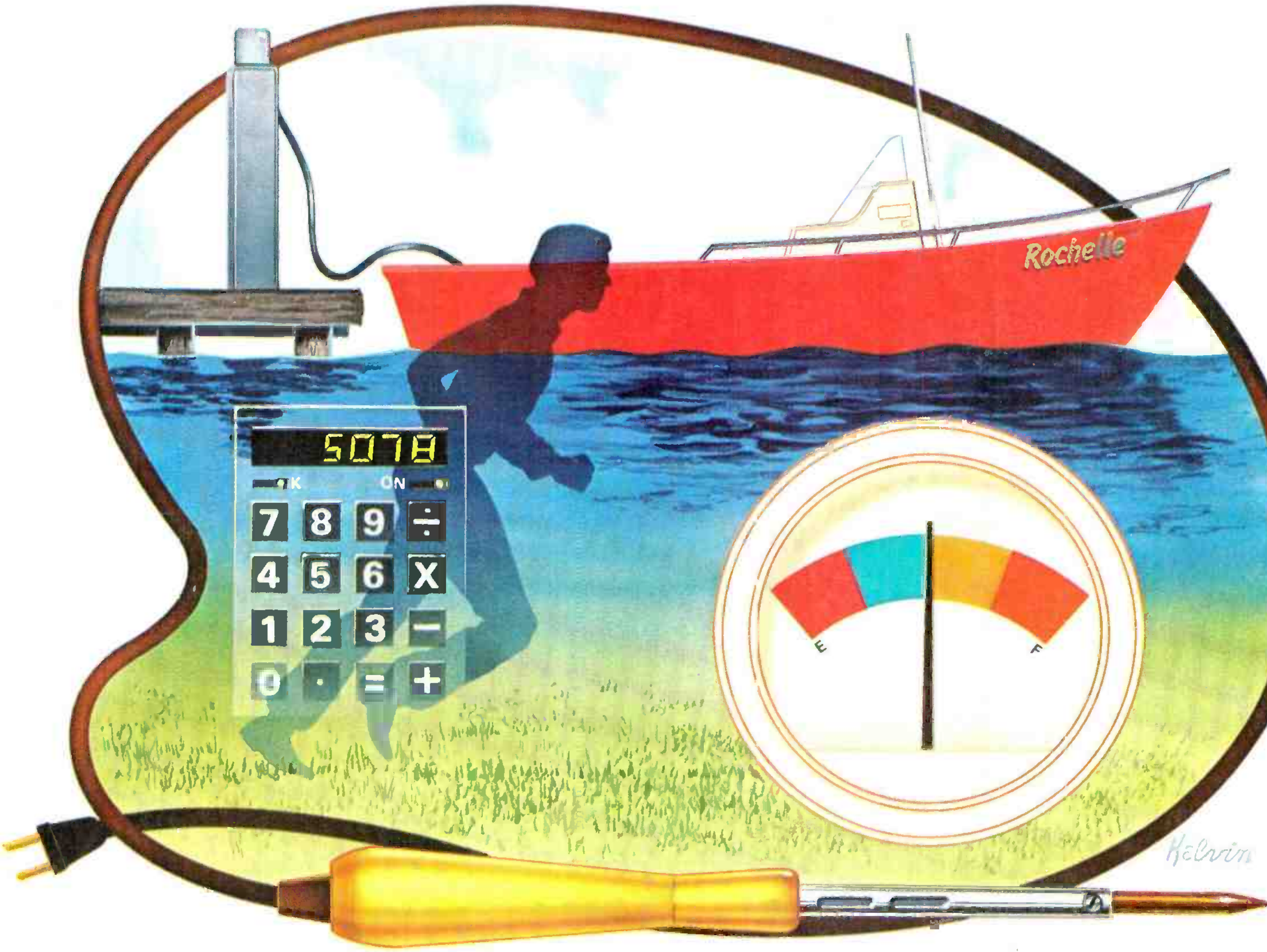
Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

AUGUST 1979/$1.25

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



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Popular Electronics

Tested In This Issue

Fisher ST460 Speaker System
Shure M95HE Phono Cartridge
Compucolor II Model 4 Personal Computer

No-Fault Radar

If you've ever been caught by radar or if you own a radar detector, please read this important message.

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 l979, 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 dash board 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.

JS&A PRODUCTS THAT THINK®

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ANNOUNCING AMERICA'S ONLY LAND, SEA AND AIR SCANNER.

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.

The new Bearcat 220 has all the features and quality Bearcat Scanners are famous for. Track tuning. Decimal display readout. Automatic Search. Selective Scan Display. Automatic squelch and lockout. Priority. And much, much more.

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

BEARCAT® 220 SCANNER

Follow the leader to real excitement.

Electra

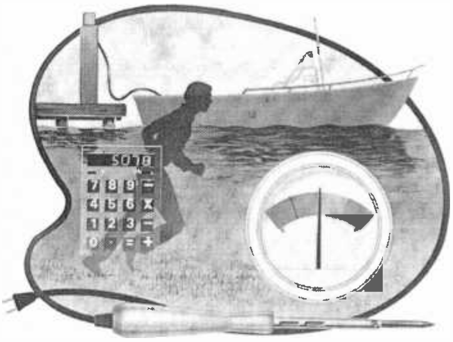
CIRCLE NO. 20 ON FREE INFORMATION CARD

AUGUST 1979

VOLUME 16, NUMBER 2

Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE



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

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Editorial

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 pro's and con's 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 results in lowered 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.

Art Salsberg

Don't take our word for it.

"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."

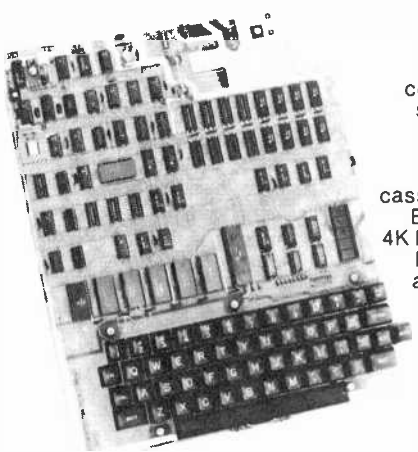
Interface Age April, 1979

"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."

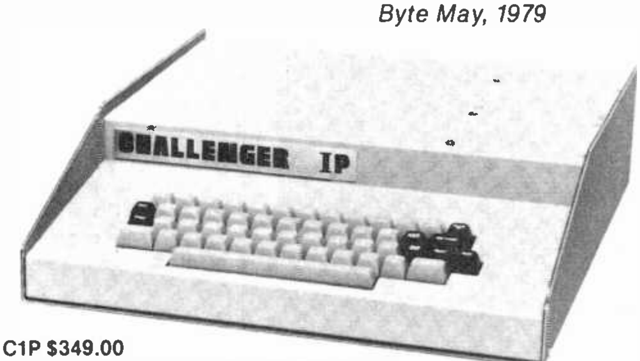
Radio Electronics June, 1979

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

Byte May, 1979



SUPERBOARD II
$279.00
The world's first complete computer system on a board including full keyboard, video display, audio cassette interface, 8K BASIC-in-ROM and 4K RAM. Expandable. Requires +5V at 3 amp power supply.



C1P $349.00
Complete with enclosure and power supply. All features of Superboard II. Easy to expand to more memory and floppy disk.

C1P MF $995.00
The first floppy disk based computer system the world has ever seen for under $1,000. 8K BASIC-in-ROM, 12K RAM. Expandable to 32K RAM.

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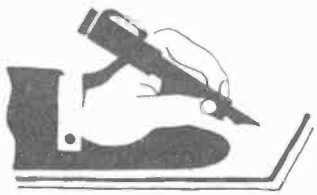
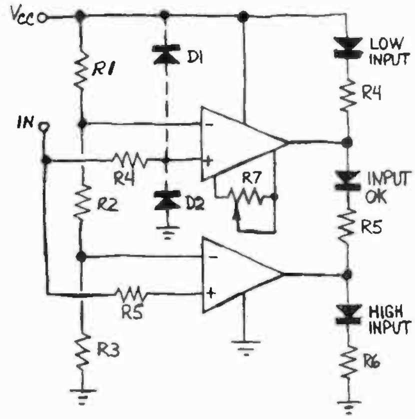


Letters



SOLENOID THAT ISN'T

We at Eumig thank Popular Electonics 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 Bensen, 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 "Experimenter's 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 $V_{CC}R3/(R1 + R2 + R3)$. 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*.

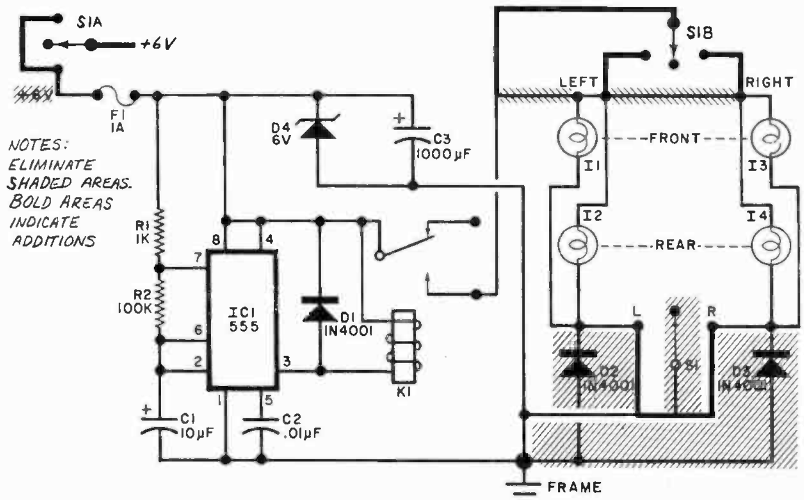
System stability is a function of V_{CC} stability and op-amp drifts. For 741s and 747s, V_{CC} should be between 8 and 30 volts. FET-input op-amps lend themselves well to this application. Resistors *R4*, *R5*, and *R6* limit LED current and should be chosen to allow about 10 mA.—*Glenn Fasnacht, Lakewood,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

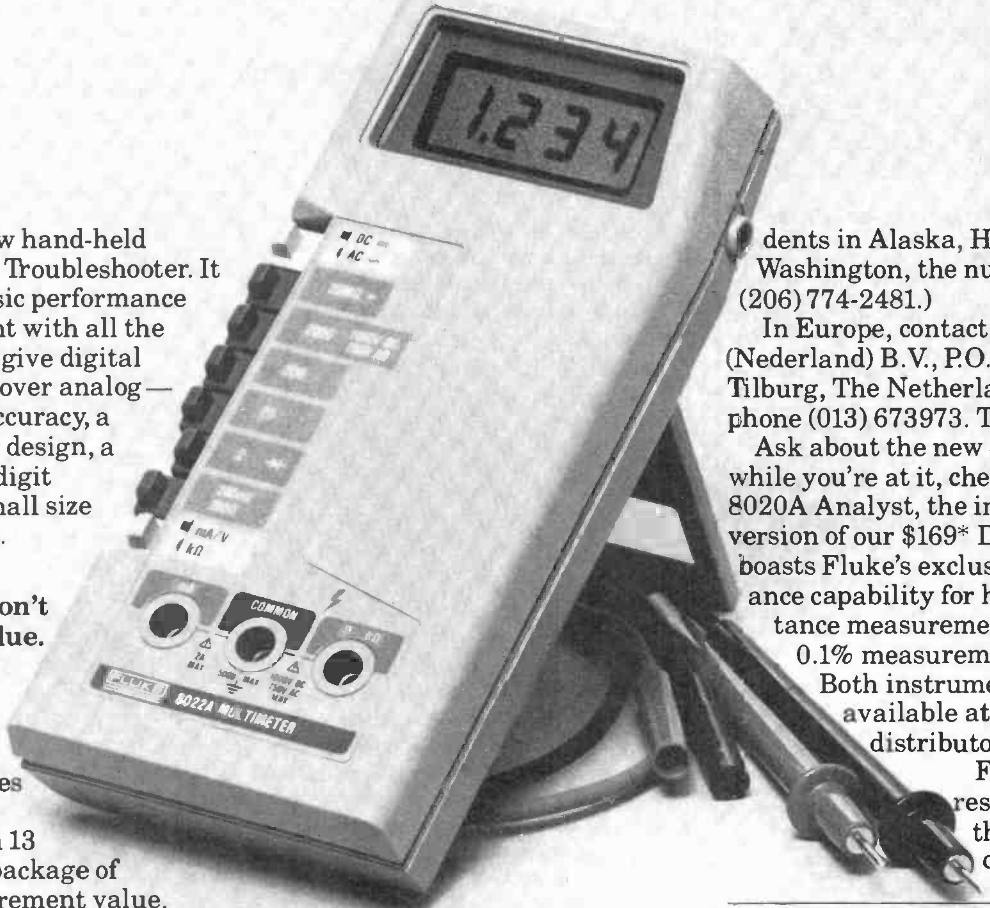
While looking over the moped turn-indicator article, I noticed that *D4* and *C3* are not switched out of the power circuit by *S1*. While this is not particularly important when the device is connected to a moped generator, if a battery is used, as suggested in the article, it would quickly discharge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



Introducing the Troubleshooter.

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



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

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

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

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

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

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

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

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

*U.S. Price Only

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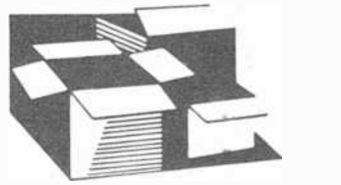
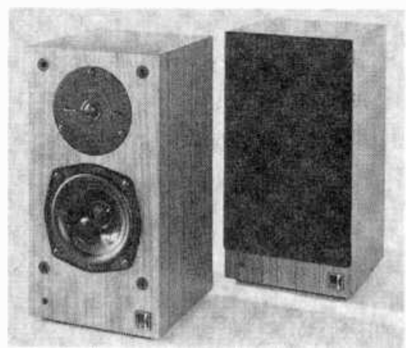


New Products

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

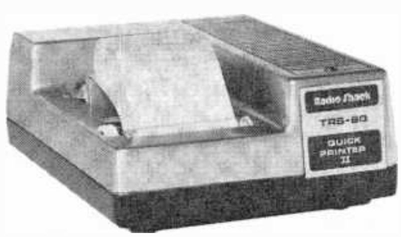


drivers—a 25-mm (1") tweeter and a 110-mm (4¼") woofer—and the crossover network as well. The speaker is rated to accept the output of an amplifier up to 100 watts and has an automatic protection system to prevent overdriving. Maximum output level is said to be 98 dB SPL. Sold in matched pairs with teak or walnut finish and a brown fabric grille.

CIRCLE NO. 88 ON FREE INFORMATION CARD

Low-Cost µC Printer

Radio Shack has introduced an inexpensive printer that produces low-cost hard copy on 2⅜" (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 printed characters. Although designed for use with Radio Shack's Level II TRS-80 systems, the printer can also be used with other computers. Measures 9¼"W × 6¾"D × 3⁵⁄₁₆"H. $219.00.

CIRCLE NO. 89 ON FREE INFORMATION CARD

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 compensat-

ing 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

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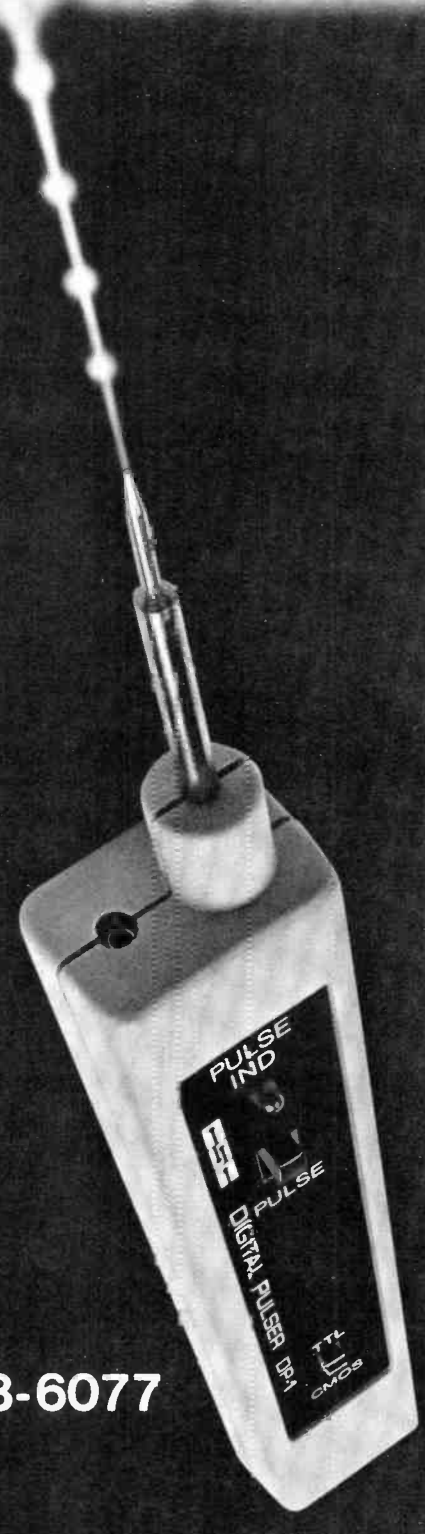
AM/SSB Mobile CB Transceiver

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)

PULSEMAKER



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.

Smarter tools for testing and design.

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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.

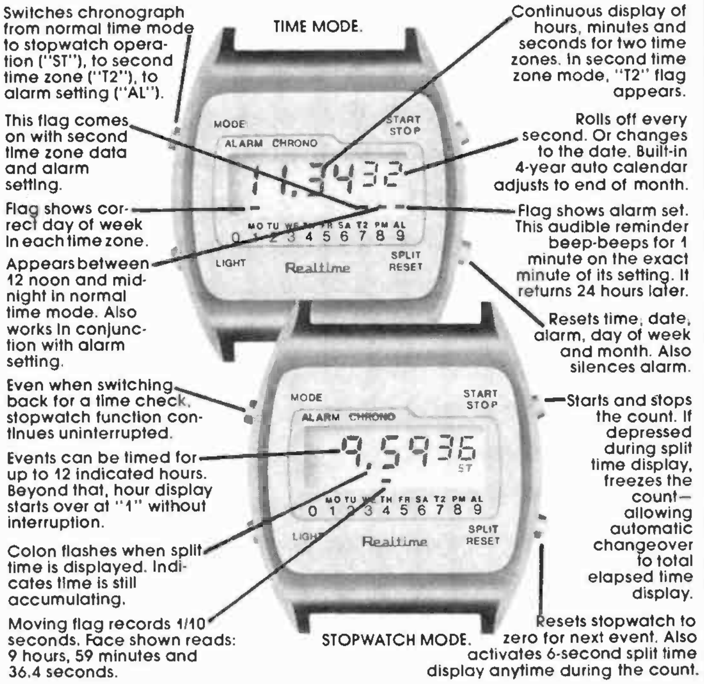
5 POPULAR ALARM CHRONOGRAPHS COMPARE THINNESS.

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.

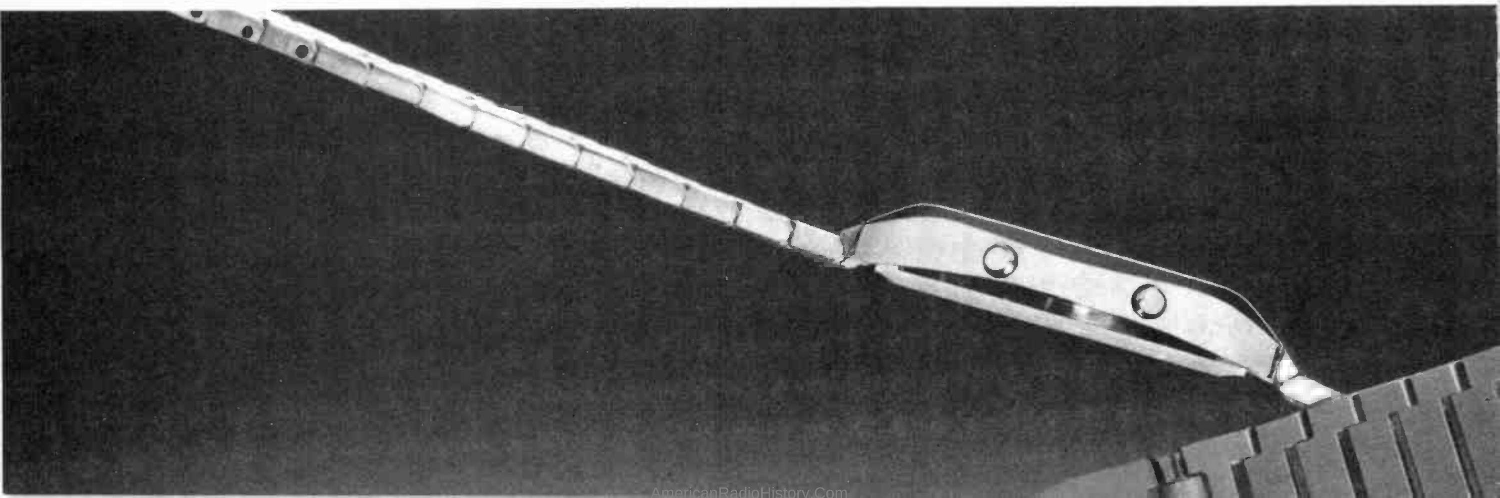
And because of Realtime's "PM" indicator, you won't be setting your alarm for the evening when you had intended to set it for the morning.

Is it Monday in New York? Or Tuesday in Hong Kong? You'll never have to ask that question



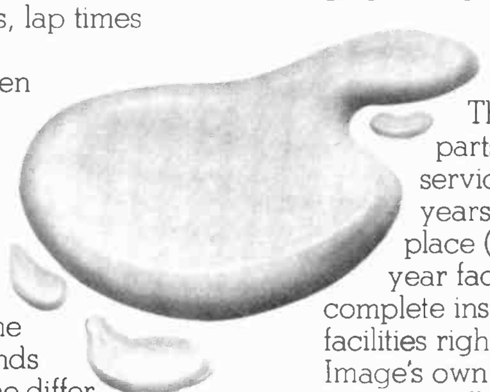
again. The day of the week is always displayed. To see the date, simply flick a button. When the sun's down, press another and the Realtime's face is instantly illuminated.

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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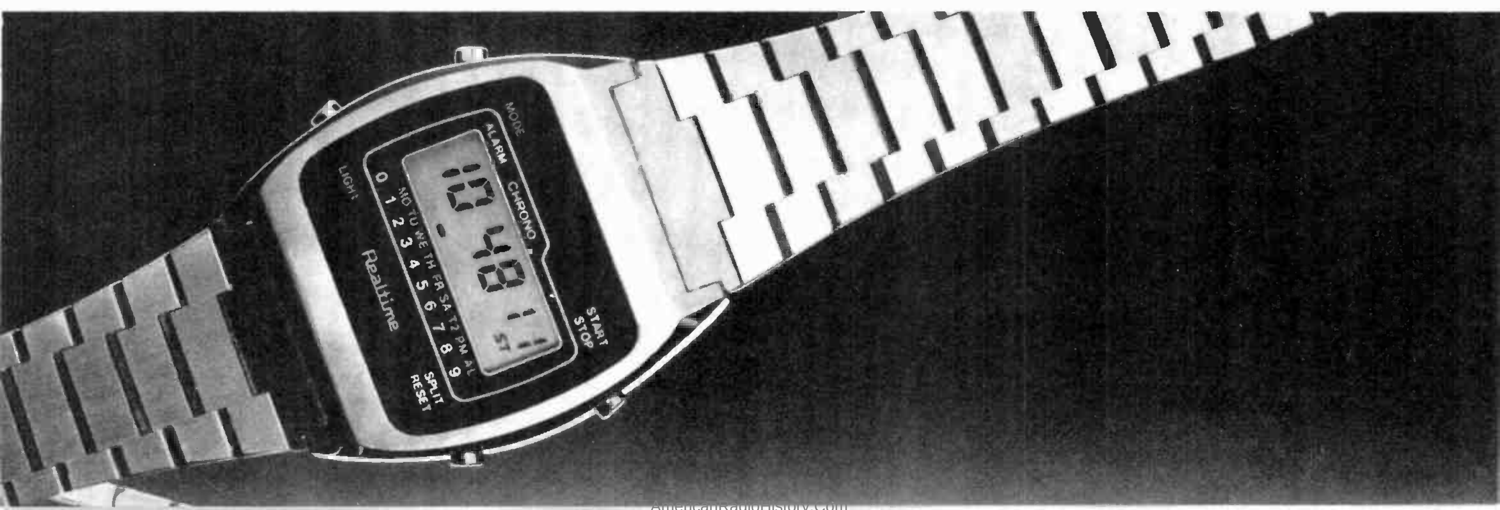
CHRONOGRAPH WITH
AND NO FAT.



segment LED display shows the channel tuned, and a large illuminated meter displays relative signal strength and transmitter output power. Specifications: less than

0.7 μV for 10 dB (S + N)/N sensitivity; 60-dB adjacent-channel selectivity and desensitization; 3 watts at 10% distortion audio output power into 8 ohms; 4 watts maximum, 3.6 watts minimum carrier power with no modulation; −65-dB spurious emissions; −40-dB transmitter, −45-dB receiver hum and noise. $319.95.

CIRCLE NO. 92 ON FREE INFORMATION CARD

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 ⅛". 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.

CIRCLE NO. 93 ON FREE INFORMATION CARD

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 ma-

chined steel drive gears, dual transformer circuitry, power braking, a control unit with illuminated meter readout, and low-voltage operation. $224.95.

Bose Spatial-Control Receiver

Designed to complement Bose 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 dBf. $799.

CIRCLE NO. 94 ON FREE INFORMATION CARD

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

(Continued on page 14)

screws into its place. All of the popular accessories can be used with the Little Devil, which has a 3/8"-24 thread. The mount and cable from the old antenna installation can still be used, saving on that part of the system. The adapter can be used with both trunk and lip mounts.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Programmable Clock Radio

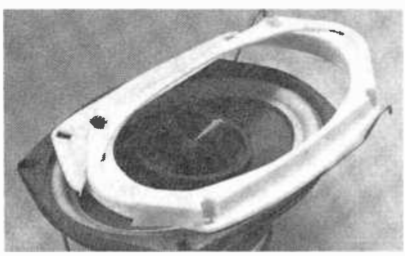
General Electric announced the first AM/FM programmable digital standard broadcast clock radio, "The Great Awakening" Model 4880. It has a programming keyboard for entering a variety of time and operating functions. For example, two people

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.

CIRCLE NO 96 ON FREE INFORMATION CARD

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.

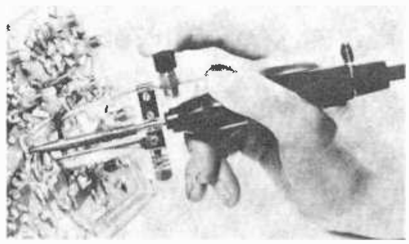
Sansui Integrated Amplifier

A slew rate of 200 V/microsecond (said to reduce transient intermodulation to vanishing point) is given as one of the premier specifications of the Sansui AU-919 integrated amplifier. The direct-coupled amplifier, which is equipped with protective circuitry designed to limit dc at speaker terminals to a safe value, is rated to deliver at least 100 watts per channel to an 8-ohm load, 5 Hz to 20 kHz, with no more than 0.008% THD. The phono equalization amplifier of the preamp section includes inputs for moving-coil and fixed-coil pickups. With the latter, it is said to yield a signal-to-noise ratio of 90 dB. Rated accuracy of EQ is ± 0.2 dB, 20 Hz to 20 kHz. $800.

CIRCLE NO. 97 ON FREE INFORMATION CARD

Desoldering Tool for Mini-Boards

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.

CIRCLE NO 98 ON FREE INFORMATION CARD

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" × 2 7/8" × 1 9/16" (102 × 73 × 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.

New Literature

HEATH INSTRUMENT CATALOG

Described in a 35-page catalog is the complete Heath-Schlumberger line of instruments. Included are: computer systems, distortion analyzers, frequency counters, generators, individual learning programs, testers, oscilloscopes, power supplies, recorders, TV service, and accessories. Products are illustrated and full specifications are given. Address: Heath/Schlumberger Instruments, Benton Harbor, MI 49022.

NEWSLETTER FOR ELECTRONIC GUITARISTS/MUSICIANS

Device, the Newsletter for the Electronic Guitarist/Musician, is a monthly publication for musicians involved in today's technology. Co-edited by Craig Anderton and Roger Clay, subjects regularly covered include reviews of musical equipment, construction articles, interviews, features on circuit design and reader opinion polls. Rates are $15/year (USA), $16 (Canada/Mexico) and $18 (International). A free sample issue is available from *Device*, P.O. Box C, Carmichael, CA 95608.

GOULD OSCILLOSCOPE BULLETIN

Rugged, lightweight professional oscilloscopes with standard features usually found in more expensive instruments are described in a new four-page illustrated bulletin from Gould. The listing includes three dual-trace and one true dual-beam scopes that range in price from $595 to $995. For a free copy of Form No. 449-7, contact: Marketing Services, Gould Inc., Instruments Div., 3631 Perkins Ave., Cleveland, OH 44115.

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-1 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.

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.

Now NRI makes it TV/Audio home

Side-by-side equipment comparison of NRI and two other leading schools shows what you get for what you pay. When you have to pay as much as $905 more for another school's course, you should carefully consider your tuition investment.

When you sit down and try to pick out the school that's best for you, it gets to be a problem. Catalogs are radically different and some are not too clear as to what you actually get for your money. So NRI has done a lot of the work for you. And put the prices right up front so you can make your own judgment.

Of course, we can't compare everything. Lesson clarity and content vary. What one covers here, another covers there...or not at all. The material one school breaks down into eight lessons may be four at another. And the qualifications and abilities of instructors are another question.

	NRI	SCHOOL A	SCHOOL B
COURSE TITLE	Master Course in TV, Audio, and Video System Servicing	Master Course in Color TV Servicing	Electronics Technology and Advanced Troubleshooting I & II
CASH PRICE (terms available)	$1,375	$1539	$2280
TV SET	NRI designed-for-learning kit. 25" (diagonal) color TV with built-in computer programming and cabinet	Heathkit GR-2001 25" (diagonal) color TV (cabinet extra)	Zenith model G4020W 19" (diagonal) color TV (fully assembled)
OSCILLOSCOPE	NRI designed-for-learning kit. 5" (8 x 10 cm) triggered sweep	Heathkit IO-4541 5" (8 x 10 cm) triggered sweep (not given until after graduation)	Heathkit IO-4541 5" (8 x 10 cm) triggered sweep
COLOR BAR GENERATOR	NRI designed-for-learning kit. 10 patterns	Elenco SG-200 (kit) 10 patterns	Elenco SG-200 (fully assembled) 10 patterns
FREQUENCY COUNTER	NRI designed-for-learning kit. Complimentary metal oxide semiconductor digital type		
METER	NRI designed-for-learning kit. Transistorized AC/DC volt-ohm meter	Heathkit (part of TV kit) DC only; 1K Ohm/volt	Private label multimeter
AUDIO	NRI designed-for-learning kit. Solid-state stereo AM/FM receiver with cabinet and speakers	Private label pocket transistor AM radio kit and AM-FM-SW solid-state portable radio kit	
TRAINER	NRI Discovery Lab	Breadboard	Experimental Electronics Lab
MISCELLANEOUS EQUIPMENT	Digital logic probe built into TV set	EICO Digital Logic Probe	

All data as shown in each school's catalog as of April 1, 1979.

One Million Students, Over 65 Years' Experience

So we can only tell you what NRI has to offer. We've been in education since 1914, starting as a radio school six years before commercial broadcasting was even on the scene. Since then, we've kept right up with the times, improving techniques, adding material, creating new courses to help people improve their skills and income.

Early on, we learned to keep our lessons compact...thoroughly covering a subject, but not so much that students would be overwhelmed. We call them "bite-size" lessons because they're easy to digest.

Learn by Doing with "Hands-on" Training

And, we pioneered the concept of "hands-on" training. NRI goes far beyond theory and textbooks to give our students actual bench experience and prepare them for the realities of electronic servicing. Every piece of equipment in our Master Course in TV and Audio Servicing is designed for learning.

You build your own big-screen TV, the only one complete with computer tuning that lets you program an entire evening's entertainment...a solid-state

Learn as you build with "hands-on" training.

easy to compare study courses.

stereo tuner and amplifier with speakers ...your own oscilloscope, digital frequency counter, and other instruments you use in your course, use later to service TV's, audio equipment, and video tape units.

The point is, none of this equipment is hobby-kit or commercial assembly line units with lessons "retrofitted" to what was at hand. NRI has designed each so you get invaluable training and experience you just can't get any other way. As you build, you study operation of circuitry, see how sections interact, perform "power-on" experiments only possible with NRI. This total training is exclusive with NRI...no other school, home study or resident, offers it.

Instructors Who Know Their Business

NRI instructors are thoroughly qualified, with both technical and educational experience. Most of them helped develop NRI courses, lessons, and equipment, so they really know what they're talking about. They're interested in their students, always ready to help with a question, a problem...give good advice to help you reach your goals.

It's instructors and training like this that have made NRI the choice of professional TV servicemen who have taken home study courses. As a national survey shows (summary on request), they recommend NRI by a majority of three to one over any other school.

So how does NRI give you all this and still cost so little? We keep costs down by designing our own training kits, eliminating the middleman's profit on hobby kits or commercial units. And by offering our training by mail only. We have no sales force, no commissions to pay. You make up your mind in your own time, without pressure, let the facts speak for themselves. We pass these savings on to you in the form of lower tuitions, more equipment, carefully designed courses and effective lessons.

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Stereo Scene

By Ralph Hodges

RECORDING AS NATURE INTENDED

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 string mikes—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 tympani 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 flatter 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

with a strip of that indispensable silver tape.

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 of 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.

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 inadvertantly 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 aural torture; you could sense that the brasses could totally overpower them unless held in check by the conductor; and the instruments in the back of the orchestra actually sounded more distant than those in the front. The bass drum was a special revelation; when it went off, you knew something had really hit you—right in the gut. In short, the record had a signal on it that actually managed to represent a symphony orchestra with some plausibility.

And this recording sold—not immediately or in great numbers, but strongly and steadily. The company, convinced it had discovered a hitherto secret love affair between the American record-buying public and *Swan Lake*, some years later issued a two-LP stereo set of excerpts played by the same orchestra. This time, however, the engineers were on familiar ground and were able to fuss around with mikes and mike placements to their hearts' content. Imagine their surprise when the new, much more lavishly produced recording didn't sell.

As adamant as my ears may be on this point, I can't prove that the differences in recording technique alone account for the wide variation in sales between the two versions. But I suspect that anyone who has no investment in the status quo in recording will prefer the results of simple miking over the multi-mike "forest" technique, at least for classical music, given the chance to compare. If you have the opportunity, try it for yourself. ◇

Julian Hirsch Audio Reports

Fisher Model ST460 Speaker System

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- to moderate-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 29¼" × 18¼" × 14 9/16" (74.3 × 46.4 × 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.

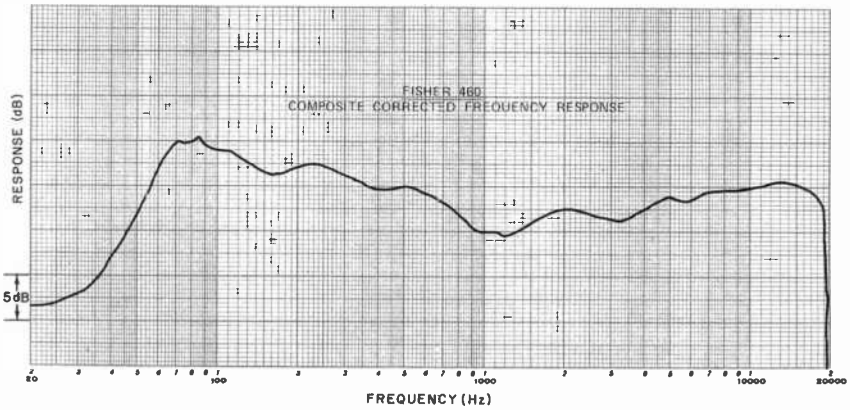
Maximum bass output was reached at frequencies between 70 and 90 Hz, falling off steeply at lower frequencies. Contribution of the port is mostly at frequencies below 40 Hz; while it is effective to a degree between 20 and 40 Hz, the average output in this octave is far below that of the upper-bass. 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

Performance Specifications

Specification	Rating	Measured
Frequency response	40-20,000 Hz ±10 dB	48-18,000 Hz ±5 dB 20-19,000 Hz ±10 dB
Efficiency (avg SPL at 1 meter, 1 watt)	92 dB	92 dB
Recommended amplifier power	25-130 watts	Confirmed
Peak distortion-free SPL with stereo pair in typical room	112 dB	Not checked
Crossover frequencies	1000 and 5000 Hz	Confirmed
Woofer diameter	15"	Confirmed
Voice coil	2"	Not checked
Loading	Ducted reflex	Confirmed
Midrange (size/type)	Two 5" cones	Confirmed
Voice coil diameter	9/16"	Not checked
Tweeter (size/type)	3" horn	2" mount diam.
Nominal impedance	8 ohms	Confirmed
Enclosure dimensions	29¼" × 18¼" × 14 9/16"	Confirmed
Weight	53 pounds	Confirmed

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.



Composite corrected frequency response for ST460 Speaker System.

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.

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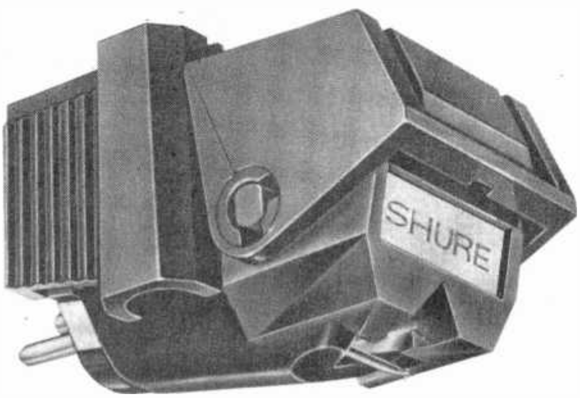


Shure M95HE Stereo Phono Cartridge

HIRSCH-HOUCK LABS REPORT

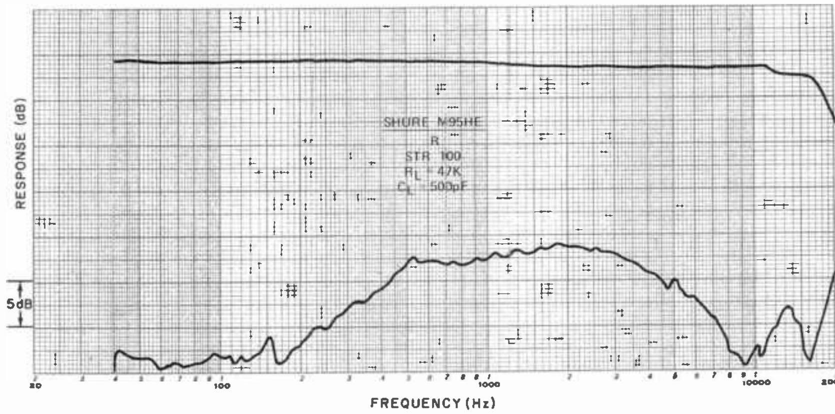
The Model M95-ED stereo cartridge has occupied the position just below the V-15 Type III in Shure's product line, filling the gap between the moderately priced M91 series and the deluxe V-15 series. Although priced only slightly above the M91, the M95 cartridge was designed for a somewhat flatter high-frequency response.

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 tracing 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.



Frequency response and crosstalk for M95HE Stereo Phono Cartridge.

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 QR-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.

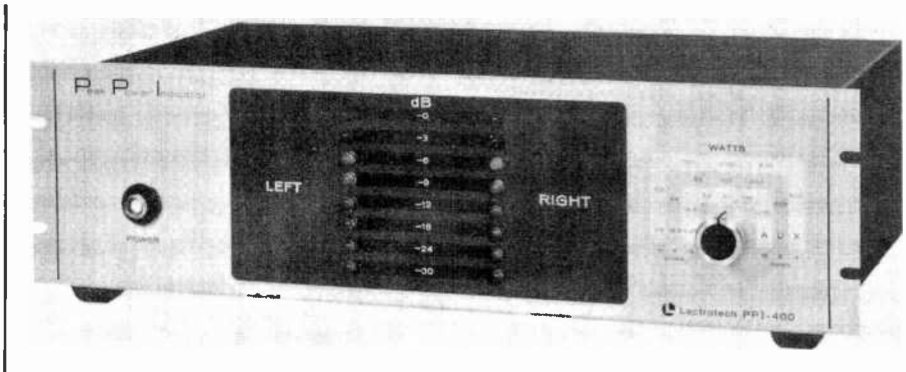
User Comment. While it is easy to distinguish between a low-priced cartridge and a high-priced one by listening or measurement, differences tend to become more elusive when comparing cartridges of similar overall quality. Consequently, we found no dramatic audible differences between Shure's M95ED and 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.

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 × 8"D × 3¾"H (35.6 × 20.3 × 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 two top 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 overdriven 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 the output of 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

MANUFACTURER	MODEL	SUG'STD. LIST PRICE	FREQUENCY RANGE	TYPE OF TIME BASE	ACCURACY OVER TEMPERATURE		SENSITIVITY			DIGITS		PRE-SCALE INPUT RESOLUTION	
					17° - 40°C	0° - 40°C	100 Hz - 25 MHz	50 MHz - 250 MHz	250 MHz - 450 MHz	No.	SIZE IN INCHES	.1 SEC	1 SEC
DSI INSTRUMENTS	100 HH	$ 99.95	50Hz-100MHz	TCXO	1 PPM	2 PPM	25 MV	NA	NA	8	.4	100 Hz	10 Hz
DSI INSTRUMENTS	500 HH	$149.95	50Hz-550MHz	TCXO	1 PPM	2 PPM	25 MV	20 MV	30 MV	8	.4	100 Hz	10 Hz
CSC‡	MAX-550	$149.95	1kHz-550MHz	Non-Compensated	3 PPM @ 25°C	8 PPM	500 MV*	250 MV	250 MV	6	.1	NA	1 kHz
OPTOELECTRONICS	OPT-7000	$139.95	10Hz-600MHz	TCXO	1.8 PPM	3.2 PPM	NS	NS	NS	7	.4	1 kHz	100 Hz

* 1 KHz - 50 MHz   ‡ Continental Specialties Corp.

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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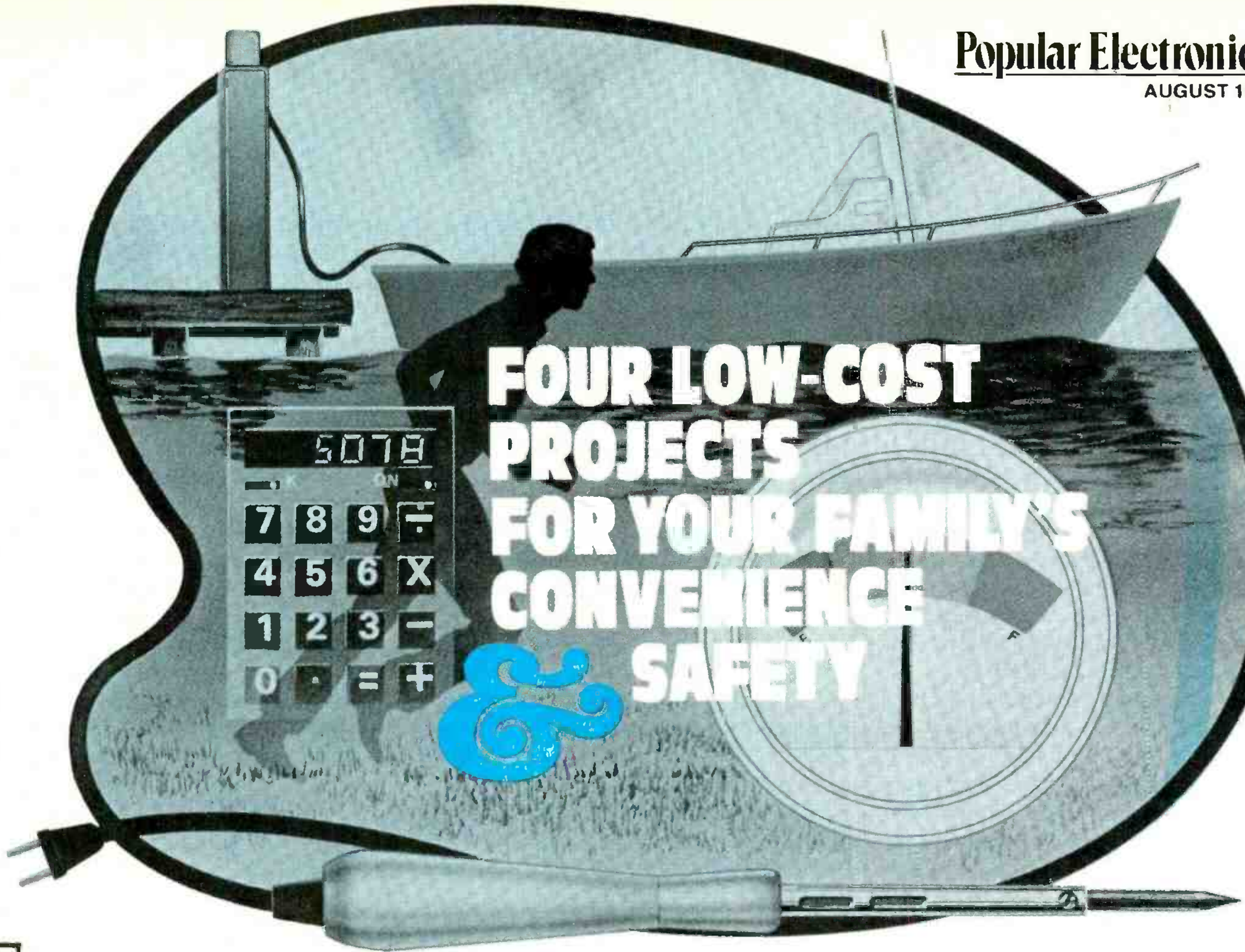


1. Solid-state level-sensing switch for sump pumps

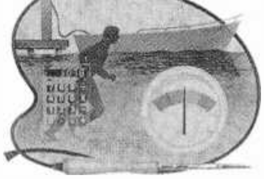
By Phillip Windolph

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.)

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.

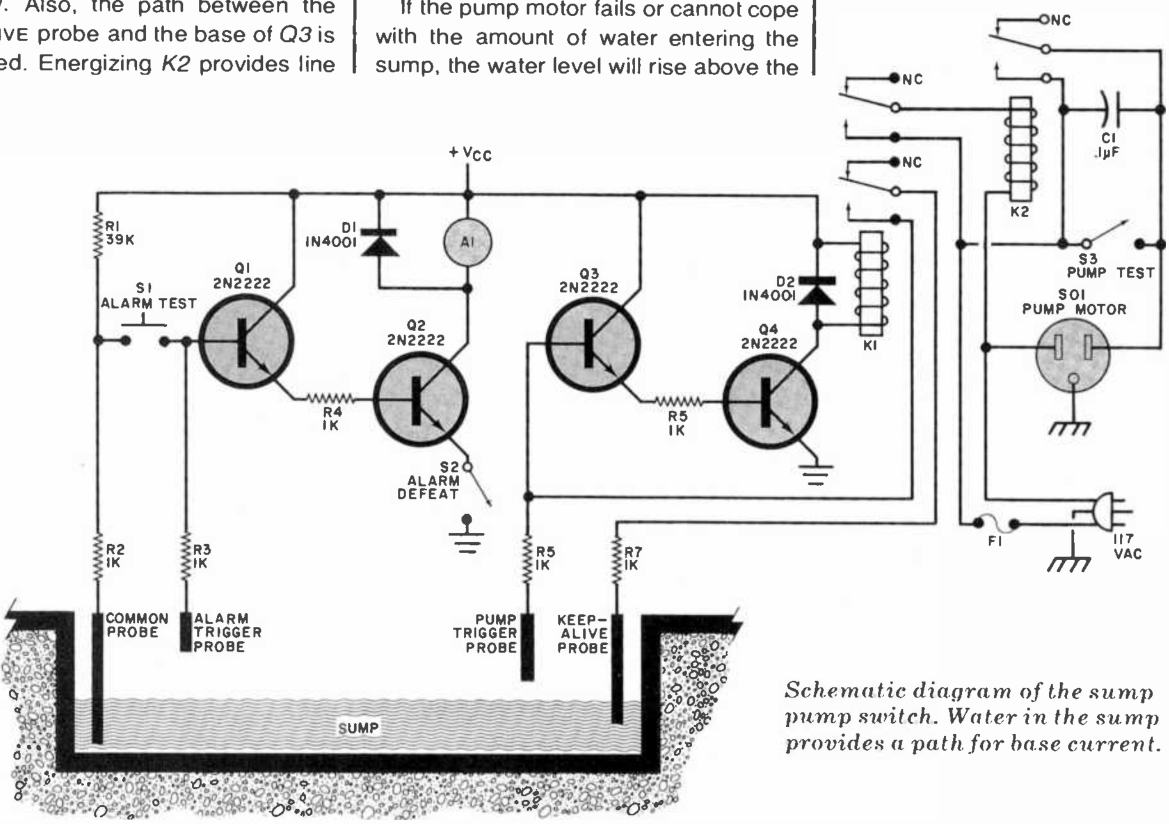
As the water level in the sump rises, the KEEP-ALIVE probe touches the water, but this still does not activate the pump. If the water reaches the level of the PUMP TRIGGER probe, current can flow from the positive supply voltage terminal through *R1*, *R2*, the water in the sump, *R5* and finally into 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



Schematic diagram of the sump pump switch. Water in the sump provides a path for base current.

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*

The following are ¼-watt, 10% tolerance carbon-composition resistors:
R1—39,000 ohms*
R2 through R7—1000 ohms*
S1—Normally open pushbutton switch
S2—Miniature spst toggle switch
S3—Spst toggle switch*

SO1—Ac power socket
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 *SO1* 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 *SO1*.

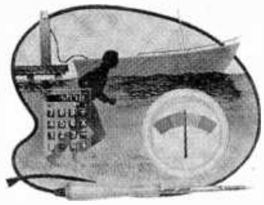
Remove the PUMP TRIGGER wire from the water. The relays should remain energized and no click should be heard. Then remove the KEEP ALIVE wire from the water. At this time, the relays should drop out and a click heard. Finally, insert the ALARM TRIGGER wire into the water. The alarm should sound and remain 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 *SO1* 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)

Low-cost Projects continued...



2. Vehicle low-fuel indicator

Alarm sounds when level in vehicle fuel tank drops to a predetermined level

By Bradley Albing

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.

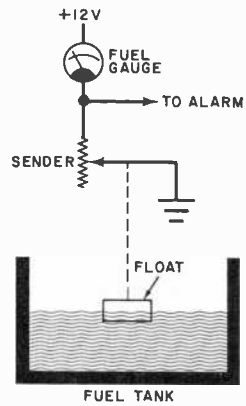


Fig. 1. Typical fuel-gauge circuit.

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.

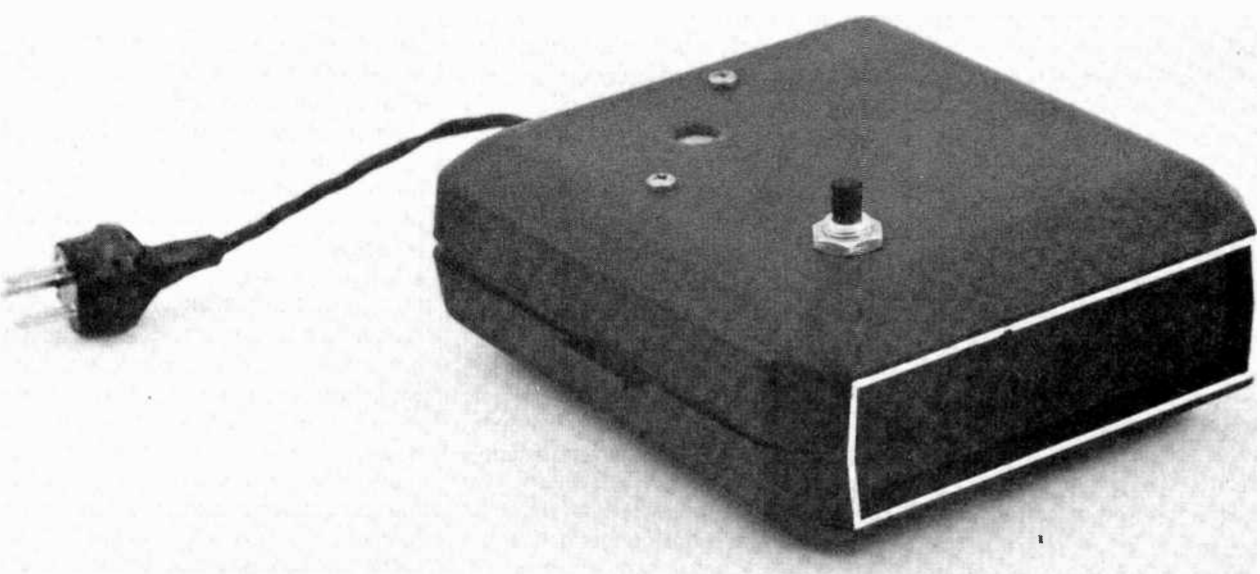
This voltage (approximately 9 volts) is high enough to cause zener diode *D6* to conduct and turn on transistor *Q1*. When turned on, this transistor draws current through audible alarm *A1*, and turns on optional indicator *LED1*.

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

A1—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
The following are ¼-watt, 10% tol. resistors.
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 $1 postage/handling from BFA Electronics, P.O.Box 212, Northfield, OH 44067. Ohio residents please add sales tax.

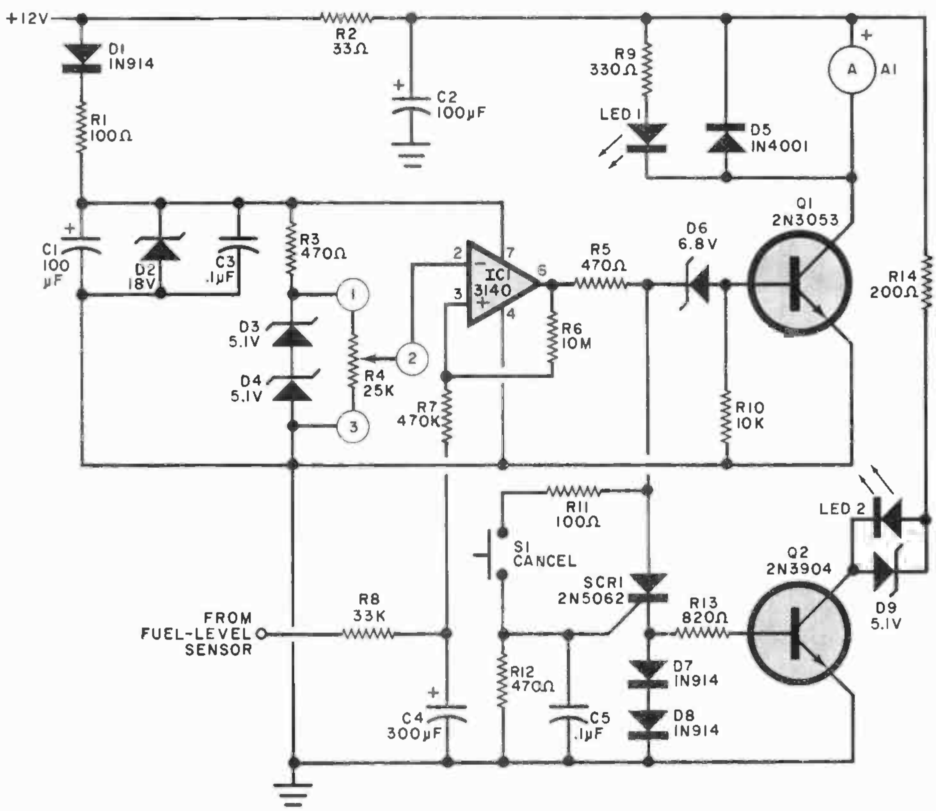
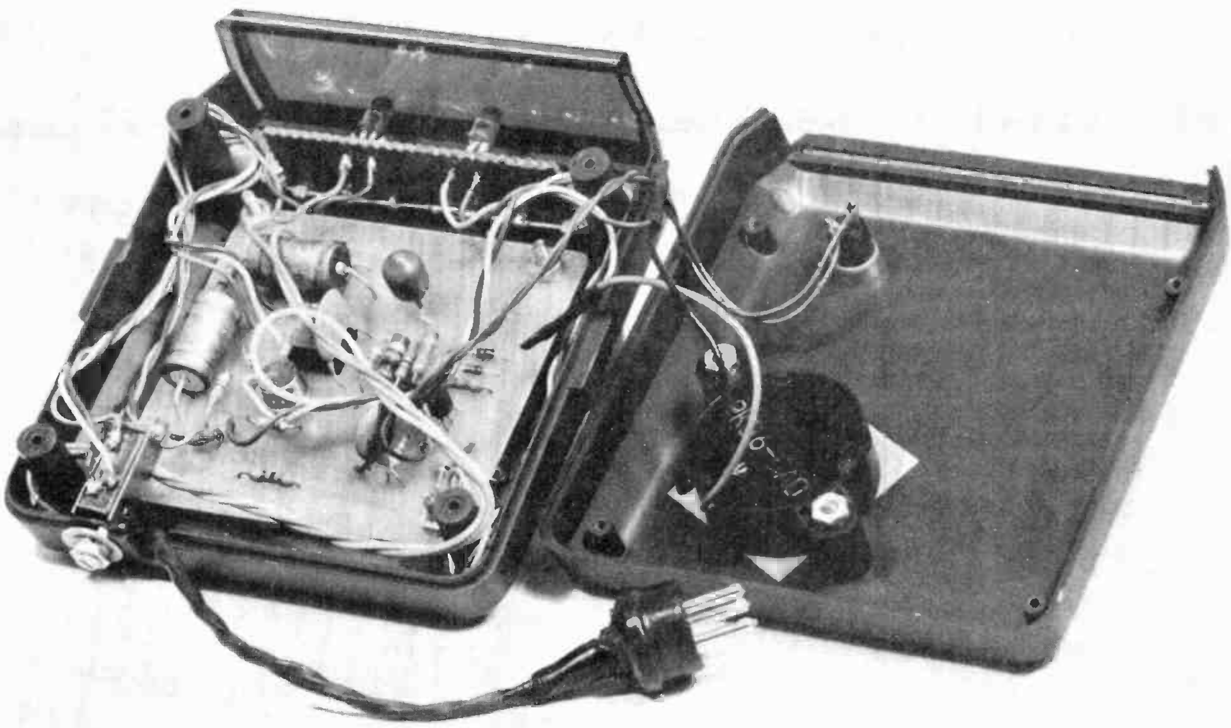


Fig. 2. Comparator IC1 turns on when fuel drops below some predetermined level, and sounds the alarm. The SCR circuit energizes a flashing LED during the Cancel mode.

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



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John E. Cunningham

Special Projects Director
Cleveland Institute of Electronics

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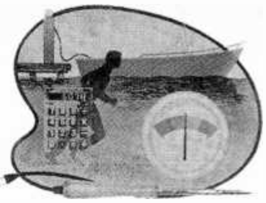


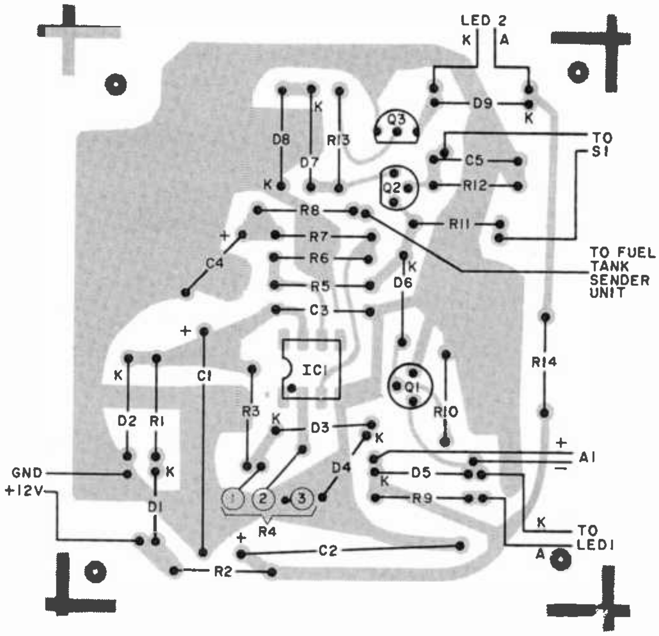


Fig. 3. Actual-size etching and drilling guide is shown at left. Component placement guide is above.

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. ◇

By Cass Lewart

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.

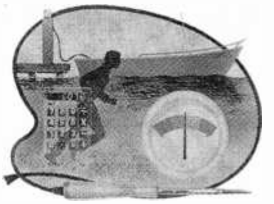
The ultra-sensitive gas-leak detector presented here indicates the quantitative presence of these gases and enables one to track down and pinpoint the *source* of a gas leak by observing the unit's meter indication. Moreover, it is a portable, battery-powered model for use in boats, automobiles, at campsites, 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, set *S1* to ON and *S2* to BATT. TEST, and make a note of the point on the meter's scale at which the pointer comes to rest. Turn off the power and carefully remove the cover from the meter's face. Use a felt marker to identify the battery-test point on the meter's scale.

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, set *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. ◇

PARTS LIST

B1—Six D cells in series
D1,D2—Germanium diode (1N34A or similar)
GS1—Model 812 gas sensor
IC1—5-volt regulator (Radio Shack No. 276-1770 or similar)
J1—Normally closed miniature phone jack (Radio Shack No. 274-281 or similar)
LED1—Red light emitting diode
M1—50-μA meter (Radio Shack No. 22-051. No substitute)
R1—1000-ohm, ½-W, 10% resistor
R2—22,000-ohm, ½-W, 10% resistor
R3,R7—4700-ohm, ½-W, 10% resistor
R4—15,000-ohm, ½-W, 10% resistor
R5—2700-ohm, ½-W, 10% resistor
R6—2200-ohm, ½-W, 10% resistor
R8—10,000-ohm linear potentiometer
S1—Spst switch
S2—Dpdt switch
Misc.—7-pin miniature tube socket; battery holder; enclosure; 9-volt dc calculator-type ac adapter (optional); machine hardware; hookup wire; solder; etc.
*Available for $7.50 postpaid from Southwest Technical Products Dept., PE-2, 219 W. Rhapsody, San Antonio, TX 78216.

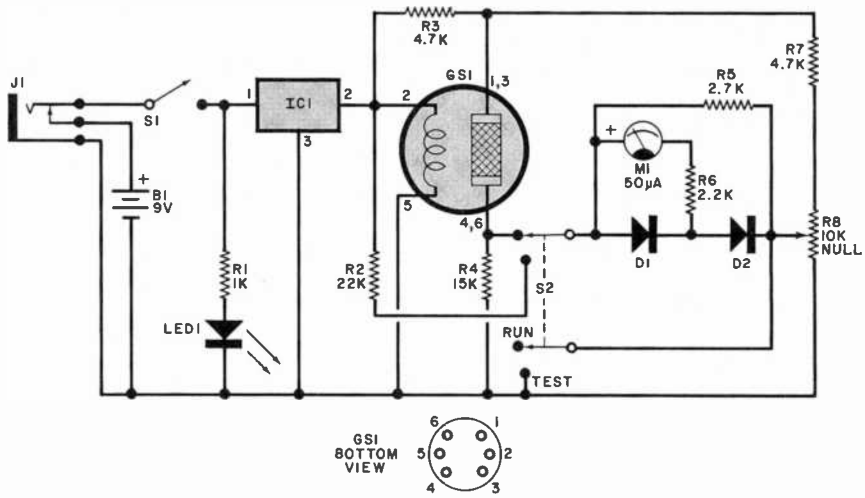


Fig. 1. The gas sensor forms one arm of a Wheatstone bridge. Pins 1, 2 and 3 can be interchanged with pins 4, 5 and 6. Once bridge is balanced by R8, a change in resistance of GS1 will cause meter pointer to swing upscale.

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.

AN INEXPENSIVE 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 or not your calculator has a built-in constant function. To do this, press CLEAR, 1, +, 1, =, =. If your calculator has the necessary constant function, the display should read 3 and should increment by 1 for each additional operation of the = key. Having established the fact that your calculator does indeed have the constant function, you can proceed with the conversion.

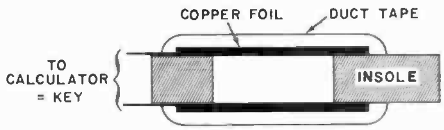
Conversion of the calculator consists in simply wiring a foot-operated switch across the = key. First, carefully open the calculator's case and locate the contacts for the = key. Then solder a 5' (1.5-meter) or so length of 26-gauge flexible stranded wire to each = switch contact. Insulate the soldered connections with a layer of electrical tape.

Now, test your hookups in the following manner. Turn on the calculator and key in 1, +, 1. Touch together and separate the free ends of the wires two times. With the first touch, the display should read 2 and with the second, 3. If the test checks out properly, turn off the calculator and reassemble it, routing the wires out through the side of the case. If necessary, use a sharp knife to cut a slot to allow the wires to exit the case. No other modification is necessary.

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

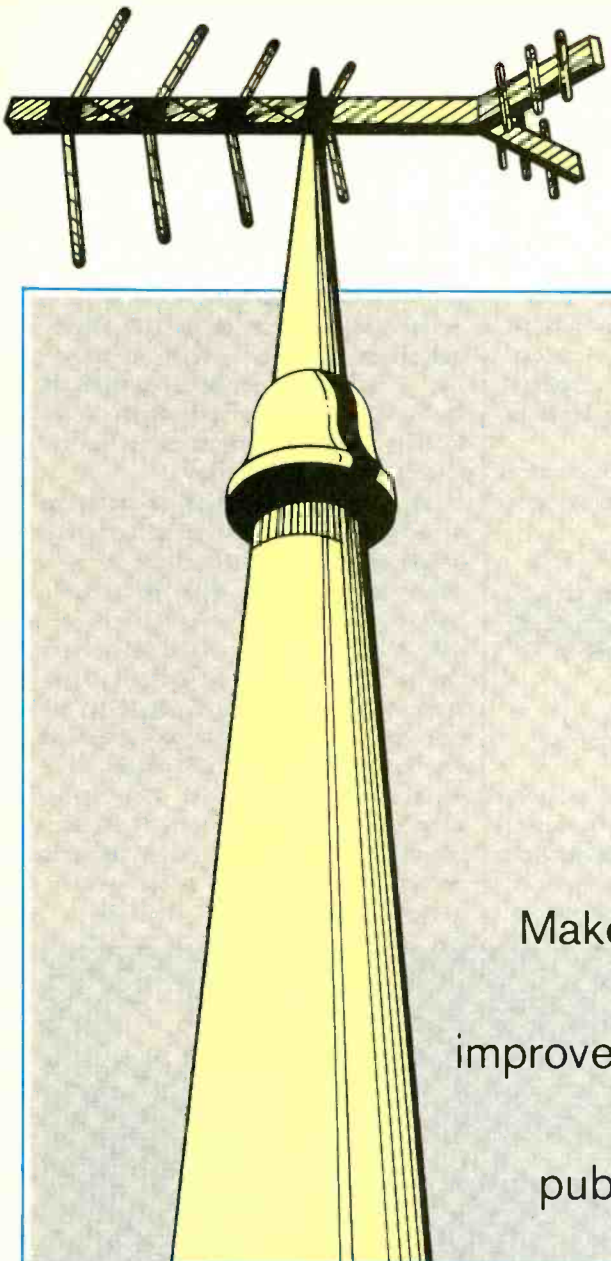


Place copper foil on each side of insole hole and insulate with tape.

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. ◇



BY ROBERT GROVE

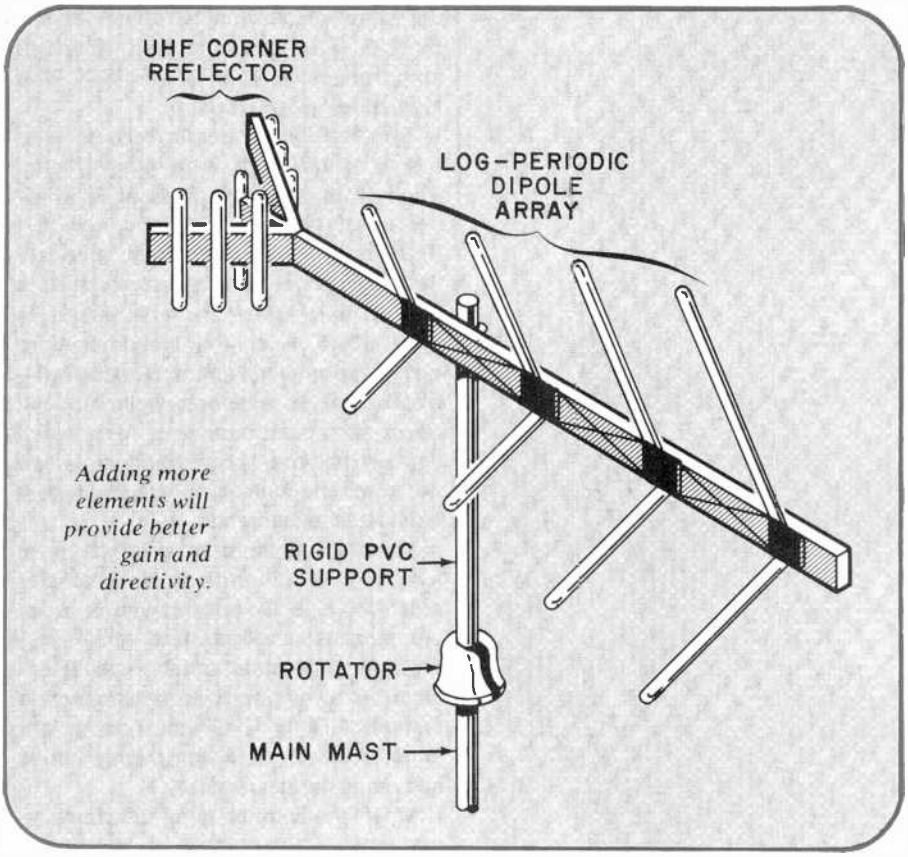
Make-it-yourself antenna improves reception of public services

SCANNER BEAM PINPOINTS THE ACTION!

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



Adding more elements will provide better gain and directivity.

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 ($\lambda/2$) frequency and its three-half-wave ($3\lambda/2$) 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 $\lambda/2$ mode and from below 400 to beyond 550 MHz in its $3\lambda/2$ 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 $3\lambda/2$ 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

third and second longest elements will be 17" (43.2-cm) and 18" (45.4-cm) long, respectively, on each side of the log periodic array's boom.

Trim the longer corner reflector elements so that each of them is 16" long. Then lift the antenna to locate its new center of balance. Drill two new ¼" (6.35-mm) holes, properly spaced, through the boom to accommodate the U bolt that fastens the antenna to its mast. Make certain that these holes are drilled to permit the antenna to be oriented so that its elements point up and down after mast mounting. Also, make certain that the U-bolt hardware does not touch the aluminum wire that cross-connects the elements.

Mount the antenna on a 36" (0.91-m) length of 1¼" (31.8-mm) outer-diameter rigid PVC pipe. Do *not* substitute a metal pipe because it will interfere with the signal path. The metal mast should be at least $\lambda/4$ away from the longest antenna element. (Rigid PVC pipe can be obtained from any building supply house and many hardware stores.)

Mount the antenna and PVC pipe support on a rotator, following the cable-routing instructions faithfully. Connect the Balun transformer to the antenna and the coax feed line to the Balun. Then coat the connections with silicone adhesive to weatherproof them.

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 also 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 130 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.

Resonance. 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

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

Table 2—Resonance (Tuned Circuits)

```
5    CLS
10   P.T.(15);"VARIOUS FORMULAS
        ON RESONANT FREQUENCY"
20   P."ENTER NUMBER OF DESIRED FUNCTION";
30   P."RESONANT FREQUENCY    (FO)                    #1"
40   P."UNKNOWN INDUCTANCE    (L)                     #2"
50   P."UNKNOWN CAPACITOR   (C)                       #3"
60   P." Q OF SERIES OR PARALLEL CIRCUIT   (Q)        #4"
70   P."BANDWIDTH     (BW)                            #5"
80   P."IMPEDANCE, SERIES OR PARALLEL   (Z)           #6"
90   IN."UNKNOWN FACTOR IS NUMBER ";U
100  IF U=1,G.170
110  IF U=2,G.240
120  IF U=3,G.280
130  IF U=4,G.320
140  IF U=5,G.360
150  IF U=6,G.520
170  IN."ENTER VALUE OF INDUCTOR IN MILLIHENRIES";L
180  IN."ENTER VALUE OF CAPACITOR IN MICROFARADS";C
210  X=(L/IE3)*(C/1E6)
220  GOS.30030
230  P."THE RESONANT FREQUENCY IS ";.159/Y;" HERTZ"
235  END
240  IN."ENTER RESONANT FREQUENCY (FO) DESIRED";F
250  IN."ENTER CAPACITOR VALUE IN MICROFARADS";C
260  L=.0254/(F*F)*(C/1E6)
270  P."THE INDUCTOR NEEDED IS ";L*1000;" MILLIHENRIES"
275  END
280  IN."ENTER RESONANT FREQUENCY DESIRED ";F
290  IN."ENTER INDUCTOR VALUE IN MILLIHENRIES ";L
300  C=.0254/(F*F)*(L/1E3)
310  P."THE CAPACITOR NEEDED IS ";C*1E6;" MICROFARADS"
315  END
320  IN."ENTER THE REACTANCE (XC OR XL) IN OHMS";X
330  IN."ENTER THE SERIES RESISTANCE IN OHMS";R
340  P."THE Q OF THE CIRCUIT IS ";X/R;" UNITS"
350  END
360  IN."ENTER UNKNOWN, Q=Q, FO=F, BW=B";X
370  IF X=Q,G.400
```

```
380  IF X=F,G.440
390  IF X=B,G.480
400  IN."ENTER FO IN HERTZ";F
410  IN."ENTER BW (F2-F1) IN HERTZ";B
420  P."THE Q IS EQUAL TO ";F/B;" UNITS"
430  END
440  IN."ENTER THE Q OF THE CIRCUIT";Q
450  IN."ENTER THE BW (F2-F1) IN HERTZ";B
460  P."THE RESONANT FREQUENCY (FO)
        IS ";Q*B;" HERTZ"
470  END
480  IN."ENTER RESONANT FREQUENCY (FO) IN HERTZ";F
490  IN."ENTER THE Q VALUE";Q
500  P."THE BANDWIDTH IS ";F/Q;" HERTZ"
510  END
520  IN."ENTER VALUE OF INDUCTOR IN MILLIHENRIES";L
530  IN."ENTER FREQUENCY IN HERTZ";F
535  IN."ENTER RESISTOR VALUE IN OHMS";R
540  P."AT SERIES RESONANCE, XL AND XC CANCEL
        THEREFORE Z=";R
550  P=(6.28)*(F)*(L/1E3)
560  Q=P/R
570  P."THE PARALLEL IMPEDANCE IS EQUAL
        TO ";P*Q;" OHMS"
580  END
30000 END
30010 REM *SQUARE ROOT* INPUT X, OUTPUT Y
30020 REM ALSO USES W & Z INTERNALLY
30030 IF X=O T. Y=O:RET.
30040 IF X > O T. 30060
30050 P."ROOT OF NEGATIVE NUMBER?":STOP
30060 Y=X*.5:Z=O
30070 W=(X/Y-Y)*.5
30080 IF (W=O) + (W=Z) T. RET.
30090 Y=Y+W: Z=W:G.30070
```

Table 3—Inductive Formulas

```
2    CLS
10   P."AFTER EACH SOLUTION, PRESS R. ENTER
        TO BEGIN."
15   P.T.(15)"VARIOUS INDUCTIVE FORMULAS"
20   P."ENTER THE NUMBER NEXT TO DESIRED
        FUNCTION"
30   P."INSTANTANEOUS VOLTAGE                          #1"
40   P."INDUCTANCE OF A SINGLE LAYER COIL              #2"
50   P."INDUCTIVE/RESISTIVE TIME CONSTANT              #3"
60   P."SERIES AND PARALLEL INDUCTORS                  #4"
70   P."Q OF A COIL                                    #5"
80   P."INDUCTIVE REACTANCE (XL)                       #6"
90   P."IMPEDANCE OF INDUCTIVE/RESISTIVE CIRCUIT       #7"
100  IN."FORMULA DESIRED";F
110  IF F=1 G.160
120  IF F=2 G.220
130  IF F=3 G.280
140  IF F=4 G.320
144  IF F=5 G.570
145  IF F=6 G.640
146  IF F=7 G.690
160  IN."ENTER VALUE OF INDUCTANCE IN HENRIES";L
170  IN."ENTER CHANGE IN CURRENT (I2-I1) IN AMPS";I
180  IN."ENTER CHANGE IN TIME (T2-T1) IN SECONDS";T
190  E=L*(I/T)
200  P."THE VOLTAGE DEVELOPED IS";E;"VOLTS"
210  END
220  IN."ENTER NUMBER OF TURNS";N
230  IN."ENTER RADIUS OF COIL IN INCHES";R
240  IN."ENTER LENGTH OF COIL IN INCHES";D
250  L=(N*R)*(N*R)/(9*R)+(10*D)
260  P."THE INDUCTANCE IS";L;"MICROHENRIES"
270  END
280  IN."ENTER THE VALUE OF INDUCTANCE
        IN HENRIES";L
290  IN."ENTER THE VALUE OF RESISTANCE
        IN OHMS";R
300  T=L/R
310  P."THE TIME CONSTANT IS";T;"SECONDS"
315  END
320  IN."ENTER THE NUMBER OF INDUCTORS";B
330  IF B=2 G.360
340  IF B=3 G.420
350  IF B=4 G.490
360  IN."ENTER VALUE OF L1 IN HENRIES";A
370  IN."ENTER VALUE OF L2 IN HENRIES";B
380  C=A+B
390  P."THE TOTAL SERIES INDUCTANCE IS";C;"HENRIES"
400  D=(1/A)+(1/B)
405  P."THE TOTAL PARALLEL INDUCTANCE
        IS";1/D;"HENRIES"
410  END
420  IN."ENTER VALUE OF L1 IN HENRIES";A
430  IN."ENTER VALUE OF L2 IN HENRIES";B
440  IN."ENTER VALUE OF L3 IN HENRIES";C
450  D=(1/A)+(1/B)+(1/C)
460  P."THE TOTAL INDUCTANCE IN SERIES
        IS";A+B+C; "HENRIES"
470  P."THE TOTAL INDUCTANCE IN PARALLEL
        IS";1/D;"HENRIES"
480  END
490  IN."ENTER VALUE OF L1 IN HENRIES";A
500  IN."ENTER VALUE OF L2 IN HENRIES";B
510  IN."ENTER VALUE OF L3 IN HENRIES";C
520  IN."ENTER VALUE OF L4 IN HENRIES";D
530  E=(1/A)+(1/B)+(1/C)+(1/D)
550  P."THE TOTAL PARALLEL INDUCTANCE
        IS";1/E;"HENRIES"
540  P."THE TOTAL SERIES INDUCTANCE
        IS";A+B+C+D; "HENRIES"
555  END
570  IN."ENTER INDUCTOR VALUE IN HENRIES";L
580  IN."ENTER THE FREQUENCY IN HERTZ";H
590  IN."ENTER RESISTOR VALUE IN OHMS";R
600  X=6.28*H*L
610  Q=X/R
620  P."THE REACTANCE OF THE CIRCUIT
        IS";X;"OHMS WITH A Q OF";Q
630  END
640  IN."ENTER THE VALUE OF INDUCTOR IN
        MILLIHENRIES";L
650  IN."ENTER THE FREQUENCY IN HERTZ";H
660  X=(6.28)*(H)*(L/1000)
670  P."THE REACTANCE OF THE CIRCUIT IS";X;"OHMS"
680  END
690  IN."ENTER THE VALUE OF INDUCTIVE REACTANCE
        IN OHMS";P
700  IN."ENTER THE VALUE OF RESISTANCE
        IN OHMS";R
710  X=(P*P)+(R*R)
720  GOS. 30030
730  P."THE IMPEDANCE OF THE CIRCUIT IS";Y;"OHMS"
740  END
30000 END
30010 REM*SQUARE ROOT*INPUT X, OUTPUT Y
30020 REM ALSO USES W AND Z INTERNALLY
30030 IF X=O T. Y=O :RET.
30040 IF X > O T. 30060
30050 P."ROOT OF A NEGATIVE NUMBER?" :STOP
30060 Y=X*.5 :Z=O
30070 W=(X/Y-Y)*.5
30080 IF (W=O)+(W=Z) T. RET.
30090 Y=Y+W :Z=W : G.30070
```

The Art of EQUALIZATION

An expert tells how to "sweeten" instruments and achieve that special recorded "sound"

BY ETHAN WINER

¶ 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)

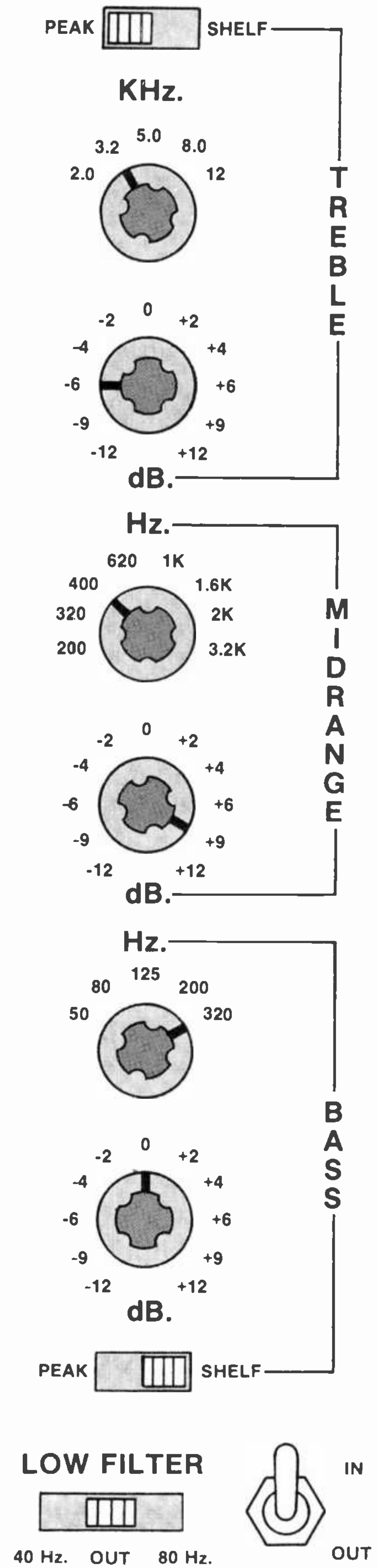


Fig. 1. Layout of a typical front panel for an equalizer. Note that it has controls for treble, midrange, and bass as well as a 3-position low-cut filter.

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 ⅓-octave equalization. The ⅓-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." Whereas 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

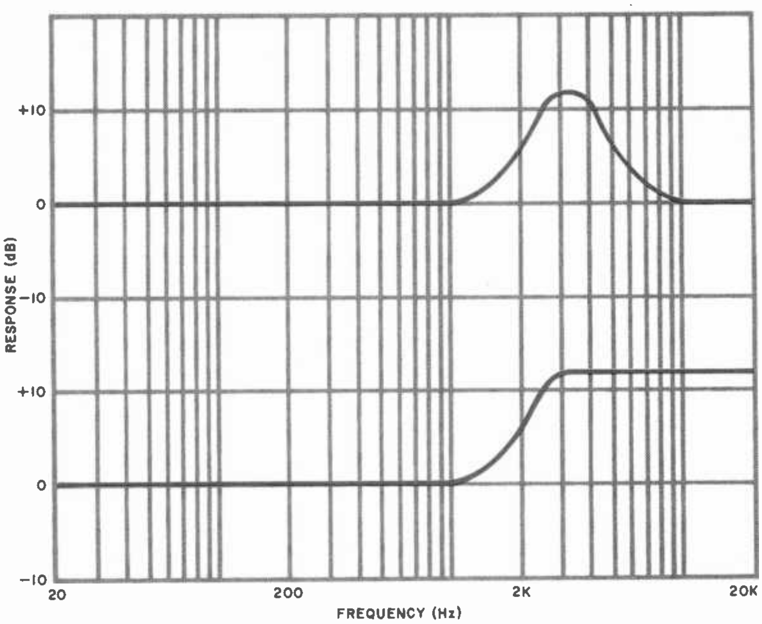


Fig. 2. The top switch in Fig. 1 changes the basic shape of the response as shown here to a peak (top) or shelf (bottom).

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. . . .

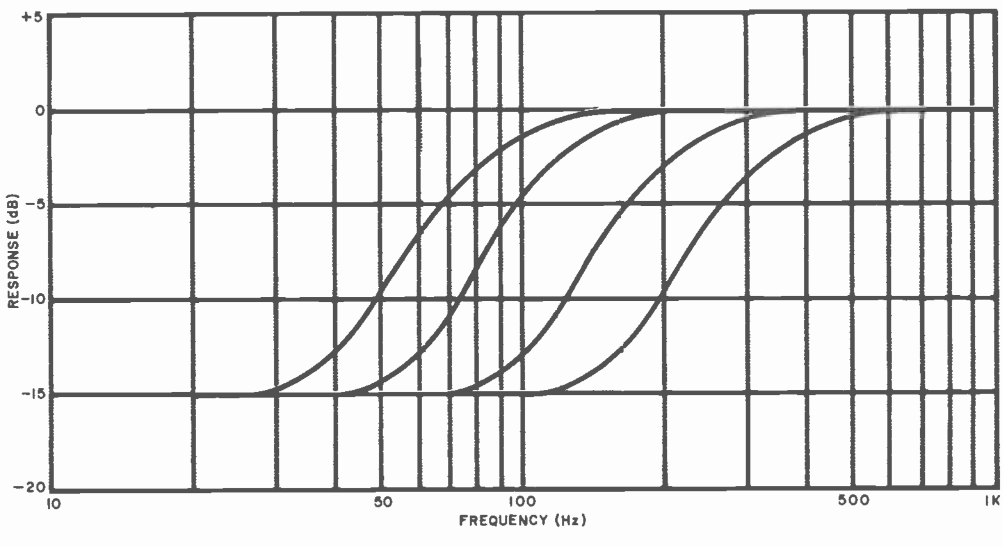
Except when dealing with drums and perhaps some tuned percussion instruments like triangles or cowbells, narrow-bandwidth boosts should usually be avoided because unpleasant resonances or other bad effects may show up when the mix is heard on different speakers. In fact, most recording studios have alternate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

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

Fig. 3. Response curves show changes for bass shelf cuts at four different frequencies.



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 mixdown, 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 surface 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. Unfortunately, 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 chracteristics or placement, or even 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-

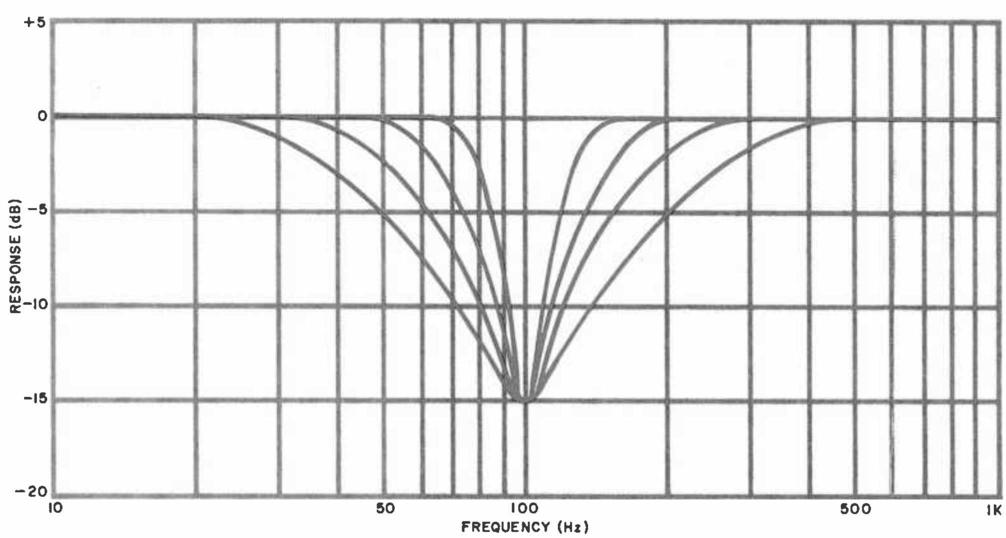


Fig. 4. Response curves showing the effect of varying the bandwidth of a midrange dip.

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.

SPECIFIC INSTRUMENTS AND THEIR CHARACTERISTIC FREQUENCIES

COMMON FREQUENCIES FOR EQUALIZATION

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

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. Pre-emphasis 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 put 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.

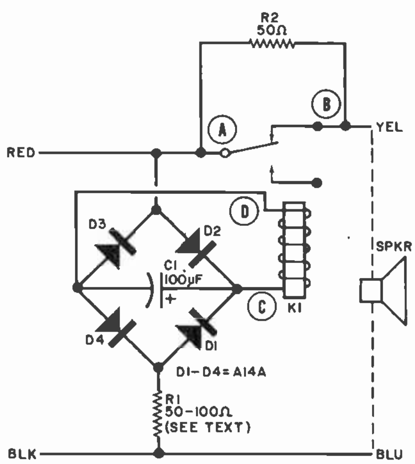
At high signal levels, the charging circuit consisting of *R1* and *C1* generates sufficient voltage levels to energize *K1* and open its contacts. When *K1* energizes, *R2*, is connected in series with the speaker system to drop the sound level. Then, when the input signal level drops, *K1* de-energizes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

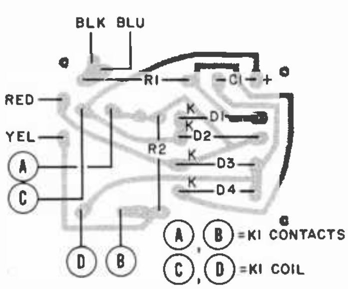
Adjustment. Make certain that the common of each amplifier output circuit is connected to the common of the speaker protector and observe proper speaker phasing when connecting the device into your audio system. With a relay whose coil resistance is about 100 ohms, the circuit shown in Fig. 1 will cut 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 Disston St., Philadelphia, PA 19111: Pc board for $3.00; board and all components (state R1 wattage) for $10.00 postpaid.

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



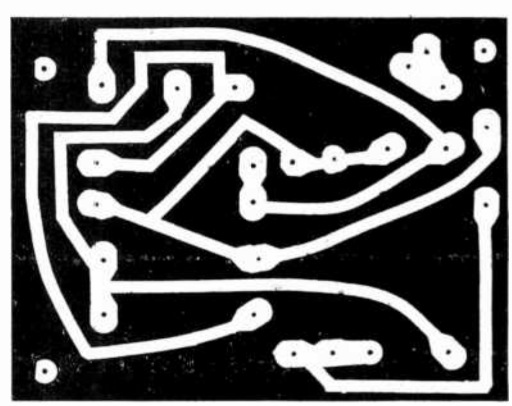
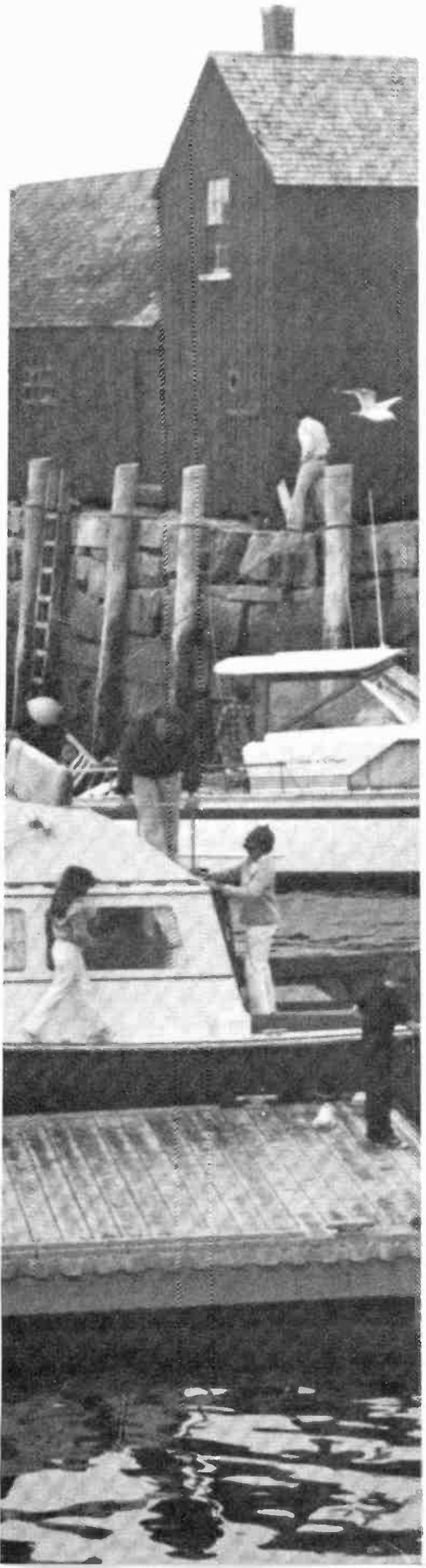


Fig. 2. Actual-size etching and drilling guide, right; component placement above.

By Harold Wright



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 ¾" (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. To

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).

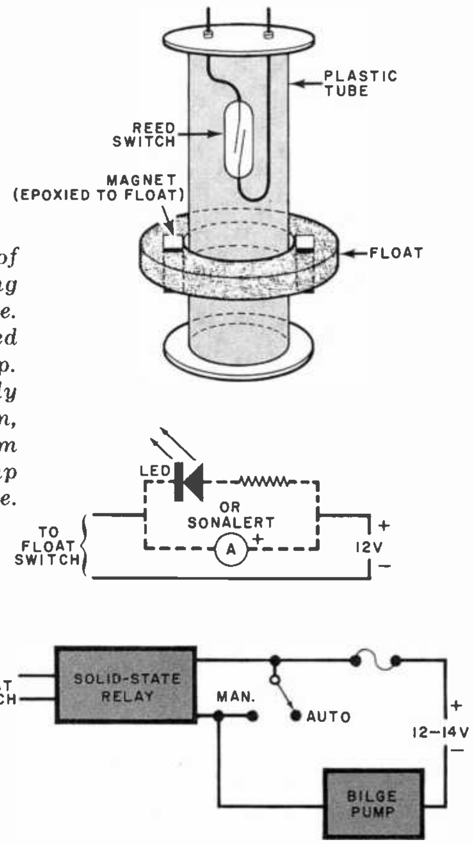


Fig. 10. A simple type of bilge-water warning system is shown here. Details of float-actuated switch are at top. Circuit in center simply actuates LED or alarm, while that at bottom turns on bilge pump at the same time.

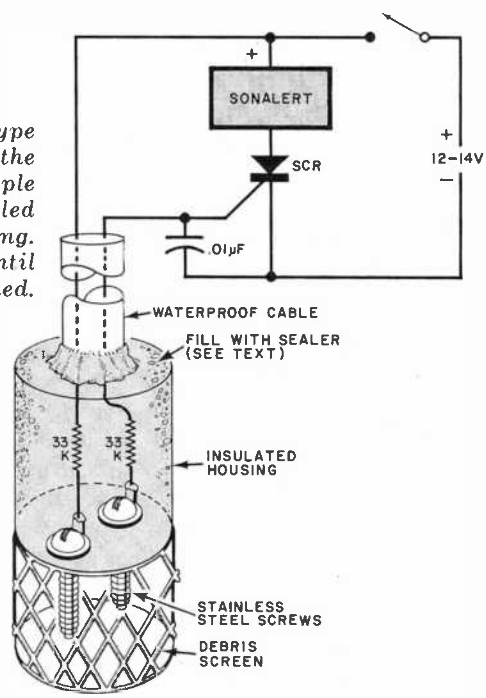


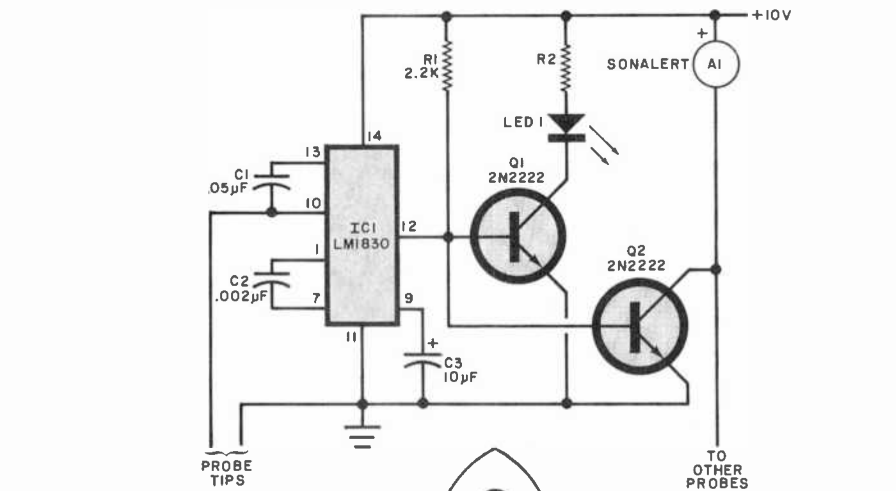
Fig. 11. In this type of bilge alarm, the electrodes are simple steel screws sealed in insulated housing. Alarm sounds until switch is opened.

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



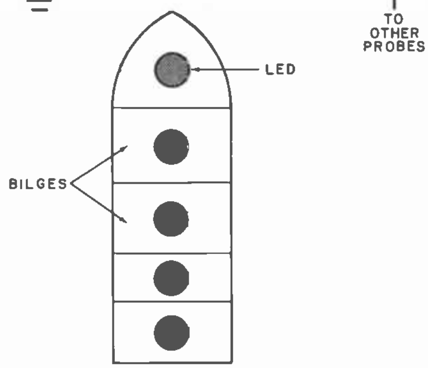


Fig. 12. Circuit above is an alarm system for boat with multiple bilge spaces. Visual and audible signals are used to indicate which bilge has water in it. LEDs are mounted in diagram as shown at right to show each area.

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, ½-W resistor
R2—To suit LED current

PARTS LIST (Fig. 13)

C1, C2—0.02-µF capacitor
C3—1-µF, 12-V electrolytic
D1—18-V 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, ½-W resistor
R2—1100-ohm, 1%, ½-W resistor
R3—2400-ohm, 1%, ½-W resistor
R4—10-ohm resistor (see text)
R5, R7—10,000-ohm, ½-W resistor
R8—470-ohm, ½-W resistor
R9—100,000-ohm, multi-turn pot
R10—10,000-ohm, multi-turn pot

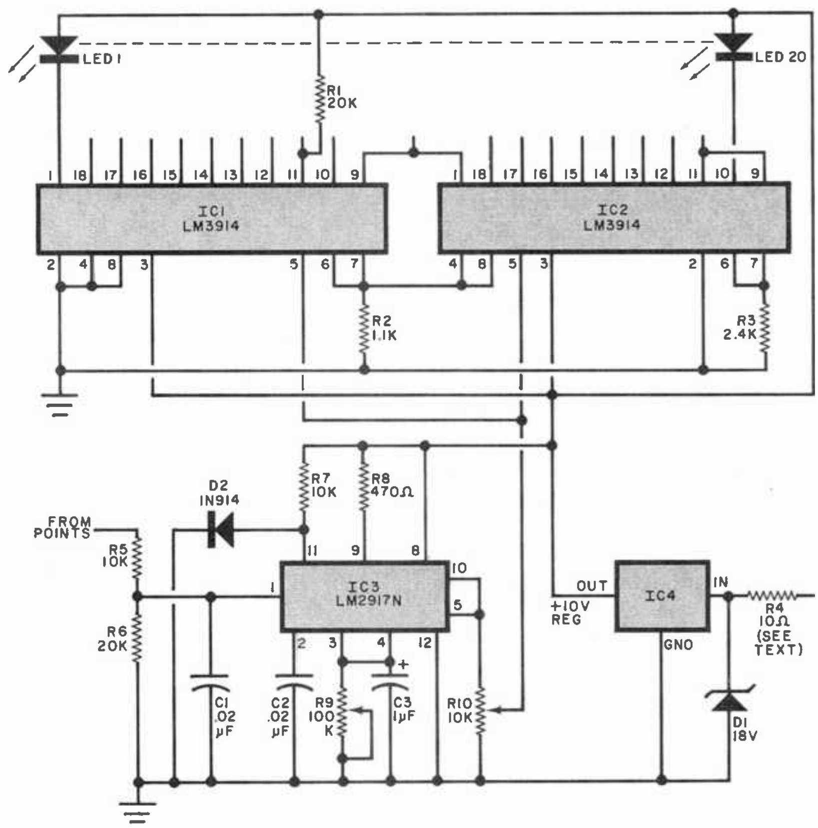


Fig. 13. Circuit for converting pulses from ignition points to voltages which activate LEDs from 1 to 20 to indicate speed.

the more 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.

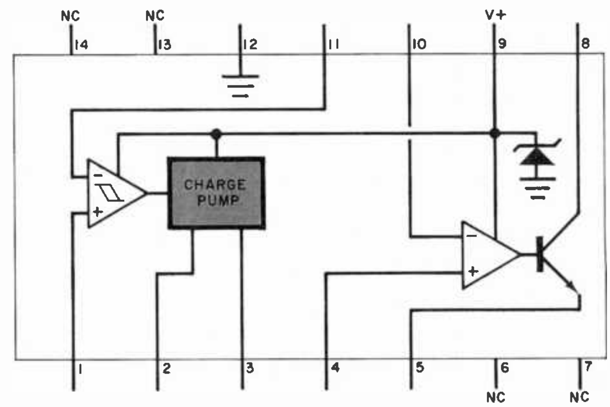


Fig. 14. A charge-pump f/v converter, op-amp/comparator, output transistor and zener diode are contained in LM2917N IC.

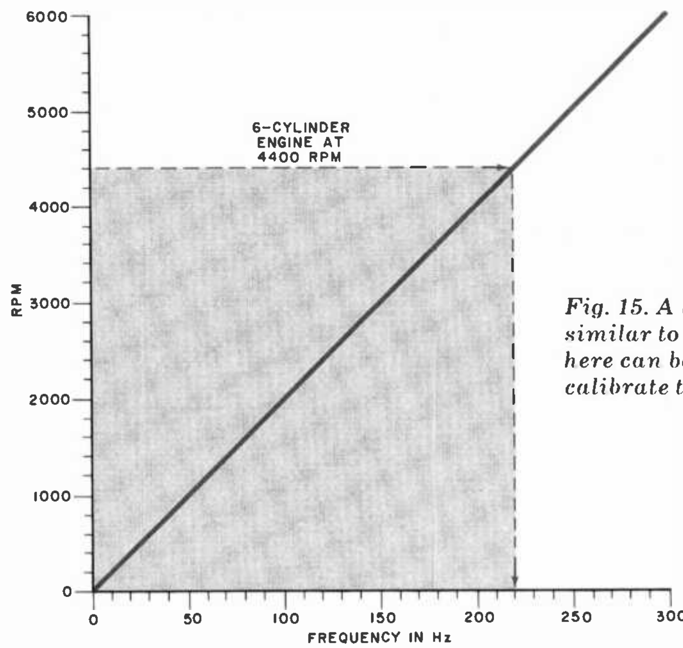


Fig. 15. A linear plot similar to that shown here can be drawn to calibrate tachometer.

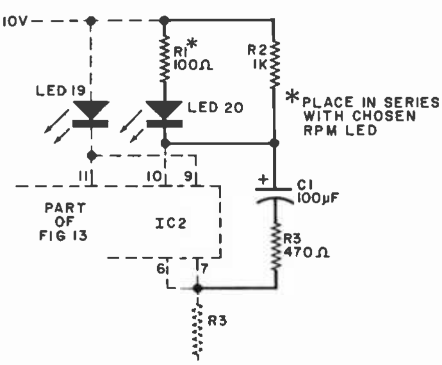


Fig. 16 Tachometer add-on is used to identify critical cruising speed.

PARTS LIST (Fig. 16)

C1—100-μF, 12-V electrolytic
R1—100-ohm, ½-W resistor
R2—1000-ohm, ½-W resistor
R3—470-ohm, ½-W resistor

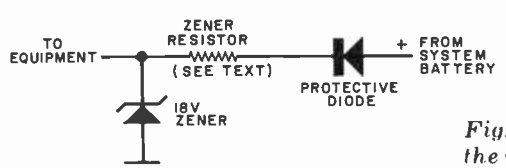


Fig. 17. A series diode is used in the positive supply for reverse voltage protection as shown here.

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 over-rpm 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 rpms 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. ◇

Experimenter's Corner

By Forrest M Mims

IC INTERVAL TIMERS

AN 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 and darkroom 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

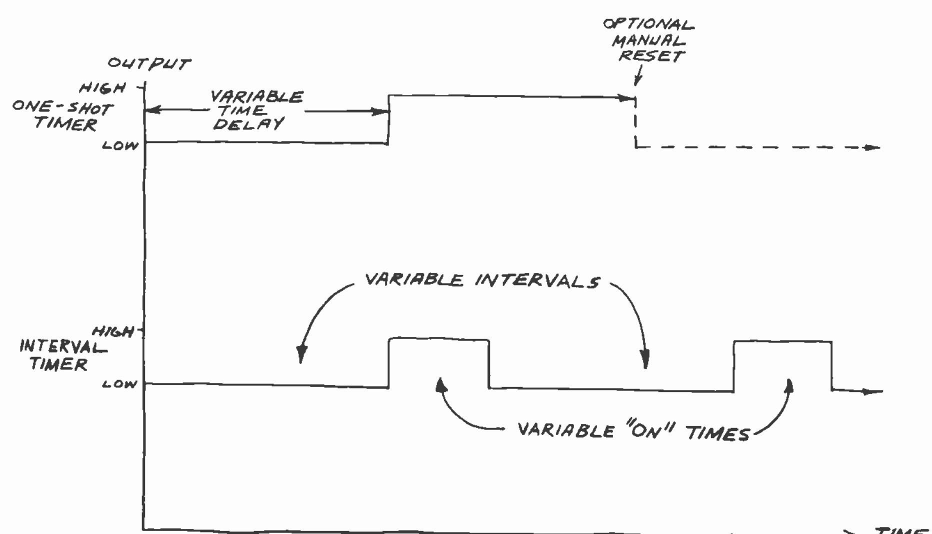


Fig. 1. Timing diagrams of the output waveforms generated by monostable multivibrator or one-shot (top) and interval timer (bottom).

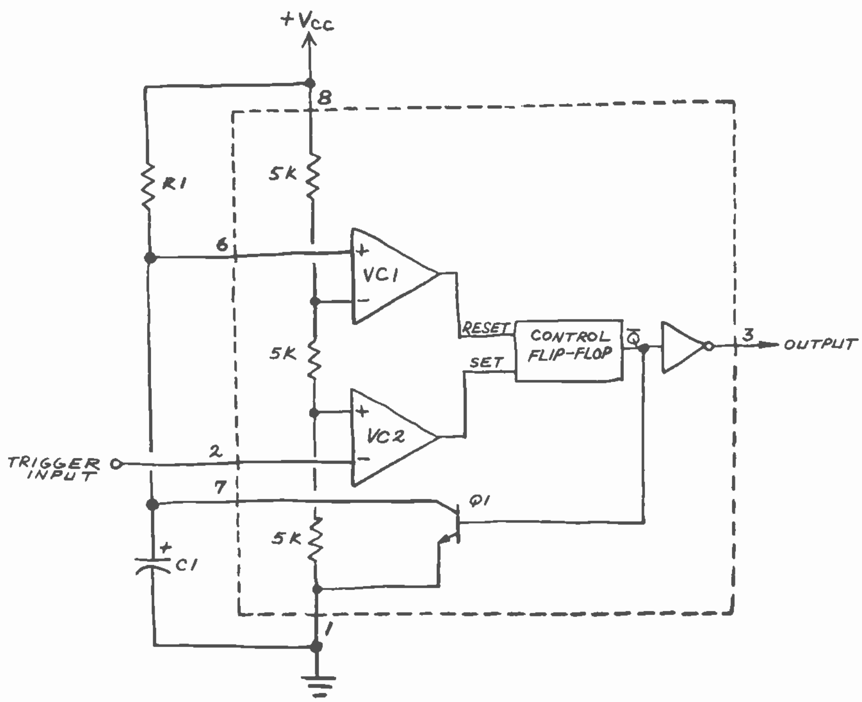


Fig. 2. Simplified functional diagram displays inner workings of a 555 timer IC. External components R1 and C1 control timer's period.

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

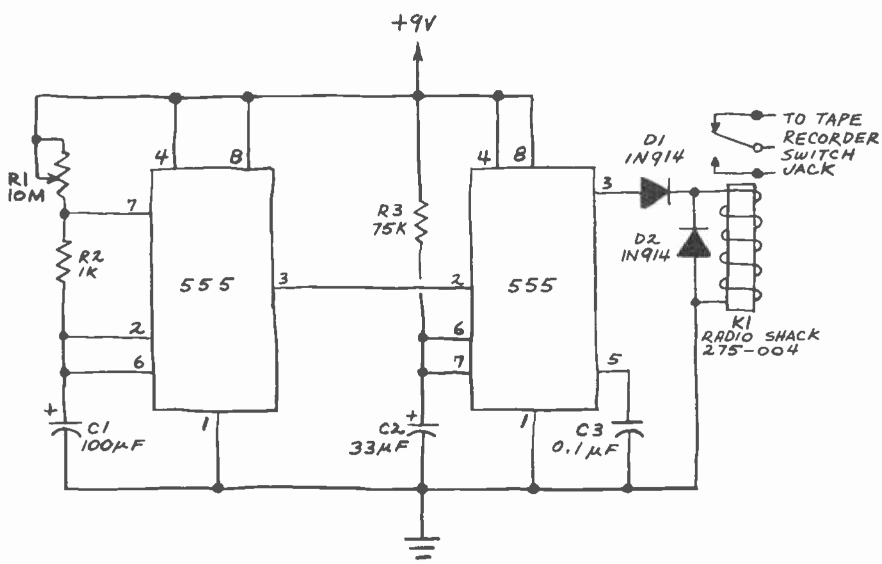


Fig. 3. Interval timer employs one 555 as an astable multivibrator to trigger a second IC operating as a monostable. Relay K1 keys external circuit.

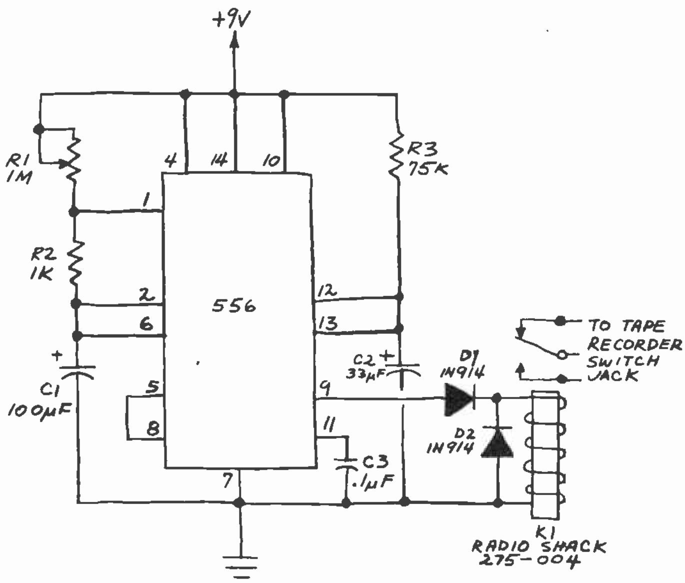


Fig. 4. This circuit, which employs a 556 dual timer, is functionally identical to the one shown in ***Fig. 3.***

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 time intervals 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 × 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 × 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. ◇

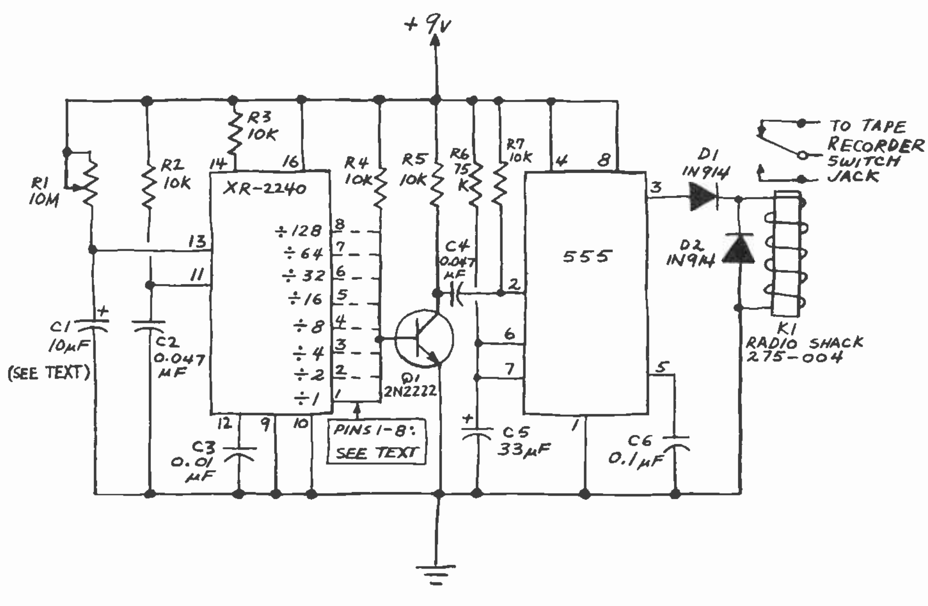


Fig. 5. Long-duration, programmable interval timer employs XR-2240 as an astable and 555 as a monostable. Relay K1 keys external circuit.

Hobby Scene Q&A

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 $\lambda = c/f$, with $c = 2.9971 \times 10^8$ m/s (speed of light in air) and $f = 27.0$ MHz, I come 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 fo 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!

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

Product Test Report

Compucolor II Model 4 Personal Computer System

Has full graphics and built-in floppy-diskette drive

AMONG THE few small computing systems that provide color graphics 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 5¼" 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. Alphanumerics consist of 32 lines of 64 characters/line for small-size capital letters or 16 lines of 64 characters/line with large-size caps. Lowercase 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 76.8K 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 simlar 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 connecter 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

For more information on advertised products, equipment tested, etc., circle appropriate number on postpaid Free Information Card.

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 appendixes 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 opitically disturbing moire patterns (from nearby TV transmitters on adjacent channels or local or mobile hams and CBers) are not seen onscreen. 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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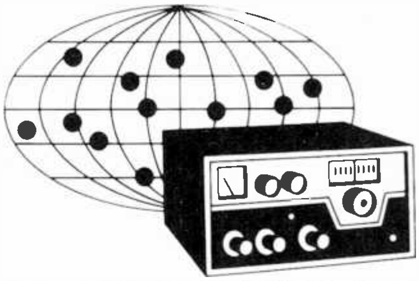


DX Listening

By Glenn Hauser

WARC-79

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, totalling 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 useable frequencies. This expansion totals 1290 kilohertz, as follows:

Proposed (kHz)	Present (kHz)
5900-6200	5950-6200
7250-7500	7100-7300 (not Region 1)
9375-9825	9500-9775
11550-12000	11700-11975
13600-13850	none
15100-15700	15100-15450
17600-17900	17700-17900
19750-19990	none
21450-21800	21450-21750
25850-26100	25600-26100

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.

FRENDX, 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 NASWA, Box 13, Liberty, IN 47353.

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, is 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 Whodunnit," on the history of detective fiction, Saturdays at 0815 and 1315, Sundays at 2015, Mondays at 0315. "Venice Preserved," 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:

GMT	Station	Frequencies, changes
1000-1030	R. Korea	11725, 9580
1000-1300	R. Moscow	9600 (via Cuba)
1000-1602	ABC, Perth	9610
1030-1300	CBC Northern Service	9625, 6065 not 11720
1100-1115	R. Pakistan	21655, 17662
1100-1330	BBC	add 21660; 11775 at 1100-1130 & 1300-1330 only
1100-1500	R. Moscow	delete

1200-1255	R. Peking	9820, not 11685
1215-1230	V. of Greece	17785, not 17830 and 15345
1220-1250	R. Ulan Bator	9575 not 6383
1230-1255	Austrian R.	17860, not 21530
1230-1300	R. Sweden	21690, 21615, not 21700
1300-2300	CBC Northern Service	11720, 9625, not from 1030
1330-2200	R. Moscow	11840 (via Cuba)
1400-1430	R. Norway	21730, not 15175
1400-1600	AFRTS	15430, not 15425
1430-1500	R. Finland	17785, not 21475
1500-1600	V. of Rev. Ethiopia	9560, not 9615
1500-1700	R. Moscow	delete
1515-1530	V. of Greece	not 15345
1530-1600	R. Yugoslavia	add 15295
1530-1630	V. of Vietnam	15012, 14990, not 12035 and 9840
1600-1615	R. Pakistan	21755, 21545, not 21735 and 21595
1600-1630	R. Korea	add 11830, not 9780, 9640, 7150
1600-1800	VOA	add 25880
1610-1655	BRT Belgium	21475 and 17745, not 17740
1700-1800	HCJB, Ecuador	17765, not 17890
1700-2300	WYFR	17845
1800-1830	R. Korea	15255, 11830, not 9780 or 9720
1800-1900	V. of Nigeria	15185, 15120 not 11770, not to 1930
1800-0815	R. New Zealand	17860
1830-1900	R. Nationale, Guinea	15310 (varies) Mon & Fri only
1900-1915	R. Japan	15270, not 15105
1900-1930	R. Can. Int.	not 11905
1900-2000	HCJB, Ecuador	not to 2030
2000-2015	R. Japan	15270, not 15105
2000-2030	R. Korea	delete
2000-2030	V. of Islamic Rev., Iran	9139, not 9022
2000-2030	R. Can. Int.	15325, not 17875 or 11855
2100-2115	R. Japan	15270, not 15105
2100-2200	V. of Nigeria	15185, 15120
2100-2300	CBC Radio	17820, 15325 (Mon-Fri), not 17875, not 2200-2300
2115-0815	R. New Zealand	delete
2130-2200	R. Can. Int.	17780 and 11940, not 17875, 17820, 15325, 11945
2130-2200	HCJB, Ecuador	21480, 17790, 15295
2130-2200	R. Sofia	15135, 11750, not 11920, 11860
2200-2400	AFRTS	17765, not 25620
2300-2330	BBC	not 5975
2300-2330	R. Sweden	15290, 11705, not 15205, 9695, 9690
2300-2330	R. Vilnius	15525, 11735
2300-2330	R. Korea	17860, 15385, 15345
2300-2400	FEBC, Philippines	15450
2300-2400	VOA	not 25990

2305-2320	Austrian R.	12015, 9770, 5945 (Sun.), not 0300-0315
2330-2400	R. Finland	11800 not 11735
0000-0030	R. Can. Int.	5960
0000-0100	VOA	not 25990
0000-0100	R. Sofia	15330
0000-0500	FEBC, Philippines	17810
0015-0100	BRT, Belgium	11715, not 6080
0030-0100	R. Sweden	15290, not 11905
0030-0100	R. Kiev	15525, 11735, 9800
0100-0120	RAI, Italy	11800, not 11810
0100-0130	R. Can. Int.	17820, not 11940
0100-0145	R. Berlin International	11970 not 11805
0100-0430	AFRTS	17765, not 25620
0100-0500	WYFR	9715, not 5985
0130-0155	Austrian R.	5945, not 6155
0130-0200	R. Budapest	17710, 15225 (Wed & Fri)
0130-0230	R. Japan	15270, not 15195
0200-0230	R. Can. Int.	11940, not 9535
0200-0230	R. Norway	add 11870
0200-0230	R. Budapest	add 17710, 15225, not 15220
0200-0300	R. Moscow	add 12030, 9600
0200-0300	R. Bras	15290, not 15280
0215-0230	V. of Greece	9655, not 9760
0230-0300	R. Lebanon	15285, not 15440
0230-0300	R. Korea	15350
0230-0300	R. Sweden	15290, not 9695
0230-0315	R. Berlin International	11970, not 11805
0300-0330	R. Can. Int.	11940, not 9605
0300-0330	R. Budapest	add 17710, 15225, not 15220
0300-0330	R. Kiev	11830, 11735, 9800
0300-0400	UBC Uganda	delete
0300-0400	R. Moscow	add 12030, 9600
0300-0700	VOA	add 17865
0330-0355	Austrian R.	5945, not 6155
0330-0450	R. Habana	not 11725
0400-0415	R. Budapest	add 17710, 15225, not 15220
0400-0430	R. Budapest	17710, 15225, etc, (Mon. only)
0400-0430	R. Can. Int.	add 11845
0400-0445	FEBA, Seychelles	11805
0430-0455	Austrian R.	15260, not 5945
0430-0500	R. Sofia	11750, not 11860
0430-0500	R. Korea	15345, 9755
0430-0700	AFRTS	9755, not 15330, 9685
0455-0630	V. of Nigeria	15185, 15120, 7275 or 7255, not 0555-0835
0500-0515	R. Japan	15270, not 15105
0530-0550	V. of Germany	11905, not 6100
0600-0615	R. Japan	15270, not 15105
0615-0630) 0645-0700)	R. Canada International	11960 and 9635, not 11845, 11775, 9590, 6045
0630-0700	R. Korea	delete
0700-0715	R. Japan	15270, not 15105
0755-fade	Action Radio, Guyana	5950
0800-1000	FEBC, Philippines	11765

Note: Frequencies not referred to in a given entry are still correct at presstime. This is a listing of changes only, not giving complete frequency list for any particular transmission. ◇

Software Sources

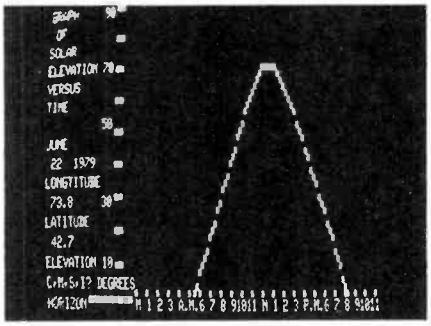
By Leslie Solomon
Technical Director

6502 Operating System. EXOS (Extended Operating System) for 6502 computers 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 computers. Price is $150. Also available is DATE (Disassembler-Assembler Trace Editor). Source programs can be entered, assembled, 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 Microtech, Box 368, Southhampton, PA 18966 (Tel: 215-757-0284).

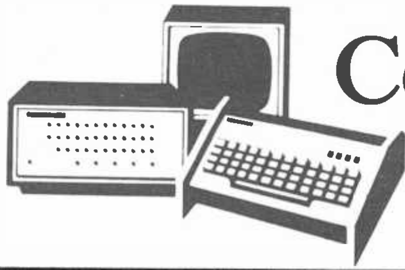
Jolt Stuff. ERAC (Editor and Resident Assembler Controller) was designed for users of ROM version of the Jolt resident assembler ($C900-CFFF). ERAC allows source text and object code to be placed anywhere in RAM. Residing in 2K starting at $0800, 1000 or A800, ERAC is an extension of the RAP. A paper tape is available for $5, manual $4.50, and source of $0800 version is $12.50. LEDIP (Line Editor Program) is a 1.1K line-oriented text editor that can be expanded. It will output source text suitable for usage with the PROM Jolt Resident assembler ($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/Z80 Macro Assembler. This 14K assembler includes a linking loader, library 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 relocatable 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 size, octal or hex 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 Z80 opcodes. Price is $200. Microsoft, 10800 NE Eighth, Suite 819, Bellvue, WA 98004 (Tel: 206-455-8080).

TRS-80 Solar Package. The SUNGRAPH 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 include graphs of elevation vs time of day, azimuth 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. Solartek, Box 298, Guilderland, NY, 12084.



Computer Bits

By Leslie Solomon
Technical Director

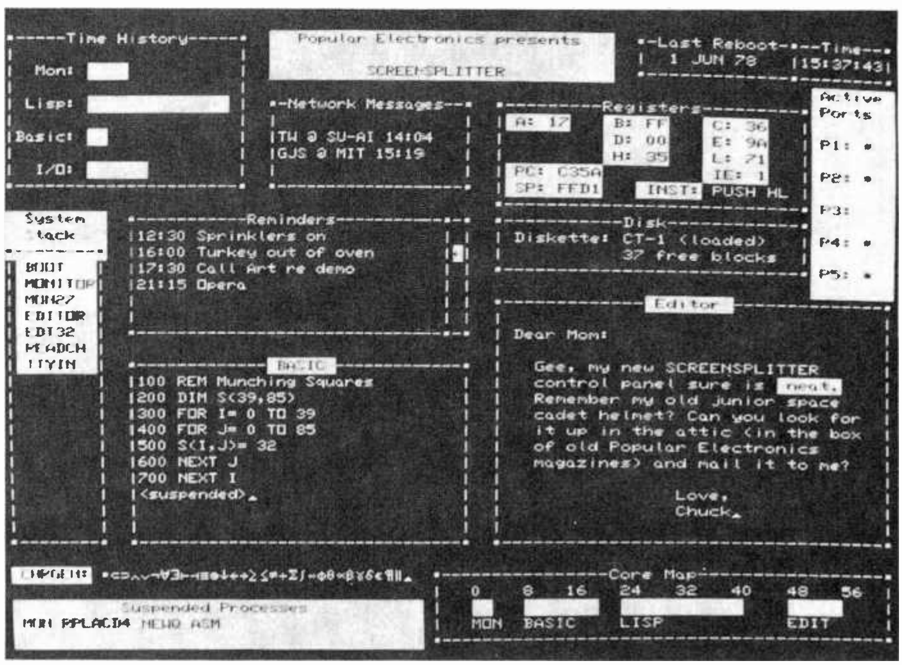
WINDOWS IN THE CRT

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



The Screensplitter can generate almost any number of independent "windows" contingent on the needs of the user.

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 (Tel: 714-979-9920).

Pet 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 IEEE 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 byte 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)

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 character/second (84 lines/minute). Printing is bidirectional, via sprocket feed. Alphanumerics 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).

Bowmar's Model TP-3150 thermal printer requires no ribbons 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. 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 Z80 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 20-mA 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 signalling. 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, 8911 Norwick Rd., Richmond, VA (Tel: 804-740-8380). ◇

A "MATCHBOX" LED OSCILLOSCOPE

PROJECT OF THE MONTH

BY FORREST M. MIMS

REGULAR readers of the Experimenter'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.

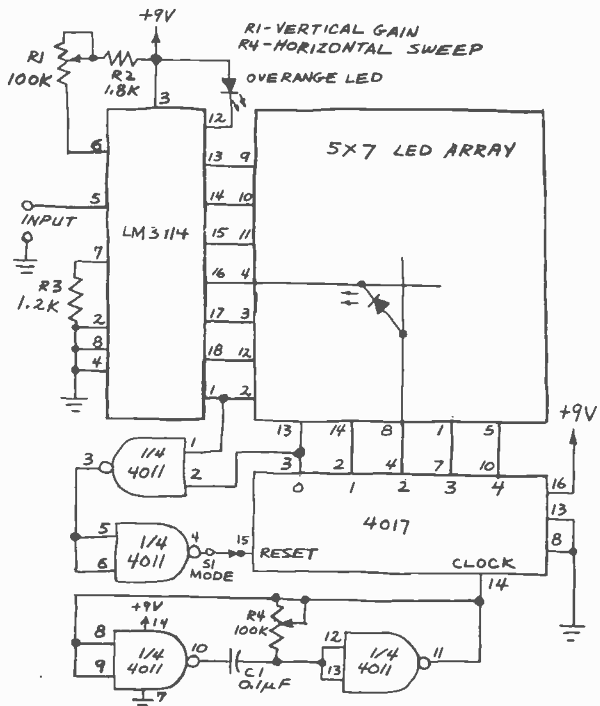


Fig. 1. Schematic diagram of matchbox LED oscilloscope.

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,

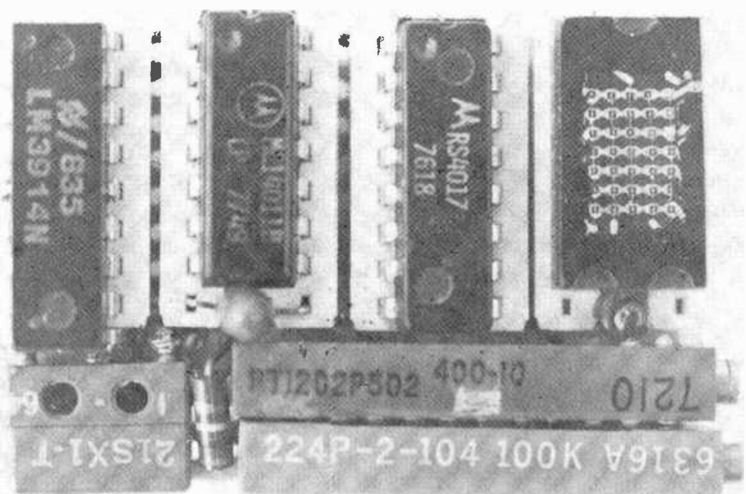


Fig. 2. Photograph of the wrapped-wire prototype LED oscilloscope assembled on a small piece of perforated board about 1.2" × 1.2".

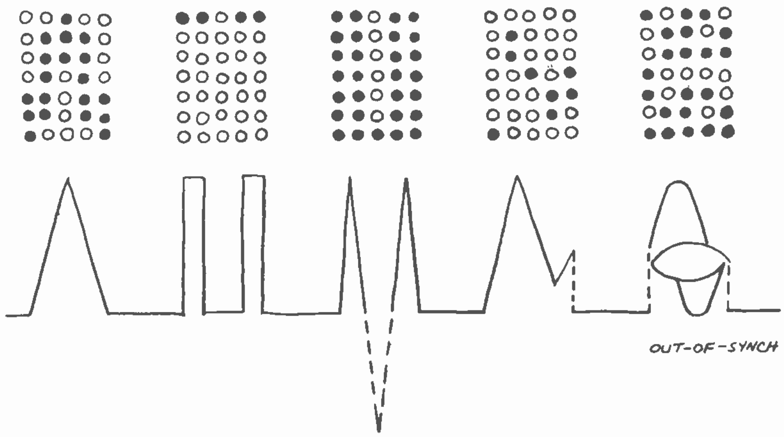


Fig. 3. Some typical display patterns obtained on a 35-element LED scope. Sometimes, the pattern bears little resemblance to the actual wave.

Wire-Wrapped prototype scope that I assembled on a perforated board measuring 1.2" × 1.9" (about 3 cm × 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 × 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 × 7 display or make a 10 × 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 × 20 or more LEDs. ◇

DIODES/ZENERS

QTY.				
	1N914	100v	10mA	.05
	1N4005	600v	1A	.08
	1N4007	1000v	1A	.15
	1N4148	75v	10mA	.05
	1N4733	5.1v	1 W Zenner	.25
	1N4749	24v	1W	.25
	1N753A	6.2v	500 mW Zener	.25
	1N758A	10v	"	.25
	1N759A	12v	"	.25
	1N5243	13v	"	.25
	1N5244B	14v	"	.25
	1N5245B	15v	"	.25
	1N5349	12v	3W	.25

SOCKETS/BRIDGES

QTY.					
	8-pin	pcb	.16	ww	.35
	14-pin	pcb	.20	ww	.40
	16-pin	pcb	.25	ww	.45
	18-pin	pcb	.30	ww	.95
	20-pin	pcb	.35	ww	1.05
	22-pin	pcb	.40	ww	1.15
	24-pin	pcb	.45	ww	1.25
	28-pin	pcb	.50	ww	1.35
	40-pin	pcb	.55	ww	1.45
	Molex pins		.01	To-3 Sockets	.35
	2 Amp Bridge			100-prv	.95
	25 Amp Bridge			200-prv	1.50

TRANSISTORS, LEDS, etc.

QTY.			
	2N2222M	(2N2222 Plastic .10)	.15
	2N2222A		.19
	2N2907A	PNP	.19
	2N3906	PNP (Plastic)	.19
	2N3904	NPN (Plastic)	.19
	2N3054	NPN	.55
	2N3055	NPN 15A 60v	.60
	T1P125	PNP Darlington	1.95
	LED Green,	Red, Clear, Yellow	.19
	D.L.747	7 seg 5/8" High com-anode	1.95
	MAN72	7 seg com-anode (Red)	1.25
	MAN3610	7 seg com-anode (Orange)	1.25
	MAN82A	7 seg com-anode (Yellow)	1.25
	MAN74	7 seg com-cathode (Red)	1.50
	FND359	7 seg com-cathode (Red)	1.25

9000 SERIES

QTY.			QTY.		
	9301	.85		9322	.65
	9309	.50		9601	.30
				9602	.45

MICRO's, RAMS, CPU's, E-PROMS

QTY.		
	8T13	2.50
	8T23	2.50
	8T24	3.00
	8T97	1.75
	74S188	3.00
	1488	1.25
	1489	1.25
	1702A	4.50
	AM 9050	4.00
	ICM 7207	6.95
	ICM 7208	13.95
	MPS 6520	10.00
	MM 5314	4.00
	MM 5316	4.50
	MM 5387	3.50
	MM 5369	2.95
	TR 1602B	3.95
	UPD 414	4.95
	Z 80 A	22.50
	Z 80	17.50
	Z 80 P10	10.50
	2102	1.45
	2102L	1.75
	2107B-4	4.95
	2114	9.50
	2513	6.25
	2708	11.50
	2716 D.S.	34.00
	2716 (5v)	69.00
	2758 (5v)	26.95
	3242	10.50
	4116	11.50
	6800	13.95
	6850	7.95
	8080	7.50
	8085	22.50
	8212	2.75
	8214	4.95
	8216	3.50
	8224	4.25
	8228	6.00
	8251	7.50
	8253	18.50
	8255	8.50
	TMS 4044	9.95

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QTY.	Part	Price	QTY.	Part	Price	QTY.	Part	Price	QTY.	Part	Price
	7400	.20		7492	.45		74H20	.25		74LS76	.70
	7401	.20		7493	.35		74H21	.25		74LS86	.95
	7402	.20		7494	.75		74H22	.40		74LS90	.85
	7403	.20		7495	.60		74H30	.30		74LS93	.85
	7404	.20		7496	.80		74H40	.35		74LS96	2.00
	7405	.35		74100	1.15		74H50	.30		74LS107	.90
	7406	.25		74107	.35		74H51	.30		74LS109	1.50
	7407	.55		74121	.35		74H52	.20		74LS123	1.95
	7408	.20		74122	.55		74H53	.25		74LS138	2.00
	7409	.25		74123	.55		74H55	.25		74LS151	.95
	7410	.20		74125	.45		74H72	.35		74LS153	1.15
	7411	.25		74126	.45		74H74	.35		74LS157	1.15
	7412	.25		74132	.75		74H101	.95		74LS160	1.15
	7413	.45		74141	.90		74H103	.55		74LS164	2.90
	7414	.75		74150	.85		74H106	1.15		74LS193	2.00
	7416	.25		74151	.95		74L00	.30		74LS195	1.15
	7417	.40		74153	.95		74L02	.30		74LS244	2.90
	7420	.25		74154	1.15		74L03	.35		74LS259	1.50
	7426	.25		74156	.70		74L04	.40		74LS298	1.50
	7427	.25		74157	.65		74L10	.30		74LS367	1.95
	7430	.20		74161/9316	.75		74L20	.45		74LS368	1.25
	7432	.30		74163	.85		74L30	.55		74LS373	2.50
	7437	.20		74164	.75		74L47	1.95		74S00	.45
	7438	.30		74165	1.10		74L51	.65		74S02	.45
	7440	.20		74166	1.75		74L55	.85		74S03	.35
	7441	1.15		74175	.90		74L72	.65		74S04	.35
	7442	.55		74176	.95		74L73	.70		74S05	.45
	7443	.45		74177	1.10		74L74	.75		74S08	.45
	7444	.45		74180	.95		74L75	1.05		74S10	.45
	7445	.75		74181	2.25		74L85	2.00		74S11	.45
	7446	.70		74182	.75		74L93	.75		74S20	.35
	7447	.70		74190	1.25		74L123	1.95		74S22	.55
	7448	.50		74191	1.25		74LS00	.40		74S40	.30
	7450	.25		74192	.75		74LS01	.40		74S50	.30
	7451	.25		74193	.85		74LS02	.45		74S51	.35
	7453	.20		74194	.95		74LS03	.45		74S64	.15
	7454	.25		74195	.95		74LS04	.45		74S74	.70
	7460	.40		74196	.95		74LS05	.45		74S112	.60
	7470	.45		74197	.95		74LS08	.45		74S114	.85
	7472	.40		74198	1.45		74LS09	.45		74S133	.85
	7473	.25		74221	1.50		74LS10	.45		74S140	.75
	7474	.30		74298	1.50		74LS11	.45		74S151	.95
	7475	.35		74367	1.35		74LS20	.45		74S153	.95
	7476	.40		75491	.65		74LS21	.45		74S157	.98
	7480	.75		75492	.65		74LS22	.45		74S158	.80
	7481	.85		74H00	.20		74LS32	.50		74S194	1.50
	7482	.95		74H01	.30		74LS37	.45		74S196	2.00
	7483	.95		74H04	.30		74LS38	.65		74S257 (8123)	2.50
	7485	.75		74H05	.25		74LS40	.70		8131	2.75
	7486	.55		74H08	.35		74LS42	.95			
	7489	1.05		74H10	.35		74LS51	.75			
	7490	.55		74H11	.25		74LS74	.95			
	7491	.70		74H15	.45		74LS75	1.20			

C MOS

QTY.	Part	Price	QTY.	Part	Price	QTY.	Part	Price	QTY.	Part	Price
	4000	.15		4017	.75		4034	2.45		4069/74C04	.45
	4001	.20		4018	.75		4035	.75		4071	.25
	4002	.25		4019	.35		4037	1.80		4081	.30
	4004	3.95		4020	.85		4040	.75		4082	.30
	4006	.95		4021	.75		4041	.69		4507	.95
	4007	.25		4022	.75		4042	.65		4511	.95
	4008	.75		4023	.25		4043	.50		4512	1.50
	4009	.35		4024	.75		4044	.65		4515	2.95
	4010	.35		4025	.25		4046	1.25		4519	.85
	4011	.30		4026	1.95		4047	2.50		4522	1.10
	4012	.25		4027	.35		4048	1.25		4526	.95
	4013	.40		4028	.75		4049	.65		4528	1.10
	4014	.75		4029	1.15		4050	.45		4529	.95
	4015	.75		4030	.30		4052	.75		MC14409	14.50
	4016	.35		4033	1.50		4053	.95		MC14419	4.85
							4066	.75		74C151	2.50

I²L, LINEARS, REGULATORS, ETC.

QTY.			QTY.			QTY.		
	MCT2	.95		LM320K24	1.65		LM373	3.95
	8038	3.95		LM320T5	1.65		LM377	3.95
	LM201	.75		LM320T12	1.65		78L05	.75
	LM301	.45		LM320T15	1.65		78L12	.75
	LM308	.65		LM323K	5.95		78L15	.75
	LM309H	.85		LM324	1.25		78M05	.75
	LM309 (340K-5)	1.50		LM339	.75		LM380 (8-14 Pin)	1.19
	LM310	.85		7805 (340T5)	1.15		LM709 (8-14 Pin)	.45
	LM311 (8-14 Pin)	.75		LM340T12	.95		LM711	.45
	LM318	1.50		LM340T15	.95		LM723	.40
	LM320H6	.79		LM340T18	.95		LM725	2.50
	LM320H15	.79		LM340T24	.95		LM739	1.50
	LM320H24	.79		LM340K12	1.25		LM741 (8-14)	.45
	7905 (LM320K5)	1.65		LM340K15	1.25		LM747	1.10
	LM320K12	1.65		LM340K18	1.25		LM1307	1.75
	LM320K15	1.65		LM340K24	1.25		LM1458	.65
							LM3900	.95
							LM75451	.65
							NE555	.45
							NE556	.85
							NE565	1.15
							NE566	1.25
							NE567	.95
							TA7205	6.95
							76477	2.95
							95H90	9.95

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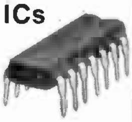

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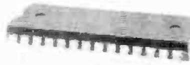
4066	276-2466	1.39
4070	276-2470	79¢
4511	276-2447	1.69
4518	276-2490	1.49
4543	276-2491	1.99

SN-76477 Sound/Music Synthesizer IC

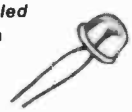


2.99 Featured in Oct. Popular Electronics

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

Mercury Tilt Switch

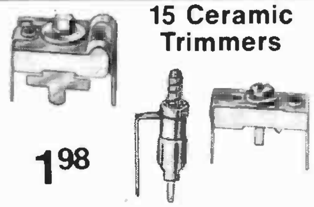
- *Hermetically Sealed*
- *Perfect for Alarm Circuits*



89¢ Actual Size!

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

15 Ceramic Trimmers



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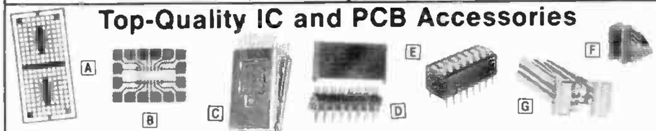
Assorted low-loss RF trimmer capacitors. May include both compression and piston types rated up to 500VDC with maximum capacity values of 3 to 100 pF. 272-805 .... Pkg. of 15/1.98

Top-Quality IC and PCB Accessories



A PC Board. Mounts two 14 or 16-pin ICs or sockets for bread boarding. Copper clad. 2½x5x1¹/₁₆". 276-151 .... 2.99
B PC Board. Mounts single 14 or 16-pin IC or socket. 276-024 .... Pkg. of 2/99¢
C 16-Pin IC Test Clip. 276-1951 .... Sale 2.89
D 16-Pin DIP Header. With snap-on cover. 276-1980 .... 1.29
E 8-Position DIP Switch. 275-1301 .... 1.99
4-Position DIP Switch. (Not shown.) 275-1304 .... 1.49
F Vertical 16-pin Socket. For LED displays. 276-1986 .... 1.49
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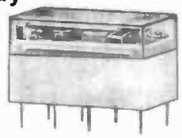
DPDT Dual Inline Relay — 4.49

Fits Std. 14-Pin IC Socket



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

Handheld 6-Digit Frequency Counter

Reg. 99.95 **49.95**

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- kHz and MHz Decimals

Accuracy is 3 ppm at 25°C or less than 30 Hz at 10 MHz. Overload-protected 1-meg input. Sensitivity, 30 mV up to 30 MHz. 3x4½". With mini-rod antenna, leads, case, instructions. Requires 9V battery. 22-351 ... Sale 49.95
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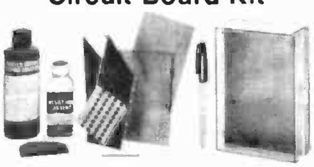

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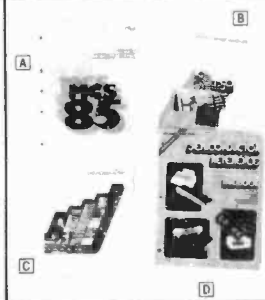

A **Intel 8080/8085 Programming Manual.** Handy reference for programming with Intel's assembly language. 62-1377 .... 3.95
B **Intel Memory Design Handbook.** Explains use of Intel's memory components and support circuits in systems. 62-1378 .... 3.95
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- *Tri-Color*
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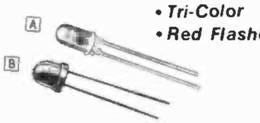
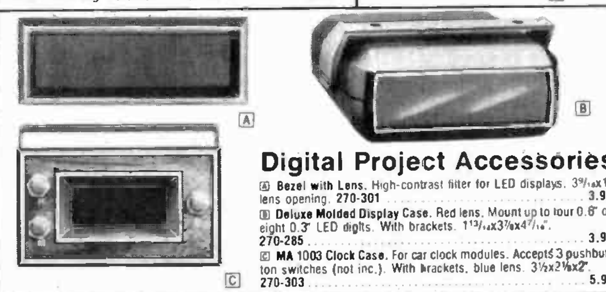


A Displays red, green, yellow. Uniform light output of 0.6 mcd. Forward voltage: 2.2VDC. Max. current: 25mA. T1-¾ case style. 276-035 .... 1.39
B Operates directly from 5VDC power source. Pulse rate: 3 Hz. Max. current: 20 mA at 5VDC. 276-036 .... 1.29



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A **Bezel with Lens.** High-contrast filter for LED displays. 3⁹/₁₆x1" lens opening. 270-301 .... 3.95
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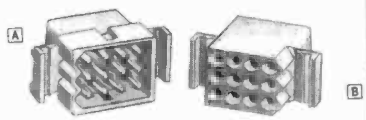
C **MA 1003 Clock Case.** For car clock modules. Accepts 3 pushbutton switches (not inc.). With brackets, blue lens. 3½x2⅛x2". 270-303 .... 5.95

Molded Connectors



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

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A	9	Male	274-229	1.39	B	9	Female	274-239	1.39
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SN7409N	.20	SN7486N	.35	SN74172N	6.00
SN7410N	.18	SN7489N	1.75	SN74173N	1.25
SN7411N	.25	SN7490N	.45	SN74174N	.89
SN7412N	.25	SN7491N	.59	SN74175N	.79
SN7413N	.40	SN7492N	.43	SN74176N	.79
SN7414N	.70	SN7493N	.43	SN74177N	.79
SN7416N	.25	SN7494N	.65	SN74179N	1.95
SN7417N	.25	SN7495N	.65	SN74180N	.79
SN7420N	.20	SN7496N	.65	SN74181N	1.95
SN7421N	.29	SN7497N	3.00	SN74182N	.79
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SN7429N	.39	SN74122N	.39	SN74191N	1.25
SN7430N	.20	SN74123N	.49	SN74192N	.79
SN7432N	.25	SN74125N	.49	SN74193N	.79
SN7437N	.25	SN74126N	.49	SN74194N	.89
SN7438N	.25	SN74132N	.75	SN74195N	.69
SN7439N	.25	SN74136N	.75	SN74196N	.89
SN7440N	.20	SN74141N	.79	SN74197N	.89
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SN7451N	.20	SN74153N	.59	SN74366N	.69
SN7453N	.20	SN74154N	.99	SN74367N	.69
SN7454N	.20	SN74155N	.79	SN74368N	.69
SN7459A	.25	SN74156N	.79	SN74390N	1.95
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CD4006	1.19	CD4029	1.19	CD4076	1.39
CD4007	.25	CD4030	.49	CD4081	.23
CD4009	.49	CD4035	.99	CD4082	.23
CD4010	.49	CD4040	1.19	CD4093	.99
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CD4023	.23	CD4059	9.95	CD4511	1.29
CD4024	.79	CD4060	1.49	CD4515	2.95
CD4025	.23	CD4066	.79	CD4518	1.29
CD4026	2.25	CD4068	.39	CD4520	1.29
CD4027	.69	CD4069	.45	CD4566	2.25

74C00

74C00	.39			74C163	2.49
74C02	.39			74C164	2.49
74C04	.39	74C85	2.49	74C173	2.60
74C08	.49	74C90	1.95	74C192	2.49
74C10	.39	74C93	1.95	74C193	2.49
74C14	1.95	74C95	1.95	74C195	2.49
74C20	.39	74C107	1.25	74C922	5.95
74C30	.39	74C151	2.90	74C923	6.25
74C42	1.95	74C154	3.00	74C925	8.95
74C48	2.49	74C157	2.15	74C926	8.95
74C73	.89	74C160	2.49	80C95	1.50
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LM304H	1.00	LM340T-6	1.25	LM741CN/H	.35
LM305H	.60	LM340T-8	1.25	LM741-14N	.39
LM307CN/H	.35	LM340T-12	1.25	LM747N/H	.79
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LM309H	1.10	LM340T-18	1.25	LM1310N	2.95
LM309K	1.25	LM340T-24	1.25	LM1458CN/H	.59
LM310CN	1.15	LM358N	1.00	MC1488N	1.39
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LM320K-15	1.35	NE510A	6.00	LM3900N(3401)	.49
LM320K-18	1.35	NE529A	4.95	LM3905N	.89
LM320K-24	1.35	NE531H/V	3.95	LM3909N	1.25
LM320T-5	1.25	NE536T	6.00	MC5558V	.59
LM320T-5.2	1.25	NE540L	6.00	8038B	4.95
LM320T-8	1.25	NE544N	4.95	LM75450N	.49
LM320T-12	1.25	NE550N	1.30	75451CN	.39
LM320T-15	1.25	NE555V	.39	75452CN	.39
LM320T-18	1.25	NE556N	.99	75453CN	.39
LM320T-24	1.25	NE560B	5.00	75454CN	.39
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LM324N	1.80	NE562B	5.00	75492CN	.89
LM339N	.99	NE565N/H	1.25	75493N	.89
LM340K-5	1.35	NE566CN	1.75	75494CN	.89
LM340K-6	1.35	NE567V/H	.99	RC4136	1.25
LM340K-8	1.35	NE570N	4.95	RC4151	2.85
LM340K-12	1.35	LM703CN/H	.69	RC4194	5.95
LM340K-15	1.35	LM709N/H	.29	RC4195	4.49

74LS00TTL

74LS00	.29			74LS138	.89
74LS01	.29			74LS139	.89
74LS02	.29	74LS47	.89	74LS151	.89
74LS03	.29	74LS51	.29	74LS155	.89
74LS04	.35	74LS54	.29	74LS157	.89
74LS05	.35	74LS55	.29	74LS160	1.15
74LS08	.29	74LS73	.45	74LS161	1.15
74LS09	.35	74LS74	.45	74LS162	1.15
74LS10	.29	74LS75	.59	74LS163	1.15
74LS11	.75	74LS76	.45	74LS164	1.25
74LS13	.59	74LS78	.49	74LS175	.99
74LS14	1.25	74LS83	.89	74LS181	2.49
74LS15	.35	74LS85	1.25	74LS190	1.15
74LS20	.29	74LS86	.45	74LS191	1.15
74LS21	.35	74LS90	.59	74LS192	1.15
74LS22	.35	74LS92	.75	74LS193	1.15
74LS26	.35	74LS93	.75	74LS194	1.15
74LS27	.35	74LS95	.99	74LS195	1.15
74LS28	.35	74LS96	1.15	74LS253	.99
74LS30	.29	74LS107	.45	74LS257	.89
74LS32	.35	74LS109	.45	74LS258	1.75
74LS37	.45	74LS112	.45	74LS260	.69
74LS40	.35	74LS123	1.25	74LS279	.75
74LS42	.89	74LS125	.89	74LS367	.75
		74LS132	.99	74LS368	.75
		74LS136	.49	74LS670	2.49

EXCITING NEW KITS

NEW! JE600 HEXADECIMAL ENCODER KIT

FEATURES:
- Full 8 bit latched output for micro-processor use
- 3 User Define keys with one being bi-stable operation
- Debounce circuit provided for all 19 keys
- LED readout to verify entries
- Easy interfacing with standard 16 pin IC connector
- Only +5VDC required for operations

FULL 8 BIT LATCHED OUTPUT—19 KEYBOARD

The JE600 Encoder Keyboard provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry strobe.

JE600 ....$59.95

Digital Thermometer Kit

NEW!

- Dual sensors—switching control for in-door/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- Sim. walnut case - AC wall adapter incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 ....$39.95

DISCRETE LEDS

.200" dia.			.125" dia.		
XC556R	red	5/$1	XC209R	red	5/$1
XC556G	green	4/$1	XC209G	green	4/$1
XC556Y	yellow	4/$1	XC209Y	yellow	4/$1
XC556C	clear	4/$1			
.200" dia.			.185" dia.		
XC22R	red	5/$1	XC526R	red	5/$1
XC22G	green	4/$1	XC526G	green	4/$1
XC22Y	yellow	4/$1	XC526Y	yellow	4/$1
.170" dia.			XC526C	clear	4/$1
MV10B	red	4/$1			
.085" dia.			.190" dia.		
MV50	red	6/$1	XC111R	red	5/$1
			XC111G	green	4/$1
			XC111Y	yellow	4/$1
			XC111C	clear	4/$1

INFRA-RED LED
1/4"x1/4"x1/16" flat
5/$1

TIMEX T1001
LIQUID CRYSTAL DISPLAY
CLASS II
FIELD EFFECT

4 DIGIT - .5" CHARACTERS
THREE ENUNCIATORS
2.00" X 1.20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive $7.95
T1001A-Reflective 8.25

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	.560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.99	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.99	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	1.30
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	2.10
MAN 6640	Common Cathode-orange-D.D	.560	.99	HDSP-3403	Common Cathode red	.800	2.10
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6710	Common Anode-red-D.D.	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

CA3013T	2.15	CA3082N	2.00
CA2023T	2.56	CA3083N	1.60
CA3035T	2.48	CA3086N	.85
CA3039T	1.35	CA3089N	3.75
CA3046N	1.30	CA3130T	1.39
CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	.85	CA3401N	.49
CA3081N	2.00	CA3600N	3.50

CALCULATOR CHIPS/DRIVERS

MM5725	$2.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
9374 7 seg. C.A. LED driver	1.50

CLOCK CHIPS

MM5309	$4.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5387/1998A	4.95
MM5841	9.95

MOTOROLA

MC1408L7	$4.95
MC1408L8	5.75
MC1439L	2.95
MC3022P	2.95
MC3061P	3.50
MC4016(74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	$.17	.16	.15	22 pin LP	$.37	.36	.35
14 pin LP	.20	.19	.18	24 pin LP	.38	.37	.36
16 pin LP	.22	.21	.20	28 pin LP	.45	.44	.43
18 pin LP	.29	.28	.27	36 pin LP	.60	.59	.58
20 pin LP	.34	.32	.30	40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin ST	$.27	.25	.24	28 pin ST	$.99	.90	.81
16 pin ST	.30	.27	.25	36 pin ST	1.39	1.26	1.15
18 pin ST	.35	.32	.30	40 pin ST	1.59	1.45	1.30
24 pin ST	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin SG	$.30	.27	.24	24 pin SG	$.70	.63	.57
14 pin SG	.35	.32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.65	1.40	1.26
18 pin SG	.52	.47	.43	40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin WW	$.39	.38	.31	22 pin WW	$.95	.85	.75
10 pin WW	.45	.41	.37	24 pin WW	1.05	.95	.85
14 pin WW	.39	.38	.37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	.42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	.68	.62	40 pin WW	1.75	1.55	1.40

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea	10 OHM, 27 OHM	12 OHM, 33 OHM	15 OHM, 39 OHM	18 OHM, 47 OHM	22 OHM, 56 OHM	50 PCS	$1.75
ASST. 2	5 ea	68 OHM, 180 OHM	82 OHM, 220 OHM	100 OHM, 270 OHM	120 OHM, 330 OHM	150 OHM, 390 OHM	50 PCS	1.75
ASST. 3	5 ea	470 OHM, 1.2K	560 OHM, 1.5K	680 OHM, 1.8K	820 OHM, 2.2K	1K, 2.7K	50 PCS	1.75
ASST. 4	5 ea	3.3K, 8.2K	3.9K, 10K	4.7K, 12K	5.6K, 15K	6.8K, 18K	50 PCS	1.75
ASST. 5	5 ea	22K, 56K	27K, 68K	33K, 82K	39K, 100K	47K, 120K	50 PCS	1.75
ASST. 6	5 ea	150K, 390K	180K, 470K	220K, 560K	270K, 680K	330K, 820K	50 PCS	1.75
ASST. 7	5 ea	1M, 2.7M	1.2M, 3.3M	1.5M, 3.9M	1.8M, 4.7M	2.2M, 5.6M	50 PCS	1.75

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$9.95 ea.**

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AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	14.95
HD0165	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.95

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ICM7045	CMOS Precision Timer	24.95
ICM7205	CMOS LED Stopwatch/Timer	19.95
ICM7207	Oscillator Controller	7.50
ICM7208	Seven Decade Counter	19.95
ICM7209	Clock Generator	6.95

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MCM6571	128 X 9 X 7 ASCII Shifted with Greek	13.50
MCM6574	128 X 9 X 7 Math Symbol & Pictures	13.50
MCM6575	128 X 9 X 7 Alphanumeric Control Character Generator	13.50

MISCELLANEOUS

TL074CN	Quad Low Noise bi-fet Op Amp	2.49
TL494CN	Switching Regulator	4.49
TL496CP	Single Switching Regulator	1.75
11C90	Divide 10/11 Prescaler	19.95
95H90	Hi-Speed Divide 10/11 Prescaler	11.95
4N33	Photo-Darlington Opto-Isolator	3.95
MK50240	Top Octave Freq. Generator	17.50
DS0026CH	5Mhz 2-phase MOS clock driver	3.75
TIL308	.27" red num. display w/integ. logic chip	10.50
MM5320	TV Camera Sync. Generator	14.95
MM5330	4½ Digit DPM Logic Block (Special)	3.95
LD110/111	3½ Digit A/D Converter Set	25.00/set

LITRONIX ISO-LIT 1
Photo Transistor Opto-Isolator
(Same as MCT 2 or 4N25)
2/99¢

SN 76477
SOUND GENERATOR
Generates Complex Sounds
Low Power - Programmable
3.95 each

TV GAME CHIP AND CRYSTAL
AY-3-8500-1 and 2.01 MHZ Crystal (Chip & Crystal includes score display, 6 games and select angles, etc. **7.95/set**

EXAR

XR205	$8.40			XR2242CP	1.50
XR210	4.40			XR2264	4.25
XR215	4.40			XR2556	3.20
XR320	1.55	JE2206KA	14.95	XR2567	2.99
XR-L555	1.50	JE2206KB	19.95	XR3403	1.25
XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	2.85
XR567CP	.99	XR2207	3.85	XR4194	4.95
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.30	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.39	XR2212	4.35	XR4739	1.15
XR1489	1.39	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
				1N4002	100 PIV	1 AMP	12/1.00
				1N4003	200 PIV	1 AMP	12/1.00
1N746	3.3	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N3600	50	200m	6/1.00
1N757	9.0	400m	4/1.00	1N4148	75	10m	15/1.00
1N759	12.0	400m	4/1.00	1N4154	35	10m	12/1.00
1N959	8.2	400m	4/1.00	1N4305	75	25m	15/1.00
1N965	15	400m	4/1.00	1N4734	5.6	1w	.28
1N5232	5.6	500m	.28	1N4735	6.2	1w	.28
1N5234	6.2	500m	.28	1N4736	6.8	1w	.28
1N5235	6.8	500m	.28	1N4738	8.2	1w	.28
1N5236	7.5	500m	.28	1N4742	12	1w	.28
1N5242	12	500m	.28	1N4744	15	1w	.28
1N5245	15	500m	.28	1N1183	50 PIV	35 AMP	1.60
1N456	25	40m	6/1.00	1N1184	100 PIV	35 AMP	1.70
1N458	150	7m	6/1.00	1N1185	150 PIV	35 AMP	1.70
1N485A	180	10m	5/1.00	1N1186	200 PIV	35 AMP	1.80
1N4001	50 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C38M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369A	4/1.00	2N3706	5/1.00	2N5088	4/1.00
MPS2369	5/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2484	4/1.00	2N3707	5/1.00	PN5129	5/1.00
2N2906	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2907	5/1.00	2N3724A	.65	PN5138	5/1.00
PN2907 Plastic	7/1.00	2N3725A	1.00	2N5139	5/1.00
2N2925	5/1.00	2N3772	2.25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	5/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

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

100 VOLT MYLAR FILM CAPACITORS

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

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
68/35V	.28	.23	.17	15/25V	.63	.50	.40
1.0/35V	.28	.23	.17				

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.10
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

Transistor Checker

– Completely Assembled –
– Battery Operated –

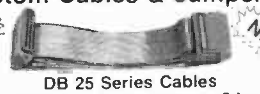
The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the alligator clip test leads provided. The unit safely and automatically identifies low, medium and high-power PNP and NPN transistors.
Size: 3¾" x 6¼" x 2"
"C" cell battery not included.

NEW

Trans-Check $29.95 ea.

Custom Cables & Jumpers

NEW NEW



DB 25 Series Cables

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

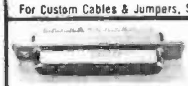
Dip Jumpers

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

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

CONNECTORS

25 Pin-D Subminiature



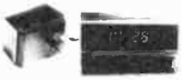
DB25P (as pictured)	PLUG (Meets RS232)	$2.95
DB25S	SOCKET (Meets RS232)	$3.50
DB51226-1	Cable Cover for DB25P or DB25S	$1.75

PRINTED CIRCUIT EDGE-CARD

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

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

4-Digit Clock Kit



- Bright .357" ht. red display
- Sequential flashing colon
- 12 or 24 hour operation
- Extruded aluminum case (black)
- Pressure switches for hours, minutes & hold functions
- Includes all components, case and wall transformer
- Size: 3¼ x 1¾ x 1¼

JE730 $14.95

Jumbo 6-Digit Clock Kit

- Four .630"ht. and two .300"ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾ x 3⅛ x 1¾

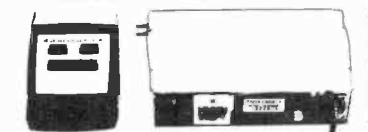
JE747 $29.95

- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¼"

JE701

6-Digit Clock Kit $19.95

REMOTE CONTROL TRANSMITTER & RECEIVER



- CAN BE USED AS REMOTE CONTROL FOR TV
- USE IT FOR YOUR OWN GARAGE DOOR OPENER
- TRANSMITS BETWEEN 36kHz AND 41.5kHz
- THOUSANDS OF USES FOR REMOTE CONTROL APPLICATIONS
- TRANSMITTER USES A 1.5V BATTERY
- SCHEMATIC INCLUDED

$19.95

Digital Stopwatch Kit

- Use Intersil 7205 Chip
- Plated thru double-sided P.C. Board
- LED display (red)
- Times to 59 min. 59.59 sec. with auto reset
- Quartz crystal controlled
- Three stopwatches in one: single event, split (cummulative) & taylor (sequential timing)
- Uses 3 penlite batteries
- Size: 4.5" x 2.15" x .90"

JE900 $39.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES		
8080A	CPU	$ 9.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	5.95
8238	System Controller	5.95
8251	Prog. Comm. 1/0 (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. 1/0 (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95
6800/6800 SUPPORT DEVICES		
MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt.	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25
MICROPROCESSOR CHIPS—MISCELLANEOUS		
Z80(780C)	CPU	$19.95
Z80A(780-1)	CPU	24.95
CDP1802	CPU	19.95
2650	MPU	19.95
6502	CPU	11.95
8035	8-Bit MPU w/clock, RAM, 1/0 lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95
SHIFT REGISTERS		
MM500H	Dual 25 Bit Dynamic	$.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
2533	1024 Static	2.95
3341	Fifo	6.95
74LS670	4X4 Register File (TriState)	2.49
UART'S		
A-Y-5-1013	30K BAUD	5.95

MICROPROCESSOR MANUALS			
M-Z80	User Manual		$7.50
M-CDP1802	User Manual		7.50
M-2650	User Manual		5.00
ROM'S			
2513(2140)	Character Generator(upper case)		$9.95
2513(3021)	Character Generator(lower case)		9.95
2516	Character Generator		10.95
MM5230N	2048-Bit Read Only Memory		1.95
RAM'S			
1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	9.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin	9.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00
PROM'S			
1702A	2048	FAMOS	$5.95
2716INTEL	16K*	EPROM	59.95
TMS2516 (2716)	16K*	EPROM	49.95
	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I	16K**	EPROM	29.95
	**Requires 3 voltages, —5V, +5V, −12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

CSC CONTINENTAL SPECIALTIES

Proto Board 203

A total ready-to-use power breadboard prototest device with a built-in regulated, short proof power supply. Just plug in and start building! 2 extra floating 5-way binding posts for external signals. Self-contained with power switch indicator lamp and power fuse. 24-14 pin DIP capacity. Attractive two-tone quality case. All metal construction. 9¾"L x 6¾"W x 2¾"H 5 lbs

PB 203 $75.00

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

Proto Board 203A

All the features of the PB 203 plus additional power supply flexibility, provides 1% Regulated 5VDC supply (same specifications as PB 203). Regulated separate +15VDC and −15 VDC 0.5A supplies, each with internally and independently adjustable output voltage. Ripple and noise of + and −15V supplies 10mV at 0.25A

PB 203A $124.95

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

THE SINCLAIR PDM35

DC Volts (4 ranges) Range 1mV to 1000V. Accuracy of reading 1.0% ± 1 count. Note 10MΩ input impedance.
AC Volts (40 Hz-5 kHz) Range 1V to 500 V. Accuracy of reading 1.0% ± 2 counts.
DC Current (6 ranges) Range 1 nA to 200 mA. Accuracy of reading 1.0% ± 1 count. Note Max resolution 0.1 nA
Resistance (5 ranges) Range 1Ω to 20 MΩ. Accuracy of reading 1.5% ± 1 count. Also provides 5 junction-test ranges.
Dimensions: 6 in x 3 in x 1½ in.
Weight: 6½ oz
Power Supply: 9 V battery or Sinclair AC adapter (Battery not incl.)
Sockets: Standard 4mm for resilient plugs

Options: AC adapter for 117 V 60 Hz power. De-luxe padded carrying wallet.

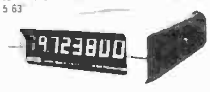
PDM35: Digital Multimeter (completely assembled)	$59.95
PDM-AC: 117V AC Adapter	6.95
PDM-DP: Deluxe padded carrying case	6.95

CSC 100 MHz 8-Digit Counter

CONTINENTAL SPECIALTIES CORPORATION

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

MAX-100 $134.95



ACCESSORIES FOR MAX 100:

Mobile Charger Eliminator use power from car battery — Model 100 — CLA $3.95
Charger/Eliminator use 110 V AC — Model 100 — CAI $9.95

REGULATED POWER SUPPLY NEW

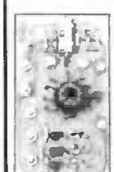
JE200 5V-1 AMP POWER SUPPLY

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

JE200 $14.95

JE205 ADAPTER BOARD

— Adapts to JE200 —
±5V, ±9V and ±12V



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

JE205 $12.95

$10.00 Min. Order – U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage – Add 5% plus $1 Insurance (if desired)

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

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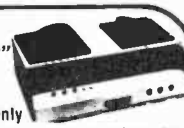
The Incredible "Pennywhistle 103"



$139.95 Kit Only

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

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable).
Maximum Data Rate	300 Baud.
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space; 2225 Hz for mark.
Transmit Channel Frequencies	Switch selectable: Low (normal) = 1070 space, 1270 mark; High = 025 space, 2225 mark.
Receive Sensitivity	−46 dbm accoustically coupled
Transmit Level	−15 dbm nominal. Adjustable from −6 dbm to −20 dbm.
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements	120 VAC, single phase, 10 Watts
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

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

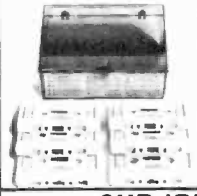
TRS-80 16K Conversion Kit

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

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

TRS-16K $75.00

COMPUTER CASSETTES



- 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
- PLASTIC CASE INCLUDED 12 CASSETTE CAPACITY
- ADDITIONAL CASSETTES AVAILABLE #C-15-$2.95 ea

CAS-6 $14.95 (Case and 6 Cassettes)

SUP 'R' MOD II

UHF Channel 33 TV Interface Unit Kit

Wide Band B/W or Color System
- ★ Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SOL-20, TRS-80, Challenger, etc.

MOD II is pretuned to Channel 33 (UHF).
- ★ Includes coaxial cable and antenna transformer.

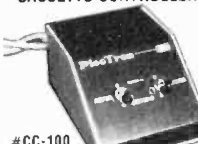
MOD II $29.95 Kit

Function Generator Kit

- Provides 3 basic waveforms: sine, triangle & square wave
- Frequency range from 1 Hz to 100K Hz
- Output amplitude from 0-volts to over 6 volts (peak to peak)
- Uses a 12V supply or a ±6V split supply
- Incl. chip, P.C. board, components and instructions.

JE2206B $19.95

IDEAL FOR TRS 80 — CASSETTE CONTROLLER

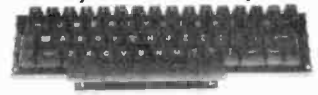


"Plug/Jack Interface to any computer system requiring remote control of cassette functions"

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

#CC-100 $29.50

63-Key Unencoded Keyboard



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

Hexadecimal Unencoded Keypad

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

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FREE DATA SHEETS!

IN OUR EFFORTS TO KEEP YOU, OUR CUSTOMERS, UP-TO-DATE; WE ARE HAPPY TO OFFER YOU FREE DATA SHEETS FOR ALL ICs THAT WE CARRY. THESE ARE HIGH QUALITY, FULL-LENGTH REPRODUCTIONS OF ORIGINAL MANUFACTURERS' DATA SHEETS. WE REQUEST, HOWEVER, THAT YOU LIMIT YOUR REQUESTS TO ONE DATA SHEET FOR EACH DOLLAR WORTH OF MERCHANDISE THAT YOU PURCHASE FROM US.

74xx

7400	$0.15
7401	0.17
7402	0.17
7403	0.17
7404	0.18
7405	0.18
7406	0.24
7407	0.24
7408	0.20
7409	0.20
7410	0.17
7411	0.20
7412	0.24
7413	0.25
7414	0.70
7416	0.24
7417	0.24
7420	0.19
7421	0.27
7423	0.25
7425	0.25
7426	0.24
7427	0.25
7430	0.19
7432	0.24
7437	0.24
7438	0.24
7439	0.29
7440	0.19
7441	0.88
7442	0.48
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7444	0.69
7445	0.69
7446	0.69
7447	0.62
7448	0.69
7450	0.19
7451	0.19
7453	0.19
7454	0.19
7459	0.19
7460	0.19
7470	0.29
7472	0.29
7473	0.29
7474	0.29
7475	0.48
7476	0.31
7480	0.49
7482	0.65
7483	0.69
7485	0.79
7486	0.27
7489	1.75
7490	0.43
7491	0.58
7492	0.43
7493	0.43
7494	0.65
7495	0.65
7496	0.65
7497	2.45
74107	0.29
74109	0.32
74121	0.34
74122	0.39
74123	0.49
74125	0.39
74126	0.39
74132	0.65
74141	0.79
74145	0.69
74147	1.60
74148	1.29
74150	0.89
74151	0.59
74152	0.59
74153	0.59
74154	0.99
74155	0.69
74156	0.69
74157	0.64
74158	0.64
74160	0.87
74161	0.87
74162	0.87
74163	0.87
74164	0.87
74165	0.87
74166	1.20
74167	1.95
74170	1.55
74173	1.20
74174	0.88
74175	0.78
74176	0.78
74177	0.78
74178	1.80
74179	1.80
74180	0.69
74181	1.95
74182	0.78
74184	1.95
74185	1.95
74188	3.25
74190	0.95
74191	0.95
74192	0.80
74193	0.80
74194	0.87
74195	0.87
74196	0.87
74197	0.87
74198	$1.45
74199	1.45
74251	1.09
74279	0.75
74283	2.20
74290	0.89
74293	0.89
74298	0.92
74365	0.62
74366	0.62
74367	0.62
74368	0.62

74LSxx

74LS00	$0.27
74LS01	0.27
74LS02	0.27
74LS03	0.27
74LS04	0.28
74LS05	0.28
74LS08	0.28
74LS09	0.28
74LS10	0.27
74LS11	0.27
74LS12	0.27
74LS13	0.46
74LS14	0.99
74LS15	0.27
74LS20	0.27
74LS21	0.27
74LS22	0.27
74LS26	0.32
74LS27	0.27
74LS30	0.27
74LS32	0.32
74LS37	0.32
74LS38	0.32
74LS40	0.27
74LS42	0.66
74LS47	0.78
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74LS74	0.38
74LS76	0.38
74LS78	0.38
74LS83	0.78
74LS85	0.97
74LS86	0.38
74LS90	0.56
74LS92	0.56
74LS93	0.56
74LS95	0.87
74LS107	0.38
74LS109	0.38
74LS112	0.38
74LS113	0.38
74LS114	0.38
74LS123	0.98
74LS125	0.48
74LS126	0.48
74LS132	0.80
74LS133	0.38
74LS136	0.38
74LS138	0.93
74LS139	0.93
74LS151	0.74
74LS152	0.74
74LS153	0.84
74LS154	1.09
74LS155	0.74
74LS156	0.74
74LS157	0.74
74LS158	0.74
74LS160	1.01
74LS161	1.01
74LS162	1.01
74LS163	1.01
74LS164	1.01
74LS168	1.13
74LS169	1.13
74LS170	1.72
74LS173	1.33
74LS174	1.05
74LS175	0.83
74LS181	2.50
74LS190	1.17
74LS191	1.17
74LS192	0.97
74LS193	0.97
74LS194	0.87
74LS195	0.87
74LS196	0.85
74LS197	0.85
74LS221	1.90
74LS251	0.99
74LS253	0.99
74LS257	0.74
74LS258	0.74
74LS259	1.81
74LS260	0.54
74LS266	0.38
74LS279	0.58
74LS283	0.99
74LS290	0.64
74LS295	0.99
74LS298	0.99
74LS365	0.66
74LS366	0.66
74LS367	0.66
74LS368	0.66
74LS386	0.38
74LS390	1.69
74LS393	1.69
74LS490	$1.49
74LS670	2.33

74Sxx

74S00	$0.35
74S02	0.35
74S03	0.35
74S04	0.36
74S05	0.36
74S08	0.38
74S09	0.38
74S10	0.35
74S11	0.38
74S15	0.38
74S20	0.35
74S22	0.36
74S30	0.35
74S32	0.50
74S40	0.35
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74S60	0.35
74S64	0.38
74S65	0.38
74S74	0.58
74S76	0.58
74S78	0.58
74S86	0.58
74S112	0.58
74S113	0.58
74S114	0.58
74S132	0.75
74S133	0.38
74S134	0.38
74S135	0.49
74S138	0.77
74S139	1.50
74S140	0.47
74S161	0.69
74S153	0.75
74S157	0.75
74S158	0.75
74S174	1.50
74S175	1.45
74S189	2.75
74S194	1.75
74S200	3.25
74S206	3.75
74S253	0.95
74S257	1.15
74S258	1.15
74S280	2.25
74S287	3.20
74S289	3.55
74S300	1.60
74S305	1.90
74S310	2.85
74S312	1.05
74S313	1.55
74S316	2.80
74S341	4.10
74S342	1.20
74S343	4.95
74S346	1.25
74S362	2.15
74S387	4.70

74Cxx

74C00	$0.24
74C02	0.24
74C04	0.26
74C08	0.25
74C10	0.24
74C14	0.90
74C20	0.25
74C30	0.24
74C32	0.25
74C42	0.94
74C48	1.27
74C73	0.71
74C74	0.48
74C76	0.71
74C83	1.37
74C85	1.37
74C86	0.49
74C89	3.95
74C90	0.97
74C93	0.97
74C95	1.09
74C107	0.69
74C151	1.89
74C154	2.90
74C157	1.89
74C160	1.17
74C161	1.17
74C162	1.17
74C163	1.17
74C164	1.09
74C165	1.09
74C173	1.29
74C174	1.15
74C175	1.15
74C192	1.37
74C193	1.37
74C195	1.08
74C200	7.50
74C221	1.89
74C901	0.48
74C902	0.48
74C903	0.59
74C904	0.59
74C905	6.00
74C906	0.59
74C907	0.59
74C908	1.19
74C909	1.78
74C910	$6.00
74C914	1.19
74C918	1.49
74C925	7.80
74C926	7.80
74C927	7.80
74C928	7.80

4xxx

4000	$0.22
4001	0.22
4002	0.22
4006	1.19
4007	0.22
4008	0.78
4009	0.43
4010	0.43
4011	0.22
4012	0.22
4013	0.39
4014	0.95
4015	0.95
4016	0.39
4017	1.04
4018	1.04
4019	0.39
4020	1.13
4021	1.13
4022	0.95
4023	0.22
4024	0.79
4025	0.22
4027	0.39
4028	0.88
4029	1.13
4030	0.29
4031	2.97
4034	2.75
4035	0.99
4040	0.99
4041	0.78
4042	0.78
4043	0.69
4044	0.69
4046	1.79
4047	1.99
4048	0.95
4049	0.39
4050	0.39
4051	1.19
4052	1.19
4053	1.19
4060	1.49
4066	0.78
4068	0.39
4069	0.26
4070	0.49
4071	0.22
4073	0.22
4075	0.22
4076	1.29
4077	0.59
4078	0.39
4081	0.22
4085	0.69
4086	0.69
4089	2.75
4093	0.99
4099	2.10
4104	2.20
4503	0.98
4507	0.99
4510	1.13
4511	1.04
4512	0.98
4516	1.22
4518	1.13
4519	0.62
4520	1.13
4527	1.67
4528	0.86
4532	0.86
4539	1.10
4555	0.67
4556	0.88
4582	0.88
4584	0.74
4702	7.10
4703	8.25
4704	7.30
4705	9.25
4706	9.75
4707	9.25
4708	14.35
4710	6.40
4720	6.95
4723	0.93
4724	1.29
4725	3.95
40014	0.90
40085	1.37
40097	0.54
40098	0.54
40106	0.90
40160	1.17
40161	1.17
40162	1.17
40163	1.17
40174	1.15
40175	1.15
40192	1.37
40193	1.37
40194	1.08
40195	1.08

Vector Breadboarding Center Vector

MINI-/MICRO-COMPUTER PLUGBOARDS

Vector Mini-/ Micro-Computer Plugboards are ideal for those who want to design their own interface or memory boards for a wide range of computers. The boards offer the same edge-connector contacts spacing as the original manufacturers', and the 0.1" x 0.1" grid of 0.042" diameter holes will accept a wide range of Vector Pins and Terminals that are listed below. The boards available are: Type 3662 for general purpose use, Type 4350 for TI 980 Series, Type 4607 for DEC LSI-11, PDP-8, and PDP-11 Series, Type 4608 for Intel SBC80 and National BCL80 Series, and Series 8800 Boards for Altair 8800 and IMSAI 8080 Series.

Plugboard Type 3662, which measures 4.5" x 6.5", features 22 numbered contacts on the front. The reverse side has 21 letter contacts, plus a grounding contact. The copper contacts are gold over nickel plated and are on 0.156" centers. The card fits standard 5¼" card cages. The "P" pattern plugboard provides maximum flexibility in component layout using any integrated circuit package or discrete component. Pre-punched grids in 1/16" epoxy glass with 0.042" diameter holes on 0.1" x 0.1" centers register with DIP sockets and similar components.
CATALOG NO. 23-36620 . . . . $7.65

The 4350 plugboard is designed for manufacturing or breadboarding of microprocessor assemblies, general digital circuits, and for interfac assemblies with both digital and analog circuits. It will mount directly into the TI 980 Series computer for inteface circuitry.

The plugboard has 80 etched contacts (40 each side) on 0.125" centers and will mount 63 DIPs (14- or 16-pin) over the power and ground buses. 14 more can be mounted in the side margins if required. Alternatively, six microprocessor DIPs (24 pin, 0.6" centers) can be mounted in the uppermost part of the board along with 45 DIPs (14- or 16-pin) in the lower part of the board and 14 more at the side if required. 40-pin microprocessor DIPs are easily accomodated by cutting one etched jumper at each upper DIP location. The board is made of blue FR4 Epoxy composite, 1/16" thick, and measures 7 inches wide by 9.6 inches long. The 2-oz. copper buses and pads on the board are tin plated and are drilled with 0.041" diameter holes to accept a wide variety of Vector pins for ease of construction. Hole spacing is standard 0.1 inch, and contact areas are gold over nickel plated. CATALOG NO. 23-43500 . . . . $18.49

Type 4607 plugboard has been designed to fit DEC LSI-11, PDP-8, and PDP-11 computers. It also fits Heathkit H-11 Microcomputers. The board which measures 5.19" by 8.43" is made of blue FR4 epoxy glass G-10 laminated with tin plated 2-Oz. copper cladding. The holes are 0.042" in diameter and are on 0.100" centers. The gold over nickel plated twin 18/36 contacts are on 0.125" centers. Up to 89 16-pin DIPs and a host of discrete components can be mounted on each board. This board is mainly intended for wire-wrapping or soldering components on it, as no pads or buses are provided on it. CATALOG NO. 23-46070 . . . . $19.95

Type 4608 plugboards are suitable for use with INTEL SBC80 and National BLC80 Series Microprocessors. It has Series 80 size, shape and connector patterns and can accomodate up to 54 16-pin DIPs. 0.042" diameter holes on 0.100" centers accept a wide variety of Vector pins and special pre-wired area is all set-up to accept a 7800-Series or LM340-Series voltage regulator. There are five contact fingers; two 25/50, one 13/26, one 30/60, all on 0.1" centers; and one 43/86 on 0.156" centers. All contact areas are gold over nickel plated. The pads on the board itself are all 2-Oz. copper with tin plating. The overall size of the board is 6.75" x 12.00", and its material is blue epoxy glass composite. CATALOG NO. 23-46080 . . . . $45.00

For Altair 8800 and IMSAI 8080 Microcomputers, Vector offers type 8800V plugboards. These 5.3" x 10" boards accept 52 14- or 16-pin DIPs, or 26 24-pin DIPs, or a combination of 14- to 40-pin DIPs. There is also a pre-wired area for up to 4 power regulators in TO-220 packages. The board material is 1/16" thick FR4 epoxy glass composite with 50/100 contacts on 0.125" centers which are gold over nickel plated. DIP zone coordinate letters are also provided for circuit layout and for wiring directly from schematics or wiring lists. Layout paper and a sample of wire wrappable terminals are supplied with each board. CATALOG NO. 23-88000 . . . . $19.95

Type 8801 is the same size as Type 8800V above, except that it has one pad per hole instead of ground and power bus runs of 8800V. CATALOG NO. 23-88010. . . . . $21.04

Type 8801-1 is the same as Type 8800V above, but no pads or buses are provided, thus being ideal for wire-wrapping or soldering. CATALOG NO. 23-88011 . . . . $15.22

Type 8802-1 is also the same as Type 8800V, but it has a pad per two holes in-place of normal ground and power buses of 8800V. CATALOG NO. 23-88021 . . . . $23.99

Type 8804 "ANY DIP" board is optimized for wire-wrapping components. It comes with already pre-wired area for power regulators of TO-220 size and even a suitable heatsink is included with the board. CATALOG NO. 23-88040 . . . . $21.95

PINS, TERMINALS, WRAP-POSTS

Vector Pins, Terminals, and Wrap-Posts go hand-in-hand with Plugboards and Vectorbords for a complete professional prototyping or short-run manufacturing job. We offer the complete line of all terminals that fit into 0.042" diameter holes, with tin and/or gold plating. For your convenience, three different packages of each type are available, so you do not have to buy more than what you may need.

TYPE	DESCRIPTION	MATERIAL	FINISH	SMALL PACK Qty/Pack	SMALL PACK CATALOG NUMBER	SMALL PACK Price /Pack	MEDIUM PACK Qty/Pack	MEDIUM PACK CATALOG NUMBER	MEDIUM PACK Price /Pack	LARGE PACK Qty/Pack	LARGE PACK CATALOG NUMBER	LARGE PACK Price /Pack	MANUAL INSERTION TOOL
K24A	Inbord Pins	Phosphor Bronze	Nickel Gold	50	22-24012	$2.73	250	22-24014	$11.76	1000	22-24016	$37.93	--
K24C	Inbord Pins	Phosphor Bronze	Bright Tin	50	22-24002	1.53	250	22-24004	5.54	1000	22-24006	17.84	--
K26A	Inbord Pins	Phosphor Bronze	Nickel Gold	50	22-26012	2.62	250	22-26014	9.56	1000	22-26016	30.82	--
K26C	Inbord Pins	Phosphor Bronze	Bright Tin	50	22-26002	0.99	250	22-26004	3.59	1000	22-26006	11.56	--
K30A	Inbord Pins	Phosphor Bronze	Nickel Gold	50	22-30012	2.56	250	22-30014	13.52	1000	22-30016	43.64	--
K30C	Inbord Pins	Phosphor Bronze	Bright Tin	50	22-30002	1.35	250	22-30004	5.32	1000	22-30006	17.19	--
K31A	Inbord Pins	Phosphor Bronze	Nickel Gold	50	22-31012	2.06	250	22-31014	7.49	1000	22-31016	24.14	--
K31C	Inbord Pins	Phosphor Bronze	Bright Tin	50	22-31002	1.11	250	22-31004	4.03	1000	22-31006	12.99	--
K32	Wrap-Post "J" Pins	Phosphor Bronze	Bright Tin	100	22-32003	1.79	500	22-32005	6.68	1000	22-32006	11.16	--
K32-2	Wrap-Post "J" Pins	Phosphor Bronze	Bright Tin	100	22-32203	2.70	500	22-32205	10.14	1000	22-32206	16.90	--
K32-3	Wrap-Post "J" Pins	Phosphor Bronze	Bright Tin	100	22-32303	2.18	500	22-32305	8.17	1000	22-32306	13.61	--
K38A	Inbord Pins	Phosphor Bronze	Nickel Gold	50	22-38012	3.18	250	22-38014	11.59	1000	22-38016	37.37	--
K38C	Inbord Pins	Phosphor Bronze	Bright Tin	50	22-38002	1.86	250	22-38004	6.74	1000	22-38006	21.73	--
R32	Socket Pins	Berylium Copper	Gold	25	22-32911	6.90	100	22-32913	21.44	1000	22-32916	173.56	--
R41	Socket Pins	Berylium Copper	Gold	50	22-41012	2.11	250	22-41014	10.17	1000	22-41016	32.78	P162
T42-1	Micro-Klip Terminals	Copper Alloy	Bright Tin	100	22-42103	1.54	500	22-42105	6.77	1000	22-42106	11.28	P149 or P149A
T44	Bifurcated Wrap-Post	Copper Alloy	Tintillate	100	22-44003	2.34	500	22-44005	8.61	1000	22-44006	14.35	A13
T44-1	Bifurcated Wrap-Post	Copper Alloy	Nickel Gold	100	22-44113	3.59	500	22-44115	14.76	1000	22-44116	24.60	A13
T46	Double Wrap-Post Pins	Phosphor Bronze	Tintillate	100	22-46003	3.68	500	22-46005	15.63	1000	22-46006	26.05	P133A
T46-1	Double Wrap-Post Pins	Phosphor Bronze	Nickel Gold	100	22-46113	6.60	500	22-46115	27.82	1000	22-46116	46.36	P133A
T46-2-9	Double Wrap-Post Pins	Phosphor Bronze	Bright Tin	100	22-46203	2.62	500	22-46205	11.94	1000	22-46206	19.89	P133B
T46-2A-9	Double Wrap-Post Pins	Phosphor Bronze	Nickel Gold	100	22-46213	4.29	500	22-46215	20.68	1000	22-46216	34.86	P133B
T46-3-9	Double Wrap-Post Pins	Phosphor Bronze	Bright Tin	100	22-46303	2.74	500	22-46305	12.54	1000	22-46306	20.90	P133B
T46-3A-9	Double Wrap-Post Pins	Phosphor Bronze	Nickel Gold	100	22-46313	4.92	500	22-46315	25.44	1000	22-46316	42.40	P133B
T46-4-9	Double Wrap-Post Pins	Phosphor Bronze	Bright Tin	100	22-46403	2.64	500	22-46405	10.15	1000	22-46406	16.91	P133B
T46-4A-9	Double Wrap-Post Pins	Phosphor Bronze	Nickel Gold	100	22-46413	4.40	500	22-46415	20.30	1000	22-46416	33.83	P133B
T46-5-9	Double Wrap-Post Pins	Phosphor Bronze	Bright Tin	100	22-46503	3.58	500	22-46505	17.36	1000	22-46506	28.93	P133B
T46-5A-9	Double Wrap-Post Pins	Phosphor Bronze	Nickel Gold	100	22-46513	5.97	500	22-46515	31.16	1000	22-46516	51.93	P133B
T46-6-9	Double Wrap-Post Pins	Phosphor Bronze	Bright Tin	100	22-46603	3.54	500	22-46605	17.13	1000	22-46606	28.54	P133B
T46-6A-9	Double Wrap-Post Pins	Phosphor Bronze	Nickel Gold	100	22-46613	5.69	500	22-46615	29.89	1000	22-46616	49.81	P133B
T49	Trifurcated Klipwrap Posts	Phosphor Bronze	Bright Tin	100	22-49003	3.76	500	22-49005	13.14	1000	22-49006	21.90	P156
T49A	Trifurcated Klipwrap Posts	Phosphor Bronze	Nickel Gold	100	22-49013	7.77	500	22-49015	33.94	1000	22-49016	56.56	P156
T49-1	Trifurcated Klipwrap Posts	Phosphor Bronze	Bright Tin	100	22-49103	3.82	500	22-49105	17.04	1000	22-49106	28.40	P156
T49A-1	Trifurcated Klipwrap Posts	Phosphor Bronze	Nickel Gold	100	22-49113	6.25	500	22-49115	31.00	1000	22-49116	61.85	P156
T50	Feed-Thru Pins	Phosphor Bronze	Bright Tin	100	22-50003	2.00	500	22-50005	7.50	1000	22-50006	12.49	P133B
T68	Bifurcated Klipwrap Posts	Copper Alloy	Tintillate	100	22-68003	2.67	500	22-68005	9.84	1000	22-68006	16.40	A13-1
T68-1	Bifurcated Klipwrap Posts	Copper Alloy	Nickel Gold	100	22-68013	4.84	500	22-68015	19.37	1000	22-68016	32.27	A13-1
T68A	Bifurcated Klipwrap Posts	Copper Alloy	Tintillate	100	22-68903	2.34	500	22-68905	8.61	1000	22-68906	14.35	A13-1
T68A-1	Bifurcated Klipwrap Posts	Copper Alloy	Nickel Gold	100	22-68913	3.99	500	22-68915	15.58	1000	22-68916	25.96	A13-1

MANUAL INSERTION TOOLS

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Type P133A, CATALOG NO. 23-81331 . . . . $2.89
Type P133B, CATALOG NO. 23-81332 . . . . $3.03
Type P149, CATALOG NO. 23-81490 . . . . $2.13
Type P149A, CATALOG NO. 23-81491 . . . . $2.61
Type P156, CATALOG NO. 23-81560 . . . . $3.52
Type P162, CATALOG NO. 23-81620 . . . . $2.13

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Type 169P44WE, 4.50" x 17.00", CATALOG NO. 23-69447. . . . . $5.04
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Eico model 720 amateur transmitter and universal modulator driver 730. Need operation manuals. Linford Fevrier, C/O Radio St. Lucia, Box 660, Castries, St. Lucia.

Dumont Fairchild model 766 oscilloscope with type 76-02 dual trace and type 74-13A delayed sweep plug-ins. Schematics. Gary Montgomery, 1011 Westwood Dr., Elkview, WV 25071

Dumont type 280 oscillograph. Service manual. **RCA** model #WT-509A. Data manual needed. **Realistic** tape deck, model #T130. Schematic diagram and service manual needed. George Warren, 8 Darius Ct., So. Boston, MA 02127.

U.S. Navy model TS-810/U digital calibrator. Schematic and technical manual. Joel M. Rubin, Box 819, Berkeley, CA 94701.

Marconiphone model T26A radio. Schematic and conversion data to 115 volts/60 cycles needed. Eddie Joseph, 20701 Reef Ln, Huntington Beach, CA 92646

Heathkit receiver model AR-3. Schematic and assembly alignment manual. David Carpenter, 2717 E. 4th St., Tucson, AZ 85716.

B&K model 650 tube tester with model 610 and model TC-615 adapter panels. Tube test set-up chart needed. Larry Delahooke, Box 7423, Rochester, NY 14615

Jerrold 900B sweep generator. Operation and service manual needed. Henry Koll, 4140 West 58th St., Chicago, IL 60629.

Cal Kit syntheshape oscilloscope pattern generator. P.C. board, manual or schematic. R. Herbison, Box 108, Errington, B.C., Can. V0R-1V0.

Channel Master model 6601 stereo. Need schematic. James H. Bryan, 500 Benton Dr., Mt. Zion, IL 62549.

Magnavox model ICV400 television camera and processor. Schematic and service manual needed. G. Amandes, 506 Lake St., Crystal Lake, IL 60014.

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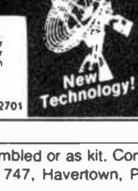

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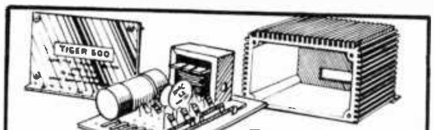

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ELECTRONICS WORLD®

Personal Electronics News

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.

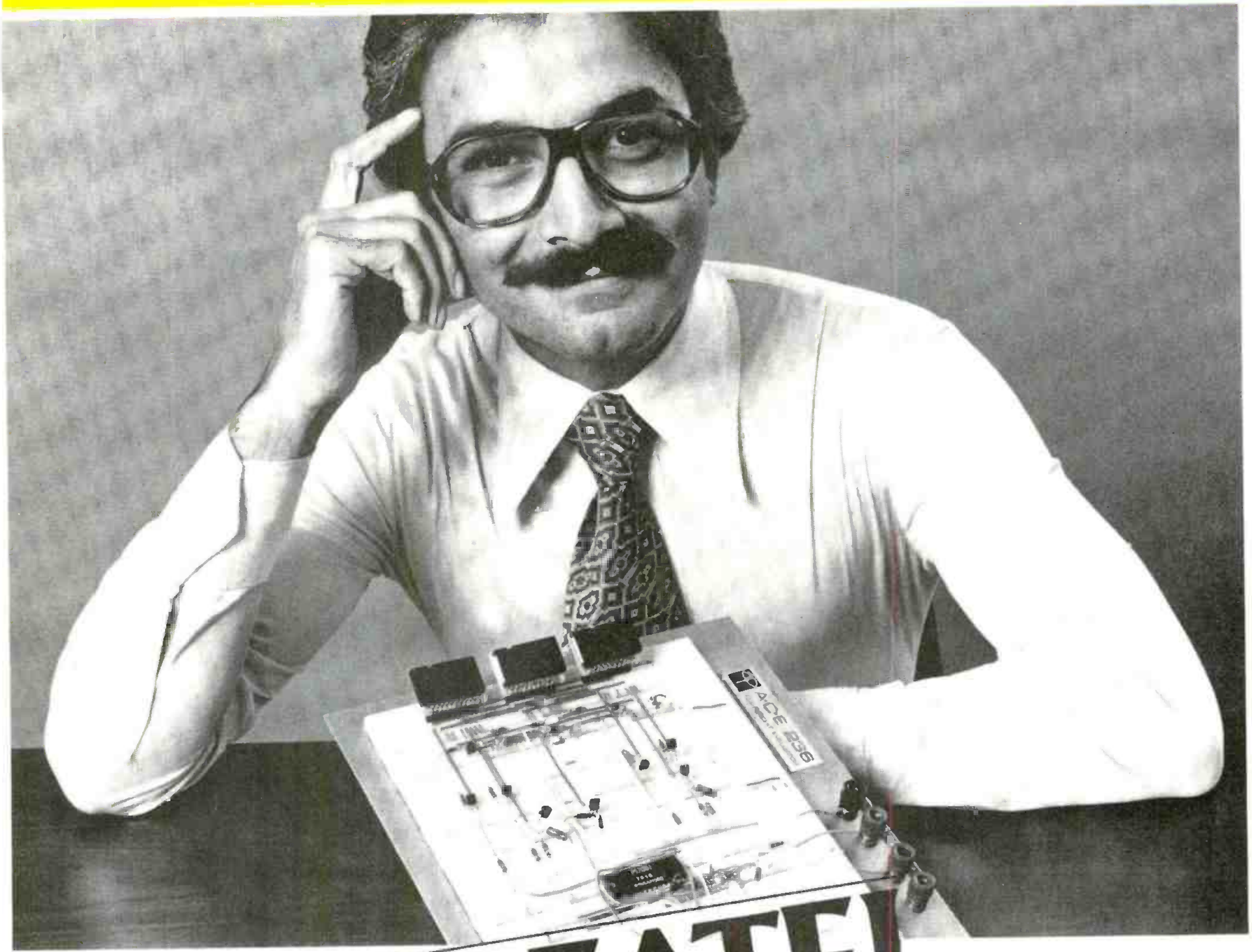
A home energy-saving system has been developed by William Lamb (No. Hollywood, CA), pioneer in the development of silicon solar cells. It consists of a lightweight panel of 36 cells that are capable of developing 16 volts to charge a 12-volt storage battery at a 1.5-ampere/hr rate. Enough power is available 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 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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