Voice synthesizers

The voice synthesizer IC used by the talking clock is manufactured by Texas Instruments. It's their TMS5220 voice-synthesis processor (VSP), and contains all the circuitry necessary to interface with a microprocessor and to generate speech. The VSP (refer to Fig. 1) consists of three major sections: the speech synthesizer itself, the microprocessor interface, and the speech-memory interface.

The speech-synthesizer section of the VSP uses the LPC method described earlier.

The TMS5220 uses a digital filter to simulate the action of the human vocal tract. The filter takes highly compressed LPC speech data from the speech memory ROM and processes it. Its output consists of another form of digital data, which is no longer compressed. The data—now in an expanded format—is a direct digital representation of the original speech waveform and is fed to an 8-bit digital-to-analog (D/A) converter, which outputs an analog voltage reproducing the original audio waveform. The voltage is then filtered to eliminate digitizing noise, and fed to an amplifier and speaker.

As explained previously, the speech synthesizer needs compressed digital speech-data to generate speech. The TMS5220 was designed to accept speech data from one of two sources: from a dedicated speech memory, or directly from a microprocessor. The dedicated memory consists of specially designed ROM's. Texas Instruments has several voice ROM's, with different vocabularies, on the market. Industrial, avionics, military, and clock vocabularies are currently available. The voice ROM's are memories either 32K bits or 128K bits in size, depending on the vocabulary size.

The ROM used (a VM71003) has a capacity of 32K-bits (in a 16-pin package) and contains data for 34 words (a 128K ROM stores over 200 words). It contains words for all the numbers needed to announce the time, as well as words for other clock-related phrases like "the time is," "AM," "good morning," etc.

In addition, the clock also uses other phrases, such as "power fail" and "set the time." Those phrases are not stored in the clock-vocabulary ROM; they are stored in an EPROM (*E*rasable *P*rogrammable *ROM*) that also stores the program that runs the clock. That speech data is read from the PROM by the microprocessor and fed to the VSP through its microprocessor interface.

The voice ROM is connected to the voice synthesis processor through a memory-interface bus. That bus consists of four address lines and two control lines. The voice ROM is specially designed to work with the TMS5220 through it. When the VSP reads data from the ROM, it first sends an address to the memory IC, and then begins reading the data one-bit-at-a-time in a serial fashion. It generates speech as the data is read. During speech generation the data rate is approximately 1200 bits per second.

continued on page 106

PARTS LIST

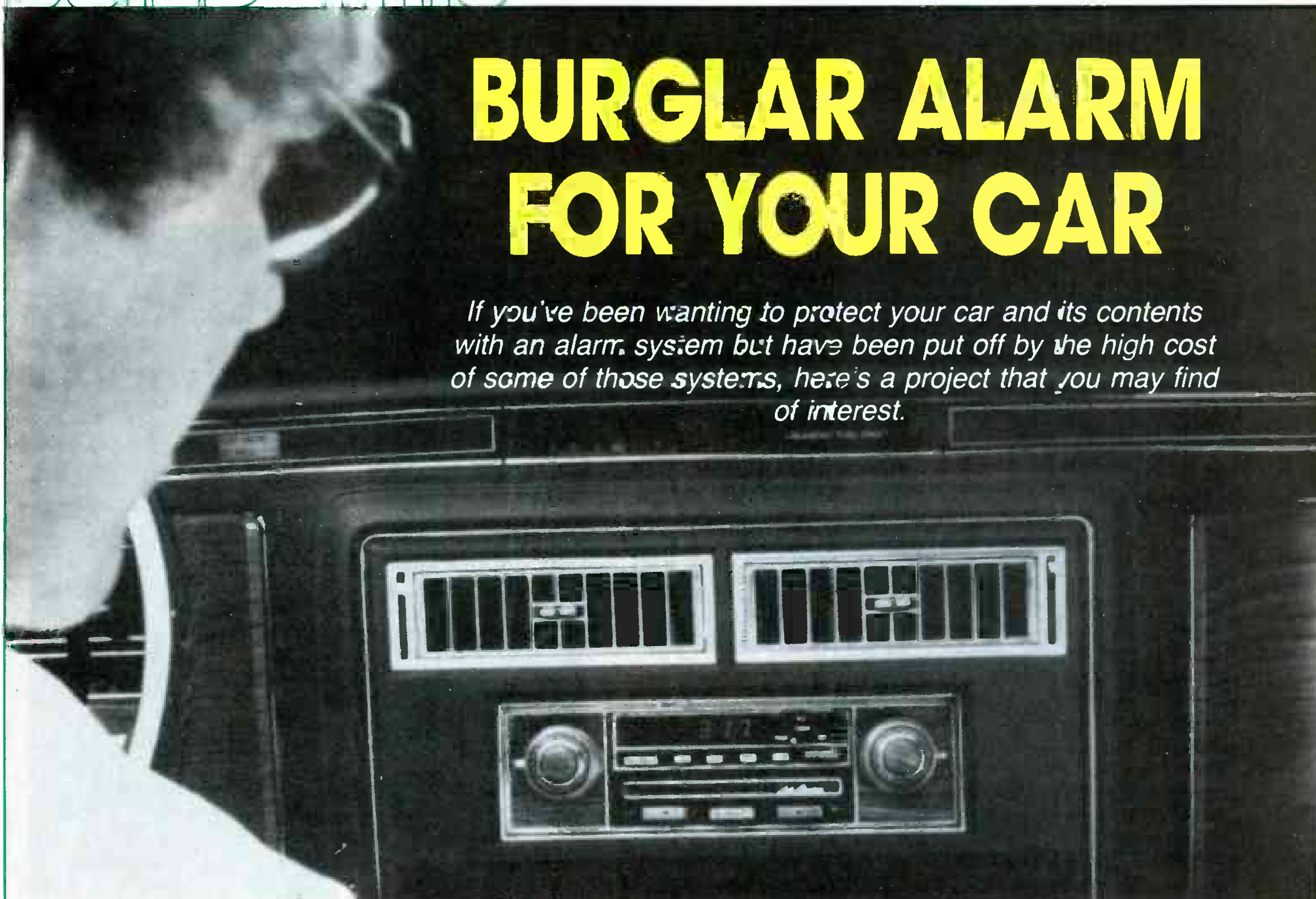
All resistors ¼ watt, 5% unless otherwise noted
R1, R11—10,000 ohms
R2—330 ohms
R3—620 ohms
R4, R8, R9, R12—1000 ohms
R5—470 ohms
R5—180,000 ohms
R7—100,000 ohms, PC-mount trimmer potentiometer
R10—100,000 ohms
R13, R14—8 × 1K SIP (*S*ingle *I*n-line *P*ackage) resistor pack

Capacitors
C1—330 µF, 10 volts, electrolytic or tantalum
C2—0.001 µF, ceramic disc
C3, C11, C12—2.2 µF, 10 volts, electrolytic or tantalum
C4—0.05 µF, ceramic disc
C5, C7, C13–C15—0.1 µF, ceramic disc
C6—0.01 µF, ceramic disc
C8, C10—100 µF, 16 volts, electrolytic
C9—680 µF, 16 volts, electrolytic

Semiconductors
IC1—Z80 microprocessor
IC2, IC3—2114 1K × 4 RAM
IC4—2516 or 2716 2K × 8 EPROM, preprogrammed
IC5—74LS245 octal bus transceiver
IC6—TMS5220 voice-synthesis processor
IC7—VM71003 clock-vocabulary ROM
IC8—74LS14 hex inverting Schmitt trigger
IC9—74LS139 dual 2/4 decoder
IC10—74LS367 hex Tri-State bus driver
IC11—LM386 audio amplifier
IC12—7805 5-volt positive regulator
IC13—7905 5-volt negative regulator
D1–D3—1N4001
T1—9 VAC, 600 mA, wall-plug transformer
S1–S3—SPST slide or toggle switch
S4–S6—SPST N.O. pushbutton switch

Miscellaneous: PC board, speaker, IC sockets, heat sink for +5-volt regulator, enclosure, wire, solder, etc.

The following are available from ELEXOR, PO Box 246, Morris Plains, NJ 07950: double-sided plated-through PC board, $12.50; IC4, $7.50; IC6 and IC7, $25.00; kit of all parts (less enclosure) $69.50. Please add $2.50 for postage and handling as well as applicable state and local sales tax(es).



BURGLAR ALARM FOR YOUR CAR

If you've been wanting to protect your car and its contents with an alarm system but have been put off by the high cost of some of those systems, here's a project that you may find of interest.

EDWARD W. LOXTERKAMP

ABOVE ALL ELSE, A GOOD ALARM SYSTEM should offer adequate protection at an affordable cost. The project we'll be presenting here meets both those criteria. First of all, it monitors all possible entry points (doors, hood, etc.); a motion detector can even be added if desired. A relatively simple, compact timing system provides for an approximate 13-second delay upon opening the door, allowing you plenty of time to enter the car and disarm the system before the alarm sounds; the alarm sounds instantly when the hood is opened.

As far as cost goes, even if you use brand-new parts, you should be able to build the unit for about $25.00, excluding the siren. A good siren—one that's sure to be heard and noticed—should run you about another $20.00. If you compare that to some similar systems on the market the cost is quite reasonable, and you can reduce it a bit more if you have a reasonably well-stocked junkbox.

About the circuit

The schematic diagram for the circuit is shown in Fig. 1. Except for the siren, it requires 5 volts DC for operation. Since 12 volts is available from the car battery, getting that voltage is no problem if a voltage regulator is used. That's taken care of by IC6, a 7805 5-volt regulator. If that IC is properly heat sinked—and because of the power that the device must dissipate, it has to be—it can handle one amp.

You can use a standard TO-220 heat sink, but a better solution is to take a piece of aluminum measuring $\frac{3}{4} \times 1 \times \frac{1}{4}$ inches and bend it 90°. The result is a less expensive heat sink, but more important, one that takes up less space. And since we're trying to make the circuit as compact as possible, every little bit helps.

Returning to IC6, its output will be 5-volts DC as long as the input is maintained above 7 volts. Capacitors C1 and C2 are used to filter the IC's output, and for stability. Those capacitors are tantalum types and must not be substituted for. The regulator's output is used to power all the circuit except the siren.

As for the siren, one side is connected directly to +12 volts (the car battery). The other side is connected through Q2, a TIP120 Darlington transistor, to ground. When 0.6 volt is applied to the base of Q2, it conducts, turning on the siren. Now let's turn to the interesting part of the circuit—how we get the siren to turn on only when we want it to...and when the thief does not.

Hood alarm

You'll want the alarm to turn on as soon as the hood is lifted in case someone tries to tinker with your engine or battery. That's why the hood sensor should trigger the alarm without any delay.

The sensor in the hood, S1, is a normally-closed switch that is open when the hood is closed. When that switch is open, the base of Q1 is pulled up causing pin 8 of IC1-a to be pulled high. That IC is half of a 556, a dual negative-edge-triggered monostable timer. Opening the hood will release the switch, thus closing it. That, in turn, will cause Q1 to conduct, and pull pin 8 low. That high-to-low transition triggers the timer and pin 9, its output pin, goes high. When that happens, Q2 conducts and the siren sounds. Once triggered, just closing the hood

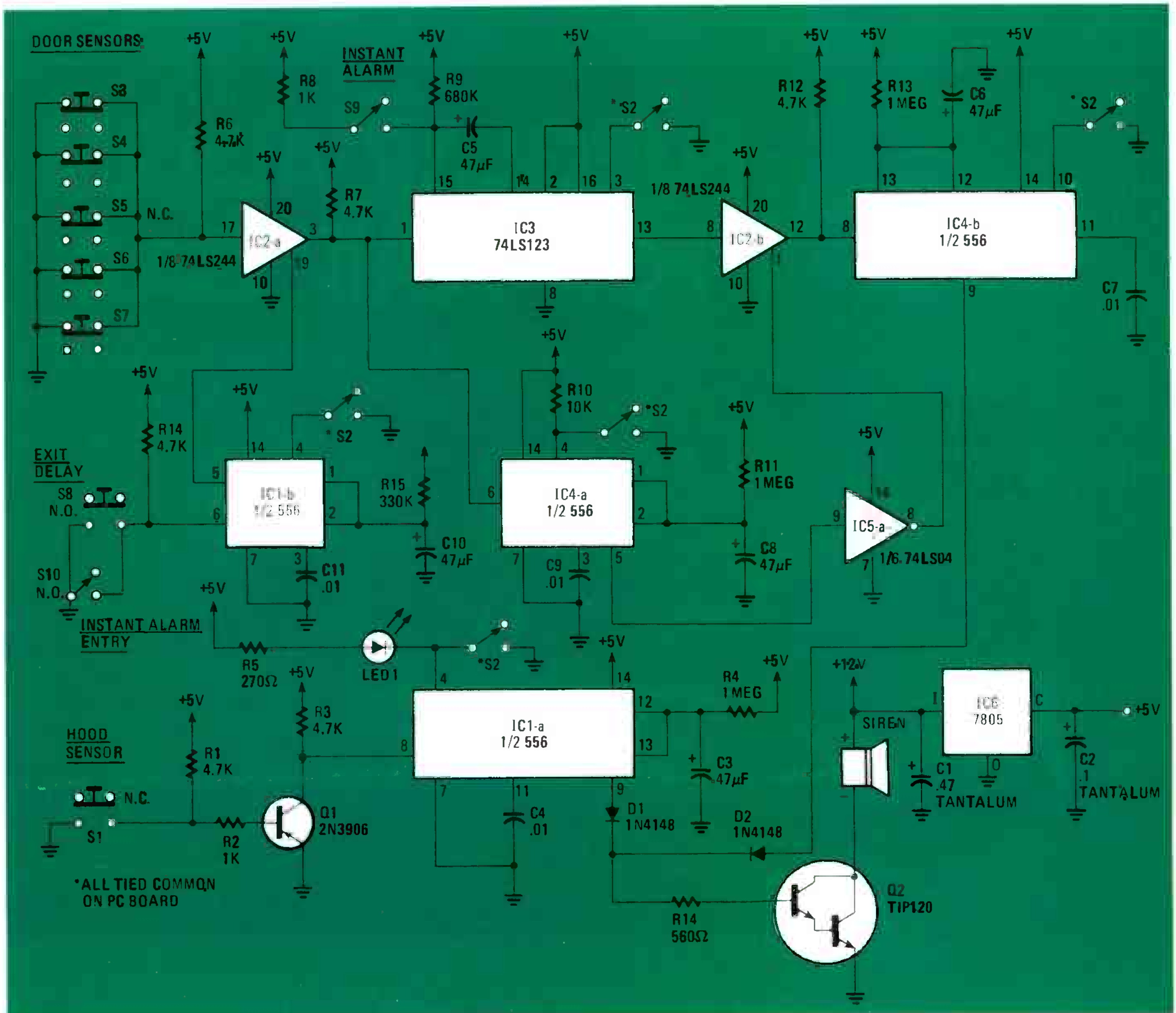


FIG. 1—SCHEMATIC DIAGRAM of the car alarm. This circuit offers reasonable protection at an affordable cost.

again will not turn the siren off. Switch S2, the master arm/disarm switch must also be thrown. If it is not, the siren will sound for a period set by the values of R4 and C3—about 52 seconds with the values shown in the schematic—before it turns off and the system is rearmed. (Note, however, that component-to-component variances can cause the alarm on-time to vary greatly from your calculated value. That on-time for this IC can be found from the formula: $t = 1.1RC$.) Diodes D1 and D2 are there simply to isolate the two timer-circuits from each other—D1 keeps IC4-b from outputting into IC1-a while D2 keeps IC1-a from outputting into IC4-b. We'll discuss the other timer circuit in a moment.

An LED, LED1, is connected to the reset pin (pin 4) of the timer and is off when the circuit is armed. When S2 is closed, the LED is forward biased and lights. Since closing the switch disarms the system, if the LED is lit the system is *dis*armed.

The circuitry for the other sensors differs in that it does not turn the alarm on instantly. Let's look at it next.

Door and hatchback sensors

The basic difference between the hood-sensor circuitry and the door- and hatchback-sensor circuitry is that the latter features a time delay. That delay allows you time to enter the car and disarm the system before the alarm sounds. It also allows you time to leave the car after you've armed the system.

When a door (or the rear hatch) is opened, one of S3–S7 closes, pulling pin 17 of IC2-a low, which in turn causes pin 1 of IC3 to go low. Integrated circuit IC2-a is a quad Tri-State buffer/driver (74LS244). Normally, it passes an input signal to its output unchanged, but when the input to pin 19 is high the output becomes high impedance. Looking into pin 3, it appears as if the device were not there at all. We'll see how that IC is used in this circuit a little later.

Let's now look at IC3, a 74LS123 dual one-shot that it is negative-edge triggered. When its pin 1 goes low, the device is triggered. Once that happens, there are only two ways to turn the alarm off—wait for the system to shut off automatically, or reset the entire system.

The length of the pulse output by IC3 is determined by the values of R9 and C5. When IC3 goes low, the signal passes through IC2-b (assuming that pin 1 is low) and triggers IC4-b. When that happens, pin 9 goes high and the alarm sounds. Pin 9 will remain high, and the siren will continue to sound, for a period of time determined by the values of R13 and C6.

Pin 1 of IC2-b goes high, putting that device into its high-impedance state, shortly after IC3 triggers the alarm. What happens is that, in addition to being fed to pin 1 of IC3, the signal from IC2-a is picked off and fed to another 556, IC4-a. The values of C8 and R11 are chosen so that the duration of that IC's output pulse

PARTS LIST

All resistors ¼-watt, 5%, unless otherwise specified
R1, R3, R6, R7, R12, R14—4700 ohms
R2, R8—1000 ohms
R4, R11, R13—1 megohm
R5—270 ohms
R9—680 ohms
R10—10,000 ohms
R15—330,000 ohms
R16—560 ohms

Capacitors
C1—0.47 µF, 25 volts, tantalum (do not substitute)
C2—0.1 µF, 25 volts, tantalum (do not substitute)
C3, C5, C6, C8, C10—47 µF, 25 volts, electrolytic, radial leads
C4, C7, C9, C11—.01µF, 25 volts, ceramic disc

Semiconductors
IC1, IC4—556 dual timer
IC2—74LS244 octal Tri-State noninverting driver
IC3—74LS123 retriggerable monostable multivibrator
IC5—74LS04 hex inverter
IC6—7804 5-volt regulator
Q1—2N3906 PNP transistor
Q2—TIP 120 NPN Darlington pair
D1, D2—1N4148 switching diode
LED1—red LED
S1, S3-S7—SPST momentary pushbutton, normally closed
S2, S9—SPST switch
S8—SPST momentary pushbutton, normally open
S10—SPST keyswitch, normally open

Miscellaneous: PC board, heat sink (see text), IC sockets, Molex connectors, wire, solder, etc.

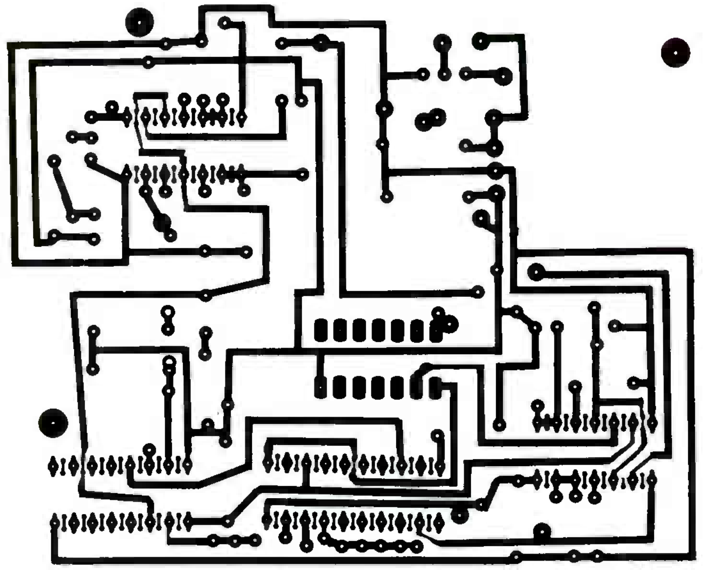


FIG. 2—HERE'S A FOIL PATTERN you can use if you wish to build the project on a PC board. Note, however, that almost any construction technique can be used.

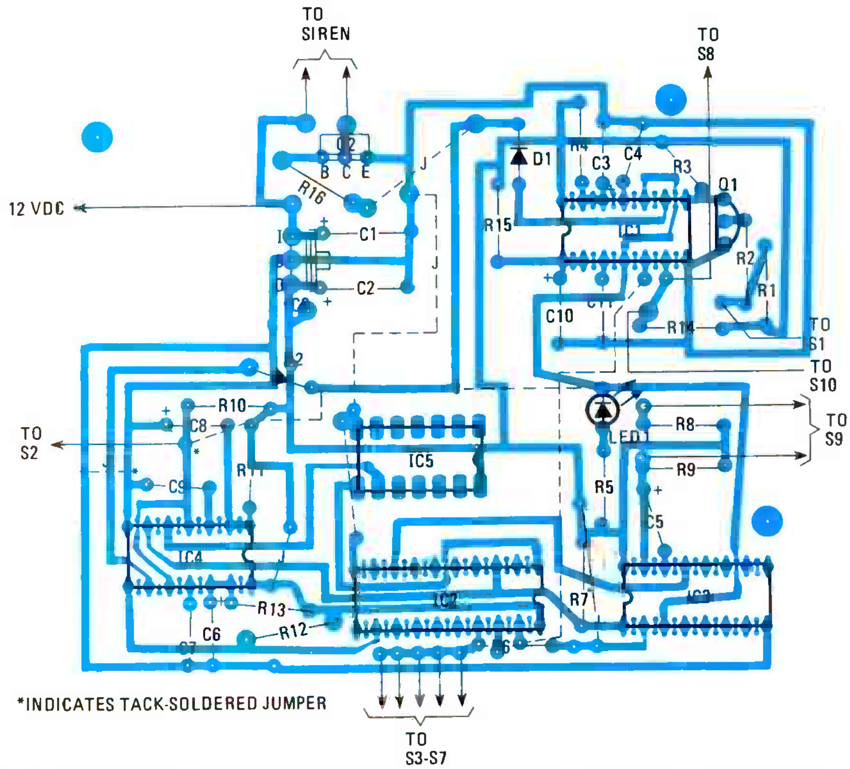


FIG. 3—PARTS-PLACEMENT DIAGRAM. Note that the foil-side jumpers are shown by dashed lines.

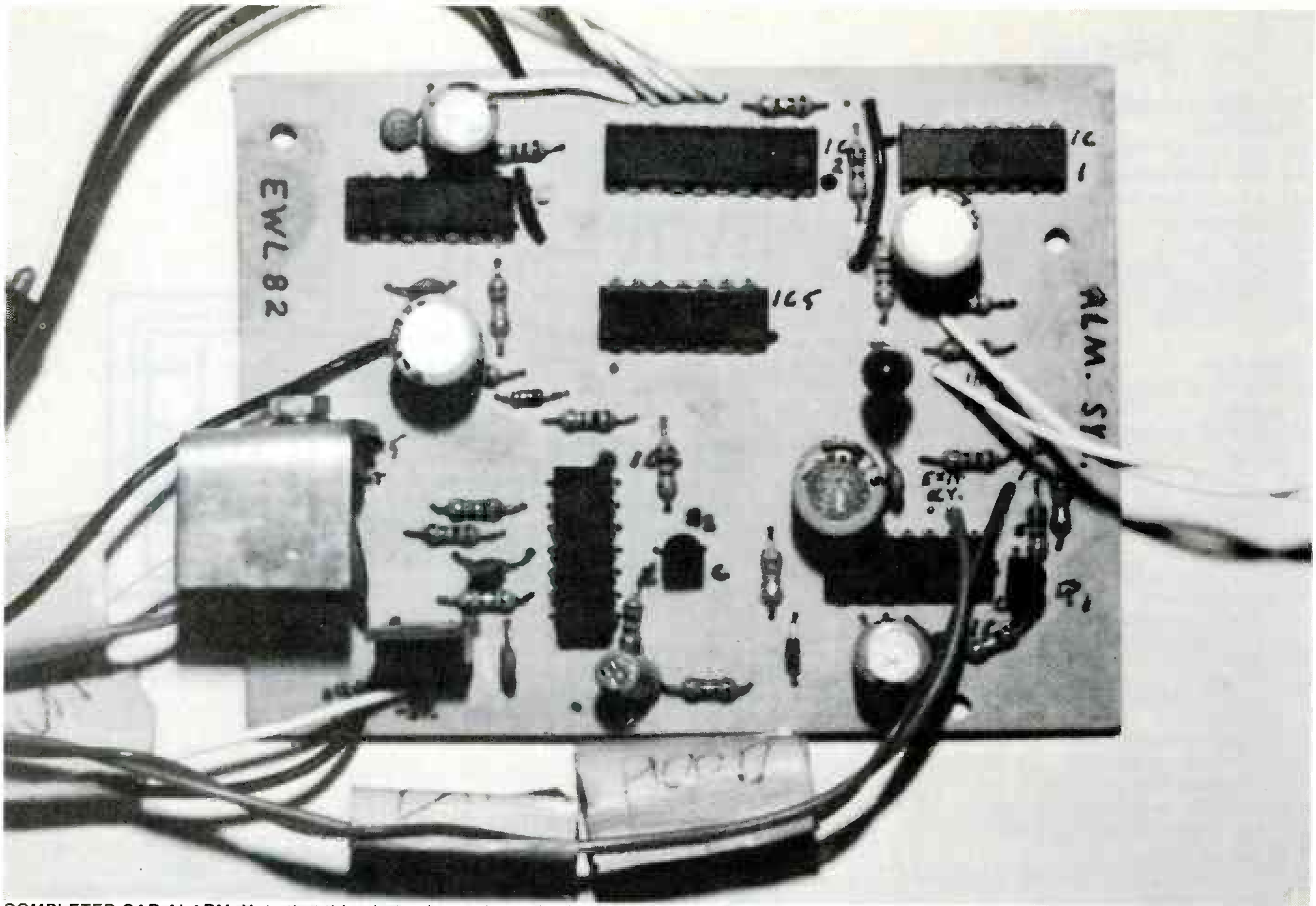
is slightly longer than the pulse output by IC3. The pin-5 output of IC4-a is then fed to IC5, one section of a 74LS04 hex inverter, and then to pin 1 of IC2-b. Thus, when the output from IC4-a cuts off, the signal at pin 1 of IC2-b goes from low to high. The purpose of all of that is to prevent any spurious or accidental triggering of the alarm.

That takes care of the operation of the entry-delay circuit, but not the exit delay. Lets go back to IC2-a again. When that device is in the high-impedance mode, it effectively disarms the sensors so they have no effect on the alarm. The trick is to disarm those sensors only long enough to allow you to get out of the car. Once that is done, the sensors should be rearmed so the circuit can fulfill its intended purpose.

That function is handled by IC1-b. Using S8 to bring pin 6 of that monostable timer (half of a 556) low triggers the device. Its timing cycle is determined by R15 and C10. The timer's pin-5 output is applied to pin 1 of IC2-a, causing it to go into the high-impedance state and cutting the sensors off from the rest of the circuit. When that is done the sensors will not be able to turn on the alarm until the pulse from the 556 goes low again. When that happens IC2-a returns to normal and the system is rearmed.

You can, if you wish, also set the alarm to sound instantly when any door or the rear hatch is opened. All that needs to be done is to throw S9. That switches R8, a 1000-ohm resistor, in parallel with R9, decreasing the entry delay-time to a few milliseconds. The net effect is an instantly triggered alarm.

Switch S10 is mounted outside the car so that you can disarm the system before entering when the system is in its instant alarm mode. That switch should be a key-type and/or mounted in a concealed location. If you don't want to include the instant-alarm-mode feature, the circuitry associated with it—S9, S10, and R8—can be eliminated without otherwise affecting performance. Another alternative would be to eliminate only S10 and to



COMPLETED CAR ALARM. Note that this photo shows the author's prototype and includes several components not used in the version described in the article.

adjust the value of R8 to give an entry delay just long enough for you to enter the car and disarm the alarm.

Building and installing the system

Building the alarm shouldn't take more than an hour or two. There is very little that is critical about the circuit, and just about any construction technique can be used. If you wish to use a printed-circuit board, a foil pattern is shown in Fig. 2; the parts placement diagram is shown in Fig. 3. Note that several jumpers are required if you use the foil pattern shown. Some of the jumpers mount on the component side of the board, but most of them mount on the foil side; the foil-side jumpers are indicated by a dashed line in Fig. 3.

Installing the system, particularly the sensors, in the car is a little more difficult. The type of car determines how easy it is. One of the biggest problems we had was grounding the trigger inputs. When we ran the sensor lines through the doors and fire wall, insulation was pierced, causing continuous triggering. Care not to ground the sensor lines must be taken when running them. A simple check with an ohmmeter before connecting the lines to the system will save a lot of headaches.

It is very helpful to run all the lines (sensor, power, alarm, etc.) from the circuit to a female Molex connector (any type of multiple-connection connector will do). All the connections made in the car can be run to a male Molex connector. That simplifies hooking the system up, and helps prevent getting wires crossed.

There you have it—a simple, low-cost and effective, car alarm you can build and install yourself. (You can also modify it yourself—see box copy to the left.) Now there's no reason for you not to put your mind at ease by protecting your car and belongings. **R-E**

SOME USEFUL MODIFICATIONS

While this car alarm system will do an excellent job of protecting your car, there is no reason for you to limit its design or applications to those discussed in this article.

There are many modifications you can make to the system to make it perform better in your car. Or, somewhere other than in your car (your house, for example). We'll look at just a few of the many possible changes that you might care to make.

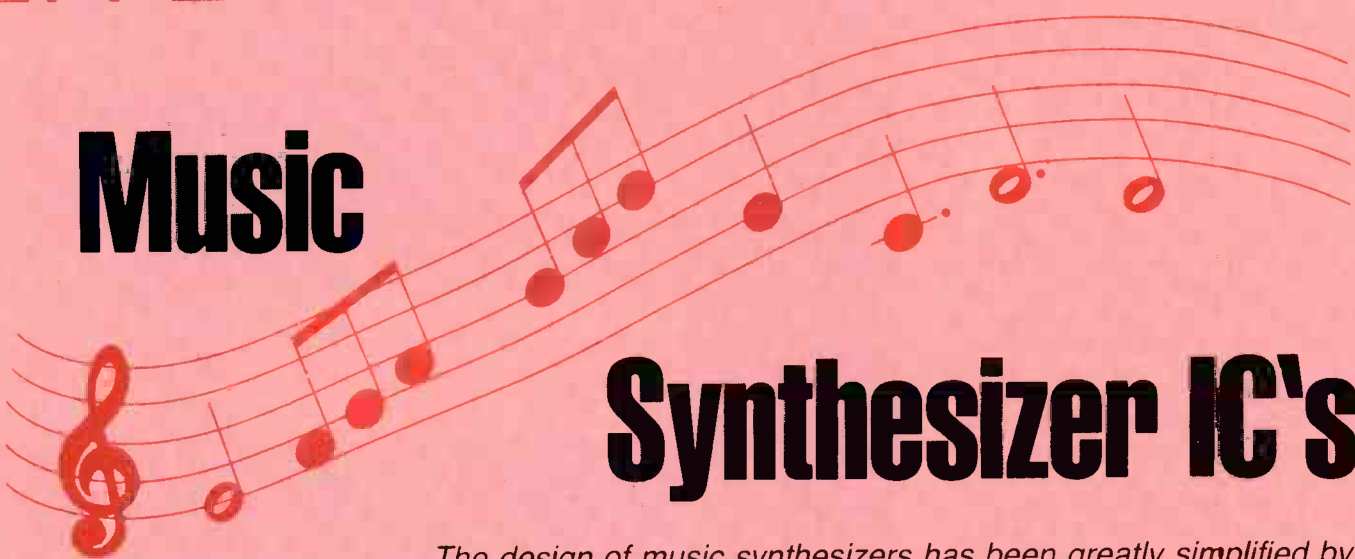
First off, for those of you who enjoy experimenting with microprocessors, why not replace S2 (the master ARM/DISARM switch) with a "combination-lock" circuit that would require the entry of a number of digits in the correct sequence before the alarm could be disarmed? For added protection—whether or not you install a combination-lock circuit—you might want to consider tying the ARM/DISARM switch to the car's ignition switch. That would eliminate the possibility of a thief finding your switch and disarming the system easily.

The sensors form another area of the alarm system that can be modified. Motion detectors—which would detect jacking or towing movements—can easily be added, as can sound sensors, which would "listen" for break-ins. Perhaps more reliable and effective, though, would be ultrasonic proximity-sensors.

A third area of modifications can affect what the alarm does once a break-in occurs.

Besides just sending out an audible alarm, why not also ground the vehicle's ignition coil so that it cannot be started? If that's not exotic enough for you, how about a radio-transmitted silent alarm?

To sum things up, you can see that the alarm system described here can serve as the basis of a larger, more complex system. There's really no limit to what features you can add. We encourage you to experiment, and we'd like to hear what you come up with.



Music Synthesizer IC's

The design of music synthesizers has been greatly simplified by new LSI IC's. We will discuss some of those IC's as well as the basics of synthesizer design.

THOMAS HENRY

WHILE HOME VIDEO, PERSONAL COMPUTERS and digital recording have recently been dominating the electronic-news scene, there has been a quiet revolution going on in the area of electronic music synthesizers. What started out as an insignificant field—with research being conducted mainly in university music studios—has become a multi-million dollar business. In fact, business has been so good for the designers of electronic music equipment that some enterprising companies have even designed and produced large scale integration (LSI) devices dedicated solely to making music.

This article will review some of the common modules found in an electronic music synthesizer. In addition, we'll show sample circuits that illustrate the use of the new integrated circuits mentioned above.

Early music synthesizers

The early days of electronic music were characterized by expensive equipment that had very inaccurate and unstable performance. The inaccuracy was caused by two things. First, until quite recently the musicians who used the equipment and the engineers who designed it were literally in two separate camps. The engineers knew very little about music and the musicians knew even less about engineering. Communication between the two groups was difficult. Engineers had to guess about what parameters were important to the musicians, and equipment design was based on those guesses. Often their assumptions were unrealistic. As a result, musicians had to make the most of the available equipment, but often found their styles or techniques cramped by it.

Most of the early composers of synthesized music came from academic backgrounds. Much of their early music was atonal—it didn't depend upon accurate reproduction of the ordinary scale. Instead, the composers were interested in the "texture" or "mood" of the music. To the untrained listener such music seems to lack continuity and to be composed of unconnected sonic events. Since that style of music didn't depend upon accurately-tuned oscillators or twelve-tone oriented keyboards, few advances were made in the design of reliable equipment.

However, that all changed because sometime in the early 1970's, pop music found the synthesizer and claimed it as its own. Pop music—being intrinsically tonal and melodic—demanded better equipment. The pop musicians needed fairly inexpensive instruments that would stay in tune, and that would work the same way from one night to the next. It also became important for the instruments to be inexpensive. That's because, instead of institutions, it was individuals who wanted to purchase the synthesizers.

Because of that new interest in synthesizers for popular music, the 1970's saw lots of activity in the area of design. Tubes and transistors were discarded in favor of the new linear integrated circuits that were starting to reach the consumer at reasonable prices. And, as research progressed, musicians started to learn more about synthesizer technology and demanded new and better instruments. Likewise, the engineers, because of that new interaction, learned more about music and were able to make design decisions based upon real needs.

The situation remained like that until quite recently. Professional-quality instruments were available, but their prices still placed them out of the reach of experimenters, home recordists, and hobbyists. However, the new LSI integrated circuits not only bring the price down to an experimenter's level, but also make construction of high-quality synthesizers relatively easy.

Music synthesizer fundamentals

Every sound can be described by three parameters. Those are *frequency*, *amplitude*, and *harmonic content*. Musicians have roughly synonymous terms: *pitch*, *volume*, and *timbre*. However, it is important to realize that pitch, volume, and timbre are really the psychological perception of frequency, amplitude, and harmonic content. For example a 3-Hz signal obviously has frequency, but does it have pitch? It hasn't, because it lies below the audio range. Also, amplitude affects the ear's perception of pitch. A 1-kHz tone played quietly has a different pitch than the same tone played at a high volume.

Any basic synthesizer can control the three parameters. For instance, frequency is controlled by using a voltage-controlled oscillator (VCO). Amplitude is varied via a voltage-controlled amplifier (VCA), and harmonic content is altered by the voltage-controlled filter (VCF).

Voltage-controlled oscillators

There is no doubt that the VCO is the most critical module in a synthesizer. It is very important that the VCO—which controls the frequency of the synthesizer's output—be extremely stable and accurate, for the human ear is very sensitive to frequency changes. Even non-musicians can detect detunings of, say, 10 *cents* (1 cent = 1/100 of a semitone, or about a 0.06% change). Compare that to the ear's sensitivity (or insensitivity) to amplitude changes—1 dB is generally taken as the smallest change that the ear can detect, and that corresponds to a change of about 12%.

Stability implies a number of things. First of all, the control-voltage input should follow some pre-assigned scale very accurately. Generally, a scale of one-volt-per-octave is used. Stability also implies low temperature-drift. That is an especially tricky problem, because to get a 1-volt-per-octave scale, an exponential converter is used. Most of those converters use the exponential relationship of a transistor's base-emitter voltage to its collector current. However, as is well known, transistors are temperature sensitive. But, clever designers over the years have come up with a number of temperature-compensating schemes that work quite well in practice. The only drawback to such schemes is that they increase the parts count of a VCO and add to its complexity.

Reliable operation requires careful thought not only at the design level but also at the construction level. Printed-circuit boards must be carefully designed to minimize stray capacitances, tuning capacitors must have good temperature-coefficients, and so on.

There are other properties, besides stability, that a VCO should have. It should have a very wide output-range—say 10 Hz to 10 kHz, minimum. Also, a variety of waveforms (such as sine, triangle, square, and so on) should be available. A linear control-voltage input should be available for frequency-modulation effects (such as vibrato).

Just several years ago a VCO incorporating all of those features would have been quite expensive and may have used a dozen IC's. However, there are now several manufacturers offering LSI integrated circuits dedicated to the VCO function. The SSM 2030 made by Solid State Micro Technology is one. Another is the Curtis CEM3340.

Figure 1 shows just how easy it is to build a VCO using one of the new IC's (in that circuit we use the CEM3340). Let's first look at the inputs available. The exponential input, which is the one most commonly used, automatically does the exponential conversion for a one-volt-per-octave response (which can be trimmed very accurately by SCALE TRIM resistor, R5).

A linear input is also provided for auxilliary control. It is used primarily for frequency-modulation effects such as vibrato. Also there are both hard-sync and soft-sync inputs available; they allow multiple oscillators to be phase locked. A non-linear feedback voltage is provided at pin 7 to correct high-frequency errors

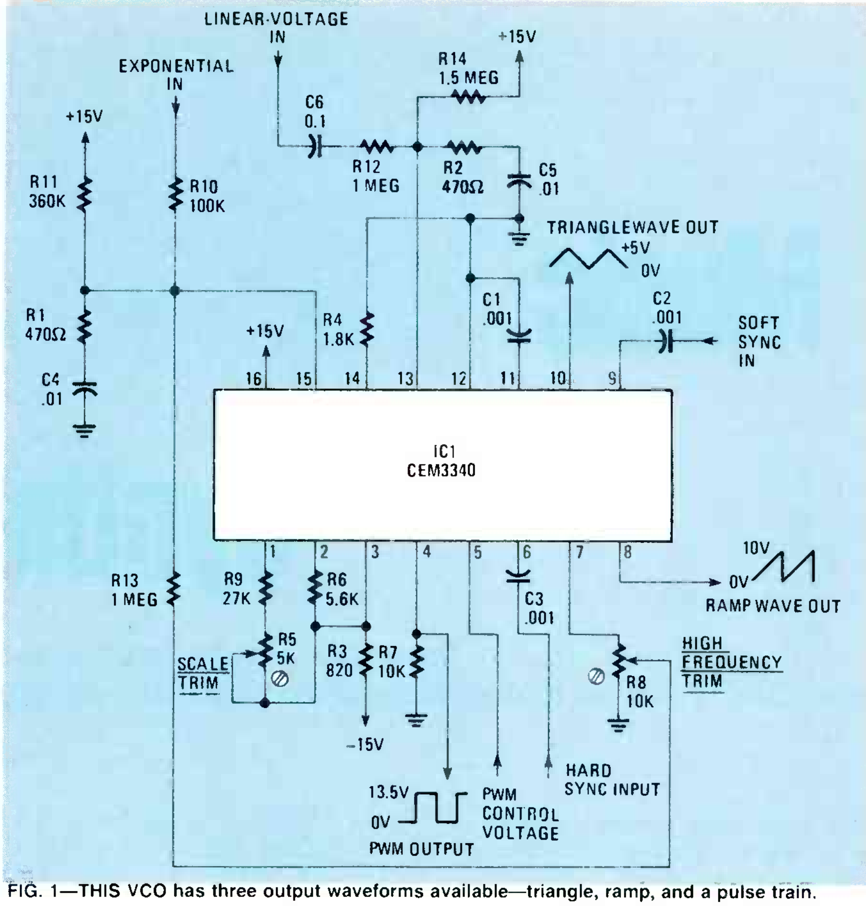


FIG. 1—THIS VCO has three output waveforms available—triangle, ramp, and a pulse train.

(which grow as the VCO is pushed toward its upper frequency-limit).

There are three output waveforms available: a trianglewave, a ramp waveform, and a pulse train. That pulse train can be modulated from 0% to 100% by applying a 0–5-volt control voltage to pin 5, the PULSE-WIDTH MODULATION input. All outputs are buffered, eliminating the need for several op-amps.

The converter is fully temperature compensated for both first and second order effects. That not only makes the designer's task easier but also reduces cost by eliminating the need for the usual thermistor required in VCO designs.

As you can see from this example, the design of a VCO is considerably simplified by use of the CEM3340 or other such LSI device. The VCO is now essentially a single-IC circuit. That simplicity makes synthesizers using multiple VCO's practical both in terms of construction and expense.

Voltage-controlled filters

The voltage-controlled filter or VCF is used to alter the harmonic content of the signal from the VCO and is the next logical block in a synthesizer. A control voltage—using the same exponential scale as the VCO—varies the cutoff frequency of the filter. Because both the VCO and VCF use the same control-voltage scale, they can be made to track one another. That allows for an undistorted waveshape or harmonic structure over the entire frequency range. Generally an organ-type keyboard provides the control voltage to both the VCF and the VCO.

Voltage-controlled filters come in many varieties and are classified according to the basic type. The low-pass type has been very popular in the past. That is because most non-electronic instruments use some sort of low-pass filter mechanism. (For example, a trumpet or trombone player may use a "mute," which is nothing more than a low-pass filter.)

Other types of filters have been used as well. Bandpass filters have been quite popular. They are characterized by the familiar "wah-wah" sound created when their center frequency is varied. Voltage-controlled high-pass filters are less common, probably since their effect in a synthesizer system is less dramatic than either the low-pass or bandpass types. Finally the all-pass filter is becoming common for creating artificial Doppler-shift effects and phasing- or flanging-type effects.

Early VCF designs used a large number of components. For example, a four-pole, low-pass design (almost the industry standard in filters for music) required anywhere from one- to two-dozen transistors. Two transistors were needed for each pole (for a total of eight); several more were required for input and output conditioning and still a few more were needed for the exponential converter. Even though transistors are relatively inexpensive, that type of discrete design can hardly be justified since the circuit

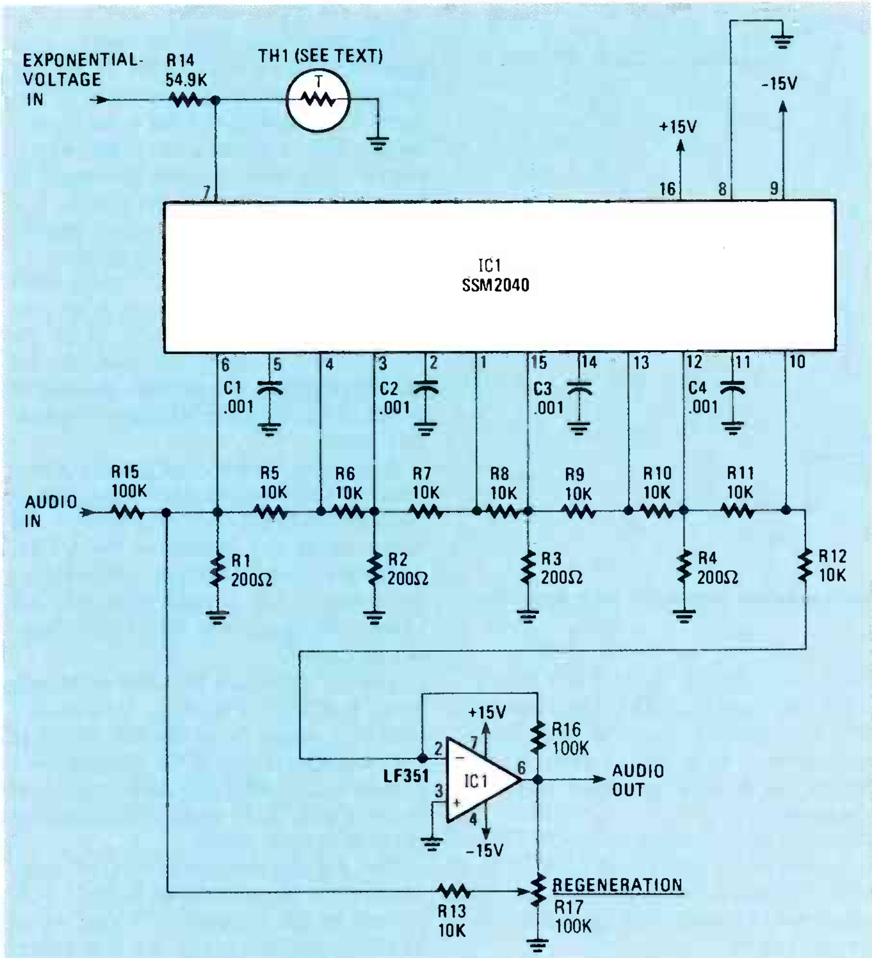


FIG. 2—NONE OF THE INTERNAL amplifiers of the SSM2040 are short-circuit proof, so none of the non-power-supply pins should contact the positive supply, the negative supply, or ground.

board layout becomes quite extensive.

The modern approach to VCF design is illustrated in Fig. 2. One IC, the SSM 2040, does all of the filtering and voltage control, while a single op-amp provides output buffering. As shown, the IC has been configured as a four pole low-pass filter. However by rearranging the components it is just as easy to create band-pass, high-pass, and all-pass types.

The VCF is internally compensated for second-order temperature effects. However, because it is not compensated for first-order effects, it is necessary to use a thermistor in the circuit. The thermistor (TH1) cancels the first-order effects and makes the VCF very stable.

Most synthesizer VCO's have a 10-volt peak-to-peak output. However, because the SSM 2040 requires an input of 1-volt peak-to-peak, input to it must be attenuated by a factor of ten. That is the purpose of R15. The output of the VCF is amplified by a factor of ten by the LF351.

Part of the output from that amplifier is fed back to the input (via R17 and R13) for regeneration. That peaks the response slightly at the filter's critical frequency, causing a more pronounced "wah" effect. Some of the newer VCF IC's (such as the Curtis CEM3320) include an on-chip gain cell that allows for voltage-controlled regeneration.

Voltage-controlled amplifiers

The voltage-controlled amplifier, or VCA, is the next synthesizer block that we will discuss. It is used to impose an amplitude envelope upon the audio signal created by the VCO.

Early VCA's were composed of many discrete components, usually transistors configured as differential pairs. The differential-pair amplifier provides a fixed gain for a fixed control-current. If you change the control current, the gain changes as well.

One major trouble with the differential-pair amplifier is that input signals have to be restricted to 10 mV or less to avoid the non-linear region of the amplifier. Intolerable distortion will occur if the signal rises above that level. Obviously the 10-volt peak-to-peak audio signal from a typical VCO has to be attenuated before reaching that type of VCA, and then boosted after it. That is why the signal-to-noise ratio of the early synthesizers was rather poor.

Although the noise figure of that sort of VCA was adequate for live performance, the noise level became apparent when it came to recorded music. Pop musicians, who were starting to do a lot of recording, demanded something better. That "something better" was the Gilbert pre-distortion input. The differential-pair amplifier actually has an exponential response. The Gilbert input stage pre-distorts the audio signal in a logarithmic fashion. The logarithm of the input is then sent to the VCA where the exponential

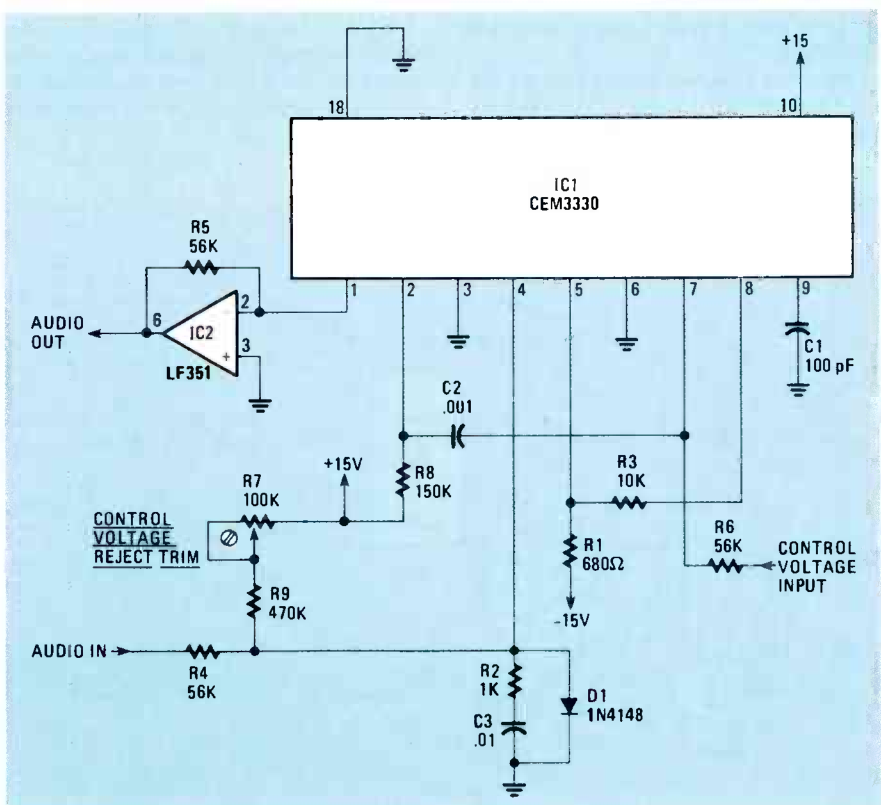


FIG. 3—MANY OF THE INPUTS of the CEM3330 are at virtual ground. That allows for easy summing of multiple inputs.

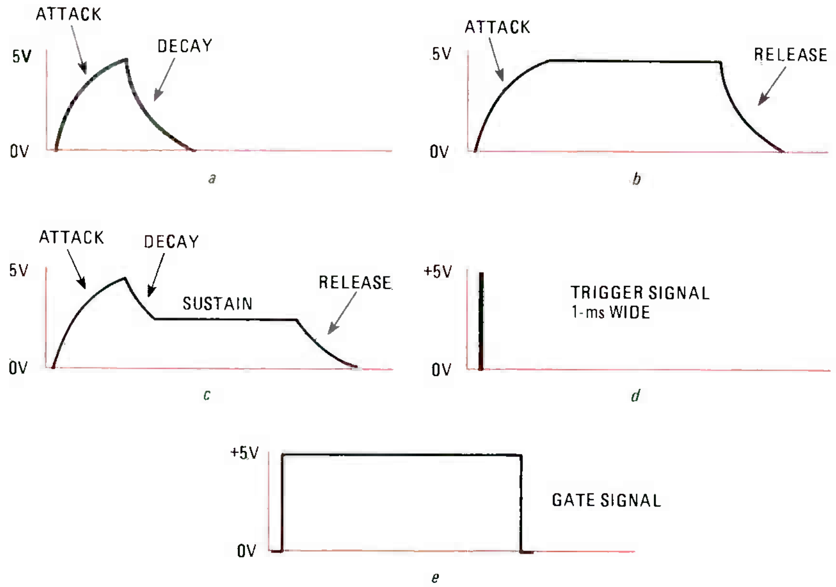


FIG. 4—TIMING DIAGRAM for some of the more commom envelope generators. Each waveform requires a trigger signal, gate signal, or both.

response "unwarps" the effects of the Gilbert stage. That results in what appears to be a linear amplifier and makes possible a marked increase in the signal-to-noise ratio.

New IC's dedicated to the VCA function now incorporate the Gilbert input-stage. A number of companies make VCA chips now, and that is probably the result of an interest in VCA's for not only music but for other areas as well. Computer-controlled mixers in recording studios, telephone technology, radio-broadcasting equipment, and audio-frequency devices for use in other areas are all in need of good voltage-controlled amplifiers.

The most common VCA chips are the CA3280 by RCA, the LM13600 by National Semiconductor, the SSM 2000, 2010, and 2020 by Solid State Micro Technology, and the CEM3330 made by Curtis Electromusic. Some of those integrated circuits incorporate converters to give the VCA an exponential control-voltage input.

Figure 3 shows an example of a VCA configured around the Curtis CEM3330. In its simplest form, the VCA has an audio input, a control-voltage input, and an audio output.

The control-voltage input used in Fig. 3 is pin 7, the linear input. Pin 6, which is shown grounded, is an exponential control-voltage input. However, most ADSR's (*A*ttack, *D*ecay, *S*ustain, *R*elease—modules that are usually used to control the VCA) have an exponential output. Therefore, pin 6 is almost never used.

Envelope generators

The last major building block of an electronic music synthesizer is the envelope generator. Its purpose is to let you control the *envelope* of the synthesizer's output. The envelope is one of the characteristics that distinguishes the sound of the organ from that of the violin. The violin has a slow attack-time and its volume builds up to a steady state over a long time-period. The organ, on the other hand, has a very fast attack time—the sound is at full volume (almost at) the instant a key is struck and held. An envelope generator should allow the user to create either effect in addition to countless others.

In general, the envelope generator provides a non-periodic waveform that is used to modulate the amplitude of the audio signal (by means of the VCA). There are three basic types of envelope generators: AD (*A*ttack–*D*ecay), AR (*A*ttack–*R*elease), and the ADSR mentioned earlier.

The AD generator provides an attack-decay envelope (Fig. 4-a). It is usually fired by a trigger pulse like that shown in Fig. 4-d. The output of the generator is a control voltage with adjustable attack and decay times. It is most often used for percussive-type sounds.

The AR envelope-generator provides an envelope like that shown in Fig. 4-b. It is fired by the presence of a gate signal like the one shown in Fig. 4-e. The generator's control-voltage output rises to a steady state and holds that state until the gate signal vanishes. The output control-signal then goes into the release portion of the curve. Because the AR generator is easy to design and build it has been popular in inexpensive commercial synthesizers.

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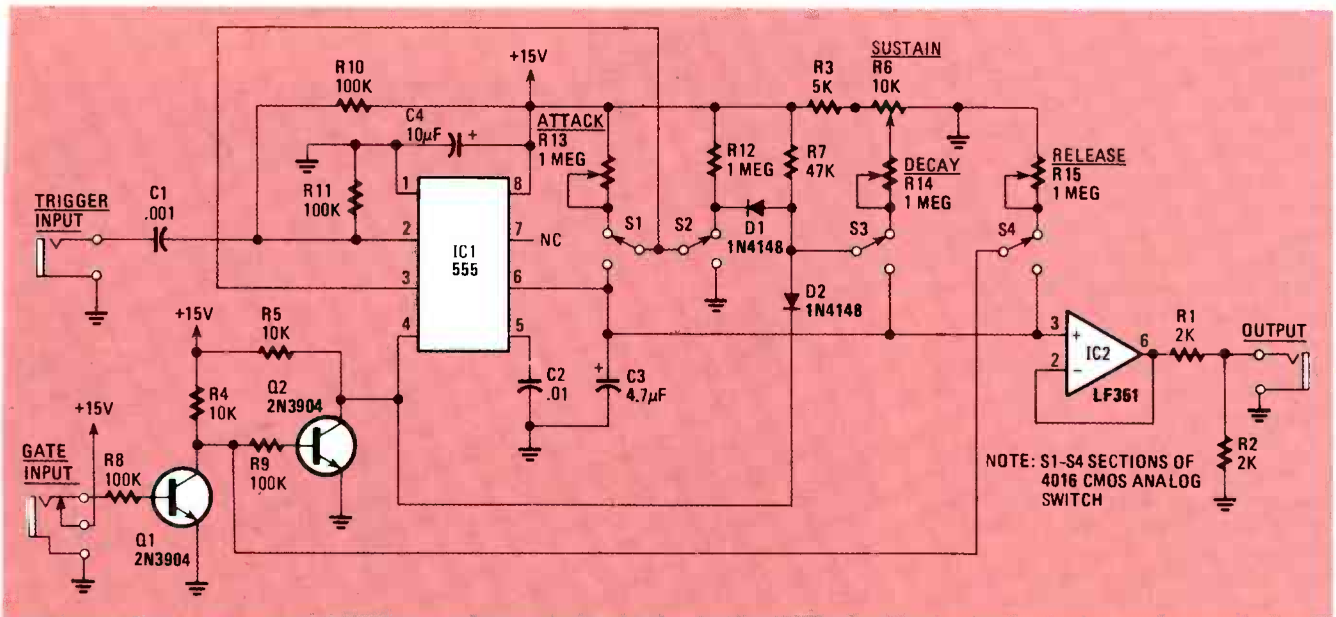


FIG. 5—THIS ADSR ENVELOPE GENERATOR circuit provides you with complete control over the attack time, decay time, sustain level, and release time.

JOSEPH J. CARR

D/A Converter Applications

A fascinating device, there's more to the digital-to-analog converter than meets the eye. Here's a closer look at the device and its applications.

FOR DIGITAL CIRCUITS AND COMPUTERS TO communicate with the real (analog) world, digital-to-analog converters are necessary. Those converters, commonly available as single IC's, allow data and information to be transferred from one world to the other.

Digital-to-analog converters (DAC's) produce an analog output that is proportional to the product of two inputs. One of those inputs is an n-bit digital word. The other input is either a reference current or a reference voltage. If that input is a reference current, then the output of the DAC can be expressed mathematically by:

$$I_O = I_{REF} \times \left(\frac{A}{2^n}\right) \qquad (1)$$

where A is the n-bit digital word. If the input is, instead, a reference voltage, then the DAC's output can be expressed by:

$$E_O = E_{REF} \times \left(\frac{A}{2^n}\right) \qquad (2)$$

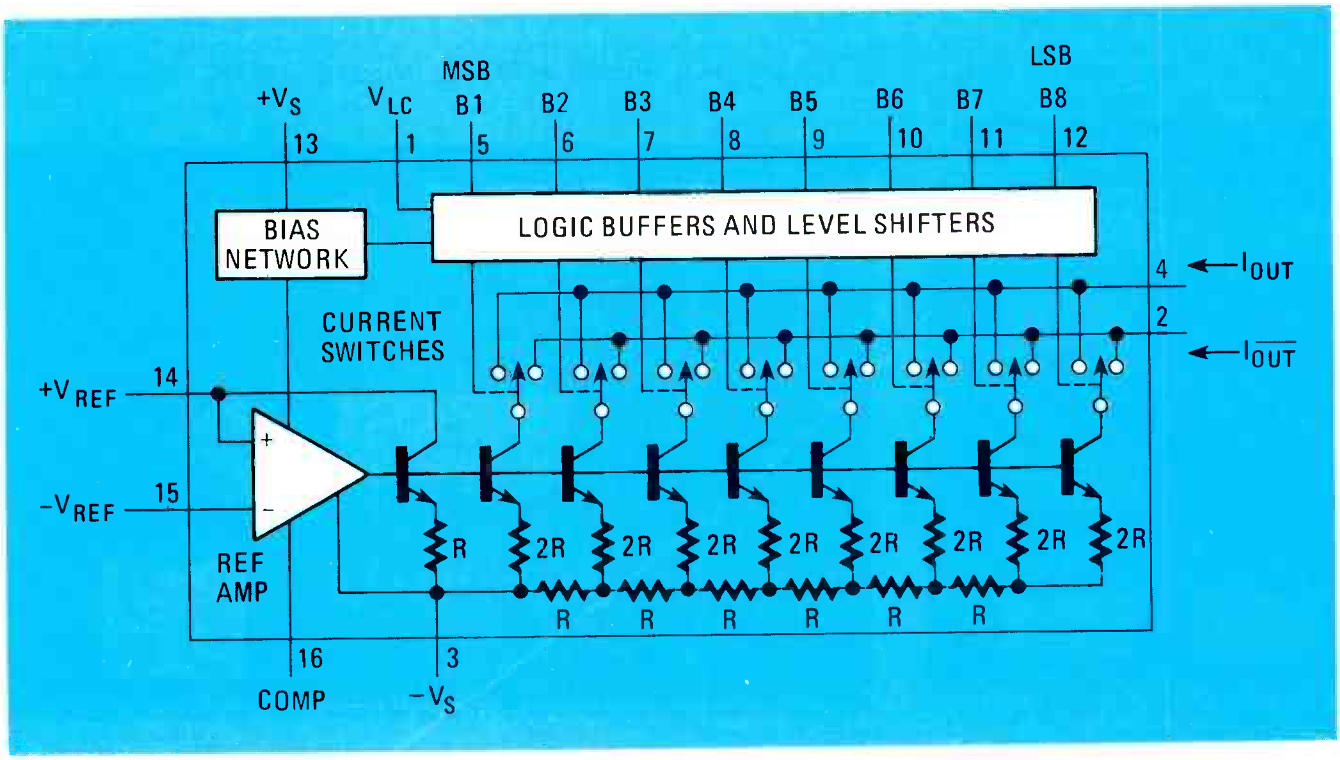
With only a little imagination we can make the DAC perform any number of functions in which equations 1 and 2 play a part. The most obvious function, and that for which the DAC was invented, is to create a DC voltage or current level proportional to the binary number applied to the digital inputs. We could, for example, connect those digital inputs to a computer's output port. The DAC's analog output then will be proportional to the digital value output from the computer. It will be in the form that we (in this analog word) will recognize, and it can be displayed on an oscilloscope or strip-chart recorder.

Figure 1 shows a typical 8-bit current-output multiplying DAC, the DAC-08 (Precision Monolithics, Inc., 1500 Space Park Dr., Santa Clara, CA 95050). Being a current-output device, the operation of the DAC-08 is described by equation 1. The device will produce an output current of (2 mA) × (A/256), where A is the digital word applied to the digital inputs. Amplifier IC2 converts the current output of the DAC-08 to a voltage output. The amplifier output E is given by the expression $I_O \times R3$, so with the component values shown E will range from 0 to 5 volts.

Operational amplifier IC3 is configured as a lowpass filter, and is optional. The output of a DAC is a step waveform, with each step being equal to the DAC's LSB (*Least Significant Bit*) voltage. The values shown in Fig. 1 will produce a gain of 2, so the output will be 10 volts for a 5-volt input. The cut-off frequency will be 1000 Hz, but circuit values can be changed to accommodate other frequencies.

Waveform generator

A DAC can be used to generate a sawtooth output waveform by connecting its digital inputs to the output terminals of an ordinary binary counter circuit (see Fig. 2). A 7-bit CMOS 4024 counter can be used with an 8-bit DAC if the clock terminal is used as the LSB input.



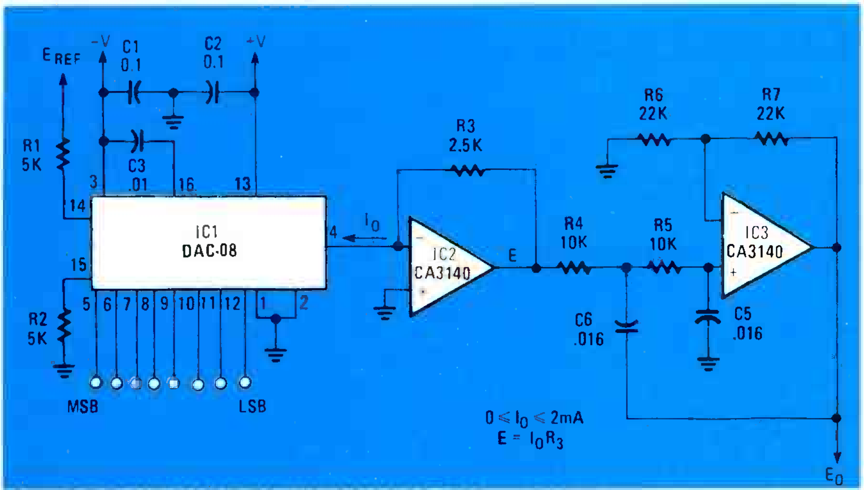


FIG. 1—A TYPICAL DIGITAL-TO-ANALOG CONVERTER, the DAC-08 used in this circuit is an 8-bit current-output multiplying device.

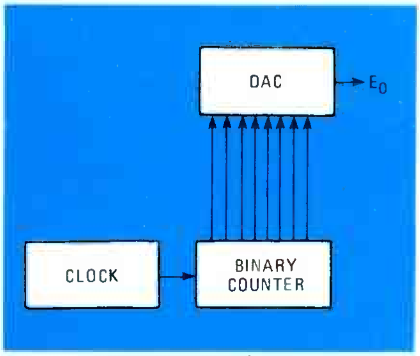


FIG. 2—A DAC CAN BE USED to generate a sawtooth waveform by connecting its input terminals to the outputs of a binary counter.

Let's see what happens. When the counter output is 00000000, the DAC output is zero. As the counter output increments, the DAC output is rising, until the counter reaches its maximum count (i.e. 11111111). At that point the DAC output is at its maximum. On the next clock pulse the counter will overrange, and reset to 00000000, so the DAC output drops back to zero. The output waveform that results is a sawtooth.

By using an up-down counter, we can generate a positive-going (as was done above) or negative-going sawtooth. The latter requires that we count down from the counter's maximum, rather than up from zero.

A triangular waveform can also be generated using an up-down counter. If we count up from 00000000 to 11111111, and then reverse the order and count back down to 00000000 (instead of merely resetting the counter), the output waveform will be a triangle function.

We actually can generate almost any function or waveform that we desire if a circuit such as the one shown in Fig. 3 is used. The bit pattern corresponding to the points on the desired curve are stored in sequential addresses in a ROM. Those bit patterns will be applied sequentially to the digital inputs of the DAC, and cause the instantaneous value of the output voltage to change accordingly.

The clock causes the counter to sweep through the waveform by incrementing the counter outputs from 00000000 to 11111111. The frequency of the generated waveform is controlled by varying the clock speed. That type of circuit, incidentally, is used in electronic music-generation.

Digitally controlled attenuator

Equations 1 and 2 show that a multiplying DAC produces an output proportional to two different factors; i.e. an analog reference and a digital word. Figure 4 shows how to connect the DAC-08 to accommodate a bipolar reference such as an AC signal. Current I_{REF} is equal to E_{REF}/R_{REF}, and should be 2 mA under normal operating conditions. Furthermore, E_{REF} must be greater than the peak AC value of the input signal E_{IN}.

The compensation capacitor, C_C, between the $-V$ supply and pin 16 affects the frequency response of the DAC. The RC time constant, $R_{REF} \times C_C$, determines the maximum slew rate of the DAC-08. With component values of 1000 ohms and 15 pF, the slew rate will be 4 mA/μS.

That same circuit can be used for on-off keying of a reference signal. That is done by tying all of the digital inputs together to form a single keying terminal. When the keying terminal is low, the AC output is cut off, but when it is brought high the AC reference is passed to the output at its full amplitude.

Op-amp offset control

A DAC can be used to control the output offset of an operational amplifier by using a circuit such as the one shown in Fig. 5. The output voltage can be expressed by:

$$E_O = \frac{-E_{IN}R_F}{R_{IN}} + \left(\frac{-AE_{REF}}{256} \times \frac{R_F}{R1}\right)$$

We can, therefore, digitally control the output offset by varying the digital word A applied to the DAC. For current-output

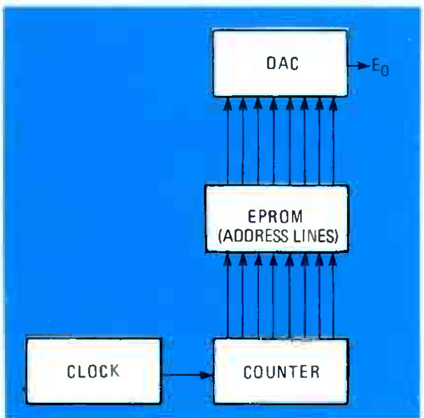


FIG. 3—ALMOST ANY WAVEFORM can be generated using a DAC. The block diagram of an appropriate circuit is shown here.

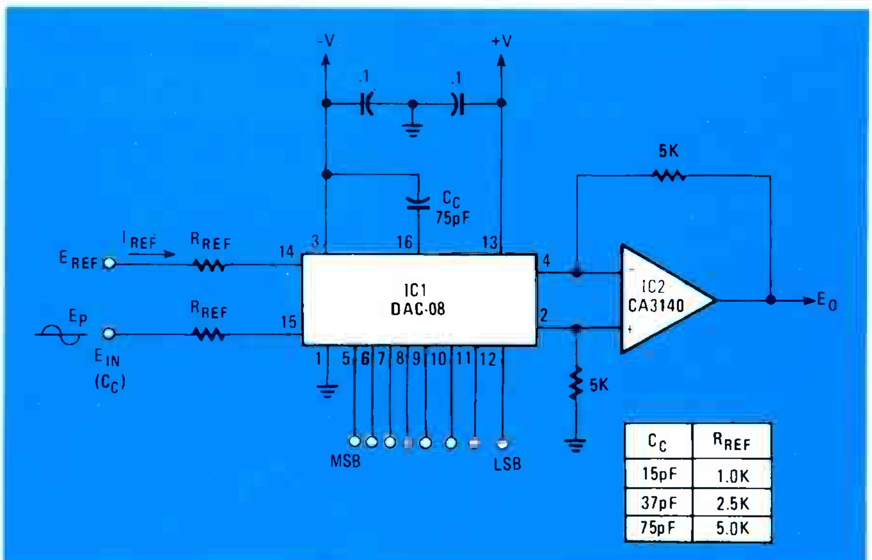


FIG 4—THE DAC-08 CAN ACCOMMODATE a bipolar reference signal, such as an AC signal, if it is configured as shown.

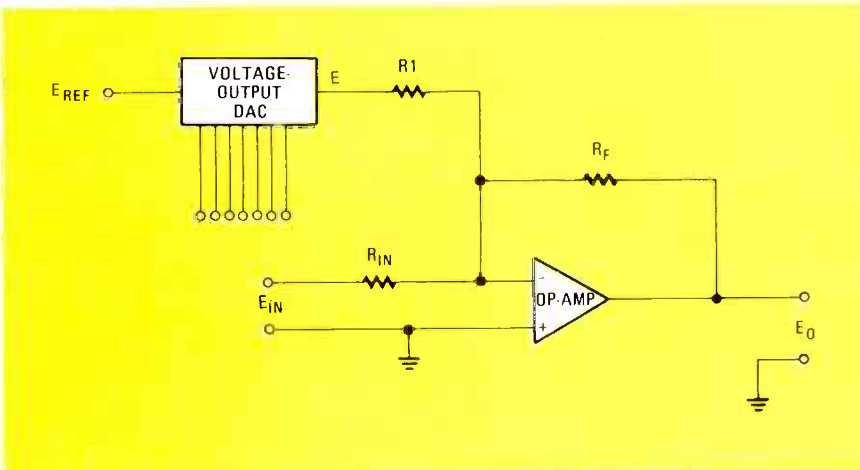


FIG. 5—THIS CIRCUIT SHOWS how a DAC can be used to control the output offset of an operational amplifier.

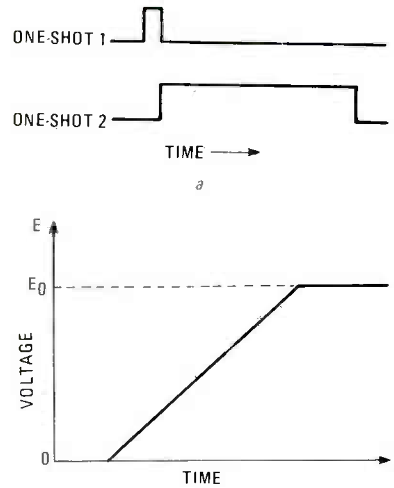


FIG. 7—TIMING DIAGRAMS for the one-shots used in Fig. 6 are shown in *a*; the resulting output, E_O, is shown in *b*.

DAC's eliminate R1.

Automatic zeroing circuits

Many circuits have an offset that must be nulled before proper operation is possible. Medical, scientific, and industrial instruments, for example, use transducers to acquire data and convert it to an electrical signal. Unfortunately, almost all transducers have a certain offset voltage. That is, they will produce an output voltage even when whatever it is they're supposed to measure (blood pressure, vibration, etc.) is not present. Consider arterial blood-pressure transducers used in medical electronics. Those instruments use Wheatstone-bridge transducers to sense the blood pressure. Theoretically, the output should be zero when the transducer is open to atmosphere. But transducer imperfections and hydrostatic pressure in the lines to the patient creates an offset in the amplifier output that must be nulled. Figure 6 shows a representative auto-zero circuit that will automatically null a circuit at the push of a button.

When power is first applied, the power-on reset circuit will reset the DAC to 00000000. When the transducer is opened to the atmosphere, a voltage will appear at the output (E_O). That voltage represents the sum of all of the offsets in the circuit preceding that stage. When the zero button is pressed, one-shot 1 fires a brief pulse that ensures that the counter and DAC are reset to zero, while also triggering one-shot 2. (The timing diagrams are shown in Fig. 7). The time period of one-shot 2 is very long relative to the time period of one-shot 1 (and might actually approach one second or more). When the output of one-shot 2 is high, clock pulses are gated into the counter causing the counter and DAC to increment. The comparator will have a high output as long as E_O is not zero. Voltage E, the DAC output, will rise in ramp-like fashion as the DAC digital inputs increment (see Fig. 7). It is summed with input voltage $-E_{IN}$ at the inverting input of the op-amp (that op-amp should be a low- or unity-gain device), so the output voltage, E_O, will drop. When E_O has dropped to zero, the output of the comparator drops low, shutting off the flow of clock pulses to the counter. The digital inputs of the DAC, therefore, remain at the last count that occurred before the comparator output dropped low. Unless the transducer offset changes, the output voltage E_O will represent only the true value of the signal, less any offset.

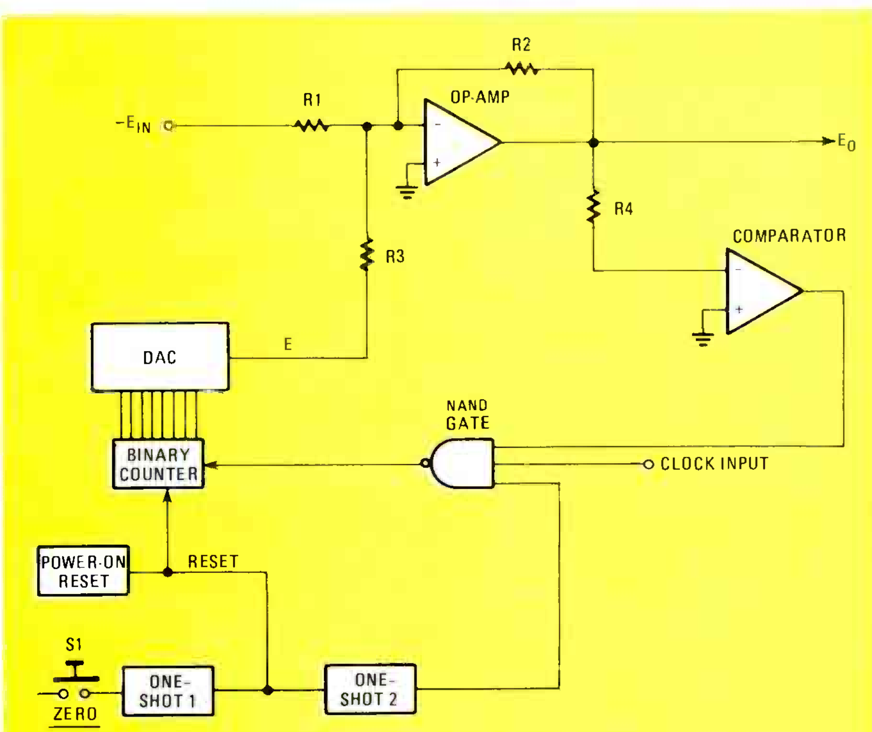


FIG. 6—A DAC CAN BE USEFUL in a circuit designed to null out any offsets in sensitive measuring equipment. Such a circuit is shown here.

Making use of a multiplying DAC

What is a multiplying DAC? All DAC's are multiplying circuits (see equations 1 and 2); they produce an output that is the product of an analog reference and a digital word applied to the digital inputs. But in manufacturers' catalogues we note that only some DAC's are referred to as "multiplying" devices. The reason for that is that a multiplying DAC is commonly defined as a DAC that operates from an external analog reference, while one that operates only from its own internal reference is a non-multiplying DAC.

A little cleverness counts for a lot in using a multiplying DAC. You can, for example, design circuits that perform arithmetic operations and produce an an-

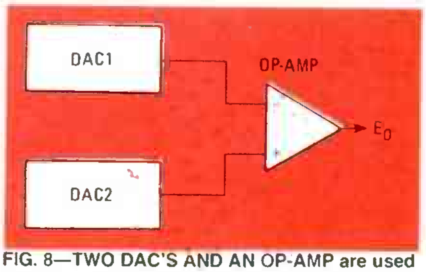


FIG. 8—TWO DAC'S AND AN OP-AMP are used in a circuit that finds the analog sum of, or difference between, two digital words.

alog output. You can also calibrate several DAC's to a single reference, thereby increasing the overall accuracy of your measurements.

Let's look at an example of an arithmetic application of the multiplying DAC, one in which it is used in a circuit that produces the analog sum or difference between two digital words. That requires two DAC's and an operational amplifier as shown in Fig. 8. Apply one digital word to each DAC. Their respective outputs are fed to the input(s) of the operational amplifier. (If the sum of the two is required, then connect both DAC outputs to the same op-amp input. But if the difference is required, connect the subtrahend—the number you wish to subtract—DAC output to the inverting input, and the minuend—the number from which it is subtracted—DAC output to the noninverting input.) The gain of the op-amp allows us to set the scaling factor (if needed), so that the op-amp output correctly represents the sum or difference between the two words.

Figures 9 and 10 show two more ways that DAC's can be used. Figure 9 shows a four-quadrant 8-bit by 8-bit digital multiplier based on the DAC-08. Two of the devices, IC1 and IC2, are connected together to make an extended range circuit, while IC3 is used to supply the analog reference for IC1 and IC2. Since the digital word applied to IC3 sets the analog reference-current applied to the other two DAC's, which are multiplying DAC's, the output will be proportional to the product of word A and word B.

Figure 10 shows a pair of DAC-08 devices connected into a ratiometric A/D converter circuit. That is the same basic circuit that is used in many A/D converters (i.e. successive approximation or binary ramp types), but with two DAC's instead of one. The resulting output word is proportional to the ratio of the two input voltages, V_X and V_Y.

Ratiometric measurements are often performed by scientific, medical, and industrial instruments because they are often more reliable than actual value measurements. It seems that factors that create drift problems often affect two or more parameters, so they will cancel out if ratios are used. Take, for example transducer measurements (as previously discussed). If the transducer's excitation potential drifts, the resultant output-voltage change will be seen by the following amplifiers as a valid change in the signal.

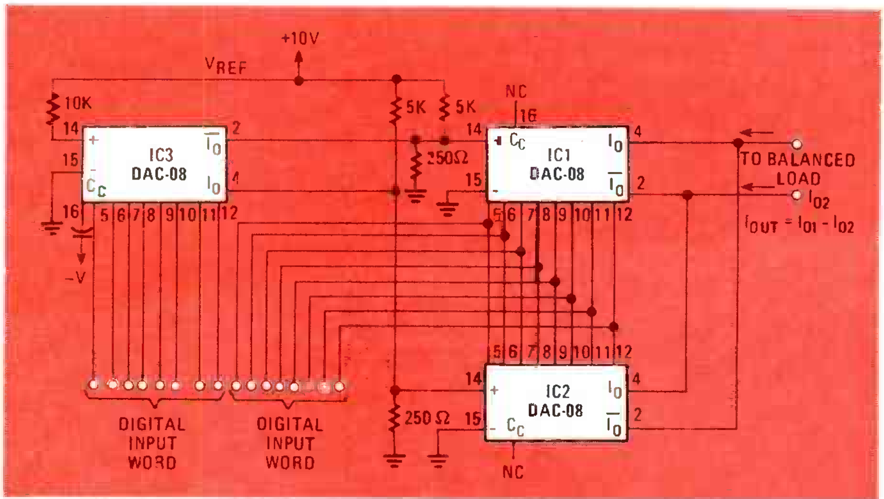


FIG. 9—THIS FOUR-QUADRANT 8-bit × 8-bit digital multiplier uses three DAC-08's. The circuit's output will be proportional to the product of word A and word B.

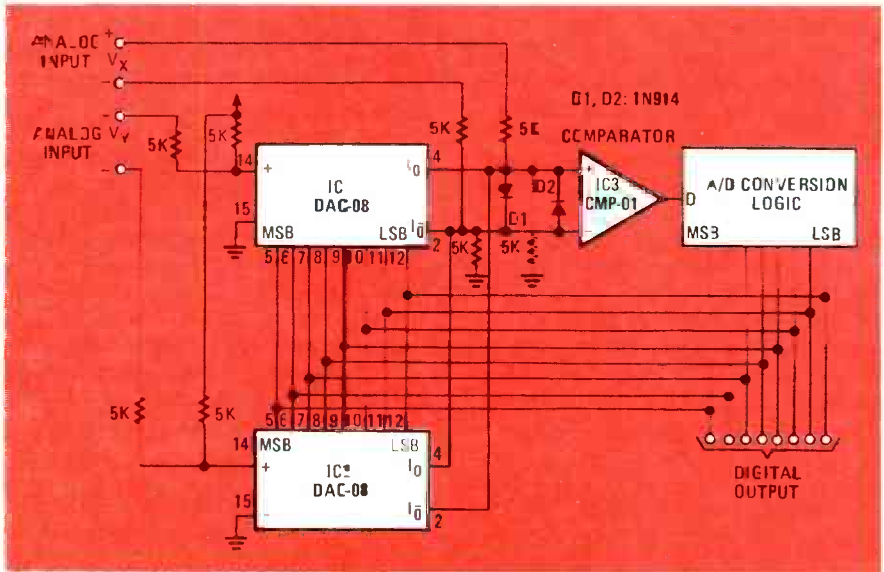
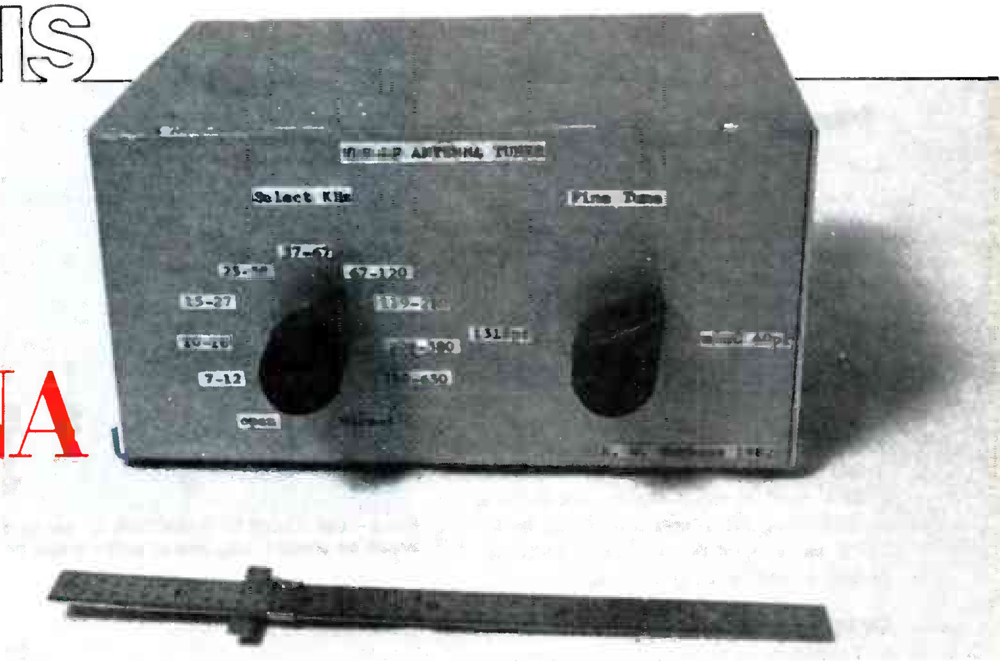


FIG 10—A RATIOMETRIC A/D CONVERTER. Ratiometric rather than direct measurements are often made by scientific, medical, and industrial instruments for greater accuracy.

The circuitry has no way of knowing which changes are data and which are not. But we can often cancel that form of drift by using ratiometric measurements. If we apply the excitation potential to one input, and the signal potential to the other, then the output potential will be the ratio of the two inputs. If the excitation drifts, then both the excitation potential and the signal potential will change by an equal amount. The result is that no output changes occur in the ratiometric signal. But if the signal changes are valid, then the excitation potential will remain constant as the signal potential changes. The result will be a change in the output of the ratiometric circuit. The output from a ratiometric circuit is called a "normalized" output. R-E

"The meaning of life? Just a second..."

PASSIVE ANTENNA TUNER FOR VLF-LF



One way to improve the performance of VLF-LF antennas is through the use of a passive antenna tuner. Here's the theory, and some ideas on how to use it.

R.W. BURHANS

Part 4 PREVIOUS ARTICLES IN this series have presented some details of short active antennas for frequencies covering the range from 10 kHz to 30 MHz. *Passive* antenna-tuners for random-length wires are another approach to the problem of good signal reception. Commercial models are available, but they are usually designed for the medium- and shortwave bands above 150 kHz; only one system claims to be effective all the way down to 10 kHz.

Since the greatest reception problems are encountered at low frequencies, let us discuss the design of selective antenna tuners covering the range of 10 kHz to 500 kHz.

Antenna lead-in

It is interesting to consider the idea of locating the antenna tuner at the receiver, with the antenna wire connected by a length of coaxial cable to the receiver and tuner as illustrated in Fig. 1. One problem at low frequencies is that the shunt cable-capacitance, C_c, in parallel with the antenna capacitance, C_a, reduces the sensitivity by the factor: $C_a/(C_a+C_c+C_t)$. By choosing a length of relatively high impedance, low-capacitance cable, it is possible to design a tuner that takes into account the cable capacitance as part of the tuner network, and that can operate with up to 50 feet (about 15 meters) of cable separating the antenna wire from the receiver and tuner. That antenna will be less effective than an active-antenna preamplifier system for the same length of antenna wire, but there will be fewer problems of intermodulation distortion because of the high selectivity, and no active preamplifier is involved. The

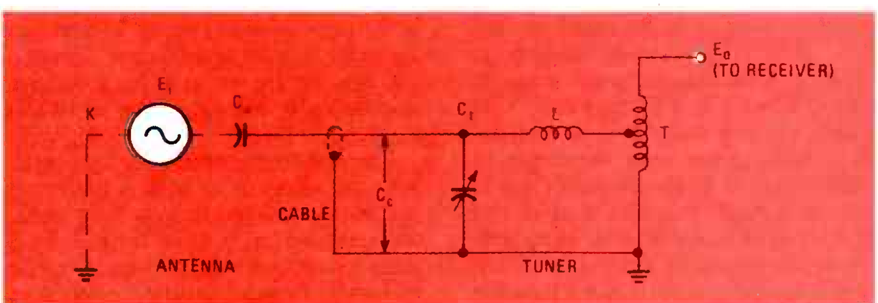


FIG. 1—IT IS IMPORTANT to take into account the capacitance, C_c, added by the coaxial cable between the antenna and tuner.

TABLE 1

Frequency range (kHz)	Inductance (mH)
10-16	150
15-27	68
23-38	33
37-67	10
67-120	3
119-210	1
208-380	0.3
380-630	0.1

advantage of having the antenna tuner located at the receiver is obvious. The coaxial lead-in helps reduce local-noise pickup since the antenna wire can be located away from power lines, home appliances, and other noise sources.

Design considerations

To design such a tuner system we must first measure or estimate the total minimum capacitance, including the antenna, cable, and minimum tuning capacitance. A relatively-high-value tuning capacitor is required, having a value several times greater than the total minimum capacitance. We chose a 3-gang variable capacitor, each section having a range of about 12 to 440 pF, like those found in older-style AM radios (commonly referred to as 360-pF units). They are still available new at rather high prices, but similar devices can often be found at surplus-electronics-parts stores.

Taking all the components together, the total minimum capacitance is:

Antenna capacitance	120 pF
Cable capacitance	360 pF
Minimum tuning capacitance	36 pF
Total minimum capacitance	516 pF

The total maximum capacitance (with the tuning capacitor fully meshed) is:

Antenna capacitance	120 pF
Cable capacitance	360 pF
Maximum tuning capacitance	1320 pF
Total maximum capacitance	1800 pF

Tuner circuit

Now that we have estimated a capacitance range for the tuning circuit of 516–1800 pF, a set of inductors is needed that will resonate with that capacitance at the frequencies we're interested in. The ratio $\sqrt{1800:516}$ gives us the tuning range for a given fixed inductor in the circuit—a range of about 1.86:1 for each coil. A set of inductors that will provide the results we're looking for over the range of 10–500 kHz can be chosen from Table 1. The inductors are connected in series with the antenna and cable lead-in, along with a very-low-resistance toroidal coupling-transformer designed to match a 500-ohm load at the receiver as shown in Fig. 2. The inductors are selected so that each frequency range will overlap the next slightly; that means an inductance change of less than $(1.86/1)^2$ between each set of coils selected for this example.

The wideband-output coupling-transformer takes the place of an additional set of parallel inductors to match the receiver's input impedance. In addition to the capacitive-divider loss at the antenna input, the transformer in series with a high reactance coil adds an insertion loss at the low-frequency end. That is, in part, compensated for by a higher Q. That selectivity decreases at higher frequencies, but gain increases. When connected to the 500-ohm receiver input-terminals, the low-impedance-input tap point of the output transformer looks like a 30-ohm load to all the coils. That is about the best that can be achieved because of the very wide variation in reactance and L/C ratio of the input network, but the overall performance is quite satisfactory, considering that we are using a single output-transformer to cover the range of 10 kHz to over 500 kHz.

The coil arrangement uses a multiple-position selector to switch frequency ranges and has a constant bandwidth-characteristic for each coil. That is, the Q for a given coil will be highest at the minimum capacitance-setting, decreasing by an amount equal to about the tuning ratio at maximum capacitance. The results obtained using low cost RF-choke-type inductors with the 120-pF antenna are shown in Table 2. The antenna used was a 10-meter-high, four-meter flat-top.

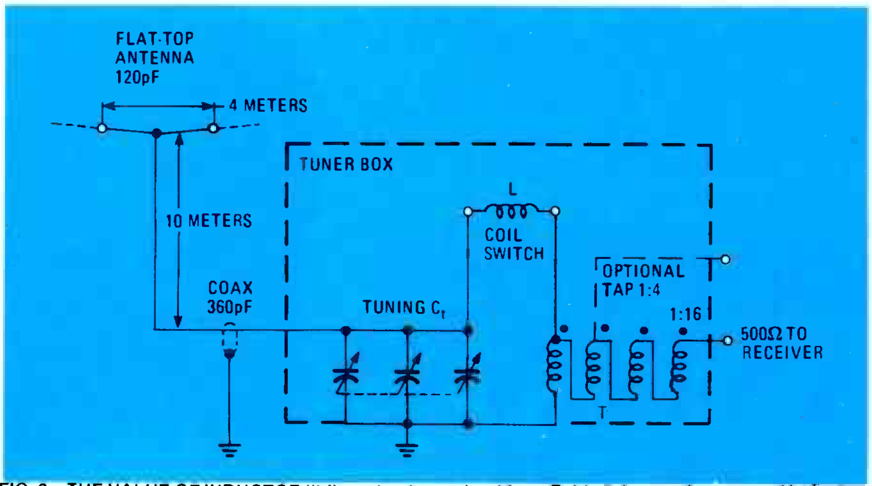


FIG. 2—THE VALUE OF INDUCTOR "L" can be determined from Table 2. In practice, several inductors would be present, only one of which would be switched into the circuit at a given time.

TABLE 2

Midband frequency (kHz)	Loss (db)	Q	Bandwidth (kHz)	Inductance (mH)	Inductor part number
13.9	−24	47	0.3	150	Mouser 43LJ415
20.1	−17	92	0.22	68	Mouser 43LJ368
30.1	−15	56	0.54	33	Mouser 43LJ333
52.7	−10	53	1.0	10	Mouser 43LH310
93.6	−9	36	2.6	3	Mouser 43LH233
168	−8	22	7.7	1	Mouser 43LH210
298	−9	12	24.	0.3	Mouser 43LR334
518	−9	12	42.	0.1	Mouser 43LR104

Input-capacitance variations

If you use an antenna wire or cable with more or less capacitance than the one we did, the inductance ratios will have to be computed for a different set of coils. The cable we used was surplus marked "FT&R Corp. Type K 109," and measured only 8 pF/ft. Thus, 45 feet of cable had a capacitance of 45 × 8 = 360 pF. For other high-impedance cable such as RG62, with a capacitance of 13.5 pF/ft., 360/13.5, or 27 feet, would be used with the same variable capacitor and coil-set. You may be able to find some high-impedance, low capacitance cable of the type used in automobile-radio installations. Each different system will involve a session of L-C calculations to match inductances and capacitances to the frequency range desired.

The following two formulas will help in those calculations:

$$f = \frac{10^6}{2\pi\sqrt{LC}}$$

$$L = \frac{10^{12}}{(2\pi f)^2}$$

TABLE 3		
Frequency	10 kHz	400 kHz
Capacitive loss factor $C_a/(C_a+C_c+C_t) = C$	−23dB	−12dB
Ground loss factor estimate = K	−26dB	−14dB
Measured network loss with antenna & cable capacitance = N	−24dB	−9dB
Antenna-to-receiver Z loss-factor, direct, no cable $500/X_{Ca}$ = A	−49dB	−17dB
Antenna sensitivity without tuner or cable = K + A	−75dB	−31dB
Antenna sensitivity with tuner and cable = K + N	−50dB	−23dB
Net improvement in sensitivity (K + N) − (K + A)	+25dB	+8dB

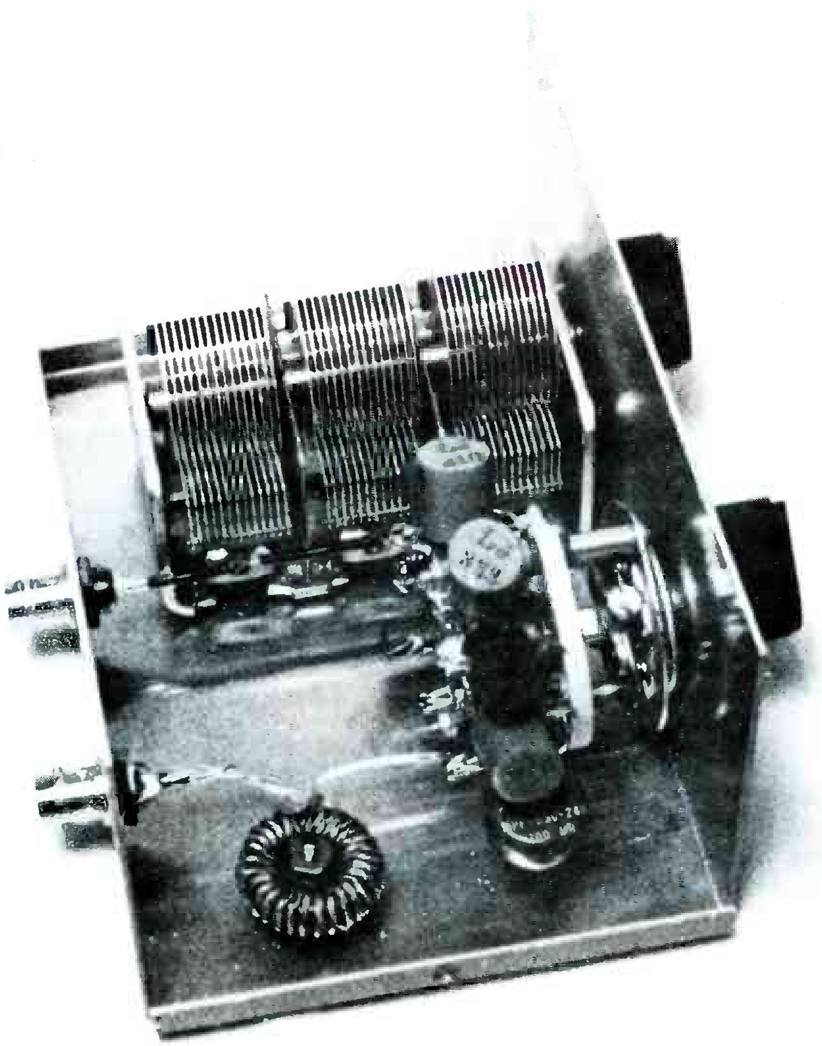


FIG. 3—INTERIOR OF THE AUTHOR'S prototype tuner. Note inductors mounted on rotary switch.

where f is the frequency measured in kHz, L is the inductance measured in μH (1000 μH = 1mH), and C is the capacitance in pF.

Performance data

Table 2 illustrates well the Q and mid-band loss of the tuning network with the antenna and cable connected; the figures were determined on the bench using a signal generator. Actual antenna performance will be somewhat worse than indicated by the loss factor because it will also be affected by the ground coupling K factor. (See Part 1, in the February 1983 issue of **Radio-Electronics.**) In our tests, K varied from .05 (an additional −26 dB) at 10 kHz to about 0.2 (−14 dB) at 400 kHz.

An estimate of overall efficiency made by comparing the wire antenna connected directly to the 500-ohm input of the receiver with the same antenna connected through the coaxial cable and tuner to the receiver, is illustrated in Table 3. From that table you can see that there is an overall improvement of 25 dB at the bottom of the VLF band (10 kHz), which decreases to only 8 dB at the high end of the LF band (400 kHz).

The high antenna-loss factors shown are typical of what happens when a random wire is connected directly to a 500-ohm receiver-input. The tuner provides an obvious improvement that is roughly proportional to the Q of the tuned circuit. In addition to increased sensitivity, the antenna tuner also provides high selectivity with practically none of the preamplifier or receiver IM problems noted with active antennas. On the other hand, active-antenna systems have better sensitivity.

The antenna tuner's narrow bandwidth requires that it be peaked whenever you shift frequency. That's easy to do if you have an S-meter, or you can listen for an increase in the signal- or background-noise level from the receiver as you adjust the tuner. For experimenters who wish to vary that method of antenna tuning, there are many factors to consider. The antenna's Q is limited by both the coils used and the series resistance of the network. That means that, even with the very best of inductors, the series resistance of the high-impedance cable and the output transformer, as well as the ground resistance, will ultimately affect performance. At the higher frequency-ranges, a lower Q is inherent in the system because of the lower coil reactance compared to the resistance in the system. Another variable is

PARTS LIST—PASSIVE TUNER

- C_t—three-gang tuning capacitor, 12–440 pF per gang (Allied 695-4200 or similar)
- T—quadrifilar toroidal transformer, 28 turns of four No. 30 insulated wire, twisted four-turns-per-inch on Amidon FT82-75 (or similar) core
- L—RF-chock-type inductor(s) (see Tables 1 and 2)
- **Miscellaneous:** high-impedance low-capacitance coaxial cable, rotary switch, metal enclosure, connectors, etc.

the turns ratio of the output transformer.

One possible improvement that could be made after inspecting the data in Table 2 would be to switch the tap on the output transformer for a 4:1 ratio for the frequencies below 50 kHz, where the coils' resistance and loss are much higher. The 16:1 tap could be used for the coils for 50 kHz to 500 kHz, where the loss is relatively constant at 9–10 dB. That change would result in a lower Q for the larger inductors, but a net improvement in power transformation to the receiver as suggested in the circuit shown in Figure 2.

Figure 3 shows the parts placement in the experimental version of the antenna tuner. The inductors are mounted radially around the switch, with the output-transformer toroid toward the rear of the housing near the receiver-output terminal. The prototype shown had an extra non-standard inductor at the lowest-frequency switch position for reception below 10 kHz.

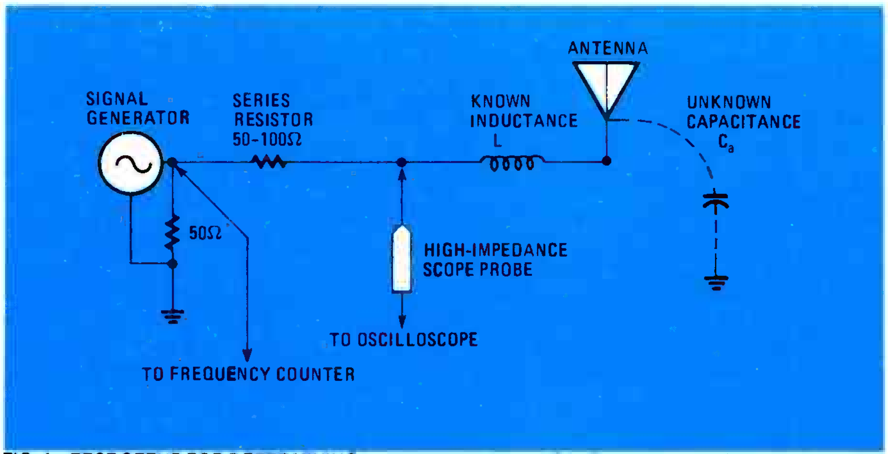


FIG. 4—TEST SETUP FOR DETERMINING antenna capacitance. Oscilloscope is used to observe slight dip in response at resonant frequency of system as frequency of signal generator is slowly varied.

Antenna-capacitance measurement

Most experimenters own a signal generator, oscilloscope, and frequency counter. They can be used to get a good estimate of the antenna's capacitance by following the method shown in Fig. 4. That is a simplified return-loss method where a small series-resistor takes the place of a 3-dB hybrid transformer. The resistor should have a value much lower than the reactance of the inductor at the frequency at which the measurement is made. Resistors in the range of 50 to 100 ohms, together with inductors having known values between 5 and 10 mH, can be used for antenna-capacitance measurements over the range of 10–500 pF for frequencies between 50–500 kHz. It is a good idea to make a preliminary estimate of the antenna capacitance by using the approximation of 10pF/meter of antenna length for wire antennas, and to use that figure as a rough guide to values for use in the initial test. After estimating the antenna's capacitance, the resonant frequency can be checked by substituting a capacitor of about the same value as that calculated for the antenna.

In our case, the flat-top antenna was terminated on a back porch, where it was easy to connect various pieces of test apparatus—and even a receiver—directly to its base. Variations on the substitution method can be used to measure cable capacitance with known inductors, or for unknown inductors with known capacitors, or even for coil distributed-capacity, using difference methods with known capacitors in parallel.

Mutually-coupled antennas

An interesting effect occurs when a tuned wire antenna is placed very near a short wideband active-antenna whip. The vertical active-antenna system is mounted at ground level, directly underneath the flat-top antenna at a distance of 5 to 10 meters (about 15–30 feet). The flat-top is connected to the tuner, but the output of the tuner is terminated with a resistor instead of the receiver. The active-antenna system is connected to the receiver as illustrated in Fig. 5. You may find that the amplitude of received signals is increased by 20 dB or more when the passive flat-top antenna tuner is tuned to resonance at the same frequency. That is an example of very-near-field mutual coupling. The active whip at ground level can be tuned for considerably increased sensitivity by placing it very near another tuned-antenna system.

That phenomenon could possibly be used to make directive VLF-LF arrays with very close spacings of 1/1000 wavelength or less between several tuned antennas and the excited active probe. Such a system, though, would probably require good series-inductors, and would be difficult to tune—the relative phase-change between antennas would be very steep because of the high Q of the tuned circuits.

VLF observers report many unusual antenna-effects due to things like drain pipes, gutters, power lines, telephone cables, trees, etc. Most of those can probably be accounted for by mutual-coupling phenomena, but are difficult to estimate or compute because of the unknown field-boundary conditions at a given location.

As we have seen, a single series-tuned inductor can improve the efficiency of a short-wire antenna at the VLF-LF range by 20 dB or more compared to the wire alone when connected to a typical 500-ohm receiver-input terminal. Local-noise pickup can be reduced by using a length of low-capacitance cable to connect the antenna to the receiver/tuner.

A dominating feature of passive VLF-LF short-wire antennas is their relatively high loss compared to the theoretical field available in space above the antenna. To offset that, though, an antenna tuner provides a considerable reduction in interference, along with high selectivity and no intermodulation distortion at the receiver input. It also offers improved sensitivity, compared to the antenna without a tuner. **R-E**

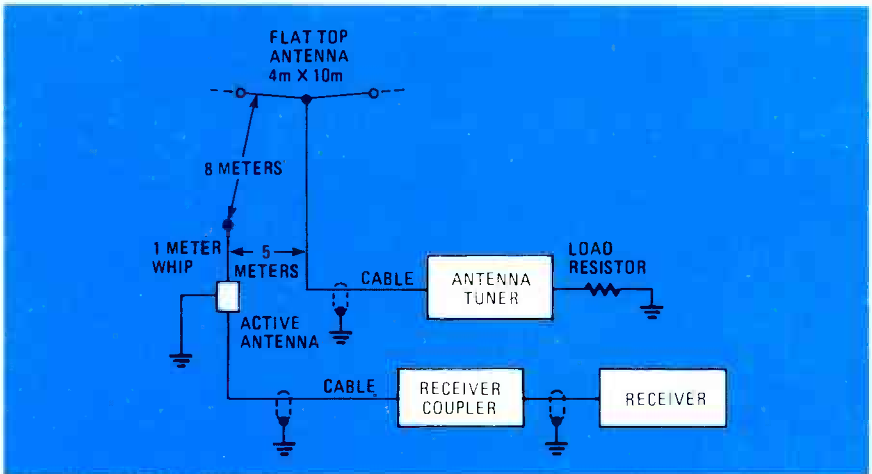
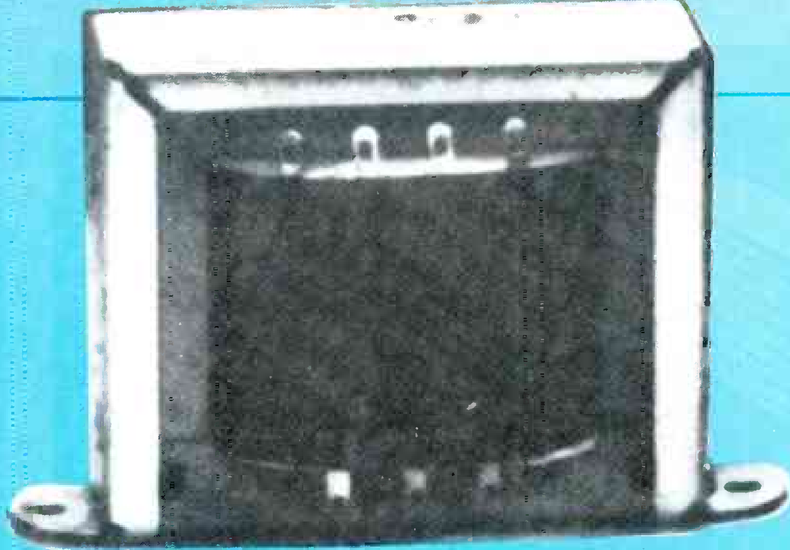


FIG. 5—MUTUAL COUPLING of antennas—one passive, one active—can improve performance by as much as 20 dB.

HOW TO



REWIND TRANSFORMERS

DON A. MEADOR

If you can't find the right transformer for your project at the right price, there's an easy solution—rewind one! As this article shows, the job is not as difficult as you might think.

ONE OF THE MOST IMPORTANT PARTS OF A power supply, whether it be for a project or your bench, is the transformer. If you've had much building experience, however, you know that getting the right transformer—one with appropriate voltage and current ratings—can be difficult and/or expensive. That's doubly true if you need something other than a "standard" voltage.

The easiest and most economical way to solve those problems is to rewind a readily available or inexpensive transformer. This article focuses on two aspects of the task: specifications, and the general guidelines for rewinding transformers. Also, we'll look at a practical example—how to rewind a transformer with a rating of 18 volts at 2.5 amps into one with a rating of 7 volts at 4.5 amps.

Manufacturer's specifications

Transformer ratings are usually given in RMS values. A secondary rated at 12.6 volts center-tapped at 1 amp means 12.6-volts RMS is across the entire secondary and that no more than 1-amp RMS can be drawn safely from it. The voltage from either end of the secondary to the center tap is one half the voltage across the entire secondary, or, in this case, 6.3 volts RMS. The current that can be supplied by each part of the secondary simultaneously is equal to the current rating of the entire secondary, or, in this case, the halves of the secondary can supply 1-amp RMS each.

The secondary's output ratings are based on the assumption that a particular RMS voltage will be applied to the primary of the transformer. Favorite values used by manufacturers are 110-, 117-, and 120-volts RMS. Note that while any transformer you buy new will have the ratings stamped either on it or its packaging, surplus or salvaged transformers usually will not. For the remainder of our discussion we will assume that the input to the primary is 117-volts RMS.

Since the maximum power capability of a transformer depends on the cross-sectional area of the iron core, the maximum power that a transformer can deliver is a constant. But any combination of voltage and current is possible provided that the voltage times the current is less than or equal to the transformer's wattage rating. Thus, if the manufacturer rates the secondary for 25.2 volts at 0.5 amps, it means that the transformer can supply 12.6 watts ($P = V \times I = 25.2$ volts $\times$ 0.5 amps = 12.6 watts). It also means that the transformer can handle any combination of voltage and current, so long as the product of the two is less than or equal to 12.6 watts—6 volts at 2.1 amps, for example.

Besides the wattage rating, the cross-sectional area of the wire used in the transformer puts a limitation on the amount of current that it can supply. If a transformer's secondary is rated for 22.5 volts at 2 amps, the manufacturer has told us that the wire used in the secondary will safely supply 2 amps RMS at any voltage, provided the transformer is capable of handling the resulting power.

Finding specifications on your own

If you have a salvaged transformer, information about its voltage, power, and current ratings is usually not available. That information is not that hard to find, however, if you follow these simple steps:

To find the voltage rating of the secondary, first find which wire belong to the primary winding. Most electronics handbooks provide a complete color code for the transformer's wires, but let's sketch out the essentials here.

The two black wires on the transformer lead to the primary and are where the 117-volts RMS line-voltage is applied. The wires to each secondary have a different color set. The wires to one secondary, for instance, may use a red color set—two solid red wires and another red wire with a different color stripe. The striped wire is the center tap of the secondary. If a secondary does not have a center tap, only two wires will be found in that color set. With the primary and secondaries identified, you simply use an AC voltmeter to find the voltages required.

To do that, hook the transformer up to your household power line and measure the voltages on each winding. **Be very careful** in performing this step. The best way to go about it is to wire a plug to the primary, attach the AC voltmeter to the winding you want to measure, and make sure that there are no exposed or touching bare wires before plugging in the transformer. To find the voltage simply plug in the transformer and read the voltage on the meter. Take enough measurements so that you know the voltage across each secondary, the voltage to each center tap, and the voltage applied to the primary. For safety, be sure to disconnect the power before you switch the meter leads.

Photo courtesy of Amecon Inc.

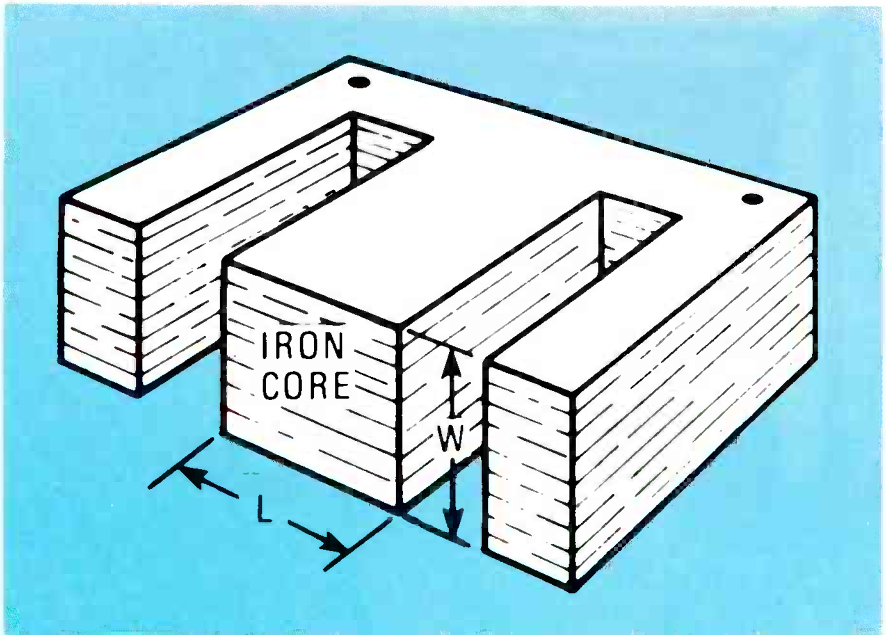


FIG. 1—TO FIND THE cross-sectional area of the transformer core, multiply L × W. Be sure to measure L and W in inches

TABLE 1

Cross-Sectional Area (Square Inches)	Power (Watts)
1	45
1.25	50
1.75	75
2	120
2.25	150
2.75	230
3	275
3.25	330
3.75	440
4	520

To find the power rating of the transformer, first find the cross-sectional area of the core by multiplying L × W as shown in Fig. 1. Be sure to measure L and W in inches so the cross-sectional area is calculated in square inches. Then, using Table 1, find the approximate wattage rating that corresponds to the cross-sectional area.

It is possible to reuse the wire from the original secondary for the new secondary. If the rating of that wire is not known, and there is only one secondary, the maximum current that the wire can safely handle is equal to the power capability of the iron core divided by the voltage of the winding. When there is more than one secondary, you would be better off to use the cross-sectional area of the wire used in each secondary to determine its current-handling capability (more on that later).

Rewinding a transformer

Since rewinding a primary is a job that should be avoided if at all possible (suggestions for handling that messy task will be given later on), the best transformers to rewind are those in which the primary is wound closest to the iron core. Transformers with a high-voltage secondary often have that winding wrapped next to the core, the primary wrapped on the outside of the high-voltage secondary, and finally the low-voltage secondaries as the outermost layer. Transformers with only one low-voltage secondary (less than 110 volts) usually have the primary wound closest to the core and the secondary on the outside. There is no way of knowing where the secondaries are until you disassemble the transformer.

The first step in rewinding a transformer is to determine what size transformer you need. To calculate the power that is required, multiply the voltage you need by the current you need.

Using Table 1 you can approximate the core size you need. If the core size is not given in a catalogue, the total power capability of a transformer can be found simply by adding the power rating of each secondary.

After you get the transformer, check the voltages using the technique we discussed earlier. The next step is to disassemble the unit. Take out the screws and anything else holding the transformer together. Usually the laminations are soaked in a special enamel and then baked. That is done to keep the transformer from buzzing and to seal it from the environment; it also makes the laminations hard to remove. As each lamination is removed, the enamel holding it must be broken off; when doing so it is very easy to damage the transformer's wires, so great care must be taken.

The first few laminations are hardest to remove. To break the enamel seal, take a very small screwdriver and slip it between the outside edges of the lamination you're removing. If you ruin a few laminations at first, don't worry—you won't be able to get all of them back in anyway when the transformer is reassembled. Set the transformer on a piece of plywood so that the lamination that you are removing projects over the edge as shown in Fig. 2. Working alternately at either end of the exposed lamination, lightly tap the screwdriver until the enamel on the inside of the core breaks loose. Then remove the lamination.

After a few laminations are removed, one of the "I"-shaped laminations can be

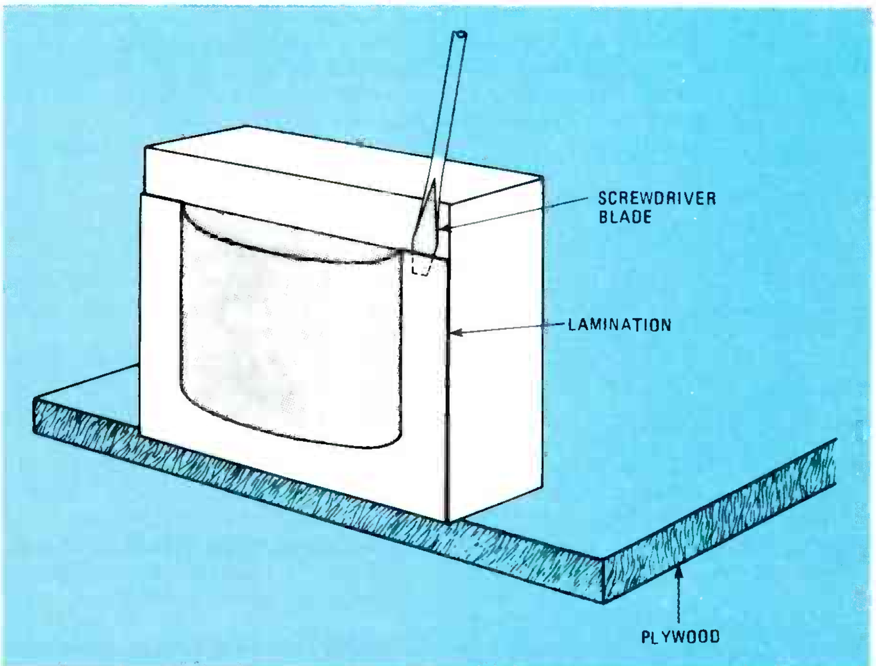


FIG. 2—TO REMOVE THE laminations, position the transformer as shown, slip a small screwdriver under the first lamination, and tap lightly with a hammer.

used to break the enamel seal on the remainder—the ones inside the coil—as shown in Fig. 3. You will still have to tap lightly with a hammer, but the "I" piece will be easier to use and cause less damage than a screwdriver.

After removing the laminations, the next step is to unwind the secondary. As you unwind the wire, count the number of turns. When the secondary is completely unwound, calculate the turns-per-volt by dividing the turns counted by the voltage previously measured on the secondary. For example, if the output from the secondary is 12.6 volts RMS and it has 40 turns, the turns-per-volt ratio is 3.175. When there is more than one secondary, the turns-per-volt ratio for each should be the same. If not, you have miscounted. In that case, use the average of the different values.

If the voltage measurements were made with something other than 117-volts RMS applied to the primary, you need to adjust the turns-per-volt value. Or, if the line voltage in your house was 112-volts RMS when you measured the secondary voltage, but most times your line voltage is 120-volts RMS, you may want to calculate the turns-per-volt value with 120 volts RMS applied to the primary. The following formula allows you to do that:

$$T_T = \frac{E_{MEAS}}{E_{NEW}} \times T_C$$

where T_C is the calculated turns-per-volt, E_{MEAS} is the voltage applied to the primary when the values were measured for the T_C calculation, E_{NEW} is the voltage you are recalculating for, and T_T is the turns-per-volt ratio with E_{NEW} applied to the primary.

The next step is to determine the number of turns you need by multiplying the turns-per-volt calculated above by the voltage you want. In the above example, if you want 6-volts RMS, then you need 19 turns (6 volts × 3.175 turns-per-volt). Keep in mind that the wire you use must be capable of handling the maximum current you desire.

The amount of current that a wire can handle, whether used for the primary or secondary, depends on the wire's cross-sectional area. The easiest way to determine its current-handling capability is to use one of the wire tables found in most complete electronics handbooks. Measure the wire's diameter in mils, using either a micrometer or a wire gauge, and using the table find the maximum current that the wire is rated to handle. The cross-sectional area of a wire is measured in a unit called the *circular mil* (a circular mil is equal to the cross-sectional area of a wire with a diameter of one mil) and wire tables often include that data for a given wire diameter or gauge. Generally speaking, a cross-sectional area of 600 mils per ampere is satisfactory for small transformers, although areas of 500 to 1000 mils are commonly used. If you are unsure about how heavy a wire you require, it is best to remember that the larger the cross-sectional area, the cooler the transformer will operate; so choose as heavy a wire as is practical.

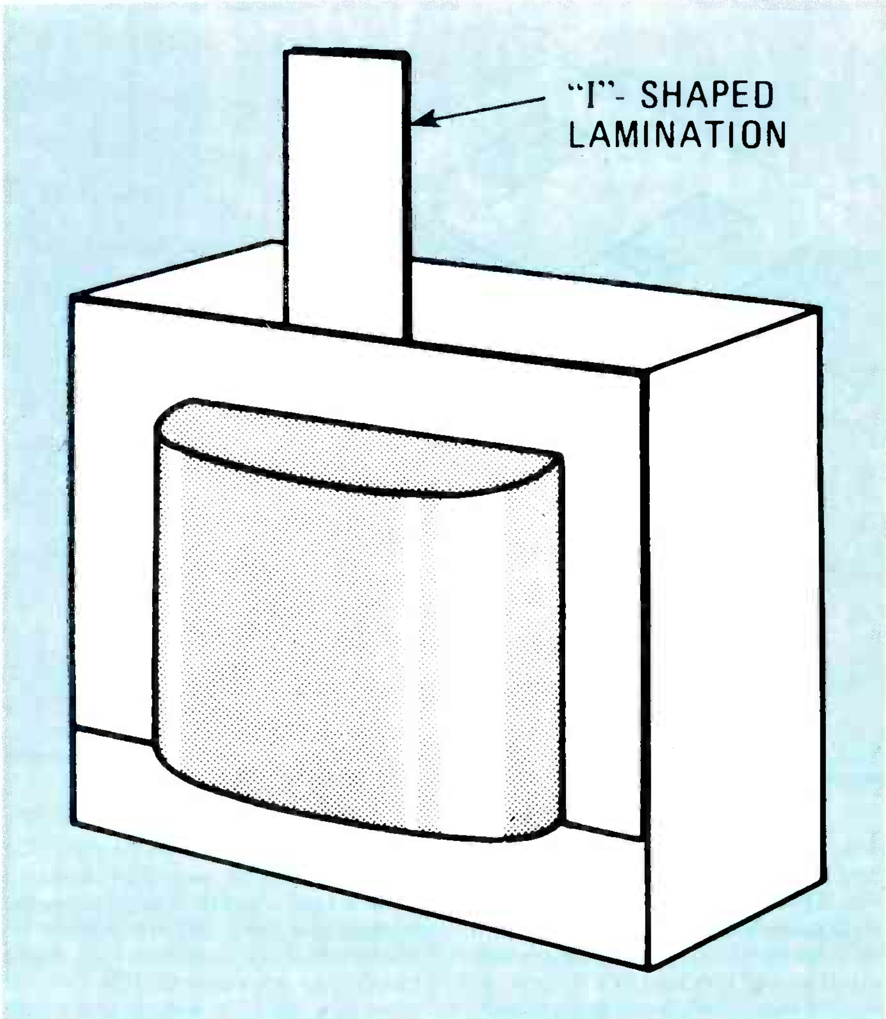


FIG. 3—AFTER A FEW laminations are removed, one of the "I"-shaped laminations can be used in place of the screwdriver.

It's best to use new wire for the new secondary, but, as we previously mentioned, if you're careful the old secondary's wire may be serviceable. Bend old wire as little as possible, and do not use it if there are any spots where the enamel has flaked off.

Once the proper wire has been chosen, the next step is to wrap the secondary. Wrap the wire without leaving any space between turns to get the maximum number of turns in the minimum amount of space. Put wax paper, duct tape, or some other type insulation capable of withstanding the maximum voltage of any one winding between each layer. The outside of the last layer should be covered extra well and taped tightly for both your and the transformer's protection.

The last step is to reassemble the transformer. Fig. 4 shows how to fit the "I"- and "E"-shaped laminations together. Most likely, there will be two to four "I" and "E" laminations left over—you will not be able to squeeze those laminations back into the core, but that will not substantially affect the power rating of the transformer.

Rewinding a primary

Rewinding a primary becomes necessary if the primary on the transformer you have chosen is not wound closest to the iron core. That task is not recommended, but the information is included here for the industrious.

After the turns-per-volt ratio has been calculated, the number of turns on the primary can be determined by multiplying the turns-per-volt ratio by the primary voltage. Using the example of the previous section and assuming the turns-per-volt was calculated with a primary voltage of 117 volts, the primary requires 371 turns (117 volts × 3.175 turns-per-volt). The alternative to that procedure is to actually count the turns of the primary, which may lead to errors.

Under the secondary's and primary's wire there is usually a cardboard or plastic form. Wrap the new primary and secondary on that form so that the laminations will fit into the new windings. Use the

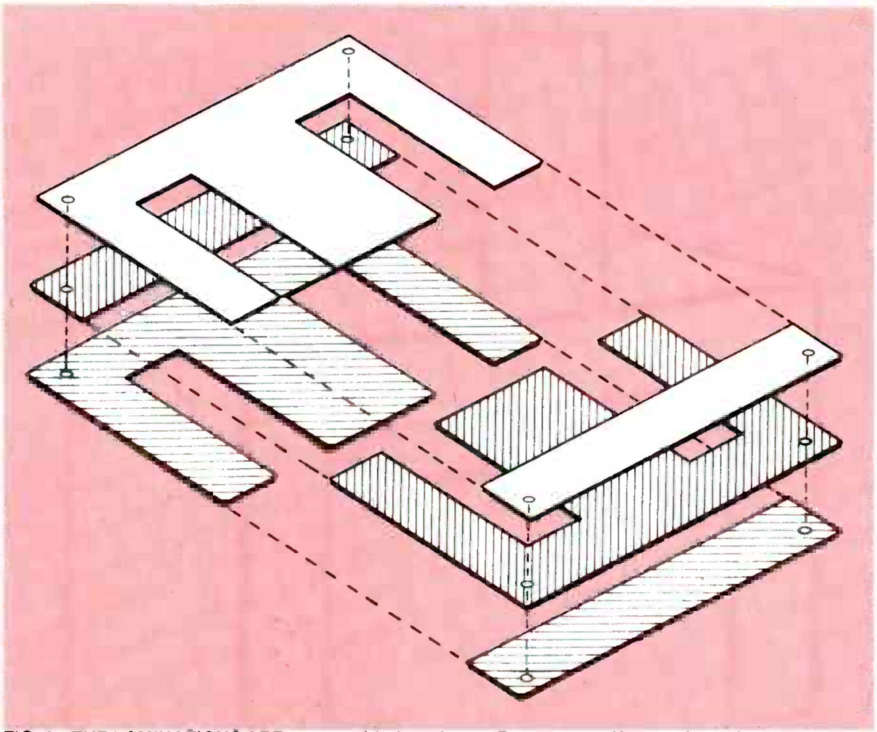


FIG. 4—THE LAMINATIONS ARE reassembled as shown. Do not worry if a couple are left over—that is sure to happen but will not have any significant effect on the rewound transformer.

same gauge wire that the manufacturer used, but do not reuse the same primary wire. That's because that wire is usually a small gauge with enamel insulation that's apt to break off easily. Since the primary wire is usually very long, it's very easy to develop shorts—when rewinding primaries, doing a lot of work for nothing is not that uncommon.

A practical example

Let's look at how we can rewind a transformer to deliver 8-volts DC at about 5 amps to a 5-volt regulator. That allows about 3 volts across the regulator. Also, for the purposes of this example, let's assume that we will use a bridge rectifier so that the transformer current rating would only need to be about 5 amps, since both halves of the AC cycle are used.

Using those specifications we get a pretty clear picture of exactly what kind of transformer is required. With a bridge rectifier a center tap is not needed on the secondary, but a bridge rectifier drops the transformer output voltage (voltage getting to the filter) by about 1.4 volts. The peak-value output of the transformer, therefore, has to be approximately 9.4 volts (8 volts + 1.4 volts). That means that the transformer's power rating has to be about 47 watts (9.4 volts × 5 amps).

The transformer we'll choose to rewind has a secondary rated at 18 volts at 2.5 amps. Therefore, that transformer has a power rating of 45 watts, which is close enough for our purposes.

As the transformer is disassembled, make notes of its characteristics. First thing to do is to take the voltage measurements. For the transformer chosen for the example, the voltage from the center tap to either end of the secondary measured about 8.1 volts, and the voltage across the primary was about 105 volts. When we disassembled the transformer we found that the primary was next to the core, the secondary from the outside end to the center tap had 51 turns in two layers, and that the wire from the center tap to the other end of the secondary was shorter but had the same number of turns. Given those measured values, the turns-per-volt ratio was 6.3 (51 turns ÷ 8.1 volts). Using the correction formula, adjust that turns-per-volt ratio for 117 volts applied to the primary. The corrected turns-per-volt ratio is therefore 5.65—105 volts ÷ 117 volts) × 6.3 turns-per-volt.

Knowing that, we can calculate the number of turns required for the secondary by multiplying the turns-per-volt by the voltage desired. The 9.4 volts peak translates to 6.65-volts RMS (9.4 volts ÷ $\sqrt{2}$) so 37.7 turns are needed (5.667 turns-per-volt × 6.65 volts). If the line voltage that the transformer is to be used with is normally below 117 volts, such as 105 volts, for instance, round the number of turns up to 40.

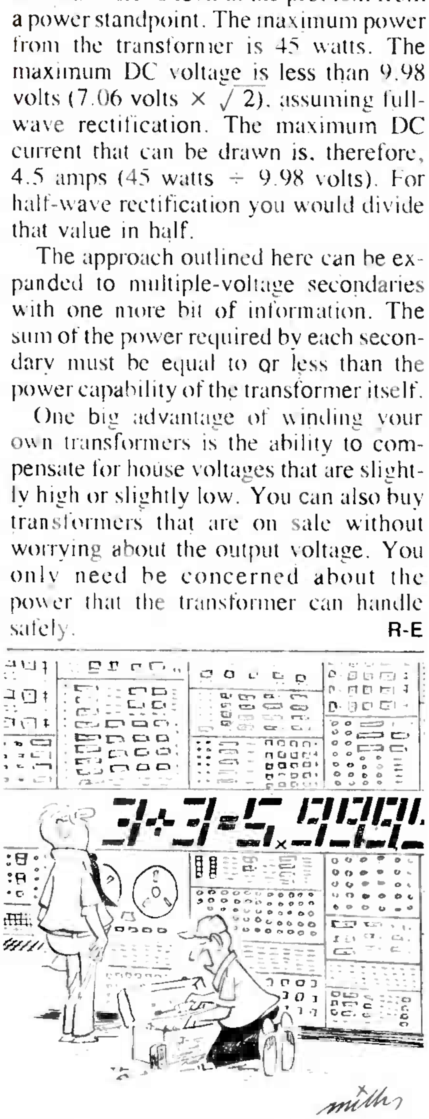
Continuing with our example, since we are using a new transformer, it is reasonable to assume that the secondary wire will be in excellent condition and can be reused. But as we stated earlier, while the wire is rated for 2.5-amps RMS, we want a transformer capable of handling 5-amps RMS. The wire can still be used, however, if two secondaries—wound for the same voltage and in parallel—are used. With two parallel secondaries, the transformer can handle the 5-volts RMS and no additional wire needs to be bought.

Cut the original secondary wire at the center tap. Use the shorter length of that wire for one secondary, wrapping it on top of the primary in two layers of twenty turns each—duct tape should be placed between the layers. For the other secondary, wrap the longer length of wire on top of the first secondary in the same manner—two layers of twenty turns each. Start that outer secondary winding at the same place you started the first secondary and be sure to wind it in the same direction. The two secondaries must be wound in the same direction. Otherwise, the net effect of paralleling them is 0 volt.

The transformer is then reassembled, but before it can be used its specifications must be re-rated. Using the number of turns of the secondary divided by the turns-per-volt ratio at 117 volts, the output voltage of the transformer is 7.06-volts RMS with 117 volts applied to the primary (40 turns ÷ 5.667 turns-per-volt). The current rating is not as easy to calculate. Let's look at the problem from a power standpoint. The maximum power from the transformer is 45 watts. The maximum DC voltage is less than 9.98 volts (7.06 volts × $\sqrt{2}$), assuming full-wave rectification. The maximum DC current that can be drawn is, therefore, 4.5 amps (45 watts ÷ 9.98 volts). For half-wave rectification you would divide that value in half.

The approach outlined here can be expanded to multiple-voltage secondaries with one more bit of information. The sum of the power required by each secondary must be equal to or less than the power capability of the transformer itself.

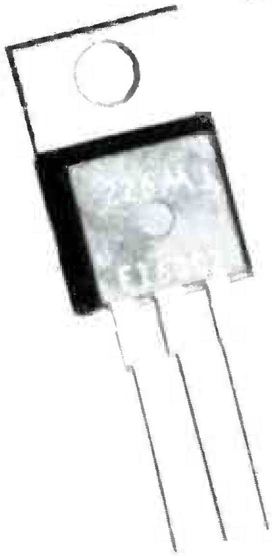
One big advantage of winding your own transformers is the ability to compensate for house voltages that are slightly high or slightly low. You can also buy transformers that are on sale without worrying about the output voltage. You only need be concerned about the power that the transformer can handle safely. **R-E**



"Well, now, if you insist on looking for mistakes, why, of course, you're most likely to find one or two."

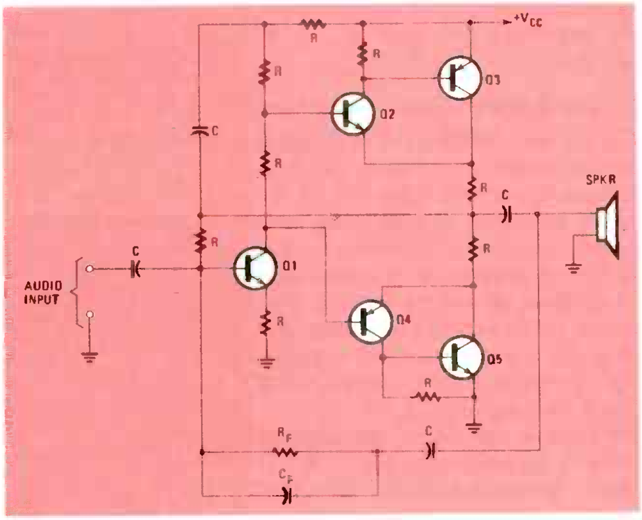
How to Design Analog Circuits

Audio Power Amplifiers



MANNIE HOROWITZ

Here's a look at some practical audio power-amplifier circuits.



Part 2 AS WE FINISHED UP last month, we were designing the ouput stage of an audio power amplifier. We were aiming for a design that did not use output capacitors, but still had a stable DC output level.

We can take the arrangement in Fig. 6 (see the March 1983 issue of **Radio-Electronics**), one step farther. We can eliminate the discrete output devices and use two power op-amps instead. That type of arrangement is known as a bridge amplifier and is shown in Fig. 7.

Signals are applied to the two op-amps. While the input is fed to the non-inverting (+) input of IC1, it is fed to the inverting input of IC2. Thus, the signals are 180° out-of-phase at the outputs of the two op-amps. Because a loudspeaker is connected to those two outputs, the out-of-phase signals add across the loudspeaker to reproduce the original input signal.

Potentiometer R1, usually about 2 megohms, is used to set the level of the signal at the output. Potentiometer R2 is used to set the DC voltage levels at the outputs of the two op-amps. By adjusting that potentiometer, those voltages can be made identical and no DC current will flow through the speaker while the circuit is idling.

An interesting variation on the circuit shown in Fig. 6, is shown in Fig. 8. Because there is no differential amplifier at the input, a capacitor must be used between the output transistors and the loudspeaker. Only one driver or voltage-amplifier stage is used here and the individual transistors are in each leg of the push-pull circuit. Although that is a very simple circuit, amplifiers using that

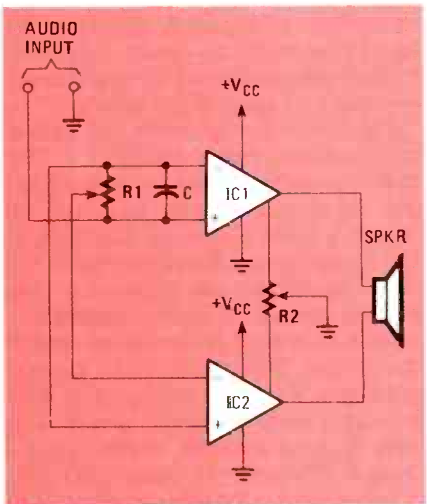


FIG. 7—ELIMINATING DISCRETE TRANSISTORS entirely, this op-amp circuit is known as a bridge amplifier.

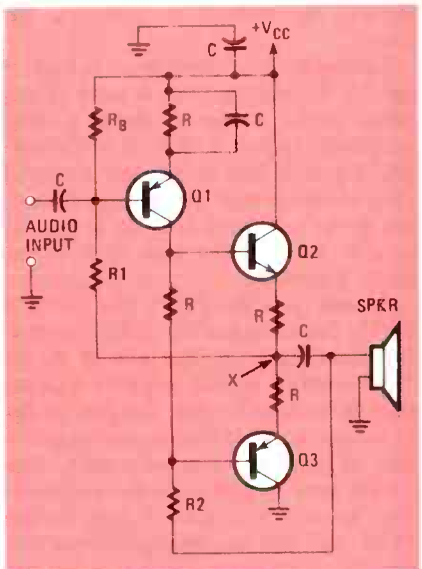


FIG. 8—ACCEPTABLE QUALITY at a reasonable price is the primary advantage of this low-cost circuit.

arrangement perform reasonably well. The big advantage here is acceptable quality at a relatively low price.

The two key components in the circuit are R1 and R2. Resistor R1 is in a DC feedback circuit. One end is connected to point the point labeled "X." Here, the voltage is ideally equal to one-half of $+V_{CC}$. Current is applied to the base of Q1 through R1. Resistor R_B, connected between the base of Q1 and $+V_{CC}$, works with R1 to help stabilize the circuit against current variations due to temperature changes.

Current is supplied from the collector of Q1 to bias output transistors Q2 and Q3. Resistor R2 helps keep that current at proper levels by providing an alternate path through itself and through the loudspeaker. While there is some negative signal feedback through R1, the positive audio feedback through R2 is insignificant.

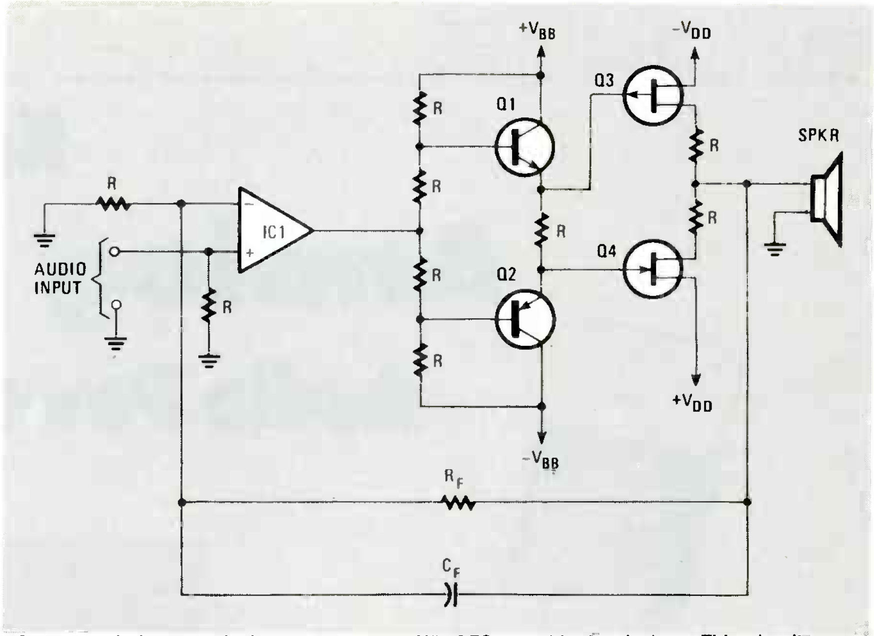


FIG. 9—FET'S OFFER CONSIDERABLE ADVANTAGES over bipolar devices. This circuit uses a complementary pair of VFET's.

VFET and MOSFET power amplifiers

VFET's and MOSFET's offer some major advantages over bipolar devices. Characteristics of both types of FET devices are linear, so circuits using them suffer from far less distortion than circuits using bipolar devices. As a result, even when feedback around the circuit is low, distortion can be kept to a minimum. Because of the minimal feedback required, stability problems arising from excessive feedback are insignificant.

But there is one factor that must be satisfied if depletion-type FET's are to perform without breakdown. Unless their gates are biased, they can conduct large amounts of current—enough to damage the device. As a result, bias must be applied to the gate before voltage is applied to the drain. One way to insure that this is done is to use a time-delay circuit. Another is to put a current-limiting device in series with the drain, along with a parallel circuit that will short that device a few seconds after voltage is applied to the gate.

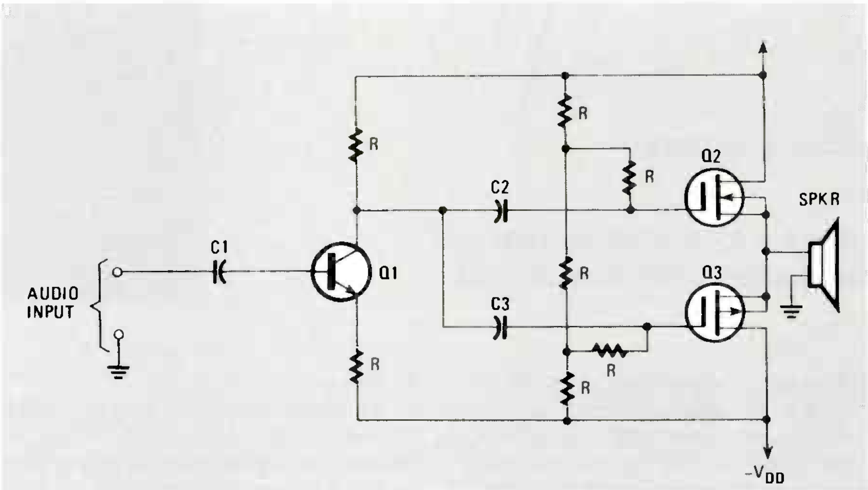


FIG. 10—A COMPLEMENTARY PAIR of MOSFET's is used in this power amplifier circuit.

Two basic circuits are shown in Figs. 9 and 10. Direct coupling is used in the circuit shown in Fig. 9. There, a complementary pair of VFET's is at the output. Signal is fed to the non-inverting input of the op-amp and the output from that device is applied to a pair of bipolar devices. Signal is fed from those to the output transistors.

Because junction FET's like VFET's must be biased so that the idling current is at a desirable level, the gate of the n-channel device is made negative with respect to its source while the gate of the p-channel device is biased more positive than its source. As noted earlier, bias voltage must be applied to the output devices before $+V_{DD}$ and $-V_{DD}$ so that the VFET will not be damaged. Note the polarity of the drain voltages in the circuit. Negative voltage with respect to ground is applied to the drain of the p-channel device while positive voltage with respect to ground is applied at the drain of the n-channel device. Also note the feedback circuit from the output to the inverting (−) input of the op-amp.

The circuit shown in Fig. 10 uses a complementary pair of MOSFET's. The input is amplified by Q1. The output from that transistor is then AC-coupled through C2 and C3 to the MOSFET's. The loudspeaker is direct-coupled to the power-output devices. Note that bias must be applied for those transistors to conduct because they are enhancement-type devices. That means that for the gate to conduct, it must be more positive than the source in a n-channel device, and more negative than the source in a p-channel transistor. The time-delay circuitry required in the previous example is not needed here—enhancement-type transistors will not conduct until the bias voltage is applied.

Quasi-complementary amplifiers

Up to now, in the complementary amplifiers we've described each half of the push-pull output stage used identical but complementary devices or amplifier circuits. Quasi-complementary amplifiers differ in that they use dissimilar arrangements in each leg of the push-pull power section.

Let's take another look at two true complementary amplifiers. Those were shown last month in Figs. 3 and 4; the one shown in Fig. 3 used a Darlington pair in both halves of the output circuit, and the amplifier in Fig. 4 used a complementary pair. The quasi-complementary arrangement, on the other hand, uses a pair of each type in each half of the push-pull output circuit. A typical amplifier of that type, is shown in Fig. 11. There, Q2 and

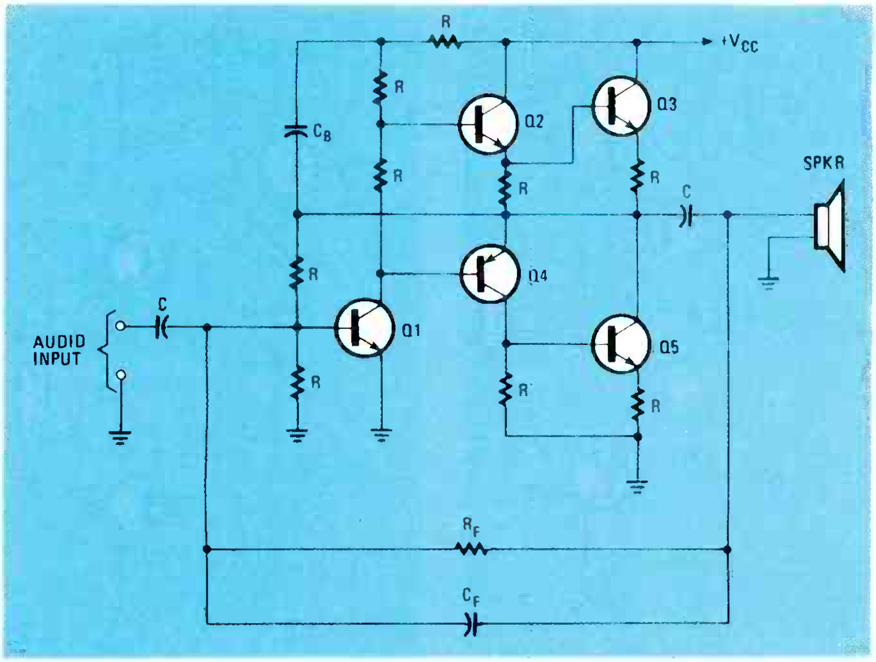


FIG. 11—THOUGH IT ACTS just like one, this circuit does not use a truly complementary arrangement. The chief advantages to this quasi-complementary amplifier are simplicity and cost.

Q3 form a Darlington pair while Q4 and Q5 form a complementary amplifier. Both circuits are driven by voltage amplifier Q1.

But why use such a circuit, especially considering that the true complementary circuit has inherently less distortion? The answer is economy and simplicity. The circuit in Fig. 11 will perform well using a minimum of critical components.

Modifications

A differential amplifier is used in the circuit shown last month in Fig. 5. The sum of the currents flowing through Q1 and Q2 must be constant. To do that, Q10 was used as a constant-current source. Current could also have been held relatively constant if Q10 were replaced with a large resistor and $-V_{CC}$ made very large. That arrangement will keep the current flowing through the transistors constant, provided that the voltage drop across the devices in series with it is much lower than the voltage drop across the resistor itself.

In Fig. 5, Q10, its emitter resistor, and the diodes from the base to $-V_{CC}$, determine how much current will flow through the circuit. Voltage is applied to both diodes through R. If they are silicon devices, a relatively fixed 0.7 volt is developed across each diode despite any minor variations in the amount of current flowing through each of those devices. Because the diodes are in parallel with the series circuit consisting of the base-emitter junction of Q10 and resistor R_E, there must be 1.4 volts across that series circuit. Of the 1.4 volts, 0.7 volt is across the base-emitter junction of Q10 (assuming, of course, that it too is a silicon device) so the remaining 0.7 volt must be across R_E. Thus, the current flowing through R_E is $0.7/R_E$. That same current also flows through the emitter and collector of Q10 and into Q1 and Q2. Thus, the sum of collector currents in Q1 and Q2 equals the the current from Q10 at all times.

Alternate constant-current sources using FET's, are shown in Fig. 12. In Fig. 12-a, the gate is connected to the source, making V_{GS} equal to 0. Now the current in the drain of the transistor is I_{DSS}. In Fig. 12-b, the fixed current can be adjusted by the potentiometer. It's setting determines the gate-source bias voltage, which, in turn, sets the drain current.

Another way to modify the various circuits we've described is to add some way to vary the bias; such a circuit would let you vary the idling current. A circuit of that type is included in the MOSFET amplifier shown in Fig. 13. Such an arrangement can also be used in circuits using bipolar devices. Because of the presence of Q1, the idling current is temperature-compensated, just as if diodes had been used instead.

Potentiometer R1 is used to adjust the amount of current flowing through Q1 and hence through R2, R3, and R4. The voltage across R1, and at the gates of Q2 and Q3, is equal to the sum of the voltages across Q1 and R2. Those voltages change with the setting of R1 and, in turn, change the bias voltage applied to the gates of the FET's.

Protecting output transistors

Output transistors are quite vulnerable when used in an amplifier. If a load or loudspeaker is shorted, the transistors may conduct excess current. If that current exceeds the rated maximum current permitted to flow in the device, the transistor may be forced to dissipate more power than it safely can and the device may suffer breakdown. Transistors may also break down if there is an instantaneous excess voltage applied across the device due to the presence of an inductive load. Another possible cause of breakdown is undesirable oscillation. That can be due to a capacitive load across the output, such as an electrostatic loudspeaker.

Several precautions can be taken to protect those devices. If a fuse is placed in series with the loudspeaker load, it should blow out before the output transistors are destroyed. (On the other hand, you may be unlucky enough that the transistors will be the first to go.) Another method is to keep the voltage applied to the driver transistor at the minimum level possible. In another arrangement, very poorly regulated voltage is applied to the output circuit, so that the voltage drops radically when there is a large demand for current from the power transistors. Fortunately, more effective protection circuits have been designed.

In the simplest arrangement, a resistor is placed between the loudspeaker and ground. Its resistance should be small—less than 20% of the resistance of the loudspeaker. Parallel-connected diodes,

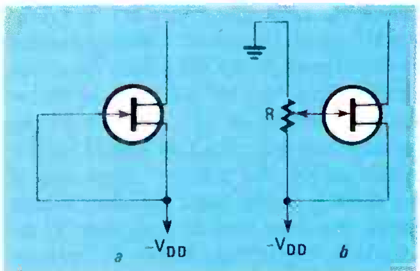


FIG. 12—CONSTANT-CURRENT SOURCES using FET's are shown here.

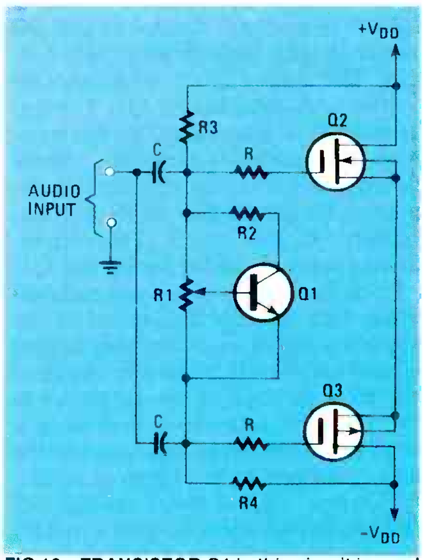


FIG 13—TRANSISTOR Q1 in this circuit is used to vary the bias voltage applied to the output transistors.

but with the cathode of one device connected to the anode of the second, are placed in a negative feedback loop from the junction of the resistor and loudspeaker to the driver transistor circuit. A voltage is developed across the resistor due to current flowing through it, through the loudspeaker, and through the output transistor. In direct-coupled circuits, that voltage may be due to an audio signal or DC, while in capacitor-coupled circuits, it is due solely to the audio. When that voltage exceeds the forward breakdown voltage of the diodes, they conduct and the resulting negative feedback reduces the circuit gain.

An alternate and more effective arrangement is shown in Fig. 14. Current from Q1 flows in R_{E1} and current from Q2 flows in R_{E2}. Those resistors are selected so that the voltage developed across them due to current from Q1 and Q2, turn on Q3 and Q4 when the output transistor current ratings are exceeded. After being turned on, transistors Q3 and Q4 divert current from the bases of the output devices. Limiting the base current reduces the collector currents of the output transistors to safe levels.

Yet another arrangement is shown in Fig. 15. Diodes D4 and D5 are normally turned off. Diodes D1, D2, and D3 conduct to bias Q2 and Q3 to the desirable collector-current levels. If the voltage across R3 becomes excessive due to the current through Q2, diodes D5, D3, D2, and D1 are all turned on, forming a series circuit. Those diodes are across the series circuit consisting of R4 and the base-emitter junction of Q3. Similar to the constant-current circuit described earlier in this article, the voltage across one of the diodes is the same as the voltage across the base-emitter junction. Consequently, the voltage across the resistor R4 must be equal to that across the remaining three diodes in the circuit. The voltage across the resistor is fixed at that value. Because the resistor's current is equal to this voltage divided by R4, the current flowing through R4 is also constant. That current also flows through the emitter and collector of Q3. Current through Q3 is thus limited to that maximum. Because D5 is turned on, it limits the base-emitter voltage of Q3 and thereby limits the current flowing through that transistor to safe levels. The current-limiting setup is similar for R3 and Q2.

Up to this point, we've concerned ourselves with limiting the current in the output transistors only when that current became excessively high. The circuit in Fig. 16, a variation of the one shown in Fig. 14, limits collector current when it either gets excessively high or when the output load gets to be extremely small.

If excess current flows through R5 from Q4, the voltage developed across R5 is applied to the base-emitter junction of Q2 through R3. Transistor Q2 is turned on to shunt current from the base of Q4. A similar situation exists if excess current from Q5 flows through R6.

Should R_L be greater than a predetermined value, the voltage developed across the load, added to that across R5, is applied to Q2. The voltage across R5 is 180° out-of-phase with the voltage across R_L. The polarity of the sum of the voltages across R_L and R5 is such as to turn off the shunting transistor, Q2. If the resistance of R_L is below the predetermined acceptable minimum value, the voltage developed across R_L is low. Now the voltage across R5 is considerably above that developed across R_L. When the two out-of-phase voltages are added, the polarity is such as to turn on Q2. It can now shunt the base circuit of Q4. The magnitude of the load resistance as well as the emitter (and collector) current through Q4, are the two factors that determine if signal is to be shunted from the base of Q4. When the voltage across R_L is considered in together with that developed across R6 due to current in Q5, the magnitude of R_L is now an important factor in determining when shunting transistor Q3 is to be turned on.

Throughout this article and the previous one, feedback arrangements were mentioned as integral parts of various circuits. Feedback circuits are important in many different applications. In the next article, we will discuss different feedback circuits, their characteristics, and their importance in different applications. **R-E**

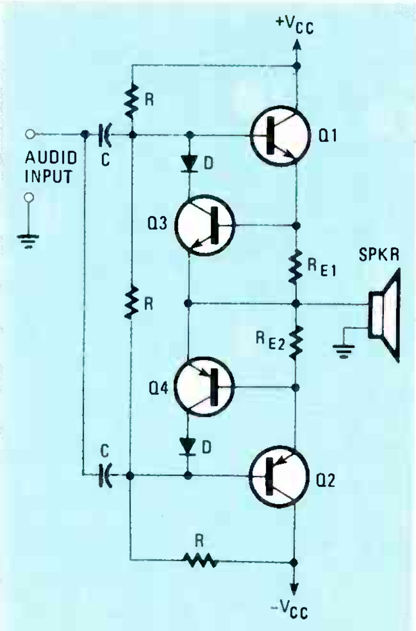


FIG. 14—WHEN THE CURRENT THROUGH Q1 and Q2 exceeds safe levels, Q3 and Q4 are turned on and current is diverted from the bases of the output devices.

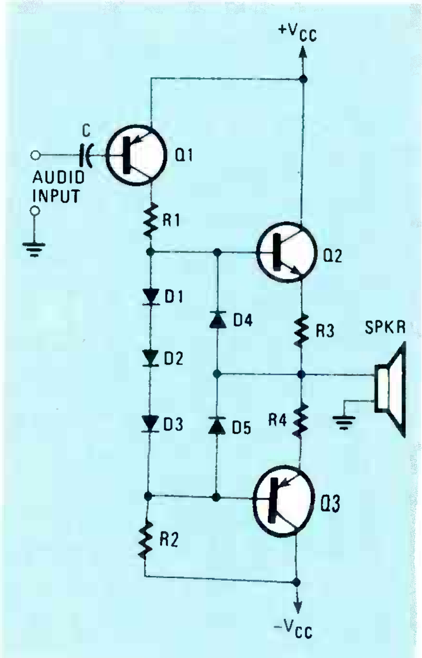


FIG. 15—THE DIODES in this circuit are included to protect the output transistors.

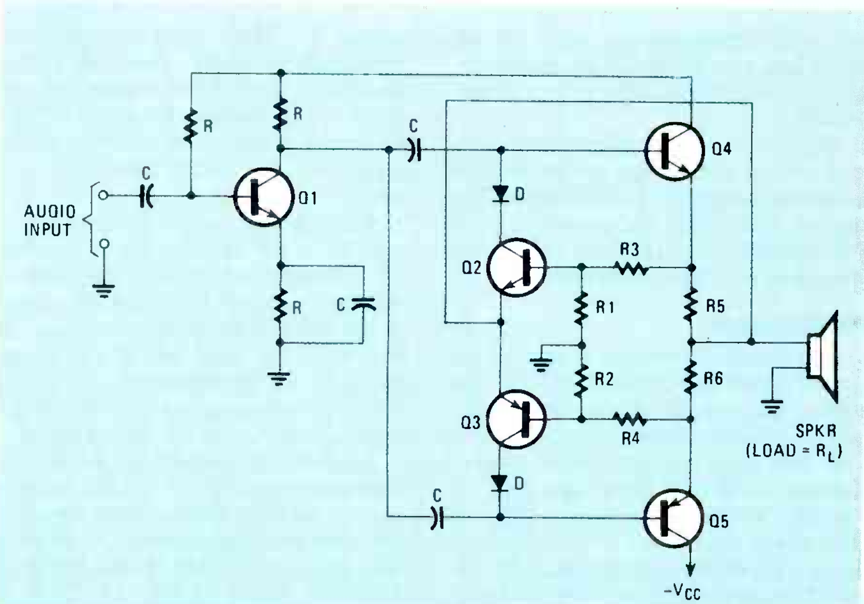


FIG. 16—RATHER THAN just protecting against excessive current, this circuit also protects the output devices against an insufficient load.

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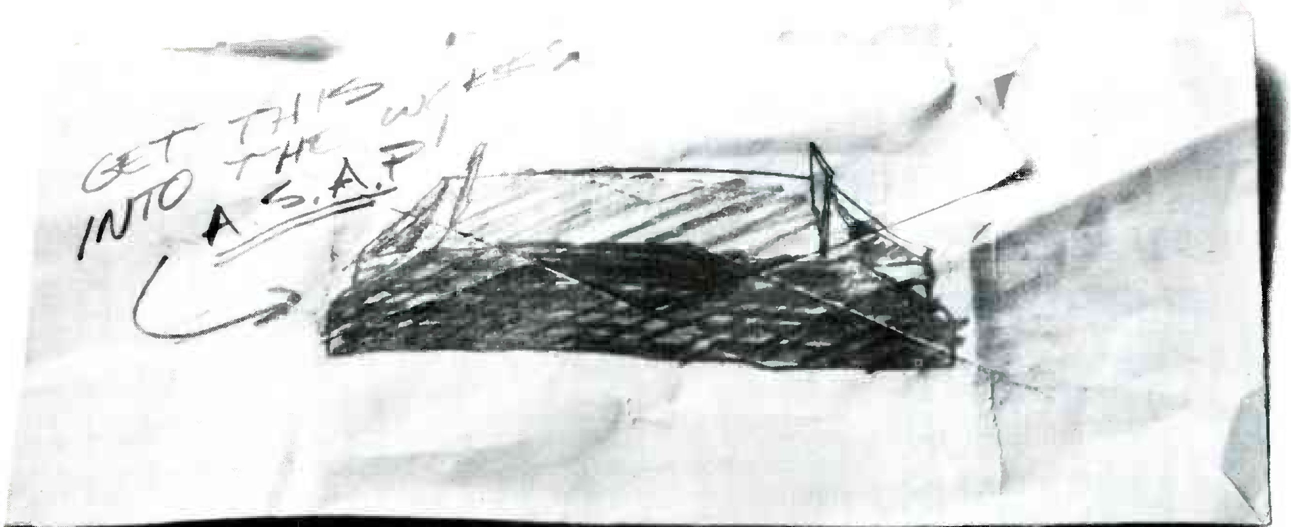

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on how far you go and the motor in your particular machine, you could reach the point that the motor would not be able to pull the tape at all!

It is very difficult, if not impossible, to back out after going too far. That is an additional reason for not attempting to modify an expensive machine—at least, not until you have some experience.

Pulley-driven machines

The mechanical method of modifying a pulley-driven-capstan machine is not fraught with quite as many pitfalls as is modifying direct-drive machines. Nevertheless, considerable care must be taken. In this case, your task is to change the size of one or more of the belt-driven pulleys. The general rules for this method are:

1—Tape speed changes directly with the size of the *driving* pulley. In other words, decrease the diameter of the pulley on the motor shaft and you decrease the speed of the tape, and vice versa.

2—Tape speed changes inversely with the size of the *driven* pulley. In other words, increase the diameter of the pulley on the capstan and you decrease the speed of the tape, and vice versa.

So, all you have to do is locate and fit a pulley of the correct size on the shaft and then install a belt of the right length. It isn't easy, but it can be done on some machines without tearing them up. (You can even change both pulleys.)

Of course, you may be lucky enough to find a motor that runs at an acceptable new speed and that can simply be installed where the old one was.

The second method—electronic

Do not overlook the possibility of decreasing the speed of the motor in the machine *without* making mechanical changes. If you can do that and still have enough power to pull the tape steadily, you have it made. Whether or not it can be done depends on the motor in your cassette player. The speed of some motors is determined by the precisely set voltage applied to them—change the voltage and you change the speed. If fidelity is important, that may require the installation of a voltage-regulator circuit. If all that's required is to be "in the ball park," a simple power resistor may do the trick. You might even get fancy and install a variable-speed control. Then, you could have available a range of speeds for various purposes.

There are, of course, other methods of controlling the speed of a motor. For example, you might run into a machine that uses the frequency of the supply voltage to determine the speed. In that case, you could modify the frequency-determining circuit. In general, to successfully change motor speed in a given machine, you will have to study the circuit used. Except for the method that requires filing the capstan, you can experiment with a method and, if you are unsuccessful, put everything back exactly as it was.

If you do attempt to change the speed of a cassette machine, choose an old/inexpensive one on which to experiment. Study your cassette recorder/player to see which methods are possible, and which of them is most practical. Don't overlook the possibility of using a combination of methods to cause a greater change than you could get with just one. Watch out for the power available versus the power required from the motor as the speed is changed. Also, when the speed is changed significantly, it may be desirable or necessary to change the frequency compensation in the record/playback circuit(s).

The success of your efforts to slow the tape speed will depend upon two factors. One, of course, is the care with which you work. The other is the minimum quality of sound reproduction acceptable in your particular application. The less stringent your requirements, the more likely you are to be satisfied with the results. Good luck!

Reminder

Your questions are welcomed, of course. We'll try to answer those of greatest general interest to all readers. Don't forget that we'll be glad, also, to get word of any unusual circuits and applications that you work out. **R-E**

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APPLE FORTRAN, by Brian D. Blackwood & George H. Blackwood; Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268; 236 pp. including index; 6 × 9 inches; softcover, spiral bound; $14.95.

This book is written for the beginning programmer using the FORTRAN language on the Apple computer. Specific details are given for use of each keyword, the column relationship of the FORTRAN language, program statements, edit descriptions, and block statements. The book gives a brief history of computers, the development of FORTRAN, and an introduction to the Pascal operating system.

Each new topic is presented in clear and concise detail. There are numerous programs that use those details, so all aspects of the language are presented. The details of the language are broken down to the simplest form, and from that form those details are incorporated into the programs. The programs range from the elementary level, to demonstrate how the specific details of the language are used, to an advanced level useful in the business and engineering world.

Numerous illustrations demonstrate specific parts of the language, and text and illustrations are coordinated to make the learning process as simple as possible.

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LEARNING TRS-80 BASIC FOR THE MODELS I, II, 16, AND III, by David A. Lien; CompuSoft Publishing, 1050 Pioneer Way, Ste E, El Cajon, CA 92020; 544 pp. including appendices, but no index; 7 × 9 inches; softcover; $19.95 + $2.00 shipping and handling—California add 6% sales tax.

This book is for anyone wishing to learn TRS-80 BASIC or to expand his or her programming knowledge. Written in a relaxed style, and amply illustrated, it leads the beginning user step-by-step through the many aspects of BASIC programming. There are many sample programs and ideas for writing custom software. Easy-to-understand directions guide the reader toward programming efficiency, and most of the chapters include question-and-answer sections that reinforce the material just presented.

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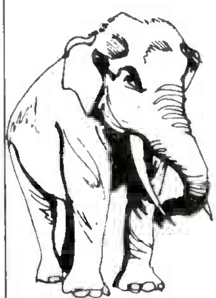

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Cassette-speed modifications

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

A SHORT WHILE BACK, A VERY THOUGHT-provoking letter came from Larry White of Texas. He has a certain brand and model of audio cassette player and would like advice on making a couple of modifications to it. Sorry, Larry, that I don't have that particular machine here for experimentation, but here are some ideas that you or any of our other readers can check out with any recorder/player.

Before discussing ways to vary tape speed, however, I feel it necessary to point out that we are very fortunate that tape-machine manufacturers have decided upon standard speeds for tape travel. The typical speeds for audio tapes for various applications are 15, 7.5 (15/2), 3.75 (15/4), 1.875 (15/8), and 0.9375 (15/16) inches-per-second (ips). All other things being equal, the faster the tape moves, the higher will be the fidelity of the recording. "Normal" audio cassettes run at 1.875 ips, more commonly referred to as 1⅞ ips.

Since all standard cassettes and machines operate at the same speed, it is evident that cassettes made on one machine will play properly on another machine (at least as far as speed is concerned). Without such standardization, you would not want to buy a pre-recorded tape; you could not send a tape to your buddy; and if you had to replace an old machine, your old tapes could not be played on the new one. The cassette world would be in chaos. And now, that obvious caveat: if you change the speed of a recorder/player, the only cassettes you will be able to play on it will be those recorded on it. Those tapes will not play on another machine. (Of course, that is not true if the accuracy of sound reproduction is unimportant!)

With that said, let's see how to do some speed changing. Some of the methods give better results than others on a given machine. No one way is better or easier on every make or model. Proceed with caution. Some of the changes are irreversible—if they don't work properly, your recorder/player can be ruined for normal use. I would not recommend your applying these procedures to a good (expensive) machine.

The first method—mechanical

The most obvious way to change tape speed is to change the size of the capstan. That's the little spinning shaft that sticks up and squeezes the tape against a rubber roller, called the pinch roller or capstan roller (see Fig. 1). In most machines, you can see those parts easily by pushing the PLAY button with no cassette in place. If you aren't familiar with the capstan and pinch roller, stop now and check them out—we'll be discussing them at some length.

Mechanically, there are two basic types of cassette players. The first type may be called direct-drive machines, and includes those in which the capstan is actually the shaft of the drive motor. The second type includes machines in which the capstan is driven by a belt-and-pulley arrangement—usually, the capstan is the shaft of a large and relatively heavy flywheel. You can determine which type your machine is by going into the case and taking a look.

With both types, one of the factors determining the tape speed is the diameter or circumference of the capstan. At any given capstan rotational speed, the tape speed varies proportionally with the size of the shaft. The smaller the diameter, the slower the tape. The larger the diameter, the faster the tape.

Direct-drive machines

The mechanical method of modifying the first type (direct drive) machine involves actually changing the size of the capstan. If you fit a "cap" of some kind on the shaft to increase its diameter, it will pull the tape faster. Great care must be taken to make the cap of a material that will not have a tendency to cause the tape to adhere to it—you can imagine, and may have experienced, the problems resulting from tape wrapping itself around the capstan! Further, the cap must be perfectly round. Metal and very hard plastic have been used with success.

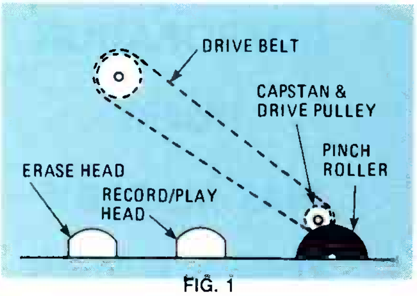

FIG. 1

Larry's need, however, is to *slow* the tape speed. That is what most folks want to do, and it involves decreasing the capstan diameter—a task which is easier said than done. If you really want to try that, remove the motor (and thus the capstan) from the machine and *gently* hold a file against the capstan while the motor runs. (If you don't remove the motor, everything may be ruined by falling filings.) Work very carefully so the capstan remains of equal diameter throughout the length that presses against the roller. The sides must be exactly straight—neither bowed in nor out, and not slanting up or down in a cone shape. If the shape isn't right, the tape will be pulled sideways as well as forward and that will cause obvious problems.

Do not change the size of the capstan much without stopping to test the results of your labors. The best way to do that is to reassemble the machine and play a previously recorded tape, listening for a change in tones of speech or musical pitch. In addition, record and play a tape at the new speed to see how things are working. If you are satisfied with the results but want greater change, continue with the operation.

I do not advise attempting to make large speed-changes in that manner. The main reason is that there is a definite relationship between speed and the power required from the motor. Depending up-

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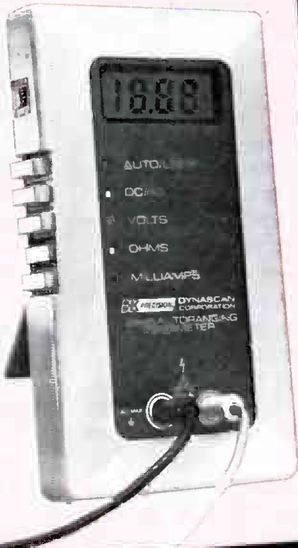

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Voltage regulators and power supplies

ROBERT GROSSBLATT

ONE THING THAT EVERY ELECTRONICS hobbyist who builds or designs his own equipment will eventually have to contend with is a power supply—it doesn't matter whether you're working on a space shuttle or on an electric toothbrush. It's obvious that there are tremendous differences between the power requirements of a rocket ship and those of a toothbrush, but the point is that if you're designing your own equipment, you're going to have to spend some time thinking about what you want your power supply to do.

It's true that most of the things we'll be discussing in this column can be powered by nothing more complicated than a fresh battery and a pair of alligator clips. From the point of view of elegance however, that approach leaves something to be desired. The power supply you use in your designs can do a lot more for you than just supply power. Most notably, the power supply can provide *protection*.

Even the most carefully designed project in the world can blow up the first time power is applied. But a well-designed power supply can go a long way toward saving you from having to repeat the work you've done in the event of a mishap. It can guard against short circuits; it can limit the current and/or voltage; it can offer protection from transient spikes, and so on. In short, it can be an extremely valuable friend when your project is still in the development stage. Let's look at some of the many possibilities.

Series regulators

There are many different approaches to power-supply design, but this time we're going to see what we can do with the simple series regulators that we're all familiar with. Those are three-terminal devices that are set up internally to provide a fixed output-voltage of a particular polarity.

The 78xx series of positive regulators (and the 79xx series of negative regulators) are usually used by themselves to provide basic voltage regulation in small electronic systems. Like most things though, those IC's can be made to provide as many exotic features as we want, including the ability to handle much more current than their basic rated capacities would seem to indicate.

Just about everyone is familiar with the circuit shown in Fig. 1, a basic five-volt regulator. Capacitor C1 is the huge filter

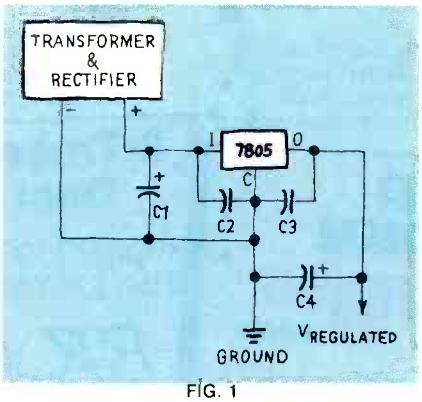

FIG. 1

capacitor that sits across the output of the rectifier. It's used to smooth out the spikes (ripple) on the line and to "brute-force" regulate the voltage going into the 7805. Even though the regulator was designed to reject noise, (referred to in the specs as "ripple rejection"), it can only cope with noise that is a certain proportion of the input voltage. Put simply, the bigger the input-voltage fluctuations, the more noise at the output.

Capacitors C2 and C3 are also filter capacitors. They are generally less than one μF and provide the regulator with local help in dealing with transients. If the regulator is physically far away from the large filter capacitor (C1), a voltage, however small, can develop on the line connecting the rectifier and the IC. The job of C2, therefore, is to make sure that those small voltage transients are eliminated before they reach the regulator. That's why C2 is always located as close to the regulator as possible—in some systems it will be soldered right to the regulator pins. Capacitor C3 does the same job at the output of the device.

Capacitor C4 can be called the "surge capacitor" because its job is to take care of the sudden surges that show up on the system +V line during power-up or power-down. The size of those surges, and consequently the size of C4, depends on the current drawn by the system. Typically though, the value of C4 is somewhere between 10 and 100 μF.

The 78xx family of regulators (and most other series regulators) is designed to be as foolproof as possible. The regulators monitor their internal temperature; and if they get too hot, they turn off. Short circuits will also cause the IC's to shut down. The trip point isn't a definite figure because it depends on the input/output voltage difference and the temperature. In general, a 78xx-series regulator that is well heat-sinked will be able to handle about an amp—but that's really the upper limit.

Now that we understand the circuit in Fig. 1, let's see what's wrong with it. As a side note here, one rule of design is *always* to design with worst-case operation in mind. Remember Murphy's Law and don't forget that one of the drawbacks to original design-work is that the responsibility for backing the warranty is yours.

Problems

Someone once said that there's no such thing as a free lunch, and that applies here. We're using capacitors to help the regulator minimize noise and transients, but capacitors cause another problem. A rapid reduction in either the input or output voltage will cause the capacitors to discharge. How much discharge current is generated depends on a lot of variables—the values of the capacitors, the rate of voltage reduction, and so on. Most regulators are built to withstand a certain amount of discharge current, but the unpredictability of the amount of that current makes for a real problem. In order to put things in perspective, consider that a 10 μF capacitor can develop 20-amp spikes when it's shorted.

If you're designing a power supply only for low-current systems, that doesn't present much of a problem. But if you're going to need a healthy amount of current, something has to be done to protect the regulator against accidental capacitor-discharge.

It will help to think of the regulator as a bunch of control circuits with a beefy pass-transistor at the output. In Fig. 2 we show only C1 and C4; since C2 and C3 are relatively small, we don't have to pay as much attention to them.

In the case of an input short, we have a big problem with C4. When the input short occurs, C1 will discharge through it and the input voltage to the collector of internal pass-transistor Q1 will rapidly fall to zero. That means the output voltage will be greater than the input voltage. Since C4 will have stored a nice, healthy charge, it will start to discharge. Some of the discharge current will go through R_{sc}—the equivalent resistance of the regulator's protection circuitry. If the current

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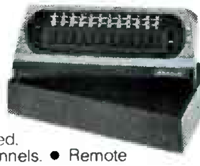

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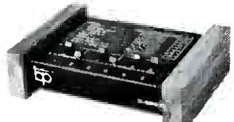

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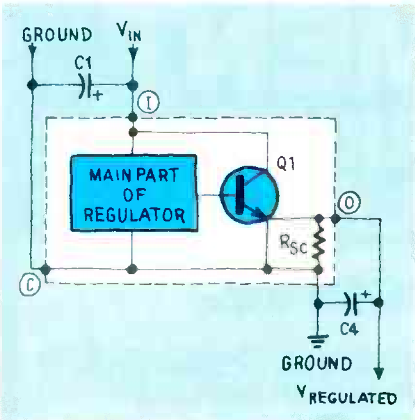

FIG. 2

is substantial enough. R_{sc} isn't going to pass it fast enough and the emitter-base junction of Q1 is going to be reverse biased. If the current is great enough, Q1 is going to break down and the regulator will be—to use a technical term—zapped.

Fortunately, an output short isn't anywhere near as serious. In that case, C4 will discharge across the output short and the input voltage will be greater than the output voltage. Luckily, the regulator was designed to deal with that. It will start to pass more and more current until its thermal-overload point is reached and it shuts down. Remember, the regulator was designed to source current, not sink it. That's why an input short is so much more potentially dangerous than an output short.

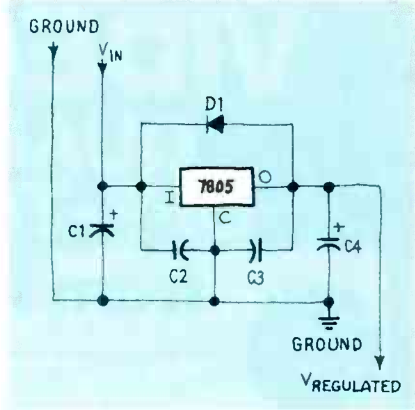

FIG. 3

In order to protect against input shorts, we have to find a way to provide an escape path for the discharge current of C4. We'll add a diode as shown in Fig. 3.

Adding protective diode D1 gives us a really slick solution to the problem. If the input shorts out now, the discharge current from C4 will forward bias the diode and all the "bad" current will be shunted to ground through the input short. You may wonder why the diode doesn't bleed off some of the "good" current when the regulator is operating normally. But we're out of space, so you'll have to wait until next month for the answer. **R-E**

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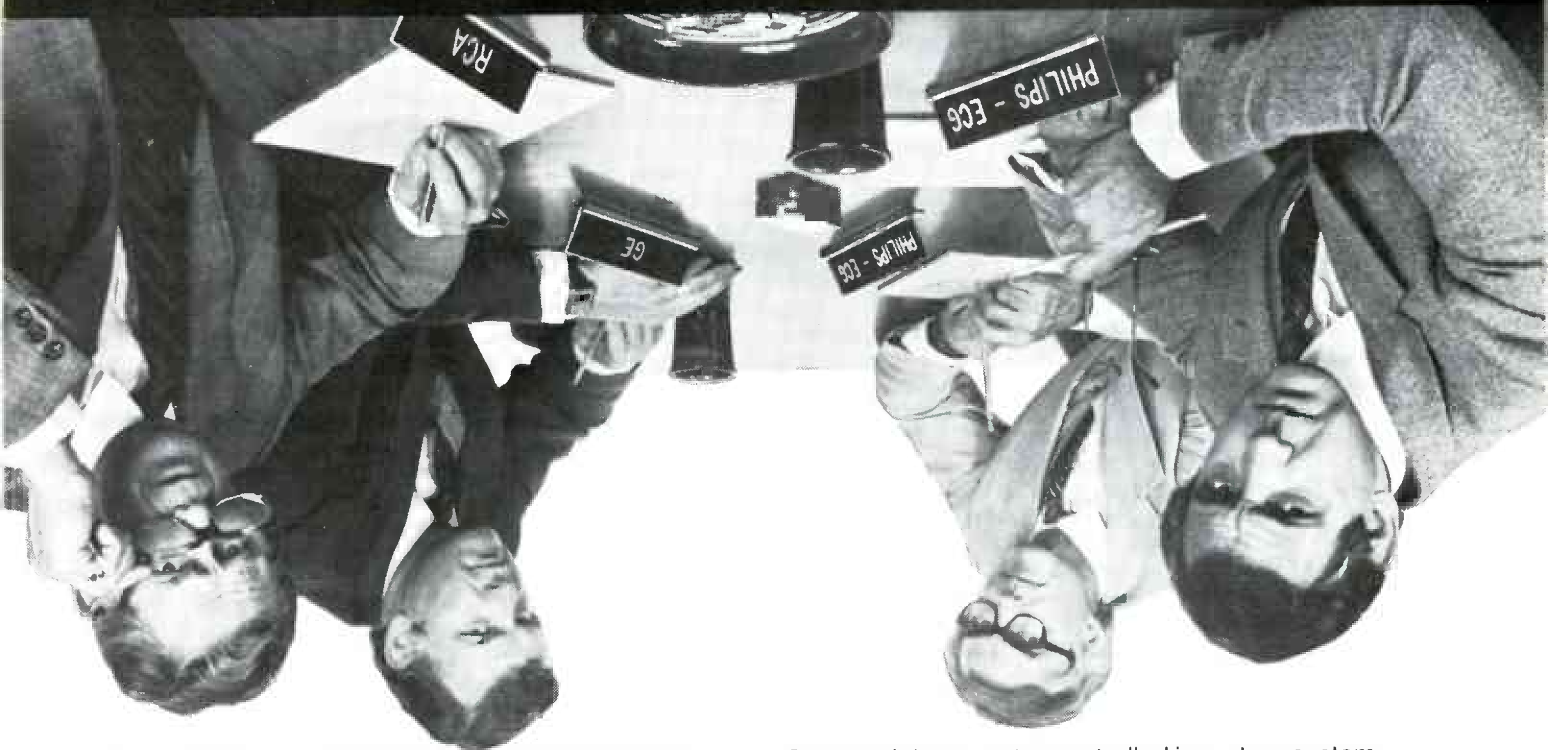

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SERVICE CLINIC

An oddball output-stage problem

JACK DARR, SERVICE EDITOR

WHAT WOULD YOU DO IN THE FOLLOWING situation? Assume that a set comes to you for repair with a blown fuse and a shorted horizontal-output transistor. That's nothing unusual so far, so you would probably replace the fuse and transistor. Now, would you plug the set in and turn it on to see the results? *No!* If you did, you might find that you then had *two* dead output transistors—one of which belonged to you! For safety, plug the set into a *Variac* (a variable-output transformer), run the line voltage well down, and measure the current through the fuse. *Then*, slowly increase the output voltage of the transformer, watching the ammeter carefully to see that it doesn't go out of bounds. Keep an eye on the DC voltages, too.

There is a new variation of this too-common symptom that's been popping up in my mail quite often lately. In fact, it appeared twice in one batch last week. That variation has the same symptoms to start with, and when you replace the transistor and fuse, you find that there's still too much current being drawn by the new output transistor. Here's the oddball thing: Grounding the base of the output transistor brings the current back down to normal! I'll count to ten while you're thinking of what could be responsible for that. It's a good symptom because it's one that tells us something—it clears the previous stages. It tells us that the output stage is working (because the drive is there), and that it's trying to drive the flyback and all of its loads (the low-voltage DC supplies from the flyback, the yoke, and the tripler—see Fig. 1). Before we go any farther, you *did* check the regulated DC voltage, didn't you? If not, do so.

What's causing the problem?

Now that the previous stages are clear, we know that we've got an overload problem somewhere in the flyback or its load. If the flyback uses a yoke-return capacitor, that could be shorted. To find the exact cause of the problem, the old process of elimination is best. Check all of the low-voltage diodes, their filter capacitors, etc. for shorts. The best way to check the rest of the loads is by load-shedding—unhook suspected things (the tripler, the yoke, etc.) one at a time and then recheck for excess current.

The yoke can be checked by unhooking it. Many sets have a B+ jumper on the yoke plug and you'll have to jumper that with a clip lead. If your test indicates a short, check the yoke-return capacitor before condemning the yoke. The "4-legged capacitor" (which is used as a collector-shunt capacitor on horizontal-output transistors) can be checked with the ohmmeter or by unhooking it and jumping it to get collector voltage to the output. Those capacitors don't seem to short too often, but sometimes, nevertheless, they do.

Check the flyback circuit. Some of them have a tuning coil in the output. Check that for shorted turns, and check the capacitor across it. One more thing: In most sets, the pincushion-correction circuits are hooked to the flyback/yoke. Those, too, can develop shorts in the transformer or capacitors. You might also have a wiring short or arc-over.

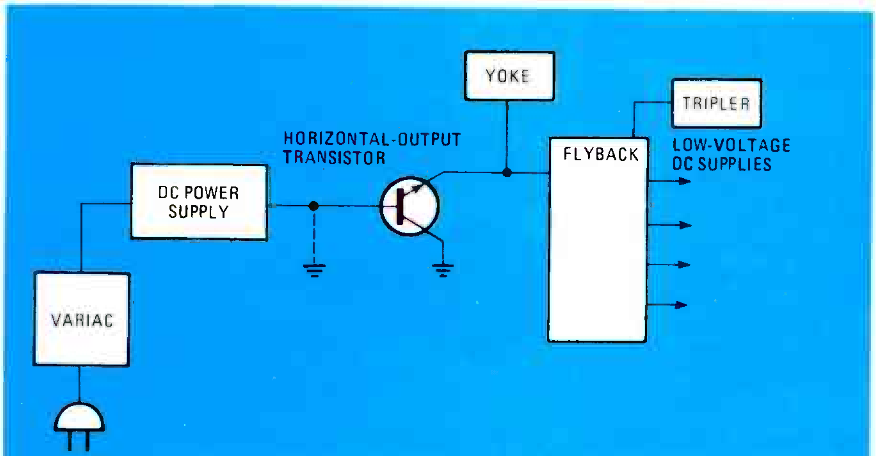

FIG. 1

Once again

To sum things up, what you have to do is check everything that could cause the flyback to be overloaded, and thus cause the symptoms you're seeing. It doesn't take as long as you'd think. What you have to do is eliminate everything that could overload a good flyback, and if it all checks out, then you're left with one thing that could be causing the problem—the flyback itself. Because of the high cost and difficulty of replacing flybacks, we'd recommend that all the other tests be made first. Replacing a flyback and finding that you still have the same old symptoms can be a real bummer. Something like that can ruin a technician's day (and a couple of days' profits!). So, make sure that you have eliminated everything that *could* cause an overload on a good flyback before you suspect the flyback itself.

We check things like that because what we're dealing with is an "AC short." Note that there is no short when there's nothing but DC on the flyback (when the base is grounded the DC's still there). But when we start feeding drive pulses into the flyback, we see the short. So, something like a shorted winding in the flyback, or an overload on one of its outputs, is responsible for the short symptoms. We're "pumping into a short" when the flyback is getting normal drive.

The scope can be a lot of help in checking things. You can (should!) check the base drive for correct frequency, peak-to-peak voltage, etc. Judging from the symptoms, something will be there. With the voltage reduced, check each output for pulses. On a working output, you should see the normal pulse as shown on the schematic, but at a reduced level—the pulse level will be in proportion to the line input. If you've reduced the line voltage to one half of normal, the pulse should be only one half of the normal amplitude. Quick checks of the low-voltage supplies can use the same test and ratios. You can even check for pulse input to the tripler; hold the probe near, but *not* touching it, and check for a good high pulse. If you find an output that should have a pulse but has nothing, that could be the shorted winding. Disconnect everything from that terminal and check the resistance at that point. It will be very low, and you may not get a usable reading. Turn the set on with the winding open and check for a

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Someone did say that. This is it.

We call it THE EVERYTHING PHONE because it does everything. It advances the science of phone communications by ten years, even in this age of wild changes and improvements.

For example—

This Phone Actually TALKS To You

The Everything Phone speaks to you in a warm, gentle voice. It never tells you wrong.

Touch the "Voice" switch and when you push a button, the phone tells you the number you've pushed. If you're working in dim light, you won't dial a wrong number, because your friendly phone voice repeats each digit immediately, as you dial it.

A Complete Phone Answering System

If you press the "Prefix" key, the "Clear" key, the Direct Memory Keys, or any of the other special function keys (more about these later), your Phone Voice tells you what you've pushed. If you get tired of company, you can shut off the voice; but it's like having a friend right inside your phone.

This feature takes some explaining.

In the bank of keys to the right of the dial pad are three marked M1, M2, and M3. M1 and M2 will tell a caller, when you're out, either when to call back or another number where you can be reached

What about M3?

M3 makes *any* cassette recorder an answering device. Using the connector (supplied), your recorder can take messages up to the total length of any tape cassette. The Everything Phone turns the recorder on and off automatically when a call comes in.

So—you have your voice of 1) a message, in the phone's own voice, to call back at whatever hour you designate; 2) a message that you're out and can be reached at whatever number you designate; 3) an invitation to leave a message after the tone, with a capacity as long as the cassette—an hour or more.

Memory Keys Galore for Automatic Dialing

At the left of the numeric keypad are ten Direct Memory Keys. The key at the upper left is for MCI, Sprint, or other computer-code dialings. It holds the access number *and* your personal code number.

The other nine let you dial stored numbers, including long distance numbers, by pressing one key. You can inset a tab showing whose number is stored.

But you ain't see nothin' yet!

You actually can store up to *50* numbers of 20 digits each, using a two-number code. Example: if you already have 30 numbers in memory and you want to store 1-305-473-2044, punch in that number, use the "Store" key and "31", and you'll be able to dial that number in the future just by pressing "31".

Quality Speaker-Phone

Of Course The Everything Phone has one-way speaker-phone capability. Of course it's high quality sound.

Just press the "Speaker" button and you have a hands-free phone. A volume control gives you just the right amount of amplification.

Music on Hold; "Mute" Switch

You can put a caller on hold just by pressing the "Hold" key. What a pleasant surprise! Instead of dead sound, the person on hold hears a pleasant melody. (You'll hear it too, so you won't forget he's on hold.)

You have a "Mute" privacy button, and it couldn't be more convenient—it's right in the center of the modern hand-phone. Press that button, and although the other party won't be able to hear you, you'll still be able to hear him or her. Release the button and communications are normal again. (No telltale "click" when you press the Mute button.)

Here's a List of Other Built-in Benefits

Your Everything Phone is an electronic butler. It has—

—Automatic redial. Press this key and your phone will redial the last number you called either once (if the phone is off the cradle) or four times (if the phone is in the cradle).

Each key has a separate function. Each one talks to you, if you want it to. What a conversation piece The Everything Phone is!

— Pulse/Tone selector switch. In areas with rotary dialing only, slide the switch to "P". In areas with touch-tone, slide it to "T".

— Ringer off switch. You can turn off the pleasant "chirper" (it isn't a bell) when you don't want to be disturbed. A separate ringer l.e.d. light will alert you, if you're interested.

— Access pause key. For Sprint, MCI, and other code numbers, the Pause button gives you the proper gap between the original dialing and the time the system takes to answer with a tone. The Pause has other uses, too, but we just can't list all of them here.

— Secretarial aids. Open a little door and you have a memo pad to jot notes. For the numbers stored in automatic dialing memory, slide out the Directory Card, concealed under the phone unit.

— Battery backup. Two tiny, easily replaceable batteries keep your memory intact. A power failure, even one that lasts for months, won't wipe out what's stored in the memory.

Anything Else?

Probably. We ourselves haven't figured out all the phone assistance The Everything Phone can give you. But we do know this: *No other phone ever made has all the benefits and comforts this one has for you.*

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THE EVERYTHING PHONE
IS YOURS FOR JUST
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Have your VISA or MasterCard handy. Phones are manned seven days a week, 24 hours a day.

We Absolutely Guarantee!

The Everything Phone is a lot of fun, and it's the darnedest electronic instrument you ever owned. But if at any time during the first full month you own it you decide not to keep it, send it back and we'll refund every cent you paid.

Send check or money order, or charge card information (**$199.95** + $4.50 shipping—Total, **$204.45**) to New Horizons, or call the toll-free number above.

The Everything Phone is another electronic marvel from

NEW HORIZONS
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New York, N.Y. 10016

pulse. If it is there, check external components for breakdown under load. The best way to do that is by replacing them.

As I said, we've been getting too many letters about this oddball problem to ignore it; I thought this little run-through might be of some help. I certainly hope it will, and wish you good luck. **R-E**

SERVICE QUESTIONS

HORIZONTAL OSCILLATOR PROBLEM

I wrote you about a problem in a Sylvania A-12—the horizontal oscillator wouldn't start. Well, after quite a bit of trouble I finally found the solution. I replaced the FET (part No. 13-28654-5, new part No. 13-43112-1). What they don't tell you is that the pinout of the new part is different from that of the old one, so watch out! I would also suggest that capacitors C410, C414, and C416 be changed.

Thanks to Ray Green of Camden, AR. That's the kind of feedback that can be a lot of help to the rest of us.

HEAT-SHRINK HINT

I have a hint for shrinking heat-sensitive tubing in tight or enclosed places. I wrap a few turns of ⅛-inch copper tubing around the barrel of a pencil-type soldering iron, slip about an inch of Teflon tubing over the top of the copper, and then slip rubber tubing over the Teflon. When you blow into the rubber tubing, your breath is heated as it passes through the hot copper. You can easily direct a stream of hot air into tight places using this method. I used an old iron with a broken tip that was no longer any good for soldering.

That sounds like a very good trick. Thanks to James Bohn of Florissant, MO for that hint.

RETRACE PROBLEM

I've got a terrible retrace problem in a Zenith 14A9C50. Nothing I can find seems to be bad, but the retrace lines are there, and they are bright enough to upset the customer. Help!—S.H., Irmo, SC.

I told him to check this and that, and as a last resort, to check the setting of the CRT screen controls. If they are too high, you'll get retrace lines. That turned out to be his problem. In older sets, those controls should be checked as a matter of course—they are too easy to get at and "twiddle."

INTERMITTENT PICTURE

The picture on this Zenith *System 3* went blank intermittently, but the sound was OK, although a bit hashy. Changing channels or turning the set off and on would somtimes bring the picture back.

No wonder they call it the SUPERFONE!

At Last—a Cordless Phone with TWICE the Range, Sound Fidelity to Rival Phones with Cords, and a Privacy Code System—All This in a Phone Less Than an Inch Thick!

The Super Fone is less than 1" thick. The base unit has a built-in speaker phone, a fully independent intercom and is 110 volt-220 volt switchable.

Until now, cordless phones have given you wonderful convenience. But they've had two problems:

1. The range is limited to 600 to 700 feet.
2. Some of them sound as though you're talking inside a barrel.

As cordless phones have become enormously popular, another problem has arisen: two people, living near each other, can have the same channel. Not only is there line confusion, but someone else can literally make a long distance call on your phone.

No more. Never again.

Range: 1500 Feet OR MORE!

The SuperFone 650 uses state-of-the-art electronics to bring you **the ultimate cordless phone.** Sound quality is superb — and it stays superb, 1500 feet or more from the base station. That's **more than twice the distance** of standard cordless phones.

Only SuperFone 650 has a secret code system to prevent interference and false operation of the phone. You choose from 512 possible "code" combinations. Both the base unit and the phone are **locked** onto that code, which you can change when you want to.

No other phone can interfere. No other unit can share the signal. No one else can hear or speak on your carrier-wave.

Enormous Range

We say the SuperFone 650 has a range of 1500 feet.

Notice we didn't say "up to" or "as far as" 1500 feet. There's no hedging, because this seems to be the **minimum,** not the maximum range.

Users report 1800 and 2000 feet. That's nearly half a mile. SuperFone 650 is a radiophone, not a toy, and that's why its signal doesn't break up or start hissing or crackling when you get half a block away.

You can tell when you heft it. It's a Little Giant. You can feel the power inside. What a marvel of electronic engineering it is! And it's tough, too. It fits into your shirt pocket, and you can bounce it around all day without damaging it.

Speakerphone, Intercom — Everything!

SuperFone 650 is The Everything Phone. Anything any phone can do, it can do.

First, the base station is a speaker phone. Touch a button and you can have a hands-free conference conversation in the room in which the base station sits.

Next, it's an intercom. You can page the handset from the base unit and have a private conversation. You have a **true wireless intercom,** not just a signal.

Third, you have a privacy button. Push that button and you'll still be able to hear anything the other party says, but he or she won't be able to hear you until you take the button off "hold."

Fourth, you have an automatic redial. Touch the key and the SuperFone will redial the last complete number.

What else? A **security switch** which makes it impossible for anyone to call out on the remote phone, without changing the ability to receive calls. A **volume control** for the speaker on the base unit. A **call button** to page the base from the cordless phone. THIS PHONE HAS EVERYTHING!

30-Second Installation

Plug your SuperFone 650 into any wall AC outlet. Push its standard modular terminal into the telephone plug. You're in business.

Every component is heavy-duty, from the built-in condenser microphone (with automatic gain control) to the LED indicator lights. This phone is designed for hard use.

The SuperFone 650 is yours for $249.95. If you want the SuperAntenna with it, giving you a range of a mile — or even more — you can have **both** for $319.95. (Or you can get the Super-Antenna alone for $79.95.)

We Absolutely Guarantee!

Use the SuperFone 650 (or any electronic instrument you acquire from us) for up to 30 days. If for any reason you decide not to keep it, return it for a 100% refund.

The SuperFone 650 — **$249.95**
The SuperAntenna — **$79.95**
BOTH Phone and Antenna — **$319.95**
SupeRange 3½ mile phone or SupeRange with 8-mile Super-Extender unit - write for information. (This phone for export only).
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The **SupeRange** phone is so powerful we're authorized to sell it for export only.

This phone operates clearly, up to 3½ miles from the base station. Add the **SuperExtender** unit and the range goes up to an incredible 8 miles.

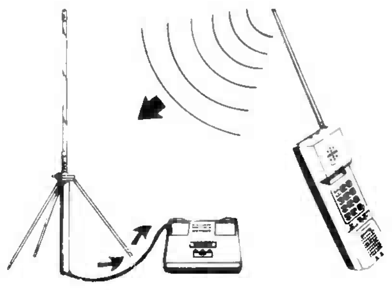
Write for information about this remarkable instrument.

TRIPLE THE RANGE OF ANY CORDLESS PHONE!

The **SuperAntenna** will give your cordless phone, **regardless of make or model,** three times the range it has now.

If the range is 700 feet, it'll leap to over 2,000. If it's 1500 feet, it could be as far as one mile!

Easy to install. Only $79.95 complete. Add $4.50 for shipping.



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Also, sometimes it would come back by itself. I suspected the Chroma-Luminance module, but the problem really could be anywhere. You suggested some things to try, including lightly tapping stages.

I found that the picture could always be restored by a tap on the shield over video amplifiers Q1226 and Q1227. Our Zenith distributer supplied a new circuit board without charge (after a letter from Zenith Customer Service, Chicago). The new board is 9-151-03C—the same number as the original, but with a "C" suffix instead of the original "A." The difference is that the shield on this one is soldered instead of pressed on. Also, there's no zero-carrier adjust as there was on the old one. That control might have been the faulty part. I hope this will help others who run into this problem.

It certainly will. Thanks to J.H. Sutton of Conway, AR for the feedback.

COMPUTERS NOW!

I've got a TRS-80 microcomputer with an intermittent video output. The screen goes dark, but the computer still works and the printer output is normal. The computer technician hasn't found the problem yet.—E.L.G., Merritt Island, FL

Whee! Now I'm a computer technician—and I know nothing about them. However, I do know how to find out why a picture tube goes dark.

Check all of the things around the CRT such as high voltage, all the DC voltages on the base, and the socket contacts. Loss of high voltage will cause your problem, as will incorrect bias and intermittant socket contacts. You may have to monitor some of those voltages to find out which one changes when cutoff occurs—but one of them does! Check and log all DC voltages while the monitor is working, and then recheck them when the fault shows up.

MUSIC-AMP DISTORTION

I asked you about distortion in a Polytone musical amplifier. Your suggestion for checking pin 9 (the feedback pin for distortion correction) of the LM-391 IC was the clue. An open resistor, R20, between pin 9 and the emitter of the 92PU07 transistor was the cause of the distortion. By the way, there's a mistake in the diagram—pin 16 is B+ and pin 11 goes to the junction of R10 and R9. *G.F.*

TUNER PROBLEM

This GE 25YME had no sound and no video, and the tuning voltage on the control assembly was a constant 30 volts on all channels, instead of the normal 1–25 volts. I replaced the PLL IC as the service manual said, but with no success. I replaced both the tuning-control assembly, EP93X168, and the wideband amp with an EP93X289 tuning assembly. That fixed it.

Thanks to David E. Law of Astoria, IL for that hint. One of these days we'll get into the problem of those tuners and their repair. More and more of them are showing up.

MORE ODD TUBES

I need a 6DL4 tube, but can't find one anywhere. Do you have ideas?—T.M., Spring, TX

Try Transeleteronic, 1365 39th Street, Brooklyn, NY 11218.

(Feedback: Thanks! They said they had 30 of them in stock, and they shipped four of them to me quickly.)

SYNC PROBLEM

I've got a dandy in a Magnavox T8-9 chassis. There are four or five vertical lines in the picture with ringing at the top—they look like upside-down Christmas tress! I'm lost.—D.A., Babbit, MN

The ringing at the top of the picture is due to horizontal instability. I'd say that that could be due to "something" getting into the horizontal sync. That can come from an open filter or bypass capacitor that is letting pulses get into the sync. Use a scope to check the DC supplies to the sync separator and horizontal oscillator. Check the composite sync to see if the

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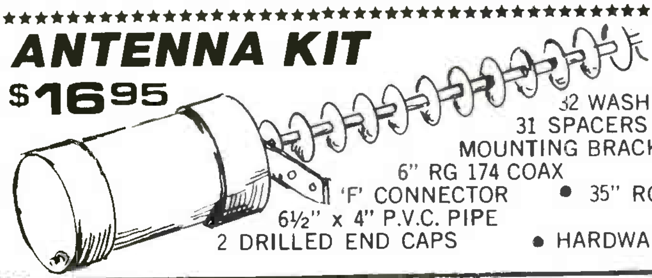

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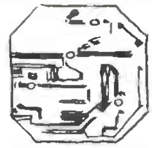

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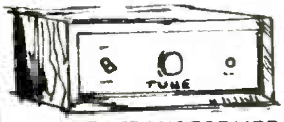

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COURSE TUNE POT.	RF CHOKE
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3 'F' CONNECTORS	WIRE
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Rainbow Kits are supplied with simple step by step instructions. All the circuits that you need expensive test equipment to do are pre wired and tested. All printed circuit boards have the outline of each part printed on them.

RECEIVER FEATURES
Built in RF modulator • Detent Tuning-3.7 to 4.2 GHz • Variable Audio-5.5 to 7.5 MHz • Invert Video • Channel Scan • Voltage monitoring • Meter output • Remote Tuning
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problem shows up there.

Check the horizontal oscillator/driver module and especially the sync input to that module. Also, it's possible that some kind of poor contact on the module itself could be causing your problem—a bad ground contact, perhaps.

HINT ON TRIPLER

I asked you a while ago about using an ECG523A tripler in this Curtis-Mathes CMC-51 chassis. You gave me some help. I found out that it could be done by taking the focus dropping-resistor out, and connecting the focus control from the new tripler directly to the focus lead from the CRT socket. I also connected the control lead from the tripler directly to the focus control on the TV, thus eliminating the drops in the TV by using (presumably) a network inside the tripler. Thanks, it works fine.

I don't think there is a dropping resistor network inside the tripler. If I'm not mistaken, the focus voltage is simply tapped off the tripler at a point where it's just about right for that use.

NOTE ON DERATING-RESISTORS CLINIC

I read your Service Clinic on derating resistors (October 1982) and I agree with you, but a word of caution is in order. In certain circuits, a low-wattage resistor is used as a protective device—for example, the small emitter-resistors in high-power transistor output stages. Those are meant to blow out, protecting the board and other parts. You'll find fusible resistors in other places, too.

Thanks to Steven R. Eddington of Bloomington, IN for that note. I'll go along with that Steve! You'll find places where resistors are deliberately low-rated for that purpose. However, if you use the one special tool that we should on all cases, those will be fairly obvious. That special tool is your *head*!

NO RASTER, BUT PLENTY OF HIGH VOLTAGE

In this Zenith 12A12C52, the high voltage is a nice 29 KV. The horizontal oscillator is running and all DC voltages are OK except for the boost, which is at about B+ (450 volts). The focus voltage at the CRT is OK. There's no raster. What's going on here?—R.M.H., Norco, LA

Well, I ran in circles for a while (not an unusual exercise for me) but it finally hit me. Your boost is low. Actually you have no boost at all, just B+. (What threw me me here was that that loss of boost usually reduces the high voltage quite a bit.) With no boost, the screen voltages on your CRT are going to be very low, and the picture tube will cut off. Check the damper, boost capacitor (it could be open), etc. **R-E**

EQUIPMENT REPORTS

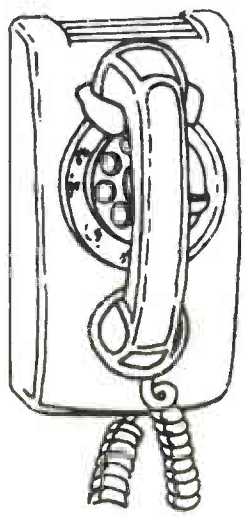
continued from page 32

shortwave listener who may have more than one radio, but is short on antennas. And, there is provision for connecting up to two antennas to the model 959. The antenna you want to use is front-panel switch selectable.

Using the model 959 combination antenna tuner and preamp is easy. The instruction pamphlet is clear and concise, so it should take no more than thirty minutes to have the unit up and working. One thing that we should note is the need of a good earth ground. That will prevent unwanted oscillation when the preamp is in use.

About the only thing missing with this nearly plug-in-and-use-it tuner is a good theory explanation in the instruction manual. Although there is some minimal-level theory included in the introduction, it still isn't enough for the technically inclined hobbyist. A schematic, however, is included.

Overall, the MFJ model 959 Receiver Tuner/Preamp should be a good addition to any shortwave listening hobbyist. Its ease of use and the extra potential it brings to your receiver is worth the asking price of $89.95. **R-E**



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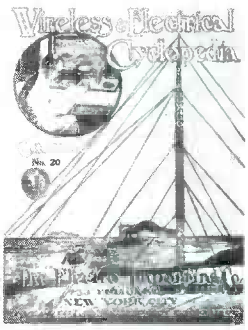

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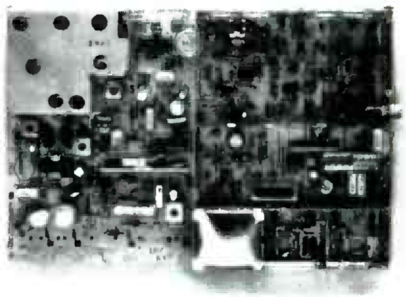

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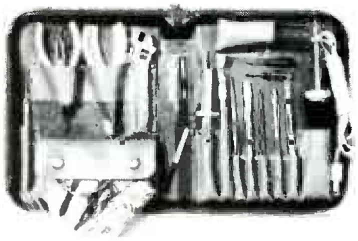

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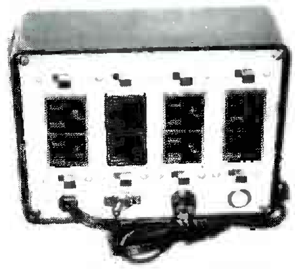

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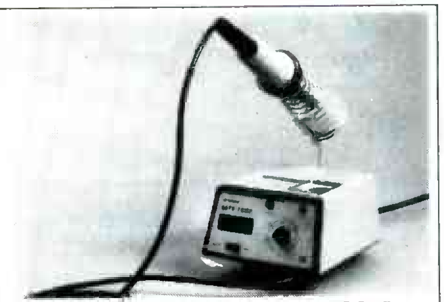

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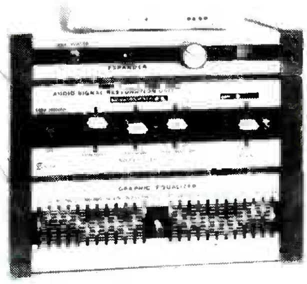

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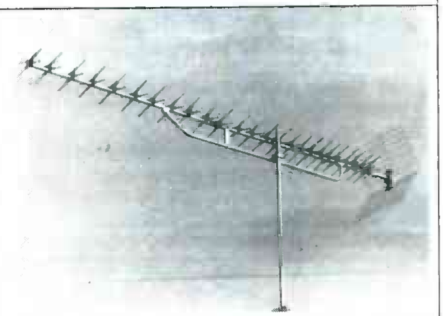

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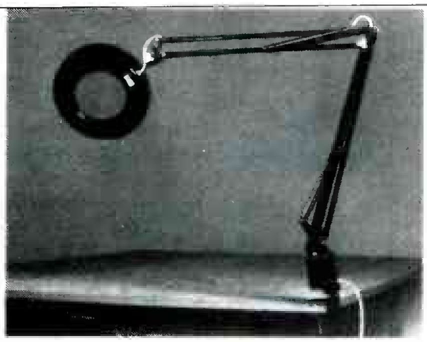

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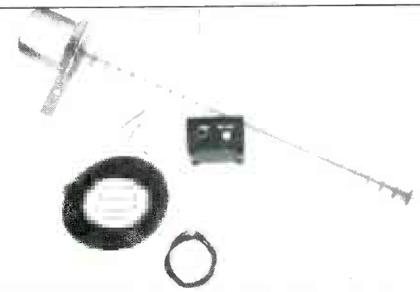

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MUSIC SYNTHESIZERS

continued from page 68

ADSR generators have been most popular among professional musicians. It is felt that that generator—which provides control over the attack time, decay time, sustain level, and release time—is the minimum required to imitate traditional instruments. ADSR-type generators require both gate and trigger signals.

Unlike the other modules that we have discussed, the envelope generator is not an audio module; it is a logic module. The output, though analog in nature, must respond to a number of digital conditions. (Is the gate present? Is the trigger present? Are both present?) Envelope-generator logic hasn't changed over many years: only the means of implementing the logic has changed. For example, early units were discrete and were composed mainly of diodes, transistors, and various R–C networks. Later, many units were designed using TTL integrated circuits. Recently many designs have been appearing that incorporate CMOS-type circuits. Finally, within the last several years a number of LSI circuits have appeared that incorporate the entire ADSR envelope generator on one chip. Some examples are the SSM 2050 and 2055 by Solid State Micro Technology, and the 3310 from Curtis. Those LSI versions are especially attractive for computer-controlled synthesizers where many ADSR's (perhaps as many as 32) are required in one unit.

The use of one-IC envelope generators cannot really be justified (except for the computer controlled synthesizers mentioned above) because of the relatively high cost of the units. Single-IC envelope generators still cost seven or eight dollars apiece. In contrast, the circuit in Fig. 5 (which uses about two-dollars-worth of IC's) accomplishes the same thing—it provides complete control over the attack, decay, sustain, and release portions of the envelope. In addition, it allows for retriggering. That means that if the gate is still present and the waveform is in the sustain portion of its curve, a new trigger will initiate the attack cycle once again.

While there is no doubt that use of LSI technology can make the designer's work much simpler in regard to VCO's, VCF's, and VCA's, it appears that, for now, the use of standard components is much more cost-effective in the design of ADSR's.

We have barely touched the four main synthesizer-components, and there are many other types of modules available such as balanced "ring" modulators, echo units, sequencers, sample-and-hold units, etc. Those other types of modules have also been affected by advances in LSI technology, bringing parts counts and prices down to a minimum. R-E

TALKING ALARM CLOCK

continued from page 60

The second way of feeding data to the VSP is through its microprocessor interface. The interface consists of a bidirectional data bus with some control lines. In addition to being used to carry speech data, that bus is also used to send commands to the VSP. Those commands control all the VSP functions.

During speech generation, the microprocessor first determines which words to speak. If the speech data for a particular word is in the dedicated speech-memory ROM, the microprocessor sends a command to the VSP to address that word, and then sends another to start speaking the word. The entire data fetching and speech-generation process is handled automatically by the VSP. The microprocessor simply commands the VSP to select a certain word and commands it to start speaking. If the speech data is not in the speech ROM, but in the PROM, then the microprocessor sends a command to the VSP instructing it to start accepting speech data via the microprocessor interface. The microprocessor then sends the coded speech-data to the VSP, and the VSP speaks the word. As the VSP generates speech, the microprocessor constantly reads its status to determine when it has finished a word. It then commands the speech processor to speak another one, thus producing phrases made up of several words.

When we continue next time, we'll describe the clock hardware as well as the software that is needed to drive it. And of course we'll cover completely construction, checkout, and use. **R-E**

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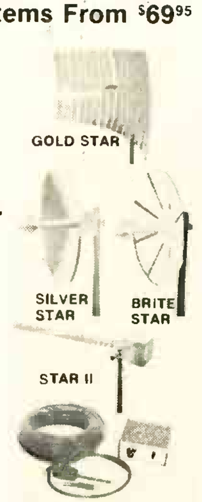

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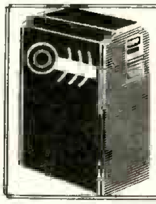

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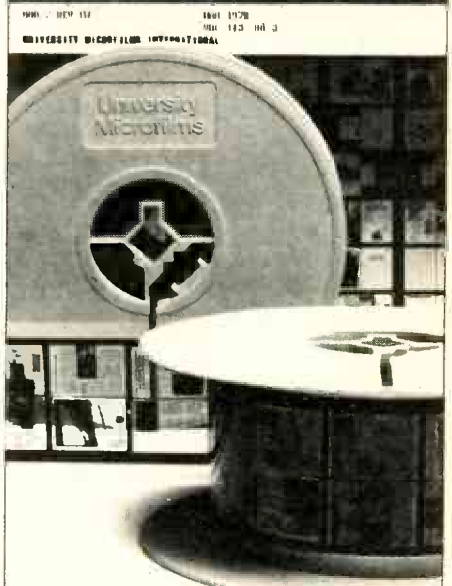

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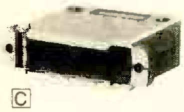
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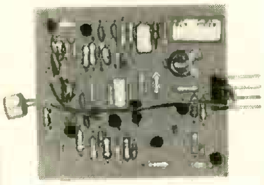

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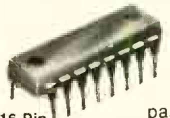
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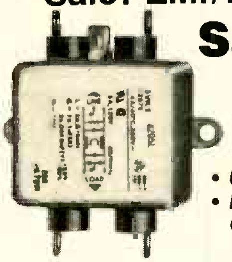

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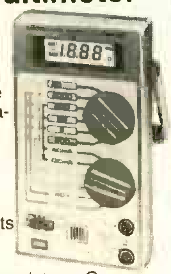

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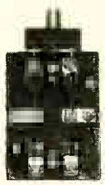

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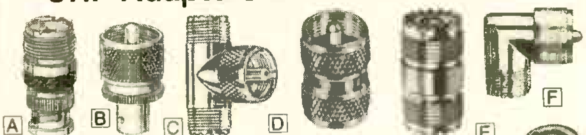


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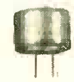

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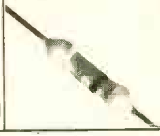

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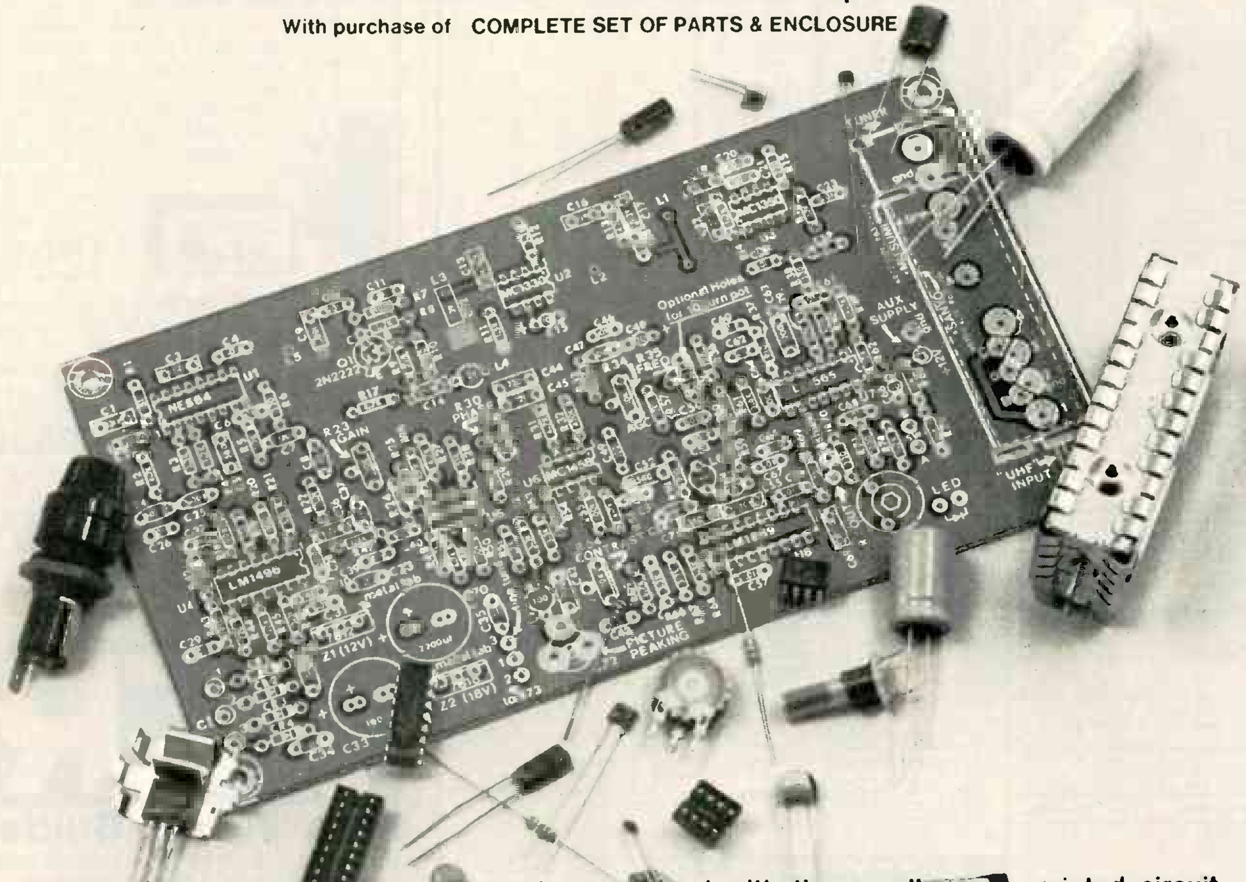

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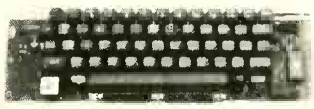

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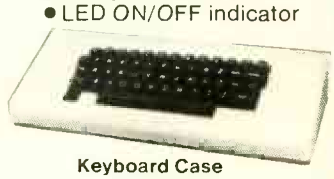

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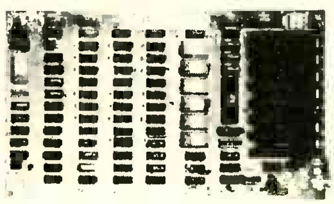

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74LS05	.24	74LS136	.49	74LS266	.49
74LS08	.24	74LS137	.95	74LS273	1.60
74LS10	.24	74LS138	.75	74LS275	3.25
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74LS20	.24	74LS153	.75	74LS295	.99
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74LS22	.24	74LS155	.89	74LS324	1.75
74LS26	.30	74LS156	.89	74LS352	1.49
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74LS51	.30	74LS173	.75	74LS385	1.89
74LS54	.35	74LS174	.89	74LS386	.59
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74LS63	1.20	74LS181	1.99	74LS393	1.79
74LS73	.39	74LS189	9.50	74LS395	1.59
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74LS76	.39	74LS192	.89	74LS447	.75
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74LS95	.79	74LS242	1.79	74LS685	2.39
74LS96	.79	74LS243	1.79	74LS688	2.39
74LS107	.39	74LS244	.95	74LS689	2.39
74LS109	.39	74LS245	1.89		
74LS112	.39	74LS247	.79	81LS95	1.65
74LS113	.39	74LS248	1.20	81LS96	1.65
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4012	.30	4026	1.60	4510	.90
4013	.45	4027	.60	4511	.90
4014	.90	4028	.75	4512	.90
4015	.90	4029	.90	4514	1.20
4016	.45	4030	.45	4515	2.20
		4034	2.90	4516	1.50
		4035	.85	4518	1.20
		4040	.90	4519	1.20
		4041	1.20	4520	1.20
		4042	.75	4522	1.20
		4043	.75	4526	1.20
		4044	.75	4527	1.90
		4046	.90	4528	1.20
		4047	.90	4531	.90
		4049	.50	4532	1.90
		4050	.50	4538	1.90
		4015	.90	4539	1.90
		4053	.90	4543	2.70
		4060	1.39	4555	.90
		4066	.75	4556	.90
		4068	.39	4581	1.90
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SN7401N	14	.19	SN7473N	14	.35	SN74157N	16	.59
SN7402N	14	.25	SN7474N	14	.35	SN74160N	16	.69
SN7403N	14	.25	SN7475N	16	.45	SN74161N	16	.69
SN7404N	14	.25	SN7476N	16	.35	SN74162N	16	.69
SN7405N	14	.25	SN7479N	14	4.95	SN74163N	16	.69
SN7406N	14	.29	SN7480N	14	.69	SN74164N	14	.69
SN7407N	14	.29	SN7482N	14	1.19	SN74165N	16	.69
SN7408N	14	.25	SN7483N	16	.59	SN74166N	16	.89
SN7409N	14	.25	SN7485N	16	.59	SN74167N	16	2.79
SN7410N	14	.25	SN7486N	14	.35	SN74170N	16	1.29
SN7411N	14	.25	SN7489N	16	2.25	SN74172N	24	4.95
SN7412N	14	.35	SN7490N	14	.39	SN74173N	16	.69
SN7413N	14	.35	SN7491N	14	.59	SN74174N	16	.69
SN7414N	14	.49	SN7492N	14	.39	SN74175N	16	.69
SN7416N	14	.25	SN7493N	14	.39	SN74176N	14	.69
SN7417N	14	.25	SN7494N	14	.69	SN74177N	14	.69
SN7420N	14	.19	SN7495N	14	.49	SN74179N	16	1.49
SN7421N	14	.35	SN7496N	16	.49	SN74180N	14	.69
SN7422N	14	.45	SN7497N	16	2.75	SN74181N	24	1.95
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SN7425N	14	.29	SN74104N	14	.89	SN74184N	16	1.95
SN7426N	14	.29	SN74105N	14	.89	SN74185N	16	1.95
SN7427N	14	.25	SN74107N	14	.29	SN74190N	16	.69
SN7428N	14	.49	SN74109N	16	.39	SN74191N	16	.69
SN7430N	14	.25	SN74116N	24	1.49	SN74192N	16	.69
SN7432N	14	.29	SN74121N	14	.29	SN74193N	16	.69
SN7437N	14	.25	SN74122N	14	.55	SN74194N	16	.69
SN7438N	14	.25	SN74123N	16	.49	SN74195N	16	.69
SN7439N	14	.59	SN74125N	14	.45	SN74196N	14	.89
SN7440N	14	.19	SN74126N	14	.45	SN74197N	14	.89
SN7441N	16	.89	SN74132N	14	.49	SN74198N	24	1.19
SN7442N	16	.45	SN74136N	14	.69	SN74199N	24	1.19
SN7443N	16	.99	SN74141N	16	.69	SN74221N	16	1.19
SN7444N	16	.99	SN74142N	16	2.95	SN74251N	16	.79
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SN7446N	16	.69	SN74144N	24	2.95	SN74279N	16	.79
SN7447N	16	.69	SN74145N	16	.59	SN74283N	16	1.49
SN7448N	16	.69	SN74147N	16	1.49	SN74284N	16	2.95
SN7450N	14	.19	SN74148N	16	1.19	SN74285N	16	2.95
SN7451N	14	.19	SN74150N	24	1.19	SN74365N	16	.55
SN7453N	14	.19	SN74151N	16	.59	SN74366N	16	.55
SN7454N	14	.19	SN74152N	14	.59	SN74367N	16	.55
SN7459A	14	.25	SN74153N	16	.59	SN74368N	16	.55
SN7460N	14	.19	SN74154N	24	1.25	SN74390N	16	1.49
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74LS00	14	.25	74LS92	14	.55	74LS192	16	.79
74LS01	14	.25	74LS93	14	.55	74LS193	16	.79
74LS02	14	.25	74LS95	14	.79	74LS194	16	.69
74LS03	14	.25	74LS96	16	.89	74LS195	16	.69
74LS04	14	.29	74LS107	14	.39	74LS197	14	.79
74LS05	14	.29	74LS109	16	.39	74LS221	16	.89
74LS08	14	.29	74LS112	16	.39	74LS240	20	1.09
74LS09	14	.29	74LS113	14	.39	74LS241	20	1.09
74LS10	14	.29	74LS114	14	.39	74LS242	14	1.09
74LS11	14	.35	74LS122	14	.49	74LS243	14	1.09
74LS12	14	.35	74LS123	16	.79	74LS244	20	1.09
74LS13	14	.35	74LS125	14	.49	74LS245	20	1.49
74LS14	14	.59	74LS126	14	.49	74LS247	16	1.09
74LS15	14	.35	74LS132	14	.59	74LS248	16	1.09
74LS20	14	.29	74LS133	16	.59	74LS249	16	1.09
74LS21	14	.29	74LS136	14	.39	74LS251	16	.59
74LS22	14	.29	74LS138	16	.59	74LS253	16	.59
74LS26	14	.29	74LS139	16	.59	74LS257	16	.59
74LS27	14	.29	74LS151	16	.59	74LS258	16	.59
74LS28	14	.35	74LS153	16	.59	74LS260	14	.59
74LS30	14	.29	74LS154	24	.99	74LS266	14	.69
74LS32	14	.35	74LS155	16	.69	74LS273	20	1.49
74LS33	14	.55	74LS156	16	.69	74LS279	14	.49
74LS37	14	.35	74LS157	16	.69	74LS283	16	.69
74LS38	14	.35	74LS158	16	.59	74LS290	14	.89
74LS40	14	.29	74LS160	16	.69	74LS293	14	.79
74LS42	16	.55	74LS161	16	.69	74LS298	16	.89
74LS47	16	.75	74LS162	16	.69	74LS352	16	1.29
74LS48	16	.75	74LS163	16	.69	74LS353	16	1.29
74LS49	16	.75	74LS164	14	.69	74LS365	16	.49
74LS51	14	.25	74LS165	16	1.19	74LS366	16	.49
74LS54	14	.29	74LS168	16	1.19	74LS367	16	.49
74LS55	14	.29	74LS169	16	1.19	74LS368	16	.49
74LS73	14	.39	74LS170	16	1.49	74LS373	20	1.29
74LS74	14	.39	74LS173	16	.69	74LS374	20	1.29
74LS75	16	.39	74LS174	16	.59	74LS375	16	.69
74LS76	16	.39	74LS175	16	.59	74LS386	14	.45
74LS78	16	.39	74LS181	24	2.49	74LS393	14	1.19
74LS83	16	.65	74LS190	16	.89	74LS399	16	1.49
74LS85	16	.79	74LS191	16	.89	74LS670	16	1.49
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74S03	14	.35	74S134	16	.50	74S251	16	1.19
74S04	14	.45	74S135	16	.69	74S253	16	1.19
74S05	14	.45	74S136	14	1.19	74S257	16	1.19
74S08	14	.39	74S138	16	.89	74S258	16	1.19
74S09	14	.39	74S139	16	.89	74S280	14	1.95
74S10	14	.35	74S140	14	.55	74S287*	16	1.95
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74S15	14	.35	74S153	16	.99	74S289*	16	2.49
74S20	14	.35	74S157	16	.99	74S373	20	2.49
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CD4018	16	.79	CD4059	24	7.95	CD4528	16	1.19
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CD4025	14	.23	CD4072	14	.29	CD4723	16	1.19
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INS8035N-6	40	MPU—8-bit (6MHz)	5.95
INS8039N-6	40	CPU-Sgl chip 8-bit (128 bts. Ram)	5.95
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INS8070N	40	CPU (64 bytes RAM)	11.95
INS8073N	40	CPU w/Basic Micro Interpreter	14.95
P8085A	40	CPU	5.95

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Part No.	**Pins	Function	Price
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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-PIO	40	Parallel I/O Interface Controller	5.95
Z80-SIO/0	40	Serial I/O (TxCB and RxCB Bonded)	15.95
Z80-SIO/1	40	Serial I/O (Lacks DTRB)	15.95
Z80-SIO/2	40	Serial I/O (Lacks SYNCB)	15.95
Z80-SIO/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-PIO	40	Parallel I/O Interface Controller	5.95
Z80A-SIO/0	40	Serial I/O (TxCB and RxCB bonded)	16.95
Z80A-SIO/1	40	Serial I/O (Lacks DTRB)	16.95
Z80A-SIO/2	40	Serial I/O (Lacks SYNCB)	16.95
Z80A-SIO/9	40	Serial I/O	16.95
Z80B	40	CPU (MK3880N-6) 6MHz	11.95
Z80B-CTC	28	Counter Timer Circuit	13.95
Z80B PIO	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
MC6848BP	40	General Purpose Int. Adapter	8.95
MC68652P2	40	Multi. Protocol Comm. Controller	24.95
MC68661PB	28	Enhanced Prog. Comm. Int.	8.95

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
INS8247	28	Display Controller (74C911)	8.95
INS8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element (INS8250)	10.95
DP8251	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	9.95
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

MICROPROCESSOR MANUALS & DATA BOOKS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00
10400	1982 Intel Data Book (1405 pg.)	14.95
30001	1981 Nat. CMOS Book (628 pg.)	6.95
30002	1980 Nat. Interface Book (640 pg.)	6.95
30003	1982 Nat. Linear Book (1952 pg.)	11.95
30005	1981 Nat. TTL Book (624 pg.)	9.95
30008	1980 Nat. Memory Data Book (464 pg.)	6.95
30011	1980 Nat. Linear Applications (736 pg.)	15.95
30013	1983 Zilog Data Book (641 pg.)	7.95
205610	1981 Intel Peripheral Design (828 pg.)	9.95

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
2141-3	18	4096x1	(150ns)	3.95
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) 3101	2.25
74C920	22	256x4	(250ns) CMOS (6551)	3.95
74C921	18	256x4	(250ns) CMOS	3.95
74C929	16	1024x1	(250ns) CMOS (6501)	3.95
74C930	18	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
27580	24	1024x8	(450ns) single +5V	2.95
MM2764	28	8192x8	(450ns)	16.95
MM2764-3	28	8192x8	(300ns)	19.95

PROMS

Part No.	**Pins			Price
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
82S185	18	2048x4	PROM T.S. (TBP24S81)	9.95
DM87S180N	24	1024x8	PROM O.C. (82S180)	9.95
DM87S181N	24	1024x8	PROM T.S. (82S181)	9.95
DM87S184N	18	2048x4	PROM O.C. (82S184)	9.95
DM87S185N	18	2048x4	PROM T.S. (82S185)	9.95
DM87S190N	24	2048x8	PROM O.C. (82S190)	19.95
DM87S191N	24	2048x8	PROM T.S. (82S191)	19.95

DATA ACQUISITION

Part No.	**Pins	Function	Price
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
AY-5-1013A	40	30K Baud Uart (TR1602)	4.95
1173AN-1	28	30 Tune Musical MPU w/specs.	8.95

CONNECTORS

DB25 — D Subminiature (meets RS232)

Part No.	Description	Price
DE9P	9 Pin Plug	$1.79
DE9S	9 Pin Socket	1.95
DA15P	15 Pin Plug	1.95
DA15S	15 Pin Socket	2.95
DB25P	**25 Pin Plug (Meets RS232)**	**2.49**
DB25S	**25 Pin Socket (Meets RS232)**	**3.25**
DB25P-831	25 Pin Right Angle Plug	4.95
DB25S-831	25 Pin Right Angle Socket	5.25
DC37P	37 Pin Plug	4.95
DC37S	37 Pin Socket	5.95
DD50P	50 Pin Plug	5.95
DD50S	50 Pin Socket	6.95

Accessories

DE-9H	Hood for DE-9 Series Connectors	$1.19
DA-15H	Hood for DA-15 Series Connectors	1.29
DB25H	Hood for DB25 Series Connectors	1.25
DC37H	Hood for DC37 Series Connectors	1.39
DD50H	Hood for DD50 Series Connectors	1.49
020418-2	2 screws for mtg. connectors to a panel	.79

Solder Eyelet/Wire Wrap Edge Card

Part No.	Cnts.	Sp.	Description	Price
15/30SE	15/30	.156	Solder Eyelet	$1.79
18/36SE	18/36	.156	Solder Eyelet	1.95
22/44SE	22/44	.156	Solder Eyelet	2.49
22/44PC	22/44	.156	PC type (no mtg. ears)	.99
50/100SE	50/100	.125	Solder Eyelet	9.95
22/44WW	22/44	.156	Wire Wrap - Level 3	4.95
67031-5	22/44	.156	WW (Pins .0625x.03x.75)	3.95
R-681-1	50/100	.125	Wire Wrap - Level 3	7.95
R-681-2	50/100	.125	Wire Wrap - Level 1	6.95

RF Coaxial Connectors

Part No.	Description	Price
PL259	UHF Plug	$.89
SO239	UHF Panel Receptacle	.69
PL258	UHF Straight Adapter	.89
UG175/U	UHF Reducing Adapter	.49
UG88/U	BNC Plug	1.49
UG89/U	BNC Jack	1.69
UG306/U	BNC Angle Adapter	2.49
UG260/U	BNC Plug	1.49
UG1094/U	BNC Bulkhead Receptacle	.89

IC SOCKETS

For Socket Required, See Column After The IC Part No.

LOW PROFILE (TIN) SOCKETS

	1-9	10-99	100-999
8 pin LP	.16	.14	.13
14 pin LP	.17	.15	.14
16 pin LP	.19	.17	.16
18 pin LP	.26	.24	.23
20 pin LP	.30	.27	.25
22 pin LP	.31	.28	.26
24 pin LP	.33	.30	.28
28 pin LP	.40	.37	.35
36 pin LP	.46	.42	.39
40 pin LP	.49	.46	.43

— Soldertail Standard Tin & Gold Also Available —

WIRE WRAP (GOLD) SOCKETS LEVEL #3

	1-9	10-99	100-999
8 pin WW	.49	.45	.42
10 pin WW	.65	.62	.59
14 pin WW	.65	.62	.59
16 pin WW	.69	.65	.61
18 pin WW	.89	.85	.79
20 pin WW	1.09	1.05	.99
22 pin WW	1.25	1.19	1.15
24 pin WW	1.29	1.23	1.18
28 pin WW	1.59	1.50	1.45
36 pin WW	1.85	1.75	1.69
40 pin WW	1.99	1.89	1.79

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DT1050 — Applications: Teaching aids, appliances, clocks, automotive, telecommunications, language translations, etc.

The DT1050 is a standard DIGITALKER kit encoded with 137 separate and useful words, 2 tones, and 5 different silence durations. The words and tones have been assigned discrete addresses, making it possible to output single words or words concatenated into phrases or even sentences. The "voice" output of the DT1050 is a highly intelligible male voice. Female and children's voices can be synthesized. The vocabulary is chosen so that it is applicable to many products and markets.

The DT1050 consists of a Speech Professor Chip, MM54104 (40-pin) and two (2) Speech ROMs MM52164SSR1 and MM52164SSR2 (24-pin) along with a Master Word list and a recommended schematic diagram on the application sheet.

DT1050 Digitalker™ .... $34.95 ea.

DT1057 — Expands the DT1050 vocabulary from 137 to over 260 words. Incl. 2 ROMs and specs.

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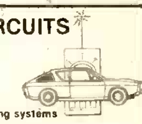
RADIO CONTROL CIRCUITS



Ideal to use for:
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- Burglar alarms • IR data link
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A complete 6-channel digital encoder and RF transmitter; low power, at frequency of 27MHz or 49MHz, a field strength of 10,000uV meter at 3 meters. 9V operation on chip RF oscillator/transmitter, on chip 4.6 regulator. Up to 80MHz carrier frequency operation.

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INTERSIL

* Evaluation Kits

Part No.	**Pins	Function	Price
7045IPI	28	CMOS Precision Timer	14.95
7045EV/Kit*	28	Stopwatch Chip, XTL	19.95
7106CPL	40	3½ Digit A/D (LCD Drive)	9.95
7106EV/Kit*	40	IC, Circuit Board, Display	34.95
7107CPL	40	3½ Digit A/D (LED Drive)	11.95
7107EV/Kit*	40	IC, Circuit Board, Display	29.95
7116CPL	40	3½ Digit A/D LCD Dis. HLD.	16.95
7117CPL	40	3½ Digit A/D LED Dis. HLD.	15.95
7201IUS		Low Battery Volt Indicator	2.25
7205IPG	24	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	24	Stopwatch Chip, XTL	14.95
7206CJPE	16	Tone Generator	4.95
7206CEV/Kit*	16	Tone Generator Chip, XTL	7.95
7207AIPD	14	Oscillator Controller	5.95
7207AEV/Kit*	14	Freq. Counter Chip, XTL	7.95
7208IPI	28	Seven Decade Counter	15.95
7209IPA	8	Clock Generator	3.95
7215IPG	24	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	24	4 Func. Stopwatch Chip, XTL	14.95
7216AIJI	28	8 Digit Univ. Counter C.A.	29.95
7216CIJI	28	8 Digit Freq. Counter C.A.	24.95
7216DIPI	28	8 Digit Freq. Counter C.C.	19.95
7217IJI	28	4 Digit LED Up/Down Counter C.A.	10.95
7217AIPI	28	4 Digit LED Up/Down Counter C.C.	11.95
7224IPL	40	LCD 4½ Digit Up Counter DRI	10.95
7226AIJL	40	8 Digit Univ. Counter	29.95
7226AEV/Kit*	40	5 Function Counter Chip, XTL	74.95

— AND MORE —

30009 1983 INTERSIL Data Book (1356p.) $9.95

NEW Programmable Array Logic (PALS)

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PAL12H6	20	Hex 12-Input AND-OR Gate Array (High Output)	5.95
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PAL10L8	20	Octal 10-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL12L6	20	Hex 12-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL14L4	20	Quad 14-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL16L8	20	Octal 16-Input AND-OR-Invert Gate Array (Low Output)	9.95
PAL16R8	20	Octal 16-Input Register AND-OR Gate Array	9.95
PAL16R6	20	Hex 16-Input Register AND-OR Gate Array	9.95
PAL16R4	20	Quad 16-Input Register AND OR Gate Array	9.95

30012 1982 NATIONAL PAL Data Book (176p.) .. $5.95

74C—C/MOS

74C00	14	.35	74C95	14	1.39	74C221	16	1.95
74C02	14	.35	74C107	14	.89	74C240	20	1.95
74C04	14	.29	74C151	16	2.49	74C244	20	1.95
74C08	14	.35	74C154	24	3.49	74C373	20	2.49
74C10	14	.35	74C157	16	2.25	74C374	20	2.49
74C14	14	.59	74C160	16	1.19	74C901	14	.59
74C20	14	.35	74C161	16	1.19	74C903	14	.59
74C30	14	.35	74C162	16	1.19	74C906	14	.59
74C32	14	.39	74C163	16	1.19	74C911	28	8.95
74C42	16	1.39	74C164	14	1.49	74C912	28	8.95
74C48	16	1.95	74C173	16	.79	74C915	18	1.19
74C73	14	.79	74C174	16	1.19	74C917	28	8.95
74C74	14	.69	74C175	16	1.19	74C922	18	4.49
74C85	16	1.95	74C192	16	1.49	74C923	20	4.95
74C86	14	.39	74C193	16	1.69	74C925	16	5.95
74C89	16	5.95	74C195	16	1.39	74C926	18	5.95
74C90	14	1.19				80C95	16	.39
74C93	14	1.19				80C97	16	.39

30001 1983 Nat. CMOS Book (628 pg.) $6.95

LINEAR

TL071CP	8	.79	LM340K-15		1.35	NE570N	16	3.95
TL072CP	8	1.39	LM340T-5		.79	LM703CN	8	1.19
TL074CN	14	1.95	LM340T-12		.79	LM709N	14	.49
TL081CP	8	.59	LM340T-15		.79	LM710N	14	.69
TL082CP	8	1.19	LM348N	14	.99	LM711N	14	.79
TL084CN	14	1.95	LM350K		4.95	LM723N	14	.55
LM301CN	8	.35	LF355N	8	1.10	LM733N	14	1.00
LM302H		1.95	LF356N	8	1.10	LM739N	14	1.95
LM304H		1.95	LM370N	14	4.49	LM741CN	8	.35
LM305H		.99	LM373N	14	3.95	LM747N	14	.69
LM307CN	8	.45	LM377N	14	1.95	LM748N	8	.59
LM308CN	8	.69	LM380N	14	.89	LM1310N	14	1.49
LM309K		1.25	LM381N	14	1.79	LM1458CN	8	.59
LM310CN	8	1.75	LM382N	14	1.39	LM1488N	14	.69
LM311CN	8	.69	LM384N	14	1.79	LM1489N	14	.69
LM312H		2.49	LM386N-3	8	.89	LM1496N	14	1.95
LM317T		1.19	TL494CN	16	2.95	LM1800N	16	1.49
LM317K		3.95	TL496CP	8	1.19	LM1889N	18	1.95
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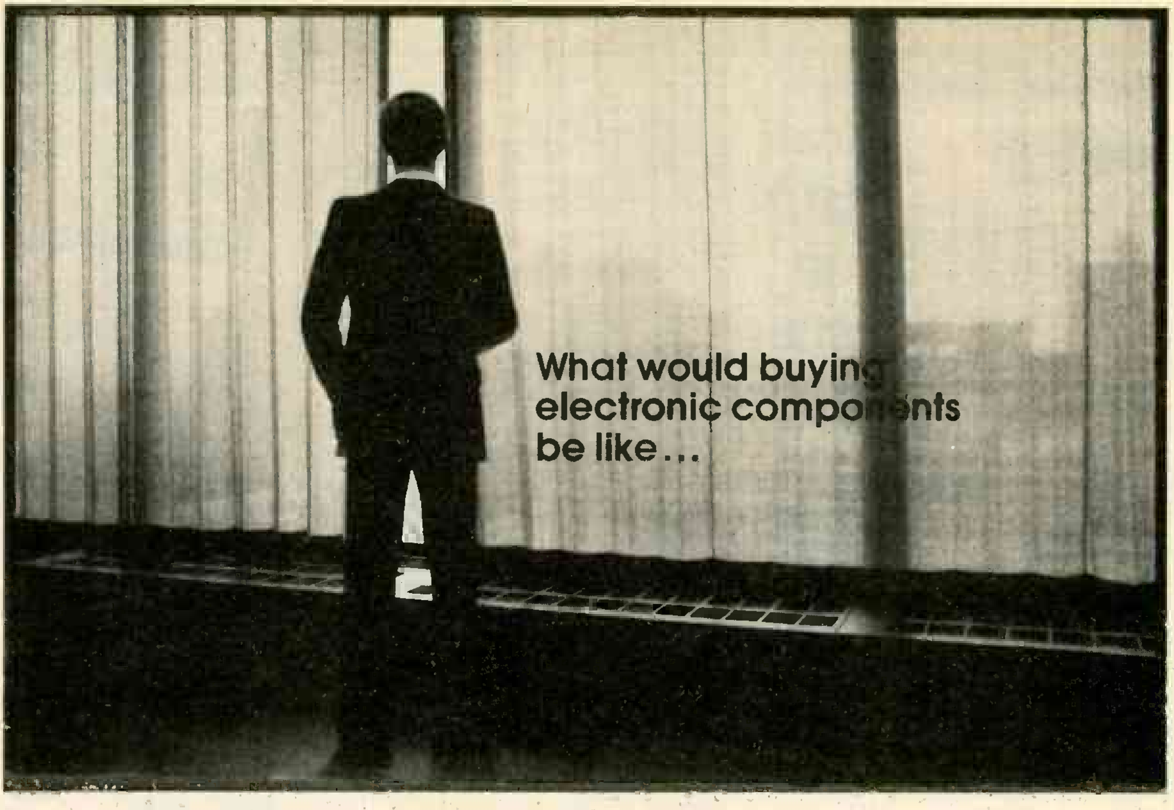

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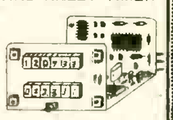

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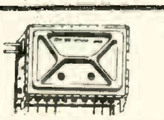

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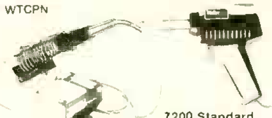

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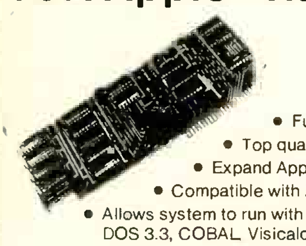

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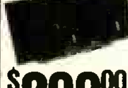

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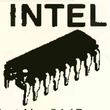

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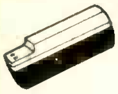

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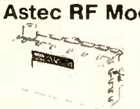

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1200Baud
5 Volts
Special ACP Price $99.00

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19 Column Printer prints 16 numerical columns plus 3 columns which have math, alpha and other notations. Each wheel has 12 positions with position 12 blank. Position 11 on numerical columns have decimal point or #. Utilizes 2.75" wide adding machine tape and a dual color ink ribbon. Input data parallel with four bit BCD comparator circuit (schematic provided). Print rate, 3 lines per second. Operating voltage 22-28VDC with typical cycle time of 340mS. Size 6½"W x 3⅛"H x 5⅜"Dp. New. $9.95 ea. 3/$27

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8212	2.75	6820	6.50	6522	9.95
8214	4.95	6821	6.50	6530-X	24.95
8216	2.75	6828	10.50	6532	17.95
8224	2.95	6834	16.95	6551	19.95
8226	2.95	6845	22.95	Z80-PIO	6.50
8228	3.95	6847	27.95	Z80A-PIO	9.50
8243	9.50	6850	5.25	Z80-CTC	6.50
8250	14.95	6852	5.25	Z80A-CTC	9.50
8251	6.50	6860	10.95	Z80-DMA	19.95
8253	11.95	6862	10.95	Z80A-DMA	27.95
8255	4.50	6875	5.95	Z80-SIO	24.95
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2716/2516, 5V		1702A	5.75
(2Kx8) TS	7.95	MM5203AQ	14.50
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2513-005 (5V) Lower	10.95	DAC100	9.95
2513-ADM3 (5V) Lower	14.95	8038 Function Generator	4.50
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MCM66740 Math Symbol	13.95	LM566 VCO	1.95
MCM66750 Alpha Control	13.45	XR2206 Function Generator	5.25
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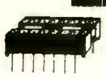
DAC01 D to A	5.95	MM5740AAC	8.95

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
40 pin WW	2.20	2.09	1.89

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78M06	1.49	LM1458CN/N	.49
78M.G.	1.49	MC1488N	.99
LM108AH	2.95	MC1489N	.99
LM300H	.99	LM1496N	.89
LM301CN	.35	LM1556N	1.50
LM304H	1.98	LM1820N	.95
LM305H	1.89	LM1850N	.95
LM306H	3.25	LM1889N	3.10
LM307CN	.29	LM2111N	1.75
LM308CN	.98	LM2900N	.99
LM309K	1.49	LM2901N	2.50
LM310CN	1.25	LM2917N	2.95
LM311D/CN	.89	CA3013T	2.19
LM312H	1.75	CA3018T	1.99
LM317T	1.70	CA3021T	3.49
LM318CN	1.49	CA3023T	2.99
LM319N/H	1.25	CA3035T	2.75
LM320K-XX*	1.35	CA3039T	1.29
LM320T-XX*	1.39	CA3046N	1.29
LM320H-XX*	1.25	LM3053N	1.49
LM323K	4.95	CA3059N	3.19
LM324N	.95	CA3060N	3.19
LM337K	5.95	CA3062N	4.95
LM338K	6.95	LM3065N	1.49
LM339N	.95	CA3080T	1.29
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LM340T-XX*	1.25	CA3082N	1.69
LM340H-XX*	1.25	CA3083N	1.55
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LM348N	1.20	CA3089N	2.99
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LM358CN	.98	CA3097N	1.99
LM360N	1.49	CA3130T	1.30
LM372N	1.95	CA3140T	1.19
LM376N	3.75	CA3146N	2.49
LM377N	2.75	CA3160T	1.19
LM380CN/N	1.25	CA3190N	1.95
LM381N	1.79	CA3410N	.59
LM383T	1.95	MC3423N	1.49
LM386N	1.25	MC3460N	3.95
LM387N	1.40	SG3524N	3.95
LM390N	1.95	CA3600N	3.39
NE531V/T	3.75	LM3900N	.59
NE555V	.39	LM3905N	1.19
NE556N	.98	LM3909N	.98
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LM709N/H	.29	RC4194TK	4.95
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LM711N/H	.39	ULN2001	1.25
LM715N	1.95	ULN2003	1.50
LM723N/H	.65	SN75450N	.59
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
LM748N/H	.39	SN75492N	.89
LM760CN	2.95	SN75493N	.89
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74S00	$ .39	74S124	3.69	74S244	$2.99
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74S03	.45	74S134	.66	74S253	1.35
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
74S10	.42	74S140	.73	74S287	2.99
74S11	.42	74S151	1.29	74S288	2.55
74S15	.42	74S153	1.29	74S373	3.10
74S20	.42	74S157	1.29	74S374	3.10
74S22	.42	74S158	1.29	74S387	2.75
74S30	.42	74S160	2.79	74S471	7.95
74S32	.49	74S174	1.49	74S472	7.95
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74S51	.42	74S194	1.89	74S475	9.95
74S64	.46	74S195	1.89	74S570	5.75
74S65	.46	74S196	1.89	74S571	5.75
74S74	.69	74S240	2.75	74S572	8.95
74S86	.72	74S241	2.75	74S573	8.95
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74S114	.72				

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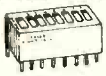

2 Position	$ .99	7 Position	$1.39
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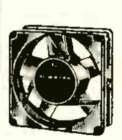

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7402	.22	7479	4.60	74163	.87
7403	.22	7480	.49	74164	.87
7404	.22	7482	.95	74165	.87
7405	.23	7483	.55	74166	1.20
7406	.35	7485	.65	74167	1.95
7407	.35	7486	.35	74170	1.69
7408	.26	7489	1.75	74172	4.75
7409	.23	7490	.39	74173	.79
7410	.22	7491	.57	74174	.89
7411	.29	7492	.45	74175	.85
7412	.29	7493	.45	74176	.75
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
7425	.29	74121	.29	74188	3.90
7426	.29	74122	.39	74190	1.15
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
7441	.79	74142	2.95	74199	1.39
7442	.57	74143	2.95	74221	1.19
7443	.95	74144	2.95	74251	.95
7444	.95	74145	.62	74273	1.05
7445	.79	74147	1.95	74276	1.89
7446	.79	74148	1.20	74279	.75
7447	.65	74150	1.09	74283	1.40
7448	.79	74151	.67	74284	3.90
7450	.19	74152	.67	74285	3.90
7451	.19	74153	.67	74290	1.25
7453	.19	74154	1.19	74298	.95
7454	.19	74155	.78	74365	.68
7459	.25	74156	.78	74366	.68
7460	.23	74157	.69	74367	.68
7470	.29	74158	1.65	74368	.68
7472	.29	74159	2.49	74390	1.45
7473	.34	74160	.88	74393	1.90
7474	.34			74490	1.90

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74LS00	$ .26	74LS113	$ .43	74LS245	$2.20
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74LS02	.28	74LS122	.55	74LS248	1.10
74LS03	.28	74LS123	1.19	74LS249	1.19
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
74LS10	.28	74LS136	.49	74LS259	2.95
74LS11	.39	74LS138	.85	74LS260	.65
74LS12	.33	74LS139	.85	74LS261	2.49
74LS13	.47	74LS145	1.25	74LS266	.59
74LS14	.95	74LS148	1.49	74LS273	1.75
74LS15	.33	74LS151	.79	74LS275	4.40
74LS20	.26	74LS153	.79	74LS279	.59
74LS21	.33	74LS154	1.70	74LS283	.99
74LS22	.33	74LS155	1.19	74LS290	.99
74LS26	.33	74LS156	.99	74LS293	.99
74LS27	.33	74LS157	.85	74LS295	1.10
74LS28	.33	74LS158	.75	74LS298	1.19
74LS30	.26	74LS160	1.05	74LS324	1.75
74LS32	.33	74LS161	1.15	74LS347	1.95
74LS33	.55	74LS162	1.05	74LS348	1.95
74LS37	.45	74LS163	1.05	74LS352	1.19
74LS38	.39	74LS164	1.19	74LS353	1.19
74LS40	.26	74LS165	.89	74LS363	1.49
74LS42	.79	74LS166	2.48	74LS365	.69
74LS47	.79	74LS168	1.15	74LS366	.69
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
74LS74	.42	74LS181	2.20	74LS377	1.95
74LS75	.59	74LS190	1.15	74LS385	1.95
74LS76	.45	74LS191	1.15	74LS386	.65
74LS78	.45	74LS192	.98	74LS390	1.95
74LS83A	.79	74LS193	.98	74LS393	1.95
74LS85	1.19	74LS194	1.15	74LS395	1.70
74LS86	.45	74LS195	.95	74LS399	2.35
74LS90	.57	74LS196	.89	74LS424	2.95
74LS92	.75	74LS197	.89	74LS668	1.75
74LS93	.75	74LS221	1.15	74LS670	2.29
74LS95	.88	74LS240	1.69	81LS95	1.69
74LS96	.98	74LS242	1.69	81LS96	1.69
74LS107	.45	74LS243	1.69	81LS97	1.69
74LS109	.45	74LS244	1.49	81LS98	1.69
74LS112	.43				

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4006	1.05	4042	.95	4098	2.29
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4008	1.39	4044	.85	14408	12.95
4009	.45	4046	1.75	14409	12.95
4010	.45	4047	1.25	14410	12.95
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4012	.25	4049	.45	14415	8.95
4013	.45	4050	.69	14419	4.95
4014	1.39	4051	1.10	4501	.39
4015	1.15	4052	1.10	4502	1.65
4016	.59	4053	1.10	4503	.69
4017	1.19	4055	3.95	4505	8.95
4018	.89	4056	2.95	4506	.75
4019	.45	4059	9.25	4507	.95
4020	1.10	4060	1.39	4508	3.75
4021	1.19	4066	.75	4510	1.19
4022	1.15	4069	.35	4511	1.19
4023	.29	4070	.49	4512	1.39
4024	.75	4071	.35	4515	2.75
4025	.25	4072	.35	4516	1.45
4027	.65	4073	.35	4518	1.39
4028	.85	4075	.35	4520	1.25
4029	1.29	4076	1.29	4555	4.95
4030	.45	4077	.35	4556	.99
4031	3.25	4078	.35	4566	2.25
4032	2.15	4081	.35	80C95	1.50
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TERMS: MO. Cashier's Check. Bank Wire. Personal checks allow 2 weeks for processing. Include Drivers License and credit card #s Visa, AMEX, CB add 3% service charge. Add 3% shipping & handling or $2.50, whichever is greater. Add 10% for foreign orders or US Parcel Post. Include Telephone number. NO CODs. Prices subject to change without notice. Some items subject to prior sale. We reserve the right to substitute manufacturer. Retail prices may vary.

ELECTRONIC KITS FROM HAL-TRONIX

2304 MHZ DOWN CONVERTERS. TUNES IN ON CHANNELS 2 TO 7 ON YOUR OWN HOME T.V. HAS FREQUENCY RANGE FROM 2000 MHZ TO 2500 MHZ. EASY TO CONSTRUCT AND COMES COMPLETE WITH ALL PARTS INCLUDING A DIE-CAST ALUM CASE AND COAX FITTINGS. REQUIRE A VARIABLE POWER SUPLY AND ANTENNA (Antenna can be a dish type or coffee can type depending on the signal strength in your area.)

2304 MOD 1 (Basic Kit) (Less case & fittings) — $19.95
2304 MOD 2 (Basic/Pre-amp) (less case & fittings) — $29.95
2304 MOD 3 (Hi-Gain Pre-amp) (Includes case & fittings) — $39.95

POWER SUPPLY FOR EITHER MODEL ABOVE IS AVAILABLE. COMES COMPLETE WITH ALL PARTS, CASE, TRANSFORMER, ANTENNA SWITCH AND CONNECTORS — (Kit) $24.95
Assembled — $34.95
Slotted Microwave Antenna For Above Downverters — $39.95

PREAMPLIFIERS

HAL PA-19—1.5 mhz to 150 mhz. 19db gain operates on 8 to 18 volts at 10ma. Complete unit $8.95.
HAL PA-1.4—3 mhz to 1.4 ghz. 10 to 12 db gain operates on 8 to 18 volts at 10 ma. Complete unit $12.95.
(The above units are ideal for receivers, counters, etc.)

16 LINE TOUCH TONE DECODE KIT WITH P.C. BOARD AND PARTS — $69.95
12 LINE TOUCH TONE DECODER KIT WITH P.C. BOARD AND PARTS — $39.95
16 LINE ENCODER KIT, COMPLETE WITH CASE, PAD AND COMPONENTS — $39.95
12 LINE ENCODER KIT, COMPLETE WITH CASE, PAD AND COMPONENTS — $29.95

Complete Sets of P.C. Boards Available For: Unicorn Robot Project and Heart-A-Matic Project.
MANY, MANY OTHER KITS AVAILABLE

Send 20 cents stamp or S.A.S.E. for information and flyer on other HAL-TRONIX products. To order by phone: 1-313-285-1782

HAL-TRONIX
P.O. Box 1101
Southgate, MI 48195

SHIPPING INFORMATION: ORDERS OVER $25.00 WILL BE SHIPPED POSTPAID EXCEPT ON ITEMS WHERE ADDITIONAL CHARGES ARE REQUESTED. ON ORDERS LESS THAN $25.00 PLEASE INCLUDE ADDITIONAL $2.00 FOR HANDLING AND MAILING CHARGES

CIRCLE 43 ON FREE INFORMATION CARD

BUY QUALITY ELECTRONIC & INDUSTRIAL COMPONENTS From the Source!

THIS MONTH'S SPECIALS!

POWER SUPPLY MODULE
WIDE RANGE INPUT 3-TERMINAL SWITCHING REGULATOR
— BOSCHERT 3T12AP
Input DC voltage +10V to 60V. Output DC voltage adjustment range +4.5V to 30V. Output current 0-12A. Dimensions 5"L × 4"W × 1⅝"H. 15⁹⁵ EACH

DC Series Regulator
POWER 1B5-6
Input DC voltage 40V, output DC voltage +4.5V to +6.5V. Input-output min. diff. 4.1VDC. Dimensions 2¾" × 2¾" × 1¼"H.
13⁵⁰ EACH

DC Power Supply
POWER-ONE
HN5-9/0VP
Input: 115/230 VAC 47-440 Hz. Output: +5 VDC at 9A. Dimensions 5"W × 7"L × 3½"H.
19⁹⁵ EACH

MUFFIN FANS 115 Vac 50/60 Hz
IMPEDANCE PROTECTED.

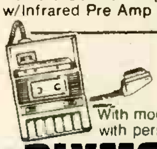
HOWARD	4¾" Sq. × 1½" 115 CFM Like New	8.95 ea.
IMC	4¾" Sq. × 1½" 115 CFM New	10.95 ea.
ETRI	3⅝" Sq. × 1" 21 CFM New	8.95 ea.

220/240 Vac 50/60 Hz-IMPEDANCE PROTECTED

IMC	4¾" Sq. × 1½" 115 CFM New	9.95 ea.
IMC	10" O.D. × 3½" 230 CFM New	19.95 ea.

1982 GTE SYLVANIA COLOR TV PARTS
Remote Control Amplifier w/Infrared Pre Amp 9.95/Set

MECHANICAL TV TUNER
Channels 2-83, Sylvania part No. 54-43617
10.95 ea.



CASSETTE DATA RECORDER
1-7/8 IPS, 4-TRACK, 2-CHANNEL DC Saturating Bias, 550 Flux reversals per inch, per channel. With modification, compatible with personal computers. 29⁹⁵

PLYMOUTH ELECTRONICS CO.
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CIRCLE 68 ON FREE INFORMATION CARD

ESP

PAT. #4,259,705

DON'T BLAME THE SOFTWARE!

Power Line Spikes and Hash often cause memory loss or erratic operation. Often floppies, printer & processor interact!

OUR patented ISOLATORS eliminate equipment interaction AND curb damaging Power Line Spikes, Surges and Hash.

Filtered 3-prong sockets and integral Spike Suppression. 125 VAC, 15 Amp, 1875 W Total - 1 KW per socket.

- ISO-1 ISOLATOR. 3 Filtered Sockets; 1000 Amp 8/20 usec Spike Suppressor . . . $76.95
- ISO-4 ISOLATOR. 6 Filtered Sockets; 1000 Amp 8/20 usec Spike Suppressor . . . $128.95
- ISO-3 SUPER-ISOLATOR. 3 DUAL filtered Sockets; 2000 Amp 8/20 usec Spike Suppressor . . . $115.95
- ISO-7 SUPER-ISOLATOR. 5 DUAL filtered Sockets; 2000 Amp 8/20 usec Spike Suppresor . . . $186.95

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TOLL FREE ORDER DESK 1-800-225-4876
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Electronic Specialists, Inc.
171 South Main Street, Natick, MA 01760
Technical & Non-800: 1-617-655-1532

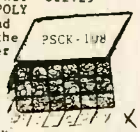
CIRCLE 48 ON FREE INFORMATION CARD

JAVANCO

1-800-251-5555 TOLL FREE ORDER LINE

160 2nd Ave.S. Nashville, Tn. 37201

PSCK-108 POLYSTYRENE KIT $12.25
108 pcs. axial lead POLY CAPS.assorted uf.s and voltages.,these are the caps which many prefer because of stability and low failure rate. 18 TRYES of (6) PCS. 108 POLYSYPRENE CAPS again packed in a reuseable,hinged top box.



EP-1001 $15.00
AN AUTOMATIC PROGRAMMER DESIGNED FOR HEATING SYSTEMS.
IT OVERRIVES THE THERMOSTAT DURING NITE HRS TO SAVE $$ OFF YOUR WINTER FUEL BILL,COMES WITH INSTRUCTIONS
EP-1001 FUEL SAVER

CLK-10 (10) ADJUSTABLE CAN TYPE RF-IF COILS. LARGE AND SMALL TYPES. $2.35 PKG.

CLK-20 (20) OPEN WINDING SLUG TUNED COILS $2.25 PKG.

CLK-25 (25) ASSORTED FIXED INDUCTOR CHOKES AND COILS. AXIAL AND PRINTED CIRCUIT TYPES. $1.70 PKG.

DCK-18 (18) LONG LEAD CERAMIC DISC CAPACITORS. HAND PICKED FOR THE BEST VALUES IN STOCK. 90¢ PKG.

DCK-21 (21) HIGH QUALITY POLYSTYRENE CAPACITORS. THESE CAN REPLACE MICA,FILM,PAPER AND CERAMIC TYPES IN MOST CASES. $1.00 PKG.

DCK-25 (25) HIGH VOLTAGE CERAMIC DISC CAPACITORS. 1Kv TO 7.5 Kv. $2.90 PKG.

DCK-100 (100) PRINTED CIRCUIT DISCAPS. PICKED FROM STOCK TO ASSURE THE CORRECT ASSORTMENT OF VALUES FOR EVERYDAY USE. $2.50 PKG.

DIK-10 (10) UNIVERSAL SIGNAL DIODES, SUCH AS 1n34,1n60,1n64,1n295 AND ECG-177. PACKED IN A REUSEABLE PLASTIC CASE. $0.65 PKG.

AC-1004

Shielded cable. very flexible. 7 ft. lengths. 1/8" diameter.. woven copper braid shield with polyethylene core and black pvc outer insulation. prestripped ends and solid tinned copper core wire.

PRICE
1 seven foot length 90¢
1 bundle (40) seven foot lengths $20.00

CRYSTALS...

CRY-1	6.1804 MHZ
CRY-2	5.6950 MHZ
CRY-3	5.7150 MHZ
CRY-4	14.4 MHZ
CRY-5	32.9 MHZ
CRY-7	5.7250 MHZ
CRY-8	6.1505 MHZ
CRY-10	32.700 MHZ
CRY-11	6.1904 MHZ
CRY-12	5.7350 MHZ
CRY-13	6.1704 MHZ
CRY-14	3.2333 MHZ
CRY-16	3.3000 MHZ
CRY-18	5.175 MHZ
CRY-19	5.1398 MHZ
CRY-20	56.993750 MHZ

WE HAVE HAD NUMEROUS CALLS FOR CRYSTALS.SOME ARE PC LEAD SOME ARE LONG LEAD SOME,SMALL CASE,SOME REG.

YOUR CHOICE $1.90 EACH

CRY-21	5.164583 MHZ
CRY-22	5.147917 MHZ
CRY-23	5.131250 MHZ
CRY-24	5.156250 MHZ
CRY-25	3691.667 KHZ KHZ
CRY-26	3650.000 KHZ KHZ
CRY-27	3695.833 KHZ KHZ
CRY-28	3654.167 KHZ KHZ
CRY-29	3779.167 KHZ KHZ
CRY-30	3.775.00 MHZ
CRY-31	3737.500 KHZ KHZ
CRY-32	3733.333 KHZ HHZ
CRY-33	3775.00 KHZ KHZ
CRY-34	5.0688 MHZ

CIRCLE 44 ON FREE INFORMATION CARD

ramsey the first name in Counters !

9 DIGITS 600 MHz $129.95 WIRED

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!

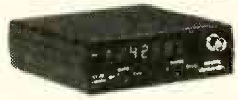
PRICES

CT-90 wired, 1 year warranty	$129.95
CT-90 Kit, 90 day parts warranty	109.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC Adapter/Charger	12.95
OV-1, Micro-power Oven time base	49.95
External time base input	14.95

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



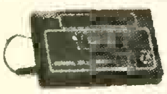
SPECIFICATIONS:

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

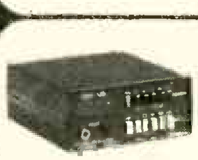
SPECIFICATIONS:

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

AUDIO SCALER

For high resolution audio measurements, multiplies UP in frequency.

- Great for PL tones
- Multiplies by 10 or 100
- 0.01 Hz resolution!

$29.95 Kit $39.95 Wired

ACCESSORIES

Telescopic whip antenna - BNC plug	$ 7.95
High impedance probe, light loading	15.95
Low pass probe, for audio measurements	15.95
Direct probe, general purpose usage	12.95
Tilt bail, for CT 70, 90, MINI-100	3.95
Color burst calibration unit, calibrates counter against color TV signal	14.95

COUNTER PREAMP

For measuring extremely weak signals from 10 to 1,000 MHz. Small size, powered by plug transformer-included.

- Flat 25 db gain
- BNC Connectors
- Great for sniffing RF with pick-up loop

$34.95 Kit $44.95 Wired

ramsey electronics, inc.
2575 BAIRD RD. • PENFIELD, NY 14526

PHONE ORDERS
CALL 716-586-3950

TERMS Satisfaction guaranteed - examine for 10 days, if not pleased, return in original form for refund. Add 5% for shipping - insurance to a maximum of $10. Overseas add 15%. COD add $2. Orders under $10.. add $1.50. NY residents add 7% tax.

4164 64K DYNAMIC 200 NS $5.95

TMM2016 2KX8 STATIC 200 NS $4.15

STATIC RAMS

2101	256 x 4	(450ns)	1.95
5101	256 x 4	(450ns) (cmos)	3.95
2102-1	1024 x 1	(450ns)	.89
2102L-4	1024 x 1	(450ns) (LP)	.99
2102L-2	1024 x 1	(250ns) (LP)	1.49
2111	256 x 4	(450ns)	2.49
2112	256 x 4	(450ns)	2.99
2114	1024 x 4	(450ns)	8/9.95
2114L-4	1024 x 4	(450ns) (LP)	8/12.95
2114L-3	1024 x 4	(300ns) (LP)	8/13.45
2114L-2	1024 x 4	(200ns) (LP)	8/13.95
2147	4096 x 1	(55ns)	4.95
TMS4044-4	4096 x 1	(450ns)	3.49
TMS4044-3	4096 x 1	(300ns)	3.99
TMS4044-2	4096 x 1	(200ns)	4.49
MK4118	1024 x 8	(250ns)	9.95
TMM2016-200	2048 x 8	(200ns)	4.15
TMM2016-150	2048 x 8	(150ns)	4.95
TMM2016-100	2048 x 8	(100ns)	6.15
HM6116-4	2048 x 8	(200ns) (cmos)	4.75
HM6116-3	2048 x 8	(150ns) (cmos)	4.95
HM6116-2	2048 x 8	(120ns) (cmos)	8.95
HM6116LP-4	2048 x 8	(200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8	(150ns) (cmos)(LP)	6.95
HM6116LP-2	2048 x 8	(120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8	(300ns) (Qstat)	34.95

LP = Low Power   Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1	(250ns)	1.99
UPD411	4096 x 1	(300ns)	3.00
MM5280	4096 x 1	(300ns)	3.00
MK4108	8192 x 1	(200ns)	1.95
MM5298	8192 x 1	(250ns)	1.85
4116-300	16384 x 1	(300ns)	8/11.75
4116-250	16384 x 1	(250ns)	8/11.95
4116-200	16384 x 1	(200ns)	8/12.95
4116-150	16384 x 1	(150ns)	8/14.95
4116-120	16384 x 1	(120ns)	8/29.95
2118	16384 x 1	(150ns) (5v)	4.95
4164-200	65536 x 1	(200ns) (5v)	5.95
4164-150	65536 x 1	(150ns) (5v)	6.95

5V = single 5 volt supply

EPROMS

1702	256 x 8	(1us)	4.50
2708	1024 x 8	(450ns)	3.95
2758	1024 x 8	(450ns) (5v)	5.95
2716	2048 x 8	(450ns) (5v)	3.95
2716-1	2048 x 8	(350ns) (5v)	5.95
TMS2516	2048 x 8	(450ns) (5v)	5.50
TMS2716	2048 x 8	(450ns)	7.95
TMS2532	4096 x 8	(450ns) (5v)	5.95
2732	4096 x 8	(450ns) (5v)	4.95
2732-250	4096 x 8	(250ns) (5v)	8.95
2732-200	4096 x 8	(200ns) (5v)	11.95
2764	8192 x 8	(450ns) (5v)	9.95
2764-250	8192 x 8	(250ns) (5v)	14.95
2764-200	8192 x 8	(200ns) (5v)	24.95
TMS2564	8192 x 8	(450ns) (5v)	17.95
MC68764	8192 x 8	(450ns) (5v)(24 pin)	39.95

5v = Single 5 Volt Supply

EPROM ERASERS

	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
10.738635	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	35.95
HD46505SP	15.95
6847	12.25
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

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
8231	call
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
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

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74LS09	.29	74LS192	.79
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74LS12	.35	74LS195	.69
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74LS38	.35	74LS253	.59
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74LS42	.49	74LS258	.59
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74LS48	.75	74LS260	.59
74LS49	.75	74LS266	.55
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74LS92	.55	74LS363	1.35
74LS93	.55	74LS364	1.95
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74LS96	.89	74LS366	.49
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74LS109	.39	74LS368	.45
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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

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TL072	1.19	LF347	2.19
TL074	2.19	LF351	.60
TL081	.79	LF353	1.00
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TL083	1.19	LF356	1.10
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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
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4030	.39	74C73	.65
4034	1.95	74C74	.65
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4066	.39	74C160	1.19
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4073	.29	74C173	.79
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* COMPLETE WITH POWER SUPPLY, SWITCH, LINE CORD, FUSE & STANDARD POWER CONNECTOR
* DIMENSIONS: 11½ x 5¾ x 3 15/16"
* +5V @ 1 AMP, +12V @ 1.5 AMP
* FITS STANDARD 5¼" DRIVES
* PLEASE SPECIFY GRAY OR TAN

NOTE: Please include sufficient amount for shipping on above items.

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* REPEAT OF A SELLOUT
* LIMITED SUPPLY (AGAIN)
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TMS2532 450NS	5.95	6800 1MHZ	3.95
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COMPONENTS

LM1488 or LM1489 .69 ea.   7805T or 7812T .75 ea.

16 PIN LOW PROFILE ST IC SOCKETS 100/8.00

16 PIN TOOLED WIRE WRAP IC SOCKETS .49 EA.

SPRING SPECIALS ARE GOOD ONLY UNTIL MAY 31, 1983

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MODEL 2 $39.95

MOUNTED ON PC BOARD

MANUFACTURED BY CONVER

+5 VOLT 4 AMP

±12 VOLT 1 AMP

NOTE: Please include sufficient amount for shipping on above items.

CONNECTORS

RS232 MALE	2.50
RS232 FEMALE	3.25
RS232 FEMALE RIGHT ANGLE	5.25
RS232 HOOD	1.25
S-100 ST	3.95
S-100 WW	4.95
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44 pin WW	4.95
72 pin ST	6.95
72 pin WW	7.95

RIBBON CABLE

CONTACTS	SINGLE COLOR 1'	SINGLE COLOR 10'	COLOR CODED 1'	COLOR CODED 10'
10	.50	4.40	.83	7.30
20	.65	5.70	1.25	11.00
26	.75	6.60	1.32	11.60
34	.98	8.60	1.65	14.50
40	1.32	11.60	1.92	16.80
50	1.38	12.10	2.50	22.00

D-SUBMINIATURE

DESCRIPTION	SOLDER MALE	SOLDER FEMALE	RIGHT ANGLE SOLDER MALE	RIGHT ANGLE SOLDER FEMALE	RIBBON CABLE MALE	RIBBON CABLE FEMALE	HOODS BLACK	HOODS GREY
ORDER BY	DBxxP	DBxxS	DBxxPR	DBxxSR	IDBxxP	IDBxxS	HOOD-B	HOOD
CONTACTS 9	2.08	2.66	1.65	2.18	3.37	3.69	—	1.60
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
37	4.80	7.11	4.83	6.19	9.22	10.08	—	2.95
50	6.06	9.24	—	—	—	—	—	3.50

For order instructions see "IDC Connectors" below.

IDC CONNECTORS

DESCRIPTION	SOLDER HEADER	RIGHT ANGLE SOLDER HEADER	WW HEADER	RIGHT ANGLE WW HEADER	RIBBON HEADER SOCKET	RIBBON HEADER	RIBBON EDGE CARD
ORDER BY	IDHxxS	IDHxxSR	IDHxxW	IDHxxWR	IDSxx	IDMxx	IDExx
CONTACTS 10	.82	.85	.86	2.05	1.15	—	2.25
20	1.29	1.35	2.98	3.28	1.86	5.50	2.36
26	1.68	1.76	3.84	4.22	2.43	6.25	2.65
34	2.20	2.31	4.50	4.45	3.15	7.00	3.25
40	2.58	2.72	5.28	4.30	3.73	7.50	3.80
50	3.24	3.39	6.63	7.30	4.65	8.50	4.74

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 IDH10SR.

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A look at the latest videogame consoles announced at the WCES show, including Intellivision II, Intellivision III, and Odyssey.

COLECOVISION
An in-depth look at the Colecovision console and accessories, and new game cartridges.

GCE'S VECTREX ARCADE GAME
A look at the first home videogame with a built-in CRT and vector-type graphics. The discussion will include a look at some of the game cartridges.

THE ATARI 5200 SUPER GAME SYSTEM
Atari's latest entry in the videogame market is described along with the game cartridges for the new system.

STARPATH'S SUPERCHARGER
A plug-in adaptor for Atari's 2600 console that improves the graphic resolution.

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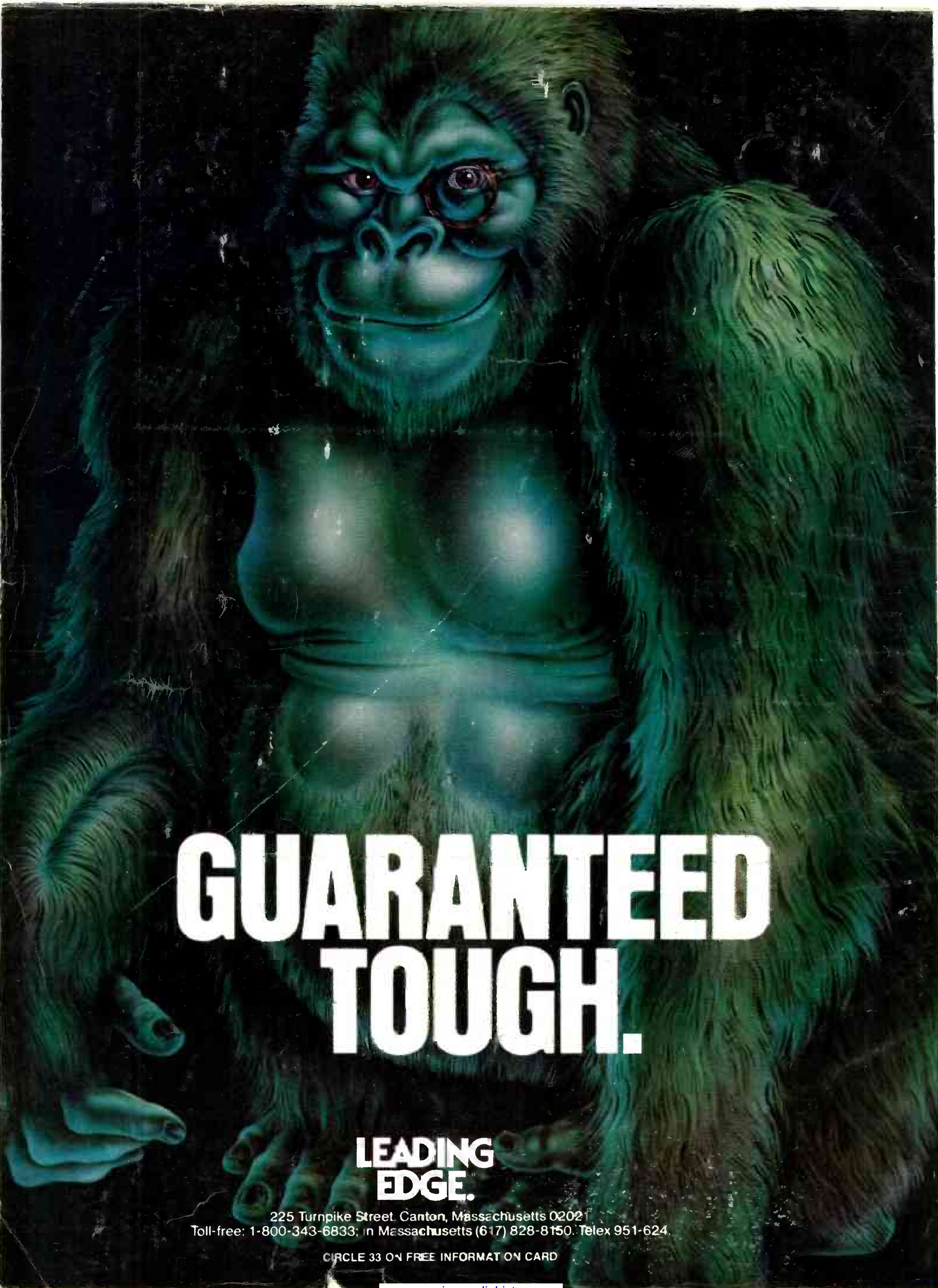

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