# Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE
OCTOBER 1978/$1

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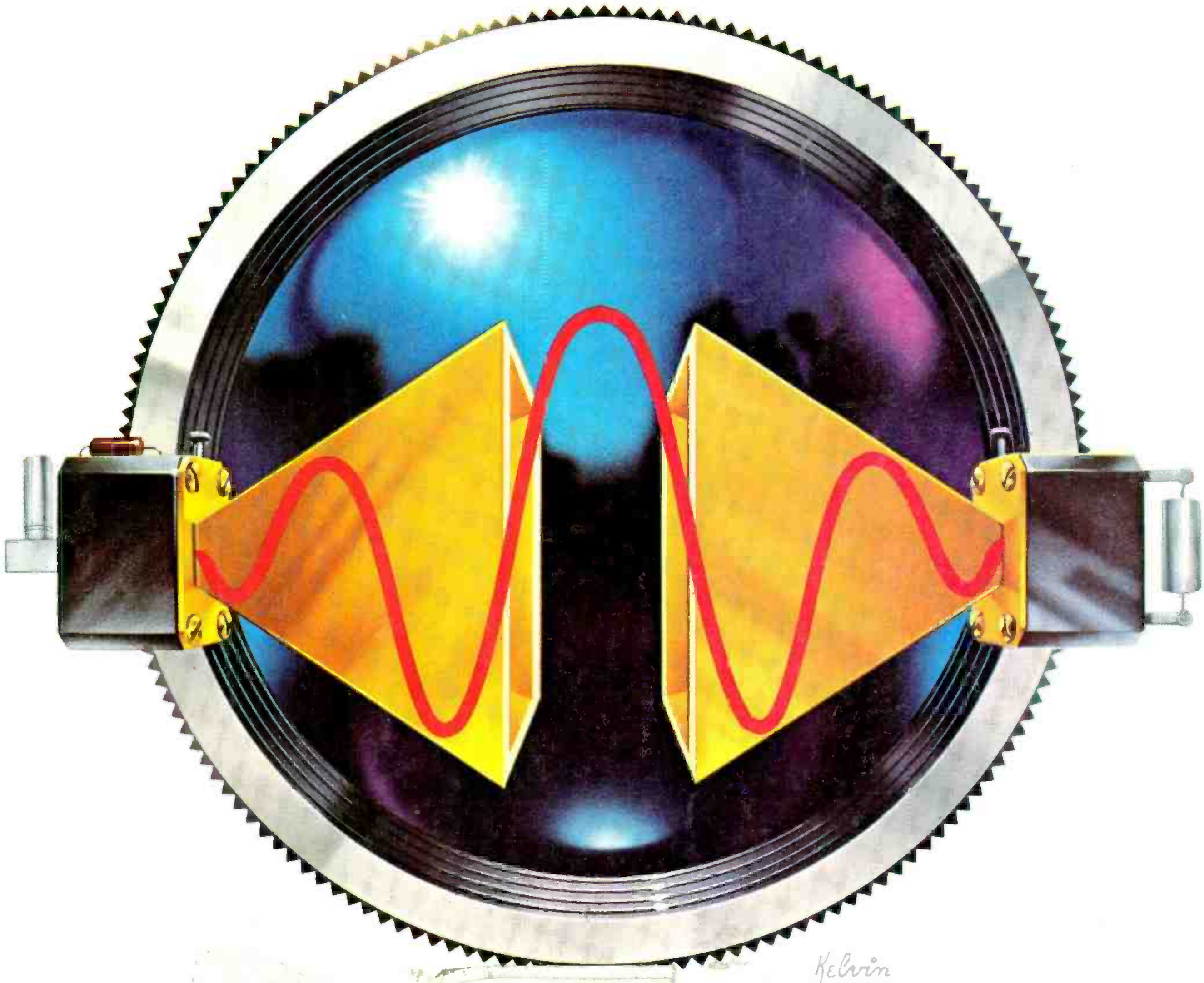


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Issue

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OCTOBER 1978
VOLUME 14, NUMBER 4

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- AUTOMATIC MODEL RAILROAD CONTROLLER
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POPULAR ELECTRONICS, October 1978, Volume 14, Number 4. Published monthly at One Park Avenue, New York, NY 10016. One year subscription rate for U.S. and Possessions, $13.00; Canada, $16.00; all other countries, $18.00 (cash orders only, payable in U.S. currency). Second Class postage paid at New York, NY and at additional mailing offices. Authorized as second class mail by the Post Office Department, Ottawa, Canada, and for payment of postage in cash.
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**Editorial correspondence:** POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. Editorial contributions must be accompanied by return postage and will be handled with reasonable care; however, publisher assumes no responsibility for return or safety of manuscripts, art work, or models.
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## Construction Articles



## Columns



## Julian Hirsch Audio Reports



## Electronic Product Test Report



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# Editorial

## THE STANDARDS MUDDLE

There's an ongoing effort in the electronics industry to set up standards so different types of products will be compatible. As often as not, this results in a handful of "standards" for the same product type.

As an example, Japanese manufacturers are pursuing a standard format for video disc players (still on the horizon). But RCA and Philips have their own incompatible systems. Moreover, there are a host of different systems even in Japan. And it might require years for developers and marketers to effect a compromise so that one system will be used. Chances for a single system are better from "Japan, Inc.," however, than from U.S. and European developers. There are many video tape recorder standards, too, which could be a contributing reason for the disappointing last-quarter sales of home VCR's.

Even the famous "S-100" computer bus is not truly a standardized bus. There are variations on the theme. Proposals to the IEEE Standards Committee for a single S-100 bus standard, however, have been made. Ithaca Audio, Ithaca, NY, sent us a copy of its suggested version—all 36 pages of it! Included is a proposal for 16-bit read/write operations on the S-100 bus, whereby data in and data out are ganged bi-directional buses during 16-bit operation.

In the TV receiver area, the FCC on May 19 ruled that all uhf tuners must limit internal noise level to 14 dB by Oct. 1, 1979 certification tests. But a divided FCC staff hasn't made it binding on manufacturers, with some members pushing for a 12-dB limit as of Oct. 1, 1982.

In the audio field, there are lots of standards that should be established or brought up-to-date. The Institute of High Fidelity is doing just this, as evidenced by a PE article on new IHF amplifier standards last month, and the new FM standard a few years ago. Now how about one for tape recorders and for transducers! At some time in the near future, digital audio standards should be established, too. Just one area, sampling rates, would be a good starting place. There's also a fine opportunity at this early time to establish equalization and bias standards for the promising new metal-particle cassette tape formulation.

And in the CB radio field, the EIA is attempting to standardize selective calling systems.

Some standards are easier to effect than others, of course. Many are essential to doing business, such as standards for audio phone plugs and jacks (ANSI/EIA-RS453-1978). Others are not, so each manufacturer can continue to go his own way or frustrate attempts to standardize a system or measurement method without suffering obvious damage.

Having sat in on same standards meetings, I can attest that getting agreement from a group of people with competing systems is not at all easy. It requires yeomanship work from technical experts, and a personal give-and-take that is easier said than done. In the final analysis, it's the marketplace that acts as the arena for action, with the consumer wielding the prod.

Art Salsberg

# Letters

## AUDIO COMPANDER ENHANCES RECORDING

I have always prided myself on making the fullest possible use of my home tape recorder. But with the addition of the "Audio Compander" (November 1977) to my taping system, I discovered that I had fallen short of my goal. I found that the Audio Compander's ability to accommodate a wide range of levels obviates the need to "pot up and down." One of the simplest and most dramatic rewards is realized when using the compander with a simple cassette deck and a stereo system. But recording from discs or off-the-air FM programs is not enough of a challenge.

One way to demonstrate the dynamic range and noise-reduction properties of the compander is to make a recording of at least a couple of people placed around a room, with one person very far from and another very close to the microphone. If you can then arrange to A-B compare the recording with and without the Audio Compander, you will immediately hear the superiority of the recording with the compander. —*David J. Malinaric, Pittsburgh, PA.*

## PATENT INFRINGEMENT POSSIBILITY

With reference to "Experiments With Programmable Logic Arrays" (June 1978), I would like to inform your readers of possible patent infringement if the circuit described in the article is used commercially. A very similar circuit forms the basis of the waveform control circuitry used in our new digital polyphonic synthesizer that can generate a virtually unlimited spectrum of waveshapes, with variable resolution (16 to 4096 points), up to 2 MHz. Our American patent has been pending since April 1977.

It may also be of interest to readers who build this project that inexpensive 8223 programmable read-only memory chips can be used as an alternative to the PLA and *IC4* through *IC6*. Of course, the 8223 PROM's must be connected to a +5-volt source through *R1*. —*Charles D. Kellner, Director, R&D, Syntauri, Inc., Salem, OR.*

## TWO-SIDED COIN

I wish to thank POPULAR ELECTRONICS for the Operation Assist column. I have received several replies to my request for a schematic diagram.—*John H. Taylor, Glen Mills, PA.*

As a long-time reader of POPULAR ELECTRONICS, I am always on the lookout for someone in the Operation Assist column to whom I might be of some help. Having offered to help several individuals who were listed in the column and receiving not even one "thank you," I've become disillusioned. —*C.A. Harvey, Sturbridge, MA.*

*We're sure that anyone aided in this manner appreciates it, but it would be a nice gesture to send a "thank you" note.—Ed.*

## PART AVAILABILITY

POPULAR ELECTRONICS readers interested in building the project in "Listen to a New World of Sounds With Ultrasonic Detector" (July 1978) may have trouble finding a source for the TBA231 dual operational amplifier specified for *IC1*. If so, (in Canada and U.S.) they can obtain it from us for $3.50 postpaid. —*D. Rost, Northern Bear Electronics, Box 7260, Saskatoon, Saskatchewan, S7K4J2, Canada.*

## CB SIDEBANDERS' REBUTTALS

I greatly enjoyed your coverage of a sideband CB club meeting in the July 1978 issue (CB Scene). However, so as not to give the general public the wrong impression, I feel I must present some of my own observations. First, the failure to use official FCC call signs must be a local phenomenon because practically all sidebanders I hear give call signs to begin and end a transmission. Secondly, the use of linears is not nearly as widespread as you would have your readers believe. Except when the DX is really bad, the average sidebander needs no more than 10 to 12 watts PEP to communicate 25 to 50 miles with an inexpensive omnidirectional antenna.

Your statement about the five-minute talk limit also deserves comment. Due to the general cooperation with slow keying, most people feel that as long as no one asks for a QSK, the frequency is clear and they are not inconveniencing anyone. I have never found a situation where someone did not give way to a QSK in a minute or so. —*Jerry Brown, △505, KAIT-5860, Louisville, KY.*

*Convenience or pragmatism still isn't a valid reason for breaking the law. We're pleased to hear that some illegal practices cited are not spread throughout the country.—Ed.*

After reading the July 1978 CB Scene, I felt I had to write in to tell you that I have been a member of the Whiskey group for almost three years. I use my W number, first name, and license information number at the end of all transmissions. There are almost 7000 members in the Chicago-area W group. I know that a lot of CB'ers on AM and a few even on SSB operate in an illegal manner, but not me. I am no fool. —*Richard W. Bailey, W-3862, Chicago Area W Group, Chicago, IL.*

## MIXED FEELINGS

Overall, the February 1978 issue of POPULAR ELECTRONICS was good. The hi-fi articles were excellent, especially the Stereo Scene on digital electronics in hi-fi. However, on the articles on computers, it appears that a reader must already know all there is to know about computers to understand them. There are a lot of us who do not understand computer jargon. —*Donald D. Capodanno, Vinton, VA.*

*There are many low-cost computer "buzz word" books available so that one may enter the field more smoothly.—Ed.*

## IMPROVING THE IMPROVEMENT

"How to Upgrade a Basic ELF Microcomputer" was a delight (Feb 78). However, the usefulness of the TAPE OUT and TAPE IN programs (Tables I and II) would be greatly improved if they contained a provision for specifying the end of the read routine. The following "fix" adds this feature to the TAPE OUT programs; a similar modification applies to the TAPE IN program.

**Original**

| Loc. | Instr. | Remarks |
|---|---|---|
| 0000 | E1 | |
| 01 | 7A | |
| 02 | F8 68 A1 | Start addr |
| 05 | F8 00 | |
| 07 | A6 A7 | |
| 09 | F8 10 A2 | |
| 0C | F8 01 A3 | |
| | • | |
| | • | |
| 5D | 64 | Display byte |
| 5E | 81 | Get next byte |
| 5F | 32 01 | If end, goto mark |
| 61 | 30 36 | Else return |

**Modification**

| Loc. | Instr. | Remarks |
|---|---|---|
| 0000 | | |
| 02 | F8 B1 | Start PAGE addr |
| 05 | F8 A1 | First byte addr |
| 08 | F8 B8 | MSB } of total bytes + 1 |
| 0B | F8 A8 | LBS } of total bytes + 1 |
| 0E | F8 00 A6 A7 | |
| 12 | F8 A2 | } See note |
| 15 | F8 A3 | } See note |
| | • | |
| | • | |
| 68 | 64 | Display byte |
| 69 | 88 FF 01 A8 | R(8).0 - 1 into R(8).0 |
| 6D | 32 72 | If end LSB, goto MSB |
| 6F | 81 | Get next byte |
| 70 | 30 41 | and return |
| 72 | 98 FF 01 B8 | R(8).1 - 1 into R(8).1 |
| 76 | 32 01 | If end MSB, goto mark |
| 78 | 30 6F | else get next byte |

This fix will now permit one to dump any contiguous section of memory (up to 65K), provided the starting address and total number of bytes plus one in hex are specified. The

MSB of the total number of bytes should have a nominal value of 01 to prevent the program from going into an infinite loop. Bear in mind that the additional instructions will affect program timing. It will be necessary, therefore, to adjust the values of R(2).0 and R(3).0, based on the system clock, to reflect the added timing. —*Henry H. Tolbert, Tallahassee, FL.*

## TAPE HEADS DO WEAR

I recently read with interest Craig Stark's article "Selecting the Best Cassette Tape for Your Recording Needs" (November 1977). It was very informative and helpful. However, I was quite surprised when I read "A better known $CrO_2$ disadvantage—rapid head wear—is actually a myth at cassette speeds and pressures. Believe it only when you find someone who has actually worn out a cassette head using any kind of tape."

I have a deck that is one year and nine months old with a worn playback/record head (high density, Permaflux) that makes listening to tape intolerable. I would estimate the total playing time of the deck to be 2500 hours. The heads have been cleaned and demagnetized regularly and it is not operating in a dusty atmosphere. I have also seen many cheaper tape decks with severely worn tape heads. So, tape head wear does occur and can be a serious problem to the recordist who uses his machine as often as I do. —*M. F. Amirault, New Glasgow, Nova Scotia, Canada.*

## TYPICAL PE READER

From your March 1978 Editorial, I've concluded that I'm a typical POPULAR ELECTRONICS reader. I'm close to the norm in age, education, and income, and most of your other survey demographics. So, I've decided to join your vocal minority as well. I would like to see the Amateur Radio column become a monthly feature.

POPULAR ELECTRONICS has been a pioneer in educating us in microcomputers and all kinds of other fine things. And I hope this leadership continues. However, I don't see any reason to scrap the Amateur Radio column in deference to the CB service.—*Mary M. Cappuccili, WB8RRG, Toledo, OH.*

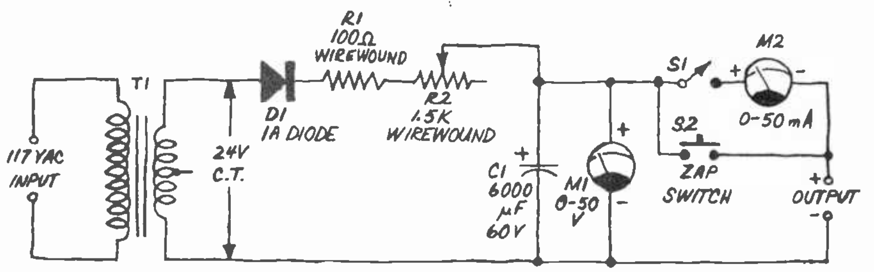
*An Amateur Radio column is planned to be run on at least a bimonthly basis.—Ed.*

## AUDIO AUTO ALARM NEEDS COMPARATOR FOR METER CIRCUITS

In regard to my article "Audio Alarm Backs Up Car Warning Lights or Meters" (August, p 64), it should be pointed out that the circuit won't work directly with most car *metering* systems. In such cases, a simple comparator would have to be added so that its limit point could be set to indicate a fault condition. The comparator output could go high or low at the limit point, assuming it were connected to the correct point in the circuits as printed. Included should be a low-pass filter (20-V, 5-µF electrolytic capacitor to ground and series 220,000-ohm resistor) between the meter output and the comparator input to provide a 1-second time constant. Also the trace between pins 13 and 14 on the Autotel (see Parts List) board will have to be opened for input C to function properly. —*Gene Nelson.*

## MODIFIED NI-CD CELL ZAPPER

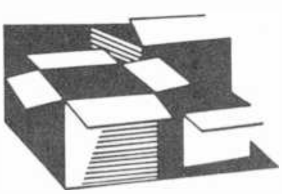
"'Zap' New Life Into Dead Ni-Cd Batteries" (July 1977) was of great interest to me. After building the project, I decided to modify it as shown in the schematic diagram to add what I feel is an extremely desirable feature. My battery "zapper" both zaps and charges Ni-Cd cells. The 1500-ohm wirewound potentiometer (*R2*) is in the circuit to accommodate the charging current required and to allow the charge rate to be varied for different size cells. The milliammeter is required to provide a means for monitoring the charge current. —*Clifford D. Dorman, La Habra, CA.*




# Out of Tune

In "Build an Electronic Voltage Regulator for Your Car" (July 1978), on page 57, the quantity n is stated to be 3; it should be 5. This would make the actual value of *R5* 2700 ohms, for an output of 14 volts, instead of 2000 ohms, which would yield a 13.5-volt output.

In "Build a Fail-Safe Timer" (May 1978), it was stated that a 556 dual-timer IC could be substituted for the two 555 timers. This is *not* the case. Both halves of the 556 share a common internal ground, which renders it useless for this application.



# 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.*

## Kenwood High-End Turntable

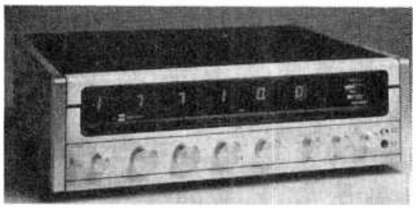
The Kenwood Model KD-750 direct-drive turntable uses a quartz/PLL controlled servo system to achieve a claimed 0.02% wow and flutter. The 13" (33-cm), 5.7-lb (2.6-kg) platter has a rubber mat designed to absorb or can-

cel all vibrations and resonances. A 20-pole, 30-slot dc motor delivers a 1.5-kg-cm starting torque that is said to bring the platter up to full speed in less than one revolution. The tonearm employs a flexible decoupling system to cancel resonances, while pivot friction has been reduced with a new high-precision dual-bearing system. A T-shaped magnesium-alloy headshell with a resonance beyond the audible range contributes to the claimed high sensitivity and accurate tracking of the tonearm. Other features include all-electronic braking, microswitch digital controls, and a turntable base that utilizes compression-molded resin concrete. $450. Address: Kenwood Electronics, Inc., 15777 S. Broadway, Gardena, CA 90248.

CIRCLE NO 87 ON FREE INFORMATION CARD

## McKay Dymek Communications Receiver

The McKay Dymek DR 33C receiver covers 50 kHz to 29.7 MHz continuous (AM, USB, LSB, CW, plus RTTY with external converter). Frequency selection is in 10, 1, 0.1, 0.005-MHz steps with 5-kHz fine tune. Sensitivity at 10 dB (S + N)/N varies from 10 $\mu$V



for 5 kHz on 100 kHz to 0.35 $\mu$V for 400 Hz on 20 to 29.7 MHz. Claimed frequency stability is ±50 Hz; image rejection 70 dB. Other features include a class-D AM envelope detector, crystal filters in first and second i-f amplifiers, switch-selectable mechanical filters in third i-f, noise limiter quartz-crystal-controlled PLL digital synthesizer, and 100-Hz accuracy LED digital frequency readout. Audio notch filter at 5000 Hz is greater than 25 dB. Headphone jacks are provided on front panel and audio output is 2 watts at 4 ohms. Dimensions: 17.5"W x 15"D x 5.1"H (43 x 37 x 13 cm). Address: McKay Dymek Co., 675 N. Park Ave., Pomona, CA 91766.

CIRCLE NO 88 ON FREE INFORMATION CARD

## Compucolor II Personal Computer

The Compucolor II "Renaissance Machine" personal computer is available in five models depending on number of display lines (16 or 32), memory size (4, 8 or 16K), and whether graphics and expanded keyboard are included. Each system has 64 characters/line on its own 13"(33-cm) diagonal video CRT 8-color display. Separate keyboards are standard ASCII 4-level, coded with 192 codes, including 77 gold crossbar commercial key switches. The microcomputer has an 8080A

CPU with total memory expandable to 64K. A built-in mini-disk drive for mass storage has 40 tracks with access time of 400 ms. The Compucolor II uses BASIC 8001 conversational programming language with English-type statements and familiar mathematical notations. Programmed diskette-albums are available (games, financial problems, engineering applications, etc.). Address: Compucolor Corp., Box 569, Norcross, GA 30091.

CIRCLE NO 89 ON FREE INFORMATION CARD

## Tannoy Floor Speaker System

Tannoy's floor-standing Buckingham speaker system has a three-way design with four drivers that can handle up to 200 watts of continuous program material. Two 12" bass drivers are mounted in a reflex ported enclosure. The 10-inch midrange transducer uses a high-energy barium ferrite magnet and "ferro fluidics," a magnetic fluid technique which is said to increase heat dissipation. The treble transducer consists of a pressure unit, phase-compensating throat, exponential horn assembly and acoustic lens. The midrange and treble transducers are spaced so that they appear to radiate from a single point. Crossovers are at 350 and 3500 Hz with four controls for variation. Power-handling range is 10 to 1000 watts (peak), while sensitivity is 1 watt for 92 dB SPL, 200 W for 112 dB SPL, both at 1 meter distance. Dimensions are 3'10"H x 2'W x 1'6"D and weight is 212.5 lb. Address: Tannoy-Ortofon, Inc., 55 Ames Ct., Plainview, NY 11803.

CIRCLE NO 91 ON FREE INFORMATION CARD

## NLS Mini-DMM Measures True RMS

The Model RMS-350 digital "Volksmeter" from Non-Linear Systems, Inc., features true rms ac voltage and current measuring capability, is battery-powered, and measures 4"D × 2.7"W × 1.9"H (10.2 × 6.9 × 4.8 cm). It


has a liquid-crystal display and employs a single-chip A/D converter. Ac voltage ranges are from 1 mV to 750 volts rms, dc voltage ranges are from 1 mV to 1000 volts, ac rms and dc current ranges are from 1 $\mu$A to 1 ampere, and resistance ranges are from 1 ohm to 10 megohms. Other features include 10-megohm input, automatic polarity and overload indication, and overload protection. Optional equipment includes rechargeable batteries and charger, high-voltage probe, leather carrying case, and tilt-stand carrying case. $189. Address: Non-Linear Systems, Inc., Box N, Del Mar, CA 92014.

CIRCLE NO 92 ON FREE INFORMATION CARD

## Tandberg Open-Reel Tape Recorder

Tandberg's new Model TD 20 A open-reel tape deck has a 4-motor logic-controlled (no solenoids) tape transport. It employs the

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| PB-102 | 1240 | 12 | 26.95 | Large capacity, moderate price |
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203-624-3103 TWX 710-465-1227
WEST COAST: 351 California St., San Francisco, CA 94104,
415-421-8872 TWX 910-372-7992
GREAT BRITAIN: CSC UK LTD., Spur Road, North Feltham Trading Estate, Feltham, Middlesex, England. 01-890-0782 Int'l Telex: 851-881-3669


Prices and specifications subject to change without notice.

CIRCLE NO. 13 ON FREE INFORMATION CARD

company's new "Actilinear" recording system that is said to provide a 20-dB improvement in headroom capacity over conventional systems. The system uses a transconductance converter to reduce the effect of amplifier slew rate and improve transient signal handling. The deck has 10½-in. reel capacity with tension switch, front-panel bias control and a two-position microphone sensitivity switch. Other features include 4 line inputs, echo and sound-on-sound capabilities, separate power supplies, and PROM and triac speed control for spool motors. Available in 3¾ and 7½ ips or 7½ and 15 ips speeds, quarter and half-track formats. $1200. Address: Tandberg of America, Inc., Labriola Ct., Armonk, NY 10504.

CIRCLE NO. 93 ON FREE INFORMATION CARD

## President AM/SSB Mobile CB Rig

The McKinley is a new compact AM/SSB mobile transceiver from President Electronics. Rated at 4 watts AM/12 watts PEP SSB, it features a digital LED channel display, large S/r-f power meter, and transmit and receive LED's. The control complement includes: channel selector, volume (and power on/off switch) control, squelch control, microphone gain control, r-f gain control, clarifier control, PA/CB selector switch, noise blanker switch, and dimmer switch. Specifications are: less than 0.5 μV sensitivity for 10 dB (S + N)/N on AM, and less than 0.25 μV on SSB; better than 60 dB spurious rejection;

−60 dB typical alternate-channel rejection; and better than −60 dB harmonic suppression. Dimensions: 9.78" L x 7.28"W x 2.28"H (25 x 18.5 x 5.8 cm). Address: President Electronics, Inc., 11691 Hale Ave., Irvine, CA 92714.

CIRCLE NO. 94 ON FREE INFORMATION CARD

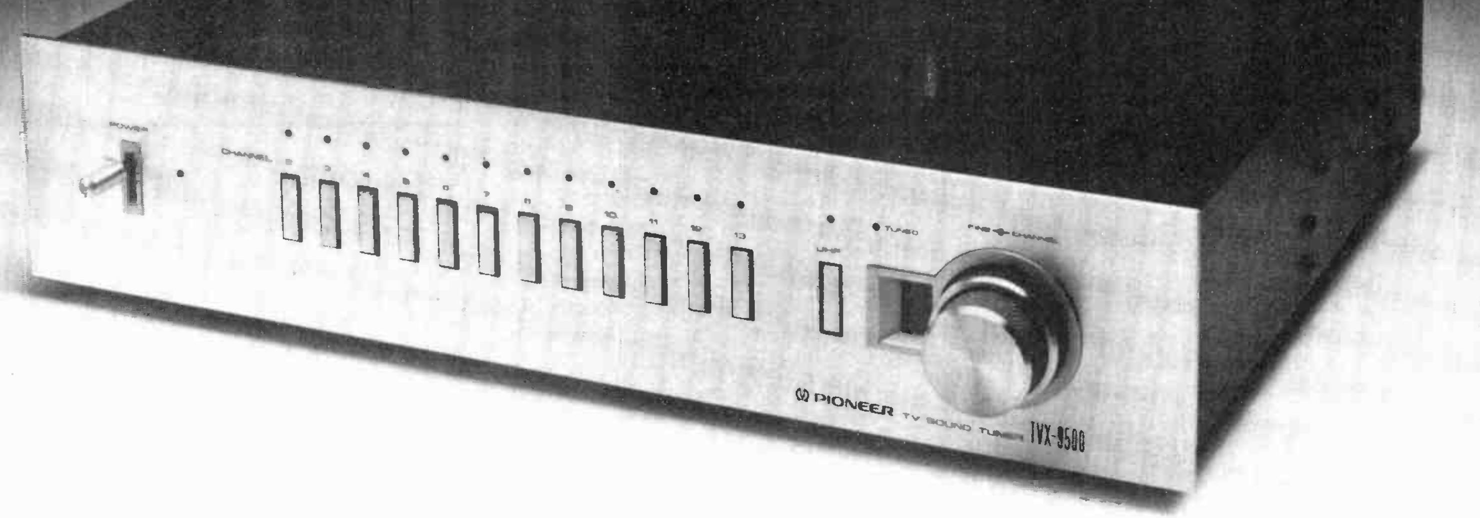
## Sherwood AM/FM Stereo Tuner

Sherwood's new HP 5500 AM/FM stereo tuner has a rated FM sensitivity of 9.31 dBf (1.6 μV) for 30-dB quieting, 1-dB capture ratio, and 85-dB alternate channel selectivity. Image and i-f rejection are said to exceed 120 dB. The HP 5500 features a five-section FM front end with dual-gate MOSFET's; FM tuning and signal-strength meters; four matched linear phase ceramic filters; coil-less r-f, detector, and MPX circuitry; and dual cross-coupled audio operational amplifiers. The AM section uses a three-gang tuning capacitor and a rotatable ferrite rod antenna. Variable muting threshold and AFC controls (automatically defeated when tuning) are also provided. A quad analog switch handles muting, stereo/mono, and stereo-only switching. Front-panel provisions include tape dubbing provisions, an FM noise filter switch, and a 75/25 μs deemphasis switch. The cabinet has walnut veneered end panels.

CIRCLE NO. 95 ON FREE INFORMATION CARD

(Continued on page 14.)

# IF YOU OWN A TV AND A HI FI, YOU'D BE FOOLISH NOT TO OWN THIS COMPONENT.




Television has always been fun to look at.

But compared to your hi fi, it's an absolute disaster to listen to.

Where your hi fi provides you with rich, undistorted sound, the average TV sounds no better than a cheap kitchen radio.

And how can you seriously expect to experience something like the "thrill of victory" (or even the agony of defeat) through a 3" TV speaker?

As the world's leading audio company, we at Pioneer have long felt obligated to do something about the quality of TV sound.

Which is why we created the TVX-9500.

It's the first TV audio tuner. A high quality audio component that attaches to your receiver or amplifier like a cassette deck, and provides you with rich, clean, clear TV sound. Through your hi fi system, instead of the TV. (When you use the TVX-9500, you turn your TV sound off.)

But the TVX-9500 does more than just make TV sound better.

It makes TV an entirely different experience.

When you watch a football game, you feel more like a participant than a spectator. You hear the signals. Feel the snap. And almost wince at the tackle.

Movies begin to feel as if you're sitting in the theatre, instead of your living room. Characters like Brando's Godfather remain just as menacing in 19" as they were in Panavision. Musicals like "The Sound of Music" don't end up featuring "the sound of distortion." And for the first time, someone like King Kong will also sound larger than life.

Then there's TV music.

With the TVX-9500, live concerts will, at last, sound that way.

Symphonies will finally be as much fun to listen to as they are to watch. (Which is the whole idea of watching them in the first place.)

And when you view something like "Gone With The Wind," you'll actually be able to hear Atlanta burning.

Admittedly, even the great sound the TVX-9500 offers won't make up for bad TV programming.

But then our advice would be to do what you'd do to a bad TV show anyway:

Turn the set off.

And enjoy your hi fi.

**PIONEER®**
**We bring it back alive.**

U.S. Pioneer Electronics Corp., 85 Oxford Drive, Moonachie, N.J. 07074.

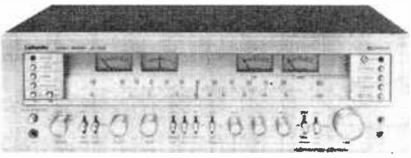
CIRCLE NO. 61 ON FREE INFORMATION CARD

## Hutec Programmable Light Controller

Hutec Corp. uses a microprocessor in its "Vigilite" light controller that simulates the user's lighting habits to discourage would-be intruders when his house is vacant. The controller features a built-in digital clock and installs in minutes in place of a standard light switch. It turns lights on and off (including overhead lights) in up to five rooms. Turn-on time can be set for between 5 and 30 minutes every hour between 6:00 and 11:30 p.m. and for 2 hours during the morning hours. $39.95. Address: Hutec Corp., 1050e E. Duane, Sunnyvale, CA 94086.

## Lafayette High-Power Receiver

The new top-of-the-line Model LR-120DB is the most powerful AM/FM stereo receiver ever offered by Lafayette Radio Electronics. It is rated to deliver 120 watts rms minimum per channel into 8 ohms from 20 to 20,000 Hz

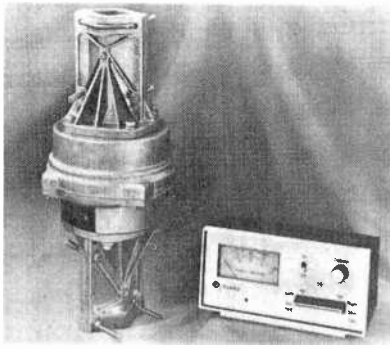


at no more than 0.09% THD. On FM, alternate-channel selectivity is rated at 80 dB, capture ratio at 1.3 dB, 50 dB quieting, sensitivity at 14.1 dBf (2.8 μV) mono and 36.8 dBf stereo, and stereo separation at 45 dB. The receiver features dual power-output meters, two-position loudness contour switch, three-position phono sensitivity switch, FM high-blend switch, Dolby FM switch, and adjustable FM mute. Additionally, it has dual tape monitors for two-way dubbing; bass, treble and midrange tone controls, two headphone jacks, and A,B,C speaker switching in any combination. $600. Address: Lafayette Radio Electronics, 111 Jericho Tpke., Syosset, NY 11291.

CIRCLE NO 96 ON FREE INFORMATION CARD

## Alliance Antenna Rotator

The Model HD-73 heavy-duty rotator, designed especially for serious radio Amateurs, has been introduced by Alliance Mfg. Features include a dual-speed control with one five-position switch, with the slower speed allowing for pinpoint fine adjustments. Automatic brake action simplifies positioning and reduces the risk of antenna damage due to sudden stops. Mast-mounted, the rotator develops a 10,000-in.-lb windload bending moment. Icing is overcome by a 400-in.-lb



torque. Vertical balance weight capacity is 1000 lb. A special support bracket design permits simplified centering for in-tower applications. Drive motor is 20-volt ac capacitor split-phase. Control box contains meter marked for full 360° as well as S-W-N-E-S and ON/OFF and CALIBRATE controls. Power supply, in control box, uses 117-V 60-Hz ac, and includes fuse and thermal protection. Mast mounting size range is 1⅜" to 2½" OD. Cable is 6-conductor. Address: Alliance Mfg. Co., Inc., Alliance OH 44601.

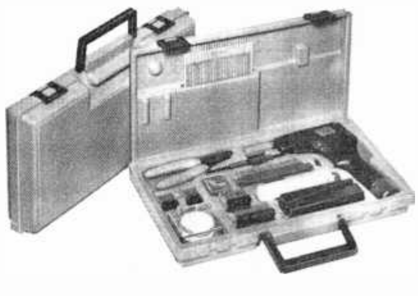
CIRCLE NO. 97 ON FREE INFORMATION CARD

## Avdex Data Cassettes

Avdex Corp. is marketing a line of data cassettes specifically designed for use in personal computers for home and small business. The new cassettes have abbreviated tape lengths in 1-, 3-, and 5-minute lengths that are more convenient to use for single programs. The cassettes use high-quality computer shells, polyolefin slip sheets, machined guide rollers, stainless-steel pins, oversized pressure pads with special liners, and oversize hubs. They're loaded with extra-short leaders that do not come in contact with the recording head, which allows for instant starting. Prices are: $4.95 for CDC-1, $5.65 for CDC-2, and $6.35 for CDC-3. Address: Avdex Corp., 2280 Grand Ave., Baldwin, NY 11510.

## OK Wire-Wrapping Kit

The Model WK-5B Wire Wrapping kit from OK Machine & Tool Corp. contains a complete range of tools and parts for prototype and hobby applications, all conveniently



packaged in a sturdy plastic carrying case. Included in the kit are: the Model BW-630 battery-powered wrapping tool with bit and sleeve; Model WSU-30 manual wrap/unwrap/strip tool; universal pc board; edge connector with Wire Wrap terminals; set of pc card guides and brackets; mini-shear with safety clip; industrial-quality 14-, 16-, 24-, and 40-pin DIP sockets; assortment of Wire Wrap terminals; DIP inserter; DIP extractor; and three-color wire dispenser with 50' (15.2-m) each of red, white, and blue Kynar insulated silver-plated solid AWG-30 copper wire. $74.95. Address: OK Machine and Tool Corp., 3455 Conner St., Bronx, NY 10475.

CIRCLE NO 98 ON FREE INFORMATION CARD

## Nagatronics Ribbon Cartridge

The Nagatronics Model HV-9100 stereo phono ribbon cartridge has no conventional coil so that its internal inductance is virtually zero. According to the company, this results in a phase-coherent signal. The cartridge is hand assembled and individually tuned for low distortion, optimum frequency response, and tonality. The cartridge is built into its own integral headshell. Frequency response specs are 20 to 30,000 Hz; channel separation 25 dB at 1000 Hz; and output voltage 0.05

mV/1000 Hz at 5 cm/s. A companion Model HA-9000 matching head amplifier is battery-powered and rated to deliver 40 dB of gain and to have a frequency response of 10 to 200,000 Hz ±1 dB and THD of 0.01% at 1000 Hz. $220.00 for Model HV-9100 cartridge; $275.00 for Model HA-9000 head amplifier. Address: Nagatronics Corp., 2280 Grand Ave., Baldwin, NY 11510.

CIRCLE NO 99 ON FREE INFORMATION CARD

## Microwave Filter Hidden CB Antenna

The "InTenna" from Microwave Filter Co., Inc. consists of a small device called a "launcher" that connects to your CB transceiver and then via a single inconspicuous wire in a vehicle window to the metal body of the vehicle. This turns the whole metal shell of the vehicle into a radiator. Hence, there are no visible antennas for a potential thief to notice and no protrusions to hang up on things and break off. $24.90. Address: Microwave Filter Co., Inc., 6743 Kinne St., East Syracuse, NY 13057.

CIRCLE NO. 100 ON FREE INFORMATION CARD

# The original, indispensable KLUGE BAG™

## The "No-Waiter"

**A six piece set in one easy to carry-on ...for overnight or around the world.**

*Two time TV Emmy Award Winner Stan Hart: "The Kluge Bag is the best. The only piece of luggage I ever use."*
*Pennsylvania cattleman Robert Johnson: "For quality, convenience, organization, the Kluge Bag tops any set of luggage I've ever used."*
*DRG Record Company President Hugh Fordin: "One carry-on piece sure beats three or four check-in bags. I'm delighted."*

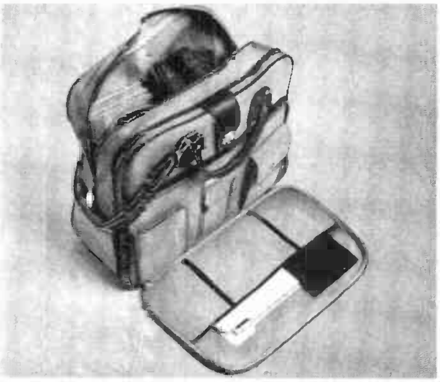
Here's the famous original you'll see on the Concorde, the shuttle to Washington, the commuter out of O'Hare. The Kluge Bag. The only combination overnighter and fortnighter in the world.

And the only bag that's as easy to carry to the last airline gate with a complete wardrobe as it is with a single change of clothing.

A "no waiter" you never check in. Never have to wait for at the baggage counter.

### Extra Comfort and Convenience

You'll use the Kluge Bag like a week-ender, too, because it's just as easy to carry on and a whole lot better. Better because nothing gets wrinkled or creased...because you have extra room for all the reports and papers you need, the tennis things you may or may not use, the sweater you'd like to be able to knock around in at night, and to bring back anything from reports to a new suit you pick up on your trip. (You can prove it yourself at our risk!)



### Beautifully Organized

The almost infinite flexibility is the result of an organization system designed by Peter Kluge, an international businessman, who travels constantly, from Chicago to Dallas, New York, Los Angeles, to Europe and the Middle East, never sure if he'll be away two days or two weeks, or of the clothing he'll need.

So, in one lightweight, compact, easy-to-carry handle or shoulder bag you get (1) a garment bag that holds two suits, (2) a pullman case, (3) a week-ender, (4) a tote-tennis bag, (5) a toilet-accessories kit, (6) a laundry-wet stuff bag...plus a full-size portfolio. Compartmentalized for easy access to your shirts, ties and belts; shoes and socks; underwear; suits, slacks and jackets; sportswear, sweater, bathrobe; business reports and papers. Anything and everything you need.

### One Vs. Two, Three or Four

You can't even begin to compare the ease and convenience of the Kluge (rhymes with huge) Bag with the bulky, heavy, loaded-down check-in luggage you usually carry on trips of three, four or more days.

The Kluge Bag alone easily outcarries a garment bag, a weekender or pullman plus a dispatch case. It not only looks better, weighs less, it's also much easier to carry and leaves your hands free to get your wallet or ticket. Most important of all, only the Kluge Bag is always ready when you are to get off the plane.

### Top Quality Construction

Simply, there's no other piece of luggage anything like this. Beautifully made of top-quality cellulose rayon, the material that's most often used in expensive luggage today because it's as strong as it is light, and sponges clean in an instant to retain its beauty through years of use and abuse, the Kluge Bag is available in natural canvas color with rich brown piping and in striking solid black diamond and brown trim.

Outside there are three sectional zippers, so you can get to anything in a second, with security snap locks and an over-all snap lock safety strap, plus comfortable carrying handles and the adjustable, burden-bearing shoulder strap.

Inside, a fold-up rigid bottom supports everything you can carry in the zippered main compartment. The fittings and details are equally impressive, like a tie rack, a fitted compartment for toiletries, a zippered compartment for valuables, pockets for cards, notes, keys and more. Plus a huge volume portfolio. Everything you need to make packing and traveling for days or weeks easier and faster than it's ever been before.

Unique Shoulder Carry System

Yet fully packed the Kluge Bag is just 18" high by 23" long and 12" deep.

### Only $40.00!

Most extraordinary of all, though, is the price. At $90 and $100, which is the price you'd probably have to spend in a fine retail store, the Kluge Bag would be an excellent value. At **$40.00** it's absolutely unbeatable.

A price that's possible because we're one of the largest mail merchandisers in the United States—able to commit for an entire manufacturing run, and to eliminate salesmen, distributors and retailers and their costs by selling direct.

### No Risk Trial

Now we invite you to judge the Kluge Bag for yourself—for 30 days without risk or obligation. You must be convinced that it's the finest, most useful, convenient and versatile piece of luggage on the market today, a time and trouble saver, the perfect piece for every trip, or return it to us for a complete refund. No questions asked.

**CALL 800-325-6400**
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These lines are in operation 24 hours,
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To order with any credit card, just call us at the *toll free* number above. Or send your check to Douglas Dunhill at the address below. Be sure to specify natural or black. (Illinois and New York State residents are required to include sales tax.)

Of couse we want you to try it on a trip during your 30-day trial. Don't worry about how you handle it. Nothing will hurt it. And we'll take it back under any circumstances anyway. So order your Kluge Bag right now. Take the lug out of luggage, the wait out of baggage.

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CIRCLE NO. 16 ON FREE INFORMATION CARD

Microwave...AM & FM Radio...Radar...TV Broadcasting...Mobile Radio...
Marine Communications and Navigation...CB...Aircraft Electronics

# The expanding world of communications means expanding opportunities for the qualified technician.

### NRI Trains You at Home in Your Spare Time... Learn Installation, Maintenance, Repair

The communications explosion of the last few years is just the beginning of an incredible expansion as business, government and public services intensify their use of more versatile, cost-efficient systems. With this tremendous growth comes a continuous demand for qualified technicians...people trained to install, manitain, and repair modern electronic equipment.

You can start an exciting new career with NRI's Complete Communications Electronics Course. You learn at home...no travel or night school. You learn in your spare time ...no need to quit your present job. And you learn the right way...with NRI "bite-size" lessons and "power-on" training.

### You Build Your Own 2-Meter Digitally Synthesized VHF Transceiver

NRI training is "hands-on" training. You get practical bench experience as you build and test this industrial quality two-way radio and power supply. You reinforce theory lessons as you induce and correct faults, study individual circuits and see how they interface with others.

You also build and keep a transistorized volt-ohm meter and digital CMOS frequency counter. NRI even gives you special training to get your Amateur License so you can go on the air with your completed unit.

### FCC License or Full Refund

In all, you get 48 lessons, 9 special reference texts, and 10 training kits ...the training you need to start in a rewarding new career. And NRI includes special training for the required FCC radiotelephone license examination. You pass *or your tuition will be refunded in full.* This money-back agreement is valid for six months after completion of your course.

### Free Catalog... No Salesman Will Call

NRI's free, 100-page full-color catalog shows all the equipment you get, describes each lesson and kit in detail, tells more about the many specialized fields we train you for...also includes facts on other opportunity areas like TV/Audio servicing and digital computer electronics. Mail the postage-paid card now and grow with the future.

If card has been removed, write to:

**NRI Schools**
McGraw-Hill Continuing Education Center
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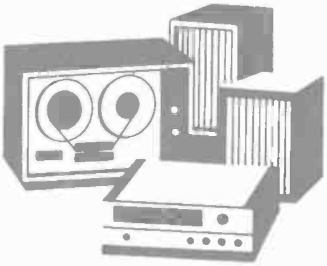


# Stereo Scene

By Ralph Hodges

## UNDER THE BIG TOP

THE SUMMER Consumer Electronics Show, the second big audio event in an unprecedentedly busy spring season, has now had its several days of glory in Chicago's enormous McCormick Place and environs. Coming so hard on the heels of Atlanta's IHF exhibition in late May (see last month's "Stereo Scene"), the CES was impressive not so much for its wealth of hitherto unseen products (there were of course some) as for its sheer size.

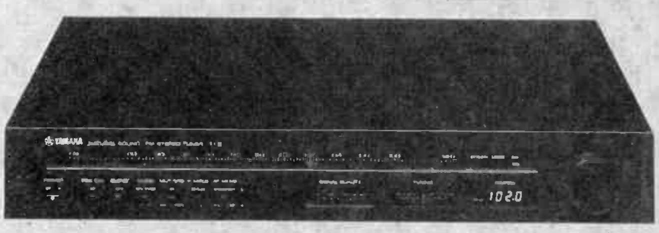
**Doing It Digitally.** Major Japanese manufacturers are not flagging a bit in their campaign to stake out major portions of the digital audio market. To previously exhibited prototypes and (in Sony's case) actual production-ready products of a digital nature can be added PCM processors from Technics and Hitachi. These are designed to be used with video-cassette recorders and employ 13-bit systems with sampling rates of about 44 kHz. Even as these things go, the new units are physically large. At present, however, they should be looked upon as essentially prototypes and thus subject to change.

Meantime, deep in the bowels of McCormick Place, behind an unmarked (and guarded) door, a privileged few could get a look at and listen to Matsushita's "VISC"—a video-disc system that has already begun branching out into audio. VISC is another 13-bit system, with dropout correction, that samples at 44 kHz. The pickup principle for the players—several were shown in prototype form, including a two-speed model—is mechanical/piezoelectric. VISC shares with some of the other disc systems a capability for real-time mastering. It also employs conventional pressing techniques and materials for its software, which was shown in 12- and 7-inch versions in forms superficially identical to their audio-only counterparts, the 12-inch LP and the 7-inch 45-rpm single. In its audio version, VISC operates at 450 rpm for a per-side playing time (stereo) of 30 minutes. Dynamic range is 85 dB, with less than 0.1 percent harmonic distortion. The price for a player is not expected to exceed $600 in Japan.

**And In Amplifiers.** Not a great deal of noise is being made about it, but a large number of the latest power amplifiers being introduced are class-A designs—at least up to the first few watts per channel. Evidently, IC technology, which is still not highly considered for use in the actual audio-signal path, has made complex control of power supplies a relatively straightforward and inexpensive affair. Hence the bias on the output stages can be easily altered under dynamic conditions, permitting an amplifier to run class A at low output and class AB for high signal levels. A comprehensive list of the products incorporating this feature would be difficult to provide just now (in many cases English-language specifications and design details are still not available for products from overseas). In one case, that of the Monogram 3300 (200 watts per channel; $595), class-A operation is said to persist up to 10 watts output, which is substantial.

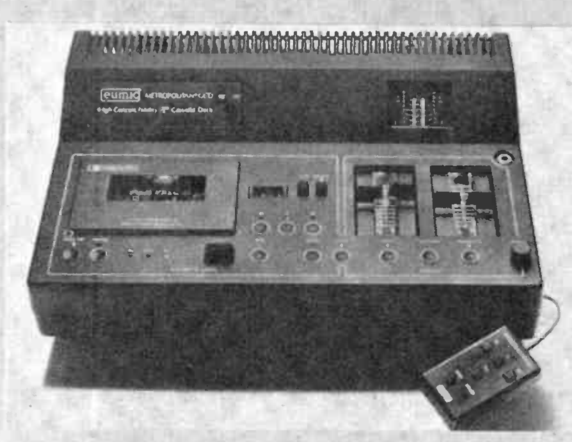
Mitsubishi's tentative name for a new group of products is "microcomponents." The rationale behind this is the full utilization of size reductions made

### SHOW HAPPENINGS



Tuner with digital readout

Twin arms



Optoelectric speed regulation

possible by modern circuitry. To emphasize the concept, the company has worked out styling that is a clear departure from current trends and something of an Arabian-Nights delight to behold. Multi-colored jewel lights gleam from petite soft-gold panels, and all control functions are handled as much as possible by microswitches rather than knobs and other gross devices. So far, Mitsubishi has introduced a preamplifier, the M-PO1, a power amplifier (M-A01; 70 watts per channel), and a quartz-oscillator synthesizing FM tuner, the M-F01.

Yamaha's 70-watt-per-channel A-1 integrated amplifier ($595) has an almost shockingly simple front panel that represents certain internal refined simplicities, such as a phono preamplifier that can be coupled to the output stages by means of the most direct signal path. Beneath a flip-down panel the A-1 provides most of the conventional controls one would expect from an integrated amplifier, but the ability to bypass most of them is the philosophy behind the new design.

Lux has recently established a "Laboratory Standard Series," all transistorized, and consisting at present of a quartz-locked tuner with automatic fine tuning, a 100-watt-per-channel integrated amplifier, 80-watt stereo power amplifier, 150-watt mono power amplifier, preamplifier, and octave-band graphic equalizer. Approximate prices range from $500 to $900, with the L-100 integrated amplifier being the costliest. Audio Research, another company known for its mixed line of vacuum-tube and transistorized gear, has spread its latest offerings between two new solid-state power amplifiers (50 and 100 watts per channel) and an all-new vacuum-tube preamplifier, the SP-6, at about $1,075. Other introductions include an electronic crossover and a moving-coil-cartridge "head amplifier."

**The Program Sources.** According to B.I.C., the 3¾-ips cassette is an idea whose time has finally come. The company has introduced three two-speed cassette-deck models, all front loading. The top-of-the-line three-head, dual-capstan Model T-3 provides all the improvements in frequency response and dynamic range that one might expect from the higher tape speed. In turntables, B.I.C. has adopted the motional-feedback approach for several of its new belt-drive machines. The more elaborate of them, such as the $200 916 MP and the $320 918 MPC, boast microprocessors to handle speed control and other operating functions, as well as digital readout of speed. The new B.I.C. machines, which include manual and single-play models, also have a unique control by which the user can adjust the compliance of the suspension.

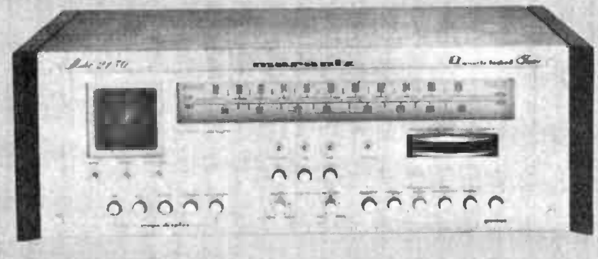
More motional feedback turns up in the new Eumig CCD cassette deck ($1,300), a three-head machine that lacks a capstan flywheel. Instead, an LED light source and a photo transistor "read" an opaque pattern of lines on a transparent disc that rotates with the capstan. The resulting photo-transistor output, compared with a fixed reference frequency, governs the speed-control circuitry. The extremely low inertia of the CCD's drive system permits astonishingly rapid switching of transport functions. The deck also uses voltage-controlled amplifiers to establish recording levels—the only machine in my experience to do so.

The latest cassette-deck manufacturer to announce the ability to handle the up-and-coming metal-alloy tape formulations such as 3M's Metafine is Marantz. By taking a machine already existing in its line and switching the heads and making appropriate changes in the electronics, Marantz has come up with the new Model 5025, with a Metafine switch prominent on its front panel.

Some months ago Fisher introduced wireless remote control on the two-head CR4025 cassette deck. Now there are two three-head machines, the CR5125 and CR5150, with the latter having a remote controller that completely duplicates all the transport functions, including fast forward and rewind. Other convenience features grace the Pioneer CT-F900, a $475 three-head deck with a four-function memory that can be set up to initiate various modes of automatic rewind. The machine also has peak-responding fluorescent recording-level indicators with peak-hold capability. Sony's new TC-K8B cassette deck employs 64-element liquid-crystal recording-level indicators for a most cheery and colorful display. In addition, Sony has established what it calls a "purist" line of components, starting with its previously introduced class-D amplifier and

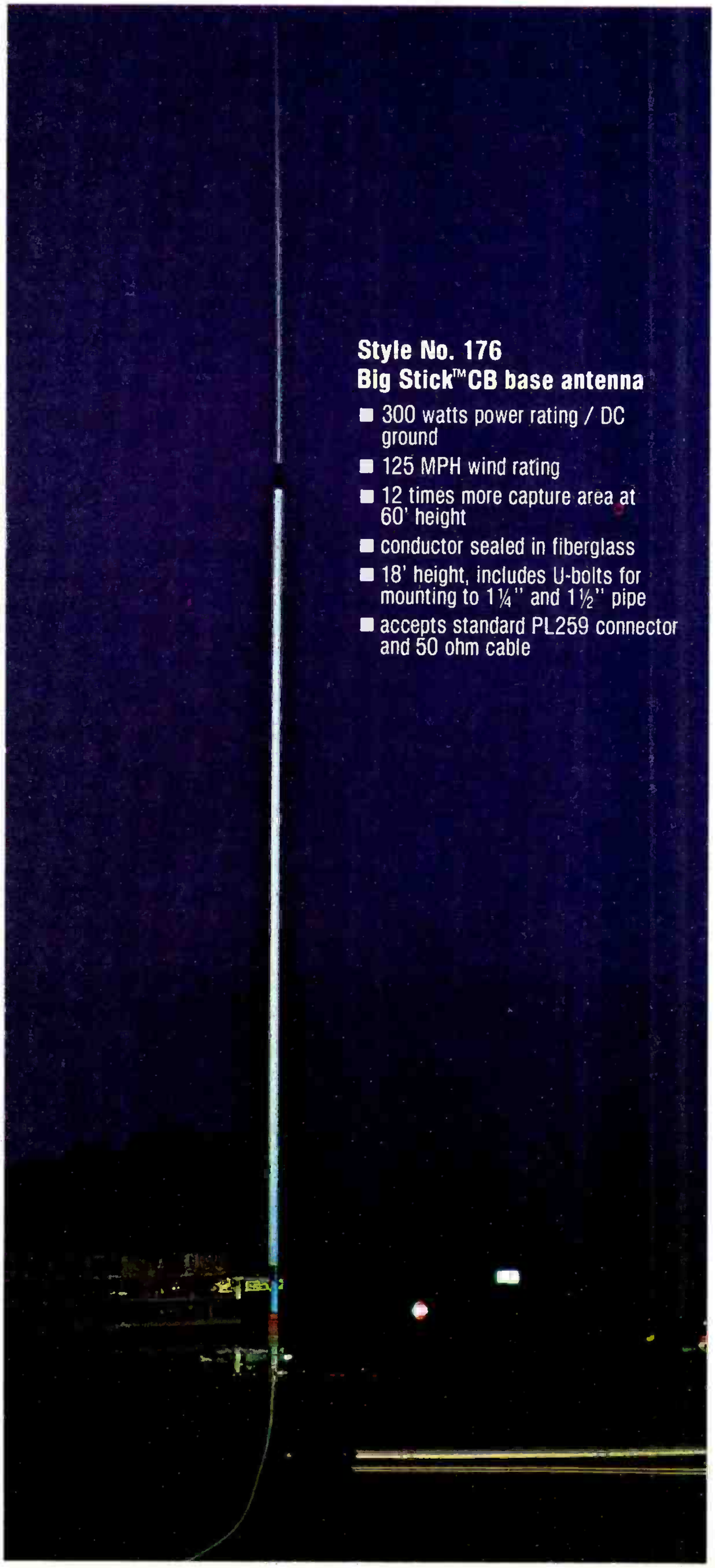
Fluorescent record level indication

Remote control phono



Scope display

# SHAKESPEARE HAS




## At a loss for words?

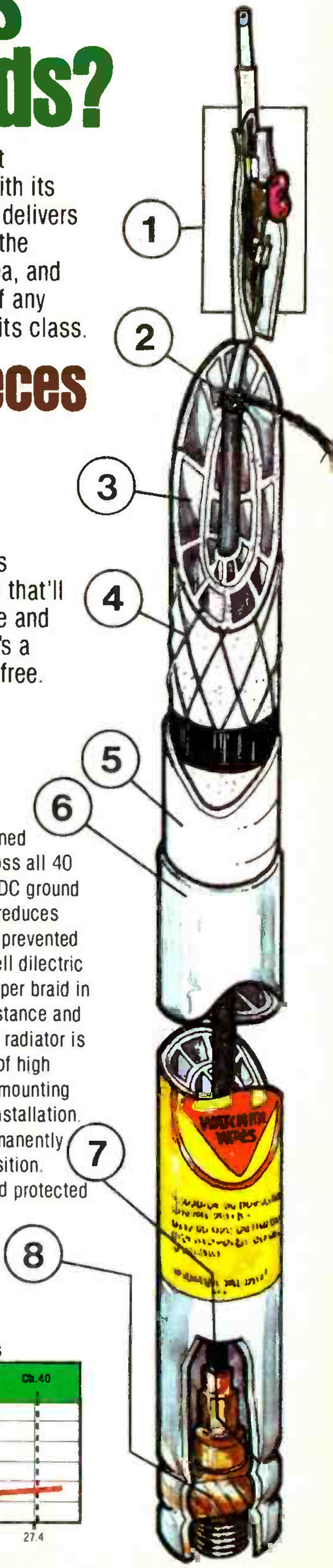
Big Stick™ Antenna gets out when the skip gets thick. With its unique design, this antenna delivers the longest possible range, the strongest signal capture area, and the lowest radiation angle of any omni-directional antenna in its class.

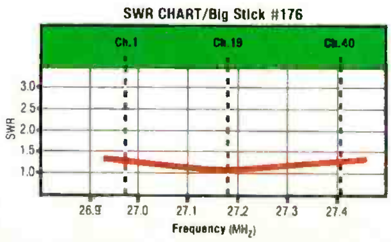
## Only two pieces make one Big Stick

You can count on Big Stick's engineering for performance that'll keep you talking. It's the one and only two piece antenna that's a cinch to install **and** trouble-free.

## U.S. Patent #4,097,870

(1) Big Stick has a band spread tuned circuit that yields a low SWR across all 40 channels. (See SWR chart) (2) Its DC ground provision lowers static noise and reduces lightning hazard. (3) Signal loss is prevented by its innovative polystyrene air cell dilectric structure. (4) The silver plated copper braid in the decoupling sleeve lowers resistance and increases efficiency. (5) The metal radiator is completely protected by a sheath of high grade fiberglass. (6) Its aluminum mounting sleeve includes U-bolts for easy installation. (7) Factory designed crimping permanently locks the SO 239 connector in position. (8) And the connector is sealed and protected from the elements.



working its way down through the similarly styled TA-N86 power amplifier [switchable between class-B (80 watts) and class-A (18 watts) operation], the TA-E88B and TA-E86 preamplifiers, and an electronic crossover.

Optonica, which recently amazed the world with its microprocessor cassette equipment, has taken that technology over to record players in the form of the RP-X1 turntable, which can be programmed to play bands or portions of bands on records in any desired order automatically, with up to ten repeats possible. A laser scanner, apparently carried on a separate sub-arm, is said to count the grooves and thus execute the program; a remote controller that duplicates the main programming keyboard transmits via infrared. Finally, an LED digital readout indicates the instructions given to the direct-drive machine.

Another giant in tape, Akai, has stepped into the record-player arena, in this case with the more conventional approach of five initial models beginning with a belt-drive semi-automatic machine and proceeding up to a fully automatic quartz-locked direct-drive model. On the unconventional side of the street, the British-made JBE turntable line is available with three different arms (Shure/SME, Formula 4, or Dynavector) and three different styling schemes, one of which involves a transparent acrylic base. The platter is made up of six large circular disc supports on an acrylic sub-platter; the controls for the direct-drive machine are housed in a separate unit. Even more unconventional is the Oasis T-1 manual turntable, which employs two motors and a fluid coupling to drive an otherwise isolated acrylic platter.

A brief look at new phono cartridges: Audio-Technica has two new top models, the AT15SS and AT20SS, with beryllium stylus shanks and improved Shibata styli. The replaceable styli fit the previous AT15Sa and AT20SLa models. Empire's "Broadcast One" is the first "ruggedized" model from that manufacturer, intended primarily for heavy-duty professional applications. ADC has worked its way up to a MK III designation for its finer phono cartridges, and has just introduced an XLM MK III together with a QLM MK III series. A new line of pickups, the Osawa "Moving Permalloy" cartridges, comprises three models ranging in price from $35 to $100. The top model, the 300 MP, has a carbon-fiber stylus cantilever. Another new moving-magnet line is entitled Andante, and is made up of two models, the E and the S, with elliptical and spherical tips. Grace's latest cartridge, the SF-90, is integrated with a universal headshell for reliable electrical connections, rigidity, and low mass.

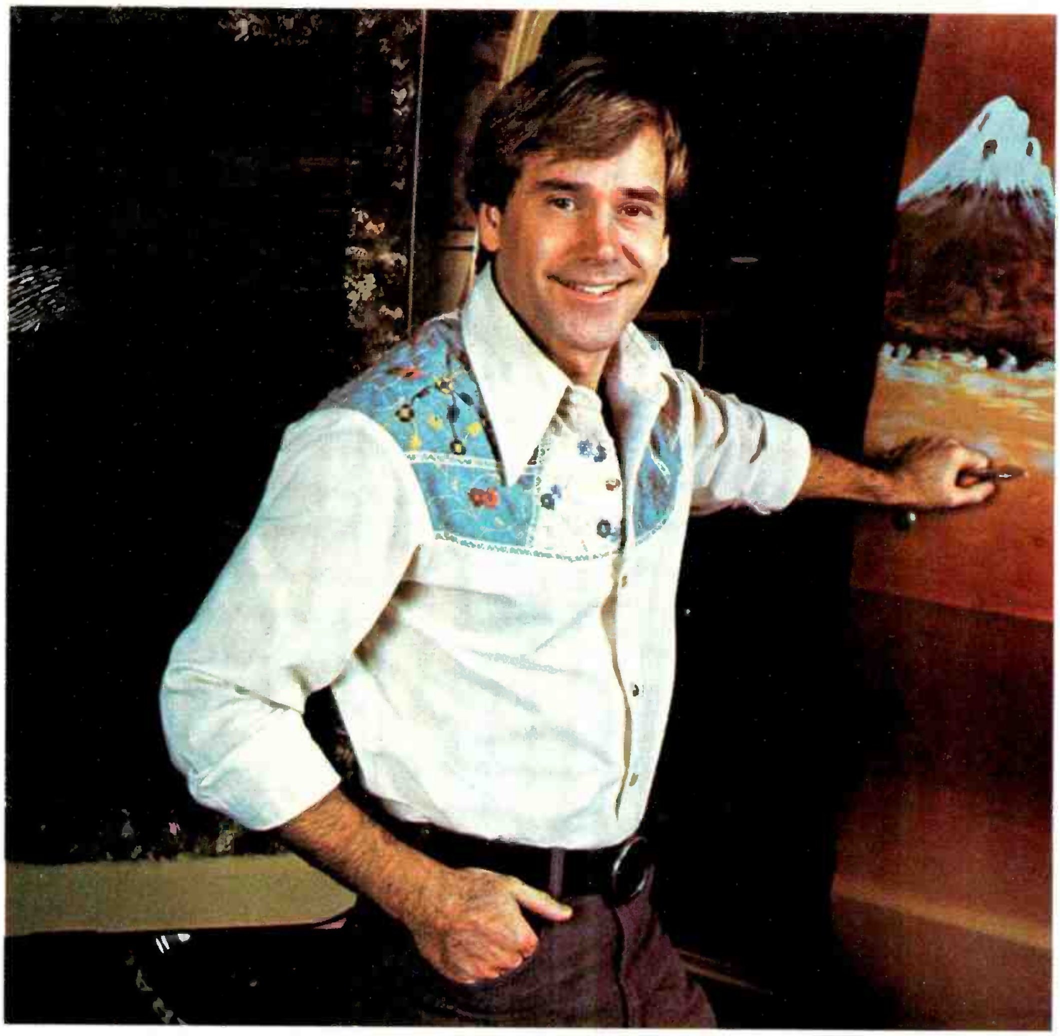
Among the more newsworthy events of the show was the *demise* of a product: the esteemed Yamaha CT-7000, one of the most celebrated FM tuners ever built. The CT-7000 will be replaced by the T-2 ($700), a model with a black front panel, even lower and leaner proportions, and a claimed augmentation in performance. (In case you wondered, there is a new T-1 tuner also, at $355.)

A novel concept in tuners comes from Technics. Its ST-9038 FM tuner, with quartz-crystal synthesized digital readout, is available with the SH-9038 "Micom Programmable Unit." The latter is a microprocessor that will literally operate four components in an audio system over a period of a week, following in detail any schedule punched in by the user. Up to eight FM stations can be preset; the SH-9038 also functions as a digital clock, with a stop-watch mode. As for the tuner itself, it offers manual tuning along with several automatic tuning modes that will reject stations with excessive noise plus distortion.

Marantz has revived oscilloscopes as front-panel features in two of its new tuners, the 2110 ($340) and the more elaborate 2130 (500). Monogram is pursuing the ideal of the totally non-mechanical tuner with the Model 3600 digital-readout design, which is entirely voltage controlled. Another British manufacturer, Amstrad, has enlarged the rather skimpy number of tuners offering multiband reception with two models, the EX.303 and EX.202. And Lux has added a quartz-locked FM-only model, the 5T10, to its prestigious Laboratory Reference Series.

**Until Next Year.** This brings us to the end of our available space, and hence necessarily to the end of this two-part highlighting of the year's newest audio products. The "highlighting" should be stressed. What has been briefly described here does not begin to approach a comprehensive cataloging of the latest high-fidelity gear soon to go on the market. But if it manages to inform you that there is truly new equipment out there—lots of it—it will have served its major purpose. ◇

# You gotta shop around.



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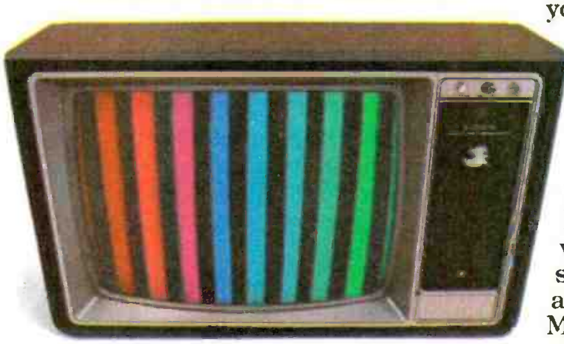

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apply your new skills to some real on-the-job-type troubleshooting! You learn to trace signal flow . . . locate malfunctions . . . restore perfect operating standards – just as with any sophisticated electronics equipment!

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# Julian Hirsch Audio Report

## What Is the Best (Tuner, Amplifier, etc.)?

I WISH I had a dollar for every time someone has asked me that question! It seems that we have a deep-seated need to know what is the "best" of anything, if for no other reason than to satisfy our curiosity. (Most of us accept the fact that the "best" will be beyond our means, but it's fun to know.)

Maybe there are ways to determine the "best" brand of frozen peas, or lawn mowers, or what have you—but how does one go about determining which high-fidelity component is the "best" of its type? If it were simply a matter of measuring a few key performance parameters, the problem *might* be solvable, but this becomes less likely when dozens of different and unrelated measurements are involved. Suppose one FM tuner has Usable and 50-dB Quieting Sensitivities of 11 and 13 dBf, and another measures 10 and 14 dBf. Which is the better? Suppose, also, that the first has an alternate-channel selectivity rating of 70 dB, and the second is 80 dB. As an additional complication, one tuner might have 25 dB of channel separation across the full audio range, while the other measures 50 dB at 400 Hz, but only 15 dB at the frequency extremes. How about noise? Is it significant that tuner A has a 70-dB S/N rating, while tuner B is only 65 dB?

*"It is quite possible . . . for two products to sound different . . . without one necessarily being better."*

I am deliberately trying to muddy the waters a bit; but, in actuality, things are much more complicated than this simple example would suggest. There are literally dozens of FM tuner performance ratings to be considered; a similar situation exists with amplifiers. Once we know all the pertinent facts (and some that are not so pertinent), is it possible to make a logical choice and say with some assurance that one product is "better" than another?

If you can do this, I wish you would pass the secret along to me! Most of the dozens of tests made on tuners and amplifiers follow standardized procedures, established by technical groups such as the IHF or the IEEE. They are meant to place the ratings of products from different manufacturers on a common footing, so that one can avoid the common error of comparing "apples and oranges." For this purpose, they are certainly useful. Nevertheless, I submit that they tell us much less than most of us would care to admit about how good a product really is. Since they do not recognize the subjective qualities that strongly influence our initial purchase decision and long-term satisfaction, they can hardly give a meaningful answer to the question: "Which is best?"

As a specific example, let us go back to that FM tuner selection problem (I use the tuner as an illustration because it is subject to frequent manual manipulation by the user, and is especially subject to quirks that are not covered by existing specifications).

I think we can agree that the purpose of a hi-fi FM tuner is to receive FM broadcasts without audible degradation of the signal transmitted by the broadcast station. I will further qualify this by stating that the evaluation of received quality will be done by listening, through amplifiers and speakers in a home environment, rather than by laboratory tests with expensive test equipment. In the vast majority of cases, no one could distinguish one tuner from another by an A-B listening comparison, regardless of the disparity in price or ratings between them. This may sound strange, but I have done it literally hundreds of times and don't always hear a difference which would induce me to spend an extra dollar for one of the tuners being compared. Of course, it is understood in this discussion that we are dealing with high-quality equipment in proper operating condition. This does not mean that all tuners are alike but that the differences between them are not too significant with available program material.

If listening quality alone is not sufficient to distinguish between tuners, how can we make a reasonable choice? What other factors distinguish FM tuners from each other, besides their electrical performance? Size, appearance, special features such as Dolby circuits or digital displays, tuning aids, dial-scale legibility and accuracy, and cost are a few that come to mind.

When I am evaluating a tuner, I connect it to an audio system and to an antenna. I then tune in several of my favorite stations, out of the more than 50 that can be received here at most times. Many of these signals are spaced only 400 kHz apart (alternate channel assignments). If the dial scale is so sparsely or inaccurately calibrated that I cannot tell whether I am tuned to 103.9 or 104.3 MHz without listening to the station, I downgrade the tuner severely. For me, the mere ability of a tuner to receive a signal and render its modulation audible is not sufficient. It must be able to receive the station that *I* want to hear, without benefit of "trial and error" or guesswork tuning processes.

Now, does the tuning meter or other indicator actually show me the best tuning point (and here, "best" means the tuning that gives lowest noise and distortion)? If not—if the meter pointer is near or beyond the edge of the indicated correct zone when the station is tuned correctly—what use is the meter? That's another strike against the tuner if this occurs.

When I tune across the FM band, are my ears assailed by bursts of noise as I pass through various broadcast channels? A muting system that does not mute solidly is worse than none at all, and is another black mark against the tuner. Does the tuner drift enough to require retuning after a time when a station has been tuned in from a "cold" start? Drift is rare these days, but it does happen, and should not be tolerated.

I won't bother going on—the point should be clear by now. The "best" tuner is the one that lets you tune in a station of your choice, without guesswork, which gives you the full audible performance inherent in the broadcast material, and which does not add any audible noises in the tuning or listening processes. This is not as difficult as it might seem, since even a moderately priced tuner has better quality than almost every FM broadcast station. If the tuner looks good, harmonizes with your amplifier appearance, and is within your budget, it is probably the "best" for you. Keep in mind that there are probably a number of "best" products, since the substantive differences between comparably priced models from reputable sources are usually negligible.

The same considerations apply to amplifier selection, except that more emphasis should be placed on adequate control flexibility. The factors to listen for are noises: switching transients, hiss, and hum. In listening to program material, and comparing two amplifiers, be suspicious of any obvious sound-quality differences. The real differences in sound between amplifiers are so subtle that they often cannot be heard without playing special records. If you plan to spend your spare hours listening only to those records, this is a valid basis for choice. If your tastes are more catholic, you might ignore those subtleties which must be pointed out to you by the person making the demonstration. (We are all very susceptible to suggestion, and can easily be convinced we are hearing something that may not be there at all.)

I have not mentioned amplifier power, which is really a system consideration. (It will either affect your choice of speakers, or if you have the speakers, it can affect your choice of an amplifier. In itself, it has little to do with sound quality.)

Insofar as distortion is concerned, you are not going to hear any difference between amplifier distortions of 0.05% or 0.005%, though some golden-eared people can sometimes distinguish sound differences even between two very-low-distortion products. But this may be due to other factors.

This article was not intended to be a guide to component selection (that would require book length), but rather to show that there are no simple answers to the question of which product is "best." I am deliberately avoiding the matter of speakers, which warrant a separate treatment.

I would like to make a final point, however. I have attempted to "de-bunk" audible differences as an absolute basis for hi-fi component selection. Please do not assume that there are *no* audible differences, for they do exist! This does not necessarily make one product better than another, though, in many instances it does. It is quite possible, for example, for two products to sound *different* (this is especially true with speakers and phono pickups) without one necessarily being *better*. And when it comes to "best" in a particular price range, there are too many tradeoffs to be made for such a statement to be possible. ◇

## Tested In This Issue

JVC JT-V77 AM/FM Stereo Tuner

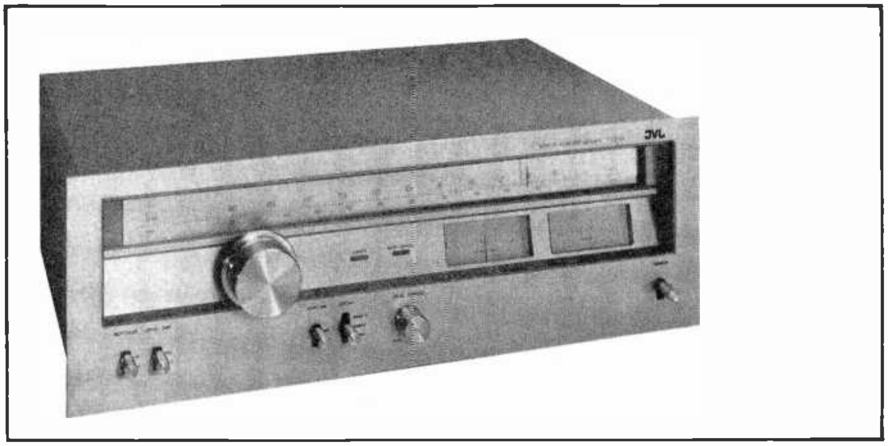
Acoustic Research AR-9 Speaker System

Shure SME-3009 Series III Tonearm

*(Audio Test Reports begin on page 32.)*

# audio test reports:

## $290 unit would have cost $1000 only 4 years ago



## quieting sensitivity and capture ratio beyond its price class in the JVC Model JT-V77 AM/FM stereo tuner

HIRSCH-HOUCK LABS REPORT

The Model JT-V77 AM and FM stereo tuner, which is a companion to the Model JA-S77 integrated amplifier, heads JVC's tuner line this year. In addition to being a full-featured deluxe tuner in all conventional respects, the Model JT-V77 has a Phase Tracking Loop (PTL) FM detector that is said to elevate its overall performance level to well beyond the norm for its price class.

The tuner measures 17¾"W × 14½"D × 6¼"H (45 × 37.4 × 15.8 cm) and it weighs 13.9 lb (6.3 kg). Its suggested retail price is $289.95.

**General Description.** The AM and FM scales, both of which are linearly calibrated, occupy most of the top half of the front panel. There are separate large center-channel (FM only) and relative signal strength (AM and FM) tuning meters on the lower half of the front panel. Between the meters and a large tuning knob are STEREO and TUNING HOLD indicators.

Across the bottom of the panel are five lever switches and a small VOLUME control knob. The switches are for controlling POWER, selecting the MODE (STEREO, MONO, or BLEND), MUTING, FM/AM selection, and REC CAL. The REC CAL switch is a convenience that simplifies off-the-air taping. It replaces the tuner's audio outputs with a 400-Hz tone at a level equivalent to 50% modulation (37.5-kHz deviation at the transmitter).

JVC suggests that the REC CAL tone level be set to give a 0-dB indication on the recorder's meters to assure that program peaks do not drive the recorder into distortion. If one wishes to record an off-the-air FM broadcast, the REC CAL tone should be used to set the recorder's meters to read in the range of 0 to −6 dB, depending on its reserve headroom (since program peaks may exceed this level by 6 dB). The REC CAL feature greatly simplifies the making of clean, distortion-free cassette recordings without any reference to the actual program levels being transmitted when the gain levels are set up.

When a stereo-FM broadcast is tuned in, the STEREO indicator comes on. The TUNING HOLD light comes on when any FM signal is accurately tuned. This indicates that the tuner has locked onto the signal and is set for optimum reception. Although JVC does not specifically state that this is an amplified automatic frequency control (afc) system, it appears to be just that, with a delayed activation that is controlled by the presence of the signal and a long filter time constant.

### 400-Hz calibration tone for cleaner taping

A hinged and pivoted ferrite-rod AM antenna is on the rear apron. Also on the rear apron are terminals for 300- and 75-ohm external FM antennas and two pairs of audio-output jacks. One pair of jacks is at a fixed level, while the other pair's level can be adjusted with the VOLUME control on the front panel.

The tuner has a very neat, uncluttered interior. Almost all of its circuitry is mounted on a single large circuit board. A smaller board, just behind the front panel, accommodates some of the lever switches and a few circuit components, while a second small board contains the power-supply circuitry.

A large portion of the tuner's active circuitry is contained inside IC's. Although no schematic diagram was supplied with the tuner, we were able to determine that most of the basic tuner functions (i-f amplification and limiting, PTL detection, and the PLL multiplex demodulator) are performed by single special-purpose IC's. A separate IC is used for the AM-tuner section.

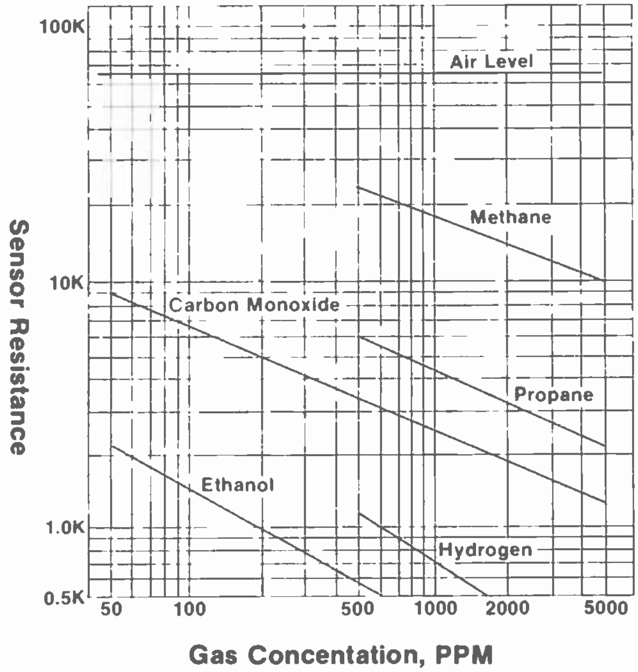
The tuner's front end has a four-gang tuning capacitor and a FET r-f amplifier for good interference rejection. A combination of a four-resonator ceramic i-f

### FM detector features phase tracking loop

# semiconductor gas sensor

The TGS—812 transducer is a solid state device which changes resistance proportionally with exposure to the following gases:

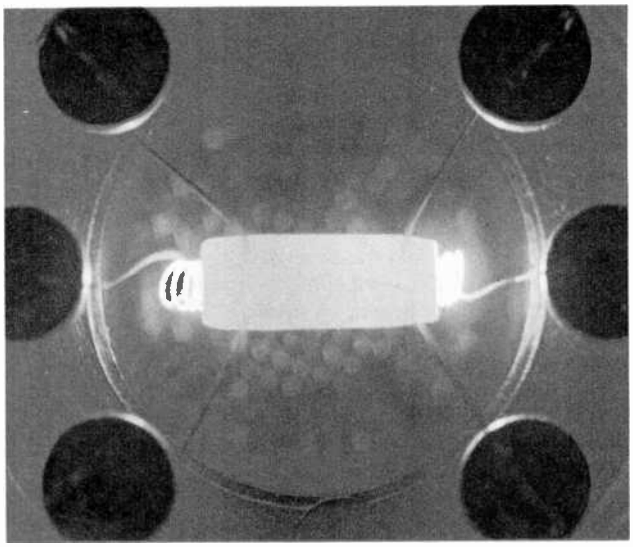
- Hydrocarbons, such as methane, ethane, propane, gasoline, kerosene and benzene;
- Halogenated Hydrocarbons, such as methyl chloride, methylene chloride, trichloroethane and vinyl chloride;
- Alcohols, such as methanol, ethanol, propanol and butanol;
- Ethers, Esters and Ketones;
- Carbon Monoxide
- Hydrogen




The transducer requires 5 volts at 125 milliamps to operate an integral heating element which maintains a temperature of 300 degrees celcius, and the semiconductor may be used in any high impedance circuit up to 28 volts.

Response and recovery time constants are a few seconds, and the life of the transducer under most conditions will be a minimum of five to eight years.

**Transducer Assembly, shown actual size**



**Infrared Photomicrograph of the Sensor**

The transducer is supplied with numerous calibration graphs, and information of interest to the experimenter or hobbyist, including plans to construct the following:

- **Carbon Monoxide Detector**
- **Gas Leak Detector**
  (Natural or LP Gas)
- **Alcohol Detector**
  (Drunk Driver Breath Analyzer)

Plans and ideas are also included for other applications. Most of the plans are simple, requiring only a few components and minimal assembly time.

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# Product Focus

*The most unusual feature of JVC's Model JT-V77 tuner is its Phase Tracking Loop (PTL) FM detector. This circuit can be considered as a variant of the phase-locked loop (PLL) used as a multiplex demodulator in many fine tuners. In fact, the PLL can be used as an excellent FM detector in which its voltage-controlled oscillator (vco) tracks the FM i-f signal in-phase. The control voltage that maintains the two in sync is actually the demodulated FM program. JVC uses the PLL as a detector in its higher-priced Model T-3030 digital tuner, but the circuit is expensive and has certain limitations.*

*The vco used in a PLL has noise modulation sidebands that set a "floor" on the obtainable S/N of the FM tuner. By taking special care in component selection, this noise can be minimized, but the resultant cost rules out the PLL detector for any but the higher-priced tuners. The PTL used in the Model JT-V77 tuner is derived from JVC's experience in developing PLL and PTL circuits for tuners and CD-4 demodulators. The incoming 10.7-MHz i-f signal enters a phase comparator directly. Part of it is diverted through a phase tracking filter, which is a voltage-tuned filter that can be scanned through the ±100-kHz bandwidth of an FM broadcast channel. The instantaneous relationship of this filter to the i-f signal frequency is such that the filter's output is 90° out-of-phase with the direct i-f signal. This quadrature signal is supplied to the other port of the phase comparator.*

*The output of the comparator is the error voltage of the phase tracking loop. After being passed through a low-pass filter and amplified, it is used to control the phase tracking filter in a manner that reduces the error voltage to a minimum. The output of the amplifier (the filter control voltage) is the recovered program modulation of the FM signal. Since the PTL has no oscillator, it is free of the noise associated with a vco.*

*If the gain of the loop is great enough, the PTL's frequency-to-voltage transfer characteristic can be made as linear as desired over the entire passband without the curvature that is typical of a conventional quadrature detector or even a ratio detector or discriminator. This high linearity is not dependent on the stability of any tuned circuit or other critical component since the PTL is a negative-feedback system that is basically independent of outside influences.*

*The PTL detector is inherently insensitive to amplitude variations, so the AM rejection and capture ratio of a tuner employing it can be made very good. Also, an interfering signal will be rejected by the PTL because the PTL is locked to the phase of the desired signal and resists capture by other signal frequencies.*

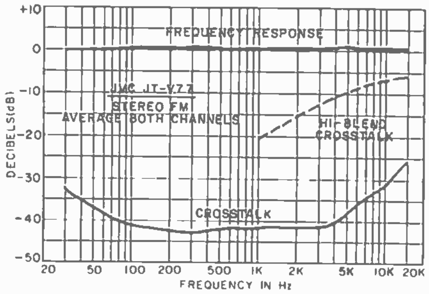
filter and a separate single-resonator filter is used to give linear phase response with satisfactory selectivity. The PLL multiplex section has an automatic pilot signal canceller to attenuate the 19-kHz pilot signal in the audio outputs without loss of high-frequency response.

**Laboratory Measurements.** Our tests of the tuner yielded some rather unusual results. For example, the IHF usable sensitivity and 50-dB quieting sensitivity were exactly the same at 12 dBf (2.2 μV). Although this was not quite as good as the rated IHF sensitivity, it was considerably better than the more important rated quieting sensitivity. The quieting curve shows that the weak signal output from the tuner is largely distortion, with a very low noise level. This is a definite "plus," since noise is much more objectionable than distortion in weak-signal reception.

The distortion and noise readings were very close to the rated values and

> capture ratio was an incredible 0.86 dB--one of the lowest ever

represent excellent performance. We found that the noise measurement was limited by the residual noise in the modulating circuits of our FM signal generator. When the generator was in the CW mode, the tuner's noise output dropped several decibels, to a very low −77 dB in mono. (However, the stereo reading of −71.3 dB had to be made with the generator in its stereo mode to supply the 19-kHz pilot carrier.)

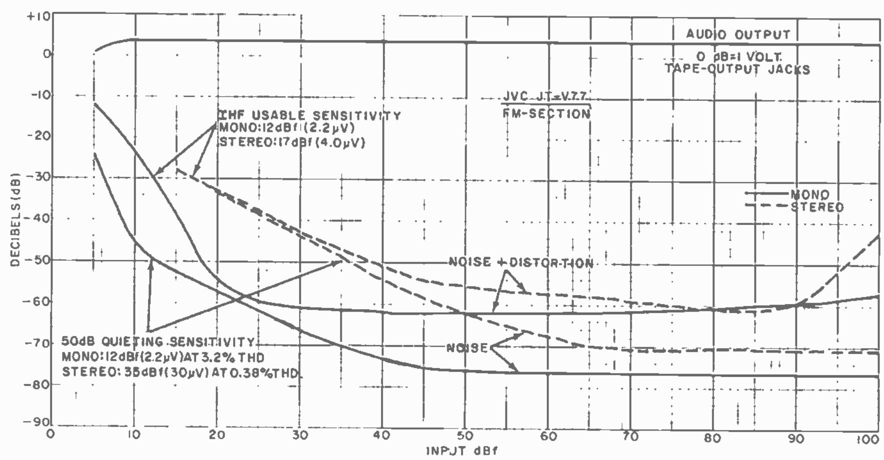



*Frequency response and crosstalk averaged for both FM channels.*

The 0.86-dB capture ratio was one of the lowest we have ever measured, and it was also remarkably noncritical and repeatable. These are very unusual qualities in a capture-ratio measurement. The measurement did not change with signal level changes between 45 and 65 dBf.

JVC claims that the PTL detector effectively increases the ability of the tuner to reject interference from other signals while maintaining the full i-f bandwidth required for optimum stereo reception. In other words, it is said to give many of the benefits of the dual-bandwidth i-f systems used in some other tuners, without their cost or other performance compromises. We confirmed this claim, at least tentatively, by our measurements. The measured alternate-channel selectivity was 70 dB, which should be more than adequate for almost any receiving location. The distortion was low enough to tax the abilities of the best signal generators. The only performance compromise that we could attribute to the relatively wide i-f bandwidth was a rather poor adjacent-channel selectivity, although it must be admitted that very few tuners have enough adjacent-channel selectivity to really separate stations only 200 kHz apart.

Another claimed and confirmed prop-




*Noise and sensitivity curves for FM section of tuner.*

# How to listen to Moscow, Russia... Moscow, Idaho and your good buddy, Max Moscow.

# Panasonic introduces the Command Series.™


Tune in. Sit back. And travel the world with Panasonic's short wave radios—the Command Series. Set your itinerary by simply setting the dial. Stop off in London for a concert with the London Philharmonic. Be in Peking when they announce the new pecking order. Or visit old friends in the old country. Any old country. Even the good ol' U.S.A.

There are thousands of overseas and domestic short wave transmissions* you can tune in. And with an optional outside antenna, you'll get incredible accuracy with the RF-2800 (shown above). Because Panasonic's LED Digital Frequency Display is so precise, it's accurate to within 1 kHz. That's the kind of tuning that used to cost twice the price. That was up until the Panasonic RF-2800.

And if you want to hear more than short wave, the RF-2800 gives you more. Like SSB (single sideband) amateur radio. All 40 CB channels. Ship to shore. Even Morse communications. And, of course, there's AM and FM.

And like more expensive short wave receivers, the RF-2800 has an RF-Gain Control to enhance weak, distant stations or to prevent overload distortion from overstrong stations.

The Command Series from Panasonic. Now you can travel the world without ever leaving home.

*Short wave reception will vary with weather conditions, operator's geographic location and other factors.

**Panasonic.**
just slightly ahead of our time.

CIRCLE NO. 37 ON FREE INFORMATION CARD

erty of the PTL detector is its low distortion over a wide tuning range. Here again, the confirmation was tentative because the effective tuning cannot be misadjusted once the TUNING HOLD light comes on. With the light on, the tuner was always set for optimum noise, distortion, and channel-separation characteristics. There was no ambiguity whatever in tuning this tuner. We noted that the muting action was completely noise-free and had a time delay that prevented any audio from appearing at the output until a second or so after a station was properly tuned in.

The stereo channel separation was almost identical in both channels, and the frequency response was virtually ruler flat. There was no loss of output at 15,000 Hz, yet the 19-kHz subcarrier was suppressed to a very low −82 dB by the automatic pilot null circuit in the PLL multiplex IC. Although the channel separation was slightly less than is claimed by JVC, it was very good over the entire audio-frequency range. The HI BLEND switch reduced the high-frequency separation and noise substantially, without serious loss of stereo effect.

A frequency-response plot was the only test we performed in the AM section of the tuner. The response was very limited, even by "typical" AM tuner standards. It was down 6 dB at 90 and 2600 Hz. On the other hand, the AM background noise was quite low.

**User Comment.** The tuner's measured performance in terms of noise, distortion, and outstanding 50-dB quieting sensitivity places the Model JT-V77 very close to the "super-tuner" category. Only its very good, but still measurable, selectivity and image rejection properties (as well as its price) distinguish it from some very high-performance tuners we have measured.

The tuner's dial calibrations were accurate, with the largest error being about 100 kHz. Over most of the FM band, the tuning error was not readable. Since the TUNING HOLD indicator signifies that a station is being received with the full performance of which the tuner is capable, the user is virtually guaranteed of being able to match the performance we measured on our test bench. This is exceedingly rare in tuners that do not employ synthesized local oscillators.

If the Model JT-V77 tuner had made its appearance only four years ago, it would have cost more than $1000. That it sells for less than $300 today says a lot for the advances made in audio electronic technology.

CIRCLE NO. 101 ON FREE INFORMATION CARD

## Performance Specifications

| Specification | Rating | Measured |
|---|---|---|
| Usable sensitivity: | | |
| Mono | 10.3 dBf (1.8 μV) | 12 dBf (2.2 μV) |
| Stereo | NA | 17 dBf (4 μV) |
| 50-dB S/N sensitivity: | | |
| Mono | 16.3 dBf (3.6 μV) | 12 dBf (2.2 μV) |
| Stereo | 36.3 dBf (36 μV) | 35 dBf (30 μV) |
| S/N ratio: | | |
| Mono | 78 dB | 77 dB |
| Stereo | 72 dB | 71.3 dB |
| Distortion at 1 kHz: | | |
| Mono | 0.08% | 0.075% |
| Stereo | 0.10% | 0.12% |
| IM distortion: | | |
| Mono | 0.05% | NA |
| Stereo | 0.08% | NA |
| Capture ratio | 1.0 dB | 0.86 dB |
| Alternate-channel selectivity | 75 dB | 70 dB |
| Adjacent-channel selectivity | NA | 2 dB |
| Image rejection | 90 dB | 88 dB |
| I-f rejection | 100 dB | NA |
| Spurious rejection | 100 dB | NA |
| R-f IM rejection | 65 dB | NA |
| AM suppression | 65 dB | 63 dB |
| Stereo separation at: | | |
| 100 Hz | 45 dB | 42.5 dB |
| 1 kHz | 50 dB | 43 dB |
| 10 kHz | 40 dB | 34 dB |
| Subcarrier rejection | 70 dB | 82 dB |
| Stereo threshold level | 31.5 dBf (20 μV) | 15.7 dBf (3.3 μV) |
| Muting threshold level | 31.5 dBf (20 μV) | 17.2 dBf (4 μV) |
| Frequency response (30-15,000 Hz) | +0.3/−0.8 dB | +0.4/−0.6 dB |
| Output level: | | |
| Variable | 0-1.3 V | 0-1.4 V |
| Fixed | 750 mV | 710 mV |
| Recording level | Equivalent to 50% FM modulation (−6 dB) | −5.9 dB |

# a radical departure from the pioneer of small enclosures, the Acoustic Research AR-9 speaker system

HIRSCH-HOUCK LABS REPORT

In its 25 years in business, Acoustic Research has been a steadfast proponent of compact speaker systems. Even its nine-driver Model AR/LST of a few years ago was relatively compact for a speaker system of its capabilities. Now AR has made a turnabout with the introduction of its Model AR-9 floor-standing speaker system that is large by any standard.

The Model AR-9 is a tall, column-shaped four-way speaker system with five drivers. It's rated to handle up to 400 watts of continuous power, with each channel driven to clipping 10% of the time on normal music material. Since

## large system handles up to 400 watts continuous power

the speaker system is rated for 87 dB SPL at 1 meter when driven by 1 watt, it can actually deliver an ear-splitting 113 dB SPL at 400 watts! The five-driver speaker system's only response specification is for its lower limit, which is −3 dB at 28 Hz. The impedance is rated at nominally 4 ohms, with a minimum of 3.2 ohms.

The speaker system measures 52 ¾"H × 15 3/16"D × 15"W (134 × 40.2 × 38.1 cm) and weighs 130 lb (59 kg). Suggested retail price is $750 each.

**General Description.** The bass frequencies from the speaker system, up to 200 Hz, are radiated by a pair of 12" (30.5-cm) acoustic-suspension woofers located at the bottom rear on the two sides of the enclosure. Radiation is to the sides. By keeping the bass radiators as close as possible to the rear-wall and floor surfaces, this placement essentially eliminates cancellation of the upper bass by reflections from room surfaces through shifting the lowest cancellation frequency to a point beyond the driver's operating range.

The midrange, from 200 to 1200 Hz, is radiated by an 8" (20.3-cm) acoustic-suspension driver located in a separately sealed subenclosure that faces forward about halfway up the front surface of the enclosure. The cancellation reflections from room boundaries that might affect the response of this driver fall below its operating range. The two remaining drivers are vertically aligned with the lower midrange driver.

## two side-firing acoustic-suspension woofers per cabinet

Frequencies between 1200 and 7000 Hz are handled by a 1½" (38.1-mm) dome tweeter surrounded by a donut-shaped ring that AR refers to as a "semi-horn." (It's designed to improve driver radiating efficiency in the upper part of its frequency range.) Beyond 7000 Hz, a smaller dome tweeter that measures ¾" (19.1-mm) takes over. The gaps in the voice coils of the two tweeters are filled with a high-temperature "ferrofluid" that helps conduct heat away from the voice coil and provides mechanical damping of the tweeters' resonances.

The front of the speaker surrounding its middle and high-frequency drivers is covered with a sheet of acoustic fiber that AR calls an "Acoustic Blanket." Its function is to absorb energy radiated in the plane of the speaker board. According to AR, the radiated energy would otherwise be reflected from the edges of the speaker cutouts and cabinet. So the "Blanket" is designed to reduce the possibility of interference with the smoothness of the system's frequency response and directional characteristics.

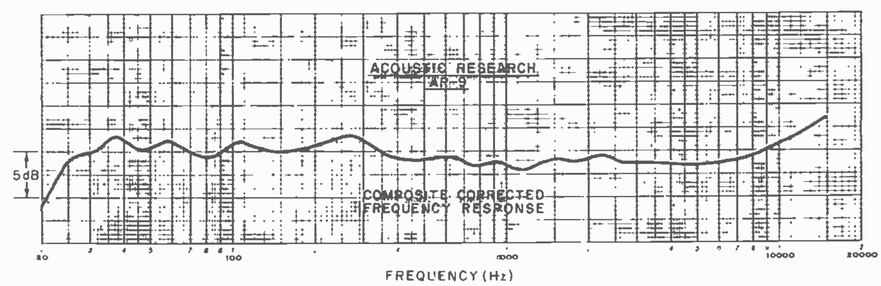
Three small three-position switches on the front panel below the 8" cone driver are provided for adjusting the levels of the lower, upper midrange, and high-frequency drivers from their maximum (nominally flat) outputs to −3 and −6 dB.

The crossovers between the lower and upper midrange drivers have a gradual 6-dB/octave slope to smooth the blending of sound in this most vital part of a speaker system's operating range. The woofer crossover circuit has an equalizing section that flattens out the bass response in the vicinity of resonance and extends it downward somewhat in frequency. Moreover, the upper midrange driver portion of the crossover system has an impedance-equalizing function as well.

**Laboratory Measurements.** The measurements we made on the Model AR-9 under semireverberant conditions yielded the widest and flattest frequency response curve we have yet obtained from a speaker system. When it was combined with the close-proximity microphone bass response curve and corrected for the room's and microphone's characteristics, the composite response of the system was within ±2 dB from 25 to 12,000 Hz. It rose slightly to +4 dB at 15,000 Hz. This was the limit of our calibrated microphone's known accuracy. (A new calibrated microphone we now use, Bruel & Kjaer's Model 4133, will enable us to give more accurate and meaningful results at the highest audio frequencies in future reviews.)

## driver positions give uncolored spatial imaging

The dispersion characteristics of the tweeter were good. There was only about 3 dB of difference in the high-frequency response curves measured on-axis with the speaker and 30° off-axis. The level switches had their indicated effects, which were confined to the rated operating frequency ranges of the respective drivers. The tone-burst response of the system was excellent, yielding bursts that were as clean as any




*Composite corrected frequency response curve.*

# Product Focus

*In designing the Model AR-9, Acoustic Research has made a special effort to achieve the best possible stereo imaging. One school of speaker system design holds that phase coherence, or uniform time delay across the system's operating frequency range, is important for the optimum stereo effect. AR made a study of the subject that led to the conclusion that the human ear is insensitive to phase shifts having a major effect on the shape of a complex waveform.*

*AR used a computer to analyze the qualities of music itself, as well as of a number of different speaker systems. In the former case, a specific musical tone from six different recordings of the same work, were analyzed and no consistent phase relationships between the components of that tone were found. The conclusion was that phase relationships are completely inconsistent over time periods longer than a few milliseconds, and that the resulting gross waveform changes are imperceptible to listeners.*

*The second experiment, involving a number of speaker systems, led to the conclusion that the "blurring" of a spatial image due to various frequency components arriving at slightly different times was mainly caused by reflections from the speaker structure itself, rather than from any "time alignment" error between the drivers. In fact, some of the stepped enclosure shapes used to obtain uniform time alignment of the drivers in a multiway system were noted to actually degrade the stereo performance of the system by causing unnecessary reflections from the edges of the enclosure.*

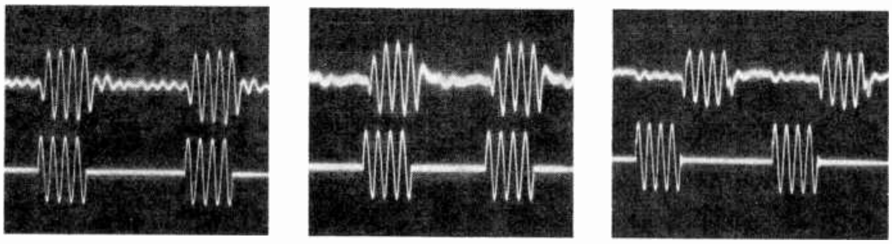
*In the Model AR-9, a high degree of accuracy in spatial imaging was obtained by positioning the midrange and high-frequency drivers on a single vertical axis and covering the front of the cabinet with a heavy fiber sheet that absorbed high-frequency energy before it could be reflected from the edges of the cabinet and speaker cutouts. This had the expected effect of smoothing out the frequency response of the system. (As our measurements confirmed, it is impressively smooth.) Furthermore, in listening tests with the blanket in place and removed, AR found that it improved the perceived stereo imaging and location of instrumental sounds and enabled the listener to judge the acoustic size of individual sound sources more accurately. It also reduced the audible coloration of the sound, as a result of the smoother frequency response.*

we have been able to make in a "live" acoustic environment. The system's sensitivity was as rated, so that driving it with 1 watt of random noise in the octave centered at 1000 Hz produced an 87-dB SPL 1 meter away.

Low bass distortion was one of the system's most striking qualities, though it was not too surprising in view of the use of two large acoustic-suspension woofers in a 4.25 cu ft (120-liter) cabinet. At a 1-watt input (based on 8 ohms, which is actually 2 watts into the speaker system's nominal impedance), the distortion was between 0.22% and 0.50% from 100 Hz down to 50 Hz. It rose very gradually to 1.3% at 25 Hz and to 2.5% at 20 Hz. A 10 dB increase in power to

tances. Also, the high end is far better than that of some of the earlier AR speaker systems, which tended to have a "soft" quality. If the program has energy in the highest audible octave, it emerges from the Model AR-9 with crystalline clarity. By the same token, if the program has any distortion or a frequency-response aberration, the system will do nothing to conceal the flaw.

The bass quality is tops, too. Male voices are not artificially colored by the usual resonances in the upper-bass system. However, not only did the AR-9 deliver the usual excellent bass response expected of any good speaker, it also seemed to have a subliminal "floor" of deep bass that could be felt rather than



*Tone-burst responses at (left to right) 60, 250 and 4000 Hz.*

the very considerable level of 20 watts into the nominal 4-ohm impedance had only a slight effect on the distortion. It then measured between 0.32% and 0.63% down to 50 Hz and rose to 3% at 30 Hz and 6.7% at 20 Hz.

The impedance was relatively constant, measuring a minimum of about 3 ohms at 50 and 2500 Hz (also its approximate dc resistance) and reaching maxima of 8 ohms at 28 Hz and just shy of 10 ohms at 750 Hz. Since the impedance was between 3 and 5 ohms almost everywhere except at 28 and 750 Hz, the 4-ohm rating is well justified.

**User Comment.** Although the Model AR-9 should be installed as close as possible to the rear wall to obtain the full benefit of its woofer placement in smoothing the upper bass response, this is not critical. We were unable to get the speaker systems much closer than 18" (45.7 cm) from a wall, but they still sounded fine.

The system's sound betrays its kinship to earlier AR models in its smoothness and lack of coloration. Moreover, it has an exceptionally blended and homogeneous sound that never gives a hint that it is emanating from five drivers distributed over a large cabinet. The unified nature of the AR-9 sound remains apparent, even at rather close listening dis-

heard on much of the material we played. In an A-B comparison against the AR/LST (which headed the AR line a few years ago, and can hardly be said to be shy of bass), the Model AR-9 appeared to have another octave of response at the low end. The feeling of "body" that this imparts to the sound is rarely, if ever, heard through speaker systems whose ouput extends only to 35 or 40 Hz. It is usually associated with a good "subwoofer" system, but in this case the subwoofer is part of the basic system (remember, there are two woofers in each speaker system).

Although the Model AR-9 can deliver a most impressive sound level when driven by a powerful amplifier, we recommend staying within the AR guidelines for driving it. Husky as the drivers are, they *can* be blown out by an overenthusiastic application of several hundred watts of power. While tastes differ widely when it comes to speaker system selection, we feel that anyone who wants to listen to music reproduced as naturally as possible in the home—and who has the space and money to accommodate a pair of Model AR-9's—should certainly audition a pair before making a final buying decision (or even to compare them to one's present speaker system, just for curiosity's sake).

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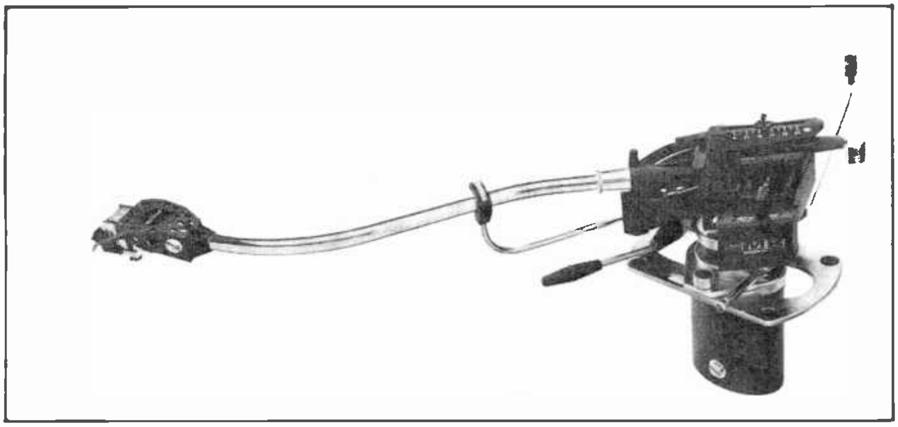


# very low mass and viscous damping highlight Shure SME Series III tonearm

## expensive tonearm is super-resistant to vibration

HIRSCH-HOUCK LABS REPORT

The British-made SME 3009 Series III tonearm (distributed here in the United States by Shure Brothers) has little in common with its predecessors. It has been designed to have extremely low mass, making it compatible with the most compliant of today's phono cartridges. The tonearm can accommodate cartridges weighing up to 13 grams and has a tracking force range of 0 to 2.5 grams. The low-frequency tonearm/cartridge resonance can be damped, at the user's option, by a viscous damping system supplied with the tonearm.

The suggested retail price of the SME 3009 Series III tonearm is $294.

**General Description.** The Series III features a knife-edge vertical pivot that is virtually frictionless and has an indefinite life. Its horizontal pivots are precision ball bearings. The tonearm has a fully adjustable sliding base that requires an elongated mounting slot. This permits the tonearm to be adjusted for minimum tracking error near the inner grooves of a record.

The structure on the rear of the tonearm is made from plastic that is reinforced with carbon to give it the desired strength and acoustical properties. The counterweight consists of a number of lead weights that are loaded into a plastic carrier that mounts on the rear of the tonearm. Since the balance range is limited to keep the mass of the counterweight near the pivots, only the proper number of weights needed to balance the cartridge and tonearm must be used. (Weights to provide the proper tonearm balance come installed for cartridges weighing 6 to 10.5 grams.)

Balancing is performed by operating a knob that moves the entire counterweight structure. Then the tracking force is set by operating another knob that moves a weight on one side of the main weight. The stylus pressure force scale is calibrated in 0.25-gram intervals from 0 to 1.5 grams. A second weight on the other side of the counterweight can be moved forward against a stop to add exactly one gram to the weight indicated on the stylus pressure scale to obtain forces up to 2.5 grams. Then the entire counterweight system can be moved laterally by a third knob to allow the tonearm's center of gravity to be placed over the center of the knife-edge pivot. Finally, the weight-and-string antiskating compensation system's control, calibrated from 0 to 2.5 grams, can be adjusted as required.

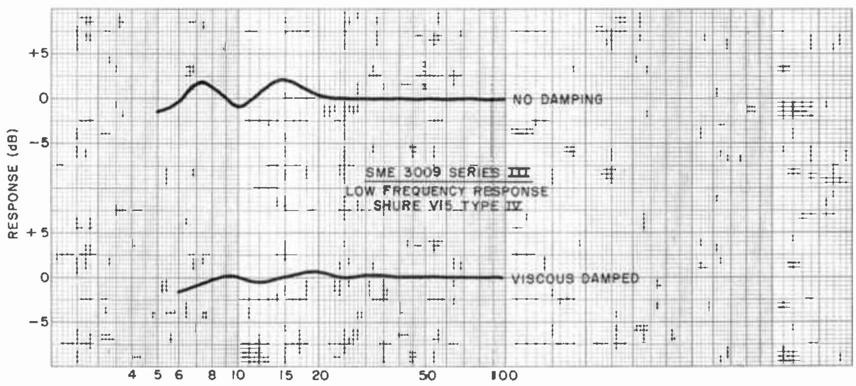
Since the usual plug-in headshell contributes a large portion of the effective mass of a tonearm, it has been eliminated in the Series III tonearm. The entire "arm" plugs into a socket near the pivots. The headshell is a slim plastic cartridge mount that is permanently fixed to the arm tube, which also contains a finger lift.

A lever that extends from the tonearm's base permits the height of the tonearm to be raised and lowered from the turntable and its distance from the center of the turntable to be adjusted. (A

## it will likely reduce record wear

stylus protractor is supplied for setting the stylus overhang for minimum tracking error.)

The low-frequency tonearm-cartridge resonance damping system consists of a curved trough that clips around the




*Illustrated is normal low-bass response vs. flattened response with viscous damping.*

metal housing that contains the tonearm's lift linkage. A small plastic paddle moves through the trough as the tonearm traverses the record's surface. A tube of silicone damping material is supplied with the tonearm. (If damping is to be used, the damping material must be emptied into the trough by the user.) Three different-size paddles are furnished to permit the user to optimize the tonearm for different compliance ratings.

**Laboratory Measurements.** We installed the tonearm on a turntable that had previously been fitted with an early model SME tonearm. While this simplified installation (the two tonearms require identical mounting cutouts), the setup procedure for the Series III tonearm is lengthy and made practical only by one of the best manuals we have seen. It took some two hours for actual installation plus two more hours later on when the damping fluid was added (it takes that long for the fluid to flow from the tube and fill the trough).

We installed a new Shure V15 Type IV cartridge in the tonearm for our tests. A piece of clay-like material supplied with the tonearm was placed between the cartridge and shell to damp out any resonances in the forward end of the tonearm. Since the cartridge has its own integral viscous damping system in its hinged brush assembly, we performed our low-frequency response tests with and without having the damping fluid in the tonearm.

Setting the tonearm tracking error to zero at a 2⅜" (60.3-mm) radius resulted in less than 0.7°/in. tracking error over the entire surface of the record. The accuracy of the tracking force calibration was perfect, within 0.05-gram resolution of our measurement balance over its full range.

The tonearm is supplied with a very high-quality signal cable that is fitted with gold-plated plugs at both ends. It plugs into jacks in the base of the tonearm. The capacitance to ground in each channel was 280 pF, and interchannel capacitance was a very low 2 pF. The effective mass of the tonearm with the Type IV cartridge was only 11.5 grams, which means that the tonearm's basic mass was an incredible 5 grams! By comparison, most contemporary tonearms have masses of 15 to 25 grams.

We measured the 4-to-100-Hz frequency response of the tonearm and cartridge with a Denon 7001 test record to evaluate the effect of the arm's damping system. To simulate the tonearm's operation with a conventional cartridge, we did not use the cartridge's damping system. Having obtained the response curve, we filled the damping trough and repeated the tests. The two curves we obtained were dramatically different and should convince anyone of the efficacy of the tonearm's damping system. Undamped, the bass response began to rise at about 25 to 30 Hz. It was +3.5 dB at 15 Hz, −1.5 dB at 10 Hz, and +3 dB at 8 Hz. It fell off steadily below 8 Hz. (Less compliant cartridges than we used will resonate at higher frequencies and could have larger response peaks at resonance.)

Operating with the damping system of the tonearm in use, the total variation in response was ±0.6 dB from 9 Hz to the 100-Hz upper limit of the test record. We have no doubt that, with sufficient patience and the selection of the proper damping paddle, the response of almost any cartridge could have been flattened as effectively as was this one.

One obvious benefit of the tonearm's damping system, which could be appreciated even without listening to a record, was the isolation it provided from external jarring and vibration.

**User Comment.** The Series III tonearm has the lowest mass by far that we have ever measured for a tonearm. Hence, it will move the resonant frequency of most cartridges installed in it to a point well above the critical 5-to-7-Hz warp range. Furthermore, the tonearm's damping will effectively wipe out any remaining resonance on the frequency-response curve. In our tests, the tonearm tracked warped records that had proved to be unplayable with conventional arms.

The immunity of this tonearm to external vibration and shock was so extraordinary that we must conclude that it would be an effective remedy for a severe or persistent case of acoustic feedback. We were able to pound and jar the turntable quite violently without causing the cartridge to skip grooves or even lose contact with the record. Since feedback can muddy the sound long before it causes audible oscillation, it can also be a valid reason for expecting cartridge sound to be improved.

The aural aspects of the tonearm/cartridge combination was impressive. We felt we heard every last nuance of the material on our records, with nothing left out and nothing added. Of course, the tonearm is not perfect. The lift and descent mechanism does not prevent the arm from drifting out during descent as a result of the antiskating force. We found the drift to be great enough to obviate the usefulness of the lift as a cueing device. In partial compensation, the viscous damping lets the tonearm descend in an especially smooth manner.

This is an expensive tonearm, to be sure. Teaming it with a cartridge of highest quality, however, should result in a winning combination. Additionally, it will likely reduce record wear.

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## Product Focus

*A major design goal of the new SME 3009 Series III tonearm was to reduce its effective mass, referred to the stylus position, to the lowest possible value. This requires that as much as possible of the arm's actual mass be located near the pivots, where it does not contribute as much to the arm's moment of inertia, which is what affects the interface with the cartridge stylus and the record groove. In a counterbalanced arm, this means that the counterweight cannot extend far behind the pivot axis; in the Series III, it is in fact concentrated directly over and just behind the pivots.*

*Another requirement is that the mass of the forward extension of the arm, where the cartridge is mounted, be an absolute minimum. In the Series III, this is an S-shaped tube with a fixed cartridge mount that is little more than a thin piece of perforated plastic containing ½" (12.7-mm) spaced mounting holes and a finger lift instead of the customary massive headshell and its socket and locking ring. The entire arm plugs into the pivoted section, so that the mass of the socket is as close as possible to the pivots.*

*Aside from its physical configuration, the "secret" of the SME design lies in the materials used for its construction. The arm's tube is thin-walled titanium that is extremely light and rigid. It is filled with a light damping material to control resonances. The rather strange looking rear section of the arm, which contains the counterweight and the many arm adjustments, is a black carbon reinforced plastic (although it looks like cast and machined metal). The actual counterweight is composed of a number of lead plates in a removable plastic holder. Only as many plates are used as are actually needed to balance the mass of the cartridge, in the interest of low mass.*

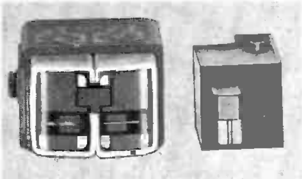
*Another feature of the Series III not found on previous SME tonearms is its optional viscous damping device. It can be used to damp arm motion, both horizontally and vertically, by means of a paddle attached to the arm.*

## The Realistic SCT-30 tells it like it is:

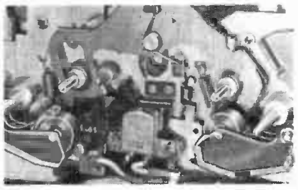
# Why 3 heads are better than 2. Why 2 capstans are better than 1. Why double Dolby* is better than single.

### 3 Heads.

Two independent record and play heads eliminate the compromises of one combined r/p head, and the head assembly is integrated to eliminate azimuth error. The result: cleaner sound. The third head lets you monitor



your recording an instant after it's made, without interrupting the program. SCT-30 *has* 3 heads!



### 2 Capstans.

Dual capstans (instead of the usual 1) reduce wow and flutter to an inaudible 0.06% WRMS or less, and extend the audio frequency response. SCT-30 *has* dual capstans!

### Double Dolby.

You know the single Dolby system cuts noise and adds dynamic range. But let's examine double Dolby. You get Dolby on *both record and monitor* so you know exactly what your tape will sound like. You get a decoder for recording superb Dolby FM stereo. And you get simultaneous listening enjoyment of the decoded broadcast on receivers with tape monitoring. The Realistic SCT-30 *has* double Dolby! About $380.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To go with 3 heads, 2 capstans and double Dolby, you need a cassette tape that will enhance — not degrade — performance. That's why we design and manufacture Supertape Gold in *our own* Fort Worth factory. Like SCT-30, it's a playmate you can believe in at a price you can afford.

### Why Realistic®?

Because Radio Shack has delivered quality audio at sensible prices since 1921, its Realistic tape and recorder line can point to over 5,000,000 customers as living proof of these claims. Add after-sale service that isn't lip service. Add in-house engineering and manufacturing of much of the Realistic line. And add the convenience of neighborhood shopping where you get "sound talk" from a specialist. That's Realistic!

*TM Dolby Laboratories, Inc.


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IF YOU'RE a communications buff or electronics experimenter who wants to try something *really* different, this construction project is for you! There's a whole new world of personal communications waiting to be explored—the world of microwaves. Now you can do just that with the compact, low-cost Mini-Wave Personal Communications system presented here. This inexpensive microwave link allows you to transmit and receive fast-scan television pictures and/or voice signals over paths of 20 miles or more. It can also be used to transmit digital information over similar paths at extremely high baud rates.

Relatively simple circuits are employed in the transmitter and receiver sections, which are available in kit form. The microwave portion of the project, called a *Gunnplexer*, is available factory assembled.

**The Gunnplexer** is the heart of the Mini-Wave system. It is a solid-state product of Microwave Associates, Inc., of Burlington, MA. The Gunnplexer (Fig. 1) consists of a Gunn diode (a microwave source) housed in a resonant cavity, one side of which has an output port called an *iris*. A short section of *waveguide* accepts energy from the iris and contains a low-noise Schottky mixer diode and a ferrite *circulator* (a type of microwave directional coupler).

When a certain level of dc bias is applied across a gallium-arsenide wafer, the current through it begins to oscillate at microwave frequencies. This is the Gunn effect, discovered in 1963 by John Gunn, a researcher at IBM. If a Gunn diode is operated in free space, it generates a train of current pulses whose period is proportional to, among other things, the thickness of the GaAs wafer. The disadvantages of this operating mode are very low efficiency and a fixed output frequency.

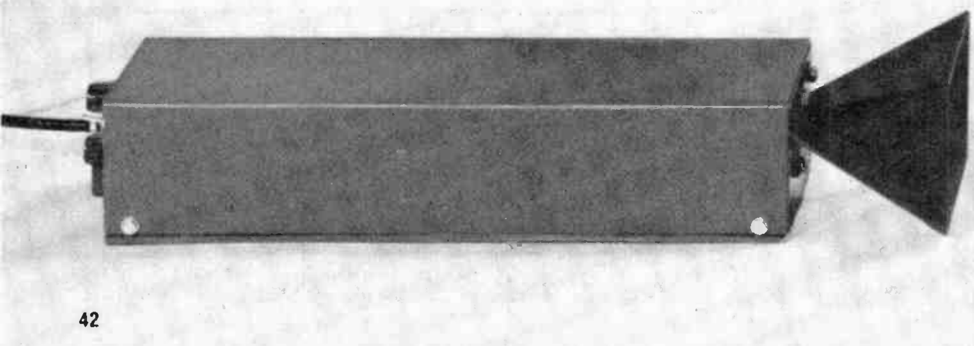
Mounting the Gunn diode in a resonant cavity, which behaves like a high-Q tuned LC circuit, allows the user to tune the microwave output (within limits) to a specific frequency. The Gunnplexer provides two methods of varying the output frequency. A mechanical tuning slug permits altering the characteristics of the cavity, resulting in a tuning range of ±100 MHz referenced to the center frequency of the Gunnplexer. Also mounted in the cavity is a Varactor diode for electronic tuning over a minimum span of 60 MHz. The Varactor is tuned by varying its bias from +1 to +20 volts dc. When the Varactor is operated in the most "sensitive" portion of its curve, a one-volt change in bias level results in a frequency excursion of 15 MHz.

The oscillating Gunn diode sets up an electromagnetic field in the cavity oscillating at (nominally) 10 GHz. A small opening in the cavity (the iris) scaled to the proper dimensions allows the energy to escape from the cavity and pass into a short section of waveguide. The waveguide plays the same role at microwave frequencies that coaxial line plays at hf, vhf and uhf—it couples signals from the source to the antenna. The output of the Gunn oscillator is relatively low (nominally 20 mW), but wavelengths are so small at these frequencies that highly directional antennas with large amounts of gain are physically practicable. Accordingly, the most convenient way to obtain a large effective radiated power (e.r.p.)

*FOR HAMS AND OTHER EXPERIMENTERS. NO-CODE LICENSES AVAILABLE (SEE TEXT).*


# A PERSONAL MICROWAVE COMMUNICATIONS SYSTEM

## THE MINI-



is to use a high-gain antenna. Microwave Associates manufactures several antennas which bolt directly to the wave guide of the Gunnplexer, including horn and parabolic dish antennas. (More on this in Part II of this article.)

In the transmit mode, the Gunn oscillator is frequency-modulated by applying a low-voltage baseband signal across the Varactor tuning diode. The characteristics of the cavity and thus the frequency of oscillation vary in step with the modulating waveform. The Gunnplexer can also be used as a microwave receiver. Here's how.

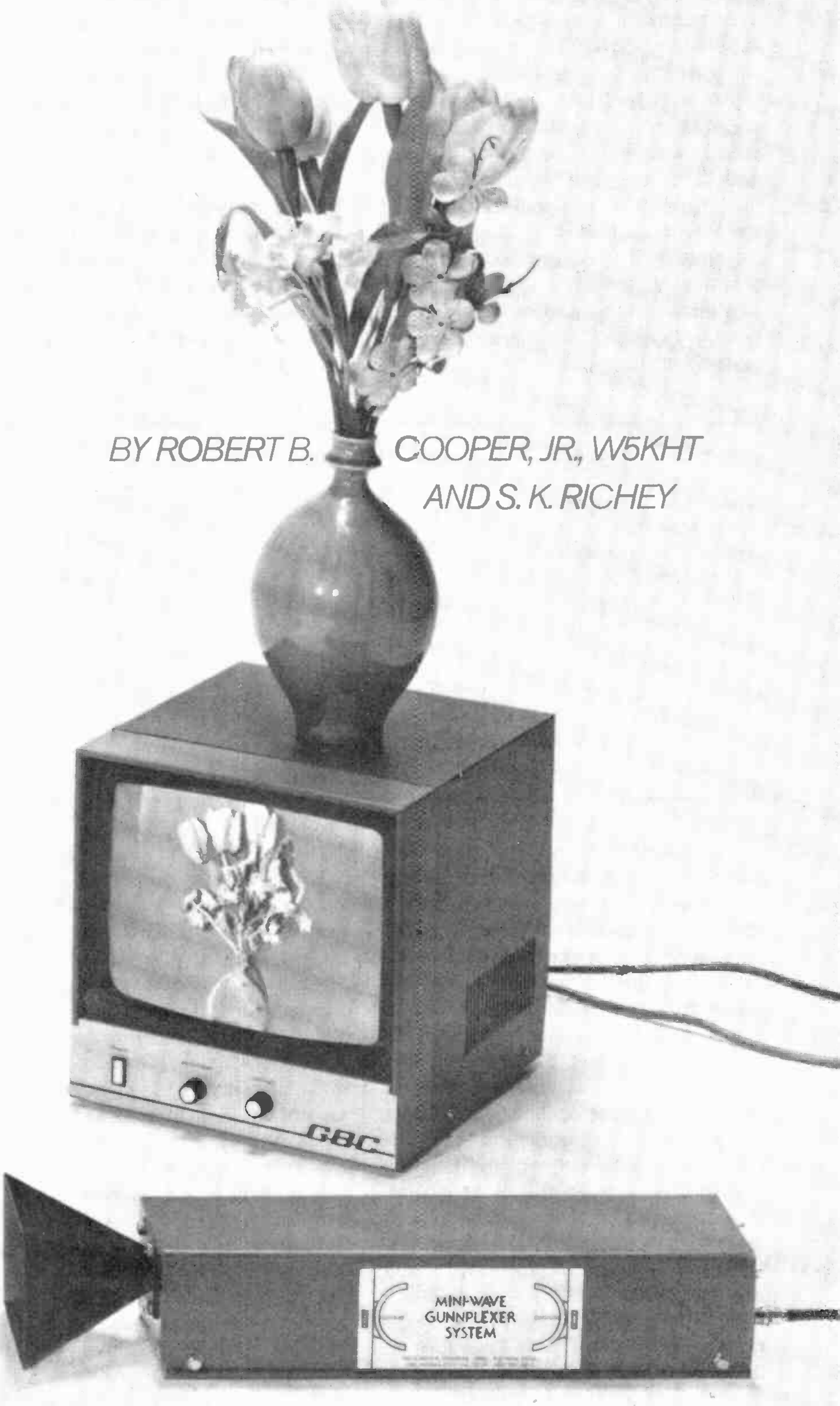
When the microwave energy generated by the Gunn oscillator escapes from the cavity and enters the waveguide, it passes by a circulator, a special ferrite rod. The circulator samples a small amount of the outbound signal (about 0.5 mW) and couples it to a Schottky diode mounted in the waveguide. Microwave energy from a remote transmitting Gunnplexer also enters the waveguide, but from the opposite direction (via the antenna). The circulator also passes this signal to the Schottky diode.

Because it is a nonlinear device, the diode causes the received signal and the local oscillator injection signal from



# PART I

BY ROBERT B. COOPER, JR., W5KHT AND S. K. RICHEY




*A low-cost link for audio, video, or data communications on the 10-GHz band.*

# WAVE

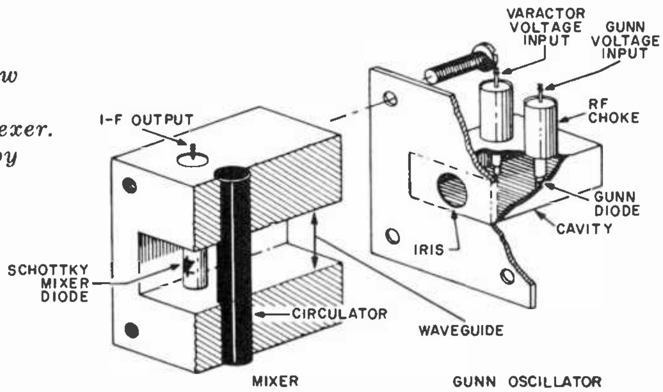
the cavity to heterodyne, resulting in sum and difference mixer products. A Schottky diode is employed. (Noise generated in the receiver can reduce range dramatically, so care must be taken to minimize it. One way to do this is to use low-noise components such as the Schottky diode.)

If the Gunn oscillator in the receiving unit is operating at 10.245 GHz and the oscillator in the transmitting Gunnplexer is operating at 10.2 GHz, the two signals will mix in the Schottky diode to produce a sum signal at 20.445 GHz and a difference signal at 45 MHz. For our purposes, we can ignore the sum signal and concentrate on the difference signal. This 45-MHz i-f signal contains all of the information used to modulate the transmitting Gunnplexer. Because it is at a relatively low frequency, we can employ more or less standard techniques to amplify the signal and extract the information from it.

This article is based on the use of Gunnplexer "transceivers" in the 10.0-to-10.5-GHz band, which has been allocated to the Amateur Radio Service. If you have a Technician or higher Class ham ticket, you can operate Gunnplexers manufactured for use in that frequency band. Gunnplexers designed to operate on other frequencies are available from Microwave Associates on a special-order basis. No-code Mobile and Experimenter licenses that allow you to operate Gunnplexers on bands slightly above 10.5 GHz can be obtained from the FCC. This will be covered next month in Part II.

**The Receiver.** The Mini-Wave video receiver with afc is shown schematically in Fig. 2. As in the previous example, we shall assume that the Gunn oscillators in the transmitter and receiver are operating at frequencies displaced from each other by 45 MHz.

*Fig. 1. Cutaway view of the Microwave Associates Gunnplexer. Energy generated by the Gunn diode escapes through the iris of the cavity into a short section of waveguide.*




The Gunnplexers in the transmitter and receiver are identical, but they are operated at different frequencies (displaced by the chosen i-f). In one-way applications the microwave energy that escapes from the antenna of the receiving unit, which is actually the bulk of the Gunn oscillator's output, is ignored. In the transmitting unit, the built-in receiving function and i-f output are ignored. Of course, you can use the Gunnplexers as transceivers by installing T/R switching to alternately connect the transmit and receive support circuits to the microwave units. You cannot duplex (send and receive at both ends *simultaneously*) video signals, but duplexing audio only is possible.

**Licensing.** Before we take a look at the support circuits schematically, a few words about microwave frequency allocations and licensing are appropriate.

The i-f signal is coupled from the Schottky diode mixer port of the receiving Gunnplexer to a low-noise 45-MHz gain stage. The active device employed, *Q1*, should be able to provide 7 to 10 dB of stage gain, have a minimum gain passband of 10 MHz (the i-f passband is 40 to 50 MHz), and have a maximum noise figure of 3 dB. The author has chosen a Siliconix J-310 low-noise, n-channel junction FET operated in the grounded-gate mode. A low noise figure is very important because it helps keep the overall receiver noise figure down. The typical Schottky diode employed in the Gunnplexer has a maximum noise figure of 12 dB. That might sound high, especially if you're used to working with semiconductors designed for operation at frequencies up to vhf or even uhf, but is fairly low for a microwave device.

The amplified 40-to-50-MHz i-f signal is coupled to another gain stage (*Q2*) via

## RECEIVER PARTS LIST

C1, C2, C8, C11, C12, C15, C17, C20, C21, C35, C36—0.001-µF disc ceramic
C3, C22, C24, C25—10-pF NPO disc ceramic
C4—1-pF NPO disc ceramic
C5—3.3-pF NPO disc ceramic
C6—2.7-pF NPO disc ceramic
C7*—4-to-40-pF trimmer (Elmenco type 422 or equivalent)
C9, C10, C13, C16—0.005-µF disc ceramic
C14, C19—0.003-µF disc ceramic
C18*, C31*, C32*—1-µF, 50-volt tantalum
C23—5-pF NPO disc ceramic
C26—22-pF NPO disc ceramic
C27—0.05-µF disc ceramic
C28*, C33*—33-µF, 50-volt electrolytic
C29—1000-µF, 25-volt electrolytic
C30*—1000-µF, 50-volt electrolytic
C34*—100-µF, 50-volt electrolytic
D1* through D4*—HP5082-2800 hot carrier diode (Hewlett Packard)
D5*—10-volt, 1-watt zener diode
F1*—1½-amp fast-blow fuse
IC1*—µA7812CU 12-volt regulator
IC2*—MC1458V dual operational amplifier
J1*—F-type chassis-mount coaxial jack
L1*—2½ turns of No. 20 wire wound on an air-core ½-inch form, tapped 2 turns above ground end.
L2*, L10*, L12*—6 turns of No. 30 wire wound on a Ferroxcube No. 56-590-65/4B ferrite bead
L3*—18 turns of No. 22 wire wound on a Gowanda Electronics No. 71525 brass-slug form
L4*—18 turns of No. 22 wire wound on a Gowanda Electronics No 71528 ferrite-slug form
L5*—14 turns of No. 22 wire wound on a Gowanda Electronics No. 71528 ferrite-slug form
L6*, L9*, L11*—6 turns of No. 30 wire wound on a Ferroxcube No. 56-590-65/4B ferrite bead, tapped two turns from one end
L7*—2 turns of No. 30 wire wound on a Ferroxcube No. 56-590-65/4B ferrite bead
L8*, L13*—4 turns of No. 20 wire wound on an air-core ¼-inch form
L14*, L15*—18 turns of No. 22 wire wound on a Gowanda Electronics No. 71528 ferrite-slug form
LED1*—20-mA light-emitting diode
Q1*, Q6*—J-310 n-channel junction field-effect transistor (Siliconix)
Q2*—SD1006 npn silicon transistor (Solid State Scientific)
Q3*, Q4*, Q5*, Q7*—2N3563 npn silicon transistor (Motorola)
Q8*—2N6122 npn silicon transistor (Fairchild)
R1*, R19*, R20*, R32*, R38*—10,000-ohm trimmer potentiometer (Beckman No. 72PMR10K or equivalent)
R23*—500-ohm trimmer potentiometer (Beckman No. 72PMR500 or equivalent)
The following are ¼-watt, 10% tolerance carbon composition resistors:
R2—100 ohms
R3, R10, R27, R37, R46—3300 ohms
R4, R6—1500 ohms
R5, R7, R16, R21, R22, R34—470 ohms
R8,R44—6.2 ohms
R9,R12,R14,R29,R30,R45—110 ohms
R11—680 ohms

R13—240 ohms
R15—560 ohms
R17, R18—51 ohms
R24—10,000 ohms
R25,R39—47,000 ohms
R26—1 megohm
R28,R33,R35,R42,R43—2200 ohms
R31—330 ohms
R36—180,000 ohms
R40—100,000 ohms
R41—8200 ohms
RECT1*—1-ampere, 100-PIV modular bridge rectifier
S1*—Spdt miniature toggle switch
S2*—Spst miniature toggle switch
T1*—30-volt center-tapped, 500-mA, transformer
Misc.—Printed circuit board*, standoffs*, ac line cord* and strain relief, suitable enclosure*, Microwave Associates Model MA-87140-1 Gunnplexer, shielded cable, hookup wire, terminal strips*, solder lugs*, fuse holder*, machine and self-tapping hardware*, solder, etc.
*—parts included in "non-standard parts" kit (see Parts Availability box).

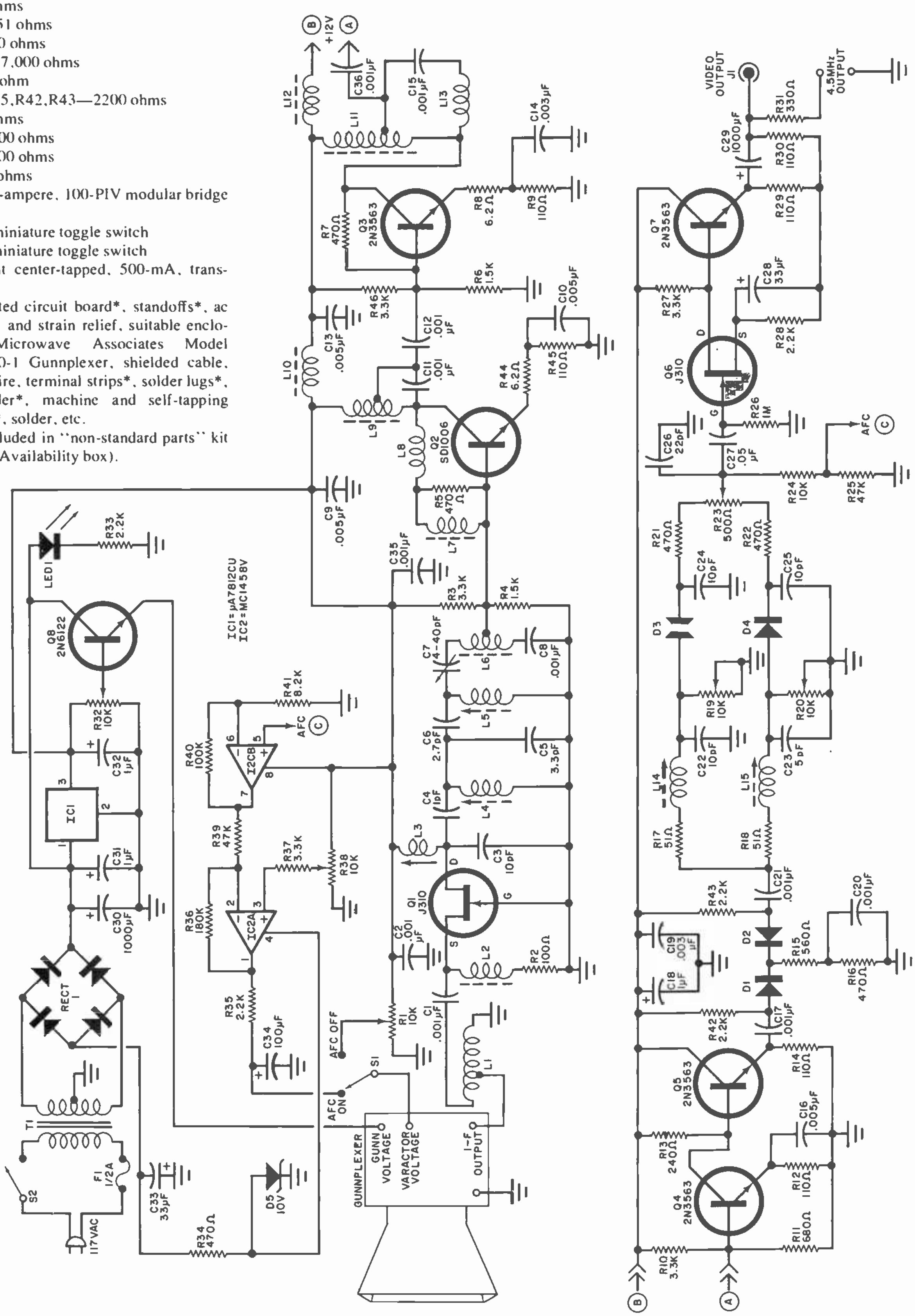



*Fig. 2. Schematic of the Mini-Wave video receiver with automatic frequency control. I-f output of Gunnplexer is coupled to 45-MHz gain stage.*

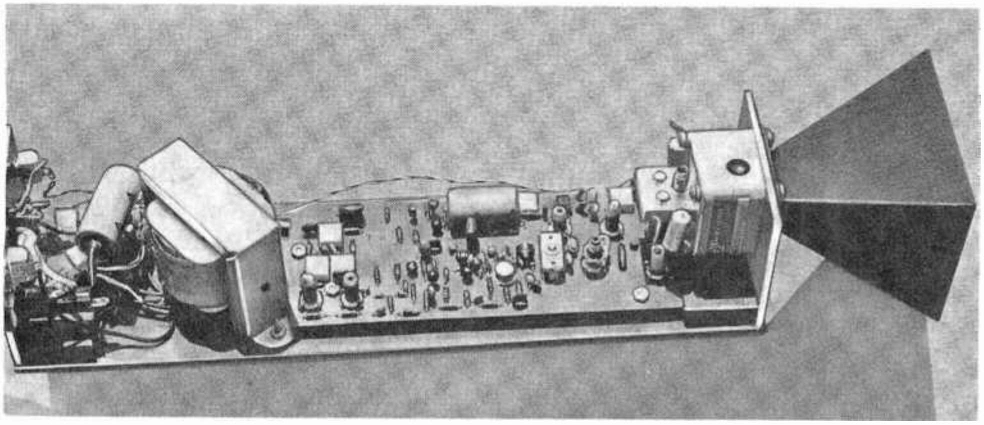
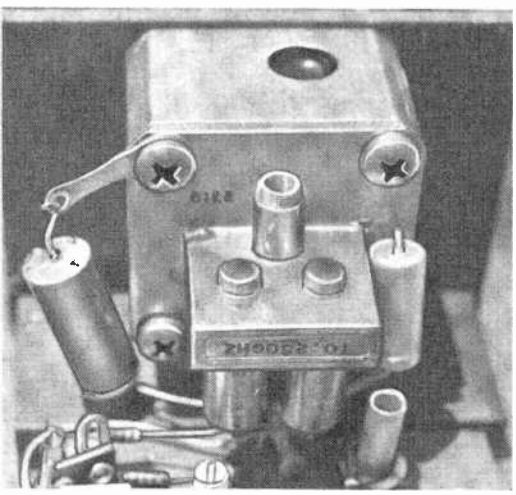


*Photo of Mini-Wave receiver without case. All components including i-f are on pc board. Power supply is located at left of the power transformer.*

an LC network. It functions as a bandpass filter, shaping the receiver's i-f response so that it is flat from 40 to 50 MHz and rejects signals outside this range. The emphasis in this part of the receiver is voltage gain, but noise cannot be ignored. A Solid State Scientific SD-1006, neutralized for stability, is employed in this stage.

Following the SD-1006 are three gain stages utilizing 2N3563 bipolar transistors (*Q3, Q4* and *Q5*). The overall gain of the first five active stages is approximately 50 to 52 dB. After the i-f signal has been amplified to this extent, it is ready to be "cleaned up" before being detected. That is, it is ready for limiting. The primary purpose of a limiter, which is found in just about every FM receiver, is to remove any amplitude variations from the signal before it is applied to the discriminator (FM demodulator). That's the major reason why FM is a much quieter mode of communications than AM.



*Rear view of Gunnplexer showing resonant cavity bolted to short section of waveguide.*

The limiter in the Mini-Wave receiver employs a pair of Hewlett Packard HP5082-2800 *Schottky barrier* diodes, *D1* and *D2*. Schottky barrier diodes consist of rectifying metal-semiconductor contacts in which current flows by means of majority carriers. Most are made of n-type silicon and a metal such as gold. When forward-biased (the metal being more positive than the n-type semiconductor), electrons are injected from the semiconductor into the metal. These electrons have greater velocities than thermally activated electrons of the metal and are called "hot electrons" or "hot carriers." Accordingly, Schottky barrier diodes are often called *hot electron* or *hot carrier diodes*. Hot carrier diodes exhibit voltage and current characteristics closely approximating those of an ideal diode. Because no minority charge carriers are involved, the diodes are faster and quieter than conventional pn junctions and have superior dynamic range and signal-handling abilities.

In the limiter stage, the hot carrier diodes are forward-biased to a predetermined level. As the signal from the last i-f amplifier increases in level, the diodes begin to detect (rectify) it. This creates a dc voltage which tends to reverse-bias the diodes, increasing their internal resistance. Further increases in signal level result in greater reverse bias and internal diode resistance, causing the signal level at the output of the limiter to remain constant once full limiting is reached. This is the limiting action necessary for good FM demodulation.

The output of the limiter is split into two equal signals by *R17* and *R18*, two 51-ohm resistors. Each half of the limiter output is applied to a tuned circuit comprising *L14* and *C22* or *L15* and *C23*. The *L14C22* network is tuned by adjusting the inductor form's slug so that it resonates at 35 MHz. The *L15C23* network is tuned to resonate at 55 MHz. Signals selectively passed by the tuned circuits are rectified by *D3* and *D4*, another pair of HP 5082-2800 hot carrier diodes. A portion of each rectified signal is shunted to ground by *R19* or *R20*, and the output signals from the two legs of the discriminator are recombined through *R23*, a 500-ohm balancing potentiometer. During alignment, *R19* and *R20* are adjusted so that an unmodulated carrier at exactly 45 MHz produces a zero-volt output, and *R23* is adjusted so that there are equal positive and negative voltage swings produced by the two discriminator legs.

Before we examine the video amplifier, here's a note concerning *D1, D2, D3* and *D4*. One might be tempted to substitute less expensive diodes for the HP5082-2800 components. *Don't!* The quality of the limiter and discriminator diodes is crucial to overall receiver performance. In fact, one of the major differences between this receiver and a commercial model that performs essentially the same function is the substitution of higher-grade and more expensive ($7.50 each) diodes in the limiter circuit. So do not substitute components in this project if you expect it to deliver the same level of performance as the author's prototype.

What the discriminator delivers is essentially pure video, or, to be more precise, the baseband (modulating) signal with a 0-to-5-MHz bandwidth. Most of the useful video information, however, is found between dc (0 Hz) and approximately 3.8 MHz. The detector output is capacitively coupled to a low-noise amplifier employing a J-310 JFET (*Q6*). Output signals from the drain of the JFET drive *Q7*, a 2N3563 npn silicon transistor operating as an emitter follower. The output of the follower is capacitively coupled to *J1*, the video output jack. When the limiter is fully limiting, an output signal of 1 volt peak-to-peak across a 75-ohm load will be produced.

The output signal will not contain a dc component because of the blocking action of coupling capacitors *C27* and *C29*. It will, however, contain a 4.5-MHz audio subcarrier if one was introduced at the transmitter. The composite output can be tapped via *R31* for application to the optional audio subcarrier demodulator, which will be examined later.

**Frequency Stability and AFC.** To receive signals from a transmitting Gunnplexer, the receiver must of course

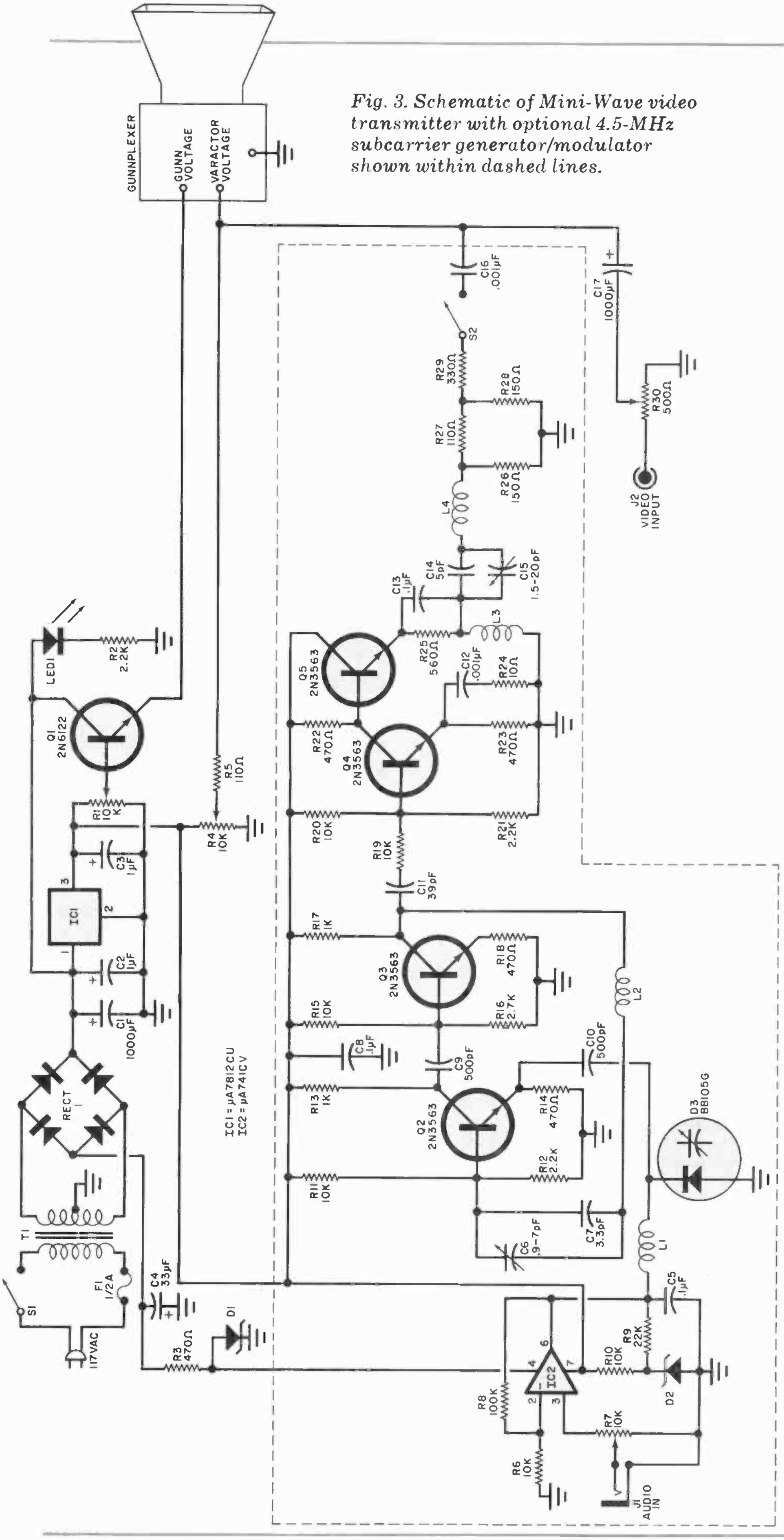



*Fig. 3. Schematic of Mini-Wave video transmitter with optional 4.5-MHz subcarrier generator/modulator shown within dashed lines.*

## TRANSMITTER PARTS LIST

C1*—1000-µF, 50-volt electrolytic
C2*,C3*—1-µF, 50-volt tantalum
C4*—33-µF, 50-volt electrolytic**
C5, C8, C13—0.1-µF disc ceramic**
C6*—0.9-to-7-pF trimmer** (Elmenco type 400 or equivalent)
C7—3.3 pF NPO disc ceramic**
C9,C10—500-pF NPO disc ceramic**
C11—39-pF NPO disc ceramic**
C12, C16—0.001-µF disc ceramic**
C14—5-pF NPO disc ceramic**
C15*—1.5-to-20-pF trimmer** (Elmenco type 402 or equivalent)
C17*—1000-µF, 25-volt electrolytic
D1*—10-volt, 1-watt zener
D2*—5-volt, 1-watt zener**
D3*—BB105G Varactor** (Amperex)
F1*—½-ampere fast-blow fuse
IC1—µA7812CU 12-volt regulator
IC2*—µA741CV operational amplifier**
J1*—miniature phone jack**
J2*—F-type chassis-mount coaxial jack
L1* through L4*—100-µH inductor ** (J.W. Miller No. 70-F-104AI or equivalent)
LED1*—20-mA light-emitting diode
Q1*—2N6122 npn transistor (Fairchild)
Q2* through Q5*—2N3563 npn silicon transistor** (Motorola)
R1*,R4*—10,000-ohm trimmer potentiometer (Beckman No. 72PMR10K or equivalent)
R7*—10,000-ohm trimmer potentiometer** (Beckman No. 72PMR10K or equivalent)
R30*—500-ohm trimmer potentiometer (Beckman No. 72PMR500 or equivalent)
The following are ¼-watt, 10% tolerance carbon composition resistors unless otherwise noted:
R2—2200 ohms
R3,R14,R18,R22,R23—470 ohms**
R5—110 ohms
R6,R10,R11,R15,R19,R20—10,000 ohms**
R8—100,000 ohms**
R9—22,000 ohms**
R12,R21—2200 ohms**
R13,R17—1000 ohms**
R16—2700 ohms**
R24—10 ohms**
R25—560 ohms, ½-watt**
R26,R28—150 ohms**
R27—110 ohms**
R29—330 ohms**
RECT1*—1-ampere, 100 PIV modular bridge rectifier
S1*—Spst miniature toggle switch
S2*—Spst miniature toggle switch**
T1*—30-volt center-tapped, 500-mA transformer
Misc.—Printed circuit board*, standoffs*, ac line cord* and strain relief, suitable enclosure*, Microwave Associates Model MA-87140-1 Gunnplexer, shielded cable, hookup wire, terminal strips*, solder lugs*, fuseholder*, machine and self-tapping hardware*, solder, etc.
*—parts included in "non-standard parts" kit (see Parts Availability box)
**—required only if optional 4.5-MHz audio subcarrier generator/modulator is included in transmitter

be tuned to the proper frequency. It also must *stay* tuned to that frequency. In our Mini-Wave system, the goal is to keep the receiver local (Gunn) oscillator exactly 45 MHz *above* the transmitting Gunnplexer's output frequency. Initially, the Gunnplexers can be tuned to their respective frequencies by adjusting the coarse (mechanical) tuning control and fine-tuning them electronically by varying Varactor bias.

However, Gunnplexers will drift to an extent. The major cause of the drift is the effect of temperature upon the cavity in which the Gunn diode is mounted. As the ambient temperature increases, the cavity will expand slightly and the frequency of oscillation, which is very dependent on the resonant frequency of the cavity, will decrease. Conversely, cooling the Gunnplexer will cause the cavity to contract and the frequency of oscillation to increase. Each one degree (Celsius) change in temperature will cause the Gunnplexer frequency to shift by 0.35 MHz.

If both the transmitting and receiving Gunnplexers are located in roughly the same environment—say, outdoors reasonably close to each other—both units will drift in the same direction and will stay in tune. However, if one Gunnplexer is indoors, the other is outdoors, and there is a substantial difference in ambient temperature, the Gunnplexer output frequencies might drift considerably away from each other. A switchable afc circuit has been incorporated into the Mini-Wave receiver to help the user cope with this potential problem.

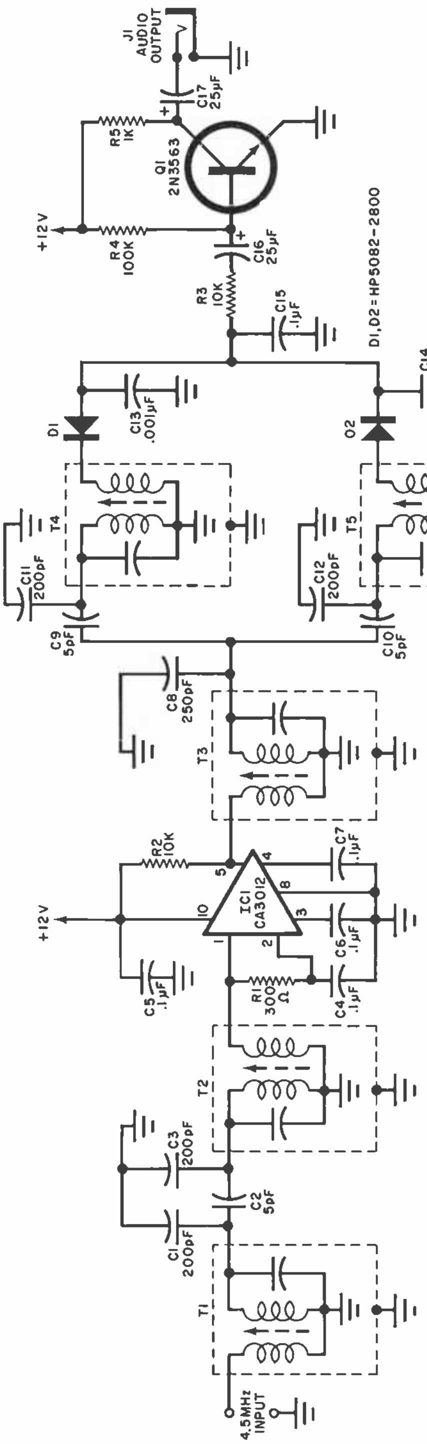



*Fig. 4. Schematic of the optional audio subcarrier demodulator for use with the Mini-Wave video receiver.*

### AUDIO DEMODULATOR PARTS LIST

C1,C3,C11,C12—200-pF NPO disc ceramic
C2,C9,C10—5-pF NPO disc ceramic
C4,C5,C6,C7,C15—0.1-µF disc ceramic
C8—250-pF NPO disc ceramic
C13,C14—0.001-µF disc ceramic
C16*,C17*—25-µF,50-volt electrolytic
D1*,D2*—HP5082-2800 hot carrier diode (Hewlett Packard)
IC1*—CA3012 wideband amplifier (RCA)
J1*—miniature phone jack
Q1*—2N3563 npn transistor (Motorola)
The following are ¼-watt, 10% tolerance carbon composition resistors:
R1—300 ohms
R2,R3—10,000 ohms
R4—100,000 ohms
R5—1000 ohms
T1* through T5*—10.7-MHz i-f transformer (Mouser Electronics No. 801F or equivalent)
Misc.—Printed circuit board*, standoffs*, shielded cable, hookup wire, hardware*, solder, etc.
*—parts included in "non-standard parts" kit (see Parts Availability box).

Directly after the 500-ohm discriminator balancing potentiometer (*R23*) there is a 10,000-ohm resistor (*R24*) which taps a portion of the discriminator output. This signal is applied to the noninverting input of *IC2B*, one half of an MC1458 dual operational amplifier. It is amplified by this stage and *IC2A*. In the second gain stage, the amplified discriminator output is applied to the inverting input. A positive dc voltage is applied to the noninverting input via *R37* and *R38*. The trimmer potentiometer is adjusted during the alignment procedure so that a +4-volt offset appears at the output of *IC2A* under no-signal conditions. Trimmer *R1* is also adjusted during alignment with *S1* in the AFC OFF position so that +4 volts is applied to the Varactor diode. This is the normal reverse bias for the tuning diode in the Mini-Wave receiver.

If *S1* is placed in the AFC ON position and one or both Gunnplexers start to drift so that the normal 45-MHz frequency offset is not maintained, an "error" voltage will be developed at the output of the discriminator. This error voltage is sampled, amplified, and level shifted by the afc circuit. The result is a change in Varactor bias and, thus, in the receiving Gunnplexer's frequency of oscillation. The afc circuit allows the receiver's local (Gunn) oscillator to track the transmitter over a ±10-MHz range with a worst-case error of 0.5 MHz. In this way, the 45-MHz offset can be maintained and the received signal kept in the center of the receiver's i-f passband.

The temperature drift characteristic of the Gunnplexers was carefully considered when forming the "band plan" for the 10-GHz amateur band described in Part II of this article. (The band plan is a system of channelization intended to provide as many interference-free, simultaneous one-way video channels in a single area as possible within the 500-MHz wide allocation.) Normally, temperature-caused drift is an undesirable characteristic of communications equipment; good engineering practice is to make it as small as possible. However, there are applications which *depend* on thermally induced drift in the equipment employed.

For example, a transmitting Gunnplexer can be set up at a remote location and its frequency allowed to drift wherever (within band limits!) variations in temperature take it. A receiving Gunnplexer is then installed in an environment with a closely controlled ambient temperature. The difference frequency at the i-f output of the receiving Gunnplexer is sampled, counted, and scaled using the 0.35-MHz/°C thermal characteristic. Finally, the quantity obtained via the foregoing procedure is added to the ambient temperature at the receiver. These operations can be performed by suitable digital arithmetic circuits. The numerical result is the ambient temperature at the transmitting Gunnplexer, and the entire system forms a highly accurate, remote-sensing, wireless electronic thermometer!

The Mini-Wave receiver requires several operating voltages which are furnished by a line-powered, regulated supply. Transformer *T1* and modular bridge *RECT1* convert line-voltage ac into low-voltage bipolar pulsating dc. The positive bridge output is filtered by *C30* and the negative output by *C33*. Regulator *IC1* delivers +12 volts at pin 3, its output terminal. Most of the receiver is powered by this +12-volt line.

A few circuits call for other operating voltages. The operational amplifiers in the afc circuit require −10 volts dc as well as +12 volts. The negative voltage is derived by regulating the filtered negative bridge output by means of zener diode *D5* and current-limiting resistor *R34*. The Gunn diode in the Gunnplexer requires +8 to +12 volts of *pure* dc at 500 mA maximum. The diode is supplied with +8 volts regulated by tapping the +12-volt output of the regulator IC via trimmer potentiometer *R32*. The potentiometer supplies base drive for pass transistor *Q8* and is adjusted so that +8 volts appears between the emitter of *Q8* and ground. The Varactor diode is normally biased by +4 volts, which is derived from either trimmer *R1* (afc off) or the afc circuit (afc on).

The power supply is extensively bypassed and r-f decoupled. Tantalum capacitors *C31* and *C32* prevent noise from disturbing the regulator IC, and such components as *L10*, *L12* and *C13* provide decoupling. The supply is fuse-protected and has a LED pilot light.

**The Transmitter.** The Mini-Wave video transmitter with optional 4.5-MHz audio subcarrier generator/modulator is shown schematically in Fig. 3. In the transmit mode, the Gunn oscillator output, except for the small portion sampled by the circulator, is radiated by the antenna. The receiving capabilities of the Gunnplexer and the small loss of output signal to the circulator are, for our present purpose, ignored. The typical 10-GHz Gunnplexer provides 12 to 20 mW of output power, drawing a maximum of 500 mA from an 8-to-12-volt dc source.

We have already seen that the Gunnplexer's frequency of oscillation can be varied by mechanical (coarse tuning) and electronic (fine tuning) means. The frequency can be shifted electronically by varying the bias applied across the Varactor tuning diode from +1 to +20 volts. If a modulating signal with an amplitude varying within these limits is applied across the diode, the amount of frequency deviation will depend on the amplitude of the modulating signal, while the rate of deviation will depend on the frequency of the modulating signal. In other words, it's possible to frequency modulate the Gunnplexer merely by applying an audio or video baseband signal across the Varactor diode. That's exactly what is done.

The transmitter is relatively simple—the bulk of the "hard work" has already been done by Microwave Associates in assembling the Gunnplexer. In fact, the major portion of the transmitter schematic is occupied by the optional 4.5-MHz audio subcarrier circuit shown within the dashed lines.

The video input signal, say, from a TV camera or video tape player is applied to jack *J2*. A portion of this signal is tapped by the wiper of level control *R30* and capacitively coupled by *C17* to the Gunnplexer's Varactor input port. The level control should be adjusted so that a 1-volt peak-to-peak modulating signal is obtained. This signal and a dc level are simultaneously applied across the Varactor. The dc level is derived from the transmitter power supply's 12-volt regulated output via trimmer *R4* and *R5*. The trimmer should be adjusted during alignment for a +4-volt bias level.

The power supply is similar to that in the receiver. Line-voltage ac is stepped

### PARTS AVAILABILITY

So that readers with varying levels of experience in building projects and/or parts procurement opportunities can get started in microwave communications, Mini-Wave hardware is available in several different versions.

- Kit of parts for one Mini-Wave transmitter and one Mini-Wave receiver, including pc boards, all components, enclosures, etc., but not including Gunnplexers:
  a) video only, $140.00;
  b) video and audio, $180.00
- Non-standard parts kit including all components marked with single asterisks in the Parts Lists:
  a) video only, $105.00;
  b) video and audio, $145.00.

The above items are available from Microwave Division, CSSC, Box 20335, Oklahoma City, OK 73120. Add $7 postage and handling for each kit shipped within U.S. Oklahoma residents please add sales tax.

**Gunnplexers and Antennas.** The following are available from Microwave Associates, Inc., 63 Third Avenue, Burlington, MA 01803, Attention: Dana Hapgood.

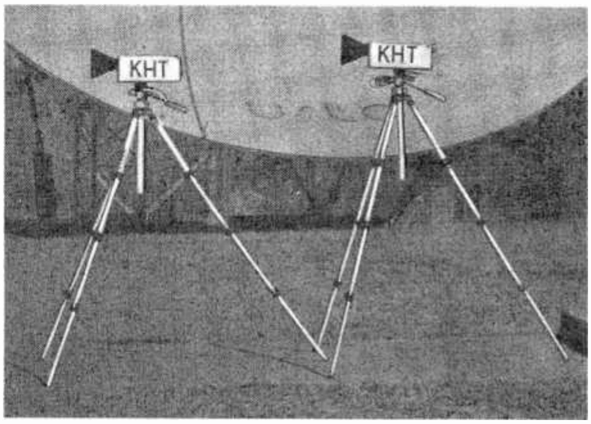
- Two Gunnplexers with 17-dB gain horn antennas, Part No. MA-87141-1, $180.00. Specify operating frequency or channel number.
- One Gunnplexer with 17-dB gain horn antenna, Part No. MA-87140-1, $108.00. Specify operating frequency.
- Two Gunnplexers less 17-dB gain horn antennas, Part No. MA-87127-1, $160.00. Specify operating frequency.
- One Gunnplexer less 17-dB gain horn antenna, Part No. MA-87127-1, $85.00. Specify operating frequency.

Prices of Gunnplexers operating outside the 10.0-to-10.5-GHz amateur band are slightly higher.

- Two-foot diameter, solid-surface parabolic antenna with 32 dB gain and 4° half-power (−3 dB) beamwidth, mounts to 2-inch pipe, Part No. MA-86555, $165.00. Specify operating frequency.
- Four-foot diameter, solid-surface parabolic antenna with 38 dB gain and 2° half-power (−3 dB) beamwidth, mounts to 2-inch pipe, Part No. MA-86556, $265.00. Specify operating frequency.

Prices include postage and handling for items shipped within U.S. Massachusetts residents please add sales tax.

**Additional Literature.** Gunnplexer data sheets, a compilation of application notes from prior users of Gunnplexer equipment, are available at no charge (include stamped, self-addressed business-size envelope) from Microwave Associates, 63 Third Avenue, Burlington, MA 01803, Attention: Dana Hapgood. ◇




*Mini-Wave units with 17-dB horn antennas can be mounted on camera tripods.*

down by *T1* and converted by *RECT1* into pulsating bipolar dc. Positive and negative dc components are filtered by *C1* and *C4*, respectively. The positive dc is regulated by *IC1*, a $\mu$A7812CU 12-volt regulator. This regulated voltage supplies the bulk of the audio subcarrier generator/modulator circuit. It is also tapped by *R4* and *R5* to provide dc bias for the Varactor tuning diode inside the Gun oscillator cavity.

Operating voltage for the Gunn diode (+8 volts regulated) is supplied by pass transistor *Q1*. The collector of *Q1* is connected to the unregulated positive dc voltage. Base drive is derived from the regulated +12-volt output via trimmer *R1*, which is adjusted so that +8 volts appears between the emitter of *Q1* and ground. The −10 volts regulated dc required by the op amp in the subcarrier generator/modulator section is provided by zener diode *D1* and current limiting resistor *R3*.

Now let's examine the audio subcarrier generator/modulator. Input signals from a high-impedance (10,000 ohms or more) source are sampled by level control *R7*, which couples them to op amp *IC1*. The output of the op amp *IC1* is applied across Varactor diode *D3*, whose capacitance varies in step with the amplitude of the audio waveform. Changes in diode capacitance cause the frequency of oscillation of *Q2*, a 2N3563 npn transistor oscillating at 4.500 MHz under no-signal conditions, to vary. Thus, the resulting output is frequency-modulated by the audio input waveform.

Common emitter amplifiers *Q3* and *Q4* boost the level of the 4.5-MHz frequency modulated audio subcarrier. Emitter follower *Q5* buffers the amplified subcarrier, which passes through an LC network tuned for maximum response at 4.5 MHz to a resistive pad. Trimmer capacitor *C15* tunes the LC network's response; trimmer *C6* in the oscillator stage (*Q2*) allows the subcarrier frequency to be set at exactly 4.500 MHz.

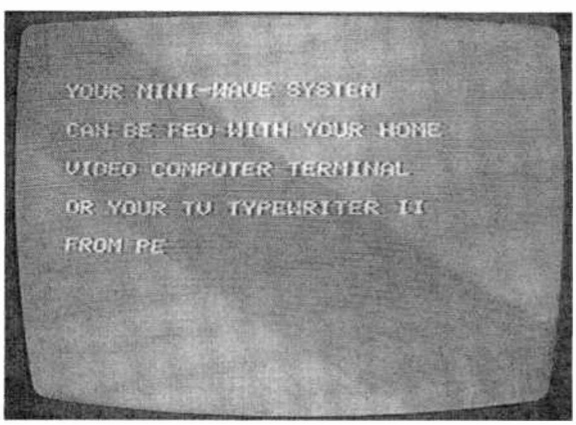
When switch *S2* is closed, the subcarrier is coupled to the Gunnplexer's Varactor diode via *C16*. The video input and the audio subcarrier simultaneously frequency modulate the Gunnplexer. However, the level of the audio subcarrier is 20 dB below that of the video input due to the attenuation introduced by the resistive attenuator. This difference in signal level (1 volt peak-to-peak video, about 0.1 volt rms audio subcarrier) prevents the subcarrier from adversely affecting the quality of video reception.

Switch *S2* allows the user to disconnect the subcarrier generator/modulator from the rest of the transmitter if he wants to stop transmitting audio or employ a video source with built-in audio circuits. Of course, if audio capability is not desired or a video source with a built-in audio subcarrier generator/modulator is used to drive the Gunnplexer, the circuit shown within the dashed lines in Fig. 3 can be omitted. The components comprising the subcarrier generator/demodulator are denoted with *two* asterisks *after* their values or part numbers in the Transmitter Parts List.

**Audio Subcarrier Demodulator.** The output of the Mini-Wave receiver is relatively broadbanded, and will contain a frequency modulated 4.5-MHz audio subcarrier if one was generated in the transmitter. The receiver's composite video output is tapped via *R31* for application to the optional audio subcarrier demodulator shown in Fig. 4.

The circuit employs relatively inexpensive components, but delivers a high level of performance. Commonly available J.W. Miller type 801F i-f "cans," designed for operation at 10.7 MHz, are padded down with external 200- and 250-pF disc ceramic capacitors to resonate at 4.5 MHz. The composite output of the receiver is applied to two cascaded i-f transformers (*T1* and *T2*) which are tuned to pass only the frequency modulated audio subcarrier. This signal is amplified by *IC1*, an RCA CA3012 wideband amplifier, which drives *T3*, a tuned i-f transformer padded by *C8*. Supply voltage for *IC1* and audio amplifier *Q1* is derived from the receiver.

Transformers *T4* and *T5* and hot carrier diodes *D1* and *D2* form an FM demodulator or discriminator. The transformers are tuned to the extremes of the audio subcarrier passband and selectively route signals to the diodes. The recombined, demodulated audio is capacitively coupled to *Q1*, a 2N3563 common-emitter amplifier. Audio signals from the amplifier are coupled by *C17* to *J1*, the audio output jack. The signal level at the jack is approximately 50 millivolts across 1000 ohms. That's enough to drive a pair of earphones, but is inadequate for a loudspeaker. If you want to use a speaker, signals should be coupled from *J1* to a suitable audio amplifier, which will drive the speaker. ◇




*Mini-Wave system can be used in data communications. Photo shows information received from a TV typewriter located several miles away.*

*This concludes Part I. In Part II, we will present pc board guides, cover construction, alignment, set-up and licensing of the system, and discuss suitable antennas and their effect on communications range.*

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# Secrets of the New Amateur Code Exams

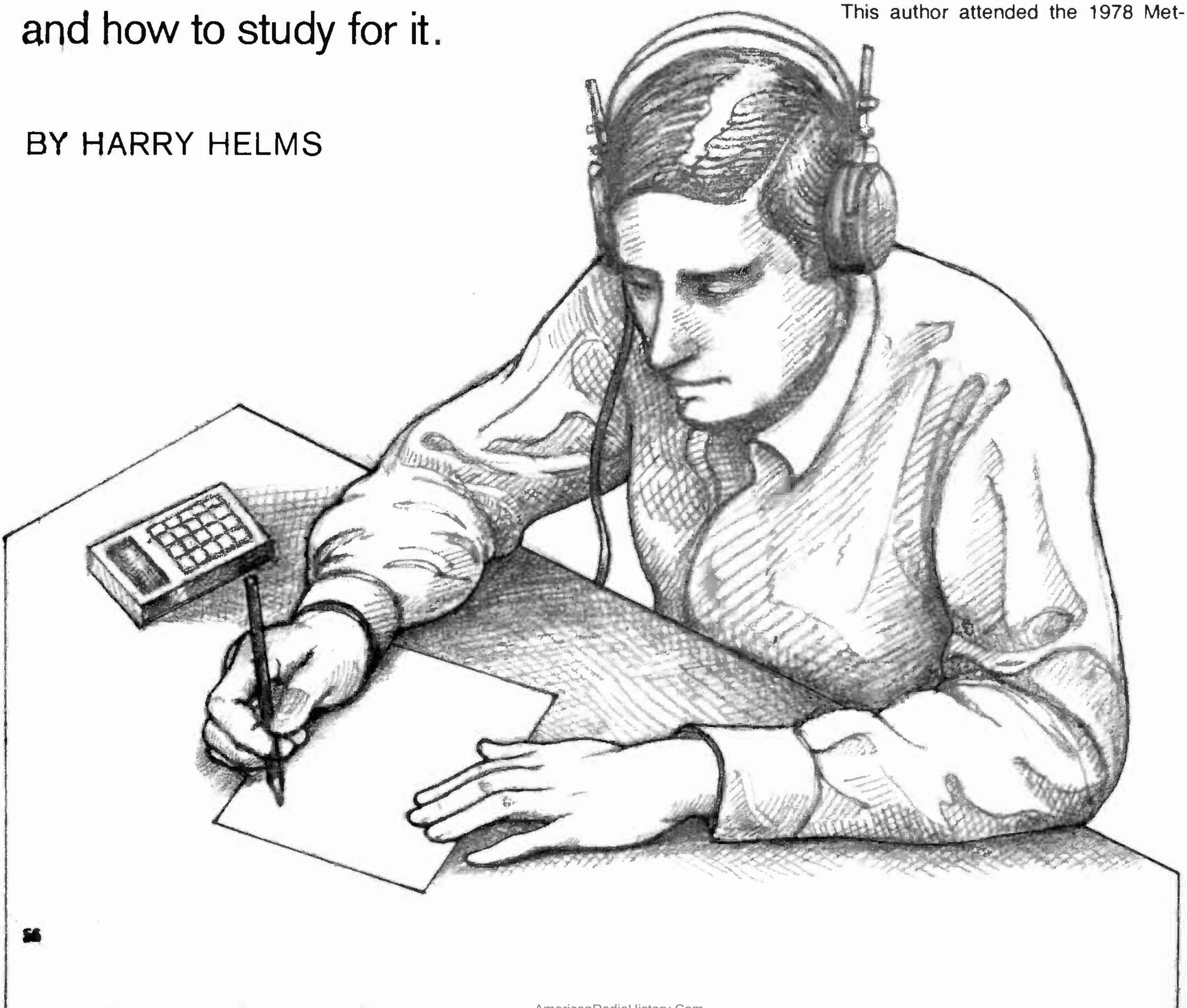
What recent changes have been made in the ham radio license exam and how to study for it.

BY HARRY HELMS

In 1977, the Federal Communications Commission broke with 50 years of tradition that had required all candidates for an Amateur radio license to prove proficiency in receiving Morse code by copying a solid minute of code without error. Instead, the FCC introduced new "comprehension" exams. Here, a five-minute-long message is sent in CW and the applicant answers ten multiple-choice questions about the message's content. If the applicant correctly answers at least eight questions, he passes the test. Sounds easy, but is it?

When the new exams were introduced, some old-timers thought the FCC had virtually eliminated Morse code as a requirement for an Amateur license. Hams-to-be were almost universally relieved at the prospect of taking an "easier" code exam. Yet, many persons still failed the code portion of the Amateur exams after the introduction of the comprehension exams. Dark rumors soon began to circulate that the FCC had "pulled a fast one" on Amateurs; that the new exams were actually tougher than the old straight-copy tests!

This author attended the 1978 Met-



## SAMPLE TEXT OF TYPICAL FCC COMPREHENSION CODE EXAM

VVV VVV VVV BK K2XXX DE WB2XYZ OK JACK TNX FOR CL. NAME HR IS JACK ES QTH IS NEW BEDFORD, CONN. TNX FOR THE RST 579 RPT, UR RST IS 589. MY XMTR IS A DX60, 90 WATTS INPUT, INTO 40 MTR INVERTED L. RCVR IS A DRAKE 2C WITH NINE TUBES. TEMP HR IS 35 DEGREES C ES WX IS CLOUDY ES WARM. I AM AN ATTORNEY, 47 YRS OLD. I ALSO WORK SSTV ES HAVE A SKED AT 0230 GMT WITH VU6DZZ. I HOLD A GENERAL CLASS LICENSE ES PLAN TO TAKE THE EXTRA EXAM IN JULY. JUST RCVD MY WAC CERTIFICATE IN THE MAIL. AR K2XXX DE WB2XYZ K

### Sample Questions

*1. The call sign of the transmitting station is:*
A. WA2XYZ
B. K2XXX
C. WB2XYZ
D. WB2XXX
E. K2XYZ

*2. The names of the two operators are:*
A. Jack, John
B. Jack, James
C. Jack, Jackie
D. Jack, Jack
E. Jackie, John

*3. The location of station transmitting is:*
A. New York, New York
B. New Bedford, New York
C. New Bedford, New Jersey
D. New Beddington, New York
E. New Bedford, Connecticut

*4. The RST signal report sent by the transmitting station is:*
A. RST 579
B. RST 569
C. RST 589
D. RST 559
E. RST 599

*5. The input power used by the transmitting station is:*
A. 60 watts
B. 70 watts
C. 80 watts
D. 90 watts
E. 150 watts

*6. What type of antenna is the transmitting station using?*
A. Dipole
B. Inverted V
C. Vertical
D. Longwire
E. Inverted L

*7. The temperature at the transmitting station's location is:*
A. 35 degrees Fahrenheit
B. 45 degrees Fahrenheit
C. 35 degrees Centigrade
D. 45 degrees Centigrade
E. 30 degrees Centigrade

*8. The operator of the transmitting station is an:*
A. accountant
B. advertiser
C. attorney
D. actuary
E. adviser

*9. The transmitting station has a schedule with which station and at what time?*
A. VU6DZZ at 0130 GMT
B. VU6BZZ at 0230 GMT
C. VU6DZZ at 0230 GMT
D. VU6BZZ at 0130 GMT
E. VU6DZZ at 0230 EST

*10. The transmitting station just received which of the following certificates?*
A. WAS
B. DXCC
C. WAZ
D. WAC
E. WAE

rolina Hamfest in Charlotte, NC, where more than 600 applicants took Amateur exams administered by the FCC. Those who took the new CW exams had a variety of reactions, terming them: "easy," "nitpicking," "tricky," "less pressurized," and "devious." But one word kept popping up time after time: *different*. It became readily apparent from the reactions of those taking the new exams that many of the study techniques and test-taking strategies applicable to the old straight-copy tests no longer apply.

**What It Involves.** As noted earlier, previous Amateur code exams were split into separate sending and receiving tests. Five minutes of CW were sent, and the applicant had to copy at least one solid minute without error to receive a passing score. The sending test was similar, with the applicant required to send at least one minute of perfect CW.

Today, there is only a receiving exam. The FCC is now using personnel who do not know CW themselves to administer some Amateur exams, thus making elimination of the sending test a necessity. The use of such personnel also forced a conversion to the new receiving tests. When an exam is graded, the examining officer ignores the applicant's copy. Only the answers to the multiple-choice questions are graded. In fact, there is no requirement to write down any of the code received. You can copy in your head or merely make notes on what you hear. Of course, you may still copy everything received if you wish.

When you report for the code exam, the examiner gives you a sheet of paper with space to copy the message and spaces for answering the multiple-choice questions. One minute of CW is sent as a warm-up exercise, after which the examiner asks if anyone had problems hearing the code. If everyone heard the warm-up material satisfactorily, the examiner sends a five-minute message. The content of the message is a typical amateur QSO. All code tests are on tape cassettes, and each group examined on a particular day gets a different test.

At the end of the message, the examiner distributes a sheet with 10 multiple-choice questions about the material sent. Each question has five choices for answers. You can refer to the copy or notes you made during the message. Upon completing the test, the examiner grades your paper. If you answer at least eight out of 10 questions correctly, you pass. The examiner keeps your answer and question sheets and any notes or copy you made.

**The Pitfalls.** One of the biggest problems encountered by many applicants on the new exams is a misunderstanding of what the FCC means by the term "comprehensive." Many people apparently interpret this to mean that test questions will involve only generalities. This is not so! The questions deal with details. Some people would even term the exams "picky." The fact is, however, that you cannot pass the new exams without knowing specifics of the message sent.

Among the items you must copy are station call signs, names of operators, signal reports, locations, types of gear and antennas used, ages of the operators, transmitter power, and virtually everything else involving a number. That's quite a bit to keep straight in your head. So, you're well advised to copy down what you hear unless you are blessed with total recall from memory.

One frequent complaint is that the

new exams are deceptive. This seems to be justified, judging from some of the examples told to this author. The various answer possibilities offered are so similar that copying one letter or number wrong could result in an incorrect response. Exam questions must be read very carefully if one is to avoid an incorrect response owing to confusing the transmitting and receiving stations and their call signs.

The message must be followed very literally when answering questions. Some of the information in the message may be improbable, but it is the only information on which your responses should be based. Here are some examples: A station with a W4 prefix, normally assigned to the Southeast, may be located in the Northwest. Both operators may have the same first names. The weather may be inappropriate for a station's location, such as "snow in Florida." Yet, all responses must be based on the message.

**Other Considerations.** Many applicants express surprise at the pitch at which the code in these tests is sent. The pitch is fairly high in comparison to many commercial code-practice tapes. Consequently, you will find it worthwhile to spend some time copying high-pitched CW.

Many people seeking the 5-WPM Technician license are startled to discover the CW sent at about 13 WPM, but spaced out between characters for 5 WPM. Only 25 characters are sent in each minute, yet the speed of each character is such that it is virtually impossible to count the dots and dashes that make up each character. In contrast, many commercial code practice tapes for 5 WPM are sent at a speed slow enough to allow such counting and may therefore harm the prospects of passing the Technician tests. Fortunately, the widely heard code practice transmissions of the American Radio Relay League on W1AW send CW at 5 WPM in the same manner as does the FCC.

**Taking the Test.** Though you must mark your answers to the multiple-choice questions with a pencil, you can copy by pen if you like. Having a pencil point break while copying CW for your license is not a pleasant experience! Since the exams are a "typical amateur" QSO, you can anticipate some of the items that will be sent, such as signal reports, descriptions of gear, locations, etc. But be prepared for some "clunkers." Items such as call signs and frequencies may pop up unexpectedly in the middle of the text. When you miss a character, resist the temptation to dwell on it. Concentrate on copying the remaining characters. Chances are you'll be able to "fill in" any missing letters by guesswork.

**Studying for Tests.** Since the exams simulate Amateur QSO's, the best practice is to actually copy Amateur contacts that you hear on your receiver. Proper tapes can be an asset, of course. Finally, don't overlook the previously mentioned ARRL's W1AW transmissions. (For a complete schedule of W1AW transmissions, send a self-addressed stamped envelope to the American Radio Relay League, 225 Main Street, Newington, CT 06111.) When copying, be sure to practice for full five-minute periods. Writer's cramp can develop in a hurry when you're not used to writing rapidly without interruption.

Good luck on your exams! ◇

# Energy Leak Detector Reveals Home Heat and Cooling Losses

Provides instantaneous readings of temperature changes to check leaks around doors, windows, etc.

*BY RALPH TENNY*

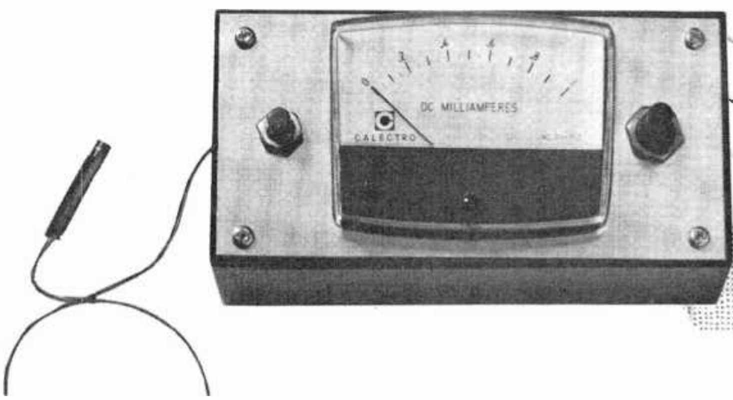
CONSIDERING the high price you pay for the energy to air condition and heat your home, you should be aware of how much of your expensive cooled air escapes and how much cold air leaks into your house at the wrong times of the year.

Large air leaks can be easily felt with the hand, of course. But what about those smaller leaks that can add up to a large, expensive one? Now you can find these leaks with the "Energy Leak Detector," described here, and take corrective action.

The Detector, or ELD, is a low-cost differential temperature detector that can be built in an evening. This useful instrument features a new solid-state temperature sensor that has a positive temperature coefficient (PTC). This means that the sensor's resistance increases linearly with temperature.

**Circuit Operation.** The current-mode amplifier (LM3900) used in the detector amplifies the difference between the current flowing in the two inputs to produce a voltage change at the output.

The input circuit is shown in Fig. 1. Note that there is an arrow between the inverting and noninverting inputs in the diagram for this type of amplifier. Also observe that the inputs are simply base-emitter junctions of grounded emitter transistors.



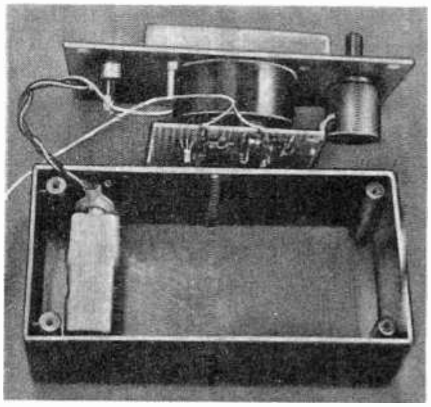


*Photo of internal construction shows board attached to meter.*

This leads to a very important consideration regarding current-mode amplifiers: *Never apply voltage directly to the inputs that can cause a current flow of 5 mA or more.* This limitation allows for some unusual circuitry that can be an advantage under some circumstances. Two other limitations must also be mentioned. The open-loop gain (gain without feedback) can be as low as 1000:1, and the amplifier will not respond to voltages lower than 0.6 volt.

The amplifier maintains correct operation over a wide variety of power supply voltages, and uses about the same amount of power supply current (exclusive of load current), regardless of the power supply voltage. Thus, the amplifier is well suited for battery operation.

As shown in Fig. 2, temperature sensor *TH1* is connected in a bridge circuit consisting of *R1*, whose value is nominally equal to the *TH1* resistance at 25°C (1000 ohms) plus *R2*, *R3*, and *R12*. Potentiometer *R12* is used to balance the bridge when the sensor is at any given temperature. Voltage for the bridge (+3 volts) is furnished by *IC1C* operated in conjunction with zener diode *D1* as a reference. The resulting +3 volts is stable since the current amplifier regulates the zener current. Power is applied only when pushbutton switch *S1* is depressed, thus extending battery life.

A change in bridge balance that occurs whenever *TH1* changes resistance is amplified by *IC1A*. The output of *IC1A* serves as the reference voltage for one input of *IC1B*, which is used as a current amplifier. When there is a bridge unbalance, the output current of *IC1A* flows through *R7*, forcing *IC1B* to drive *Q1* until the current through feedback resistor *R10* equals the current through *R7*. Since meter *M1* is in series with the *Q1* collector, any current passed through *R11* to bias *R10* also passes through the meter. Resistor *R11* is selected so that *M1* indicates about half scale with the bridge balanced at 25°C. If a different sensitivity is required for the ELD, the ratio of *R7/R10* can be changed and, most likely, the value of *R11* too.

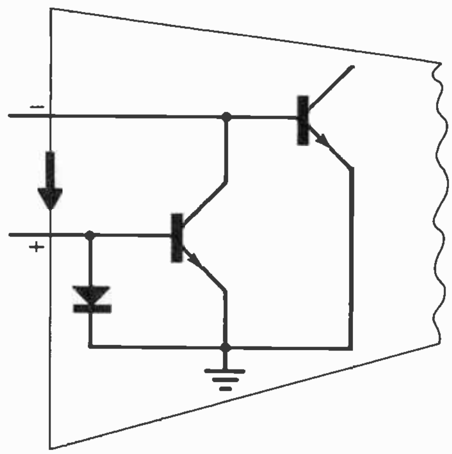
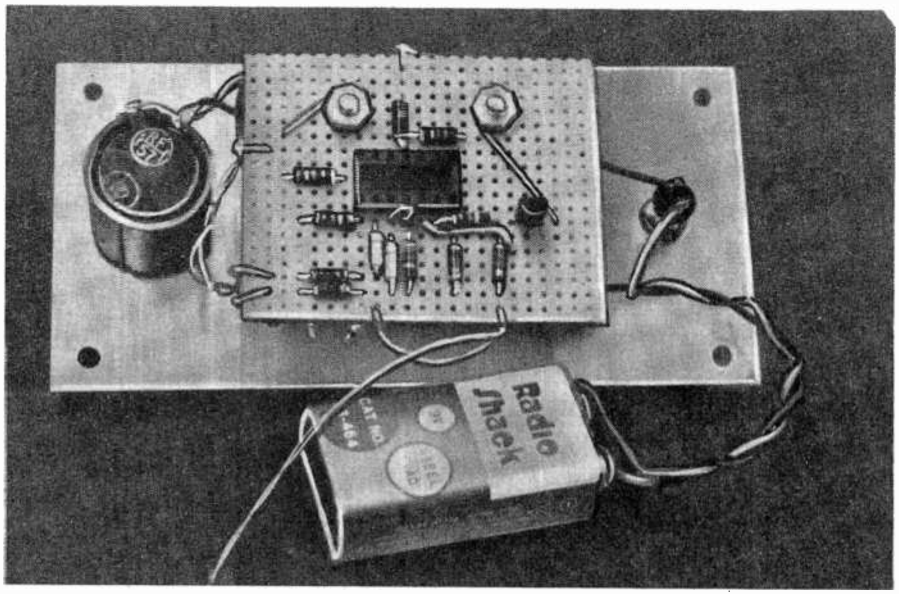



*Fig. 1. The input circuits of a current (Norton) amplifier consist of base-emitter transistor junctions.*




*Rear view of the detector's front panel with perforated board mounted on meter and battery attached.*

**Construction.** The circuit can be assembled by any desired method, using perforated board, Wire-Wrap, or a small pc board. A conventional 14-pin socket may be used for *IC1*.

The author's prototype pictured in this article illustrates how the perforated board (in this case) mounts on the meter lugs. The meter, in turn, is mounted to the metal cover of a small plastic box.

Balance control *R12* and pushbutton switch *S1* are mounted beside the meter. The battery is mounted in a holder affixed to the bottom of the plastic case. A small hole in the cover plate allows the temperature sensor leads to exit.

The temperature sensor (*TH1*) can be mounted at the end of a length of plastic, wood, or even thin metal rod. Make sure the sensor is not surrounded by a large mass that can slow the response of the device.

**Use.** Although this sensor can be used to measure temperature directly (more on this later), for use as a relative temperature sensor, depress switch *S1* and adjust balance control *R12* for a mid-scale meter indication.

Touching the sensor with your fingertips, which are relatively warm, should cause an up-scale meter movement. Cooling the sensor should cause a down-scale movement.

With the sensor exposed to ambient air, and the meter adjusted to mid-scale, place the sensor near a suspected air

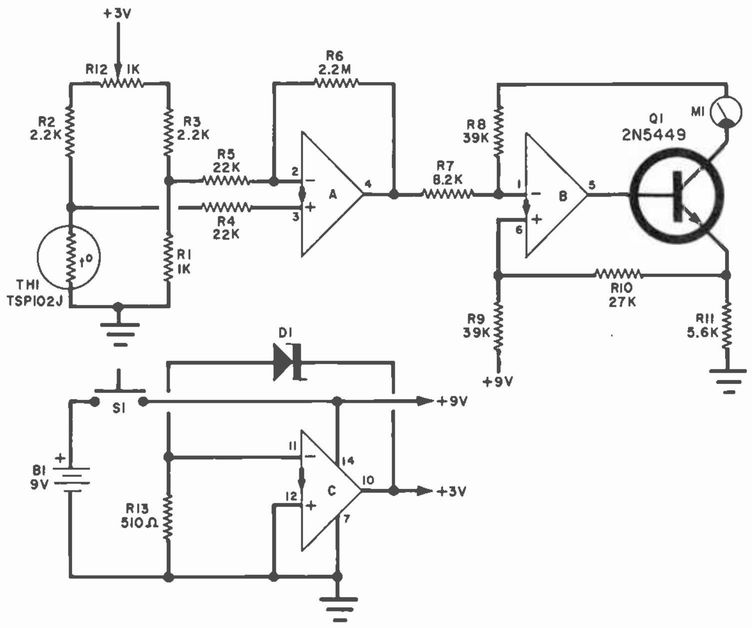



*Fig. 2. Any unbalance in bridge circuit, containing TH1, is amplified and indicated on the meter.*

**PARTS LIST**

B1—9-volt battery and holder
D1— 1N5226 diode
IC1—LM3900 quad Norton amplifier
M1—0-1 mA meter (Calectro D1-912, Radio Shack 22-052 or similar)
Q1—2N5449
The following are ¼-watt resistors unless otherwise noted:
R1—1000-ohm
R2, R3—2200-ohm
R4, R5—22,000-ohm
R6—2.2-megohm
R7—8200-ohm
R8, R9—39,000-ohm
R10—27,000-ohm
R11—5600-ohm
R12—1000-ohm, 10-turn potentiometer
R13—510-ohm
S1—spst NO pushbutton switch
TH1—TSP102J positive temperature coefficient thermistor (Texas Instruments)
Misc.—Suitable enclosure, mounting hardware, knob.
Note: Sensor, TSP102J, is available for $1.50 from Tenny, Box 545, Richardson, TX 75080.

leak. If there is cold air leaking in, the meter will show a sharp drop as the sensor gets closer to the air leak. Conversely, if there is a warm air leak, it can be pinpointed with great accuracy by watching the meter move upscale.

Keep in mind that in this configuration you are measuring relative temperature. Also remember that there is a temperature differential between the ceiling and the floor in a room even without an air leak.

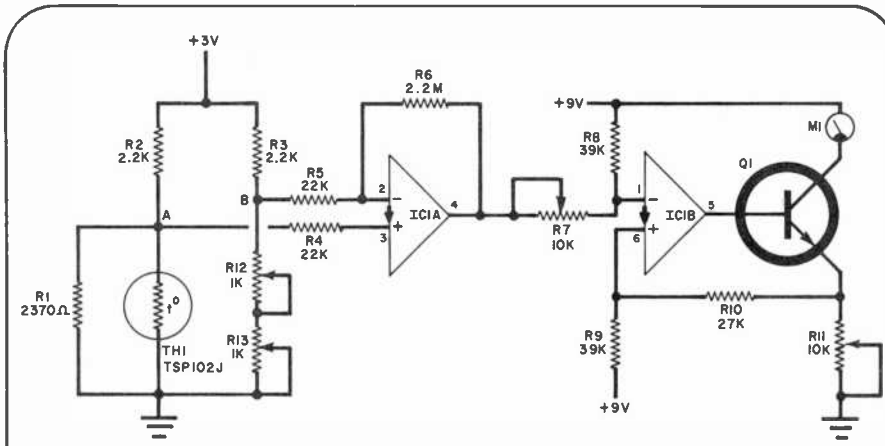



*Fig. 3. Optional circuit shows how to convert the leak detector into a conventional thermometer.*

**Thermometer.** The basic probe can be modified to create a thermometer by using the circuit shown in Fig. 3.

Potentiometer *R12*, used to balance the circuit, is still a 1000-ohm, 10-turn potentiometer. But now it has a turns-counting dial. Trimmer potentiometer *R13* is a 1000-ohm, multi-turn type, while *R7* and *R11* have been changed to 10,000-ohm, multi-turn potentiometers.

Since the circuit has now become a thermometer, it must be calibrated. The basic technique is to create two water baths at each end of the desired temperature range. Since water and ice reach an equilibrium at 0°C, and water boils at 100°C (at sea level), these are convenient to duplicate.

Assuming a linear sensor, the circuit is adjusted to 0°C and 100°C with the sensor immersed in the appropriate water bath. With the linear control and turns-counting dial, intermediate temperatures can be read from the dial after the meter is again center-scaled. Compensation for the 100°C range must be made if you live at high altitudes.

To calibrate the circuit, set up the ice bath and keep it stirred as long as the sensor is immersed in it; also prepare a boiling water bath.

Set potentiometers *R7* and *R11* to their maximum resistance, and *R12* to its minimum resistance. Be sure that the counter on *R12* indicates zero when *R12* is at its minimum resistance.

Immerse the sensor in the ice water, short the bridge at points A and B, and adjust *R7* and *R11* until the meter indicates at center scale. Remove the short across the bridge and adjust *R13* to center the meter again.

Then immerse the sensor in boiling water and set the turns counter of *R12* to 10.0. Adjust *R7* until the meter is centered, then return the meter to the ice water. Rotate the *R12* dial to 0.0 and adjust *R11* for a meter center. Return to the hot water and adjust *R7*, repeating the actions until the meter indicates the temperatures at each end of the scale.

Other temperature ranges may be calibrated, but the dial will no longer indicate the temperature directly. A chart can be created to translate dial indications into temperature.

If you wish to use the ELD as a remote thermometer, the circuit will tolerate a considerable length of lead between the circuit and the sensor. Just be sure that you calibrate the system using the long leads so that resistance will be taken into account.

Happy energy savings! ◇

# Designing Circuits for Worst-Case Operation

BY STEVEN L. CHEAIRS

*How to choose components with tolerances to insure that circuits work properly.*

ONE CONSTANTLY recurring problem for many hobbyists is that some circuits in the projects they build fail to work properly. Other than improper assembly and bad components, the most probable cause of this problem is that a "typical" circuit design was used. A typical circuit design might be sound on paper, but unless component characteristic variations are taken into account, the design may not produce a working circuit. And the cause is *normal* component parameter variations. It is important, therefore, that when you design or build a project, you take into account the possible variation range of the components you will be using to ensure that the project works properly.

In this article, we will discuss why component characteristics vary and what can be done to circumvent possible problems. Stated differently, we will discuss how to design for worst-case conditions.

**Why They Vary.** Component characteristics can vary for any number of reasons. For example, IC's are manufactured in "batch" lots, wherein a number of identical chips are fabricated simultaneously on a single silicon wafer. This approach results in significant manufacturing savings and a very low cost per circuit element. Unfortunately, the parameters of the individual components can vary greatly from one wafer to the next, even though component characteristics on a single wafer will "track" very closely.

It is not uncommon to find a circuit that contains components whose parameters fall anywhere between their worst-case limits. If the circuit was designed around devices that have typical parameters, there is the possibility that it will not function because it contains a device that operates at an extreme end of its parameters. Here is an example.

Assume a circuit has 50 components. Of these, 80% have typical parameters and 10% are sensitive to parameter variations. That means 20%, or 10 components, have atypical characteristics and 5 components are parameter sensitive.

The probability of an event occurring can be defined by the equation P = M/N, where P is the probability, M is the number of times the event is expected to occur, and N is the number of trials. Hence, the probability of a sensitive component occurring per circuit is 1/10, while the probability of a component having atypical performance is 1/5.

By the Law of Multiplication Probability (compound probability), when an event is regarded as occurring if a number of subevents independently occurs, the compound probability of occurrence of the event is equal to the product of the individual probabilities of the subevents. This can be expressed in a mathematical way by the equation P = P1 × P2 or P = (M1/N1) (M2/N2). Therefore, 1/5 times 1/10 or one out of every 50 circuits may not function due to the typical design technique used in our example.

In all likelihood, the figures used in the example are applicable to many hobbyist-built projects and account for the occasional project that fails to work even when all the wiring is correct. It should also be noted that this condition is worsened when "surplus" components are used, since the probability of using a component that is just barely within its specifications increases. Using such components, it becomes possible for a designer to produce a working design prototype that when duplicated by others will fail to operate.

Given the above conditions, it becomes mandatory for all circuit designs to be subjected to worst-case design analysis if the circuit is to be duplicated by others. Any circuit can be so analyzed. The most convenient method is to use worst-case parameter values during the initial design phase to insure proper operation from the start.

**Defining the Problem.** It is essential to recognize which parameter or combination of parameters create the worst case for a particular circuit. Unfortunately, these conditions and how they affect circuit performance vary from circuit to circuit. Also, there may be different performance specs for any given circuit.

Most modern circuits contain both IC's and discrete components. When an IC and a number of discrete components can be combined to make a subcircuit, it is acceptable and may even be desirable to consider the subcircuit thus formed as a self-contained entity. This is

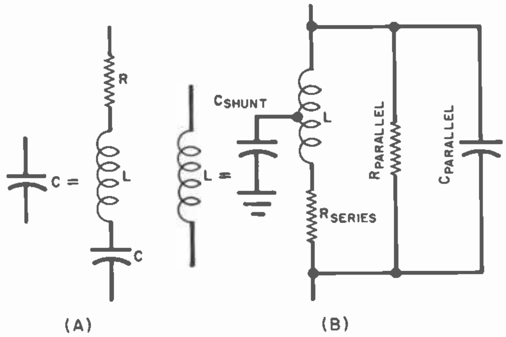



*Fig. 1. A theoretical capacitor (A) actually contains parasitic R and L. Theoretical equivalent of an inductor (B) is even more complex.*

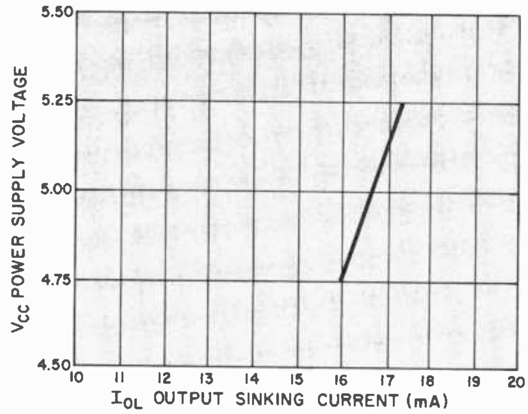



*Fig. 2. Maximum sinking current as a function of power supply voltage variation.*

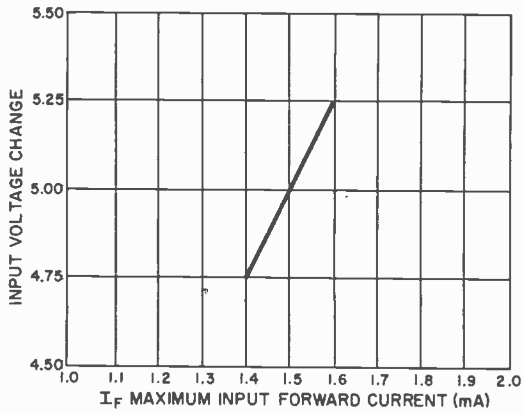



*Fig. 3. Maximum input forward current as a function of the input voltage.*

also true for combining gates and other elements of IC's. When circuit elements are so combined, a block diagram is created. The self-contained entities can then be individually analyzed and the results combined to analyze total circuit performance. This approach also allows system partitioning and interconnection methods to be considered, as well as such problems as impedance matching, level shifting, and fan-out.

The entire circuit's specifications can be divided down to the individual blocks that are sufficiently detailed to be treated on a stand-alone basis. All characteristics must be considered. If the circuit block does not satisfy the detailed requirements (input and output impedance, temperature range, threshold levels, propagation delay, hold times, etc.), the circuit must be modified.

Every component in a circuit must be allowed to vary over its full range of values, as specified by its tolerance, and still allow satisfactory circuit operation. It is the tolerance range that specifies the worst-case parameter range.

Every component contains parasitic components, such as capacitance, inductance, and resistance. In many circuits, the parasitic components are observed only during worst-case conditions. For example, consider a capacitor. A capacitor cannot simply be added to a high-frequency circuit with the expectation that the circuit will behave as if a theoretically pure capacitor were added. This simple component is actually quite complex, as can be seen in Fig. 1A. An inductor is even more complex, as shown in Fig. 1B. Therefore, for proper worst-case operation, these parasitic effects must be considered when designing and building circuits.

Fixed resistors also have broad tolerance specifications that can range up to ±10% (±20% in older resistors) of their specified nominal values.

**The Spec Sheet.** Manufacturer specification sheets for a particular IC should be consulted for pinout and to gain a working knowledge of the device itself. A typical spec sheet, this one for a 74123 dual retriggerable monostable multivibrator IC, is shown in Table I.

Assume you require a 50-ns pulse and decide to use the 74123 to generate it. Note in the table that $t_{wQ(min)}$ (minimum output pulse width) has a typical value of 45 ns and a worst-case value of 65 ns when external capacitance $C_{ext}$ is zero and external resistance $R_{ext}$ is

**TABLE I—SWITCHING CHARACTERISTICS $V_{CC}$=5 V, $T_A$=25°C**

| Parameter* | From input | To input | Test | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|---|
| $t_{PLH}$ | A | Q | $C_{ext}$=0 | | 22 | 23 | ns |
| | B | | $R_{ext}$=5k | | 19 | 28 | ns |
| $t_{PHL}$ | A | Q | $C_L$=15 pF | | 30 | 40 | ns |
| | B | | $R_L$=400 | | 27 | 36 | ns |
| $t_{PHL}$ | Clear | Q | | | 18 | 27 | ns |
| $t_{PLH}$ | | Q | | | 30 | 40 | ns |
| $t_{wQ(min)}$ | A or B | Q | | | 45 | 65 | ns |
| $t_{wQ}$ | A or B | Q | $C_{ext}$= 1000 pF, $R_{ext}$=10k, $C_L$=15 pF, $R_L$=400 | 2.76 | 3.03 | 3.37 | μs |

*$t_{PLH}$= propagation delay time, low- to high-level output
$t_{PHL}$= propagation delay time, high- to low-level output
$t_{wQ}$= width of pulse at output Q

**TABLE II—RECOMMENDED OPERATING CONDITIONS**

| Parameter | Min. | Nom. | Max. | Units |
|---|---|---|---|---|
| Supply voltage, $V_{CC}$ | 4.75 | 5 | 5.25 | V |
| High-level output current, $I_{OH}$ | | | −800 | μA |
| Low-level output current, $I_{OL}$ | | | 16 | mA |
| Operating free-air temp., $T_A$ | 0 | | 70 | °C |

**TABLE III—ABSOLUTE MAXIMUM RATING OVER FREE-AIR TEMPERATURE RATING**

| | |
|---|---|
| Supply voltage, $V_{CC}$* | 7 V |
| Input voltage | 5.5 V |
| Operating free-air temperature range | 0-70°C |
| Storage temperature range | −65 to +150°C |

*Voltage values are with respect to network ground terminal.

5000 ohms. (If you were making only one circuit, you could hand-select the components to make it work, but this is not a safe approach to use in a construction article.) Now note $t_{WQ}$ when $C_{ext}$ is 1000 pF and $R_{ext}$ is 10,000 ohms. The width of the pulse can be between 2.76 and 3.37 μs. Hence, the value can range from +8.9% to −11.2% of the typical specified value for the given R and C values. Note also that the spec sheet does not tell you that this error is linear throughout the $t_{WQ}$ range. For all we know, this may be the best point on the curve. So, when designing such a circuit, make certain that your design can accommodate this type of tolerance.

Note the column in Table II headed Nom (nominal). This value is the one for which you should strive, but you may find that it is not possible to obtain or hold it through the design.

It should be understood that one parameter may affect another. For example, consider the effect of varying the power supply voltage on the output sinking current ($I_{OL}$). The output sinking current is a linear function of the power supply voltage, as shown in Fig. 2. When the supply potential is 4.75 volts, the output can sink 15 mA. A similar condition can be observed in Fig. 3, where the maximum input forward current ($I_F$) is shown as a function of input voltage. Here again, the variation of one parameter can cause a variation in another.

At this point, you should realize that you must know which characteristics are important so that you can design with a knowledge of their probable variations. To do this, you must know just what will affect a given parameter.

All of the parameters thus far discussed have been of the type that can cause circuit failure, not failure of a component. Most IC data sheets carry a set of catastrophic characteristics, such as those listed in Table III. With resistors and capacitors, characteristics like maximum power dissipation and breakdown voltage should never be exceeded. Never come close to these specifications in your circuit designs.

**Summing Up.** If you use the techniques detailed in this article, or keep them in mind, your circuits will work and so will other circuits built from your design. If you build projects from magazines, steer clear of broad-tolerance components, especially in critical components. Do not be afraid to test semiconductors and passive components before using them. ◇

BY WILLIAM P. JOHNSON, JR.

# BUILD A STEREO ROTO-BLENDER

*Lets you manipulate your stereo to blend or transpose the two channels.*

MOST STEREO recordings made in a professional studio begin as a number of "tracks" (usually 16 or more) on tape, which are subsequently mixed down to two channels. During mixing, the apparent location of each instrument and vocalist is fixed in the final left and right channels by its relative loudness. Usually, the listener cannot alter the mix other than by transposing or by blending the two channels to reduce stereo separation. With the "Stereo Roto-Blender," however, he can remix the recording, within certain limitations, to improve the mix and emphasize previously "buried" sounds. It also allows him to blend and transpose the two resulting channels in the conventional manner. The new mix will have roughly the same channel separation as the original program.

**The Basic System.** The Roto-Blender is made up of two basic parts: a stereo ROTATE control, which is the heart of its remixing capabilities, and a stereo BLEND control (Fig. 1). The ROTATE control "rotates" the performers in a circle around the listener. With the control centered, the mix is unaltered. As it is rotated clockwise, the sounds originating from the left and center shift to the right. The sound originating from the right moves over to the left to complete the rotation.

The above effect is illustrated in Fig. 2. Note that, with the ROTATE control centered (NORMAL), a vocalist is centered between a guitar on the left and a piano on the right. By rotating the control to the left, the vocalist and piano shift one position to the left and the guitar comes over to the right. Exactly the opposite rotation occurs when the control is rotated in the clockwise direction. The control alters both the sonic directions and relative loudnesses of each sound. Normally, when a sound is shifted to the center, it becomes louder, and when it is shifted away from center, it becomes quieter. This allows the listener to emphasize interesting or previously unnoticed sounds.

The BLEND control allows you to reduce channel separation down to monaural as it is turned from fully clockwise to center. Rotating the control counterclockwise causes the separation to increase, this time with the left and right channels transposed. This transposition provides additional flexibility in the remixing process.

**About the Circuit**. The left- and right-channel inputs to the Roto-Blender in Fig. 1 are buffered by *IC1A* and *IC1B* and passed to differential amplifier *IC1C* whose output is an R − L signal. This signal is similar to the combined left- and right-channel signals minus the center-channel material. NULL ADJ control *R13* permits the center-channel material to be precisely cancelled to achieve optimum results.

The R − L signal is inverted by *IC1D* to produce an L − R signal. The left- and right-channel signals plus the composite signals are applied to ROTATE potentiometer *R14*. Figure 3 illustrates the signals applied to *R14* and indicates how the resulting output signals on each control wiper vary over the range of the potentiometers. An important feature of this arrangement is the cancellation of one channel when the control is at its center of rotation, leaving only the remaining channel, attenuated by one half. In this manner, normal stereo is obtained at center of rotation. The attenuation is counteracted by *IC2A* and *IC2B*, whose boosted outputs are added to the *R14* outputs through *R11* and *R12*. This does not affect the signal at the extreme positions of the ROTATE control, due to the potentiometer's zero source impedance, but increases in effect as the pot is adjusted to its center position. This results in a nearly constant loudness at all positions of the potentiometer for most stereo signals.

After rotation occurs, the signals are applied to buffer amplifiers *IC2C* and *IC2D*. BLEND control *R15* mixes the signals in varying proportions to achieve

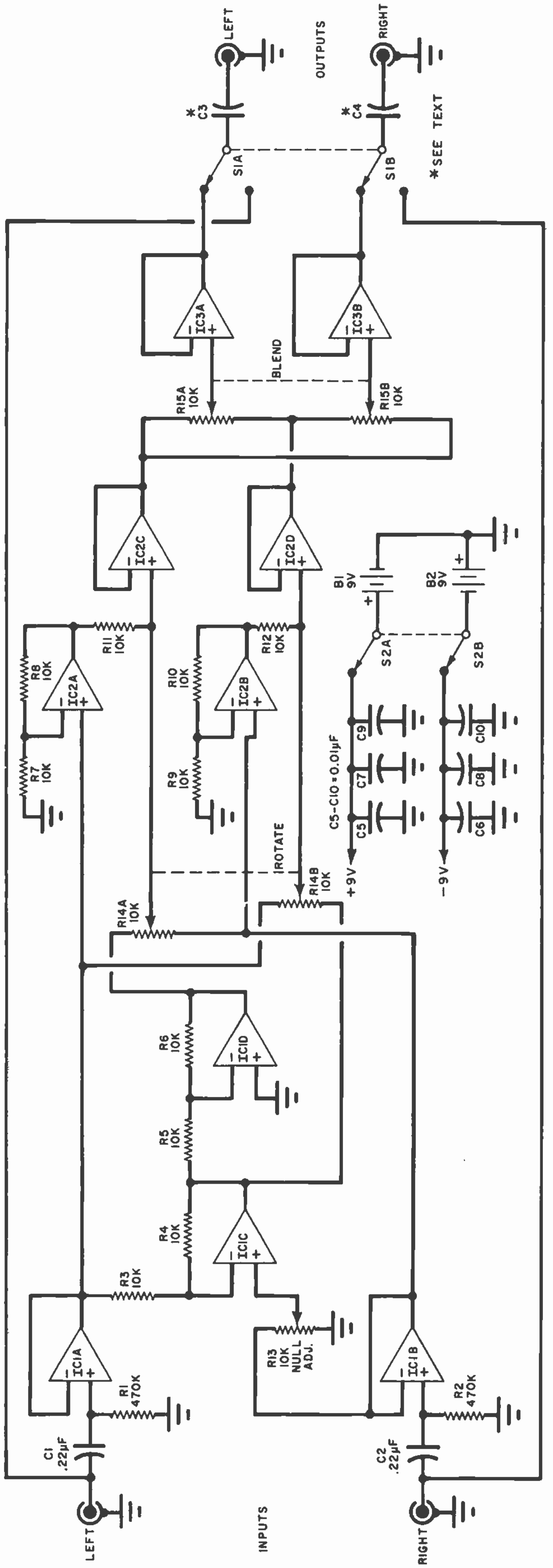



*Fig. 1. The left and right stereo signals are buffered in IC1A and IC1B and combined in IC1C. Potentiometer R13 adjusts the null.*

## PARTS LIST

B1, B2—9-volt battery
C1, C2—0.22-µF disc
C3, C4—1-µF nonpolarized (see text)
C5 through C10—0.01-µF disc (see text)
IC1, IC2, IC3—4136 quad op amp (or any other op amp IC—see text)
J1 through J4—Phono jack
R1, R2—470,000-ohm, ¼-watt, 10% resistor
R3 through R12—10,000-ohm, ¼-watt, 10% resistor
R13—10,000-ohm, linear-taper potentiometer
R14, R15—10,000-ohm, linear-taper dual potentiometer
S1—Dpdt switch
S2—Dpst switch
Misc.—Holders for B1 and B2; printed circuit or perforated board; sockets for IC's; control knobs (3); suitable enclosure; lettering kit; machine hardware; hookup wire; solder; etc.

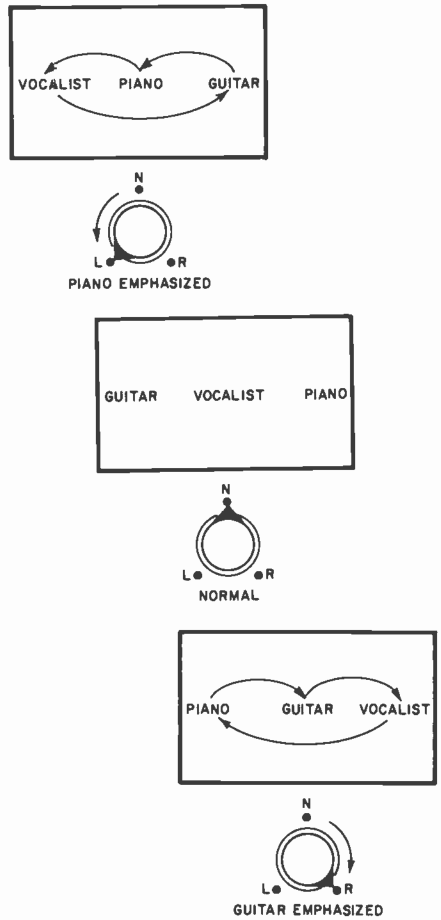



*Fig. 2. With R14 centered, as in middle diagram, vocalist is between piano and guitar. With R14 rotated to either extreme, relative positions are changed.*

either normal or reversed stereo, mono, or anything in between. These signals are then buffered by *IC3A* and *IC3B*, after which they are delivered to the Roto-Blender's outputs. Capacitors *C3* and *C4* are optional and are required only if the input to the amplifier to which the Roto-Blender is connected does not have similar capacitors. Their values should be chosen to have a low impedance at 20 Hz, compared to the impedance of the amplifier.

The Roto-Blender can be either battery powered as shown in Fig. 1 or driven by a ±6-to-±15-volt ac operated supply, which should be decoupled using capacitors *C5* through *C10* located close to the +V and −V pins of each op amp used. (The op amps used in the author's prototype were 4136 quad types, which required only three IC packages. If you use a different op-amp type, and almost any other type will work in this circuit, you will have to increase the number of 0.01-µF capacitors so that two capacitors are used for each IC package.)

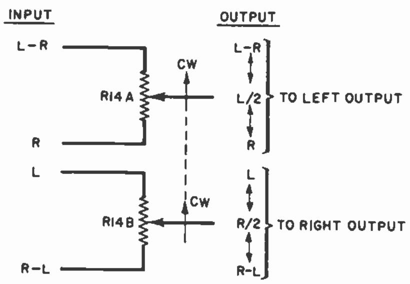



*Fig. 3. The left and right signals and the composite are applied to R14 as shown. Note how the resulting output signals on each control wiper vary over potentiometer range.*

some other deficiency in the source material or amplifier's electronics.

Cancellation of center sounds with some recordings is not possible when the sounds are reproduced differently in each channel, using reverberation techniques. This case should not be confused with the case where distortion prevents nulling with a raspy sound.

Once nulling is accomplished, the right channel can be reconnected and the ROTATE pot should be centered for normal stereo reproduction. If an instrument on the left—a trombone, for example—is to be emphasized, rotate the sound to the right by turning the ROTATE control clockwise. This moves the trombone to the center, where it will be more dominant. At this point, if the BLEND control is rotated fully counterclockwise, the trombone will remain centered while the left and right channels will be effectively transposed.

**Construction.** The circuit can be assembled on a printed circuit board of your own design or on a perforated board using pencil wiring techniques. In either case, it is a good idea to use sockets for the IC's. Mount the potentiometer controls, input and output jacks, and POWER and IN/OUT switches on the box in which the circuit is housed. Use a dry-transfer lettering kit to label the controls, jacks, and switches according to function and operation.

**Application.** The Roto-Blender unit should be connected to suitable high-level inputs and outputs for optimum results. You can connect it between a preamplifier and power amplifier or, lacking this facility, into the tape-monitor loop. It is a good idea to hook it up ahead of the headphone amplifier, since the Roto-Blender is best appreciated using headphones.

For proper operation, the Roto-Blender should be nulled to counteract imbalances in the source material and preceding electronics. This can be done by disconnecting the right channel output of the Roto-Blender and, with the ROTATE and BLEND controls fully clockwise, adjusting the NULL ADJ control to exactly cancel the center sounds of the program source. If a mono source is used, adjust for minimum sound. Excessive distortion heard at this time indicates either a worn record or stylus or some other deficiency in the source material or amplifier's electronics.

The effects achieved by the Roto-Blender are a function of the source material and cannot be fully described here. Perhaps the most fascinating aspect of the Roto-Blender is its ability to bring forth sounds that were never noticed before. ◇

# How to Measure THE RESISTANCE OF HOT ELEMENTS

BY ALVIN G. SYDNOR

A CONVENIENT means of measuring the hot resistance of lamp filaments, or other elements whose resistance changes with operating temperature is a highly desirable item for the electronics experimenter. This is especially true in cases where these elements are used in circuits requiring close voltage tolerances.

Although there are several ways to measure hot resistance, excellent results can be obtained from the simple circuit shown here.

Using conventional components, the circuit has a range from one or two ohms, up to several thousands.

The transformer should have a secondary voltage and current sufficient to fully illuminate the lamp under test. In the case of a 117-volt lamp, *T1* should be a 1:1 isolation type whose secondary can handle the required lamp current.

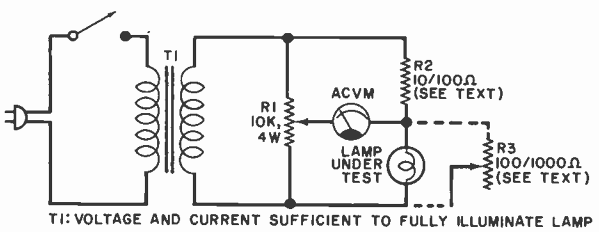
The range of the bridge is about 100:1 and depends on the value of *R2*. A 10-ohm value of *R2* enables measurement between one and 100 ohms, while an *R2* value of 100 ohms, produces a 10-to-1000-ohm range. The lower the resistance of *R2*, the more accurate the measurement. This is due to the low voltage drop across *R2*. The wattage of *R2* should be such that it can handle the necessary load.

If the lamp must be measured at full operating voltage, measure the voltage across the lamp. Then increase the input voltage to overcome the voltage drop across *R2*.

With the circuit connected as shown in the schematic (*R3* not installed), adjust *R1* until the ac voltmeter indication is at a minimum. Switch to a lower voltmeter range as the minimum is approached. Record the value indicated on the ac voltmeter.

Without disturbing the setting of *R1* , remove the lamp under test, and substitute potentiometer *R3* for the lamp. This potentiometer can have a value between 100 and 1000 ohms.

Adjust *R3* until the ac voltmeter indicates the same value as that previously recorded. Remove *R3* from the circuit and measure its resistance. This will be the hot resistance of the lamp. ◇




*This circuit can be used to measure resistances up to several kilohms.*

BY GERALD BEENE

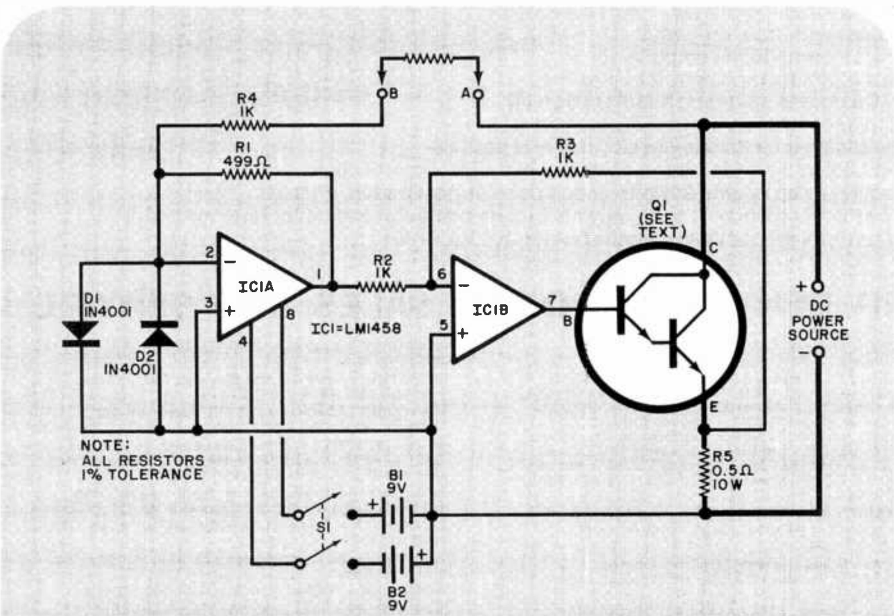
# BUILD AN ACTIVE POWER R BOX

*Converts any resistor into a 40-watt unit for load measurements.*

IT IS OFTEN necessary to simulate a wide range of load conditions when building and repairing power supplies. To perform such a task, a large supply of power resistors or a power-resistor substitution box would normally be required. However, the "Active Power R Box" described here reduces the demand to a minimum. The R Box can convert any resistor, whether fixed or potentiometer, into 40-watt power resistors.

The R Box's active circuitry is programmed by an external resistor, connected across terminals A and B in the schematic diagram, so that it functions as a power resistor with a value that is 1/1000 of the external resistor's actual value. There is also a 1-ohm resistance preprogrammed into the circuit that adds to the resistance programmed in. Hence, if an 8000-ohm resistor is placed across programming terminals A and B, the resulting power resistance will be (8000/1000) + 1 = 9 ohms.

The R Box can be programmed to serve as a constant-current load if desired. This is accomplished by replacing the programming resistor with a dc bias voltage between terminal B and the negative (−) terminal. It is important that the positive side of the biasing source be connected to terminal B. The magnitude of the programming current load will be 1 ampere per volt on terminal B. For example, if terminal B is biased at 150 mV, the positive terminal of the R Box will take in 150 mA for all supply potentials.




*The circuit of the "R Box" converts the resistance at terminals A and B to 1/1000 its value plus one ohm and circuit can handle 40 watts. Use 12-gauge wire for power circuit (heavy lines).*

The input potential must be restricted to 40 volts, and maximum power (input voltage times input current) must be limited to 40 watts. Also, the proper polarity must be observed or the R Box will not operate. The R Box will operate for supply outputs as low as 3 volts. The maximum allowable current is 3 amps.

When assembling the R Box, use 12-gauge wire for the high-current path (shown with heavy line in schematic diagram) and minimize the length of this wiring. Since the current drain of the dual operational-amplifier circuit (*IC1*) is only about 5 mA, a pair of 9-volt batteries for *B1* and *B2* will do fine. Mount the 10-watt, 0.5-ohm resistor (*R5*) so that the heat generated in it does not increase the heat of power-Darlington transistor *Q1*.

The heart of the R Box is transistor *Q1*. It can be a Motorola MJ1000 or any other suitable power-Darlington npn transistor. During assembly, *Q1* must be mounted on an adequate heat sink, such as the Wakefield No. NC-403-2.

The dual op amps in *IC1* sense both the input voltage and the potential across the 0.5-ohm resistor and compute the required base drive for *Q1* so that the desired performance is obtained. The accuracy of the R Box will be very good if 1% tolerance resistors are used throughout the circuit. The resistors can be rated at ¼ or ½ watt, except for *R5*, since little current flows through the circuit. ◇

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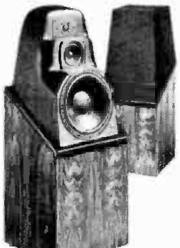

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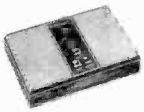

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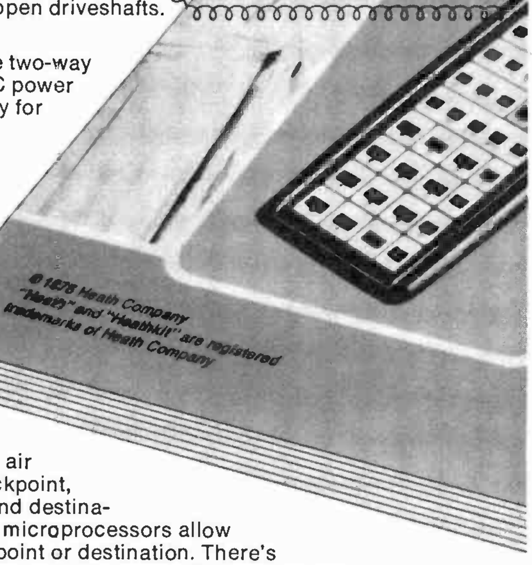


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CIRCLE NO. 5 ON FREE INFORMATION CARD

*BY VAUGHN MARTIN*

# BUILD A KEYBOARD CONVERSION CIRCUIT

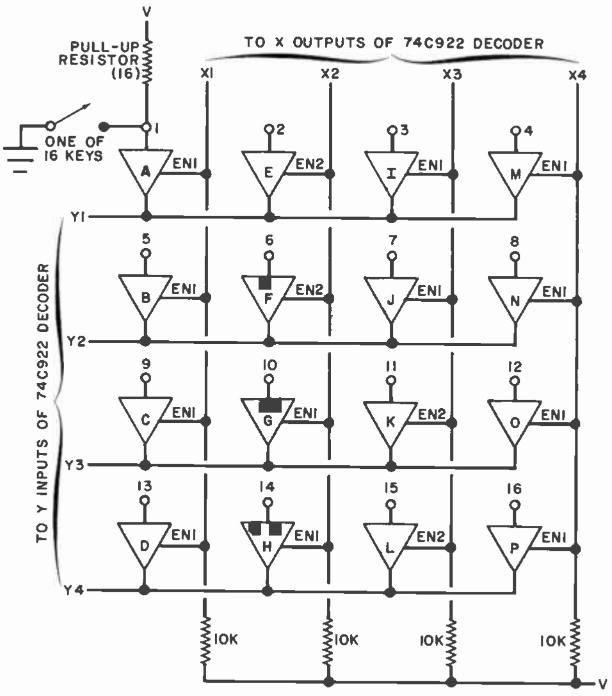
*Three IC's convert spst keyboard output to column-row format used by decoder chips.*

ESSENTIALLY, there are two types of keyboards available for the digital experimenter. These are column-row types, and low-cost keyboards having independent spst switches with one side of the switches sharing a common bus.

There are several decoder chips (such as the 74C922 16-key and the 74C923 20-key decoder) that provide all the logic necessary to fully decode a column-row device. The circuit shown here converts an independent spst keyboard into the column-row format that can be used with the above mentioned decoder chips.

The circuit requires three DM8097, DM7097 or SN74367 noninverting hex three-state buffers. The columns have their three-state enable pins bussed together with these lines serving as the X-inputs to the decoder chip. The row (Y) signals are also bussed to form the Y-inputs to the decoder.

The individual keys are grounded on one side, with the other side tied to each buffer input. Each key may be tied high through a pull-up resistor to improve noise immunity. The three-state enable lines (X) are scanned by one input at a time going low, or becoming active with the next one becoming active and the others inactive, etc., until all columns have been scanned (tested). This action enables a column, and each individual keyswitch enables its associated buffer (within the enabled column). The column-row enabled input is applied to one of the 16- or 20-key decoder logic where it is latched at the output. The output of the decoder is also three-state. ◇




*Buffers A through F are on one IC (DM8097, DM7097, or SN74367); G-L on second; and M-P on third.*

# Solid State

By Lou Garner

## CHIRP, JANGLE, WOOSH, BOOM!

A VERSATILE and unusual IC, virtually made-to-order for the experimenter and hobbyist, has been introduced by Texas Instruments, Inc., Box 84, Sherman, TX 75090. Designated the SN76477 complex sound generator, the new device is a monolithic IC combining both bipolar analog and I²L digital circuitry on a single silicon wafer. It includes basic circuit "blocks" which can be interconnected to produce an almost unlimited number of special sound effects ranging from a dog's bark or bird chirp to a gunshot or explosion. With the proper choice of external components, the SN76477 is capable of developing either familiar sounds such as a train whistle or futuristic sounds such as a "talking computer" or firing "phaser" ray gun. Offered in both standard 0.6-inch (1.5-cm) wide type N and the smaller 0.4-inch (1.0-cm) type NF 28-pin DIP's, the SN76477 can be powered by either a 5-volt regulated dc supply or well-filtered dc at 7.5 to 10.0 volts.

Not only is the SN76477 capable of producing a virtually unlimited variety of special sound effects, but the number of ways in which these may be used is limited only by the imagination and skill of the circuit designer and builder. In fact, a more experienced hobbyist might easily assemble a wide-range "Sound Effects Generator" by combining the SN76477 with a power amplifier, loudspeaker, and dc power supply. Such a project would also require multiple input and output jacks for the device terminals, potentiometers, various control switches, and a broad assortment of external components, selectable by means of appropriate rotary or toggle switches.

The functional block diagram of the new device is shown in Fig. 1. The SN76477 comprises a super-low-frequency (slf) oscillator, a programmable logic circuit permitting a choice of inputs to a voltage-controlled oscillator (vco), a noise clock, noise generator, noise filter, mixer, logic circuits for both systems inhibit and envelope selection, a one-shot, an envelope generator and modulator, an output buffer amplifier, and voltage regulator. Most of the circuits can be controlled or programmed externally by suitable components or signals. Circuit inputs identified with circles are programmed by using different capacitor values, squares identify programming by means of various resistors, triangles via logic levels and diamonds by analog voltages. Device pinout is shown in Fig. 2.

The slf oscillator has a nominal range of 0.1 to 30 Hz, depending on the R and C values used for programming, but can be used to generate frequencies as high as 20,000 Hz. It supplies two output signals, a 50% duty-cycle square wave which is applied to the Mixer and a triangle wave which can be routed to either an external vco or, through the SLF SELECT logic circuit, to the on-chip vco which can supply a fixed or frequency-modulated output over an almost 10:1 frequency range. Its lowest frequency is established by the values of the external resistor and capacitor connected to pins 18 and 17, respectively. The vco's output signal also is coupled to the mixer. A noise clock generates clock pulses to control the noise generator which, in turn, develops pseudo-random white noise that is applied through a variable-bandwidth, low-pass noise filter to the mixer. Accepting input signals from one or more sources (slf, vco, noise filter), the mixer performs a logical AND function and delivers the resulting signal to the envelope generator and modulator circuit. The mixer output is estab-

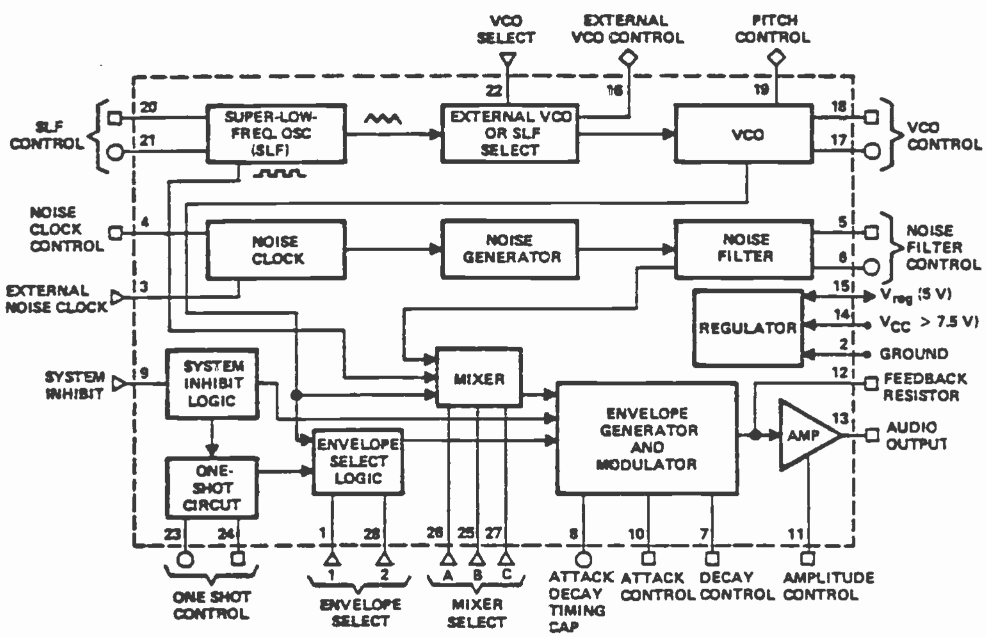



*Fig. 1. Functional block diagram of Texas Instruments' new SN76477 Complex Sound Generator integrated circuit.*

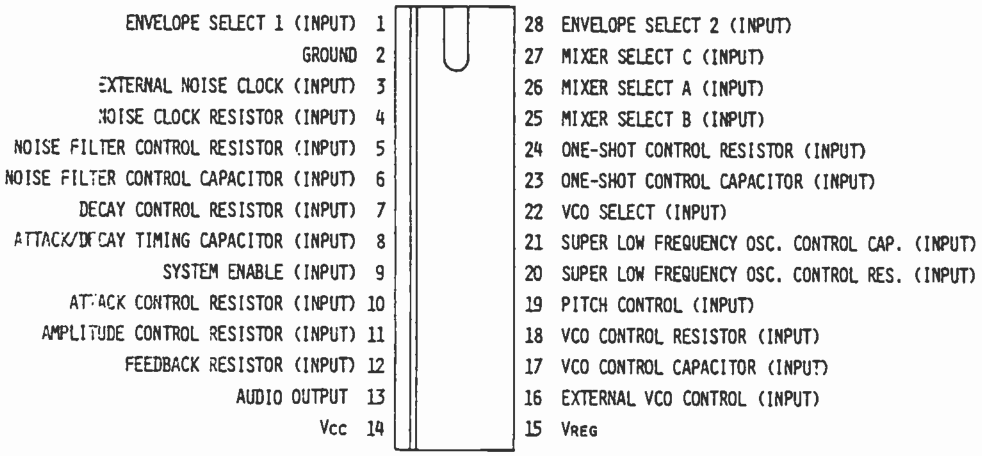



*Fig. 2. Pin-out configuration and lead connections for the SN76477.*

lished by the logic levels applied to its three SELECT terminals, pins 25, 26 and 27.

System inhibit logic circuit controls the system's output and also triggers a separate one-shot used to develop short-duration momentary sounds such as gunshots, bells or explosions. The duration of the one-shot's output is determined by the values of the control resistor and capacitor connected to pins 24 and 23, respectively, with the maximum period of approximately 10 seconds. The one-shot does not generate a sound signal itself, but is coupled through the envelope select logic circuit to the envelope generator and modulator, which provides an envelope for the signals from the mixer.

The envelope select logic circuit establishes the overall shape of the envelope which amplitude modulates the combined signal obtained from the mixer. Depending on the logic signals applied to ENVELOPE SELECT control pins 1 and 28, one of several operating modes can be selected, including vco, mixer only, one-shot, and vco with alternating cycles. The final shaping of the generated signal is performed by the envelope generator and modulator circuit, where the slf, vco, and filtered noise signals from the mixer are controlled by the system inhibit logic and modulated with the envelope established by the envelope select logic. This circuit also acts to modify the resulting signal's attack (rise time) and decay (fall time) characteristics.

Developing a maximum 2.5 volts, peak-to-peak, the output amplifier buffers the signal so that it can be applied to an external modulator or power amplifier. The buffer has a low output impedance. Finally, the regulator is designed to operate from *either* of two power sources. If available, 5 volts regulated dc can be applied to pin 15 ($V_{REG}$). Alternatively, 7.5 to 10 volts unregulated dc can be applied to pin 14 ($V_{CC}$), in which case the on-chip regulator will furnish a 5 V regulated output at up to 10 mA to power other circuits.

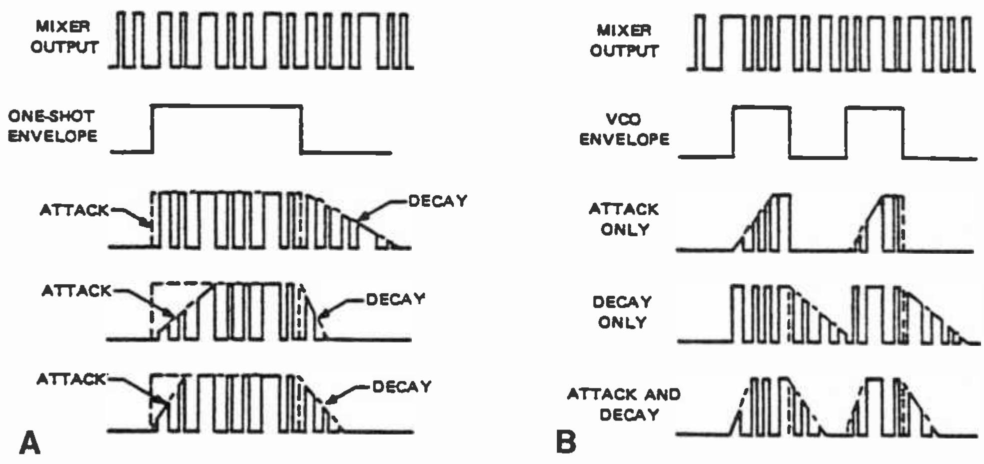
In summary, the SN76477 generates complex audio signal waveforms by combining the outputs of a low frequency oscillator, variable frequency (voltage controlled) oscillator, and noice source, modulating the resulting composite signal with a selected envelope and, finally, adjusting the signal's attack and decay periods. At each stage, the process can be controlled at the programming inputs of the signal modification and generation circuits, using control voltages, logic levels, or different resistor and capacitor values.

Representative signal waveforms developed during the process are illustrated in Fig. 3. The mixer output in the example shown in Fig. 3A is a variable-frequency signal containing filtered noise elements. This is modulated with a pulse envelope obtained from the one-shot and then shaped to form different types of sounds by altering the signal's attack and decay. In the second example (Fig. 3B), the mixer output is modulated by a repetitive pulse derived from the vco.

Different sounds are developed by varying the attack or decay, or both. The attack and decay can be modified by connecting different capacitor values to pin 8 and different resistor values to pins 10 and 7 which control the attack and decay, respectively.

Practical circuits featuring the SN76477 are illustrated in the figures. These were selected from among many circuits described in TI's data sheets. All feature a simple but effective audio amplifier to provide a low-level loudspeaker output and are designed for operation on a standard 9-volt transistor battery. At those points in the circuits where 5 V is required, it

*Fig. 3. Complex signal waveforms showing different attack and decay characteristics with (A) one-shot and (B) voltage-controlled oscillator modulation envelopes.*



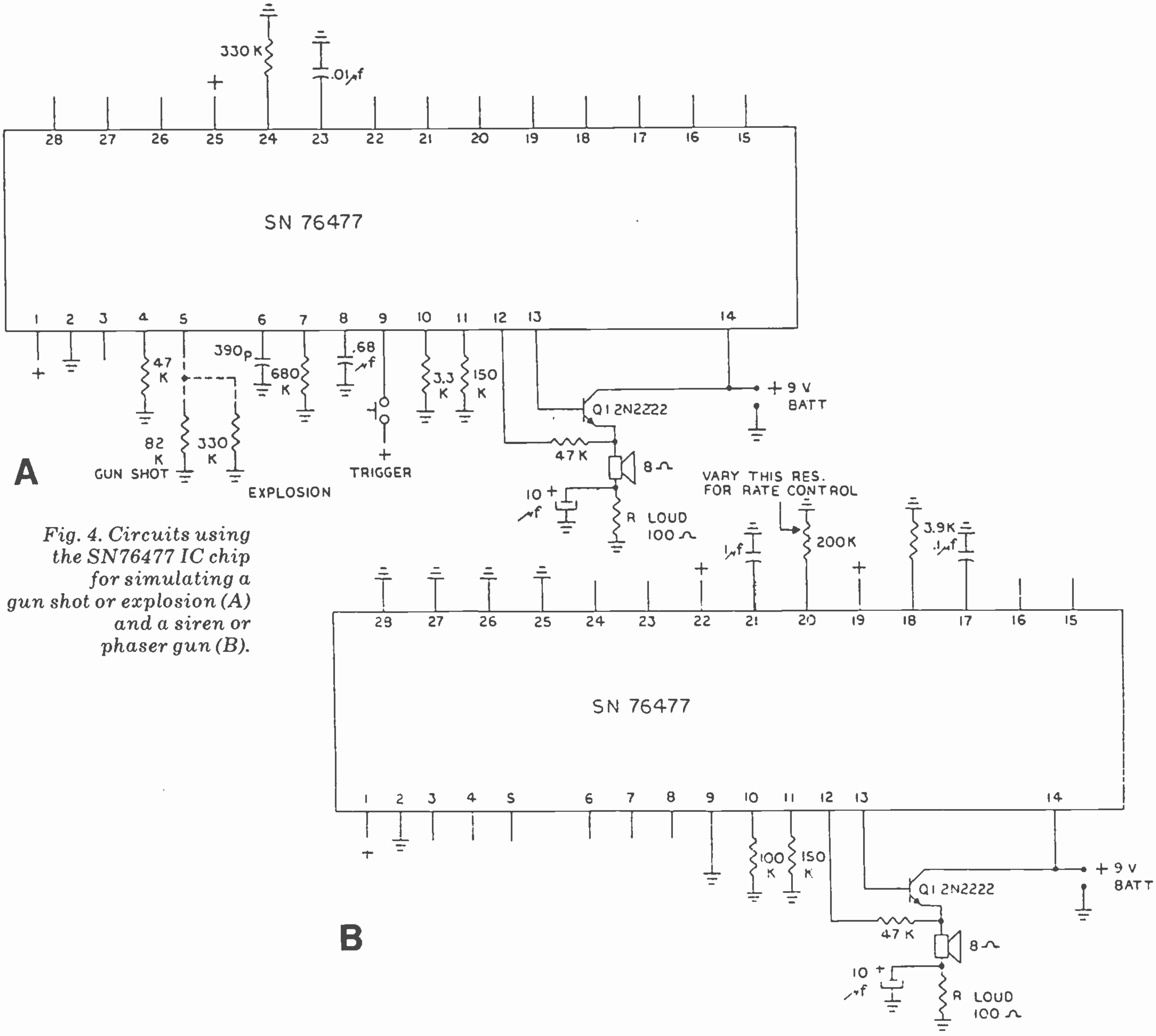



*Fig. 4. Circuits using the SN76477 IC chip for simulating a gun shot or explosion (A) and a siren or phaser gun (B).*

can be derived from pin 15 of the IC. All can be assembled using standard, readily available components. Except where potentiometers are specified, all resistors are either ¼- or ½-watt components. Small capacitors can be ceramic, plastic film, or tubular paper units; larger capacitances are 15-volt electrolytics.

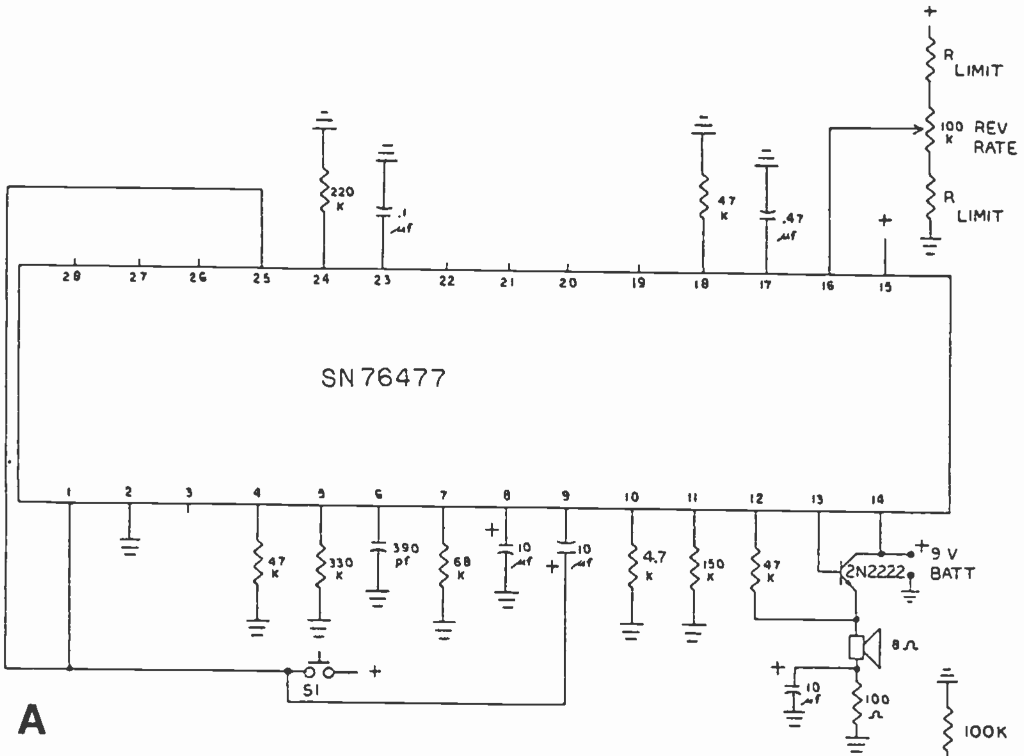
Neither layout nor lead dress are critical in any of the circuits, which can be duplicated using a solderless breadboard, perforated or printed circuit board. The usual precautions should be observed when soldering to avoid overheating the semiconductors, and all polarities must be observed.

When duplicating a normally loud sound such as a gunshot or explosion, it will be necessary to couple the circuit to a high-power audio amplifier driving a large loudspeaker. However, a 4-to-6-inch (10.2-to-15.3-cm) loudspeaker and the push-pull amplifier shown in the schematics should be adequate for most applications.

Designed to simulate the sounds of either a gunshot or explosion, the circuit shown in Fig. 4A is triggered by applying a 5-volt pulse through a momentary-contact, normally open pushbutton switch to the system inhibit logic and one-shot circuits (pin 9). The 5-volt dc level required here as well as for the envelope select logic (pin 1) and mixer select (pin 25) is obtained from the IC's $V_{REG}$ output (pin 15). Different resistor values are used to program the noise filter circuit (pin 5) to simulate the two sounds, (82,000 ohms for a gunshot and 330,000 ohms for an explosion).

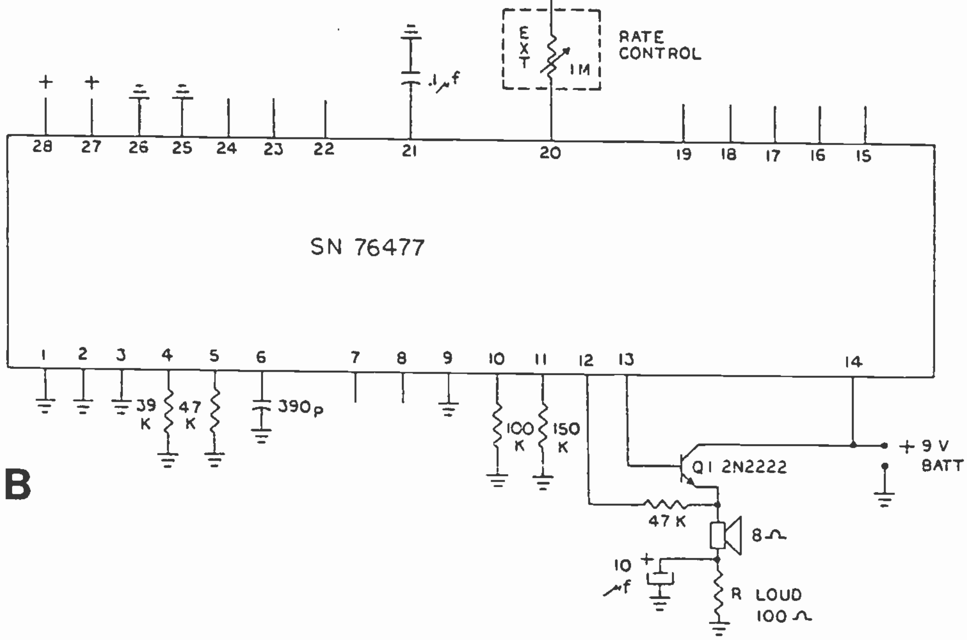
Several different sounds can be simulated by the circuit shown in Fig. 4B, including a siren, space war, or "phaser" gun, depending on the adjustment of the 200,000-ohm RATE CONTROL potentiometer. For increased realism, the IC's one-shot (pins 9, 23, 24) and decay (pins 8, 7) functions can be implemented. As before, +5 volts dc needed for pins 1, 19, 22 is obtained from $V_{REG}$ (pin 15).

Circuits for simulating the sounds of a racing car motor or crash and a chugging steam engine or reciprocating airplane engine are shown in Fig. 5A and 5B, respectively. In the first circuit, the racing car motor's rev rate is adjustable by means of a 100,000-ohm potentiometer which varies the dc voltage applied to the external vco control input (pin 16). The maximum and minimum rev rates are set by fixed resistors in series with the potentiometer. A crashing sound is initiated by




A

*Fig. 5. Two circuits using the SN76477: (A) simulating a racing car's rev rate or a crashing sound; and (B) a chugging steam engine or reciprocating airplane.*




B

depressing a spst normally open pushbutton switch, which applies a voltage pulse through a 10-µF capacitor to the system inhibit logic and one-shot circuits (pin 9), simultaneously changing the envelope select (pin 1) and mixer select (pin 25) settings.

In the second circuit, the slf oscillator frequency is controlled by a 1-megohm potentiometer connected to one of its programming input (pin 20). As this RATE CONTROL is adjusted from a very low to a moderately low frequency, the generated sound is like that of a steam engine gradually increasing in speed. At higher frequencies, the sound approximates that of a propeller-driven airplane.

From a technical viewpoint, there's virtually no limit to the number and types of sounds that can be generated using one, two, three or more SN76477 IC's in conjunction with multiplexing and external programming networks. By using programmable analog switches to select outputs from different units, for example, a clever experimeter easily could create circuits to generate background jungle noises, night sounds, complete battlefield or eerie haunted-house sounds, or even musical selections interspersed with unusual sound effects. In commercial and industrial alarm applications, different sounds could be used to identify various danger conditions, such as illegal entry, fire, basement flooding, or power failure. The IC's are available through TI franchised dealers and are relatively inexpensive. The rest is up to your imagination!

**Reader's Circuit.** Alan Peter Allegra (218 11th Ave., Bethlehem, PA 18018) was intrigued with J. Fortuna's "Digistart" project in our column of April 1977. One of his friends, Frank Resul, had designed a "combination lock" digital ignition switch for his '75 VW sometime earlier.

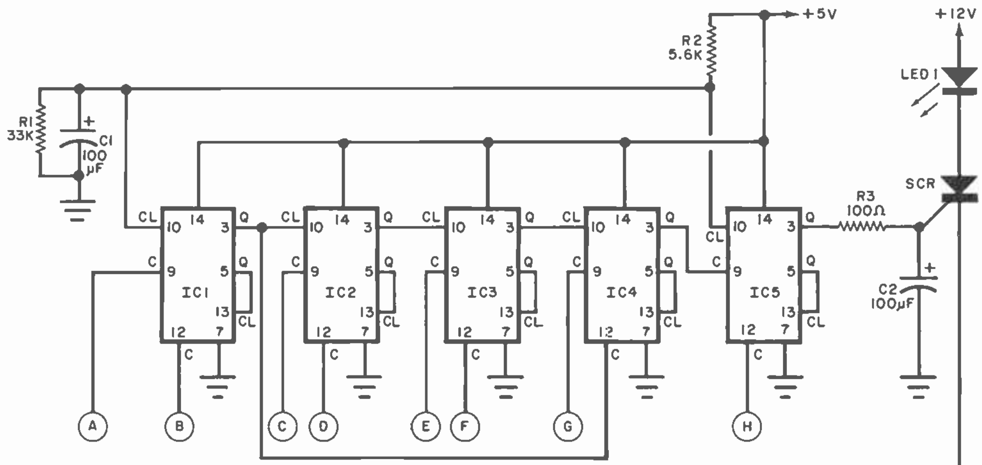
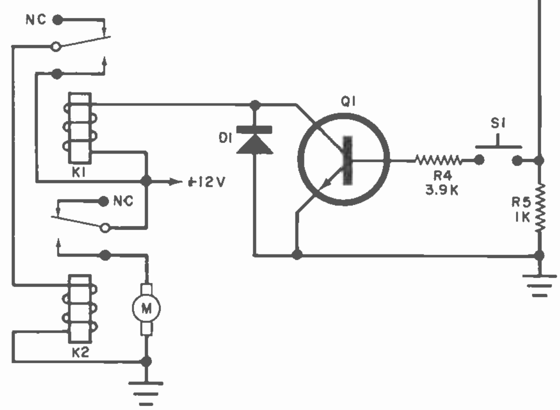



*Fig. 6. Reader's circuit for a digital combination lock for a car's ignition switch.*




Although it is based on the same operating principle as Fortuna's design (flip-flops must be actuated in the proper sequence for operation), the Resul/Allegra circuit shown in Fig. 6 is different in a number of details. First, the dual J-K flip-flops (*IC1* through *IC5*)) are wired as simple toggles rather than in the J-K configuration. Second, there is no interlocked timer, permitting the operator ample time to set the combination, because reader Resul felt that the odds were against a thief hitting the right sequence by pure chance. Third, a LED indicator has been provided to alert the operator when the proper sequence has been completed. Fourth, a nine, rather than five, number (letter) sequence is required for operation.

Referring to the schematic diagram, the dual flip-flops, *IC1* through *IC5*, are toggled sequentially by depressing pushbutton switches connected to each of the lettered clock (*C*) terminals (A through H). Alan writes that the proper sequence with the wiring arrangement shown is A-B-C-D-E-F-G-A-H. When *IC5*'s *Q* output (pin 3) goes high, the SCR's gate is triggered through current limiting resistor *R3*, bypassed by *C2*. The SCR switches to a conducting state, lighting indicator *LED1* and developing a dc voltage across cathode resistor *R5*. This causes base current to flow into npn power transistor *Q1* when start switch *S1* is depressed. Series resistor *R4* acts as a simple current limiter.

When *S1* is closed, then, *Q1* furnishes current to ignition relay *R1* which, in turn, passes the heavier current required by

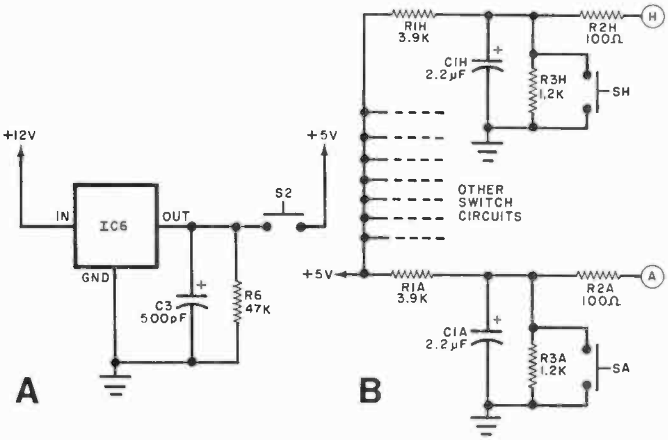



*Fig. 7. Five-volt supply (A) and key debounce (B) circuits for Fig. 8.*

the starter solenoid *K2* which, of course, supplies current to starter motor *M*. Diode *D1* is included to suppress switching transients as *K1* is switched on and off. Voltage divider *R1-R2*, bypassed by *C1*, furnishes a voltage to hold the clear (CL) pins of *IC1* and *IC5* high.

The 5-volt dc source required by the flip-flops is obtained from the auto's 12-volt electrical system using a standard 3-terminal voltage regulator, *IC6*, as shown in Fig. 7A. Capacitor *C3* serves as a noise filter and bypass and *R6* provides the minimum load needed to insure reliable regulation. A normally closed pushbutton switch, *S2*, is the system's reset control. Alan recommends that "debounce" RC networks similar to those shown in Fig. 7B be provided for each of the normally open pushbutton switches used to enter the digital code.

Neither parts placement nor lead dress is overly critical, and the circuit can be duplicated using perforated board, pc or Wire-Wrap construction techniques. All components are standard types, readily available through both local and mail-order outlets. Digital devices *IC1* through *IC5* are 74107 dual J-K flip-flops, *IC6* is an LM309K regulator, the SCR type MCR 103, *D1* 1N5400, and transistor *Q1* any npn power type with (at least) a 20-volt $V_{CEO}$ rating and the ability to handle the current required by *K1*. Any standard LED can be used as an indicator. All resistors are half-watt types and all capacitors 15-volt electrolytics. The code entry switches *SA* through *SH* can be an inexpensive calculator or telephone touchpad or standard normally open pushbuttons. Normally closed pushbuttons are required for *S1* and *S2*. ◇

# Hobby Scene Q&A

By John McVeigh

## SPEAKER IMPEDANCE

**Q.** ***How does one measure the impedance of a speaker system to determine, for example, if it is 4, 8 or 16 ohms? If a manufacturer states that his amplifier is designed for use with 8-ohm loads, is it possible to use 4- or 16-ohm speakers instead? What matching techniques, if any, can be used to make the amplifier and speakers compatible?—Ronald L. Williams, Ithaca, NY.***

**A.** When a loudspeaker's impedance is given as 4, 8, or 16 ohms, a *nominal* rating is being reported. In actuality, a speaker's impedance will vary dramatically with frequency. The absolute value of a representative two-way speaker system's impedance is plotted against frequency in Fig. A. Immediately obvious is a peak in the system's impedance at its resonant frequency, here about 55 Hz. A secondary peak occurs at about 800 Hz.

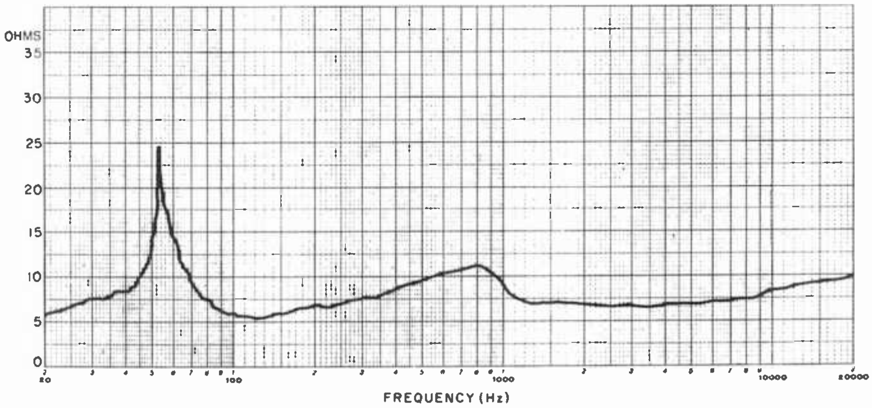



*Fig. A. Impedance vs. frequency for a typical two-way speaker system.*

A loudspeaker's impedance is far from constant over the audio frequency range. How then, do manufacturers arrive at an 8-ohm rating? The EIA standard specifies that the rated impedance is the minimum value noted as the driving signal's frequency is increased above that of resonance. This is sometimes referred to as the trough impedance. For modern speakers, the trough is usually located at about 400 Hz.

Impedance is the vector sum of resistance, inductive reactance and capacitive reactance. To fully describe its variation with frequency, impedance must be plotted in the complex plane (Fig. B). You might not be familiar with the operator "j." This symbol is used by electrical engineers in place of the mathematician's "i" (the square root of negative one) to avoid confusion with current terms, which are traditionally expressed by "i" or "I." If a reactance is written as "+j10," it is 10 ohms of inductive reactance. A reactance expressed as "−j10" is 10 ohms of capacitive reactance.

You might be surprised by the relatively large incursions into the capacitive region. Although part of the reason for this is the intrinsic capacitance of the voice coil, a larger contribution is due to the back emf generated by the speaker. This voltage is 180° out of phase with the applied signal, so it "looks" like the product of a capacitive reactance.

Clearly visible in the polar impedance plot is the resonant frequency of the system (55 Hz), at which point the impedance is 25 ohms resistive. The complex nature of the system's impedance is also obvious. The rated "nominal" impedance of this system is 5 ohms, the minimum value it attains above system resonance.

Contemporary solid-state power amplifiers have low output impedances. They usually work well into 4-, 8-, or 16-ohm (nominal) loads without requiring any impedance matching. Of course, an amplifier will produce more output power when coupled to a lower output impedance. This is a fact well known to those who follow Julian Hirsch's Audio Reports. Test results of a new superpower amplifier indicate the following output power levels at clipping: 207 watts into 16 ohms (per channel!); 312.5 watts into 8 ohms; 458 watts into 4 ohms.

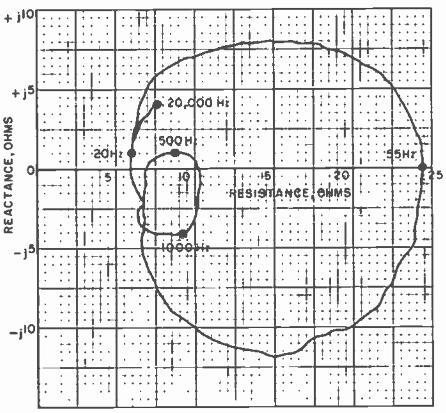



*Fig. B. Speaker impedance plotted in complex plane.*

On the other hand, vacuum-tube circuits usually have high output impedance, necessitating the use of impedance-matching output transformers. These transformers usually have selectable taps to provide the right match for 4, 8 and 16 ohms. When impedances are matched, maximum power transfer occurs.

As noted earlier, transistorized amplifiers will usually work with loads in the 4-to-16-ohm range. They will work a little harder driving 4-ohm speakers, producing somewhat greater output levels. Rarely, however, will trouble result when 4-ohm loads are used. This is *not* true when the load impedance is reduced to, say, 2 ohms—a condition which results when two 4-ohm speakers are wired in parallel. To avoid such problems, follow the manufacturer's guidelines concerning output impedance. Most amplifier designs now include protective circuitry to prevent excessive output levels. This protection can be supplemented by properly fusing the speaker lines.

Have a problem or question on 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.

# Experimenter's Corner

By Forrest M. Mims

## ANALOG TO DIGITAL CONVERTERS, PART 2

IN OUR FIRST look at A/D converters, we briefly examined several ways of converting analog information such as a variable voltage into the binary format that microprocessors and other digital circuits understand. We also developed a homebrew *parallel* or *flash* A/D converter made from a voltage divider and a series of comparators. Now we're going to increase the resolution of our homebrew A/D converter from two bits (00-11) to four BCD digits (0000-1001). We're also going to substitute a single IC for the complicated network of gates we previously used to encode in binary form the output of the comparators.

**Parallel A/D Converter with BCD Output.** Figure 1 shows the circuit of the simplified A/D converter with increased resolution. The heart of the new circuit is the 74147 *priority encoder*. This chip is not often used in experimenter circuits. It's a standard 7400 series TTL part, however, and is available from many mail-order suppliers in the "Electronics Marketplace" section of POPULAR ELECTRONICS.

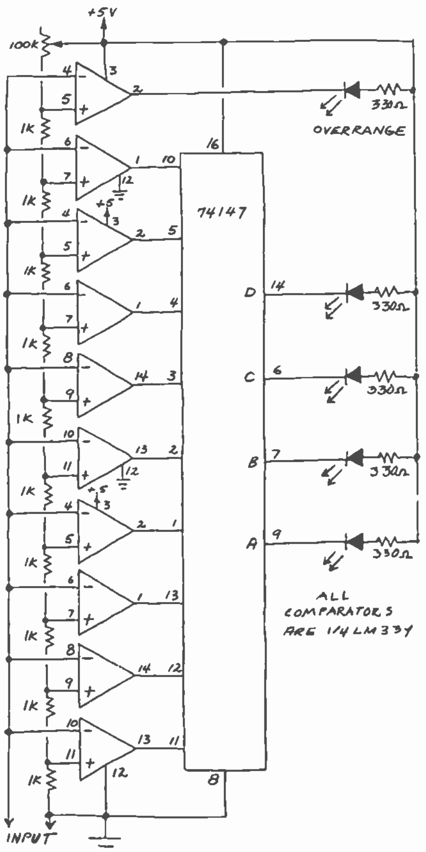
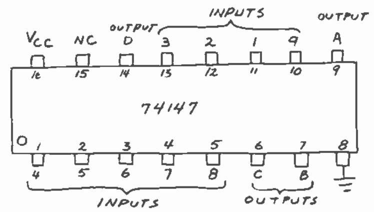



Fig. 1. Parallel A/D converter.




| INPUTS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | OUTPUTS D | C | B | A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | H | H | H | H | H | H | H | H | H | H | H | H |
| X | X | X | X | X | X | X | X | L | L | H | H | L |
| X | X | X | X | X | X | X | L | H | L | H | H | H |
| X | X | X | X | X | X | L | H | H | H | L | L | L |
| X | X | X | X | X | L | H | H | H | H | L | L | H |
| X | X | X | X | L | H | H | H | H | H | L | H | L |
| X | X | X | L | H | H | H | H | H | H | L | H | H |
| X | X | L | H | H | H | H | H | H | H | H | L | L |
| X | L | H | H | H | H | H | H | H | H | H | L | H |
| L | H | H | H | H | H | H | H | H | H | H | H | L |

*Fig. 2. Pin outline and truth table for the 74147.*

The technical designation for the 74147 is *10-line-to-4-line priority encoder*. It's an MSI (medium scale integration) device comprising 31 gates, and is available in both conventional and low-power (74LS147) versions.

The 74147 has ten inputs and four outputs. It's called a priority encoder because it encodes only the highest priority or most significant input and ignores all others. In other words, if inputs 1, 3, 5 and 7 are active, only input 7 will be encoded since it has the highest priority. The binary output will then be 0111. This feature makes the 74147 ideal for use as a simple single-chip encoder for calculator and telephone keypads.

Figure 2 shows both the pin outline and truth table of the 74147. Notice that an active input is low (L) while an inactive input is high (H). The status of each input below that with the highest priority is irrelevant. Therefore, these "don't care" states are indicated by X's.

In Part 1 we covered the operation of the voltage-divider and comparator portions of the homebrew parallel A/D converter. Now that you know how the 74147 works, look back at Figure 1 again and note how simple the complete A/D converter becomes when the encoding network used in the original circuit is replaced by the 74147. Keep in mind that this simplification is accompanied by an *increase* in resolution from two bits to four BCD digits.

The circuit in Figure 1 employs four LED's to indicate the BCD output. The highest-order comparator is connected to an additional LED to indicate an overrange condition. You can use this basic circuit for such A/D converter applications as a single-digit voltmeter, storing analog data in a RAM for later retrieval, and supplying analog data to a 4-bit microprocessor.

In operation, an analog voltage is connected to the circuit's input. The potentiometer (at the top left) is then adjusted to give the desired calibration factor, which can range from a few millivolts/LED to one volt/LED (see Part 1). As the input voltage is *gradually* increased, one or more of the output

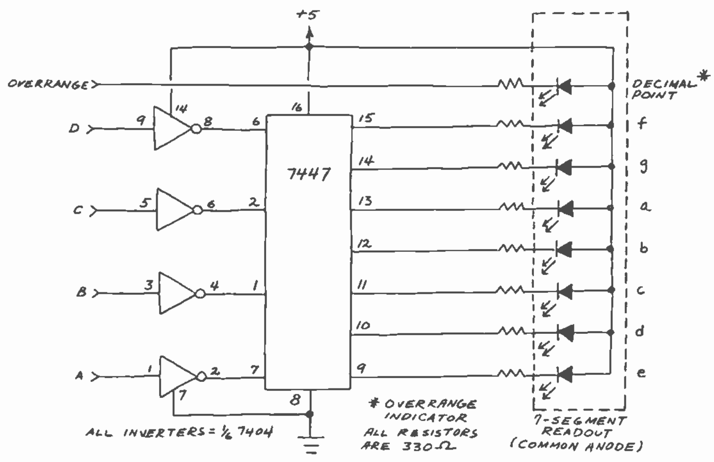



*Fig. 3. Adding a digital readout to the A/D converter.*

LED's may tend to oscillate on and off at certain critical points. This is caused by the highest priority comparator rapidly switching on and off as the voltage applied to it via the resistive divider just reaches its turn-on threshold.

This is usually not a major problem when only LED's are connected to the outputs because the oscillating LED's just glow dimmer than those that are fully on. Oscillation can cause major problems, however, if the circuit is coupled into another digital circuit as false readings can occur. One way to reduce or eliminate the oscillation is to reduce the gain, hence the sensitivity, of the comparators. This can be done by connecting a 100,000-ohm resistor between the noninverting (+) input and the output of each comparator.

**Single-Digit Voltmeter.** It's easy to use the basic A/D converter in Fig. 1 as a simple single-digit voltmeter with the help of a 7404 hex inverter, a 7447 BCD to 7-segment decoder and any common-anode LED display. Figure 3 shows how the new components are connected together and added to the circuit in Fig. 1.

The inverters are necessary to change the BCD data from the 74147 to the logic levels accepted by the 7447. The decimal point of the display is used as an overrange indicator. The four LED's connected to the 74147 in Fig. 1 can either be removed or left in place when the 7-segment readout components are added. They will not affect the operation of the circuit, although they will increase current consumption.

The single-digit voltmeter has some interesting and very practical applications. It's great for checking approximate voltages in battery-powered equipment. It also allows you to check quickly the approximate voltage level of rechargeable cells and batteries. It can even be assembled into a miniature probe and used as a hand-held voltmeter.

As you will recall from Part 1, the parallel A/D converter can be used as a timer by connecting a capacitor directly across its inputs. Try this with the single-digit voltmeter and you'll have a 0-9 (plus overrange) timer that can indicate fractions of a second to several minutes per count. Larger capacitors provide longer intervals. You can also measure resistance with the single-digit voltmeter. Just connect the input terminals directly across the unknown resistance.

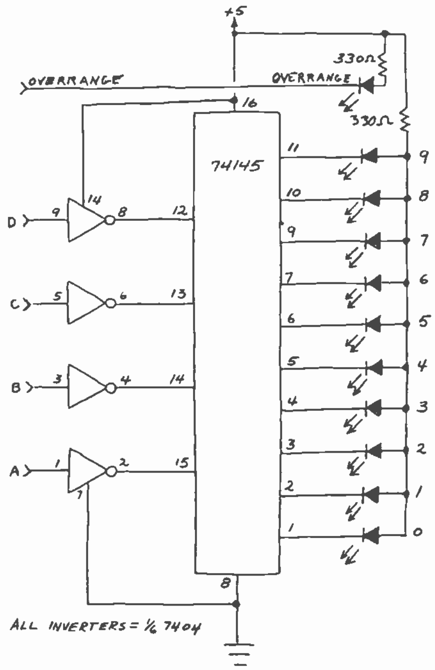



*Fig. 4. Ten-position moving-dot readout circuit.*

In all these applications it's necessary to calibrate the circuit by adjusting the 100,000-ohm potentiometer in the voltage divider. For best results, use a knob with a pointer and a homemade scale. This will help insure repeatable results. In some applications you'll want to *increase* the value of the 100,000-ohm potentiometer. By using a 10-megohm potentiometer, for example, I was able to measure the resistance of a human chain formed by a dozen people.

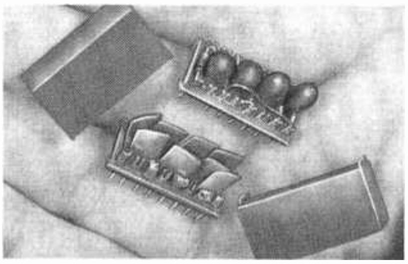
**Moving-Dot Readout**. You can use solid-state electronics to simulate a mechanical meter movement with the help of the circuit in Fig. 4. This circuit, like the previous one, is connected directly to the A/D converter of Fig. 1.

In operation, a voltage increasing from zero lights each LED in succession until the overrange LED glows. Note that only one of the LED's connected to the 74145 glows at any instant. This produces a moving-dot effect that draws less current than a bargraph or "thermometer" readout made by connecting LED's directly to the outputs of the comparators in the A/D converter (see Part 1). Because only one LED is on at any instant, a single current-limiting series

# PROJECT OF THE MONTH

## MINIATURE DC-DC UPCONVERTERS

The subject of the June 1978 Experimenter's Corner was voltage multipliers made from a network of diodes and capacitors. If you read that column, you'll recall that voltage multipliers provide an easy way to obtain high-voltage dc from low-voltage ac.

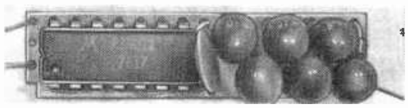


*Two multipliers on DIP headers.*

Voltage multipliers are easy to miniaturize. The photo shows two compact multipliers I assembled on miniature dual in-line (DIP) headers. The upper circuit has four diode-capacitor pairs connected as a voltage quadrupler; the lower has eight diode-capacitor pairs. With their plastic covers installed, each of these circuits occupies no more space than a 16-pin DIP!

Figure A shows the circuit diagram and construction details of the four-stage multiplier in the photo. A cascade voltage multiplier chain like the one shown in Fig. 5 in the June 1978 column was used in the eight-stage circuit. Ideally, each additional diode-capacitor stage should add the approximate value of the input voltage to the output voltage. In practice, the actual output voltage is affected both by the size of the capacitors and the frequency of the input voltage.

The four-stage circuit uses 4.7-µF miniature tantalum capacitors and has an open-circuit multiplication factor of 2.5. The eight-stage circuit uses 0.005-µF ceramic capacitors and has an open-circuit multiplication factor of 3.5. These multiplication factors were measured by applying a 100-kHz square wave to the input of each multiplier.



*Prototype of circuit in Fig. B.*

You can drive either of these miniature multipliers with an audio-frequency oscillator made from an op amp, 555 timer or a few gates connected as an astable multivibrator. Refer to the June 1978 column for sample oscillator circuits.

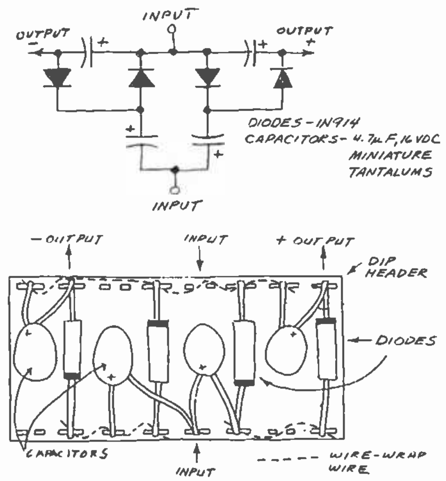
Meanwhile, you might want to build the self-contained upconverter circuit shown in Fig. B. This circuit includes its own oscillator made from the four gates in a single 4011 and a six-stage multiplier. I assembled the prototype version of the circuit on a small perforated board only twice the length of a 16-pin DIP, but you can modify the construction to suit your requirements and the space available.

If you want to miniaturize the circuit, use perforated board with small copper solder pads at each hole (Radio Shack 276-152 or similar). *Before* installing the components, thread Wire-Wrap wire between the various holes where the IC will be installed in accordance with the circuit diagram. The wires should be laid flat against the *top* side of the board.

After the wires are in place, insert the IC into the board (over the wires) and carefully solder each of its pins to the appropriate solder pads and Wire-Wrap wires. Be sure to use proper CMOS handling and soldering methods to avoid damaging the IC.

Complete assembly by installing the resistor and capacitor of the 4011 oscillator and the diodes and capacitors of the multiplier. The prototype circuit is shown in the photo. The resistor and the six diodes are hidden under the various capacitors.

This circuit multiplies a 3-to-15 volt dc input by a factor of approximately 5 (no load). It's therefore ideal for miniature circuits employing avalanche detectors, four-layer diodes and other components requiring from 15 to 75 volts. ◇



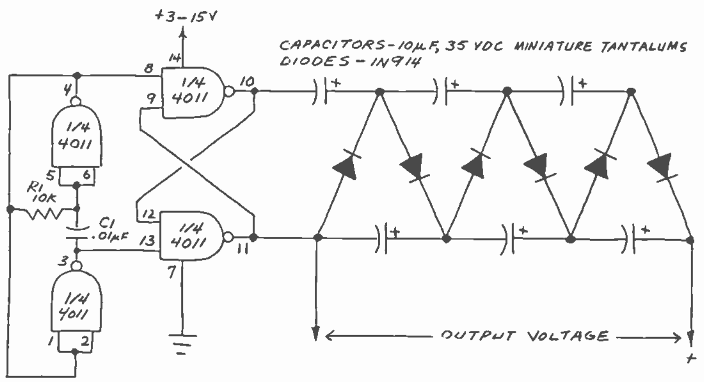




*Fig. B. Miniature dc-dc upconverter circuit.*

*Fig. A. Circuit diagram and construction details of 4-stage miniature voltage multiplier.*

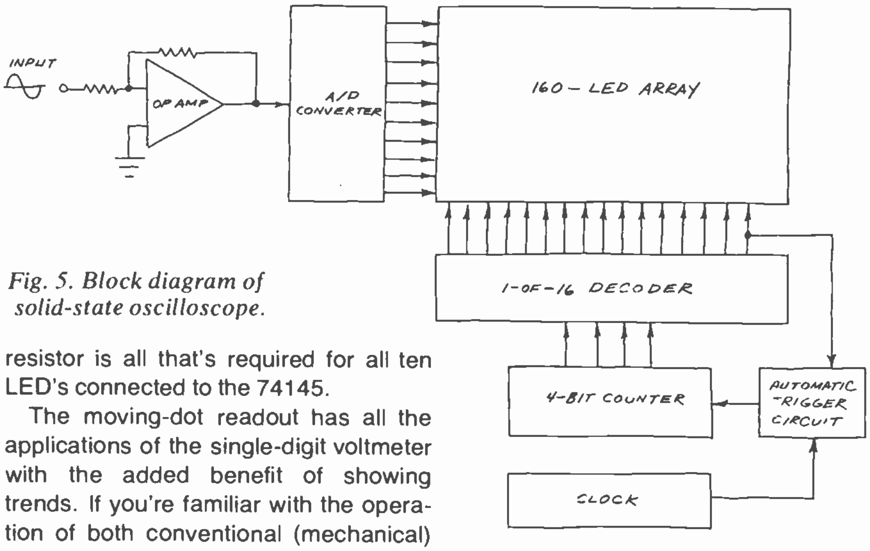



*Fig. 5. Block diagram of solid-state oscilloscope.*

resistor is all that's required for all ten LED's connected to the 74145.

The moving-dot readout has all the applications of the single-digit voltmeter with the added benefit of showing trends. If you're familiar with the operation of both conventional (mechanical) meter movements and digital readouts, you know that the latter are totally unacceptable for monitoring quickly fluctuating changes in an input signal.

For example, it's easy to watch the rate of charge on a capacitor with a mechanical meter movement, a simple and routine task for which a digital display is almost totally unsuited. Likewise, a mechanical meter indicates the passage of a pulse with a quick bounce of its needle (assuming that the inertia of the meter movement is small enough and the pulse width sufficiently large). Digital readouts are not suited for this.

Mechanical meter movements, are of course, inherently fragile. By contrast, the A/D converter with a moving-dot readout provides simulated analog readout and solid-state reliability.

**Solid-State Oscilloscope**. The moving-dot readout in Fig. 4 can be used to replace the traditional cathode-ray tube (CRT) with an array of LED's. An obvious application for such an LED array is a fully solid-state oscilloscope.

One way to make a solid-state scope is to assemble a series of ten-element moving-dot readouts on a single card. A counter circuit is then used to sequentially connect each readout to the A/D converter. An incoming voltage that varies with time is then displayed as a waveform on the array of LED's.

The speed of the counter circuit must be synchronized with the frequency of the incoming signal to freeze the waveform being displayed. This can be done by manually adjusting the frequency-control potentiometer of the clock that supplies pulses to the counter.

A better way to synchronize the scope is to use an automatic trigger that initiates the sweep when an input arrives. This is easily done with a few gates.

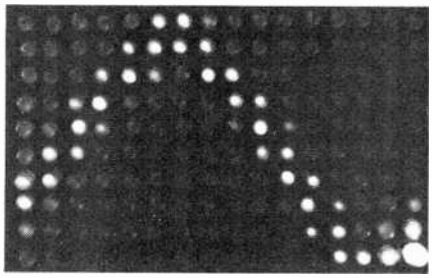


*Fig. 6. Screen of 160-LED solid-state scope.*

I recently assembled a Wire-Wrapped solid-state scope based on the parallel A/D converter shown in Fig. 4. A block diagram of the scope is shown in Fig. 5. Figure 6 is a photograph of the 'scope's "screen" showing the positive half of a triangle wave.

The screen has 160 yellow LED's organized as 16 columns of 10 rows. A single red LED at the upper left side of the screen indicates an overrange condition. The LED at the lower right corner glows brighter than the other LED's in the screen because the trigger is connected to it.

As you can see, the resolution of the 160-element screen is limited. Also, up to three LED's in a single column can appear to be on when a sloping waveform is displayed. Fortunately, the human eye is usually able to integrate the information displayed by the array so that the true shape of the waveform is apparent. Waveforms with flat tops are even easier to visualize.

The circuit for the scope shown in Fig. 6 uses thirteen IC's and is reasonably straightforward. It's construction details, however, are much too involved to be included here. The 160-LED screen, for example, requires more than 650 solder connections and several hours of tedious work. ◇

# Product Test Reports

## Sencore Model TF46 Transistor/FET Tester


*Battery-powered in/out-of-circuit instrument features quick, accurate device evaluations.*

SENCORE'S Model TF46 "Super Cricket" transistor/FET tester is designed to test signal and power transistors for gain and leakage, determine whether they are npn or pnp, and identify their leads. It also tests for leakage and $I_{DDS}$ in both normal and enhanced FET's and identifies their leads and whether they are n- or p-channel. All tests can be performed both in and out of circuit.

The tester measures 10"H × 5.5"W × 3.5"D (25.4 × 13.8 × 8.9 cm) and weighs 4.5 lb (2 kg) with battery installed. Suggested retail price is $225.00.

**General Information.** Devices to be tested are connected to the instrument through color-coded "E-Z-Mini-Hooks." There are no sockets on the instrument to fatigue and fail. The E-Z Hooks connect directly to component leads and apply a positive, secure grip. There is no need to determine beforehand which leads are the emitter, base, and collector (or source, gate, and drain) on the device being tested.

To make a test, the E-Z Hooks are simply connected to the device under test in any order at all. Then the large Permutator switch is rotated until a tone is emitted by the instrument and the meter's pointer deflects into the GOOD area of the scale. At this point, the device is identified as either an npn or a pnp bipolar transistor or an n- or p-channel FET and its basing will be known.

Imprinted on the bar of the Permutator switch are the legends EBC and SGD for emitter / base / collector and source/ gate/ drain. On the panel surrounding the switch are the legends for the various combinations of the green, yellow, and red color code of the test-lead cable's E-Z Hooks. The code combinations are repeated on both the N and P sides of the dial. Hence, if the tone is emitted when the Permutator switch is in the GRY position on the N side of the dial and the device under test is a bipolar transistor, it is an npn type and the leads of the test cable are connected green to emitter, red to base, and yellow to collector.

Once the type of device—bipolar transistor or FET—is known, the remaining tests on it can be performed. To do this, the Permutator switch is left in the proper position and the type of device is fed in by depressing the SIG TRANS, OUTPUT TRANS, NORMAL FET, or ENHANCE FET switch to the left of the rotary switch. Then by momentarily pressing the GAIN and LEAKAGE switches to the right of the rotary switch and observing the meter's pointer, the condition of the bipolar transistor can be determined. To determine the condition of a FET, one presses the GAIN and then $I_{DSS}$ buttons.

Although the Model TF46 is not specifically designed to test silicon controlled rectifiers, it will test many types of SCR's. The SCR specification that determines whether or not it can be tested is the gate trigger voltage or current. Diodes are tested by connecting the red and green test leads to it and rotating the Permutator switch alternately between the two DIODE positions (YGR and YRG on the P side) of the dial, simultaneously pressing the LEAKAGE button. A good diode will indicate high leakage in one position of the Permutator switch and low leakage in the other position. If the meter indicates high leakage in both positions, it is shorted, and if it indicates no leakage in both positions, the diode is open. Lead identification is spelled out in the instrument's manual.

The instrument's test currents have been chosen to provide the best balance between high testing accuracy and protection for the device under test. In addition, protection circuits prevent the application of bias signals if the Permutator switch is not in one of the positions that produce the gain test. This makes the instrument safe for testing any transistor or FET.

The Super Cricket's 4½" (11.4-cm) meter movement has five easy-to-read scales. The topmost scale is a simple BAD/GOOD indicator. The next two scales are for GAIN over ranges of from 0 to 500 beta and from 0 to 25K $\mu$mhos. Finally, the two LEAKAGE scales are calibrated from 0 to 2.5K $\mu$A ($I_{CBO}$ or $I_{GSS}$) and 0 to 50 mA $I_{DSS}$. Built into the instrument's case is a metal plate that one can slide over the meter movement to protect it from damage when not in use.

The test cable folds up and fits into a well at the bottom front of the instrument when not in use. Also in this well are the SPEAKER ON/OFF (which can be set to OFF to defeat the tone and conserve battery power) and BATT. TEST switches. A door swivels up to enclose the well when the instrument is not in use. At the top of the instrument's case is a convenient carrying handle that doubles as a tilt stand on the service bench.

The Super Cricket is normally powered by six AA cells that fit into a well in the rear of its case. An optional No. PA202 ac adapter is available for operating the instrument on line power and recharging Ni-Cd cells installed at the user's option. The Model TF46 has a built-in circuit that automatically defeats the power after 10 minutes of no use to conserve battery power.

**Technical Details.** The specifications for the Super Cricket are excellent. The good/bad gain test uses Sencore's patented square-wave approach, which employs a test frequency of 2000 Hz and a $V_{CE}$ of $\pm$4 volts dc and a $V_{BE}$ of 7 volts peak-to-peak on a zero reference. Test currents are 12 mA maximum $I_C$ with 2 to 3 mA average and 7 mA maximum $I_B$ with 3 mA average.

The dynamic beta test operates with the good/bad tests with a 25 mA maximum $I_C$ for signal transistors and 150 mA maximum for power transistors. The respective $I_B$'s are 50 and 300 $\mu$A max.

The bipolar leakage-key tests measure the reverse collector-to-base leakage($I_{CBO}$) and all other paths ($I_{EBO}$, $I_{BEO}$, $I_{CEO}$, and $I_{BCO}$) with the Permutator switch. Test levels are $\pm$3.5 volts for $V_{CB}$, with emitter open, and 0 to 2500 leakage range.

FET's are tested using the dynamic mutual-conductance approach. The test frequency is 2000 Hz, and the test potentials are $\pm$4 volts dc $V_{DS}$ and 0 volt $V_{GS}$. The signal level is 0.4 volt peak-to-peak, while the Gm range is 0 to 25,000 $\mu$mhos. The open-source $I_{GSS}$ FET leakage test potential is $\pm$3 volts and the $I_{DSS}$ zero-bias drain current test uses a $\pm$4-volt dc $V_{DS}$.

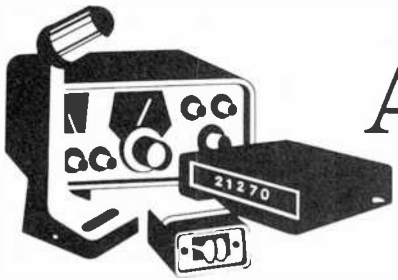
**User Comment.** Having worked with the Model TF46 Super Cricket at our workbench for a couple of months, we can readily attest to the instrument's accuracy and ease of handling. It did not take us long to test and sort several hundred transistors and FET's we have accumulated over the years. The connect-in-any-order E-Z-Mini-Hooks and Permutator switch arrangement took most of the hassle out of testing and reduced the time required significantly.

The test tone was perhaps the most helpful indicator for the tests we performed. Backed by the meter indications obtained, we performed all our tests with complete confidence.

Once we had our transistors tested and sorted, we proceeded to test the multitude of diodes we had lying around. We did not have many SCR's to test, but those we did have were easily tested and appeared to be good.

The price of the Model TF46 Super Cricket is a bit steep; but if you work with a lot of transistors, FET's, diodes, and SCR's, it can pay for itself in short order in time saved. ◇

CIRCLE NO 104 ON FREE INFORMATION CARD



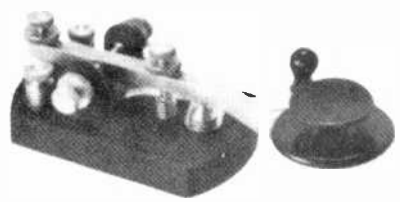

# Amateur Radio

By Karl T. Thurber, Jr., W8FX

## KEYS, KEYERS AND OTHER ACCESSORIES

OF ALL station accessories, the telegraph key is usually given the lowest priority and the smallest budgetary allocation. Actually, it should not be considered an accessory at all, but an integral part of the station. In the CW-only Novice installation, the "straight" or hand key is (forgive the pun) the key piece of telegraphic equipment. Until the hand key is mastered, it's wise to keep away from semiautomatic "bugs" or fully automatic electronic keyers. Using such a key enables the Novice to develop a sense of timing and rhythm invaluable in attaining the proficiency needed to successfully tackle the General and Extra Class code requirements.

**Straight Keys.** Many different straight keys are available commercially, ranging from the old military surplus J-38 that many old timers (including this columnist) used to pound their first brass, to the newer but essentially similar models of Japanese manufacture distributed by Radio Shack and others. Also of interest to Novices and higher-class licensees who are straight-key buffs is the relatively new line of keys manufactured by the Wm. N. Nye Company, Inc. (1614 130th Ave., N.E., Bellevue, WA 98005).



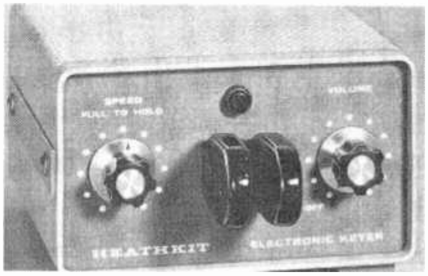
*Nye Viking's heavy-duty Speed-X straight key with Navy knob.*

Nye Viking standard Speed-X keys feature adjustable bearings, silver contacts and are mounted on an oval die-cast base with a black wrinkle finish. They are available with standard or Navy knob, with or without switch, with nickel or brass-plated key arm and hardware and are priced under $10.00. Nye Viking's slightly more expensive heavy-duty Speed-X keys are mounted on a die-cast rectangular base with baked black wrinkle finish. Features include a Navy knob mounted on a 1/4-inch (6.4-mm) square brass key arm, adjustable bearings and silver contacts. The keys come with brass, chrome, or nickel-plated hardware and with or without switch. Those who really want something *special* in a straight key might be interested in Nye Viking's special "presentation" model Speed-X key. It has the smooth action of the other Nye keys, but all metallic elements are gold-plated and the key is mounted on a jet black plastic sub-base. Price is $50.

Any of these straight keys is suitable for Novice work, but some brass pounders prefer the feel (and/or look) of one particular model. If possible, you should visit a radio store that carries a wide variety of keys and try each one yourself. No matter what key you choose, it should be properly mounted and adjusted so that you can use it to send good code, comfortably. It should be mounted on a sub-base that will not "walk" across the table while you're sending code, or it can be secured directly to the operating table. In any event, the key should be positioned so that you can rest your elbow and forearm on the table while you are using it.

The key's contacts should be clean and free of oxidation. Careful experimentation should be made to discover the optimum combination of the various key adjustments—contact spacing and vertical travel, side bearing adjustments and spring tension. When making these adjustments it's best to enlist the aid of an experienced CW operator. He can not only help you adjust the key properly but also audition your sending off the air through a code oscillator and suggest ways to develop a good "fist."

A good straight key should see you through your Novice days. However, sooner or later, the CW operator gives thought to the use of a semi-automatic "bug" or fully automatic electronic keyer. You should not make the switch until you can send at 15 WPM for sustained periods using your hand key with very few mistakes. The bug, very popular during the 50's and early 60's, generates dits automatically by means of a vibrating metallic reed and permits good sending up to about 40 WPM, a code speed adequate for most amateur applications. Actually, the limiting factor is the dahs which can be sent just so fast manually. Bug adjustments can be a bit tricky and, with the advent of relatively inexpensive electronic keyers, the Novice should consider sticking with his straight key until he has sufficient proficiency to try the electronic keyer. Usually the change to a keyer is made after the General ticket is won. (The old-fashioned CW purist will undoubtedly disagree with this recommendation and will say that real CW operators never abandon their Vibroplex bugs!)




*Heathkit Model HD-1410 electronic keyer with adjustable volume.*

The fully automatic keyer is a sensible progression beyond the bug if the operator wants cleaner, faster signals with much less physical effort and strain ("glass arming"). Keyers are more costly than straight keys with prices starting at about $20 for basic assembled circuit boards which are less paddle (mechanical "heart" of the unit, a sensitive single-pole, double-throw switch) and enclosure to several hundred dollars for very sophisticated units with memories which are actually keyers plus a microprocessor all rolled into one.

Keyers contain complicated circuitry, including IC's and other exotica to generate the dits and dahs electronically. This makes possible virtually perfect CW if properly used by an experienced operator. Listening to good keyer-generated CW is a genuine pleasure. The key to the intelligent use of a keyer lies with the operator, who must learn to synchronize himself with his keyer and send within the confines of its timing parameters.

A Novice who is considering the purchase of a keyer should thoroughly analyze his needs. If he intends to permanently abandon CW once he gets his General, a keyer would not be a good investment. However, a Novice who really enjoys CW would be wise to invest in a good keyer at the time he is upgrading his license. All the literature should be thoroughly studied to obtain a working knowledge of keyer terminology (for example, completing vs. non-self-completing characters, iambic operation, types of paddle mechanisms, and whether or not the keyer has an internal memory—a "must" for the serious contest operator).

Many excellent keyers are commercially available, such as the Heath HD-1410, the MFJ CMOS-8043, the Ten-Tec KR-50,and the Ham-Key HK-5. Some keyers, such as the Heath and Ten-Tec units, include a built-in paddle mechanism, while others require an additional expenditure for a separate paddle.

The Autek Research Model MK-1 is a state-of-the-art programmable keyer. It has a built-in 100-character memory allowing CQ's, QRZ's, or any other "canned" messages, including so-called "contest exchanges"to be sent automatically. Also included are dot and dash memory to forgive minor timing mistakes and a built-in CW sidetone to boot, all for under $100. An external paddle is required, however, which will cost from $15 to $50 if a commercial unit is purchased. Ten-Tec, Brown Brothers, Nye Viking, and Ham-Key all make paddle mechanisms to complement the basic keyer. A particularly interesting unit is the Ham-Key Model HK-4. Although this model costs $45, it combines a sturdy straight key and dual squeeze-level paddle on one heavy base. It is therefore a very good investment for the beginner as his first key as it will never become obsolete. The Brown Brothers Model CTL-B has similar features and is just $40.

**Other Accessories**. A transceiver or receiver and transmitter, key, and an antenna are absolutely necessary to get the Novice on the air, but some simple accessories will add considerably to operating convenience. Most hams today buy the major pieces of station equipment ready-made. However, homebrewing accessories or buying kits is a fair compromise between the expertise required to build equipment and the need to develop construction skills.

On the receiving side, the addition of the usually optional CW i-f filter accessory to the transceiver or receiver will work wonders in helping you separate and work closely spaced CW signals which would otherwise not be possible to copy. Many rigs on the market today are designed primarily for SSB operation, sporting i-f selectivity on the order of −6 dB at ±1200 to ±1500 Hz, usable on CW but much too broad for serious work on today's Novice bands.

Complementing the i-f filter is the CW audio filter. Some of the more advanced designs are truly amazing in their ability to bring down effective receiver selectivity to 50 Hz or less. MFJ and Autek Research offer sharp active audio filters and their products are also available in circuit-board form to fit into one corner of a receiver or transceiver or in a separate enclosure.

The SWR bridge is another useful accessory, and a necessary one if an antenna coupler is used. Many inexpensive CB-type bridges are designed to work well with power levels up to 1000 watts. Some, however, are capable of operation up to only about 200 watts and should not be acquired if you entertain notions of getting high-power gear after upgrading your license. The Dentron Model W-2 is a very handy unit as it doubles as a direct-reading wattmeter as well as an SWR bridge.

Also highly recommended is a crystal calibrator to provide known reference marker signals for receiver dial calibration and as insurance that one is operating within the band—the FCC frowns on out-of-band operation! In selecting a calibrator, if one is not already an integral part of the receiver or transceiver, be sure that it is capable of putting out markers a maximum of every 100 kHz. A calibrator requires a simple initial adjustment—zero beating the calibrator output with the carrier of the National Bureau of Standards' time and frequency station, WWV. If your receiver doesn't cover the frequencies on which WWV transmits (2.5, 5, 10, and 15 MHz), you can use a general-coverage receiver to trim the calibrator. A very interesting calibrator is that produced by Rainbow Industries, Indianapolis, Ind. It is capable of generating markers as low as 25 Hz, making it useful as an audio generator and oscilloscope calibrator in addition to its primary function. It is available in an attractive cabinet or as a wired circuit board for custom installation in the receiver.

A receiving preamp is generally not necessary if you are using contemporary solid-state equipment with good sensitivity [1 microvolt or less for 10 dB (S + N)/N]. A preamp can even cause receiver overloading and cross-modulation if used improperly. However, the gain of even some of the best receiving gear tends to decrease on 10 meters and, to a lesser extent, on 15 meters. A preamp may be of some value in compensating for this roll-off in gain. Whether a homebrew or commercial unit is selected, make sure that, if you are using it with a transceiver, there is a positive means of switching the preamp out of the circuit (by either a relay or electronic switching) to prevent its ruin by application of the rig's r-f output on transmit. Ameco's PC-series of preamps and MFJ's Model 1030BX are popular and highly effective commercial units. Building an equivalent preamp is not too difficult even for the beginner. There are many designs to choose from in the ARRL Handbook and other amateur radio publications.

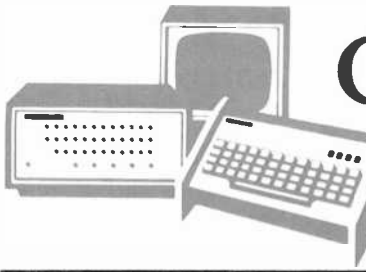
If your Novice transmitter is crystal-controlled, a vfo (variable frequency oscillator) would most certainly be a valuable addition, providing considerable operating flexibility and convenience. Anyone contemplating vfo construction should have some mechanical ability and good tools to make a mechanically rugged unit, plus enough circuit knowledge to troubleshoot any key clicks or chirps (common maladies in poorly designed vfo's) which may develop. A number of good vfo's are on the market and they can be made to work with a wide variety of transmitters. The old Heath Model HG-10 or Johnson Viking vfo's are good companions for the crystal-controlled Heath DX series transmitters or such old-timers as the Johnson Adventurer and Challenger.

Most operators can send better code if they can actually hear what they are sending. Many beginners using equipment which doesn't contain a built-in sidetone oscillator simply use the station receiver or an auxiliary receiver as an on-the-air monitor. Employing the main receiver for code monitoring is inconvenient because you must constantly retune the receiver and "ride the gain" to prevent blasting and overloading. There are many different ways to monitor your keying, such as using a small r-f-actuated audio oscillator or simultaneously keying both the transmitter and a separate code practice oscillator. If your transmitter or transceiver doesn't have a built-in monitor, your best bet is to buy a keyer which contains its own sidetone (most do). This will allow you to practice your sending off the air without connecting the keyer to a practice oscillator.

**Necessities.** Two accessories which belong in every ham shack are a low-pass filter and a dummy load. Although the use of a good antenna coupler can add 10 to 20 dB of harmonic suppression, this still might not be enough in "fringe" TV reception areas. Also, the use of a multi-band antenna, such as a trap dipole, actually increases the possibility of harmonic radiation. A good TVI filter, such as a Drake, Nye Viking or Barker and Williamson model can provide 70 to 90 dB of harmonic suppression. That should make the rig "clean" as far as TVI harmonics are concerned, assuming the rig itself is well shielded and grounded.

A dummy load absorbs the power output of the transmitter and allows you to make practically any transmitter adjustment without actually radiating a signal and interfering with other hams. Most dummy loads are nothing more than 50-ohm air- or oil-cooled resistors. In a pinch, an ordinary light bulb can be used to absorb the transmitter's power output. One disadvantage of using the light bulb is that its resistance changes with filament temperature, causing transmitter loading to change as the bulb gets warm. Various commercial products are available, some of which include a direct-reading wattmeter to indicate actual transmitter output power so you can keep a continuous check on transmitter performance. However, the simpler units should be adequate for most purposes, such as the Heathkit Cantenna. This load, if filled with oil coolant, can handle a full kilowatt at frequencies up to 30 MHz and sells for under $15. It can be used in conjunction with your SWR bridge or directional wattmeter to tune the rig for maximum power without conducting excessive on-the-air tuning—something the FCC frowns upon.

A grid-dip meter and field-strength meter are also useful additions to the ham shack and, if bought in kit form, offer good construction practice. They are especially helpful when you are tuning a directional antenna such as a Yagi or cubical quad. ◇



# Computer Bits

By Leslie Solomon

## ANOTHER GRAPHICS SYSTEM

THERE IS no doubt that the next advancement in personal computing will be in graphics. Alphanumerics are great if the program you are running has to be read or printed out. However, the old adage about one picture being worth 10K words still applies.

Currently, most computers use either their associated CRT terminal or a "plug-in" video module to display a coarse form of graphics that uses character-generator types of symbols. Resolution, in such cases, is fine for games. In many other instances, however, higher resolution is desirable.

A couple of manufacturers have indeed made high-resolution plug-ins, especially for the ubiquitous S-100 bus that can create up to 256 x 256 pixels (picture elements) for an excellent image on a monitor CRT screen.

Now, another company has entered the lists: Vector Graphics Inc., 790 Hampshire Rd., Westlake Village, CA 91361 (Tel: 805-497-6853). They introduced a "High Resolution Graphics" board at $235 assembled, and $195 in kit form. This S-100 bus plug-in is raster scan and can operate in either of two modes—digital with 256 horizontal by 240 vertical screen elements or a 16-level gray scale having 128 horizontal by 120 vertical elements. In either case, the video output conforms to RS-170 to allow interface with any raster-scan video monitor.

Special circuitry on the new board allows the video screen to be updated without "glitches."

The board, specifically designed for the Vector Graphic 8K static RAM memory board, is used for both screen refresh memory and as conventional memory. The two boards are interconnected by five small cables.

The graphics board has all the circuitry required to multiplex the address and data signals to the associated 8K memory board. This logic allows the memory to be addressed by the MPU and the video counters, thus delivering both conventional data transfer and video to the monitor.

Software provided includes the source listing for a callable alphanumeric U/L case character generator set that could also be used to create special symbols and graphics. A North Star diskette is also provided, and includes a robot control language by Dr. LiChen Wang, and some demo graphics.

We installed the graphics/memory pair in our computer and ran the demo program. Some of the images generated were of excellent quality. We understand that these photographic demos were created by digitizing a slow-scan TV camera.

The robot language was interesting. The cursor forms a "bodyless" robot that can be programmed to move around the screen in almost any pattern desired. Routines within the language can be called to make the "robot" move around. We assume that once a robot is built, the bits that position the cursor can then be transmitted to the robot mechanics to make the machine physically move in the same programmed manner.

This is the second high-resolution graphics board that we have had the opportunity to work with. We feel that such graphic displays open up new application areas for the computer enthusiast.

*This is the kind of resolution obtained from Vector Graphics video board.*

**Hard Copy Stuff.** If you have, or are going to get, a Selectric Model 731 or 735 I/O Writer, then take a look at the "Typeaway." This is an S-100-to-Selectric interface from Micromation, Inc., 524 Union St., San Francisco, CA 94133 (Tel: 415-398-0289). This $350 assembled ($275 in kit) board includes a single S-100 plug-in that has solenoid drivers, I/O ports, complete software in PROM, all necessary cabling and connectors, and a power supply.

Software is supplied in two 1702A PROM's; all code conversions and control functions are included.

**SWTP Board.** National Multiplex Corp., 3474 Rand Ave., Box 288, South Plainfield, NJ 07080 (Tel: 201-561-3600) is now selling a Z80 board that plugs into the SWTP bus. Costing $190 assembled and tested (plus $3 shipping and handling), the new board uses a 2-MHz clock, and on-board baud-rate generator up to 9600 baud. A 1K ROM monitor, and tape recorder read/write routines for both KC and National NRZ recorders are included. This new board replaces the 6800 board currently used.

This same company also has a 2SIO plug-in for the SWTP machine. It features 3K of ROM space and two I/O ports. One or two recorders can be controlled via a 4-bit parallel port along with two serial ports.

**Apple Stuff.** Electronic Systems, Box 9641, San Jose, CA 95157 (Tel: 408-374-5984) announced its serial I/O board for the Apple II. The board comes with software to input or output BASIC programs, monitor a serial 20-mA device, or for using the Apple II as a video terminal. Both input and output are RS-232 compatible. The board also features selectable parity, number of stop bits, and has a jumper-selectable address. Data rate is to 30,000 baud.

The board is available as an assembled and tested unit for $62, or as a kit for $42. Full documentation and software is included with each board. The circuit board is available for $15.

Other available kits include a tape interface, modem, r-f modulator, power supply, 8K static RAM for the S-100 bus, UART and baud-rate generator, tape interface DMA board for the S-100 bus, a TVT, and RS-232 to TTL or TTY.

Microproducts, 1024 17th St., Hermosa Beach, CA 90254 (Tel:



smallest controller cards around, the new Apple Disk-II ($495) and its DOS can drive one or two minifloppys for almost instant access to 1.6-million bits of data. The system provides full disk capability with 16K of RAM, ability to load and store files by name, random and sequential access, automatic generation of

213-374-1673) has announced its EPROM programmer for the Apple II at $89.95, with a $9.95 2716 socket adapter. Two empty ROM sockets can be filled with 4K of user-selected programs. This assembled and tested plug-in fits into any available slot in the Apple and contains a zero-insertion-force socket.

**Pet Peripherals.** If you have a Pet and wish to increase its memory capacity to 16-, 24-, or 32K-bytes, then take a look at the Pet Store from Computer Mart Systems, 13 E. 30th St., New York, NY 10016 (Tel: 212-686-7923).

Priced at $550 for the 16K, $650 for the 24K, and $750 for the 32K version,

file-name directories, storage capacity of 116K per diskette, and use of the present Apple power supply.

Each track contains 13 sectors of 256 bytes, and data transfer is 156K bits/second. Track access time is 200 ms average and disk latency is 100 ms.

**Apple Listens, Too.** Until now, only S-100 bus systems could have speech input. Now, Heuristics, Inc., 900 N. San Antonio Rd., Los Altos, CA 94022 (Tel: 415-948-2542), introduces the Speechlab 20A ($189 assembled and tested) for the Apple II computer. With a 20-word "vocabulary," the new Speechlab plugs directly into an Apple connector, where it is addressed as a keyboard. Several games, like Shooting Star, Blackjack, and Mastermind, are available for this new vocal interface.

**Take AIM.** Rockwell International has now come on the one-board computer scene with its AIM 65 general-purpose microcomputer. Priced at $375 for the 1K version and available at any Hamilton Avnet supplier, this new machine features an on-board 20-character printer and display, and a 54-key terminal-style keyboard. Its R6502 processor can address up to 64K with 13 addressing modes and both decimal and binary functions. An 8K ROM resident monitor provides all peripheral control and user programming functions. Spare sockets are provided for expansion.

A separate application connector on the computer interfaces a TTY and two conventional cassette recorders. It also includes a user-dedicated adapter that has three 8-bit bidirectional ports (two parallel and one serial) and two 16-bit interval timer/event counters.

The 4K version is $450, the assembler is $100, and BASIC is also $100. ◇



# Software Sources

**CP/M Disk Sort/Merge.** QSORT is a CP/M-compatible sort/merge program which can sort and merge files with fixed record lengths under 256 bytes, up to a full diskette of data. Output is written to a temporary file which is renamed after the sort has been completed. Therefore, the previous output file will remain intact in case of power failure or malfunction. Files may reside on any drive, independent of each other. Sort parameters can be filed separately for later reference, so they need only be entered once. Up to five sorting keys can be specified, and upper- and lower-case letters are treated equivalently for sorting. Single-density diskette of object code with 20-page user's manual, $95. Structured Systems Group, 5615 Kales Ave., Oakland, CA 94618.

**TDL Software for Digital Group Z80.** Z80 software written by Technical Design Labs is available in a version for Z80-based Digital Group systems. The programs are provided in self-loading cassette, and do not require disabling the EPROM. Programs are available with hard-copy routines for 110-baud TTY, Baudot TTY, and Digital Group Printer. Programs, prices and requirements are: MICRO Monitor (requires 2K memory starting at page 340), $40; Relocating Macro Assembler (requires 9K, controlled reader and Micro-Monitor), $40; Zapple Text Editor (requires 7K plus text space), $30; Zapple Text Output Processor (requires 3K, controlled reader, Zapple Text Editor and Micro-Monitor), $40; Zapple 8K BASIC (requires 12K plus program space), $40; Zapple 12K Super BASIC (requires 16K plus program space), $79. Micro-Com, 1261 Southwest 11th Ave., Deerfield Beach, FL 33441.

**8080 Floating-Point Math Package.** For 8080- or Z80-based systems with any peripheral configuration, this new floating-point package requires less than 2k bytes. It includes floating-point routines for addition, subtraction, multiplication and division, plus routines to place the floating-point accumulator anywhere in memory, and for conversion from BCD to binary and vice versa. Also included are square root, natural logs and anti-logs, sine and cosine, hyperbolic sine and cosine, arctangent, and base-10 logs. The package is available as object or source code. The machine-language, object-code version, on Intel hex-format paper tape, loads from address 1k. It is $10, complete with annotated source listing. Two source-code (mnemonic) versions are available, both on paper tapes in Intel assembly format, for $25 each. Version I, the commented version, requires about 40k bytes if the whole program is resident in memory. Version II, with comments stripped, requires about 15–20k bytes. Write: Burt Hashizume, Box 447, Maynard, MA 01754.

# BROADCASTS IN ENGLISH TO NORTH AMERICA

## Sept.—Oct. 1978

by Glenn Hauser

| TIME[1] CDT/EST | TIME UTC/GMT | STATION | QUAL.[2] | FREQUENCIES, kHz[3] |
|---|---|---|---|---|
| 4:00-4:15 a.m. | 0900-0915 | BBC | A | 9510, 6195 |
| 4:00-4:15 a.m. | 0900-0915 | R. Japan[4] | B | 9505 |
| 4:00-5:00 a.m. | 0900-1000 | AFRTS-Washington | A | 11805, 9755 |
| 4:00-6:00 a.m. | 0900-1100 | R. Oman | D | 11890 |
| 5:00-5:05 a.m. | 1000-1005 | UN Radio | A | 9565, 5955 (Tue-Sat) |
| 5:00-5:30 a.m. | 1000-1030 | R. Japan | B | 9505 |
| 5:00-5:30 a.m. | 1000-1030 | V. of Vietnam | C | 12035, 10040 |
| 5:00-6:00 a.m. | 1000-1100 | KGEI, San Francisco | A | 9575 |
| 5:00-7:00 a.m. | 1000-1200 | AFRTS-Washington | A | 11805, 9755, 9700 |
| 5:00-sunrise | 1000- | R. Australia | B | 5995 |
| 5:30-6:30 a.m. | 1030-1130 | Sri Lanka Br. Corp. | C | 17850, 15120, 11835 (Not all Eng.) |
| 5:30-7:00 a.m. | 1030-1200 | CBC Northern Service | B | 9625, 6065 (Mon-Fri 1155) |
| 5:55-6:55 a.m. | 1055-1155 | R. Thailand | C | 11905, 9655 |
| 6:00-6:15 a.m. | 1100-1115 | R. Japan | B | 9505 |
| 6:00-6:25 a.m. | 1100-1125 | R. Tirana | C | 11985, 9500 |
| 6:00-6:30 a.m. | 1100-1130 | V. of Chile | B | 15175, 15150, 15145, 15125, 15115, 15110, 11765, 11755 |
| 6:00-6:56 a.m. | 1100-1156 | R. RSA | B | 21535, 17780 |
| 6:00-7:35 a.m. | 1100-1235 | TWR-Bonaire | A | 11815 (Sat, Sun-1220) |
| 6:00-7:50 a.m. | 1100-1250 | R. Pyongyang | C | 11535, 9977 |
| 6:00-8:00 a.m. | 1100-1300 | R. Australia | A | 9580 |
| 6:00-8:30 a.m. | 1100-1330 | BBC | A-B | 15215, 11775, 6195, 9510 |
| 6:00-9:00 a.m. | 1100-1400 | VOA | A | 9730, 9565 (to 1430), 5955 |
| 7:00-7:13 a.m. (Mon-Fri) | 1200-1213 | CBC Northern Service | B | 9625, 6065 (Sun 1205-1300) |
| 7:00-7:15 a.m. | 1200-1215 | R. Japan | B | 9505 |
| 7:00-7:30 a.m. | 1200-1230 | Israel Radio | C | 21495, 17685, 15530, 15405 |
| 7:00-7:30 a.m. | 1200-1230 | R. Tashkent | C | 15460, 15115, 11925, 17730 |
| 7:00-7:30 a.m. | 1200-1230 | HCJB, Ecuador | A | 11800, 9715 (Mon & Thu only) |
| 7:00-7:45 a.m. | 1200-1245 | V. of Germany | B | 17765, 15410 |
| 7:00-7:45 a.m. | 1200-1245 | R. Berlin International | C | 21540, 15320, 15125 |
| 7:00-7:55 a.m. | 1200-1255 | R. Peking | C | 11685 |
| 7:00-9:00 a.m. | 1200-1400 | AFRTS-Washington | A | 15430, 15330, 11805, 9700 |
| 7:00-11:30 a.m. | 1200-1630 | HCJB, Ecuador | A | 15115, 11745 |
| 7:15-7:30 a.m. | 1215-1230 | V. of Greece | B | 17830, 15345, 11730 |
| 7:20-7:50 a.m. | 1220-1250 | R. Ulan Bator, Mongolia | D | 12070, 6383 (not Sun) |
| 7:30-7:55 a.m. | 1230-1255 | Austrian R. | C | 15110 (frequent changes) |
| 7:30-8:00 a.m. | 1230-1300 | R. Bangladesh | D | 21683, 15520 (both vary) |
| 7:30-8:00 a.m. | 1230-1300 | V. of Chile | B | 15125, 15110, 11765, 11755 |
| 7:30-8:00 a.m. | 1230-1300 | R. Sweden | C | 21690 |
| 7:30-8:20 a.m. (Sat) | 1230-1320 | TWR-Bonaire | A | 15255 |
| 7:30-9:20 a.m. (Sun) | 1230-1420 | " | " | " |
| 8:00-8:15 a.m. | 1300-1315 | R. Japan | B | 9505 |
| 8:00-8:30 a.m. | 1300-1330 | R. Finland | C | 15105 |
| 8:00-9:50 a.m. | 1300-1450 | R. RSA | B | 21535, 17780, 15220, 11900 |
| 8:13-11:13 a.m. (Mon-Fri) | 1313-1613 | CBC Northern Service | B | 11720, 9625 |
| 8:00-11:00 a.m. (Sun) | 1300-1600 | " | " | " |
| 8:10-12:05 p.m. (Sat) | 1310-1705 | " | " | " |
| 8:15-8:45 a.m. | 1315-1345 | Swiss R. International | C | 21520, 17830, 17740-SSB, 15350, 15305, 15140 |
| 8:30-9:30 a.m. | 1330-1430 | R. Finland | C | 15200, 15105 |
| 8:30-10:00 a.m. | 1330-1500 | All India R. | C | 11810 |
| 8:30-11:00 a.m. | 1330-1600 | BBC | B-C | 21710, 17705, 15400, 15070 |
| 9:00-9:30 a.m. | 1400-1430 | R. Japan | B | 9505 |
| 9:00-9:30 a.m. | 1400-1430 | R. Sweden | B | 17790 |
| 9:00-9:30 a.m. | 1400-1430 | R. Norway | B | 17840 (Sun only) |
| 9:00-9:30 a.m. | 1400-1430 | V. Rev. Party, N. Korea | D | 4557, 4120 |
| 9:00-9:30 a.m. | 1400-1430 | R. Afghanistan | C | 4775 |
| 9:00-9:30 a.m. | 1400-1430 | R. Tashkent | C | 15460, 15115, 11925, 11730 |
| 9:00-9:30 a.m. | 1400-1430 | R. Ghana | C | 17870 (has been inactive) |
| 9:00-9:45 a.m. | 1400-1445 | R. Berlin International | B | 21540, 15125 |
| 9:00-10:00 a.m. | 1400-1500 | V. of Indonesia | C | 11789 |
| 9:30-10:00 a.m. | 1430-1500 | R. Finland | B | 15200 |
| 9:30-10:00 a.m. | 1430-1500 | V. of Chile | C | 17755, 11755 |
| 9:30 a.m.-5:00 p.m. | 1430-2200 | UN Radio | A | 21670, 15410 (also French: when in session |
| 9:45-10:30 a.m. | 1445-1530 | R. Ghana | C | 21540, 17870 (has been inactive) |
| 10:00-10:15 a.m. | 1500-1515 | R. Japan | C | 9505 |
| 10:00-10:50 a.m. | 1500-1550 | R. RSA | B | 21535, 11800 (Sat, Sun only) |
| 10:00-11:00 a.m. | 1500-1600 | V. of Rev. Ethiopia | D | 9615 (frequent changes) |
| 10:00-11:00 a.m. | 1500-1600 | BBC | B | 17840, 11775 (Sat, Sun) |
| 10:00 a.m.-12:30 p.m. | 1500-1730 | R. Australia | C | 11775 |
| 10:15-10:30 a.m. | 1515-1530 | V. of Greece | B | 17830, 15345, 11730 |

| | | | | |
|---|---|---|---|---|
| 10:30-11:00 a.m. | 1530-1600 | Swiss R. International | B | 21570 |
| 10:30-11:30 a.m. | 1530-1630 | V. of Vietnam | C | 12035, 10040 |
| 10:45-11:00 a.m. | 1545-1600 | R. Canada International | A | 17820, 15325 (Mon-Fri only) |
| 11:00-11:15 a.m. | 1600-1615 | R. Japan | C | 9505 |
| 11:00-11:15 a.m. | 1600-1615 | R. Pakistan | C | 15520, 11672 |
| 11:00-11:30 a.m. | 1600-1630 | R. Korea | C | 9720, 9640, 7150 |
| 11:00-11:30 a.m. | 1600-1630 | R. Norway | B | 17795, 15175 (Sun only) |
| 11:00-11:30 a.m. | 1600-1630 | V. of Chile | C | 11755, 11720 |
| 11:00-11:50 a.m. | 1600-1650 | R. RSA | C | 21535, 17780, 11900 |
| 11:00-12:00 a.m. | 1600-1700 | VOA | A | 21485, 17870, 15250 |
| 11:00 a.m.-12:09 p.m. | 1600-1709 | BBC | B | 21710, 17840, 11775 (Sat, Sun-1745) |
| 11:05-11:55 a.m. | 1605-1655 | R. France International | B | 21620, 21580, 17860, 17850, 17800, 17720, 15315, 15300, 15155 (from October, 1705-1755) |
| -11:30 a.m. | -1630 | R. Singapore | C | 11940 (fade-in time varies) |
| 11:30 a.m.-1:00 p.m. | 1630-1800 | HCJB, Ecuador | B | 21480, 17755, 15310 |
| 11:45-12:00 a.m. | 1645-1700 | R. Canada International | A | 17820, 15325 |
| 12:00-12:15 p.m. | 1700-1715 | R. Japan | C | 9505 |
| 12:00-1:00 p.m. | 1700-1800 | VOA | A | 21670, 21485, 17870, 17785, 15250 |
| 12:00-3:00 p.m. | 1700-2000 | R. Kuwait | C | 12085 |
| 12:05-2:00 p.m. | 1705-1900 | CBC Northern Service | C | 11720, 9625 (Sun only) |
| 12:45-3:00 p.m. | 1745-2000 | BBC | C | 15400, 15070 |
| 1:00-1:15 p.m. | 1800-1815 | R. Japan | B | 15105 |
| 1:00-1:30 p.m. | 1800-1830 | CBC Northern Service | C | 11720, 9625 (Mon-Fri only) |
| 1:00-1:30 p.m. | 1800-1830 | R. Canada International | B | 17750, 15260 |
| 1:00-1:30 p.m. | 1800-1830 | R. Norway | C | 15175 (Sun only) |
| 1:00-1:30 p.m. | 1800-1830 | R. Korea | C | 9720 |
| 1:00-2:30 p.m. | 1800-1930 | V. of Nigeria | C | 15120, 11770 |
| 1:00-5:00 p.m. | 1800-2200 | VOA | A | 21670, 21485, 17870, 17710, 15410 |
| 1:00-6:00 p.m. | 1800-2300 | AFRTS-Washington | A | 17765, 15430, 15330, 11790 |
| 1:15-1:45 p.m. | 1815-1845 | Swiss R. International | B | 21585 |
| 1:15-2:00 p.m. | 1815-1900 | V. of Revolution, Guinea | B | 15310 (varies) (Sun only) |
| 1:30-1:35 p.m. | 1830-1835 | UN Radio | A | 21670, 19505-SSB, 15410 (Mon-Fri) |
| 1:30-2:00 p.m. | 1830-1900 | R. Teheran | D | 9022, (1930-2000 from Oct.) |
| 1:45-2:45 p.m. | 1845-1945 | Sri Lanka Br. Corp. | C | 17850, 15120, 15115, 11870 |
| 1:45-3:00 p.m. | 1845-2000 | R. Ivory Coast | C | 11920 |
| 2:00-2:10 p.m. | 1900-1910 | R. Tahiti | C | 15170, 11825 (exc Sun) |
| 2:00-2:15 p.m. | 1900-1915 | R. Japan | C | 15105 |
| 2:00-2:30 p.m. | 1900-1930 | R. Canada International | A | 17820, 15325, 11855 |
| | | | B | 17750, 15260 |
| 2:00-2:30 p.m. | 1900-1930 | V. of Chile | C | 17790, 17715, 17640, 15115 |
| 2:00-2:30 p.m. | 1900-1930 | R. Afghanistan | C | 11820 |
| 2:00-3:00 p.m. | 1900-2000 | B.S.K. Saudi Arabia | C | 11855 |
| 2:00-3:30 p.m. | 1900-2030 | HCJB, Ecuador | B | 21480, 17755, 15300 |
| 3:00-3:15 p.m. | 2000-2015 | R. Japan | B | 15105 |
| 3:00-3:30 p.m. | 2000-2030 | R. Canada International | A | 17820, 15325, 11855 |
| 3:00-3:30 p.m. | 2000-2030 | Israel R. | C | 11655, 9815 |
| 3:00-4:00 p.m. | 2000-2100 | R. Ghana | C | 11850, (has been inactive) |
| 3:00-4:05 p.m. (Sat) | 2000-2105 | CBC Northern Service | B | 11720, 9625 |
| 3:00-6:00 p.m. (Sun) | 2000-2300 | " | " | " |
| 3:00-4:15 p.m. | 2000-2115 | BBC | A | 17840, 15260, 6175 |
| 3:10-4:50 p.m. | 2010-2150 | R. Habana Cuba | A | 17855 |
| 3:30-4:25 p.m. | 2030-2125 | R. Nederland | B | 21640, 17810, 11740, 11730 |
| 3:30-4:30 p.m. | 2030-2130 | V. of Vietnam | C | 15012, 12035, 10040 |
| 3:50-4:40 p.m. | 2050-2140 | R. Habana Cuba | C | 17750, 9770 |
| 4:00-4:15 p.m. | 2100-2115 | R. Japan | B | 15105 |
| 4:00-4:50 p.m. | 2100-2150 | R. RSA | B | 17780, 15155, 11900 |
| 4:15-5:00 p.m. | 2115-2245 | BBC | A | 15420, 15260, 15070, 9510, 6175 |
| 4:30-4:45 p.m. | 2130-2145 | R. TV Congolaise | B | 15190 |
| 4:30-5:00 p.m. | 2130-2200 | R. Canada International | A | 17820, 15325, 15150, 11945, 9745 |
| 4:30-5:00 p.m. | 2130-2200 | R. Sofia | B | 15135, 11750 |
| 4:30-5:00 p.m. | 2130-2200 | R. Baghdad | C | 9745 |
| 4:30-6:00 p.m. | 2130-2300 | V. of Turkey | C | 9665, 9515, 7270, 7170 |
| 4:40-5:40 p.m. | 2140-2240 | V. Of Free China | C | 17890, 15345 |
| 5:00-5:15 p.m. | 2200-2215 | R. Yugoslavia | C | 9620 |
| 5:00-5:15 p.m. | 2200-2215 | R. Japan | B | 15105 |
| 5:00-5:30 p.m. | 2200-2230 | R. Nacional, Venezuela | B | 15400 (irregular) |
| 5:00-5:30 p.m. | 2200-2230 | R. Norway | C | 11850, 9550 (Sun only) |
| 5:00-5:30 p.m. (Mon-Fri) | 2200-2230 | CBC Northern Service | B | 11720, 9625 |
| 5:15-7:00 p.m. (Sat) | 2215-2400 | " | " | " |
| 5:00-5:45 p.m. | 2200-2245 | BBC | A | 15420, 15260, 15070, 11910, 9590, 6195, 6175 |
| 5:00-7:00 p.m. | 2200-2400 | CBC Southern Service | A | 5960 (2300-0100 from Oct. 30) (Mon-Fri only) |
| 5:00-7:00 p.m. | 2200-2400 | VOA | A | 21610, 17895, 17820, 15250 |
| 5:30-6:00 p.m. | 2230-2300 | Israel R. | A | 15485, 11655, 9815, 9435 |
| 5:30-6:20 p.m. | 2230-2320 | R. RSA | B | 15155, 11900, 11800, 9585 |
| 5:45-6:00 p.m. | 2245-2300 | BBC | A | 15420, 15260, 15070, 11910, 9590, 7325, 6195, 6175 |
| 5:45-6:00 p.m. | 2245-2300 | UN Radio | A | 15240, 11955 (Mon-Fri) |
| 6:00-6:30 p.m. | 2300-2330 | BBC | A | 15420, 15260, 15070, 11910, 9590, 9580, 7325, 6195, 6175, 5975 |

| | | | | |
|---|---|---|---|---|
| 6:00-6:30 p.m. | 2300-2330 | R. Japan | B | 15105 |
| 6:00-6:30 p.m. | 2300-2330 | R. Sweden | B | 15205, 9690 |
| 6:00-6:30 p.m. | 2300-2330 | R. Finland | B | 15265, 11800 |
| 6:00-6:30 p.m. | 2300-2330 | R. Vilnius | B | 15405, 15180, 12060, 11790, 11780, 9600 |
| 6:00-6:50 p.m. | 2300-2350 | Rdif. Argentina | C | 11710 (Mon-Fri) |
| 6:00-7:00 p.m. | 2300-2400 | R. Clarin, Dom. Rep. | B | 11700 (Sat–2430 Sun; not Sun) (irregular) |
| 6:00-7:00 p.m. | 2300-2400 | AFRTS-Washington | A | 15430, 15330, 6030 |
| 6:00-7:50 p.m. | 2300-2450 | R. Pyongyang | C | 11535, 9977 |
| 6:00-8:00 p.m. | 2300-0100 | R. Moscow | B | 15425, 15245, 15100, 12050, 12030, 11960, 11750, 11735, 9685, 9665, 9600, 9530 |
| 6:30-7:30 p.m. | 2330-2430 | BBC | A | 15070, 11910, 9590, 9580, 7325, 6175, 6120, 5975 |
| 6:45-7:45 p.m. | 2345-2445 | R. Japan | B | 17825, 15270 |
| 7:00-7:15 p.m. | 0000-0015 | R. Japan | B | 15105 |
| 7:00-7:25 p.m. | 0000-0025 | R. Tirana | B | 9750, 7065 |
| 7:00-7:30 p.m. | 0000-0030 | R. Norway | C | 9605, 6080 (Mon only) |
| 7:00-7:30 p.m. | 0000-0030 | R. Canada International | A | 5960 |
| 7:00-7:30 p.m. | 0000-0030 | V. of Chile | B | 17800, 15175, 15140 |
| 7:00-7:55 p.m. | 0000-0055 | R. Peking | B | 17680, 15520, 15060 |
| 7:00-8:00 p.m. | 0000-0100 | R. Sofia | B | 15330 |
| 7:00-8:00 p.m. | 0000-0100 | AFRTS-Washington | A | 17765, 15330, 6030 |
| 7:00-9:00 p.m. | 0000-0200 | CBC Northern Service | B | 9625, 6195 (Sun -0100) |
| 7:00-9:00 p.m. | 0000-0200 | VOA | A | 15205, 11740, 9640, 6130 |
| 7:00-9:00 p.m. | 0000-0200 | Spanish Foreign R. | B | 11880, 9630 (exc. Mon) |
| 7:00-9:00 p.m. | 0000-0200 | R. Luxembourg | C | 6090 |
| 7:15-7:30 p.m. | 0015-0030 | V. of Greece | B | 11730, 9760 |
| 7:15-8:00 p.m. | 0015-0100 | BRT, Belgium | C | 6080 |
| 7:30-7:50 p.m. | 0030-0050 | SODRE, Uruguay | C | 11885, 9515 (time varies) |
| 7:30-8:00 p.m. | 0030-0100 | R. Sweden | B | 9590 |
| 7:30-8:00 p.m. | 0030-0100 | R. Prague | C | 9630, 6055 |
| 7:30-8:00 p.m. | 0030-0100 | R. Kiev | B | 15405, 15180, 11780, 9600 |
| 7:30-10:30 p.m. | 0030-0330 | BBC | A | 9580, 9510, 9410, 7325, 6175, 6120, 5975 |
| 7:30-12:00 p.m. | 0030-0500 | HCJB, Ecuador | B | 11915, 9560 |
| 7:35-8:35 p.m. | 0035-0135 | TWR-Bonaire | B | 11925 |
| 8:00-8:15 p.m | 0100-0115 | R. Japan | B | 15105 |
| 8:00-8:15 p.m. | 0100-0115 | R. Vatican | B | 11845, 9605, 6015 |
| 8:00-8:20 p.m. | 0100-0120 | RAI, Italy | B | 11810, 9575 |
| 8:00-8:30 p.m. | 0100-0130 | R. Canada International | A | 9755, 9535 |
| 8:00-8:45 p.m. | 0100-0145 | R. Berlin International | C | 9730 |
| 8:00-8:55 p.m. | 0100-0155 | R. Prague | B | 11990, 9630, 9540, 7345, 5930 |
| 8:00-8:55 p.m. | 0100-0155 | R. Peking | B | 17680, 15520, 15060 |
| 8:00-9:00 p.m. | 0100-0200 | V. of Free China | C | 17890, 15425 |
| 8:00-10:00 p.m. | 0100-0300 | R. Moscow | B | 15425, 15245, 15100, 12050, 12030, 11750, 11735, 9700, 9685, 9665, 9600, 7290, 7250 |
| 8:00-10:30 p.m. | 0100-0330 | R. Habana Cuba | A | 11930 |
| 8:00-12:00 p.m. | 0100-0500 | R. Australia | B | 17795, 15320 |
| 8:00-12:00 p.m. | 0100-0500 | WYFR, Family Radio | A | 5985 |
| 8:00-12:00 p.m. | 0100-0500 | AFRTS-Washington | A | 17765, 15330, 11790, 6030 |
| 8:30-8:50 p.m. | 0130-0150 | V. of Germany | A | 11865, 9605, 9565, 9545, 6100, 6085, 6075, 6040 |
| 8:30-8:55 p.m. | 0130-0155 | Austrian Radio | C | 9770, 6155 |
| 8:30-8:55 p.m. | 0130-0155 | R. Tirana | B | 7300, 6200 |
| 8:30-9:00 p.m. | 0130-0200 | V. of Chile | B | 11890, 11765 |
| 8:30-9:25 p.m. | 0130-0225 | R. Bucharest | C | 11940, 11840, 11705, 9690, 9570, 6155, 5990 |
| 8:30-9:30 p.m. | 0130-0230 | R. Japan | B | 17825, 17755, 17725, 15195 |
| 8:45-9:15 p.m. | 0145-0215 | Swiss R. International | B | 15305, 11780-SSB, 11715, 9725 6135 |
| 9:00-9:15 p.m. | 0200-0215 | R. Japan | B | 15105 |
| 9:00-9:30 p.m. | 0200-0230 | R. Canada International | A | 11845, 9755 |
| 9:00-9:30 p.m. | 0200-0230 | R. Norway | B | 11860, 9550, 6180 (Mon only) |
| 9:00-9:30 p.m. | 0200-0230 | R. Budapest | B | 15225, 11910, 9833, 9585, 6000 6080 (not Mon) |
| 9:00-9:30 p.m. | 0200-0230 | R. Warsaw | C | 15120, 11815, 9525, 7270, 7145, 6135, 6095 |
| 9:00-9:55 p.m. | 0200-0255 | R. Peking | B | 17680, 15060, 12055 |
| 9:00-10:30 p.m. | 0200-0330 | R. Cairo | B | 9475, 6230 |
| 9:15-9:30 p.m. | 0215-0230 | V. of Greece | B | 11730, 9760, 9655 |
| 9:30-9:45 p.m. | 0230-0245 | R. Pakistan | C | 21590, 17830 |
| 9:30-9:55 p.m. | 0230-0255 | R. Tirana | B | 7300, 6200 |
| 9:30-10:00 p.m. | 0230-0300 | R. Lebanon | B | 11965 (frequent changes) |
| 9:30-10:00 p.m. | 0230-0300 | R. Korea | C | 11850 |
| 9:30-10:00 p.m. | 0230-0300 | R. Sweden | B | 11705, 9695 |
| 9:30-10:15 p.m. | 0230-0315 | R. Berlin International | C | 9730 |
| 9:30-10:25 p.m. | 0230-0325 | R. Nederland | A | 9590, 6165 |
| 9:30 p.m.-12:10 a.m. | 0230-0510 | CBC Northern Service | B | 9625, 6195 (Mon) |
| 10:00-10:15 p.m. | 0300-0315 | R. Japan | B | 15105 |
| 10:00-10:15 p.m. | 0300-0315 | Austrian Radio | C | 9770, 6155 (Sun only) |
| 10:00-10:30 p.m. | 0300-0330 | R. Canada International | A | 11845, 9755, 9535, 5960 |
| 10:00-10:30 p.m. | 0300-0330 | V. of Chile | B | 11890, 11765 |
| 10:00-10:30 p.m. | 0300-0330 | R. Portugal | B | 11935, 6025 (Mon -0320) |

| | | | | |
|---|---|---|---|---|
| 10:00-10:30 p.m. | 0300-0330 | R. Budapest | B | 15225, 11910, 9833, 9585, 6080, 6000 |
| 10:00-10:30 p.m. | 0300-0330 | R. Warsaw | C | 15120, 11815, 9525, 7270, 7145, 6135, 6095 |
| 10:00-10:30 p.m. | 0300-0330 | R. Kiev | B | 15425, 12060, 12050, 12030, 11780, 9775 |
| 10:00-10:55 p.m. | 0300-0355 | R. Prague | B | 11990, 9630, 9540, 7345, 5930 |
| 10:00-10:55 p.m. | 0300-0355 | R. Peking | B | 17735, 15305, 15060, 12055 |
| 10:00-11:00 p.m. | 0300-0400 | RAE, Argentina | C | 9690 (Tue-Sat) |
| 10:00-11:00 p.m. | 0300-0400 | R. Baghdad | C | 11925 |
| 10:00-11:00 p.m. | 0300-0400 | R. Moscow | B | 9700, 9685, 9665, 9600, 9530, 7290, 7250 |
| 10:00-11:26 p.m. | 0300-0426 | R. RSA | B | 9585, 7270, 5980, 4990, 3995 |
| 10:00 p.m.-12:07 a.m. | 0300-0507 | CBC, Northern Service | B | 9625, 6195 (Sun -0510) (not Mon) |
| 10:15-10:45 p.m. | 0315-0345 | UBC, Uganda | B | 15325 (time varies) |
| 10:25-10:30 p.m. | 0325-0330 | V. of Armenia | B | 15405, 15180, 15100, 11870 (Sun, Wed, Thu, Sat) |
| 10:30-10:55 p.m. | 0330-0355 | R. Tirana | B | 7300, 6200 |
| 10:30-10:55 p.m. | 0330-0355 | Austrian Radio | C | 9770, 6155 |
| 10:30-11:15 p.m. | 0330-0415 | R. Berlin International | B | 11970, 11890, 11840 |
| 10:30-11:30 p.m. | 0330-0430 | R. Moscow | B | 15180, 15100, 12050, 12030, 12000, 11720, 9710 |
| 10:30-11:45 p.m. | 0330-0445 | BBC | A | 9410, 6175, 5975 |
| 10:30-11:50 p.m. | 0330-0450 | R. Habana Cuba | A | 11930, 11725 |
| 10:30 p.m.-1:00 a.m. | 0330-0600 | R. Habana Cuba | A | 11760 |
| 11:00-11:15 p.m. | 0400-0415 | R. Japan | B | 15105 |
| 11:00-11:15 p.m. | 0400-0415 | R. Budapest | B | 15225, 11910, 9833, 9585, 6000 6080 (Wed & Sat) |
| 11:00-11:30 p.m. | 0400-0430 | R. Bucharest | C | 11940, 11840, 11705, 9690, 9570, 6155, 5990 |
| 11:00-11:30 p.m. | 0400-0430 | R. Canada International | A | 11845, 9535, 5960 |
| 11:00-11:30 p.m. | 0400-0430 | R. Norway | B | 9645, 6180 (Mon only) |
| 11:00-11:55 p.m. | 0400-0455 | R. Peking | B | 17735, 15305, 15060, 12055 |
| 11:00 p.m.-2:00 a.m. | 0400-0700 | R. Kuwait | C | 15345 |
| 11:30-11:55 p.m. | 0430-0455 | R. Austria | C | 6015 |
| 11:30-12:00 p.m. | 0430-0500 | Swiss R. International | B | 11715, 9725 |
| 11:30-12:00 p.m. | 0430-0500 | R. Sofia | B | 11750 |
| 11:30 p.m.-1.30 a.m. | 0430-0630 | R. Moscow | B | 15100, 12030, 12000, 11720, 9730, 9710, 9610 |
| 11:45 p.m.-2:30 a.m. | 0445-0730 | BBC | A | 9510, 6175, 5975 |
| 12:00-12:15 a.m. | 0500-0515 | Israel R. | B | 11960, 11655, 9833 |
| 12:00-12:15 a.m. | 0500-0515 | R. Japan | B | 15105 |
| 12:00-12:30 a.m. | 0500-0530 | R. Portugal | B | 11935, 6025 (Mon -0520) |
| 12:00-1:00 a.m. | 0500-0600 | AFRTS, Washington | A | 15330, 9755, 6030 |
| 12:00-1:00 a.m. | 0500-0600 | R. Australia | C | 17725, 15240, 15140 |
| 12:00-2:00 a.m. | 0500-0700 | HCJB, Ecuador | B | 6095 |
| 12:15-1:15 a.m. | 0515-0615 | Spanish Foreign R. | B | 11880, 9630 (exc. Mon) |
| 12:30-12:50 a.m. | 0530-0550 | V. of Germany | A | 9545, 6185, 6135, 6100, 5960 |
| 12:30-1:00 a.m. | 0530-0600 | V. of Chile | B | 11765 |
| 12:30-1:25 a.m. | 0530-0625 | R. Nederland | A | 9715, 6165 |
| 12:45-1:00 a.m. | 0545-0600 | UN Radio | A | 9620, 6055 (Tue-Sat) |
| 12:55-3:35 a.m. | 0555-0835 | V. of Nigeria | B | 15120, 11770, 7255 |
| 1:00-1:15 a.m. | 0600-0615 | R. Japan | B | 15105 |
| 1:00-1:30 a.m. | 0600-0630 | R. Norway | B | 9645 (Mon only) |
| 1:00-2:00 a.m. | 0600-0700 | RAE, Argentina | C | 11755, 9690, 6120 (Tue-Sat only) |
| 1:00-2:00 a.m. | 0600-0700 | R. RSA | C | 17780, 15220 |
| 1:00-2:30 a.m. | 0600-0730 | R. Australia | B | 17795, 17725 |
| 1:00-4:00 a.m. | 0600-0900 | AFRTS-Washington | A | 15330, 11805, 9755, 6030 |
| 1:00-6:30 a.m. | 0600-1130 | HCJB, Ecuador | C | 11900, 6130 |
| 1:15-1:30 a.m. | 0615-0630 | R. Canada International | B | 11960, 9655, 6150, 6140 (Mon-Fri) |
| 1:30-2:00 a.m. | 0630-0700 | R. Korea | C | 9640 |
| 1:30-2:30 a.m. | 0630-0730 | R. Moscow | B | 15100, 12030, 12000, 11750, 11720, 9730, 9710, 9610 |
| 1:30-3:00 a.m. | 0630-0800 | R. Habana Cuba | A | 9525 |
| 1:45-2:00 a.m. | 0645-0700 | R. Canada International | B | 11960, 9655, 6150, 6140 (Mon-Fri) |
| 2:00-2:15 a.m. | 0700-0715 | R. Japan | B | 9505 |
| 2:00-3:30 a.m. | 0700-0830 | HCJB, Ecuador | C | 11835, 9665 |
| 2:00-4:55 a.m. | 0700-0955 | V. of Philippines | C | 9580 (varies) |
| 2:00-5:30 a.m. | 0700-1030 | HCJB, Ecuador | C | 9745 |
| 2:07-2:15 a.m. | 0707-0715 | UN Radio | A | 6135, 6055 (Tue-Sat) |
| 2:30-2:45 a.m. | 0730-0745 | UN Radio | A | 6135, 6055 (Tue-Sat) |
| 2:30-3:25 a.m. | 0730-0825 | R. Nederland | B | 9770, 9715 |
| 2:30-4:00 a.m. | 0730-0900 | BBC | A | 9510 |
| 2:30-5:00 a.m. | 0730-1000 | R. Australia | C | 17725, 11835 |
| 3:00-3:15 a.m. | 0800-0815 | R. Japan | B | 9505 |
| 3:30-4:25 a.m. | 0830-0925 | R. Nederland | B | 9715 |

Explanatory Notes.

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

# SAVE COMPUTER INTERFACES & PERIPHERALS SAVE

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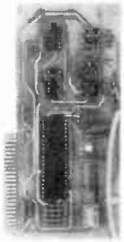
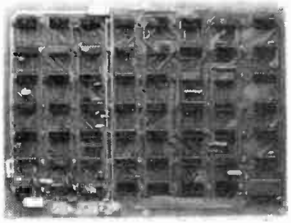
## APPLE II SERIAL I/O INTERFACE *



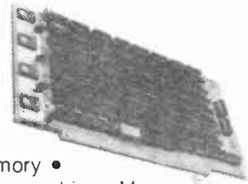
Part no. 2
Baud rate is continuously adjustable from 0 to 30,000 • Plugs into any peripheral connector • Low current drain. RS-232 input and output • On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity either odd or even • Jumper selectable address • SOFTWARE • Input and Output routine from monitor or BASIC to teletype or other serial printer. • Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some selectrics. Board only — $15.00; with parts — $42.00; assembled and tested — $62.00.

## T.V. TYPEWRITER



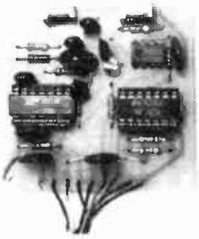
Part no. 106
• Stand alone TVT • 32 char/line, 16 lines, modifications for 64 char/line included • Parallel ASCII (TTL) input • Video output • 1K on board memory • Output for computer controlled curser • Auto scroll • Non-destructive curser • Curser inputs: up, down, left, right, home, EOL, EOS • Scroll up, down • Requires +5 volts at 1.5 amps, and -12 volts at 30 mA • All 7400, TTL chips • Char. gen. 2513 • Upper case only • Board only $39.00; with parts $145.00

## 8K STATIC RAM



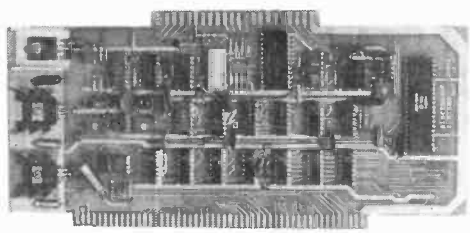
Part no. 300
• 8K Altair bus memory • Uses 2102 Static memory chips • Memory protect • Gold contacts • Wait states • On board regulator • S-100 bus compatible • Vector input option • TRI state buffered • Board only $22.50; with parts $160.00

## MODEM *



Part no. 109
• Type 103 • Full or half duplex • Works up to 300 baud • Originate or Answer • No coils, only low cost components • TTL input and output-serial • Connect 8 ohm speaker and crystal mic. directly to board • Uses XR FSK demodulator • Requires +5 volts • Board $7.60; with parts $27.50

## TIDMA *



Part no. 112
• Tape Interface Direct Memory Access • Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate. • S-100 bus compatible • Board only $35.00; with parts $110.00

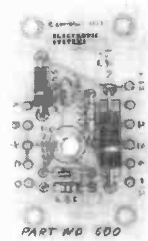
## RF MODULATOR *

Part no. 107
• Converts video to AM modulated RF, Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal. Recommended by Apple. • Power required is 12 volts AC C.T., or +5 volts DC • Board $7.60; with parts $13.50

## DC POWER SUPPLY *

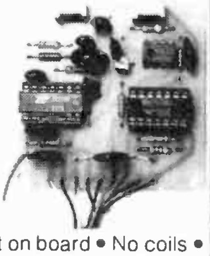
Part no. 6085
• Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp. • Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps. • Board only $12.50; with parts excluding transformers $42.50

## RS 232/TTY * INTERFACE



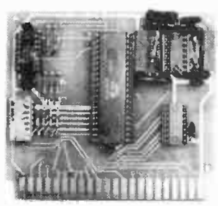

Part no. 600
• Converts RS-232 to 20mA current loop, and 20mA current loop to RS-232 • Two separate circuits • Requires +12 and -12 volts • Board only $4.50, with parts $7.00

## TAPE INTERFACE *



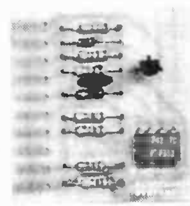
Part no. 111
• Play and record Kansas City Standard tapes • Converts a low cost tape recorder to a digital recorder • Works up to 1200 baud • Digital in and out are TTL-serial • Output of board connects to mic. in of recorder • Earphone of recorder connects to input on board • No coils • Requires +5 volts, low power drain • Board $7.60; with parts $27.50

## UART & BAUD RATE GENERATOR *



Part no. 101
• Converts serial to parallel and parallel to serial • Low cost on board baud rate generator • Baud rates: 110, 150, 300, 600, 1200, and 2400 • Low power drain +5 volts and -12 volts required • TTL compatible • All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity. • All connections go to a 44 pin gold plated edge connector • Board only $12.00; with parts $35.00 with connector add $3.00

## RS 232/TTL* INTERFACE



Part no. 232
• Converts TTL to RS-232, and converts RS-232 to TTL • Two separate circuits • Requires -12 and +12 volts • All connections go to a 10 pin gold plated edge connector • Board only $4.50; with parts $7.00 with connector add $2.00

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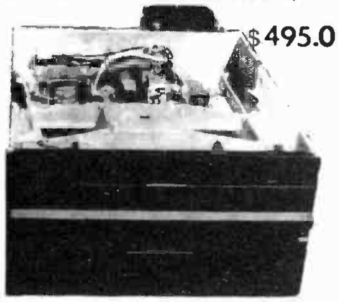
### 8" FLOPPY DISC DRIVE.

$495.00



**MODEL 801R Shugart Disc with Cabinet**

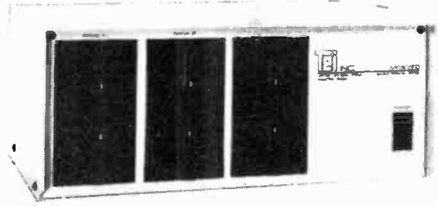
Includes Cabinet, Disc Drive, Power Supply, Cable, Fan & Data Cable. Has AC line filter.
Cabinet size 10"H x 10"W x 16"D
MODEL DM 2700-S $750.00

### FLOPPY DISC INTERFACE

JADE Floppy Disc (Tarbell Board) KIT $175.00 ea.
S.D. Computer Products Versa Floppy Kit $159.00 ea.
Assembled & Tested $189.00 ea.

### Tei INC. DISK CABINETS

**MCS DFD 0** CABINET for two Shugart 801 or 850 standard size floppy disc drives plus regulated power supply for same. $495.00



**MCS TFD 0** CABINET for three Shugart SA400 drives plus regulated power supply for same. $295.00

### KIM-1

Assembled and Tested
**$245.00**

### MEMORY PLUS for KIM-1

8K RAM (21L02)
8K EPROM
ASSEMBLED & TESTED
$245.00

### APPLE II

One of the best "Total Package" home and business computers on the market. "Basic" in ROM, Color Graphics, Floating Point Basic Package, etc.
16K version only **$1,095.00**

### Price Breakthrough! $17.50

**MA1003 CAR CLOCK**

Bright Green Fluorescent Display Crystal Time Base Assembled, just add switches and 12 VDC.

### CONNECTORS

| | |
|---|---|
| DB-25P | $2.25 |
| DB-25S | $3.25 |
| COVER | $1.50 |
| 44 Pin - PC & EYE | $1.95 |
| 44 Pin - WW | $2.50 |
| 86 Pin - (6800) PC | $5.00 |
| 86 Pin - (COSMAC ELF) PC | $5.00 |
| 100 Pin - (Altair) PC | $4.50 |
| 100 Pin - (Imsai) WW | $4.25 |
| 100 Pin - (IMSAI) PC | $3.25 |

### MEMORY EXPANSION KIT 4116 (16K×1,200NS)

Dynamic Ram Chip can be used for expanding Apple II Memory or the TRS-80 (200ns)
8 for **$128.00**
CONTAINS INSTRUCTIONS
Call for quote on larger quantities

### LIQUID CRYSTAL DIGITAL CLOCK-CALENDAR

APPLIED MARKETING

- For Auto, Home, Office
- Small in size (2x2½x½)
- Push button for seconds release for date.
- Clocks mount anywhere with either 3M double-sided tape or VELCRO, included.
- 2 MODELS AVAILABLE:
  LCD-101, portable model runs on self-contained batteries for better than a year.
  LCD-102, runs on 12 Volt system and is back-lighted
- LCD-101 or LCD-102 your choice **$34.95**

### full ASCII PROFESSIONAL KEYBOARDS

* Full 128 Character ASCII
* Tri-Mode MOS Encoding
* MOS/DTL/TTL Compatable Output
* Two-key Rollover
* Level and Pulse Strobe
* Shift and Alpha Lock
* Selectable parity
* Positive or Negative Logic.

MODEL 756 (56 keys)

PRICING INFORMATION

| | |
|---|---|
| Model 756 (assembled) | $75.95 |
| Model 756K (kit) | 64.95 |
| Model 702 enclosure | 29.95 |

### ELLI-WRAP

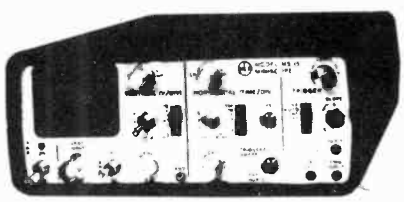
Wraps insulated wire on .025" square posts
FOUR TIMES FASTER than regular manual wrap post tools
P180 with two 100' spools of 28 ga. wire **$24.50**
P180-4T includes charger, wire **$75.00**

NO PRE-STRIPPING
NO PRE-CUTTING
SPOOL-FED WIRE

SLIT-N-WRAP WIRE
NO. 28 GAGE INSULATED WIRE, 100' SPOOLS

### MS-15 MINISCOPE $289

*With Rechargeable Batteries & Charger Unit*

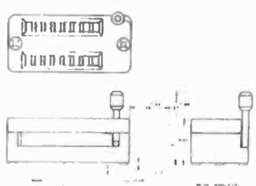


- 15 megahertz bandwidth.
- External and internal trigger.
- Time base — .1 microsec. to 0.5 Sec/div - 21 settings ± 3%.
- Battery or line operation.
- Automatic & line sync modes.
- Power consumption < 15 watts.
- Vertical Gain — .01 to 50 V/div - 12 settings ± 3%.
- Viewing area 1.1" x 1.35".
- Case size 2.7"H x 6.4"W x 7.5"D. 3 pounds.
- Parts & Labor guaranteed 1 year
- 10 to 1, 10 meg probe $27.
- Leather carrying case $45.

MS-215 Dual Trace Version of MS-15 **$435.**

### ZIP DIP® II Socket

TEXTOOL



This new type of zero insertion pressure dual in-line package socket (ZIP DIP II) is perfectly suited for both hand test and burn-in requirements.

The ZIP DIP II socket has been designed for the utmost simplicity in its mechanical action. Coupled with a thoughtful system of ramps and bevels to guide the device leads into the contacts results in a socket into which the device can literally be dropped. With the flip of a locking lever the socket is ready to operate with exceptionally good electrical contact. Flip the lever again and the device may be extracted with zero pressure being exerted on the leads by the socket contacts.

PRICES:

| | |
|---|---|
| 16 pin Zip Dip II | $5.50 |
| 24 pin Zip Dip II | $7.50 |
| 40 pin Zip Dip II | $10.25 |

### MICROPROCESSORS

| | |
|---|---|
| F8 | 16.95 |
| Z80 | 20.00 |
| Z80A | 25.00 |
| 1802 | 17.95 |
| 2650 | 19.95 |
| AM2901 | 20.00 |
| 6502 | 11.95 |
| 6800 | 16.95 |
| 6802 | 24.95 |
| 8008-1 | 12.95 |
| 8035 | 20.00 |
| 8080A | 9.95 |
| 8085 | 23.00 |
| 8748 | 60.00 |
| TMS9900 | 50.00 |

### 8080A SUPPORT DEVICES

| | |
|---|---|
| 8212 | 3.90 |
| 8214 | 4.60 |
| 8216 | 2.75 |
| 8224 | 4.00 |
| 8224-4 | 9.95 |
| 8226 | 2.75 |
| 8228 | 6.40 |
| 8238 | 6.40 |
| 8251 | 7.50 |
| 8253 | 20.00 |
| 8255 | 6.35 |
| 8257 | 19.95 |
| 8259 | 19.95 |
| 8275 | 75.00 |
| 8279 | 18.50 |

### 6800 SUPPORT

| | |
|---|---|
| 6810P | 4.00 |
| 68B10P | 6.00 |
| 6820P | 6.50 |
| 6821P | 6.50 |
| 6828P | 11.25 |
| 6834P | 16.95 |
| 6850P | 8.75 |
| 6852P | 11.00 |
| 6860P | 9.00 |
| 6862P | 12.00 |
| 6871P | 28.00 |
| 6875P | 8.75 |
| 6880 | 2.50 |

### CHARACTER GEN.

| | |
|---|---|
| 2513 U/L | 6.75 |
| 2513 (5v) U/C | 9.75 |
| 2513 (5v) L/C | 10.95 |
| 6571 | 10.95 |
| 6571A | 10.95 |
| 6574 | 13.25 |

### DYNAMIC RAMS

| | |
|---|---|
| 416D (200ns) | 16.00 |
| 4116 (200ns) | 16.00 |
| 2104/4096 | 4.00 |
| 2107B-4 | 3.95 |
| TMS4027 | 4.00 |
| TMS4050 | 4.00 |
| TMS4060 | 4.50 |
| 4096 | 4.00 |
| MM5270 | 4.50 |

### PROMS

| | |
|---|---|
| 1702A | 5.00 |
| 2516 (5v) | 38.00 |
| 2708 | 9.00 |
| 2716 (TI) | 24.95 |
| 2716 (INTEL) | 38.00 |
| 2758 | 23.25 |

### STATIC RAMS

| | 1-63 | 64 up |
|---|---|---|
| 21L02 (450ns) | 1.50 | 1.18 |
| 21L02 (250ns) | 1.75 | 1.50 |
| 410D | 10.00 | 8.50 |
| 2101-1 | 2.95 | 2.50 |
| 2102 | 1.25 | .90 |
| 2111-1 | 3.25 | 2.65 |
| 2112-1 | 2.75 | 2.35 |
| 2114 (300ns) | 10.00 | 8.25 |
| 2114 (450ns) | 9.00 | 7.69 |
| 2125L | 7.69 | 6.60 |
| TMS4044 (250ns) | 9.95 | 8.00 |
| TMS4044 (450ns) | 8.95 | 7.40 |
| 4200A | 10.00 | 8.60 |
| TMS4045 (250ns) | 10.50 | 9.00 |
| TMS4045 (450ns) | 9.00 | 8.00 |

### FLOPPY DISC CHIPS

| | |
|---|---|
| 1771B-01 | 39.95 |

### KEYBOARD ENCODERS

| | |
|---|---|
| AY-5-2376 | 13.75 |
| AY-5-3600 | 13.75 |

# JADE ELECTRONICS Market Place

## JADE VIDEO INTERFACE KIT

KIT $117.95
Assembled & Tested $159.95

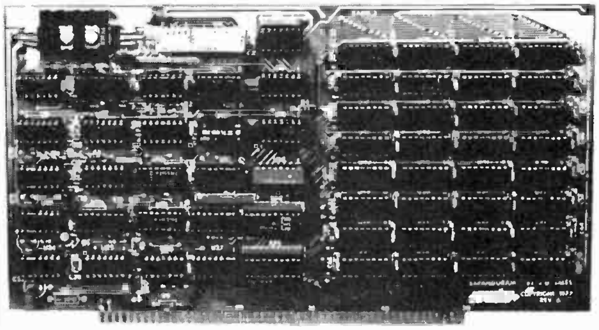
S-100 Bus compatible
32 or 64 Characters per line - 16 lines
Graphics (128 x 48 matrix)
Parallel & compositive video
On board low-power memory
Powerful software included for cursor, home, EOL, Scroll Graphics/Character Upper case, lower case and Greek. Black-on-white & White-on-black.

## JADE PARALLEL/SERIAL INTERFACE KIT

KIT $124.95
Assembled & Tested $174.95

* S-100
* 2 Serial interfaces with RS232 interfaces or 1 Kansas City cassette interface.
* Serial interfaces are crystal controlled
* Selectable baud rates.
* Cassette works up to 1200 baud.
* 1 parallel port.

## EXPANDORAM



### EXPANDO-32 KIT

Uses 4115 (8K×1) Dynamic RAMs, It can be expanded in 8K increments up to 32K

8K —— $179.00
16K —— $255.00
24K —— $325.00
32K —— $399.00

### EXPANDO-64 KIT

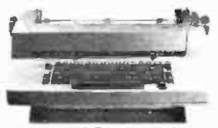
Uses 4116 (16K×1) Dynamic RAMs, It can be expanded in 16K increments up to 64K

16K —— $260.00
32K —— $579.00
48K —— $757.00
64K —— $925.00

## TV-1

Convert T.V set to Video Monitor
KIT . . . $8.95

## SELECTRA-TERM



The Best SELECTRIC II* Printer Going for ANY Computer!

SELECTRA-TERM is a brand new IBM Selectric II* typewriter which has been fully converted for direct connection to your computer. A special typing element gives you full ASCII and upper/lower case alphanumerics.

Complete electronics package, cable sets and documentation are supplied.

MODEL 9710 $1,850
MODEL TRS-80 $1,925

## SEALS ELECTRONICS, INC.

68KSC (SWTPC 6800 compatible Static Memory Card)

- 8192 Words of Static Memory
- Access Time 500nsec. (250 nsec on request)
- Memory Chip 91L02 APC or 2102AL-4
- Battery Standby
- Address Selected 8 ea. SPST Dip Switch
- Low Power
- All Lines Buffered.
- All IC's with Sockets
- Solder Mask on both sides of PC Board

Assembled $175.00

## MOTHER BOARDS - S100 STYLE

9 slot "Little Mother" $35.00
Assembled and Tested $85.00
13 slot with front panel slot
Bare board $40.00
Kit $95.00
Assembled & Tested $110.00
22 slot Assembled & Tested $149.95

## JADE Z80

with PROVISIONS for ONBOARD 2708 and POWER ON JUMP

(2MHZ) $135.00ea.
Assembled & Tested $185.00ea.
(4MHZ) $149.95ea.
Assembled & Tested $199.95ea.
Bare Board $35.00ea.

## MICROPROCESSOR CRYSTALS

| FREQUENCY | CTS P/N |
|---|---|
| 1.0 MHz | MP010 |
| 1.8432 MHz | MP018 |
| 2.0 MHz | MP020 |
| 2.097152 MHz | MP021 |
| 2.4576 MHz | MP024 |
| 2.667 MHz | MP026 |
| 3.00 MHz | MP030 |
| 3.20 MHz | MP031 |
| 3.2768 MHz | MP032 |
| 3.579545 MHz | MP036 |
| 4.0 MHz | MP040 |
| 4.0 MHz | MP04A |
| 4.194304 MHz | MP041 |
| 4.91520 MHz | MP042 |
| 5.0 MHz | MP05A |
| 5.0688 MHz | MP050 |
| 5.185 MHz | MP051 |
| 5.7143 MHz | MP057 |
| 6.00 MHz | MP060 |
| 6.144 MHz | MP061 |
| 6.40 MHz | MP064 |
| 6.5536 MHz | MP065 |
| 8.0 MHz | MP080 |
| 10.0 MHz | MP100 |
| 18.00 MHz | MP180 |
| 18.432 MHz | MP184 |
| 20.0 MHz | MP200 |
| 22.1184 MHz | MP221 |
| 27.0 MHz | MP270 |
| 36.0 MHz | MP360 |
| 48.0 MHz | MP480 |

### CRYSTAL PRICES

1-4 $4.95 ea.
5-9 $4.75 ea.
10-24 $4.50 ea.
25-99 $4.00 ea.

Mix or match for maximum discount

## ULTRAVIOLET EPROM ERASER

$34.95

- Erases up to 48 I.C.'s at a time
- Uses popular (and readily available) 12" shortwave UV bulbs.

## HITACHI

VIDEO MONITORS – BLACK & WHITE

**VIM-909** 215.00
9" Solid-State Video Monitor
500 lines horizontal resolution
line lock sync
High voltage 10KV

**VIM-129** 370.00
12" Solid-State Video Monitor
700 lines horizontal resolution
Includes black level clamping, DC restoration circuit (switchable), Ext-sync provision (Optional)

## PROBLEM SOLVER SYSTEMS, INC.

16K STATIC BOARD
with memory management can be used with Alpha Micro or Cromenco Systems.

ASSEMBLED & TESTED
RAM 65(250ns) $390.00
RAM 65B (450ns) $350.00

## E-PROM BOARDS

MR-8 (8K uses 2708) KIT $99.50
with 1K RAM
MR-16T (16K uses 2716) KIT $99.50
with 1K RAM
EPM-1 (uses up to 4K of 1702) $59.95
RAM/N/ROM (16K uses any E-PROM) KIT $117.00
JG-8/16 (uses 2708 or 2716) KIT $59.95
BARE BOARD $30.00

EXPANDABLE E-PROM — S.D. Computer Products
16K or 32K EPROM $99.95 without EPROM
Allows you to use either 2708's for 16K of Eprom or 2716's for 32K of EPROM.

## STATIC RAM BOARDS ASSEMBLED & TESTED

8K
Ram 8 (250ns) $169.95
Ram 8B (450ns) $139.95
250ns KIT Mem-1 $149.95
450ns KIT Mem-1 $125.00
BARE BOARD $25.00

16K Uses 2114 (lo pwr.)
Ram 16 (250ns) $375.00
Ram 16B (450ns) $325.00
MEM-2 Kit (250ns) $285.00
32K Assembled & Tested by SEALS ELECTRONICS
JG-32 (250ns) $795.00
JG-32B (450ns) $725.00
250ns KIT $575.00
6800 Adapter - adapts Mem-1 8K board to Motorola MEK 6800D2 evaluation kit. $12.95

## JADE Computer Products

4901 W. Rosecrans,
Department P
Hawthorne, Ca. 90250

Freight Charge $2.00 less than 10-lbs.
Cash, Check, Money Order or Credit Card
6% sales tax on all parts delivered in California
Discounts available at OEM quantities.

VISA · master charge · AMERICAN EXPRESS
Cards Welcome

## JADE 8080A

KIT $100.00
A+T $149.95
BARE BOARD $30.00

" THE PIGGY IS COMING "

## DIODES/ZENERS

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

## SOCKETS/BRIDGES

| | | | | |
|---|---|---|---|---|
| 8-pin | pcb | .20 | ww | .35 |
| 14-pin | pcb | .20 | ww | .40 |
| 16-pin | pcb | .20 | ww | .40 |
| 18-pin | pcb | .25 | ww | .75 |
| 22-pin | pcb | .35 | ww | .95 |
| 24-pin | pcb | .35 | ww | .95 |
| 28-pin | pcb | .45 | ww | 1.25 |
| 40-pin | pcb | .50 | ww | 1.25 |

Molex pins .01 To-3 Sockets .25

2 Amp Bridge 100-prv .95

25 Amp Bridge 200-prv 1.95

## TRANSISTORS, LEDS, etc.

| | | |
|---|---|---|
| 2N2222 | NPN (2N2222 Plastic .10) | .15 |
| 2N2907 | PNP | .15 |
| 2N3906 | PNP (Plastic - Unmarked) | .10 |
| 2N3904 | NPN (Plastic - Unmarked) | .10 |
| 2N3054 | NPN | .35 |
| 2N3055 | NPN 15A 60v | .50 |
| T1P125 | PNP Darlington | .35 |
| LED Green, Red, Clear, Yellow | | .15 |
| 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 |
| MAN74A | 7 seg com-cathode (Red) | 1.50 |
| FND359 | 7 seg com-cathode (Red) | 1.25 |

## C MOS

| | |
|---|---|
| 4000 | .15 |
| 4001 | .15 |
| 4002 | .20 |
| 4004 | 3.95 |
| 4006 | .95 |
| 4007 | .20 |
| 4008 | .75 |
| 4009 | .35 |
| 4010 | .35 |
| 4011 | .20 |
| 4012 | .20 |
| 4013 | .40 |
| 4014 | .75 |
| 4015 | .75 |
| 4016 | .35 |
| 4017 | .75 |
| 4018 | .75 |
| 4019 | .35 |
| 4020 | .85 |
| 4021 | .75 |
| 4022 | .75 |
| 4023 | .20 |
| 4024 | .75 |
| 4025 | .20 |
| 4026 | 1.95 |
| 4027 | .35 |
| 4028 | .75 |
| 4030 | .35 |
| 4033 | 1.50 |
| 4034 | 2.45 |
| 4035 | .75 |
| 4040 | .75 |
| 4041 | .69 |
| 4042 | .65 |
| 4043 | .50 |
| 4044 | .65 |
| 4046 | 1.25 |
| 4049 | .45 |
| 4050 | .45 |
| 4066 | .55 |
| 4069/74C04 | .25 |
| 4071 | .25 |
| 4081 | .30 |
| 4082 | .30 |
| MC 14409 | 14.50 |
| MC 14419 | 4.85 |
| 4511 | .95 |
| 74C151 | 1.90 |

## – T T L –

| | |
|---|---|
| 7400 | .10 |
| 7401 | .15 |
| 7402 | .15 |
| 7403 | .15 |
| 7404 | .10 |
| 7405 | .25 |
| 7406 | .25 |
| 7407 | .55 |
| 7408 | .15 |
| 7409 | .15 |
| 7410 | .15 |
| 7411 | .25 |
| 7412 | .25 |
| 7413 | .25 |
| 7414 | .75 |
| 7416 | .25 |
| 7417 | .40 |
| 7420 | .15 |
| 7426 | .25 |
| 7427 | .25 |
| 7430 | .15 |
| 7432 | .20 |
| 7437 | .20 |
| 7438 | .20 |
| 7440 | .20 |
| 7441 | 1.15 |
| 7442 | .45 |
| 7443 | .45 |
| 7444 | .45 |
| 7445 | .65 |
| 7446 | .70 |
| 7447 | .70 |
| 7448 | .50 |
| 7450 | .25 |
| 7451 | .25 |
| 7453 | .20 |
| 7454 | .25 |
| 7460 | .40 |
| 7470 | .45 |
| 7472 | .40 |

| | |
|---|---|
| 7473 | .25 |
| 7474 | .30 |
| 7475 | .35 |
| 7476 | .40 |
| 7480 | .55 |
| 7481 | .75 |
| 7483 | .75 |
| 7485 | .55 |
| 7486 | .25 |
| 7489 | 1.05 |
| 7490 | .45 |
| 7491 | .70 |
| 7492 | .45 |
| 7493 | .35 |
| 7494 | .75 |
| 7495 | .60 |
| 7496 | .80 |
| 74100 | 1.15 |
| 74107 | .25 |
| 74121 | .35 |
| 74122 | .55 |
| 74123 | .35 |
| 74125 | .45 |
| 74126 | .35 |
| 74132 | .75 |
| 74141 | .90 |
| 74150 | .85 |
| 74151 | .65 |
| 74153 | .75 |
| 74154 | .95 |
| 74156 | .70 |
| 74157 | .65 |
| 74161 | .55 |
| 74163 | .85 |
| 74164 | .60 |
| 74165 | 1.10 |
| 74166 | 1.25 |
| 74175 | .80 |

| | |
|---|---|
| 74176 | .85 |
| 74180 | .55 |
| 74181 | 2.25 |
| 74182 | .75 |
| 74190 | 1.25 |
| 74191 | .95 |
| 74192 | .75 |
| 74193 | .85 |
| 74194 | .95 |
| 74195 | .95 |
| 74196 | .95 |
| 74197 | .95 |
| 74198 | 1.45 |
| 74221 | 1.00 |
| 74367 | .75 |
| 75108A | .35 |
| 75491 | .50 |
| 75492 | .50 |
| 74H00 | .15 |
| 74H01 | .20 |
| 74H04 | .20 |
| 74H05 | .20 |
| 74H08 | .35 |
| 74H10 | .35 |
| 74H11 | .25 |
| 74H15 | .45 |
| 74H20 | .25 |
| 74H21 | .25 |
| 74H22 | .40 |
| 74H30 | .20 |
| 74H40 | .25 |
| 74H50 | .25 |
| 74H51 | .25 |
| 74H52 | .15 |
| 74H53J | .25 |
| 74H55 | .20 |

| | |
|---|---|
| 74H72 | .35 |
| 74H101 | .75 |
| 74H103 | .55 |
| 74H106 | .95 |
| 74L00 | .25 |
| 74L02 | .20 |
| 74L03 | .25 |
| 74L04 | .30 |
| 74L10 | .20 |
| 74L20 | .35 |
| 74L30 | .45 |
| 74L47 | 1.95 |
| 74L51 | .45 |
| 74L55 | .65 |
| 74L72 | .45 |
| 74L73 | .40 |
| 74L74 | .45 |
| 74L75 | .55 |
| 74L93 | .55 |
| 74L123 | .85 |
| 74S00 | .35 |
| 74S02 | .35 |
| 74S03 | .25 |
| 74S04 | .25 |
| 74S05 | .35 |
| 74S08 | .35 |
| 74S10 | .35 |
| 74S11 | .35 |
| 74S20 | .25 |
| 74S40 | .20 |
| 74S50 | .20 |
| 74S51 | .25 |
| 74S64 | .15 |
| 74S74 | .35 |
| 74S112 | .60 |
| 74S114 | .65 |

| | |
|---|---|
| 74S133 | .40 |
| 74S140 | .55 |
| 74S151 | .30 |
| 74S153 | .35 |
| 74S157 | .75 |
| 74S158 | .30 |
| 74S194 | 1.05 |
| 74S257 (8123) | 1.05 |
| 74LS00 | .20 |
| 74LS01 | .20 |
| 74LS02 | .20 |
| 74LS04 | .20 |
| 74LS05 | .25 |
| 74LS08 | .25 |
| 74LS09 | .25 |
| 74LS10 | .25 |
| 74LS11 | .25 |
| 74LS20 | .20 |
| 74LS21 | .25 |
| 74LS22 | .25 |
| 74LS32 | .25 |
| 74LS37 | .25 |
| 74LS38 | .35 |
| 74LS40 | .30 |
| 74LS42 | .65 |
| 74LS51 | .35 |
| 74LS74 | .35 |
| 74LS86 | .35 |
| 74LS90 | .55 |
| 74LS93 | .55 |
| 74LS107 | .40 |
| 74LS123 | 1.00 |
| 74LS151 | .75 |
| 74LS153 | .75 |
| 74LS157 | .75 |
| 74LS164 | 1.00 |
| 74LS193 | .95 |
| 74LS367 | .75 |
| 74LS368 | .65 |

## LINEARS, REGULATORS, etc.

| | |
|---|---|
| MCT2 | .95 |
| 8038 | 3.95 |
| LM201 | .75 |
| LM301 | .45 |
| LM308 (Mini) | .95 |
| LM309H | .65 |
| LM309K (340K-5) | .85 |
| LM310 | .85 |
| LM311D (Mini) | .75 |
| LM318 (Mini) | 1.75 |
| LM320K5 (7905) | 1.65 |
| LM320K12 | 1.65 |

| | |
|---|---|
| LM320T5 | 1.65 |
| LM320T12 | 1.65 |
| LM320T15 | 1.65 |
| LM324N | 1.25 |
| LM339 | .75 |
| 7805 (340T5) | .95 |
| LM340T12 | .95 |
| LM340T15 | .95 |
| LM340T18 | .95 |
| LM340T24 | .95 |
| LM340K12 | 1.25 |

| | |
|---|---|
| LM340K15 | 1.25 |
| LM340K18 | 1.25 |
| LM340K24 | 1.25 |
| 78L05 | .75 |
| 78L12 | .75 |
| 78L15 | .75 |
| 78M05 | .75 |
| LM373 | 2.95 |
| LM380 (8-14 PIN) | .95 |
| LM709 (8,14 PIN) | .25 |
| LM711 | .45 |

| | |
|---|---|
| LM723 | .40 |
| LM725N | 2.50 |
| LM739 | 1.50 |
| LM741 (8-14) | .25 |
| LM747 | 1.10 |
| LM1307 | 1.25 |
| LM1458 | .65 |
| LM3900 | .50 |
| LM75451 | .65 |
| NE555 | .35 |
| NE556 | .85 |
| NE565 | .95 |
| NE566 | 1.25 |
| NE567 | .95 |

## 9000 SERIES

| | | | |
|---|---|---|---|
| 9301 | .85 | 95H03 | 1.10 |
| 9309 | .35 | 9601 | .20 |
| 9322 | .65 | 9602 | .45 |

## MICRO'S, RAMS, CPU'S, E-PROMS

| | | | |
|---|---|---|---|
| 74S188 | 3.00 | 8214 | 8.95 |
| 1702A | 4.50 | 8224 | 3.25 |
| MM5314 | 3.00 | 8228 | 6.00 |
| MM5316 | 3.50 | 8251 | 8.50 |
| 2102-1 | 1.45 | 8255 | 10.50 |
| 2102L-1 | 1.75 | 8T13 | 1.50 |
| 2114 | 9.50 | 8T23 | 1.50 |
| TR1602B | 3.95 | 8T24 | 2.00 |
| TMS 4044- | 9.95 | 8T97 | 1.00 |
| | | 2107B-4 | 4.95 |
| 8080 | 8.95 | 2708 | 9.50 |
| 8212 | 2.95 | Z80 PIO | 8.50 |

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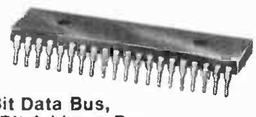
**By National Semiconductor and Motorola — first quality**

| Type | Cat. No. | ONLY |
|---|---|---|
| 301CN | 276-017 | 49¢ |
| 324N | 276-1711 | 1.49 |
| 339N | 276-1712 | 1.49 |
| 386CN | 276-1731 | 99¢ |
| 555CN | 276-1723 | 79¢ |
| 556CN | 276-1728 | 1.39 |
| 566CN | 276-1724 | 1.69 |
| 567CN | 276-1721 | 1.99 |
| 723CN | 276-1740 | 69¢ |
| 741CN | 276-007 | 49¢ |
| 741H | 276-010 | 49¢ |
| 3900N | 276-1713 | 99¢ |
| 3909N | 276-1705 | 99¢ |
| 3911N | 276-1706 | 1.99 |
| 4558CN | 276-038 | 79¢ |
| 75491 | 276-1701 | 99¢ |
| 75492 | 276-1702 | 99¢ |
| 7805 | 276-1770 | 1.29 |
| 7812 | 276-1771 | 1.29 |
| 7815 | 276-1772 | 1.29 |

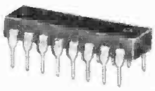
### Computer Chip



**8-Bit Data Bus, 16-Bit Address Bus**

8080A Microprocessor. 100% prime CPU handles up to 65K bytes memory. 276-2510. Reg. 17.95 .......... **12.95**

### RAM Memory IC



**Under 450 nS Access Time**

**2102 1K Static RAM.** Low power version. 16-pin DIP. Buy 8 and save! **276-2501** .......... **2.49 Ea. or 8/14.95**

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**Full-Spec Devices Direct from Motorola and National Semiconductor**

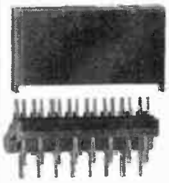
| Type | Cat. No. | ONLY |
|---|---|---|
| 7400 | 276-1801 | 35¢ |
| 7402 | 276-1811 | 39¢ |
| 7404 | 276-1802 | 35¢ |
| 7406 | 276-1821 | 49¢ |
| 7410 | 276-1807 | 39¢ |
| 7413 | 276-1815 | 79¢ |
| 7420 | 276-1809 | 39¢ |
| 7427 | 276-1823 | 49¢ |
| 7432 | 276-1824 | 49¢ |
| 7441 | 276-1804 | 99¢ |
| 7447 | 276-1805 | 99¢ |
| 7448 | 276-1816 | 99¢ |
| 7451 | 276-1825 | 39¢ |
| 7473 | 276-1803 | 49¢ |
| 7474 | 276-1818 | 49¢ |
| 7475 | 276-1806 | 79¢ |
| 7476 | 276-1813 | 59¢ |
| 7485 | 276-1826 | 1.19 |
| 7486 | 276-1827 | 49¢ |
| 7490 | 276-1808 | 79¢ |
| 7492 | 276-1819 | 69¢ |
| 74123 | 276-1817 | 99¢ |
| 74145 | 276-1828 | 1.19 |
| 74150 | 276-1829 | 1.39 |
| 74154 | 276-1834 | 1.29 |
| 74192 | 276-1831 | 1.19 |
| 74193 | 276-1820 | 1.19 |
| 74194 | 276-1832 | 1.19 |
| 74196 | 276-1833 | 1.29 |
| 4001 | 276-2401 | 49¢ |
| 4011 | 276-2411 | 49¢ |
| 4013 | 276-2413 | 89¢ |
| 4017 | 276-2417 | 1.49 |
| 4020 | 276-2420 | 1.49 |
| 4027 | 276-2427 | 89¢ |
| 4049 | 276-2449 | 69¢ |
| 4050 | 276-2450 | 69¢ |
| 4511 | 276-2447 | 1.69 |
| 4518 | 276-2490 | 1.49 |

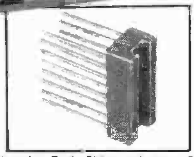
### *NEW* Digital IC Logic Probe

**Multi-Logic Family Compatibility from 5-15VDC** **24.95**

Detects one-shot, low-repetition-rate, narrow pulses ordinary scopes miss. Combined level detector, pulse detector and pulse stretcher. Nonsymmetrical duty cycles of less than 30% light Lo-LED; over 70% light Hi-LED. Input impedance: 300K ohms. Overload and reverse-polarity protected. With 36" cables. 22-300 .......... 24.95

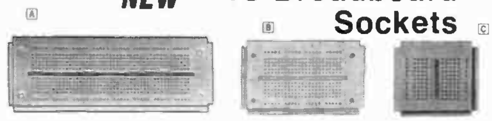
### Wire Wrapping Accessories





IC Socket Wrapping Tool. Strips and wraps 30-gauge wire. 276-1570 .......... 6.95
14-Pin Wire Wrapping Sockets. 276-1993 .......... 2/1.29
16-Pin Wire Wrapping Sockets. 276-1994 .......... 2/1.39
DIP Header. 16 pins. 276-1980 .......... 1.29
50' Red 30-ga. Kynar® Wire. 278-501 .......... 1.99
50' White 30-ga. Kynar Wire. 278-502 .......... 1.99
50' Blue 30-ga. Kynar Wire. 278-503 .......... 1.99

### *NEW* IC Breadboard Sockets




Modular boards snap together and feature standard 0.3" center. Accepts 22 through 30-gauge solid hookup wire.

A 550 connections in 2 bus strips of 40 tie points each with 47 rows of 5 connected tie points. 2⅛x6". **276-174** .......... 9.95

B 270 connections in 2 bus strips of 40 tie points each with 23 rows of 5 connected tie points. 2⅛x3⅝". **276-175** .......... 5.95

C **Mini-Socket.** 22 rows of 5 tie points each, plus 2 bus strips with 10 connections each. 2⅛x1⅞". **276-176** .......... 3.95

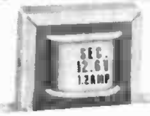
### Metal Project Cabinets

*NEW*

**Slope Front.** Sloping top panel — ideal for lab projects. 1⅜ to 2¾x7⅞x5⅝". 270-265 .......... 6.99

**Project Cabinet.** 20 ga. steel cover with 16 ga. aluminum chassis.
2⁷⁄₁₆x4⁹⁄₁₆x6⁵⁄₈". 270-268 .......... 5.99
3½x7⁷⁄₈x5¹¹⁄₁₆". 270-269 .......... 7.99

### Low-Cost Power Transformers




- Primaries Designed to Operate from 120VAC, 60 Hz
- Solder Lugs for Easy Wiring or PC Board Mounting

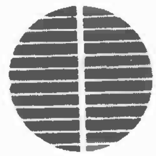
| Volts | Current | Cat. No. | Each |
|---|---|---|---|
| 6.3 | 1.2A | 273-050 | **2.49** |
| 6.3 | 300 mA | 273-1384 | **1.99** |
| 12 | 300 mA | 273-1385 | **1.99** |
| 24 | 300 mA | 273-1386 | **2.49** |
| 24 | 1.2A | 273-1480 | **2.99** |
| 12.6 CT | 1.2A | 273-1505 | **2.89** |

| Volts | Current | Cat. No. | Each |
|---|---|---|---|
| 6.3 CT | 3A | 273-1510 | **3.99** |
| 12.6 CT | 3A | 273-1511 | **4.69** |
| 25.2 CT | 2A | 273-1512 | **4.99** |
| 12 | 5A | 273-1513 | **8.95** |
| 18 CT* | 4A | 273-1514 | **8.95** |
| 18 CT* | 2A | 273-1515 | **4.99** |

*Ideal for 5V (using CT) or 12V solid-state regulators

### Solar Cell

*NEW*



**2¼" Round Silicon Device**

High efficiency — provides approximately 0.5 volt at 400 mA. For higher voltage or current outputs use several in series or parallel. 276-121 .... 5.99

### Radio Shack Reference Books

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**Voltage Regulator Handbook.** **62-1371** .......... 2.95

**Linear Integrated Circuits.** Covers op-amps, voltage regulators, more. **62-1372** .......... 3.95

**Linear Applications.** Fully indexed and cross-referenced. **62-1373** .......... 2.95

**Linear Applications, Vol. 2.** The latest data sheets, applications. **62-1374** .......... 2.95

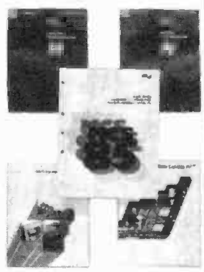
**CMOS Integrated Circuits.** Covers 74C series, CD4000 with data specs. **62-1375** .......... 3.95

**Memory Data Book.** **62-1376** .......... 3.95

**Intel® 8080/8085 Programming Manual.** Uses Intel's assembly language. **62-1377** .......... 3.95

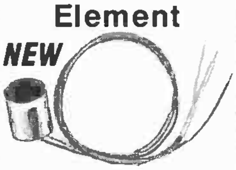
**Intel Memory Design Handbook.** Companion to Data Catalog, below. **62-1378** .......... 3.95

**Intel Data Catalog.** 928 pages of complete specs on most Intel standard devices. **62-1379** .......... 4.95



### Electret Mike Element

*NEW*



Condenser mike element for new or replacement use. Built-in FET preamp. 30-15,000 Hz audio response. Requires 2 to 10VDC. **270-092** .......... 2.49

### Epoxy-Glass Plug-In PC Boards

*NEW*

For 22-pin connectors. 4½x4". ¹⁄₁₀" grid. 3 styles available.
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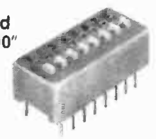
**Digital. 276-156** .......... 4.49
**Op-Amp. 276-157** .......... 4.49
**22-Pin Dual Connector. 276-1551** .......... 2.99

### 8-Rocker DIP Switch

**Standard .100x.300" DIP**



Designed for easy change of preset logic states in digital circuits. Fits 16-pin IC socket or mounts on PC board. **275-1301** .......... 1.99

### Test Lead Jumper Cables

**Low As 2.69 Pack**

**Handy Hookups Easily**

**Set of 10 Color-Coded Leads.** 14" long with insulated clips. **278-1156** .......... 2.69

**8-Pack of 24" Cables.** 4 colors. **278-1157** .......... 2.99

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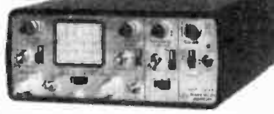

DUAL TRACE MS-215 **$435.00**

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AVAILABLE OPTIONS — usable on both the MS-215 and the MS-15
41-140 Leather Carrying Case $45.00 — 41-141 10 to 1 Probe $24.50

| DIP SWITCHES SPST SLIDE TYPE | | | | | |
|---|---|---|---|---|---|
| JS8722-01 | $1.00 | JS8722-03 | $1.40 | JS8722-07 | $1.85 |
| JS8722-02 | 1.08 | JS8722-04 | 1.70 | JS8722-08 | 1.95 |
| | | JS8722-05 | 1.75 | JS8722-09 | 2.00 |
| | | JS8722-06 | 1.80 | JS8722-10 | 2.20 |

Dash No. Indicates number of switch positions on DIP Switch.

## ALUMINUM ELECTROLYTIC (RADIAL LEAD)

| mfd | 10 volt | 16 volt | 25 volt | 35 volt | 50 volt |
|---|---|---|---|---|---|
| 1 | 8/$1.00 | 7/$1.00 | 7/$1.00 | 7/$1.00 | 6/$1.00 |
| 4.7 | 7/$1.00 | 7/$1.00 | 6/$1.00 | 5/$1.00 | 4/$1.00 |
| 10 | 7/$1.00 | 7/$1.00 | 6/$1.00 | 5/$1.00 | 4/$1.00 |
| 22 | 7/$1.00 | 6/$1.00 | 5/$1.00 | 4/$1.00 | 4/$1.00 |
| 33 | 6/$1.00 | 6/$1.00 | 4/$1.00 | 4/$1.00 | 4/$1.00 |
| 47 | 6/$1.00 | 5/$1.00 | 4/$1.00 | 4/$1.00 | 3/$1.00 |
| 100 | 5/$1.00 | 5/$1.00 | 4/$1.00 | 4/$1.25 | 3/$1.00 |
| 220 | 4/$1.00 | 4/$1.00 | 3/$1.00 | 3/$1.25 | 2/$1.00 |
| 330 | 3/$1.00 | 3/$1.00 | 3/$1.25 | 2/$1.00 | 2/$1.00 |
| 470 | 3/$1.00 | 3/$1.25 | 2/$1.00 | 2/$1.25 | $ .80 |
| 1000 | — | — | 2/$1.25 | $ .80 | $1.20 |
| 2200 | — | — | $1.30 | $1.60 | $2.50 |

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$1.25 PER PACKAGE

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| .0012 | 8/pkg | .047 | 7/pkg |
| .0015 | 8/pkg | .056 | 7/pkg |
| .0018 | 8/pkg | .068 | 7/pkg |
| .0022 | 8/pkg | .082 | 7/pkg |
| .0027 | 8/pkg | .1 | 7/pkg |
| .0033 | 8/pkg | .12 | 6/pkg |
| .0039 | 8/pkg | .15 | 6/pkg |
| .0047 | 8/pkg | .18 | 5/pkg |
| .0056 | 8/pkg | .22 | 5/pkg |
| .0068 | 8/pkg | .27 | 4/pkg |
| .0082 | 8/pkg | .33 | 4/pkg |
| .01 | 8/pkg | .39 | 3/pkg |
| .012 | 8/pkg | .47 | 3/pkg |
| .015 | 7/pkg | .56 | 3/pkg |
| .018 | 7/pkg | .68 | 2/pkg |
| .022 | 7/pkg | .82 | 2/pkg |
| .027 | 7/pkg | 1.0 | 2/pkg |
| .033 | 7/pkg | | |

## 50 VOLT CERAMIC DISC CAPACITORS

$1.00 PER PACKAGE

| pf | Qty | pf | Qty | mfd | Qty | mfd | Qty |
|---|---|---|---|---|---|---|---|
| 5 | 9/pkg | 220 | 8/pkg | .001 | 9/pkg | .015 | 8/pkg |
| 15 | 9/pkg | 270 | 7/pkg | .0015 | 9/pkg | .02 | 8/pkg |
| 25 | 9/pkg | 300 | 7/pkg | .0022 | 9/pkg | .022 | 8/pkg |
| 27 | 9/pkg | 330 | 7/pkg | .003 | 9/pkg | .03 | 8/pkg |
| 47 | 8/pkg | 390 | 7/pkg | .0047 | 9/pkg | .039 | 7/pkg |
| 68 | 8/pkg | 470 | 7/pkg | .005 | 9/pkg | .047 | 7/pkg |
| 100 | 8/pkg | 560 | 7/pkg | .01 | 9/pkg | .1 | 6/pkg |
| 150 | 8/pkg | 680 | 7/pkg | | | | |

| Microprocessor & Support ICs | 1-9 | 10 up | 100up |
|---|---|---|---|
| AM2901ADC | 24.80 | 20.15 | 15.50 |
| C8080A | 11.20 | 9.60 | 8.00 |
| P8080A | 5.95 | 5.10 | 4.25 |
| C8085A | 26.75 | 23.00 | 19.25 |
| P8085A | 22.00 | 19.00 | 16.00 |
| D8212 | 4.40 | 3.86 | 3.30 |
| P8212 | 3.26 | 2.85 | 2.44 |
| D8216 | 4.20 | 3.67 | 3.15 |
| P8216 | 3.06 | 2.68 | 2.29 |
| D8224 | 5.60 | 4.90 | 4.20 |
| AM8224PC | 4.00 | 3.50 | 3.00 |
| D8226 | 4.20 | 3.67 | 3.15 |
| P8226 | 3.06 | 2.86 | 2.29 |
| D8228 | 8.00 | 7.00 | 6.00 |
| AM8228PC | 7.00 | 6.12 | 5.25 |
| D8238 | 8.00 | 7.00 | 6.00 |
| AM8238PC | 7.00 | 6.12 | 5.25 |
| C8251 | 11.20 | 9.60 | 8.00 |
| P8251 | 5.95 | 5.10 | 4.25 |
| C8255 | 10.25 | 8.75 | 7.30 |
| P8255 | 5.60 | 4.80 | 4.00 |
| AM8257PC | 14.35 | 12.30 | 10.25 |
| **1024x4 N-Channel Static RAM** | | | |
| AM9130ADC | 20.90 | 15.70 | 12.55 |

| 4096x1 N-Channel Static RAM | 1-9 | 10 up | 100up |
|---|---|---|---|
| AM9140ADC | 20.90 | 15.70 | 12.55 |
| AM9141ADC | 17.10 | 13.70 | 11.40 |
| **One-Shot & Dual One-Shots** | | | |
| 9600PC | 1.70 | 1.49 | 1.27 |
| 9601PC | .78 | .68 | .58 |
| 9602PC | 1.00 | .87 | .75 |
| **Line Drivers** | | | |
| 9614PC | 2.06 | 1.80 | 1.54 |
| 9615PC | 2.06 | 1.80 | 1.54 |
| 9616PC | 3.00 | 2.62 | 2.25 |
| 9617PC | 2.06 | 1.80 | 1.54 |
| 9620PC | 2.80 | 2.45 | 2.10 |
| 9621PC | 2.80 | 2.45 | 2.10 |
| **1024x4 N-Channel Static RAM** | | | |
| P2114 = AM9114BPC | | | |
| P2114L = AM91L14BPC | | | |
| AM9114BPC | 17.20 | 12.60 | 11.00 |
| AM91L14BPC | 18.90 | 13.85 | 12.10 |
| **Arithmetic Processing Unit** | | | |
| AM9511-4DC | 295.00 | 295.00 | 280.00 |
| **DMA Controller — 2MHz** | | | |
| AM9517PC | 14.35 | 12.30 | 10.25 |
| **Priority Interupt Controller-2MHz** | | | |
| AM9519PC | 14.00 | 12.50 | 10.00 |

| LINEAR | 1-24 | 25up | 100up |
|---|---|---|---|
| LM100H | $7.00 | $5.55 | $4.65 |
| LM101H | 1.65 | 1.32 | 1.10 |
| LM101AH | 1.80 | 1.44 | 1.20 |
| LM105H | 4.85 | 3.90 | 3.25 |
| LM106H | 4.80 | 3.80 | 3.20 |
| LM107H | 2.10 | 1.68 | 1.40 |
| LM109K | 5.70 | 4.50 | 3.90 |
| LM110H | 6.00 | 4.80 | 4.00 |
| LM111H | 4.50 | 3.60 | 3.00 |
| LM114 | 4.50 | 3.60 | 3.00 |
| LM118H | 12.75 | 10.20 | 8.50 |
| LM124D | 3.23 | 2.58 | 2.15 |
| LM200H | 6.00 | 4.80 | 4.00 |
| LM201H | 1.80 | .86 | .72 |
| LM201AN(14) | 1.95 | 1.55 | 1.30 |
| LM202H | 7.50 | 6.00 | 5.00 |
| LM205H | 5.50 | 4.40 | 3.70 |
| LM206H | 4.25 | 3.40 | 2.85 |
| LM208H | 6.60 | 5.25 | 4.40 |
| LM209H | 3.00 | 2.50 | 2.10 |
| LM209K | 3.25 | 2.75 | 2.45 |
| LM210H | 6.05 | 4.85 | 4.05 |
| LM211H | 3.45 | 2.75 | 2.30 |
| LM211N(8) | 5.50 | 4.50 | 3.65 |
| LM218H | 10.65 | 8.50 | 7.10 |
| LM300H | 2.70 | 2.15 | 1.80 |
| LM301AH | .95 | .78 | .65 |
| LM301AJ | 1.25 | .98 | .83 |
| LM302D | 4.35 | 3.45 | 2.90 |
| LM302H | 4.00 | 3.20 | 2.65 |
| LM304H | 3.25 | 2.58 | 2.15 |
| LM305H | 1.45 | 1.15 | .90 |
| LM306H | 1.80 | 1.40 | 1.20 |
| LM307H | .90 | .72 | .60 |
| LM307N(8) | .80 | .64 | .53 |
| LM307N(14) | .90 | .72 | .60 |
| LM308H | 1.28 | 1.02 | .85 |
| LM308AH | 5.10 | 4.00 | 3.40 |
| LM308AD | 6.75 | 5.40 | 4.50 |
| LM308AN(8) | 4.50 | 3.60 | 3.00 |
| LM308D | 3.45 | 2.75 | 2.30 |
| LM308N(8) | .86 | .68 | .57 |
| LM309H | 1.85 | 1.60 | 1.10 |
| LM309K | 2.40 | 2.00 | 1.40 |
| LM310H | 2.55 | 2.00 | 1.70 |
| LM310D | 4.80 | 3.85 | 3.20 |
| LM310N(8) | 2.00 | 1.56 | 1.34 |
| LM311D | 5.50 | 3.90 | 3.20 |
| LM311H | 1.05 | .84 | .70 |
| LM311N(8) | 1.05 | .84 | .70 |
| LM312H | 3.53 | 2.82 | 2.35 |
| LM316H | 6.45 | 5.15 | 4.30 |
| LM317H | 3.45 | 2.95 | 2.00 |
| LM317K | 3.95 | 3.15 | 2.35 |
| LM318H | 3.38 | 2.70 | 2.25 |
| LM318N(8) | 3.00 | 2.40 | 2.00 |
| LM319H | 2.85 | 2.28 | 1.90 |
| LM319N(14) | 2.48 | 1.98 | 1.65 |
| LM324D | 1.58 | 1.26 | 1.05 |
| LM324N(14) | 1.50 | 1.20 | 1.00 |
| LM339AD | 3.00 | 2.40 | 2.00 |

| LINEAR | 1-24 | 25 up | 100up |
|---|---|---|---|
| LM339AN(14) | 1.95 | $1.56 | $1.30 |
| LM339J | 2.50 | 1.98 | 1.67 |
| LM339N | 1.05 | .84 | .70 |
| LM348D | 2.63 | 2.10 | 1.75 |
| LM348N(14) | 1.80 | 1.44 | 1.20 |
| LM349D | 2.90 | 2.30 | 1.95 |
| LM349N(14) | 2.00 | 1.60 | 1.35 |
| LF355H | 1.60 | 1.25 | .95 |
| LF356H | 1.60 | 1.25 | .95 |
| LF357H | 1.60 | 1.25 | .95 |
| LM380N(14) | 1.90 | 1.80 | 1.50 |
| LM380N(8) | 1.90 | 1.80 | 1.50 |
| LM381N | 2.90 | 2.60 | 2.00 |
| LM388N | 2.90 | 2.60 | 2.00 |
| NE555N | .45 | .35 | .30 |
| NE556A | 1.12 | .98 | .84 |
| LM565CN | 1.50 | 1.20 | 1.00 |
| LM566CN(8) | 2.60 | 1.90 | 1.60 |
| AM592PC | 1.80 | 1.45 | 1.20 |
| AM685DL | 14.25 | 11.40 | 9.50 |
| AM685HL | 13.40 | 10.70 | 8.95 |
| AM686CN | 5.25 | 4.20 | 3.50 |
| AM686HC | 13.40 | 10.70 | 8.95 |
| AM687ADL | 28.50 | 22.80 | 19.00 |
| AM687DL | 22.50 | 18.00 | 15.00 |
| LM703L | 1.50 | 1.20 | 1.00 |
| LM709CH | .90 | .70 | .60 |
| LM709CN | .62 | .51 | .43 |
| LM710CH | 1.25 | .99 | .83 |
| LM710CN | 1.00 | .79 | .66 |
| LM710DC | 1.80 | 1.60 | 1.40 |
| LM711CH | 1.85 | 1.47 | 1.23 |
| LM711CN | 1.05 | .84 | .70 |
| LM715HC | 4.20 | 3.15 | 2.85 |
| LM715HM | 30.00 | 24.00 | 20.00 |
| LM715DC | 7.40 | 5.90 | 4.95 |
| LM723HC | 1.35 | 1.10 | 1.00 |
| LM723PC | 1.15 | .90 | .75 |
| LM725DC | 5.25 | 4.20 | 3.50 |
| LM725HC | 4.50 | 3.60 | 3.00 |
| LM725HM | 18.00 | 14.40 | 12.00 |
| LM733HC | 1.35 | 1.08 | .90 |
| LM733DC | 2.20 | 1.75 | 1.45 |
| LM733CN(14) | 2.00 | 1.60 | 1.35 |
| LM741DC | 1.15 | .90 | .75 |
| LM741HC | .90 | .72 | .60 |
| LM741CN(14) | .85 | .67 | .56 |
| LM741CN(8) | .75 | .60 | .50 |
| LM741DM | 2.25 | 1.80 | 1.50 |
| LM741HM | 1.40 | 1.15 | .95 |
| LM747DC | 2.10 | 1.65 | 1.40 |
| LM747HC | 1.95 | 1.55 | 1.30 |
| LM747PC | 1.65 | 1.30 | 1.10 |
| LM747DM | 2.18 | 1.74 | 1.45 |
| LM747HM | 1.95 | 1.56 | 1.30 |
| LM748HC | .98 | .78 | .65 |
| LM748HM | 1.50 | 1.20 | 1.00 |
| LM748CN(8) | .90 | .72 | .60 |
| LM748CN(14) | .95 | .78 | .65 |
| uA1458CH | 1.95 | 1.55 | 1.30 |
| LM3909N | 1.80 | 1.40 | 1.20 |

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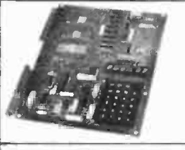

# KIM-1 MICROCOMPUTER

Fully Assembled & Tested
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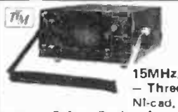

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| 2525V | 3.65 | 3.55 | 3.42 |
| 2533V | 4.90 | 4.02 | 3.42 |
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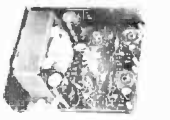

| MODEL NUMBER | RATING Vdc | Amps |
|---|---|---|
| APS5-3 | 5 | 3 |
| APS6-2.5 | 6 | 2.5 |
| APS12-1.6 | 12 | 1.6 |
| APS15-1.5 | 15 | 1.5 |

1—4 $42.00 · 5—9 $34.00 · 10 up $32.20

| MODEL NUMBER | RATING Vdc | Amps |
|---|---|---|
| DAPS 5.8 | ±5 | 0.8 |
| DAPS 9-12.5 | ±9 to 12 | 0.5 |
| DAPS 12.75 | ±12 | 0.75 |
| DAPS 15-.60 | ±15 | 0.60 |

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REGULATION .005 Line .01 Load Ripple PK PK 1mV

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|---|---|
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| .125 Wirewrap | |
| MP-0125-22-DW-5 | 2.90 |
| MP-0125-31-DW-5 | 3.90 |
| MP-0125-36-DW-5 | 4.30 |
| MP-0125-40-DW-5 | 4.70 |
| MP-0125-50-DW-5 | 5.60 |
| .156 Wirewrap | |
| MP-0156-18-DW-5 | 3.40 |
| MP-0156-22-DW-5 | 3.70 |
| MP-0156-36-DW-5 | 4.90 |
| MP-0156-43-DW-5 | 5.90 |
| .125 Solder Tail | |
| MP-0125-50-DS-5 | 5.50 |
| .156 Solder Tail | |
| H411121-10 | 1.37 |
| H411121-15 | 1.98 |
| H411121-18 | 2.31 |
| H411121-22 | 2.74 |
| H411121-25 | 3.07 |
| .156 Solder Eye | |
| H411131-10 | 1.37 |
| H411131-15 | 1.98 |
| H411131-18 | 2.31 |
| H411131-22 | 2.74 |
| H411131-25 | 3.07 |

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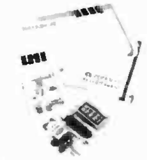

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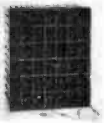

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¼W ..... $1.69 ½W ..... $1.69

| | | | | | |
|---|---|---|---|---|---|
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| 11 | 110 | 1.1K | 11K | 110K | 1.1M |
| 12 | 120 | 1.2K | 12K | 120K | 1.2M |
| 13 | 130 | 1.3K | 13K | 130K | 1.3M |
| 15 | 150 | 1.5K | 15K | 150K | 1.5M |
| 16 | 160 | 1.6K | 16K | 160K | 1.6M |
| 18 | 180 | 1.8K | 18K | 180K | 1.8M |
| 20 | 200 | 2.0K | 20K | 200K | 2.0M |
| 22 | 220 | 2.2K | 22K | 220K | 2.2M |
| 24 | 240 | 2.4K | 24K | 240K | 2.4M |
| 27 | 270 | 2.7K | 27K | 270K | 2.7M |
| 30 | 300 | 3.0K | 30K | 300K | 3.0M |
| 33 | 330 | 3.3K | 33K | 330K | 3.3M |
| 36 | 360 | 3.6K | 36K | 360K | 3.6M |
| 39 | 390 | 3.9K | 39K | 390K | 3.9M |
| 43 | 430 | 4.3K | 43K | 430K | 4.3M |
| 47 | 470 | 4.7K | 47K | 470K | 4.7M |
| 51 | 510 | 5.1K | 51K | 510K | 5.1M |
| 56 | 560 | 5.6K | 56K | 560K | 5.6M |
| 62 | 620 | 6.2K | 62K | 620K | 6.2M |
| 68 | 680 | 6.8K | 68K | 680K | 6.8M |
| 75 | 750 | 7.5K | 75K | 750K | 7.5M |
| 82 | 820 | 8.2K | 82K | 820K | 8.2M |
| 91 | 910 | 9.1K | 91K | 910K | 10.0M |

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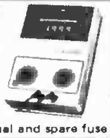

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| □ SN7403 | .25 | .26 | □ SN7474 | .59 | .60 | □ SN74156 | .39 | .40 |
| □ SN7404 | .19 | .20 | □ SN7475 | .69 | .70 | □ SN74157 | .99 | 1.00 |
| □ SN7405 | .19 | .20 | □ SN7480 | .19 | .20 | □ SN74158 | .99 | 1.00 |
| □ SN7406 | .19 | .20 | □ SN7482 | .29 | .30 | □ SN74161 | 1.25 | 1.26 |
| □ SN7410 | .25 | .26 | □ SN7483 | .99 | 1.00 | □ SN74163 | 1.39 | 1.40 |
| □ SN7416 | .35 | .36 | □ SN7486 | .49 | .50 | □ SN74164 | .79 | .80 |
| □ SN7420 | .32 | .33 | □ SN7488 | .79 | .80 | □ SN74165 | .99 | 1.00 |
| □ SN7421 | .49 | .50 | □ SN7489 | 3.49 | 3.50 | □ SN74166 | 1.99 | 2.00 |
| □ SN7423 | .29 | .30 | □ SN7490 | .99 | 1.00 | □ SN74173 | .99 | 1.00 |
| □ SN7426 | .19 | .20 | □ SN7491 | 1.29 | 1.30 | □ SN74175 | .99 | 1.00 |
| □ SN7430 | .29 | .30 | □ SN7492 | .79 | .80 | □ SN74177 | .78 | .80 |
| □ SN7437 | .19 | .20 | □ SN7493 | .69 | .70 | □ SN74179 | 1.99 | 2.00 |
| □ SN7438 | .25 | .26 | □ SN7494 | .79 | .80 | □ SN74180 | .49 | .50 |
| □ SN7440 | .19 | .20 | □ SN7495 | .59 | .60 | □ SN74182 | .49 | .50 |
| □ SN7443 | .59 | .60 | □ SN7496 | .29 | .30 | □ SN74190 | 1.99 | 2.00 |
| □ SN7444 | .19 | .20 | □ SN7498 | .79 | .80 | □ SN74191 | 1.75 | 1.76 |
| □ SN7446 | 1.25 | 1.26 | □ SN74107 | .99 | .30 | □ SN74192 | .85 | .86 |
| □ SN7450 | .19 | .20 | □ SN74113 | .39 | .40 | □ SN74193 | .99 | 1.00 |
| □ SN7451 | .19 | .20 | □ SN74114 | .25 | .26 | □ SN74194 | 1.25 | 1.26 |
| □ SN7453 | .19 | .20 | □ SN74121 | .59 | .60 | □ SN74197 | .75 | .76 |
| □ SN7454 | .29 | .30 | □ SN74123 | .69 | .70 | □ SN74199 | 1.50 | 1.51 |
| □ SN7455 | .19 | .20 | □ SN74126 | .99 | 1.00 | □ SN74200 | 3.50 | 3.51 |
| □ SN7460 | .35 | .36 | □ SN74136 | .49 | .50 | □ SN74251 | .79 | .80 |
| □ SN7464 | .19 | .20 | □ SN74140 | .49 | .50 | □ SN74284 | 5.99 | 6.00 |
| □ SN7465 | .19 | .20 | □ SN74145 | .69 | .70 | □ SN74298 | 3.75 | 3.76 |
| □ SN7470 | .19 | .20 | □ SN74153 | 1.29 | 1.30 | | | |

## POP-AMPS AT "CENT-CIBLE" PRICES

Case code: T-TO-220 Power Tab; V-Mini dip; K-TO-3; H-TO-5; N-DIP.

| Type No. | Each | 2 for | Type No. | Each | 2 for | Type | Each | 2 for |
|---|---|---|---|---|---|---|---|---|
| □ LM300H | $ .79 | $ .80 | □ LM340T-18 | 1.49 | 1.50 | □ LM709H | .19 | .20 |
| □ LM300N | .49 | .50 | □ LM340T-24 | 1.49 | 1.50 | □ LM709N | .49 | .50 |
| □ LM301V | .45 | .46 | □ LM350N | .49 | .50 | □ LM723N | .49 | .50 |
| □ LM301H | .45 | .46 | □ LM376V | .29 | .30 | □ LM733N | .79 | .80 |
| □ LM308V | .29 | .30 | □ LM377N | 2.25 | 2.26 | □ LM741H | .30 | .31 |
| □ LM308H | .69 | .70 | □ LM380N | 1.39 | 1.40 | □ LM747H | .59 | .60 |
| □ LM309K | 1.49 | 1.50 | □ LM386N | 1.49 | 1.50 | □ LM1304 | 1.49 | 1.50 |
| □ LM311V | .29 | .30 | □ LM531H | 1.49 | 1.50 | □ LM1310 | 1.79 | 1.80 |
| □ LM320T-6 | 1.49 | 1.50 | □ LM532N | .25 | .26 | □ LM1312 | 2.49 | 2.50 |
| □ LM322N | 1.19 | 1.20 | □ LM532H | .25 | .26 | □ LM1414V | .19 | .20 |
| □ LM339N | 1.79 | 1.80 | □ NE540H | 5.95 | 5.96 | □ LM1458V | .39 | .40 |
| □ LM340K-5 | 1.49 | 1.50 | □ LM555V | .75 | .76 | □ LM1800N | .79 | .80 |
| □ LM340K-6 | 1.49 | 1.50 | □ LM556N | 1.79 | 1.80 | □ LM3028H | .65 | .66 |
| □ LM340K-8 | 1.49 | 1.50 | □ LM558V | .39 | .40 | □ LM3900N | .49 | .50 |
| □ LM340K-12 | 1.49 | 1.50 | □ LM558H | .39 | .40 | □ LM3909V | 1.25 | 1.26 |
| □ LM340K-15 | 1.49 | 1.50 | □ LM561N | 1.00 | 1.01 | □ LM4250 | 1.20 | 1.21 |
| □ LM340K-18 | 1.49 | 1.50 | □ LM565N | 1.00 | 1.01 | □ LM75451 | .69 | .70 |
| □ LM340K-24 | 1.49 | 1.50 | □ LM565H | 1.00 | 1.01 | □ LM75453 | .69 | .70 |
| □ LM340T-5 | 1.49 | 1.50 | □ LM566 | 2.49 | 2.50 | □ LM75491 | .80 | .81 |
| □ LM340T-6 | 1.49 | 1.50 | □ LM567 | 2.39 | 2.40 | □ LM75492 | .80 | .81 |
| □ LM340T-12 | 1.49 | 1.50 | □ LM703N | .59 | .60 | □ LM75494 | .60 | .61 |
| □ LM340T-15 | 1.49 | 1.50 | □ LM704H | .19 | .20 | □ PA263 | 1.50 | 1.51 |
| | | | | | | □ DM8864N | 1.29 | 1.30 |

## PENNIES FOR YOUR MEMORIES

Order by Cat. No. 3459 & Type No.

| Type | Description | Sale | 1¢ Sale! |
|---|---|---|---|
| □ 1103 | 1K Dynamic RAM | 1.29 | 1.30 |
| □ 5202 | 2K Prom | 2.95 | 2.96 |
| □ 5262 | 2K x 1 Dynamic RAM | .99 | 1.00 |
| □ 1702A | 256 x 8 EPROM | 4.95 | 4.96 |
| □ MM5280* | 4K x 1 Dynamic RAM | 3.95 | 3.96 |

*Removed from new tested equipment

## 1 AMP SCR'S

TO-92 Case, 2N5060 series. Order by Cat No. 2367 and voltage

| | Sale | 1¢ Sale |
|---|---|---|
| □ 30 | 4 for $1 | 8 for 1.01 |
| □ 60 | 3 for $1 | 6 for 1.01 |
| □ 100 | 3 for $1 | 6 for 1.01 |
| □ 150 | 2 for $1 | 4 for 1.01 |
| □ 200 | 1 for $1 | 2 for 1.01 |

## RIBBON CABLE!

Order by Cat. 3939 and Conductors

| Cond. | | Sale | | 1¢ Sale |
|---|---|---|---|---|
| □ 26 | 4-ft. | 1.98 | 8-ft. | 1.99 |
| □ 34 | 3-ft. | 1.98 | 6-ft. | 1.99 |
| □ 40 | 3-ft. | 1.98 | 6-ft. | 1.99 |

## ZENERS!

Order by Cat. No. 5210A & voltage & wattage

| 1 Watt | Sale | 1¢ SALE |
|---|---|---|
| □ 7.5V | 5 for $1. | 10 for $1.01 |
| □ 8.2V | 5 for 1. | 10 for 1.01 |
| □ 9.1V | 5 for 1. | 10 for 1.01 |
| □ 10.V | 5 for 1. | 10 for 1.01 |
| □ 11.V | 5 for 1. | 10 for 1.01 |
| □ 12.V | 5 for 1. | 10 for 1.01 |
| □ 15.V | 5 for 1. | 10 for 1.01 |

Order by Cat. No. 5210B

| 5 WATTS | Sale | 1¢ SALE |
|---|---|---|
| □ 6. V | 3 for 1. | 6 for 1.01 |
| □ 8.2V | 3 for 1. | 6 for 1.01 |
| □ 15. V | 3 for 1. | 6 for 1.01 |
| □ 18. V | 3 for 1. | 6 for 1.01 |
| □ 24. V | 3 for 1. | 6 for 1.01 |
| □ 30. V | 3 for 1. | 6 for 1.01 |

## PARTS & SEMI "ONE-CENTERS"

| | Sale | 1¢ Sale |
|---|---|---|
| □ 100-CAPACITOR SPECIAL, discs, mylar, lytics, more (# 2738) | 2.00 | 200 for 2.01 |
| □ 10-VOLTAGE REGULATORS, hobby LM320, 340, TO-3 (# 3330) | 2.00 | 20 for 2.01 |
| □ 30-PANEL SWITCHES, slides, rotaries, mod, etc (# 3268) | 2.00 | 60 for 2.01 |
| □ 200-RESISTOR SPECIAL, ¼ to 1W, carbon, metal (# 3054) | 2.00 | 400 for 2.01 |
| □ 200-HALF WATTERS, resistors, carbon, metal (# 3046) | 2.00 | 400 for 2.01 |
| □ 100-NATIONAL IC BONANZA, linears, 7400s ROMS (# 2860) | 2.00 | 200 for 2.01 |
| □ 15-LM340T VOLTAGE REGULATORS, 5 to 24V, TO-220 (# 2635) | 2.00 | 30 for 2.01 |
| □ 100-POLYSTYRENE CAPS, asst'd values, voltage, hi-Q (# 2729) | 2.00 | 200 for 2.01 |
| □ 50-THERMISTORS, resistors that change with temp (# 4089) | 2.00 | 100 for 2.01 |
| □ 20-BRIDGES, untested, 2, 4, 6, amp, full wave (# 4022) | 2.00 | 40 for 2.01 |
| □ 25-LAMP'N'SOCKET SETS, micro, 1.5V, T2 (# 3957) | 2.00 | 50 for 2.01 |
| □ 15-MIXED READOUTS, hobby, untested, .127, .3, .5, etc. (# 3619) | 2.00 | 30 for 2.01 |
| □ 150-QUARTER WATTERS, resistors, metal film, marked (# 3413) | 2.00 | 300 for 2.01 |
| □ 100-PLASTIC TRANSISTORS, untested, TO-92 (# 2604) | 2.00 | 200 for 2.01 |
| □ 200-PREFORMED RESISTORS, ¼, ½, 1W, marked, asst'd (# 2608) | 2.00 | 400 for 2.01 |
| □ 200-PRECISION RESISTORS, ¼, ½, 1W, 1%, 2% marked (# 2428) | 2.00 | 400 for 2.01 |
| □ 60-DIPPED MYLARS, shiny finish, asst'd values (# 2597) | 2.00 | 120 for 2.01 |
| □ 30-VOLUME CONTROLS, audio, linear, asst'd values (# 2421) | 2.00 | 60 for 2.01 |
| □ 30-CLOCK CHIPS, National, hobby & untested, alarm (# 5089) | 2.00 | 60 for 2.01 |
| □ 30 MM5262 2K RAMS, hobby, untested (# 3940) | 2.00 | 60 for 2.01 |
| □ 10-PUSH SWITCHES, push-to-break, spst, alarms (# 5289) | 2.00 | 20 for 2.01 |
| □ 25-CD-4000 SERIES CMOS, untested, 50% useable yield (# 5284) | 2.00 | 50 for 2.01 |
| □ 1-CHARACTER GENERATOR, 5 x 7 Mostek MK 2002P (# 3898) | 4.95 | 2 for 4.96 |
| □ 1-CONDENSER MIKES, sensitive, 500 ohms 1.5 Volts (# 3178) | 4.95 | 2 for 4.96 |
| □ 150-GLASS ZENERS, 400 MW, untested, better than 50% yield (# 2740) | 2.00 | 300 for 2.01 |
| □ 75-CARBOFILM RESISTORS, ¼, ½ watt, 5 & 10%, marked, asst's (# 3534) | 2.00 | 150 for 2.01 |
| □ 250-UNMARKED CAPACITORS, polystyrene, molded, pop values (# 3805) | 2.00 | 500 for 2.01 |
| □ 300-SILICON SIGNAL DIODES, micro, glass, zeners too! 50% yield (# 2628) | 2.00 | 600 for 2.01 |
| □ 8-IC SOCKETS, 14, 16 pin, solder tail. (# 3421) | 2.00 | 16 for 2.01 |
| □ 100-1N4148/914 SWITCHING DIODES, 50%+ yield. Untested! (# 2418) | 2.00 | 200 for 2.01 |
| □ 30-PC TRIM POTENTIOMETERS, thumbwheel, screwdriver ass't. (# 3345) | 2.00 | 60 for 2.01 |
| □ 15-SLIDE VOLUME CONTROLS, asst'd values, duals, singles (# 3057) | 2.00 | 30 for 2.01 |
| □ 75-4" CABLE TIES, plastic, like "Ty-wrap" (# 5218) | 2.00 | 150 for 2.01 |
| □ 10-CRYSTALS, may include CB, Ham & more (# 3250) | 2.00 | 20 for 2.01 |
| □ 100-TERMINAL STRIPS, from 2 lugs up (# 2136) | 2.00 | 200 for 2.01 |
| □ 30-NE-2NEON LAMPS, all 100% good (# 2613) | 2.00 | 60 for 2.01 |
| □ 40-ft. SHIELDED CABLE, 1 cond, mikes, phones, (# 3577) | 2.00 | 80 ft. for 2.01 |
| □ 3-SOUND TRIGGERS, sound triggers scr w/amp (# 3625) | 2.00 | 6 for 2.01 |
| □ 10-CB CRYSTALS, for phase lock loop, HAM, HC/18 (# 5050) | 2.00 | 20 for 2.01 |

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□ 5291 LED

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| | Sale | 1¢ Sale |
|---|---|---|
| □ 1-VEEDER ROOT COUNTER, 000-999, resettable, panel mt. (# 5081) | 1.49 | 2 for 1.50 |
| □ 2-DUAL GATE MOSFET, sim. to 3N200, 3N187, for RF & Mixer (# 5101) | 1.00 | 4 for 1.01 |
| □ 2-LCD THERMAL INDICATORS, 88-108°F, 7x1", flexible (# 5195) | 1.00 | 4 for 1.01 |
| □ 1-JOYSTICK, four 100K pots, with knob (# 3808A) | 4.95 | 2 for 4.96 |
| □ 1-EECO THUMBWHEEL SWITCH, BCD, 0-7 (# 2870A) | 1.49 | 2 for 1.50 |
| □ 1-PLESSEY TV SIDEBAND FILTER, for chan. 3 or 4 (# 3975) | 1.95 | 2 for 1.96 |
| □ 2.9V NI-CAD CHARGER PAK, plug-in, 125ma, 125 VAC pri (# 4098) | 1.49 | 2 for 1.50 |
| □ 20-DATA ENTRY PUSH-SWITCHES, spst, norm open, for keyboards (# 5279) | 2.00 | 40 for 2.01 |
| □ 75-SN7400 TTL ICs, untested 50%+ yield, pop types (# 2415) | 2.00 | 150 for 2.01 |
| □ 100-MINI DIP ICs, linears, untested 50%+ yield, pop types (# 3245) | 2.00 | 200 for 2.01 |
| □ 30-LM380 AUDIO IC's, 2 watts on-a-dip 50%+ yield (# 5284) | 2.00 | 60 for 2.01 |
| □ 75-LINEARS, OP AMPS, untested 50%+ yield, amps-dips-minidips (# 2416) | 2.00 | 150 for 2.01 |
| □ 100-TTLs & LINEAR MIXED, with 7400s, 50%+ yield (# 2431) | 2.00 | 200 for 2.01 |
| □ 1-40 CHANNEL CB SELECTOR, w/knob, for PLL circuits (# 5045) | 1.00 | 2 for 1.01 |
| □ 1-23 CHANNEL CB SELECTOR, w/knob, for PLL & xtal (# 5044) | 1.00 | 2 for 1.01 |
| □ 15-"POP" OPTICAL LENSES, plano-convex, 1" dia. plastic (# 5043) | 1.19 | 30 for 1.20 |
| □ 10-IC "DICE", microscopic circuits, teaches theory (# 5065) | 1.19 | 20 for 1.20 |
| □ 1-6" HI-FI SPEAKER, full range, for car-n-home (# 5294) | 4.95 | 2 for 4.96 |
| □ 1-LED WATCH GUTS, men's, how good? We don't know (# 5267) | 1.95 | 2 for 1.96 |
| □ 1-UHF TUNER, solid state, standard type (# 2927) | 1.00 | 2 for 1.01 |
| □ 10-SLIDE SWITCHES, asst pop styles (# 1495) | 1.00 | 20 for 1.01 |
| □ 4-TANTALUM CAPACITORS, 6.8 uF 35V, dipped (# 5281) | 1.00 | 8 for 1.01 |
| □ 5-PANCAKE PHOTOCELLS, 600 to 15K ohms (# 2939) | 1.00 | 10 for 1.01 |
| □ 1-100KHZ MARKER CRYSTALS, approx for marker gen. (# 3896) | 1.95 | 2 for 1.96 |
| □ 1-MOTHERBOARD EDGE CONNECTOR, 106 pins, .125" (# 3987) | 3.50 | 2 for 3.51 |
| □ 1-48-PIN EDGE CONNECTOR, .125" spacing (# 3963) | 1.95 | 2 for 1.96 |
| □ 1-SPST 24V REED RELAY, norm open, dip style, 1250 ohms (# 5175) | 1.49 | 2 for 1.50 |
| □ 150-PREFORMED DISC CAPACITORS, marked values, asst'd (# 2605) | 2.00 | 300 for 2.01 |
| □ 10- CALCULATOR KEYBOARDS, 20 keys and up. (# 3524) | 2.00 | 20 for 2.01 |
| □ 3- ALARM WARNING STICKERS, for windows, 2-3/4" x 3" (# 5338) | 1.00 | 6 for 1.01 |
| □ 10- CALCULATOR SWITCHES, SPST-N.O., asst'd, ½" sq. (# 5371) | 1.00 | 20 for 1.01 |
| □ 1- ITT 6 DIGIT COUNTER, 110VAC, with mounting flange (# 5392) | 1.95 | 2 for 1.96 |
| □ 6- 2N2369 TRANSISTORS, NPN switch, like 2N2222. (# 1992) | 1.00 | 12 for 1.01 |
| □ 3- 6 AMP, 50 PIV TRIAC, TO-5 metal case. (# 5403) | 1.00 | 6 for 1.01 |
| □ 2000-FACTORY REJECT DIODES, zeners, rect, signal, untested (# 5369) | 2.00 | 4000 for 2.01 |
| □ 40- AXIAL ELECTROS, asst'd values & capacitance. (# 3227) | 2.00 | 80 for 2.01 |
| □ 40- UPRIGHT ELECTROS, asst'd values & capacitance. (# 3226) | 2.00 | 80 for 2.01 |
| □ 150- RED DISC SPECIAL, Erie, mostly marked, pop values (# 5341) | 2.00 | 300 for 2.01 |
| □ 10- 15 VOLT ZENERS, 400 mw, glass, axial. (# 5404) | 1.00 | 20 for 1.01 |

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Order by Cat. No. and Type No. • 1.5 Amp! • Miniature!

| Cat. No. | Type | Volts | Sale | 1¢ SALE! |
|---|---|---|---|---|
| □ 2377 | 1N4001 | 50 | 10 for $ .75 | 20 for $ .76 |
| □ 2378 | 1N4002 | 100 | 10 for .85 | 20 for .86 |
| □ 2379 | 1N4003 | 200 | 10 for .95 | 20 for .96 |
| □ 2380 | 1N4004 | 400 | 10 for 1.19 | 20 for 1.20 |
| □ 2381 | 1N4005 | 600 | 10 for 1.39 | 20 for 1.40 |
| □ 2382 | 1N4006 | 800 | 10 for 1.49 | 20 for 1.50 |
| □ 2383 | 1N4007 | 1000 | 10 for 1.59 | 20 for 1.60 |

## 10 AMP POWER TABS

1730 - SCR'S
1448 - TRIACS
1590 - QUADRACS

| PRV | Sale | 2 for |
|---|---|---|
| □ 50 | $ .55 | $ .56 |
| □ 100 | .69 | .70 |
| □ 200 | 1.19 | 1.20 |
| □ 400 | 1.60 | 1.61 |

## BULLET RECTIFIERS!

Order by Cat. No. 60B84 and voltage
1.5 AMP

| | Sale | 1¢ Sale |
|---|---|---|
| □ 50V | 10 for $.59 | 20 for $.60 |
| □ 100V | 10 for .69 | 20 for .70 |
| □ 200V | 10 for .79 | 20 for .80 |
| □ 400V | 10 for .89 | 20 for .90 |

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(m) = multiturn (s) = single turn

□ 10(m) □ 20(m) □ 50(m) □ 100(m) □ 200(m) □ 500(m) □ 750(m) □ 1K(m) □ 2K(m) □ 2.5K(s) □ 5K(s) □ 10K(s) □ 20K(s) □ 200K(m) □ 250K(m) □ 500K(m) □ 1 Meg(m)

Order No. 5336 and value

## FULL WAVE BRIDGE RECTIFIERS!

10 AMP

Order by Cat. No. 2447 & voltage

| PRV | Sale | 2 for | PRV | Sale | 2 for |
|---|---|---|---|---|---|
| □ 50 | $1.29 | $1.30 | □ 400 | 1.99 | 2.00 |
| □ 100 | 1.49 | 1.50 | □ 600 | 2.25 | 2.26 |
| □ 200 | 1.69 | 1.70 | □ 800 | 2.50 | 2.51 |
| | | | □ 1000 | 2.75 | 2.76 |

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| □ # 1802 | MICRO SINGLE PIN RED |
| □ # 1948 | MICRO YELLOW |
| □ # 2135 | JUMBO RED |
| □ # 2136 | JUMBO TAPER RED |
| □ # 2137 | MICRO RED |
| □ # 2790 | JUMBO RED CLEAR |

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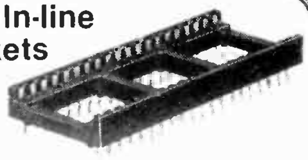
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 74H00 | .16 | 74H20 | .16 | 74H61 | .18 | 74H101 | .35 | 74S00 | .25 | 74LS00 | .15 | 74LS83 | .79 | 74LS156 | .80 | 74LS197 | 1.09 |
| 74H01 | .16 | 74H22 | .16 | 74H62 | .18 | 74H102 | .35 | 74S04 | .27 | 74LS04 | .18 | 74LS93 | .49 | 74LS161 | .84 | 74LS251 | .85 |
| 74H02 | .16 | 74H30 | .18 | 74H64 | .16 | 74H103 | .50 | 74S11 | .19 | 74LS12 | .19 | 74LS95 | .70 | 74LS163 | .84 | 74LS257 | .60 |
| 74H03 | .16 | 74H40 | .16 | 74H65 | .16 | 74H106 | .45 | 74S15 | .19 | 74LS14 | .68 | 74LS109 | .32 | 74LS165 | 1.25 | 74LS258 | .85 |
| 74H04 | .17 | 74H50 | .16 | 74H71 | .35 | 74H108 | .49 | 74S20 | .19 | 74LS15 | .17 | 74LS112 | .32 | 74LS170 | 1.25 | 74LS280 | 1.70 |
| 74H05 | .17 | 74H51 | .17 | 74H72 | .31 | 74H113 | .24 | 74S22 | .19 | 74LS28 | .19 | 74LS123 | .79 | 74LS174 | .69 | 74LS283 | .85 |
| 74H08 | .22 | 74H52 | .17 | 74H73 | .49 | 74H114 | .24 | 74S40 | .19 | 74LS37 | .23 | 74LS132 | .79 | 74LS175 | .69 | 74LS290 | .85 |
| 74H10 | .16 | 74H53 | .17 | 74H74 | .24 | 74H183 | 2.25 | 74S64 | .19 | 74LS38 | .23 | 74LS138 | .64 | 74LS191 | .90 | 74LS324 | 1.25 |
| 74H11 | .22 | 74H54 | .18 | 74H76 | .55 | | | 74S74 | .39 | 74LS40 | .19 | 74LS139 | .64 | 74LS192 | .95 | 74LS365 | .55 |
| 74H12 | .16 | 74H55 | .18 | 74H78 | .55 | | | 74S112 | .45 | 74LS47 | .89 | 74LS151 | .59 | 74LS195 | .66 | 74LS366 | .55 |
| 74H15 | .17 | 74H60 | .18 | 74H87 | 2.75 | | | 74S151 | .60 | 74LS73 | .29 | 74LS153 | .59 | 74LS196 | 1.09 | 74LS390 | 1.50 |
| | | | | | | | | | | | | | | | | 74LS393 | 1.25 |

## TTL PLASTIC DUAL-IN-LINE I.C.'s

*Lowest Prices Ever Offered Anywhere*

| Stock level | Part No | Price | Stock level | Part No | Price | Stock level | Part No | Price |
|---|---|---|---|---|---|---|---|---|
| 11300 | 7400 | .09 | 9500 | 7480 | .19 | 48000 | 74174 | .39 |
| 29800 | 7404 | .09 | 24000 | 7482 | .15 | 16000 | 74175 | .39 |
| 4900 | 7423 | .07 | 51000 | 7491 | .19 | 9000 | 74180 | .34 |
| 8100 | 7425 | .12 | 16000 | 74150 | .39 | 8000 | 74181 | .79 |
| 37000 | 7437 | .09 | 42000 | 74151 | .29 | 26000 | 74182 | .29 |
| 46000 | 7438 | .09 | 11000 | 74152 | .89 | 24080 | 74190 | .34 |
| 17000 | 7443 | .15 | 56000 | 74153 | .29 | 36000 | 74191 | .34 |
| 31080 | 7445 | .19 | 17000 | 74154 | .49 | 9000 | 74192 | .34 |
| 21000 | 7454 | .07 | 1800 | 74155 | .29 | 11000 | 74194 | .34 |
| 29000 | 7460 | .07 | 22000 | 74156 | .19 | 47000 | 74195 | .29 |
| 24000 | 7472 | .12 | 34000 | 74157 | .29 | 6000 | 74199 | .69 |
| | | | 36000 | 74162 | .34 | 28000 | 74283 | .49 |

## Dual In-line Sockets



*Finest Quality Sockets Available Anywhere*

- PLUGGABLE SOCKET FOR IC PACKAGES WITH LEADS
- HIGH RELIABILITY GAS-TIGHT JOINT.
- FULLY QUALIFIED TO Mil-S-8374
- COMPACT LOW PROFILE DESIGN
- NO WICKING WHEN SOLDERED TO PC BOARD
- FLAMMABILITY RATING UL-940V-0

| Stock level | Contacts | Price |
|---|---|---|
| 140000 | 8 PIN | .11 |
| 345000 | 14 PIN | .13 |
| 156000 | 16 PIN | .15 |
| 33000 | 18 PIN | .19 |
| 18000 | 22 PIN | .27 |
| 84000 | 24 PIN | .28 |
| 25000 | 28 PIN | .36 |
| 46000 | 40 PIN | .48 |

## GENERAL INSTRUMENT

1 AMP Rectifiers (Epoxy)

| Stock level | Part No | | Price |
|---|---|---|---|
| 2.3 Million | 1N4001 | 50V | .029 |
| 1.2 Million | 1N4002 | 100V | .039 |
| .7 Million | 1N4003 | 200V | .045 |
| 3.8 Million | 1N4004 | 400V | .049 |
| 2.1 Million | 1N4005 | 600V | .055 |
| .4 Million | 1N4006 | 800V | .065 |
| 3.7 Million | 1N4007 | 1000V | .07 |

### 1.5 AMP Single Phase

Silicon Bridge Rectifiers

| Stock level | Part No. | | Price |
|---|---|---|---|
| 8000 | W02M | 200V | .28 |
| 42000 | W04M | 400V | .32 |
| 450000 | W06M | 600V | .34 |
| 120000 | W08M | 800V | .39 |
| 11000 | W10M | 1000V | .60 |

## SWITCHING DIODES

| Part No. | | | Price |
|---|---|---|---|
| 1N914 | 100V | 4NS | .027 |
| 1N4148 | 100V | 4NS | .027 |

## UV EPROM

| Stock level | Part No. | Price |
|---|---|---|
| 18800 | 2708 | ~~8.45~~ 7.99 |

### MOS Static RAM's

| Stock level | Part No | | Price |
|---|---|---|---|
| 57600 | 2114 | 4K (1K x 4) 450NS | ~~7.95~~ 7.50 |
| 26200 | 2102LFPC | 1K 350NS (Low Power) | 1.19 |

### MOS Dynamic RAM's

| Stock level | Part No. | | Price |
|---|---|---|---|
| 17700 | 4060 | 4K 300NS | 3.95 |
| 11200 | 416 | 16K 250NS | ~~14.95~~ 13.95 |

### UART's

| Stock level | Part No. | Price |
|---|---|---|
| 38000 | AY5-1013A | 4.95 |
| 11000 | AY3-1015 | 5.95 |

### 1K CMOS RAM

| Stock level | Part No. | | Price |
|---|---|---|---|
| 13800 | 5101 | 450NS (Low Power) | 4.95 |

## MICROPROCESSOR CHIPS

*CPU's*

| Stock level | Part No. | Price |
|---|---|---|
| 13900 | 8080A | ~~6.95~~ 5.95 |
| 3500 | 6800 | ~~8.95~~ 7.95 |

### Interface Support Circuits

| Stock level | Part No. | Price |
|---|---|---|
| 16400 | 8212 | 1.98 |
| 1100 | 8214 | ~~4.95~~ 3.95 |
| 36800 | 8216 | 1.98 |
| 2800 | 8224 | 2.75 |
| 4700 | 8226 | 1.98 |
| 2800 | 8228 | 4.75 |
| 1200 | 8238 | 4.75 |
| 8800 | 8251 | ~~5.95~~ 4.95 |
| 700 | 8253 | 14.95 |
| 5800 | 8255 | 5.95 |
| 1600 | 8257 | 9.95 |
| 500 | 8259 | 14.95 |
| 2300 | 6810 | ~~3.95~~ 3.50 |
| 2800 | 6820 | ~~4.95~~ 3.95 |
| 5500 | 6850 | ~~5.95~~ 4.95 |
| 1000 | 6852 | ~~5.96~~ 4.95 |

## 1978 IC MASTER

Complete integrated circuit data selector. New 1978 edition (2200 pages) is twice as big as last year. Master guide to the latest I.C.'s including microprocessors and consumer circuits.

*Free quarterly updates.*

**$24.95**

**Lowest price available**

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**Over-the-counter sales.**
12 Mercer Rd., Natick, Mass 01760
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**Telephone Orders & Enquires (617) 879-0077**

**IN CANADA 3 LOCATIONS**

| | | |
|---|---|---|
| 5651 FERRIER ST.<br>MONTREAL, QUEBEC<br>H4P 2K5<br>Tel: (514) 735-6425 | 4800 DUFFERIN RD.<br>DOWNSVIEW, ONTARIO<br>M3H 5S9<br>Tel: (416) 661-1115 | BAXTER CENTRE<br>1050 BAXTER ROAD<br>OTTAWA, ONTARIO<br>K2C 3P2<br>Tel: (613) 820-9471 |

MINIMUM ORDER $10.00 • ADD $2.00 TO COVER POSTAGE & HANDLING • Canadian customers add 30% for exchange and handling. All federal and provincial taxes extra.

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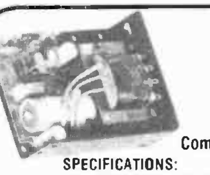
CIRCLE NO 14 ON FREE INFORMATION CARD



## ELPAC POWER SUPPLIES

**Completely Assembled**

**SPECIFICATIONS:**

105-125/210-250 Vac, 47-440 Hz Input:

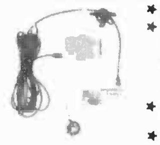
| | |
|---|---|
| Line Regulation | ±0.1% |
| Load Regulation | ±0.1%no-load to rated-load |
| Output Ripple and Noise | ±0.1%p-p,dc to 10 MHz |
| Input/Output Isolation | 100 megohm dc, 900 Vac |
| Short Circuit Current | 35% rated current |

| PART NO. | RATINGS WATTS | VOLTS | AMPS | PRICE |
|---|---|---|---|---|
| SOLV15-5* | 15 | 5 | 3 | $36.95 |
| SOLV15-12* | 15 | 12 | 1.5 | 36.95 |
| SOLV30-5 | 30 | 5 | 6 | 59.95 |
| SOLV30-12 | 30 | 12 | 3 | 59.95 |
| OVP1 | over voltage protection for SOLV30-5, -12 | | | 9.95 |

*SOLV15-5, 12 includes OVP installed

## 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, IRS-80, Challenger, etc.
- MOD II is pretuned to Channel 33 (UHF).
- Includes coaxial cable and antenna transformer.

**MOD II $29.95 Kit**

## CRYSTALS

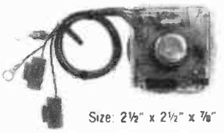
THESE FREQUENCIES ONLY

| PART NO. | FREQUENCY | CASE | PRICE |
|---|---|---|---|
| CY1A | 1.000MHz | HC33 | 5.95 |
| CY1.84 | 1.8432MHz | HC33 | 5.95 |
| CY2A | 2.000MHz | HC33 | 5.95 |
| CY2.01 | 2.010MHz | HC33 | 1.95 |
| CY2.50 | 2.500MHz | HC33 | 4.95 |
| CY3.27 | 3.2768MHz | HC33 | 4.95 |
| CY3.57 | 3.579545MHz | HC33 | 4.95 |
| CY3A | 4.000MHz | HC18 | 4.95 |
| CY4.91 | 4.916MHz | HC18 | 4.95 |
| CY7A | 5.000MHz | HC18 | 4.95 |
| CY5.18 | 5.185MHz | HC18 | 4.95 |
| CY6.14 | 6.144MHz | HC18 | 4.95 |
| CY6.40 | 6.400MHz | HC18 | 4.95 |
| CY6.55 | 6.5536MHz | HC18 | 4.95 |
| CY12A | 10.000MHz | HC18 | 4.95 |
| CY14A | 14.31818MHz | HC18 | 4.95 |
| CY19A | 18.000MHz | HC18 | 4.95 |
| CY18.43 | 18.432MHz | HC18 | 4.95 |
| CY22A | 20.000MHz | HC18 | 4.95 |
| CY30A | 32.000MHz | HC18 | 4.95 |

## AUTO-TEL KITS

**As Featured in August - Popular Electronics**

*An Electronic Warning Device For Temperature and Oil Failure*



Size: 2½" x 2½" x ⅞"

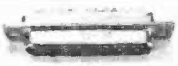
AUTOTEL — An audible alarm kit indicating potential engine damage. An audible signal (70 db pulsing) immediately forewarns a malfunction or failure. There is no sound during normal operation. Features CMOS circuitry. Complete kit with all components, hardware. **$4.95/ea**

## 1/16 VECTOR BOARD

| | 0.1 Hole Spacing Part No | P-Pattern L | W | Price 1-9 | 10 up |
|---|---|---|---|---|---|
| PHENOLIC | 64P44 062XXXP | 4.50 | 6.50 | 1.72 | 1.54 |
| | 169P44 062XXXP | 4.50 | 17.00 | 3.69 | 3.32 |
| EPOXY | 64P44 062WE | 4.50 | 6.50 | 2.07 | 1.86 |
| GLASS | 84P44 062WE | 4.50 | 8.50 | 2.56 | 2.31 |
| | 169P44 062WE | 4.50 | 17.00 | 5.04 | 4.53 |
| | 169P84 062WE | 8.50 | 17.00 | 9.23 | 8.26 |
| EPOXY GLASS COPPER CLAD | 169P44 062WEC1 | 4.50 | 17.00 | 6.80 | 6.12 |

## CONNECTORS

**25 Pin-D Subminiature**



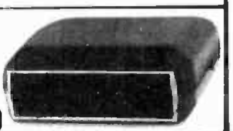
| | | |
|---|---|---|
| DB25P(as pictured) | PLUG | $3.25 |
| DB25S | SOCKET | 4.95 |
| DB51226-1 | Cover for DB25 P or S | 1.75 |

## MOLEX CONNECTOR PINS

M-530-1 $1.95/100 pins (minimum order) $16.00/1000 pins

Pre-packaged in strips

## INSTRUMENT/CLOCK CASE



Injection molded unit. Complete with red bezel. 4½" x 4" x 1-9/16".

**$3.49**

## MICROPROCESSOR COMPONENTS

| | | | | | |
|---|---|---|---|---|---|
| P8085 | CPU | $29.95 | CDP 1802 | CPU | $19.95 |
| 8080A | CPU | 10.95 | Z80 | CPU | 24.95 |
| 8212 | 8-Bit Input/Output | 4.95 | 2650 | MPU | 26.50 |
| 8214 | Priority Interrupt Control | 7.95 | MC6800 | MPU | 19.95 |
| 8216 | Bi-Directional Bus Driver | 4.95 | MC6810API | 128 x 8 Static Ram | 5.95 |
| 8224 | Clock Generator/Driver | 5.95 | MC6820 | Periph. Interface Adapter | 7.95 |
| 8228 | System Controller/Bus Driver | 5.95 | MC6821 | Periph. Interface Adapter | 11.50 |
| 8251 | Prog. Comm. Interface | 9.95 | MC6830L8 | 1024 x 8 Bit ROM | 14.95 |
| 8255 | Prog. Periph. Interface | 10.95 | MC6850 | Asychronous Comm. Adapter | 14.95 |

### RAM'S

| | | | |
|---|---|---|---|
| 1101 | 256 x 1 | Static | $ 1.49 |
| 1103 | 1024 x 1 | Dynamic | .99 |
| 2101 | 256 x 4 | Static | 5.95 |
| 2102 | 1024 x 1 | Static | 1.75 |
| 2107/5280 | 4096 x 1 | Dynamic | 4.95 |
| 2111 | 256 x 4 | Static | 6.95 |
| 2112 | 256 x 4 | Static | 5.95 |
| 2114 | 4K x 1 | Static 450ns | 9.95 |
| 2114L | 4K x 1 | Static 450ns Low Power | 10.95 |
| 2114-3 | 1K x 4 | Static 300ns | 10.95 |
| 2114L-3 | 1K x 4 | Static 300ns Low Power | 11.95 |
| 7489 | 16 x 4 | Static | 1.75 |
| 8101 | 256 x 4 | Static | 5.95 |
| 8111 | 256 x 4 | Static | 6.95 |
| 8599 | 16 x 4 | Static | 3.49 |
| 21L02 | 1024 x 1 | Static | 1.95 |
| 74200 | 256 x 1 | Static | 6.95 |
| 93421 | 256 x 1 | Static | 2.95 |
| MM5262 | 2K x 1 | Dynamic | 3/1.00 |
| MK4027 (UPD414) | 4K | DYNAMIC 16 PIN | 5.95 |
| MK4116 (UPD416) | 16K | DYNAMIC 16 PIN | 19.95 |
| TMS4044-45NL | 4K | STATIC | 14.95 |

### 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 |

### USER MANUALS

| | | |
|---|---|---|
| 1802M | CDP1802 Manual | $ 7.50 |
| Z80M | Z80 Manual | 7.50 |
| 2650M | 2650 Manual | 5.00 |

### PROMS

| | | | |
|---|---|---|---|
| 1702A | 2048 x 1 | Famous | $ 5.95 |
| 5203 | 2048 x 1 | Famous | 14.95 |
| 82S23 | 32 x 8 | Open C | 5.00 |
| 82S115 | 4096 x 1 | Bipolar | 19.95 |
| 82S123 | 32 x 8 | Tristate | 5.00 |
| 74S287 | 1024 x 1 | Static | 7.95 |
| TMS2532 | 32K | EPROM | 99.95 |
| 2708 | 8K | EPROM | 10.95 |
| 2716 T.I. | 16K | EPROM | 29.95 |
| 2716 Intel (2516 T.I.) | 16K | EPROM | 59.95 |
| 6301-1 | 1024 x 1 | Tri-State Bipolar | 3.49 |
| 6330-1 | 256 x 1 | Open C Bipolar | 2.95 |

### SHIFT REGISTERS

| | | |
|---|---|---|
| MM5013N | 1024 BitAccumulator Dynamic | 2.95 |
| MM5016H | 500/512 Bit Dynamic | .89 |
| MM5017N | Dual 500/512 Bit Dynamic | 2.95 |
| 2504T | 1024 Dynamic | 3.95 |
| 2518 | Hex 32 Bit Static | 4.95 |
| 2519 | Hex 40 Bit Static | 4.00 |
| 2522 | Dual 132 Bit Static | 2.95 |
| 2524 | 512 Dynamic | .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 | 4 X 4 Register | 1.95 |

### UART'S

| | | |
|---|---|---|
| AY-5-1013 | 30K BAUD | $ 5.95 |

## SPECIAL REQUESTED ITEMS

**TELEPHONE KEYBOARD CHIPS**

| | |
|---|---|
| AY-5-9100 | $14.95 |
| AY-5-9200 | 14.95 |
| AY-5-9500 | 4.95 |
| AY-5-2376 | 14.95 |
| HD0165 | 7.95 |
| 74C922 | 9.95 |

**ICM CHIPS**

| | |
|---|---|
| ICM7045 | $24.95 |
| ICM7205 | 19.95 |
| ICM7207 | 7.50 |
| ICM7208 | 19.95 |
| ICM7209 | 6.95 |

**NMOS READ ONLY MEMORIES**

| | |
|---|---|
| MCM6571 | $13.50 |
| MCM6574 | 13.50 |
| MCM6575 | 13.50 |

**TV GAME CHIP SET**
AY-3-8500-1 Chip and 2.010 MHZ Crystal **$7.95**

**MISCELLANEOUS**

| | | | |
|---|---|---|---|
| 11C90 | $19.95 | MK40240 | $17.50 |
| MC3061P | 11.95 | DS0026CH | 3.75 |
| MC1408L7 | 4.95 | TIL308 | 10.20 |
| MC1408L8 | 5.75 | 95H90 | 11.95 |
| LD110/111 | $25.00/set | | |
| MC4016(74416) | 7.50 | | |
| 4N33 | 3.95 | | |

## The Sinclair PDM35. A personal digital multimeter for only $59.95

NEW

Now everyone can afford to own a digital multimeter

A digital multimeter used to mean an expensive, bulky piece of equipment. The Sinclair PDM35 changes that. It's got all the functions and features you want in a digital multimeter, yet they're neatly packaged in a rugged but light pocket-size case, ready to go anywhere.

The Sinclair PDM35 is supplied completely assembled with test leads and prods, protective wallet and Operator's Manual. The Sinclair PDM35 is tailor-made for anyone who needs to make rapid measurements. Development engineers, field service engineers, lab technicians, computer specialists, radio and electronics hobbyists will find it ideal.

**Technical specification**

DC Volts (4 ranges) Range 1 mV to 1000 V. Accuracy of reading 1.0% ± 1 count. Note 10 MΩ input impedance

AC Volts (40 Hz-5 kHz) Range 1 V 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 1 Ω 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 4 mm for resilient plugs

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

| PART NO | DESCRIPTION | PRICE |
|---|---|---|
| PDM35 | Digital Multimeter (Completely Assembled) | $59.95 |
| PDM-AC | 117volt AC Adapter | 6.95 |
| PDM-DP | Deluxe padded carrying case | 6.95 |

## B&K PRECISION 3½-Digit Portable DMM

- Overload Protected
- .3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv 1Va 0.1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage 0-1000V
AC Voltage 0-1000V
Freq Response 50-400 HZ
DC/AC Current 0-100mA
Resistance 0-10 meg ohm
Size 6¼ x 4.4 x 2

**Model 2800 $99.95**

Comes with test leads, operating manual and spare fuse

**Accessories:**

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

## CSC 100 MHz 8-Digit Counter

- 20 Hz-100 MHz Range
- .6" LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1.75" x 7.38" x 5.63"
- Four power souces, 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

## KEYBOARDS

**63-Key Unencoded**

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 Key Pad Unencoded**

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

**$5.00 Minimum Order – U.S. Funds Only**
**California Residents – Add 6% Sales Tax**

**Spec Sheets – 25¢**
**1978 A Catalog Available—Send 41¢ stamp**

NEW NAME

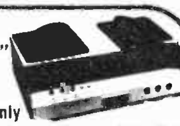
# Jameco ELECTRONICS

A Division of JAMECO ELECTRONICS of California

PHONE ORDERS WELCOME (415) 592-8097

*MAIL ORDER ELECTRONICS – WORLDWIDE*
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
Advertised Prices Good thru October

## 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 for the deaf. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

| | |
|---|---|
| Data Transmission Method | Frequency-Shift Keying, full-duplex (half-duplex selectable) |
| Maximum Data Rate | 300 Baud |
| Data Format | Asynchronous Serial (return to mark level required between each character) |
| Receive Channel Frequencies | 2025 Hz for space; 2225 Hz for mark |
| Transmit Channel Frequencies | Switch selectable: Low (normal) 1070 space, 1270 mark; High 2025 space, 2225 mark |
| Receive Sensitivity | -46 dbm acoustically coupled |
| Transmit Level | -15 dbm nominal. Adjustable from -6 dbm to -20 dbm |
| Receive Frequency Tolerance | Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz |
| Digital Data Interface | EIA RS-232C or 20 mA current loop (receiver is 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

## The Original the 3rd Hand

**$9.95 each**

- Leaves two hands free for working
- Clamps on edge of bench, table or work bench
- Position board on angle or flat position for soldering or clipping
- Sturdy, aluminum construction for hobbyist, manufacturer or school rooms

## DIGITAL STOPWATCH

- Bright 6 Digit LED Display
- Times to 59 minutes 59.59 seconds
- Crystal Controlled Time Base
- Three Stopwatches in One: Times Single Event — Split & Taylor
- Size 4.5 x 2.15 x .90 (4½ ounces)
- Uses 3 Penlite Cells

**Kit — $39.95**
**Assembled — $49.95**
**Heavy Duty Carry Case $5.95**

Stop Watch Chip Only (7205) $19.95

## IMC 3½ DIGIT DPM KIT

- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

| | |
|---|---|
| **Model KB500 DPM Kit** | **$49.00** |
| **Model KB503 5V Power Kit** | **$17.50** |

## JE700 CLOCK

The JE700 is a low cost digital clock, but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6" x 2½" x 1". It utilizes a MAN72 high brightness readout, and the MM5314 clock chip.

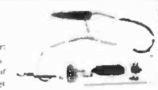
12 or 24 Hour

115 VAC

*KIT ONLY* **$16.95**

## JE803 PROBE

The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols: (HI) 1 (LOW) 0 (PULSE) P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.



**$9.95 Per Kit**

printed circuit board

## T²L 5V 1A Supply

This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only **JE225 $9.95 Per Kit**

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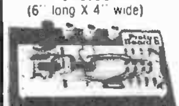
**PROTO BOARD 6**
**$15.95**
(6" long X 4" wide)



| | |
|---|---|
| PB100 - 4.5" x 6" | $ 19.95 |
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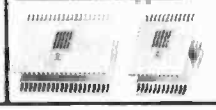
| PB203A - 9.75 x 6½ x 2¾ (includes power supply) | 124.95 |

**PROTO CLIPS**



| | |
|---|---|
| 14 PIN | $4.50 |
| 16 PIN | 4.75 |
| 24 PIN | 8.50 |
| 40 PIN | 13.75 |

# 7400 TTL

| | | | | | |
|---|---|---|---|---|---|
| SN7400N | 16 | SN7470N | 29 | SN74160N | 89 |
| SN7401N | 18 | SN7472N | 29 | SN74161N | 89 |
| SN7402N | 18 | SN7473N | 35 | SN74162N | 1 95 |
| SN7403N | 18 | SN7474N | 35 | SN74163N | 89 |
| SN7404N | 18 | SN7475N | 49 | SN74164N | 89 |
| SN7405N | 20 | SN7476N | 35 | SN74165N | 89 |
| SN7406N | 29 | SN7479N | 5 00 | SN74166N | 1 25 |
| SN7407N | 29 | SN7480N | 50 | SN74167N | 1 95 |
| SN7408N | 20 | SN7482N | 99 | SN74170N | 1 59 |
| SN7409N | 20 | SN7483N | 59 | SN74172N | 6 00 |
| SN7410N | 18 | SN7485N | 79 | SN74173N | 1 25 |
| SN7411N | 25 | SN7486N | 35 | SN74174N | 89 |
| SN7412N | 25 | SN7489N | 1 75 | SN74175N | 79 |
| SN7413N | 40 | SN7490N | 45 | SN74176N | 79 |
| SN7414N | 70 | SN7491N | 59 | SN74177N | 79 |
| SN7416N | 25 | SN7492N | 43 | SN74179N | 1 95 |
| SN7417N | 25 | SN7493N | 43 | SN74180N | 79 |
| SN7420N | 20 | SN7494N | 65 | SN74181N | 1 95 |
| SN7421N | 29 | SN7495N | 65 | SN74182N | 79 |
| SN7422N | 39 | SN7496N | 65 | SN74184N | 1 95 |
| SN7423N | 25 | SN7497N | 3 00 | SN74185N | 1 95 |
| SN7425N | 29 | SN74100N | 89 | SN74186N | 9 95 |
| SN7426N | 29 | SN74107N | 35 | SN74188N | 3 95 |
| SN7427N | 25 | SN74109N | 59 | SN74190N | 1 25 |
| SN7429N | 39 | SN74116N | 1 95 | SN74191N | 1 25 |
| SN7430N | 20 | SN74121N | 35 | SN74192N | 79 |
| SN7432N | 25 | SN74122N | 39 | SN74193N | 79 |
| SN7437N | 25 | SN74123N | 49 | SN74194N | 89 |
| SN7438N | 25 | SN74125N | 49 | SN74195N | 69 |
| SN7439N | 25 | SN74126N | 49 | SN74196N | 89 |
| SN7440N | 20 | SN74132N | 75 | SN74197N | 89 |
| SN7441N | 89 | SN74136N | 75 | SN74198N | 1 49 |
| SN7442N | 49 | SN74141N | 79 | SN74199N | 1 49 |
| SN7443N | 75 | SN74142N | 2 95 | SN74200N | 5 59 |
| SN7444N | 75 | SN74143N | 2 95 | SN74251N | 1 79 |
| SN7445N | 75 | SN74144N | 2 95 | SN74279N | 79 |
| SN7446N | 69 | SN74145N | 79 | SN74283N | 2 25 |
| SN7447N | 59 | SN74147N | 1 95 | SN74284N | 3 95 |
| SN7448N | 79 | SN74148N | 1 29 | SN74285N | 3 95 |
| SN7450N | 20 | SN74150N | 89 | SN74365N | 69 |
| SN7451N | 20 | SN74151N | 79 | SN74366N | 69 |
| SN7453N | 20 | SN74152N | 59 | SN74367N | 69 |
| SN7454N | 20 | SN74153N | 59 | SN74368N | 69 |
| SN7459A | 25 | SN74154N | 99 | SN74390N | 1 95 |
| SN7460N | 20 | SN74155N | 79 | SN74393N | 1 95 |
| | | SN74156N | 79 | | |
| | | SN74157N | 65 | | |

**20% Discount 100 pcs combined order 25% -1000 pcs combined order.**

# C/MOS

| | | | | | |
|---|---|---|---|---|---|
| CD4000 | 23 | CD4028 | 89 | CD4070 | 55 |
| CD4001 | 23 | CD4029 | 1 19 | CD4071 | 23 |
| CD4002 | 23 | CD4030 | 49 | CD4072 | 19 |
| CD4006 | 1 19 | CD4035 | 99 | CD4081 | 23 |
| CD4007 | 25 | CD4040 | 1 19 | CD4082 | 23 |
| CD4009 | 49 | CD4041 | 1 25 | CD4093 | 99 |
| CD4010 | 49 | CD4042 | 99 | CD4098 | 2 49 |
| CD4011 | 23 | CD4043 | 89 | MC14409 | 14 95 |
| CD4012 | 25 | CD4044 | 89 | MC14410 | 14 95 |
| CD4013 | 39 | CD4046 | 1 79 | MC14411 | 11 95 |
| CD4014 | 1 39 | CD4047 | 2 50 | MC14419 | 4 95 |
| CD4015 | 1 19 | CD4048 | 1 35 | MC14433 | 19 95 |
| CD4016 | 49 | CD4049 | 49 | MC14506 | 75 |
| CD4017 | 1 19 | CD4050 | 49 | MC14507 | 99 |
| CD4018 | 99 | CD4051 | 1 19 | MC14562 | 14 50 |
| CD4019 | 49 | CD4053 | 1 19 | MC14583 | 3 50 |
| CD4020 | 1 19 | CD4056 | 2 95 | CD4508 | 1 95 |
| CD4021 | 1 39 | CD4059 | 9 95 | CD4510 | 1 39 |
| CD4022 | 1 19 | CD4060 | 1 49 | CD4511 | 1 29 |
| CD4023 | 23 | CD4066 | 79 | CD4515 | 2 95 |
| CD4024 | 79 | CD4068 | 39 | CD4518 | 1 29 |
| CD4025 | 23 | CD4069 | 45 | CD4520 | 1 29 |
| CD4026 | 1 25 | | | CD4566 | 2 25 |
| CD4027 | 69 | | | | |

# 74C00

| | | | | | |
|---|---|---|---|---|---|
| 74C00 | 39 | 74C89 | 6 49 | 74C163 | 3 00 |
| 74C02 | 55 | 74C90 | 3 00 | 74C164 | 3 25 |
| 74C04 | 75 | 74C91 | 2 00 | 74C173 | 2 60 |
| 74C08 | 75 | 74C95 | 2 00 | 74C192 | 3 49 |
| 74C10 | 65 | 74C107 | 1 25 | 74C193 | 2 75 |
| 74C14 | 3 00 | 74C151 | 2 90 | 74C195 | 2 75 |
| 74C20 | 65 | 74C154 | 3 00 | 74C922 | 9 95 |
| 74C30 | 65 | 74C157 | 2 15 | 74C923 | 8 95 |
| 74C42 | 1 85 | 74C160 | 3 25 | 74C925 | 11 95 |
| 74C48 | 1 75 | 74C161 | 3 25 | 74C926 | 11 95 |
| 74C73 | 1 50 | | | 80C95 | 1 50 |
| 74C74 | 1 15 | | | 80C97 | 1 50 |

# LINEAR

| | | | | | |
|---|---|---|---|---|---|
| 78MG | 1 75 | LM340T 8 | 1 25 | LM733N | 1 00 |
| LM300H | 80 | LM340T 12 | 1 25 | LM739N | 1 19 |
| LM301H | 35 | LM340T 15 | 1 25 | LM741CH | 35 |
| LM301CN | 35 | LM340T 18 | 1 25 | LM741CN | 35 |
| LM302H | 75 | LM340T 24 | 1 25 | LM741 14N | 39 |
| LM304H | 1 00 | LM350N | 1 00 | LM747H | 79 |
| LM305H | 60 | LM351CN | 65 | LM747N | 79 |
| LM307CN H | 35 | LM370N | 1 15 | LM748H | 39 |
| LM308H | 1 00 | LM373N | 3 25 | LM748N | 39 |
| LM308CN | 1 00 | LM377N | 2 00 | LM1303N | 99 |
| LM309H | 1 10 | LM380N | 1 25 | LM1304N | 1 19 |
| LM309K | 1 25 | LM380CN | 99 | LM1305N | 1 40 |
| LM310CN | 1 15 | LM381N | 1 79 | LM1307N | 85 |
| LM311H | 90 | LM382N | 1 79 | LM1310N | 2 95 |
| LM311N | 90 | NE501N | 8 00 | LM1351N | 1 65 |
| LM317K | 6 50 | NE510A | 6 00 | LM1414N | 1 75 |
| LM318CN | 1 50 | NE529A | 4 95 | LM1458CN H | 59 |
| LM319N | 1 30 | NE531H | 3 00 | MC1488N | 1 95 |
| LM320K 5 | 1 35 | NE536T | 6 00 | MC1489N | 1 95 |
| LM320K 5 2 | 1 35 | NE540L | 6 00 | LM1496N | 95 |
| LM320K 12 | 1 35 | NE550N | 1 30 | LM1556V | 1 75 |
| LM320K 15 | 1 35 | NE555V | 19 | MC1741SCP | 3 00 |
| LM320K 18 | 1 35 | NE556N | 99 | LM2901N | 2 95 |
| LM320K 24 | 1 35 | NE560B | 5 00 | LM3053N | 1 50 |
| LM320T 5 | 1 25 | NE561B | 5 00 | LM3065N | 69 |
| LM320T 5 2 | 1 25 | NE562B | 5 00 | LM3900N(3401) | 49 |
| LM320T 8 | 1 25 | NE565H | 1 25 | LM3905N | 89 |
| LM320T 12 | 1 25 | NE565N | 1 25 | LM3909N | 1 25 |
| LM320T 15 | 1 25 | NE566CN | 1 75 | MC5558V | 1 00 |
| LM320T 18 | 1 25 | NE567H | 1 75 | LM7525N | 90 |
| LM320T 24 | 1 25 | NE567V | 99 | LM7534N | 75 |
| LM323K-5 | 5 95 | NE570N | 10 50 | 8038B | 4 95 |
| LM324N | 1 80 | LM703CN H | 45 | LM75450N | 50 |
| LM339N | 99 | LM709H | 29 | 75451CN | 39 |
| LM340K 5 | 1 35 | LM709N | 29 | 75452CN | 39 |
| LM340K 6 | 1 35 | LM710N | 79 | 75453CN | 39 |
| LM340K 8 | 1 35 | LM711N | 39 | 75454CN | 39 |
| LM340K 12 | 1 35 | LM723H | 55 | 75491CN | 79 |
| LM340K 15 | 1 35 | LM723N | 55 | 75492CN | 89 |
| LM340K 18 | 1 35 | | | 75494CN | 89 |
| LM340K 24 | 1 35 | | | RC4151 | 5 95 |
| LM340T 5 | 1 25 | | | RC4194 | 5 95 |
| LM340T 6 | 1 25 | | | RC4195 | 4 49 |

# 74LS00 TTL

| | | | | | |
|---|---|---|---|---|---|
| 74LS00 | 23 | 74LS51 | 23 | 74LS139 | 69 |
| 74LS01 | 23 | 74LS54 | 23 | 74LS151 | 69 |
| 74LS02 | 23 | 74LS55 | 23 | 74LS155 | 69 |
| 74LS03 | 23 | 74LS73 | 35 | 74LS157 | 69 |
| 74LS04 | 29 | 74LS74 | 35 | 74LS160 | 89 |
| 74LS05 | 29 | 74LS75 | 49 | 74LS161 | 89 |
| 74LS08 | 29 | 74LS76 | 35 | 74LS162 | 89 |
| 74LS09 | 29 | 74LS83 | 75 | 74LS163 | 89 |
| 74LS10 | 23 | 74LS85 | 99 | 74LS164 | 99 |
| 74LS13 | 49 | 74LS86 | 35 | 74LS175 | 79 |
| 74LS14 | 99 | 74LS90 | 49 | 74LS181 | 2 49 |
| 74LS15 | 23 | 74LS92 | 59 | 74LS190 | 89 |
| 74LS20 | 23 | 74LS93 | 59 | 74LS191 | 89 |
| 74LS21 | 29 | 74LS95 | 79 | 74LS192 | 89 |
| 74LS22 | 29 | 74LS96 | 89 | 74LS193 | 89 |
| 74LS26 | 29 | 74LS107 | 35 | 74LS194 | 89 |
| 74LS27 | 29 | 74LS109 | 35 | 74LS195 | 89 |
| 74LS28 | 29 | 74LS112 | 35 | 74LS253 | 79 |
| 74LS30 | 23 | 74LS123 | 99 | 74LS257 | 69 |
| 74LS32 | 29 | 74LS132 | 79 | 74LS260 | 55 |
| 74LS37 | 35 | 74LS136 | 39 | 74LS279 | 59 |
| 74LS40 | 29 | 74LS138 | 69 | 74LS367 | 59 |
| 74LS42 | 69 | | | 74LS368 | 59 |
| 74LS47 | 69 | | | 74LS670 | 1 95 |

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| 125 dia | | | 190 dia | | |
|---|---|---|---|---|---|
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| XC209 | Green | 4 $1 | XC111 | Green | 4 $1 |
| XC209 | Yellow | 4 $1 | XC111 | Yellow | 4 $1 |

| 200 dia | | | 185 dia | | | 200 dia | | |
|---|---|---|---|---|---|---|---|---|
| XC22 | Red | 5 $1 | XC526 | Red | 5 $1 | XC556 | Red | 5 $1 |
| XC22 | Green | 4 $1 | XC526 | Red | 100 $8 | XC556 | Red | 100 $8 |
| XC22 | Yellow | 4 $1 | XC526 | Green | 4 $1 | XC556 | Green | 4 $1 |
| SSL 22 | RT | 1 $1 | XC526 | Yellow | 4 $1 | XC556 | Yellow | 4 $1 |
| | | | XC526 | Clear | 4 $1 | XC556 | Orange | 4 $1 |
| | | | | | | XC556 | Clear | 7/$1 |

085 dia: MV50 Red 6 $1
170 dia: MV10 Red 4 $1
INFRA-RED LED ... Flat 5 $1 00

# DISPLAY LEDS

| TYPE | POLARITY | HT | PRICE | TYPE | POLARITY | HT | PRICE |
|---|---|---|---|---|---|---|---|
| MAN 1 | Common Anode red | 270 | 2 95 | MAN 6680 | Common Cathode orange | 560 | 99 |
| MAN 2 | 5 x 7 Dot Matrix red | 300 | 4 95 | MAN 6710 | Common Anode red D D | 560 | 99 |
| MAN 3 | Common Cathode red | 125 | 25 | MAN 6730 | Common Anode red 1 | 560 | 99 |
| MAN 4 | Common Cathode red | 187 | 1 95 | MAN 6740 | Common Cathode red D D | 560 | 99 |
| MAN 52 | Common Anode green | 300 | 1 25 | MAN 6750 | Common Cathode red 1 | 560 | 99 |
| MAN 71 | Common Anode red | 300 | 1 25 | MAN 6760 | Common Anode red | 560 | 99 |
| MAN 72 | Common Anode red | 300 | 99 | MAN 6780 | Common Cathode red | 560 | 99 |
| MAN 74 | Common Cathode red | 300 | 1 25 | DL701 | Common Anode red 1 | 300 | 99 |
| MAN 81 | Common Anode yellow | 300 | 99 | DL702 | Common Cathode red | 300 | 1 25 |
| MAN 82 | Common Anode yellow | 300 | 99 | DL704 | Common Cathode red | 300 | 99 |
| MAN 84 | Common Cathode yellow | 300 | 99 | DL707 | Common Anode red | 300 | 99 |
| MAN 3620 | Common Anode orange | 300 | 99 | DL741 | Common Anode red | 600 | 1 25 |
| MAN 3630 | Common Anode orange 1 | 300 | 99 | DL746 | Common Anode red 1 | 630 | 1 49 |
| MAN 3640 | Common Cathode orange | 300 | 99 | DL747 | Common Anode red | 600 | 1 49 |
| MAN 4610 | Common Anode orange | 300 | 99 | DL749 | Common Cathode red 1 | 630 | 1 49 |
| MAN 4640 | Common Cathode orange | 400 | 99 | DL750 | Common Cathode red | 600 | 1 49 |
| MAN 4710 | Common Anode red 1 | 400 | 99 | DL338 | Common Cathode red | 110 | 35 |
| MAN 4730 | Common Anode red | 400 | 99 | FND70 | Common Cathode | 250 | 69 |
| MAN 4740 | Common Cathode red | 400 | 99 | FND359 | Common Anode | 350 | 75 |
| MAN 4810 | Common Anode yellow | 400 | 99 | FND503 | Common Cathode (FND500) | 500 | 99 |
| MAN 6610 | Common Anode orange D D | 560 | 99 | FND507 | Common Anode (FND510) | 500 | 99 |
| MAN 6630 | Common Anode orange | 560 | 99 | 5082 7300 | 4 x 7 Sgl Digit RHDP | 600 | 19 95 |
| MAN 6640 | Common Cathode orange D D | 560 | 99 | 5082 7302 | 4 x 7 Sgl Digit LHDP | 600 | 19 95 |
| MAN 6650 | Common Cathode orange 1 | 560 | 99 | 5082 7304 | Overrange character (± 1) | 600 | 15 00 |
| MAN 6660 | Common Anode orange | 560 | 99 | 5082 7340 | 4 x 7 Sgl Digit Hexadecimal | 600 | 22 50 |

# RCA LINEAR

| | | | |
|---|---|---|---|
| CA3013 | 2 15 | CA3082 | 2 00 |
| CA2023 | 2 56 | CA3083 | 1 60 |
| CA3035 | 2 48 | CA3086 | 85 |
| CA3039 | 1 35 | CA3089 | 3 75 |
| CA3046 | 1 30 | CA3130 | 1 39 |
| CA3059 | 3 25 | CA3140 | 1 25 |
| CA3060 | 3 25 | CA3160 | 1 25 |
| CA3080 | 85 | CA3401 | 49 |
| CA3081 | 2 00 | CA3600 | 3 50 |

# CALCULATOR CHIPS AND DRIVER

| | |
|---|---|
| FCM3817 | $ 5 00 |
| MM5725 | 95 |
| MM5736 | 1 95 |
| MM5738 | 95 |
| DM8864 | 2 00 |
| DM8865 | 1 00 |
| DM8887 | 75 |
| DM8889 | 75 |
| 5030 | 1 95 |

# CLOCK CHIPS

| | |
|---|---|
| MM5309 | 9 95 |
| MM5311 | 3 95 |
| MM5312 | 4 95 |
| MM5314 | 3 95 |
| MM5316 | 6 95 |
| MM5318 | 9 95 |
| MM5369 | 95 |
| MM5841 | 9 95 |
| [illegible] | 5 95 |

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|---|---|---|---|---|---|---|---|
| 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)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 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)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 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 75 | 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

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 pin WW | $ 40 | 38 | 35 | 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 |

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ASST. 5 — 5 ea — [illegible] — 1/4 WATT 5% — 50 PCS
ASST. 6 — 5 ea — [illegible] — 1/4 WATT 5% — 50 PCS
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- 50 pcs each 1", 2", 3" & 4" lengths — pre-stripped wire

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## WIRE WRAP WIRE — 30 AWG

25 ft min $1 25  50 ft $1.95  100 ft $2.95  1000 ft $15 00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

## WIRE DISPENSER — WD-30

- 50 ft roll 30 AWG KYNAR wire wrap wire — $3.95 ea.
- Cuts wire to desired length
- Strips 1" of insulation — Specify — Blue-Yellow-White-Red

**REPLACEMENT DISPENSER SPOOLS FOR WD 30**
Specify blue, yellow, white or red — $1.98/spool

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| | | | | | |
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| XR210 | 4 40 | XR1489 | 1 39 | XR2567 | 2 99 |
| XR215 | 4 10 | XR1800 | 3 20 | XR3403 | 1 25 |
| XR320 | 1 55 | XR2206 | 4 40 | XR4136 | 1 25 |
| XR555 | 39 | XR2207 | 3 85 | XR4151 | 2 85 |
| XR556 | 99 | XR2208 | 5 20 | XR4194 | 1 45 |
| XR567CP | 99 | XR2209 | 1 75 | XR4202 | 3 60 |
| XR567CT | 1 25 | XR2211 | 5 25 | XR4212 | 2 05 |
| XR1310P | 1 30 | XR2212 | 4 35 | XR4558 | 75 |
| XR1468CN | 3 85 | XR2240 | 3 45 | XR4739 | 1 15 |
| XR1488 | 1 39 | XR2264 | 4 25 | XR4741 | 1 47 |

# ZENERS — DIODES — RECTIFIERS

| TYPE | VOLTS | W | PRICE | TYPE | VOLTS | W | PRICE |
|---|---|---|---|---|---|---|---|
| 1N746 | 3 3 | 400m | 4 1 00 | 1N4005 | 600 PIV | 1 AMP | 10 1 00 |
| 1N751A | 5 1 | 400m | 4 1 00 | 1N4006 | 800 PIV | 1 AMP | 10 1 00 |
| 1N752 | 5 6 | 400m | 4 1 00 | 1N4007 | 1000 PIV | 1 AMP | 10 1 00 |
| 1N753 | 6 2 | 400m | 4 1 00 | 1N3600 | 50 | 200m | 6 1 00 |
| 1N754 | 6 8 | 400m | 4 1 00 | 1N4148 | 75 | 10m | 15 1 00 |
| 1N959 | 8 2 | 400m | 4 1 00 | 1N4154 | 35 | 10m | 12 1 00 |
| 1N965B | 15 | 400m | 4 1 00 | 1N4305 | 75 | 25m | 20 1 00 |
| 1N5232 | 5 6 | 500m | 28 | 1N4734 | 5 6 | 1w | 28 |
| 1N5234 | 6 2 | 500m | 28 | 1N4735 | 6 2 | 1w | 28 |
| 1N5235 | 6 8 | 500m | 28 | 1N4736 | 6 8 | 1w | 28 |
| 1N5236 | 7 5 | 500m | 28 | 1N4738 | 8 2 | 1w | 28 |
| 1N456 | 25 | 40m | 6 1 00 | 1N4742 | 12 | 1w | 28 |
| 1N458 | 150 | 7m | 6 1 00 | 1N4744 | 15 | 1w | 28 |
| 1N485A | 180 | 10m | 5 1 00 | 1N1183 | 50 PIV | 35 AMP | 1 60 |
| 1N4001 | 50 PIV | 1 AMP | 12 1 00 | 1N1184 | 100 PIV | 35 AMP | 1 70 |
| 1N4002 | 100 PIV | 1 AMP | 12 1 00 | 1N1185 | 150 PIV | 35 AMP | 1 70 |
| 1N4003 | 200 PIV | 1 AMP | 12 1 00 | 1N1186 | 200 PIV | 35 AMP | 1 80 |
| 1N4004 | 400 PIV | 1 AMP | 12 1 00 | 1N1188 | 400 PIV | 35 AMP | 3 00 |

# SCR AND FW BRIDGE RECTIFIERS

| | | | |
|---|---|---|---|
| C36D | 35A @ 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 | [illegible] | 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 |
| [illegible] | 5 1 00 | PN3567 | 3 1 00 | PN4249 | 4 1 00 |
| [illegible] | 5 1 00 | PN3568 | 4 1 00 | PN4250 | 4 1 00 |
| 40409 | 1 75 | PN3569 | 4 1 00 | 2N4400 | 4 1 00 |
| 40410 | 1 75 | MPS3638A | 5 1 00 | 2N4401 | 4 1 00 |
| 40673 | 1 75 | MPS3702 | 5 1 00 | 2N4402 | 4 1 00 |
| 2N918 | 4 1 00 | 2N3704 | 5 1 00 | 2N4403 | 4 1 00 |
| 2N2219A | 3 1 00 | MPS3704 | 5 1 00 | 2N4409 | 5 1 00 |
| 2N2221A | 4 1 00 | 2N3705 | 5 1 00 | 2N5086 | 4 1 00 |
| 2N2222A | 5 1 00 | MPS3705 | 5 1 00 | 2N5087 | 4 1 00 |
| 2N2369 | 5 1 00 | 2N3706 | 5 1 00 | 2N5088 | 4 1 00 |
| 2N2369A | 4 1 00 | MPS3706 | 5 1 00 | 2N5089 | 4 1 00 |
| MPS2369 | 5 1 00 | 2N3707 | 5 1 00 | 2N5129 | 5 1 00 |
| 2N2484 | 4 1 00 | 2N3711 | 5 1 00 | PN5134 | 5 1 00 |
| 2N2906 | 4 1 00 | 2N3724A | 65 | PN5138 | 5 1 00 |
| 2N2907 | 5 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 | 4 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 | 10 25V | 40 | 35 | 29 |
| 1 0 35V | 28 | 23 | 17 | 15/25V | 63 | 50 | 40 |

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

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| | | | | |
|---|---|---|---|---|
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| 22pf/50V | 82pf/50V | 270pf/50V | .001uf/100V | .047uf/100V |
| 33pf/50V | 100pf/50V | 470pf/50V | .0022uf/100V | .1uf/100V |
| 47pf/50V | 150pf/50V | 600pf/50V | .0033uf/100V | .2uf/100V |
| 56pf/50V | 180pf/50V | 820pf/50V | .0047uf/100V | .47uf/100V |
| | | | .01uf/100V | |
| | | | .015uf/100V | |

5 ea of above capacitors............$13.95
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Cabinet shipping chrg (US & Canada) $2.00

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molded epoxy ±20% - radial
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.47uf/10V 3.3uf/10V 22uf/10V
1.0uf/10V 4.7uf/10V
10ea of above values....$10.25

### TANTALUM CAPACITOR ASSORTMENT

solid dipped ±20%
.22uf/35V 3.3uf/35V 15uf/20V
.33uf/35V 4.7uf/16V 22uf/16V
1uf/35V 6.8uf/16V 33uf/10V
2.2uf/25V 10uf/20V 47uf/20V
5ea of above values..........$17.75
Supplied in clear styrene utility box...........$21.95
Box shipping (US & Can.) $1.00

### CERAMIC CAPACITOR ASSORTMENT - 50V

| | | | | |
|---|---|---|---|---|
| 1pf | 33pf | 82pf | 220pf | 820pf | .022uf |
| 5pf | 47pf | 100pf | 270pf | .001uf | .030uf |
| 10pf | 56pf | 150pf | 470pf | .0047uf | .050uf |
| 22pf | 68pf | 180pf | 600pf | .01uf | .1uf |

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Supplied in steel cabinet with clear styrene drawers...........$19.95
Cabinet shipping chrg (US & Canada)........ $2.00

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6.8K, 10K, 33K, 100K, 1M
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2708 8K EROM $8.95

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| | | | | | |
|---|---|---|---|---|---|
| DL10A | .27" | Red | CA | LHD | .79 |
| MAN66 | .60" | Red | CA | LHD | 1.19 |
| DL33B | .12" | 3 Dig | Red | CC | .29 |
| DL33B | .12" | 3 Dig | Red | CC | .49 |
| NSN33 | .12" | 3 Dig | Red | CC | .39 |
| MAN72 | .30" | Red | CA | LHD | .59 |
| MAN74 | .30" | Red | CC | RHD | .59 |
| NSN74R | .30" | Red | CC | RHD | .59 |
| MAN82 | .30" | Yellow | CA | LHD | .69 |
| DL702 | .30" | Red | CC | LHD | .69 |
| HP7651 | .5" | Red | CA | RHD | .79 |
| HP7653 | .5" | Red | CC | RHD | .79 |
| HP3400 | .8" | Red | CA | LHD | 1.25 |
| HP3405 | .8" | Red | CC | LHD | 1.25 |
| MAN3620 | .30" | Orange | CA | LHD | .79 |
| MAN3630 | .30" | +1 Orange | CA | RHD | .49 |
| MAN4610 | .40" | Orange | CC | RHD | .59 |

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|---|---|---|---|
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| 14 | .18 | 24 | .35 |
| 16 | .20 | 28 | .42 |
| 18 | .27 | 36 | .58 |
| 20 | .29 | 40 | .57 |

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**Philco** model 39-80 radio. Schematic and battery connection information. Jack A. Freeman, Rt. 9, Box 62, Reidsville, NC 27320.

**Daven** noise and distortion measuring set, type 35A. Schematic. David Kleinschmidt, 15429 Lake Ave. Lakewood, OH 44107.

**Superior Instrument** CB model TD-55. Schematics, parts list, and operating manual. Franklin Bergquist, 104 Sarver Dr., Leesville, LA 71446.

**Hickok** model 51X vacuum tube tester. Schematics and operating manual. Rob Martin, 215 West 22nd St., Minneapolis, MN 55404.

**Hammarlund** SW receiver, model SP-600. Operator's manual. R. Seiffert, 934 Pearl St., Suite B-1, Boulder, CO 80302.

**Emerson** color television, model #26C39. Need vhf tuner. Also parts source and schematic. James Minadeo, 219 Wallace St., Providence, RI 02909.

**Tennelec** Memoryscan MS2. Schematic. Robert Kafarski, 303 Upper Delaware St., Walton, NY 13856.

**Crown** model 714C tape recorder. Any information or a source for 10" tape reels. Mark W. Edel, 3030 W. Birchwood, Chicago, IL 60645.

**Gonset** automobile FM converter. Schematic and operating instructions. Walter T. Marable, 10930 Clermont Ave., Garret Park, MD 20766.

**Allied Radio Knight** kit KG-620 VTVM calibration procedure and schematic. Kim R. Boyer, 1841 Monterey Blvd., Hermosa Beach, CA 90254.

**Hy-Gain** industrial pocketscope, model S-14-A. Schematic and operating manual. Stephen Killingsworth, 112 Auburn Ave., Fort Walton Beach, FL 32548.

**Elco** 723 CW transmitter. Construction manual, schematic and any available information. Fred Aguirre, Tempe, AZ 85282.

**Sparton** model 194OR TV. Schematic. Ray Alexander, Fredericton, Junction, N.B. EDG1TO Canada.

**Telmar** model 40 AM-FM receiver. Schematic. Marvin Henley, 132 Brightside Ave., Central Islip, NY 11722.

**Zenith** 7-band transoceanic receiver model B600. Schematic and any available information. T. Allen, Box 32, Prattville, AL 36067.

**Superior Instrument** Multi-tester model 670-A. Parts list, schematic, and operating manual. Roy Swanger, 104 Valley Dr., Bridgeport, WV 26330.

**Dumont** type 241 cathode ray oscilloscope. Instruction and service manual. Frank Bloom, Box 1128, Rockville, MD 20850.

**Knight** T-60 transmitter. Schematic and operating instructions. Alan Stanczik, 8731 W. 161st Pl., Orland Park, IL 60462.

**Paco** model C-20 resistance capacity ratio bridge. Instruction manual. Jose Varas, 515-4th St., Apt. 3A, Union City, NJ 67082.

**Jackson** oscilloscope model CRO-1. Schematic. Keith Holmes, 1825 War Eagle, No. Eagle Rock, AR 72116.

**Senco** model LC2 leakage checker. Operating manual and schematic. **Superior Instruments** model TW11 tube checker and up to date tube chart. Norman Reiss, 633 Hoss St., Random Lake, WI 53075.

**Allied Knight** battery eliminator model 6-12V. Schematic or manual. H.C. Boemer, 3401 W. Osborne Ave., Tampa, FL 33614.

**Eico** 460 oscilloscope. Operating and service manual. Don Billey, VEG 88A, Box 442, Millet, Alta, Canada TOC120.

**Precision Electronics** signal tracer model 102. Schematic and parts list. Andrew Lee, 1522 W. 34th St., Houston, TX 77018.

**Eico** ST70 construction manual. Fernando Molina, 863 Ostrom Ave., Syracuse, NY 13210.

**Wurlitzer** juke box model 1700F. Schematics, maintenance manual or repair information. James F. Shuey, 464 Starr Rd, RD5, Gibsonia, PA 15044.

**White** noise generator. Schematics and parts list. Anthony R. Juliano, Box 32, Claymont, DE 19703.

**RCA** oscilloscope model WBO-50. Service manual, parts list and schematic. James H. Bunyan, 199-14 119 Ave., St. Albans, NY 11412.

**Lafayette** signal generator model LSG-10. Schematic and owner's manual. Laurence Mittag, 85 Prescott St., #32, Cambridge, MA 02138.

**Mercury** model 990 tube tester. Operating instruction, schematic, and tube chart. Reginald Higgins, 656 Clevenger Rd., Ontario, NY 14519.

**Mercury** model 1000 model dynamic mutual conductance tube tester. Need power transformer and latest tube chart. Jeff Brown, 1431 Jonah Dr., North Huntington, PA 15642.

**Friden** electronic calculator model 130-SN #6314. Service manual and schematic. Lester C. Viles, 21255 Bon Huer St., St. Clair Chrs, MI 48081.

**Maganavox** electrostatic headphone power supply. Model 1A9217 or part #1A9224. Ken Mossman, #3 1205 Bay Victoria, B.C., Canada V8T1S7.

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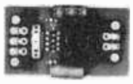

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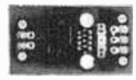

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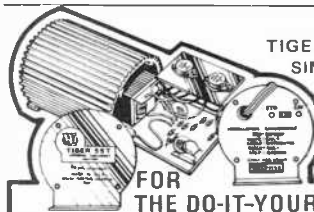

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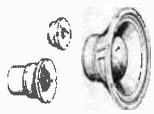

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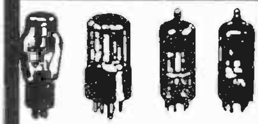

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| 5U8 | 2.12 | 6DQ5 | 2.40 |
| 5U4 | 1.61 | 6DQ6 | 2.58 |
| 5V4 | 2.66 | 6DS4 | 4.77 |
| 5Y3 | 1.58 | 6DT6 | 1.59 |
| 5Y4 | 2.31 | 6DW4 | 1.80 |
| 5Z3 | 4.26 | 6DX8 | 1.55 |
| 6A8 | 5.19 | 6E5 | 5.99 |
| 6AB4 | 1.70 | 6EA8 | 1.91 |
| 6AC10 | 2.09 | 6EB8 | 2.81 |
| 6AD10 | 3.89 | 6EH5 | 1.52 |
| 6AF4 | 2.40 | 6EH7 | 1.85 |
| 6AF9 | 3.11 | 6EJ7 | 1.76 |
| 6AG5 | 1.85 | 6EM5 | 2.02 |
| 6AG7 | 5.04 | 6EM7 | 2.72 |
| 6AG9 | 3.21 | 6ES8 | 2.70 |
| 6AH6 | 2.99 | 6EU7 | 1.83 |
| 6AJ8 | 2.67 | 6EW6 | 1.73 |
| 6AK5 | 2.28 | 6EW7 | 2.75 |
| 6AK8 | 1.92 | 6F5 | 5.00 |
| 6AL3 | 1.75 | 6F6 | 5.00 |
| 6AL5 | 1.56 | 6FG6 | 1.65 |
| 6AL11 | 3.01 | 6FG7 | 2.60 |
| 6AM8 | 2.49 | 6FM7 | 2.22 |
| 6AN8 | 2.19 | 6FQ5 | 2.22 |
| 6AQ5 | 1.64 | 6GE5 | 2.61 |
| 6AQ8 | 1.73 | 6GF7 | 2.55 |
| 6AR5 | 1.26 | 6GH8 | 1.52 |

| | | | | | |
|---|---|---|---|---|---|
| 6GJ7 | 1.73 | 6LM8 | 2.34 | 10JT8 | 3.02 |
| 6GK6 | 1.70 | 6LN8 | 1.37 | 10JY8 | 1.80 |
| 6GM6 | 2.02 | 6LR6 | 3.69 | 10KR8 | 2.33 |
| 6GS7 | 2.10 | 6LR8 | 2.84 | 11AF9 | 3.20 |
| 6GU7 | 2.02 | 6LT8 | 1.97 | 11BM8 | 2.43 |
| 6GW8 | 1.93 | 6LU8 | 2.33 | 11BQ11 | 3.29 |
| 6GX6 | 1.67 | 6LX8 | 1.32 | 11BT11 | 3.62 |
| 6H6 | 3.59 | 6LY8 | 2.02 | 11DS5 | 2.24 |
| 6HA5 | 1.85 | 6M11 | 3.30 | 11FY7 | 2.06 |
| 6HB7 | 1.86 | 6MD8 | 2.82 | 11HM7 | 2.46 |
| 6HE5 | 2.31 | 6ME8 | 2.79 | 11KV8 | 2.66 |
| 6HF5 | 3.96 | 6MU8 | 2.81 | 11LQ8 | 2.49 |
| 6HF8 | 2.51 | 6Q7 | 4.80 | 11MS8 | 2.04 |
| 6HQ5 | 2.43 | 6SA7 | 4.80 | 12AB5 | 1.76 |
| 6HS5 | 3.54 | 6SG7 | 3.75 | 12AL5 | 1.92 |
| 6HS8 | 2.30 | 6SJ7 | 3.50 | 12AQ5 | 1.63 |
| 6HV5 | 4.26 | 6SK7 | 4.25 | 12AT6 | 1.43 |
| 6HZ6 | 1.53 | 6SL7 | 2.60 | 12AT7 | 1.65 |
| 6J5 | 3.87 | 6SN7 | 1.86 | 12AU6 | 1.64 |
| 6J6 | 2.49 | 6SQ7 | 4.75 | 12AU7 | 1.47 |
| 6J10 | 2.93 | 6T10 | 2.70 | 12AV6 | 1.41 |
| 6J11 | 3.03 | 6U5 | 9.00 | 12AV7 | 2.21 |
| 6JA5 | 2.37 | 6U8 | 1.88 | 12AX7 | 1.52 |
| 6JB6 | 2.90 | 6U10 | 1.97 | 12AZ7 | 1.97 |
| 6JC6 | 2.15 | 6V6GT | 2.21 | 12BA6 | 1.40 |
| 6JD6 | 2.21 | 6X4 | 1.73 | 12BE6 | 1.26 |
| 6JE6 | 4.02 | 6X5 | 1.77 | 12BF11 | 2.85 |
| 6JF6 | 3.32 | 6X8 | 1.97 | 12BH7 | 1.92 |
| 6JG6 | 3.38 | 6X9 | 2.46 | 12BY7 | 1.71 |
| 6JH6 | 1.71 | 6Z10 | 2.93 | 12BZ6 | 2.40 |
| 6JH8 | 2.75 | 7B7 | 5.40 | 12DQ6 | 2.61 |
| 6JM6 | 2.61 | 7KY6 | 2.33 | 12DT8 | 1.77 |
| 6JN6 | 2.43 | 7V7 | 4.20 | 12DW7 | 1.75 |
| 6JS6 | 3.12 | 8AL9 | 5.67 | 12FX5 | 1.61 |
| 6JT8 | 2.73 | 8AR11 | 3.38 | 12GE5 | 2.42 |
| 6JU6 | 3.23 | 8AW8 | 2.48 | 12GN7 | 2.70 |
| 6JU8 | 2.13 | 8BA11 | 2.70 | 12HL7 | 2.34 |
| 6JW8 | 1.64 | 8BM11 | 3.50 | 12JB6 | 3.12 |
| 6K6GT | 1.89 | 8BQ11 | 2.85 | 12MD8 | 2.27 |
| 6K7 | 4.61 | 8BU11 | 2.82 | 12SK7 | 4.75 |
| 6KA8 | 2.34 | 8CB11 | 3.41 | 12SQ7 | 4.75 |
| 6KD6 | 4.07 | 8CG7 | 1.46 | 12T10 | 2.81 |
| 6KE8 | 2.93 | 8JU8 | 1.58 | 13FM7 | 1.97 |
| 6KT8 | 2.61 | 8JV8 | 2.22 | 13J10 | 3.08 |
| 6KV6 | 3.21 | 8LT8 | 1.95 | 14BL11 | 3.54 |
| 6KZ8 | 1.97 | 9GH8 | 1.91 | 14BR11 | 2.90 |
| 6L6GC | 2.93 | 9JW8 | 1.52 | 15BD11 | 2.70 |
| 6L7 | 4.77 | 9KX6 | 2.33 | 15CW5 | 1.71 |
| 6LB6 | 3.87 | 10CW5 | 1.71 | 15DQ8 | 1.92 |
| 6LE8 | 2.79 | 10DX8 | 1.46 | 15KY8 | 3.50 |
| 6LF6 | 3.84 | 10GF7 | 2.51 | 15MF8 | 2.72 |
| 6LF8 | 2.82 | 10GK6 | 2.18 | 16A8 | 2.49 |
| 6LJ6 | 3.48 | 10GN8 | 2.31 | 167LU8 | 3.59 |
| 6LJ8 | 2.15 | 10GV8 | 1.88 | 17AY3 | 1.82 |

| | | | |
|---|---|---|---|
| 17BE3 | 1.82 | 27 | 5.40 |
| 17BFU | 2.88 | 27GB5 | 1.67 |
| 17BR3 | 1.64 | 30AE3 | 1.86 |
| 17BW3 | 1.64 | 31JS6 | 3.48 |
| 17CT3 | 1.67 | 31LZ6 | 4.07 |
| 17DW4 | 1.82 | 33GY7 | 3.11 |
| 17EW8 | 1.28 | 34CE3 | 1.92 |
| 17JB6 | 2.73 | 35C5 | 1.47 |
| 17JM6 | 2.91 | 35L6 | 2.27 |
| 17JN6 | 2.63 | 35LR6 | 3.69 |
| 17JZ8 | 2.04 | 35W4 | 1.22 |
| 17KV6 | 3.50 | 35Z5 | 1.64 |
| 19CG3 | 1.89 | 36KD6 | 4.04 |
| 20AQ3 | 1.71 | 38HE7 | 3.53 |
| 20LF6 | 3.96 | 38HK7 | 3.53 |
| 21GY5 | 2.45 | 42KN6 | 3.38 |
| 21HB5 | 2.36 | 50B5 | 1.41 |
| 21JS6 | 4.32 | 50C5 | 1.47 |
| 21JZ6 | 2.54 | 50L6 | 2.22 |
| 21LR8 | 2.39 | 80 | 2.10 |
| 21LU8 | 2.39 | 6267 | 1.58 |
| 22JF6 | 3.20 | 6973 | 2.33 |
| 22JR6 | 3.41 | 7025 | 1.52 |
| 23Z9 | 2.58 | 7189 | 1.97 |
| 24JE6 | 3.84 | 7199 | 2.63 |
| 25C5 | 1.85 | 7247 | 1.85 |
| 25CG3 | 1.67 | 7408 | 1.92 |
| 25EH5 | 1.71 | 7543 | 1.64 |
| 26HU5 | 4.40 | 7581 | 3.42 |
| | | 7591 | 2.51 |

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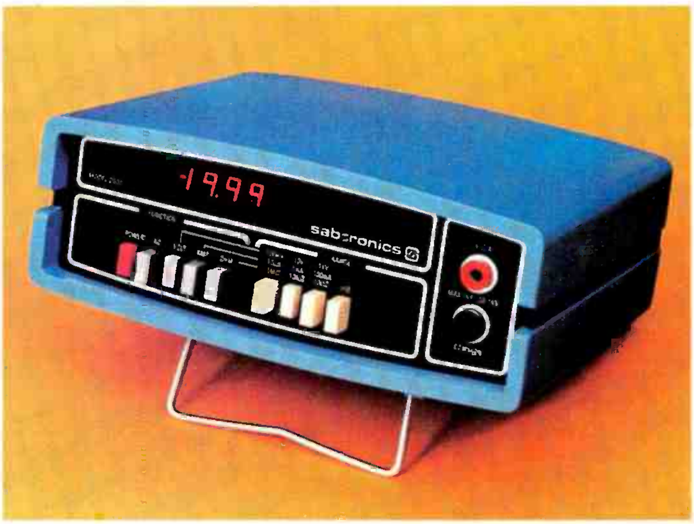


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ST-9030. THD (stereo, 1 kHz): Wide—0.08%. Narrow—0.3%. S/N (stereo): 73 dB. FREQUENCY RESPONSE: 20 Hz—18 kHz +0.1, −0.5 dB. SELECTIVITY: Narrow—90 dB. CAPTURE RATIO: Wide—0.8 dB. IF, IMAGE and SPURIOUS RESPONSE REJECTIONS (98 MHz): 135 dB. STEREO SEPARATION (1 kHz): Wide—50 dB.

SU-9070. PHONO MAX. INPUT VOLTAGE (1 kHz RMS): MM—380 mV. MC—9 mV. S/N (IHF A): MM—100 dB (10 mV input). MC—72 dB (60 µV). FREQUENCY RESPONSE: Phono 20 Hz—20 kHz (RIAA ±0.2 dB).

SE-9060. POWER OUTPUT: 70 watts per channel (stereo), 180 watts (mono) min. RMS into 8 ohms from 20 Hz to 20 kHz with no more than 0.02% total harmonic distortion. S/N: 120 dB (IHF A).

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