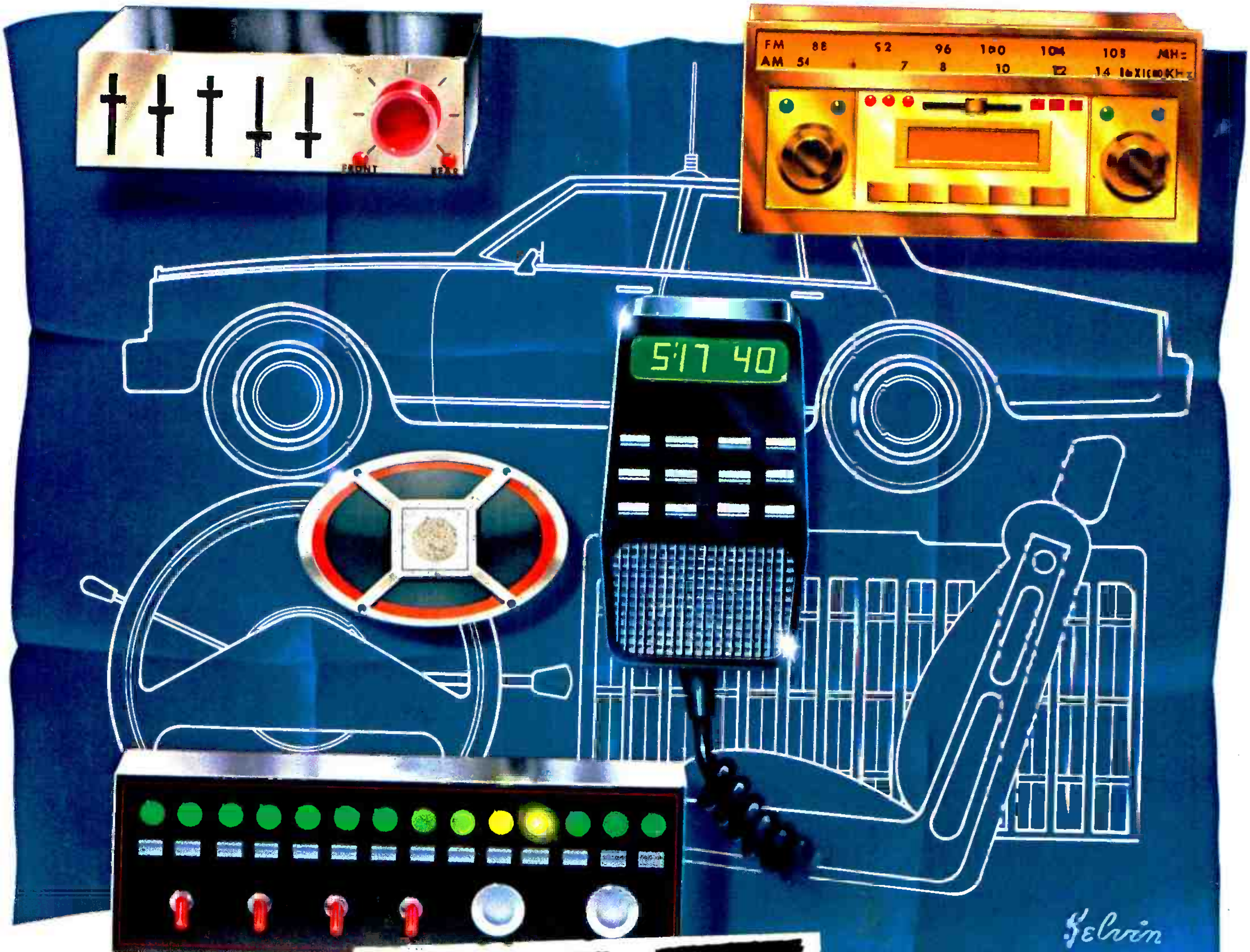
Popular Electronics

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE JUNE 1979/$1.25

Pulse-Width Modulation Controls Motor Speed
A Simple, Adjustable Bench Power Supply
Electronically Simulated Ocean-Surf Sound

Special Focus on Car Stereo & CB Radio



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Popular Electronics

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Issue

Stereo Headphones
f Speaker System
Stereo 150 Basic Power Amplifier

Quartz lock meets linear drive.

When Fisher introduced our radically new linear drive turntable two years ago, it was hailed as the most important advance in turntables since direct drive.

But now we've taken linear drive to a new level of performance, by combining it with a sophisticated quartz-locked speed control. Presenting the MT6250 Studio Standard turntable—we think the world's finest.

The MT6250 uses the same 120-pole linear motor direct drive system that has been thoroughly proven in other Fisher turntables. This system uses three precisely phased drive coils to propel a 120-pole magnetic strip encircling the turntable platter. And it is so elegantly simple and smooth that it would be difficult to improve upon. The overlapping drive pulses and large number of poles (compared with 12 or 16 in conventional direct drive systems) assure almost perfect smoothness, freedom from "cogging," and lower wow & flutter.

For speed stability, Fisher engineered a unique, quartz crystal-controlled, phase locked loop speed servo. The servo electronically monitors the rotation of the platter thousands of times every minute, and keeps it locked in perfect sync with the crystal oscillator. This system is so stable that speed variation of the MT6250 is practically zero.

Of course, the rest of the MT6250 lives up to the performance standards set by its drive system. The fully-counterbalanced tonearm easily handles virtually any cartridge, and provides the convenience of automatic return and shutoff at end of record, or when reject is actuated. Built into the beautifully finished base are adjustable leveling feet and a bubble level which doubles as a stylus overhang gauge.

If you want the best performing turntable money can buy, see and hear the Fisher MT6250 at $300.*

Quartz lock meets linear drive now at selected audio dealers or the audio department of your favorite department store. Don't miss the action.

*Manufacturer's suggested retail value. Actual selling price determined solely by the individual Fisher dealer.

New guide to buying high fidelity equipment. Send $2 for Fisher Handbook, with name and address to Fisher Corp., Dept. H, 21314 Lassen St., Chatsworth, CA 91311.

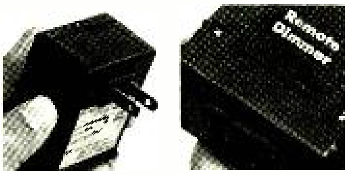
FISHER

The first name in high fidelity.®

MT6250

This $20 pager can control 16 of either your appliances or your lights. There's no installation required and the complete story is explained below.

Space Pagers



Control your entire home from your pocket with the world's first micro electronic remote Space Pager.

You're in bed. It's late at night and you're watching TV. It's time to shut off your TV, so you reach for a remote control device, press a button, and off it goes.

That's not unusual. But what is about to invade the typical American home will be.

ELECTRONIC PAGING

Scientists have developed the technology to individually page any light or electrical appliance in your home and command it to go on or off from a device that fits in your pocket.

Remote paging requires no special home installation since it utilizes your existing household wiring system and small inexpensive modules that plug into your wall outlets.

The system is also very inexpensive. It costs less than $14 per module to control any light or appliance, and less than $100 for a complete paging system.

HERE'S HOW IT WORKS

You press a number on a calculator-type keyboard that sends out a digital signal picked up by the electrical wiring system in your home.

The digital signal pages only those wall modules set to the number you keyed. If you page a light, for example, you can also page it to turn on, off, or you can even dim it (just like the dimmer switch you have on your wall). You can page an appliance such as your coffee maker or toaster to turn either on or off. There are up to 16 different electrical devices you can control with your pager.

WHAT IT WILL DO

Remote space paging will perform many useful functions that will quickly pay for your modest investment.

Security From your bed, you can turn on all the interior lights, your exterior lights, and sound an alarm to warn your neighbors.

Convenience Wake up in the morning, turn on your coffee maker, the TV and all your lights from the convenience of your bed.

Because it is so easy to use and so inexpensive, you can start with just a few modules and expand later. There are modules that plug into your outlets, and modules that replace your present wall switches.

To make space paging work, you need a device to generate the digital code and transfer the signal to your household wiring. There are two systems available to do this:

Direct-Controlled The direct system consists of a control unit at $39.95. The control unit is plugged into the wall and placed by your bed or at any location you select. To open, close, or dim a light, you press the appropriate number and press the function you want to perform. You also have the option of using the system with a remote ultrasonic pager. You point the ultrasonic pager at the control unit and enter the command. The remote pager lets you move about a room or area and is an optional accessory of the direct system at only $19.95.

Timer-Controlled The timer-controlled unit consists of a digital clock and a memory. You can program the exact time you want each light or appliance to turn on or off. You also have a "dynamic living pattern" switch which controls the lights randomly and automatically to make it look like you are home while you are away or on vacation. You can now have your TV wake you up, your coffee started, and even your car warmed up in a set sequence every morning. It's like having your own invisible robot.

Let's say you're in the living room and the lights are plugged into the modules and the control unit is in the bedroom. No problem. You can override the system by turning the lights on or off manually at your lamp switch.

You can inexpensively expand the system by adding more modules. If you want to control your lighting from two locations, order another control unit. You can always expand your system.

Once you've turned your bedroom into a paging command center, there is one more expansion possibility: the timer-controlled system which will be available for approximately $50 in the fall of 1979. JS&A customers will be advised first of its availability.

JS&A is America's largest single source of space-age products. We back the system with a prompt service-by-mail facility, a one year limited warranty and a 30-day trial period. If you're not completely satisfied, simply return the system within 30 days for a prompt and courteous refund.

Space paging will bring you freedom, security, convenience, and peace of mind. It will save you steps, time, and money. Finally, right from your bed, you can control your entire home's electronics–something that only a thousand dollar home computer could have done until the Space Pager was developed.

TRY THE SYSTEM NOW

We recommend that you purchase a series of modules, wall switches, and the direct system. A good starter package consists of one plug-in module for a plug-in light at **$13.95**, two modules for appliances at **$14.95** each, one wall switch for **$14.95**, and the control unit for **$39.95**. The total cost for the package is **$98.75** complete. If you wish to order the remote pager, it costs **$19.95**. Postage and handling is only $2.50 for each order no matter how many modules or receiving control units you purchase. (Illinois residents please add 5% sales tax.) Credit card buyers may call our toll-free number below.

Let space-age technology turn your house into a home of the future. Order your Space Pager system at no obligation, today.

JS&A PRODUCTS THAT THINK

Dept. PE One JS&A Plaza
Northbrook, Ill. 60062 (312) 564-7000
Call TOLL-FREE 800 323-6400
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JUNE 1979

VOLUME 15, NUMBER 6

Popular Electronics®

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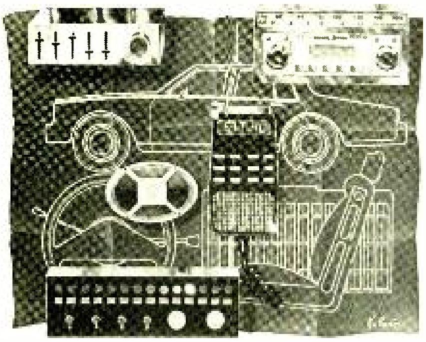

About the cover:

This issue's special editorial focus reflects the growing use of car stereo and communication equipment in mobile environments.

Cover Art by George Kelvin

Special Focus on Mobile Sound and CB

Feature Articles

Construction Articles

Columns

Julian Hirsch Audio Reports

Electronic Product Test Report

Departments

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Editorial

ELECTRONIC PARTS DEARTH

"Water, water everywhere, and not a drop to drink . . ." is not actually analogous to the position that electronics experimenters are in where electronic parts are concerned. But we all feel the tightening of parts availability amidst a sea of components being sold for consumer electronics and commercial and military equipment.

Sure, Sprague and others are enjoying a banner year in the production of electronic components. But how many parts being popped out by automatic machines are for one-piece-at-a-time sale? Unfortunately, more and more manufacturers are dropping manufacture of commonplace, low-cost semiconductors and other devices to concentrate on higher-ticket IC's, especially microprocessors. Along these lines, capacitor makers in Japan are moving the manufacture of low-cost components to Southeast Asia, while concentrating at home on more expensive items.

Of special interest, Motorola recently discontinued its Hobbyist and Experimenter Program (HEP) line of parts. Some good (for electronics hobbyists) may come out of it, though. The company is expanding distribution of its Maintenance and Repair Operations (MRO) line. I understand that there will be about 1,000 devices, and that the bagged products will initially be marked with a HEP number as well as a device number. Moreover, retail prices will remain the same, while distributor prices will be reduced. Hopefully, this will be sufficient motivation for distributors to carry more product types. GC Electronics, too, has exhibited great interest recently in expanding its Calectro line of electronic devices.

Even kit suppliers report an increasingly difficult time in gathering all parts required; some of the larger companies, in fact, cut back on kit models owing to this problem. And that's why there are times when direct-mail suppliers of parts, such as companies in our "Electronics Market Place" section, are sometimes forced to backorder some items, much to the chagrin of purchasers. Truly, it sometimes cannot be helped owing to forces beyond their control. In trying to reach a minimum-dollar mail-order purchase, therefore, it would be wise to add some widely used transistors and chips that can be stored away in the junkbox for future applications.

The law of supply and demand will take over, I believe, and some bright component makers will recognize a growing vacuum and fill the void. That might be nirvana for many of us. If it's any consolation, toy makers who entered the electronic-toy market were shocked to learn of the long lead times required to get all their necessary components. With up to 26 weeks delivery time cited, they're still dazed.

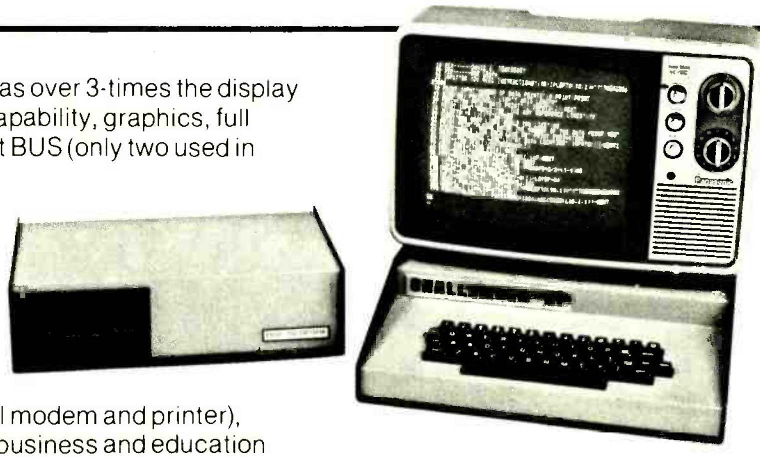
Art Salsberg

The Personal Computer Line by OHIO SCIENTIFIC

C1P: $349! A dramatic breakthrough in price and performance. Features OSI's ultra-fast BASIC-in-ROM, full graphics display capability, and large library of software on cassette and disk, including entertainment programs, personal finance, small business, and home applications. It's a complete programmable computer system ready to go. Just plug-in a video monitor or TV through an RF converter, and be up and running. 15K total memory including 8K BASIC and 4K RAM — expandable to 8K.

C1P MF: $995! First floppy disk based computer for under $1000! Same great features as the C1P plus more memory and instant program and data retrieval. Can be expanded to 32K static RAM and a second mini-floppy. It also supports a printer, modem, real time clock, and AC remote interface, as well as OS-65D V3.0 development disk operating system.

C2-4P: $598! The professional portable that has over 3-times the display capability of 1P's. Features 32 x 64 character display capability, graphics, full computer type keyboard, audio cassette port, and 4 slot BUS (only two used in base machine). It has 8K BASIC, 4K RAM, and can be expanded to 32K RAM, dual mini-floppies and a printer.



C2-4P MF: $1599! It's a big personal computing mini-floppy system at a special package price. Contains the famous C2-4P microcomputer with 20K static RAM, 5" mini-floppy unit for instant program and data loading, RS-232 circuitry (for optional modem and printer), and four diskettes featuring exciting games, personal, business and education applications.

C2-8P: $799! The personal class computer that can be expanded to a full business system. Has all the features of the C2-4P plus an 8 slot BUS (3-times greater expansion ability than the C2-4P). Can be expanded to 48K RAM, dual floppies, hard disk, printer and business software.

C2-8P DF: $2599! A full business system available at a personal computer price! The system includes the powerful C2-8P microcomputer (32K RAM expandable to 48K), dual 8" floppy unit (stores 8-times as much information as a mini-floppy), and 3 disks of personal, educational and small business applications software. Has all the capabilities of a personal system including graphics plus the ability to perform Accounting, Information Management, and Word Processing tasks for small business. Contact your local Ohio Scientific dealer

All prices, suggested retail

OHIO SCIENTIFIC

America's largest full-line microcomputer manufacturer

1333 S. CHILLICOTHE RD., AURORA, OHIO 44202 (216) 562-3101

* Monitors and cassette recorders not included. Ohio Scientific offers a combination TV/Monitor (AC-3P) for $115.

CIRCLE NO. 39 ON FREE INFORMATION CARD

Letters

GEM OF A FIND

Your "Special Focus On Speakers" in the March 1979 issue is the most complete and understandable reference I've come across. Well done! What was surprising was to find such a focus in POPULAR ELECTRONICS and not some publication devoted solely to audio and high-fidelity sound. —*Rod Sweetland, Sacramento, CA.*

GARAGE DOOR CLOSER CAUTION

The design of the door closer ("An Automatic Garage-Door Closer" March 1979) is creative and simple but presents some risks. Most garage-door-opener manufacturers tell you not to allow unattended operation. The possibility of an obstruction or jamming of the motor can be serious. The auto-reversing feature will normally trip at about 5 to 10 lb of resisting force at midtravel. But as the door nears the final few inches of travel, the toggle effect of the operating arm can produce forces in excess of 100 lb. An improperly adjusted sense mechanism is even worse. A digitally coded transmitter/receiver is a better solution. —*Mark L. Shaw, Mesa, AZ.*

PE IS "TOPS"

I was so impressed with your March 1979 Editorial that I decided to write and congratulate you on the accuracy of your "comprehensive study of POPULAR ELECTRONICS subscribers." I'm a chemist, but in our field we make use of the latest in electronics technology. The most interesting way to keep on "top" is to read your magazine. There are always articles we can use in analytical chemistry. Thanks for the effort to find out who your readers are. (I'm 28 years old with a B.S. and M.S. from Oregon State U.)—*Dick D. Wilson, Columbia, MO.*

RAM TITLE ERROR

When you listed on the April cover and in the Table of Contents a "Buying Guide to Microcomputer I/O Boards," I was surprised to find that the list actually covered RAM boards. What happened?—*M. I. Leavey, Randallstown, MD.*

We could say, "April Fool," but regrettably RAM boards were substituted at the last moment owing to a space problem and the title inadvertently remained I/O (see this issue's I/O Board Buying Guide).—Ed.

Truth Computer

Can a voice stress analyzer tell if someone is telling the truth? It can and it can't. Here's the true story.

This $250 unit represents a major breakthrough in voice stress technology.

By David D. Harrison

There is no device that can tell you if somebody is telling the truth. Not even a lie detector.

Lie detectors (or polygraph machines) simply detect stress, but it takes a competent professional polygraph examiner to interpret the results.

The same goes for voice stress analyzers. Voice stress analyzers will detect stress in a person's voice, but there are three types of voice stress and only one type is caused by not telling the truth.

EASIER TO USE

But voice stress analyzers are easier to use than the polygraph machines. A polygraph machine obtains four separate readings from a subject who is strapped into a chair and obviously aware of the test, whereas the voice stress analyzer uses one reading from a subject who may be unaware of the test.

It is therefore easier to obtain and interpret the results from a voice stress analyzer and with the proper instruction, a person can be trained to differentiate between the three types of voice stress.

TRUTH IS COSTLY

The problem with most voice stress analyzers is that they are costly – from $800 to $4,000. To make them appear more costly, manufacturers have added tape recorders, graph-producing devices and elaborate carrying cases, and some have even taken out full-page national color advertisements.

There is a voice-stress analyzer that I personally helped design and there is no mysterious secret about its low price of $250 either. First let me explain the principle of voice stress analysis and why my unit is priced so low.

PRINCIPLE OF VOICE STRESS

When you are relaxed and talk, your vocal chords vibrate at a certain frequency and produce voice tremors. But your vocal chord is a muscle and like any other muscle in your body, when you're tense, the muscle exhibits stress, tightens up and squelches these voice tremors. Voice stress analyzers detect the absence of these voice tremors.

Voice stress analysis was first discovered during World War II. Two OSS officers noticed that when a subject was under mental stress, the central nervous system surrendered muscular control to the involuntary or automatic nervous system, which squelched the voice tremors. The OSS men then set up a company to manufacture and market devices which could detect stress and which are still used by intelligence groups throughout the world.

Since the tremor is really a frequency, by developing a system to detect and amplify this frequency, similar to an FM receiver, you can indeed determine stress.

When I first analyzed the market I saw the serious manufacturers and the usual fast-buck artists. Any new emerging industry has both. But my investigation revealed that both elements had problems.

TO KEEP COSTS LOW

The serious manufacturers could not produce large quantities to keep their prices low nor did they want to and the fast-buck artists were ruining the reputations of the very serious people in the industry.

I realized that the basic system was nothing more than a very sophisticated FM receiver. I also realized that I could produce that system to sell for $250. But something was missing.

In order for any of these systems to work, you required training. So I developed a training course that is sent free with each analyzer I sell. With the proper training and my unit you can indeed determine more accurately the nature and the cause of voice stress and you can then intelligently draw your own conclusions.

12 PATENT CLAIMS

My unit uses the highest quality components and I've personally checked it against units selling for up to $4,000. It works as accurately as some of the higher priced units on the market.

There are over 12 patent claims that were allowed for our unit so not only is it a quality product, it is quite unique. Other units measure the AM component of a voice whereas my system measures the FM component. The signal is cleaner and easier to define. My unit comes with a direct input jack for a microphone or tape recorder. You can therefore record conversations and then play them back later for analysis.

THE NEW MORALITY

There's a new morality in this country. Ask any professional polygraph examiner. Years ago, it was unusual to find an employee stealing from you. Today it's almost part of the job. In fact, most theft from retail store owners is not from shoplifting, but from employees who feel that it's one of the store benefits.

There is a great moral controversy raised by the sale of voice stress analyzers. Is it immoral to determine whether or not someone is lying to you? We like to look at it the other way. Is it moral for somebody to lie to you in the first place? If people treat you fairly and honestly, would they care if you discovered that they were honest?

I CAN HELP YOU

My voice stress analyzer and my course can help you protect your business from the dishonesty that has come to plague our nation. It can be a great deterrent. It can aid you in making personal decisions, in evaluating prospective employees and finally it can become a very valuable business tool that can help you for the rest of your life.

The JS&A Group was so impressed with my unit that they have agreed to market my system through their outstanding organization. JS&A is America's largest single source of space-age products – further assurance that your modest investment is well protected.

To order my Harrison Voice Stress Analyzer, simply send your check for **$250** to JS&A (Illinois residents please add 5% sales tax) or credit card buyers, please call their toll-free number below. JS&A will send you your unit in a plain box along with my course. Use it for 30 days and if it does not function to your complete satisfaction, return it for a prompt and courteous refund.

I'm really proud to offer this unit. My efforts will make life more difficult for those who believe dishonesty is the new morality and it will make life easier for those of you who still believe that honesty is the best policy. Order one of my systems at no obligation, today.

JS&A PRODUCTS THAT THINK

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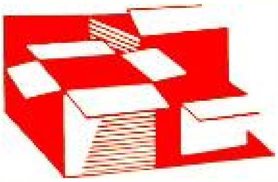
Northbrook, Ill. 60062 (312) 564-7000
Call TOLL-FREE 800 323-6400
In Illinois Call .... (312) 564-7000



New Products

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Free Information Card or write to the manufacturer at the address given.

Morrow S-100 Computer Interface

With Morrow's "Speakeasy" interface for "Thinker Toys" plugged into any S-100 computer bus, you can use up to three cassette player/recorders with motion control, a Teletype or RS-232 serial terminal, and any 8-bit parallel device. The interface provides 512 bytes of RAM and 512 bytes of PROM preprogrammed with COPE (Cassette Operating Executive) to handle the interfacing. The CPU in your present computer accomplishes several interfacing functions—generation and detection of waveforms for cassette decks, and translation of serial and parallel data for the TTY/RS-232 devices. COPE generates the Kansas City Convention (1200/2400-Hz, 300-baud) waveforms. Other COPE routines detect biphase waveforms and convert them to binary information. The interface comes with COPE written for the 8080A. $130 kit, $175 assembled.

CIRCLE NO. 88 ON FREE INFORMATION CARD

Mitsubishi DA-C7 Tuner-Preamp

Mitsubishi's new Model DA-C7 includes the functions of an AM/FM-stereo tuner and a control preamp. It can be physically and electrically joined with any of the com-

pany's power amplifiers to form a receiver controlled entirely from the front panel of the DA-C7. The tuner/preamp has two phono inputs and input/output connections for two tape recorders with two-way dubbing capability. The FM section offers a choice of wide and narrow bandwidth and has distortion rated at 0.1% with a claimed 73-dB stereo S/N ratio. Dimensions are 16¾"W × 11½"D × 6¾"H (42.5 × 29.2 × 17.1 cm). $360.

CIRCLE NO. 89 ON FREE INFORMATION CARD

Atlas Radio Ham Receiver

The solid-state Model RX-110 amateur-radio receiver from Atlas Radio operates in both CW and SSB modes on 10, 15, 20, 40, and 80 meters. It is self-contained with built-in ac supply and loudspeaker. It can operate with an external 12-to-14-volt dc supply and can be converted to a transceiver by plugging in a low-cost matching transmitter module manufactured by Atlas Radio. Modules are available in 15- and 200-watt versions and are designed to operate in both CW and SSB. Receiver size is 9¾"W × 8"D × 3¾"H (24.8 × 20.3 × 9.5 cm). $229.

CIRCLE NO. 91 ON FREE INFORMATION CARD

Keithley DMM Has True RMS

Keithley Instruments, Inc., has announced the Model 179-20A, 4½-digit multimeter that offers five-function capability, includ-

ing HI/LO ohms. It can measure 10 µV to 1200 volts dc; 10 µV to 1000 volts true rms ac; 10 nA to 20 amperes dc and true rms ac; and 0.1 ohm to 20 megohms. Basic accuracy is rated at 0.04% in the dc-volts and resistance functions. Overload protection is provided up to 1000 volts on resistance, 2- or 20-ampere fuse on current functions. The display consists of ½" seven-segment numeric LEDs. The display flashes 0000 when an overload condition exists. Range and function controls are color coded to minimize operator errors. Standard operation is from the ac line, but an optional rechargeable battery pack is available for portable operation. $349.

CIRCLE NO. 92 ON FREE INFORMATION CARD

Motorola AM/FM/Cassette/ CB Combo

Motorola's new in-dash Model CC975AX combines an AM/FM-stereo radio, cassette player with "Auto-Cue" program sensor, and 40-channel CB transceiver in a single in-dash unit. The CB section features a LED numeric channel display; switchable full or mixed interrupt on standby monitoring; digital PLL frequency synthesizer; anl; and adjustable squelch. The radio features pushbutton operation; LOCAL/DISTANCE switch on FM; automatic stereo mute; STEREO light; and BALANCE and FADER controls. The cassette section has a locking fast-forward function that's 8½ times normal speed; and automatic tape motor shutoff at tape end; pushbutton tape eject; and the Auto Cue system that quickly advances to the next taped selection. Size is 7"W × 7"D × 2⅞"H (17.8 × 17.8 × 7.2 cm). Weight is 7¼ lb (3.3 kg).

CIRCLE NO. 93 ON FREE INFORMATION CARD

JBL Monitor Speaker System

The JBL Model 4343 Professional Series Control Monitor speaker system, designed primarily for control rooms and mix-down

facilities, is suitable for demanding home-listening applications. The compact system has three drivers—a 10" (25.4-cm) woofer, 5" (12.7-cm) midrange driver, and 1" (2.54-cm) tweeter. The drivers are coupled to a crossover network that employs special phase-correcting circuitry and level controls that affect only the midrange speaker and tweeter. In-line mounting of the drivers is claimed to promote stereo imaging. Dense ¾" (1.9-cm) material is used for the basic enclosure, but a contemporary-styled walnut finish is available. Size is 22¾"H 14¼"W × 9 ¹⁵⁄₁₆"D (57.8 × 36.2 × 24.2 cm) and weight is 42.5 lb (19.3 kg). $369.

CIRCLE NO. 94 ON FREE INFORMATION CARD

TI Loran C-to-LAT/LON Module

Texas Instruments is offering a new Loran

The craftsmen at Realtime™ have done something quite unusual. They've created a dramatically thin, rugged alarm chronograph for under $250.

In fact, way under $250.

And while they've trimmed their timepiece's profile to a slim 9mm, they have done it without sacrificing a single feature, or compromising quality.

We have yet to see an alarm chronograph that even approaches the value of this superb new product, in a store or offered through the mail.

Microcomputer technology pushed to the limit.

It's truly remarkable the amount of information you can now carry on your wrist, especially when you consider it's a piece of jewelry no bulkier than an ordinary, slim wristwatch.

With this chronograph, you have bright liquid crystal digits always telling you the time of day. In hours, minutes and seconds (with accuracy to ±5 seconds a month).

What's more, you can even program the hours, minutes and seconds for any other time zone you wish for immediate recall, thanks to Realtime's dual time-zone feature.

It's a multitalented wrist alarm too. You may set it to beep-beep you in both

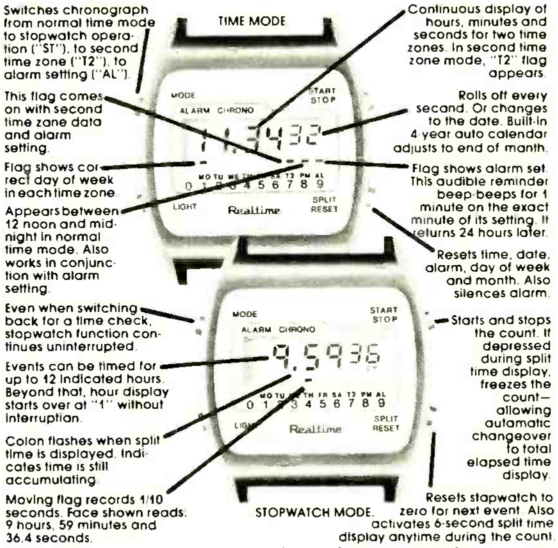
5 POPULAR ALARM CHRONOGRAPHS COMPARE THINNESS.

Texas Instruments ($125) 12.00 mm
Advance ($100) 11.5 mm
Citizen ($225) 11.0 mm
Seiko ($250) 10.5 mm
Realtime ($99) 9.0 mm

time zones, and at precisely the minute you choose. And because of Realtime's "PM" indicator, you won't be setting your alarm for the evening when you had intended to set it for the morning.

Is it Monday in New York? Or Tuesday in Hong Kong? You'll never have to ask that question again. The day of the week is always displayed. To see the date, simply flick a button. When the sun's down, press another and the Realtime's face is instantly illuminated.

And just as quickly as you recalled the date, you can set into motion a full-featured stopwatch. By the way, this stopwatch doesn't just count to 59



minutes like many other chronographs do—but up to 12 hours or more. It also precisely cleaves every second into tenths.

You may record split times, lap times or freeze the figures anytime. You may even alternate between your stopwatch functions and normal time ones without concern; by activating one mode, you don't interrupt the other.

$99 buys an honest design.

We wish you had a Realtime alarm chronograph in your hands right now. You'd see and feel the difference a 100% solid stainless steel case makes. (Most other comparably priced chronographs are chrome plated and not solid stainless.) Realtime's back and bracelet are also solid stainless. And every one of those bracelet links is double stamped to produce the exact size and taper required. Each link is then ground and polished. (We defy anyone to find workmanship like this, elsewhere at this price.)

You'll also notice there's no front speaker grill on this alarm chronograph; it doesn't need one. The alarm sound emanates from the rear of the case. Many other chronographs, in trying to look like Seiko with its front-mounted speaker, cleverly paste on printed front grills. These are functionless. Everything on your Realtime is there for function.

Water? Don't you worry.

The Realtime's face crystal isn't plastic like most chronographs you see. It's tough rock crystal. And not only is it hard enough to resist scratches, but it is fitted so tightly that the chronograph has passed water immersion tests of up to 100 feet. We know of no other chronograph—at any price—that can offer you this security.

This chronograph also has no moving parts to break down, and it is unlikely that servicing will ever be required even after years of hard use. It comes with batteries in place (easily changed by any jeweler), a one-year factory warranty from its manufacturer, complete instructions, service-by-mail facilities here in the U.S., and The Sharper Image's guarantee: if you are not delighted with your purchase, return it within two weeks for a complete and courteous refund.

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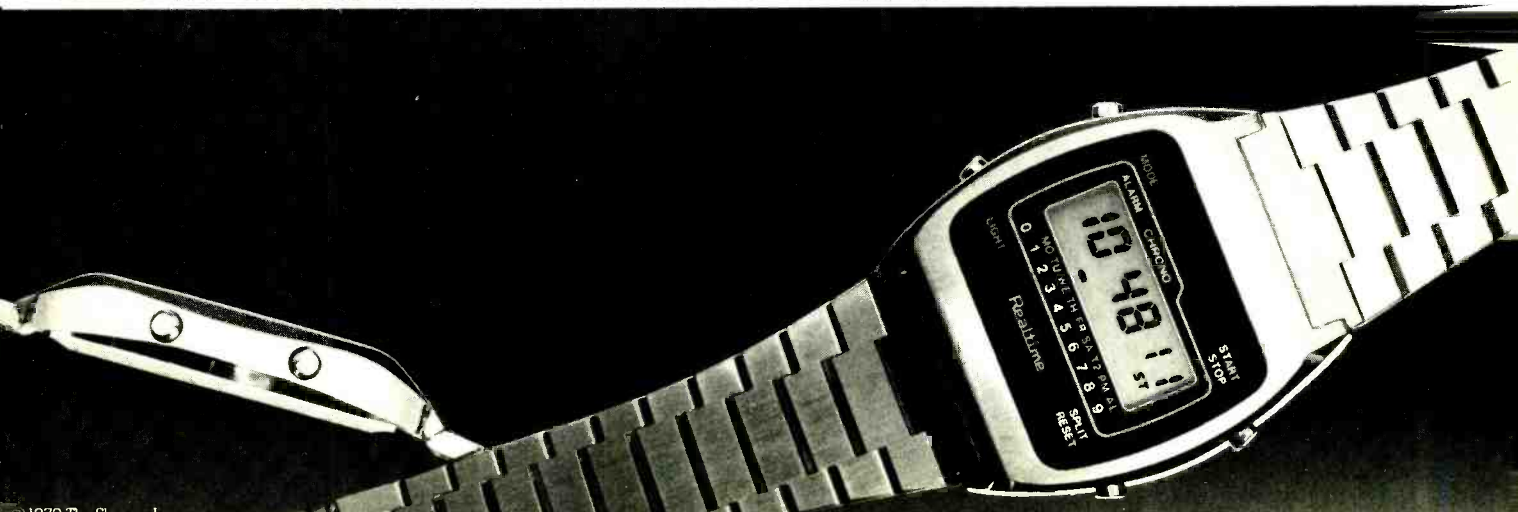
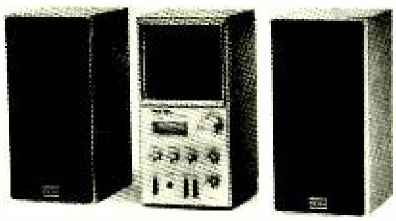


C-to-latitude/longitude Solid State Software^{TM} plug-in module for its TI-58 programmable calculator. Time differences (TDs) read from TI 9000, TI 9000A, or TI 9000N Loran C receivers are converted to equivalent Lat/Lon coordinates on the calculator. The operator can also calculate great-circle range and bearing between two Lat/Lon coordinates. The converter is claimed to work with all Loran C chains worldwide, present and scheduled, for which data was available as of January 1, 1979. According to TI, having the module is like having all of the world's Loran charts at your fingertips. Combined with the separately available Solid State Software Marine Navigation Library for the TI-58, the navigator can have a complete navigation and piloting system available.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Rotel Mini-System

Weighing a mere 30 lb and occupying only 1.2 cu ft, the RV-555 stereo system from Rotel consists of a receiver and two small



speakers. The receiver is rated to deliver 20 watts continuous to an 8-ohm load, 20 to 20,000 Hz at no more than 0.5% total harmonic distortion. The speakers weigh 7½ lb each and are said to be efficient enough to provide high sound pressure levels. Ceramic filters are used in the FM section, which incorporates a signal-strength meter as well. For mobile applications, an optional adapter enables the system to work with a dc power supply. $310.

CIRCLE NO. 96 ON FREE INFORMATION CARD

Astatic Touch-Pad Microphone

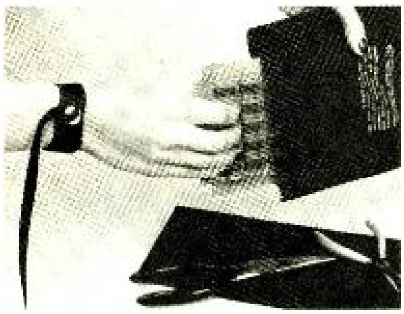
Astatic's new Model T^2M amplified communication microphone has a built-in touch-pad encoder for repeater control and phone-patch operations. The touch pad has a tactile 12-key chromeric keyboard and a visual feedback via a front-mounted LED. The mike features a preamplified electret element with tailored response and integral modulation control; digital integrated tone generator with crystal control for stable frequency operation; and a mixer amplifier with up to 15 dB of gain. The mike's case contains shielding to reduce

external interference and r-f feedback. The Model T^2M operates from filtered 6-to-16-volt dc sources. Included is an 8′ (2.4-m) three-conductor coiled cord.

CIRCLE NO. 97 ON FREE INFORMATION CARD

Conductive Grounding Strap

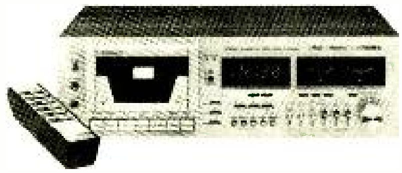
Charleswater Products has introduced a new "Statfree" wrist strap and cord made of conductive woven ribbon fabric to provide positive personal grounding while working on electrical equipment. The flexible strap is 1" wide and 11" long with a Velcro® fastener, and it snaps to a 4′ or 6′ cord that attaches by alligator clip to the



work bench. Providing one-megohm resistance, the strap avoids contact-point deterioration from perspiration. $3.65 in quantities of 25 with a 4′ grounding cord; $4.60 with a 6′ cord. Address: Charleswater Products, Inc., George R. Berbeco, 3 Walnut Park, Wellesley, MA 02181.

Fisher Three-Head Cassette Deck

The Fisher CR5150 "Studio Standard" front-load three-head cassette deck features wireless remote control of stop, play, record, rewind, fast forward, and pause functions. It also has a digital LCD tape counter with timer which can be set to turn



on the deck and a receiver or tuner at a preset time for unattended recording, dual-process Dolby noise reduction, LED peak indicators, switchable limiter, separate reel-drive motor, and an MPX filter switch. Claimed specifications include: frequency response, 30-15,000 Hz ±3 dB (normal tape); S/N, 64 dB (with Dolby); wow and flutter, 0.04% wrms. Address: Fisher Corp., 21314 Lassen St., Chatsworth, CA 91311.

CB Antenna Matching Device

The "Un-Tenna" is a behind-the-dash unit, requiring no mounting brackets or tools, that can be used to allow a mobile AM/FM antenna to double for CB use. The solid-

state circuit can be tuned to match the CB band without the use of meters—a built-in LED indicates proper tuning. A VSWR of 1.1 to 1 is said to be attainable with an isolation of 40 dB. The unit, by General Technologies Inc., is equipped with 18-inch cables to the antenna and the AM/FM radio, and a 29-inch cable to the CB radio. Measures 3½"L × 3¼"W × 1¼"H (9 × 8 × 3 cm) and weighs 8 oz. $34.95.

CIRCLE NO. 98 ON FREE INFORMATION CARD

Permabond Wire Tacking Kit

The Wire Tacking Kit is a new adhesive system designed for a variety of electronic

Introducing the Troubleshooter.

Six functions and 24 ranges for $129* make the jump from Analog to Digital more affordable than ever.

We call our new hand-held 8022A DMM the Troubleshooter. It combines the basic performance features you want with all the advantages that give digital DMM's the edge over analog—0.25% basic dc accuracy, a rugged, reliable design, a razor sharp 3½-digit LCD readout, small size and light weight.

Measure for measure you won't find a better value. Six functions—high and low ohms, ac and dc voltage and current (24 ranges in all) make the Troubleshooter a 13 ounce (0.37 kg) package of excellent measurement value. This kind of value wasn't possible until our custom CMOS LSI single chip design made hand-held DMM's an affordable reality and Fluke the industry leader.

Here's something new that won't shock you. Fluke's exclusive probe design features finger guards on the probe and shrouded connections to discourage accidental contact with circuit voltages.

You won't find a more rugged or reliable hand-held DMM. There's a lot more to building a high-quality hand-held DMM than you might suspect. The case has to survive bumps, scrapes, and scuffs. The LCD readout must withstand the extremes of humidity, temperature, and vibration. Function switches need to perform reliably through thousands of cycles. And electrical circuitry must survive both physical shock and electrical overloads.

We built the 8022A to withstand all these tortures—with a rugged impact resistant plastic case, a custom LCD display, reliable push-buttons instead of rotary switches and over 20% of the components devoted to overload protection.

Take the next step. Contact the Fluke office, representative or authorized distributor in your area. In the U.S., CALL TOLL FREE (800) 426-0361. (For residents in Alaska, Hawaii, and Washington, the number is (206) 774-2481.)

In Europe, contact: Fluke (Nederland) B.V., P.O. Box 5053, Tilburg, The Netherlands. Telephone (013) 673973. Telex 52237.

Ask about the new 8022A. And while you're at it, check into the 8020A Analyst, the improved version of our $169* DMM. It boasts Fluke's exclusive conductance capability for high resistance measurements and 0.1% measurement accuracy. Both instruments are available at your distributor from stock.

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☐ Please send the 8020A Analyst specs.
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PE 6/79

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This module features two essential texts, one covering analog and the other covering digital meters. You'll learn to use both in measuring voltage, current and resistance. What's more, you'll come to understand sensitivity ... high input impedance...integrating meters...resolution ... the different types of probes available and more. When you've completed the module, you'll have a new appreciation of the workhorse VOM ... and you'll understand its proper use much better!

EE-3105-1 .... $19.95

MODULE 2:
Oscilloscopes

Whether you're testing, servicing or designing electronic equipment, the oscilloscope is a necessary tool. You'll learn how the scope works: how to choose and use a scope, with full understanding of deflection sensitivity and bandwidth, horizontal and vertical deflection, blanking and unblanking, triggered and free-running sweeps, delayed sweep, dual-trace presentation, and most importantly, the interpretation of scope displays and the use of lissajous figures in phase and frequency measurements. In short, you'll have mastered a most complex — but essential — instrument!

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MODULE 3:
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In order to do any troubleshooting or repair work, you'll need the understanding of frequency generation and measurement you'll get from this module. When you've finished, you'll be familiar with the three different passive frequency meters ... the four types of active frequency meters with emphasis on modern digital counters ... and the techniques of calculating unknown frequencies and other characteristics of the circuit on which you're working. You'll discover the advantages of electronic counters, and gain complete understanding of the use of audio, RF and function generators and the most common waveforms used in circuit testing.

EE-3105-3 .... $19.95

MODULE 4:
Special Measuring Instruments

Once you've graduated to today's solid devices and digital circuits, you'll find you need more specialized test instruments. Included in this module are the operation and use of bridge circuits, transistor testers, curve tracers, spectrum analyzes, logic probes and logic pulsers. You'll learn what types of measurements can be made with these instruments . . . which tests can be made in-circuit . . . and which you'll need as you get deeper and deeper into the engrossing study of electronics. Module is complete with components for experiments using the optional ET-3100 Trainer.

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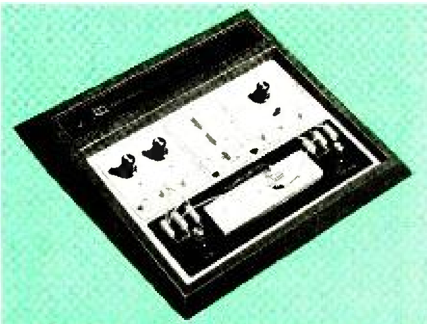

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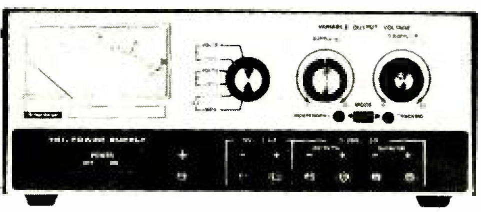

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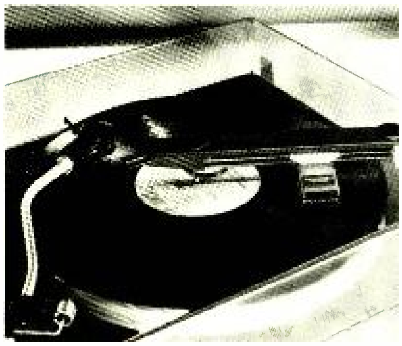
0344 CIRCLE NO. 5 ON FREE INFORMATION CARD assembly operations from Permabond International Corp. The kit contains adhesive in an easy-applicator bottle and a felt-tip pen "accelerator." Bonding is claimed to allow for simpler assembly in close-fitting designs while reducing the risk of damage in the assembly. Since all material is contained in the pen, there is no chance of spilling. A thin layer of the accelerator plus a drop of the adhesive is all that is necessary to achieve an instant bond. Address: Permabond International Corp., 480 S. Dean St., Englewood, NJ 07631.

Lencomatic Record-Cleaning System

Designed for hands-off, automatic operation, the Lencomatic system is a dry cleaning method reported to simultaneously remove dust and drain away static charges.



It consists of a sliding brush assembly that attaches to the inside of the turntable cover in such a way that when the cover is opened, the brush returns to where it is ready for the next disc. Static is drained away by a spring contact that connects the brush assembly to the turntable spindle and by a conductive turntable pad. $19.95.

CIRCLE NO. 99 ON FREE INFORMATION CARD

Cincinnati Pulse Generator

The Model 400 pulse generator from Cincinnati Electrosystems uses a quasicomplementary VMOS FET output to produce a less than 10-ns rise/fall time with an output impedance of less than 5 ohms. Pulse width and repetition rate are variable from 1 μs to 1 s. One-shot pulses are pushbutton or externally triggered. Output amplitude typically swings within 0.1-volt of the 5-to-15-volt external supply voltage, is current limited to approximately 100 mA, and can withstand a direct short to V_{CC} or ground. Size is 4" × 2⅞" × 1$\frac{9}{16}$" (10.2 × 7.3 × 4 cm). $59.95.

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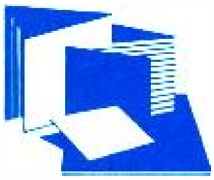


New Literature

HEWLETT-PACKARD CALCULATOR BROCHURE

A 16-page brochure provides a brief explanation of Hewlett-Packard's calculator language (RPN) and a guide to HP calculators. The brochure, "The Students' Choice . . . The Professionals' Choice . . . The Logical Choice" includes a catalog of HP's preprogrammed/programmable, printing/nonprinting, pocket/portable calculators. Address: Inquiries Manager, Hewlett-Packard Company, 1507 Page Mill Road, Palo Alto, CA 94304.

SONY TV INTERFERENCE BOOKLET

"How to Cure TV Interference" is published by Sony Corp. of America as a detailed guide to how to prevent TV interference due to CB radio and eight other forms of transmission which can cause TVI. The latter include FM broadcast stations, aviation, adjacent TV channels, motors in the home, ignition systems, video games, etc. Its purpose is to instruct the sophisticated TV owner as to how TV reception can coexist happily with interference sources and as an aid to qualified service people in dealing with such problems. $1.00. Address: Sony Corporation of America, Technical Publications Department, 47-47 Van Dam St., Long Island City, NY 11101.

B&K-PRECISION INSTRUMENT CATALOG

The 48-page "BK-79" catalog of B&K-Precision test instruments from Dynascan Corp. includes oscilloscopes, frequency counters, digital and analog multimeters, function and r-f signal generators, capacitance meters, digital probes, semiconductor testers, power supplies, and radio and TV test instruments. New products include a digital capacitance meter, 50-MHz digital probe, 3½-digit lab DMM, 15-MHz portable dual-trace scope, and multiple-output power supply. Two new function generators are also featured. Address: B&K-Precision, Dynascan Corp., 6460 W. Cortland Ave., Chicago, IL 60635.

RUSSELL CATALOG

A catalog of electronic/electrical components for maintenance, repair and operations covers heat shrinkable tubing, rubber bumpers and grommets, retractile cords, cable clamps, test leads, spacers, washers, standoffs, desoldering aids, clips, dry transfer lettering, electromagnetic shielding materials and flexible "rubber duckie" antennas for receivers, transceivers and scanners is available from Russell Industries Inc., 3069 Lawson Blvd., Oceanside, N.Y. 11572.

NASHUA MEMORY PRODUCTS LISTING

A 70-page, pocket-size compatibility listing of Nashua Corp.'s line of disk packs, cartridges, and diskettes includes a description of the company's part numbers and overall media characteristics. It also gives criteria to help evaluate whether standard, certified error-free, or mapped disk packs are required for a given application. Listings provide the name of the marketing company and the manufacturer for each disk drive in common use, drive model number, the manufacturer's disk pack number, bits per inch, tracks per inch, sectors, and compatible Nashua product. Address: Nashua Corp., 44 Franklin St., Nashua, NH 03061.

SYLVANIA ANTI-INTRUSION SYSTEM BROCHURE

"Wired for Sound" describes the Sylvania FPS-2 electronic anti-intrusion system, designed for fence protection. Using a sensor cable and signal processor, the system detects vibrations caused by intrusion attempts and sounds an alarm. Fence disturbances caused by wind, rain, birds or animals are filtered out, and the processor is programmed to select only the signals characteristic of an intrusion. Address: GTE Sylvania Security Systems Department, Box 188, Mountain View, CA 94042.

BIRD R-F FILTER CATALOG

The 20-page r-f filter catalog FC-8 from Bird Electronic Corporation displays nearly 200 coaxial filters, filter/couplers and filter/coupler/switches. Filter tables in the catalog list salient performance data and mechanical specifications of low-pass, high-pass and band-pass models with cut-off frequencies from 1 MHz to 2.7 GHz. Filter-couplers included combine harmonic rejection with r-f power level sampling in one compact package. Some have a solid-state switch which controls trasnmit/receive signal path. Extensive application notes guide the reader in quickly identifying essential specifications. Address: Bird Electronic Corporation, 30303 Aurora Rd., Cleveland (Solon), OH 44139.

SHAKESPEARE CB ANTENNA CATALOG

A 26-page CB antenna and accessory catalog is available from Shakespeare Electronics & Fiberglass Division. Line drawings illustrate the complete selection of mobile, base-station, directional beam and marine CB antennas. Electrical specifications and mounting information are included. Address: Shakespeare Company, Electronics & Fiberglass Division, P.O. Box 246, Columbia, SC 29202.

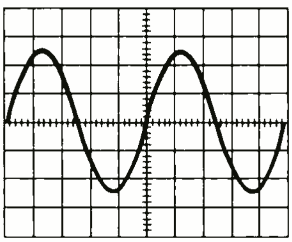
LOW TIM MAKES THE LISTENING DIFFERENT.

COMPARABLE AMPLIFIERS DO SOUND DIFFERENT

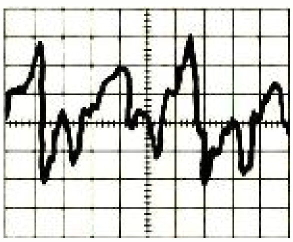
Choosing the best amplifier for your audio system involves comparing specs, features and, of course, price. But ultimately, if you love music, you should base your decision on the way an amplifier sounds when reproducing music.

Two amplifiers may have identical power ratings and virtually no Total Harmonic Distortion, but can sound very different: one clean and clear, the other harsh and metallic. The difference you hear is Transient Intermodulation Distortion (TIM, for short). The real effects of TIM on music, however, have only recently been recognized, since TIM does not show up in even the most accurate traditional laboratory measurements.

Measurements for THD are made with smooth, repetitive signals (sine waves). Music, on the other hand, presents an amplifier with a series of non-repeating, pulsive, "transient" signals, as illustrated below.



SINE WAVES



DYNAMIC MUSIC SIGNALS

An amplifier that cannot faithfully follow the sharp transients demanded by music may have very low THD, but very high TIM.

WHAT CAUSES TIM?

It has been discovered that TIM distortion in an amplifier is caused by an insufficient slew rate – the engineer's term for an amplifier's ability to handle the high power, high frequency signals a musical transient presents. Poor slew rate in conventional amplifiers is most often caused by the very mechanism used to reduce THD, namely, the addition of negative feedback. Put more simply, in conventionally-designed power amplifiers, the more negative feedback you use, the lower will be the THD (which is good), but the higher will be the TIM (which is not so good).

It took Sansui, and a whole new approach to amplifier design, to solve the high-frequency slew-rate problems of TIM without compromising our superbly low THD specifications.

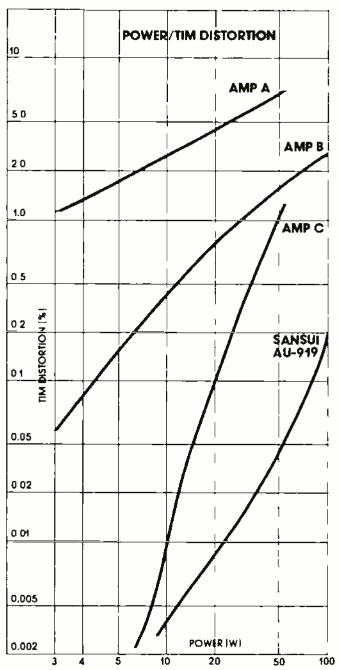
THE SANSUI SOLUTION

The most important step in the solution was to "speed up" (increase the frequency response of) the basic amplifier – even before negative feedback is applied – by using Sansui's own patent-pending DD/DC (Diamond Differential/Direct-Coupled)

AU-919 DD/DC AMPLIFIER

circuit. The DD/DC circuitry includes a sophisticated "lag + lag-lead" dual compensation system, more often found in instrumentation amplifiers than hi-fi products, which maintains stability without decreasing frequency response. With DD/DC, the amplifier can instantly supply the enormous negative feedback current demanded by transients, without restricting the slew rate, so without introducing TIM.

How well our unique circuitry succeeds in eliminating TIM, while maintaining extraordinarily-low levels of THD is shown in these comparative curves. The Sansui AU-919 amplifier (bottom curve) is rated at 110 watts per channel, min. RMS, both channels into 8 ohms from 10Hz to 20,000Hz, with no more than 0.008% total harmonic distortion.



Power output vs. TIM distortion curves for the Sansui AU-919 and competitive amplifiers. Derived using the TIM measurement method described in a paper presented at the 63rd Convention of the AES May, 1979; available from Sansui on request.

LET YOUR EARS BE THE JUDGE

Instruments and circuit-design analysis are fine in their place, which is the laboratory. But you listen to music in your home; and we're confident that you will hear the difference in musical clarity that a Sansui amplifier makes. Your local Sansui authorized dealer can demonstrate all the convincing reasons for choosing Sansui.

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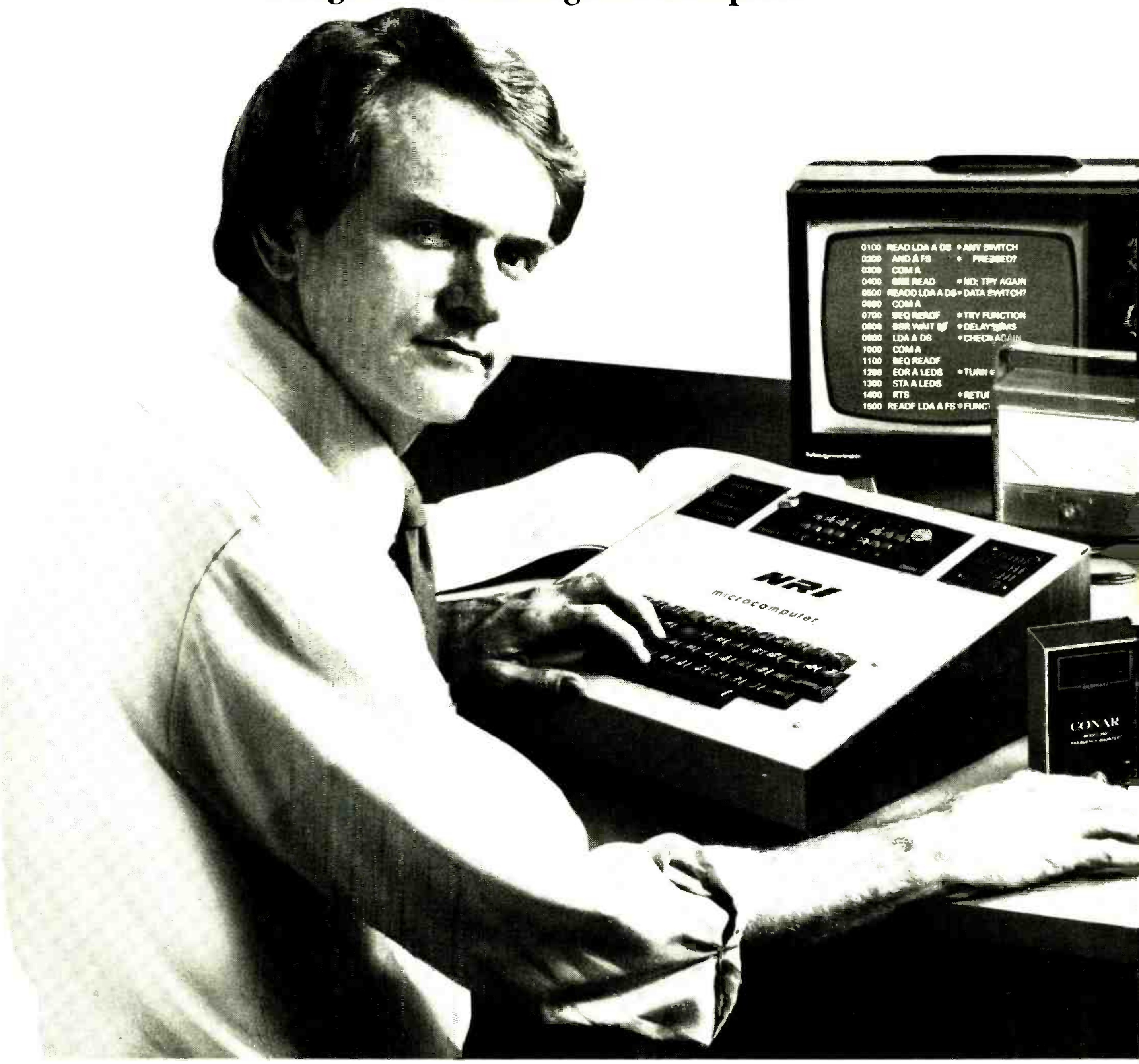
Microcomputers are here! Get in on the ground floor with NRI's new "at home" training in computer technology.

Only NRI Gives You "Hands-on" Experience as You Build Your Own Designed-for-learning Microcomputer



The microprocessor, that amazing little chip which shrinks electronic circuitry to microscopic size, has changed the world of the computer with dramatic speed. Now, big-performance computers are here in compact sizes...priced to make them practical for thousands of medium and small businesses, even homeowners and hobbyists.

Microcomputers are already being put to work on jobs like inventory control, payrolls, cost analysis, billing, and more. In homes, they're able to handle budgets and tax records, control environmental systems, index recipes, even play sophisticated games. And hobbyists across the country are expanding the state of the art while developing their own programs.

Become a Part of This Incredible World ... Learn at Home in Your Spare Time

NRI can give you the background you need to get into this booming new field. Microcomputers require a new discipline, a broader viewpoint... the ability to think in both hardware and software terms. And NRI's new course in computer technology is geared to bridge the gap.

You get a firm foundation of digital theory while you get practical,

"hands-on" experience working with the NRI Discovery Lab®, assembling test instruments you keep, and even building your own fully functional microcomputer.

Best of all, you do it at your own convenience. You learn at home with clearly written, "bite-size" lessons that carry you through the course in logical progression. There's no need to go to night school or quit your job...you progress at the pace that's most comfortable to you, backed by your personal NRI instructor and individual counseling whenever you want it.

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Stereo Scene

By Ralph Hodges

ON FACING THE MUSIC

There is, among those of us who spend their working lives fiddling around with audio hardware, a lack of consensus on what sounds best, why, and what it all means anyway. If you're using the conventional IHF-approved procedures for evaluating equipment, it has become difficult to find a speaker, cartridge, amplifier, or anything that doesn't perform at least adequately in laboratory tests—"adequately" meaning that the faults of the product should be audibly inconsequential by generally accepted standards. On the other hand, if you insist on devices that behave as if they were perfectly distortionless, inertialess, and without discernable sonic personality under any conceivable conditions, your search will be long and probably futile.

Given this state of affairs, you could follow the lead of many others and pick your equipment solely by listening. But what sometimes happens then is that you find yourself preferring equipment that the test laboratory looks upon as mediocre if not downright deficient in one or more aspects of performance.

Most equipment reviewers have felt the exasperation of performing tests conscientiously and assembling the best profile of a product we can, giving what we hope is enlightened attention to the relevant psychoacoustical factors, only to find someone who will say that the product doesn't sound as good as it should, or that something—even a measurably inferior something—sounds better. When this situation develops we tend to: (1) decide that the dissenter is hallucinating; (2) agree that the dissenter's preferred product probably *sounds* as good as any other, even if it doesn't test quite as well, which merely goes to show that laboratory instruments are more critical than the ear or that many people actually enjoy the sound of certain types of distortion; (3) suspect that we are insensitive to certain aural phenomena that other people pick up quite readily; or (4) begin to consider the possibility that our tests and other evaluation procedures are consistently missing something.

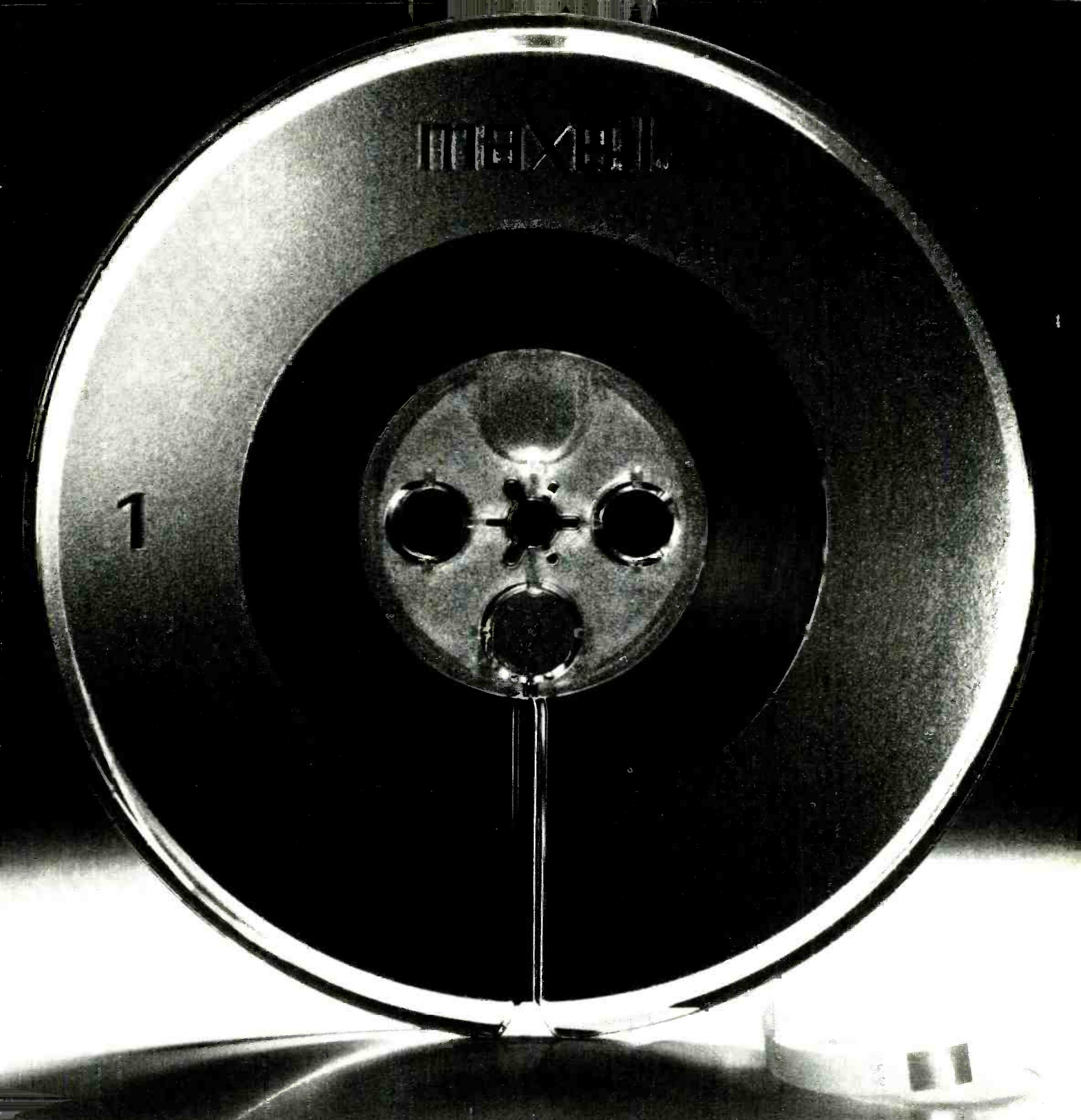
If you regularly read test reports in audio magazines, you'll have no trouble discerning the tendencies of the various reviewers. You will also note that those reviewers who have seriously tried to come to grips with proposition number four have met with no resounding success. Pinning the "something" down, if it in fact is one thing, is a considerable task, even when we are determined that we can hear it and identify it when called upon to do so.

It's About Time. But in a growing field like audio, there are new data coming to light at a fairly rapid rate, and some of these can offer insight into problems hitherto unsolved. For example, highly critical listeners have been known to declare that the binaural illusion from an appropriately made recording heard through headphones is so convincing as to bury the presumed deficiencies of the playback chain. It is just too real and too satisfying to argue with. A more recent example: people who have heard digital recording demonstrated have marveled at the way it can surmount mediocre loudspeakers and other questionable components in the system to present a credible and enjoyable rendition of the music.

What do these two techniques have in common that might account for the persuasiveness of their illusions? The time factor is the only thing that comes to mind. A binaural recording is temporally very well controlled. You are limited to two microphones, and these are placed with some precision and kept fixed and at an essentially constant level of feed to the console. Playback is usually through a set of single-diaphragm transducers that don't exhibit serious discontinuities in phase/time relationships.

Digital recording, too, through much of the audio-frequency range, is essentially time-invariant. It pays no attention to

(Continued on page 24)



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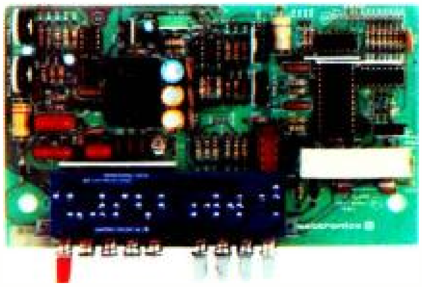

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Brief Specifications

DC Volts: 100µV to 1000V in 5 ranges
AC Volts: 100µV to 1000V in 5 ranges
DC Current: 0 1µA to 10 A in 6 ranges
AC Current: 0 1µA to 10 A in 6 ranges
Resistance: 0 1Ω to 20 MΩ in 6 ranges
Diode Test Current: 0 1µA, 10µA, 1mA
ACV Frequency Response: 40Hz to 40kHz
Input Impedance: 10 MΩ on ACV and DCV
Overload Protection: 1200 VDC or RMS on all voltage ranges except 250 VDC or RMS on 200mV and 2V AC ranges Fuse protected on ohms and mA ranges
Power Requirement: 4 5 to 6 5 VDC (4 "C" cells) optional NiCd batteries or AC adapter charger
Display: 0 36" (9 2mm) Digits reading to - 1999
Size: 8"W x 6.5"D x 3"H (203 x 165 x 76 mm)
Weight: 1 5 lbs (0 68kg) excl battery

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STEREO SCENE *(Continued from page 20)*

tape skew, it ignores gap-colinearity problems, and it doesn't recognize the existence of wow and flutter at all. In the time domain it holds up just about as well as any recording process we can envision, and its rock-solid imperturbability is a real comfort to those who are bothered by speed/time irregularities. (Furthermore, I suspect it is a joy to those listeners who don't *realize* that they respond to such irregularities.)

What Studies Show. There are not a lot of sources you can draw upon to decide just how time confusion affects human hearing. We know of a phenomenon called temporal masking, by which a correctly designed sound of sufficient intensity can disguise the direction or even eclipse entirely a sound that came a split second before. And we can demonstrate that rapid repetition of a recorded sound can impart some of the reverberant quality of the space in which it originally propagated, a distracting echo, or a thoroughly unnerving experience (as when you're trying to speak against a background of your own voice delayed artificially or by highly unfavorable acoustics). In recording, signals mixed from several microphone channels can sound innocuous or obnoxious depending on the time/phase relations.

Although we know this, we still can't talk quantitatively or even analytically about what we can expect when we let time relationships get out of hand in a reproduction system. We don't even know whether our specific response is to time or phase (different sides of the same coin, really), but evidence is building to support the idea that we get significant aural effects from both.

Time as a Hi-Fi Criterion. What time distortions can you expect from a high-fidelity system? They begin at the recording microphones, particularly if they're used in multiples, and proliferate, sometimes shockingly, throughout the recording chain. The typical record player contributes a dose of complex flutter effects, tape machines being offenders in this respect as well. And efforts to make loudspeakers time-coherent have gone on for several years now.

If time-base distortions are so important, why have not the so-called time-corrected speaker systems now offered devastated the marketplace? Two answers rush immediately to mind. The first is that the signal they receive to reproduce is not only not time corrected, but is most probably seriously time disordered by (at the very least) the previous components in the playback chain, the mechanical devices such as the record player or tape machine being the major culprits. (An initial and irreversible degradation may well have occurred during the recording process, but we presently have no way of fixing that.)

The second is that, quite frankly, the geometry of many speaker systems that claim to be time corrected cannot accomplish the job except in a very narrow zone projected (usually) straight out in front of the speaker. This zone is sometimes so narrow that in most listening rooms you could not get far enough away from the speaker to fit both ears into it at the same time.

Would it be possible to assemble a sound-reproduction system that is perfectly time-precise, in order to compare it with a less "talented" array of components and therefore begin to appreciate the audible difference? I don't think so. But it is possible, at grim expense, to put together a system that comes closer to time correctness than most others, and the rules you have to follow are not obscure, but merely arduous.

I heard such a system just the other day. The turntable was elaborately designed to resist any internal or external influence that might distract it from its task. The electronics were imperturbable and well-matched to the speaker systems, and the speakers themselves were designed to minimize the early reflections from nearby room-boundary surfaces and control the reflections that were inevitable as carefully as possible. If this system hadn't sounded magnificent there would be no reason to talk about it here. Even more impressive was its relative indifference to its acoustical surroundings. Physically the ensemble was very large, but it seemed to sound as attractive in a small room as a large, and it circumvented many of the problems that had plagued most other systems in notoriously difficult rooms.

I suggest that, if you are dissatisfied with the sound of a system you have put great care into choosing, you consider the possibility of time errors being the cause. There is not a great deal you can do about them right now, but I think you should keep alert to the possibilities that test instruments cannot yet explore, read equipment reviews with such considerations in mind, and watch for products that stress new concepts about the satisfactory reproduction of sound. My guess is that there will be quite a few interesting and worthwhile examples. ◇

Julian Hirsch Audio Reports

Dynaco Stereo 150 Power Amplifier Kit

Dynaco's Stereo 150—available in kit form or assembled—is a basic two-channel power amplifier rated at 75 watts/channel (150 watts mono) continuous into 8 ohms at less than 0.25% THD between 20 and 20,000 Hz. Except for the dc-offset coupling protection in the inputs, direct coupling is employed throughout. The amplifier features a differential pair at each input, fully complementary output stages with regulated and thermally tracking bias, a very husky power supply, and several levels of circuit protection.

The Stereo 150 measures 14½" W × 13¾" D × 6⅝" H (36.8 × 34.9 × 16.8 cm) and weighs 29 lb (13.3 kg). Suggested retail price is $269 in kit form, $399 assembled. Also built into our sample amplifier was the optional Model MC-2 power meter kit, which has a suggested retail price of $85. Prices are slightly higher west of the Mississippi.

Physical Description. Most of the front panel of the Stereo 150 is a dark pewter color. On a brushed aluminum strip across the bottom of the panel are a hefty rocker ac power switch and a blue pilot light. If the power meter kit is installed, a smoked plastic panel replaces the upper panel and blacks out the large blue power meters when line power is removed. Also, the blue pilot light is replaced by two locking pushbutton switches that control sensitivity of the output power meters.

On the rear apron are two phono type input jacks; three-way speaker output binding posts (spaced ¾" apart to accept standard double banana plugs); fuseholders for the speaker line fuses; and two massive output-transistor heat sinks. Walnut panels cover the sides of the amplifier.

About the Circuit. The block diagram shows one channel of the Stereo 150. Two pnp transistors form a differential input pair. These transistors receive current from a constant-current-source transistor. A potentiometer permits adjustment of the constant current source to eliminate any dc offset present at the output of the amplifier.

Signals from the input stages are applied to a predriver transistor that in turn, supplies signals to the positive and negative drivers. Driver and output-transistor class of operation is determined by a discrete bias regulator. The pnp transistor in this network is mounted so that it is thermally coupled to the drivers to enhance circuit stability by providing temperature compensation for the amplifier. The setting of a potentiometer determines the quiescent current through the output transistors, which is 50 mA for optimum Class AB operation.

The driver and output stages of the amplifier are in a complementary-symmetry configuration. Positive and negative driver and output transistors form discrete Darlington pairs. A volt-amp limiter stage is provided for each Darlington pair. When the current through a sensing resistor connected to the emitter of the output transistor exceeds a predetermined value, the resulting voltage drop across the resistor causes a transistor to conduct. This then shunts a portion of the base drive away from the driver transistor and forces a decrease in output current. Diodes are connected across the output transistors so that they are normally reverse biased. This limits maximum possible reverse voltage from collector to emitter to 700 mV, preventing damage from reverse voltages generated by inductive loads.

A negative-coefficient thermistor is thermally coupled to the output transistors of each channel. If the temperature of the heat sink (and hence the thermistor) increases to 75°C or 167°F, attenuation of a voltage divider increases, thus reducing the input signal to a safe level. Consequently, the Stereo 150's thermal protection circuit, unlike that in most other amplifiers, does not abruptly interrupt circuit operation. As the heat sink cools, the input level automatically increases.

The amplifier's power supply employs a husky step-down transformer, 25-ampere bridge rectifier, and two 10,000-µF filter capacitors. In normal stereo operation, the supply provides ±50 volts dc with a high degree of regulation. The power transformer's primary can be wired for use with either 120- or 240-volt, 50- or 60-Hz lines. In 120-volt applications, a 5-ampere slow-blow fuse protects the primary of the transformer. Individual 4-ampere, fast-blow fuses are provided for the $+V_{CC}$ and $-V_{CC}$ supply lines of each channel. Finally, each speaker output is fused.

The Model MC-2 power meters are physically large, highly readable, and calibrated in decibels. They are driven from the output of each amplifier channel via series strings of resistors. Two locking pushbutton switches are provided for selecting meter sensitiv-

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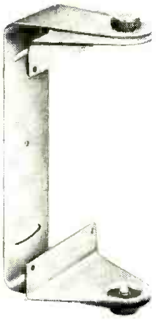

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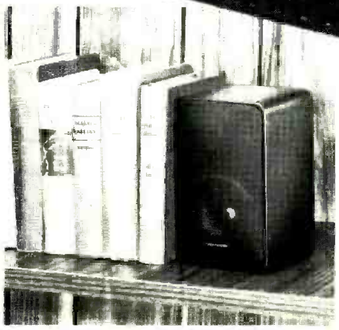
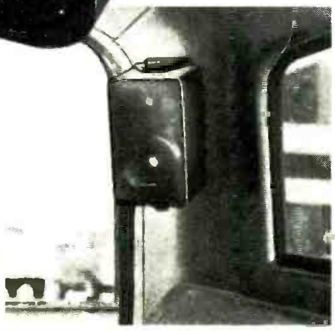


Use 'em on a shelf



Use 'em in your vehicle

ity (0 dB on the meter scale equal to 0, -6, -12, or -18 dB, referenced to the rated output of the amplifier).

Assembly Details. The Stereo 150 amplifier is really a semikit, since the main circuit board comes assembled and tested. The builder puts together the chassis hardware and wires the power supply and output transistors into the circuit. Hence soldering is limited to relatively few operations. Our assembly time therefore, occupied only about seven hours of unhurried work. Dynaco's kit-assembly instructions helped us put the amplifier together without a hitch.

The main pc board contains four trimmer potentiometers. Two are for controlling the dc offset, while the other two are for controlling the bias applied to each channel's driver and output transistors. The manual states that these potentiometers are factory adjusted and need not be disturbed. However, a simple procedure is detailed for touching up the adjustments with the aid of a milliammeter and millivoltmeter, if desired. We performed touch-up with digital multimeters and found that our final settings were almost identical to the factory ones.

Test Results. Our laboratory measurements confirmed that the amplifier met or considerably exceeded its published performance specifications. At the end of the one-hour preconditioning period at 25 watts/channel output, the amplifier was only slightly warm. The onset of clipping occurred at 91.8 watts into 8 ohms (for an IHF clipping headroom of 0.9 dB), at 139.2 watts into 4 ohms, and at 54.8 watts into 16 ohms. Attesting to the stiffness of the power supply, the amplifier's IHF dynamic headroom exactly equalled its clipping headroom.

Input sensitivity was 0.1 volt for a reference output of 1 watt. The A-weighted output noise was below our measurement limit of 100 μV (-90 dBV). The amplifier had a wider frequency response and was quicker than its specifications indicate. Frequency response was down 1 dB at 5 and 50,000 Hz and down 3 dB at 100,000 Hz. Rise time was approximately 3.5 μs; slew rate was 15 volts/μs (considerably faster than the rated 5 volts/μs). Slew factor was 10.

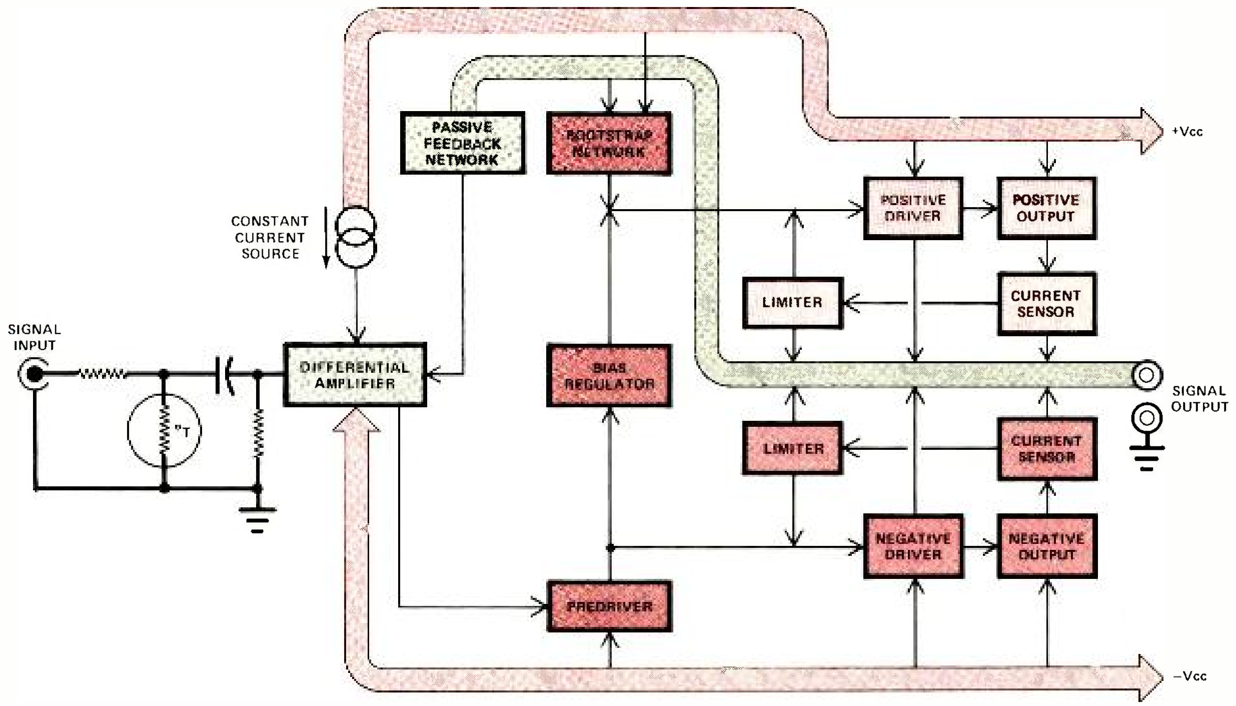
Also easily exceeded were Dynaco's harmonic and IM distortion ratings (less than 0.25% at any power level up to 75 watts/channel into 8 ohms). At one-tenth rated output (7.5 watts), the THD varied from 0.0075% at 50 Hz to 0.057% at 20,000 Hz. At rated output, harmonic content was lowest at 1000 Hz (0.015%) and highest at 20,000 Hz (0.07%).

Driving the amplifier with a 1000-Hz sine wave of variable amplitude, we plotted the THD content in its output against power delivered to the load. At 0.1 watt, distortion was 0.0015%. It gradually increased to 0.016% at 80 watts (into 8 ohms), 0.0215% at 90 watts, and 0.23% at 95 watts. Most of the distortion at 95 watts was the result of mild clipping. At lower power levels, the harmonic content consisted of second-, third-, and some higher-order products. The presence of low-level, high-order distortion products suggested that some crossover distortion was occurring. However, all harmonic distortion products were so weak that none was audible.

A similar test was conducted to determine how IM distortion varied with output power, using 60- and 7000-Hz sine waves. At 0.1 watt (all power levels are into 8 ohms), distortion measured 0.01%. As the amplifier generated more output power, the IM content increased but remained below 0.025% up to 60 watts and was only 0.06% at 95 watts. Again, actual test results were considerably better than Dynaco's published specifications.

We were pleasantly surprised by the accuracy of the power meters. They are not calibrated directly in watts. Instead, they have a logarithmic scale ranging from −20 to +3 dB like that of a standard VU meter.

When sensitivity of the meters is set at 0 dB, the 0-dB mark on the meter scale corresponds nominally to the rated output power of the amplifier.



Block diagram of one channel of the Stereo 150 Amplifier.

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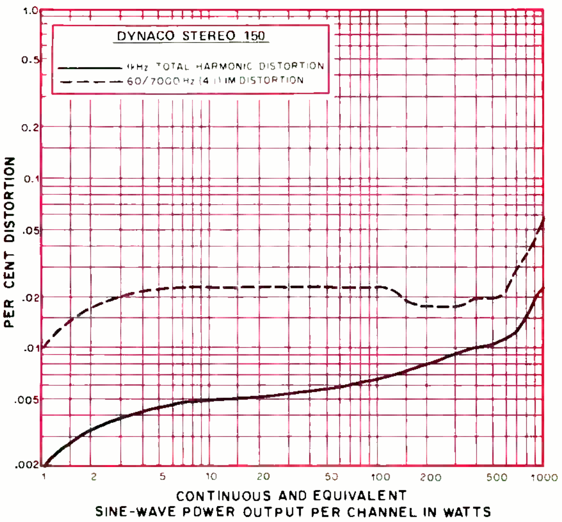
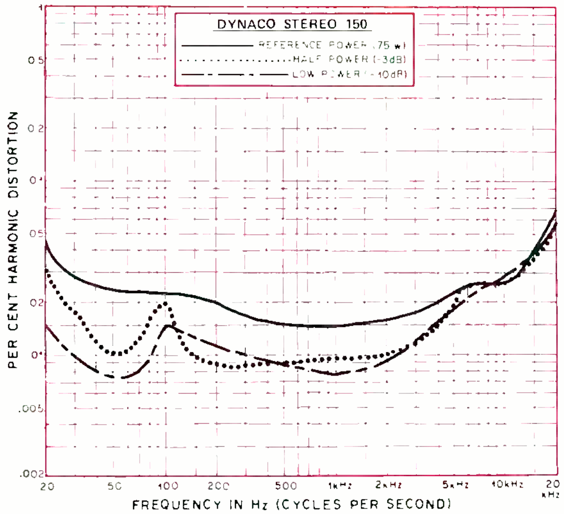


THD and IM distortion at 8 ohms.



Percent harmonic distortion at three power levels.

With sensitivity set to −6 dB, the 0-dB mark corresponds to 6 dB below rated power. Accordingly, in the −12- and −18-dB positions, 0 dB on the meter scale corresponds to −12 and −18 dB relative to the rated output.

Although this logarithmic calibration (and lack of direct calibration in watts) might at first seem inconvenient, it has definite advantages. A "correction factor" for various load impedances is built-in—0 dB on the meter scale when the sensitivity is set at 0 dB refers to the rated output power, whether the load is 4, 8, or 16 ohms. Of course, the numerical value in watts corresponding to 0 dB is different for each load impedance. An audiophile using the Stereo 150 to drive 4-ohm loads can consider 0 dB to be 100 watts, and has no need to ignore the common "watts into 8 ohms" scale.

Under steady-state conditions, the power meters proved to be extremely accurate. In the 0-dB sensitivity mode, the meters yielded a 0-dB reading at 72.6 watts/channel into 8 ohms. (The ideal figure would be 75 watts.) This amazing accuracy was not confined to the 0-dB mark on the scale. A reading of −1 dB corresponded to 56.7 watts (ideally 59.6 watts); −3 dB to 35.3 watts (ideally 37.5 watts); −5 dB to 20.8 watts (ideally 23.7 watts); −10 dB to 7.13 watts (ideally 7.5); and −20 dB to 1.03 watts (ideally 0.75).

This steady-state accuracy was not confined to the 0-dB sensitivity mode. For example, in the −6-dB mode, a 0-dB reading corresponded to a power level of 18.6 watts, as compared to an ideal 18.75 watts. In the −12-dB mode, the 0-dB reading corresponded to an output of 4.9 watts, as compared to an ideal of 4.68 watts. Finally, in the −18-dB mode, the 0-dB reading corresponded to 1.25 watts, very close to the ideal 1.17 watts.

capable of much higher level of performance than specifications suggest

To test the ballistics of the power meters, we applied a 0-3-second burst at 1-second intervals to the input to drive the amplifier to its rated output power. The meters were a bit slow, reaching a peak level of −1.5 dB. This means that the meters are useful as indicators of average power levels, but not as true monitors of transient program peaks.

User Comment. The Stereo 150 sounded clean and neutral—the way an amplifier should sound. It was never distressed in performing tasks we assigned it, even when it was called upon to drive loads with substantial reactive components.

The protection systems were effective. Also, the volt-amp limiter and heat-sink thermistors protected the amplifier without the disconcerting abrupt cutoff often experienced with other amplifier protective systems. However, we blew the 3-ampere speaker fuses supplied by Dynaco when we first attempted to measure the full-power output into 4-ohm loads. This was predictable (after the fact) because a 3-ampere fuse can pass only 36 watts to a 4-ohm load. Therefore, anyone planning to use the Stereo 150 to pump large amounts of power into 4-ohm speaker systems will have to use fuses with higher current ratings.

Although the amplifier has elaborate fusing facilities, only the speaker output fuses are accessible from the rear panel. To replace the ac line fuse or any of the four dc supply fuses, the side panels and the top cover must be removed. Even so, the four dc fuses are not easily reached. A similar problem was noted with regard to the pilot lamps that back-light the power meters (if the meter kit is installed).

We found the Stereo 150 capable of a considerably higher level of performance than its specifications suggest. It is not in the super-high-power class, but it can provide all the output that most audiophiles will ever need. The Stereo 150's clean sound, conservative design and operating stability commend it to any audiophile, in the market for a medium-power basic power amplifier. Those who prefer amplifiers equipped with power meters will doubtlessly be interested in adding the surprisingly accurate meter option to the basic amplifier. Readers who enjoy kit building are given the option of buying the Stereo 150 in kit form and taking on a very easy assembly job while saving money.

CIRCLE NO. 101 ON FREE INFORMATION CARD

/530
nage”
lf Speaker System

Koss Model /530 is a moderate-priced, two-way bookshelf speaker system . 1" dome tweeter and what ufacturer calls a “quasi-vent- ass radiator. The low-frequency ction includes a passive cone to augment the woofer output at the lowest frequencies.

The CM/530 is manufactured in mirror-imaged pairs, in the interest of better dispersion and stereo imaging throughout the listening area. Each speaker is in a walnut cabinet, with a dark brown, acoustically transparent cloth grille. Enclosure dimensions are 13¾" × 11¾" × 24" (35 × 30 × 61 cm), and each speaker weighs 35 lb (15.9 kg). Suggested retail price is $175 per speaker.

General Description. Removing the snap-on grille reveals what appears to be two 8" woofers, with a dome tweeter between and slightly above them (with the speaker in a horizontal position). However, only one of the 8" cones is a woofer, the other being a passive cone that radiates the lower bass frequencies. Since the driven cone is not required to make large excursions to handle the deep bass, it can be designed to operate at relatively high frequencies without breakup, making possible a crossover to the tweeter at 3000 Hz.

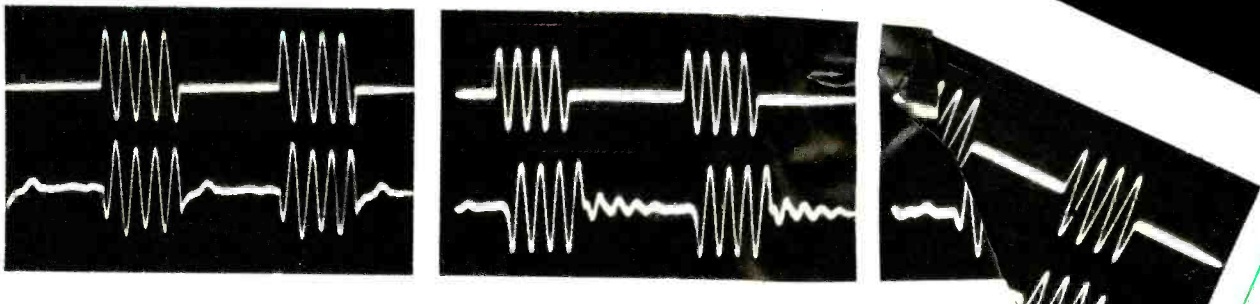
The low frequency section of the CM/530 is designed to have a −3-dB response at 36 Hz, and the dome tweeter (which is acoustically loaded by a ring or collar that extends about ¼ inch, or 6 mm, from the base of the dome) has its high-frequency −3-dB response point at 17,000 Hz. Koss specifications are exceptionally complete, including the test conditions.

In the rear of the CM/530 is a three-position toggle switch that raises or lowers the tweeter level by 3 dB about a nominally flat center setting (“flat” being defined by Koss as a uniform power spectrum in the far field of the speaker). Near the switch are the insulated spring connectors and a protective fuse.

Laboratory Measurements. It is recommended by Koss that the speakers be placed with the driven cones of the two units toward the center of the room (in a normal horizontal “bookshelf” installation). We placed them in that position, about 7 feet apart and at ear level. The smoothed frequency response in the reverberant field of the room was spliced to a close-miked, low-frequency curve to form a composite response curve.

Performance Specifications

Specification	Rating	Measured
Bandpass response (far field integrated power response)	−3 dB at 36, 17,000 Hz −6 dB at 30, 20,000 Hz	−3 dB 25, 16,500 Hz −6 dB 20, 20,000 Hz
Polar response (within 90-degree included angle)	−3 dB: 8000 Hz −6 dB: 10,000 Hz	— —
IM distortion (41.2 & 440 Hz, 1:1 2 V, 1 m on axis)	Less than 2%	—
Crossover frequency	3000 Hz	Confirmed
Reference sensitivity (2 pi steradian load 1 m on axis 2.83 V sine input)	88 dB SPL	Confirmed (using noise, 1 octave, 1000 Hz center)
Minimum recommended amplifier power	15 W/channel	—
Maximum recommended amplifier power	75 W/channel	—
Impedance	Nom: 7 ohms Min: 4 ohms	 Min: 5 ohms
Spectrum shape control (±3 dB)	Tweeter	Confirmed
Input power overload protection	Fused 3AG 2A	Confirmed

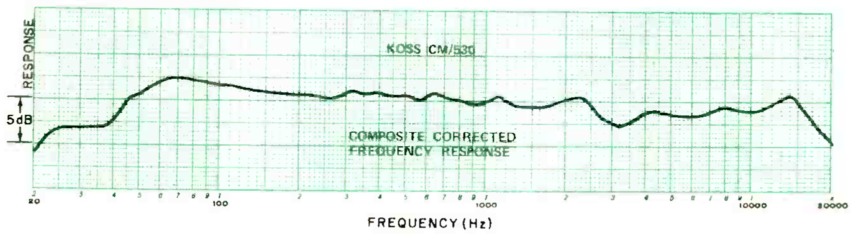


Tone-burst responses for (left to right) 100, 1000, and 10,000 Hz.

The low-frequency response was measured separately for the driven and passive cones, on the same chart paper, and combined to form a single response. The crossover between them was at 45 Hz, with the passive cone being responsible for practically all the output below that frequency. The response flatness of the driven cone, up to 1000 Hz, was remarkably good. As the wavelength of the sound approached the dimensions of the speaker, the close microphone placement produced an irregular frequency response at the higher frequencies, as might be expected.

When we spliced the two curves, at about 1000 Hz, we obtained one of the flattest speaker frequency-response curves we have yet measured! The overall variation was ±3 dB from 25 to 16,500 Hz, with a notable lack of holes or peaks between those limits. The tweeter switch had the rated effect, a change of ±3 dB above about 3000 Hz. The center position gave the flattest overall response to our test instrumentation (and to our ears, as well).

Bass distortion was 1% or less down to 40 Hz, rising slowly to 5% at 25 Hz at a 1-watt drive level. Increasing drive to 10 watts resulted in distortion of 2 to 3% down to 35 Hz, with a rapid rise down to 25 Hz. The impedance of the CM/530 system was about 5 ohms in the vicinity of 200 Hz and above 3000 Hz, rising to 16 ohms at 20 Hz, 25 ohms at 55 Hz, and 11 ohms at 1800 Hz. Our sensitivity measurements confirmed Koss's ratings, with a 2.83-volt input of random noise in an octave bandwidth at 1000 Hz, giving an 88-dB SPL at 1 meter from the speaker. The tone-burst response was excellent at all frequencies.



Composite corrected frequency response for Koss CM/530 Speaker System.

one of the flattest frequency-response curves we have yet measured

User Comment. In our experience, speakers that give a smooth measured freque[...] sound good. [...] room for indiv[...] course, as the s[...] made that will ple[...] ertheless, we expe[...] be at least a very l[...] based on its measure[...] all of that, and more!

The Koss CM/530 ex[...] no tendency to impart a[...] to male voices, as so ma[...] systems do. (The woofer o[...] only a couple of decibels a[...] Moreover, dispersion of th[...] tweeter, even at the highest fr[...] cies, was exceptional. There wa[...] little difference between resp[...] curves we obtained from the [...] speakers (the test microphone was [...] the axis of the left speaker and abou[...] 30 degrees off axis of the right speaker). The sound is completely unified and nonlocalized. Thus it gave no sense of emanating from such a small box, let alone from the three drivers inside. When we placed the CM/530 units on top of some large floor-standing speakers, the illusion that the big ones were playing was very strong. So clearly, there is nothing "compact" about the sound of the CM/530.

The CM/530 is not the first speaker we have tested that uses a passive radiator to augment the woofer at the lowest frequencies. It is certainly one of the better examples of the genre, however. In conclusion, Koss's CM/530 is a thoroughly exceptional speaker, and one is not likely to find another at its price with better sound.

CIRCLE NO. 102 ON FREE INFORMATION CARD

Stanton "Open-Air" Dynaphase 35 Stereo Headphones

HIRSCH-HOUCK LABS REPORT

The Stanton Dynaphase 35 is a lightweight, 15-ohm (at 1000 Hz) stereophonic headphone. Each earcup contains a dynamic driver with a 1.5" (38-mm)

(Continued on page 38)

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BECKMAN

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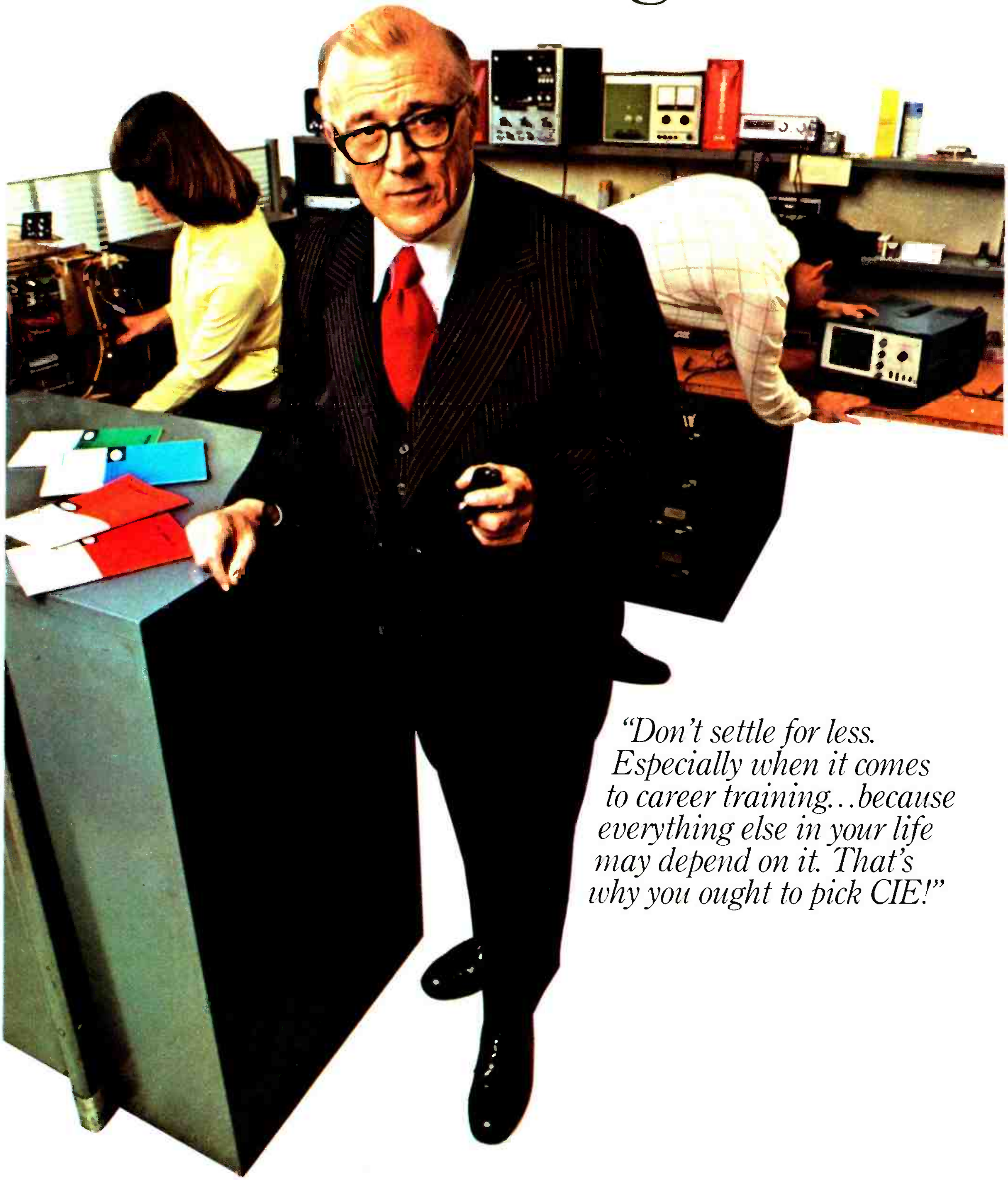
"If you're going to learn electronics, you might as well learn it right!"



"Don't settle for less. Especially when it comes to career training...because everything else in your life may depend on it. That's why you ought to pick CIE!"

Mylar diaphragm. The earcups rest on the ears without sealing tightly so that the phones do not completely exclude ambient sounds.

Each earcup has a soft, vinyl-covered foam cushion and is vented to the outside through its rear. The light spring headband is also vinyl-covered and padded for wearing comfort. A separate signal cable, is attached to each earcup; the two meet in a molded Y junction that terminates a lightweight 10-ft (3-m) cord. The other end of the cord has a molded stereo phone plug with a built-in strain relief to minimize breakage of the cable's conductors where they enter the plug. Total weight is only 8.5 oz (264.4 g).

The headphones are rated to handle a maximum input of 0.2 watt/channel. At a 0.1-volt input (0.0007 watt), the rated output is 100 dB SPL at 1000 Hz. The frequency response (no test conditions or tolerances stated) is claimed to be 20 to 20,000 Hz, and distortion (frequency not stated) is rated at less than 0.5% for a 110-dB SPL. Price is $45.

Laboratory Measurements. The frequency response of the headphones was measured with a slightly modified ANSI headphone coupler. The phones were driven from a power amplifier through a series resistance of 100 ohms. (All amplifiers and receivers with headphone outputs have built-in series resistors to protect phones from damage, though there is no standardization of the value. We set our own standard of 100 ohms, unless the manufacturer specifies otherwise.) The drive level ahead of the 100-ohm resistor was 3 volts.

Frequency response was relatively flat from 150 to 500 Hz rolling off at lower frequencies at a rate of 8 to 9 dB/octave. Following a peak of about 6 dB at 850 Hz, the output at higher frequencies became irregular and cut off sharply above 10,000 Hz. The irregularity we observed is commonplace in headphone measurements and cannot be disassociated from the internal dimensions of the coupler, just as the listening room has a major effect on the perceived frequency response of a loudspeaker. Independent evidence has shown that a fair amount of irregularity in the midrange and highs may contribute to naturalness and be preferable to a flat response. Compared to an average of the response liked best by listeners in one set of tests, the Stanton shows somewhat less output at midrange frequencies and a fairly sharp rolloff of the highs. It should be borne in mind, however, that ears are highly individual, and no single response characteristic will be optimum for all people.

The SPL output in the flat portion of the midrange response was 110 dB at the 3-volt level, which corresponded to about 0.4 volt at the headphones themselves. Harmonic distortion was measured at the same input level over a 50-to-5000-Hz range. As expected, it was higher at very low frequencies, partly because the fundamental output fell off rapidly below 150 Hz. Distortion was down to 1% at 300 Hz and higher frequencies, reaching a fine 0.63% at 1000 Hz. Impedance of the phones measured about 15 ohms across most of the audio range, with a broad rise to 25 ohms at 130 Hz and to just over 20 ohms at 20,000 Hz.

User Comment. The Dynaphase 35 phones were exceptionally comfortable, even when worn for extended listening periods. The combination of minimal weight with well-designed and softly padded headband and earcups appears to be close to the optimum for a headphone. Accordingly, it does not press uncomfortably at any point of contact with the wearer's head or ears and does not produce a "closed-in" feeling like some phones that seal tightly.

The sound of the phones has a pleasant and airy character, though without the precise resolution that more high-frequency response would provide. Moreover, it maintains resolution in the low-bass region, avoiding the tubby quality found in many phones with high output in this region. As is generally characteristic of phones that ride on the ears rather than surrounding them, these give a relatively dry sound that would probably endear them more to a fan of popular music than to a classics buff. At no point, however, did we find anything in the distortion or frequency-response characteristics that we felt would contribute to listening fatigue.

While it is true that headsets selling for substantially higher prices are capable of outperforming the Stanton, it is fully comparable with those in its price range. To the extent that its sound differs from that of competing units, the choice of one or another model must be made on the basis of personal taste. Our tests show no appreciable difference in quality.

A point to consider is that most competitive phones have an impedance in the 200-to-600-ohm range. Although they can be driven easily from any amplifier or receiver, many cassette decks have low-impedance headphone outputs and cannot produce a really useful listening level with high- or medium-impedance phones. In contrast, the Stanton Dynaphase 35 should be an excellent choice for anyone who expects to use headphones for listening directly to the output of a tape deck as well as for those who wish moderately priced phones that will both reproduce sound most satisfactorily and allow one to hear a telephone ring or someone talking. Furthermore, the phones are attractive looking and the extra-long cord is most welcome.

CIRCLE NO. 103 ON FREE INFORMATION CARD

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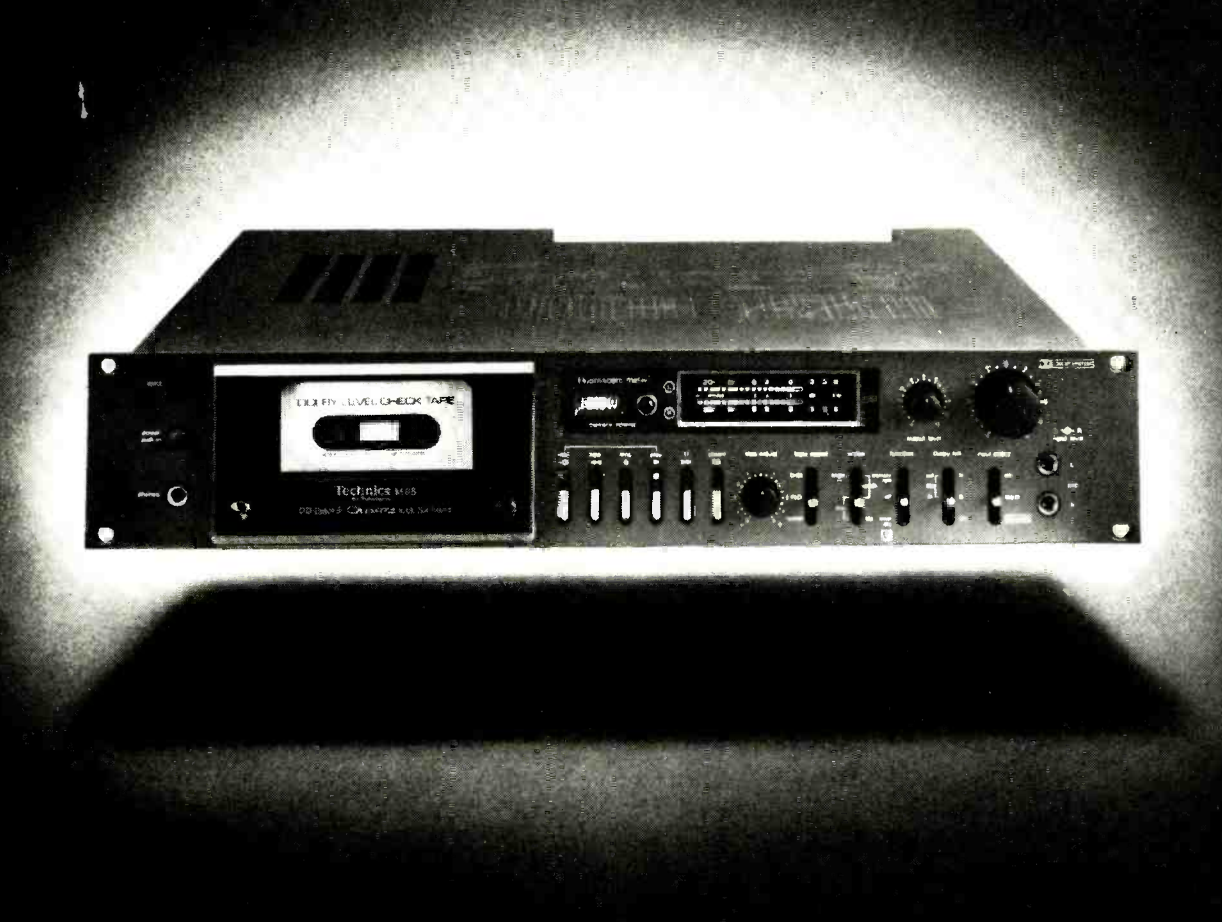
You know what Technics quartz-locked direct drive does for records. Now listen to what it does for cassettes.



Accuracy good enough for even the most demanding professional, that's what Technics quartz-locked direct-drive turntables are all about. And that's why radio stations use them and discos abuse them.

Now you can record your records as accurately as a Technics turntable plays them. With the RS-M85, our new quartz-locked direct-drive cassette deck. Not only does it have the kind of transport accuracy that's hard to beat, it has that kind of price, too. The reason for all this accuracy: The performance of Technics direct drive combined with the precision of our quartz oscillator.

The RS-M85's servo-controlled system compares the motor rotation with the unwavering frequency of the quartz oscillator and instantly applies corrective torque if any speed deviations are detected.

To complement that accuracy, Technics RS-M85 has a Sendust head with a high-end frequency response of 18,000 Hz, low distortion and excellent dynamic range.

Since there's nothing ordinary about the RS-M85's performance, there's nothing ordinary about its meters. The RS-M85 features Fluorescent Bar-Graph meters. They're completely electronic and therefore highly accurate. Response time is a mere 5μS. There's also a peak-check mode plus two selectable brightness levels.

To all this sophistication, the RS-M85 adds all this: A separate, coreless DC motor for reel drive. Dolby NR.* Full IC logic control in all modes. A low-noise, high-linearity amplifier section. And a 3-position bias/EQ selector with bias fine adjustment.

Also available is Technics RP-070. An optional full function infrared wireless remote control.

Technics RS-M85. Compare specifications. Compare prices.

FREQ. RESP. (CrO_2): 20-18,000 Hz. WOW AND FLUTTER: 0.035% WRMS. S/N RATIO (DOLBY): 69 dB. SPEED DEVIATION: No more than 0.3%.

Technics RS-M85. A rare combination of audio technology. A new standard of audio excellence.

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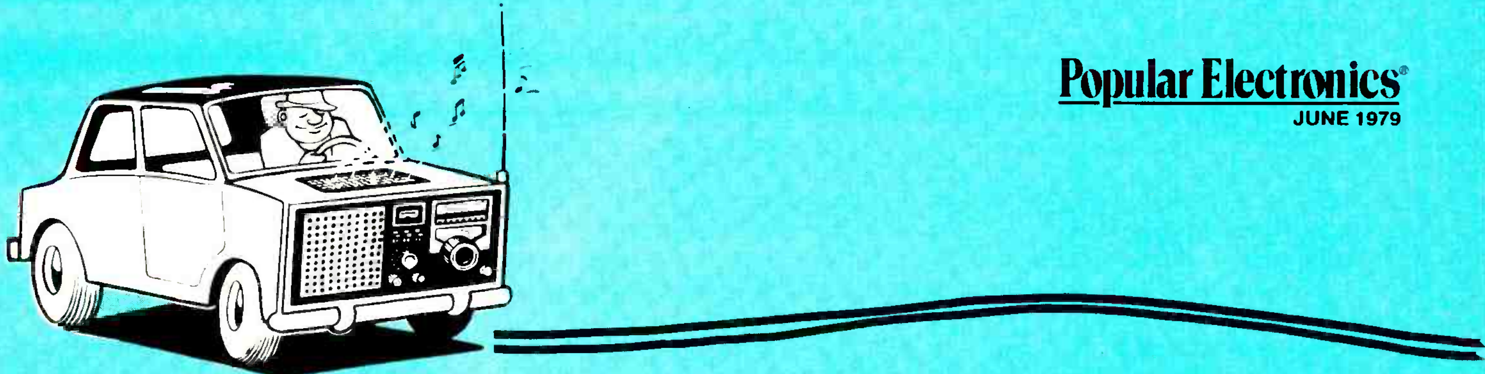

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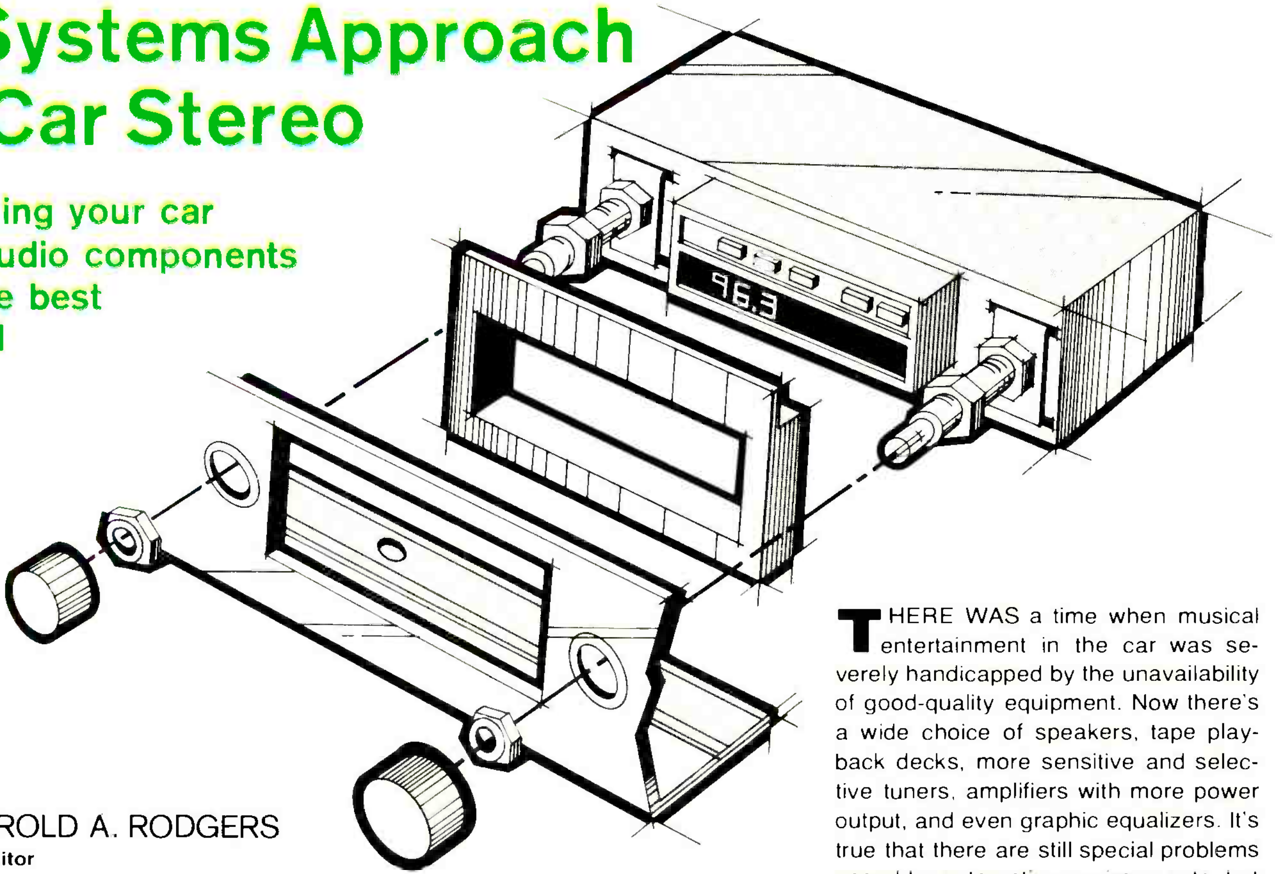
A Systems Approach to Car Stereo

Matching your car and audio components for the best sound



BY HAROLD A. RODGERS
Senior Editor

THERE WAS a time when musical entertainment in the car was severely handicapped by the unavailability of good-quality equipment. Now there's a wide choice of speakers, tape playback decks, more sensitive and selective tuners, amplifiers with more power output, and even graphic equalizers. It's true that there are still special problems posed by automotive environments, but these can be resolved with sufficient success to make listening to stereo in the car an attractive proposition. Though car audio is not quite on a par with what can be realized in the home, it certainly adds a lot of pleasure to traveling.

Anyone who seeks maximum attainable performance from a stereo system installed in a car must face some basic problems, such as high extraneous noise levels, restricted space for component installation, limitations of mobile audio and radio equipment, and unfavorable acoustic properties of the vehicle interior. Furthermore, it is necessary to solve or minimize these problems without hurting driving efficiency.

If you're buying a new car and elect to add factory-installed audio equipment, some of these challenges (though not all, by any means) will be met. However, the prices and levels of performance are such that factory units do not usually represent the best value. If you can install your own car audio gear, the difference separating factory-installed prices and attainable hi-fi performance will tilt even more to nonfactory equipment.

Here is an approach designed to help you select a sound system for your vehicle while maximizing return on money spent and avoiding pitfalls that may prevent system performance from being as good as it should.

Laying the Groundwork. Whatever your final plans may be, it's wise to prepare the car to accept the sound system. Regardless of how simple or elaborate the system turns out to be, care taken at this stage pays dividends. If you are ordering a new car, be sure to include as much sound-deadening treatment as possible. This might be an option, such as more insulation between the overhead liner and the car's metal top. Every dollar saved by scrimping here will cost many more in the long run—if the same level of performance is to be obtained. Even the model of car can be an important choice, as there can be considerable variation from one to the next. For example, *Car and Driver* finds that the interior noise levels of four luxury cars ranging in price from about $11,000 to $22,000 fall between 65 and 71 dBA when measured at a 70-mph cruise. (The least expensive of this group, the Buick Riviera S type, is the quietest.) Adherence to the national speed limit should improve these figures by a dBA or two and yield noise levels that, while not too bad, are still some 20 dB above those found in an average residence.

Air conditioning, which allows windows to be kept rolled up in summer, thus limiting aerodynamic and traffic noises, is also desirable (assuming the blower is operating at a low speed). So are tires with treads designed to produce minimum noise. You should note, too, that "hot rodding" and car stereo are not a good mix. If you favor good sound quality on the road, avoid using heavy-duty or sport suspensions, which generally transmit more road noise than standard systems, and any sort of performance modifications (headers, free-flow exhausts, turbochargers, etc.) that encourage an engine to behave noisily.

Should you wish to add a sound system to a fairly noisy vehicle you already own, it will pay you to install an acoustical treatment yourself. Fiberglass batting, to be installed along firewalls and the undersides of hoods, among other places, can be obtained from automotive supply houses. Also resonant panels can be deadened by injecting plastic foam into the cavities behind them. Use a closed-cell foam to avoid problems with moisture, and be sure not to fill spaces that provide clearance for moving parts or that you will need as mounting locations for loudspeakers. In vans whose sound systems will be used with the vehicle stationary much of the time, control of acoustic noise is less critical.

Suppression of electrical noise is best achieved in a new vehicle by ordering the package that goes along with factory-installed sound systems. (Most automotive manufacturers, preferring to sell their own sound systems if they can, don't say much about the existence of the electrical noise suppression package, but it can usually be selected as a separate option.) If you are retrofitting into an older car with no radio or sound system, you will probably have to troubleshoot electrical noise problems should they occur.

Another consideration, especially if you are contemplating a super-power audio system, is whether the car's electrical system can stand the extra current drain. A high-output alternator and heavy-duty battery could be a wise investment. The minimum recommended, particularly if the car has numerous electrically operated accessories, is sufficient instrumentation to warn of excessive current draw or voltage drop. With meters rather than standard "idiot lights," you will know when to turn off non-essential items temporarily if problems occur. If it is expected that the sound system will operate for extended periods with the engine turned off, a dual battery system with a high-output alternator might be required.

Choosing the Components. "Buy cheap, pay dear," is an old maxim that also applies to car stereo equipment. There are a variety of special needs that automotive stereo equipment must meet. For instance, car stereo gear must withstand vibrations and gross changes in humidity. It must also be as small as possible while retaining high performance. Moreover, it must cope with a listening environment vastly different from that at home.

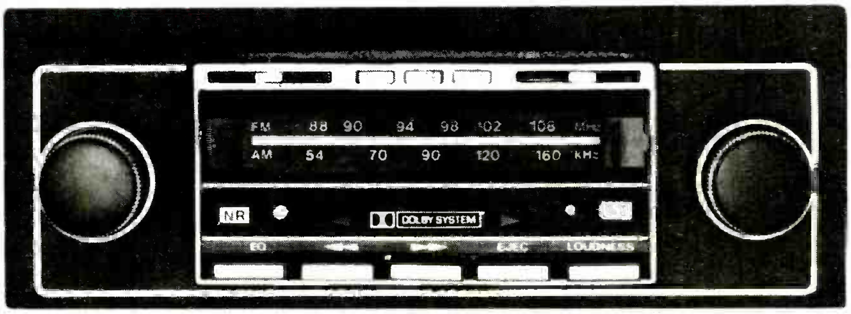
One vexing problem is that the interior finish of a car is highly absorptive at midrange and high frequencies. Moreover, the limited internal volume of a car does not allow bass frequencies to propagate efficiently. The low notes may, in fact, excite resonances at frequencies well within the audio bandpass. Another irritating problem is that few cars have locations that are both functionally and cosmetically ideal for speakers.

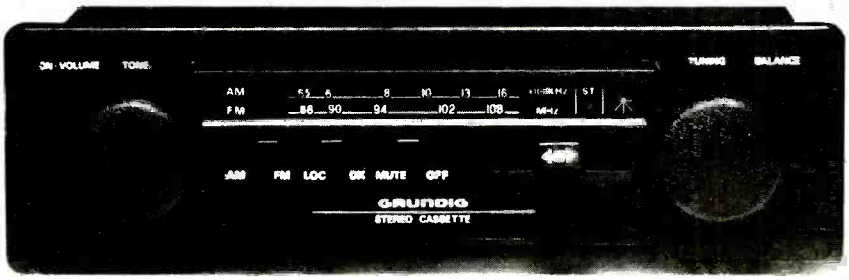
A reasonable solution for high and middle frequencies can be achieved by locating loudspeakers as close to the listeners' ears as possible, making sure that the high frequencies can follow straight paths to the ears. At the same time, however, adequate bass performance demands that speakers be baffled and vent their back radiation into a reasonably large space.

For these and other reasons (as in home systems, full-range drivers often have difficulties handling extremes of the audio spectrum), systems that strive for more than modest performance generally use multiple drivers with appropriate crossovers. When they can be mounted so that high frequencies don't suffer excessive attenuation, the two-way minispeakers of the type offered by ADS, Visonik, and others can provide very fine performance. To do their best, though, they require substantial power (25 watts per channel or more) from the electronics. They have two principal drawbacks. One is theft security; they do not mount flush and may therefore invite unwelcome attention. They can, of course, be dismounted and stored out of

IN-DASH PRODUCT SAMPLER

Here are some examples of the diverse models available in in-dash car stereo radios. Sparkomatic's Model SR-2400 (top) is an AM/FM stereo radio combined with an 8-track tape player. The large digital readout can display either time or station frequency tuned in. Motorola's Model TC-881AX (second from top) is rated at 8 watts total system power. The AM/FM stereo unit incorporates a cassette player that ejects tape automatically at end of play. Craig's Model T-688 (center), also an AM/FM stereo unit, has a cassette player equipped with Dolby noise reduction. Sharp's Model RG-5252 (second from bottom) features an Automatic Program Search System (APSS) that allows the cassette player to skip to next recorded selection or repeat the current one. It also includes an AM/FM stereo radio and 14 watts system power and is designed for foreign-made cars. Grundig Model GCM-4600 (bottom) AM/FM stereo radio/cassette player features FM muting and a local/distance sensitivity switch. It has a European DIN input connector.





sight when the vehicle is unattended. The other is that they take up valuable interior vehicle space or block part of the rear window.

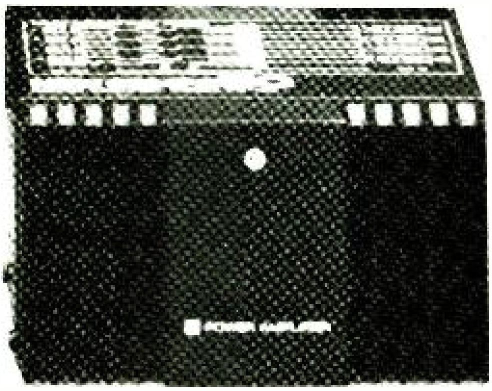
Unitized, multi-way speaker systems that do mount flush are available from numerous manufacturers, such as Motorola, Jensen, EPI, Advent, Kriket, Marantz, Sparkomatic, KLH, and Pioneer, among others. These too are capable of excellent results, but their proper mounting can pose problems.

Since optimum performance from the woofer sections requires baffling with the rear wave venting into a space of reasonable size, the rear deck seems like a natural location. This is fine as far as the bass goes, but the midrange and highs now must bounce off of several surfaces, some highly absorptive, before being heard. Advent deals with the problem by equalizing the system (which comes with integral power amps) to make up for the losses. This idea is more universally applicable if the electronics package includes an equalizer and power amps that can provide the necessary muscle. But beware of applying it to budget systems—you can get amplifier clipping or failing speakers by pushing things too far. Most of the better integrated speakers have the needed power-handling capability.

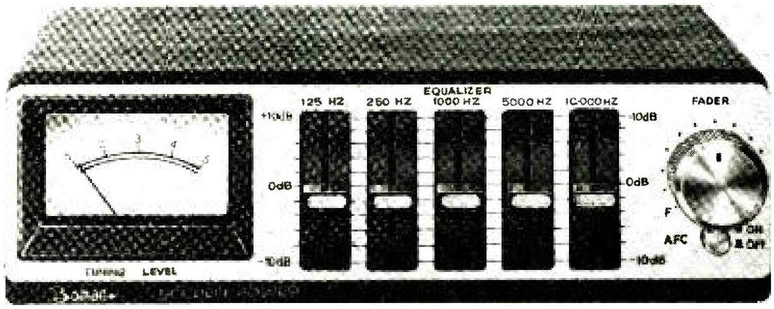
Another approach is to use separate drivers, readily available from a large number of companies, for the separate frequency ranges. The flexibility gained this way can solve a host of problems. For example, woofers (or even a single woofer fed from both channels, since low frequencies are not very directional) can be mounted on the rear deck, with the midrange drivers surface-mounted high on the doors and the tweeters high on the dash. Now the bass drivers are well baffled, the midranges are reasonably close to the ears, and the tweeter output can be heard without being reflected first. Purists may complain about "time smear," noting that radiation of the various units travels radically different distances to the ear. Whatever the audible effects of this may be, I doubt that even a 12th-degree golden ear could complain of them too much in a moving car. And even if he can, there is usually not much that can be done about it.

Generally speaking, it is easier to use a speaker "separates package" from a single manufacturer than to mix brands. However, if you feel that no one company has just what you want, certain precautions are in order when mating drivers from various sources: (1) Make sure that all have the same nominal impedance. It is very difficult to fit crossovers

UNDER-DASH EQUIPMENT SAMPLER



Fujitsu Ten's Model PA-150F is a four-channel power amplifier with rated output power of 20 watts per channel.



Boman's Audio Graphic Equalizer, an add-on for the company's Models Mach 80 and 90 car radios, contains a front/rear fader, a tuning-level meter, and five bands of equalization.

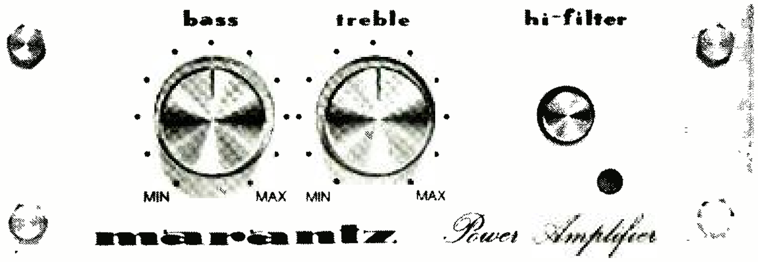
Panasonic's Model CA-9500 is really a mobile components package of three modules: AM/FM stereo tuner, preamp with cassette deck, and a power amp. It is shown with a CSMB-1 mounting bracket, which allows for an adjustable angle and has a quick-release latch.

to a mix of 4-ohm and 8-ohm drivers, among other problems that could arise. (2) Be certain that the speakers can handle the power delivered by the electronics and, conversely, that the electronics can drive the speakers to the levels you want. In a high-powered system, you may wish to resort to multiple drivers in each frequency range (purists again notwithstanding). Identical drivers can be connected in parallel, series, or series-parallel depending on the desired impedance of the combination. But most amps cannot take heavy drive when loaded with less than 3 ohms or so without running into trouble.

Having chosen speakers, you will next want to decide what power amplifiers to use ahead of them. The important parameters here are how much power the speaker system requires to produce a given level of loudness and how much power it can handle before apparent distortion or self-destruction sets in. For low- through middle-performance systems, the all-in-one units that combine single sources, controls, and power amps may well suffice, although separates offer more flexibility (a separate power amp could be hidden in the trunk, for example). A high-performance system, on the other hand, will almost certainly require separates.

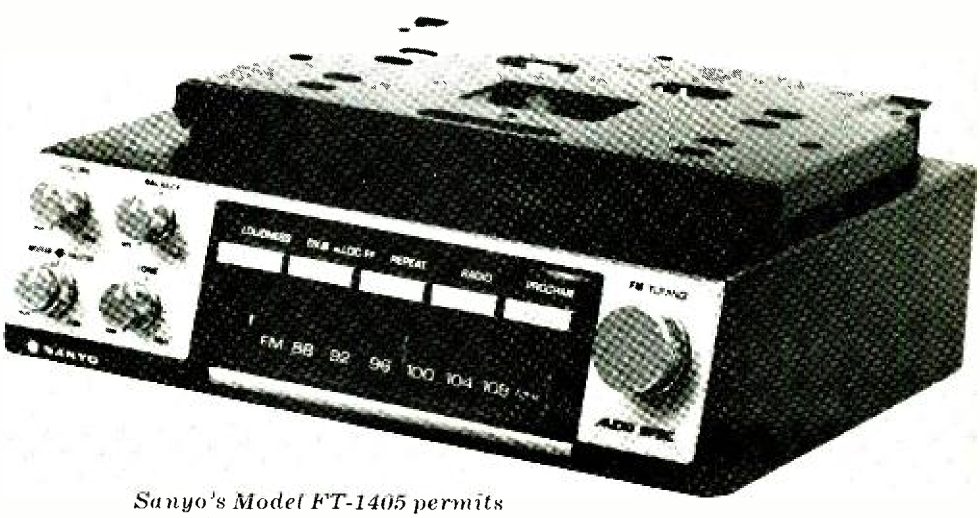
One of the greatest obstacles to high-power audio in automobiles is the limited voltage available from the electrical system. The 12 to 14 volts normally supplied can deliver only 4 watts or so to an 8-ohm load. One way to get around this limitation is to use different amps for each frequency range, with electronic crossovers. Another technique, which in theory raises power output by a factor of four, is to connect the speaker across the hot leads of two amps with a common ground, driven in opposite phases. Strapping, or bridging, as this method is called, effectively doubles the minimum impedance the amplifiers can tolerate: a pair of strapped amplifiers individually rated to handle 4-ohm loads would not be safe with less than 8 ohms. But even bridged amps are limited to 16 watts or so. To go higher than this, many integrated units, separate amps, and boosters are operated from power supplies that use dc-to-dc converters to give higher voltage.

As noted earlier, the acoustics of a car interior can pose some peculiar problems, many of which yield at least in part to equalization. A graphic equalizer, then, can be considered a near necessity in an optimum installation. The function of the equalizer will not be to act as a "super tone control." Rather, it should



The Marantz SA-230 moble integrated amplifier features separate bass and treble controls, switchable high-cut filter, and 40 watts rated maximum power.

A high-performance tape-only system combining a Nakamichi Model 250 cassette player and biamplified Model 2002 speakers from ADS.



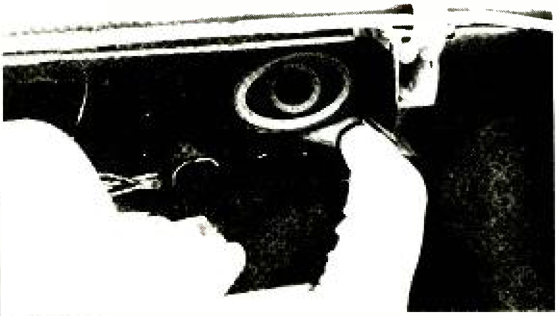
Sanyo's Model FT-1405 permits retaining a stock AM radio, while adding an FM stereo radio and a cassette player, and is designed for biamplification.

be used to adjust the system for the flattest output response that can be achieved, leaving more conventional tone controls for use in equalizing the program. In fact, a case can be made for mounting the graphic equalizer so that its controls are inaccessible. The reason is that deficiencies in source material are not generally confined to single bands; usually, one end of the spectrum rises or falls too fast. This is far easier to correct with an ordinary tone control than with a graphic equalizer, especially when you have to concentrate on driving as well. Second, if a good graphic setting is disturbed, restoring it can be difficult.

Program material in a high-quality car stereo will largely originate from FM radio and tape. For a first-class system, it is essential that the radio and tape sections be of high quality. Once an inadequate "head-end" device deteriorates a signal, nothing can be done to correct it. Furthermore, the better the "downstream" components are, the more they will expose such deterioration. In practical terms, this means that, though integrating a factory-installed radio into the system may be tolerable where moderate performance will suffice, it will seldom suffice for an optimum system. Skimping on the antenna, incidentally, is also a bad idea. And it is wasteful to install wideband speakers and amps only to feed them signals whose "highs" have been stripped away by a marginal-performance tape player.

For playing prerecorded tapes, you have a choice between eight-track players, once undisputed kings of the road, and cassette decks, which held sway at home. Cassette players, whether integrated in an all-in-one unit or separate, are far and away the most popular car types for more serious audio enthusiasts. Perhaps owing to competition, eight-track car tape players have been upgraded to a bandwidth generally comparable to that of cassettes—and they have the advantage that prerecorded software is abundant. Besides, they allow the option of discrete quadraphonics. Cassette decks, still uncontest-

LOUDSPEAKERS FOR MOBILE USE



Here's an example of how different speakers can be used to enhance car stereo sound, using Kriket "Audio Separates" drivers. Dome tweeters are installed high in dash (left), 5-inch midrange/woofers mount in front doors (center); Domaxial™ biamplified full-range speakers mount in trunk (right).

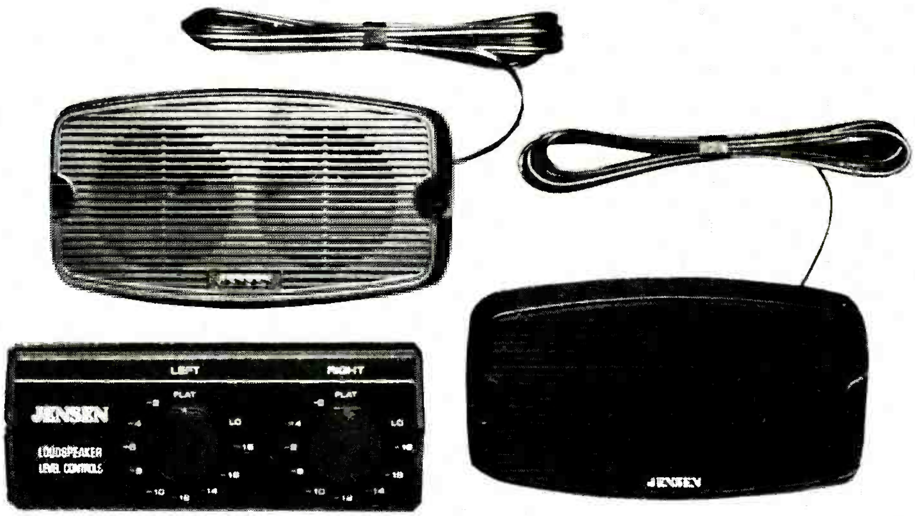
Opposite page: KLH Model 693 DMSC (top left) is a three-way, full-range loudspeaker designed to fit a car's standard 6″ × 9″ cutout. Jensen's tweeter/midrange module kit (top right) consists of two surface-mount modules and associated crossover/level-control unit. The Roadstar Model 6044 (lower left) is a two-way minispeaker whose adjustable bracket allows speakers to be aimed for the best sound coverage. Pioneer Bodysonic (lower right), shown with its associated amplifier, uses special transducers mounted in cushion to produce bass that can be felt.

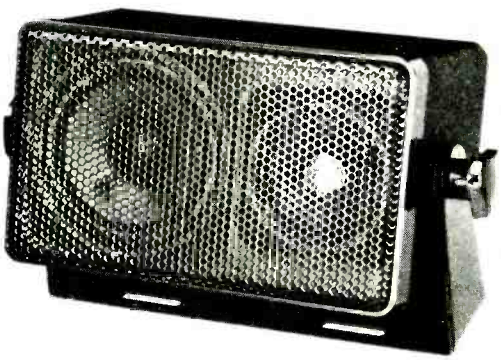
ed in the home, offer the advantage that an existing library of tapes can readily be pressed into mobile service. True, there is the problem that few car players are equipped with Dolby noise reduction, which is nearly ubiquitous in home machines. But this is not as serious as it may seem; the extra "brightness" given by undecoded playback of a Dolby-encoded tape can be helpful in a car.

Whether the tape and radio are combined in a single unit or not depends partly on what space is available in your vehicle and partly on personal taste. As with home audio, separates allow more flexibility in upgrading and expansion. All-in-one units usually offer advantages of compactness and lower total cost. Whatever you decide, take into account the fact that when the car reaches trade-in age, you will either have to trade the audio system with the car or restore the interior to nearly pristine condition after removing the system if you are to avoid losing a considerable part of the value invested. Bear in mind, too, that the system that fits your present vehicle may not fit the next one.

Before we go on to consider actual installation, a few special situations are worth considering. A good car audio system may keep the vehicle's acoustics at bay, but a dead-sounding quality that results from high absorptiveness of the interior is hard to defeat. Help is available from Sound Concepts with its time-delay system and Fosgate with its Tate SQ quad system. Both of these use an extra pair of speakers and associated power amplifiers to route ambient information derived from the stereo signal to the back of the car. Both methods can be worth the extra effort and expense, particularly since speakers of relatively modest capabilities can perform very well in handling ambience only. Moreover, high-frequency demands are few in this application, simplifying installation and placement as well.

Installing the Equipment. Once you have selected speakers and decided where they should be located, it is a good idea to proceed slowly and make





sure that they will actually fit before cutting any holes. Remember, too, that neatness counts—especially if you value the equity in your car. In general, a speaker will sound best mounted flush with its supporting surface. Cavities and/or sharp edges promote coloration due to diffraction and resonances. Once in place, speakers should be protected by acoustically transparent foam unless they have integral grillwork. Additional protection can be had by backing up the foam with screening or wire mesh.

Mounting speakers in doors may be necessary, but mechanical and acoustical considerations—not to mention the danger of rain leaking past the window gasket—make it a less than optimum choice. Proceed by removing the interior trim panel and check to see if there is a place inside the door where the speaker will not interfere with either the window or door-latch mechanisms. Once such a location is found, a layer of sound-deadening material should be cemented to the inner surface of the sheetmetal "skin" to prevent sound issuing from the back of the speaker from being reflected through the cone. This treatment should be given to any mounting cavity, save, perhaps, the trunk, whose dimensions may make this impractical.

Rear-deck mounting is more straightforward mechanically. However, since speakers are exposed to the sun in that location, proper protection with a grille is even more important. If the vehicle is relatively airtight, it may be a good idea to allow some air leakage between the passenger compartment and the trunk. That way, slamming a door with the windows closed is less likely to rupture the speaker cones.

Although it is possible to use the automobile chassis as a ground return for the loudspeakers, several manufacturers advise against doing so, suggesting instead that an additional wire be used. When bridged (strapped) amplifiers are used, neither side can be grounded to the chassis, of course. For good results, speakers should be connected with wire no smaller than #18 gauge (#16 is probably an even better choice). Care must be taken to wire all speakers in correct phase. If the speakers are all of the same type, this can be accomplished by observing markings on the terminals. If the speakers are mixed, polarity must first be determined. An easy way of doing this is to connect a 1.5-volt cell across the terminals and observe cone movement for a positive signal.

Crossovers can present difficulties in finding the best phasing, particularly when the individual drivers are not mounted in the same location. It may be a good idea to connect drivers of a multi-way speaker system with molded nylon connectors to allow experimentation.

Electronics can be mounted either in the available dash cutouts or located under the dash. Amplifiers, especially those of high power, will lead a longer life if well ventilated. Systems of modest power can be fed power via a spare fuse in the car's fuse block. But when large amounts of current are to be drawn, connection is best made directly to the battery, with the equipment turned on and off by means of a relay controlled by the key switch or the main power switch. In this case, in-line fusing is imperative.

Should interference rear its ugly head, the best course is to try to find the source and eliminate it there. In some cases, it may be necessary to filter the supply voltage taken from the battery, or to add bypass capacitors to parts of the ignition system, to the voltage regulator and alternator or across motor contacts. Such bypasses must be added carefully, as they can interfere with the function of the device in question. Where the source of the interference is elusive, a "sniffer coil" (Fig. 1) and a pigtail (Fig. 2) can help in tracking it down. Sometimes, speaker leads can act as antennas, feeding interference into power amps and elsewhere. Often the solution is to add inductance by feeding several turns of the speaker leads through a ferrite core or adding a high-current filament choke (20 to 30 microhenries) in series with each hot leg. Low-pass filters designed for speaker leads are also a possibility, but be sure that they don't set the amp into oscillation. Any of these should be as close to the amplifier as possible.

Once the entire system has been installed and is operating without significant interference, you may wish to check its frequency response and, if a graphic equalizer is included in the package, tune it for best or flattest results. This can easily be done with an inexpensive sound-level meter and a test cassette. Alternatively, you could feed the output of a battery-operated signal generator into an input intended for a tape player and proceed from there. Should you choose to record your own test cassette using a signal generator or test record (1/3-octave bands of pink noise make excellent test signals), remember that it will be necessary to record the cassette at −20 VU or less if high-frequency response is to be maintained.

When you actually run the test, you probably won't be able to get a flat response across the audio band, but if you can manage, say, ±5 dB from 100 Hz to 16 kHz, you are doing well. The limited volume of the car interior makes it unlikely that frequencies below 100 Hz will propagate efficiently. Besides, you are unlikely to find program material with highs beyond 16 kHz anyway. What is more important than the absolute span of bandwidth is balance. If there is an

Diagrams courtesy Champion Spark Plug Co

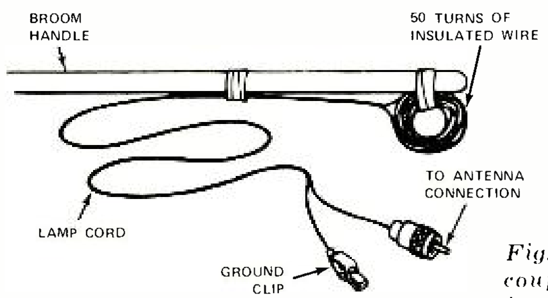


Fig. 1. "Interference sniffer" has coil on broomstick, coupled to radio antenna. Maximum sound in loudspeaker is produced when coil is brought near source of r-f noise.

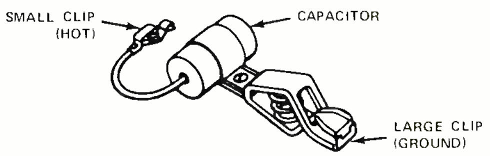


Fig. 2. Capacitor with alligator clips can be used as a temporary bypass to pinpoint a cause of interference.

unavoidable loss of extreme bass, you may want to roll off some treble to compensate—or vice versa. For this, your ear will do far better than any test instruments. Indeed, if there is any doubt, believe your ears rather than instruments.

Safety Considerations. One obvious concern in installing an auto sound system is that it pose no hazards for the driver or passengers. The following points should be carefully addressed in making sure that this is so: (1) Be certain that all components are adequately protected by fuses. (2) Make sure that all parts are rigidly fixed in place so that they will not come loose in an accident and act as missiles. Be sure, too, that externally mounted components do not present a hazard to other occupants, whether it's getting in or out of a car or as a dangerous obstacle that one might hit his head on during an accident or quick stop. (3) In some cars, the rear deck is a metal structure that acts as a firebreak between the fuel tank and the passenger compartment. If you have cut through this to install speakers, it is best to surround the speakers from the rear with heavy wire mesh so as to regain some of the protection, unless the speaker is well encased by metal. (4) Some manufacturers of high-powered amplifiers warn that it is possible to create sound pressure levels in a car that are dangerous to hearing. Use your judgment as to how loud you play your system, and try to be aware of when you start experiencing listener's fatigue. Also, don't allow music to isolate you, the driver, from real-world sounds, such as an emergency vehicle's siren.

Conclusion. We have now covered the major considerations involved in making an audio system part of your automobile. Individual installations are bound to depart from the generalized approach taken here, but most of the additional problems you are likely to encounter will probably yield to common sense. Your mobile listening system is, of course, no substitute for a concert hall, nor should it be compared to what you have at home. Mr. Masaneo Okatani, a spokesman for Pioneer, sums up the difference: ". . . in home audio, we try to give the listener the sensation that he is seated in a concert hall. Car stereo gives more of an 'on-stage' feeling . . . as if the listener is one of the musicians." Come to think of it, when you're faced with a long, boring trip, "on-stage" is not a bad place to be. ◇

Polarity Protection for Mobile Equipment

A silicon diode or modular bridge rectifier can be inexpensive insurance against reverse-voltage damage to CB or car stereo

BY ROBERT J. TRAISTER

TODAY'S solid-state mobile electronics gear is, as a rule, rugged and dependable. However, it is susceptible to damage if its power leads are inadvertently cross-wired to the vehicle's dc supply. Unless mobile gear contains reverse-polarity protection, the user runs the risk of "popping" one or more of the unit's semiconductors if a wiring error is made. Fortunately, such protection can easily be added to any existing dc-powered equipment. This article will describe how this is done using readily available, inexpensive components.

Adding Polarity Protection. An important property of a semiconductor diode is that it conducts when forward biased (anode positive with respect to cathode) but acts as an open circuit when reverse biased. This property is commonly employed to rectify ac into dc, but can also form the basis of reverse-polarity protection for dc-powered equipment.

The simple schematics of Fig. 1 show a dc power supply (represented as a 12-volt battery), a polarity-sensitive load (shown as a resistor with polar markings and a power switch), and *D1*, a silicon diode. When the load is connected to the supply so that their polarities agree (Fig. 1A) and the power switch is closed, *D1* becomes forward-biased and current flows through the load.

If the leads to the power supply are transposed, as in Fig. 1B, *D1* becomes reverse biased when the power switch is closed. The diode acts as an open circuit and prevents the potentially destructive reverse voltage from reaching the load. Under these conditions, the load will receive no power and will act

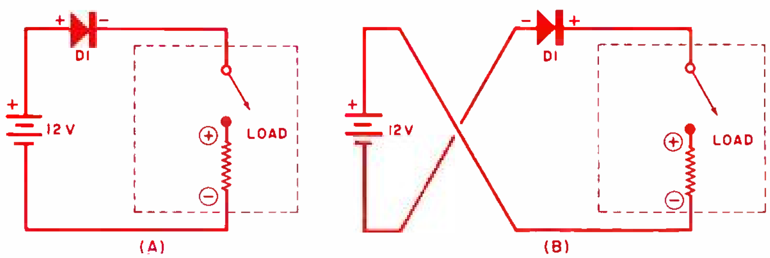
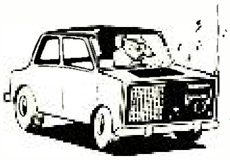


Fig. 1. Inserting a silicon diode in positive power lead prevents reverse voltages from reaching polarity sensitive load.



"dead," as if a fuse had blown. No damage will have occurred, however, and the load will function normally as soon as the leads to the power supply are transposed.

For CB and auto radios (excluding those with significant audio output), a 50-PIV, 3-ampere silicon rectifier will be adequate. Power-hungry components such as audio or amateur r-f power amplifiers will require diodes capable of handling larger amounts of current. To determine the proper current rating of a protective diode, ascertain the amount of current drawn by the component to be protected. Do this experimentally, by measuring the current with an ammeter, or by consulting the manufacturer's literature. Double the measured or published value—the result is a safe current-handling rating for the protective diode. The PIV rating of the diode is not critical as long as it is at least 50 volts.

The protective diode can easily be added to any dc-powered equipment. If space permits (and a warranty is not voided by opening the enclosure), the diode can be installed inside the gear to be protected. Most equipment will easily accommodate the modest size of a silicon diode. However, if warranty considerations preclude mounting the diode internally, it can be wired into the positive power lead using an in-line fuse holder. Solder connections can be made between the diode leads (trimmed to size) and the small, flat contacts which normally touch the ends of the fuse.

Whether the diode is mounted internally or externally, make sure that it is properly oriented (anode toward the supply, cathode toward the load). Otherwise, reverse-polarity protection will *not* be afforded. To the contrary, a diode installed backwards will block current when the power leads are connected correctly and will pass reverse voltage to the load when the power leads are transposed!

Another Method. We have seen that simple diode protection prevents reverse voltage from reaching the load (and prevents the load from functioning) when the power supply leads are transposed. There is another way to protect dc-powered equipment from the application of reverse voltage. This second method, employing a modular bridge rectifier, enjoys a significant advantage over the simpler scheme already discussed. It automatically routes dc of the correct polarity to the load, whether the leads to the power supply are transposed or not.

A full-wave modular bridge rectifier is used in this application in Fig. 2. The bridge rectifier comprises four diodes (labelled *A* through *D*) in one package with four leads. Two of the leads are normally employed for the application of ac, and are customarily marked "AC," with sine waves (as in Fig. 2), or left unmarked. The two leads from which pulsating dc is normally extracted are designated + and −, referring to the polarity of the dc output. It is to these latter terminals that the load should be connected with strict attention to polarity (+ to +, − to −) if polarity protection is to be obtained. If this is done, it is irrelevant how the ac terminals of the bridge rectifier are connected to the power source. Here's why.

If the bridge is connected to the power supply as shown in Fig. 2A, diodes *B* and *C* are forward-biased and connect the load's positive side to the positive terminal of the power supply and the load's negative side to the negative supply terminal. Diodes *A* and *D* are reverse-biased and effectively not in the circuit.

If the leads from the bridge to the power supply are transposed (Fig. 2B), diodes *A* and *D* become forward-biased and diodes *B* and *C* become reverse-biased. The positive side of the load is connected to the positive side of the supply by way of diode *D*. Similarly, the negative side of the load is connected to the negative supply terminal by way of diode *A*. It can thus be seen that even though the leads to the power source are transposed, the load still receives dc of the proper polarity. The switching action of the bridge rectifier diodes is responsible for this and ensures that the load never sees reverse voltage as long as the load is connected to the bridge as shown.

In all vehicles, one side of the dc electrical system (usually the negative side) is grounded to the chassis. If the chassis of the equipment to be protected serves as ground for the circuits it houses (which is often the case), one of the two forward-biased diodes in the bridge will be short-circuited—assuming that the chassis of the equipment makes contact with the body of the vehicle, a valid assumption in many installations. For example, assume that the vehicle electrical system of Fig. 2 is one employing a negative ground return. Grounding the chassis of the load bypasses diode *C* (Fig. 2A) or diode *A* (Fig. 2B). This is of no consequence, however, because diode *B* (Fig. 2A) or diode *D* automatically routes positive voltage to the positive side of the load.

The same ratings that were discussed earlier with respect to the single protective diode apply to the modular bridge rectifier. A 50-PIV, 3-ampere bridge will be adequate for most auto radios and CB transceivers. In general, the bridge should have a current-handling capacity that is double the current drawn from the power source by the load to be protected. There is no advantage to be gained from using a bridge with a PIV rating significantly greater than 50 volts.

Because a modular bridge is not as compact, mounting it presents more of a problem than that encountered with a single diode (which really presents no problem to speak of). If space permits, the bridge can be mounted inside the

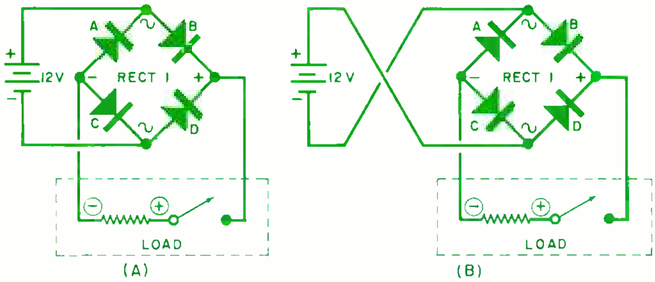


Fig. 2. Modular bridge rectifier automatically routes dc of correct polarity to load if connected as shown here.

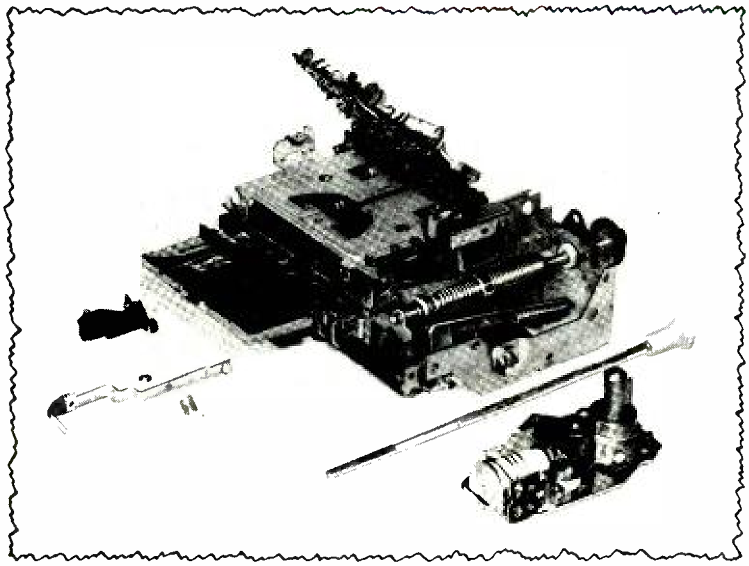
equipment enclosure. A bridge with a center mounting hole could be installed on the inside or outside of the rear panel, or on any flat surface nearby. Be sure the lugs or leads of the modular bridge do not come in contact with exposed metal surfaces. If necessary, apply silicone cement to the exposed contacts or pot the entire bridge (after connection of leads) in epoxy.

Voltage Drops. Using a single diode or bridge rectifier will cause the load to receive slightly less than the full output voltage of the battery or alternator. This is because a forward-biased silicon diode exhibits a voltage drop of approximately 0.6 volt that remains relatively constant as the current varies. Therefore, a load protected by a single diode will receive, say, 13.2 volts instead of 13.8 volts. A load protected by two of the diodes in a modular bridge will receive 12.6 volts.

These voltage drops might sound dramatic, but are really small enough to be neglected. In practice, they will cause no deleterious effects in radio or audio equipment, and are a small price to pay for immunity from the destructive potential of reverse voltages. ◇

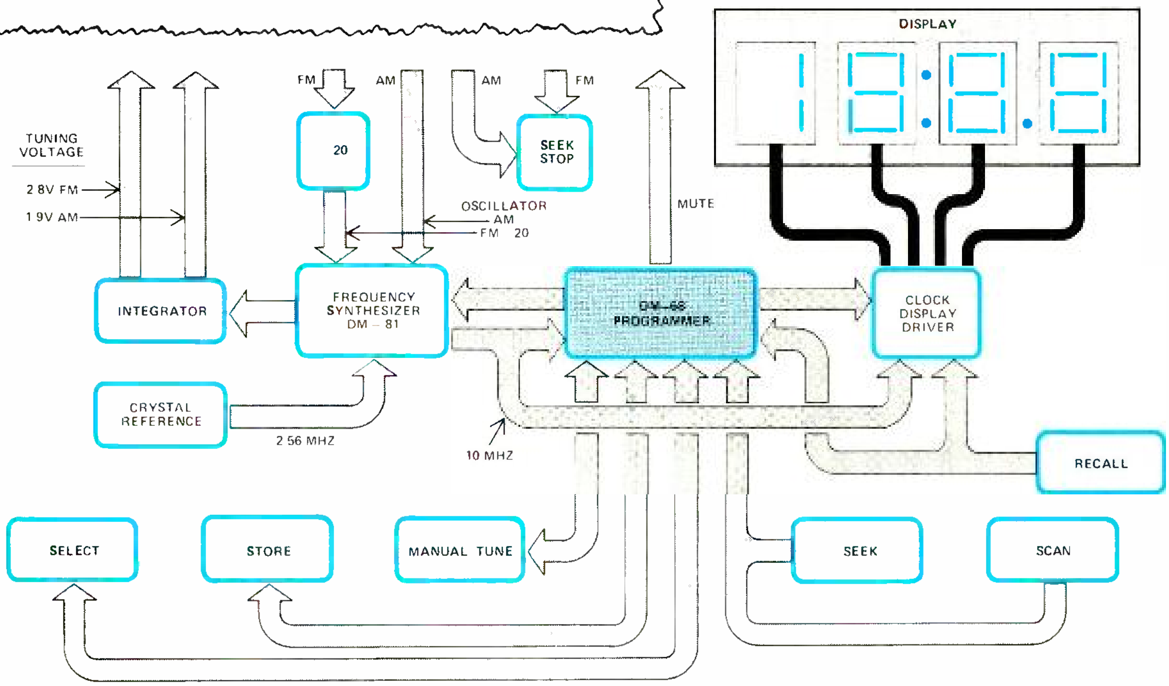
Electronic Signal–Seeking Car Radios—How They Work

BY JOSEPH J. CARR



Courtesy Delco Electronics Div., GM Corp.

At left is the electro-mechanical Delco "Wonder Bar" radio, a signal-seeking system continually refined over the years. Below is a diagram of the company's all-electronic model, first introduced last year.



SIGNAL-SEEKING car radios represent the pinnacle of automation in an automobile. By pressing a button on the radio or a footswitch, the dialing mechanism advances to the next strong signal up-band and stops at a perfectly tuned-in broadcast station. Thus, a driver enjoys increased driving safety and operating convenience.

(Continued on page 56)

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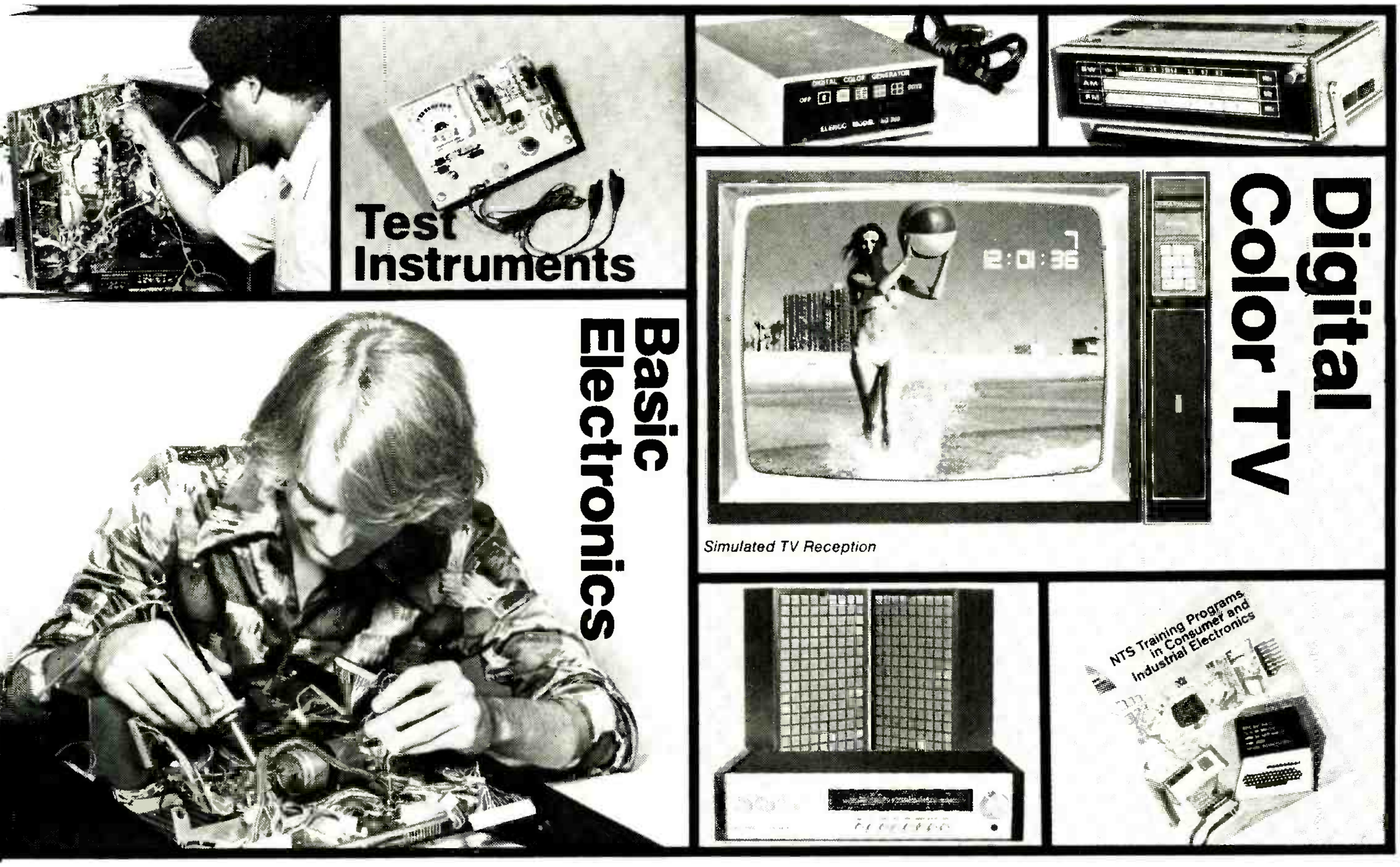

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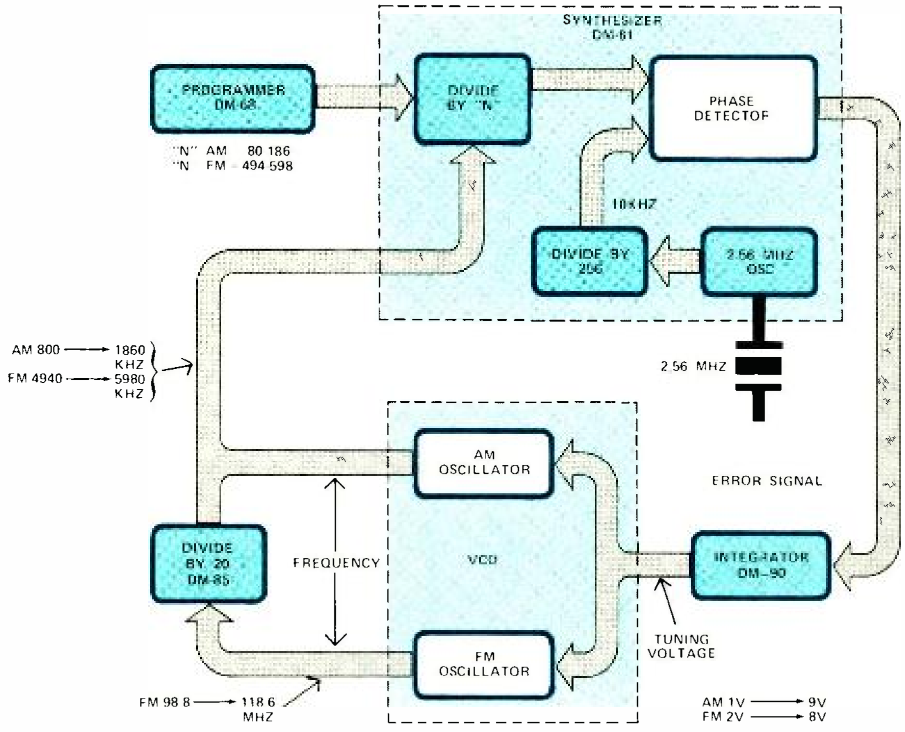


Courtesy Delco Electronics Div., GM Corp.

Fig. 1. Tuning voltages are obtained from an integrator controlled by a frequency-synthesizer IC. The latter, in turn, is controlled by a digital programmer IC.

volts on FM and 1 to 9 volts on AM. These voltages are obtained with an integrator circuit, under control of the DM-81 frequency-synthesizer IC in Fig. 1 which is, in turn, controlled by the digital DM-68 programmer IC.

The DM-81 contains a phase detector, divide-by-N counter, and 10-kHz clock that consists of a 2.56-MHz crystal-controlled oscillator and a divide-by-256 circuit. The 10-kHz signal serves as the reference frequency against which the AM and FM local oscillator frequencies are compared. The AM local oscillator signal is applied directly to the DM-81, while the FM local oscillator signal is first divided by a factor of 20 before being applied to the DM-81.

The divide-by-N stage in the DM-81 divides the local oscillator signal down to 10 kHz so that it can be compared with the reference signal. Division ratio N is determined by the DM-86 programmer in the form of a digital N code. The specific N code determines which station is being tuned by the radio.

If the output of the divide-by-N counter and the reference frequency (10 kHz) are the same, the phase detector's out-

There are three basic types of signal-seeker radio: motor-driven, spring-driven, and all-electronic. The first two are electro-mechanical and have been in use since the 1950s. The all-electronic seeker radio, is a more recent development, and will be discussed in detail.

All-Electronic Seekers. For the 1978 model year, Delco engineers developed a digital car-radio-tape-player combination unit with seeker/scanner capability. This was a giant step forward from its spring-driven "Wonder Bar" model that, though continually refined, dates back more than 20 years. It uses a power spring to drive the permeability tuning mechanism that's coupled to a rack and worm-gear assembly, while the all-electronic seeker system is tuned by a phase-locked-loop (PLL) circuit. In the electronic seeker, both AM and FM local oscillators are voltage-tuned using Varactor variable-capacitance diodes in their respective tuned circuits. (The intermediate frequencies commonly used in U.S.-built auto radios are 262.5 kHz on AM and 10.7 MHz on FM.) The tuning voltage to cover the entire band is 2 to 8

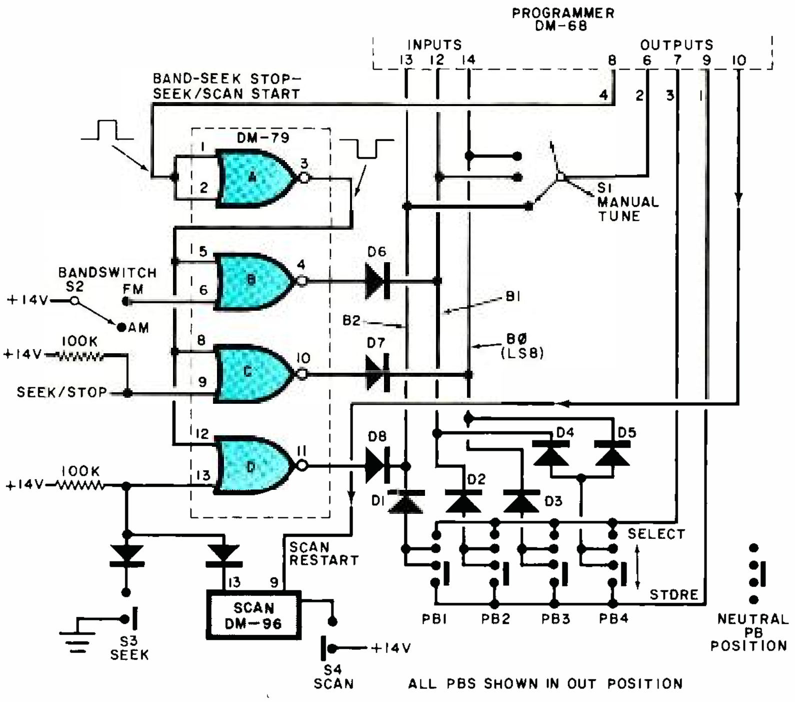


Fig. 2. Schematic of the DM-68 digital programmer control circuits that produce the different modes of operation. It has 3-bit input and 4-bit output buses.

put is near zero. When the station is changed, the DM-68 programmer responds by generating a new N code and the output of the counter will no longer be 10 kHz. In this case, the dc integrator's output voltage will begin to change in a direction to bring the local oscillator to the new frequency.

All tuning is controlled by the DM-68 programmer IC. It will recognize and respond to the following modes of operation: manual tune, select, store, seek, scan, and recall.

The manual-tuning mode allows the operator to select a station manually with the knob on the radio's front panel.

The recall mode affects only the digital display. Ordinarily, the station frequency is displayed only on initial turn-on, when a new station is selected, and when the RECALL button is pressed. At other times, the digital clock data is displayed.

The select and store modes have to do with pushbutton operation. The store mode stores in a register in the DM-68 the N code of the station being received. When one of the four selector buttons is pressed, the N code stored in the register for this button is recalled and fed to the divide-by-N counter in the synthesizer to tune in the desired station.

Seek and scan are similar functions.

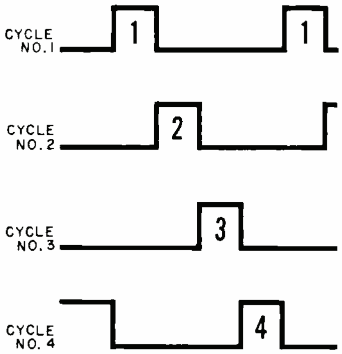


Fig. 3. Waveforms of the four output bus lines. They go high in sequence at an 80-Hz rate. Each controls one tuning mode.

Both are automatic tuning modes. In seek, the tuner advances to the next higher frequency station and stops. In the scan mode, on the other hand, the tuner stops at each active station for about 5 seconds and then goes on to the next station unless the scan command is cancelled. This allows the driver to survey all stations in his area before selecting a given one.

The DM-68 control circuits that produce the different modes of operation are shown in Fig. 2. There are two data buses—a 3-bit input and a 4-bit output bus. The output bus lines are normally low. They go high in sequence (see Fig. 3) at an 80-Hz rate. Each of these cycles, numbered 1 through 4, controls one of the tuning modes.

Cycle 1 controls the operation of the front-panel pushbuttons in the store mode. When the pushbutton is pulled out, the store function is engaged. Pushing in the pushbutton activates the select function.

The DM-68 knows what to do by monitoring the data applied to the input bus during each successive cycle. If a station is to be stored on, say, *PB2*, one merely pulls out on *PB2*. When output line 1 goes high, a high is passed through isolation diode *D2* to bit 1 of the input bus. The DM-68 "sees" the code 010, which informs it to store the N code of the station tuned in in a register that is accessed by *PB2*. The store codes for the other buttons are: 100 for *PB1*, 001 for *PB3*, and 011 for *PB4*.

Cycle 2 controls manual tuning. This radio differs from others by its lack of PTM. Hence, the manual tuning shaft on the front panel rotates a three-prong switch (*S1*) that is always connected to at least one input line. When output line 2 goes high, the DM-68 examines the input bus to determine if the data word is the same as it was on the immediately preceding cycle. If no change has occurred, no action is taken. If the new

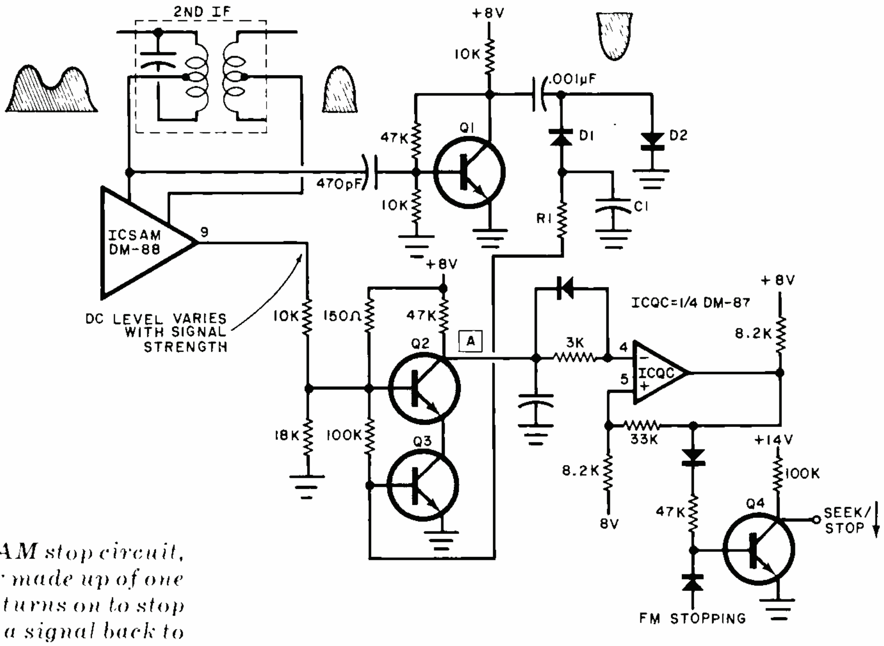


Fig. 4. Schematic of the AM stop circuit, when the output of the comparator made up of one fourth of DM-87 goes high, Q4 turns on to stop the seeker by supplying a signal back to NOR gate C in IC DM-79 in Fig. 2.

data word has changed from the previous one, however, the DM-68 increments or decrements the N code, depending upon the direction of the change made by the tuning knob.

Cycle 3 is the opposite of cycle 1. It selects the stations stored if one of the pushbuttons is pressed. Again using *PB2* as the example, if *PB2* is pressed, also causes pin 13 to drop low, but it contains a 5-second RC timer to produce the scanning action described earlier. The DM-68 initiates a seek or scan if B2 is high during cycle 4.

Seeker stopping is controlled by gate C. This gate's input (pin 9) is normally held high, but drops low if the stop circuits indicate that a station is tuned in. The collector of *Q2* (point A) remains high unless both *Q2* and *Q3* are conducting. The AM agc voltage cuts off *Q2*, and *Q3* is turned on by the voltage from *R1*. When both of these conditions are met, point A goes low to force the output of the comparator high. The high output of the comparator turns on *Q4*, stopping the seeking action.

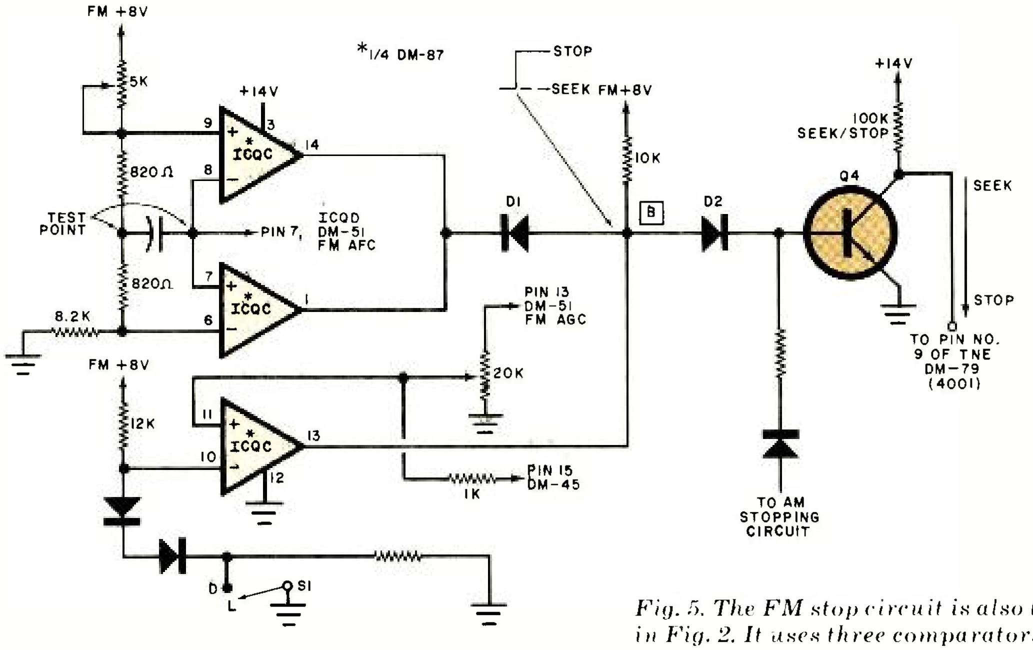


Fig. 5. The FM stop circuit is also tied back to the NOR gate in Fig. 2. It uses three comparators to determine if certain conditions have been met before stopping the seeking action.

the code on the input bus during cycle 3 will be 010. This "tells" the DM-68 to output the N code stored in register 010.

Cycle 4 controls bandswitching and all seeker functions. This cycle is controlled by DM-79, a 4002 CMOS NOR-gate IC. Section A inverts the DM-68's cycle-4 pulse and applies it to one input of each of the three remaining gates. This enables the gates during cycle 4. When the inverted cycle-4 pulse goes low, it enables sections B, C, and D.

Different N-code ranges are required for AM and FM tuning. Bandswitch *S2* makes the remaining input of gate B high for FM and low for AM. The DM-68 tells which is selected by "looking" at input line B1 during cycle 4. If B1 is low, FM is selected, while if B1 high, the AM mode is selected.

Seek and scan are controlled by gate D. The input (pin 13) of this section is normally high. If it goes low, the DM-68 initiates seeking action. The scan circuit The DM-68 recognizes this command by a high on input B0 during cycle 4.

Stop Circuits. The AM and FM stop circuits are shown in Figs. 4 and 5, respectively. In both cases, transistor *Q4* is the seek/stop switch that is connected to NOR gate C in Fig. 2. The collector of *Q4* goes to ground when a stop command is issued but remains high at all other times.

The AM stop circuit uses an IC comparator whose noninverting (+) input is biased by the +8-volt dc supply. Two signals, the 262.5-kHz AM i-f and a dc agc voltage, are used here. Transistor *Q1* amplifies and inverts the i-f signal, which is rectified by *D1* and *D2* and filtered to dc by *R1* and *C1*. The dc voltage from *R1* is applied to the base of transistor *Q3*.

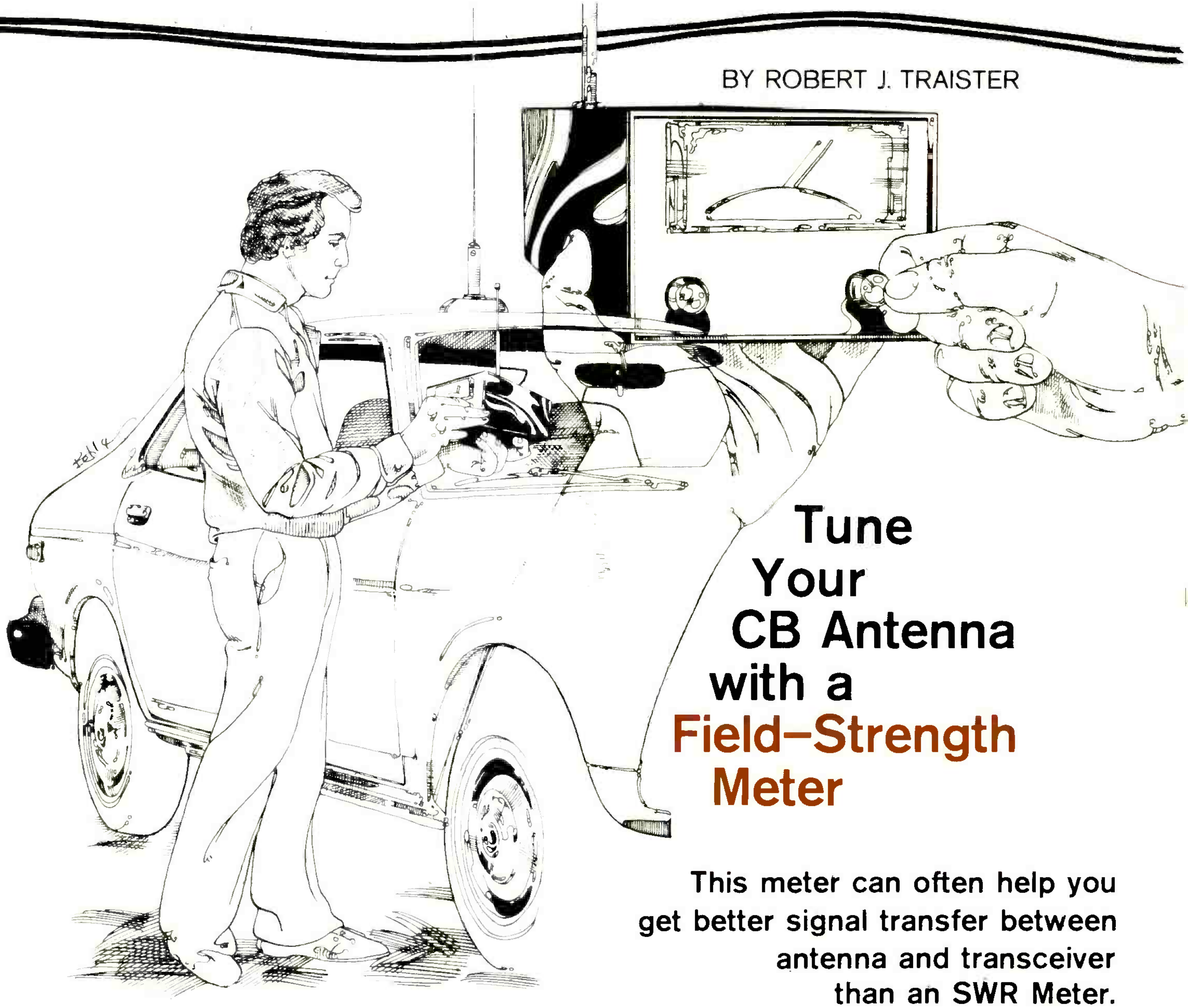
Transistors *Q2* and *Q3* operate as an AND gate, which means that both must be forward biased for either to conduct.

The FM stop circuit shown in Fig. 5 uses the three remaining sections of the quad comparator. Two sections of the comparator form a window detector that determines when the FM station is tuned in exactly by looking at the afc voltage from the FM detector. If the afc condition is not met, indicating incorrect tuning, the cathode end of diode *D1* (point B) is grounded.

Point B is also controlled by the FM agc through the last comparator circuit. If the station has insufficient signal strength, pin 13 of the comparator remains low, keeping point B low. A LOCAL/DISTANT switch changes the trip point of the comparator to allow for differences in average signal strength around town and out on the highway.

If both agc and afc conditions are met, the outputs of all three FM stop comparators will go high, forcing point B high and forward biasing *Q4* to stop the seeking action.

BY ROBERT J. TRAISTER



Tune Your CB Antenna with a Field-Strength Meter

This meter can often help you get better signal transfer between antenna and transceiver than an SWR Meter.

YOU HAVE just installed your new CB transceiver in your vehicle and mounted the latest mobile antenna on the trunk lid, bumper or wherever. Now the only thing necessary to get on the air is to adjust the antenna for minimum SWR, right? Wrong! Contrary to what you may have read or heard, adjusting for minimum SWR does not always assure maximum radiation of r-f power by the antenna.

In many cases, the lowest SWR reading will produce less radiated power than a higher SWR reading in a less-than-ideal mobile communication system. Many CB'ers have spent much time trimming and/or lengthening their mobile antennas to obtain a minimum SWR without realizing that in so doing they were actually losing communication power. A better way to tune for maximum power transfer to a mobile antenna system is with a field-strength meter—not an SWR meter.

Theory Vs. Practice. One of the first things most of us learned as budding CB'ers was that a perfect 1:1 SWR was the only thing to aim for when setting up a new antenna system. This view, however, is sound only when dealing with near-perfect antennas that exhibit an impedance of 50 ohms at the transmission-line connector.

A vertical can be considered to be such an antenna when it is exactly one-quarter wavelength (106") and is mounted above a ground plane of *sloping* radials extending in a spoke-like pattern. (Obviously, this is not for mobile communication purposes as its height and breadth are too great.) This type of antenna usually exhibits a base impedance close to 50 ohms. Coaxial RG-8/U or RG-58/U cable is normally used between the transmitter and antenna for CB applications. It also exhibits a 50-ohm characteristic impedance. When the impedance of the antenna at a specific frequency matches that of the transmission line, the SWR will be 1:1 and efficiency will be at maximum. Keep in mind that the foregoing is based on a communication system that has an overall impedance of 50 ohms for a specific frequency.

In actual operating conditions, a mobile CB antenna is rarely a quarter-wavelength in height. Loading coils, which electrically lengthen antennas, are used with whips that in some cases are no longer than 3′ (91.4 cm). The ground system is not made up of carefully spaced and measured radials, but is entirely a mass of steel (the body of the vehicle on which the antenna is installed). This, to say the least, can hardly be described as a perfect antenna system.

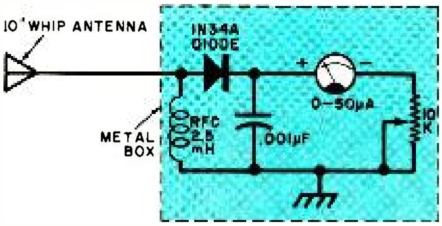
If you took impedance measurements of the typical mobile antenna system, you would find that the rated 50 ohms might turn out to be closer to 15 or 20 ohms. With your coax transmission line and SWR meter set up to operate into a 50-ohm antenna, the only way to match the antenna for a 1:1 SWR is to change its length. But consider this: the length of the antenna is already designed to operate at CB frequencies. By shortening the whip, the base impedance of the antenna can be brought up to 50 ohms, but this detunes the antenna. It will yield a 1:1 SWR but your radiated power will drop because the antenna is not the correct length to operate most efficiently on the CB channels at 27 MHz.

Reconciling Theory & Practice. Lest this article seem totally iconoclastic, we should point out that practice and theory can be readily reconciled. The feedpoint impedance of a vertical antenna is actually a combination of various resistances and reactances—radiation resistance, ground plane resistance, antenna-to-ground-plane capacitive reactance, loading coil (if any) resistance and reactance, etc. The radiation resistance is a "phantom" component which accounts for the power actually radiated by the antenna. For greatest radiation efficiency, this resistance should be maximized and/or the other components minimized. However, this does not always coincide with the SWR minimum.

A few practical examples will make this clear. An antenna system composed of a quarter-wave vertical radiator and a large system of perpendicular radials has a combined ground and radiation resistance that is considerably lower than the characteristic impedance of 50-ohm coax. Reducing the number of radials increases the ground resistance, thus lowering the SWR, but now the r-f power heating the ground plane is subtracted from the radiated signal.

A center-loaded whip for 11 meters has a radiation resistance of about 15 ohms and an average "ground" resistance of 7 ohms. The resistance of a high-Q loading coiling is approximately 2 ohms, but can go as high as 15 ohms in a lossy coil. Neglecting other impedance components, the good coil will produce an SWR of about 2:1, but the lossy one will result in an SWR of only 1.4:1. R-f power wasted in heating the lossy coil will far exceed the small loss caused by the higher SWR on the short length of coax feeding the antenna. In both cases, maximum radiation will *not* occur when SWR is at a minimum.

Tuning For Maximum Radiation. At this point, we have a word of advice: Do not tune your antenna system using only an SWR meter. Rather, use a field-strength meter as well. Many manufacturers design their SWR meters so that they can be used to give a relative indication of field strength, which is proportional to the power radiated by an antenna. These SWR/field-strength meters usually come equipped with a small antenna that telescopes about 10″ (25.4 cm) for sampling the radiated signal.



You can make your own field-strength meter for just a few dollars by following this circuit diagram. Wiring is not critical but use a metal housing.

Antenna adjustments are performed by placing the field-strength meter (FSM) in a location where a fairly strong meter indication can be obtained. Avoid getting too close to the antenna—about one wavelength (11 meters or 34 feet) is a good distance. Hold the meter case so that the small sensing whip is vertical and adjust the meter's sensitivity control for a half-scale deflection when the transmitter is keyed. Then, without resetting the sensitivity control, lengthen or shorten the antenna whip while someone else observes the meter. The length that yields the greatest deflection of the meter needle is the correct one. That's where maximum radiation occurs.

The SWR meter can now be placed in the line for a reading. Do not be surprised if it indicates an SWR of 2:1 or more. Your mobile antenna system is performing as efficiently as it possibly can, regardless of the SWR indication.

Although it is true that an unusually high SWR can place a strain on the output stage of a transmitter, excessive standing wave ratios do not occur at maximum field strengths. Greatest radiation can and does occur at SWR's of greater than 1.5:1 which will not damage output circuits. Some CB transceivers will tolerate relatively high SWR's, but others can blow a final amplifier when subjected to them. However, the antenna can still be tuned for maximum field strength with the transmitter "seeing" the impedance it likes if an antenna matchbox is used. Radiated and received signal power may increase when the matchbox is properly adjusted, but not dramatically.

Make Your Own FSM. If you do not have a field-strength meter, you can build one for a few dollars. Unlike SWR meters, FSM's do not require exact placement of components and critical wiring to be accurate. All you need are a 1N34A signal diode, 0-to-50-µA meter, a 2.5-mH r-f choke, 0.001-µF capacitor, 10,000-ohm potentiometer, a metal box to house the circuit, and some hookup wire and terminal strips. The circuit's schematic diagram is shown in the figure. The potentiometer serves as a sensitivity control.

In Closing. Maximum radiated power is what the average CB'er is seeking from his mobile system. A low SWR at your rig means nothing on the listening end—only signal strength has any meaning there. So tune your antenna using an FSM and your CB system will operate at maximum efficiency and radiate as much r-f as it can. ◇

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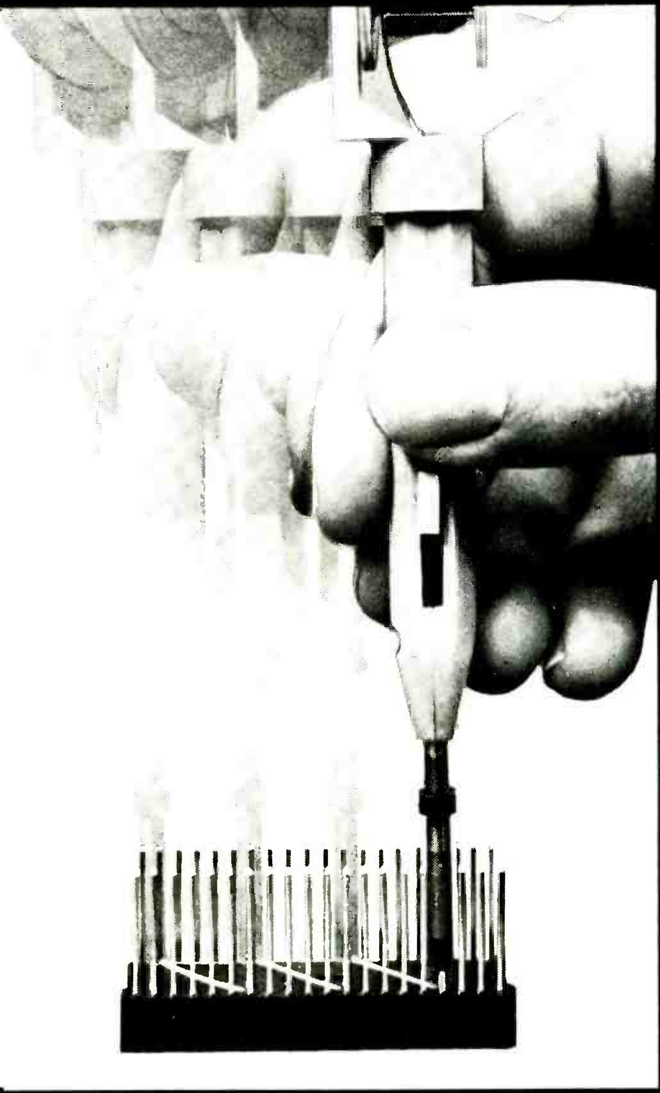

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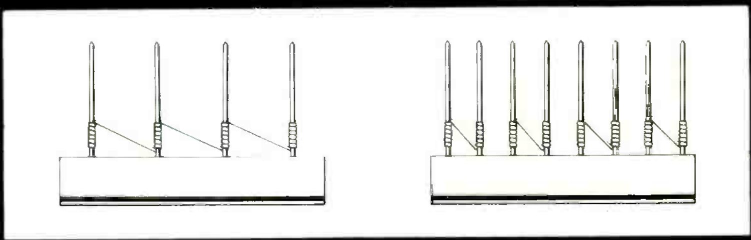

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BY RODNEY A. KREUTER

Controlling DC Power with Pulse-Width Modulation

IF YOU NEED to control the speed of a small dc motor, the brightness of a lamp, or otherwise drop a dc voltage, consider using pulse-width modulation (PWM). Ordinarily, dc power is controlled by dropping a portion of the available voltage across a variable resistor or a potentiometer-governed pass transistor. This method, although it is inexpensive, has two major drawbacks. It is inefficient in that much of the energy potentially available to the load is dissipated as heat by the transistor or resistor. Also, in the case of a motor, start-up is awkward because torque decreases with motor speed. Here we will describe how PWM can be employed and will present a working PWM control circuit you can assemble from inexpensive readily available parts.

PWM (and Motor) Basics. Shown in Fig. 1 is a circuit which demonstrates the operating principle of a PWM power controller. It consists of a power supply represented as a battery, a switch *S* and a dc motor. During the interval T_{OFF}, switch *S* is open and the motor receives no voltage (or current) from the supply. During the interval T_{ON}, the switch is closed and the motor receives the full supply voltage and draws the maximum amount of current from the supply (assuming there is no load on the motor). Over the long term, the average voltage applied across the motor is determined by the ratio $T_{ON}/(T_{OFF} + T_{ON})$.

The speed of a dc motor is primarily determined by the average voltage across the rotor coil (or the average current flowing through it) and the strength of the magnetic field surrounding the armature and rotor coil. An increase in applied voltage or the surrounding magnetic field (or both) will cause an increase in rotor speed. In most small motors, the magnetic field is generated by a permanent magnet and is therefore fixed.

The amount of torque (torsion or twisting force) a motor generates, as well as its power, which relates torque to time, are also affected by the applied voltage and surrounding magnetic field. An increase in either or both will result in an increase in torque and power. Torque is important if the motor is to be smoothly brought up to speed from a dead stop—an almost impossible feat using variable-voltage techniques, but a simple task for a PWM controller.

The relationship between motor torque and rotor current and the effects of a motor's *time constants* make PWM an effective way to control motor speed. A motor's mechanical time constant is that interval required for the motor to accelerate from 0 rpm to 63 percent of its maximum rotational velocity. This time constant typically varies from 5 to 200 milliseconds and depends on the size and design of the motor. The inductive time constant is the period required for the rotor current to increase from zero to 63 percent of its ultimate value, about 0.2 times the mechanical time constant.

If the T_{ON} interval of the control switch is shorter than the motor's mechanical time constant, the inertia of the motor will act as an averaging device and the motor will rotate at a speed that is less than the maximum the motor can deliver. Also, keep in mind that the torque a motor can generate is proportional to the applied voltage and the amount of current flowing through the rotor coil. It is therefore possible to obtain a large amount of torque, even at slow speeds, by applying constant-amplitude voltage pulses to the motor. The pulses should be long enough to allow rotor current to increase to a substantial value but short enough (or spaced far enough apart) so that either the motor cannot achieve its full speed or the average voltage is low.

This allows very smooth start-up of a dc motor, something that is rarely achieved using variable-voltage control. What usually happens in a variable-voltage system is that the motor speed control must be advanced to the point when there is enough rotor current flowing (and enough torque generated) to allow the motor to "break loose." When the motor finally does start turning, its speed quickly becomes so great that the operator must dramatically back off the control to slow the motor down. If he reduces the control setting too much, the motor will stall. Model railroaders, boaters, and others who use variable-voltage control of small dc motors are painfully aware of awkward, unrealistic start-up and the difficulties of maintaining slow-speed control. For them, PWM is an ideal solution. What follows is a description of a working PWM controller that can be used with loads drawing as much as several amperes of dc.

The PWM Controller The controller (Fig. 2) employs the familiar 555 timer IC operating in the astable mode, but there is a twist—the multivibrator produces square waves of a constant frequency but variable duty cycle. The addition of silicon switching diodes *D1* and *D2* (1N914 or similar) makes this possible. Here's how.

Assuming *C1* is initially discharged, the output of the IC (pin 3) remains low as the capacitor starts to charge up toward the positive supply voltage. The capacitor receives charge via *R1* and the wiper, which we will refer to as *R2A*. Diode *D1* is forward-biased and effectively connects the positive plate of the capacitor to the wiper of the potentiometer. Diode *D2*, on the other hand, is reverse-biased and isolates the capacitor's positive plate from *R3* and the other portion of the potentiometer, which we will call R2B.

When *C1* charges up to two-thirds of the positive supply voltage, a flip-flop inside the IC toggles and simultaneously forces pin 3 high and pin 7 low. The capacitor then starts to discharge through

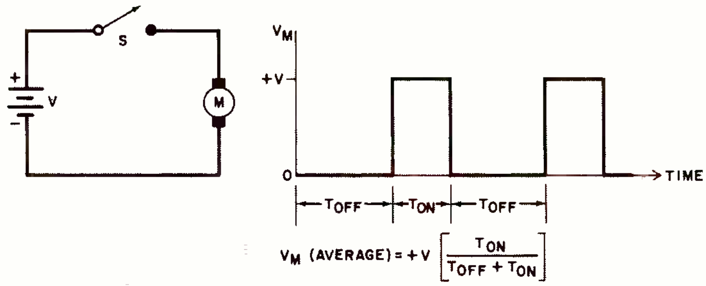

Fig. 1. In basic PWM, switch S is toggled to create dc pulse train across the motor. The longer time T_{ON} is, the higher the average voltage across the motor and the faster the motor turns.

D2, which becomes forward-biased, through *R3*, and through *R2B*. Diode *D1* is reverse-biased and acts like an open circuit. Discharge continues until the voltage across the capacitor decreases to one-third of the supply voltage, at which time the internal flip-flop toggles again and causes pin 3 to go low and pin 7 to go high. Capacitor *C1* then starts to charge up again toward two-thirds of the positive supply voltage, and the cycle repeats itself endlessly.

A train of pulses much like the waveform shown in Fig. 1 appears at the output of the timer IC. The T_{OFF} interval corresponds to the time that pin 3 is low, and the T_{ON} interval corresponds to the period that pin 3 is high. Substituting our component labels for those found on manufacturer's 555 data sheets, we find that:

$T_{ON} = 0.7\,(R1 + R2A)\,C1$,

$T_{OFF} = 0.7\,(R3 + R2B)\,C1$, and

$T = 0.7(C1)(R1 + R2A + R3 + R2B)$

$= 0.7(C1)(R1 + R2 + R3)$

where T is the total period of the output waveform, the reciprocal of the output frequency. It can be seen upon inspection of these equations that T_{ON} and T_{OFF} vary with the setting of *R2*, but the total period of the waveform, and hence its frequency, do not.

For the component values given, the duty cycle of the waveform (the ratio of T_{ON} to T_{ON} plus T_{OFF}) varies from approximately 5 to 95 percent of the total period of the waveform, depending on the setting of *R2*. The total period should be about twice the motor's mechanical time constant, which you probably won't know if you've paid less than $10 for the motor. If that is the case, simply experiment with the value of *C1* until you achieve the desired result. As a general rule, the smaller the motor, the smaller the capacitance required.

The schematic suggests a capacitance of from 0.1 to 10 µF for *C1*. Neglecting tolerances, the period of the output waveform will be 0.0038 second and its frequency 263 Hz if a 0.1-µF capacitor is used. The period will be 0.38 second and the frequency 2.63 Hz if the value of *C1* is 10 µF. Substitutions can be made for *R1*, *R2* and *R3*, but the two fixed resistors should not be less than 1000 ohms.

A 555 timer can sink or source up to 200 mA of current. That's more than enough for some small motors, but to increase the circuit's flexibility, a high-power driver transistor has been included. Designated *Q1*, the transistor receives base drive from the timer IC via *R4*. The transistor alternately conducts and turns off in step with the output of *IC1*, acting like a switch to govern the operation of the motor. Diode *D3* has a dual function. It not only protects *Q1* against the inductive spikes generated across the rotor coil but acts as a "free-wheeling" diode. That is, it shunts the motor during the T_{OFF} interval, during which the motor acts as a generator. The diode employed as *D3* should be capable of handling one-half the current drawn by the motor and have a suitable PIV rating.

Other Approaches. There are many ways to obtain a pulse train with a variable duty cycle, the 555 circuit just presented being only one method. For example, an astable multivibrator triggering a monostable multivibrator with a variable-output pulse width could be used. The variable resistance in the one-shot circuit could be programmed using a rotary switch or a BCD thumbwheel switch teamed up with a BCD-to-decimal decoder chip and a group of fixed resistors. This would allow selection of one of several discrete motor speeds instead of continuously variable control.

A microprocessor could be programmed to provide a pulse train with a variable duty cycle. (It's always nice to find another use for that micro!) However, the limited current-sourcing abilities of microprocessors make it advisable either to connect a small npn transistor (2N2222 or similar) to *Q1* in Darlington or replace *Q1* with a commercial power Darlington device.

Pulse-width modulation can be used to control loads other than motors. For example, a lamp can be substituted for the motor in Fig. 2 and the "free-wheeling" diode removed. The circuit is now an efficient dc lamp dimmer. (The familiar ac lamp dimmers operate on this principle, employing thyristors as power switches.) Voltage dropping can also be accomplished using PWM, especially if the dropped voltage need not be very "clean" dc. Simply replace the lamp with the load you want to power and adjust *R2* until the required voltage drop exists across the load. Connecting a good filter capacitor across the load will smooth out the dc. Also, the higher the frequency of the pulse train driving the transistor, the easier it is to smooth the dc into an acceptable supply voltage. ◇

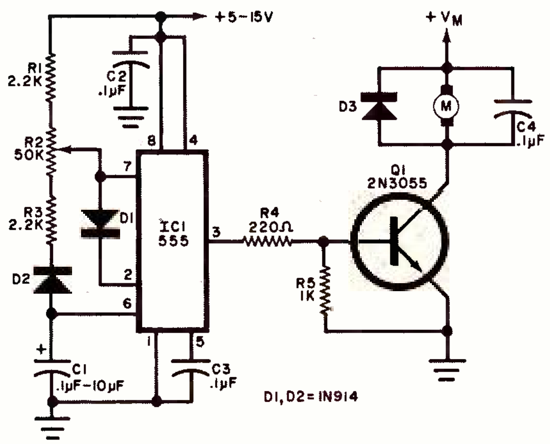

Fig. 2. A PWM controller for dc-powered loads. Timer IC1 generates a pulse train of constant period but variable duty cycle.

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BY MAYNARD GRADEN

Psycho-acoustic device simulates sound of surf, gentle rain, or white noise to provide tranquil background for sleep, study or concentration.

IT IS WELL known that certain naturally occurring sounds can help us to relax, to study, and to concentrate. Among the more familiar of these are the sounds of the surf, rain, and white noise (as when you cup a seashell or a drinking glass to your ear). The "Surfer" is a simple electronic device that can generate all three of these pleasant, tranquil sounds at the flip of a switch. You can use the Surfer to set just the right mood for falling off to sleep, studying, or concentrating simply by setting the selector switch to the appropriate sound position.

About the Circuit. Transistor *Q1* in Fig. 1 serves as a white-noise source by virtue of its being operated in the reverse-bias breakdown mode. The "white-noise" signal is generated across *R2* and is amplified by *Q2*, whose high-frequency rolloff is determined by *C3* (and *C5* when *S1* is in the SURF position). With *S1* set to SURF, *Q3* has two inputs. One is the white-noise signal from *Q2* and the other is determined by the light intensity from *I1* falling on photocell *PC1*. As the intensity of light from *I1* varies, the bias on *Q3* is shifted which, in effect, amplitude modulates the white-noise signal. Trimmer potentiometer *R9* can be adjusted to prevent the white noise from being cut off.

When *S1* is set to RAIN, *PC1* is out of the *Q3* input circuit. This causes *Q3* to function as a conventional emitter-follower stage. The white noise at the emitter of *Q3* is passed through *R11* and VOLUME control *R12* for amplification by *IC1*. The circuit and its operation remain the same when *S1* is set to NOISE, except that, in this mode, limiting resistor *R11* is bypassed.

Photocell *PC2*, which is also illuminated by *I1*, and capacitors *C8*, *C9*, and *C10* form a nonlinear high-cut tone control circuit whose high-frequency attenuation is proportional to the light intensity that illuminates *PC2*.

The period of relaxation oscillator *Q6* is determined by the values of *C16* and the preset value of potentiometer *R20*. The interval controlled by *R20* can be adjusted between 7 and 35 seconds.

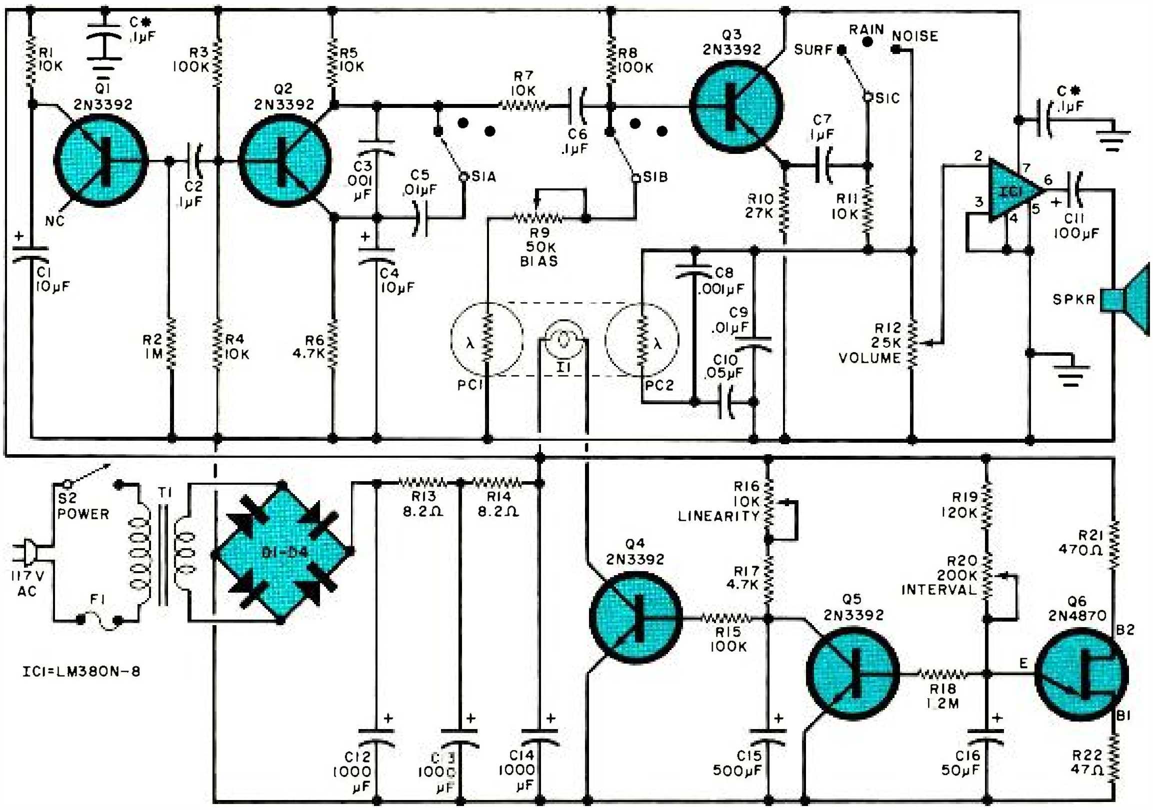


Fig. 1. White noise generated in Q1 is amplitude-modulated and filtered to produce different sounds.

PARTS LIST FOR FIG. 1

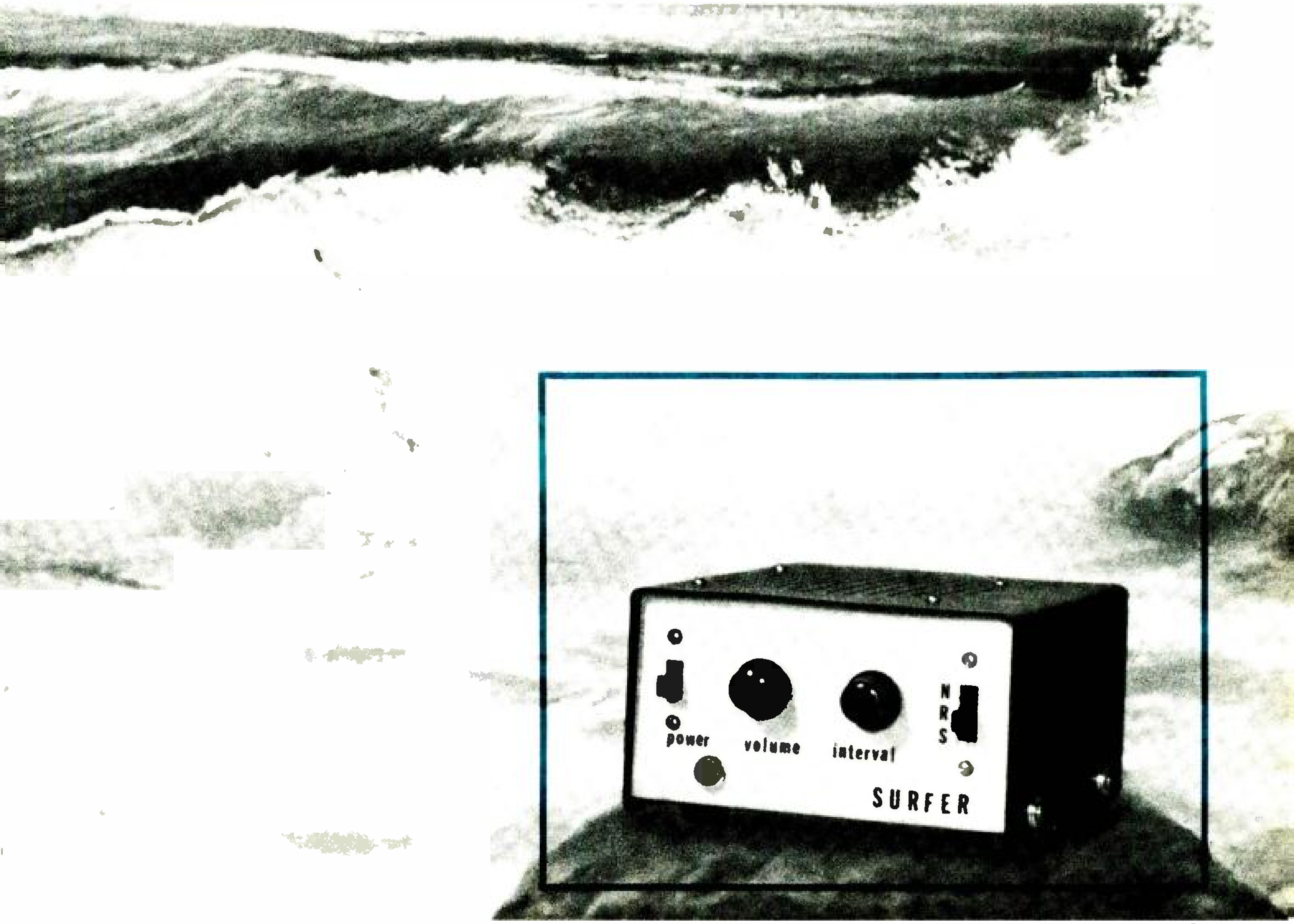
C1,C4—10-µF, 25-volt electrolytic
C2,C6,C7—0.1-µF disc capacitor
C3,C8—0.001-µF disc capacitor
C5,C9—0.01-µF disc capacitor
C10—0.05-µF disc capacitor
C11—100-µF, 25-volt electrolytic
C12,C13,C14—1000-µF, 25-V electrolytic
C15—500-µF, 25-V electrolytic
C16—50-µF, 25-V electrolytic
C*—0.1-µF capacitor (see text)
D1 through D4—1N4001 rectifier diode
F1—¼-ampere fuse and holder
I1—#1869 miniature lamp (10 V, 0.014 A, with wire leads)
IC1—LM380CN (National) or similar audio amplifier
PC1,PC2—Photoresistive cell with 5-megohm dark and 15,000-ohm light resistances (Clairex No. CL702L or Vactec No. VT322L)
Q1 through Q5—2N3392 transistor
Q6—2N4870 unijunction transistor
The following resistors are ¼-watt, 10%:
R1,R4,R5,R7,R11—10,000 ohms
R2—1 megohm
R3,R8,R15—100,000 ohms
R6,R17—4700 ohms
R10—27,000 ohms
R13,R14—8.2 ohms
R18—1.2 megohms
R19—120,000 ohms
R21—470 ohms
R22—47 ohms
R9—50,000-ohm trimmer potentiometer
R12—25,000-ohm audio-taper potentiometer
R16—10,000-ohm trimmer potentiometer
R20—200,000-ohm linear-taper potentiometer
S1—3-pole, 3-position nonshorting slide or rotary switch
S2—Spst switch
SPKR—8- or 16-ohm loudspeaker (see text)
T1—12.6-volt, 300-mA transformer
Misc.—Metal chassis box; line cord; materials for light shield (see text); rubber grommet; spacers; machine hardware; hookup wire; solder; etc.

The waveform present at the emitter of *Q6* is directly coupled to buffer/amplifier *Q5*, whose *C15/R16/R17* output circuit linearizes the signal before it is applied to lamp driver *Q4*.

Typical waveforms for the circuit are shown in Fig. 2. The upper waveform is present at the emitter of *Q6* when *R20* is set for a period of 17 seconds. The next waveform down illustrates the voltage at the collector of *Q4* after waveshaping by the *Q5* buffer stage. The inverse of this waveform is the voltage across *I1*. The third and fourth traces illustrate the outputs of the *Q1* white-noise source and *IC1*, respectively. Note that the output of *Q1* is a constant 10 mV, while the output of *IC1* varies between 100 and 400 mV. This amplitude variation is the result of the varying bias on *Q3* caused by the *I1/PC1* system.

Construction. There is nothing critical about circuit layout and you can use any wiring scheme you prefer. If you want printed-circuit board construction, you can make your own pc board using the etching-and-drilling guide shown in Fig. 3, which also contains component-installation instructions.

Lamp *I1* and photocells *PC1* and *PC2* must be mounted close together and shielded from outside light. Mount *I1* vertically with *PC1* and *PC2* on opposite sides of it so that they receive equal illumination. (Once the circuit is adjusted,



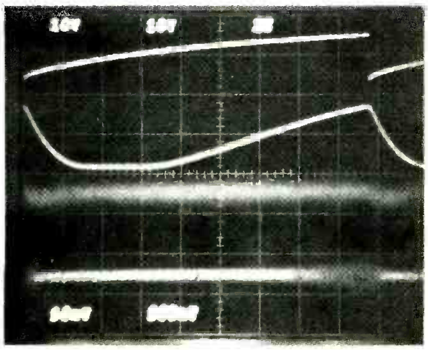
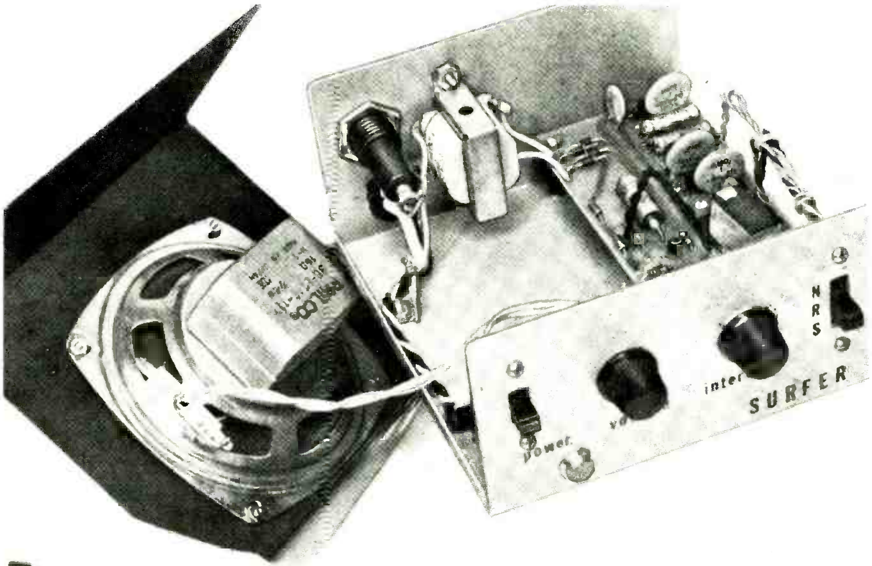
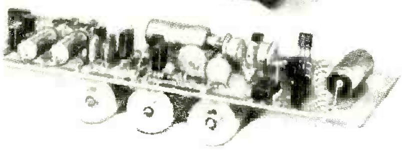
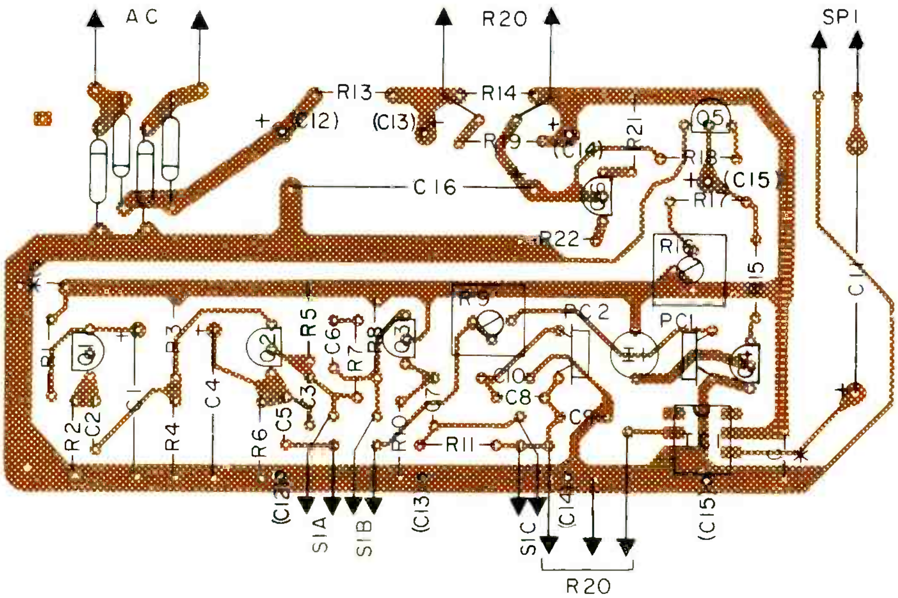


Fig. 2. Circuit waveforms show, at top, output of UJT; and, below that, collector of Q4 after waveshaping. Next two traces are white noise. One from Q1 at 10 mV and, at bottom, final audio output, with swing from 100 to 400 millivolts.





Printed circuit board is mounted on spacers in metal enclosure with T1, fuseholder and line cord on rear apron.



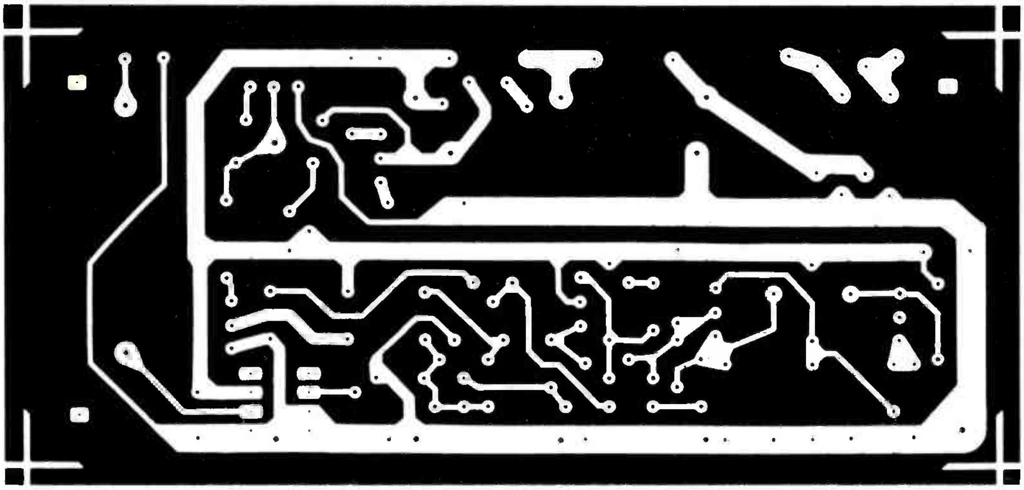


Fig. 3. Actual-size foil pattern is at left, with component placement above. Capacitors C12, C13, C14 and C15 are mounted on foil side.

opaque tape or cardboard tubing can be used to make a light shield to exclude external light.

Note that there are two capacitors identified by asterisks (*). One of these decoupling capacitors must be mounted as close as possible to pin 7 of *IC1*, while the other should be mounted as close as possible to the positive end of *R1*. If you use the pc board pattern shown in Fig. 3, *C12*, *C13*, *C14*, and *C15* go on the *foil* side of the board and should be the last components installed.

The quality of the loudspeaker used in the circuit is a significant factor in performance. The maximum output power from *IC1* is about 0.5 watt into 8 ohms. Needless to say, do not use a 4-ohm speaker because it can damage *IC1*. A good choice is a 4" to 6" (10.2 to 15.2 cm) high-compliance, high-fidelity quality loudspeaker with an 8- or 16-ohm impedance.

With *Q1* operated in the manner shown, it is susceptible to detecting r-f. Hence, the circuit should be housed in a metal box and the common bus on the pc board electrically connected to the box. The pc board assembly mounts in place with spacers and machine hardware. POWER switch *S2*, VOLUME control *R12*, INTERVAL control *R20*, and SELECTOR switch *S1* mount on the front panel. Transformer *T1* and the holder for fuse *F1* can be mounted on the rear of the box. Also, the line cord for the project should enter the box through a grommet-lined hole in the rear panel.

Adjustment and Operation. Two simple adjustments are required to get the Surfer into proper operating order. Set trimmer pots *R9* and *R16* to their centers of rotation, set the VOLUME control fully clockwise (maximum volume), and set *S1* to the SURF position. Now, apply power and set the INTERVAL control for a period of about 25 seconds. Adjust *R16* so that *I1* extinguishes about a second before the end of the cycle. Wait several cycles and then check *R16* again and readjust it if necessary. Once *R16* is adjusted, place the shield over the lamp/photocell assembly.

Set the VOLUME control to its center of rotation. Then adjust trimmer pot *R9* until the sound is just barely audible at the beginning of the cycle. This completes adjustments.

During operation, when *S1* is set to SURF, *C5* (see Fig. 1) produces the maximum high-frequency rolloff and *PC1* is connected to the base of *Q3*. This produces a roaring sound that changes in intensity and tone. In the RAIN position of *S1*, maximum high-frequency attenuation occurs with no amplitude modulation. This creates a constant-volume "hiss" whose tone varies. When *S1* is in the NOISE position, *R11* is shorted out, which causes the tone control to lose its effectiveness. In general, a long interval is best for the SURF function, while a short interval is best for RAIN.

The Surfer is not intended to be used as a sound-effects generator to which one consciously listens. Rather, it is meant to provide a nondistracting background of sounds. Best effects are created when the Surfer is positioned 6' (1.8 m) or more from the listener with the VOLUME adjusted so that the sound is barely audible. ◇

DETERMINING "555" DUTY CYCLES

BY BRIAN WALMANN

Ends the confusion caused by conflicting data sheets.

THERE SEEMS to be much confusion about the duty cycle of a 555 when this commonly used timer IC is operated in the astable mode. For the circuit shown in Fig. 1, Texas Instruments states that the duty cycle is $R_B/(R_A + R_B)$. Signetics and Fairchild, however, claim in their literature that the duty cycle equals $R_A/(R_A + 2R_B)$. But the *true* expression for the duty cycle is $(R_A + R_B)/(R_A + 2R_B)$.

Figures 2, 3, and 4 prove the validity of the last expression given and the invalidity of those appearing in the manufacturers' literature. These figures show the waveforms appearing at pins 6 and 2 of the circuit shown in Fig. 1 for three different combinations of values of R_A and R_B. The horizontal axes are incremented in units of time which are proportional to resistance.

For the waveforms of Fig. 2, R_A is 1000 ohms and R_B 100,000 ohms. According to TI's formula, the duty cycle is 100/101 or 99%—a preposterous figure. The value according to the Signetics and Fairchild formula is 100/201 or 49.8%. The duty cycle of an astable 555 must be greater than 50%, so this figure is clearly wrong. The *true* expression yields a duty cycle of 50.25%, which is just right.

For the case of Fig. 3, R_A is 100,000 ohms and R_B 1000 ohms. The TI equation gives a duty cycle of 1/101 or 1%. Signetics and Fairchild peg the duty cycle at 1/102 or approximately 1%. Both figures are clearly erroneous. The duty cycle according to the true expression is 101/102 or 99%, an accurate value.

Finally, for Fig. 4, R_A and R_B are both 100,000 ohms. The Texas Instruments formula gives the duty cycle as 100/200 or 50%. The Signetics/Fairchild equation yields a result of 100/300 or 33%. Both are wrong. The correct duty cycle is 200/300 or 67%, the result given by the author's equation.

Using this simple formula you will be able to predict accurately the duty cycle of a 555 astable multivibrator, or design this commonly used circuit to produce a specific duty cycle. ◇

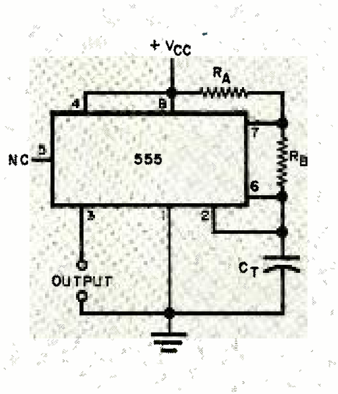


Fig. 1. Schematic diagram of a 555 astable multivibrator.

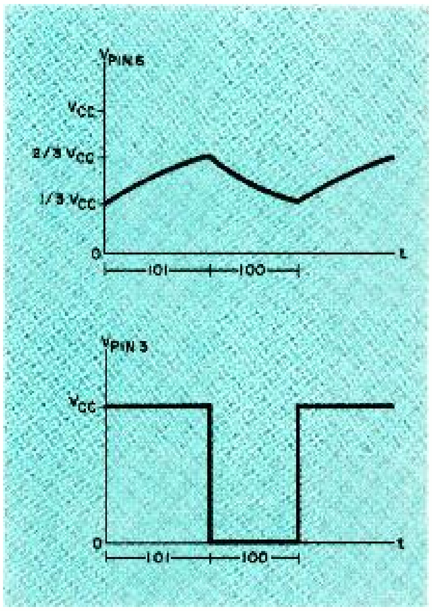


Fig. 2. Waveforms at pins 6 and 3 for R_A = 1000 ohms and R_B = 100,000 ohms.

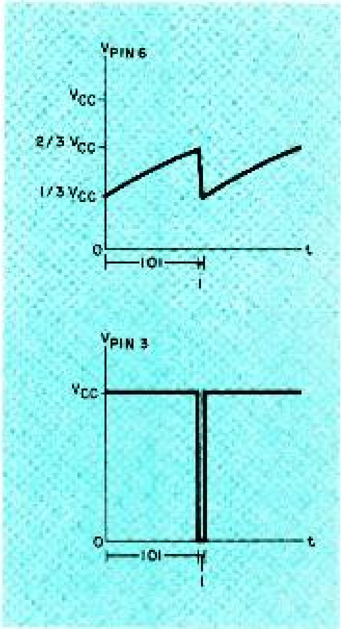
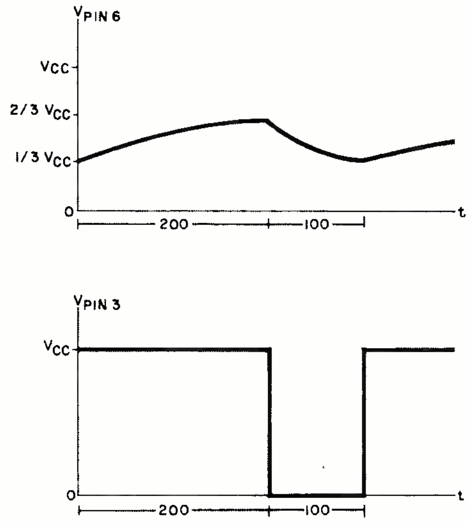


Fig. 3. Waveforms at pins 6 and 3 for R_A = 100,000 ohms and R_B = 1000 ohms.

Fig. 4. Waveforms at pins 6 and 3 for R_A and R_B = 100,000 ohms.



A SIMPLE PRECISION POWER SUPPLY for your work bench

BY FRAN HOFFART

Adjustable (1¼ to 33 volts) supply delivers up to 1½ amperes with excellent regulation

ONE ITEM that belongs on every experimenter's work bench is a source of clean, regulated dc. The ideal hobbyist supply would be relatively inexpensive, easily built, adjustable over a fairly wide range of output voltage, and capable of sourcing an ampere or more of dc. In addition, it would have a high degree of line and load regulation and contain such protection as automatic current limiting, maximum power limiting, and thermal shutdown.

The project presented here satisfies these requirements handily. It is built around an LM317, a monolithic variable-voltage regulator IC that can provide an output voltage from 1.25 to 40 volts. The supply can generate output currents up to 1.5 amperes at 1.25 to 33 volts. It has a low parts count and is rugged enough to withstand the abuse to which most bench supplies are subjected at one time or another.

Before we examine the power supply circuit, let's first look at the LM317 variable-voltage regulator IC. Because this chip is the essence of the supply, a prior understanding of its operation will simplify our later discussion of the power supply as a whole.

The LM317 Regulator IC. Shown in Fig. 1 is a simple schematic which illustrates the basic operation of the LM317. The integrated circuit keeps the voltage drop between the output terminal (the case of the regulator, which is housed in a TO-3 package) and the adjustment terminal (Pin 1) a constant 1.25 volts. In practice, resistor *R1* is connected between these two terminals, thereby setting up a constant adjustment current. The magnitude of this current and the setting of potentiometer *R2* determine the output voltage of the regulator.

If the adjustment current is sufficiently large, the output terminal is always 1.25 volts more positive than the adjustment terminal. Accordingly, setting the wiper of *R2* so that the adjustment terminal of the IC is grounded causes the LM317 to act as a 1.25-volt regulator. Rotating the control shaft of *R2* elevates the adjustment terminal above ground, simultaneously increasing the voltage at the output terminal.

Any voltage greater than 1.25 volts can be obtained at the output terminal simply by increasing the resistance between the adjustment terminal and ground. Although the manufacturer (National Semiconductor) rates the IC's maximum differential input-to-output voltage at 40 volts, the LM317 can be used to provide higher regulated voltages. However, such operation necessitates the inclusion of additional components to protect the regulator from excessive differential voltages.

Note that the LM317 has no ground terminal. This means that all quiescent operating current for the IC must flow through its output terminal, and necessitates that a minimum load current be established if the regulator is to function properly. Shown in Fig. 2 is a plot of the minimum operating current required against the differential input-to-output voltage. A convenient way to satisfy this minimum-load-current requirement is to select a value for the adjustment current that is suitably greater than the quiescent operating current of the IC.

The internal design of the LM317 makes possible a wide variety of applications other than that of a series-pass voltage regulator. These include tracking preregulators, switching regulators, ac voltage regulators, two-terminal current regulators, and power regulators, to name just a few!

Even more important than the inherent simplicity and flexibility of the three-terminal regulator IC is its ability to protect itself from practically every type of overload condition, thereby greatly in-

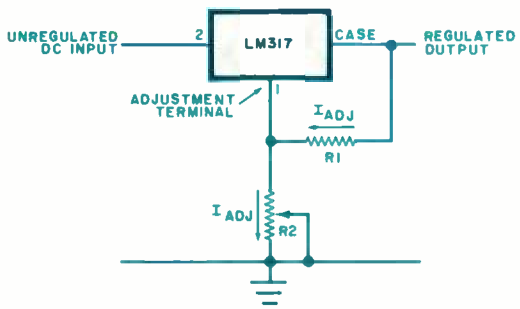


Fig. 1. Basic circuit showing the operation of the LM317 regulator integrated circuit.

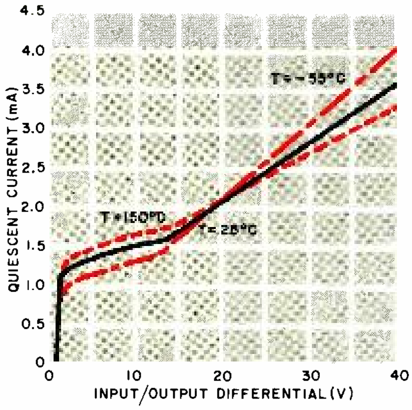


Figure. 2. Plots of minimum load currents vs. differential input-to-out voltage.

creasing reliability. Output current is limited to 2.2 A to protect the IC as well as the power transformer and rectifier. Safe-area protection limits the maximum power dissipated by the regulator to approximately 20 W, thus guarding the series-pass transistor located on the chip against a destructive secondary breakdown. The safe-area protection circuit decreases the maximum possible output current as the differential input-to-output voltage increases, thereby limiting the power dissipated to a safe value. A plot of output current limiting versus differential input-to-output voltage is shown in Fig. 3.

Thermal protection built into the LM 317 limits the maximum chip temperature to approximately 170°C. This protects the regulator from overheating, regardless of the type of overload or the amount of heat sinking provided. The temperature is sensed on the chip at a point near the series-pass transistor, enabling the regulator to shut down quickly if a potentially destructive overload condition occurs. Once the overload has been corrected and the chip cools down, the regulator turns back on and resumes normal operation.

All these protective circuits remain functional as long as an input-to-output differential of at least 2 volts exists, even if the adjustment terminal is accidentally disconnected from the rest of the circuit.

About the Circuit. The complete schematic of a 32-volt, 1.5-ampere bench power supply is shown in Fig. 4. Using the LM317 voltage regulator greatly simplifies the design and construction of the supply but keeps performance and reliability at high levels.

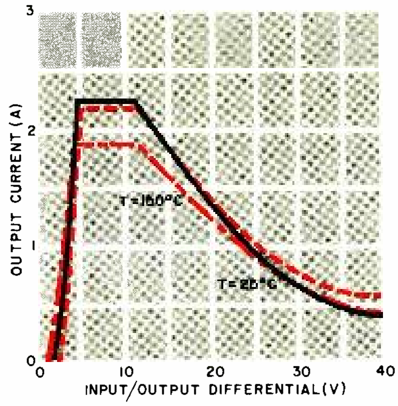


Fig. 3. The 20-watt safe-area curves for the LM317 regulator IC at three operating temperatures.

Power transformer *T1* is a "universal" multiwinding unit. Switch *S2* selects one of two primary winding configurations, causing the ac input to the full-wave bridge rectifier to vary from 18 volts in the LOW position to 32 volts in the HIGH position. This minimizes power dissipation by the LM317 regulator. It also allows full output current to be generated at low voltages by reducing the input voltage to the regulator when the supply is being used at low output-voltage lev-

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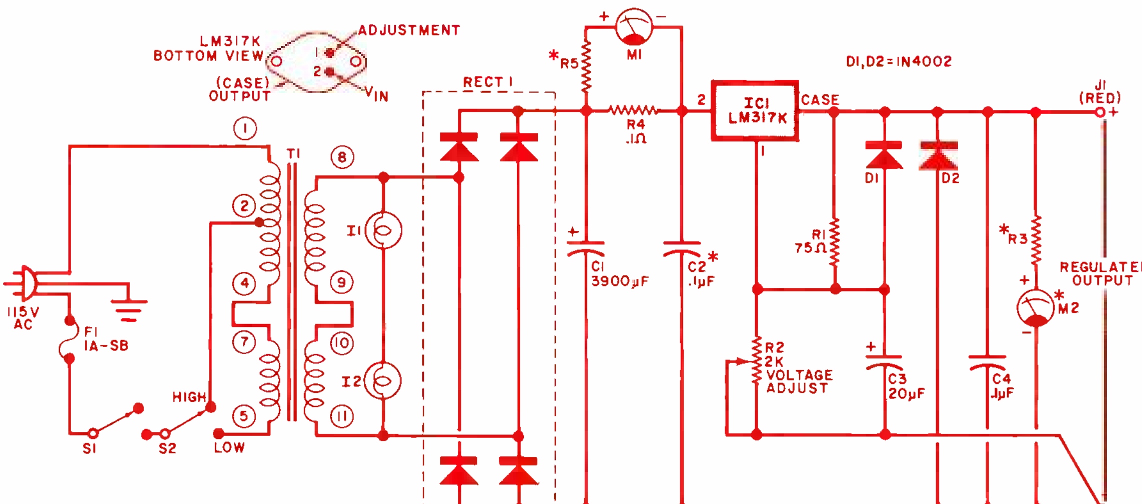


Fig. 4. Complete schematic of the precision power supply.

PARTS LIST

C1—3900-μF, 50-V electrolytic
C2,C4—0.1-μF disc ceramic (C2 optional)
C3—20-μF, 50-V electrolytic
D1,D2—1N4002
F1—1-A slow-blow fuse
IC1—LM317K TO-3 voltage regulator (National Semiconductor)
I1,I2—15-V pilot lamp
J1,J2—Color-coded 5-way binding post
M1—1-mA, 2-inch (5.1-cm) panel meter, relabeled to read 0 to 1.5 A.
M2—1-mA, 2-inch (5.1-cm) panel meter, relabeled to read 0 to 30 V.
R1—75-ohm, 1%, ¼-W metal-film resistor
R2—2000-ohm, 10-turn potentiometer
R3—Select for individual meter used (approximately 30,000 ohms for 1-mA meter movement)
R4—0.1-ohm, 5%, ½-W resistor
R5—Select for individual meter used (typically 10 to 100 ohms for 1-mA meter movement)
RECT1—2-A, 100-PIV modular bridge rectifier
S1,S2—Spdt miniature toggle switch
T1—30-V, 2-A secondary "universal" power transformer (Stancor RT-202 or equivalent)
Misc.—Suitable aluminum enclosure (LMB-564 or similar), heat sink, TO-3 socket and mica washer, silicone thermal compound, line cord, fuse holder, control knob, rubber feet, dry-transfer lettering, hookup wire, solder, hardware, etc.

(Continued from page 70)

els. An added benefit is a cooler-running heat sink.

Filter capacitor *C1* keeps the peak-to-peak ripple voltage under 2 volts at the input of the regulator, resulting in less than 300 microvolts rms of ripple at the output. Ceramic disc *C2* should be located close to the IC regulator and, although it is designated in the Parts List as optional, it is required if filter capacitor *C1* is located more than 4 inches (10.2 cm) from the IC. It is good practice, however, to include *C2* even if *C1* is close to the LM317 regulator.

Resistors *R4* and *R5* are the current shunt and calibrating resistors, respectively, for milliammeter *M1*. Note that *R4* is located on the input side of the regulator rather than the output side, so that it will not degrade load regulation. The exact value of *R5* will depend on the characteristics of the particular meter used for *M1*. It will usually be between 10 and 100 ohms if a 0-to-1-mA meter movement is employed.

Precision metal-film resistor *R1* establishes an adjustment current of 16 mA which flows through VOLTAGE ADJUST potentiometer *R2*. Adjusting *R2* for maximum resistance places the adjustment terminal of the IC at 32 volts above ground. This sets the power supply output voltage at 33.25 volts required. For a high degree of resolution in adjusting the output voltage, a ten-turn potentiometer is specified for *R2*. However, a lower-cost, single-turn potentiometer could be substituted if your budget won't accommodate a precision component or if you have difficulty procuring one.

Capacitor *C3* filters out any ripple voltage appearing at the adjustment terminal, increasing the ripple rejection at high output voltages. Transient response and stability of the power supply are improved by the addition of *C4*. Diode *D1* provides a discharge path for *C3* in the event of a short circuit at the supply output. The IC regulator is protected by *D2* against reverse voltages that might be accidentally applied to the output of the supply.

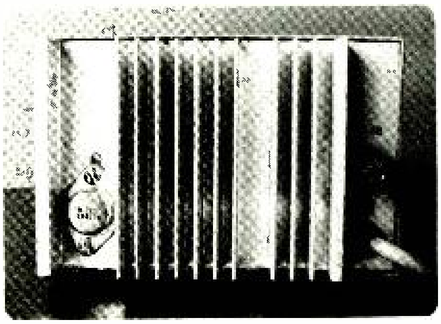


Fig. 6. Rear view of heat sink on prototype. A mica washer provides good thermal contact between regulator and heat sink.

Resistor *R3* is the calibration component for the output voltmeter *M2*. Both this meter and *M1* are standard 1-mA meter movements with the meter faces relabeled. The exact value of *R3* will depend on the characteristics of the individual meter used for *M2*. It will be approximately 30,000 ohms if a 0-to-1-mA meter movement is employed. Incandescent lamps *I1* and *I2* illuminate the supply's meters and act as pilot lights.

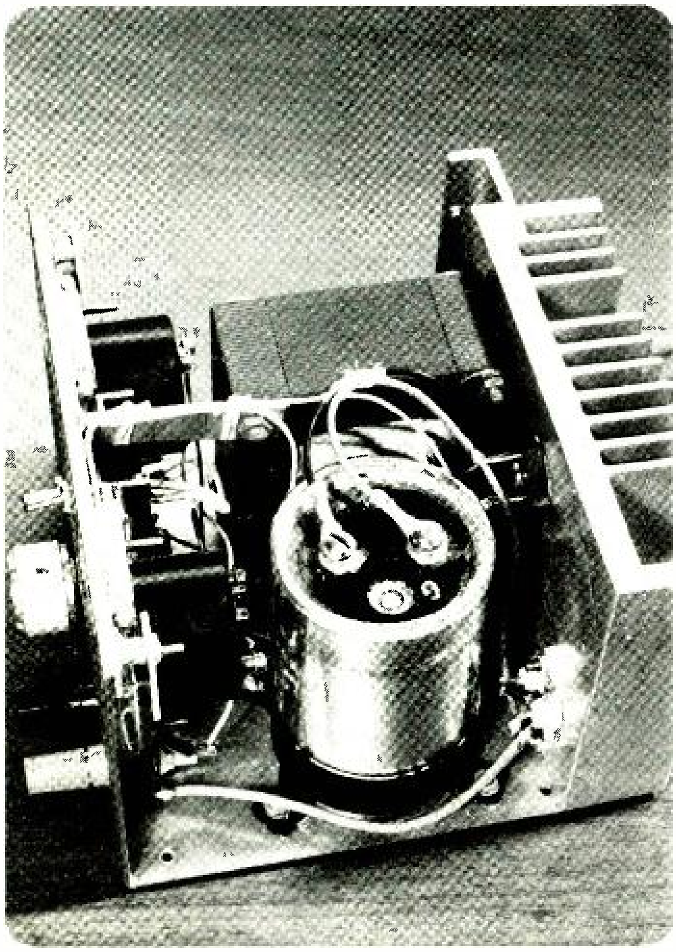


Fig. 5. Interior view of the author's prototype. Heat sink must limit IC temperature to 75°C above ambient.

Construction. The 1.5-ampere bench supply was constructed in an aluminum enclosure measuring 4"H by 6"W by 5"D (10.2 x 15.2 x 12.7 cm). The back of the case was removed and replaced with an aluminum heat sink containing thirteen 1-inch (2.5-cm) fins. An interior view of the author's prototype is shown in Fig. 5. The heat sink selected must be of sufficient size to limit the regulator temperature to no more than approximately 75°C above ambient when dissipating a maximum of 25 watts.

A mica washer will provide good thermal conductivity between the case of the LM317 regulator and the heat sink while maintaining electrical isolation. Be sure to apply a layer of silicone thermal compound on each side of the mica washer. Also bolted to the heat sink of the author's prototype is the bridge rectifier, *RECT1*. The rectifier, however, is mounted on the inside of the modular heat sink and is not visible in the rear view of Fig. 6.

After drilling holes for the various components, and cutting the front panel for the meters, the cabinet was painted and labeled with dry-transfer lettering. Next, using suitable hardware, all components except the filter capacitor and the meters were mounted. This provided enough room to wire the switches, potentiometer, etc.

Relabeling the meter faces was easily accomplished by first detaching the plastic meter cover. Then the meter face was carefully removed and the existing numbers erased with a pencil eraser. Dry-transfer lettering was used to relabel the meter face.

Although the wiring of the supply is simple and straightforward, several precautions should be taken to ensure the best possible load regulation. One lead of *R1* should be connected directly to the case of the TO-3 package, the output terminal of the regulator IC. A separate, heavy wire is connected from the case of the regulator directly to the positive output jack. Finally, the wiper of the VOLTAGE ADJUST control and the potentiometer lug connected to it should be wired directly to the negative output jack. This improves load regulation by providing remote ground sensing directly at the output of the supply.

In Conclusion. The finished supply will prove to be a worthwhile investment for any home lab. Although the goal of simplicity guided the design of this power supply (less than 25 components were used), its performance is more than adequate for most bench work. With the VOLTAGE ADJUST control set for 15 volts, a 1-ampere load current will typically result in less than a 15-mV drop at the output and less than 1 mV peak-to-peak of ripple. Varying the ac line voltage between 90 and 125 volts causes less than a 10-mV change on the output. Output voltage drifts of 0.01%/°C can be obtained if stable components are used for *R1* and *R2*.

With a few additional parts, the output can be made to go down to zero. This is accomplished by connecting the wiper (and the lug connected to it) of the VOLTAGE ADJUST potentiometer to a stable −1.25-volt reference. Output current can be increased by replacing the LM317 with an LM350, a new 3-ampere version of the LM317. If this is done, the power transformer and rectifier must be replaced with components having increased current-handling capabilities. If a bipolar dc power supply is needed, you can build two supplies and connect the positive output post of one to the negative output post of the other. Alternatively, you can build a modified version of this project incorporating both an LM317 and an LM337, another IC from National Semiconductor which is a negative-voltage version of the LM317. ◇

Microcomputer I/O Board Buying Directory

Make & Model	Price[1] ($)	Power required[2] (mA)[2] +8V	+16V	−16V	Ports[3]	Serial: 20-mA? RS-232?[4]	Cassette Ports	Remarks
S-100								
Alpha Microsysts.								
AM-300	695				6S	R		Multi-level interrupt under program control.
Byte								
Byt-LIF	200	X			1P	no		For Okidata and similar parallel printers; 37-pin connector.
CGRS Microtech								
A Lot of I/O	170 (k)				2S, 4P			With ROM space, and connector for PerSci floppy controller card.
	220 (w)							
TIM I/O	40 (b)				2S, 3P			Memory-mapped; w. 320 bytes RAM, 1K TI F M, breadboard area for custom I/O.
	140 (k)							
	170 (w)							
Cromemco								
8PIO	195 (k)	1.5A			8Pb			
	295 (w)							
PRI	195 (w)	700			4P (1I, 10), 1 control			For printers; supports 1 dot-matrix, 1 daisy-wheel.
Tu-Art	195 (k)	1A	80	40	2S, 2P	B		With interval timers, vectored interrupts.
	205 (w)							
Educational Data Systs. of Va.								
PK3	85	300			1S 2P	B		Expandable; options include 8 interrupts, real-time clock, floating-point processor.
PK4	150	800			1S, 8P	B		
PK1	130	500			2P	opt.		
Fire Bird Sales								
1SIB4	214				S4	R		
1PIB4	268				P4			
Franklin Elect.								
I/O Interface	165 (k)	750	50	50	3S, 1P	B		LEDs for send, receive data.
	250 (w)							
IMSAI								
MIO	195 (k)				2P, 1S	B	1 Tarbell	Includes 1 control port.
	350 (w)							
PIO 4-1	93 (k)				1P			Status and indicator lights.
	140 (w)							
PIO 4-4	156 (k)				4P			As above.
	299 (w)							
PIOM	22 (k)				1P			Expansion kit for PIO4-1.
PIO 6-6	169 (k)				6P			
	279 (w)							
PIO 6-3	139 (k)				3P			Expandable to PIO 6-6.
	239 (w)							
PO6M	54 (k)				3P			Expansion module for PIO 6-3.
	90 (w)							
SIO 2-2	156 (k)				2S	B		
	299 (w)							
SIO 2-1	125 (k)				1S	B		Expandable to SIO 2-2.
	235 (w)							
SIOM	47 (k)				1S			Expansion kit for SIO 2-1.
	69 (w)							
SIOC	31 (k)							Serial I/O clock piggyback.
Infinite								
MFIO-1K	234	730	145	85	1P 1S	B	See Remarks	Also has 2K EPROM, 128 bytes RAM, firmware avail., cassette port for 300-baud K.C., 1200-baud Processor Tech, 600 & 2400 baud.

Make & Model	Price[1] ($)	Power required[2] (mA)[2] +8V	+16V	−16V	Ports[3]	Serial: 20-mA? RS-232?[4]	Cassette Ports	Remarks
Jade Computer								
JG-PS-01	125 (k) 175 (w)	X	X	X	2S, 1P	B	1 KC	Crystal-controlled baud rate.
Morrow's Microstuff								
Speakeasy	120	700			1S, 1Pb	B	3 KC	512 bytes ROM and RAM; cassete stop/start relays.
National Multiplex								
2SIO	190	600			2S, ½P	B	RS-232	For terminal & digital tape.
PUCI	235	600			3S, 1P	B	RS-232	For term., tape & printer.
Parasitic								
Speakeasy	150 (k) 185 (w)	900	40	60	1S, 1Pb	B	3 KC	Baud rate software-selectable.
Pickles & Trout								
P&T-488	250 (k) 325 (2)	X			1 IEEE 8Pb		1 KC	S-100 to IEEE-488 software on KC cassette.
BDIO	165 (w)							8 bidirectional data lines with 3 control, 3 port-select, 3 filtered interrupt lines; for up to 6 devices on one cable.
Processor Tech.								
3P+S	149 (k) 199 (w)				2Pb, 1S	B	no	1 serial, 2 parallel, 1 control port.
Solid State Music								
IO-2	55 (k)	300			1P			Experimenters' card with 1 port, spare IC patterns for serial port or PROM.
IO-4	150 (k)				2P, 2S	B	no	With 6 ribbon cables.
Space-Time Prod.								
Master I/O	48 (b) 369 (w)	1A	200	200	1S, 6P	TTL		With 3K ROM, 1K RAM, 3 counter-timers.
Vector Graphic								
Bit-Streamer	195 (w)				1S, 2P	B		Can be software-configured for 5-8 data bits.
Wameco								
SIO-1	30 (b)				2S, 2P	1 KC		
Xecon Micro								
Smart Controller	205 (w)	800	X		1S	B	mod KC	On-board ROM with file-formatting tape OS; KC @ 1200-4800.
Xitan								
SMB-2	395 (w)		170	170	2S, 1P	B*	1*	*One RS-232 configurable as 20-mA; cassette interface 1200/2400 baud; parallel port has 8 bits + 2 control lines, board has socket for 2K RAM, 4K EPROM, ZAPPLE monitor in 12K ROM; see main listing.

Make & Model	Price[1] ($)	Power required[2] (mA) +5V	+12V	−12V	Ports[3]	Serial: 20-mA? RS-232?[4]	Cassette Ports	Remarks
SS-50								
F&D Associates								
VPI-1	33 (b)				5P	no	no	36 bidirectional lines, 4 inept only; configurable as four 8-bit ports with 1 I/O and 1 input handshake line; can run Selectric; can replace 2 SWTP MP-L.
Gimix								
1 ACIA	99 (w)	X	X	X	1S	B	no	
2 PIA	98 (w)	X			2P			
4 ACIA	198 (w)	X	X	X	4S	B	no	Real-time clock for 1-sec. and 1-min. interrupts.
8 PIA	198 (w)	X			8P (5b)			
Midwest Scientific								
PIA-1	50 (k) 65 (w)				1P			
SI-1	58 (k)				2SI, 2SO	B		

Make & Model	Price[1] ($)	Power required[2] (mA) +5V	+12V	−12V	Ports[3]	Serial: 20-mA?	Cassette Ports	Remarks
National Multiplex 2S10 (R)	190	500			2S 1P	B	RS-232	For terminal & tape: OS in ROM.
SDS Tech. Devices MP-S	35 (k)	200			1S	B	2 SWTP AC-30	
Southwest Tech. MP-S	[illegible] (b) 35 (k)	200			1S	B		110-9600 baud
MP-C	10 (b)				1S	B		110-300 baud; serial & control board.
MP-LA	35 (k)	300			2P			

NOTES:
[1](b)=bare board, (k)=kit, (w)=wired. Prices shown may not include cables.
[2]In amperes where indicated by "A."
[3]S=serial, P=parallel; I=input only, O=output only, b=bidirectional.
Types of parallel port given only if specified by manufacturer. Some manufacturers count 8 I/O lines as one port, others count each line separately.
[4]R=RS-232, T=20 mA (TTY), B=both.

BUILD A PAIR OF "LAZY-LEADS"

BY GENE FRANCISCO

Eliminate switching leads when testing semiconductors

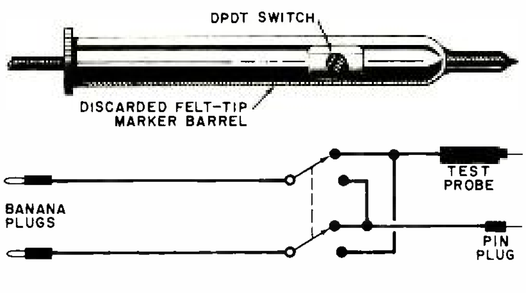
If you have ever tested a batch of semiconductors with an ohmmeter, you know that continually transposing test leads results in tired hands and tangled leads. Presented here is a simple probe called "Lazy Leads" which eliminates the need to transpose leads thanks to a built-in dpdt switch. It can be assembled from odd parts in a few moments.

Construction of the Lazy Leads is very simple. Locate a used felt-tip marker whose barrel sits comfortably in your hand. Also, select a subminiature dpdt switch. The switch must be small enough to fit inside the marker barrel. (Alternatively, choose a marker whose barrel is large enough to accommodate a small dpdt switch.) Other required items include a pin-tipped test probe, a pin plug, a length of three-conductor flexible cable and a pair of plugs compatible with your meter.

Remove the sealing plug from the top of the marker barrel and discard the spent ink reservoir and tip. Thoroughly clean the barrel with rubbing alcohol. Next, cut an opening in the barrel near the tip to accommodate the dpdt switch. Drill a hole in the sealing plug large enough to allow the three-conductor cable to run through it. Pass a length of the cable somewhat longer than the barrel through the hole and then tie a knot in the cable on the inner side of the seal.

Separate one of the conductors on the *outer* side of the sealing plug and solder it to a test probe. Solder banana plugs to the two remaining conductors. Then feed the three-conductor cable down the barrel and through the hole cut for the switch. Solder the conductors to the switch contacts according to the schematic shown in the figure. Also, solder one end of a short length of hookup wire to a pin plug and the other end to the remaining switch contacts. Screw the pin plug into the tip end of the marker, replace the sealing plug and secure the switch in place with cement or suitable hardware.

The Lazy Leads are now ready for use. You will be able to change the polarity of the leads merely by throwing the dpdt switch. This will greatly simplify semiconductor tests with an ohmmeter or voltage or current tests with a multimeter lacking an autopolarity function.◇



The Lazy Leads are made by inserting probe tips and a subminiature switch in the barrel of a felt-tip marker.

Calculating Capacitive Reactance Made Easy

BY ARTHUR F. BLOCK

THERE ARE a number of shortcuts to simplifying problem solving in electronics. In problems involving capacitive reactance, for instance, a useful procedure is to use the "magic" number of 160,000. This process may lead to errors of less than 1% in comparison to using standard textbook methods, but the components involved have 10% to 50% tolerances anyway.

Using the magic number in solving capacitance problems lets you deal with the basic units instead of the units involved in traditional formulas.

The Magic Formula. When dealing with capacitance in a problem, two of three variables are given. The traditional textbook formula for calculating capacitive reactance is: $X_C = 1/(2\pi FC)$, where X_C is in ohms, π is equal to 3.14159296, f is frequency in hertz, and C is capacitance in farads. (F). As you can see, this formula can be cumbersome to work with, especially if the frequency is in kilo- or megahertz and/or the capacitance is in micro- or picofarads. The problem can be greatly simplified as: $X_C fC = 160{,}000$ with C in microfarads.

To solve for X_C, f, or C, you simply transfer the two known values to the right side of the equals sign, where they become the divisor for the 160,000 constant. Hence, $f = 160{,}000/X_C C$ and $C = 160{,}000/fX_C$. The following examples will illustrate the relationship.

1. What is the equivalent reactance of a 0.01-µF capacitor at 1600 Hz? First, write down the formula $X_C = 160{,}000/fC$. Next, fill in the values of f and C: $X_C = 160{,}000/(1600 \times 0.01) = 160{,}000/16 = 10{,}000$ ohms.

2. A crossover point is the frequency at which a capacitor and resistor have equal reactance. Hence, it is sometimes necessary to calculate the capacitance value required for a given X_C and f in order to match a given resistance. What value capacitor is required to provide a crossover at 800 Hz with a 100,000-ohm resistor? First write down the formula: $C = 160{,}000/(800 \times 100{,}000) = 160{,}000/80{,}000{,}000 = 0.002\ \mu F$.

3. Now, let us determine the low-frequency cutoff of a 10-µF capacitor across a 100-ohm resistance: $f = 160{,}000/CX_C = 160{,}000/(10 \times 100) = 160{,}000/1000 = 160$ Hz.

4. Finally, how large a coupling-capacitor value is required to provide signals down to 20 Hz into a 500-ohm load? Write the problem: $C = 160{,}000/fX_C = 160{,}000/(20 \times 500) = 16\ \mu F$.

Now we can expand the usefulness of the basic relationship further. If you wish to work in megahertz, change the capacitance from microfarads to picofarads. In this manner, the frequency and capacitance are changed by a 1,000,000:1 ratio and results are read out directly in megahertz, ohms, or picofarads.

Going Further. Resistance-capacitance (RC) combinations exhibit what is known as a "time constant." The formula for determining the time constant is: T = RC, where T is the time in seconds, R is the resistance in ohms, and C is the capacitance in farads. Microfarads and ohms yield time constants in microseconds. Using picofarads and megohms, you also obtain results in microseconds.

As an example of how to use our "magic" number here, consider the 75-µs deemphasis used in FM radio. Since microseconds can be represented by ohms and microfarads, dividing 160,000 by 75 yields a crossover frequency of 2133 Hz for the deemphasis. Generally, however, you will be more interested in what component to use to obtain the 75-µs deemphasis.

To determine the component values required, just remember that any RC combination that yields a product of 75 (µs) can be used. For example, if you wish to use a 100,000-ohm resistor, the first thing to do is translate this value into 0.1 megohm. Then, using the formula, you will find that a 750-pF capacitor will provide the proper deemphasis.

Keep the R and C values within reason and consistent with the circuitry in which the network is to be used. You would not, for example, use a 750-µF capacitor because it would require a 0.1-ohm resistor to provide the proper deemphasis. ◇

ANTENNA MATCHING QUIZ

BY ROBERT P. BALIN

To test your knowledge of antennas, see how many of those illustrated below (A-L) you can properly identify by the following names (1-12).

1. **Batwing**

2. **Conical**

3. **Corner reflector**

4. **Cubical quad**

5. **Doublet**

6. **Folded dipole**

7. **Ground plane**

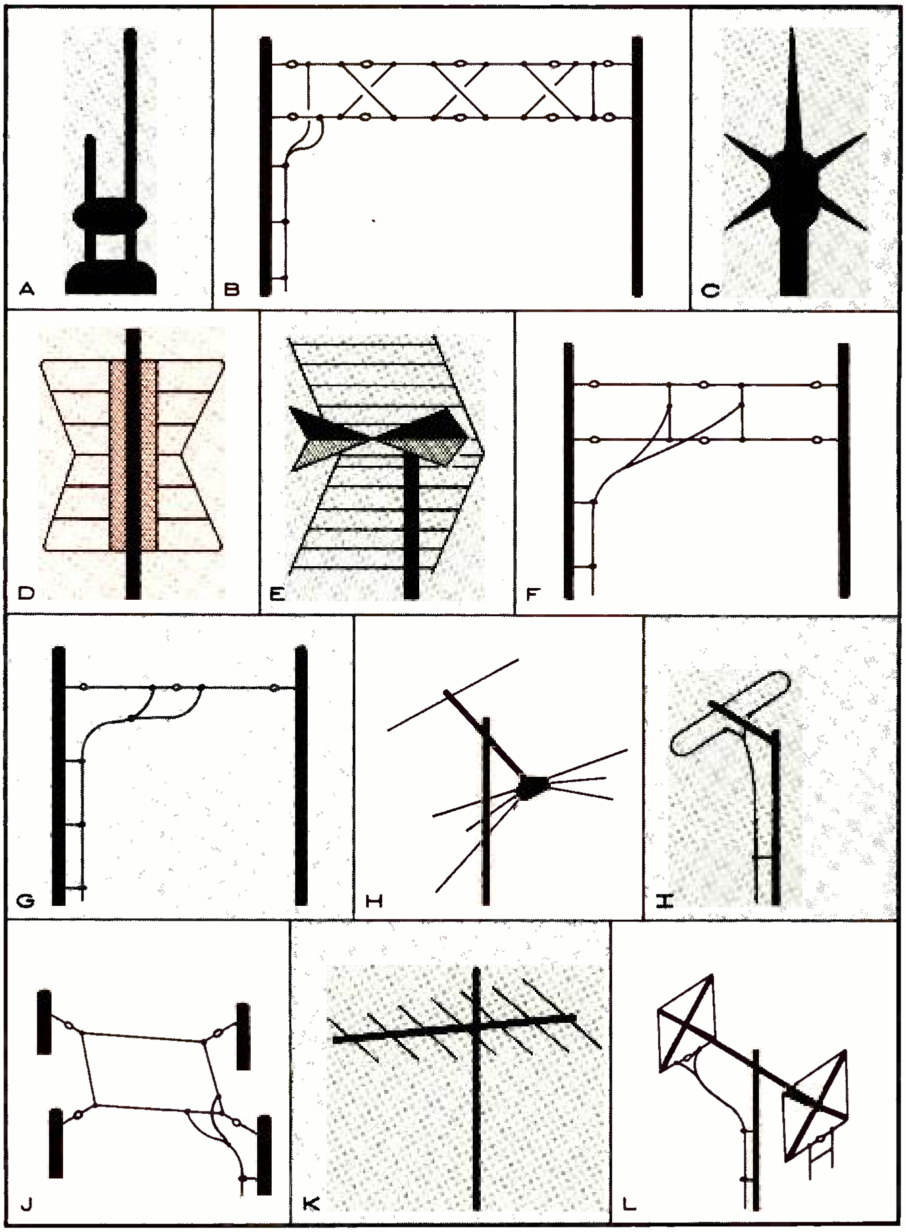
8. **J**

9. **Lazy H**

10. **Rhombic**

11. **Sterba curtain**

12. **Yagi**



ANSWERS:

1-D 4-L 7-C 10-J
2-H 5-G 8-A 11-B
3-E 6-I 9-F 12-K

Experimenter's Corner

By Forrest M. Mims

THE DIGITAL COMPARATOR

IN LAST MONTH'S column, we discussed the analog comparator and illustrated some applications for it. This month, we're going to look at its digital counterpart, the *magnitude comparator*. Figure 1 is the logic diagram for a simple magnitude comparator. The circuit, which can be made using a single 7400 quad NAND gate, compares two logic signals applied to its inputs. When both input signals are at the same logic level, a logic 0 appears at the output. When the inputs are at different logic levels, the output is a logic 1.

If this behavior sounds familiar, you're probably acquainted with the Exclusive-OR gate, one of the most important combinational logic circuits. Figure 1 is, in fact, an Exclusive-OR gate synthesized from NAND gates. The logic diagram and truth table for this important circuit are shown in Fig. 2.

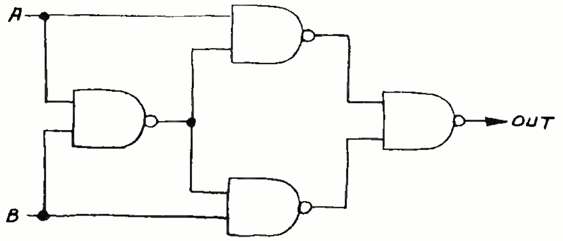


Fig. 1. Logic diagram for an Exclusive-OR gate synthesized from NAND gates.

Exclusive-OR Parity Generator. When large quantities of digital information are transmitted from one point to another, it is not uncommon to lose (or "drop") a few bits. Although the level of error might be extremely low, in many applications, it is important to find and correct *any* error that occurs. A single dropped bit, for example, can change a number such as 128 (10000000_2) to 0 (00000000_2). On the other hand, if a leading bit is somehow changed from a 0 to a 1, a transmitted 0_{10} will be received as a 128_{10}. You can imagine the problems that would occur if a few bits are dropped (or a dropped bit or two turn up) in a computerized payroll account!

The exclusive-OR gate gives rise to clever methods of preventing most dropped bits from slipping into a digital system undetected. The even-parity bit generator, shown in Fig. 3, is employed in one common error-detection system. This logic circuit continually monitors each bit in a four-bit nibble. If the nibble has an odd number of 1's, its output is logic 1. If the nibble has an even number of 1's, the circuit generates a logic-0 output. The extra bit is tagged onto the nibble as a fifth bit.

The fifth (parity) bit stays with the nibble while it is transmitted to a data processing circuit anywhere from a few feet to perhaps thousands of miles away. When the nibble is received, it is inspected by a parity detector which, like the parity generator, is made from Exclusive-OR gates. If the parity is correct, the nibble is accepted for processing. If not, an error signal is generated.

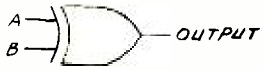
This simple parity method is effective, but it is not foolproof. A dropped parity bit, for example, could cause an otherwise perfectly valid nibble to be flagged as erroneous. Nevertheless, the odds for losing a parity bit are much smaller than those for losing a nibble bit since there are four times as many of the latter. In demanding applications, more complicated parity generation and detection methods can be used.

Multiple-Bit Digital Comparators. Many interesting applications are made possible by multiple-bit digital comparators. These comparators use Exclusive-OR circuits to compare respective pairs of bits in each of two words. The outputs of the comparators are applied to a gate that generates a logic 1 at its output when all the bit pairs are equal and a logic 0 when one or more are not.

Additional output bits can indicate which input is larger than the other, should that be the case. Additional inputs can permit two or more multiple-bit comparators to be cascaded so that larger words can be compared.

The 7485 4-Bit Magnitude Comparator. You can use Exclusive-OR gates for comparing one- or two-bit numbers, but the 7485 4-bit magnitude comparator is by far the best solution in more advanced applications. The 7485 provides three fully decoded outputs that indicate which of two input nibbles is larger than the other or if both nibbles are equal. It also includes three cascade inputs that permit two or more 7485's to compare words having eight or more bits.

Figure 4 is the pin diagram of the 7485. Note the reasonably consistent placement of the cascade inputs and comparator outputs, a feature you will find useful when you're working with this chip. Although the 7485 is rarely used in experimenter and hobbyist projects, it is a very versatile chip with some powerful applications. Just compare some of its decision making features with a pocket programmable calculator or a mi-



A	B	OUTPUT
0	0	0
0	1	1
1	0	1
1	1	0

Fig. 2. Symbol and truth table for Exclusive-OR gate.

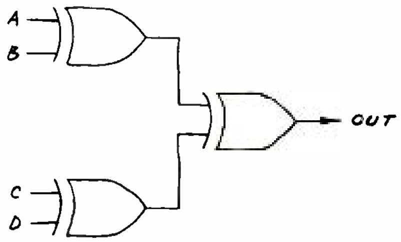


Fig. 3. Even-parity bit generator.

crocomputer and you'll see why. Indeed, you might be able to solve some fairly complex circuit requirements with a 7485 comparator rather than a more complicated approach such as using a microprocessor.

7485 Demonstration Circuit. A good way to learn how the 7485 works is to assemble the test circuit shown in Fig. 5. This circuit allows you to manually apply two 4-bit nibbles to a 7485 and simultaneously monitor three LEDs that indicate the status of the chip's outputs. Because the activated output of the 7485 is high, the LED connected to it is *off* and the other two LEDs are on. This might seem a little confusing at first, but you'll soon become accustomed to it. If you prefer that the LED connected to the activated output glow and the other two LEDs remain off, you can use the 7485 as a current source rather than a current sink. We'll see how this is done later.

Although the circuit shown in Fig. 5 specifies two 4-position DIP switches, you can use a single 8-position switch if you prefer. In operation, a switch that has been closed applies a logic 0 to the comparator input, and an open switch applies a logic 1. For this reason, it's best to install the DIP switches upside down. While experimenting with this circuit, you might find that the DIP switch occasionally fails to register properly. Some DIP switches are less reliable than conventional toggle switches, and you might have to press a switch into position more than once before it makes or breaks contact. You will also, no doubt, find that this circuit poses a test of your ability to manipulate binary numbers. We'll explore this aspect of using the 7485 in more detail later.

Finally, you'll probably begin to develop some applications of your own for the 7485. For example, how about a binary combination lock? One switch holds the combination, which you can easily change in only a few seconds. The second switch becomes the combination dial. Connect a solenoid lock to the A=B output (pin 6) through an SCR or power transistor and your combination lock is complete.

You can make a more sophisticated lock by inserting a normally-open pushbutton switch between the 7485 and the positive power supply and using the two A≠B outputs to activate

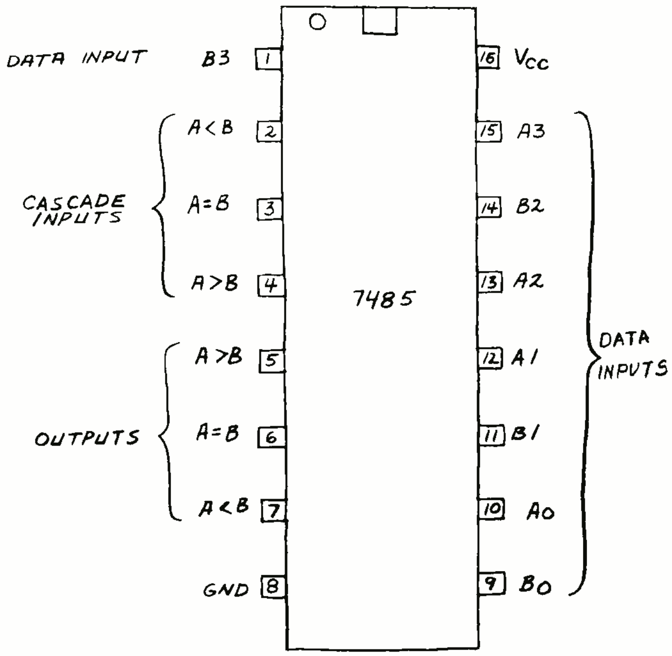


Fig. 4. Pin diagram for 7485 4-bit magnitude comparator.

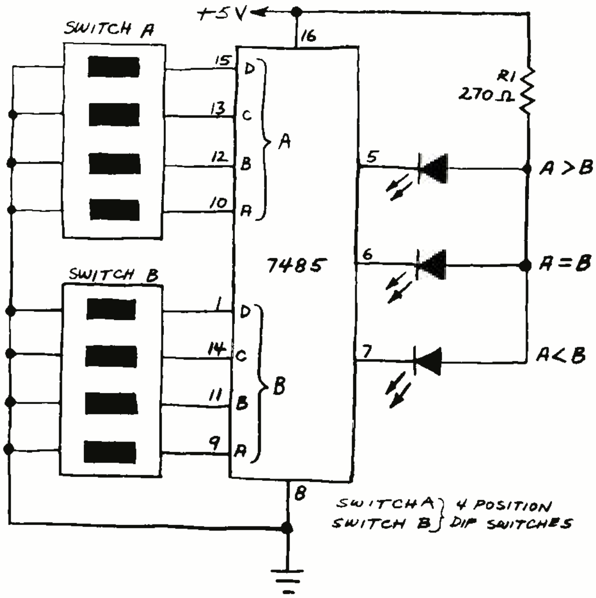


Fig. 5. Demonstration circuit using a 7485.

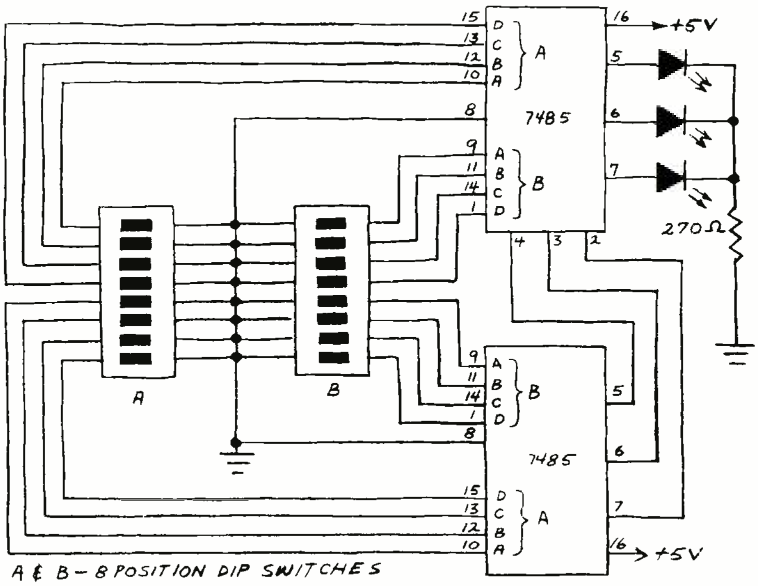


Fig. 6. Two 7485 comparators can be cascaded as shown.

an alarm bell. An incorrect combination entry followed by a press of the switch to activate the lock will ring the bell and discourage further tampering.

How to Cascade Two 7485's. The circuit in Fig. 5 has only sixteen possible combinations, but you can increase the number to 128 by adding a second 7485 and using an 8-bit combination. Cascaded comparators have other applications as well, particularly in light of the fact that most microprocessor and controller circuits work with words having eight or more bits.

Figure 6 shows how to cascade two 7485's. Although this circuit includes DIP switches to allow you to make manual entries, it can be readily adapted to receive bit patterns from a pair of 8-bit buses. Be sure to compare Fig. 6 with the pinout in Fig. 4 to see how the outputs of one 7485 are connected to the cascade inputs of the second 7485. Also, note how the indicator LEDs are sourced by the 7485 in this circuit. This means the LED connected to the activated output glows and the other two are off.

It's possible to cascade more than two 7485's so that words having more than 8 bits can be compared. The Texas Instruments *TTL Data Book*, for example, shows how to connect six 7485's to compare two 24-bit words (see page 7-64). *Five* 24-bit comparator circuits can be used with a single 7485 to compare two 120-bit words.

A 120-bit comparator made from 7485's would be very fast, but would require 31 chips. If speed is not essential, a much more practical way to compare very long words is to break them up into 4-bit nibbles or 8-bit bytes and compare respective nibbles or bytes a pair at a time in sequential fashion. That's a comparatively easy task for a microprocessor.

Using the 7485 in a Programmable Counter. Figure 7 shows how to make a programmable 4-bit counter with the help of a 7485. The desired count, which can be any number between 0001 and 1111, is entered into the DIP switch. The 555 functions as a clock that drives the 74193 through its count sequence. In operation, the 7485 continually interrogates the count and compares it with the number loaded into the DIP switch. When the two are equal, the comparator sends a pulse to the CLEAR input of the 74193 which resets the count to 0000. The cycle then repeats.

This basic circuit is easily modified for more sophisticated applications. Cascading counters and comparators, for example, will permit higher counts. By adjusting *R1* and *C1* to provide one clock pulse at a known interval, the circuit can be used as a programmable digital timer. Increasing *R1* or *C1* or both will slow down the clock rate.

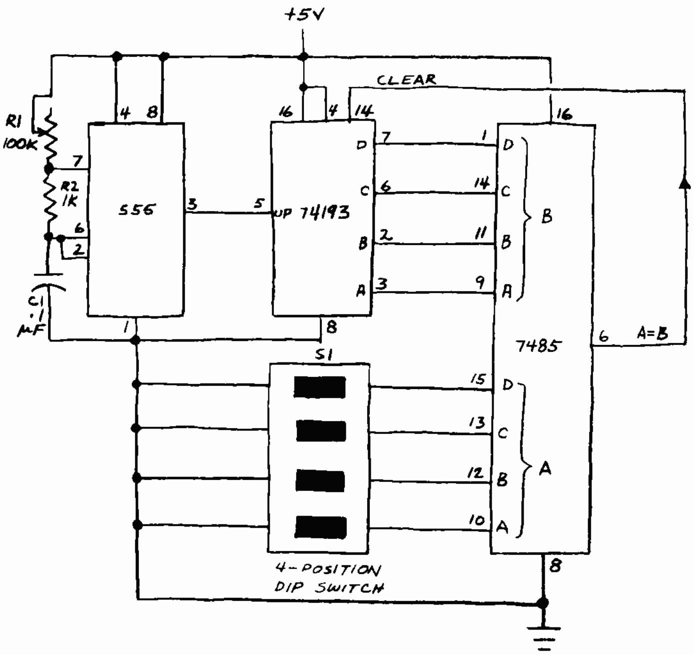


Fig. 7. A programmable 4-bit counter using a 7485 with a 74193 and 555 clock.

The A≠B outputs of the 7485 provide a number of other application possibilities. For example, by connecting the A<B output to the CLEAR input of the 74193, the counter will be reset upon the next clock pulse *after* the programmed number has been reached. If you build this circuit, be sure to experiment with this and other modes of operation.

BCD Trainer. Once you have assembled any of the 7485 circuits described thus far, you will realize how important the ability to think in binary is. The circuit shown in Fig. 8 will help you quickly learn the first ten binary numbers (0000-1001). These numbers are used in most if not all logic circuits that employ decimal readouts and are collectively known as the *binary-coded decimal* or *BCD* system.

The circuit is operated by pressing pushbutton *S1* for a second or two. This allows a fast stream of clock pulses to enter the 74192 BCD counter. When the switch is released, the last count attained by the 74192 remains in the counter register. This number is for practical purposes random because the clock frequency is far too high to allow anyone to second-guess what the count is when *S1* is released.

The BCD number stored in the 74192 is decoded by the 7447, which lights the appropriate segments of a LED readout to display the decimal equivalent. The way to use this training circuit is to set up on the DIP switch the BCD equivalent of the displayed digit. If the switch entry is correct, the appropriate LED will glow. If not, one of the other two LEDs will indicate that the switch entry is either too high or too low.

As with all the other 7485 circuits we've looked at so far, this one is easily modified. You can use a clock of your own design. You can also substitute a 7448 decoder and common cathode display in place of the readout circuit shown if you remember to connect the display's common cathode pin to ground instead of to +5 volts.

Another possibility is to eliminate all three response LEDs and use the decimal-point LED in the readout in place of the LED that indicates a correct response.

Number Guessing Game. The circuit in Figure 8 can be easily converted into a guessing game that is both educational and entertaining. Simply connect pin 6 of the 7485 to pin 4, the blanking input, of the 7447. The display will then stay extinguished *until* the correct BCD number is entered on the DIP switch. The two A≠B LEDs will indicate if your guesses are too high or too low.

If you would like to build a 4-bit version of this guessing game, see the Project of the Month. Meanwhile, try to think up more applications for the 7485. ◇

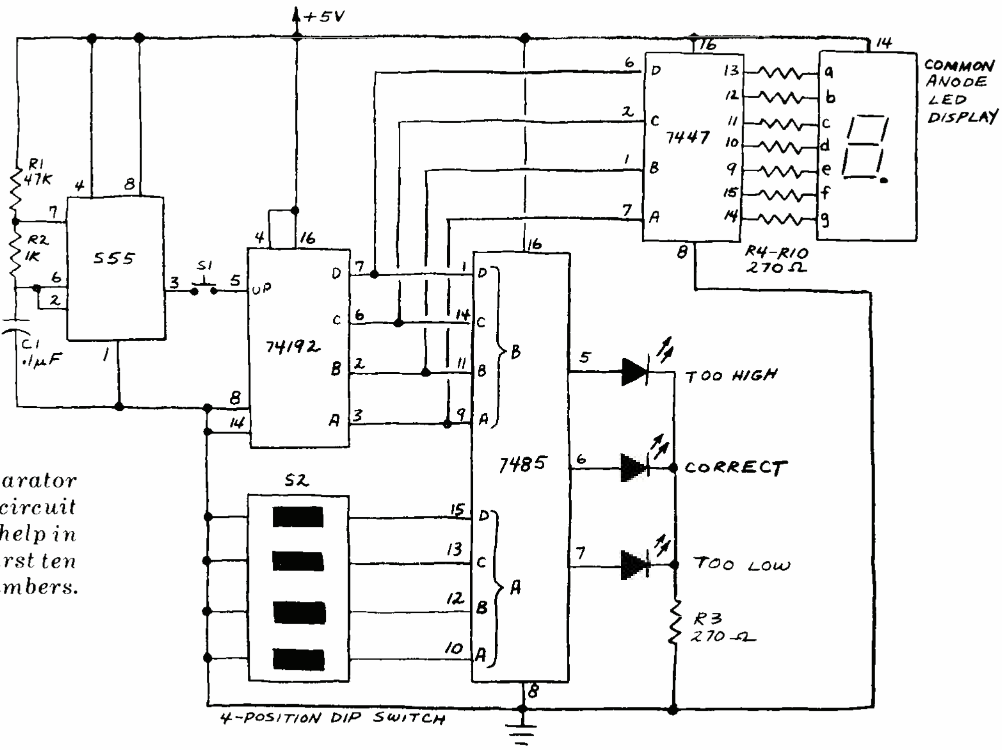


Fig. 8. A 7485 comparator is used to form a circuit that will help in learning the first ten binary numbers.

Hobby Scene Q&A

By John McVeigh, Technical Editor

BROADCAST BAND DX

Q. I have a portable radio of European manufacture with two AM bands. There's a 50,000-watt station in Hartford, Connecticut that I would like to listen to, but the reception with my present receiver isn't too good. Would a receiver with a wide AM band get better reception than a receiver with a narrower one? What would be the best AM radio that I could buy that would pick up distant stations? —Carl Moskowitz, Brooklyn, NY.

A. If I understand your first question correctly, you want to know if a receiver with a wider tuning dial (greater bandspread) will provide better reception than one with a narrower dial. The answer to that question is, "It depends . . ." As a general rule, a radio with a large bandspread eases the task of tuning in stations on a crowded band, and simplifies fine tuning. Accordingly, this feature is desirable, but has no direct relation to sensitivity.

If a manufacturer has designed his receiver with "human engineering" in mind and has thus provided a wide bandspread, it can be assumed that he has devoted similar efforts in areas like sensitivity, selectivity, etc. But that's only an assumption. Because of the physical limitations on the size of a portable radio, bandspread is usually narrow, especially when compared to that in a good desk-top "communications receiver."

Although the following statement is a gross generalization, I believe that it has some validity. For *serious* DX listening on the shortwave, mediumwave, or longwave bands, a communications receiver is preferable to a portable.

As to your second question, for policy reasons, I cannot recommend a specific brand or model number. However, I can tell you that I have successfully used relatively inexpensive portable receivers for mediumwave DX'ing.

The key to my success is that I used an external loop antenna to supplement the ferrite bar inside the radio. See, for example, "A BCB Loop Antenna for DX'ing" by Norman Fallon in the March 1976 issue of POPULAR ELECTRONICS. Commercial products, such as those manufactured by the McKay Dymek Company, 675 North Park Ave., Box 2100, Pomona, CA 91766, are also suitable.

The company's model DA 5 is a ferrite rod antenna (shielded loop) with a built-in preamp having preselector and sensitivity controls. The company claims the antenna's directional and nulling capabilities allow reception of AM stations up to 1500 miles distant. The antenna covers the mediumwave band and is available in kit or assembled form. McKay Dymek also makes a similar product, the model DA 7, which covers the longwave (150-300 kHz) and mediumwave (550-1600 kHz) bands. Both require either 110 or 220 volts ac. Finally, the Edmund Scientific Company, Edscorp Building, Barrington, NJ 08007, offers two "Select-A-Tenna" models (regular and super) which apparently are ferrite bar antennas. They are coupled inductively (no wires) to the radio's ferrite bar, like the construction project previously mentioned. Edmund claims a listening range of 100 miles for the regular model, and that better results will be experienced with the super model, which requires 50 ft. (15.2 m) of antenna wire and a ground connection.

Using any of the alternatives I have described, I'm confident that you'll be able to receive the Hartford station with your present receiver.

MOBILE STEREO AMPLIFIER

Q. I'm looking for a low-power stereo amplifier for use with my Nakamichi Model 550 cassette deck in my car and at my country cabin. Do you have a circuit for one that could be powered by an automotive battery? Alternatively, would it be possible to tap into an ac-powered amplifier past the power transformer? —Frank Winstan, Montreal, Quebec, Can.

A. An article entitled, "Build a High-Power Mobile Stereo Amplifier" appeared in the February 1976 issue of POPULAR ELECTRONICS. It detailed an amplifier which is powered by 12 volts dc, has a high-frequency dc-to-dc converter, and features the Signetics NE540 audio IC in an amplifier stage which can deliver 15 watts per channel continuous into 8 ohms (20 watts per channel into 4 ohms) at low distortion levels.

Contemporary amplifiers usually feature direct-coupled, complementary-symmetry output stages which require bipolar (±V) dc power supplies for accurate reproduction of both halves of ac musical waveforms. The amplifier just described is of this type, deriving its required ±20 volts dc from a dc-to-dc converter powered directly by the 12-volt automotive system and operating at ultrasonic frequencies.

The need for a bipolar supply rules out tapping into an amplifier past its ac power transformer and rectifier—unless the amplifier is transformer or capacitively coupled. Also, its line-powered supply would have to normally supply +12 volts dc or you risk upsetting its correct bias levels. If such an amplifier is available, its maximum output swing would be 12 volts peak-to-peak, corresponding to 2.25 watts continuous into 8 ohms or 4.5 watts continuous into 4 ohms—too low for most high-fidelity applications.

THE CURRENT CONVENTION

Q. Why do some authors still talk in terms of conventional current, which flows from positive to negative. Why not standardize current as the flow of electrons, negative to positive? —John Cottrell, Anderson, IN.

A. Every electronics text I have ever used follows the current convention by which current flows from positive to negative. Therefore, I don't know why you have found only "some" authors observe it. However, you correctly point out that electrons flow from negative to positive, and current could be defined as such. I suspect that the current convention is so established that it would be difficult to change it now. Also, the advent of semiconductor electronics has given rise to the concept of "hole" flow in a crystal lattice. The hole, being the absence of an electron, flows in the opposite direction with respect to an electron. Thus, hole current is consistent with the current convention as it flows from positive to negative, and this consistency seems to give continued vitality to the existing current convention.

Have a problem or question in circuitry, components, parts availability, etc? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, N.Y. 10016. Though all letters can't be answered individually, those with wide interest will be published.

Product Test Report

Continental Specialties PS–500 Prescaler

Low-cost add-on extends counter range to 500 MHz

MOST LOW-COST frequency counters are limited to a top end of 30 to 50 MHz. However, modern measurements in ham, CB, and marine radio often require a counter with a range out to as much as 500 MHz. The problem here is that the high cost of a 500-MHz counter may not always be justifiable. Fortunately, if you already have a low-cost frequency counter, all you really need to give it 10 times its basic top end (up to 530 MHz) is a relatively inexpensive prescaler, such as the Continental Specialties Corp. Model PS-500.

The compact PS-500 accessory measures 4½" × 2" × 1½" (11.4 × 5.1 × 3.8 cm) and weighs 6 oz (170 g). It sells for $59.95. Available accessories include: 117-volt ac No. 100 CA1 and 220-volt ac No. 100 CA2 power packs; No. PSA-1 36" (about 1-m) power cable with dc plug to alligator clips; No. 100 CLA car cigarette-lighter adapter; No. PSA-2 36" BNC-BNC interconnect cable; No. PSA-3 36" phono-connector cable; and No. PSA-4 18" (46-cm) phono-to-miniature-phone-plug cable.

General Description. The diode-protected input of the prescaler is rated at 50 ohms impedance. Minimum input-signal level is claimed to be 250 mV at frequencies up to 500 MHz and 300 mV up to 530 MHz. Maximum input level is rated at 2 volts rms between 50 and 500 MHz. (A BNC connector is used for the input to the accessory.)

The output of the PS-500 is capacitively coupled. Impedance is 50 ohms, and output signal level is 400 mV peak-to-peak. (A standard phono plug is the output connector.) Switching facilities are provided for selecting either a direct input, bypassing the PS-500's circuits (for frequencies within the range of the frequency counter being used), or for division by a factor of 10.

Operating power for the prescaler can be anywhere between 7 and 10 volts at 100 mA. The source supplying power need not be regulated, since the accessory has built-in electronic regulation.

The prescaler is built into a rugged plastic enclosure. The input and output connectors are located at opposite ends of the box. On top of the case is the single operating control, a two-position switch labelled DIRECT and ÷ 10.

Test Report. We checked the performance of the PS-500 by connecting it to a Continental Specialties Corp. "Mini-Max" 50-MHz portable pocket-size frequency counter. With the prescaler's mode switch set to DIRECT, we applied the output of a signal generator to the input and monitored the counter's display as we slowly increased the frequency. (In the DIRECT mode, the PS-500 is bypassed so that the input signal is effectively routed directly to the input of the frequency counter.)

As we increased the output frequency of the generator, we noted that the display of the counter accurately registered the frequency up to about 54 MHz, after which we obtained unreliable readings. Having established the point at which the counter "topped out," we switched to the ÷ 10 mode. As soon as the prescaler's switch was set to this mode, the basic accuracy of the counter again made itself known as the displayed frequencies went to 54.

We were able to check out the prescaler's performance at frequencies up to about 250 MHz. (This was the upper frequency limit of the signal generator we used during our tests.) We have no doubt, however, that the accessory will respond at least out to 530 MHz, based on its performance on our bench during our laboratory testing.

During our frequency tests, we also monitored the signal levels required to obtain accurate triggering. On the average, the levels required were well within those specified, averaging some 15% or 20% better than 250 mV. All laboratory tests were performed following 48 hours of continuous "burn-in" to assure stable operation.

User Comment. In our opinion, the PS-500 is a very worthwhile investment for anyone involved in servicing and experimenting with vhf and uhf radio. It is certainly a very realistic approach to upgrading a "general-purpose" low-cost frequency counter, preserving the original investment.

Another plus for the prescaler is its ability to be battery powered. When teamed with a portable battery-powered frequency counter, it can be used in the field, where line power is often not available. The prescaler's relatively low 100-mA drain will assure several hours of operation on medium- to heavy-duty rechargeable batteries.

CIRCLE NO. 104 ON FREE INFORMATION CARD

English Broadcasts Audible in No. America

by Glenn Hauser

TIME[1] CDT	TIME UTC/GMT	STATION	QUAL.[2]	FREQUENCIES, kHz[3]
4:00-4:15 a.m.	0900-0915	BBC	A	11955, 9640, 9510, 6195
4:00-4:15 a.m.	0900-0915	R. Japan[4]	B	9505
4:00-5:00 a.m.	0900-1000	R. Australia	C	9670
4:00-5:30 a.m.	0900-1030	R. Oman	D	11890
5:00-5:05 a.m.	1000-1005	UN Radio	A	9565, 5955 (Sat.)
5:00-5:30 a.m.	1000-1030	R. Japan	B	9505
5:00-5:30 a.m.	1000-1030	V. of Vietnam	C	12035, 10040, 9840
5:00-fade out	1000-	R. Australia	B	5995
5:00-6:00 a.m.	1000-1100	AFRTS	A	6030
5:30-6:30 a.m.	1030-1130	Sri Lanka Br. Corp.	C	17850, 15120, 11835 (not all Eng.)
5:30 a.m.-6:00 p.m.	1030-2300	CBC Northern Service	B	11720, 9625 (not all Eng.)
5:55-6:55 a.m.	1055-1155	R. Thailand	C	11905, 9655
6:00-6:15 a.m.	1100-1115	R. Japan	B	9505
6:00-6:56 a.m.	1100-1156	R. RSA	C	25790
6:00-7:45 a.m.	1100-1245	TWR-Bonaire	A	15255, (Sat-1330, Sun-1415)
6:00-7:50 a.m.	1100-1250	R. Pyongyang	C	11535, 9977
6:00-8:00 a.m.	1100-1300	R. Australia	A	9580
6:00-8:30 a.m.	1100-1330	BBC	A-B	25650, 21710, 21550, 11775, 11750, 9510, 6195
6:00-9:00 a.m.	1100-1400	4VEH, Haiti	B	11835, 9770
6:00-9:00 a.m.	1100-1400	AFRTS	A	15430, 15330, 11805, 9700
6:00-9:00 a.m.	1100-1400	VOA	A	11715, 9730, 9565, 5955
6:00-10:00 a.m.	1100-1500	R. Moscow	B	15150, 11770
6:30-6:45 a.m.	1130-1145	R.R.I. Yogyakarta	C	5046
7:00-7:15 a.m.	1200-1215	Vatican R.	B	21485
7:00-7:15 a.m.	1200-1215	R. Japan	B	9505
7:00-7:30 a.m.	1200-1230	Israel Radio	C	25640, 21495, 17685
7:00-7:30 a.m.	1200-1230	R. Tashkent	C	15460, 15125, 11925, 11730
7:00-7:45 a.m.	1200-1245	V. of Germany	B	21600, 17765, 15410
7:00-7:45 a.m.	1200-1245	R. Berlin International	C	21540, 15320, 15125
7:00-7:55 a.m.	1200-1255	R. Peking	C	11685
7:00-8:00 a.m.	1200-1300	HCJB, Ecuador	A	15115, 11740
7:15-7:30 a.m.	1215-1230	V. of Greece	B	21655, 17830, 15345, 11730
7:20-7:50 a.m.	1220-1250	R. Ulan Bator, Mongolia	D	12070, 6383 (not Sun)
7:30-7:55 a.m.	1230-1255	Austrian R.	C	21530
7:30-8:00 a.m.	1230-1300	R. Sweden	C	21700
8:00-8:15 a.m.	1300-1315	R. Japan	B	9505
8:00-8:30 a.m.	1300-1330	R. Finland	C	15400
8:00-10:50 a.m.	1300-1550	R. RSA	B	25790, 21535, 15220
8:00-9:30 a.m.	1300-1430	HCJB, Ecuador	B	17890, 15115, 11740
8:15-8:45 a.m.	1315-1345	Swiss R. International	C	21570, 21545-SSB, 21520
8:30-9:30 a.m.	1330-1430	R. Finland	C	15400 (Sun. only)
8:30-10:00 a.m.	1330-1500	All India R.	C	15335, 11810
8:30-11:00 a.m.	1330-1600	BBC	B-C	25650, 21710, 21660, 21550, 15400 (from 1430), 15070
9:00-9:30 a.m.	1400-1430	R. Japan	B	9505
9:00-9:30 a.m.	1400-1430	R. Sweden	B	21615
9:00-9:30 a.m.	1400-1430	R. Norway	B	17840, 15175 (Sun only)
9:00-9:30 a.m.	1400-1430	V. Rev. Party, N. Korea	D	4557, 4109
9:00-9:30 a.m.	1400-1430	R. Afghanistan	D	4775
9:00-9:30 a.m.	1400-1430	R. Tashkent	C	15460, 15125, 11925, 11730
9:00-9:45 a.m.	1400-1445	R. Berlin International	C	21540, 15125
9:00-10:00 a.m.	1400-1500	VOA	A	11715, 9565
9:00-10:00 a.m.	1400-1500	V. of Indonesia	C	11789, 15200
9:00-11:00 a.m.	1400-1600	AFRTS	A	15425, 15330, 11605, 9700
9:30-10:00 a.m.	1430-1500	R. Finland	B	15400, 21475
9:30-10:25 a.m.	1430-1525	R. Nederland	B	21480
9:30-11:00 a.m.	1430-1600	HCJB, Ecuador	A	17890, 15115
9:30-11:00 a.m.	1430-1600	Burma Br. Ser.	D	5985
9:30 a.m.-5:00 p.m.	1430-2200	UN Radio	A	21670, 15410 (also French; when in session)
10:00-10:15 a.m.	1500-1515	R. Japan	C	9505
10:00-11:00 a.m.	1500-1600	V. of Rev. Ethiopia	D	9615
10:00-11:00 a.m.	1500-1600	V. of Rev. Ethiopia	D	9615
10:00-11:00 a.m.	1500-1600	BBC	B	17830, 11775 (Sat, Sun)
10:00-12:00 a.m.	1500-1700	R. Moscow	B	11770
10:15-10:30 a.m.	1515-1530	V. of Greece	B	21455, 17830, 15345, 11730 (last two, not Tues.)
10:30-11:00 a.m.	1530-1600	R. Yugoslavia	C	15240
10:30-11:00 a.m.	1530-1600	Swiss R. International	B	21570
10:30-11:15 a.m.	1530-1615	NSB, Tokyo	C	9595, 6055 (exc Sun)
10:30-11:30 a.m.	1530-1630	V. of Vietnam	C	12035, 10040, 9840
10:45-11:00 a.m.	1545-1600	R. Canada International	A	17820, 15325 (Mon-Fri only)
11:00-11:15 a.m.	1600-1615	R. Japan	C	9505

11:00-11:15 a.m.	1600-1615	R. Pakistan	C	21735, 21595, 21485, 17665, 17640
11:00-11:30 a.m.	1600-1630	R. Korea	C	9780 or 9720, 9640, 7150
11:00-11:30 a.m.	1600-1630	R. Norway	B	17755, 15175 (Sun only)
11:00-12:00 a.m.	1600-1700	VOA	A	26040, 21485, 17870, 17710
11:00 a.m.-12:45 p.m.	1600-1745	BBC	B	21710, 21550, 17880, 17830, 11775
11:00 a.m.-1:00 p.m.	1600-1800	AFRTS-Washington	A	17765, 15430, 15330, 11805
11:05-11:55 a.m.	1605-1655	R. France International	B	21580, 17860, 17850, 17720
11:10-11:55 a.m.	1610-1655	BRT, Belgium	C	17740 (frequent changes)
-11:30 a.m.	-1630	R. Singapore	C	11940 (fade-in time varies)
11:45-12:00 a.m.	1645-1700	R. Canada International	A	17820, 15325
12:00-12:15 p.m.	1700-1715	R. Japan	C	9505
12:00-12:15 p.m.	1700-1715	Vatican R.	B	17900
12:00-12:30 p.m.	1700-1730	R. Pakistan	C	15470, 11675
12:00-1:00 p.m.	1700-1800	HCJB, Ecuador	B	21480, 17890 (frequent changes)
12:00-1:00 p.m.	1700-1800	VOA	A	26040, 21590, 21485, 17870, 17710
12:45-3:00 p.m.	1745-2000	BBC	C	15400, 15070, 12095 (11820 from 1800)
12:45-5:30 p.m.	1745-2230	All India R.	C	11620
1:00-1:15 p.m.	1800-1815	R. Japan	B	9505
1:00-1:30 p.m.	1800-1830	R. Canada International	B	17820, 15260
1:00-1:30 p.m.	1800-1830	R. Norway	C	15175 (Sun only)
1:00-1:30 p.m.	1800-1830	R. Korea	C	9780 or 9720
1:00-2:00 p.m.	1800-1900	R. Australia	C	11800
1:00-2:30 p.m.	1800-1930	V. of Nigeria	C	15120, 11770
1:00-4:00 p.m.	1800-2100	R. Kuwait	C	15345
1:00-5:00 p.m.	1800-2200	AFRTS-Washington	A	21570, 17765, 15430, 15330, 11790
1:00-5:00 p.m.	1800-2200	VOA	A	26040, 21590, 21485, 17870, 17785, 17710, 15445
1:15-1:45 p.m.	1815-1845	Swiss R. International	C	21585
1:15-2:15 p.m.	1815-1915	R. Bangladesh	D	15285, 11765 (both vary, freq. changes)
1:30-1:35 p.m.	1830-1835	UN Radio	A	21670, 19505-SSB, 15410 (Fri)
1:45-2:15 p.m.	1845-1915	Sri Lanka Br. Corp.	C	17850, 15120, 15115, 11870
1:45-3:00 p.m.	1845-2000	R. Ivory Coast	C	11920
2:00-2:10 p.m.	1900-1910	R. Tahiti	C	15170, 11825 (exc Sun)
2:00-2:15 p.m.	1900-1915	R. Japan	C	15105
2:00-2:30 p.m.	1900-1930	R. Canada International	A	17875, 15325, 11905
			B	17820, 15260
2:00-2:30 p.m.	1900-1930	R. Afghanistan	C	15140, 11890 (frequent changes)
2:00-3:00 p.m.	1900-2000	B.S.K. Saudi Arabia	C	11855
2:00-3:30 p.m.	1900-2030	HCJB, Ecuador	C	21480, 17790, 15295 (freq. changes)
2:45-4:10 p.m.	1945-2110	R. Free Grenada	C	15104 (time varies)
3:00-3:15 p.m.	2000-2015	R. Japan	B	15105
3:00-3:30 p.m.	2000-2030	V. of Iran	C	9022 (frequent time changes)
3:00-3:30 p.m.	2000-2030	R. Algeria	C	9510
3:00-3:30 p.m.	2000-2030	R. Korea	C	11860
3:00-3:30 p.m.	2000-2030	R. Canada International	A	17875, 17820, 11855
3:00-3:30 p.m.	2000-2030	Israel R.	B	21625, 17645, 11655
3:00-4:15 p.m.	2000-2115	BBC	A	21710, 17840, 15260, 15070, 6175
3:10-4:50 p.m.	2010-2150	R. Habana Cuba	A	17855
3:30-4:20 p.m.	2030-2120	R. Nederland	B	21640, 17810, 11740, 11730
3:30-4:30 p.m.	2030-2130	V. of Vietnam	C	15012, 10040
3:50-4:40 p.m.	2050-2140	R. Habana Cuba	C	17750, 9770
4:00-4:15 p.m.	2100-2115	R. Japan	B	15105
4:00-4:50 p.m.	2100-2150	R. RSA	B	17780, 15155, 11900, 9585
4:15-5:00 p.m.	2115-2200	BBC	A	21710, 15420, 15260, 15070, 11750, 6175
4:15-5:45 p.m.	2115-2245	R. Free Grenada	B	15045
4:15 p.m.-3:15 a.m.	2115-0815	R. New Zealand	C	17770
4:30-5:00 p.m.	2130-2200	R. Canada International	A	17875, 17820, 15325, 15150, 11945
4:30-5:00 p.m.	2130-2200	KGEI, San Francisco	C	15280
4:30-5:00 p.m.	2130-2200	R. Sofia	B	11920, 11860 (frequent changes)
4:30-5:30 p.m.	2130-2230	R. Baghdad	C	9745
4:30-6:00 p.m.	2130-2300	V. of Turkey	C	11955, 9515, 7170, 6185
4:40-5:40 p.m.	2140-2240	V. of Free China	C	17890, 15345
5:00-5:15 p.m.	2200-2215	R. Yugoslavia	C	9620
5:00-5:15 p.m.	2200-2215	R. Japan	B	17755
5:00-5:30 p.m.	2200-2230	R. Nacional, Venezuela	B	15400 (irregular)
5:00-5:30 p.m.	2200-2230	R. Norway	C	17795, 15345 (Sun only)
5:00-5:45 p.m.	2200-2245	BBC	A	21710, 15420, 15260, 15070, 6175, 6120
5:00-6:00 p.m.	2200-2300	R. Canada International	A	17875, 15325 (Mon-Fri)
5:00-7:00 p.m.	2200-2400	CBC Southern Service	B	5960 (Mon-Fri)
5:00-7:00 p.m.	2200-2400	AFRTS–Washington	A	25620, 21570, 15430, 15330, 11790
5:30-6:00 p.m.	2230-2300	Israel R.	A	21625, 17645, 15485, 11655, 9815
5:45-6:00 p.m.	2245-2300	BBC	A	15420, 15260, 15070, 9410 6175, 6120
5:45-6:00 p.m.	2245-2300	SODRE, Uruguay	C	11885, 9515 (time varies)
5:45-6:00 p.m.	2245-2300	UN Radio	A	15225, 11920 (Fri)
6:00-6:30 p.m.	2300-2330	BBC	A	15420, 15260, 15070, 11910, 9590, 9580, 9410, 7325, 6175, 6120, 5975
6:00-6:30 p.m.	2300-2330	R. Japan	B	17755
6:00-6:30 p.m.	2300-2330	R. Sweden	C	15205 or 11705, 9695 or 9690
6:00-6:30 p.m.	2300-2330	R. Vilnius	B	15405, 15180, 12060, 11790, 11780, 9600

6:00-6:50 p.m.	2300-2350	Rdif. Argentina	C	11710 (Mon-Fri)
6:00-7:00 p.m.	2300-2400	VOA	A	26095, 25990, 21610, 21460, 17895, 17820
6:00-7:00 p.m.	2300-2400	4VEH, Haiti	B	11835, 9770
6:00-7:50 p.m.	2300-2450	R. Pyongyang	C	11535, 9977
6:00-9:00 p.m.	2300-0200	RTVD, Dom. Rep.	B	9505 (not all Eng.)
6:00-9:00 p.m.	2300-0200	R. Moscow	B	15425, 15245, 15100, 12050, 12030, 11960, 11750, 11735, 9685, 9665, 9600, 9530
6:00 p.m.-1:06 a.m.	2300-0506	CBC Northern Service	B	9625, 6195 (not all English)
6:15-8:00 p.m.	2315-0100	R Free Grenada	B	15370
6:30-7:00 p.m.	2330 2400	R. Finland	B	15265, 11735
6:30-7:30 p.m.	2330-2430	BBC	A	15420, 15260, 15070, 11910, 9590, 9580, 7325, 6175, 6120
6:45-7:45 p.m.	2345-2445	R. Japan	B	17825, 15270
7:00-7:15 p.m.	0000-0015	R. Japan	B	17755
7:00-7:25 p.m.	0000-0025	R. Tirana	B	9750, 7065
7:00-7:30 p.m.	0000-0030	R. Norway	C	11860, 9605 (Mon only)
7:00-7:55 p.m.	0000-0055	R. Peking	B	17680, 15520, 15060
7:00-8:00 p.m.	0000-0100	VOA	A	25990, 21460, 17895, 17820, 15205, 11740, 9640, 6130
7:00-8:00 p.m.	0000 0100	R. Sofia	B	9705 or 15330
7:00-9:00 p.m.	0000-0200	R. Luxembourg	C	6090
7:05-8:55 p.m.	0005 0155	Spanish Foreign R.	B	11880, 9630
7:15-7:30 p.m.	0015-0030	V. of Greece	B	11730, 9655, 9515
7:15-8:00 p.m.	0015-0100	BRT, Belgium	C	6080
7:30-7:50 p.m.	0030-0050	SODRE, Uruguay	C	11885, 9515 (time varies)
7:30-8:00 p.m.	0030-0100	R. Sweden	C	11905
7:30-8:00 p.m.	0030-0100	R. Prague	C	9630, 6055
7:30-8:00 p.m.	0030-0100	R. Kiev	B	15405, 15180, 11780, 9600
7:30-9:00 p.m.	0030-0200	HCJB, Ecuador	A	15115
7:30-9:30 p.m.	0030-0230	BBC	A	15260, 15070, 11910, 11750, 9580, 9410, 7325, 6175, 6120, 5975
7:30-12:00 p.m.	0030-0500	HCJB, Ecuador	B	11915, 9745
7:50-8:35 p.m.	0050-0135	TWR-Bonaire	B	11925
8:00-8:15 p.m	0100-0115	R. Japan	B	17755
8:00-8:15 p.m.	0100-0115	Vatican R.	B	11845, 9605, 6015
8:00-8:20 p.m.	0100-0120	RAI, Italy	B	15315, 11810
8:00-8:30 p.m.	0100-0130	R. Canada International	A	11940, 5960
8:00-8:45 p.m.	0100-0145	R. Berlin International	C	11805, 9730
8:00-8:55 p.m.	0100-0155	R. Prague	B	11990, 9630, 9540, 7345, 5930
8:00-8:55 p.m.	0100-0155	R. Peking	B	17680, 15600, 15520, 15060, 12055
8:00-9:00 p.m.	0100-0200	VOA	A	15205, 11740, 9640, 6130
8:00-9:00 p.m.	0100-0200	V. of Free China	C	17890, 15425, 15345
8:00-10:30 p.m.	0100-0330	R. Habana Cuba	A	11930
8:00-10:30 p.m.	0100-0330	R. Australia	B	21740, 17795
8:00-11:30 p.m.	0100-0430	AFRTS-Washington	A	25620, 21570, 15430, 9685, 6030
8:00-12:00 p.m.	0100-0500	WYFR, Family Radio	A	5985
8:15-9:30 p.m.	0115-0230	R. Free Grenada	B	15104
8:30-8:50 p.m.	0130-0150	V. of Germany	A	11865, 9605, 9565, 9545, 6100, 6085, 6075, 6040
8:30-8:55 p.m.	0130-0155	Austrian Radio	C	9770, 6155
8:30-8:55 p.m.	0130-0155	R. Tirana	B	9750, 7120
8:30-9:25 p.m.	0130-0225	R. Bucharest	C	11940, 11840, 9690, 9570, 6155, 5990
8:30-9:30 p.m.	0130-0230	R. Japan	B	21640, 17825, 17725, 15195
8:45-9:15 p.m.	0145-0215	Swiss R. International	B	15305, 11715, 9725, 6135
9:00-9:15 p.m.	0200-0215	R. Japan	B	17755
9:00-9:30 p.m.	0200-0230	R. Canada International	A	9535, 5960
9:00-9:30 p.m.	0200-0230	R. Norway	B	11860, 9610 (Mon only)
9:00-9:30 p.m.	0200-0230	R. Budapest	B	15220, 11910, 9833, 9585, 6105, 6000 (not Mon)
9:00-9:30 p.m.	0200-0230	R. Warsaw	C	15120, 11815, 9525, 6135, 6095
9:00-9:50 p.m.	0200-0250	R. RSA	B	11900, 9610, 9585, 5980
9:00-9:55 p.m.	0200-0255	R. Peking	B	17680, 15600, 15060, 12055
9:00-10:00 p.m.	0200-0300	R. Moscow	B	11770, 11750, 11735, 11720, 9700 9665, 9530
9:00-10:00 p.m.	0200-0300	Radio Brás, Brazil	A	15280
9:00-10:30 p.m.	0200-0330	R. Cairo	B	12050, 9475
9:15-9:30 p.m.	0215-0230	V. of Greece	B	11730, 9760, 9515
9:30-9:45 p.m.	0230-0245	R. Pakistan	C	21590, 17830
9:30-9:55 p.m.	0230-0255	R. Tirana	B	9750, 7120
9:30-10:00 p.m.	0230-0300	R. Lebanon	C	15440 (frequent changes)
9:30-10:00 p.m.	0230-0300	R. Sweden	C	11705, 9695
9:30-10:15 p.m.	0230-0315	R. Berlin International	C	11805, 9730
9:30-10:25 p.m.	0230-0325	R. Nederland	A	9590, 6165
9:30-10:30 p.m.	0230-0330	BBC	A	15070, 11910, 11750, 9580, 9410, 7325, 6175, 6120, 5975
9:50-11:00 p.m.	0250-0400	TIFC, Costa Rica	B	5055
10:00-10:15 p.m.	0300-0315	R. Japan	B	17755
10:00-10:15 p.m.	0300-0315	Austrian Radio	C	9770, 6155 (Sun only)
10:00-10:30 p.m.	0300-0330	R. Canada International	A	11845, 9605, 9535, 5960
10:00-10:30 p.m.	0300-0330	R. Portugal	B	11935, 6025 (Mon -0320)
10:00-10:30 p.m.	0300-0330	R. Budapest	B	15220, 11910, 9833, 9585, 6105, 6000
10:00-10:30 p.m.	0300-0330	R. Warsaw	C	15120, 11815, 9525, 6135, 6095

10:00-10:30 p.m.	0300-0330	R. Kiev	B	12060, 11780, 9800, 9775
10:00-10:50 p.m.	0300-0350	V. of Free China	C	17890, 15345
10:00-10:55 p.m.	0300-0355	R. Prague	B	11990, 9630, 9540, 7345, 5930
10:00-10:55 p.m.	0300-0355	R. Peking	B	17532, 15300, 15060, 12080, 12055, 11685
10:00-11:00 p.m.	0300-0400	RAE, Argentina	C	9690 (Tue-Sat)
10:00-11:00 p.m.	0300-0400	R. Baghdad	C	11935
10:00-11:00 p.m.	0300-0400	UBC, Uganda	B	15325
10:00-11:00 p.m.	0300-0400	R. Moscow	B	11960, 11770, 11750, 11720, 9700, 9685, 9530
10:00-11:26 p.m.	0300-0426	R. RSA	B	9585, 7270, 5980, 4990, 3995
10:00 p.m.-2:00 a.m.	0300-0700	VOA	A	15240, 9670, 5995
10:25-10:30 p.m.	0325-0330	V. of Armenia	B	15405, 15180, 15100, 11870 (Sun., Wed, Thu, Sat)
10:30-10:55 p.m.	0330-0355	R. Tirana	B	7300, 6200
10:30-10:55 p.m.	0330-0355	Austrian Radio	C	9770, 6155
10:30-11:00 p.m.	0330-0400	R. Australia	B	17795
10:30-11:15 p.m.	0330-0415	R. Berlin International	B	11970, 11890, 11840
10:30-11:45 p.m.	0330-0445	BBC	A	11910 (to 0430), 9410, 6175, 5975
10:30-11:50 p.m.	0330-0450	R. Habana Cuba	A	11930, 11725
10:30-12:00 p.m.	0330-0500	R. Tanzania	D	15435
10:30 p.m.-1:00 a.m.	0330-0600	R. Habana Cuba	A	11760
10:30 p.m.-2:30 a.m.	0330-0730	R. Moscow	B	15180, 15100, 12050, 12000, 11720, 11690, 9710
11:00-11:15 p.m.	0400-0415	R. Japan	B	17755
11:00-11:15 p.m.	0400-0415	R. Budapest	B	15220, 11910, 9833, 9585, 6105, 6040 (Wed & Sat)
11:00-11:30 p.m.	0400-0430	R. Bucharest	C	11940, 11840, 9690, 9570, 6155, 5990
11:00-11:30 p.m.	0400-0430	R. Canada International	A	9535, 5960
11:00-11:30 p.m.	0400-0430	R. Norway	B	11860, 9645 (Mon only)
11:00-11:55 p.m.	0400-0455	R. Peking	B	17532, 15300, 15060, 12055, 11685
11:00-12:00 p.m.	0400-0500	R. Australia	B	17795, 15320
11:30-11:55 p.m.	0430-0455	Austrian R.	C	5945
11:30-12:00 p.m.	0430-0500	Swiss R. International	B	11715, 9725
11:30-12:00 p.m.	0430-0500	R. Sofia	B	11860 (frequent changes)
11:30 p.m.-2:00 a.m.	0430-0700	AFRTS-Washington	A	17765, 15430, 15330, 9685, 6030
11:45 p.m.-12:45 a.m.	0445-0545	BBC	A	9510, 6175, 5975
12:00-12:15 a.m.	0500-0515	Israel R.	B	15485, 15105, 11655
12:00-12:15 a.m.	0500-0515	R. Japan	B	15105
12:00-12:30 a.m.	0500-0530	R. Portugal	B	11935, 6025 (Mon-0520)
12:00-1:00 a.m.	0500-0600	R. Australia	C	21680, 17890, 17870, 17725, 15240
12:00-2:00 a.m.	0500-0700	HCJB, Ecuador	B	11915, 9745, 6095
12:15-1:15 a.m.	0515-0615	Spanish Foreign R.	B	11880, 9630
12:22-12:30 a.m.	0522-0530	UN Radio	A	9540, 6055 (Sat)
12:30-12:50 a.m.	0530-0550	V. of Germany	A	11785, 9545, 6185, 6100, 5960
12:30-1:25 a.m.	0530-0625	R. Nederland	A	9715, 6165
12:45-1:00 a.m.	0545-0600	UN Radio	A	9540, 6135 (Sat)
12:45-2:30 a.m.	0545-0730	BBC	B	15070, 11955, 11860, 9640, 9510, 6175
12:55-3:35 a.m.	0555-0835	V. of Nigeria	B	15185, 15120, 11770, 7255
1:00-1:15 a.m.	0600-0615	R. Japan	B	15105
1:00-1:30 a.m.	0600-0630	R. Norway	B	11860 (Mon only)
1:00-2:00 a.m.	0600-0700	RAE, Argentina	C	9690 (Tue-Sat only)
1:00-2:00 a.m.	0600-0700	R. RSA	C	21535, 17780, 15220
1:00-4:15 a.m.	0600-0915	R. Australia	B	15320
1:15-1:30 a.m.	0615-0630	R. Canada International	B	11845, 11775, 9655, 9590, 6140, 6045 (Mon-Fri)
1:25-3:55 a.m.	0625-0855	V. of Malaysia	C	15295, 12350, 9750
1:30-2:00 a.m.	0630-0700	R. Korea	C	9640
1:30-3:00 a.m.	0630-0800	R. Habana Cuba	A	9525
1:40-7:15 a.m.	0640-1215	R. New Zealand	C	6105
1:45-2:00 a.m.	0645-0700	R. Canada International	B	11845, 11775, 9655, 9590, 6140, 6045 (Mon-Fri)
2:00-2:15 a.m.	0700-0715	R. Japan	B	15105
2:00-3:00 a.m.	0700-0800	Xandir Malta	C	9670 (Sat only) (frequent changes)
2:00-4:00 a.m.	0700-0900	R. Australia	B	11740, 9570
2:07-2:15 a.m.	0707-0715	UN Radio	A	9540, 6135 (Sat)
2:30-2:45 a.m.	0730-0745	UN Radio	A	9540, 6135 (Tue-Sat)
2:30-3:25 a.m.	0730-0825	R. Nederland	B	9770, 9715
2:30-4:00 a.m.	0730-0900	BBC	B	15070, 11955, 9640, 9510
3:00-3:15 a.m.	0800-0815	R. Japan	B	9505
3:30-4:25 a.m.	0830-0925	R. Nederland	B	9715

Explanatory Notes.

1. Times in first column are CDT. For EDT, add 1 hour. MDT, subtract 1 hour. PDT, subtract 2 hours. Days of week are in GMT.
2. Quality. A—strong signal and very reliable reception. B—regular reception. C—occasional reception under favorable conditions. D—rarely audible. These ratings are for locations in the central USA. European and African stations are in general, more reliably received in eastern North America. Asian and Pacific stations are more reliably received in western North America. North American stations are received well except in areas too close to the transmitter site.
3. The information in this listing is correct to press time. However, frequencies and schedules are constantly changing. Listen to "DX Digest" at 1807, 1920 to Europe, Sunday, 0120, 0320, on Monday and 1915 Wednesday to Africa on R. Canada International for late changes.
4. R.—Radio; V.—Voice

Computer Bits

By Leslie Solomon
Technical Director

TWO NEW GRAPHIC SYSTEMS

THIS MONTH, our focus is on a couple of fascinating graphic systems. One is a computer plug-in that uses an external tablet and pen. The other is a very low-cost true light pen that works in conjunction with the CRT screen just like the big guys.

The computer plug-in system is the Talos Digitizer Interface ($449) from Talos Systems, Inc. (7419 East Helm Drive, Scottsdale, AZ 85260; Tel: 602–948-6540). The version we tested was for the Apple-II microcomputer. Other versions, including those for the IMSAI and Radio Shack TRS-80, are planned. There is also an RS-232 version available.

The interface comes with an Apple plug-in card, a 6′ (1.8-m) interconnecting ribbon cable, an 11″ (28-cm) square plastic "writing surface" tablet, and a built-in pen at the end of a soft flexible cable. Power is supplied by the Apple computer. All you do is plug the board into an I/O slot, riffle in a small (about 33 bytes) machine-language program and a short BASIC program—both are in the manual—and run. Using the integer BASIC residing in the Apple, up pops a low-resolution graphics program that demonstrates the usefulness of the Talos system.

The screen shows all black, with a "menu" display of seven different colors (in boxes) arranged across the bottom. You "dip" the pen into one of these colors, and proceed to "paint" on-screen. Colors as well as the background can be changed when desired. Erase is also provided. Drawing speed is 100 coordinate pairs (X and Y axis) per second, somewhat faster than a 9600-baud RS-232 port. Although the large block graphics appear crude, the system does show how to create graphics in the high-resolution mode of the Apple.

To take full advantage of the high-resolution graphics, you should have floating-point BASIC like Apple's "Applesoft-II." Unfortunately, the cassette version of this language needs 10K of RAM and since we have only 16K (almost an Apple "standard"), we elected to use an Applesoft-in-ROM board. This board plugs into an I/O slot, and the BASIC pops up when the usual control-B is operated. This option costs about $200, but when you consider that you still have 16K of RAM and the 10K floating-point BASIC at your fingertips, the cost balances out.

Since Applesoft (from Microsoft) is a version of a widely used BASIC, there is lots of software for it. Like other Apple manuals, the Applesoft manual is excellent. It completely explains the BASIC with many programming examples. It also does an excellent job of answering a big problem—how can a hardware-oriented computerist create the great high-resolution color graphics that programmers find so easy?

The manual completely explains how to create high-resolution color shapes, move them around, change their size, and even rotate them. There are programming examples to illustrate each step. If you want to see this BASIC you can buy the Applesoft-II manual for $6.95, a small investment for a good book on BASIC even if you don't have an Apple microcomputer.

Once we had the Applesoft running, we played the Talos Super-Graphics tape. This BASIC high-resolution (280 × 160 or 280 × 192) program resides in the 16K of RAM. Once running, it requires no further contact with the computer. There are seven programs available. The first displays the X–Y coordinates of the pen as it is moved around the tablet. It also indicates pen (on/off) status. The second program allows measuring the distance between any two points on the tablet, including irregular lines. The third program allows measuring the area of any irregular polygon, while the fourth program is a demonstration of music in which pen position on the tablet determines pitch and duration. The fifth program is the low-resolution color graphics previously described.

The fun starts with the sixth program—drawing on the screen in high resolution. In this mode, a small "crosshair" cursor indicates pen position. You can have a black screen with white drawing or a white screen with black drawings. You can have an automatic point-to-point feature (black or white) to make nice straight lines. In this high-resolution mode, handwriting looks almost normal. We traced newspaper and magazine photos and drawings with ease and excellent quality.

The seventh program is similar to the CALMA and CALCOMP drafting programs. There is a menu of AND and OR gates and an inverter symbol. Any symbols can be brought on screen, positioned, and rotated as desired. You can draw in the interconnects to draw a logic diagram, or use the automatic point-to-point mode at inputs and outputs to make clean interconnects.

Using the Applesoft and Talos manuals, we have written a couple of animated "shoot-em-up" programs and, for the first time, feel a good sense of graphic accomplishment. Take a look at the Talos Digitizer at your local computer store, if graphics is your interest.

Light Pen. The second graphics approach we tested uses a simple low-cost real light pen and some relatively simple software. Many of us have seen light pens in use, mostly in large mainframe systems in conjunction with marvelous graphics systems. This seemed to be one area where microcomputers were far behind.

The particular light pen we played with is the Vidiet-Stik from Esmark Inc. (507½ McKinley Hwy., Mishawaka, IN 46544), priced at $39.95 plus $1.50 postage and handling.

The pen itself is extremely simple. It consists of just a light-sensitive Darlington phototransistor, mounted near the tip of a slender plastic tube. The tip becomes active when its movable end piece is pressed against the CRT screen. The flexible cable coming from the pen has three color-coded leads: one for +5 volts, one for ground, and the third carries the signal. The first two leads are conventionally connected, while the third (signal) lead is connected to bit-8 of the computer parallel port.

The manual that comes with the Vidiet-Stik explains its operating software in detail. It also shows several approaches for the pen's use, including a program used both for testing and learning operation of the light pen. Some machine language (Z80/8080) programs are shown for creating the interface between the computer and light pen.

We modified the latter machine-language program for our computer and used it as a subroutine in BASIC programs. When "called," this subroutine Pokes the machine-language program into an out-of-the-way memory location (we used the spare RAM space in our VDM-1) so that it will not get written over by the BASIC.

When called, this subroutine "keeps an eye" on bit-8 of the parallel port, looking for some action of the light pen. When the light pen reacts to a light signal on the CRT screen, the machine-language program passes a bit into the computer. Once the signal is entered, the machine-language subroutine then passes back to the BASIC program, awaiting another call.

All you have to know is which bit of the parallel port is being used and the address of the parallel port. If your machine does not have a parallel port, one of the keyboard entry bits can be used.

With this machine-language program as a subroutine in BASIC, we have used it in conjunction with a graphics board that has much better resolution than the VDM-1. We've been having a ball trying out our artistic skill with this light pen.

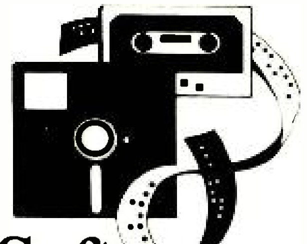
Studio II Conversion. Information package on how to construct a new cartridge for the RCA Studio II to convert it into a simple microcomputer is available. It includes schematics, ROM monitor listings, operating instructions, and program listings. No modifications to Studio II are required. Price is $5.00. A pc board and PROM are also available. ARESCO, P.O. Box 43, Audubon, PA 19407 (Tel: 215-631-9052 or 9257).

PET Floppy/S100. The EXS100 is a single S100 size board that connects to the PET memory expansion socket and provides a floppy-disk controller. The board can then be plugged into an S100 "motherboard" for further expansion. Up to three minifloppy-disk drives plug directly into the EXS100. The board uses the IBM3740 format. A special software package that permits loading and storing on disk is available. The board also has provisions for on-board EPROM. Three versions are available: S100 adapter alone ($199.95); disk controller alone ($299.95); and a combination of the two ($349.95). The board is also available as a complete disk package for $799.95. CGRS Microtech, P.O. Box 368, Southampton, PA 18966 (Tel: 215-757-0284).

SS-50 Control Interface. This 6800 computer interface plugs into the SS-50 (SWTP) bus and has 16 DIP switches for address selection. Fully buffered, the board has eight relays (28 volts at 0.1 ampere). It also features eight optoisolators for real world/computer communication. It can be used to input keyboard data or a response from the device it is controlling. The optoisolators can be software and the relays manually disabled to allow the outputs to form a parallel interface. The board can be controlled by assembly language or BASIC Peek and Poke instructions. Priced at $98 (kit) or $125 (assembled), the board is available from Transition Enterprises Inc., Star Route Box 241, Buckeye, AZ 85326.

Heath Printer. The WH-14 Line printer ($895) prints standard 96-character ASCII (upper and lower case) using a 5 × 7 dot matrix print head with a maximum instantaneous print speed of 135 characters per second. Line spacing is 6 lines per inch (8 lines per inch software selectable) with selectable line length of 80, 96, or 132 characters. Baud rate is selectable between 110 and 9600. The device uses 0.5" nylon inked ribbon on 2" spools. Adjustable-width sprocket feed allows paper from 2.5" to 9.5" width. The WH-14 uses an RS-232C or 20-mA current-loop serial interface. A kit version will soon be available. Heath Co., Benton Harbor, MI 49022.

S1001/S50 Bus. If you have an S100 bus system and would like to use S50 SWTP peripherals, or vice versa, AUM-ideas (P.O. Box 2582. Richardson, TX 75080) is manufacturing its Dual Bus Board ($29.85, for the bare board) that allows this combination. The Wire-Wrap board comes with layout sheets, instructions, four matching heat sinks, and two yards of #18 wire. The board is fully compatible with the S50 bus. An S50 extender board, with 22 slots is also available for $49.95. ◇



Software Sources

By Leslie Solomon
Technical Director

Tiny-c for 8080 Alpha-Micro and PDP-11. Tiny-c is a shortened version of the structured programming language "c". It handles integer, character and pointer data, one-dimensional arrays, and allows unlimited variable name lengths. IF-ELSE, WHILE, BREAK, RETURN and compound assignment statements are allowed, as are multiple assignments and recursive, returned-value and argument function calls. The interpreter, about 5K bytes, includes facilities to input and output characters, read, write, open and close files, and load programs, and includes a 14-function library. There is also a 4K program preparation system, written in tiny-c, with write, edit, run, debug, store, read and link capabilities, error diagnostics, and 25 standard library functions. Manuals are $40. Tarbell cassettes and PDP-11 disks are $20 each, Poly-88 cassettes are $25, CUTS cassettes are $30, CP/M and Helios disks are $35, and Alpha Micro disks are $55. Tiny-c associates, Post Office Box 269, Holmdel, NJ 07733.

TRS-80 Fortran/Utility Package. Written by Microsoft, this package can be used by a TRS-80 with 32K of RAM, one or more disk drives, and TRSDOS. It features a true relocatable machine code compiler for ANSI Fortran X3.9, and accepts complex variables. It also contains a disk-based macroassembler using Zilog mnemonics and producing relocatable code; a subroutine library existing as relocatable linkable modules for Fortran or an assembler program (e.g., double precision, square root, natural log, transcendentals, etc.); a linking loader to link-edit and load Fortran and assembler modules for execution; and a disk text editor to create and modify Fortran and assembler programs as disk files. In addition, it can be used as a general-purpose text editor. Diskette and documentation, $325. Lifeboat Associates, 164 W. 83rd St, New York, NY 10024 (Tel:212-580-0082).

Text Editor. EDIT-80, a random-access, line-oriented text editor for 8080 and Z80 systems is now available for $120. Allowing random line access to floppy disk files, it provides access to any record of the file even if the available memory space is considerably smaller than the file being edited. In addition to standard line commands, it features automatic line renumbering, global find and substitute, multiple page files and ability to read files without EDIT-80 line numbers. It also provides for intraline subcommands to edit portions of individual lines. Also included is a file compare utility that compares source or binary files and outputs differences between them. Microsoft, 10800 NE Eighth, Suite 819, Bellevue, WA 98004 (Tel: 206-455-8080).

Apple II Assembler/Editor. This 6K machine language program allows entering and editing assembly language programs using standard 6502 mnemonics. Source text, object code, and symbol table may be located anywhere in memory space. The program is provided on Apple II cassette with full documentation. Price is $29.95. ARESCO, P.O. Box 43, Audubon, PA 19407.

Computer Teacher. The Mind-Memory Improvement (Course steps 1 and 2) are designed for the TRS-80 Level 1 and Level 2 machines. Each cassette contains a number of programs that form a memory training aid for remembering and listening. Emphasis is placed on remembering peoples names and faces. A training manual is provided. Suggested retail price for Mind-Step 1 is $24.95, and Mind-Step 2 is $29.95. Both are $49.95. TYC Software, 25 Cedar Cliff Dr., Camp Hill, PA 17011. (Tel: 717-763-0405).

PROJECT OF THE MONTH

BY FORREST M. MIMS

BINARY HI-LO GAME

IT'S EASY to learn all sixteen 4-bit binary numbers (0000–1111), but can you *think* in binary? The growing popularity and importance of programmable logic makes the ability to "think binary" very helpful to those who wish to exploit as fully as possible the various tricks and shortcuts made possible by binary number manipulations.

The circuit described here provides a painless way to help learn to "think binary." It's a HI-LO game that uses binary instead of decimal numbers. For consistently good scores, you must know and be able to manipulate binary nibbles.

The game is designed around a 7485 4-bit magnitude comparator. Referring to the schematic diagram, you can see the operation of the circuit is very similar to that of the BCD trainer described in this month's Experimenter's Corner.

In operation, the 555 generates a rapid stream of clock pulses at a rate determined by the values of *R1* and *C1*. When normally open pushbutton *S1* is pressed for a few seconds, the 74193 4-bit counter cycles through its count sequence hundreds of times. This means an essentially random number will be stored in the counter when *S1* is released.

After *S1* is released, one of the output LEDs will glow to indicate whether the 4-bit nibble entered on the DIP switch is the same as the nibble in the 74193 or, more likely, if it is too high or too low. If the entry is incorrect, and the odds are 16 to 1 *against* the first entry being correct, a second guess is entered into the DIP switch. This process is continued until the CORRECT LED glows.

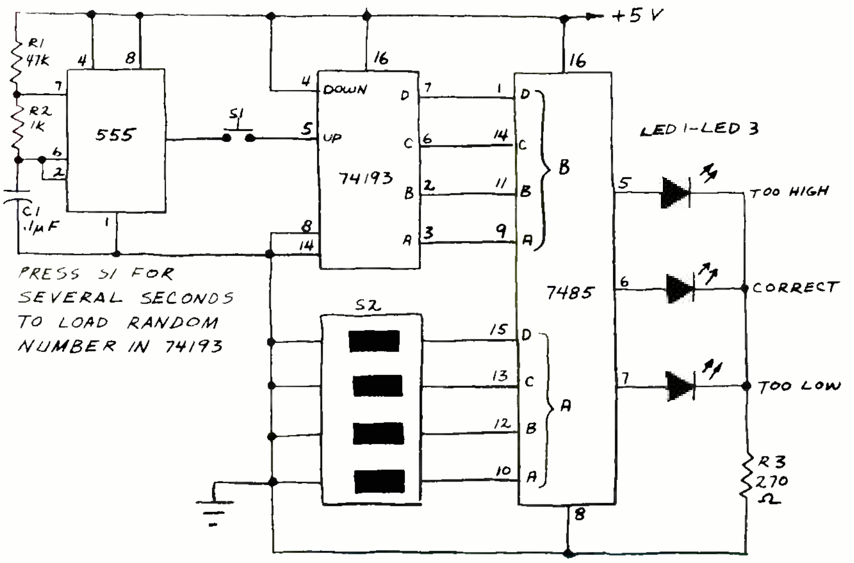
The best way to find the correct number with the fewest possible guesses is to make your first entry equal to approximately half the highest possible number. Since there are sixteen possible numbers, your first guess would then be 0111 (seven) or 1000 (eight).

If this guess is too low, then your second guess should be halfway between your first try and 1111. Similarly, if your first guess is too high, your second try should be halfway between your first guess and 0000.

This process is continued until you arrive at the correct number. As you can readily see, the game certainly encourages you to "think binary."

It's easy to make a permanent version of this game on a small circuit board. Use a perforated board with copper solder pads at each hole and connect the components with wrapping wire for fast assembly. Apply wrapping wire directly to the IC and DIP switch pins and use a low-wattage soldering iron and small-diameter solder to secure the wires in place. Power the circuit with four AA cells in a plastic holder. A 1N914 silicon diode connected between the positive battery terminal and the rest of the circuit will drop the voltage down to about 5½ V, the level required by TTL.

If you want more of a challenge, you can expand the basic 4-bit (16-guess) game to an 8-bit (128-guess) version. Just add another 74193 and 7485 and use an 8-position DIP switch. The expanded game is very easy to design. Just remember to feed the carry output (pin 12) of the first 74193 to the count-up input (pin 5) of the second 74193. You can find out how to cascade two 7485's by referring to this month's Experimenter's Corner. ◇



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SN7404N	18	SN7475N	49	SN74164N	89
SN7405N	20	SN7476N	35	SN74165N	89
SN7406N	29	SN7479N	5 00	SN74166N	1 25
SN7407N	29	SN7480N	50	SN74167N	1 95
SN7408N	20	SN7482N	99	SN74170N	1 59
SN7409N	20	SN7483N	59	SN74172N	6 00
SN7410N	18	SN7485N	79	SN74173N	1 25
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SN7412N	25	SN7489N	1 75	SN74175N	79
SN7413N	40	SN7490N	45	SN74176N	79
SN7414N	70	SN7491N	59	SN74177N	79
SN7416N	25	SN7492N	43	SN74179N	1 95
SN7417N	25	SN7493N	43	SN74180N	79
SN7420N	20	SN7494N	65	SN74181N	1 95
SN7421N	29	SN7495N	65	SN74182N	79
SN7422N	39	SN7496N	65	SN74184N	1 95
SN7423N	25	SN7497N	3 00	SN74185N	1 95
SN7425N	29	SN74100N	89	SN74186N	9 95
SN7426N	29	SN74107N	35	SN74188N	3 95
SN7427N	25	SN74109N	59	SN74190N	1 25
SN7429N	39	SN74116N	1 95	SN74191N	1 25
SN7430N	20	SN74121N	35	SN74192N	79
SN7432N	25	SN74122N	39	SN74193N	79
SN7437N	25	SN74123N	49	SN74194N	89
SN7438N	25	SN74125N	49	SN74195N	69
SN7439N	25	SN74126N	49	SN74196N	89
SN7440N	20	SN74132N	75	SN74197N	89
SN7441N	89	SN74136N	75	SN74198N	1 49
SN7442N	49	SN74141N	79	SN74199N	1 49
SN7443N	75	SN74142N	2 95	SN74S200	4 95
SN7444N	75	SN74143N	2 95	SN74251N	1 79
SN7445N	75	SN74144N	2 95	SN74279N	79
SN7446N	69	SN74145N	79	SN74283N	2 25
SN7447N	59	SN74147N	1 95	SN74284N	3 95
SN7448N	79	SN74148N	1 29	SN74285N	3 95
SN7450N	20	SN74150N	89	SN74365N	69
SN7451N	20	SN74151N	59	SN74366N	69
SN7453N	20	SN74152N	59	SN74367N	69
SN7454N	20	SN74153N	59	SN74368N	69
SN7459A	25	SN74154N	99	SN74390N	1 95
SN7460N	20	SN74155N	79	SN74393N	1 95
		SN74156N	79		
		SN74157N	65		

C/MOS

CD4000	23	CD4028	89	CD4070	55
CD4001	23	CD4029	1 19	CD4071	23
CD4002	23	CD4030	49	CD4072	49
CD4006	1 19	CD4035	99	CD4076	1 39
CD4007	25	CD4040	1 19	CD4081	23
CD4009	49	CD4041	1 25	CD4082	23
CD4010	49	CD4042	99	CD4093	99
CD4011	23	CD4043	89	CD4098	2 19
CD4012	25	CD4044	89	MC14409	14 95
CD4013	39	CD4046	1 79	MC14410	14 95
CD4014	1 39	CD4047	2 50	MC14411	14 95
CD4015	1 19	CD4048	1 35	MC14419	4 95
CD4016	49	CD4049	49	MC14433	19 95
CD4017	1 19	CD4050	49	MC14506	75
CD4018	99	CD4051	1 19	MC14507	99
CD4019	49	CD4053	1 19	MC14562	14 50
CD4020	1 19	CD4056	2 95	MC14583	3 50
CD4021	1 39	CD4059	9 95	CD4508	3 95
CD4022	1 19	CD4060	1 49	CD4510	1 39
CD4023	23	CD4066	79	CD4511	1 29
CD4024	79	CD4068	39	CD4515	2 95
CD4025	23	CD4069	45	CD4518	1 29
CD4026	2 25			CD4520	1 29
CD4027	69			CD4566	2 25

74C00

74C00	39	74C85	2 49	74C163	2 49
74C02	39	74C90	1 95	74C164	2 49
74C04	39	74C93	1 95	74C173	2 60
74C08	49	74C95	1 95	74C192	2 49
74C10	39	74C107	1 25	74C193	2 49
74C14	1 95	74C151	2 90	74C195	2 49
74C20	39	74C154	3 00	74C922	5 95
74C30	39	74C157	2 15	74C923	6 25
74C42	1 95	74C160	2 49	74C925	8 95
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LM302H	75	LM340T-8	1 25	LM739N	1 19
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LM307CN/H	35	LM340T 18	1 25	LM747N/H	79
LM308CN/H	1 00	LM340T-24	1 25	LM748N/H	39
LM309H	1 10	LM358N	1 00	LM1310N	2 95
LM309K	1 25	LM370N	1 95	LM1458CN/H	59
LM310CN	1 15	LM373N	3 25	MC1488N	1 39
LM311N/H	90	LM377N	4 00	MC1489N	1 39
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LM317K	6 50	LM380CN	99	LM1556V	1 75
LM318CN H	1 50	LM381N	1 79	MC1741SCP	3 00
LM319N	1 30	LM382N	1 79	LM2111N	1 95
LM320K 5	1 35	NE501N	8 00	LM2901N	2 95
LM320K-5 2	1 35	NE510A	6 00	LM3053N	1 50
LM320K-12	1 35	NE529A	4 95	LM3065N	1 49
LM320K 15	1 35	NE531H/V	3 95	LM3900N(3401)	49
LM320K 18	1 35	NE536T	6 00	LM3905N	89
LM320K-24	1 35	NE540L	6 00	LM3909N	1 25
LM320T-5	1 25	NE544N	4 95	MC5558V	59
LM320T-5 2	1 25	NE550N	1 30	8038B	4 95
LM320T-8	1 25	NE555V	39	LM75450N	49
LM320T 12	1 25	NE556N	99	75451CN	39
LM320T-15	1 25	NE560B	5 00	75452CN	39
LM320T-18	1 25	NE561B	5 00	75453CN	39
LM320T-24	1 25	NE562B	5 00	75454CN	39
LM323K-5	5 95	NE565N/H	1 25	75491CN	79
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74LS03	29	74LS55	29	74LS155	89
74LS04	35	74LS73	45	74LS157	89
74LS05	35	74LS74	45	74LS160	1 15
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74LS15	35	74LS90	59	74LS190	1 15
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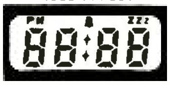

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XR1488	1 39	XR2212	4 35	XR4739	1 15
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1N751	5 1	400m	4/1 00	1N4005	600 PIV	1 AMP	10/1 00
1N752	5 6	400m	4/1 00	1N4006	800 PIV	1 AMP	10/1 00
1N753	6 2	400m	4/1 00	1N4007	1000 PIV	1 AMP	10/1 00
1N754	6 8	400m	4/1 00	1N3600	50	200m	6/1 00
1N757	9 0	400m	4/1 00	1N4148	75	10m	15/1 00
1N759	12 0	400m	4/1 00	1N4154	35	10m	12/1 00
1N959	8 2	400m	4/1 00	1N4305	75	25m	15/1 00
1N965	15	400m	4/1 00	1N4734	5 6	1w	28
1N5232	5 6	500m	28	1N4735	6 2	1w	28
1N5234	6 2	500m	28	1N4736	6 8	1w	28
1N5235	6 8	500m	28	1N4738	8 2	1w	28
1N5236	7 5	500m	28	1N4742	12	1w	28
1N5242	12	500m	28	1N4744	15	1w	28
1N5245	15	500m	28	1N1183	50 PIV	35 AMP	1 60
1N456	25	40m	6 1 00	1N1184	100 PIV	35 AMP	1 70
1N458	150	7m	6 1 00	1N1185	150 PIV	35 AMP	1 70
1N485A	180	10m	5/1 00	1N1186	200 PIV	35 AMP	1 80
1N4001	50 PIV	1 AMP	12/1 00	1N1188	400 PIV	35 AMP	3 00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1 95
C38M	35A @ 600V	SCR	1 95
2N2328	1 6A @ 300V	SCR	50
MDA 980-1	12A @ 50V	FW BRIDGE REC	1 95
MDA 980-3	12A @ 200V	FW BRIDGE REC	1 95

TRANSISTORS

C106B1	50			2N3904	4/1 00
MPSA05	30	2N3055	89	2N3905	4/1 00
MPSA06	5 1 00	MJE3055	1 00	2N3906	4/1 00
TIS97	6 1 00	2N3392	5/1 00	2N4013	3/1 00
TIS98	6 1 00	2N3398	5/1 00	2N4123	6/1 00
40409	1 75	PN3567	3/1 00	PN4249	4/1 00
40410	1 75	PN3568	4/1 00	PN4250	4/1 00
40673	1 75	PN3569	4/1 00	2N4400	4/1 00
2N918	4/1 00	MPS3638A	5 1 00	2N4401	4/1 00
2N2219A	2/1 00	MPS3702	5 1 00	2N4402	4/1 00
2N2221A	4/1 00	2N3704	5 1 00	2N4403	4/1 00
2N2222A	5/1 00	MPS3704	5/1 00	2N4409	5/1 00
PN2222 Plastic	7/1 00	2N3705	5/1 00	2N5086	4/1 00
2N2369	5/1 00	MPS3705	5 1 00	2N5087	4/1 00
2N2369A	4/1 00	2N3706	5/1 00	2N5088	4/1 00
MPS2369	5/1 00	MPS3706	5/1 00	2N5089	4/1 00
2N2484	4/1 00	2N3707	5/1 00	2N5129	5/1 00
2N2906	4/1 00	2N3711	5/1 00	PN5134	5/1 00
2N2907	5 1 00	2N3724A	65	PN5138	5/1 00
PN2907 Plastic	7/1 00	2N3725A	1 00	2N5139	5/1 00
2N2925	5/1 00	2N3772	2 25	2N5210	5/1 00
MJE2955	1 25	2N3823	1 00	2N5449	3/1 00
2N3053	2 1 00	2N3903	5/1 00	2N5951	3/1 00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100		1-9	10-99	100
10 pf	05	04	03	001µF	05	04	035
22 pf	05	04	03	0047µF	05	04	035
47 pf	05	04	03	01µF	05	04	035
100 pf	05	04	03	022µF	06	05	04
220 pf	05	04	03	047µF	06	05	04
470 pf	05	04	035	1µF	12	09	075

100 VOLT MYLAR FILM CAPACITORS

	1-9	10-99	100		1-9	10-99	100
001mf	12	10	07	022mf	13	11	08
0022	12	10	07	047mf	21	17	13
0047mf	12	10	07	1mf	27	23	17
01mf	12	10	07	22mf	33	27	22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

	1-9	10-99	100		1-9	10-99	100
1/35V	28	23	17	1 5/35V	30	26	21
15/35V	28	23	17	2 2/25V	31	27	22
22/35V	28	23	17	3 3/25V	31	27	22
33/35V	28	23	17	4 7/25V	32	28	23
47/35V	28	23	17	6 8/25V	36	31	25
68/35V	28	23	17	10/25V	40	35	29
1 0/35V	28	23	17	15/25V	63	50	40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead	1-9	10-99	100	Radial Lead	1-9	10-99	100
47/50V	15	13	10	47/25V	15	13	10
1 0/50V	16	14	11	47 50V	16	14	11
3 3/50V	14	12	09	1 0/16V	15	13	10
4 7/25V	15	13	10	1 0/25V	16	14	11
10/25V	15	13	10	1 0/50V	16	14	11
10/50V	16	14	12	4 7/16V	15	13	10
22/25V	17	15	12	4 7/25V	15	13	10
22/50V	24	20	18	4 7/50V	16	14	11
47 25V	19	17	15	10/16V	14	12	09
47 50V	25	21	19	10/25V	15	13	10
100 25V	24	20	18	10/50V	16	14	12
100 50V	35	30	28	47/50V	24	21	19
220/25V	32	28	25	100/16V	19	15	14
220/50V	45	41	38	100/25V	24	20	18
470/25V	33	29	27	100/50V	35	30	28
1000/16V	55	50	45	220/16V	23	17	16
2200/16V	70	62	55	470/25V	31	28	26

Transistor Checker

— Completely Assembled —
— Battery Operated —

The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the 3 alligator clip test leads provided. The unit safely and automatically identifies low, medium and high power PNP and NPN transistors. Size 3¼" x 6¼" x 2". "C" cell battery not included.

NEW

Trans-Check $29.95 ea.

Custom Cables & Jumpers

NEW NEW

DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 Ft	2-DP25P	$15.95 ea
DB25P-4-S	4 Ft	1-DP25P 1-25S	$16.95 ea
DB25S-4-S	4 Ft	2-DP25S	$17.95 ea

Dip Jumpers

DJ14-1	1 ft	1-14 Pin	$1.59 ea
DJ16-1	1 ft	1-16 Pin	1.79 ea
DJ24-1	1 ft	1-24 Pin	2.79 ea
DJ14-1-14	1 ft	2-14 Pin	2.79 ea
DJ16-1-16	1 ft	2-16 Pin	3.19 ea
DJ24-1-24	1 ft	2-24 Pin	4.95 ea

For Custom Cables & Jumpers, See JAMECO 1979 Catalog for Pricing

CONNECTORS

25 Pin-D Subminiature

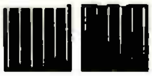
DB25P (as pictured)	PLUG (Meets RS232)	$2.95
DB25S	SOCKET (Meets RS232)	$3.50
DB51226-1	Cable Cover for DB25P or DB25S	$1.75

PRINTED CIRCUIT EDGE-CARD

156 Spacing-Tin Double Read-Out — Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)	$1.95
18/36	PINS (Solder Eyelet)	$2.49
22/44	PINS (Solder Eyelet)	$2.95
50/100 (.100 Spacing)	PINS (Wire Wrap)	$6.95
50/100 (.125 Spacing)	PINS (Wire Wrap) R681-1	$6.95

Solar Cells 2x2cm



- 0.4 volts
- 100mA
- 41 MW

Can be added in series for higher voltage or parallel for higher current.

#SC 2x2 $1.95 ea. or 3/$5.00

the 3rd Hand

MAKES CIRCUIT ASSEMBLY A BREEZE!

Lets you work with both hands. Sturdy Aluminum Construction. **$9.95 ea.**

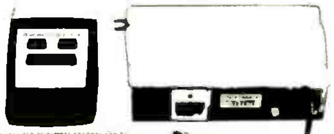
- Clamp "3rd Hand" on edge of bench, table or workboard. Insert circuit board, position components.
- Flip circuit board to flat position for soldering and clipping.

- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701

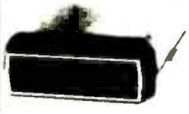
6-Digit Clock Kit **$19.95**

REMOTE CONTROL TRANSMITTER & RECEIVER



$19.95

INSTRUMENT/CLOCK CASE



This case is an injection molded unit that is ideal for uses such as DVM, COUNTER, or CLOCK cases. It has dimensions of 4½" in length by 4" in width by 1-9/16" in height. It comes complete with a red bezel.

PART NO: IN-CC $3.49 each

MICROPROCESSOR COMPONENTS

8080A 8080A SUPPORT DEVICES		
8080A	CPU	$9.95
8212	8-Bit Input Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator Driver	3.95
8226	Bus Driver	3.49
8228	System Controller Bus Driver	5.95
8238	System Controller	5.95
8251	Prog. Comm. I/O (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. I/O (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95
6800 6800 SUPPORT DEVICES		
MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810AP1	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024x8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25
MICROPROCESSOR CHIPS—MISCELLANEOUS		
Z80(780C)	CPU	$19.95
Z80A(780-1)	CPU	24.95
CDP1802	CPU	19.95
2650	MPU	[illegible]
8035	8-Bit MPU w/clock, RAM, I/O lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95
SHIFT REGISTERS		
MM500H	Dual 25 Bit Dynamic	$.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
2533	1024 Static	2.95
3341	Fifo	6.95
74LS670	4x4 Register File (TriState)	2.49
UART'S		
AY-5-1013	30K BAUD	5.95

MICROPROCESSOR MANUALS			
M-Z80	User Manual		$7.50
M-CDP1802	User Manual		7.50
M-2650	User Manual		5.00
ROM'S			
2513(2140)	Character Generator(upper case)		$9.95
2513(3021)	Character Generator(lower case)		9.95
2516	Character Generator		10.95
MM5230N	2048-Bit Read Only Memory		1.95
RAM'S			
1101	256x1	Static	$1.49
1103	1024x1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024x1	Static	1.75
21L02	1024x1	Static	1.95
2111(8111)	256x4	Static	3.95
2112	256x4	Static MOS	4.95
2114	1024x4	Static 450ns	9.95
2114L	1024x4	Static 450ns low power	10.95
2114-3	1024x4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256x4	Static	7.95
5280/2107	4096x1	Dynamic	4.95
7489	16x4	Static	1.75
74S200	256x1	Static Tristate	4.95
93421	256x1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin	14.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024x4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	1.00
PROM'S			
1702A	2048	FAMOS	$5.95
TMS2516 (2716)	16K*	EPROM(Intel 2716)	49.95
	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I.	16K**	EPROM	29.95
	**Requires 3 voltages: −5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32x8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

CSC CONTINENTAL SPECIALTIES PROTO BOARDS

Proto Board 203

PB 203 **$75.00**

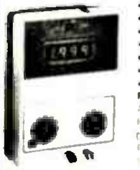
Proto Board 203A

PB 203A **$124.95**

Model Number	L x W x H (Inches)	Price
PB-6	6.0 x 4.5 x 1.4	$15.95
PB-100	6.0 x 4.5 x 1.4	$19.95
PB-101	6.0 x 4.5 x 1.4	$22.95

Model Number	L x W x H (Inches)	Price
PB-102	7.0 x 4.5 x 1.4	$26.95
PB-103	9.0 x 6.0 x 1.4	$44.95
PB-104	9.8 x 8.0 x 1.4	$54.95

B&K PRECISION 3½-Digit Portable DMM



- Battery or AC operation
- Auto Zeroing

Ranges: DC Voltage 0-1000V
AC Voltage ... 1000V
Freq. Response ... 400 Hz
DC/AC Current 0-100mA
Resistance ... 10 meg ohm

Model 2800 **$99.95**

Accessories:

AC Adapter BC-28	$9.00
Rechargeable Batteries BP-26	20.00
Carrying Case LC-28	7.50

CSC 100 MHz 8-Digit Counter

- 20 Hz 100 MHz Range
- 6 LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1.75 x 7.38 x 5.63
- four power sources: i.e. batteries, 110 or 220V with charger, 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 **$134.95**

ACCESSORIES FOR MAX 100:

Mobile Charger Eliminator — use power from car battery — Model 100 — CLA $3.95

Charger/Eliminator — use 110 V AC — Model 100 — CA1 $9.95

REGULATED POWER SUPPLY NEW

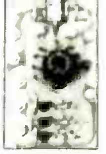
JE200 5V-1 AMP POWER SUPPLY

- Uses LM309K
- Heat sink provided
- PC Board construction
- Provides a solid 1 amp @ 5 volts
- Can supply up to ±5V, ±9V and ±12V with JE205 Adapter
- Includes components, hardware & instructions
- Size: 3½"x5"x2"H

JE200 $14.95

JE205 ADAPTER BOARD

— Adapts to JE200 —
±5V, ±9V and ±12V



- DC/DC converter w/ +5V input
- Toriodal hi-speed switching XMFR
- Short circ. protection
- PC Brd. construction
- Piggy-back to JE200 board
- Size: 3½"x2"x9/16"h

JE205 $12.95

$10.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets — 25¢
1979 Catalog Available—Send 41¢ stamp

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Jameco ELECTRONICS

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1021 HOWARD AVENUE, SAN CARLOS, CA 94070
ADVERTISED PRICES GOOD THRU JUNE

The Incredible "Pennywhistle 103"

$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable)
Maximum Data Rate	300 Baud
Data Format	Asynchronous Serial (return to mark level required between each character)
Receive Channel Frequencies	2025 Hz for space, 2225 Hz for mark
Transmit Channel Frequencies	Switch selectable: Low (normal) 1070 space, 1270 mark. High 2025 space, 2225 mark
Receive Sensitivity	−46 dbm acoustically coupled
Transmit Level	−15 dbm nominal. Adjustable from −6 dbm to −20 dbm
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is opto isolated and non-polar)
Power Requirements	120 VAC, single phase, 10 Watts
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

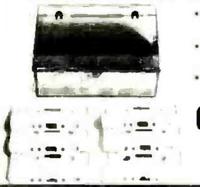
TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:

- 8 each UPD416-1 (16K Dynamic Rams) 250NS
- Documentation for conversion

TRS-16K $99.95

COMPUTER CASSETTES

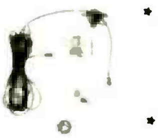


- 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
- PLASTIC CASE INCLUDED 12 CASSETTE CAPACITY
- ADDITIONAL CASSETTES AVAILABLE #C-15-$2.50 ea

CAS-6 $14.95
(Case and 6 Cassettes)

SUP 'R' MOD II

UHF Channel 33 TV Interface Unit Kit



Wide Band B/W or Color System

- Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SOL-20, TRS-80, Challenger, etc.

MOD II is pretuned to Channel 33 (UHF)

- Includes coaxial cable and antenna transformer

MOD II $29.95 Kit

ELLIT WRAP

Model P180 includes 2-100' spools #28 AWG wire wrap wire

Supplies insulated wire from spool to wrap-posts without prestripping and precutting using "daisy chain" method

Model P180 Tool $24.50

P180A Replacement Bit	$12.95
W28-2 Replacement wire (3 spool pkg.)	$2.75 ea.

Specify color: A-green B-red C-clear D-Blue

IDEAL FOR TRS 80 — CASSETTE CONTROLLER

Plug/Jack interface to any computer system requiring remote control of cassette functions.

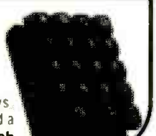
The CC100 controls cassette motor functions, monitors tape location with its internal speaker and requires no power. Eliminates the plugging and unplugging of cables during computer loading operation from cassette.

#CC-100 $29.50

63-Key Unencoded Keyboard

This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most application. IN STOCK **$29.95/each**

Hexadecimal Unencoded Keypad



19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key **$10.95/each**

ELECTRONICS Market Place

Active Electronic Sales Corp.

ELECTRONICS Market Place

Features..........

BRAND NEW!
1979 IC MASTER
2500 pages

Complete integrated circuit data selector. Master guide to the latest I.C.'s including microprocessors and consumer circuits.

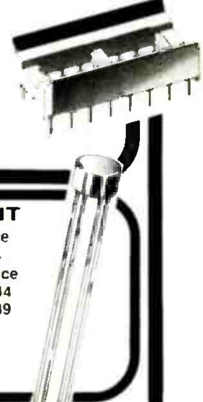
Free Quarterly Updates **$39.95**

Texas Instruments Low Profile Sockets

Finest Quality Socket available in the world. Nobody can match Texas Instruments quality — a unique combination of I.C. technology and multi-metal expertise.

Over one million pieces in stock.

Contacts	Price	Contacts	Price
8 PIN	.08	22 PIN	.22
14 PIN	.12	24 PIN	.24
16 PIN	.14	28 PIN	.28
18 PIN	.18	40 PIN	.40
20 PIN	.20		



GENERAL INSTRUMENT

1 Amp Rectifiers (Epoxy)

Part No.		Price
1N4001	50V	.029
1N4002	100V	.039
1N4002	200V	.045
1N4004	400V	.049
1N4005	600V	.055
1N4006	800V	.065
1N4007	1000V	.07

1.5 Amp Single Phase
Silicon Bridge Rectifiers

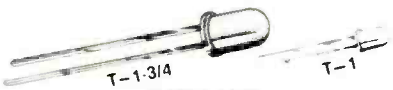
Part No.		Price
W06M	600V	.34
W08M	800V	.39

CMOS I.C.'S

CD4000BE	17	CD4023BE	17	CD4052BE	54	CD4516BE	69
CD4001BE	17	CD4024BE	49	CD4053BE	54	CD4518BE	79
CD4002BE	17	CD4025BE	17	CD4066BE	44	CD4520BE	69
CD4007BE	17	CD4026BE	$1 39	CD4068BE	21	CD4522BE	99
CD4008BE	75	CD4027BE	39	CD4070BE	29	CD4526BE	99
CD4009BE	39	CD4028BE	57	CD4071BE	21	CD4527BE	$1 09
CD4010BE	39	CD4029BE	74	CD4072BE	21	CD4531BE	74
CD4011BE	17	CD4030BE	35	CD4073BE	21	CD4532BE	$1 19
CD4012BE	17	CD4033BE	$1 45	CD4075BE	21	CD4539BE	99
CD4013BE	32	CD4034BE	$2 25	CD4077BE	25	CD4555BE	65
CD4014BE	73	CD4035BE	64	CD4078BE	21	CD4556BE	65
CD4015BE	69	CD4040BE	74	CD4082BE	21	CD4581BE	$2 25
CD4016BE	35	CD4041BE	74	CD4104BE	$2 25	CD4582BE	79
CD4017BE	62	CD4042BE	59	CD4508BE	$2 25	40160PC	89
CD4018BE	69	CD4043BE	57	CD4510BE	88	40161PC	99
CD4019BE	39	CD4044BE	55	CD4511BE	99	40174PC	89
CD4020BE	69	CD4049BE	33	CD4512BE	59	40175PC	89
CD4021BE	69	CD4050BE	33	CD4514BE	$1 95	40192PC	$1 19
CD4022BE	69	CD4051BE	54	CD4515BE	$1 95	40193PC	$1 19

L.E.D. LAMPS

LED209	T-1 3mm Red	.09
LED211	T-1 3mm Green	.14
LED212	T-1 3mm Yellow	.13
LED220	T-1-3/4 5mm Red	.11
LED222	T-1-3/4 5mm Green	.15
LED224	T-1-3/4 5mm Yellow	.14



DISPLAYS

FND357	.375"	Common Cathode	~~$1.45~~	$1.09
FND500	.500"	Common Cathode	~~$1.80~~	$1.09
FND507	.500"	Common Anode	~~$1.80~~	$1.09
FND567	.500"	Common Anode	~~$1.40~~	$1 29
DL747	.630"	Common Anode	~~$2.75~~	$2 49
DL704	.300"	Common Cathode	~~$1.50~~	$1 29
DL707	.300"	Common Anode	~~$1.50~~	$1 29

ISOLATORS

TIL112	Opto Isolator 1500V	~~$0.68~~	$0.49
MCT6	Dual Opto Isolator 1500V	~~$1.30~~	$1 29

MICROPROCESSOR CHIPS

CPU's

Part No.	Price
8080A	5.50
6800	7.95

INTERFACE SUPPORT CIRCUITS

Part No.	Price	Part No.	Price
8212	1.98	8255	4.95
8214	3.95	8257	10.95
8216	1.98	8259	14.95
8224	2.75		
8226	1.98	6810	3.95
8228	3.98 ~~4.75~~	6820	3.95
8238	3.98 ~~4.75~~	6821	3.95
8251	5.50	6850	4.95
8253	14.95	6852	4.95

Zilog

Z80-CPU	$13 60
Z80A-CPU	$16 20
Z80-PIO	$10 90
Z80A-PIO	$13 10
Z80-CTC	$10 90
Z80A-CTC	$13 10
Z80-DMA	$32.20
Z80-SIO/0	$45.00
Z80A-SIO/0	$50.00
Z80-SIO/1	$45 00
Z80A-SIO/1	$50 00
Z80-SIO 2	$45.00
Z80A-SIO 2	$50.00

LINEAR I.C.'S

LM324N	.49	Quad Op Amp
LM339N	.49	Quad Comparator
LM555N-8	.29	Timer
LM556N-14	.59	Dual Timer
LM723CN	.34	Voltage Regulator
LM723CH	.39	Voltage Regulator
LM741CH	.37	Op Amp
LM741CN-8	.24	Op Amp
LM1458N-8	.39	Dual Op Amp

MICROCOMPUTER BOARDS

SYM-1 MICROCOMPUTER BOARD

- Hardware compatibility with KIM-1
- Standard interfaces include audio cassette with remote control both 8 bytes second (KIM) and 185 bytes second (SYM-1) cassette formats TTY and RS232 system expansion bus TV KB expansion board interface four I O buffers and an oscilloscope single-line display
- Single+5V power requirements

SYM-1 $329.00

NEC MICROCOMPUTER TK-80A

- The TK-80A is a complete microcomputer on a board, based on the industry standard 8080A The board has both 1K RAM and 1K Electrically Erasable PROM expandable to 4K x 8 and 8K x 8, respectively on-board It also features 300 or 1200 baud cassette interface the Kansas City type and three 8-Bit Programmable I O Ports (24 lines) Keypad with 25 real keys (not a glorified calculator keypad) and 8 big bright digits for display are also included

TK-80A $299.00

EPROM'S

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1702A-6 ~~$6.95~~ $4.45
256 x 8 1.5 uS

2708 $9.95
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MOS Static RAM's

Part No.	Price
2101 (1K 22 PIN)	$2.45
2102LFPC (1K 350NS (Low Power))	~~$1.19~~ $1.14
2102-1PC (1K 450NS)	~~$.99~~ 0.94
2114 (4K (1K x 4) 300NS)	~~$7.50~~ $6.99
2114 (4K (1K x 4) 450NS)	$6.50

MOS Dynamic RAM's

Part No.	Price
4K 4027 (4K (4K x 1) 300NS 16 PIN)	$2.95
16K 416-3 (16K (16K x 1) 200NS 16PIN)	$9.95
16K 416-5 (16K (16K x 1) 300NS 16PIN)	$7.95

UART's

Part No.	Price
AY5-1013A	~~$4.95~~ $4.50
AY3-1015	~~$5.95~~ $5.50

1K CMOS RAM

Part No.	Price
5101 (450NS (Low Power))	$4.95
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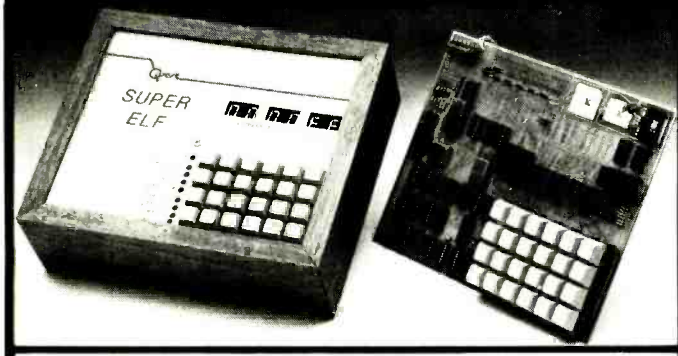

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INTEGRATED CIRCUITS

7400TTL

7400N	17
7402N	17
7404N	19
7409N	23
7410N	17
7411N	63
7420N	17
7422N	1 39
7430N	20
7442N	50
7445N	69
7447N	60
7448N	69
7450N	17
7474N	29
7475N	49
7485N	88
7489N	2 00
7490N	43
7492N	43
7493N	43
7495N	69
74100N	90
74107N	29
74121N	34
74123N	59
74125N	39
74145N	69
74150N	95
74151N	69
74154N	1 00
74157N	69
74161N	87
74162N	87
74163N	87
74174N	96
74175N	90
74190N	1 15
74192N	87
74193N	85
74221N	1 55
74298N	1 65
74365N	66
74366N	66
74367N	66

74LS00 TTL

74LS00N	25
74LS02N	25
74LS04N	25
74LS05N	25
74LS08N	25
74LS10N	25
74LS13N	40
74LS14N	90
74LS20N	25
74LS22N	25
74LS28N	41
74LS30N	25
74LS33N	39
74LS38N	30
74LS74N	70
74LS75N	47
74LS90N	51
74LS93N	51
74LS95N	1 89
74LS107N	35
74LS112N	35
74LS113N	35
74LS132N	72
74LS136N	35
74LS151N	67
74LS155N	67
74LS157N	67
74LS162N	91
74LS163N	91
74LS174N	95
74LS190N	1 06
74LS221N	1 95
74LS258N	67
74LS367N	1 35

LINEAR

CA3045	90
CA3046	67
CA3081	1 80
CA3082	1 90
CA3089	2 95
LM301AN AH	35
LM305H	87
LM307N	35
LM308N	89
LM309H	1 15
LM309K	1 50
LM311H N	90
LM317T K	2 92
LM318	1 35
LM320K-5	1 20
LM323K-5	6 95
LM320K-12	1 35
LM320K-15	1 35
LM320T-5	1 60
LM320T-8	1 60
LM320T-12	1 50
LM320T-15	1 60
LM324N	1 15
LM339N	1 55
LM340-5	1 35
LM340-8	1 35
LM340K-12	1 35
LM340K-15	1 35
LM340K-24	1 35
LM340T-5	1 25
LM340T-8	1 25
LM340T-12	1 25
LM340T-15	1 25
LM340T-18	1 25
LM340T-24	1 25
LM343H	4 50
LM350	7 50
LM370	1 15
LM377	3 00

LM379	5 00
LM380N	1 00
LM381	1 60
LM382	1 60
LM703H	40
LM709H	28
LM723H N	50
LM733N	67
LM741CH	35
LM741N	25
LM747H N	62
LM748N	35
LM1303N	82
LM1304	1 10
LM1305	1 27
LM1307	2 00
LM1310	2 75
LM1458	47
LM1800	1 75
LM1812	7 50
LM1889	3 00
LM2111	1 75
LM2902	1 50
LM3900N	60
LM3905	1 75
LM3909N	61
MC1458V	50
NE540L	2 89
NE550N	65
NE555V	43
NE556A	79
NE565A	1 00
NE566V	1 50
NE567V	1 20
NE570B	5 00
NE571B	5 00
78L05	60
78L08	60
79L05	70
78M05	85
75108	1 75
75491CN	50
75492CN	55
75494CN	89

A to D CONVERTER

8038B	4 50
8700CJ	13 95
8701CN	22 00
8750CJ	13 95
LD130	9 95
9400CJV/F	7 40
ICL7103	9 50
ICL7107	14 25

CMOS

CD34001 Fair	50
CD4000	16
CD4001	21
CD4002	21
CD4006	1 10
CD4007	21
CD4008	21
CD4009	39
CD4010	39
CD4011	21
CD4012	21
CD4013	36
CD4014	86
CD4015	86
CD4016	36
CD4017	94
CD4018	94
CD4019	21
CD4020	1 02
CD4021	1 02
CD4022	86
CD4023	21
CD4024	75
CD4025	21
CD4026	1 51
CD4027	36
CD4028	79
CD4029	1 02
CD4030	21
CD4035	1 02
CD4040	1 02
CD4042	71
CD4043	63
CD4044	63
CD4046	1 67
CD4049	36
CD4050	36
CD4051	1 13
CD4060	1 42
CD4066	71
CD4068	40
CD4069	40
CD4070	40
CD4071	21
CD4072	21
CD4073	21
CD4075	21
CD4076	1 75
CD4078	40
CD4081	21
CD4082	21
CD4116	47
CD4490	5 50
CD4507	1 00
CD4508	4.25
CD4510	1 02
CD4511	94
CD4515	2 52
CD4516	1 10
CD4518	1 02
CD4520	1 02
CD4527	1 51
CD4528	79
CD4553	3 50
CD4566	2 25
CD4583	4 50

CD4585	1 10
CD40192	3 00
74C00	28
74C04	33
74C10	28
74C14	2 10
74C20	28
74C30	28
74C48	1 95
74C74	75
74C76	1 40
74C90	1 15
74C93	1 40
74C154	3 00
74C160	1 44
74C175	1 35
74C192	1 65
74C221	2 00
74C905	3 00
74C906	75
74C914	1 95
74C922	5 50
74C923	5 50
74C925	6 95
74C926	6 95
74C927	6 95

INTERFACE

8095	65
8096	65
8097	65
8098	65
8T09	1 25
8T10	4 50
8T13	3 00
8T20	5 50
8T23	3 10
8T24	3 50
8T25	3 20
8T26	1 69
8T28	2 75
8T97	1 69
8T98	1 69

MOS/MEMORY RAM

2101 1	3 95
2102-1	95
2102AL-4	1 60
21L02 1	1 18
21F02	1 25
2104A-4	4 95
2107B	4 95
2111-1	3 75
2112-2	3 95
2114L-3	7 90
4116	10 95
2513B	6 30
MM5262	40
MM5280	3 00
MM5320	9 95
MM5330	5 94
PD411D-3	4 00
PD411D-4	5 00
P5101L	13 95
4200A	9 95
82S25	2 90
91L02A	1 50
HD0165-5	6 95
MM57100	4 50
GIA38500-1	9 95
MCM6571A	9 95
9368	3 50
410D	10 00
416	16 00

CLOCKS

MM5309	3 00
MM5311	3 60
MM5312	4 80
MM5313	3 60
MM5314	3 90
MM5315	4 00
MM5316	5 00
MM5318	3 60
MM5369	2 10
MM5841	14 45
MM5865	7 95
CT7001	5 80
CT7002	8 95
CT7010	8 95
CT7015	7 25
MM5375AA N	3 90
MM5375AB N	4 90
7205	16 50
7207	7 50
7208	15 95
7209	4 95
DS0026CN	3 75
DS0056CN	3 75
MM53104	2 50

MICROPROCESSOR

6800	17 50
6802	24 95
8080A with data	8 95
8085	27 00
780A	19 75
8212	2 90
8214	8 00
8216	2 90
8224	2 90
8228	5 35
8251	8 50
8253	10 00
8255	9 25
8257	19 50
8259	19 50
1802CP plas	13 95
1802DP plas	17 95
1861P	11 50
CDP1802CD	19 95

CDP1802D	25 00
CDP1861	12 95
6820	9 95
6850	12 95
6502	12 50

IC SOCKETS

Solder Tin Low Profile

PIN	1 UP	PIN	1UP
8	15	22	30
14	18	24	35
16	20	28	42
18	27	36	58
20	29	40	57

3 level wire wrap gold 14 pin 25
2 level 14 pin ww 20

WIRE WRAP LEVEL 3

PIN		PIN	
14	25	24	86
16	33	28	1 00
18	57	40	1 23

UART/FIFO

AY5-1013	5 50
AY5-1014	7 50
3341	6 95

PROM

1702A	3 95
N82S23	2 95
N82S123	3 50
N82S126	3 75
N82S129	3 75
N82S131	3 75
N82S136	8 75
N82S137	8 75
2708	10 50
DM8577	2 90
8223	2 90
2716TI	29 50
2716 Intel	48 00

CRYSTALS

1 MHz	4 50
2 MHz	4 50
4 MHz	4 25
5 MHz	4 25
10 MHz	4 25
18 MHz	3 90
20 MHz	3 90
32 MHz	3 90
32768 MHz	4 00
1 8432 MHz	4 50
3 5795 MHz	1 20
2 0100 MHz	1 95
2 097152 MHz	4 50
2 4576 MHz	4 50
3 2768 MHz	4 50
5 0688 MHz	4 50
5 185 MHz	4 50
5 7143 MHz	4 50
6 5536 MHz	4 50
14 31818 MHz	4 25
18 432 MHz	4 50
22 1184 MHz	4 50

CONNECTORS

44 pin edge	2 75
100 pin edge	4 50
100 pin edge WW	5 25

KEYBOARD ENCODERS

AY5-2376	$12 50
AY5-3600	13 50
74C922	5 50
74C923	5 50
HD0165-5	6 95

IC Test Clips

	1	10
Red	55	47
Black	55	47

Keyer 8043 14 50
comp w spec sock

TRANSISTORS

2N1893	40
2N2222A	18
2N2369	30
2N2904A	20
2N2907A	25
2N3053	40
2N3638	25
2N3643	25
2N3904	18
2N3906	18
2N3055	69
2N4400	25
2N4401	75
2N4402	20
TIP31	60
TIP33A	1 00

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25 Pin Subminiatures

DB25P	2 95
DB25S	3 95
Cover	1 50
RS232 Complete Set	6 50
DE9P	1 50
DE9S	1 95
DA15P	2 10
DA15S	3 10

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Jumbo Red	20
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Cliplite LED Mounting Clips	8/$1 25

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Extender Board w connector	12 50
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North Star Floppy Disk Kit	$665 00
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SPECIAL PRODUCTS

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Voice actuated switch	50
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Model 10 Trigger Expander Kit	$229 00
Model 150 Bus Grabber Kit	$369 00
Sinclair 3½ Digit Multimeter	$59 95
Clock Calendar Kit	$23.95

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12V CT 250 ma wall plug	3 50
24V CT 400 ma	3 95
10V 1 2 amp wall plug	4 85
12V 6 amp	12 95

DISPLAY LEDS

MAN1	CA	270	2 90
MAN3	CC	125	39
MAN72 74	CA CA	300	1 00
DL704	CC	300	1 25
DL707 DL707R	CA	300	1 00
DL727 728	CA CC	500	1 90
DL747 750	CA CC	600	1 95
DL750	CC	600	1 95
FND359	CC	357	70
FND500 507	CC CA	500	1 35
FND503 510	CC CA	500	90
FND800 807	CC CA	800	2 20
3 digit Bubble			60
4 digit bubble			80
DG8 Fluorescent			1 75
DG10 Fluorescent			1 75
5 digit 14 pin display			1 00
NSN69 9 digit display			60
7520 Clairex photocells			39
TIL311 Hex			9 50

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1600	mfd	200V	4 50
2000	mfd	45V	2 50
3200		50V	2 50
5500		25V	2 50
5800		40V	3 00
6100		40V	3 00
6100		50V	3 00
7700		50V	2 50
8000		55V	2 50
9400		65V	3 00
10000		20V	2 50
12000		30V	3 50
35000		25V	5 00
55000		25V	5 00
82000		15V	6 00
60000		10V	6 00

RCA Cosmac Super Elf Computer $106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many **big** things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded** with **additional memory, Tiny Basic, ASCII Keyboards, video character generation, etc.**

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest address and data bus displays before, during** and **after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on eight LED indicator lamps.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select** and **single step**. Large, on board displays provide output and optional **high** and **low address**. There is a 44 pin standard connector for PC cards and a 50 pin connector for the **Quest Super Expansion Board**. Power supply and sockets for **all** IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game.

Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and research and development.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95. NiCad Battery Memory Saver Kit $6.95.** All kits and options also come completely assembled and tested.

Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year.

Tiny Basic for ANY 1802 System

Cassette $10.00. On ROM $38.00. Super Elf owners, **30%** off. **Object code listing with manual $5.00. Object list, manual and paper tape $10.00. Original ELF Kit Board $14.95.**

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed**. EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatible cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up.

Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports with full handshake.** They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. A Godbout 8K RAM board is available for $135.00. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95. S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $12.50 for easy connection between the **Super Elf** and the **Super Expansion Board.**

The **Power Supply Kit** for the Super Expansion Board is a 5 amp supply with multiple positive and negative voltages $29.95. Add $4.00 for shipping. Prepunched frame $5.00. Case $10.00. Add $1.50 for shipping.

Auto Clock Kit $15.95

DC clock with 4-.50" displays. Uses National MA-1012 module with alarm option. Includes light dimmer, crystal timebase PC boards. Fully regulated, comp. instructs. Add $3.95 for beautiful dark gray case. Best value anywhere.

RCA Cosmac VIP Kit $229.00

Video computer with games and graphics. Fully assem. and test. **$249.00**

Not a Cheap Clock Kit $14.95

Includes everything except case. 2-PC boards. 6-.50" LED Displays. 5314 clock chip, transformer, all components and full instructions. Orange displays also avail. **Same kit w/.80" displays.** Red only. **$21.95** Case **$11.75**

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Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy. Kit includes: PC board, IC, crystal, resistors, capacitors and trimmer.

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Indoor and outdoor. Switches back and forth. Beautiful. .50" LED readouts. Nothing like it available. Needs no additional parts for complete, full operation. Will measure –100 to +200 F, tenths of a degree, air or liquid. Very accurate. **$39.95**
Beautiful woodgrain case w/bezel **$11.75**

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Opens shorted cells that won't hold a charge and then charges them up, all in one kit w/full parts and instructions. **$7.25**

PROM Eraser

Will erase 25 PROMs in 15 minutes. Ultraviolet, assembled **$34.50**

Rockwell AIM 65 Computer

6502 based single board with full ASCII keyboard and 20 column thermal printer. 20 char. alphanumeric display. ROM monitor, fully expandable. $375.00. 4K version $450.00. 4K Assembler $85.00, 8K Basic Interpreter $100.00. Power supply assembled in case $60.00.

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8v 5 amp, –18v .5 amp, 5v 1.5 amp, –5v .5 amp, 12v .5 amp, –12 option, ±5v, ±12v are regulated. Kit $29.95. Kit with punched frame $34.95. Woodgrain case $10.00.

Video Modulator Kit $8.95

Convert your TV set into a high quality monitor without affecting normal usage. Complete kit with full instructions.

2.5 MHz Frequency Counter Kit

Complete kit less case **$37.50**

30 MHz Frequency Counter Kit

Complete kit less case **$47.75**
Prescaler kit to 350 MHz **$19.95**

79 IC Update Master Manual $35.00

Complete IC data selector, 2500 pg. master reference guide. Over 50,000 cross references. Free update service through 1979. Domestic postage $3.50. Foreign $5.00. 1978 IC Master closeout $19.50.

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Full six digit battery operated. 2–5 volts. 3.2768 MHz crystal accuracy. Times to 59 min., 59 sec., 99 1/100 sec. Times std., split and Taylor. 7205 chip, all components minus case. Full instructions.

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Batt/AC oper. 0.1mv–1000v. 5 ranges, 0.5% accur. Resistance 6 low power ranges 0.1 ohm–20M ohm. DC curr. .01 to 100ma. Hand held, ½" LCD displays, auto zero, polarity, overrange. $74.95.

S-100 Computer Boards

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24K Static RAM Kit	423.00
32K Dynamic RAM Kit	310.00
64K Dynamic RAM Kit	470.00
8K/16K Eprom Kit (less PROMS)	**$89.00**
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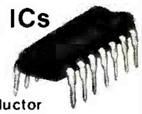

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7404	276-1802	35¢
7406	276-1821	49¢
7410	276-1807	39¢
7413	276-1815	79¢
7420	276-1809	39¢
7427	276-1823	49¢
7432	276-1824	49¢
7441	276-1804	99¢
7447	276-1805	99¢
7448	276-1816	99¢
7451	276-1825	39¢
7473	276-1803	49¢
7474	276-1818	49¢
7475	276-1806	79¢
7476	276-1813	59¢
7485	276-1826	1.19
7486	276-1827	49¢
7490	276-1808	79¢
7492	276-1819	69¢
74123	276-1817	99¢
74145	276-1828	1.19
74150	276-1829	1.39
74154	276-1834	1.29
74192	276-1831	1.19
74193	276-1820	1.19
74194	276-1832	1.19
74196	276-1833	1.29
4001	276-2401	49¢
4011	276-2411	49¢
4012	276-2412	69¢
4013	276-2413	89¢
4017	276-2417	1.49
4020	276-2420	1.49
4021	276-2421	1.49
4023	276-2423	69¢
4027	276-2427	89¢
4028	276-2428	1.29
4046	276-2446	1.69
4049	276-2449	69¢
4050	276-2450	69¢
4051	276-2451	1.49
4066	276-2466	99¢
4070	276-2470	69¢
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4518	276-2490	1.49
4543	276-2491	1.89

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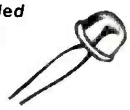
Creates almost any type of sound — music to "gunshots!" Built-in audio amp. Includes 2 VCO's, LF osc., noise gen., filter, 2 mixers, envelope modulator, logic circuit. 28-pin DIP. With data/applications circuits. **276-1765** **2.99**

NEW Mercury Tilt Switch

- *Hermetically Sealed*
- *Perfect for Alarm Circuits*



89¢ **Actual Size!**

Subminiature position-detecting switch for use in projects or special applications. Switch is normally closed when upright, opens when tilted more than 45°. Rated 100mA at 24VDC. **275-025** .... 89¢

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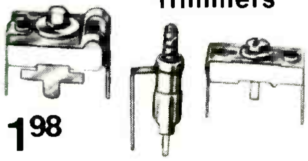

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Assorted low-loss RF trimmer capacitors. May include both compression and piston types rated up to 500VDC with maximum capacity values of 3 to 100 pF. **272-805** .... **Pkg. of 15/1.98**

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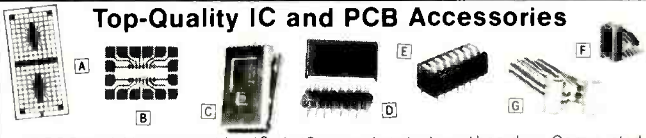

- [A] **PC Board.** Mounts two 14 or 16-pin ICs or sockets for bread boarding. Copper clad. 2½x5x1¹/₁₆. **276-151** **2.99**
- [B] **PC Board.** Mounts single 14 or 16-pin IC or socket. **276-024** .... **Pkg. of 2/99¢**
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- [D] **16-Pin DIP Header.** With snap-on cover. **276-1980** **1.29**
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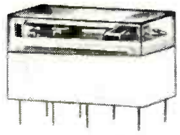
NEW DPDT Dual Inline Relay

Fits Std. 14-Pin IC Socket



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Subminiature relay is designed for use with TTL or CMOS circuitry. Contacts rated 1A at 125VAC. Coil requires 5VDC. Coil resistance, 50 ohms. **275-215** **4.49**

SALE Handheld 6-Digit Frequency Counter

Reg. 99.95 **69.95**

- **Lead Zero Blanking**
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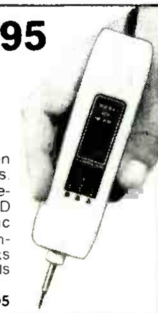
- **kHz and MHz Decimals**

Accuracy is 3 ppm at 25°C or less than 30 Hz at 10 MHz. Overload-protected 1-meg input. Sensitivity, 30 mV up to 30 MHz. 3x4½". With mini-rod antenna, leads, case, instructions. Requires 9V battery. **22-351** .... **Sale 69.95**
AC Adapter. U.L. listed. **65-731** **4.95**

Digital IC Logic Probe 24.95

Multi-Logic Family Compatibility from 5-15VDC



Detects one-shot low repetition rate, narrow pulses scopes miss. Combines level detector, pulse detector and pulse stretcher. Hi-LED indicates logic "1". Lo-LED is logic "0". Pulse LED displays pulse transitions to 300 nanoseconds, blinks at 3 Hz for high-frequency signals (up to 1.5 MHz). With cables. **22-300** **24.95**

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CMOS chip replaces over 8 separate IC's in a digital display circuit. Input pulse shaping. Master reset pin. 16-pin DIP. **276-2498** **2.99**

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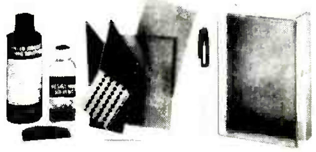

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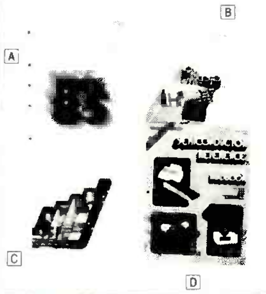
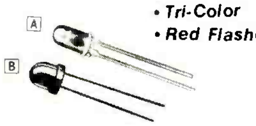
Computer Data Manuals & Semiconductor Handbook



- [A] **Intel 8080/8085 Programming Manual.** Handy reference for programming with Intel's assembly language. **62-1377** **3.95**
- [B] **Intel Memory Design Handbook.** Explains use of Intel's memory components and support circuits in systems. **62-1378** **3.95**
- [C] **Intel Data Catalog.** 928 pages of specifications on most of Intel's standard microcomputer-related products. **62-1379** **4.95**
- [D] **Semiconductor Reference and Application Handbook.** Complete specs and applications for popular IC transistors, diodes. **276-4002** **1.95**

NEW LEDs

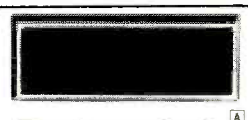
- *Tri-Color*
- *Red Flasher*

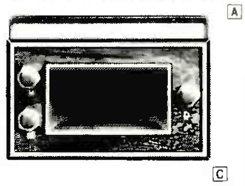


[A] Displays red, green, yellow. Uniform light output of 0.6 mcd. Forward voltage, 2.2VDC. Max. current: 25mA. T1-¾ case style. **276-035** 1.39

[B] Operates directly from 5VDC power source. Pulse rate: 3 Hz. Max. current: 20 mA at 5VDC. **276-036** 1.29

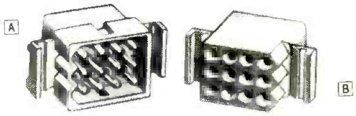
Digital Project Accessories





- [A] **Bezel with Lens.** High-contrast filter for LED displays. 3⁹/₁₆x1" lens opening. **270-301** **3.95**
- [B] **Deluxe Molded Display Case.** Red lens. Mount up to four 0.6" or eight 0.3" LED digits. With brackets. 1¹³/₁₆x3⅞x4⁷/₁₆". **270-285** **3.95**
- [C] **MA 1003 Clock Case.** For car clock modules. Accepts 3 pushbutton switches (not inc.). With brackets, blue lens. 3½x2⅛x2". **270-303** **5.95**

Molded Connectors



Rated 8A @ 250V. Standard .093" pin diameter.

Fig	Pins	Type	Cat. No	Each	Fig	Pins	Type	Cat. No	Each
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A	6	Male	274-226	1.19	B	6	Female	274-236	1.19
A	9	Male	274-229	1.39	B	9	Female	274-239	1.39
A	12	Male	274-232	1.49	B	12	Female	274-242	1.49

2-Pin Male & Female. (Not shown.) **274-222** .... **Pair 89¢**

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☐ 50	.35	.36
☐ 100	.43	.44
☐ 200	.54	.55
☐ 400	.61	.62
☐ 600	.79	.80
☐ 800	.90	.91
☐ 1000	1.19	1.20

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- Heavy Sand Type Hermet Construction
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25	25	.17	.18
25	50	.24	.25
50	15	.17	.18
50	25	.19	.20
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100	15	.23	.24
100	25	.25	.26
100	50	.35	.36
100	100	.39	.40
150	15	.23	.24
200	15	.24	.25
220	25	.32	.33
250	16	.29	.30
250	25	.32	.33
250	50	.45	.46
300	15	.31	.32
300	25	.33	.34
500	15	.33	.34
500	25	.36	.37
500	50	.39	.40
1000	15	.55	.56

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50-TUBE SOCKETS, 4,5,6,7 pin tubes, asst(#3839)	1.29	100 for 1.30
1-10 AMP POWER TAB QUADRAC, 200 PRV, TO220, 2/trigger(#1590)	1.29	2 for 1.30
10-BULLETT RECTIFIERS, 1.5 amp, 200V, axial(#84)	1.29	20 for 1.30
6-READOUTS, MAN-3, common cath, LED, the claw, RED(#3338)	1.29	12 for 1.30
8-LEDS, asst sizes and shapes, red, green, yellow, amber(#3869)	1.29	16 for 1.30
PHOTO FLASH ELECTRO. CAP, 600 MF @ 360V(#3897)	1.29	2 for 1.30
2-CIRCUIT BREAKERS, glass sealed, axial, rated @ 1 amp(#3905)	1.29	4 for 1.30
MICRO MINI TOGGLE, SPST, 2 pos, on-off, 125V @ 3 amps(#3936)	1.29	2 for 1.30
5-SLIDE VOLUME CONTROLS, asst of popular values, for HIFI(#2318)	1.29	10 for 1.30
10-D33021 TRANSISTORS, low power, silicon, hfe-60, TO-92(#5627)	1.29	20 for 1.30
60-TERMINAL STRIPS, form two lugs up, Solder type(#35A334)	1.29	120 for 1.30
60-CERAMIC CAPS, incl. NPO's, neg. coef. N750's asst values(#35590)	1.29	120 for 1.30
10-TV/FM SPLICERS, for 300 ohm shielded twin lead. Bakelite.(#5547)	1.29	20 for 1.30
10-15V ZENERS, 400mw, axial, glass case(#5404)	1.29	20 for 1.30
10-G.E. POWER TAB TRANSISTORS, D40N1,N2, some N5, TO-220(#5629)	1.29	20 for 1.30
2-¼" BLOCK TRIM POTS, 200K(#2535)	1.29	4 for 1.30
1-12VDC 5MIL REED RELAY, spst, N.O. 2200 ohms, 7/8" x 5/16" x 5/16"(#5515)	1.29	2 for 1.30
50-TEMP. COEFFICIENT VOLTAGE REF. DIODES, asst volt, +50%(#5647)	1.29	100 for 1.30
12-SKINNY TRIM POTS, PRECISION, asst. styles, values 50% yield(#3389)	1.29	24 for 1.30
60-pc-PRECUT, PRETINNED WIRE, various lengths and colors(#1971)	1.29	120 for 1.30
60-MINI RESISTORS, for PC appl, vert, 1/8W, color coded(#2235)	1.29	120 for 1.30
20-NYLON GEARS, hi-quality, asst sizes(#3446)	1.29	40 for 1.30
10-5K POTS, audio taper, plastic snap-in mounting(#5124)	1.29	20 for 1.30
10-1&2 MEG DUAL POTS, audio taper, snap-in mounting(#5125)	1.29	20 for 1.30
50-1 AMP ZENERS, wide asst of values, untested(#1964)	1.29	100 for 1.30
12-SCR'S & TRIACS, 10 AMP, asst values, untested(#2087)	1.29	24 for 1.30
3-QUADRACS, 10 AMP, 100% prime, 50-100-200V, TO-220(#5048)	1.29	6 for 1.30
20-MINI RECTIFIERS, 1½ AMPS, 25V, epoxy, axial(#5374)	1.29	40 for 1.30
10-2N3704 TRANSISTORS, silicon, TO-92 case, hfe-300 100%(#5625)	1.29	20 for 1.30
50-IF TRANSFORMERS, asst sizes(#35A9)	1.29	100 for 1.30
10-TV CHEATER CORD JACKS(#5519)	1.29	20 for 1.30
10-2N3705 TRANSISTORS, silicon, TO-92 case, hfe-150 100%(#5626)	1.29	20 for 1.30
4-1.5V SILVER OXIDE WATCH BATTERIES, specify: RW-15,18(#5063)	1.29	8 for 1.30
3-LCD WATCH READOUTS, 3½" digits, 7 seg. dim 1½ x 1"(#5066)	1.29	6 for 1.30
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10-INSTRUMENT KNOBS, asst styles and colors, ¼" shaft(#5121)	1.29	20 for 1.30
4-MIKE HOLDERS, for CB's and other mobile rigs(#5634)	1.29	8 for 1.30
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7-2N3055 HOBBY NPN TRANSISTORS, TO-3(#U3771)	1.29	14 for 1.30

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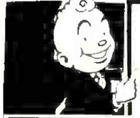

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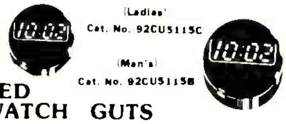

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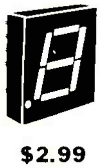

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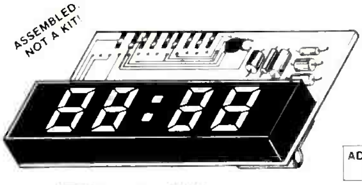

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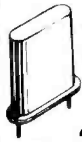

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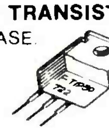

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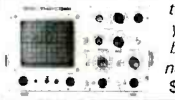

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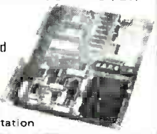

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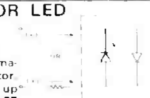

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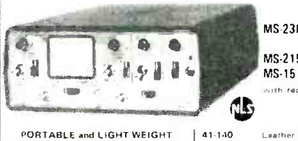

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with rechargeable batteries and charger

PORTABLE and LIGHT WEIGHT
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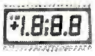

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4 Digit display with 16 segment font, CMOS driver includes memory, ASCII ROM and multiplexing circuitry, full TTL Compatability.

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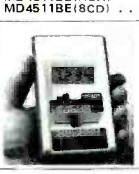

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Operation Assist

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Victor model 40, type 13 animatograph 16-mm cine projector. Need schematic, service manual and operations manual and parts list. Wesley C. Kranitz, RR2, Box 823, Lot 357, Pompano Beach, FL 33067.

Heathkit oscilloscope model 0-9. Need power transformer, part #54-19. Leslie H. Ferrier, 30 Stony Brook Rd., Raynham, MA 02767.

IBM model 11C electric typewriter and **IBM** type 866 and 868 cardatype typewriter. Need schematics, service or operating manual. F. J. Kluth, 1060 DeLeone Dr., Kent, OH 44240.

Electro Instruments Inc., model 883 digital multimeter. Need operation manual, schematics and any other data. Joseph Czajkowski, 14 Matthew Ave., Carteret, NJ 07008.

Acoustic Research AR-2A speaker. Need specifications. **Eico** HF-85 stereo preamplifier and **Eico** HFT-90 FM tuner. Need specifications and schematic. Rick Edelstein, 450 Claremont Ave., Westmount, Quebec H3Y2N2, Canada.

Sycor Inc. model 350 cassette. Schematic and operation manual. James R. Cook, 11451 Olson Dr., Garden Grove, CA 92641.

Heathkit model G.R. 110 vhf scanning monitor. Operation manual and schematic. Maurice King, 560 S. Main St., Mansfield, OH 44907.

Dumont type 350-R oscilloscope. Operations manual and schematic. James G. Brown, 15 New Ocean St., Lynn, MA 01902.

Central Electronics model 20-A multiphase exciter. Schematic and/or manual. A. McGinnis, 55 Patton St., Iselin, NJ 08830.

Knight KG250 stereo amplifier. Need knobs, schematic or any other information. D. Whitmore, RFD 1, Box 241D, Underhill, VT 05489.

Aircastle model S-515 six tube AC/DC AM/FM receiver. Need schematic and alignment information. T. M. Dusek, 6030 Belmont, Downers Grove, IL 60515.

Knight model KG-2100 dc oscilloscope. Schematic and operating instructions. Henry Senra, 740 East 11th Place, Hialeah, FL 33010.

R.C.A. model AR-77 communications receiver. Schematic and operations manual. James M. Caughey, RD 2, Cobleskill, NY 12043.

Eico model 3566 stereo tuner amplifier. Need construction manual. Eric Peterson, 120 Vanderbilt Ave., Staten Island, NY 10304.

Zenith model Y600 7-band transoceanic receiver. Schematic and any other information. Greg Brendon, 1667 Valecroft Ave., Westlake Village, CA 91361.

Seco model 107C tube tester. Operating manual and tube chart. Robert J. David, 21 Bank St., Elizabeth, NJ 07201.

Bendix model BC-625-A army transmitter. Schematic or any other information. David Weisenthal, 29 Northview Ave., Montclair, NJ 07043.

Hammarlund model HZ-180A receiver. Need schematic and service manual. Gene R. Walega, 5266 Olentangy Circle, New Middletown, OH 44442.

Zenith 1L6 tube for transoceanic radio. WD6BTM Christopher E. Bille, 860 N. Cedar St., Escondido, CA 92026.

Magnavox K.O. 597 stereo translator. Need to know where unit or schematics can be purchased. Herman Perloe, Century Village, Apt. 52, Easthampton, FL 33409.

Yaesu model FT-401B transceiver. Need schematic and/or operation manual. George Jennings, Rt. 3, Petersburg, TN 37144.

Westinghouse International model H-201 radio. Schematic and operating instructions. Edwin P. Bealand, 304 Morningside Dr., Palm Harbor, FL 33563.

Tally system 111 paper tape reader. Operating instructions or service documentation. C. C. Caffee, 8 Vanderbelt Rd., Acton, MA 01720.

Hallicrafters HT 37 transmitter. Operation manual and schematic and **Knight Kit** VTVM. Need schematics. Will H. Hays, 3125 Baybrook Dr., Corpus Christi, TX 78418.

National model NC 300 ham band receiver. Need operation manual and maintenance manual. George D. Nilsen, N4BN, 211 Lucerne Dr., Debary, FL 32713.

EMC model 700 crystal marker TV bar generator and **Philco** signal generator. Need schematics. T. E. Isaacson, 65 Dellbrook Ct., O'Fallon, MO 63366.

Simpson model 311-2 VTVM. Need probe and operating manual. C. E. McLellan, Box 575, Clarkson, NY 14430.

Tektronix type 514D oscilloscope. Service manual, schematics and operation manual. Frank Giove, 437 Pierson Run Rd., Pittsburgh, PA 15239.

B&K model 1075 TV analyst. Schematic and service manual. B. Bacher, 27675 Chatsworth, Farmington Hills, MI 48018.

Philco radio model 38-2. Schematic and parts list needed. Tom Phillips, Box 542, Neah Bay, WA 98357.

Magnus Organ model 03-4085. Need resistor network and amplifier circuit board. Tim Dill, 1134 Wimbledon Ct., Evansville, IN 47710.

Panoramic BC-1931A adaptor. Need operation manual. Charles J. Harvey, 70 Phillips St., Watertown, MA 02172.

Cromenco TV computer peripheral. Need schematic, etching and drilling guide and component placement diagram. Bruce Alley, 200 Solano Lane, Vacarille, CA 95688.

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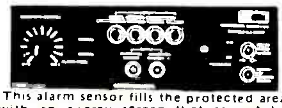

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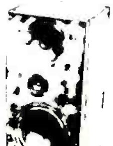

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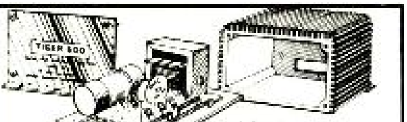

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