New, Exciting Low-Cost Projects

- For Joggers: Electronic Pedometer
- For Motorists: Low-Fuel Warning Buzzer
- For Boating: Portable Gas-Leak Meter
- For Basements: Sump Pump Switch/Alarm

Tested In This Issue
Fisher ST460 Speaker System
Shure M95HE Phono Cartridge
Compucolor II Model 4 Personal Computer
no loose ends
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*$1195 without floppy. Mail order kit price, F.O.B. Benton Harbor, MI. Also available at Heathkit Electronic Centers at slightly higher prices. Prices subject to change without notice.
JS&A has never offered a radar detector. As our president put it, “A radar detector is a flagrant anti-police device that does nothing but permit abuse of our traffic laws.”

Although many devices were presented to JS&A, none were acceptable. Despite all of our efforts, our president stood firm. “Our company will not, under any circumstances, sell radar detectors.”

For three years we saw radar detectors—some good, some bad—but because of our president’s policy, we were unable to offer a single unit. We saw the units go to both X and K bands; we saw the police develop radar jamming devices; and we saw the FCC prohibit these jamming devices. We followed with great envy as other companies sold thousands of them while JS&A stood firm on its decision not to sell them.

In January of 1979, our president was traveling on an interstate highway at 55 miles per hour. Other cars were passing him.

As he approached the top of a hill, he neglected to pay attention to his speedometer. As he rolled down the hill his speed increased to 63 MPH. At the bottom of the hill was a police radar trap.

He was apprehended and charged with exceeding the speed limit by eight miles per hour. He was taken to a Justice of the Peace who was in the barber shop, so our president had to wait until he finished. Finally there was a quick trial and a fine was paid.

Our president was four hours late. He felt that he was treated like a common criminal despite his good driving record and he lost very valuable time.

ATTITUDE CHANGES

This small incident created an entire change in his attitude. Our president saw for the first time that even law-abiding citizens are subject to the inequities of radar justice. He saw that the law-abiding citizen must also be protected from the abuses of radar power when unfairly used.

And when he studied the entire situation, our president realized something very frightening for all motorists. Many police departments have quotas imposed on them to realize either federal or state funds. They must issue a certain amount of tickets to qualify. With more and more motorists using radar detectors and CB’s, police must strictly enforce speed limits to reach their quotas. Now, even law-abiding motorists, who might make a slight mistake, are more vulnerable to speeding violations.

NEW MEMORANDUM

In a recent memorandum our president stated, “Due to the changing nature of police radar, JS&A may offer radar detectors as part of its program if presented within the quality image of our company and if the product represents a truly unique radar detector product.”

With the green light to find a radar detector, our product selection group was prepared. They had brochures from practically every manufacturer in the world. And they eventually selected what even our president thought was the most professional and well-designed unit available.

HIDDEN ANTENNA

Manufactured by a company called Chicago Radar, the unit consists of two parts—one that is hidden behind your grill, and the other under your dash. There’s nothing on top of your dashboard to indicate that you’ve got a radar detector and the system is difficult for anybody to steal. The unit under your dash is attached with a self-adhesive Velcro material so there’s no screws or installation to worry about.

The control unit has two lights—one to indicate that the unit is on, and the other to indicate that your car is under radar surveillance. There is also an audible alarm that will sound. But at night, when the light is all that you need, you can switch off the audible sound.

The control unit plugs into your cigarette lighter. The radar antenna is placed behind your grill. Just pull into any service station and the mechanic can easily install the entire system. The Velcro material and mounting brackets are all provided.

AMPLIFIED SENSING

The antenna is one of the keys to the unit’s high performance. Instead of the square-shaped dish antennas, the Chicago Radar version is a round cylinder. It tends to sense the radar signals sooner and around curves and hills because of its unique design.

The unit responds to both police radar bands X and K and uses all solid-state computer technology in its design.

We urge you to test our selection of what we feel to be the nation’s finest radar detector. Order one from JS&A. When you receive it, drive to your nearest service station or CB dealer and have them install your unit. The antenna installs with just a few brackets and the control unit attaches under your dash with the Velcro material.

Then use it for 30 days. During that time, count the number of radar traps you encounter. On the 30th day, turn off your unit as you travel. See how naked and unprotected you feel.

40 DAYS PROOF

If for any reason you are not completely satisfied, just return your unit within our 40-day trial period and we’ll gladly send you a prompt and courteous refund.

To order your system, send $179.95 plus $3.00 for postage and handling to the address shown below. (Illinois residents, please add 5% sales tax.) Credit card buyers may call our toll-free number below. By return mail, you'll receive the complete system, all cables, Velcro material, instructions, and a 90-day limited warranty.

The patented unit is precision crafted by Chicago Radar—one of the most respected names in radar detection systems. JS&A is America’s largest single source of space-age products—further assurance that your modest investment is well protected.

We firmly support our police departments and their efforts, but if they are encouraged to use radar to maintain quotas, the law abiding consumer has no choice but to protect himself. Start today. Order your unit now at no obligation.

If you’ve ever been caught by radar or if you own a radar detector, please read this important message.
Only the incredible, new, no-crystal Bearcat 220 Scanner tunes in all the real excitement of the entire AM aircraft band—plus every FM public service frequency—with pushbutton ease.

Now.
Tune in all the real excitement of the wild blue yonder, at the touch of a button.

The new, no-crystal Bearcat 220 Scanner searches and tunes in the entire aircraft band. Jets at 30,000 feet. All the tense tower talk. Everything is pre-programmed in space-age memory banks.

Only the 7-band Bearcat 220 Scanner also brings home every public service frequency, too. Pre-programmed Marine frequencies. Police action. Fire calls. Weather warnings. You name it.


After all, Bearcat invented Scanning. And we'll stop at nothing to bring you all the excitement—of land, sea, and air.
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About the cover:

A soldering iron and a few inexpensive parts can be used to make some especially useful devices to add safety and convenience to your lives.

Cover Art by George Kelvin

AmericanRadioHistory.Com
THE TV PIGGYBACKING FUROR

In what appears to be a David vs. Goliath contest, Texas Instruments, with inspirational support from RCA, is attempting to have rules on Class I devices for TV amended to include a Class II category. This would permit legal sale of stand-alone r-f modulators to be used for computers and peripherals. Such a change in the present interface rule that requires r-f modulators to be FCC type approved together with signal-source equipment is vociferously opposed by Radio Shack, Apple, Commodore, and Interact, among personal computer makers.

TI says, essentially, that it’s unfair to make a buyer purchase a video monitor when he could just as easily use an existing TV receiver if only the FCC would OK the use of separate r-f modulators. Other computer makers, who are already marketing personal computers, cry “foul,” saying, in a nutshell, that such approval would give TI an unfair marketing advantage. Moreover, they point out that this would also cause increased interference with radio and TV reception.

TI also requested a temporary permit to go ahead with the separate r-f modulator concept while the FCC’s bureaucratic wheels turn ever so slowly to reply to the company’s initial request for changing the rules. (Note: the FCC has yet to act on a similar request by RCA made about two years ago.) The National Association of Broadcasters (NAB) observes that this second request amounts to trying to solve a private marketplace problem by changing the rules.

With the foregoing as background, let’s examine the pros and cons of the rules change proposal. [I’ll ignore the waiver request entirely because (1) it indeed gives a company not yet in the field an unfair advantage and (2) since the Part 15 radiation standards are under active review, it’s possible that the “temporary” r-f modulators will not be in line with new standards.]

From a typical consumer’s viewpoint, using a separate modulator to connect a computer to one’s own TV receiver would likely appear to be an ideal opportunity to save substantial monies. Given the fact that computers are great noise generators, however, it is possible that interference within the household and on nearby neighbors’ receivers would be objectionable. Furthermore, using a home TV receiver as information display equipment resulted in lower video quality under the best of circumstances when compared to video monitors.

Nevertheless, the possibility of employing a legalized separate r-f modulator is an appealing one, and should be pursued. I firmly believe, though, that the FCC should not rush into making a positive decision on this without setting signal radiation standards that we can live with in the future. On the other hand, it’s unfair to penalize manufacturers by the foot-dragging procedures practiced by the FCC.

RCA, by the way, has pointed out that the TI request for an r-f modulator physically separated from computers is not the same as its petition for a rules change that relates to all-in-one-package video disk and tape machines. So the company suggests three classifications: the present Class I TV devices that require type approval, a second classification for built-in r-f modulators, and a third for stand-alone modulators. (How come RCA and other TV makers don’t incorporate video jacks in their TV receivers, which would make these rules change requests moot?)

Since this is written in May, I hopefully will learn more about all this at the Consumer Electronics Show in Chicago in June.
"We can heartily recommend the Superboard II computer system for the beginner who wants to get into microcomputers with a minimum of cost. Moreover, this is a 'real' computer with full expandability."

*Popular Electronics* March, 1979

"(Their) new Challenger 1P weighs in at $279 and provides a remarkable amount of computing for this incredible price."

*Kilobaud Microcomputing* February, 1979

"Over the past four years we have taken delivery on over 25 computer systems. Only two have worked totally glitch free and without adjustment as they came out of the carton: The Tektronic 4051 (at $7,000 the most expensive computer we tested) and the Ohio Scientific Superboard II (at $279 the least expensive) . . . The Superboard II and companion C1P deserve your serious consideration."

*Creative Computing* January, 1979

"The Superboard II and its fully dressed companion the Challenger 1P series incorporate all the fundamental necessities of a personal computer at a very attractive price. With the expansion capabilities provided, this series becomes a very formidable competitor in the home computer area."

*Interface Age* April, 1979

"The graphics available permit some really dramatic effects and are relatively simple to program . . . The fact that the system can be easily expanded to include a floppy means that while you are starting out with a low-cost minimal system, you don't have to throw it away when you are ready to go on to more complex computer functions. Everything is there that you need; you simply build on to what you already have. You don't have to worry about trading off existing equipment to get the system that will really do what you want it to do. At $279, Superboard II is a tough act to follow."

*Radio Electronics* June, 1979

"The Superboard II is an excellent choice for the personal computer enthusiast on a budget."

*Byte* May, 1979

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Requires +5V at 3 amp power supply.

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CIRCLE NO. 41 ON FREE INFORMATION CARD

AUGUST 1979
SOLENOID THAT ISN'T

We at Eumig thank POPULAR ELECTRONICS for the fine review regarding our Metropolitan CCD cassette deck in the May 1979 issue. We did, however, note an error regarding the deck's transport in the "User Comment" section: "The solenoid-operated transport is astonishingly silent. We heard none of the thumps or clunks usually associated with solenoid operation." You then go on to state that there is a "motor" sound instead of a solenoid sound.

As a point of information, the reason solenoids are not heard is that there are no solenoids. The motor sound is heard because the head mounting assembly is step-motor engaged, using the same motor that governs fast forward and rewind. —Tom Benson, Eumig (U.S.A.) Inc., Great Neck, NY

MAKING A BETTER WINDOW?

The window comparator circuit shown above has fewer parts and has better input protection than that shown in Fig. 5 of the May 1979 "Experimenters' Corner." Resistors R1, R2, and R3 form the reference voltage source with the upper limit defined by \( V_{CC}/(R2 + R3)/(R1 + R2 + R3) \) and the lower limit defined by \( V_{CC}/(R1 + R2 + R3) \). For small windows, R2 determines the window opening. For very small windows, on the order of 0 to 15 mV, R2 can be eliminated and the opening can be adjusted via R7. Resistors R4 and R5 protect the inputs from excessive current during accidental inputs exceeding \( V_{CC} \) or ground. Diode limiting can be added from the inputs to \( V_{CC} \) and ground, using D1 and D2.

System stability is a function of \( V_{CC} \) stability and op-amp drifts. For 741s and 747s, \( V_{CC} \) should be between 8 and 30 volts. FET-input op-amps lend themselves well to this application. Resistors R4, R5, and R6 limit LED current and should be chosen to allow about 10 mA. —Glenn Fasnacht, Lakewood, OH

MOPED TURN INDICATORS

Many thanks for "Solid-State Turn Indicators for Mopeds" (May 1979). The article was clearly written. The project will almost certainly prevent accidents because blinking lights are easier to see and interpret. Also, the project is small enough to easily mount on all mopeds. —Bill Saehler, Minnesota City, MN.

While looking over the moped turn-indicator article, I noticed that D4 and C3 are not switched out of the power circuit by S1. While this is not particularly important when the device is connected to a moped generator, if a battery is used, as suggested in the article, it would quickly discharge to the zener voltage. To obviate this, I would rewire the circuit as shown below.

Note, too, that by substituting a dpdt (center-off) switch for S1 several advantages arise. Diodes D3 and D4 are eliminated, light assemblies do not have to be insulated from the frame, and return wiring from the lamps to the switch is not required. —Roy F. Gordon, Hampton, VA.
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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.

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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. For immediate response, fill out the attached coupon.
**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.

**KEF Model 101 Loudspeaker**

The Model 101 loudspeaker by KEF Electronics has a total volume of only 0.25 cu. ft. and is designed for bookshelf placement. A computer is used to match the two drivers—a 25-mm (1") tweeter and a 110-mm (4½") woofer—and the crossover network as well. The speaker is rated to accept the output of an amplifier up to 100 watts and has an automatic protection system to prevent overdriving. Maximum output level is said to be 98 dB SPL. Sold in matched pairs with teal or walnut finish and a brown fabric grille.

**Low-Cost µC Printer**

Radio Shack has introduced an inexpensive printer that produces low-cost hard copy on 2½" (60.3-cm) wide aluminum-coated paper. The TRS-80 Quick Printer II prints upper- and lower-case, double-size, and double-spaced characters to allow special effects such as titling pages and printing headings. Automatic "wrap-around" prevents data loss due to overflow when text exceeds maximum line length. Printer software is selectable for 16 or 32 characters/line and produces 120 lines/minute (64 characters/second). The 96-character, 5 × 7 dot-matrix characters are a modified ASCII subset. Vertical spacing is 6 lines/inch. All 32 ASCII codes can be produced, as well as codes for the print-ed characters. Although designed for use with Radio Shack's Level II TRS-80 systems, the printer can also be used with other computers. Measures 9½"W × 6½"D × 3½"H. $219.00.

**Digital Capacitance Meter**

A new digital capacitance meter has been introduced by Data Precision Corp. The 3½-digit Model 938 has a rated measuring range of 0.1 pF to 1999 µF in eight switchable ranges, with a basic accuracy of 0.1%. Range selection is via pushbutton switches handily located along the left side of the case. A zero-adjust control with a ±20 pF range is provided for compensating for stray capacitance of test leads. Measurements appear on a 0.5" (12.7-mm) high liquid crystal display. An internal fuse prevents instrument damage from charged capacitors and should the test leads be inadvertently connected across a voltage source. Uses a single 9-volt alkaline battery. $149.00.

**AM/SSB Mobile CB Transceiver**

The Model 7001 is the most precise AM/SSB CB mobile transceiver in Midland's Precision Series. It features: RF attenuator switch; RF gain, clarifier, squelch, and Mic gain controls; LED transmit/receive (TX/RX) indicator; DIM, CB/PA, LSB/AM/USB mode selector, NB & ANL, and TONE switches. A two-digit, green seven-

(Continued on page 12)
It's a digital signal injector. And it thinks for itself.

It may look like a logic probe but our DP-1 Digital Pulser is a lot more unique. This handheld, circuit-powered instrument is actually a miniature pulse generator built to speed digital troubleshooting.

Touch it to a circuit, and DP-1 automatically senses the logic state. So when you push the button, out comes one perfect pulse — preset to the logic family you’re working with — of the proper polarity to force the state the other way. Hold the button down for a second and it starts injecting a 100pps pulse train. With all the punch you need — up to 100 mA.

Think what a help that can be when your logic circuit is doing something illogical. (And just in case you do something illogical, we’ve included reverse-polarity and short-circuit protection, as well.) It's smart to save time with a DP-1. At $74.95*, it's a smart buy, too.

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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, either 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 within 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.

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

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

**FINALLY. AN ALARM ALL FUNCTIONS**
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; they are just imitation. Everything you see on your Realtime chronograph is there for function, not for show.

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 to the case 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, convenient service-by-mail facilities right here in the U.S., and The Sharper Image's own guarantee to customers: if for any reason at all, you are not completely delighted with your purchase, please return it within two weeks for a complete and courteous refund.

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CHRONOGRAPH WITH AND NO FAT.
NEW PRODUCTS (Continued)

Compact Electric Drill
Wahl Clipper Corporation’s "Iso-Tip" is a compact electric drill that's said to be ideal for circuit board revision, solder removal, and lead hole cleaning, among other jobs. It runs at about 9000 rpm and accommodates drills and burrs with shank size up to ¼". Less than 5" long (excluding drill bit), the Iso-Tip is small enough to use at close quarters. The device is housed in high-impact plastic and is equipped with a 10' power cord, as well as a collet chuck, four collets and two drill bits.

Antenna Rotor System
The new Ham IV from Cornell-Dubilier Electric Corp. is an antenna rotor system for large communication arrays with maximum wind load areas of 15 sq ft when tower mounted. Includes such features as m-

Boise Spatial-Control Receiver
Designed to complement Boise 901 Direct/Reflecting speakers, but usable with other speakers as well, the Spatial Control Receiver contains equalization for the 901’s and “source and room compensation” controls that function in lieu of tone controls. In addition, it is capable of directing mid and high frequencies to either the inner or outer banks of reflected drivers of the 901’s, narrowing or widening the stereo image at the listener's option. Bass is directed equally to all drivers at all times. The unit contains four main power amplifiers and two secondary amplifiers for driving headphones. Strapped in pairs, the large amps are rated at 100 watts per channel into 8 ohms, 20 Hz to 20 kHz, with no more than 0.09% THD. The FM section is said to achieve 50 dB of quieting in stereo with an input signal of just over 36 dB. $799.

Anixter-Mark CB Antenna Upgrader
Anixter-Mark’s “Little Devil” adapter is designed to allow CBers to upgrade to a higher-performance antenna without requiring a new mount or cable assembly. The base loading coil merely unscrews from the present antenna and the Little Devil...
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<thead>
<tr>
<th>Assembled</th>
<th>Kit</th>
<th>Base</th>
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<tr>
<td>CL7401A Diagonal</td>
<td>$79.50</td>
<td>$59.50</td>
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<tr>
<td>CL7402 Grandpa</td>
<td>$99.50</td>
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<tr>
<td>Chimes</td>
<td>$45.00</td>
<td>$39.00</td>
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Hunter Associates is offering the Model GSS Desoldering Tool, which is intended for use on miniature and microminiature circuit boards and modules. Operating by means of compressed air, the tool creates suction in its tip, with the high-pressure air flow causing a continuous self-cleaning action as well. Air can be supplied either from a pressurized line or by an ordinary foot pump. The tool has a tip 2.4 mm in diameter with a 1.2-mm vent. $39.95.

Debounce Switch

Cincinnati Electrosystems’ new Debounce Switch provides a convenient method for clocking logic circuits without contact bounce. A pushbutton switch, when operated, generates a choice of positive or negative 10-μs pulse or a level change. This latest addition to the company’s Black Box series of laboratory instruments measures 4” x 2¾” x 1½” (102 x 73 x 40 mm). It is designed to be powered from virtually any 5- to 15-volt external dc source. $7.95. Address: Cincinnati Electrosystems Inc., 469 Ward’s Corner Rd., Loveland, OH 45140.

Programmable Clock Radio

General Electric announced the first AM/FM programmable digital standard broadcast clock radio, “The Great Awakening” Model 4880. It has a programming keyboard for entering a variety of time and operating functions. For example, two people can wake up at different times to different stations without resetting, or the two systems can be used for weekday/weekend wake-up times. Further, one can fall asleep listening to one station and wake up to a completely different station. Memory capability to store six radio stations, instantly recallable by touching a button, is built in. Also all timekeeping and memory information is protected by battery back-up during power outages. $116.95.

Automotive Speaker Adapter

East Coast Enterprises has introduced “Adapt-A-Sound,” a device that matches a standard 6” by 9” automotive loudspeaker to the 4” by 10” mounting locations provided in some of the newer, space-efficient cars. The adapter is said to cause little or no loss of sound quality. A snap-in mounting spring designed to fit all 4” by 10” locations is claimed to simplify and facilitate installation. Address: East Coast Enterprises, Inc., P.O. Box 639664, Miami, FL 33163.
AKAI STEREO COMPONENT CATALOG

Akai's 56-page catalog describes its full line of stereo components, including tape decks, turntables, receivers, amplifiers, tuners, loudspeaker systems, an equipment cabinet, a mic/line mixer and stereo accessories. The catalog has information on product features, specifications, and color photos of each model, plus a glossary to explain specifications and provide stereo terminology. Address: Catalog, Akai America, Ltd., P.O. Box 6010, Compton, CA 90224.

ANTENNA INCORPORATED CATALOG

An expanded Land Mobile Antenna catalog for commercial two-way communications systems is offered by Antenna Incorporated. The catalog includes several new antenna models and provides reference material in chart format, enabling the reader to match antenna frequency range and model number with the desired type of antenna mount. Included are: 100- and 200-watt low-band vhf antennas; 100-, 150- and 200-watt, 3-dB gain, high-band vhf antennas; 100-watt and 150-watt, 5-dB gain collinear uhf antennas; ¼-wavelength models, heavy-duty mobile antennas for use between 25 and 54 MHz; “disguise” cowl-mount models and base station antennas. Address: Antenna Incorporated, 26301 Richmond Road, Cleveland, OH 44146.

RADIO SHACK MICROCOMPUTER CATALOG

The TRS-80 Microcomputer Catalog #RSC-2 is offered by Radio Shack. The 20-page catalog includes current information on the TRS-80 microcomputer, its peripherals and accessories with descriptions, application ideas and specifications. A general section explains what a computer is, what it can do, “Who can use the TRS-80,” and “Why the TRS-80?” The catalog then describes the TRS-80 System, Level-I and Level-II Basic Language, and the peripheral equipment available for use with the TRS-80 including its expansion interface, Mini-Disk System, printers, interfaces, manuals and TRS-80 System Desk. Address: Radio Shack, 1400 One Tandy Center, Fort Worth, TX 76102.
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<td>Master Course in TV, Audio, and Video System Servicing</td>
<td>Master Course in Color TV Servicing</td>
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<tr>
<td>CASH PRICE (terms available)</td>
<td>$1,375</td>
<td>$1,539</td>
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<tr>
<td>TV SET</td>
<td>NRI designed-for-learning kit. 25&quot; (diagonal) color TV with built-in computer programming and cabinet</td>
<td>Heathkit GR-2002 25&quot; (diagonal) color TV (Cabinet extra)</td>
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<tr>
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<td>NRI designed-for-learning kit. 5&quot; (8 x 10 cm) triggered sweep</td>
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<td>COLOR BAR GENERATOR</td>
<td>NRI designed-for-learning kit. 10 patterns</td>
<td>Elenco SG-200 (kit) 10 patterns</td>
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<tr>
<td>FREQUENCY COUNTER</td>
<td>NRI designed-for-learning kit. Complimentary metal oxide semiconductor digital type</td>
<td>Heathkit (part of TV kit) DC only, 1Ω Ohm/volt</td>
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<tr>
<td>METER</td>
<td>NRI designed-for-learning kit. Transistorized AC/DC volt-ohm meter</td>
<td>Heathkit (part of TV kit) DC only, 1Ω Ohm/volt</td>
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<td>AUDIO</td>
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All data as shown in each school's catalog as of April 1, 1979.

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AUGUST 1979
IT WAS to be a typical recording session (details of time and place are not pertinent to this discussion), and once it began, our little party of journalists took just five minutes to zero in on the best seats from which to hear the orchestra. What we heard as the music unfolded was indeed magnificent. As I sat, spellbound by the glorious sound, I could almost visualize my own microphones hanging there just so far off the floor and just the right distance from the front desks of musicians.

However, that wasn't where the mikes were at all! For one thing, instead of the two or perhaps three I had visualized, there were some two dozen (neither the producer nor the engineer could recall the exact number) and they were strewn around the orchestra like raisins in a fruit cake. The treatment of French horns was particularly puzzling. Sound-reflecting panels had been erected a short distance behind them, which seemed logical because the bell of the horn faces to the rear and the back wall of the stage reflects the sound out to the audience.

Since the recording team had brought the orchestra off the stage and out into what would be the audience seating area—a very common practice in U. S. orchestra recording—something was needed to take the place of the stage's enclosure. What seemed less logical was that the mikes were not in front of the horns but behind them, a few feet away from the reflecting panels. Now if God intended the French horn to be heard with its bell pointing away from the listener or the microphone, what were mikes doing behind the horns and in line with the bell openings? Certainly the sound in the control room did nothing to throw light on the matter.

I suppose I have heard worse emanating from a set of monitors, but that's not saying much. When, for example, the producer wanted to make sure the brass did not drown out the strings, he had the engineer turn up the strings—often to the point where the violins became shrill caricatures of themselves. With microphones sprinkled hither and yon throughout the orchestra, there were no landmarks by which a listener could get his bearings in the stereo image. Perhaps this was just as well, for a more plausible perspective that churned and twisted as this one did (because of the continual changes in instrumental balance that were being dialed in), might have caused motion sickness. The timpani were getting into all the microphones, thus losing their crispness and much of the "snap" of their impact. It was discouraging to realize that this sound was the product for which many dollars per minute were being spent, when you could walk 30 steps into the hall and hear how wrong it all was.

Miking the Space. A reaction against this sort of recording technique has been underway for some time now. As a concept it might be termed "miking the space." Instead of trying to pick up 40 violins, 25 violas, 20 cellos, 10 string basses, 2 oboes, etc., you adopt the outlook that you're going to try to capture every acoustic event that takes place in an area of, say, 80 by 40 feet—the sort of area a symphony orchestra might occupy. The nature of the acoustic event doesn't matter—it might be a concert of music, a tap-dancing competition, a game of dice, or a fly buzzing around. What matters is that the event as recorded sounds natural; that it seems to occupy the amount of space that it did in reality; and that its aural perspectives are preserved. If something is happening in the rear or over to the left, the sound should come from there when the finished recording is played back.

Of course, this is not the sort of recording technique you use if you are trying to cover up deficiencies in the performance or flatten the sound in some way. What actually takes place is what the microphones hear and the tape preserves, warts and all. Nor is it a technique that is easy to bring off in every environment. But if you accept the idea that the space need not be a nice neat rectangle as long as your performing forces can be squeezed into it, and if you realize in advance that the minimum number of microphones required is usually best, with additional microphones often proving detrimental, you can usually manage something.

Here is a procedure I very often find helpful, although like everything in audio, it is fallible. First consider the recording environment, because it will determine the character of the reverberation present on the finished tape. A small auditorium, for example, is usually less reverberant than a stone church. This means that microphones can usually be placed a bit farther away from the performers without loss of clarity. An advantage can be realized here when working with very few microphones, because a more distant mike means less variation in performer-to-mike distance for any given performer and fewer problems with balance. If the performers know how to balance themselves, the recording will be balanced.

A church may require closer miking if reverberation is not to interfere with clarity. In this case, you might want to try more closely spaced mikes and group the performers in an arc around them; in other words, the "space" you're defining now becomes a rough semicircle instead of a rectangle. These suggestions are perforce very general; every recording situation is a cut-and-try proposition.

Setting Up. Once the mikes are roughly placed (and before the performers arrive), send your assistant to stage center and have him move forward and back, continuously announcing his distance from an imaginary line connecting the microphones. When the monitor system yields what seems to you the most pleasing balance between the sound coming directly from him and the reverberation his voice sets up in the environment, you've established an approximate "subjective distance" for the performance—subjective because you will usually find that he is somewhat closer to the mikes than he sounds to be. Have him mark his position on the stage floor.
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Then, while he faces forward and talks continuously, have him move left and right on a traverse that approximately encompasses the width you expect the performing group to occupy on stage. If at any time during his traverse his voice seems to recede, have him move forward until the original sense of distance is restored and mark that position with tape. (And, of course, have him move back appropriately if his voice seems to approach the microphones.) When this process is over you will have established a base line for the front row of performers. Ultimately you'll be able to move them slightly forward or back from this line to establish final balances.

Finally, your assistant should cavort around the performing area stamping his feet, clapping his hands, and making as much noise as possible, but never stepping forward of the base line. As he does his act, you should get a vivid sense of continuous movement within a well-defined space. The space may not sound quite like the area blocked out on stage, but it should seem plausible.

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**The Inevitable Little Things.** By this time you should be in pretty good shape for the arrival of the performers, who it is to be hoped will give you a few minutes of run-through so you can set final balances. If the environment is reverberant and you have had to mike fairly closely, you may find that sibilants are exaggerated in vocals. Raising the mikes somewhat and instructing the performers not to sing at the mikes but instead straight out into the presumed audience is the usual remedy.

A frequent problem that can be baffling unless you're prepared for it is the initial sound reflection that comes from the performer, caroms off the floor just in front of him, and reaches the microphone an instant after the direct sound. As a rule this is the strongest reflection you'll have to deal with, and it can have an appreciable influence on the sound. The easiest remedy is a sound absorber at the exact bounce point. Church-pew cushions can be highly recommended as absorbers. Do not, however, overdo the treatment at first. Start with a single cushion at the bounce point—which can be easily worked out when you consider that the angle of reflection will equal the angle of incidence—and work up from there as necessary.

If the performance calls upon the performers to move—or if they move whether required or not—you have a special problem. Practical stereo microphone setups simply do not respond to movement as two ears attached to a human head do. To get the most natural-sounding effect, you will probably have to discuss their movements with them in advance, using the subjective-distance base line as a guide. Even then there are likely to be difficulties.

... and it works. You may not believe it now, but with luck, application, and a mere two microphones, it is possible to get startlingly credible and satisfactory results with this basic technique, as many brilliant tapes produced by persevering amateurs have shown. Even large-studio professional recordists, who sometimes seem incapable of believing, have inadvertently proven it. Here, an anecdote might serve. It may be apocryphal in some details, but I believe it to be true in the overall sense.

Back shortly before the era of stereo, a major label had proposed to do an LP of excerpts from Swan Lake with a well-known orchestra. Evidently, the production was to be a quick and easy job just to fulfill contractual agreements. But there was a hitch—the orchestra was going to be on tour on the date for which the session was scheduled, and the engineers knew nothing about miking the hall in which the recording would have to be made. Worse yet, there was no time to experiment.

This was an intimidating state of affairs because recording engineers and the particular hall had had a long history of enmity. Engineers had found the place prone to echoes, lack of clarity, unfortunate balances, and almost any other sonic ill you can name. The only statement that could be made in the hall's favor was that expert listeners have long found it to be one of the most thrilling and satisfactory environments in the world for listening to symphonic music. In the end, not knowing what else to do, the engineers hung a single microphone above the orchestra on stage and crossed their fingers.

The recording that resulted was peculiar in a number of respects. The strings sounded like strings instead of strident implements of a crisply sharp attack. Vocalists were able to achieve the natural-sounding effect, you will probably have to discuss their movements with them in advance, using the subjective-distance base line as a guide. Even then there are likely to be difficulties.

... and it works. You may not believe it now, but with luck, application, and a mere two microphones, it is possible to get startlingly credible and satisfactory results with this basic technique, as many brilliant tapes produced by persevering amateurs have shown. Even large-studio professional recordists, who sometimes seem incapable of believing, have inadvertently proven it. Here, an anecdote might serve. It may be apocryphal in some details, but I believe it to be true in the overall sense.

Back shortly before the era of stereo, a major label had proposed to do an LP of excerpts from Swan Lake with a well-known orchestra. Evidently, the production was to be a quick and easy job just to fulfill contractual agreements. But
The Model ST460 from Fisher is a floor-standing three-way speaker system whose salient characteristic is high efficiency, which permits it to develop very high output levels when driven by low-power amplifiers. Bass frequencies are propagated by a 15" (38.1-cm) woofer that operates at frequencies up to about 1000 Hz, where a pair of 5" (12.7-cm) cone-type midrange drivers take over. There is a second crossover at 5000 Hz to a single horn-loaded tweeter with a nominal 3" (7.5-cm) mouth diameter. Both crossovers have symmetrical, 12-dB/octave slopes.

Overall size of the ST460 is 29 1/4" x 18 1/4" x 14 9/16" (74.3 x 46.4 x 37 cm) and weight is 53 lb. Suggested retail price is $389.95, or with genuine walnut veneer finish as the Model ST461 for $409.95.

**General Description.** The drivers are mounted symmetrically on the front of the cabinet, with the woofer at the bottom in its own approximately 4-cu-ft ducted-port enclosure. The two midrange drivers are side by side above the woofer with the tweeter centered above them. At the top of the cabinet is a control panel with separate three-position switches for adjusting the levels of the midrange and high-frequency drivers over a range of ± 3 dB. A pushbutton near the controls resets the circuit breaker that protects the system against overloads. The front of the speaker is covered by removable, acoustically transparent cloth.

**Laboratory Measurements.** We made our basic measurements on the ST460 with the system’s midrange and tweeter level controls in their 0-dB (center) positions. The frequency response curve obtained in the reverberant field of our testing room was spliced to a woofer response curve taken with close microphone spacing. The latter includes the separately measured contribution of the port radiation at very low frequencies, corrected for the relative radiating areas of the port and the driven cone.

As a rule, even a 12" woofer might be expected to show cone breakup, beaming, and other undesirable effects at an operating frequency as high as 1 kHz. We were not too surprised, therefore, to find response irregularities and a general drop in output from the ST460’s 15" woofer beyond about 500 Hz.

Maximum bass output was reached at frequencies between 70 and 90 Hz, falling off steeply at lower frequencies. Contribution of the port is mostly at frequencies below 40 Hz; while it is effective to a degree between 20 and 40 Hz, the average output in this octave is far below that of the upper bass. Above 100 Hz, the output dropped off smoothly and gradually to a minimum at 1000 Hz of 10 dB below the maximum bass level. Beyond 1000 Hz, the output again rose gradually to

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**Performance Specifications**

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<th>Rating</th>
<th>Measured</th>
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<tbody>
<tr>
<td><strong>Frequency response</strong></td>
<td>40-20,000 Hz ± 10 dB</td>
<td>48-18,000 Hz ± 5 dB</td>
</tr>
<tr>
<td><strong>Efficiency (avg SPL at 1 meter, 1 watt)</strong></td>
<td>92 dB</td>
<td>20-19,000 Hz ± 10 dB</td>
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<tr>
<td><strong>Recommended amplifier power</strong></td>
<td>25-130 watts</td>
<td>92 dB</td>
</tr>
<tr>
<td><strong>Peak distortion-free SPL with stereo pair in typical room</strong></td>
<td>112 dB</td>
<td>Confirmed</td>
</tr>
<tr>
<td><strong>Crossover frequencies</strong></td>
<td>1000 and 5000 Hz</td>
<td>Not checked</td>
</tr>
<tr>
<td><strong>Woofers diameter</strong></td>
<td>15&quot;</td>
<td>Confirmed</td>
</tr>
<tr>
<td><strong>Voice coil</strong></td>
<td>2&quot;</td>
<td>Confirmed</td>
</tr>
<tr>
<td><strong>Loading</strong></td>
<td>Ducted reflex</td>
<td>Not checked</td>
</tr>
<tr>
<td><strong>Midrange (size/type)</strong></td>
<td>Two 5&quot; cones</td>
<td>Confirmed</td>
</tr>
<tr>
<td><strong>Voice coil diameter</strong></td>
<td>9/16&quot;</td>
<td>Confirmed</td>
</tr>
<tr>
<td><strong>Tweeter (size/type)</strong></td>
<td>3&quot; horn</td>
<td>Confirmed</td>
</tr>
<tr>
<td><strong>Nominal impedance</strong></td>
<td>8 ohms</td>
<td>Confirmed</td>
</tr>
<tr>
<td><strong>Enclosure dimensions</strong></td>
<td>29 1/4&quot; x 18 1/4&quot; x 14 9/16&quot;</td>
<td>2&quot; mount diam.</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>53 pounds</td>
<td>Confirmed</td>
</tr>
</tbody>
</table>
about +5 dB between 7000 and 16,000 Hz and fell off sharply at about 18,000 Hz. Overall frequency response (with the controls centered) was ±5 dB from 48 to 19,000 Hz, well within Fisher’s ratings. Tweeter dispersion was quite good.

The ST460’s high efficiency was demonstrated by its ability to produce a 92-dB sound pressure level (SPL) at a distance of 1 meter when driven by 2.83 volts of random noise in an octave centered at 1000 Hz. The tone-burst response was uniformly good, with no signs of prolonged ringing or spurious output frequencies. Impedance averaged about 8 ohms, reaching a maximum of about 30 ohms at the 65-Hz bass resonance and a minimum of 6 ohms at 750 Hz. Bass distortion at a 1-watt input was less than 1% from 100 to 50 Hz, and only 7% at 30 Hz. At a 10-watt input, distortion measured less than 2% down to about 50 Hz and climbed to 14% at 30 Hz.

User Comment. We listened to a stereo pair of the Fisher ST460 speakers mounted on stands that raised them about 7” above the floor—an arrangement that, while not critical, seems to enhance the sound of many speakers. What we heard sounded clean, with a generally good frequency balance that correlated well with what we had measured. Occasionally, we experienced a heaviness in male speaking voices and in some musical material. We attribute this to the emphasis in bass response around 80 Hz. Although some of the low-frequency performance is based on psychoacoustic illusion, it is convincing enough to give an overall impression of very solid bass.

Clearly, the balance of compromises (a component of all loudspeaker design) has been tipped in favor of disco and rock music in the case of the ST460. The frequency response gives a little extra “punch” to the bass and “sizzle” to the treble, without weakening the midrange to an extent that would cloud vocals. And while the system’s performance with classical music might not suit the most demanding listeners, it is more than adequate for its intended application.

One characteristic of the ST460 that will probably have a special appeal to the rock and disco listener is its ability to conserve amplifier power. We were able to drive the system to ear-shattering levels with a 20-watt amplifier. On the other hand, the system took the output of a 200-watt amplifier right in stride. By most standards, the ST460 would not be considered cheap, but if the potential saving in amplifier power is taken into account, along with the level of musical performance offered, it seems like quite an economical speaker.

When Shure introduced the top-of-the-line Model V-15 Type IV phono cartridge last year, one of its features was a hyperelliptical stylus shape derived from the hyperbolic stylus previously developed for the M24H (CD-4) cartridge. This type of stylus has an extended contact area against the groove wall and a small radius that gives it excellent high-frequency tracking ability. It occupies the same position in the Shure products that the Shibata and its derivatives do in the lines of other manufacturers.

The new M95HE consists of an M95 body fitted with the new N95HE stylus. The diamond tip of the stylus is identical to that of the V-15 Type IV. According to Shure, it makes a reduction of as much as 25% in harmonic and intermodulation distortion compared to the elliptical stylus used in the M95ED. Since the M95 cartridge is electromagnetically similar to the
V-15 series, it would appear that adding the N95HE stylus to the M95 body might result in a cartridge that has many of the special qualities of the V-15 Type IV but at a substantially lower price.

The M95HE is designed to track at forces from 0.75 to 1.5 grams. Shure's "trackability" ratings rank it a close second to the V-15 Type IV. Since the body is that of a standard M95ED, owners of that cartridge can upgrade to an M95HE at any time by merely plugging in a new N95HE stylus assembly. The M95HE costs $89.50, the N95HE stylus $34.00.

**Laboratory Measurements.** We tested the M95HE in the tonearm of a Thorens Model TD-115C record player at the maximum tracking force of 1.5 grams. The electrical load was 47,000 ohms in parallel with 500 picofarads. Shure recommends capacitance between 400 and 500 pF, (more than most turntables and preamps supply), but response measurements with both values showed that 500 pF yielded flatter overall response.

The cartridge's output was 4.75 mV/channel at a 3.54-cm/s velocity. Channel levels balanced within 0.9 dB. The vertical stylus angle, measured with a CBS STR160 record, was 26°. Frequency response and channel separation were measured with CBS STR100, JVC TRS-1007, and B&K OR-2009 test records. In addition, we measured the separation at a number of spot frequencies with an Audio-Technica AT-6605 record.

Frequency response differences between the records were relatively minor. With the STR100 record, response was flat within ±1 dB from 40 to 16,000 Hz falling to about -6 dB at 20,000 Hz. Channel separation readings fell into two groups. The CBS and B&K records revealed less separation than the JVC and Audio-Technica records, which were fairly similar. The midrange separation was 22 to 23 dB with the first two discs and 30 to 35 dB with the other two. At 10,000 Hz, the separation was 28 to 30 dB with all but the B&K record, which gave a 20-dB reading. At 20,000 Hz, the CBS and B&K records gave respective separation readings of 17.5 and 15 dB, while the JVC and Audio-Technica records showed a 22-dB separation.

The low-frequency resonance in the low-mass Thorens tonearm (14 grams effective mass, including the 6.3 grams of the cartridge) was at 10 Hz, with an amplitude of about 7 dB. Tracking distortion was measured with Shure's TTR102 (400- and 4000-Hz intermodulation distortion) and TTR103 (10.8-kHz tone bursts at a 270-Hz repetition rate) test records. The IM readings with the TTR102 increased from 2% or 3% at low levels to 6% to 8% at velocities in the 22- to 27-cm/s range. With the tracking force reduced to 1 gram, the cartridge mistracked severely above 22 cm/s.

The repetition rate distortion with the TTR103 record was extremely low (Shure cartridges have consistently been outstanding in this test), increasing from 0.63% to 0.84% as the velocity increased from 15 to 30 cm/s.

Subjective tracking of the M95HE was judged with Shure "Audio Obstacle Course" records. As with the TTR103, we have found that Shure cartridges tend to be among the best in their ability to track these very-high-velocity musical selections without audible distortion. The M95HE was no exception, handling everything on the ERA III record without difficulty and revealing only a trace of "hardness" on the highest levels of the bells and combined harp and flute sections of the ERA IV record.

**User Comment.** While it is easy to distinguish between a low-priced cartridge and a high-priced one by listening or measurement, differences tend to become more elusive when comparing cartridges of similar overall quality. Consequently, we found no dramatic audible differences between Shure's M95ED and M95HE cartridges. Their measured performance was similar, too, although most of the differences did favor the M95HE. Of course, we could not measure record wear, which should be appreciably lower with the greater contact area of the hyperelliptical stylus.

The M95HE supplements, but does not supplant, the M95ED in the Shure line. Anyone about to replace a worn stylus on the M95ED would do well to choose an N95HE, but it would be harder to justify replacing a good N95ED stylus with the N95HE just to modernize. While these two siblings can be distinguished on the basis of audible and measured performance, it is the family resemblance that prevails. It may be that reduced record wear, a fairly intangible factor hard to confirm through measurement, will tip the balance in favor of the M95HE.

**Circle No. 102 On Free Information Card**

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**Lectrotech Model PPI-400**
Dual-channel
Peak Power Indicator

**THE Lectrotech Model PPI-400**
dual-channel, LED peak-power indicator is suitable
for monitoring the outputs of a stereo or two mono power amplifiers. It indicates power levels over a 30-dB range on two vertical columns of LEDs. A range switch provides 18 calibration points for the 0-dB level (six power levels at impedances of 4, 8, and 16 ohms). The indicator can also be calibrated to any other power or impedance over a very wide range by connecting appropriate resistances across terminals on the rear apron. The 0-dB power level can be set anywhere from 3 to 1250 watts at 8 ohms or over a different power range for impedances between 2 and 35 ohms.

The device can be connected across the speaker outputs of an amplifier or across the input terminals of the speaker systems themselves. It measures 14"W x 8"D x 3.75"H (35.6 x 20.3 x 9.5 cm) and weighs 3.5 lb (1.6 kg). Suggested retail price is $129.95 (plus $24.95 for optional No. LWC-1 walnut cabinet).

**General Description.** Each column of power indicators consists of eight calibrated LEDs. The bottom four are green LEDs and are labelled -30, -28, -24, and -12 dB. The next two are yellow LEDs and are labelled -9 and -6 dB. Finally, the top two LEDs are red and are labelled -3 and 0 dB. If the red LEDs flash during operation, it can be assumed that the amplifier is being overloaded or is being driven too close to its limits. This, of course, assumes that 0 dB corresponds to the amplifier's rated maximum output power.

The seven-position range switch has six positions calibrated in watts full-scale from 25 to 800 at a 4-ohm impedance. Separate inner scales are used for 8- and 16-ohm loads, with 0-dB power levels corresponding to 12.5 to 400 watts full-scale at 8 ohms and 6.25 to 200 watts full-scale at 16 ohms. The seventh position, labelled aux, can be used with the optional calibration procedure to set the 0-dB sensitivity for almost any power and impedance level one wishes.

The Model PPI-400 is shipped from the factory with its calibration terminals connected together by jumper links and the aux sensitivity set for 6.25 watts into 4 ohms for a 0-dB level indication. (This is 6 dB more sensitive than the lowest standard range.) By replacing the links with suitable resistances, their values determined according to a formula given in the owner's manual, the 0-dB sensitivity can be set as desired.

Although the accuracy of the 0-dB calibration depends on the accuracy of the resistors, the relationship between it and other power-level LEDs is fixed by the internal design of the Model PPI-400. (Precision resistors are available from Lectrotech.) Since the two channels are fully independent of each other, it is possible to set each for a different 0-dB reference.

**Laboratory Measurements.** We connected the Model PPI-400 across an amplifier capable of developing the 60 volts or so required to activate its highest level LEDs. We then drove both channels in parallel to check the device's tracking.

The accuracy of the LED displays was checked at 1000 Hz. At each setting of the range switch, we increased the signal level until each of the LEDs in turn began to glow at its maximum brightness. The actual voltage applied to the device was then measured with an accurate meter and converted to an equivalent power level. Since the LEDs are not driven by a flip-flop or similar circuit, there was some ambiguity as to exactly when each LED was just on. The LEDs began to glow well below the level that produced full brightness, which resulted in an uncertainty factor of a couple of decibels when reading the display. In every case, however, the two channels behaved in identical manner.

The readings we obtained were consistently low. (The indicated power was less than the actual power.) If we had elected to use the point at which a LED first began to glow as our measuring criterion, the error would have been even greater. The error was not significant in any case, measuring about 1 dB and a maximum of 2 or 3 dB near the -24-dB indicator.

We measured the response of the device with 1000-Hz tone-burst signals. As we changed the duty cycle from continuous to 4 cycles on and 128 cycles off, the error did not exceed 1 dB. Sensitivity was up about 0.7 dB at 20 Hz and down 4.4 dB at 20,000 Hz, relative to 1000 Hz.

**User Comment.** In view of its intended application as a peak-power indicator (not a meter), the errors we observed in the Model PPI-400 are of no significant import. The device does a fine job of displaying the actual operating signal levels—both average, shown by the number of LEDs lighted during any passage, and peak. (Even the briefest peak registers visibly on the display.)

The PPI-400 is easy to connect into an audio system, and its LED displays are clearly visible and easy to interpret even from a distance.

The owner's manual refers to the use of the Model PPI-400 as a speaker-system phasing checker. This is not entirely accurate, since all it can check is a polarity reversal of the two sets of signal leads coming from the amplifier to the speaker systems and to the device itself. Actual phasing of the connections at the speaker systems can have no effect on the behavior of the Model PPI-400.

A power-on indicator in the Model PPI-400 would have been a welcome addition. Its absence, for example, caused us to unwittingly leave the device powered for days on end. But even leaving it powered continuously, the PPI-400 operated coolly, even under full-load conditions.

In sum, this was one of the most versatile and inexpensive peak-power indicators we have used. It is attractive, flexible, and does exactly what it is supposed to do. Such a device can be an educational addition to an audio system.

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FREQUENCY COUNTER CONSUMER DATA COMPARISON CHART

<table>
<thead>
<tr>
<th>MANUFACTURER</th>
<th>MODEL</th>
<th>SUG/STD. LIST PRICE</th>
<th>FREQUENCY RANGE</th>
<th>TYPE OF TIME BASE</th>
<th>ACCURACY OVER TEMPERATURE</th>
<th>SENSITIVITY</th>
<th>DIGITS</th>
<th>PRE-SCALE INPUT RESOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSI INSTRUMENTS</td>
<td>100 HH</td>
<td>$99.95 500Hz-100MHz TCXO</td>
<td>1 PPM</td>
<td>100 Hz 25 MHz 250 MHz 250 MHz 450 MHz 500 MHz 500 MHz</td>
<td>10 Hz</td>
<td>1 SEC</td>
<td>5 SEC</td>
<td></td>
</tr>
<tr>
<td>DSI INSTRUMENTS</td>
<td>500 HH</td>
<td>$149.95 500Hz-500MHz TCXO</td>
<td>2 PPM</td>
<td>25 MV NA NA NA</td>
<td>10 Hz</td>
<td>1 SEC</td>
<td>5 SEC</td>
<td></td>
</tr>
<tr>
<td>CSCI</td>
<td>MAX-550</td>
<td>$149.95 1kHz-500MHz Non-Compensated</td>
<td>3 PPM @ 25°C</td>
<td>8 PPM</td>
<td>10 Hz</td>
<td>1 SEC</td>
<td>5 SEC</td>
<td></td>
</tr>
<tr>
<td>OPTOELECTRONICS</td>
<td>OPT-700</td>
<td>$139.95 1Hz-100MHz TCXO</td>
<td>3.2 PPM</td>
<td>500 MV 250 MV 250 MV</td>
<td>10 Hz</td>
<td>1 SEC</td>
<td>5 SEC</td>
<td></td>
</tr>
</tbody>
</table>

The specifications and prices included in the above chart are as published in manufacturer's literature and advertisements appearing in early 1979. DSI INSTRUMENTS only assumes responsibility for their own specifications.

100 HH...$99.95 W/Battery Pack...$119.95
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A flooded basement is a minor household disaster. That's why most homeowners whose basements are prone to flooding install sump pumps. Some, however, have discovered to their chagrin that the pump somehow fails to operate when it is most needed. In many instances of failure, the pump itself is actually in perfect working order. Rather, it is the water-detecting actuator switch that's the culprit, never sending a turn-on command to the pump.

Here's a simple, dependable circuit to replace the often-unreliable (usually mechanical) switch supplied as part of the pump assembly. It will automatically activate the pump when the water level reaches the level of a pump trigger probe. Once activated, the pump will remain energized until the water level falls below a keep-alive probe. If the pump fails or cannot keep the water in check, an optional alarm will sound as the water level reaches a trigger probe specifically for that purpose. The project can be powered either by batteries or the ac line. Inexpensive components are employed, most of which will be found in any well-stocked junk box.

**About the Circuit.** The Electronic Sump Pump Switch is shown schematically in the figure. Positive voltage from the power supply is applied to the common probe via resistors R1 and R2 (This and all other probes are stiff wires or metal rods suspended above and extending to different levels in the sump.)

**Solid-state level-sensing switch for sump pumps**

By Phillip Windolph

Replaces often-unreliable pump switch and sounds alert if water level continues to rise or pump isn't working.
As can be seen in the figure, the COMMON probe extends almost to the bottom of the sump. Any water entering the sump comes into contact with this probe, but as yet nothing which would cause activation of the pump happens.

As the water level in the sump rises, the KEEP-ALIVE probe touches the water, but this still does not activate the pump. If the water reaches the level of the PUMP TRIGGER probe, current can flow from the positive supply voltage terminal through R1, R2, the water in the sump, R5 and finally into the base of Q3. This transistor then turns on and provides base current for Q4. When Q4 conducts, it energizes the coil of relay K1.

Once this relay is energized, the normally open contacts are closed and two things happen. Line current is able to flow through the coil of K2, a heavy-duty ac relay. Also, the path between the KEEP-ALIVE probe and the base of Q3 is completed. Energizing K2 provides line voltage across S01 for the pump. If the sump pump is connected to the socket, it will be activated and will start to pump the water out of the sump.

As the water level drops, the conductive path provided by the water in the sump between the COMMON and PUMP TRIGGER probes will be interrupted. However, current will continue to reach the base of Q3 via the KEEP-ALIVE probe, R7, and one set of contacts of relay K1. Because this probe extends almost to the bottom of the sump, relays K1 and K2 remain energized (as does the pump motor) until practically all of the water has been evacuated. When the water level drops below the free end of the KEEP-ALIVE probe, Q3 is deprived of base current and is cut off. This causes Q4 to stop conducting, deenergizing K1, K2 and the pump motor.

If the pump motor fails or cannot cope with the amount of water entering the sump, the water level will rise above the PUMP TRIGGER and KEEP ALIVE probes and eventually reach the ALARM TRIGGER probe. This probe is part of the optional alarm circuit and should be mounted near the top of the sump. Although the alarm circuit is independent of the pump controller, it is a valuable addition to the project.

The alarm circuit closely resembles that of the pump controller and operates in a similar manner. Water reaching the ALARM TRIGGER probe provides a path for current to reach the base of Q1. This transistor begins to conduct and provides base drive for Q2. Transistor Q2 then conducts and completes the circuit for audible alarm A1, which alerts the homeowner to the fact that water in the sump has risen to a critically high level. He can then try to get the pump working

---

**PARTS LIST**

- A1—DC-energized buzzer. bell, Sonalert™ or similar audible alarm *
- C1—0.1-µF, 1000-volt disc ceramic
- D1, D2—1N4001 rectifier
- F1—Fast-blow fuse *
- K1—DC-energized relay *
- K2—117-volt relay *
- Q1 through Q4—2N2222 or similar npn switching transistor *
- R1—39,000 ohms *
- R2 through R7—1000 ohms *
- S1—Normally open pushbutton switch
- S2—Miniature spdt toggle switch
- S3—2pdt toggle switch *

Pump switch. Water in the sump provides a path for base current.

---

The following are ½-watt, 10% tolerance carbon-composition resistors:

<table>
<thead>
<tr>
<th>Component</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>39,000 ohms</td>
</tr>
<tr>
<td>R2 through R7</td>
<td>1000 ohms</td>
</tr>
</tbody>
</table>

Misc.—Line-powered, regulated or battery dc supply *, suitable enclosure; barrier terminal strip; perforated board; fuseholder; line cord; metal rods or stiff, solid-conductor wire; hookup wire; solder; self-tapping and machine hardware, etc.

*See text.
or, if necessary, bail the water out of the sump manually.

Two switches are associated with the alarm circuit and one switch is included in the pump controller. These switches provide test facilities for the alarm and pump (S1 and S3, respectively) and the ability to silence the alarm (S2). The currents handled by S1 and S2 are relatively small, so miniature components can be used in these locations. Switch S3, however, as well as the contacts of K2 must be capable of handling the current demanded by the pump motor, so use heavy-duty components.

The author employed a solenoid/spring-type buzzer as his prototype's audible alarm. Diode D1 is connected across the buzzer to protect Q2 from inductive spikes generated by the buzzer. Other types of alarms can be used, some of which will not require the inclusion of D1. A Sonalert™ or similar audio oscillator will not necessitate diode protection for Q2, but an alarm bell will.

Which type of audible alarm you choose is largely a matter of personal preference and parts availability. Similarly, there is a great deal of leeway in the choice of components Q1 through Q4 and R1 through R7. General-purpose 2N2222 transistors are suggested in the parts list. Just about any low-power npn transistor is suitable for use as Q1 and Q3. Exactly which transistor types are acceptable for use as Q2 and Q4 depends on the audible alarm and relay (K1) used. If the current demand of either load is fairly low, say, 300 mA or less, a general-purpose component such as type 2N2222 can be used as a relay or alarm driver.

However, if a load draws more than 300 mA, a higher-power driver will have to be used. A good rule of thumb is to use a transistor with a collector current rating that is double the current required by the alarm or relay coil. The author employed a sensitive 6-volt relay for K1 (Sigma No. 70R4T-6DC), which permitted the use of a low-power npn driver. Diode D2 was included to protect the relay driver from inductive spikes.

The values specified for the fixed resistors (R1 through R7) are nominal ones. Substitutions can be made freely if you want to use components you have on hand. However, do not make the fixed resistances so low that they tax the base current ratings of the transistors employed in the project.

Either a line-powered or battery supply can be used for the project. The exact value of supply voltage is not critical and can be chosen to accommodate a particular dc relay (K1). Practical supply voltages range from 6 to 15 volts. Although it is not necessary, voltage regulation is desirable in a line-powered supply. The widespread availability of voltage regulator ICs makes the inclusion of regulation simple and inexpensive.

If the alarm circuit is included in the project, battery power enjoys a significant advantage over a line-powered supply—it will still provide power to the project if the commercial power line is blacked out. Of course, if line power is not available, the pump motor will not be activated, even though K1 will be energized. The alarm circuit, however, will be activated if the water in the sump rises to the level of the ALARM TRIGGER probe. This will alert the homeowner that water is accumulating and had best be bailed out before any damage occurs. Also, when neither the alarm nor pump controller circuit is triggered, practically no current is drawn from the battery supply. If nonrechargeable batteries are used to power the project, long operational life can be expected.

Construction. The circuit is relatively simple, which suggests the use of perforated board and point-to-point wiring techniques. Remote mounting of the alarm and pump controller circuits will simplify any future servicing. If this is done, the circuit board, relays, switches and power supply can be housed in a suitable enclosure which can be installed at some convenient location.

A four-terminal barrier strip can be mounted on the control box for the leads running to the sump probes. These probes can be fashioned from either metal rods or lengths of solid No. 12 or No. 14 copper wire and should be mounted rigidly above the sump. The probes are of varying length, with the COMMON probe extending almost to the bottom of the sump, the KEEP-ALIVE probe extending almost as deeply, the PUMP TRIGGER probe reaching about halfway down, and the ALARM TRIGGER probe extending only a short distance into the sump. Suitable lengths of hookup wire should be soldered to the probes and routed to the barrier terminal strip on the control box.

When constructing the control box, be sure to observe the polarities of all semiconductors and, if a line-powered supply is built in, of electrolytic capacitors. Use the minimum amount of solder and heat consistent with making good connections. Take special care in wiring the 117-volt ac portions of the project so that no shock hazard is present.

Checkout and Installation. After the control box has been wired, connect short lengths of hookup wire to the barrier terminal strip. Remove a portion of the insulation from the free end of each wire. Next, fill a drinking glass or measuring cup with water and place the wire connected to the COMMON probe terminal into the water. Place the wire connected to the KEEP-ALIVE probe terminal into the water. (Keep these and all probes from touching each other to realistically simulate actual operation. No damage will occur, however, if the probes accidentally come into contact.) Activation of the pump controller, indicated by a click as the relays are energized, should not yet happen.

Now insert the wire connected to the PUMP TRIGGER probe terminal into the water. You should hear a click as the relays are energized. If desired, a lamp can be connected to power socket S01 and the line cord connected to the power line (assuming this has not yet been done). The lamp will then indicate that the relays are energized and that line power is reaching socket S01.

Remove the PUMP TRIGGER wire from the water. The relays should remain energized and no click should be heard. Then remove the KEEP ALIVE wire from the water. At this time, the relays should drop out and a click heard. Finally, insert the ALARM TRIGGER wire into the water. The alarm should sound and remain on until the wire is removed from the water.

Press the ALARM TEST pushbutton and keep it depressed. The alarm should sound and remain activated until the ALARM DEFEAT switch is opened. The operation of the PUMP TEST switch can be checked by closing it and observing whether the load connected to socket S01 receives line power.

Once it has been determined that the control box is functioning properly, a permanent installation can be made. Mount the control box at some convenient point and interconnect it with the sump probes and pump motor. Be sure to bypass the stock pump-activating switch as it is no longer needed. As a final check, you can quickly fill the sump with water. The alarm should sound until the pump has lowered the water level beyond the reach of the ALARM TRIGGER probe. The pump should remain on until the KEEP ALIVE probe is no longer immersed, at which point nearly all of the water will have been taken out. (Projects continued overleaf) .
2. Vehicle low-fuel indicator

Running out of gas can be an exasperating experience. The low-fuel indicator described here can help you avoid this situation. It will sound an alarm when the fuel level in your gas tank reaches a predetermined minimum. This level can be preset by a simple potentiometer adjustment.

Circuit Operation. In most vehicles, the fuel-level sensor is a float-controlled potentiometer (sender) wired in series with the dashboard-mounted fuel gauge (meter) and connected between the chassis and +12-volt line as shown in Fig. 1. As the fuel level changes, the resistance changes, making the meter indication change.

The voltage level thus generated across the fuel-level sensor can be tapped off (at the meter) and, as shown in Fig. 2, applied through a low-pass filter R8-C4 so that the voltage across C4 is the average across the sender. This low-pass filter also eliminates any rapid voltage fluctuations due to gasoline sloshing and a bouncing sensor float, or voltage transients generated by the switching voltage regulator as used in some vehicles.

The C4 voltage is applied to the non-inverting (+) input of comparator IC1, and rises with decreasing fuel in the tank. When this voltage exceeds the R4 preset voltage on the inverting (-) input, the output of IC1 (pin 6) goes high.

This voltage (approximately 9 volts) is high enough to cause zener diode D6 to conduct and turn on transistor Q1. When turned on, this transistor draws current through audible alarm A1, and turns on optional indicator LED1.

As long as the fuel level is low, the output of IC1 remains high. To silence the alarm until the tank is filled, CANCEL switch S1 is depressed to trigger SCR1. When triggered, the SCR brings the junction of R5-D6 (the input to Q1) down to approximately 2.2 volts, which is not high enough to cause D6 to conduct and activate the alarm circuit. Since the SCR is powered by dc, it will remain turned on as long as the IC1 output is high (the fuel level is low).

As long as SCR1 is conducting, there will be about 1.2 volts (two diode drops) across D7 and D8, enough to turn on Q2 and cause LED2 to operate. This LED is a special type that incorporates a built-in flasher circuit that makes the LED flash at a 2.5-Hz rate as long as the LED is

(Continued on page 40)

Cable on author’s prototype has connector for +12 volts, ground and tank sender unit.
PARTS LIST

A—Sonalert, buzzer or other 12-volt alarm
(Radio Shack 273-060 or similar)
C1, C2—100-µF, 25-V aluminum electrolytic
C3, C5—0.1-µF, 25-V disc or Mylar
C4—300-µF, 15-V tantalum electrolytic
D1, D7, D8—1N914
D2—1N5742, 18-V, 400-mW zener
D3, D4, D9—1N751A, 5.1-V, 400-mW zener
D5—1N4001
D6—1N5732, 6.8-V, 400-mW zener
IC1—3140E op amp
LED1—red LED
LED2—Litronix FRL-4403 flashing LED (Radio Shack 276-036)
Q1—2N3053 or similar
Q2—2N3904 or similar
R1, R11—100 ohms
R2—33 ohms
R3, R5, R12—470 ohms
R6—10 megohms
R7—470,000 ohms
R8—33,000 ohms
R9—330 ohms
R10—10,000 ohms
R13—820 ohms
R14—200 ohms
R4—25,000 ohm potentiometer
SCR1—2N5062
S1—normally open pushbutton switch
Misc.—Suitable enclosure (Radio Shack 270-285 or similar), interconnecting leads, mounting hardware
Note: The pc board (LF-2) is available for $4.50 plus S1 postage/handling from BFA Electronics, P.O. Box 212, Northfield, OH 44067. Ohio residents please add sales tax.

Printed circuit board mounted in prototype with alarm and CANCEL switch on top.

Fig. 2. Comparator IC1 turns on when fuel drops below some predetermined level, and sounds the alarm. The SCR circuit energizes a flashing LED during the Cancel mode.
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John E. Cunningham
Special Projects Director
Cleveland Institute of Electronics
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Low-cost Projects continued...

powered. The maximum voltage permitted across this special LED is 6 volts, hence the presence of 5.1-volt zener diode D9.

The incoming dc power line is noise decoupled by R1, C1 and C3. Zener diode D2 clamps any transients to a maximum of 18 volts while diode D1 makes sure that the correct polarity is supplied to IC1. Filter R2-C2 decouples the power line to the alarm and indicator circuit. Diode D5 clamps any voltage spikes that may occur if an inductive load, such as a buzzer, is used as the alarm. Resistor R6, connected between the output of IC1 (pin 6) and the noninverting (+) input, adds a small amount of positive feedback to give the comparator a little hysteresis and speed up the transition from low to high. This also reduces the likelihood of comparator oscillation.

Construction. The circuit may be constructed on perf board, Wire-Wrapped, or on a pc board such as that shown in Fig. 3 along with the component installation.

The two LED indicators, cancel switch S1, level-select potentiometer R4, and the selected audible alarm are not mounted on the pc board.

The finished pc board can be mounted within a selected enclosure that will also mount the off-board components. Power can be derived from any +12-volt source that becomes active when the vehicle ignition key is operated. The ground can be any convenient metal element that is solidly connected to the vehicle chassis.

You will have to locate the dashboard end of the fuel sensor lead. Test this lead by measuring the voltage across it with various levels of fuel. Usually, the lower the fuel level, the higher the voltage. It is possible for this voltage to vary due to the action of the vehicle switching voltage regulator (if your vehicle uses one) so this must be considered.

If you have any doubt as to the type and wiring of the fuel-level sensor in your vehicle, consult the vehicle repair manual.

Calibration. There are two ways to calibrate the system. The first is to wait until the fuel level is down to the selected low level, then adjust R4 until the alarm sounds off.

The second approach is to disconnect the fuel gauge from its feed line to the fuel sender but leave the lead connected to the low-fuel alarm, then connect a resistor-substitution box between the fuel gauge and ground (as a substitute for the fuel sender). Adjust the value of the resistor until the fuel gauge indicates the desired level. Adjust R4 to sound the alarm at that point. Disconnect the resistor box and replace the fuel sender line.

Once the fuel-level turn-on point has been determined, depress S1 to silence the alarm. After the tank is filled, the alarm will be reset until the fuel level drops below the predetermined point.
3. Portable gas leak meter

Ultra-sensitive instrument gives quantitative indication of natural gas, propane, fuel vapors, etc.

TOXIC and explosive gases are an ever-present danger in our modern society. They include natural gas, propane, fuel vapors, and invisible and odorless carbon monoxide.

The ultra-sensitive gas-leak detector presented here indicates the quantitative presence of these gases and enables one to track down and pinpoint the source of a gas leak by observing the unit's meter indication. Moreover, it is a portable, battery-powered model for use in boats, automobiles, at campsites, or in any other location where AC power is not available. (An ac-operated noxious gas detector with an audible alarm for preset gas levels was described in a project that appeared in POPULAR ELECTRONICS, August 1976.)

**Circuit Operation.** The gas sensor, GS1 in Fig. 1, consists of an electrically heated tin-oxide pellet that changes resistance when exposed to carbon monoxide, hydrogen, propane, alcohol, gasoline vapor, and other oxygen-reducing gases. Power for the circuit can be obtained from either six D cells, preferably rechargeable, connected in series or from an optional 9-volt battery eliminator. Regulator IC1 reduces the available 9-volt level to the 5 volts required by the circuit. Optional LED1 is a 9-volt power-on indicator. Current from the regulator heats gas sensor GS1's semiconductor pellet. The sensor, R4, R7, and R8 are arranged in a bridge configuration. The null indicator consists of M1 and R6, while D1 and D2 serve as protection for M1. Overall circuit sensitivity is determined by the value of resistor R5, while S2 provides a BATT TEST function.

Once the bridge is balanced, by null potentiometer R8, any change in the resistance of GS1 will create an unbalanced condition. When this occurs, the meter's pointer swings up-scale, by an amount proportional to the change in resistance of GS1.

**Construction.** With the exception of GS1, J1, M1, B1, R8, S1, and S2, the circuit can be assembled on a piece of perforated board. Select an enclosure large enough to accommodate the board and all off-board components, including B1 and its holder.
Low-cost Projects continued...

Mount the meter movement on one side of the enclosure's front panel, the remaining off-board components (except B1 and J1) on the other side of the panel. The battery holder and optional battery-eliminator/charger jack J1 are best mounted on the rear wall of the enclosure. If desired, GS1 can be mounted either directly on the front panel or in a separate housing, the latter fitted with a cable to connect it to the main enclosure. The sensor itself takes a miniature 7-pin tube socket.

After the project is assembled, install a fresh set of D cells in the battery holder and optional battery-eliminator/charger jack J1 are best mounted on the rear wall of the enclosure. If desired, GS1 can be mounted either directly on the front panel or in a separate housing, the latter fitted with a cable to connect it to the main enclosure. The sensor itself takes a miniature 7-pin tube socket.

After the project is assembled, install a fresh set of D cells in the battery holder and optional battery-eliminator/charger jack J1 are best mounted on the rear wall of the enclosure. If desired, GS1 can be mounted either directly on the front panel or in a separate housing, the latter fitted with a cable to connect it to the main enclosure. The sensor itself takes a miniature 7-pin tube socket.

Operation. Set S1 to ON and allow the sensor to heat up for about two minutes. Set S2 to BATT, TEST and check that sufficient voltage is available from the battery. (A set of fresh D cells will last about 20 hours. An external 9-volt battery-eliminator/charger can be used.)

After the sensor has warmed up, settle S2 to RUN and, in a neutral atmosphere, adjust NULL control R8 until the meter indicates zero. Now, place a drop of alcohol or gasoline on a finger and approach the sensor. The meter pointer should swing up-scale. Move the finger away from the sensor; it will take a minute or so for the sensor to settle back for the next measurement. Readjustment of R8 may be necessary occasionally. If setting time is too long, change R7 to 1000 ohms.

When looking for a gas leak, note locations where the meter swings upscale to narrow down the location.

4. Electronic pedometer for Joggers

By Andrew A. Modla

How to convert a calculator into a pedometer to record distance covered while walking or jogging.

A pocket calculator can be converted to operate as an electronic pedometer to keep an ongoing tally of the number of steps taken while walking and jogging. Then, with a simple conversion, you can use the calculator to determine the number of yards, meters, miles, or kilometers travelled. Although the conversion described here is "hard wired" into the calculator, you sacrifice none of the calculator's basic built-in capability.

Calculator Conversion. The first thing you must do is determine whether...
Footswitch Fabrication. As shown in the drawing, the footswitch is fabricated from a commercially available “air-pillow” foam insole. Begin by cutting a 1” (25.4-cm) square away from the center of the heel area of the insole. Cement a square of copper-coated Mylar or any other flexible conductive material over the cutout on both sides of the insole, conductive surfaces face-to-face. Solder the free ends of the flexible wires from the calculator to the conductive material. Then cover the “switch” assembly with duct or other durable tape to keep out dirt and moisture.

Slide the insole into your shoe and put on the shoe. Turn on the calculator and key in 1, +, 1. Now, as you walk around, the display should read 2, then 3, then 4, etc., as you successively put weight on the switch shoe with each step. If you do not obtain these results, turn off the calculator and carefully check out the switch arrangement.

Determining Distance. Every time you use the pedometer, you must first key in 1, +, 1. Thereafter, the calculator increments the display by 1 for each step taken by the shoe in which the switch is installed. To determine how far you have run or walked, you must find out how many steps you take in a given measured distance (mile, kilometer, etc.). You must, therefore, measure off the “control” distance and walk or run it to determine how many steps are required to cover the course.

Let us assume you wish to know how many miles you have walked and have previously determined that it takes you 1056 steps to walk a mile. (Note that a step is two strides. If the switch is in your right shoe, a step is completed every time you set down your right foot.) Now, subtract 1 from the total displayed by the calculator. This is necessary because the first step you take will register 2. If we assume you stopped at 7200 steps, simply divide this number by 1056, your “control” number, using the calculator to obtain the number of miles walked. Therefore, 7200/1056 = 6.82 miles.

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GOOD RADIO reception depends as much on a good antenna as it does on a "hot" radio receiver. This is especially true with modern public-safety-band vhf/uhf scanning monitors, which almost invariably have high sensitivities in the range of 0.5 µV or better. Aside from the usual whip antenna supplied with the scanning monitor, there are few commercially made antennas available for working vhf and uhf.

Fortunately, there is an alternative to a commercially made vhf/uhf antenna. A standard TV antenna can be "tailored" to provide excellent reception on the public safety bands. In this article, we will describe how this can be done and give you some idea of how the modified TV antenna stacks up against a popular high-performance discone antenna.

Antenna Theory. The standard whip antenna supplied with scanning monitors is generally adequate for city-wide reception of repeaters and base stations. However, when an external antenna is connected to the scanner to improve weak-signal reception, all signal

Make-it-yourself antenna improves reception of public services

SCANNER BEAM PINPOINTS THE ACTION!

BY ROBERT GROVE
levels increase dramatically—including the levels of local signals. This can lead to problems. The most serious forms of scanning monitor interference are front-end overloading and intermodulation distortion, recognized by their frequent recurrence throughout the tuning range of the receiver. Images from aircraft communication and FM and TV signals that pop up in the middle of the public safety bands are another problem.

The problems that plague the public-safety-band listener are especially severe in metropolitan areas. The problem is compounded with the use of omnidirectional ground-plane antennas that respond equally well in all directions. What is really needed to maximize reception is a beam antenna with high forward gain and greatly limited side and rear gain. Such an antenna can be aimed at the transmitting source to zero in on that single signal to the virtual exclusion of other signals that can interfere with and mask the desired signal.

A few modifications to a low-cost TV antenna can produce an excellent beam antenna for vhf/uhf public-safety-band monitoring. We modified a Radio Shack “Super Color Special” (similar to the Model VU-90) antenna for our purposes. The results we obtained were so satisfactory that no further experimentation was necessary.

The TV antenna employs a log-periodic design in which every element is cross-connected to the feed line. The antenna is actually a series of center-fed dipoles, each slightly different in length to resonate at a slightly different frequency. The dipoles are connected to a common feedline. The response of the elements is related to the logarithm of the frequency; hence, the name log-periodic dipole array.

Electrically, elements that are not resonant at the frequency to which a receiver is tuned at any given moment behave like directors and reflectors. This endows the antenna array with both directivity and gain. The elements of a log-periodic antenna are incrementally shortened from the longest wavelength at the lowest frequency to the shortest wavelength at the highest frequency, which gives the antenna a characteristic V-shaped outline.

Each dipole is used at two frequencies—its resonant half-wave (λ/2) frequency and its three-half-wave (3λ/2) frequency. Hence, the longest element performs on 140 and 420 MHz, while the shortest element performs on 174 and 522 MHz. Also, because of the large diameter of the elements, compared to their length, the dipoles are very broadband. This makes the modified antenna usable over a range from well below 130 to beyond 174 Mhz in its λ/2 mode and from below 400 to beyond 550 MHz in its 3λ/2 mode.

With the antenna erected, you will note that its elements are angled forward. This is done to merge the front lobes of the characteristic cloverleaf pattern that occurs on any 3λ/2 dipole. The result is that the directivity of the antenna is considerably increased.

When used for TV only applications, the Radio Shack Super Color Special (as well as the Model VU-90) antenna offers an average gain of 4 to 6 dB (about 1 S unit) over a single dipole. Its front-to-back ratio is around 12 dB. Antennas with more elements will provide better gain and directivity figures.

Because the feed impedance for the antenna is approximately 300 ohms or less, a standard 4:1 TV Balun matching transformer is required between the antenna and the coaxial line you will be using. You need not concern yourself about the impedance of the feed line; either 50- or 75-ohm coax will work fine. For cable runs in excess of 50' (15.2 m), use RG-8/U foam dielectric coax. Although new dry 300-ohm twin-lead feed cable is low in losses, when it gets old, wet, and cracked, it causes more problems than it is worth. It is for this reason that coaxial cable is recommended industry-wide for two-way radio communication and commercial TV signal distribution systems.

Modification. Referring to the drawing, saw off the entire boom section that contains the 6" (15.2-cm) elements in front of the corner reflector. Be careful to avoid damaging the longer element closest to the reflector (this element is connected to the antenna's cross-feed system) or any of the reflector elements.

Next, cut the longest pair of angled elements to a length of 20" (50.8 cm) on each side of the boom. This 40" (101.6-cm) dipole is now cut for 140 and 420 MHz. Now, cut the shortest pair of angled elements to 16" (40.6 cm) on each side of the boom. This 32" (81.2-cm) dipole is now cut for 170 and 510 MHz.

Once the longest and shortest elements are trimmed to size, the remaining elements can be proportionately trimmed so that the outline of the antenna will have a characteristic V shape. You simply place a straightedge on each side of the antenna so that it touches the extreme ends of the cut elements and locate the cut points for the remaining elements. In the case of the Super Color Special and Model VU-90 antennas, the
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How It Performs. We made comparison checks between the modified TV antenna and an excellent commercially available vhf/uhf discone monitor antenna. Signals that were barely readable on vhf with the discone antenna came in substantially stronger with the modified beam antenna. More important was the fact that signals from the back of the antenna were noticeably reduced and those off to the sides were deeply attenuated with the beam, all of which contribute to a reduction in interference and an overall improvement in reception. The modified beam performed even better on uhf than it did on vhf. Signals improved from "barely-discernable" to "full-quieting."

Our experience with the modified beam makes it clear that this antenna is an excellent choice for listeners who are plagued by strong nearby transmitters and experience weak incoming signals. The modified beam even has the added advantage that it works well on the 2-meter amateur radio band; just be careful to avoid pumping more than a few watts into the Balun to avoid overheating. Happy listening.
BASIC programs for Ohm's law, resonance, and inductive formulas using a Level-1 machine with 4K of RAM

SIMPLE TRS-80 PROGRAMS SOLVE ELECTRONICS CALCULATIONS

BY ROY BABYLON

The following programs were designed to be run on a Level-1 TRS-80 microcomputer having 4K of memory. All the programs are self-prompting when run and are readily adaptable to any other BASIC. (The square-root subroutine can be eliminated if your particular BASIC has a built-in square-root function.)

Ohm's Law. This program, shown in Table 1, is fairly short and has no subroutines. Line 40 selects the unknown resistance, voltage, current or power. Lines 70 through 100 are used to determine the unknown resistance; lines 110 through 150 are for current, while lines 145 through 160 are used to determine the voltage. Once the current (I) and resistance (R) have been determined, line 295 displays the wattage.

The program shown in Table 2 can determine frequency of a tuned circuit when C and L are known, or can determine either C or L if the desired resonant frequency and one of these two elements are known. The program will also determine the Q of a series or parallel tuned circuit, bandwidth and/or the impedance. The square-root subroutine used in determining resonant frequency is called at line 220.

Inductive Formulas. Table 3 illustrates a program that will determine instantaneous voltage, inductance of a single-layer coil, inductive/resistive time constant, the values of series and/or parallel inductors, the Q of a coil, inductive reactance and impedance of an inductive/resistive circuit. The only subroutine used (square root) is called at line 720, with this subroutine residing at line 30000.

Table 1—Ohm's Law

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>15</td>
<td>CLS</td>
</tr>
<tr>
<td>20</td>
<td>P.T. (20): &quot;OHM'S LAW FORMULAS&quot;</td>
</tr>
<tr>
<td>30</td>
<td>P. &quot;SELECT NUMBER FOR DESIRED FUNCTION&quot;</td>
</tr>
<tr>
<td>40</td>
<td>IN. &quot;RESISTANCE = R, CURRENT = C, VOLTAGE = V, POWER = P&quot;; A</td>
</tr>
<tr>
<td>60</td>
<td>IF A = R, G.70</td>
</tr>
<tr>
<td>62</td>
<td>IF A = C, G.110</td>
</tr>
<tr>
<td>65</td>
<td>IF A = V, G.145</td>
</tr>
<tr>
<td>67</td>
<td>IF A = P, G.180</td>
</tr>
<tr>
<td>70</td>
<td>IN. &quot;ENTER VOLTAGE IN VOLTS&quot;; E</td>
</tr>
<tr>
<td>80</td>
<td>IN. &quot;ENTER CURRENT IN AMPERES&quot;; I</td>
</tr>
<tr>
<td>100</td>
<td>P. &quot;THE RESISTANCE EQUALS&quot;; E/I; &quot;OHMS&quot;</td>
</tr>
<tr>
<td>105</td>
<td>END</td>
</tr>
<tr>
<td>110</td>
<td>IN. &quot;ENTER VOLTAGE IN VOLTS&quot;; E</td>
</tr>
<tr>
<td>120</td>
<td>IN. &quot;ENTER RESISTANCE IN OHMS&quot;; R</td>
</tr>
<tr>
<td>130</td>
<td>P. &quot;THE CURRENT IS EQUAL TO&quot;; E/R; &quot;AMPERES&quot;</td>
</tr>
<tr>
<td>140</td>
<td>END</td>
</tr>
<tr>
<td>145</td>
<td>IN. &quot;ENTER CURRENT IN AMPERES&quot;; I</td>
</tr>
<tr>
<td>150</td>
<td>IN. &quot;ENTER RESISTANCE IN OHMS&quot;; R</td>
</tr>
<tr>
<td>160</td>
<td>P. &quot;THE VOLTAGE IS&quot;; &quot;VOLT;&quot; VOLTS WITH &quot;V;&quot; &quot;OHMS&quot; AND &quot;I;&quot; &quot;AMPERES&quot;</td>
</tr>
<tr>
<td>170</td>
<td>END</td>
</tr>
<tr>
<td>180</td>
<td>IN. &quot;ENTER MISSING VARIABLE R,I,E,B; B</td>
</tr>
<tr>
<td>190</td>
<td>IF B = R, G.210</td>
</tr>
<tr>
<td>195</td>
<td>IF B = I, G.90</td>
</tr>
<tr>
<td>200</td>
<td>IF B = E, G.270</td>
</tr>
<tr>
<td>210</td>
<td>IN. &quot;ENTER CURRENT (I)&quot;; I</td>
</tr>
<tr>
<td>220</td>
<td>IN. &quot;ENTER VOLTAGE (E)&quot;; E</td>
</tr>
<tr>
<td>230</td>
<td>P = I*E</td>
</tr>
<tr>
<td>235</td>
<td>G.295</td>
</tr>
<tr>
<td>240</td>
<td>IN. &quot;ENTER VOLTAGE (E)&quot;; E</td>
</tr>
<tr>
<td>250</td>
<td>IN. &quot;ENTER RESISTANCE (R)&quot;; R</td>
</tr>
<tr>
<td>260</td>
<td>P = (E/E)*R</td>
</tr>
<tr>
<td>265</td>
<td>G.295</td>
</tr>
<tr>
<td>270</td>
<td>IN. &quot;ENTER CURRENT (I)&quot;; I</td>
</tr>
<tr>
<td>280</td>
<td>IN. &quot;ENTER RESISTANCE (R)&quot;; R</td>
</tr>
<tr>
<td>290</td>
<td>P = (I*I)/R</td>
</tr>
<tr>
<td>295</td>
<td>P. &quot;THE POWER IS&quot;; P; &quot;WATTS&quot;</td>
</tr>
<tr>
<td>300</td>
<td>END</td>
</tr>
</tbody>
</table>

Table 2—Resonance (Tuned Circuits)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>CLS</td>
</tr>
<tr>
<td>10</td>
<td>P.T.(15); &quot;VARIOUS FORMULAS ON RESONANT FREQUENCY&quot;</td>
</tr>
<tr>
<td>20</td>
<td>P. &quot;ENTER NUMBER OF DESIRED FUNCTION&quot;</td>
</tr>
<tr>
<td>30</td>
<td>P. &quot;RESONANT FREQUENCY (FO)&quot;</td>
</tr>
<tr>
<td>40</td>
<td>P. &quot;UNKNOWN INDUCTANCE (L)&quot;</td>
</tr>
<tr>
<td>50</td>
<td>P. &quot;UNKNOWN CAPACITOR (C)&quot;</td>
</tr>
<tr>
<td>60</td>
<td>P. &quot;Q OF SERIES OR PARALLEL CIRCUIT (Q)&quot;</td>
</tr>
<tr>
<td>70</td>
<td>P. &quot;BANDWIDTH (BW)&quot;</td>
</tr>
<tr>
<td>80</td>
<td>P. &quot;IMPEDANCE, SERIES OR PARALLEL (Z)&quot;</td>
</tr>
<tr>
<td>90</td>
<td>IN. &quot;UNKNOWN FACTOR IS NUMBER&quot;; U</td>
</tr>
<tr>
<td>100</td>
<td>IF U = 1, G.170</td>
</tr>
<tr>
<td>110</td>
<td>IF U = 2, G.240</td>
</tr>
<tr>
<td>120</td>
<td>IF U = 3, G.280</td>
</tr>
<tr>
<td>130</td>
<td>IF U = 4, G.320</td>
</tr>
<tr>
<td>140</td>
<td>IF U = 5, G.360</td>
</tr>
<tr>
<td>150</td>
<td>IF U = 6, G.520</td>
</tr>
<tr>
<td>170</td>
<td>IN. &quot;ENTER VALUE OF INDUCTOR IN MILLIHENRIES&quot;; L</td>
</tr>
<tr>
<td>180</td>
<td>IN. &quot;ENTER VALUE OF CAPACITOR IN MICROFARADS&quot;; C</td>
</tr>
<tr>
<td>210</td>
<td>X = (L/1E3)*(C/1E6)</td>
</tr>
<tr>
<td>220</td>
<td>GOS.30030</td>
</tr>
<tr>
<td>230</td>
<td>P. &quot;THE RESONANT FREQUENCY IS&quot;; &quot;159/Y; HERTZ&quot;</td>
</tr>
<tr>
<td>235</td>
<td>END</td>
</tr>
<tr>
<td>240</td>
<td>IN. &quot;ENTER RESONANT FREQUENCY (FO) DESIRED&quot;; F</td>
</tr>
<tr>
<td>250</td>
<td>IN. &quot;ENTER CAPACITOR VALUE IN MICROFARADS&quot;; C</td>
</tr>
<tr>
<td>260</td>
<td>L = 0.054/(F<em>F)</em>(C/1E6)</td>
</tr>
<tr>
<td>270</td>
<td>P. &quot;THE INDUCTOR NEEDED IS&quot;; &quot;L&quot;*1000; &quot;MILLIHENRIES&quot;</td>
</tr>
<tr>
<td>275</td>
<td>END</td>
</tr>
<tr>
<td>280</td>
<td>IN. &quot;ENTER RESONANT FREQUENCY DESIRED&quot;; F</td>
</tr>
<tr>
<td>290</td>
<td>IN. &quot;ENTER INDUCTOR VALUE IN MILLIHENRIES&quot;; L</td>
</tr>
<tr>
<td>300</td>
<td>C = 0.054/(F<em>F)</em>(L/1E3)</td>
</tr>
<tr>
<td>310</td>
<td>P. &quot;THE CAPACITOR NEEDED IS&quot;; &quot;C&quot;*1E6; &quot;MICROFARADS&quot;</td>
</tr>
<tr>
<td>315</td>
<td>END</td>
</tr>
<tr>
<td>320</td>
<td>IN. &quot;ENTER THE REACTANCE (XC OR XL) IN OHMS&quot;; X</td>
</tr>
<tr>
<td>330</td>
<td>IN. &quot;ENTER THE SERIES RESISTANCE IN OHMS&quot;; R</td>
</tr>
<tr>
<td>340</td>
<td>P. &quot;THE Q OF THE CIRCUIT IS&quot;; &quot;X/R; UNITS&quot;</td>
</tr>
<tr>
<td>350</td>
<td>END</td>
</tr>
<tr>
<td>360</td>
<td>IN. &quot;ENTER UNKNOWN, Q=O, FO=F, BW=B; X</td>
</tr>
<tr>
<td>370</td>
<td>IF X = Q, G.400</td>
</tr>
</tbody>
</table>
Table 3—Inductive Formulas

2 CLS
10 P."AFTER EACH SOLUTION, PRESS R. ENTER TO BEGIN." #1
15 P.T.(15)"VARIOUS INDUCTIVE FORMULAS" #2
20 P."ENTER THE NUMBER NEXT TO DESIRED FUNCTION" #3
30 P."INSTANTANEOUS VOLTAGE" #4
40 P."INDUCTANCE OF A SINGLE LAYER COIL" #5
50 P."INDUCTIVE/RESISTIVE TIME CONSTANT" #6
60 P."SERIES AND PARALLEL INDUCTORS" #7
70 P."Q OF A COIL" #8
80 P."INDUCTIVE REACTANCE (XL)" #9
90 P."IMPEEDANCE OF INDUCTIVE/RESISTIVE CIRCUIT" #10
100 P."FORMULA DESIRED:" #11
110 IF X=1 G.160 #12
120 IF X=2 G.220 #13
130 IF X=3 G.280 #14
140 IF X=4 G.320 #15
144 IF X=5 G.570 #16
145 IF X=6 G.640 #17
146 IF X=7 G.690 #18
160 IN."ENTER VALUE OF INDUCTANCE IN HENRIES":L #19
170 IN."ENTER CHANGE IN CURRENT (12-11) IN AMPS":I #20
180 IN."ENTER CHANGE IN TIME (2T-1T) IN SECONDS":T #21
190 E=L'/T) #22
200 P."THE VOLTAGE DEVELOPED IS";E;"VOLTS" #23
210 END
220 IN."ENTER NUMBER OF TURNS":N #24
230 IN."ENTER RADIUS OF COIL IN INCHES":R #25
240 IN."ENTER LENGTH OF COIL IN INCHES":O #26
250 L=I(N')I(N'R)/(9TR)+(10D) #27
260 P."THE INDUCTANCE IS";L:"MICROHENRIES" #28

AmericanRadioHistory.Com
#1
#2
#3
#4
#5
#6
#7
#8
#9
#10
#11
#12
#13
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#28

AUGUST 1979
A growing number of audio enthusiasts are using equalizers to shape a stereo system's frequency response, whether to "adjust" a room or for creative recording purposes. An equalizer is nothing more than a device to allow frequency response of an audio signal path to be adjusted in some way. Thus, conventional bass and treble controls qualify as charter members of the club. More often, however, the term implies equipment that is more complex and sophisticated, such as that used by a mixing engineer. Let's take a look at some of the reasons equalization (EQ) is useful and how its implementation has developed into a high art.

Standard bass and treble tone controls are broadband devices that have greatest effect at the frequency extremes; that is, the highest highs and the lowest lows. While this is fine for touching up reproduction, it is of virtually no help in correcting for narrowband colorations, which are often highly disturbing. For example, a peak in the response of an audio system in the low-to-middle treble region can produce a shrill or scratchy quality that a normal treble control cannot effectively tame. Turning down the control enough to eliminate the shrillness kills too much of the highest treble, robbing music of clarity and sparkle. Similarly, using a bass control to correct tubbiness or muddy bass response also falls short of success. Turning the control down to relieve such midbass exaggeration would simply remove the deepest frequencies so important to lifelike reproduction, while perhaps still allowing some muddiness to persist. There's got to be a better way—and there is. (continued overleaf)
Enter the Graphic Equalizer. The graphic equalizer has become very popular in recent years. It is called "graphic" because, as the front-panel sliders are adjusted, their positions give an approximate display of the resultant frequency response. Each of the five to ten or more frequency bands into which the audible spectrum is divided by these devices is adjustable via its own boost/cut control. Instead of broad adjustments of treble, bass, and maybe the midrange (presence), we now have independent control over the low bass, midbass and high bass, low midrange, etc.

If we attack that shrill midtreble emphasis with an octave-band graphic equalizer, we should be able, more or less, to correct for only the troublesome peak. We'll have to settle for "more or less" because it is highly unlikely that any response anomaly could correspond exactly to the adjustments of even a ten-band device. Therefore, many professional sound contractors, recording studios and audio enthusiasts seeking precise results use the even greater resolution afforded by 1/8-octave equalization. The 1/8-octave graphics usually have 27 or so bands, and can, when teamed up with the proper measuring equipment, be used to make just about any high-quality speaker system flat to within a dB or so over much of the audible range. But there's much more to EQ than simply correcting nonideal loudspeakers or listening rooms.

EQ In the Studio. Now, let's look at the professional recording studio with its abundant knobs, lights, and buttons. This is where the multiple original tracks are adjusted in level and equalized before being mixed together to comprise the final two-track product. The key phrase is "before being mixed." Wherein the home listener can alter the program only in its entirety, the recording engineer can—and must—equalize sounds picked up by each microphone separately. The tool of choice for this application is yet another equalizer referred to by many as the "console type." Virtually all professional mixing consoles use this sort of device, with one available for each mike or line input. Additional equalizers are often devoted to echo and reverb lines.

A typical front panel for such an equalizer (Fig. 1) shows that we're back to the bass-mid-and-treble format. But there are no less than five different frequency choices for treble, eight for midrange, and another five for bass. In addition, a 3-position low-cut filter is provided, as is an in/out switch for instant comparison of "before" and "after." Here we have a device that can exercise control over fifteen different frequency ranges and also be made small enough to fit in quantity into a single mixing board. (A large console will have some 30 or more of these, so size is an important factor.) Though all 15 frequencies cannot be adjusted simultaneously as with the graphic, this rarely is needed in a "one-for-each-mike" situation. Besides, you can always "patch-in" a graphic if you absolutely have to.

The last control, the PEAK/SHELF switch, changes the basic shape of the response curve being created. This is shown in Fig. 2, where in both cases treble frequency has been set to 3.2 KHz and 12 dB of boost is applied. The upper curve represents the switch in the PEAK position while the lower curve shows a SHELF. Notice that, while the treble peak affects mainly the specified frequency, there is still some influence on nearby frequencies, whether boosting or cutting. In the SHELF position, the boost or cut reaches its maximum at that frequency and remains there for all higher frequencies. The same principle applies to the bass control. The boost or cut reaches maximum at the named frequency but instead continues downward thereafter. The midrange has no shelf capability, but more expensive consoles generally have a second, additional midrange control for added flexibility. Fig. 3 contains bass shelf cuts at four different frequencies. Fig. 4 illustrates the effect of varying the bandwidth of a midrange dip. Bandwidth? Well now we're talking about the "parametric equalizer," the most recent addition to the EQ machine family.

Parametric Power. In a sense, the parametric equalizer is the most powerful of the equalizer types, allowing continuous adjustment of all equalization parameters (hence the name). It is
structured similarly to the console equalizer, but there are differences worth elaborating. First, and probably most important, all controls of a parametric are continuously adjustable. Potentiometers, rather than discrete, switch-related resistors, are employed as the tuning elements, allowing a choice of virtually any center frequency. Boost and cut controls are also continuous and typically offer a range of ±20 dB, more than is characteristic of other equalizer types.

Another important difference is the inclusion of a bandwidth control. It was explained previously that in boosting or cutting a peak, the effect "spills over" to adjacent frequencies. How far away from the indicated center this influence extends is determined by the setting of the bandwidth control. When set to narrow, it allows only a small range of frequencies to be influenced. This is particularly useful for suppressing ringing or removing extraneous tones from, say, drums without changing the basic sound character. On the other side of the coin, this narrowband setting can be used to emphasize a single tone and can often effectively "purify" a muddy-sounding tom tom. Of course, this is not a substitute for proper tuning of the drums, but when all else fails, . . .

Except when dealing with drums and perhaps some tuned percussion instruments like triangles or cowbells, narrow-bandwidth boosts should usually be avoided because unpleasant resonances or other bad effects may show up when the mix is heard on different speakers. In fact, most recording studios have alternate speaker systems available for making instant comparisons.

Broad-bandwidth settings accentuate a larger range of frequencies. Parametric equalizers are inherently peaking rather than shelving devices, but a wide setting can reasonably approximate a shelf. Do not confuse peaking with boosting, though. Peaking refers only to the shape of the curve, not to whether it is boosting or attenuating.

All this newfound versatility, however, is not without some potential drawbacks. Probably the most obvious is the lack of precise repeatability. Since the operating controls are continuously variable, it may be difficult to recreate settings exactly to perhaps undo something you later don't like. Another factor is noise. Parametric equalizer designs generally use more op amps per frequency band than do graphic and console types. This means that cumulative noise can be more of a problem, especially when large amounts of boost are used. Distortion can build up in a similar fashion, though the latest high-slew, low-noise FET input op amps are bringing both of these factors under better control. Still, most commercially available units have a switch to bypass each band or section if it's not needed.

While studios have not unanimously traded in all their old equalizers for parametrics, many have added at least one or two. And some of the newer mixing boards are showing up with equalizers having a sweepable midrange band or a two-position switch for sharp or broad peak shape selection. So a few of the
conveniences are added without having to go to a full parametric design.

Now that we’ve looked at the different types of devices and know how they operate, how can we use EQ to best advantage? When and how would a professional recording engineer use it? Well, first we should note that equalization can be used in two basic ways: as a tool and for personal taste.

**EQ As A Tool.** If you reflect on the task of a recording engineer, the idea that he is going to run into problems in his work will not seem surprising. The difficulties encountered may lie in the areas of instrumental balances, equipment overload, signal-to-noise ratio, and frequency response, to name a few possibilities. When the problem can be traced to frequency response—and quite a few can—the equalizer becomes an extremely valuable tool.

For example, one problem that occurs regularly is caused by the “proximity effect,” a bass boost that happens when using a directional microphone in close-miked situations. Here, the low filter would be your best bet. First, it will attenuate the excessive low-frequency signal before it enters the actual EQ circuitry, minimizing the chance of overload; second, it will leave the bass control free for other uses if needed. (If the mike has its own switchable low-cut filter built in, using that to keep the unwanted frequencies out of the preamp as well will give even more overload protection.)

Another proper occasion to use the low filter is when recording vocals close-up. Not only because of the proximity effect just mentioned, but also to minimize “popping” P’s, which contain a lot of low-frequency energy. Moreover, rumble and low-frequency mud can enter your recordings owing to extraneous vibrations such as walking on non-concrete floors, operating air conditioners, and the like.

Treble is often accentuated to increase clarity or to enhance the presence of a vocal or string part that might otherwise be lost in the mix. Horns, cymbals, acoustic guitars and many other instruments can also be greatly enhanced in this way, but the engineer must know where the formants (the most important characteristic frequencies for the various instruments) lie. Boosting high treble on an instrument with little output in that region will do nothing but add hiss. In fact, when dealing with such an instrument, it is often possible to make a substantial improvement in the signal-to-noise ratio by carefully reducing the unnecessary high-frequency bandwidth with treble control on each channel for frequencies beyond the range of interest. This is most effective when done in mixed down, as tape hiss will also be reduced. For this same reason, when treble boost is employed, it is usually best applied ahead of the recorder.

EQ can also help to correct for poor room acoustics. Recording live, even the most accurate mike may not capture that terrific sound you hear when you stand right next to the instrument. Close-miking may help, but in many cases this is impractical since many instruments do not radiate sound from a single point source.

Consider a grand piano, string bass, xylophone, or gong. All of these radiate sound from a large area, leaving no single mike position that would be close to all parts of the source. Such large instruments require a more distant microphone placement if a well-balanced pickup is to be had. Unfortu-

nately, as the distance between source and mike increases, acoustics of the room begin to affect the sound. This isn’t always bad—a good room might add a warmth and character unobtainable in any other manner. But when a close-up sound with lots of presence is desired, equalization in the form of treble boost or midrange cut can often do the trick.

**Seasoning To Taste.** While no one yet has found a definitive way to tell what sounds good and what doesn’t, recording engineers have developed various techniques for emphasizing what they consider to be the more pleasant qualities of musical sounds. In fact, many engineers pride themselves on “getting their own sound.” This is an area of taste, so naturally there are no hard, fast rules to apply. Some good starting points can be established, though, as follows. Generally speaking, you would boost treble for clarity or presence (the midrange can affect this too), and bass for fullness or punch. Sometimes it seems that no matter how much top or bottom you add, something is still not right. Often what is involved is one or more unpleasant resonances caused, as mentioned earlier, by either microphone characteristics or placement, or by bad qualities within the instrument itself, especially if it is out of adjustment or of low quality. Eliminating these midrange resonances will often improve the sound and may minimize a need to boost highs and/or lows.

To find these magic EQ settings, start by turning off all but the principal microphone that can pick up the instrument you’re working with. If it’s the snare drum, for example, shut off the tom and kick mikes. They’ll interact later anyway, but the less you need to concern your-

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**Fig. 4. Response curves showing the effect of varying the bandwidth of a midrange dip.**

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POPULAR ELECTRONICS
The chart given below lists some common instruments with frequencies at which boost or cut can be effectively applied to cure various problems or obtain certain effects. Indicated frequencies are necessarily approximate, as no two instruments sound exactly alike. The column marked "comments" gives cautions or observations based on experience. They should be taken as guidelines rather than prescriptions for every situation is different and every recordist has his own sonic goals.

A few general hints may contribute to the effective use of equalization: (1) Your memory is shorter than you think; return to a flat setting now and then to remind yourself where you began.

(2) Make side-by-side comparisons against commercial releases; this will help you in judging overall blend.

(3) You can tailor the sound of an instrument only so far without losing its identity, every instrument can’t be full, deep, bright, sparkly, etc., all at once. Leave some room for contrast.

(4) Take a break once in a while. Critical listening tends to numb one’s senses after awhile, especially if you like to run monitors at high levels. Sounds may appear very different to you the next morning.

(5) Don’t be afraid to experiment. If you can’t find just what you want with equalization, try moving the mike a little; if that won’t work, move the instrument. But, most of all, keep trying.

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**SPECIFIC INSTRUMENTS AND THEIR CHARACTERISTIC FREQUENCIES**

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**COMMON FREQUENCIES FOR EQUALIZATION**

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Cutting</th>
<th>Boosting</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Voice</td>
<td>Scratchy at 2 kHz.</td>
<td>Hot at 8 or 12 kHz.</td>
<td>Tend towards thin when blending many voices.</td>
</tr>
<tr>
<td></td>
<td>Nasal at 1 kHz.</td>
<td>Clarity above 3 kHz.</td>
<td>Not too much bottom when mixing with rhythm section.</td>
</tr>
<tr>
<td></td>
<td>Popping p’s below 80 Hz.</td>
<td>Body at 200-400 Hz.</td>
<td>Sound varies greatly depending on type of strings used.</td>
</tr>
<tr>
<td>Piano</td>
<td>Tinny at 1-2 kHz.</td>
<td>Presence at 5 kHz.</td>
<td>Also try adjusting tightness of snare wires.</td>
</tr>
<tr>
<td></td>
<td>Boomy at 320 Hz.</td>
<td>Bottom at 125 Hz.</td>
<td>Usually recorded with front drum head removed.</td>
</tr>
<tr>
<td>Electric guitar</td>
<td>Muddy below 80 Hz.</td>
<td>Clarity at 3.2 kHz.</td>
<td>Place blanket inside of drum resting against head.</td>
</tr>
<tr>
<td>Acoustic guitar</td>
<td>Tinny at 2-3.2 kHz.</td>
<td>Sparkle above 5 kHz.</td>
<td>Tuning head tension is extremely important.</td>
</tr>
<tr>
<td></td>
<td>Boomy at 200 Hz.</td>
<td>Full at 125 Hz.</td>
<td>Record these instruments at conservative levels, especially at slower tape speeds.</td>
</tr>
<tr>
<td>Electric bass</td>
<td>Tinny at 1 kHz.</td>
<td>Growl at 820 Hz.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Boomy at 125 Hz.</td>
<td>Bottom below 80 Hz.</td>
<td></td>
</tr>
<tr>
<td>String bass</td>
<td>Hollow at 620 Hz.</td>
<td>Slap at 3.2-5 kHz.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Boomy at 200 Hz.</td>
<td>Bottom below 125 Hz.</td>
<td></td>
</tr>
<tr>
<td>Snare drum</td>
<td>Annoying at 1 kHz.</td>
<td>Crisp above 2 kHz.</td>
<td></td>
</tr>
<tr>
<td>Kick drum</td>
<td>Floppy at 620 Hz.</td>
<td>Full at 125 Hz.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Boomy below 80 Hz.</td>
<td>Deep at 80 Hz.</td>
<td></td>
</tr>
<tr>
<td>Tom toms</td>
<td>Boomy at 320 Hz.</td>
<td>Slap at 3.2-5 kHz.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bottom at 80-125 Hz.</td>
<td></td>
</tr>
<tr>
<td>Cymbals, bells, tambourines</td>
<td>Annoying at 1 kHz.</td>
<td>Sparkle above 5 kHz.</td>
<td></td>
</tr>
<tr>
<td>Horns and strings</td>
<td>Scratchy at 3.2 kHz.</td>
<td>Hot at 8 or 12 kHz.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Honky at 1 kHz.</td>
<td>Clarity above 2 kHz.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Muddy below 125 Hz.</td>
<td>Lush at 320-400 Hz.</td>
<td></td>
</tr>
</tbody>
</table>

AUGUST 1979

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self with now, the better. Next, try boosting some different midrange frequencies, adding at least 10 or 15 dB, to make the changes obvious. Where you start will naturally depend on the instrument. Since physical resonances of instruments usually fall between, say, 100 Hz and 1 or 2 kHz, these frequencies are likely starting points. After determining which one sounds the worst, return to the flat setting momentarily to allow your ears to readjust, and then cut the chosen frequency in small steps until the optimum point is reached. The same general plan can work for boosting, although then you’d be looking for frequencies that make the sound better when boosted.

When adding treble or bass, be sure the controls are doing what you expect them to. If you don’t obtain an appreciable improvement, move on to a different frequency. Remember, a lot of boost at the extreme low end can route excessive infrasonic energy to the loudspeakers, which could damage them. Similarly, too much ultrasonic content can damage tweeters and overload the tape deck. Even with VU meter indicators in the black, safety is not guaranteed; limited meter frequency response sometimes prevents them from giving a true picture. Also, VU meters tend to miss sharp transients from drums and other percussion instruments. the pointer simply cannot move fast enough. Preemphasis within the deck also can aggravate the situation, so be particularly careful at the slower tape speeds.
BUILD A Speaker Protection Circuit

BY MIKE ROGALSKI

After long periods of listening to reproduced music played at a high volume level, it's not uncommon for one's hearing to become insensitive to average loud sounds. As a result, the listener often turns up the gain to compensate for this diminished sensory perception.

The best way to protect our hearing ability—and do a good turn for our speaker systems—is to use an upper limit on the decibel level our sound systems can generate. This is precisely what the automatic audio-overload/speaker-protection circuit described here does.

There are, of course, many circuits that use zener diodes and SCRs to shunt power to dummy loads. Most act too fast, however. This causes important dynamics such as drum rolls, cymbal crashes, and trumpet blasts to get "crunched." A slow-acting threshold sensor that has built-in hysteresis and a comparator circuit would be excellent for providing automatic level limiting, but it requires a power supply.

The speaker-protection system here, on the other hand, is far simpler in circuitry, self-powered, automatic in action, and connects directly between the power amplifier and the speaker system it is to protect. It is also inexpensive to build.

About the Circuit. The output from the power amplifier to the speaker-protection circuit is shown in Fig. 1. (The rectifier diodes should have a forward resistance of approximately 600 ohms to introduce minimal signal distortion.) The signal then goes to the normally-closed relay contacts and out to the speaker system.

At high signal levels, the charging circuit consisting of R1 and C1 generates sufficient voltage levels to energize K1 and open its contacts. When K1 energizes, R2, is connected in series with the speaker system to drop the sound level. Then, when the input signal level drops, K1 de-energizes and its contacts automatically close, removing R2 from the circuit.

Construction. The simplicity of the protection circuit lends itself to just about any method of construction desired. For those who wish to use printed-circuit construction, an actual-size etching-and-drilling guide and components-placement diagram are given in Fig. 2. Once wired, this compact pc assembly can be permanently mounted inside the speaker system's enclosure or connected directly to the speaker terminals.

Relay K1 should have a dc coil resistance of about 100 ohms and a dc pull-in rating of at least 2 volts less than the required rms voltage cutout point of the speaker system. This allows for the voltage drop across the rectifier circuit. The diodes and capacitors should have twice the peak voltage rating of the signal passing through them. The components specified in Fig. 1 are for a 4- and an 8-watt unit and will protect a speaker system rated at 5 to 10 watts with a 20% derating factor for safety.

Resistor R1 can be bypassed to move the operating point of K1 down to 4 watts.

Adjustment. Make certain that the common of each amplifier output circuit is connected to the common of the speaker protector and observe proper speaker phasing when connecting the device into your audio system. With a relay whose coil resistance is about 100 ohms, the circuit shown in Fig. 1 will cut out at 4, 8, or 12 watts if the value of R1 is 0, 50, or 100 ohms, respectively. Since the circuit is basically a voltage divider, doubling the value of R1, shifts the rms point 50% higher. You can also experiment with the value of R2 to obtain the low level desired.

Parts List

C1—100-µF, 50-volt electrolytic
D1 thru D4—Silicon rectifier diode (see text)
K1—Spst relay with 100-ohm dc-resistance coil (American Zetler No. A 535-11-2 or similar) (see text)
R1—Value depends on power protection level: 0 ohms for 4 watts; 50 ohms for 8 watts; 100 ohms for 12 watts
R2—50-ohm, ½-watt resistor
Note: The following items are available from Micpro Sound, 1012 Disson St., Philadelphia, PA 19111: Pcb board for $3.00; and all components (state R1 wattage) for $10.00 postpaid.

Fig. 1. The self-powered circuit, left, automatically reduces speaker level when peaks occur.

Fig. 2. Actual-size etching and drilling guide, right: component placement above.

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SPACE-AGE ELECTRONIC PROJECTS FOR BOATS

PART TWO

LAST MONTH, we showed you various ways to use the LM3914 dot/bar display driver in instruments for your boat, new approaches to water-level detection, and a rudder-angle indicator. In this second and final part, concentration is on bilge-water warning systems, electrical-system transient protection, and a unique digital tachometer.

Bilge Alarm. There are a number of ways to provide bilge-water warning. One of the simplest is the float-actuated-switch system shown in Fig. 10. Here, a sealed tube containing a reed switch is surrounded by a float with a built-in magnet. The float rides up and down the tube with increasing and decreasing water level, closing and opening the switch's contacts.

With the actuating switch assembly placed low in the bilge, the float lifts with rising water level. At some predetermined point, the contacts of the reed switch close and the alarm sounds or/and an indicator light comes on. Alternatively, the system can be rigged to automatically turn on the bilge pump as well as sound an alert.

There is nothing electronic about the system shown in Fig. 10, but it is so simple that it is just about foolproof. While you can fabricate your own float switch if you wish, it is hardly worth the effort because all-plastic units for boats are available from marine hardware stores at low cost.

A second bilge alarm is shown in Fig. 11. Here, a pair of electrodes is sealed in an insulating housing that is mounted low in the bilge. A small screen surrounds the probe-like elements to prevent bridging by debris.

In fabricating the probe shown in Fig. 11, two small brass bolts are mounted on a small disc of insulating board and are connected through a pair of resistors to a water-tight cable that goes to the instrument panel. The disc fits one end of a ¼" (19.1-mm) plastic plumbing fitting. Then the whole rear of the assembly is filled with epoxy to seal in the probe ends, resistors, and cable connections.

When potting is finished, there should be no place, except at the probe tips, where moisture can bridge the circuit. When water bridges the probe tips, the SCR fires and actuates the alarm. The Sonalert alarm will continue to sound, even after the water level drops below the point where it bridges the probe tips, until the switch is opened.

Projects in this concluding part cover a bilge-water alarm, a tachometer and voltage-transient protection.
rearm the alarm, simply close the switch.

A third type of bilge alarm is illustrated in Fig. 12. This system is designed for boats with multiple bilge spaces that are separated by watertight bulkheads. An audible alarm and a visual indicator to tell you which bilge has water in it are required in this system.

The sensors in this circuit are LM1830 fluid-detector ICs. When water bridges the probes, the output of the associated IC goes high and turns on the pair of transistors connected to it. Output connections to the transistor switches are arranged so that water entering any bilge space and bridging its probes will activate the Sonalert but will light only the LED labelled for that bilge. You can duplicate the circuit for each bilge to be protected. The only thing in common among the circuits is the Sonalert.

Shown in Fig. 12 is a method for marking the safety panel area where the LEDs are mounted. Using the layout shown, you know instantly which of the bilges is leaking (by its lighted LED) when the alarm sounds.

The transistors can be replaced by a DIP transistor array, provided the outputs can sink enough current to drive the Sonalert. You can use a high-power alarm sounder by replacing the Sonalert with a relay whose contacts can handle the bigger alarm's current. If you use this arrangement, be sure to install a protective diode across the relay's coil.

**Tachometer.** The circuit shown in Fig. 13 consists of a basic 0-to-2.4-volt meter system and a frequency-to-voltage (f/v) converter. The voltmeter portion made up of IC1 and IC2 features 20 divisions, each represented by a LED. The IC3 f/v converter accepts varying-frequency pulses from the engine's ignition points and converts them into proportional dc voltages with constant updating.

Using a system like that shown makes possible an economical solid-state alternative to the traditional analog meter. It is free from parallax errors and is much easier to read and interpret than the analog meter, too. At night, readability increases, and the red emission of the LEDs has little effect on night vision.

The two LED drivers are cascaded by connecting mode pin 9 of IC1 to pin 1 of IC2. Pin 9 of IC2 connects to pin 11 to produce dot operation. Internal IC operation requires R1 to be connected across LED9 (pin 11 of IC1) to obtain proper operation. Resistor R2 sets the scale of IC1 to half the voltmeter range. Because 1.2 volts should be generated across it, this resistor should have a 1% or better tolerance. Also, since 2.4 volts is generated across it, R3 should be rated at 1% or better tolerance. These resistors also program the ICs to deliver 10 mA to each LED.

A charge-pump frequency-to-voltage (f/v) converter, high-gain op-amp/comparator, and an uncommitted output transistor are contained in IC3 (Fig. 14).
A Schmitt-trigger device is used for the input. It features a built-in hysteresis to provide clean switching if noise is present on the input signal. In the 14-pin DIP LM2917N version of the IC, an internal zener diode also maintains calibration stability.

In Fig. 13, R5, R6, and C1 condition the input signal from the points. A stable-temperature-characteristic capacitor must be used for C2, which is the timing capacitor for the charge pump. Potentiometer R9 serves as the discharge path and doubles as the scale calibration control. Charge-pump filtering is provided by C3. The uncommitted emitter of the internal output transistor is connected to R10.

The input signal for the voltmeter is taken from R10’s wiper. This allows the output of the tach section to be matched to the voltmeter’s full-scale range. (Although this could be accomplished via R9, better linearity is possible when the full output of the tach circuit is used and then reduced in level to match the requirements of the voltmeter.) Biasing for the internal op amp is obtained with R7 and D2.

There are a number of ways to assemble the tach. The LEDs can be arranged in a vertical column, with the highest rpm at the top, or you can opt for

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**PARTS LIST (Fig. 12)**

A1—Sonalert SC628 or similar
C1—0.05-µF disc capacitor
C2—0.002-µF disc capacitor
C3—10-µF, 6-V electrolytic
IC1—LM1830 (National)
LED1—Bright red LED
Q1, Q2—2N2222 transistor
R1—2200-ohm, 1/2-W resistor
R2—To suit LED current

**PARTS LIST (Fig. 13)**

C1, C2—0.02-µF capacitor
C3—1-µF, 12-V electrolytic
D1—1-KV zener (see text)
D2—1N914
IC1, IC2—LM3914 Dot/Bar Driver (National)
IC3—LM2917N 14-pin F/V Converter (National)
IC4—10-V, 0.5-A positive regulator
LED1 through LED20—Bright red LED
R1, R6—20,000-ohm, 1/2-W resistor
R2—1100-ohm, 1% 1/2-W resistor
R3—2400-ohm, 1% 1/2-W resistor
R4—10-ohm resistor (see text)
R5, R7—10,000-ohm, 1/2-W resistor
R8—470-ohm, 1/2-W resistor
R9—100,000-ohm, multi-turn pot
R10—10,000-ohm, multi-turn pot

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**Fig. 12.** Circuit above is an alarm system for boat with multiple bilge spaces. Visual and audible signals are used to indicate which bilge has water in it. LEDs are mounted in diagram as shown at right to show each area.

**Fig. 13.** Circuit for converting pulses from ignition points to voltages which activate LEDs from 1 to 20 to indicate speed.
For inboard boat engines, it is important that the range be familiar circular arrangement.

When assembling the project, it is best to slightly recess the LEDs behind a red filter to avoid effects of washout in brightlight. Use high-luminosity LEDs instead of the commonly available “standard” LEDs. Finally, to assure maximum contrast and eliminate reflections as much as possible, apply a coat of matte black paint on all surfaces behind the LEDs and the front panel or bezel into which the red filter is set.

Wiring is not critical. However, it is important that you observe the common ground point near pin 2 of IC1.

There is a considerable variation in the range requirements for a tachometer for inboard boat engines. Commercial analog tachs are scaled for 6000 rpm and supplied with links to adapt them to all types of engines. With the tach described here, the top end of the range can be chosen to suit the requirements of any given engine.

A 4-cycle engine fires each cylinder once every two revolutions. An 8-cylinder engine running at 4000 rpm would fire 4 × 4000 or 16,000 times per minute. This is equivalent to a tach input frequency of 266.67 Hz. For a 6-cylinder engine operating at 4000 rpm, there are three pulses per revolution, which is equivalent to an input frequency of 200 Hz. Note that this is a linear relationship and can be plotted as shown in Fig. 15.

Following is the calibration procedure for a 6-cylinder engine with LED20 indicating 4400 rpm. Apply 15 volts from a bench-type power supply to the power leads of the tach. Next, connect the output of a square-wave generator to the tach's input through a 0.1-μF capacitor. Using a frequency counter, set the generator for a high-level output of 220 Hz. Set R9 near maximum resistance. Using a high-impedance voltmeter, connected between pin 5 of IC1 and ground, adjust R10 for a 2.4-volt reading. This should turn on LED20. Adjust R9 until LED19 extinguishes and LED20 is at full brilliance. There is some overlap built into the dot drivers so that one LED fades out as the next LED comes on. Slowly reduce the frequency of the generator while observing both the tach display and frequency counter to check the linearity of the tach’s scale. It will not be perfect, but it will be better than a quick glance at a standard analog meter.

The calibration procedure for an 8-cylinder engine will be the same as that for the 6-cylinder engine above. The only difference is that you start with a generator frequency of 293.3 Hz.
If your finished tach has a tendency to flicker at low rpm, increase the value of C3. Do not overdo this because if the value is raised to 2 µF, the flicker will be reduced, but at higher speeds there may be a tendency for adjacent LEDs to flicker back and forth as a low-frequency oscillation sets in. Of course, a rough-running engine is going to produce lots of flicker, which can serve as a reminder to have your engine tuned. The value of C3 is a compromise. Once you install the tach, it is a good idea to have it checked against a good-quality tachometer.

The circuit shown in Fig. 16 is a useful add-on for the tach. It can be used to identify the critical cruising rpm where fuel economy is at its best or as an overrpm warning. The LED in the string to which it is connected will flash on and off when the indicated rpm is reached. The flash range is quite narrow. Bear in mind, therefore, that this circuit may not be usable as an attention getter with a rough-running engine. The rpm would be traversing the flash point too rapidly for the circuit to go into action.

**Transient Protection.** Any mobile electrical system, including that in a boat, can suffer from voltage transients of many kinds. Some transients are capable of destroying solid-state components and systems. Hence, it pays to have adequate transient protection.

There are simple ways to give a large measure of transient protection to home-built projects. GE’s MOV transient protectors is one simple way. A second method is shown in Fig. 13, where 10-ohm resistor R4 and 18-volt zener diode D1 protect the power input line. If the circuit is to take care of a blown regulator, where 18 volts may be on the line continuously, the division of dissipated power between the zener diode and resistor must be calculated. Once breakdown occurs, the circuit will be carrying well over 1 ampere of current. This means that the power (wattage) ratings of the resistor and diode must be calculated.

Reverse voltage protection is a simple matter of installing a series diode in the +V line, with the diode’s anode connected to the + input, as shown in Fig. 17. Each subsystem should be individually protected, both for transients and reverse voltages, to assure maximum security against failure. Of course, one heavy-duty zener-diode circuit can be used for an entire instrument group to handle steady-state overvoltage conditions, but smaller suppressor circuits should still be used on each board.

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- Electronic Quartz Accuracy
- 24 hour alarm

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The time base is a finely tuned quartz crystal, trimmed by the manufacturer electronically to an accuracy of 5 seconds per month. And the manufacturer stands behind this accuracy with a one year limited warranty plus a 5 year replacement warrant on the micro-rechargeable energy cells.

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U.I.T. has been the innovator in the digital watch industry for years. U.I.T. is the prime manufacturer, assembler and importer of LCD watches. U.I.T. has been the pioneers of solar powered watches where “light energy” recharges micro-energy cells contained in the watch. A system so efficient they are able to offer the unheard of 5 year warranty.

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IC INTERVAL TIMERS

A N INTERVAL timer is a circuit that provides an output pulse of predetermined width at periodic intervals. This can be readily accomplished using any one of several timer ICs available to today’s electronic experimenter. Many IC timers, such as the well-known 555, are not only capable of such astable operation but can also function as monostable multivibrators or “one-shots.”

Figure 1 is a timing diagram comparing the operation of a monostable to that of an interval timer. Note that a one-shot timer is designed to activate an external device or circuit for or after a fixed period. An interval timer, on the other hand, provides uniform output pulses at an adjustable interval.

You are probably already familiar with numerous applications for conventional one-shot timers. Common examples include automatic switches that extinguish the headlights of a car a minute or so after the ignition is turned off, delayed-action intrusion alarms, switch debouncers, kitchen timers, etc.

Although the applications for interval timers are not as numerous, they include two that are particularly interesting: time-lapse photography and time-lapse sound recordings.

You have probably seen many examples of time-lapse photography—the opening of a flower, formation of clouds, construction of a building, etc. Time-lapse sound recordings can store periodic samples of data encoded as an audio tone as well as simply capture ambient sounds. In the latter category, an interesting possibility is to compress a 24-hour history of the sounds at a busy street corner into a one-minute recording. Another is entertaining your family or friends at a party by sampling brief segments of a record, radio program or conversation and playing back the string of sound “snapshots.”

Of course, time-lapse photography and sound recordings are not the only applications for interval timers. Before you’ve finished reading this column, you will probably have thought of several more.

Basic 555 One-Shot. Although most experimenters have assembled either breadboard or permanent circuits that use a 555 timer, many do not fully understand how this IC works. For those of you in this category, the following paragraphs will provide a quick overview of the monostable operation of the 555. If you’re already familiar with 555 basics, you can skip ahead to the next section.

Figure 2 is a simplified block diagram of a 555 connected as a monostable or one-shot timer. The key sections of the 555 are the two comparators, VC1 and VC2. They sense when the timing capacitor (C1) has charged or discharged to a predetermined level.

To understand how the 555 works, assume the circuit in Figure 2 is “off.” This means the control flip-flop is reset and Q1 is on. Capacitor C1 is therefore short circuited by Q1 and cannot charge. The output of the circuit (pin 3) is low. A negative pulse applied to the TRIGGER input (pin 2) momentarily causes the output of comparator VC2 to go high, setting the control flip-flop. This cuts off Q1, which allows C1 to charge exponentially at a rate determined by the values of C1 and R1. During this period, the output at pin 3 is high.

Notice the three series-connected 5000-ohm resistors in the 555. These resistors form a voltage divider that biases the noninverting input of comparator VC2 at one-third of the supply voltage and that of comparator VC1 at two-thirds of the supply voltage. When the voltage across C1 reaches two-thirds of the supply voltage, the output of comparator VC1 goes high and resets the control flip-flop. This turns Q1 on and shorts out C1. The output at pin 3 returns to ground and remains there until the entire timing cycle is repeated. This is...
accomplished by applying a new trigger pulse at pin 2.

This explanation should give you some insight into the operation of the 555 in its monostable mode. It should now be obvious that you can easily select the time delay by the proper choice of components for R1 and C1. If long delays (more than several minutes) are to be obtained, it's important to use a component with extremely low leakage for C1. Otherwise, the capacitor will never be able to charge as it should and the circuit will not function properly.

**555 Interval Timer.** A 555 monostable can function only as a single-delay timer. A reset pulse is required to initiate a new delay period. An interval timer, however, can be made by connecting the output of a 555 operated as a free-running (astable) oscillator to the TRIGGER input of a 555 monostable. The period of oscillation of the astable will determine the interval time. The RC time constant of the monostable will determine the duration of the output pulse that follows each timing interval.

Figure 3 shows the schematic of a working dual-555 interval timer. Interval times (determined by the values of R1 and C1) of up to several minutes are achievable with the values shown. Note that the output pulse from the first 555 is directly coupled into the input of the 555 monostable. The output of the monostable is connected to a low-voltage relay coil through D1. Diode D2 shorts out the powerful inductive kick produced across the relay coil when current to it is interrupted, thereby protecting the 555’s output stage from damage.

The values of R3 and C2 determine how long the relay is energized after each timing interval. Those specified keep the relay energized for almost exactly 5 seconds (4.98 seconds for the breadboard circuit I built). Change the value of R3 or C2 or both to obtain different times.

The relay contacts can be used to switch many different circuits or devices on or off. Figure 3, for example, shows the normally-off contacts connected to the switch jack of a tape recorder. This jack is commonly found adjacent to the microphone jack on many cassette recorders. It allows the recorder to be switched on or off at regular intervals.
to be turned on and off remotely by means of a small switch such as one mounted on the case of the microphone.

If you want to connect the relay to a tape recorder, use an appropriate plug. You'll have to improvise when connecting the relay contacts to other equipment or circuits. (A few words of caution—never connect the relay to a circuit that exceeds the maximum ratings for the relay's contacts. Also, never switch ac line power with an unenclosed relay. Personally, I prefer to play it safe with low-voltage applications only.)

556 Interval Timer. The 556 is a pair of 555 timers on a single silicon chip. The circuit in Figure 3, as you might suspect, can be readily assembled with a single 556 dual timer rather than separate 555's. Figure 4 shows the functionally identical circuit.

XR-2240/555 Long-Duration Timer. Because of leakage in the timing capacitor, the maximum period of a 555 operated as an astable oscillator is usually limited to several minutes. The XR-2240 (or XR-2340) is a specialized IC timer that incorporates a self-contained flip-flop divider chain to increase the length of the fundamental time delay by a factor of up to 255. Because the output of each flip-flop in the chain is directly accessible, many different interval times can be selected without having to alter the values of the circuit's timing capacitor and resistor.

Figure 5 is the schematic of a long-duration, programmable interval timer made from an XR-2240 connected as an astable oscillator and a 555 operated as a monostable. Timing components R1 and C1 control the oscillation rate of the XR-2240. The values shown give an adjustable interval T of up to about 100 seconds. The outputs at pins 1 through 8 allow you to select multiples of T ranging from 1 to 128. Therefore, selecting pin 8 will give you a time delay of up to 128 x 100 seconds or more than 200 minutes!

The selected output of the XR-2240 is inverted by Q1 and coupled through C4 to the 555 monostable, a circuit essentially identical to the monostable in Figure 3. The timing period of the monostable is controlled by the time constant R6 C5.

The XR-2240/555 interval timer is far more versatile than the dual 555 or 556 version because intervals of several hours can easily be obtained. Calibrating the circuit, however, can pose problems if you attempt to perform the operation when output pin 8 is selected. Calibration is much easier if you select output pin 1. If, for example, you want a timing interval of one hour (3600 seconds), adjust R1 until the interval at pin 1 is 28.13 seconds. Pin 8 will then output a pulse at 128 x 28.13 seconds or every 3600 seconds.

Incidentally, it's possible to select various combinations of XR-2240 outputs to achieve any time interval of from T to 255T when the chip is operated in its triggered, monostable mode. However, this procedure does not give the desired results when the astable mode is used.

It might be possible to obtain the full versatility of the XR-2240 by operating the chip in its one-shot mode and triggering it externally. The XR-2240 would continue to trigger the 555 one-shot to provide the brief "on" time after each interval. The time delay would be selected by shorting combinations of outputs to a common bus. The delay would be the sum of the delays of the selected outputs. Thus, outputs 4T, 8T and 128T will give a total delay of 4 + 8 + 128 or 140T.

I'll leave the details to those readers who like challenges. See the XR-2240 data sheet for design tips.
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CIRCLE NO. 5 ON FREE INFORMATION CARD
**Hobby Scene**

By John McVeigh, Technical Editor

**ANTENNA LENGTH CALCULATIONS**

Q. I am writing with reference to your article, "Choosing a Mobile CB Antenna," which appeared in the April 1978 issue. In the article, it was stated that at CB frequencies, a vertical half-wave dipole would have a length of 5.2 meters. Using the formula \( \lambda = \frac{c}{f} \), with \( c = 2.9971 \times 10^8 \text{m/s} \) (speed of light in air) and \( f = 27.0 \text{MHz} \), I came up with \( \lambda = 11.10 \) meters, or a half-wavelength of 5.55 meters. Working backwards, I find the frequency corresponding to a half-wavelength of 5.2 meters to be 28.818 MHz, which isn't even close to actual CB frequencies. Could you explain to me why this difference exists? I have searched through my technical references, but have been unable to come up with an answer. —Jim Sloot, Calgary, Alberta, Canada.

A. Your calculations are correct, but the length of a "half-wave" antenna is not exactly one half-wavelength. Rather, a resonant dipole has an electrical length of one half-wavelength. The length of conductor required for a resonant antenna depends on several factors, including the ratio of its length to its diameter. The smaller the ratio (the thicker the conductor), the shorter the antenna for a given electrical length. Practically speaking, the diameter of the conductor accounts for a 2-to-5-percent shortening. The end effect also reduces antenna length. That is, the strain insulators and wire loops wound on the insulators (in the case of a dipole) contribute a small amount of capacitance, which lowers the resonant frequency. To compensate, the antenna must be shortened by a few percent.

Finally, your calculations are based on a frequency of 27.0 MHz. Generally, an antenna will best cover a range of frequencies when it is tuned to the center frequency. For the 40-channel Citizens Band, which extends from 26.965 to 27.405 MHz, channel 19 at 27.185 MHz is the median frequency. That's 0.185 MHz above the frequency you used in your calculations and further explains the disparity between my statement and your result.

**RFI**

Q. I have amateur and CB radio equipment as well as an audio system. Whenever I'm recording an 8-track or cassette tape and using one of my rigs, my transmissions come through the stereo system and are recorded on the tape. All the components are well grounded, and I've inserted low-pass filters at the outputs of the transmitters. The problem still exists. What can I do to cure it? —Bill Columa, KA4DAP, Rocky Mount, NC.

A. The space we have here is far too small to permit a detailed discussion of the RFI problem, but what basically happens is this. At some point in the audio system r-f enters and is rectified (detected), giving up the information used to amplitude modulate it. The detected audio is then processed by the rest of the system, which cannot distinguish between it and the desired audio signals.

The key to solving an RFI problem is to locate the point of entry and treat it with shielding and/or filtering. I wrote a comprehensive article on the RFI problem for the May 1977 issue of our sister publication Stereo Review. That article contained a methodical, step-by-step procedure for eliminating RFI, and I suggest you either locate that issue or order a reprint of the article (ask for Reprint No. 21) at a cost of $1.50 from Stereo Review Reprints, Box 278, Pratt Station, Brooklyn, NY 11205. Residents of CA, CO, DC, FL, IL, MI, MO, NY, TX, or VT must add applicable sales tax. P.S. — I don't get royalties on reprint sales!
Among the few small computing systems that provide colorgraphics is the Compucolor II from Compucolor Corp. (Address: 5965 Peachtree Corners East, Norcross, GA 30071; Tel: 404-449-5861). Several versions of this computer are available, offering a variety of optional RAM, keyboards, single and multiple disk drives, etc. These are basically two-package systems consisting of a 13" (33 cm) diagonal color monitor and disk drive in one and a keyboard/computer system in the other package. The two are interconnected via a single 30" (76.2 cm) long multiconductor flat ribbon cable.

We evaluated the Model 4 version of the Compucolor II, configured with 16K of user-available RAM and a single 51/4" floppy-disk drive. The optional 101-key Model 101 Extended Keyboard was substituted for the Standard 72-key keyboard. In addition to the standard 72 keys, the Extended Keyboard has a separate four-function calculator-type cluster, and a cluster of editing keys. (There is also an optional Deluxe keyboard with 117 keys and offering extended plotting capabilities available at extra cost).

The keyboard/computer package measures 19" (48.3 cm) wide by 7" (178 mm) deep and slopes from 4" (102 mm) high at the rear to 2" (51 mm) at the front. The monitor/disk drive package measures 18" wide by 15" deep by 13" high (457 x 381 x 330 mm). Price of the Model 4 with a Standard Keyboard is $1695, plus $135 when substituting the Model 101 Extended Keyboard.

Technical Details. The computer is based on an 8080A operated with a 2-µs cycle time. It can support up to 65K of memory, and has on-board space for 32K. There is 16K of ROM in which are the operating system and BASIC, and sockets are provided for additional 8K of ROM. The system is designed to use up to 480 I/O ports, 30 of which are implemented in the standard computer. This number includes an RS-232C serial port for printer or modem, with a broad selection of baud rates.

The graphics display features an 8-
color selection on a 10" by 7" (254 x 178 mm) usable screen area. The 128 x 128 graphics is refreshed at power-line frequency. Alphanumericics consist of 32 lines of 64 characters/line for small-size capital letters or 16 lines of 64 characters/line with large-size caps. Lower-case letters are not included, but 64 special graphic symbols are.

Conventional 40-track diskettes are used with an average access time of 40 ms for 40 tracks, while average latency is 200 ms. Data transfer rate is 78.8K bits per second, with a diskette storage capacity of 51.2K bits per side (both sides usable).

The basic keyboard is standard ASCII four-level with 192 codes. It uses gold crossbar keyswitches of commercial quality. CPU reset and automatic diskette loading keys are included.

In software, a complete disk operating system as well as disk BASIC are in ROM. The BASIC is similar to most other disk BASICS and has 32 statements and commands, 19 mathematical functions, nine string-manipulation functions, and 12 disk-file commands. Calculations are to five decimal places.

The operating system has 31 CONTROL-plus-key commands, 31 ESCape-plus-key codes, and 12 graphic-plot commands. There is also a full complement of CRT Terminal commands as well as full-function foreground/background color selection along with 15 plot commands. This wide variety of commands gives the user control over every possible function of the computer.

Most of the keys are assigned two functions. Switching from one function to the other is via the CAPS LOCK key. Some keys are used in conjunction with the CONTROL and ESC keys. Those keys that permit color changes are color coded with their respective colors.

A 50-pin bus connector (located on the rear) provides all addresses, data, clocks, etc., to allow the Compucolor to be extended with any upcoming peripherals. Also located on the rear apron is a connector for RS-232C signals. This latter port can also be used for a printer or modem. Each connector is fully described in the manual.

A large loose-leaf-type "Programming and Reference Manual" is supplied with the system. This manual contains 10

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sections that cover full details for using the BASIC language (and covers programming examples), print formatting, and machine-level interfaces for the disk BASIC. The disk-manipulation system is spelled out in detail, as are all color and graphics techniques and the file control system (FCS).

The Manual concludes with seven appendices that contain in-depth discussions of the disk BASIC, file control system, CRT commands, internal features of the computer, an ASCII value table, and the Compucolor alphanumeric and graphic character set, along with other documentation.

User Report. The Compucolor is a complete computer. Simply unpack the two sections, interconnect them via the flat ribbon cable, plug the line cord into an ac outlet and turn on the power. That's all there is to getting the system up and ready to go in either the operating system or BASIC.

To use a diskette, simply insert the diskette in the drive, close the drive door, and press the auto key on the keyboard. In just a couple of seconds, the disk "menu" pops up on the screen.

The graphics display was clean and sharp with bright colors. The overall quality of the graphics was excellent due to good convergence and the fact that the monitor bandwidth is better than that of a conventional color-TV receiver. One of the major advantages of the color monitor is that optically disturbing moire patterns (from nearby TV transmitters on adjacent channels or local or mobile hams and CBers) are not seen on-screen. Also, this approach provides an apparent increase in bandwidth since the monitor is not bandwidth-limited by r-f or sound circuits. The Compucolor "Sampler" program on diskette demonstrates the system's graphics capability.

The keyboard was a dream to operate. It has a positive professional "feel" and operated flawlessly.

Having had experience with other BASICs, we found Compucolor's version easy to use. It is a fast BASIC and is broad enough to easily adapt to programs written in other BASICs, except where unique symbols are used.

After working some of the programming examples given in the Manual, we typed in several game programs incorporating color graphics. This is quite easy to do, as a single keystroke can be used to change colors, flash symbols, invert and do other formerly difficult graphics "tricks." These keystrokes can be written into the program.

We also adapted a couple of simple business programs to the color format, making them much easier to read and interpret. Credits and debits for example, are much easier to follow when they are color-coded.

The bottom line here is that the addition of color to a video display does make working and playing with a computer much more pleasant and exciting. Compucolor is supporting its system with lots of software (diskettes), including a large variety of color games, text editor, assembler, and several money-management programs.

In our opinion, the Compucolor II is an excellent choice for a computer system to start and stay with for home use. It is very flexible, thanks to its built-in disk drive, and has sufficient on-board memory to handle just about any length programs. This is a lot of computer for the money. —Leslie Solomon, Technical Director

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AUGUST 1979
THIS FALL, the World Administrative Radio Conference (WARC) in Geneva will reallocate the entire radio spectrum, in keeping with anticipated needs through the end of the century. Of prime concern to DX listeners is the proposed reallocation of the shortwave spectrum to allow more space for broadcasting.

Fixed (point-to-point) communication has largely switched to satellites in the past 15 years. This trend will no doubt continue. At the same time, the relatively small shortwave broadcast bands have become overloaded to about three times their capacity. This is why co- and adjacent-channel interference has become the rule rather than the exception. It would appear, then, that the natural solution would be to turn over a portion of the fixed bands to broadcasting. But it's not that simple. There are many other claimants to the hf spectrum (such as Amateur Radio), and different countries have different priorities.

For the past few years, the FCC has sponsored a series of meetings by the International Broadcasting Service Group, to help it determine exactly what should be the US position at WARC. In April, the IBSG issued its final proposal and disbanded, its mission completed.

The world is divided into three broad regions for allocation purposes. Region 1 includes Europe, Africa, the Mideast, and the USSR. Region 2 consists of North and South America. Region 3 is comprised of the rest of the world, which includes Asia and the Pacific.

The IBSG proposes that international broadcasting between 5.8 and 22 MHz should be expanded by 93% in Region 2, and 80% elsewhere, very nearly a doubling of available in-band space, from the present total of 2350 kilohertz to 3940 kilohertz.

Since Third World countries hold the balance of power at WARC, the US position also proposes a 60% expansion of bands for tropical broadcasting by adding five new tropical bands in the 3-to-14-MHz range and making all tropical bands, new and old, exclusively for tropical instead of international broadcasting. No changes are proposed between 3.0 and 5.8 MHz, either in tropical or international bands. The five proposed new tropical bands, totaling an addition of 300 kHz are: 5850 to 5900 kHz, 7500 to 7550 kHz, 9825 to 9875 kHz, 11,500 to 11,550 kHz, and 13,900 to 14,000 kHz. These are adjacent, or almost adjacent, to existing or newly proposed international broadcasting bands, for the convenience of listeners, receiver designers, and existing transmitting equipment.

In the proposed new international broadcasting band allocations, all existing bands (except 25 MHz) are expanded, and two totally new bands are added. These new bands would further relieve congestion on adjacent bands and make better use of prevailing maximum usable frequencies. This expansion totals 1290 kilohertz, as follows:

<table>
<thead>
<tr>
<th>Proposed (kHz)</th>
<th>Present (kHz)</th>
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</thead>
<tbody>
<tr>
<td>5900-6200</td>
<td>5950-6200</td>
</tr>
<tr>
<td>7250-7500</td>
<td>7100-7300</td>
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<td>9375-9825</td>
<td>9500-9775</td>
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<td>11550-12000</td>
<td>11700-11975</td>
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<tr>
<td>13600-13850</td>
<td>none</td>
</tr>
<tr>
<td>15100-15700</td>
<td>15100-15450</td>
</tr>
<tr>
<td>17600-17900</td>
<td>17700-17900</td>
</tr>
<tr>
<td>19750-19990</td>
<td>none</td>
</tr>
<tr>
<td>21450-21800</td>
<td>21450-21750</td>
</tr>
<tr>
<td>25850-26100</td>
<td>25600-26100</td>
</tr>
</tbody>
</table>

The US position calls for selective sharing between fixed services and broadcasting in all added band space. However, it is not considered likely such sharing will be adopted by the Conference this fall.

The US position also urges, but does not give a specific date for, adoption of single sideband for international broadcasting. But this change is not likely in the near future. Also being considered are power limits of 50 kW for domestic operations and either 250 or 500 kW for international operations. While this may seem excessive, it is realistic. There are already some instances of a full 1000 kW and even 1250 kW being used in some situations.

Our thanks to Lawrence E. Magne, member of the IBSG, for supplying this information.

Moscow via Cuba. The USSR has long been the target of American broadcasts from such nearby countries as Greece, Germany, and Britain. Now, more than 20 years after the triumph of the socialist revolution in Cuba, Radio Moscow has begun transmitting in English to North America via Cuba.

We first noted the foregoing arrangement on April 22, Lenin's 109th birthday, as the "newscasts" reminded us every half hour.

The Moscow signals were and are the strongest on the bands during the daytime. This, combined with their steady strength even during ionospheric disturbances that block direct reception from the USSR, made it obvious that a relay was in use. Radio Moscow characteristically made no public announcement of the new relay, nor has it ever been publicly admitted that some of its other broadcasts to North America are relayed via Bulgaria.

Why wasn't the Cuban connection made use of long ago? Cuba has been making full use of its shortwave facilities, but there has always been a shortage of power and spare parts, and there has been no reliable way of feeding the Moscow audio to Cuba. Now, however, Cuba has a satellite link with Moscow and finds it advantageous to dedicate one of its...
transmitters to Soviet broadcasts to North America. In return, a Soviet transmitter is dedicated to Cuba’s broadcasts to the Mediterranean area.

Radio Moscow thus becomes the international broadcaster with the most hours per day beamed to North America, surpassing the BBC by far. And with this Cuban relay on one good frequency at a time, we may hope that Radio Moscow will no longer find it necessary to use a dozen different frequencies on direct broadcasts from the USSR.

Publications. For a list of club publications and services, send a legal-size SASE with 28¢ postage to ANARC, 557 N. Madison Ave., Pasadena, CA 91101.

FRENDEX, the shortwave broadcast journal, provides a great deal of timely schedule, logging, and QSL information plus receiver reviews and nontechnical articles. Sample $1, subscription $13, from NASAW, Box 13, Liberty, IN 47355.

Review of International Broadcasting, a monthly listeners’ magazine emphasizing free discussion of programming and issues affecting the DX listening hobby (an approach lacking in other publications) is $1 a sample or $12 a year from Glenn Hauser, Radio WUOT, Knoxville, TN 37916.

The World in My Ears, a new book by well-known New Zealand DX listener Arthur Cushen, who, despite blindness, has been very successful in shortwave, to the point of being knighted. For information, contact Cushen direct, at 212 Earn St., Invercargill, New Zealand.

August BBC World Service. Among the many fine BBC programmes planned this month are these (dates and times GMT): “Play of the Week,” August 5 at 0030 and 1130 presents the winning entry in the World Service Drama Competition. “On Their Majesties Most Secret Service,” four programs on the history of British espionage, Saturdays at 1130, Tuesdays at 2030, Wednesdays at 0230. “The Art of the Whodunit,” on the history of detective fiction, Saturdays at 0815 and 1315, Sundays at 1515, Mondays at 0315. “Venice Pre- 

erved,” week of August 20, Monday at 0945 and 2130, Thursday at 1430. Week of August 27 at same times, “Pompeii.” Week of August 26, Sunday at 1830, Monday at 0100, Tuesday at 1345. “A Thurber Carnival.” “Behind Every Great Man ...”, Saturdays at 0430, Mondays at 0815 and 2315. (Subject to change).

Updating Listings. The following changes and additions should be made in the “English Broadcasts” listings that appeared in the June issue:

<table>
<thead>
<tr>
<th>GMT</th>
<th>Staiton</th>
<th>Frequency, changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000-1030</td>
<td>R. Korea</td>
<td>11725, 9580</td>
</tr>
<tr>
<td>1000-1300</td>
<td>R. Moscow</td>
<td>9600 (via Cuba)</td>
</tr>
<tr>
<td>1000-1602</td>
<td>ABC, Perth</td>
<td>9610</td>
</tr>
<tr>
<td>1030-1300</td>
<td>CBC Northern Service</td>
<td>9625, 6065 not 11720</td>
</tr>
<tr>
<td>1100-1115</td>
<td>R. Pakistan</td>
<td>21655, 17662</td>
</tr>
<tr>
<td>1100-1300</td>
<td>BBC</td>
<td>add 21660 to 11775 at 11100 &amp; 1300-1330 only</td>
</tr>
<tr>
<td>1100-1500</td>
<td>R. Moscow</td>
<td>delete</td>
</tr>
</tbody>
</table>

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AUGUST 1979

71
<table>
<thead>
<tr>
<th>Time</th>
<th>Country/Region</th>
<th>Frequency</th>
<th>Notes</th>
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<td>WYFR</td>
<td>9715</td>
<td></td>
</tr>
<tr>
<td>0100-0145</td>
<td>Austria</td>
<td>5945</td>
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<tr>
<td>0100-0130</td>
<td>R. Budapest</td>
<td>17770</td>
<td>Thursday</td>
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<tr>
<td>0100-0200</td>
<td>R. Japan</td>
<td>15207</td>
<td></td>
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<td>0200-0300</td>
<td>V. of Greece</td>
<td>15440</td>
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<td>R. Korea</td>
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Software Sources
By Leslie Solomon
Technical Director

6502 Operating System. EXOS (Ex¬
tended Operating System) for 6502 com¬
puters comes in a 4K 2708 PROM and has 20
commands including display, enter, math,
memory test, find, fill, move, compare, speed
change, load/dump a hex formatted MUST
tape, verify, and several "go to" commands.
The program is compatible with all MOS
Technology TIM systems, or other 6502 com¬
puters. Price is $150. Also available is DATE
(Disassembler-Assembler Trace Editor).
Source programs can be entered, assem¬
bled, edited, traced and disassembled. The
trace mode executes the user program one
instruction at a time, displays MPU registers,
the instruction and the MOST mnemonics.
$150. Both programs $295. CGRS Mi-
crotech, Box 368, Southhampton, PA 18966
(Tel: 215-757-0284).

Jolt Stuff. ERAC (Editor and Resident
Assembler Controller) was designed for us¬
ers of ROM version of the Jolt resident
assembler ($C900-CFFF). ERAC allows source
text and object code to be placed anywhere
in RAM. Residing in 2K starting at $0800,
1000 or A800, ERAC is an extension of the
RAP. A paper tape is available for $5, manual
$4.50, and source of $0800 version is
$12.50. LEDIP (Line Editor Program) is a
1.1K line-oriented text editor that can be ex¬
panded. It will output source text suitable for
usage with the PROM Jolt Resident assem¬
bler. ($E800-EFFF). Paper tape is $2.75, manual
$3.25, cross assembly $5. For further
information, send $1 to the 6502 Program
Exchange, 2920 Moana, Reno, NV 89509.

8080/280 Macro Assembler. This
14K assembler includes a linking loader, li-
brary manager and cross-reference facility
and assembles over 1000 lines per minute.
It supports the Intel standard macro facility
and the number of nesting macros is limited
only by memory. Code is assembled in relocat¬
able modules. Conditionals may be nested to
255 levels. Other features include comment
blocks, variable input radix from base-2 to
base-16, titles and subtitles, variable page
distance, hex or decimal listings, PRINTX for printing
assembly or diagnostic messages, and
PHASE/DEPHASE to allow code to reside in
one area of memory but operate in another.
It accepts both 8080 and 280 opcodes. Price is
$200. Microsoft, 10800 NE Eighth, Suite 819,
Bellvue, WA 98004 (Tel: 206-455-8080).

TRS-80 Solar Package. The SUN-
GRAPH program calculates and plots the
sun's local elevation and azimuth for any
location on the Earth. It uses TRS-80 Level-II
BASIC, and requires 13K storage. Options in¬
clude graphs of elevation vs time of day, azi-
muth vs time of day, maximum elevation vs
date and elevation at a specified azimuth and
date. Save options allow the graph to be
stored on cassette. Cassette is $49, disk is
$75. Solaritek, Box 286, Guilderland, NY,
12084.

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WINDOWS IN THE CRT

The MOST common way to communicate with a computer today is via a plug-in or a separate video terminal. The ordinary video terminal forms a single "window," in which all you can see is one piece of data at a time as it appears in sequential order on the screen. Recently, we had the opportunity to work with a very special graphics display system called the "Screensplitter" from Micro Diversions, Inc. (8455-D Tyco Rd., Vienna, VA 22180 Tel: 703-827-0888). This novel plug-in video module is not limited to a single window (see photo). Rather, the user can create, under software control, almost any number of data-display windows, each with its own independent display.

Individual windows in the Screensplitter can be sized, labelled, and framed as desired. Furthermore, frame and window can be made to flash, display in reverse video, clear, scroll, and use any character as a blinking or nonblinking cursor. The window package is contained in an EPROM and has 20 user-callable functions. You can, for example, run a BASIC program and display each subroutine in its own window. Or you can display different data in different windows. You can even move the windows around at will.

If you are doing assembly-language programming, one window can be used as a real-time clock, another to display run time, and others to display register contents or anything else you desire. Debugging information can be contained in its own window. For game playing, you can create as many windows as required. Too, some windows can be dedicated strictly to graphics.

The Screensplitter does not preclude operation as a single window with 40 lines of 80 characters each. Bear in mind, however, that this dense a display...
requires a video monitor with at least a 10-MHz bandwidth.

The Screensplitter occupies a single S-100 bus slot. It contains its own 4K of RAM that is memory mapped into the address space so that it can be accessed if you wish to use the window package.

Pascal Microengine. This new computer contains 64K of RAM, two RS-232C ports, two parallel ports, and a floppy-disk controller with DMA. It features self-test diagnostics, Pascal compiler, BASIC compiler, file manager, screen-oriented editor, debugger, and graphics package. Available options include a floppy-disk subsystem, printer, and terminal. Cost at this writing is $1995. Address: Computer Interface Technology, 2080 South Grand, Grand Center, Santa Ana, CA 92717.

S-100 Interface. The Betsi interface/Motherboard contains all logic required for interfacing S-100 boards to the Pet microcomputer. It connects directly to the Pet's expansion connector and has four S-100 slots. It does not interfere with the Pet's parallel or IEE ports. The board also contains a dynamic memory controller that permits use of a 32K RAM board. There are also sockets and decoding circuitry for 8K of 2716 PROM. Price is $119.00 for the kit, which includes one S-100 connector, or $165.00 assembled and with four S-100 connectors. Address: Forethought Products, P.O. Box 8066, Coburg, OR 97401 (Tel: 503-485-8575).

S-100 Video Board. The new ALTR-2480 is a 24-line by 80-character S-100 bus video display board. It features upper- and lower-case characters plus graphics. The system also has built mapping (4K by eight), built-in read/write refresh, 2716 user-programmable EPROM, external/internal sync, normal/inverse/blink control, 500 ns access time, and direct drive for a CRT monitor. Using "Transparent Memory," the CPU can access the refresh memory at any time, the display is glitch-free, and the CPU is never interrupted. No reliance is placed on the peculiar characteristics of a particular CPU. A multiplexing technique permits nonconflicting access by both CRT controller and CPU. Price is $295.00. Address: Matrox Electronic Systems, Ltd., 2795 Bates Rd., Montreal, Quebec, Canada H3S 1B5 (Tel: 514-481-6838/735-1182).

(continued on page 76)
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COMPUTER BITS
(continued from page 75)

S-100 Extender Board. A 7-segment display logic probe and a pulse-catcher LED, whose brightness corresponds to the duty cycle of the pulse stream, are used in the new TB-2 Extender Board kit from Mullen. The board features a general-purpose “kluge” area for circuit development. This section is provided with its own on-board 5-volt, 1-ampere regulator that also powers the logic probe. Other features include power supply links for current measurement, labelled S-100-bus edge connector, and gold-plated connector contacts. Price is $35.00. Address: Mullen Computer Products, P.O. Box 6214, Hayward, CA 94545 (Tel: 415-783-2866).

S-100 to IEEE Interface. The P&T 488 Interface Board permits the broad spectrum of S-100-bus computers to directly interface with instruments and peripherals that operate on the IEEE 488-1975 Standard Digital Interface for Programmable Instrumentation. The board comes with 488 cable assembly. Software is distributed as source code in machine-readable form. An integral “Bit-wiggler” tape interface is used for reading software with a conventional cassette tape recorder. Price is $250.00 in kit, $325.00 in wired form. Address Pickles & Trout, P.O. Box 1206, Goleta, CA 93017 (Tel: 805-967-9563).

New Printers In Town. The Model DP-8000 hard-copy printer from Anadex prints 80-character lines at 112 characters/second (84 lines/minute). Printing is bidirectional, via sprocket feed. Alphanumericics are formed from a 9 × 7 dot matrix. The complete 96-character ASCII set is available. Basic ASCII inputs include RS-232C, 20/60-mA current loop, and parallel-bit/serial character, the last synchronous at high strobe rates. Three data lines of FIFO buffer storage are available, and data can be accepted continuously or in bursts. Serial ASCII is adjustable to 9600 baud. Up to 1000 characters/second can be fed into the input. Address: Anadex, Inc., 9825 DeSoto Ave., Chatsworth, CA 91311 (Tel: 213-998-8010).

Bowman’s Model TP-3150 thermal printer requires no rubbons or ink. It has an 18-character capacity and uses a 5 × 5 solid-state dot-matrix print head. Print direction and character rotation are user controllable.

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controllable. ASCII data can be synchronous parallel or asynchronous serial. The printer accepts the 64 standard ASCII characters and ignores all other codes. Price is $270.00. Address: Bowmar Instrument Corp., Commercial Products Div., 8000 Bluffton Rd., Fort Wayne, IN 46809.

A bidirectional printer from Printer Terminals operates at 75 lines/minute and offers a choice of 7 × 9 or 9 × 9 dot-matrix print capability. It can print up to four copies simultaneously. The full 96-character, upper-and-lower-case ASCII set, plus triple-wide character font, are available. The operator can choose either 80- or 132-character lines. Included are RS-232C and parallel interfaces and 2K of memory for full-page dump. The printer is designed to accommodate roll paper, combination pin form and roll, and tractor feed. Price is $1395.00. Address: Printer Terminals Corp., P.O. Box 535, Ramona, CA 92065 (Tel: 714-789-5200).

Single-Board Microcomputer. The 90F/MPS microcomputer from Quay is based on the 286 and contains multidensity-DMA floppy-disk controller. It can accommodate up to 65K of dynamic RAM, 14K of EPROM with programmer, and 1K of static RAM. Up to four 8-bit programmable I/O ports are available. There are also four programmable counter/timer channels and an RS-232C or 20mA serial port, the latter with selectable baud rates. A resident PROM system monitor contains debug capabilities. With 16K of dynamic RAM and two parallel ports, price is $1295.00. Address: Quay Corp., P.O. Box 386, Freehold, NJ 07728 (Tel: 201-681-8700).

S-100/Telephone Interface. The MK-II transceiver board from MK Enterprises interfaces an S-100 bus to the telephone line and uses Touch-Tone frequencies. On incoming calls, vectored interrupts allow for ring detection and DTMF signaling. This permits calling the computer and using the telephone pushbuttons for entry. A 4-bit input post allows additional data to be transferred coincident with decoded DTMF. On outgoing calls, the board operates at telephone company speeds. A 4-bit output port allows supervision of trunk interface equipment (DAA). Single tones can be generated. Price is $425.00. Address: MK Enterprises, 9119 Norwick Rd., Richmond, VA (Tel: 804-740-8380).
A "MATCHBOX" LED OSCILLOSCOPE

REGULAR readers of the Experimenteer's Corner are by now familiar with the design of simple solid-state oscilloscopes that employ an array of LEDs for a screen. Thanks to the new LM3914 dot/bar display driver, the design of such a scope can be simplified considerably. The result is a scope small enough to fit inside a pocket matchbox!

Figure 1 is the schematic diagram of a compact LED scope that uses only three ICs and consumes only 15 mA. Operation of the circuit is fairly straightforward, especially if you're already familiar with solid-state scope basics.

The incoming waveform is applied directly to pin 5 of the LM3914, where its instantaneous amplitude is detected by a voltage divider/comparator chain. Decoding logic then drives one of the LM3914 outputs low.

Any LED in the row connected to the selected output is then eligible to glow. The remaining requirement is a positive voltage at the LED’s anode. This is obtained from a horizontal sweep circuit made from a 4011 quad NAND gate and a 4017 Johnson counter.

The 4011 performs two important functions, one of which is to provide a stream of clock pulses. This is accomplished by two gates connected as a free-running or astable oscillator. The frequency of oscillation is determined by the values of R4 and C1.

The 4017 counter is unique in that it includes a 1-of-10 decoder. This eliminates the need for a separate decoder IC. Furthermore, because the activated output of the 4017 goes high when all other outputs remain low, the 4017 can be connected to the anode of an LED.

The remaining two gates in the 4011 form an AND gate that provides an automatic trigger. When MODE switch S1 is closed, the gate resets (clears) the 4017 if the input voltage has sufficient amplitude to activate the lowest-order output of the LM3914 at the same time that the lowest-order counter output is high. This feature makes it relatively easy to freeze the waveform being displayed.

The "screen" of the scope is a single 5 × 7 dot-matrix LED display (Monsanto MAN-2A, Texas Instruments TIL305, Litronix DL-57 or equivalent). Although 35 LEDs provide very limited resolution at best, with experience it’s possible to visualize square and triangle waves being displayed on the readout.

In case you’re wondering where the current limiting resistors of the LED display are, they are not necessary! The LM3914 includes a novel feature that permits the current at the selected output to be externally programmed by a single resistor R3 connected to pin 7. This pin provides a reference voltage of 1.2 to 1.3 volts, and the current through R3 is 1/10 the LED current. According to Ohm’s law, the current flowing through a resistor is the quotient of the voltage across the resistor divided by the resistance in ohms. The current through R3 is therefore 1 mA, which means that the LED current is 10 mA.

Figure 2 is a photograph of a miniature,
**Project of the Month continued**

Wire-Wrapped prototype scope that I assembled on a perforated board measuring 1.2" x 1.9" (about 3 cm x 5 cm). Notice that pins 9 and 10 of the LM 3914 extend over the lower end of the socket. The small capacitor installed in the two unused pin positions of the 4011 socket is C1. The overrange LED is installed below the 5 x 7 LED array. Components R1, R4 and S1 are attached to the circuit board with cyanoacrylate adhesive. I used a miniature Micro Switch™ pushbutton switch as S1 because I had one on hand, but any other spst switch is suitable.

Some typical display patterns I have obtained are shown in Fig. 3. Often, the displayed pattern will bear little resemblance to the actual wave. Sometimes it’s easier to visually integrate the approximate shape of a wave by switching off the automatic trigger and adjusting R4 until the waveform slowly parades across the display.

For some interesting visual effects, try connecting a radio or audio amplifier to the input of the scope. Music and voice signals will stimulate a dynamic, miniaturized light show. For best results, leave the trigger switch off.

Finally, remember that it’s relatively easy to expand the scope’s display. You can add a second 5 x 7 display or make a 10 x 10 display from individual LEDs or 10-element LED bars. If you’re really ambitious, you can add additional LM3914’s and 4017’s and make a scope having 20 x 20 or more LEDs.

---

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**MICRO's, RAMS, CPUs, E-PROMS**

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**SOCKETS/BRIDGES**

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**TRANSISTORS, LEDS, ETC.**

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### Resistors

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<td>10 ohm</td>
<td>$0.20</td>
</tr>
<tr>
<td>100 ohm</td>
<td>$0.40</td>
</tr>
<tr>
<td>1k ohm</td>
<td>$0.80</td>
</tr>
<tr>
<td>10k ohm</td>
<td>$1.00</td>
</tr>
<tr>
<td>100k ohm</td>
<td>$2.00</td>
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</tbody>
</table>

### Integrated Circuits

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>74HC00</td>
<td>Quad 2-input NAND gate</td>
</tr>
<tr>
<td>74HC04</td>
<td>Quad 2-input OR gate</td>
</tr>
<tr>
<td>74HC138</td>
<td>Octal 3-to-8 line decoder</td>
</tr>
</tbody>
</table>

### Microprocessors

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6800A</td>
<td>8-bit microprocessor</td>
</tr>
</tbody>
</table>

### Resistors

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 ohm</td>
<td>$0.20</td>
</tr>
<tr>
<td>1k ohm</td>
<td>$0.40</td>
</tr>
<tr>
<td>10k ohm</td>
<td>$0.80</td>
</tr>
<tr>
<td>100k ohm</td>
<td>$1.00</td>
</tr>
<tr>
<td>1M ohm</td>
<td>$2.00</td>
</tr>
</tbody>
</table>

### Capacitors

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>100pf</td>
<td>$0.10</td>
</tr>
<tr>
<td>0.1uf</td>
<td>$0.20</td>
</tr>
<tr>
<td>1uf</td>
<td>$0.40</td>
</tr>
<tr>
<td>10uf</td>
<td>$0.80</td>
</tr>
<tr>
<td>100uf</td>
<td>$1.00</td>
</tr>
</tbody>
</table>

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<td>8-bit microprocessor</td>
</tr>
</tbody>
</table>

---

**Additional Information:**

- The Panasonic MA1023 circuit board is available in various sizes and shapes to fit different applications.
- Capacitors are available in a wide range of values and tolerances to suit various circuit requirements.
- Resistors are offered in different resistance values and power ratings.

---

**Further Resources:**

- Electronic components catalog for more detailed information.
- Data books for specific component specifications.
- AmericanRadioHistory.com for historical context and related events.
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- Resistor Networks for all 16 inputs
- Easy mounting with standard 3.50 pin header connectors

**JE600 $59.95**

**JE300 $39.95**

**DISCRETE LEDS**

<table>
<thead>
<tr>
<th>LED Type</th>
<th>Color</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>74C73</td>
<td>Gold</td>
<td>$1.50</td>
</tr>
<tr>
<td>74042</td>
<td>Yellow</td>
<td>$1.15</td>
</tr>
<tr>
<td>5147459</td>
<td>Red</td>
<td>$1.00</td>
</tr>
<tr>
<td>14E567V/H</td>
<td>Blue</td>
<td>$0.35</td>
</tr>
<tr>
<td>741575</td>
<td>Green</td>
<td>$0.99</td>
</tr>
<tr>
<td>7415163</td>
<td>Blue</td>
<td>$1.15</td>
</tr>
<tr>
<td>741555</td>
<td>Red</td>
<td>$0.29</td>
</tr>
<tr>
<td>7415160</td>
<td>Green</td>
<td>$1.19</td>
</tr>
<tr>
<td>LM3401324</td>
<td>Red</td>
<td>$1.35</td>
</tr>
<tr>
<td>004174</td>
<td>Yellow</td>
<td>$0.75</td>
</tr>
<tr>
<td>7415260</td>
<td>Blue</td>
<td>$1.79</td>
</tr>
<tr>
<td>7415194</td>
<td>Green</td>
<td>$1.25</td>
</tr>
<tr>
<td>LM747911</td>
<td>Red</td>
<td>$1.19</td>
</tr>
</tbody>
</table>

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- Recovery from water damage is guaranteed.
- All items are tested and verified for quality assurance.

**SHIPPING INCLUDES**

- Shipping rates are calculated automatically based on the weight of the goods.
- All goods are shipped via standard shipping methods.
- Insurance for goods is included in the shipping cost.

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- Items must be in original packaging and in new condition.
- A 15% restocking fee applies to all returns.

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- A 2% late fee is charged on past-due invoices.
- All invoices must be paid in full before delivery is finalized.

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- Your satisfaction is our priority.
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- Battery Operated

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0.151-1 | 1 ft | 1/16 Pin | 5.99
0.241-1 | 1 ft | 1/16 Pin | 5.99
0.151-14 | 1 ft | 1/16 Pin | 5.99
0.161-15 | 1 ft | 1/16 Pin | 5.99
0.241-24 | 1 ft | 1/16 Pin | 5.99

For Custom Cables & Jumpers, Tax Exempt 1979 Catalog Page 91

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JE701 $19.95

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Proto Board 203

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P20-104 | $60.00

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Model | Kit Price
---|---
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P20-107 | $40.00
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Mega JE205 $14.95

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* 1 each 8112, 8122, 8132, 8152

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JE22056 $29.95 Kit

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- Output amplitude from 0 to 5 volts
- Pulse width from 0 to 0.1 ms
- Includes a 100 MHz 8-Digit counter
- Includes a printed circuit board

JE22058 $19.95 Cartridge

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GM deletes "standard" radios in a settlement of the auto sound antitrust suit filed against it in March by members of the Custom Automotive Sound Association (CASA). Under terms of the settlement, General Motors will offer the delete option on the standard radios of all of its recently introduced X-body cars. Moreover, GM will permit dealers to exchange a Delco radio in these cars for credit against purchase of any GM part. (Former policy restricted exchange credit only toward purchase of another Delco radio.) GM also agreed not to standardize Delco radios in any additional models through the end of the 1983 model year. Thereafter, if GM intends to extend radio standardization, it will furnish CASA with at least four months notice.

A home energy-saving system has been developed by William Lamb (No. Hollywood, CA), pioneer in the development of silicon solar cells. It consists of a lightweight panel of 36 cells that are capable of developing 16 volts to charge a 12-volt storage battery at a 1.5-ampere/hr rate. Enough power is available from a single panel system to operate a low-power 12" monochrome TV receiver. The glass surface of each cell is toughened and backed by a special chemical compound that makes it practically impervious to hammer blows and all kinds of weather. Virtually maintenance-free, the system costs nothing to operate. Also, its modular design permits quick expansion of the system at any time. Price of a 36-cell system is $325.

Microwave-oven market growth could be hampered unless frequencies near 10 GHz are allocated for cooking, according to Litton Microwave Cooking. As a result, Litton will try to bypass a recent FCC ruling by taking its case to the World Administrative Radio Conference (WARC) to be held in Geneva in September. The FCC, currently considering a proposal for a common-carrier data network based in part on local 10-GHz radio facilities, said microwave-oven use in those bands is "incompatible with existing and planned services for both bands." Resolutions adopted at WARC will be submitted to participating governments for approval. If the U.S. Senate approves WARC resolutions including the change Litton seeks, it would overturn the FCC ruling, since Senate approval would have treaty status.

A computer marathon record is claimed by a group of Holy Cross high-school students in San Antonio, TX. The 311 students who took part in an 8½-day around-the-clock training sessions believe their accomplishment deserves mention in record books. Instructor Dennis Doose suggested the training marathon after students voluntarily began staying after class to use the school's TRS-80 microcomputer. Radio Shack, manufacturer of the TRS-80, agreed to lend the school 22 additional microcomputers for the event.

A talking Language Translator, utilizing speech synthesis and offering solid-state modules for various languages, was announced by Texas Instruments. Designed as an aid in communicating in a foreign country and for language students in learning to pronounce a foreign language, it is programmed with a vocabulary of words and phrases selected for everyday use. The translator has the ability to form thousands of spoken phrases by linking together its spoken vocabulary words. Each module will contain about 1000 words of which half will be spoken and displayed and half will be displayed only. Prices will be about $250 for the Language Translator and $50 for each language module.

The deaf can read TV dialog with a new device soon to be marketed by Sears, Roebuck and Co. Next year, ABC-TV, NBC-TV, and Public Service Broadcasting will be airing about 20 hours of programs with special encoding. When decoded, dialog will appear on-screen in caption form with the aid of the decoding device. Captioning information will not appear on the screen if no decoder is used. For the past eight years, the department of Health, Education and Welfare (HEW) has paid for the research that has culminated in the development of captioned programs.
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