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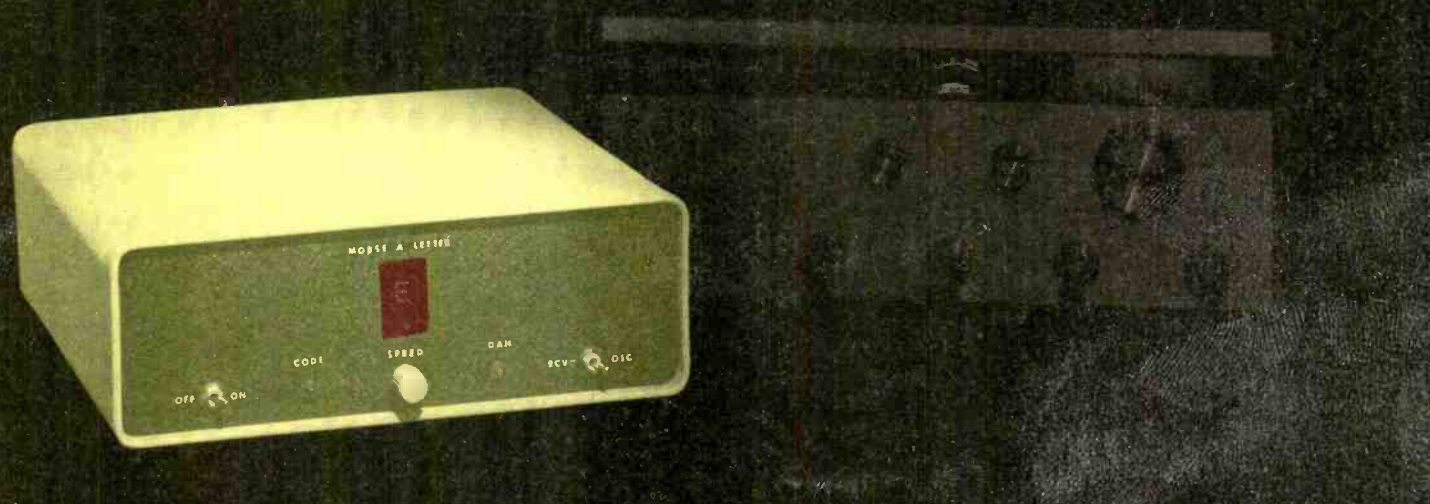

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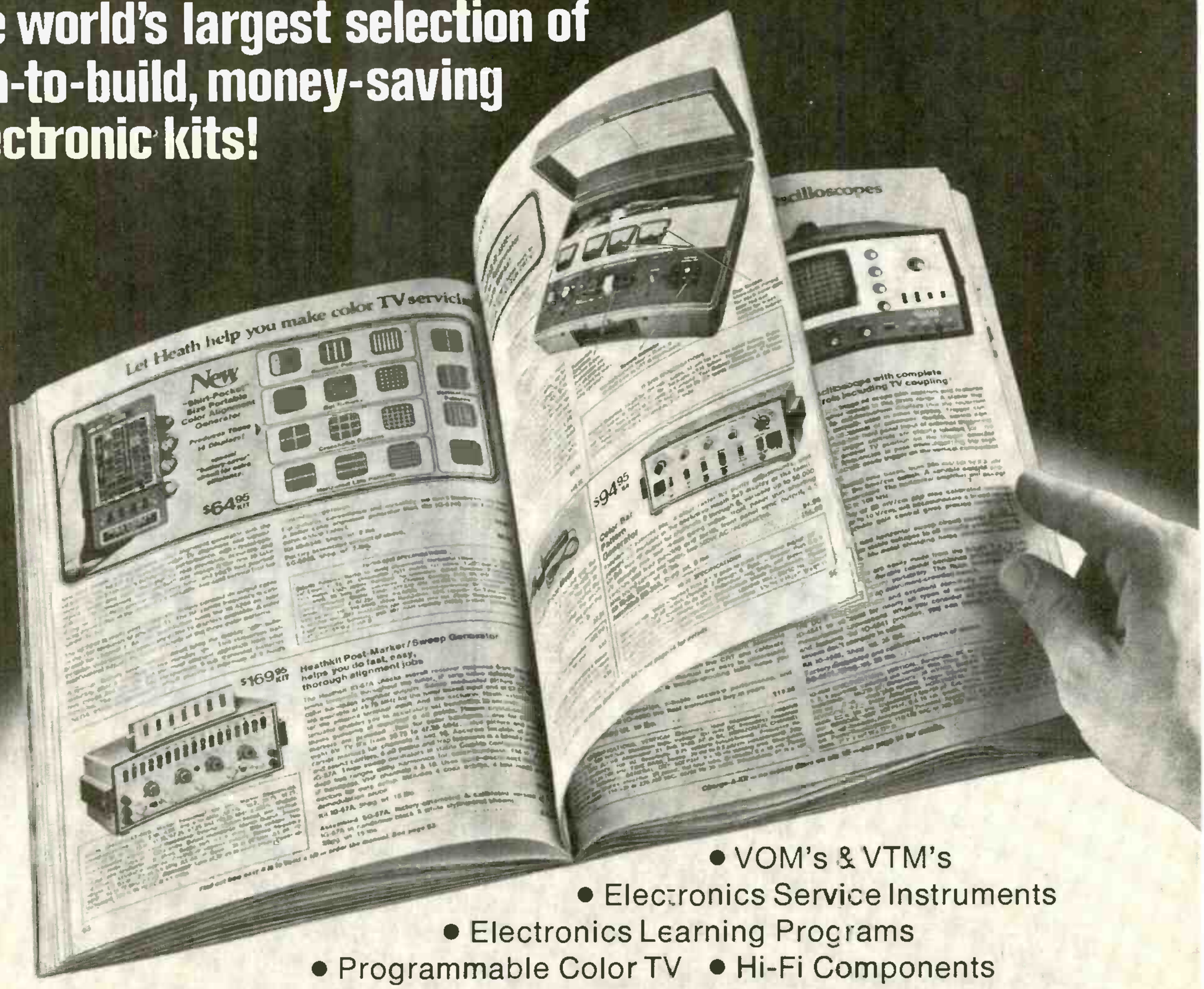

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JANUARY 1977 VOLUME 11, NUMBER 1

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DEPARTMENTS

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Popular Electronics
Editorial and Executive Offices
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212-725-3500
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Editorial

WHITHER TV SERVICING?

Few people realize that the entire picture of the TV servicing industry is changing rapidly. While circuitry is becoming more complicated due to the increasing ownership of color TV models and the introduction of more automatic features, the incidence of service promises to decrease due to solid-state design.

A 1976 study by the Massachusetts Institute of Technology on servicing consumer durable products revealed the following:

Total annual number of TV service calls (millions): 1960—135 to 140; 1970—136 to 153; 1980 (projected)—125 to 148.

TV receiver failures: 1970—40% color models; 1980 (projected)—67% color models.

"Carry-in" TV service business: 1970—57%; 1980 (projected)—74%.

TV service technicians employed (thousands): 1960—105; 1970—137; 1980 (projected)—126.

Though we won't attempt to analyze the import of these figures, it is evident that large shop investments will have to be made to handle carry-in receiver repairs.

TV service shops, along with auto mechanics, home improvement contractors, etc., are some of the favorite whipping boys of consumer advocates and the news media. For example, a recent New York City investigation of 21 TV shops by a consumer affairs agency revealed a high percentage of "cheats" or incompetents. The public should, of course, view these sensationalized reports in the proper perspective and not condemn the whole field. It should also remember that, while such abuses cannot be condoned, part of the problem lies with the public's continuous search for "bargains." As in all things, one must pay for competent, honest service, or risk the consequences.

Remember that TV servicing is a complex business—especially with today's sophisticated circuit designs. It requires a high order of technical competence and an increasingly greater investment in test equipment and technology learning time. Add to this the cost of an automobile or truck, shop rental, phone service, advertising, etc., and it is not hard to see how the price of a service call for professional-calibre work mounts up.

To help the TV servicing industry improve its picture in the public eye, the National Alliance of Television and Electronic Service Associations (NATESA) has suggested the following standards: (1) Do not use "no fix, no pay" phrase. (2) Don't refer to amount charged for a house call unless time limit or labor charge for excess time is used. (3) Don't use a telephone number in an advertisement that is not listed with the telephone company's directory under advertiser's name. (4) Don't use such statements as "Service within one hour," "24-hour service," etc. (5) When the word "authorized" (or similar) is used, the advertiser must have available for inspection written authorization from manufacturers or franchised distributors for sets named.

Furthermore, NATESA's Code of Ethics includes: no student shall be passed off as a technician; adequate insurance coverage must be carried; proper arrangements for protection of reserve funds on contracts must be made; etc.

So you see, TV technician dealers are making a concerted effort to provide honest, much-needed professional service, although the media obviously doesn't consider this fact to be newsworthy.

Art Salsberg

Letters

OBTAINING LOGS

Michael Covington's method of obtaining common logarithms with a calculator equipped with only the ln function (Letters, September 1976) is difficult to remember and gives only a two-place accuracy. A method that will produce an exact conversion for base-10 logs is to first obtain the natural log of the number and then divide by ln 10. The accuracy here is down to the tenth place. Interestingly, this method can be used to find the log of a number to *any* base. Just find the natural log of the number and divide by the natural log of the desired base. For example, (ln 3.2)/(ln 6.5) will give the log of 3.2 to the base 6.5—*Craig A. Pearce, Berwyn, IL*

KEEP 'EM HAPPY

I have been a reader of POPULAR ELECTRONICS for three years and am happy to renew my subscription. I particularly liked the August 1976 Editorial ["Planting Electronics Hobby Seeds"] I am one of the 8.2% of your readers who are under 18 years old and I can assure you that PE has been my best source of information on electronics over the years. Thanks to a few nice people, I have learned FORTRAN and BASIC computer languages and have used the Altair 8800 with 8K BASIC and IBM 360 with FORTRAN IV.—*Scott Crane, Victoria, TX*

MORE EM BOOKS

I teach electronic music at Bucks County Community College and have enjoyed the EM articles published in POPULAR ELECTRONICS. John McVeigh mentioned some excellent books on this subject in the September 1976 Hobby Scene. I would like to add two more titles to his list: Craig Anderton's "Electronic Projects for Musicians," which is slanted toward beginners and deals with sound modification instead of sound-generating devices and National Semiconductor's "The Audio Handbook," which has a wealth of information on preamps, electronic effects, IC power amps, etc. I use Mr. Anderton's book as a textbook in my classes.—*David Karr, Levittown, PA*

DETECTING COLOR-TV X-RAY

With regard to the September 1976 Editorial, if the test kit for color-TV X-ray emission is non-screen film, at least 25 to 50 millirads of X-ray would be required to visibly darken the film. This is a comparatively large amount of radiation. Secondly, if the detector is capable of detecting X-ray emissions from the TV receiver, it would probably do a poor job of evaluating the total leakage. In a Bureau of Radiological Health article issued in 1969, a radiation measuring device with the trade name "Ray-alert" was reviewed. I believe that the remarks addressed to this unit would be very relevant to the color-TV radiation detector kit described in the Editorial.—*Clark Hickman, Public Health Physicist, Division of Environmental Health, Santa Ana, CA*

LIKE REFERENCE TABLES

In "Designing Optimum-Q and Small Inductors" (September 1976), the author states that intermediate inductance or number of turns can be found using the formula L = KT. However, the formula should be $L = KT^2$ to agree with the table listed. The article provided me with some much needed information. Keep the reference tables coming.—*Rodney L. Egleston, Alderson, WV*

The September issue's two charts on "Designing Optmium-Q and Small Inductors" made this issue worth the entire subscription renewal price.—*George E. S. Thompson, Oakland, CA*

SENSOR PIN NUMBERS

In my "Improved Gas and Fume Detector" (August 1976), the pin-number diagrams for the sensor and the semoconductors were


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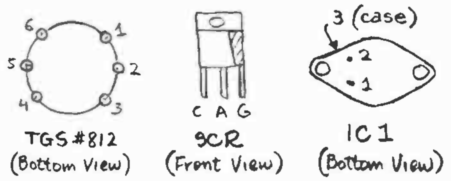
omitted. The numbering of the pins is as follows:



—*C.R. Lewart, Holmdel, NJ.*

MAIL FOR THE "ELF"

I'm building the "Cosmac 'Elf'" featured in the August 1976 issue and would like to correspond with others who are doing the same or have already built their microcomputers.—*E.M. Robertson, Jr., 1534 Hermitage Ct., Durham, NC 27707.*

We have included Mr. Robertson's entire address so that interested readers can correspond directly with him.

I have just completed building the "Cosmac 'Elf'" and am very happy with it. Some things I would like to see in upcoming issues are a 1K memory or a means of expanding the memory broken down into 1K blocks and a program that could be used with the Elf on the "HIT" recording system. Thanks for interesting projects like the Elf. If you keep up bringing us projects like this, I will have to extend my subscription, which is good only until 1980.—*Stanley W. Pozerski, Jr., Lowell, MA.*

I would very much like to complete assembling my Elf microcomputer, but I do not understand where the remaining 11 connections go after the circuits in Fig. 4 and Fig. 5 in the construction article are interconnected.—*David W. Getchell, Madison, CT.*

As you surmised, there are 11 connections left over after the two circuits are interconnected. The left-over connections go nowhere; just leave them as shown in Fig. 4.

JFET'S SELF-LIMIT

"Universal Interface Between Low-Power Logic and Load Drivers" (June 1976) presented some unique interfacing techniques. However, what I do not understand is what prevents the JFET's junction between the source and gate from becoming heavily forward biased as it clearly will in D, E, and F with the logic swing shown and implied. Would not the current flow be rather heavy under these conditions?—*William D. Kraengel, Jr.*

The advantage inherent in JFET's is their self-limiting of current. The I_{DSS} is intended to be the normal and maximum current in these applications.—*Vern Gregory*

KIT SUPPLIER RESPONDS

I was less than pleasantly surprised to find a letter in the October 1976 Letters column complaining about articles containing "ultra-unique" devices that are not widely available. The complaint about using state-of-the-art components to do previously impossible tasks does not warrant comment. What upsets me very much is the implication that I marked up the price of the MN3001. Thanks to an untimely price increase, unknown to me at the time, the one-to-nine-piece price was almost 25% less than it should have been. The only distributor I know of selling MN3001's in less than thousand-piece quantities is Solid State Inc. in NJ. Price is \$19.50.—*John H. Roberts, Phoenix Systems, Westport, CT.*

Out of Tune

In "A Digital Clock for Vehicles" (October 1976), the hookup from the main to the display board is in error. Connections A and 2 should be moved one pad each to the right, connection 1 two pads to the right, and connection C one pad to the right (see Fig. 2 component layout diagram).

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 Reader Service Card inside the back cover or write to the manufacturer at the address given.

RADIO SHACK MIKE-CONTROLLED CB MOBILE

The Realistic TRC-61 "One-Hander" mobile CB AM transceiver from Radio Shack has all controls built into the microphone. This includes the on-off/volume control, squelch, and rotary 23-channel selector. The remote section can be mounted where desired. All crystals are supplied for 23-channel operation of this 4-watt r-f unit. The One-Hander

has a built-in noise-blanker and automatic noise limiter. Sensitivity is given as 0.5 μV for 10 dB (S+N)/N, selectivity as −6 dB ±3 kHz, adjacent channel rejection as −60 dB. A three-position switch on the transceiver selects a built-in speaker, external speaker, or uses the microphone as a speaker. The remote section measures 7″D x 5¼″W × 1½″H (17.8 x 13.3 x 3.8 cm). $149.95.

CIRCLE NO. 87 ON FREE INFORMATION CARD

YAMAHA POWER AMPLIFIER

The B-2 power amplifier is the second-generation amplifier using the Yamaha FET's in a patented cascode bootstrap circuit, said to achieve a 115-dB S/N. The front panel is like the $250 UC-1 control panel used on the B-1, except that it is permanently attached and has connections for two sets of speakers instead of five. The dual peak-reading meters

have a range from −50 to + 5 dB, and are said to indicate peaks within 2 dB for a single 10-kHz sine wave. The B-2 is rated at 100 watts per channel, 20 to 20,000 Hz at 0.08% THD, into 8 ohms (140 W into 4 ohms). The frequency response, at 1 W output, 8 ohms, dc setting, is dc to 100 kHz, +0/−1 dB. Measures 17⅛″W x 14⅝″D x 6″H (43.5 x 37.1 x 15.2 cm). $850.

CIRCLE NO. 88 ON FREE INFORMATION CARD

AVANTI TVI FILTERS

Avanti offers three filters for CB'ers with TV interference problems. The AV-800 low-pass filter is for transceivers radiating harmonics of the same frequency as one or more of the local TV channels. The AV-811 filter on the TV lead-in is designed for problems at the TV receiver due to front-end overloading. The AV-820 AC Line Filter is prescribed if the CB signal is being transmitted through ac power lines.

CIRCLE NO. 89 ON FREE INFORMATION CARD

B&K 30-MHz DUAL-TRACE SCOPE

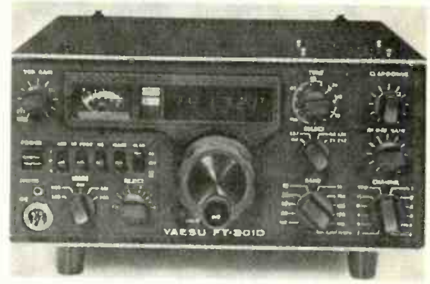
A dual-trace triggered scope with signal delay, designed for applications where very high-speed waveforms must be viewed with clarity and accuracy, has been introduced by B&K-Precision as the Model 1474. An internal 160-ns signal delay line permits the user to view information appearing during the very short rise and fall times of high-frequency waveforms. Minimum visible delay is 12 ns. The 1474 is suitable for such applications as microprocessor system development, troubleshooting of minicomputers and peripheral equipment, and most other digital applications. Rise time is specified as 11.7 ns or less. Waveforms are displayed on an 8 x 10 cm CRT viewing area. A ten-position vertical attenuator covers 5 mV to 5 V/cm at an accuracy of ±30%. The unit is said to have a

smooth response to well beyond 30 MHz and can trigger on signals up to 50 MHz. Other features include 20 calibrated sweep positions from 0.2 μs/cm to 0.5 s/cm (X5 magnification increases sweep speed to 40 ns/cm). The unit, $820, is fully regulated and designed to maintain accuracy over a 105–130-volt ac range. It measures 9.8″H x 14.5″W x 17.8″D (20 x 25 x 36 cm). Net weight is 19.6 lb (8.8 kg).

CIRCLE NO. 91 ON FREE INFORMATION CARD

YAESU "DIGITAL" HAM TRANSCEIVER

The Yaesu FT-310D solid-state transceiver with digital readout covers amateur bands from 160 through 10 meters, plus WWV/JJY reception for time signals. Frequency readout to six places is provided by a red LED display. It's rated at 200 watts PEP power input, 200 watts CW, 50 watts AM and FSK (accepts keyboard shifts of 170 or 850 Hz). Receiver sensitivity is 0.25 μV at S/N 10 dB. Features switchable selectivity. Audio re-



sponse is 300 to 2700 Hz at −6 dB. Distortion products are less than −31 dB. Frequency drift during any 30-minute period is said to be less than 100 Hz. The unit may be powered by a 13.5-V dc source, negative ground, drawing 21 A in transmit, 0.9 A receive. A matching ac supply with self-contained speaker is available. Measures 11″W × 7 11/16″D × 4 15/16″H (28 x 19.5 x 12.5 cm).

CIRCLE NO. 92 ON FREE INFORMATION CARD

AUTO CASSETTE/RADIO

The Superscope CA-15 is an in-dash stereo cassette-tape player that features automatic reverse, manual direction select switch, fast

forward and rewind, manual eject, and slide controls for volume, tone and stereo balance. There are also indicator lights for each direction of tape travel.

CIRCLE NO. 93 ON FREE INFORMATION CARD

TRIPLETT FET VOM

Triplett's model 64 battery-powered FET volt-ohmmeter has 29 ranges, including six for low-power ohms. These six have an open-cir-

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cuit voltage of 90 mV, for fast in-circuit resistance and continuity measurements without biasing or destroying sensitive diodes, IC's or transistors. The 64 is said to have internal circuitry that prevents explosive arcs in high-energy circuits up to the 2-A/1000-V fuse capacity. The ranges include eight each for dc and ac volts, six for low-power ohms, one megohm, junction test forward and reverse conduction. The meter also features a single range-selector switch and modular construction. One test-probe set is used for all measurements. $130.00.

CIRCLE NO. 94 ON FREE INFORMATION CARD

SAE POWER AMPLIFIER

The SAE 2000 medium-power stereo amplifier is rated at 100 watts per channel, and at 0.05% THD and IM, from 20 Hz to 20 kHz, ±0.25 dB, at 250 mW to rated power. The dual-differential inputs, full complementary drivers and output stages are said to provide very low transient and steady-state distortion. The power display uses 15 LED's per channel to indicate the average power (peak responding) of the amplifier over a range of 20 mW to full rated power plus indicating any amplifier overloads. The display indicates power in 3-dB increments. $450.00.

CIRCLE NO. 95 ON FREE INFORMATION CARD

M&R COMPUTER KIT

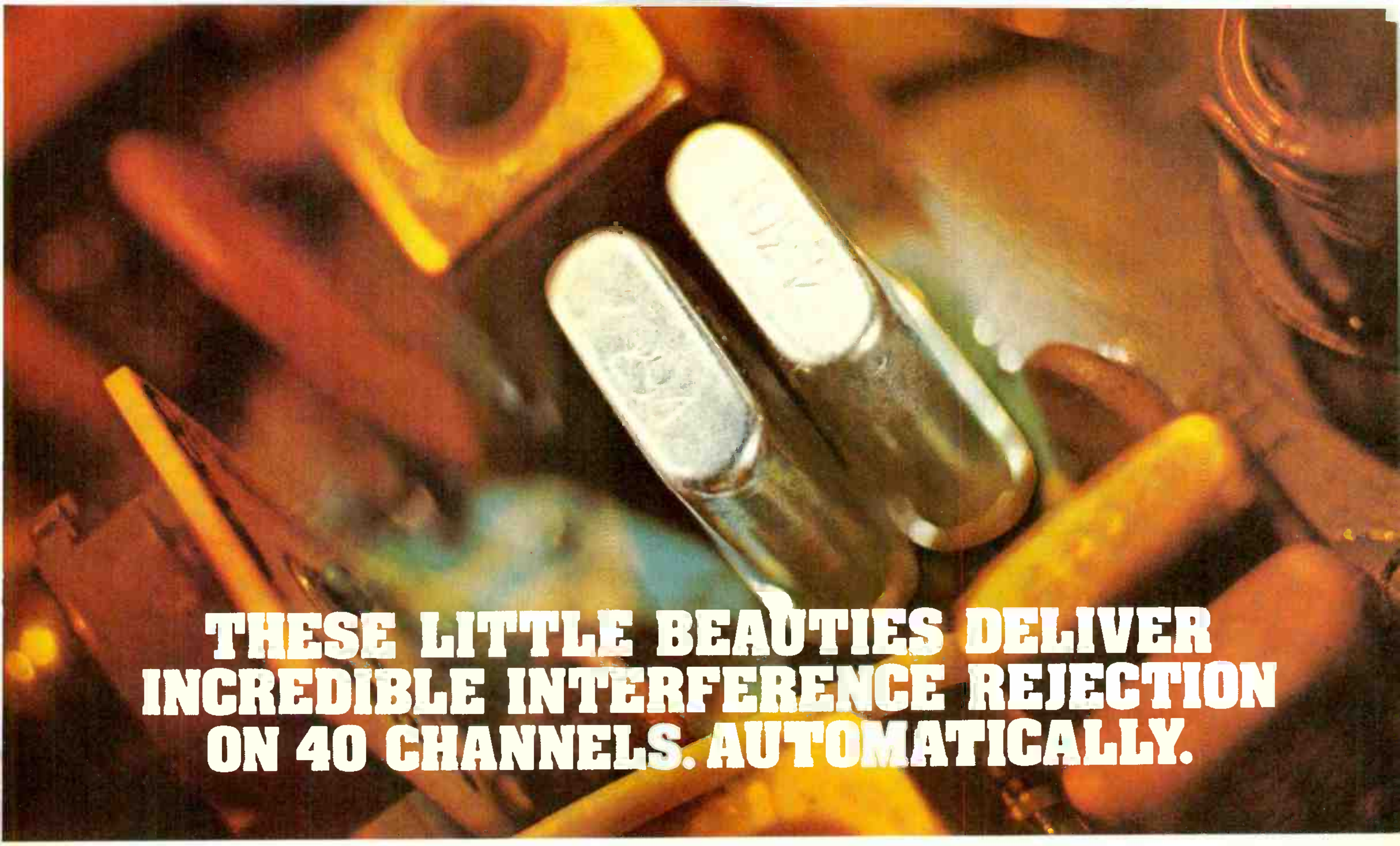
Although called a "kit," the Astral 2000 microcomputer from M&R Enterprises is actually over 70% assembled. The power supply, 6800-based processor board and 8K RAM board are assembled and tested. All boards

plug directly into the backplane. Both RS-232 and 20-mA current loop are provided, along with a 2k monitor in ROM, cycle-stealing DMA, and a built-in software-controlled, real-time, six-digit clock display. Options include a video terminal board, 8k EPROM board, I/O tape interface, and 8k BASIC. The minimum Astral 2000 consists of power supply, cabinet, front-panel components, backplane, processor board and 8K RAM board, at $995 partially assembled, $1250 fully assembled.

CIRCLE NO. 96 ON FREE INFORMATION CARD

RCA MOBILE CB TRANSCEIVER

The RCA 14T301 Co-Pilot is a 23-channel mobile CB transceiver with a frequency-synthesized phase-locked loop circuits and maximum allowable r-f power output. Features include a switchable automatic noise limiter, illuminated double-function S/r-f/SWR meter, delta tuning, noise-blanker switch, LO/DX



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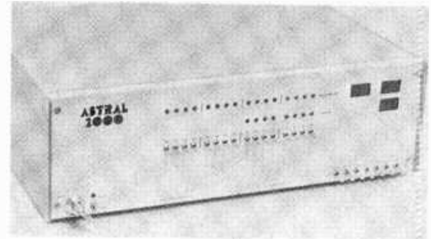

switch, a built-in ALC circuit to compensate for variations in voice level, public address mode and an external speaker jack. $189.95.

CIRCLE NO. 97 ON FREE INFORMATION CARD

WELLER-XCELITE TOOL SET

A 12-piece starter tool set, Model 250K, for electronic technicians and kit builders, from Weller-Xcelite, comes in a compact plastic carrying case with storage tray. The set includes a Weller 25-watt iron with two 750°F tips; soldering-aid tool and 10 oz of rosin-core solder; Xcelite 4" long-nose pliers; diagonal cutters and wire strippers, all plastic grips; ¼" nut-driver; and both slotted and Phillips-head screwdrivers with chrome vanadium steel blades and plastic handles. $35.95.

CIRCLE NO. 98 ON FREE INFORMATION CARD

GARRARD AUTOMATIC TURNTABLE

Garrard's GT55 is a belt-driven turntable with single- and multiple-play modes. It features a tonearm of lightweight magnesium alloy, with a mass of 14 grams. Called the "True Tangent Tonearm," it has an articulated head that maintains the 90-degree relationship from rim to center, and is said to eliminate

tracking error. Belt-driven by a 1000-rpm dc servometer, the GT55 also features an electronic variable-speed control with an illuminated stroboscope, variable-rate cueing damped by the main cam, and magnetic antiskating control. $249.95.

CIRCLE NO. 99 ON FREE INFORMATION CARD

CB HATCHBACK MOUNT ANTENNA

The Antenna Specialists M-431 CB antenna has a hatchback mount that lets the user adjust the antenna to vertical on hatchback and fastback cars. The antenna also doubles as a trunk-groove mount. It has a base-loaded coil, stainless-steel shock spring, and a 17-7PH stainless-steel whip. Complete with 17 feet of 58/U coax and attached PL-259 connector, the M-431 is $26.95.

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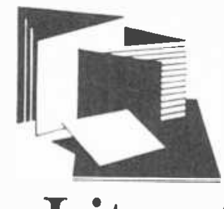

New Literature

SEMICONDUCTOR REPLACEMENTS

The 1976 Replacement Guide and Catalog, Bulletin No. ECG2129, that cross-references more than 119,000 industry parts numbers to its ECG semiconductor line is available from GTE Sylvania. The 240-page publication contains 5000 more part numbers than previous editions. Among new devices in the Sylvania line are high-voltage divider networks, high-power bridge and half-wave rectifiers, additional digital and linear IC's, and transistors. Designed as a quick reference for maintenance and repair technicians, the 1976 guide includes a section of outline drawings, circuit diagrams, and technical descriptions of the listed transistors, diodes, rectifiers, SCR's, modules, IC's, gate-controlled switches, and special-purpose devices. Listings in the Replacement Directory are alphanumeric. Price is $2.95. Address: GTE Sylvania Advertising Services Center, 70 Empire Dr., West Seneca, N.Y. 14224.

MOBILE CB ANTENNA BROCHURE

The importance of the antenna to good CB communications performance is outlined in a new full-color, 4-page brochure available from Avanti. Using cutaway photos with callout descriptions of each component, the booklet explains the importance of each feature to satisfactory CB performance. Although pinpointing the Racer 27 base-loaded mobile antenna, the publication also illustrates and describes other mobile antennas in the company's line. Address: Avanti Research & Development, Inc. 340 Stewart Ave., Addison, IL 60101.

HARD-TO-FIND TOOLS

A 128-page catalog of unusual and hard-to-find tools is available from Jensen Tools and Alloys. It describes over 2800 tools of interest to engineers, electronics technicians, and instrument mechanics working on fine assemblies. Major categories include micro-tools, power tools, test equipment, soldering equipment, engineering supplies, and a 30-page section featuring the company's tool kits and tool cases. Also included is technical data on tool selection, metric and temperature conversion charts, glossaries of tool terms, equivalency tables, safety tips, and specific information on plastics and the solderability, tensile strength, and melting point of various metals. Address: Jensen Tools and Alloys, 4117 No. 44th St., Phoenix, AZ 85018.

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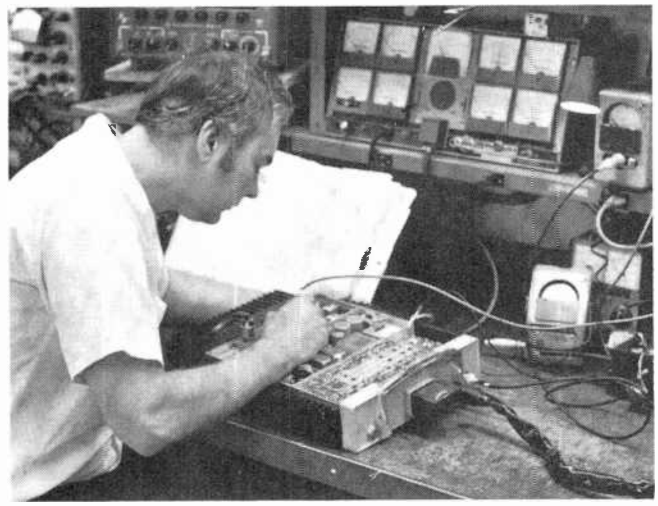

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Stereo Scene

By Ralph Hodges

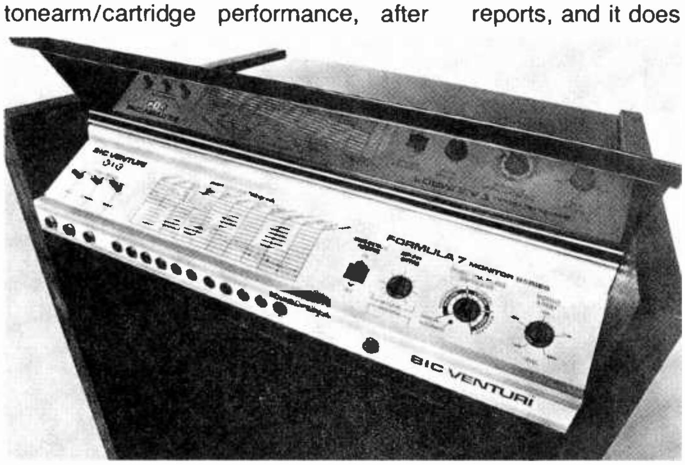
SPEAKERS AND SUCH

I NOTICE that the latest installment of the great omnidirectional vs. directional loudspeaker controversy has pretty much died down, with its combatants a bit out of breath but certainly unbowed, and (I suspect) hardly anyone's opinion changed one iota. If you missed the action, it concerned the view (held by one side) that omnidirectional speakers provide nothing but an "undifferentiated wodge of sound" where the stereo should be, opposed by the counterview that omnidirectional speakers are the *only* means to a truly satisfactory stereo image.

It turned out to be quite a tussle this time (everyone had obviously been nursing his grievances since the last go-round), with missiles of vituperative prose being lobbed across the Atlantic from England on an almost fortnightly basis, their arrival provoking vigorous volleys of return fire. In my view, the American effort was hampered to an extent by a dearth of really top-quality directional speakers. Most U.S. "hi-fi" speakers are designed for maximum possible dispersion of sound, if not actually for multidirectional propagation. Hence it was hard to find a suitable standard-bearer for the directional-speaker cause with which to make comparison. I confess I had trouble getting good stereo from either speaker type until I made some headway in stabilizing tonearm/cartridge performance, after which both seemed to do very well. This, I was curtly informed, was because the exaggerated stereo of multi-tracked U.S. recordings to an extent worked against the omnis' faults and glossed them over. Never did get that point resolved to my satisfaction.

The Dust Settles. With the passing of the "great debate," events seem to have slowed to a much more moderate pace in speaker-design circles around the country. Now that many of the serious audiophiles have settled down with their electrostatics, big folded horns, or other preferences of the moment and are fixed up for the next couple of years, the focus of activity has turned once again to the first-time buyer. And the first-time buyer seems, as always, to be most interested in simple, unadorned boxes in the medium- to low-price range, perhaps bearing a brand name he recognizes from some previous contact or report. He wants nothing too complicated or razzle-dazzle, just a solid middle-of-the-road performer.

For example: in a recent conversation with George Sioles, president of Design Acoustics, I learned that this company's latest product, the D-1 speaker system, is turning in a puzzling performance in the marketplace. On the face of it, it should be a winner; the price is right, the sound is all it should be from advance reports, and it does not come surrounded by a blizzard of technical verbiage likely to panic the timid. There's just one thing, however—its cabinet is brushed aluminum.



The B.I.C. Formula 7's control panel. The prominent chart facilitates interpretation of the sound-level indicators.

The cabinet was supposed to be a good idea. It is comparatively inexpensive, good looking in a sleek, modern sort of way, and even after being braced and damped for rigidity and inertness it is substantially thinner than a wood-panel design, conserving internal volume while shrinking external dimensions. When on display it appears to attract a lot of attention, and ultimately the D-1 seems to sell briskly enough—but in the slightly larger and more expensive walnut-cabinet version, not the aluminum. The innate conservatism of the buyer in this price range seems to persist as usual.

The Heil Woofer Again. For years now, the innovative ESS/Heil *woofer* has poised for introduction during the winter months, and every time it has faded back into the Sacramento labs for more development work. This time it may make it, judging from the increased pitch of promotional activity at ESS.

Not long ago I saw what are supposed to be the final prototypes at a semi-private showing. The design retains its "squeeze-box" configuration, with squared-off Lexan diaphragms working into wedge-shaped chambers open at the thicker end. The floor of the wedge forms the stationary plate against which the diaphragm above squeezes its charge of air. Five or more wedge assemblies (not large) are mounted on a baffle board, arranged so that each diaphragm has the bottom of another wedge—to serve as a stator for its upward excursions—just above it. Vertical drive shafts to propel the diaphragms penetrate the row of wedges from top to bottom and terminate in a large voice coil that is driven by a comparatively conventional permanent-magnet motor. It is not at the moment clear to me whether there will be voice coils at both top and bottom, operating in a push-pull fashion, or whether a single coil, presumably at the base of the affair, will be the final arrangement. The prototypes appeared to have just a single coil.

The Heil device remains a dipole radiator, subject to front-to-back acoustical cancellations at lower frequencies. This didn't seem to bother it much in the demonstration I heard. Indeed, ESS has designed electronics to complement the speaker, and these may be sold as an integral part of the final package. One of the factors that prompted this is that the

woofer's impedance curve begins to go mountain-climbing near the bottom of its useful output range. Rather than suffer the reduced output that would be inevitable with a conventional amplifier seeing such a load, ESS has developed a "current-feedback" power amplifier that is said to include the speaker in its feedback loop. And apparently there are other reasons besides this that are responsible for ESS's strongly recommending—nay, almost insisting on—the use of their own electronics with this particular speaker.

The Design Acoustics D-1 in brushed aluminum.

Blinkenlights. Elsewhere in the speaker scramble, B.I.C. has an idea it is convinced will revolutionize our listening habits. It is a set of indicator lights—the inevitable LEDs—intended to monitor the performance of speaker and amplifier, and they come as an integral part of two new B.I.C. speaker systems.

One light display is concerned with detecting overdrive conditions, and as such it must be precalibrated by the user. The procedure is simple. Using a test record supplied by B.I.C. (containing a rapidly pulsed sinewave at about 1 kHz), you raise the volume until the sound begins to turn sour, indicating the onset of amplifier clipping. At this point you adjust the threshold control of the indicator light until it almost turns on. On the other hand, if the light should come on before distortion occurs, it presumably means that the amplifier's available output exceeds the power-handling capability of the loudspeaker (the light is preset to respond to maximum allowable input at the factory). In this case you don't move the calibration control from its full-up position; you simply keep in mind that whenever the light comes on (except for brief flickers) your speakers are on the point of disintegrating. The test signal involves only mid-frequencies, so it is not clear what effect excessive input to the woofer or tweeter has on the indicator system. However, to avert the worst, the speaker incorporates pre-set circuit breakers, separate for the woofer and the higher-frequency drivers, with indicator lights to tell you which one has tripped.

The second set of lights, provided only on the larger Formula 7, shows acoustic-output levels referred to designated measuring distances on the loudspeaker's axis. This should be good for compiling an impressive list of facts and figures, but it is not likely to be utilitarian in the strictest sense.

The Other Transducer. Worldwide, the audiophile community is continuing to get lathered up over the moving-coil cartridges that are rising up out of Japan and elsewhere. In response, the specialist market is beginning to teem with transformers and active-gain boxes that will let these low-impedance devices drive a standard phono preamplifier to a reasonable output, and it is not unusual to find suitable high-gain preamplifiers ("head amps," they are usually called) already built into the newer deluxe preamplifiers.

As for the cartridges themselves, I've gotten together a partial list of distributors for these little wonders. I can't in all cases be entirely specific about models and prices; some of the manufacturers bring out new models at the slightest provocation. (On my last trip to Japan, the stores had some that hadn't even been heard of here yet.) And I can't be sure of long-term availability, as some of these devices have an uncertain status in relation to existing U.S. patents. But here goes:

The Denon cartridges, manufactured by Nippon Columbia, include two moving-coil designs that have attracted a vast following. One has a spherical stylus, the other a bi-radial CD-4 stylus. Preferences between these two vary. I have successfully driven a conventional phono amplifier with their outputs directly, but I can't guarantee they will work to satisfaction with every preamp. A major U.S. source for Denon is American Audioport, 317 Professional Building, 909 University, Columbia, MO 65201. At this writing the spherical-stylus model costs $175, the CD-4 $200. (There are reports that Denon will be entering the U.S. market as its own entity sometime soon.)

Fidelity Research, a popular brand for some time, has relatively frequent model updates, and I fear anything I said now would be out of date when it reached print. However, the FR cartridges are generally admired for their top end, (among other characteristics), which exhibits a rising response on most samples measured. They usually require a gain box or step-up transformer. The source is Fidelity Research of America, P.O. Box 5242, Ventura, CA 93003.

Nakamichi introduced its moving-coil cartridge, the MC 1000, in mid-1976. The first published test reports (from England) have been excellent. The MC 1000 has a Shibata stylus, although it is not unconditionally recommended for CD-4. It requires some help in driving preamps, and Nakamichi offers a transformer for $100. Nakamichi Research is at 220 Westbury Avenue, Carle Place, NY 11514.

Superex has undertaken the distribution of the Satin pickups from Japan, the only moving-coil cartridges with user-replacable styli. There are models with Shibata, elliptical, and spherical tips at prices of $190, $170, and $140. Outputs are said to be compatible with direct preamp connection. The Superex address is 151 Ludlow Street, Yonkers, NY 10705.

Supex was perhaps the first Japanese moving-coil to reach these shores and receive acclaim. Several improved models have followed, and are held in high esteem. Some assistance is generally needed for preamp interface. The latest Supex models (between Japan and here I have become confused about what they are) are available from Sumiko, Inc., P.O. Box 5046, Berkeley, CA 94705. At last report, prices were well over $100 and may be passing $200 by now.

Ultimo has been trying to break into the U.S. market for some time, and may succeed at any moment. They offer one of the two moving-coil (CD-4/stereo) types with beryllium cantilevers (the other being Nakamichi), together with a more conventional stereo model. Both have unusually high outputs and can almost always plug directly into a preamp. However, availability is uncertain, as are prices.

And, lest we forget, Ortofon, which has been quietly marketing moving-coils to the U.S. for years, is still with us. Their latest, the MC-20 ($120), has a modified Shibata stylus; the SL-20Q ($150), for stereo and CD-4, has a bi-radial stylus; and the acclaimed SL-20E ($100) retains its elliptical stylus. These cartridges require either a gain box, which Orotofon now makes for $170 (MCA-76), or a transformer. Ortofon can be reached through Harman International, 55 Ames Court, Plainview, NY 11803.

For those cartridges that need them, some people apparently prefer to use transformers, rather than gain boxes. A number of the foregoing manufacturers offer transformers; and there is even an independent supplier, Verion (1 Riverdale Ave., Bronx, NY 10463), that builds what is said to be a very good one. Gain boxes come from companies like Mark Levinson and (more and more) as existing facilities in new preamplifiers.

Now that you've been suitably scandalized by the prices charged for these things, and will perhaps soon become aware of their interface complexities, rather high weight, generally unimpressive compliances, and other crotchets (old-timers will remember their distressing affinity for small metallic objects and ferrous turntable platters—characteristics they still possess), you're justified in asking the question "Why?"

I look forward to answering that question as soon as the reasons for their vaunted sonic superiority (which I'm convinced I hear) are adequately explained to *me*. Until then, I suggest you find one and listen to it. ◇

CIRCLE NO. 58 ON FREE INFORMATION CARD

Julian Hirsch Audio Reports

HIRSCH/HOUCK LABORATORIES

ABOUT THIS MONTH'S REPORTS

"Super" FM tuners are usually priced from $1000 up. So it is interesting to find that Sansui's new Model TU-9900 tuner, at a modest $450, matches the performance of more expensive models, at least in the most important respects.

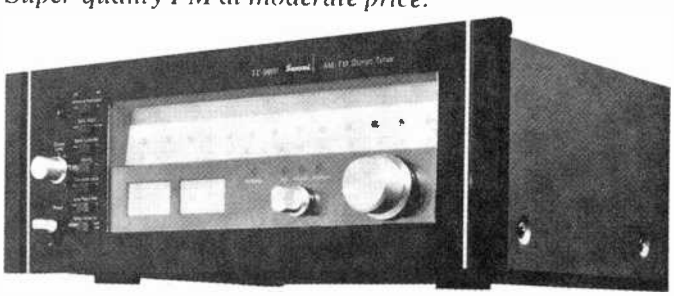
Kenwood's Model 600 integrated stereo amplifier uses separate power supplies for each channel. Measuring the conservatively rated amplifier's distortion can tax the capabilities of the finest laboratory test equipment.

The $400 JVC JR-S300 receiver features a built-in graphic equalizer. It combines exceptional control capabilities with a clean, moderate-power amplifier and competent tuner.

—Julian D. Hirsch

SANSUI MODEL TU-9900 AM/STEREO FM TUNER

Super-quality FM at moderate price.



HIRSCH-HOUCK LABS REPORT

The Model TU-9900 is Sansui's finest stereo FM tuner. It is an ideal mate for the highest quality amplifiers and speaker systems. Interestingly, the TU-9900's nationally advertised value of approximately $450 belies its performance capabilities.

Esthetically impressive, the large, heavy tuner is finished in black and is designed to complement other recent separate components from Sansui. It measures 18⅛"W × 12¼"D × 6 5/16"H (46 × 31.1 × 16 cm) and weighs just slightly more than 21 lb (about 9.5 kg).

General Description. The upper half of the large front panel is occupied by a dial cutout behind which are the FM and AM scales. Below the cutout are a large tuning knob; the mode selector switch with positions for AM, FM AUTO, and FM MONO, each of which has its own colored lights; and a red STEREO pilot light. Two illuminated meters are provided for indicating relative signal strength and FM center-channel tuning.

To the left of the cut-out area are seven pushbutton switches. The top switch, labelled ANTENNA ATTENUATOR, introduces a nominal 20-dB attenuation to prevent overload from very strong local signals when it is pushed in. Below this are BAND WIDTH, NOISE CANCELLER (blends stereo channels at high frequencies to reduce hiss on weak signals), MUTING, CALIBRATION LEVEL, LOW PASS FILTER and METER SELECTOR switches. The last switch allows the signal-strength meter to indicate FM multipath distortion when pressed in. To the left of the switches are the VOLUME control and a lever-type POWER switch.

The tuner offers a choice of two FM i-f bandwidths. WIDE is for normal use, while NARROW is for situations where the greatest possible selectivity is needed. In the NARROW mode, the stereo channel separation, capture ratio, and distortion are somewhat degraded (but still meet all essential requirements for high-fidelity reception). In WIDE, the tuner achieves state-of-the-art performance, but at some sacrifice of adjacent- and alternate-channel selectivity.

The CALIBRATION LEVEL button replaces the normal audio outputs with a tone whose level corresponds to −10 dB, relative to 100% modulation. It can be used to set up the level controls of a tape recorder so that program peaks will not exceed a safe recording level. The LOW PASS FILTER removes the 19- and 38-kHz components of a stereo signal from the tuner outputs, with minimal effect on the audio frequency response. (These ultrasonic signals could create beats with the bias oscillator on some tape recorders, or could affect the operation of a Dolby noise reducing accessory.) With the filter out of the circuit, there is an appreciable amount of 19-kHz pilot carrier in the audio outputs (though not enough to affect normal listening), but the response is perfectly flat up to 15,000 Hz and beyond.

On the rear apron are binding post terminals for a 300-ohm FM antenna and a wire-type AM antenna, a coaxial connector for a 75-ohm FM antenna, and a hinged and pivoted AM ferrite rod antenna. In addition to the normal audio outputs, there is a second pair of outputs designated DOLBY FM whose level is not affected by the VOLUME control, and whose deemphasis characteristic is the 25 μs required by a Dolby decoder instead of the normal 75 μs. There is also an FM DETECTOR output, without deemphasis, for use with a future 4-channel FM decoder. Vertical and horizontal outputs are provided for connection of an oscilloscope multipath indicator. The single accessory ac outlet is unswitched.

Laboratory Measurements. The setting of the BAND WIDTH switch has a profound effect on many of the tuner's performance parameters. It was necessary, therefore, to check all related aspects of the tuner's operation separately in the WIDE and NARROW settings of the BAND WIDTH switch.

With the switch set to the WIDE position the IHF sensitivity was 10 dBf (1.8 μV) in mono and 21 dBf (6 μV) in stereo, the latter determined by the stereo switching threshold. The 50-dB quieting sensitivity was 15 dBf (3 μV) at 0.35% THD in mono and 35 dBf (30 μV) at 0.3% THD in stereo. The S/N at 65 dBf (1000 μV) was 74 dB in mono and 71.5 dB in stereo, while distortion measured an incredible 0.021% and 0.052% respectively. (These figures, like some of the others we obtained, are better than

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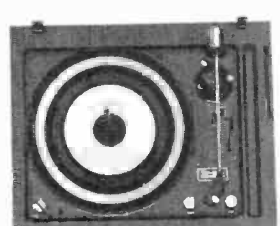

Realistic/Miracord-42
Fully automatic. Umbrella-spindle, cartridge, simulated walnut grain finish. 149.95*

Realistic LAB-50
Fully automatic, belt-drive. Cartridge, walnut grained vinyl veneer base. 99.95*

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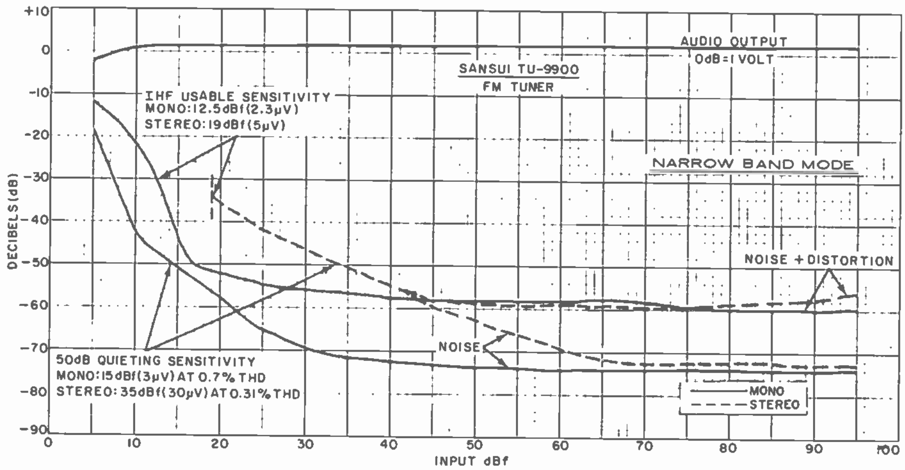


Sensitivity, noise and distortion in narrow-band mode.

the guaranteed performance of the Sound-Technology signal generator we used, but they leave no doubt that the tuner has stretched the capabilities of our test equipment to its limits.) The stereo distortion, using L-R modulation, was 0.32% at 100 Hz, 0.032% at 1000 Hz, and 0.075% at 6000 Hz.

The capture ratio at 65 dBf input was just under 1 dB, a point at which measurement becomes very difficult. AM rejection was an excellent 71 dB. Image rejection was unmeasurable, exceeding the 100-dB range of our test equipment. The selectivity measured 53.5 dB at 400-kHz spacing (alternate channel) and 5.7 dB at 200-kHz spacing (adjacent channel). The muting threshold was 22 dBf (7 μV), approximately the same as the stereo switching threshold. Hum level was −70 dB.

With the LOW PASS filter switched out, the frequency response was flat within +0.2 and −0.6 dB from 30 to 15,000 Hz. Switching in the filter dropped the response at 12,000 Hz by 0.4 dB and at 15,000 Hz by 2.5 dB, typical of most tuners in which the filter is always in the circuit.

Stereo channel separation was almost as unbelievable as the distortion figures, exceeding 60 dB from 60 to 600 Hz and reducing smoothly to 45 dB at 5000 Hz, 40 dB at 10,000 Hz, and 34 dB at 15,000 Hz. The 19-kHz pilot carrier leakage into the audio outputs was relatively large, −36 dB, but switching in the filter reduced it to an almost unmeasurable −85 dB.

With the BAND WIDTH switch set to NARROW the S/N, IHF stereo sensitivity, muting threshold, pilot-carrier leakage, hum, and frequency response were the same as in the WIDE mode. The mono IHF sensitivity was slightly poorer, measuring 12.5 dBf (2.3 μV). The 50 dB quieting sensitivity was the same as in WIDE, but with a slightly higher mono distortion of 0.7%.

The THD was 0.13% in mono and 0.11% in stereo, which would be considered excellent for any tuner, although it was considerably higher than in our WIDE mode measurement. The stereo L-R distortion was also somewhat higher, measuring 0.36% at 100 Hz, 0.044% at 1000 Hz, and 0.63% at 6000 Hz.

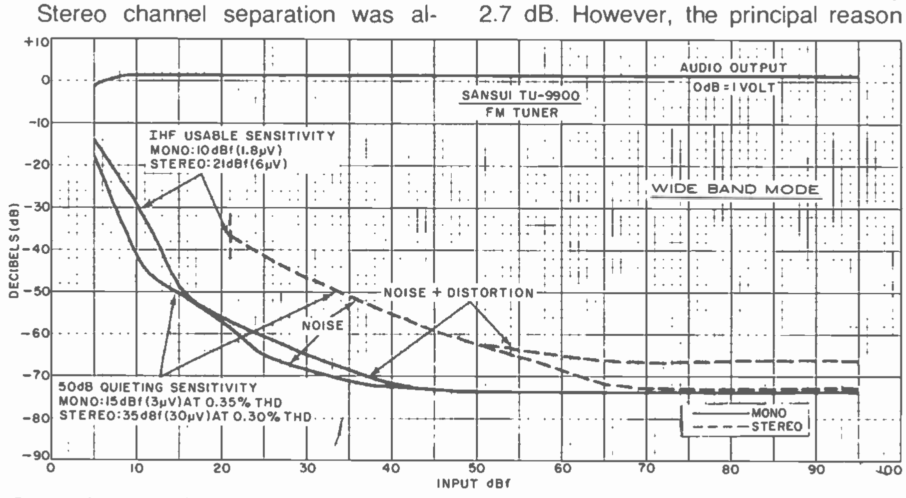
The capture ratio was noticeably degraded in the NARROW mode, measuring 2.7 dB. However, the principal reason for using the NARROW mode is to improve selectivity, which it did admirably. The alternate-channel selectivity was unmeasurable (greater than 100 dB) and the adjacent-channel selectivity of 17 dB was one of the best we have ever measured on a tuner. The stereo channel separation was reduced, though not in a way that could affect listening quality. It measured an almost constant 27 dB from 30 to 3000 Hz and 26 dB beyond 3000 Hz.

The DOLBY FM output was a constant 0.42 volt at 100% modulation, with a 25-μs deemphasis. Pressing in the CALIBRATION LEVEL button replaced the tuner's audio signal with a tone that was exactly 10 dB below 100% modulation. The ANTENNA ATTENUATOR reduced the sensitivity by 22.7 dB. The MUTING operated positively, yet silently, with no transient thumps or noises. Calibrated at 0.25-MHz intervals, the dial proved to be extremely accurate, with no discernible error. The tuning mechanism was one of the smoothest we have used, with a flywheel action that made it possible to cover the entire FM band with a single spin of the knob.

The only test we made on the AM section was of its frequency response, which was even more restricted than most AM tuners we have measured. The frequency response was down 6 dB at 60 and 2200 hertz.

User Comment. Clearly, the Sansui Model TU-9900 tuner is a very superior performer. It is unfortunate that few FM stations transmit programs with sufficient fidelity to make this tuner sound any different from many competitive tuners. (Most good tuners tend to sound pretty much alike on most stations.) On the other hand, it is a safe assumption that any untoward sounds heard via this tuner originate from the FM station or in a subsequent part of the sound system in which it is used.

The calibrating signal is a genuine convenience to anyone who tapes programs off the air. Normally, it is used to set the recorder's meters to −10 dB, which allows a couple of decibels reserve for an occasional over-modulated peak without risking distortion from tape saturation. If your recorder has, say, 5 dB of "headroom" above 0 dB, the tone can be set to give a −5-dB reading. In any case, you are no longer at the mercy of the FM station program levels at the time you are setting up your recorder for a future taping. The only feature of the tuner that did not perform superbly was the multipath meter indication. Checking



Sensitivity, noise and distortion in wide-band mode.

it against an oscilloscope display, we found that the meter was of little value in revealing moderate amounts of multipath distortion, although very high distortion levels did cause some deflection of its pointer.

In sum, this separate tuner excels in virtually every area of FM performance and is capable of capturing all the fidelity that FM broadcasters can produce. Sure, the TU-9900 doesn't offer some special features (digital readout, oscilloscope, variable muting, etc.) that some higher-priced units do. But considering raw performance and the special features it does provide, this tuner is worthy of serious consideration by anyone who wishes to listen to superlative FM, assuming that is the quality being broadcast. And considering the TU-9900's moderate price, it's a top-value unit.

CIRCLE NO. 101 ON FREE INFORMATION CARD

KENWOOD MODEL 600 INTEGRATED STEREO AMPLIFIER

Features compactness, dual power supplies and flexible preamp.

HIRSCH-HOUCK LABS REPORT

The performance caliber of Kenwood's new top-of-the-line Model 600 stereo control amplifier is clearly reflected in its 130-watt/channel power rating into 8 ohms from 20 to 20,000 Hz at less than 0.08% distortion. It is surprisingly compact for such a powerful amplifier, measuring only 17 5/16"W × 15¼"D × 6"H (44 × 38.7 × 15.2 cm), but its 47-lb (21.4-kg) weight is a clue to the quality of design and construction of this handsome and versatile amplifier.

In addition to providing a moderately high power level, the amplifier is also equipped with just about every control facility one could desire. The controls themselves are large and easy to manipulate, including large-size toggle and pushbutton switches. All inputs and outputs (except the headphone output) are conveniently grouped on the amplifier's rear apron. Priced at $749.95.

General Description. The amplifier's pale gold, satin-finished front panel is dominated by a large VOLUME control at its center. A concentric ring around this control provides for BALANCE adjustment. The VOLUME control is a stepped attenuator that varies the volume in almost imperceptible 1-dB steps from maximum to about −33 dB and in progressively larger steps to greater than −64 dB before completely silencing the outputs. The BALANCE control is lightly detented at its center position. A small yellow lamp is located just above the VOLUME knob. It comes on whenever power is turned on.

Three knobs at the upper left of the panel control the speaker system outputs for three pairs of speakers and one combination of two pairs and OFF and the BASS and TREBLE controls. The tone controls are continuous rotary potentiometers, although they are detented at 2-dB intervals over a ±10-dB range. They are separate for the two channels, but a slip clutch arrangement permits both channels to be adjusted simultaneously or individually, as desired.

Below the tone controls are TURNOVER switches that bypass the tone controls in their center positions and offer a choice of 150- and 400-Hz bass and 3000- and 6000-Hz treble turnover frequencies in their alternate positions. A third lever switch allows the user to introduce a fixed midrange PRESENCE boost that is centered at either 800 or 3000 Hz. Two pushbutton switches are provided for engaging and disengaging the LOW and HIGH FILTER circuits. When engaged, they provide 12-dB/octave slopes and turnover frequencies of 40 and 8000 Hz.

At the upper right of the panel are the INPUT SELECTOR and a lever switch for selecting either the TUNER or AUX 1 high-level inputs or transfer control to the INPUT SELECTOR switch, which has positions for PHONO 1, PHONO 2, and AUX 2. A three-position lever-type ATTENUATOR switch allows the gain to be reduced by 15 or 30 dB, adapting it to the input levels and speaker efficiency so that the VOLUME control can be operated in the portion of its range that gives the smoothest control and a suitable loudness compensation, assuming the latter feature is used.

A TAPE DUBBING switch is provided for interconnecting two tape decks so that a program can be copied from either deck onto the other. The MONITOR switch connects the amplifier to the playback output of either deck or to the selected source signal, giving the capability of dubbing tapes while listening to another program.

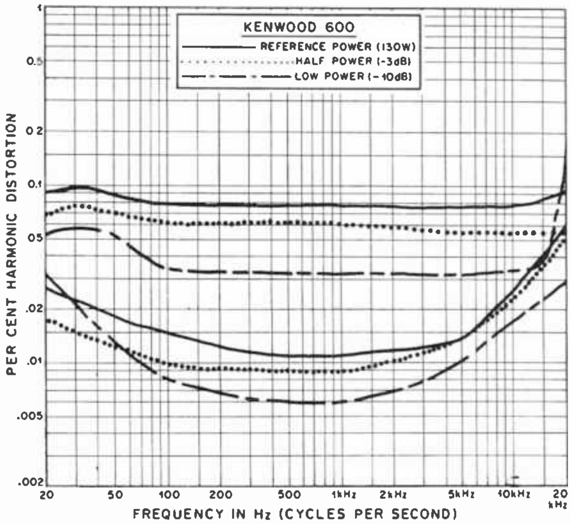
At the lower right of the panel are small knob controls for LOUDNESS compensation (OFF plus four degrees of low-frequency boost as the VOLUME setting is reduced); MODE (L, R, STEREO, REV stereo, and L+R); and a PHONO 2 GAIN control that can be used to reduce the gain of the PHONO 2 input by up to 6 dB relative to the PHONO 1 input level for matching the levels from two different phono cartridges. Next to these controls is a switch that allows selection of 30,000, 50,000, or 100,000 ohms input impedance for the PHONO 1 input. The PHONO 2 input impedance is fixed at 50,000 ohms.

In addition to having all the signal input and output jacks, the rear apron also has separate preamplifier output and power amplifier input jacks. These two latter sets of jacks are normally joined together by a switch adjacent to them. Each of the tape recorder jacks is duplicated by a DIN socket.

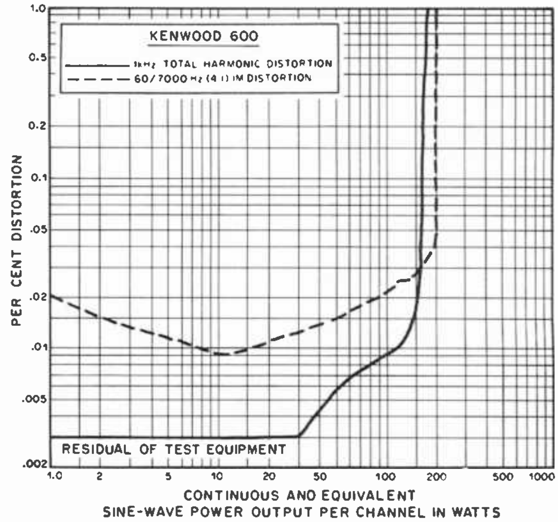
Insulated binding posts are provided for speaker system hookups to the amplifier. There are two switched and one unswitched accessory ac outlets on the rear apron.

The amplifier has entirely separate power supplies for the two channels. Its power amplifiers are direct coupled from their inputs to the speaker outputs. A fast-acting relay provides a 4-second turn-on delay before connecting the speaker systems to the outputs and protects the speakers against damage in the event of a catastrophic failure in the amplifier. The output transistors are also electronically protected against overload damage.

Kenwood claims that the combination



1-kHz total harmonic and 60/7000-Hz IM distortion.



Harmonic distortion at three power levels.

of dc amplifiers and separate power supplies gives the Model 600 exceptionally low dynamic crosstalk distortion. According to the company, a very-low-frequency transient signal in one channel can cause a "sag" of power supply voltage in amplifiers that use a single power supply, introducing an intermodulation (IM) distortion component in the opposite channel.

Other special design features of the amplifier include an all-FET preamplifier with precision components in its phono equalization circuits; a dual VOLUME control attenuator that acts both ahead of and following the preamp to reduce noise to a minimum; and the greatest possible use of printed boards to minimize point-to-point wiring and possible interaction between channels.

Laboratory Measurements. Following the standard preconditioning period at one-third power, the amplifier delivered 153 watts/channel at 1000 Hz into 8-ohm loads at the clipping point, exceeding its rating. The power into 4- and 16-ohm loads was 216 and 95 watts/channel, respectively. At 1000 Hz, the THD was below our measurement limit of 0.003% from 0.1 to 30 watts output. It reached 0.014% at the rated 130-watt output and was 0.023% at 150 watts, just before the onset of clipping. The IM distortion measured between 0.01% and 0.02% between 1 and 90 watts, reaching 0.058% at 180 watts. It rose slightly at very low power levels, to 0.18% at an output of about 13 mW.

Across the full frequency range of the amplifier, the distortion was less than 0.015% from 100 to 6000 Hz at the rated output power. It increased to 0.028% at 20 Hz and to 0.06% at 20,000 Hz. It was lower at reduced power levels, which means that the distortion could be expected to fall between 0.006% and 0.01% at most frequencies and output powers.

The amplifier could be driven to a reference 10-watt output by 46 mV at its high-level inputs (0-dB ATTENUATOR setting). The 15- and 30-dB settings of the ATTENUATOR switch reduced the sensitivity to 0.25 and 1.45 volts, respectively. The noise level, referred to 10 watts, was −75 to −76 dB through the high-level inputs on all ATTENUATOR control settings.

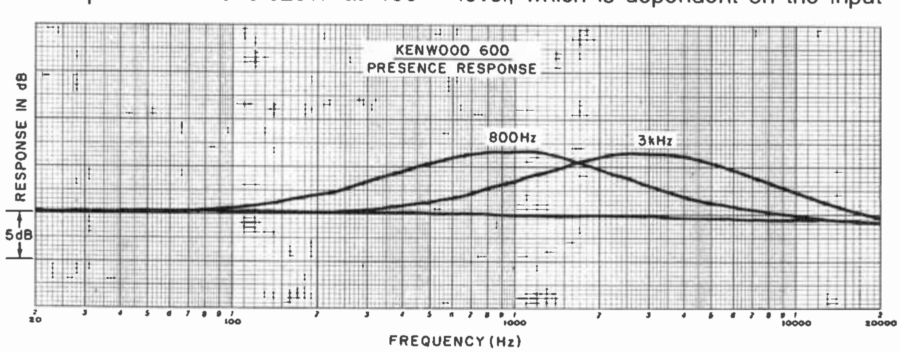
The phono sensitivity measured 0.72, 4.2, and 23 mV, depending on the setting of the ATTENUATOR control. These figures were doubled through the PHONO 2 input when the PHONO 2 GAIN control was set for minimum gain. The noise level, which is dependent on the input source impedance as well as the settings of the ATTENUATOR and VOLUME controls, was difficult to define in a universally applicable manner. Our normal procedure is to terminate the phono input with a 2200-ohm resistor, set the gain for a 10-watt output with a 10-mV input at 1000 Hz, and read the wideband (unweighted) noise at the amplifier's output. Depending on the various control settings, the S/N referred to 10 watts was between −66 and −70 dB. Shorting the phono inputs reduced the noise substantially. Kenwood's −76-dB rating is based on an "A" weighting curve; considering the difference in test conditions, it is probably consistent with our findings.

We were impressed with the high phono overload input of about 230 mV. (It was 440 mV through the PHONO 2 input with a −6-dB gain setting.)

The responses of the filters were down 3 dB at 28 and 5500 Hz, with the slopes at 12 dB/octave. The loudness compensation boosted only the low frequencies at reduced VOLUME control settings. The four positions of the LOUDNESS switch, in combination with the other gain-setting controls of the amplifier, gives an almost infinite variety of response curves.

The RIAA phono equalization was within ±0.6 dB from 50 to 15,000 Hz and ±1 dB from 20 to 20,000 Hz. The phono cartridge's inductance had a negligible effect on the equalization, changing it by less than 0.5 dB at any frequency.

Tone controls provided a wide range of response curves. When the 150- or 6000-Hz turnover frequencies were selected, it was possible to have about ±9 dB of response variation at the extremes of the frequency range, with less than 1 dB change between 250 and 3000 Hz.



Response effects produced by Presence switch.

The PRESENCE switch introduced a broad rise of 6.5 dB, maximized at about 1000 or 3000 Hz and affecting a total of about four octaves.

The square-wave rise time was about 3 μs through the entire amplifier and about 1.5 μs through the power amplifier section alone. We could not measure the slew rate because the amplifier's protective relay tripped whenever we tried. A 2-μF capacitor across the 8-ohm load resulted in a 50% amplitude ringing on a 1000-Hz square wave at about 50,000 Hz.

Although we did not attempt to duplicate Kenwood's test setup for evaluating dynamic crosstalk, we made one test that appeared to verify its absence. One channel was driven to a 1-watt output at 1000 Hz while the other was delivering 130 watts at 10 Hz. A spectrum analysis around the 1000-Hz output of the first channel revealed absolutely no sign of modulation sidebands at ±10 Hz or its harmonics, down to a measurement floor of −90 dB (0.003%).

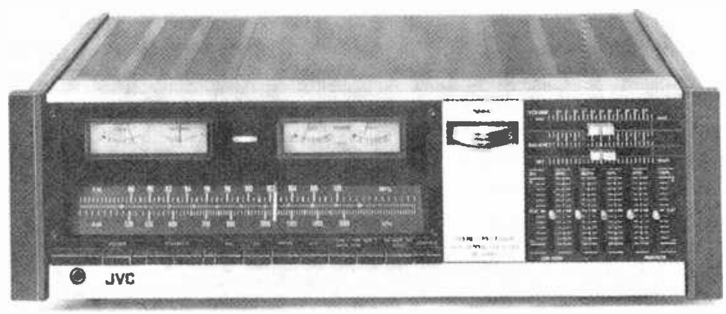
User Comment. The Model 600 is directly competitive with several other fine integrated amplifiers that have roughly similar power ratings and control features. Without attempting to make any comparisons (which would be meaningless when one is dealing with the near perfection of this type of equipment), we can say that the Model 600 does everything claimed for it and is rated with great conservatism.

It is interesting to note that this integrated amplifier is considerably smaller than some basic power amplifiers with the same or slightly higher, ratings. Yet it includes a fine, fully flexible preamplifier section. Not only is there no sign of skimping in its design or construction, but the Model 600 appears to have sufficient safeguards to withstand almost any abuse to which it might be subjected. It is a "brute" in performance, if not in appearance.

Kenwood's attention to detail and smooth control operation makes it a delight to handle and for listening. It even has filters that really work, removing unwanted noise without damaging the sonic balance, and that rarest of features—a loudness compensation circuit that does not muddy the sound. It should appeal to the audiophile who wishes to use a separate tuner.

JVC MODEL JR-S300 AM/STEREO FM RECEIVER

Features excellent built-in graphic equalizer.



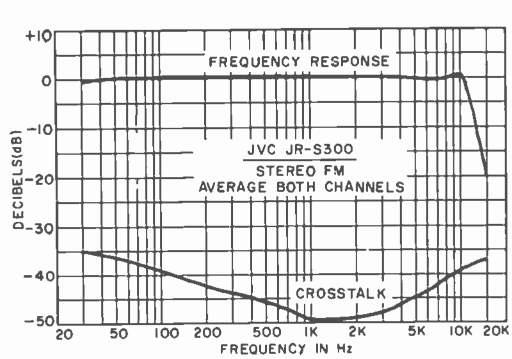
HIRSCH-HOUCK LABS REPORT

In the middle of JVC's receiver line is the Model JR-S300, a medium-power receiver rated at 50 watts/channel into 8 ohms between 20 and 20,000 Hz with less than 0.3% total harmonic distortion (THD).

Perhaps the most striking aspect of the JR-S300 is the total absence of any conventional control knobs. Every control is either a pushbutton or a slide potentiometer (the tuning "knob" is a horizontal wheel, a portion of which protrudes from the panel).

The receiver makes extensive use of integrated circuits in its tuner section. After the discrete-component "front end," which has a FET r-f amplifier, there are an isolation stage, dual ceramic filter, and single IC that provides the i-f gain, limiting and FM-detection functions. Another IC is the multiplex demodulator. (It is not stated whether it is a PLL type, but its performance suggests that it is.) The entire AM tuner's active circuitry is on a single IC chip. The balance of the circuits employ discrete components, and the power amplifiers are direct-coupled all the way out to the speaker terminals. A relay in the output circuit provides a turn-on time delay and protects the speakers from damage if a transistor or other component fails.

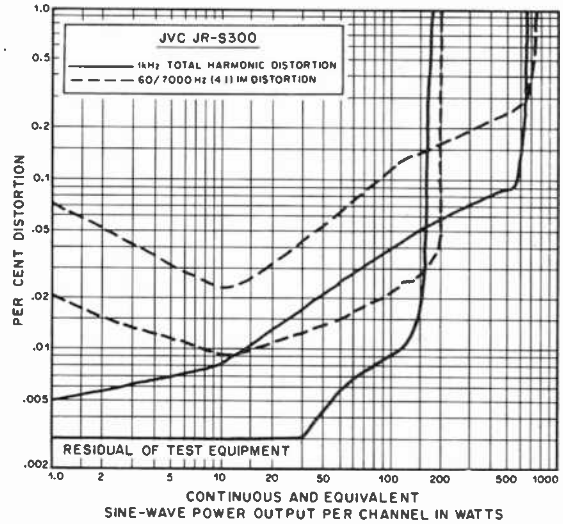
The Model JR-S300 measures 19 11/16" W × 13 3/16" D × 6 5/16" H (50 × 33.5 × 16 cm) and weighs about 23 lb (10.4 kg.). Price is $400.



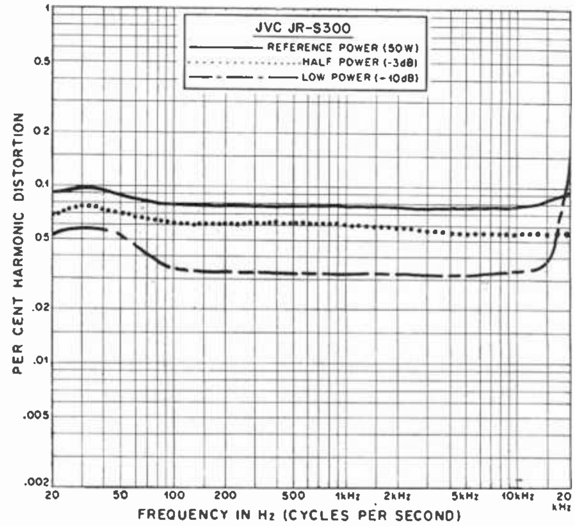
Frequency response and crosstalk averaged for both channels in stereo FM of JVC receiver.

General Description. The receiver is finished in black, with accents of aluminum, and the meter scales are lighted in blue. The dial occupies the lower portion of a large cutout on the left side of the panel. Above it are two pairs of meters. The left pair are tuning meters that indicate relative signal strength and FM center-channel tuning. To their right are audio "power output" meters for the two channels, calibrated to indicate from 0.25 to 50 watts, based on the use of 8-ohm loads. Between the groups of meters is an FM STEREO indicator.

The tuning wheel is on an aluminum panel to the right of the dial, and the slider controls form a group at the right side of the panel. Across the top of the control section are the horizontal VOLUME and BALANCE controls (the latter is detented at its center point). Below them are the five SEA ("Sound Effect Amplifier," in JVC's terminology) sliders, which take the place of tone controls and offer the greater flexibility of a graphic equalizer. They operate at center frequencies of 40, 250, 1000, 5000, and 15,000 Hz, and provide a nominal control range of



1-kHz total harmonic and 60/7000-Hz IM distortion.



Harmonic distortion at three power levels.

as much as ±12 dB at their respective center frequencies.

A row of pushbutton switches along the lower edge of the dial area completes the front-panel lineup. From left to right, they control POWER; two sets of SPEAKERS that can be activated individually or simultaneously; input selection for AM, FM, PHONO, and AUX; TAPE MONITOR functions for two tape decks; a combined FM MUTE OFF/MONO switch; and LOUDNESS compensation. Programs can be dubbed from TAPE 1 to TAPE 2 (but not the other way around), and the TAPE 1 circuit is also designated for use with an external noise-reduction unit (Dolby or JVC's own ANRS system). When so used, the TAPE 2 circuits are still available for a tape recorder. For proper reception of Dolby-encoded FM programs with an external adapter, it is also necessary to use an external network to convert the 75-μs FM de-emphasis to a 25-μs characteristic. The side panels of the receiver are ribbed to resemble metal heat sinks, but they are actually plastic and their only nonprotective function is to serve as handles for lifting the receiver. In addition to the signal connectors, the rear apron has a DIN socket for TAPE 2, an FM DET OUT jack for use with a future FM discrete 4-channel decoder, and separate preamplifier outputs and main amplifier inputs that are joined by removable jumper links. There are FM antenna terminals for 75- and 300-ohm antennas, a wire that capacitively couples the line cord to the antenna terminals to serve as an antenna in strong-signal areas, a hinged AM ferrite-rod antenna and a terminal for a long-wire AM antenna. Speaker terminals are insulated pushbutton spring clips. Two accessory ac outlets are incorporated, one of which is switched.

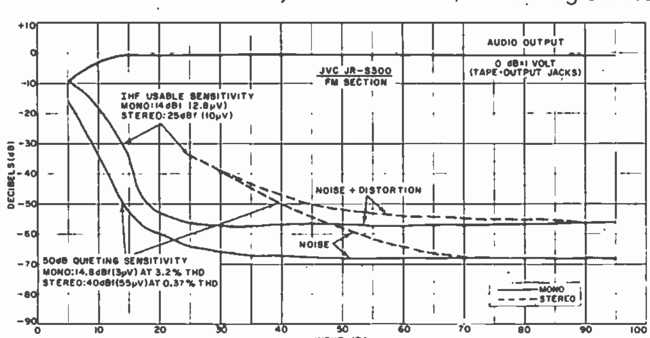
Laboratory Measurements. In almost every respect, the FM tuner section of the JVC JR-S300 surpassed its published ratings. The major exception was the IHF sensitivity, rated at 1.9 μV. Our test sample measured 2.8 μV (14 dBf). The stereo sensitivity was set by the switching threshold of 25 dBf (10 μV). However, the tuner's limiting curve was steep, which resulted in a 50-dB quieting sensitivity in mono of 14.8 dBf (3.0 μV) with 3.2% THD. In stereo, it was considerably less sensitive, measuring 40 dBf (55 μV) with 0.37% THD.

The FM distortion at 65 dBf (1000 μV) was low, measuring 0.41% in mono and 0.2% in stereo. Respective S/N measurements at that level were 68 and 66 dB. The stereo THD, with 100% L-R modulation, was 0.89% at 100 Hz, 0.63% at 1000 Hz, and 0.1% at 6 kHz.

The FM capture ratio at 45 dBf (100 μV) was 1.6 dB, and AM rejection was 60 dB at that level. Image rejection at 98 MHz was 60-dB. The alternate-channel selectivity (400-kHz spacing) was 66 dB, and the 200-kHz selectivity (adjacent channel) measured 6.4 dB. Muting and stereo thresholds were both 22 dBf (7 μV). FM frequency response was flat within ±1 dB from 30 to 10,000 Hz, but the pilot-carrier filter cut off at too low a frequency, dropping the response to −5.5 dB at 12,000 Hz and to −19.3 dB at 15,000 Hz. However, the 19-kHz pilot-carrier leakage was a very low −75 dB referred to 100% modulation. The stereo channel separation was excellent, better than 35 dB from 30 to 15,000 Hz and exceeding 45 dB between 500 and 5000 Hz. Tuner output hum was −72 dB. The AM frequency response, down 6 dB at 35 and 3000 Hz, was typical of the AM sections of most receivers.

The audio amplifier outputs clipped at a power of 60.5 watts into 8-ohm loads at 1000 Hz. Into 4 ohms, the clipping power was 78.3 watts, and into 16 ohms it was 40 watts. The THD at 1000 Hz was a very low 0.005% at 0.1 watt. It rose slowly to 0.04% at 10 watts, 0.089% at the rated 50 watts, and 0.14% at 60 watts. The IM was 0.07% at 0.1 watt, fell to 0.022% at 1 watt, and rose smoothly to 0.24% at 50 watts and 0.52% at 75 watts.

Distortion was virtually independent of frequency, with the 50-watt THD remaining between 0.08% and 0.1% from 20 to 20,000 Hz. At half power and one-tenth



Noise and sensitivity curves for FM section.

power the characteristic was similar, but the distortion was about 0.06% and 0.02% at the respective power levels.

The high-level (AUX) input sensitivity for a 10-watt reference output was 77 mV with a very low −79-dB noise level. Phono sensitivity was 1.2 mV, with a −75-dB noise level and a very high overload input of 200 mV.

The loudness compensation boosted both low and high frequencies as the volume control setting was reduced. Although the receiver has no low- and high-cut filters as such, JVC suggests using the 40-Hz and 15-kHz SEA controls for that purpose. However, these filters removed an undesirable amount of the program content, and we would not consider them suitable for this purpose. Also, the SEA filters are able to attenuate the response by only about 12 dB, leveling off at that point and then returning to the normal response level above and below their minimum response points. This is in contrast to a normal filter, whose attenuation continues to increase, at least within the audio band.

As an equalizer, or "tone control," the SEA system performed very well. In fact, it is superior to any conventional tone control we have used, including those that offer a choice of turnover frequencies. If your ears are good enough to tell you when you have achieved the desired response, there is a very good chance that it can be realized with this highly versatile control system. Although it lacks the ultimate control capability of an octave-band equalizer, it is much easier to use.

The RIAA phono equalization was accurate to within ±0.5 dB from 20 to 20,000 Hz and was affected by less than 1 dB when measured through the inductance of a phono cartridge. Calibration of the power meters was only approximate. One channel read from 5% to 25% high, and the other was typically about 35% high. However, the meters are adequate to give one a rough idea of operating power level.

User Comment. The Model JR-S300 offers a combination of more-than-competent, if not exceptional, FM performance. (We suspect that the loss of high-frequency response mentioned earlier was doubtlessly caused by a defective component rather than a design fault) with a very clean low-distortion low-noise amplifier that is capable of driving all but the very low efficiency speaker systems likely to be used in the home.

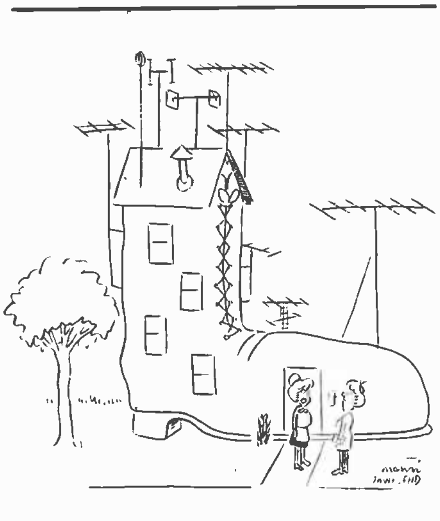
We're very impressed with the benefits of the excellent SEA tone-control system. It's one of the very few that can really improve the overall sound without introducing greater aberrations than those it corrects.

The receiver has its peculiarities, though, and people will doubtlessly react to them in different ways. For example, some may find it hard to see the advantages of linear slider controls used for volume and balance. (In the case of the SEA controls, of course, everyone will agree that the "graphic" configuration makes good sense; others may feel it exudes a "professional-appearance" touch). The horizontal tuning wheel, while perfectly functional, requires some getting used to. We found it helpful to rest the hand on top of the receiver when adjusting either tuning or volume with a thumb or finger to achieve the necessary smoothness of control (which would have been more easily obtained with conventional knob-operated controls).

At first, the combining of the muting and stereo/mono switching functions into a single pushbutton switch seemed strange, but after some thought it proved to be logical. The muting and stereo thresholds are identical, so that any signal too weak to overcome the muting system will be receivable only in mono anyway. Thus, simultaneously un-muting and going into the mono mode causes no real inconvenience. Incidentally, the muting action was positive and free of transients.

On overall balance, the JR-S300 is a lot of receiver for the money. Its generally good performance and distinctive styling will appeal to many people looking for all-in-one package stereo electronics at a moderate price.

CIRCLE NO 103 ON FREE INFORMATION CARD



"First Junior got interested in amateur radio; then Henry took up CB; George got an FM stereo; Fred got color TV; then—"

Hobby Scene Q&A

By John McVeigh

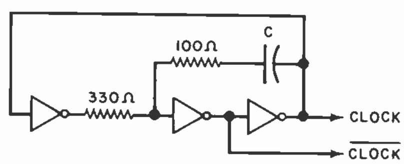
COIL FORMULA

Q. ***When I read the letter from David Gardner in the May issue, I knew for sure what your answer would be. Tell Dave to get a Lightning Calculator from the ARRL. It will tell him everything he needs to know about winding coils for r-f circuits.—Oscar A. Hoyt III***

A. Thanks for the tip, Oscar. I've used a Lightning Calculator myself and have found it to be most useful. The L/C/F Calculator (Type A) will, at the flick of a wrist, tell you the number of turns you will need for a particular coil, and will determine the resonant frequency of an LC network. It is available for $2.00 postpaid from the American Radio Relay League, 225 Main Street, Newington, CT 06111. Also of interest to experimenters is the new ARRL Electronics Data Book. It covers (among other things) filter design, transformer design (emphasizing toroids), antennas and feed systems, and construction and testing data. The Data Book is available for $4.00 from the same source.

SIMPLE TTL CLOCK

Q. ***I need a simple circuit that generates TTL-compatible clock pulses. Any ideas?—Jean-Baptiste Duval, Levis, Quebec***

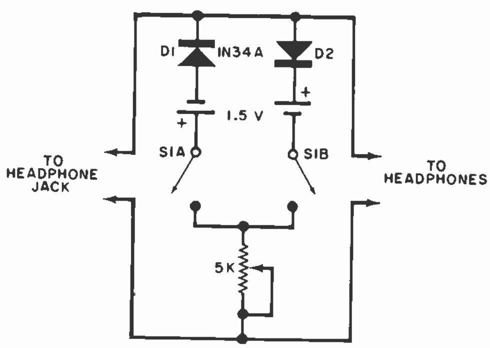


A. The circuit shown uses one half of a hex inverter—say, a 7404—and three passive components. A two-phase clock output is provided. The frequency of the clock is dependent on the value of *C*. For example, when a 200-pF capacitor is used, the output frequency is 5 Megahertz. When *C* is increased to 1600 pF, the output frequency drops to 1 Megahertz. A 100-kHz output can be obtained when 0.018 μF is used, or 10 kHz with 0.18 μF. Use of a close tolerance, high-quality capacitor is recommended to minimize frequency drift. Be sure to make V_{CC} and ground connections to the proper pins of your inverter IC.

EAR-SAVER

Q. ***Is there a device I can build to limit static crashes at the audio output of my communications receiver? Whenever I listen with my headphones on, I am plagued by atmospheric and power switch noise bursts.—Don R. Smith, K6CHS, Hemet, CA***

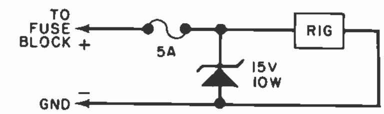
A. The circuit shown will give some relief to your ears. It's actually a biased diode clipper which prevents the audio signal from exceeding a threshold in either the positive or negative direction. Adjust the 5,000-ohm potentiometer for the desired clipping level. When no clipping is desired, open switch *S1*. Note, however, that this circuit can do nothing to prevent preceding stages such as the i-f amplifiers from being overloaded by noise spikes. The best solution is the use of an r-f noise blanker installed before the high-selectivity stages of the receiver.



MOBILE PROTECTION

Q. ***How can I protect my mobile transceiver from overvoltages?—Steve Hackett, Bangor, ME***

A. The circuit shown uses the "crowbar" technique. That is, if the voltage applied



to the rig reaches 15 volts, the zener diode starts conducting heavily and will blow the 5-Ampere (fast blow) fuse. The circuit will "crowbar" and remove power from the transceiver before it is damaged by the overvoltage. If you have a positive-ground electrical system, reverse the zener diode. The fuse can be inserted on either side of the dc supply.

MULTIPATH

Q. ***What is "multipath" and how does it affect FM reception? What can be done to prevent it?—Tom McLaughlin, Redford, MI***

A. Multipath is the constructive and destructive combination of two or more out-of-phase versions of an FM signal at the receiver. It occurs when a building or similar structure reflects a portion of the signal. When the reflected signal arrives at the receiving antenna, it slightly lags the phase of the signal travelling directly from the transmitting site to the receiving antenna. Reflections by several structures compound the problem. Multipath can be dealt with in several ways. First, the reflected signals should be attenuated as much as possible by the use of a high-gain directional antenna. The antenna should be oriented for minimum fading. Proper receiver tuning also helps. The use of a zero-center tuning meter is recommended. Some sophisticated tuners and receivers now come with a "multipath oscilloscope" which allows precise tuning for minimum distortion. Finally, it's important that the tuner's capture ratio be as low as possible. Reflections can be almost as strong as the direct signal, and it definitely helps to have a tuner that can reject signals whose strength is just below that of the desired one.

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, NY 10016. Though all letters can't be answered individually, those with wide interest will be published.

news HIGHLIGHTS

New Novice Callsigns

As of October 1, 1976 the FCC stopped issuing distinctive callsigns to Novice Class Amateur radio stations. Under the old system, callsigns were prefixed by the letters "WN" to facilitate their identification as Novice stations. This, however, lead to difficulties in the processing of Amateur applications. Now, all Amateur Novices with license expiration dates of October 1 or later will be issued new Novice licenses. The new licenses will be identical to the old, except they will be printed with the callsign the Novice licensees would have received under the old system upon obtaining higher class operating privileges. The new call assignment must be used by the Novice licensee as his callsign.

Computerized Devices at WESCON

"Dynavit," a bicycle exerciser based on a Rockwell PPS-4/2 microcomputer, was introduced at WESCON last year. The exerciser monitors fitness level, calorie loss and heartbeat. Weight, age and sex are punched in with a keyboard and used by the computer to calculate loading on the machine's pedals. After a few minutes, pulse beat is combined with this data to calculate a "health factor." Calorie loss and pulse beat are also displayed, and a flashing red light warns if pulse rate is more than normal.

TVI Inquiry Center

An inquiry center to deal with television interference problems caused by Citizens Band radios has been set up by the United States CB Radio Association. A television interference instructional kit prepared by the R.L. Drake Company and J.W. Miller Company details how to handle the interference problem, and can be obtained free of charge by writing to TVI, P.O. Box 21, Hartford, CN 06101.

Computer Records Dance

A University of Pennsylvania engineer has designed a computer editing system which enables choreographers to notate their dance scores quickly and accurately. New ballets can be recorded by several methods of notation, the most common being Labanotation, but it is rarely done due to the extremely complicated symbols used. The editing system employs a graphic display terminal connected to a keyboard with Labanotation symbols instead of letters on its keys. After a page of notation is completed, it is stored in the computer's memory and can be retrieved easily for quick reference. This new technique is expected to revolutionize the art of dance, where choreography was most often only recorded in the memories of the dancers and their audiences.

Interconnect Plan Opposed

AT&T has asked a federal court panel to reject the Federal Communications Commission's registration program for terminal interconnection, based on the Commission's alleged lack of consideration to the cost involved in implementing such a program and the economic effect it would have on operating telephone companies. A spokesman for AT&T claimed that the FCC's refusal to consider the economic impact of the program so undermined it, legally, that the court must reject the program and send it back to the FCC for further consideration. Thus, the registration program introduced by the FCC, bypassing the telephone companies who heretofore charged for a modem on a monthly basis, has not yet been implemented.

QSL Card for Hawaii

As part of Hawaii's Bicentennial celebration, the standard time and frequency broadcast station of the Commerce Department's National Bureau of Standards (NBS) in Hawaii has issued a QSL card for shortwave listeners and ham operators who tune in to the station. The card depicts an open, double-hulled sailing canoe and honors the bicentennial voyage of a Polynesian canoe that sailed from Hawaii to Tahiti recently without the use of modern navigational equipment.

1977 Computer Conference

A major program on personal computing is being planned as part of the 1977 Computer Conference to be held June 13-16 in Dallas, Texas. Included will be a personal computing fair; exhibits of computer products; paper, panel and workshop presentations; and a computing club congress where representatives of clubs can gather to discuss ideas and problems. For further information on the 1977 NCC, write to AFIPS Headquarters, 210 Summit Avenue, Montvale, New Jersey 07645.

23-Channel Retrofit OK'd

The Federal Communications Commission has decided that manufacturers of Citizens Band transceivers can retrofit their 23-channel models to 40-channel capacity. Add-on devices are strictly prohibited. However, CB manufacturers can obtain equipment authorizations for units capable of operating on the new frequencies and then use a type-accepted 23-channel unit in the manufacture of certified equipment covering the full 40 channels.

REACT Convention

Representing 21 states and Canada, 208 delegates attended the first REACT International Convention, held at Trinity College, Deerfield, Illinois, last August. Highlighted was the potential growth of REACT through regular exchanges of information at the state and local levels. Discussion included the expansion of Class D Citizens Radio channels, National Emergency Air Radio, the monitoring of channel 9, and disaster preparedness. REACT received recognition and approval from the government agencies attending the convention, and a new era of cooperation and mutual assistance is expected between REACT and the American Radio Relay League. Due to the success of the meeting, it was decided that an International Convention should be held annually.

SwTPC NEWS

More Memory-Same Price
4K Now Standard In 6800

San Antonio--The SwTPC 6800 computer system, always a best buy is now an even greater bargain. Price reductions by the manufacturers of MOS memory circuits have made it possible to now offer the standard $395.00 6800 computer kit with 4K of memory instead of 2K as previously. Memory circuits are 21L02 types which make possible powering up to 24K of memory in the stock chassis with the standard power supply.

The Southwest Technical 6800 at $395.00 includes everything needed to work with your terminal. You get 4K of static MOS memory and a serial interface as part of the basic package. These are not extra cost options (?) as in many computer systems on the market.

8K MEMORY CARDS ANNOUNCED –

For those 6800 systems needing the maximum possible amount of memory, Southwest Technical Products announces 8K memory cards. These memory expansion cards have 8K Bytes of low power MOS memory per board. These kits feature the new 4K static RAMS that are now becoming available. These new RAMS make it possible to put 8K of memory on a board without crowding the parts, or using small hard to solder connecting lines. These new memory boards feature DIP switch address selection and a write protect switch on each board.

The low power consumption of this new memory board makes it possible to use up to 48K of memory in the standard 6800 chassis with the stock power supply. Priced at $250.00 these memory cards cost no more than less dense memories from other sources.

PRICES CUT ON 4K MEMORIES

Southwest Technical Products has reduced the price of its standard 4K memory card by 20%. These cards use low power 21L02 static memories. The new price for the MP-M memory kit is $100.00 for a full 4K kit.

This kit contains 4K of memory with full buffering and dual on-board voltage regulators. Six of these memory cards may be used in a standard 6800 chassis to provide 24K of memory for the system. Memory now becomes even more of a bargain–24K for only $600.00.

Who Needs It?

We continue to get reports from customers who are amazed at the ease of assembly of the 6800 computer. One reports that he purchased test equipment before ordering a computer at the advice of friends who owned brand "X" machines. His total use of the test equipment was zero (0) when he installed each board in the 6800 and they all proceeded to work perfectly the first time. He later found in comparing notes with other 6800 owners that his was not a unique experience.

People who have built most of the various types of computers on the market generally agree that our instructions are the best and most complete. So don't worry about purchasing the least expensive computer system, there are still good honest values being offered in the world of personal computing.

SUPER SOFTWARE

"Lack of Software" can no longer be used as an excuse by those who have the poor taste to purchase computers using older, less elegant processors than the MC-6800. Southwest Technical Products has not only editor-assembler and game programs available for the 6800, but also both 4K and 8K BASIC.

The ability to run ANSII standard BASIC programs on the 6800 make the enormous number of BASIC programs out there all usable on the SwTPC 6800. That's right, you can run anyones BASIC programs on the 6800 provided they are written in standard BASIC (as most are). 4K Basic at $4.95 and 8K BASIC at $9.95 are inexpensive enough for anyone to own. They do not cost hundreds of dollars as in some systems, or only become available when combined with purchase of huge amounts of memory as in others.

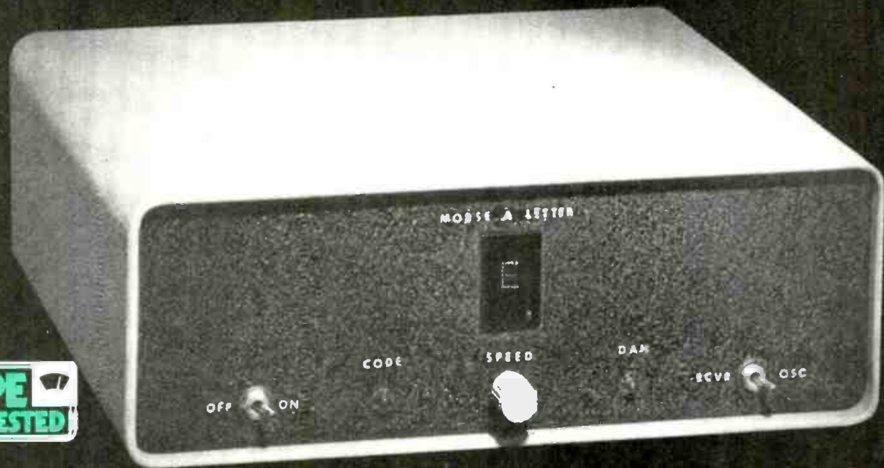
Loading even a relatively long program such as 8K BASIC into your SwTPC 6800 is not a long procedure when the AC-30 cassette interface is used. This super reliable and inexpensive ($79.95 complete with cabinet and power supply) cassette interface uses the "Kansas City" standard format and will load 8K BASIC in approximately five minutes.

SOUTHWEST TECHNICAL PRODUCTS CORPORATION
219 W. Rhapsody
San Antonio, Texas 78216

CIRCLE NO. 55 ON FREE INFORMATION CARD

GEORGE R. STEBER, WB9LVI
AND STEVEN E. REYER, WA9VNJ

Popular Electronics
JANUARY 1977



"READ" DIT'S AND DAH'S WITH THE MORSE-A-LETTER

Automatically decodes Morse transmissions and displays them alphanumerically, for amateur radio, shortwave, and code training purposes.

NOW YOU can read a message in Morse even if you don't know the code. The "Morse-A-Letter" project presented here automatically converts dahs and dits to alphanumeric characters. With this converter, SWL's can eavesdrop on code exchanges, and prospective and seasoned radio amateurs can have a valuable audio-visual Morse code training and operating aid.

What's more, the Morse-A-Letter features a sophisticated electronic design that ensures accurate and reliable performance. It accepts input signals from a receiver's headphone jack (or from across the speaker leads) and decodes them. The text characters—letters, numerals, and punctuation marks—are then shown sequentially on a LED matrix alphanumeric display. Standard TTL and linear IC's are employed, as well as two ROM's, a MOS character generator, and discrete components. Other features include a built-in monitor loudspeaker, a highly selective active filter, an agc circuit, ASCII output, and simplified, one-control operation. Total project cost is about $120.

Morse Code Theory. Before examining the Morse-A Letter circuit, let's review the basics of Morse code. International Morse code is a method of encoding Roman letters, Arabic numerals, and punctuation marks so that messages comprising them can be transmitted by radio or wire. Each character is uniquely represented as a group of *elements* taking the form of audio tones or silences (spaces) of prescribed length.

The tone elements are called dits and dahs, and the spaces consist of element spaces, character spaces, and word spaces. The dits and dahs within a character are separated by element spaces. (For example, the letter *s* is represented by the sequence: dit, element space, dit, element space, dit.) Whole characters and words are separated by character and word spaces, respectively. The normalized, ideal element lengths are shown in Fig. 1. For English text, the common method for determining the rate of transmission is expressed by the formula: code speed (in words per minute) equals dits per minute divided by 25.

Those familiar with Baudot or ASCII codes will consider Morse rather primitive. Each element is of variable length, and there is no provision for parity checking or error correction. Nevertheless, Morse is widely used by commercial press and ship-to-shore stations, the military, and amateur radio operators. This is partly due to the simplicity of the equipment required. Virtually any transmitter with provision for keying the r-f carrier on and off can be used for CW (continuous wave, or Morse code) work.

Other factors favoring Morse include its inherent efficiency. Just as much information is contained in the spaces as in the dits and dahs. Therefore, the amount of energy required to transmit a message is reduced by about 50 percent. Additional efficiency results from characters of variable length, from one to eleven elements. The most common letters in English text are assigned the shortest code.

The factors which make Morse efficient also make it difficult to decode. Atmospheric or man-made noise can occur, particularly during spaces (when no signal is present). This can introduce spurious elements. The fact that characters are not uniform in length means that character length is difficult to predict. However, the things that affect decoding most are the physical and psychological factors that influence manual sending quality. Fatigue, inattentiveness, and forgetfulness on the part of the sender cause randomness, unpredictability, and inaccuracy in element length.

The foregoing makes it clear that a Morse decoder must function with a high degree of accuracy for it to be effective. The Morse-A-Letter has been designed to meet this need by utilizing narrow filters for noise rejection, agc for fading compensation, and circuitry that allows for sending-speed variations.

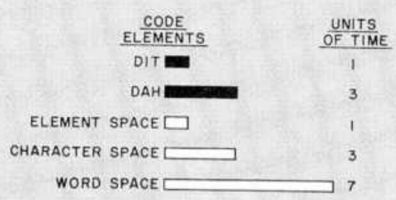


Fig. 1. Code element lengths normalized to length of a dit.

System Analysis. A block diagram of the Morse-A-Letter is shown in Fig. 2, with the complete schematic in Fig. 3. A selector switch at the system's input allows selection of either the internal 1100-Hz oscillator for code practice or an external audio signal from a radio receiver. The signal applied to the input is conditioned by an agc stage whose gain is determined by a voltage fed back from a succeeding stage. The ouput of the agc circuit feeds a two-stage narrow bandpass filter whose response is centered at 1100 Hz. An op amp and a speaker are connected to the filter output for monitoring purposes.

The filter output also drives a full-wave rectifier which demodulates the audio tones so that only low voltages or high voltages are generated. The demodulated signal is applied to two stages simultaneously. It is smoothed and filtered into the control signal of the agc loop, and is also "squared up" by a two-stage Schmitt trigger. At the output of the Schmitt trigger, a logic one corresponds to a key down condition, and a logic zero to a key up condition. Clean, constant-level Morse signals are thus available for processing by the decoding circuitry.

The processed Morse is then applied to two counters, called the key-up and key-down counters. One counter, but not both, will count, depending on whether the key is up or down. These key-condition counters operate at a rate dependent on the frequency of an internal, adjustable clock which must match the input code speed. However, the clock rate can be off by as much as ±50% and still provide solid copy.

Each time the key-up counter detects

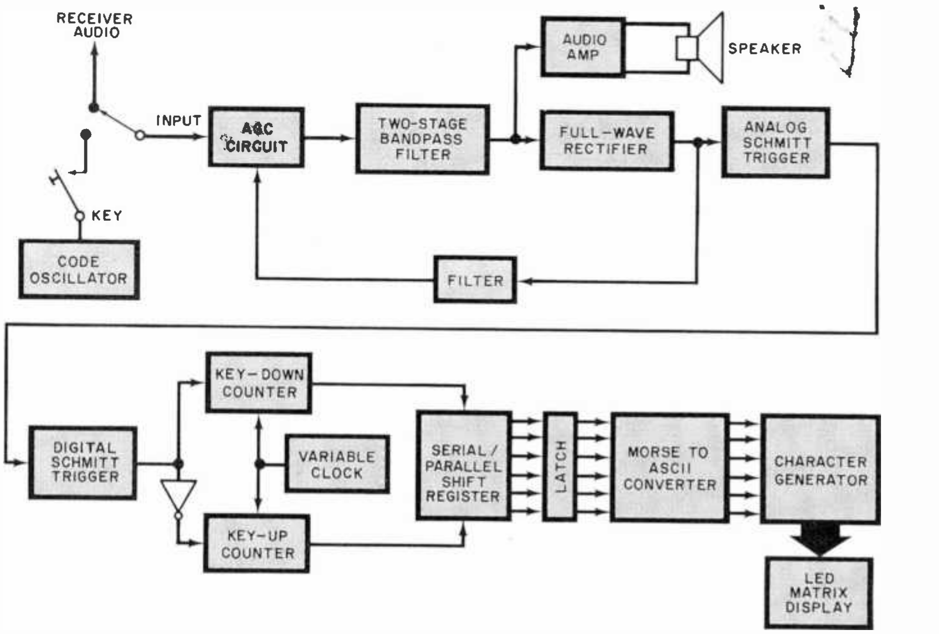


Fig. 2. Block diagram of the Morse-A-Letter shows how incoming code is converted to visual display.

PARTS LIST

C1—1-µF, 15-volt tantalum capacitor
C2 through C7, C18—0.1-µF, ±10% Mylar capacitor
C8—150-µF, 15-volt upright electrolytic capacitor
C9—6.8-µF, 15-volt tantalum capacitor
C10—0.01-µF Mylar capacitor
C11, C12,C13,C15,C17—0.1-µF disc ceramic capacitor
C14—0.15-µF Mylar capacitor
C16—470-pF silver mica capacitor
C19, C20—2.2-µF, 15-volt tantalum capacitor
D1, D2—1N914 diode
D3, D4,D5,D7,D8—1N270 diode
D6—4.7-volt, 1-watt zener diode (1N4732A or equivalent)
DIS1—MAN-2 5 × 7 LED matrix display
IC1, IC2—747A dual operational amplifier IC
IC3—741 operational amplifier IC (8-pin mini-DIP)
IC4, IC7,IC21—555 timer IC
IC5—7413 dual NAND Schmitt trigger IC
IC6, IC8,IC20—74161 synchronous four-bit counter IC
IC9—74121 monostable multivibrator IC
IC10, IC11—7495 four-bit right-shift/left-shift register IC
IC12, IC14—7475 quadruple bistable latch IC
IC13—7404 hex inverter IC
IC15, IC16—8223 256-bit bipolar programmable Read-Only Memory IC
IC17—2513 MOS character generator IC
IC18—7407 hex buffer/driver IC
IC19—74145 decoder/driver IC
LED1, LED2—20-mA miniature LED
Q1—2N3823 n-channel JFET
Q2, Q3—2N2222 npn switching transistor
The following fixed resistors are ¼-watt, 10% tolerance unless otherwise specified.
R1—4700 ohms
R2, R18, R19—10,000 ohms
R3, R12—200 ohms, 5% tolerance
R4, R5, R13, R14, R24—2200 ohms, 5% tolerance
R6, R15—180 ohms, 5% tolerance
R7, R16—100,000 ohms
R8, R10—39,000 ohms
R9, R22, R35 through R40—1000 ohms
R11, R34—470 ohms
R17, R20—1500 ohms
R23—68,000 ohms
R25—47 ohms
R26, R32—47,000 ohms
R28, R30—27,000 ohms
R29, R31, R42 through R46—330 ohms
R33, R41—5600 ohms
R21—5000-ohm printed circuit trimmer potentiometer
R27—100,000-ohm printed circuit trimmer potentiometer
R47—100,000-ohm linear taper potentiometer
S1—Spdt toggle switch
Misc.—Printed circuit board, 22-pin edge connectors (2, optional), suitable enclosure, plastic bezel, IC sockets or Molex Soldercons, small 8-ohm dynamic speaker, suitable jacks, standoff spacers, rubber grommets, brackets, machine hardware, hookup wire, shielded cable, etc.
Note—The following items are available from Select Circuits, 1411 Lonsdale Road, Columbus, OH 43227: Complete kit of parts including etched and drilled G-10 glass epoxy printed circuit board, power supply components and all parts except chassis and enclosure (MAL-1 PCK), $109.95; Etched and drilled G-10 printed circuit board (MAL-1), $17.95; Preprogrammed Letter ROM (LET-15), $6.00; Preprogrammed Numeral ROM (NUM-16) $6.00. Prices of ROM's include shipping charges if ordered with pc board MAL-1. If ordered separately, add $0.50 each for shipping charges. MAL-1 and MAL-1 PCK prices include shipping charges within the continental U.S. Ohio residents add 4% sales tax.

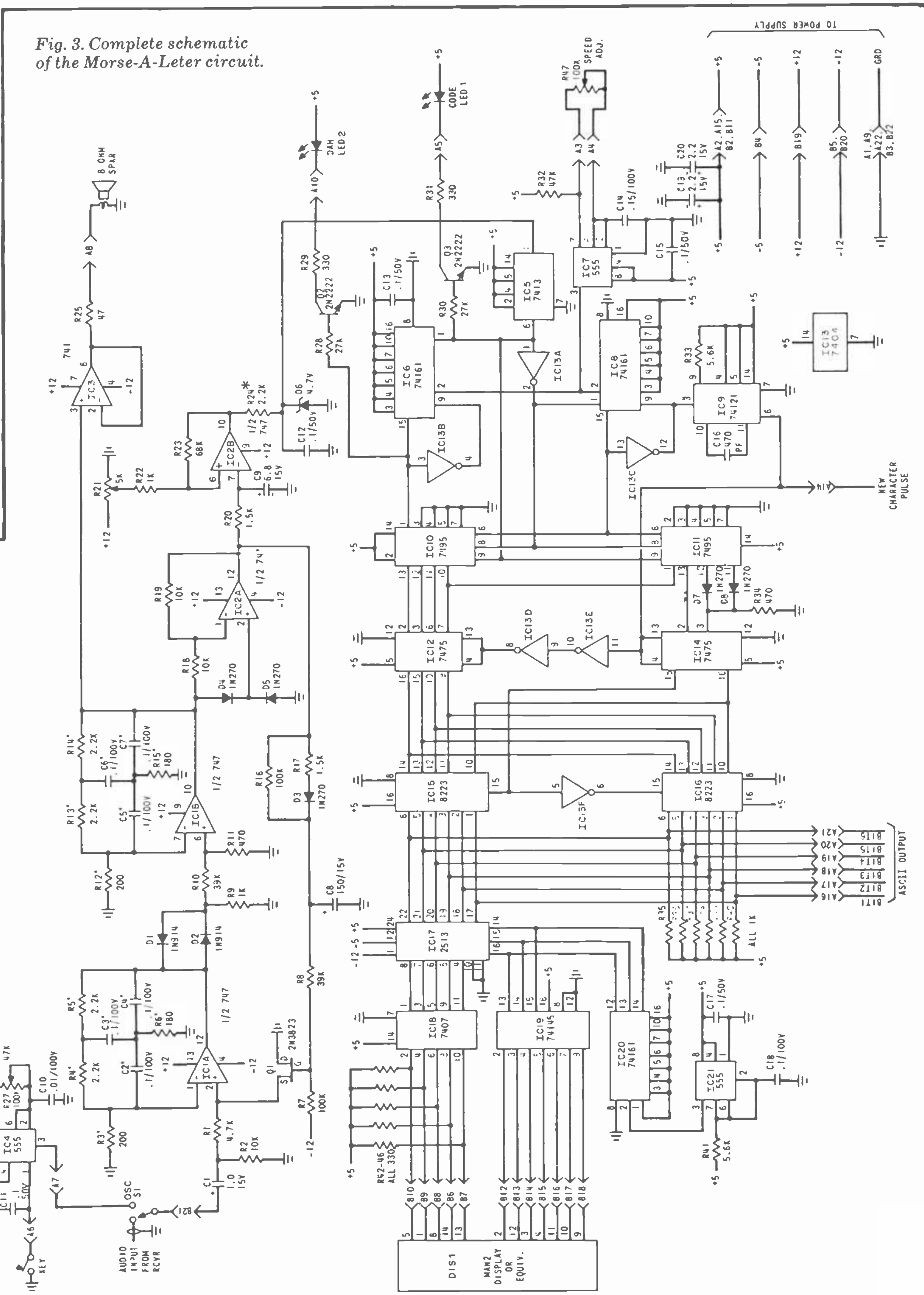


Fig. 3. Complete schematic of the Morse-A-Leter circuit.

an element space (a condition which occurs whenever the key-up counter detects less than 15 clock pulses), it serially transfers a logic 0 or 1 to the next stage, an eight-bit serial/parallel shift register. This shift register is always initialized to the binary word 00000001 so that the beginning of each Morse character will be uniquely decodable. The transfer of a logic 0 or 1 to the shift register is determined by the condition of the key-down counter. This counter differentiates between dits and dahs. If the key-down counter counts more than 15 clock pulses, the tone element is a dah. Otherwise, it is a dit. This simple detection scheme has been found to be very efficient and reliable in actual use.

This procedure continues until the key-up counter detects a space longer than an element space. At this point, it is known that a complete character has been sent, and the unique binary code present in the serial/parallel shift register is parallel-transferred to a latch for storage and ASCII encoding. The key-condition counters and shift register are then re-initialized and ready for the next Morse character.

Read-only memories (ROM's) are used to convert the binary code in the latch into ASCII. One ROM encodes letters, and another handles numerals and special characters. Conventional character-generating techniques are then employed for the display of the appropriate alphanumeric symbol.

A power supply circuit for the project is shown in Fig. 4. Current demand on the +5-volt supply is about 600 mA; while the −5-volt demand is only about 10 mA. Each 12-volt supply provides about 40 mA.

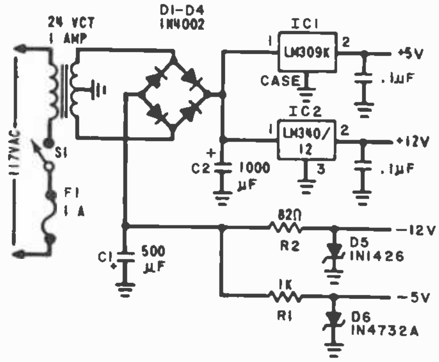


Fig. 4. Schematic of power supply.

POWER SUPPLY PARTS LIST

C1—500-µF, 35-volt electrolytic capacitor
C2—1000-µF, 35-volt electrolytic capacitor
C3, C4—0.1-µF disc ceramic capacitor
D1 through D4—1N4002 rectifier diode
D5—12-volt, 1-watt zener diode (1N1426 or equivalent)
D6—4.7-volt, 1-watt zener diode (1N4732A or equivalent)
F1—1-ampere fuse
IC1—LM309K 5-volt regulator IC
IC2—LM340/12 12-volt regulator IC
R1—1000-ohm, 10%, ¼-watt resistor
R2—82-ohm, 10%, 1-watt resistor
S1—Spst switch
T1—24-volt center tapped, 1-ampere transformer.
Misc.—Terminal strips, silicone grease, line cord and strain relief, fuseholder, hookup wire, solder, machine hardware, etc.

Construction. The Morse-A-Letter is most easily constructed on a printed-circuit board. The etching and drilling and parts placement guides for a board are shown in Fig. 5. Be sure to use a small-tipped, low-wattage soldering iron and Molex Soldercons or IC sockets. Start by inserting the smallest components first, gradually working up to the larger items. For example, install all the jumpers, then the ¼-watt resistors, followed by the diodes, etc. Naturally, you should follow good soldering practices.

Note that *DIS1, S1, S2, LED1, LED2,* the monitor speaker, jacks and sockets, and the power supply are not mounted on the pc board. Rather, provisions are made for using 22-pin edge connectors for interfacing. (See Table 1 for connector terminal number assignments.) Off-board components should be mounted in a convenient manner on a suitable project enclosure.

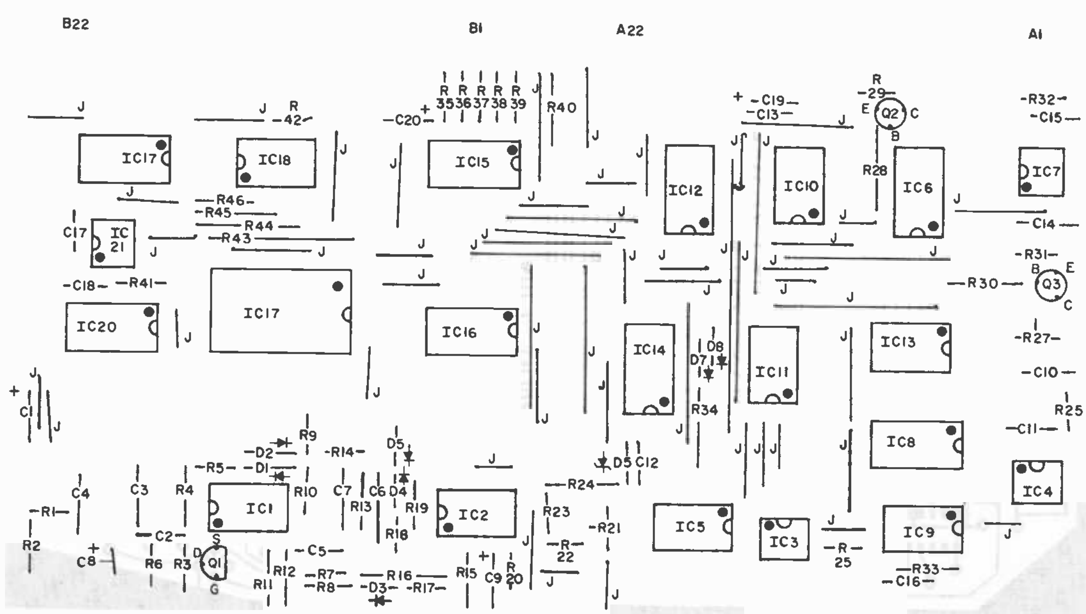
The ROM's (*IC15* and *IC16*) must be properly programmed. The truth tables are given in Tables 2 and 3. In POPULAR ELECTRONICS, July 1975, there's an article entitled "How to Program Read-Only Memories" that describes the required procedure. However, some parts sources will program the 8223's if you include the truth tables with your order. The kit supplier (see Parts List) also offers pre-programmed ROM's.

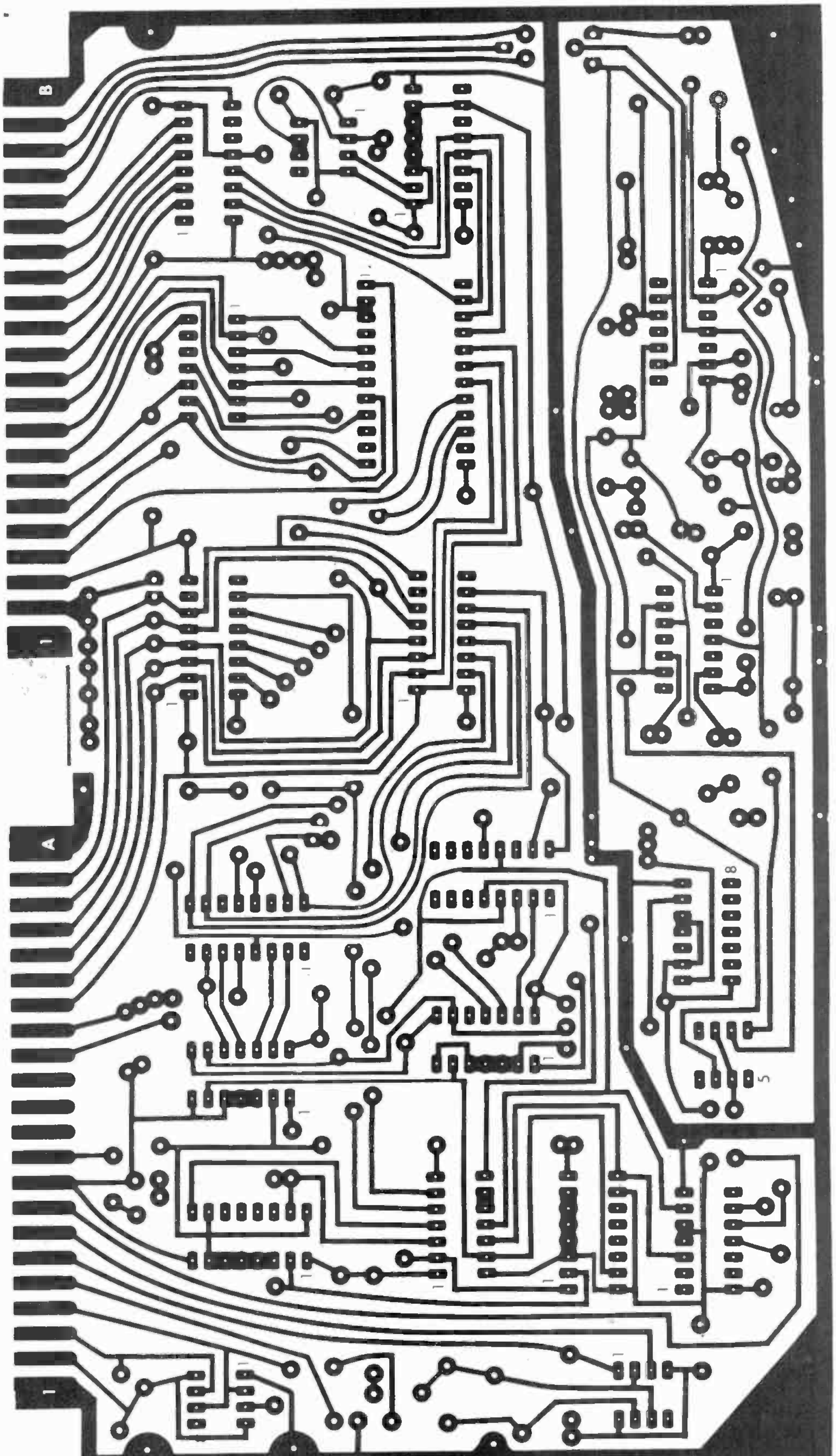
Install the IC's in their sockets, taking the usual precautions when handling MOS devices such as *IC17*. Apply power to the project.

Internal Adjustments. Two potentiometer adjustments must be made. The first determines the pitch of the code practice oscillator. Plug a telegraph key into the key jack and put *S1* in the osc position. Depress the key and adjust *R27* for the loudest output from the speaker. An aural adjustment is adequate. The pitch of the oscillator output will be approximately 1100 Hz (the center frequency of the active filter).

The second adjustment sets the threshold of analog Schmitt trigger

Fig. 5. Component placement guide is at right. Etching and drilling guide for pc board opposite.




B
A
1
8
5

IC2B. Connect the audio output of a shortwave receiver equipped with a BFO to the audio input jack of the Morse-A-Letter. You can take the audio signal from across the speaker leads or from the headphone jack. Use shielded cable for the interconnection.

The best way to make the adjustment is with a dc-coupled oscilloscope. Connect the receiver to the Morse-A-Letter audio input, and put *S1* in the RCVR mode. Carefully tune in a signal so that its pitch is in the center of the filter passband. When it is properly tuned in, the CODE LED (*LED1*) will glow. The signal will also be heard through the small monitor speaker. Note that the Morse-A-Letter's input stage is very sensitive and, therefore, does *not* require a large audio signal. Back down on the audio gain if you have trouble getting a signal properly tuned in. Connect a probe from the oscilloscope's vertical amplifier to pin 7 of *IC2*. The signal at this point should follow the code, with zero voltage when the key is up (spaces) and about four volts when the key is down (tone elements). The waveform will appear rounded or low-pass filtered.

Decide where you would like *IC2B*'s threshold to be, based on your observations of the waveform and its response to QRM (interference from other stations), QRN (interference from static), etc. Then place the scope probe on pin 6 of *IC2* and adjust *R21* so that the voltage at this point is the same magnitude as the chosen signal threshold. You'll observe that this voltage will not remain at exactly the same level, but will shift a small amount as the Schmitt trigger follows the code.

If a scope is not available, you can still make an approximate adjustment. Tune in a suitable signal as described earlier. Measure the key-up and key-down voltages at pin 7 of *IC2* with a high-impedance (20,000 ohm/volt or more) voltmeter. The key-up voltage should be zero and the key-down voltage about four volts. Then measure the voltage at pin 6 of *IC2*. Adjust *R21* so that this voltage is about 40% of the key-down voltage at pin 7. This technique should produce satisfactory results. There is nothing "magical" about the 40% figure. Experiment with the setting of *R21*.

If the Morse-A-Letter is to be used solely as a code practice device, the adjustment of *R21* should be made by either of the methods described, using the internal code practice oscillator as the signal source. Of course, the oscillator output frequency must first be set at the center of the active filter's passband.

CIRCUIT DETAILS

As shown in Fig. 3, a selective bandpass filter comprises *IC1A* and *IC1B* and the associated components. It provides a bandwidth of about 100 Hz and a degree of threshold limiting due to *D1* and *D2*. The filter forms the forward portion of the agc loop which automatically provides variable gain for operation during periods of signal fading. The agc loop is completed by full-wave detection of the audio output of *IC1B* by *IC2A, D4, D5* and the associated resistors. The resulting dc voltage controls the bias of *Q1*, a FET acting as a variable resistor. Capacitor *C8*, diode *D3*, and resistors *R16* and *R17* provide independent attack and decay times for the agc circuit.

Op amp *IC2B* is an analog Schmitt trigger which squares up the output of *IC2A*. The trigger's threshold is fixed after initial adjustment of *R21* because the agc loop maintains almost constant signal levels at this point even under extreme variations in input levels. The output level of *IC2B* is made TTL-compatible by zener diode *D6*. Op amp *IC3* is the remaining analog stage. It is a voltage follower that passes the band-pass filter output to a small speaker, providing adequate volume for monitoring purposes. A 555 free-running timer, *IC4*, is used as a code practice oscillator. Its output is fed to the band-pass filter when switch *S1* is in the OSC position.

The input to the "digital" section of the Morse-A-Letter (*IC5*) is a 7413 Schmitt trigger IC. It provides additional noise immunity and sharp rise and fall times for the succeeding stages. The output of *IC5* is used to enable or disable *IC6* and *IC8*, the 4-bit binary key-up and key-down counters, respectively. Both counters are wired to count to 15 and then latch up.

Assume that the key has been up for a few seconds. Key-down counter *IC6* is being held clear by the input signal. Key-up counter *IC8* has counted to 15 and latched. Thus, pin 15 (the carry output) of the key-up counter is at logic one, putting shift register *IC10IC11* in the parallel mode. (These two four-bit shift registers are wired together to act as one eight-bit register.)

Now assume the key is depressed. The word 00000001 is parallel-loaded into *IC10IC11* and *IC8* is cleared, putting the shift register in the serial mode. If SPEED control *R47*—which governs the clock rate of *IC7*—is set properly, *IC6* will count less than 15 clock pulses when a dit is sent, or latch at 15 when a dah is sent. Next, assume the key is released. The data at pin 15 of *IC6* is serially entered into the shift register and key-up counter *IC8* is allowed to count the length of the space. If it is short (meaning the character has not been completed), pin 15 of *IC8* will remain low and the shift register will remain in the serial mode. The stages will now process the next dit or dah.

This procedure will continue until the character is completed. The data in the shift register will then be equivalent to the Morse sent, with a dit a logic 0 and a dah a logic 1. Note, however, that a leading logic 1 has been inserted to identify the start of the character in the register. This is important because Morse is a variable length code. For example, the letter *A* (dit dah) will appear as 00000101 while a *U* (dit dit dah) will appear as 00001001. The leading (left-most) logic 1 is needed to eliminate the ambiguity that would otherwise exist.

A long space occurs at the end of a character which allows *IC8* to count to 15 and latch. This causes *IC9*, a one shot, to generate a new character pulse which will load the data from shift register *IC10IC11* into latches *IC12* and *IC14*. The data is held there and used to drive the display circuitry until the next character is completed.

If a letter is being decoded, only the first five bits are really needed. If a numeral or punctuation mark is received, six or seven bits are required. However, any punctuation mark or numeral is uniquely described by the five low-order bits in the register. If the sixth or seventh bit is a 1, the character is a numeral or punctuation mark. If the sixth and seventh bits are 0's, the character is a letter. So these bits are OR'ed together by *D7, D8*, and *R34* before being entered into the latches. The resulting signal selects either the letter ROM (*IC15*) or the numeral/punctuation ROM (*IC16*) to decode the remaining five bits.

The output of the ROM's is standard six-bit ASCII. This ASCII is used to drive *IC17*, a 2513 character generator, and is also available for use with a TV typewriter. (A "new character" pulse output is provided for CRT display.) Decoders and drivers *IC18-20* activate a MAN-2 LED matrix (*DIS1*) that provides alphanumeric display of the transmitted Morse characters. Integrated circuit *IC21* provides clock pulses for the decoder and driver stages. Two discrete LED's are also used for monitoring purposes.

The CODE *LED1* is driven by the Schmitt trigger output. This LED glows when the Morse signal is properly tuned in and is reaching the Schmitt trigger. The DAH *LED2* is driven by the data signal at pin 15 of key-down counter *IC6*. This LED glows when the transmitted tone element is longer than 15 clock pulses. A simple means of determining when SPEED (clock rate) control *R47* is properly set is thereby provided.

Operation. The Morse-A-Letter is very easy to operate. The only adjustment that you must make is the setting of the SPEED control (*R47*), and only a rough setting is required. Remember that the Morse-A-Letter input is quite sensitive, so you should set the receiver's audio gain a little lower than usual. If this is done, the primary source of audio output will be the project's internal speaker, and you will quickly learn how to tune the signal in to the center of the filter passband.

Once the signal is properly tuned in, the CODE LED will blink in step with the Morse. Adjust the SPEED control so that the DAH LED glows only when dahs are sent, not when dits are. The MAN-2 display will now read out the incoming characters. Note that "illegal" Morse characters will be displayed as @. For code practice sessions, place *S1* in the OSC position and adjust the SPEED control for the approximate sending speed. You may wish to calibrate the SPEED control. If so, the following formula will help you determine the required calibration points: Speed (wpm) = 0.15 *f*. That is, the code speed in words per minute equals fifteen hundredths of the clock frequency, which is determined by the setting of SPEED control *R47*.

Some users might feel that the center frequency of the passband (and thus the pitch of the practice oscillator) is too high. Or it may not coincide with the center frequency of the crystal filter in a given receiver. If a change of the center frequency is contemplated, the values of *R4-6* and *R13-15* should be modified. Here are alternate values for two frequencies:

Resistors	**800 Hz**	**1000 Hz**
R4,R5,R13, R14	3300 ohms	2700 ohms
R6, R15	270 ohms	220 ohms.

As mentioned earlier, the passband of the filter is about 100-Hz wide. A narrow filter is very desirable when used with a stable receiver that's equipped with a smooth, slow-moving tuning dial assembly. But if the receiver has a tendency to drift or the tuning dial is compressed or has some play in it, a narrow filter should not be used. Instead, the use of wide-tolerance, randomly selected, or even deliberately mismatched components for *C2, C4, C5, C7, R4-6* and *R13-15* is recommended to broaden the filter's passband.

As a final note, you are cautioned not to relay to a third party any information garnered from press transmissions or the like. Except for ham or broadcast transmissions, it's illegal to do so. ◇

TABLE 1
CONNECTOR TERMINAL ASSIGNMENTS

A1—Ground
A2—+5 Volts
A3—To speed pot R47
A4—To speed pot R47
A5—To "CODE" LED
A6—To key
A7—Oscillator output
(to RCVR/OSC select switch)
A8—To speaker
A9—Ground
A10—To "DAH" LED
A11—No connection
A12—No connection
A13—No connection
A14—New character pulse
A15—+5 Volts
A16—ASCII output bit 1
A17—ASCII output bit 2
A18—ASCII output bit 3
A19—ASCII output bit 4
A20—ASCII output bit 5
A21—ASCII output bit 6
A22—Ground

B1—No connection
B2—+5 Volts
B3—Ground
B4—-5 Volts
B5—-12 Volts
B6—To MAN 2 (DIS1) pin 14
B7—To MAN 2 (DIS1) pin 13
B8—To MAN 2 (DIS1) pin 8
B9—To MAN 2 (DIS1) pin 1
B10—To MAN 2 (DIS1) pin 5
B11—+5 Volts
B12—To MAN 2 (DIS1) pin 2
B13—To MAN 2 (DIS1) pin 12
B14—To MAN 2 (DIS1) pin 3
B15—To MAN 2 (DIS1) pin 4
B16—To MAN 2 (DIS1) pin 11
B17—To MAN 2 (DIS1) pin 10
B18—To MAN 2 (DIS1) pin 9
B19—+12 Volts
B20— -12 Volts
B21—Audio input from receiver
B22—Ground

TABLE 2
TRUTH TABLE FOR IC15

Character	Input					Output					
	A_0	A_1	A_2	A_3	A_4	B_0	B_1	B_2	B_3	B_4	B_5
A	0	0	1	0	1	1	0	0	0	0	0
B	1	1	0	0	0	0	1	0	0	0	0
C	1	1	0	1	0	1	1	0	0	0	0
D	0	1	1	0	0	0	0	1	0	0	0
E	0	0	0	1	0	1	0	1	0	0	0
F	1	0	0	1	0	0	1	1	0	0	0
G	0	1	1	1	0	1	1	1	0	0	0
H	1	0	0	0	0	0	0	0	1	0	0
I	0	0	1	0	0	1	0	0	1	0	0
J	1	0	1	1	1	0	1	0	1	0	0
K	0	1	1	0	1	1	1	0	1	0	0
L	1	0	1	0	0	0	0	1	1	0	0
M	0	0	1	1	1	1	0	1	1	0	0
N	0	0	1	1	0	0	1	1	1	0	0
O	0	1	1	1	1	1	1	1	1	0	0
P	1	0	1	1	0	0	0	0	0	1	0
Q	1	1	1	0	1	1	0	0	0	1	0
R	0	1	0	1	0	0	1	0	0	1	0
S	0	1	0	0	0	1	1	0	0	1	0
T	0	0	0	1	1	0	0	1	0	1	0
U	0	1	0	0	1	1	0	1	0	1	0
V	1	0	0	0	1	0	1	1	0	1	0
W	0	1	0	1	1	1	1	1	0	1	0
X	1	1	0	0	1	0	0	0	1	1	0
Y	1	1	0	1	1	1	0	0	1	1	0
Z	1	1	1	0	0	0	1	0	1	1	0

TABLE 3
TRUTH TABLE FOR IC16

Character	Input					Output					
	A_0	A_1	A_2	A_3	A_4	B_0	B_1	B_2	B_3	B_4	B_5
0	1	1	1	1	1	0	0	0	0	1	1
1	0	1	1	1	1	1	0	0	0	1	1
2	0	0	1	1	1	0	1	0	0	1	1
3	0	0	0	1	1	1	1	0	0	1	1
4	0	0	0	0	1	0	0	1	0	1	1
5	0	0	0	0	0	1	0	1	0	1	1
6	1	0	0	0	0	0	1	1	0	1	1
7	1	1	0	0	0	1	1	1	0	1	1
8	1	1	1	0	0	0	0	0	1	1	1
9	1	1	1	1	0	1	0	0	1	1	1
.	1	0	1	0	1	0	1	1	1	0	1
,	1	0	0	1	1	0	0	1	1	0	1
?	0	1	1	0	0	1	1	1	1	1	1
/	1	0	0	1	0	1	1	1	1	0	1
-	1	0	0	0	1	1	0	1	1	0	1

Chemicals for Electronics Servicing

BY A. A. MANGIERI

What you will need for:

- cleaning
- degreasing
- lubricating
- insulating
- heat-sinking
- protection
- conduction
- soldering
- cementing
- component debugging
- shielding
- paint removing

ELECTRONICS servicing requires the use of a number of specially formulated chemicals. If you do a lot of servicing work, you will need cleaners, lubricants, insulating chemicals, adhesives, etc. On the other hand, if your needs are minimal, you might be able to get by with only a few general-purpose chemicals. Bear in mind that best results are obtained by using the types and kinds of chemicals specially formulated for given jobs.

It is well to have some chemicals in both liquid and aerosol-spray form. Special packaging of many chemicals in dispenser vials, syringes, squeeze tubes and bottles, and pen oilers offer convenience in portability and application.

Keeping It Clean. Fundamental to all electronics servicing is to have on hand a wide variety of cleaners and degreasers. A service technician is often called upon to clean TV tuners, volume and tone control potentiometers, switch and relay contacts, and chassis and cases. It is quite common to restore an erratic TV tuner simply by cleaning away gummy residues and oxides from switch contacts.

Aerosol-spray and liquid cleaners include degreasing cleaners that leave no residue, and the polishing cleaners that leave behind a light protective lubrication. Most aerosol cleaners come with an extension tube that allows the user to pinpoint a confined blast of the cleaner and to get into otherwise inaccessible locations in a chassis.

To clean a tuner, you start by blowing out loose dust, using *WEP Air Blast* (Workman Electronic Products) or a similar compressed-air product. If the tuner's switch contacts are not visibly worn or oxidized, you can use a degreasing cleaner, such as *GC Nuvi-Tran* and *Tuner Bath* (GC Electronics) and *WEP Ultra Wissh* and *Miracle Bath*, etc. These nonresidue cleaners are specially formulated not to detune critical circuits or induce drift. If the tuner's contacts seem worn or oxidized, a lubricating and polishing cleaner with silicone, such as *WEP Super Wissh* or *GC Spra-Lube*, is called for. Foaming cleaners, such as *GC Magic Vista* and *WEP Lubrite*, lift off dirt and lubricate and polish the switch contacts. Lubricating cleaners usually do not induce drift or instability. If this should occur, you can use a degreasing cleaner on neutralizing and trim capacitors.

All parts of a TV tuner should be cleaned, including the fine-tuning mechanism, shafts and bearings, and grounding wipers. Lubricate the mechanical portions where required. For big cleaning jobs, you should use a nonflammable liquid cleaner like *GC Chloro-Kleen.*

De-Ox-Id is an effective cleaner in an oil base that loosens oxides and leaves a light lubricant on switch contacts. This cleaner should be applied sparingly on switch and relay contacts, after first removing dust and grime with *GC Replay-Kleen.* You can usually restore scratchy volume and tone controls by injecting a drop or two of *De-Ox-Id* inside them and on the shaft bushings. Touch up rough relay contacts with the burnisher supplied in the *GC Contact Burnishing Kit*, which also includes a cleaning solvent. Faulty toggle switches used in light-duty applications are usually dirty, rather than worn. Try working in some *De-Ox-Id* along the solder lugs or other opening to clear up the problem.

Oxide build-up on audio and video tape heads impairs frequency response. Use a cleaner that is especially formulated for tape heads and does not harm tape, plastics, or paint. You may prefer to brush clean tape heads with *GC Mag-Netic Head Cleaner*. Record discs should also be cleaned periodically. You can use cleaner/lubricators like *Discwasher, Sound Guard, Rek-O-Magic Reco Kleen* or others with built-in anti-static chemical.

Smooth Running. Lubricants for electronics servicing are highly refined oils and greases that provide high lubrication, rust inhibition, and stable viscosity over a wide temperature range. Additives minimize oxidation, foaming, and gumming.

Always apply lubricants sparingly since any excess may drip or creep from the point of application onto nearby rubber parts and insulation, causing damage. Most lubricants are convenience packaged in unbreakable pocket pen oilers and vials, plastic squeeze bottles, and aerosol-spray cans. Greases are packaged in bottles, syringes, and squeeze tubes.

Dispensing high-quality instrument oil, the *Reach-All* pen oiler with steel extension tube permits application of one drop at a time or less. Also dispensing high-quality general-purpose oil, the *Zoome-Spout Oiler* has a 7" (17.8-cm) flexible extension spout that reaches into normally inaccessible places with ease. *WEP's Lub-A-Kit* is a pocket-size lubrication kit that includes vials of instrument oil and liquid graphite, as well as dry graphite that is dispensed in puffs from a squeeze tube.

Although general-purpose oils do a creditable or superior job in most applications, special-purpose oils are available for special applications. The *GC No. 9400 Electronic Oils* kit, for example, includes radio-TV, phono, tape-recorder, penetrating, and dripless oils, plus liquid graphite. Dripless oil should be used wherever messy oil creeping must be avoided, such as on cabinet hinges, topside tape deck drives, etc. Liquid graphite can be used to lubricate locks, slides, hinges, pushbutton switch mechanisms (mechanical portions only) with a thin film of lubricant that does not foul easily with grit.

Lubricants in aerosol spray cans allow large areas to be sprayed for lubrication and rust prevention. For spraying smaller areas, the spray extension tube that comes with the aerosols can be used. The *WEP Spray Oil* dispenses general-purpose oil with a silicone additive. Silicone spray oils like the *GC Sili-Spra* provide a light lubrication and long-lasting protection. *Sili-Spra* can be applied in a light, medium, or heavy coating by adjusting its three-way spray valve. An unusually slippery silicone lubricant, *WEP Slic-Spra* lubricates and protects as well as eliminates sticking. It also protects rubber and leather and waterproofs fabrics.

You will need several grades and types of grease for record-changer mechanisms, switch and relay contacts, and other mechanical devices that require no-flow lubrication. Light greases for switch contacts and controls, such as *GC Lube-Rex* and *Contact Dope*, lubricate and protect self-wiping contacts. You can also use *Lube-Rex* on gears, bearings, and slides.

Greases in squeeze tubes, like *Lubriplate* and *Phonolube*, are easy to apply as needed and tuck away unobtrusively in a tool caddy. *WEP Precision Grease* comes in a syringe, which precludes messy over-lubrication. This grease is free of zinc and metal oxides, which would impair high-frequency operation.

Insulating Chemicals. Problems with insulation are likely to occur in the high-voltage section of a TV receiver. Arcing and corona discharge result when the insulation on the flyback transformer or horizontal output transformer peels, cracks, or melts off. If the flyback transformer is still operative, repairs can be made with any of several chemicals.

When repairing a flyback transformer, the first thing to do is check out the horizontal output tube and circuit to correct the fault that caused the problem. Then, clean the high-voltage cage and components inside it with a nonresidue cleaner. You may be able to remove portions of the cage or the entire cage by unsoldering two wires. Spray or brush onto the flyback transformer's windings several coats of *GC Red-X, GC HV Corona Dope, WEP Corona Dope* or similar product. If thick pieces of insulation have peeled off the windings, make repairs with *GC High-Voltage Putty*. Then check for corona discharge in a darkened room; apply *High-Voltage Putty* and/or corona dope as required. (CAUTION: Readers not familiar with TV receiver circuits and safe working practices around high voltages should *not* open the high-voltage cage or attempt such repairs.)

A fast-drying coil dope, *GC Polystyrene Q-Dope*, insulates and protects r-f, uhf, and vhf coils without affecting Q. Insulate and protect motor windings and transformers with *GC Red GLPT Insulating Varnish. GC Liquidope*, a versatile general-purpose transparent coil

Chemicals galore assist you in servicing today's electronics. They include lubricants, contact cleaners, component coolers, etc.

Pc board chemicals include silicone grease heat-sink compounds, conductive paints, silicone resin lacquer board coating and solvent.

coating, shrinks on drying and tightens loose coil windings. You can use it in TV receiver high-voltage cages as a corona dope and in many other applications. *GC Liquid-Tape* is a black viscous high-voltage coating that is strong and pliable and will not chip, crack, or peel. It can be used to coat fraying motor-lead wires, as a sealant to exclude moisture, as a paint-on insulator, etc.

Insulating and Dipping Varnish from GC has an exceptionally high dielectric strength (2000 volts/mil), penetrates well and insulates and moisture proofs field coils, power and output transformers, filter chokes, linearity chokes, width coils, etc. Among the aerosol-spray insulating coatings are *GC Insul-Volt* and *Koloid K-29,* which are general-purpose coatings for electrical windings. Although the various insulating coatings have a common job to perform, their differences in drying rates, penetrating quality, temperature range, toughness, flexibility, etc., will influence your choice for a particular application.

Chemicals for PC Work. An indispensable chemical for servicing solid-state circuits, silicone-grease heat-sinking compound insures efficient heat transfer from transistor cases to heat sinks. It is applied between the case of the transistor and the heat sink and does not melt or run or freeze over a wide temperature range. *GC Z5 Transistor Silicone Compound,* a transparent grease, and *WEP Silicone Lube* are free of metals and oxides. They can also be used as anti-corona compounds and protective lubricants. *GC Z9 Silicone Super Heat Sink Compound* contains metal oxides that effectively increase the thermal conductivity of the grease.

Liquid solder fluxes that can safely be used on printed circuit boards are *GC Print Kote* and *Liquid Solder Fluxes.* These solutions contain rosin as the active agent. In a pinch, you can make a better than passable solder wick by dipping small-size tinned wire braid into these solutions. The potent noncorrosive *Soldering Paste* from GC effectively tins soldering iron tips. If you must use this paste on an electrical connection, thoroughly clean the connection to remove all traces of the flux.

Resin lacquer coatings that are often applied to printed circuit boards to protect the foil traces from oxidizing foul solder wicks and impede desoldering. The coatings can be removed with *Print-Kote Solvent* and replaced with *Silicone Resin Lacquer,* both from GC.

Conductive paint permits a foil trace on a pc board to be touched up, without having to go to the bother of soldering. It can also be used to paint a conductive shield or draw a ring around the input terminals of a sensitive component. *GC Copper Print* consists of copper particles suspended in a fast-drying binder. This paint requires very thorough mixing before and during use to keep the copper particles in suspension.

Silver Print paint, also by GC, is costlier but much easier to use than is *Copper Print. Silver Print* consists of finely divided silver particles in a somewhat more fluid binder. More like an ink than a paint, *Silver Print* mixes easily and stays in suspension during use. *Silver Print* can be applied with the finest of brushes and even ruling pens and compasses used by draftsmen. To develop a feel for conductive paints, paint a few lines of varying widths, lengths, and weights and measure the resistance, which may vary between a few milliohms to tens of ohms for thin films.

Cements and Adhesives. You will need at least one of three classes of cements and adhesives to repair loudspeaker cones, control knobs, and equipment cases and cabinets. The super-strength epoxy and cyanoacrylate cements are invaluable but cannot be used on porous materials. The plastic-base cements with solvent agents are inexpensive but cure slowly when bonding nonporous materials and most have low initial bonding strength. In the last group are the contact cements that bond almost all materials with good initial

Servicing adhesives include plastic base cements, rubber base contact cements, and the super-strength epoxy and cyanoacrylate adhesives.

bonding strength but are not well suited for small-area, high-stress bonds.

The latest of the super-strength "miracle" adhesives, the cyanoacrylates (such as *GC Permabond* and *WEP Quick Bond*), are thin-film adhesives that bond nonporous materials almost instantly. These cements flow readily into hairline cracks but will not fill in larger voids or tolerate dirty or ill-fitting surfaces. You can obtain maximum bonding strength with the aid of a highly effective surface cleaner and activator supplied in the *Workman No. 33-102 Bond-Solv Kit*. In addition to *Quick Bond* adhesive, the kit includes *Bond-Fix* solvent for cleaning and activating the surfaces; *Bond-Solv,* a true solvent for releasing cured bonds and cleaning up; and the unique *Pro-Bond Industrial Syringe* with flexible needle that applies the adhesive without waste. With the Workman kit, you can bond plastics, metals, rubber, vinyl, nylon, Teflon, polyethylene, and even some silicone materials.

Cyanoacrylate cement must never be spread on the surfaces to be joined because it dries too rapidly. Apply a drop in a puddle on only one surface and firmly press the parts together to spread the adhesive. Although developing high strength in seconds, allowing the bond to cure overnight will insure maximum strength.

Epoxy cement, also a super-strength adhesive, cures by chemical action between epoxy resin and a hardener mixed in equal proportions before use. Standard epoxy cements cure overnight. You may, however, find it more convenient to use the "five-minute" epoxies, such as GC's *Quik-Stik* and WEP's *Double Barrel Epoxy*, the latter dispensed from a double syringe to assure mixture of the proper proportions of resin and hardener. Epoxy cement readily fills in gaps and voids between the surfaces to be joined and cures without serious shrinkage or loss of bonding strength. Cleaning up of cured excess epoxy is difficult. Therefore, it is always good policy to clean away any excess promptly, before the cement has had time to cure. Although it is preferably used on nonporous materials, epoxy cement can be used on dense woods like maple, ash, etc.

Less expensive plastic-based cements are well suited for many repairs. The fast-drying *GC Radio-TV Service Cement* is ideal for cementing speaker cones and grille cloth, but it dries slowly on nonporous materials. A general-purpose cement for plastics, *GC Plastic Cement* bonds acetates, butyrates, phenolics, and vinyls. Special-purpose plastic cements include *Bakelite Cement*, which bonds such thermoplastics as the ureas and phenolics, *Acrylic Cement*, which bonds such thermoplastics as *Lucite* and *Plexiglass*, and *Vinylite Cement*, which welds or bonds vinylite. All three are available from GC, as is *Magnetic Cement*, which bonds broken loopsticks, yoke cores, and other ferromagnetic materials.

Contact cements are rubber based. They must be applied to both surfaces that are to be joined and allowed to dry until tacky before pressing the two surfaces together. You can use contact cements on grille cloths, paper, rubber, wood, plastics, and metals. A high-grade general-purpose contact cement available under the name *Plybond* from GC surpasses ordinary contact cements. Special-purpose contact cements include *GC Rubber To Metal Cement* and *Ne-O-Prene Cement*. An aerosol spray cement, such as *WEP Stik-E-Wipe*, makes cementing a tube-replacement chart or schematic diagram to a cabinet a no-mess snap of a job.

Miscellaneous Chemicals. You can spend a lot of time tracking down an intermittent transistor, capacitor, resistor, or other component. But you can also save a lot of time by using a circuit cooler, such as *GC Zero-Mist Circuit Cooler* or *WEP Super Freez-It*, which are aerosol spray refrigerants that almost instantly cool the suspected component to below freezing. In use, when the heat-related intermittent component is cooled and circuit operation returns to normal, you have located the fault.

You can replace peeling or flaking picture tube coating with *GC No. 49-12* aerosol *Television Tube Koat* or *No. 49-2* brush-on *Tube Koat*. The conductive coating often flakes off where it contacts a grounding spring or wiper. Incidentally, this chemical can also be sprayed or painted on the inside surfaces of a plastic case to form an electrostatic shield. As a last resort, you can use *Tube Koat* to repair breaks or worn spots of the carbon element in a volume or tone control.

You can safely remove enamel from the thin wire used in r-f coils and chokes by applying *Strip-X,* which removes enamel, Formvar, Formex, and other such coatings. Other useful chemicals include *WEP Lubricant & Moisture Displacer*, which clears electrical short circuits due to moisture, and *GC Liquid Non-Slip*, which eliminates slippage of dial cables and belts. ◇

PHOTOELECTRIC SENSOR

DETECTS (AND COUNTS) ENTRANCES & EXITS

In/out detection system counts events (up and down) and can be used to control lights, appliances, etc.

BY DAVID MARKEGARD

MOST photoelectric entry detectors are unidirectional. They can detect when an individual enters a given area but not when he leaves. A more practical system, from both a security and a convenience point of view, would be able to detect motion in both directions. A store owner would then know whether or not all customers who entered his premises had left by the close of the day. In the home, such a system could be used to automatically turn on and off lights as you enter and leave a room.

The in/out detection system described here is a relatively simple and inexpensive approach that takes advantage of readily-available TTL IC's. It not only turns on the room lighting (or any other electrical device) when the first person enters the monitored area, it also keeps tabs on the number of people entering and leaving the area. The system turns off the electrical device only after the last person has passed the sensor while exiting the area.

The basic circuit is designed to count up and down a maximum of nine events. However, it can easily be modified to count 99, 999, etc., events simply by adding extra IC's and diodes. Additionally, the system can accommodate two or more sets of sensors should you have more than one doorway to monitor.

About the Circuit. In the circuit shown in Fig. 1, the UP and DOWN sections of the system operate in an identical manner, the only difference being in the direction of the count. Since operation is identical, we will discuss the sequence of events in only the UP section.

When an external light beam shines on *LDR1*, the resistance of this light-dependent resistor is a low 100 ohms (approximately). Consequently, the input to pin 13 of *IC1* is low, making the output of this inverter stage, at pin 12, high. Now, when the beam to *LDR1* is broken, the light-dependent resistor's characteristic resistance rapidly increases to several megohms, placing a relatively high positive voltage at the pin-13 input of *IC1* to generate a low output at pin 12. The steep edge of the rapidly falling voltage at pin 12 is differentiated by *C1, R2*, and *R3* to produce a sharp negative pulse whose width remains constant regardless of how long the light path to *LDR1* is broken.

Resistor *R2* also serves as a "pull-up" for the input of *IC2*, a timer integrated circuit that is connected as a one-shot multivibrator. When triggered, *IC2* generates a positive-going pulse at its pin-3 output. This pulse is then inverted by another inverter stage in *IC1*, after which it is passed to the "count-up" input (pin 5) of up/down counter *IC4*, registering a one-count increase. With each successive breaking of the beam to *LDR1*, the system registers another up-count (to a maximum 9 count, after which the system automatically resets to 0).

The same inverted signal that is applied to the pin-5 input of *IC4* is also applied to the reset input (pin 4) of *IC3*, another timer integrated circuit connected as a one-shot multivibrator. This inhibits the output of *IC3* and prevents any possibility of generating a false down-count in the system. Bear in mind that *LDR1* and *LDR2* in the finished project are mounted physically close to each other so that a common light beam can be used for both. This means that when an opaque body passes between the beam and *LDR1*, a discrete interval later it passes between *LDR2* and the beam. Hence, if *IC3* were not inhibited, the system would count up and almost immediately count down as the beam to first one and then the other LDR is broken. The system must, therefore, respond to the count generated by the first LDR to be activated—in this case, *LDR1*—for true bidirectional performance.

The four outputs from *IC4* are coupled through isolating diodes *D1* through *D4* and current-limiting resistor *R10* to the base of transistor *Q1*. The transistor is held in cutoff whenever all the outputs of *IC4* are low and conducts whenever any one or more outputs are high. When *Q1* is conducting, relay *K1* is energized and operates whatever external device is connected to its contacts.

As noted earlier, the basic system is configured for a maximum count of 9 in either direction. If you wish to increase the count range, you can add one or more 74192 up/down counter IC's to the basic circuit as shown in Fig. 2. Each added 74192 IC will then provide a one-decade increase in range. For example, two 74192's increase the maximum count to 99, three 74192's to 999, etc. When up/down counters are added, the "carry" and "borrow" pins (pins 12 and 13) of each preceding counter become the inputs to the next counter in line. Note also that all "clear" inputs (pin 14) of the counters must connect to CLEAR switch *S1*.

An adequate light source for the system can be obtained by using a low-voltage power transformer with an appropri-

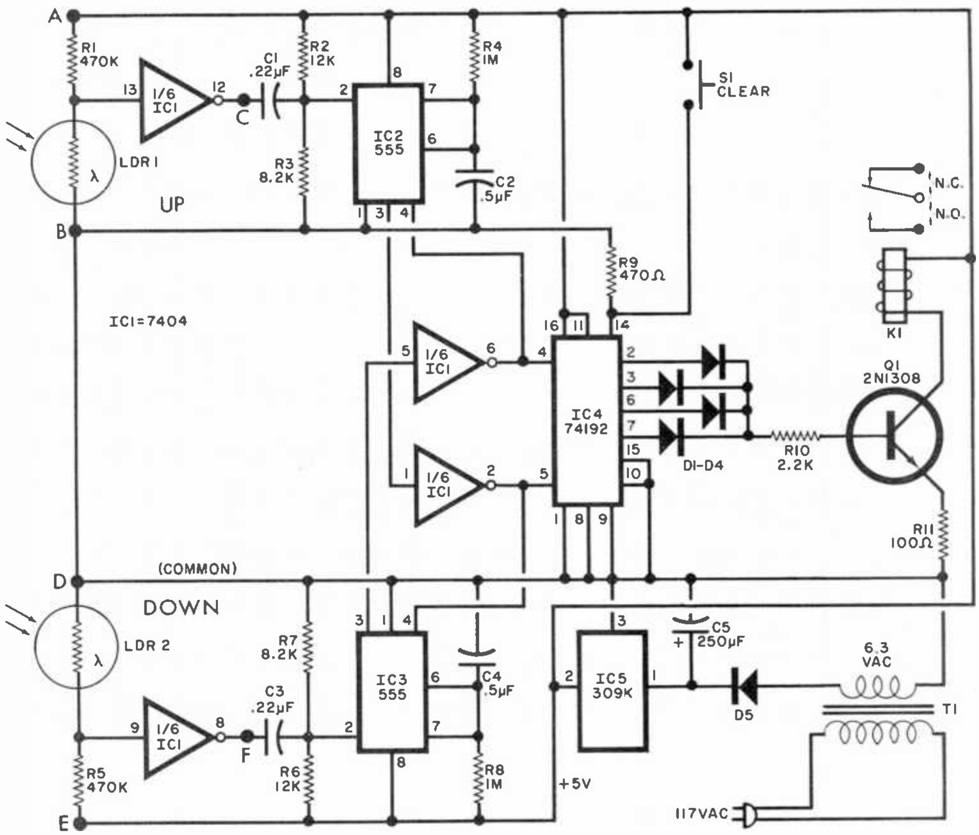


Fig. 1. Any sudden change in light on LDR1 causes an output pulse which is counted to drive relay K1. Two one-shots are cross-coupled so that only the first one activated is counted.

PARTS LIST

C1, C3—0.22-μF capacitor
C2, C4—0.5-μF capacitor
C5—250-μF, 25-volt electrolytic capacitor
D1 through D5—1N4001 rectifier diode
IC1—7404 hex inverter IC
IC2, IC3—555 timer IC
IC4—74192 up/down counter IC
IC5—309 5-volt regulator IC
K1—3-volt, 25-mA relay (Calectro No. D1-965 or similar)
LDR1, LDR2—Light-dependent resistor with 1-megohm maximum, 100-ohm minimum resistance (Radio Shack No. 276-116 or similar)
Q1—2N1308 or similar transistor
The following resistors are ½-watt, 10%:
R1, R5—470,000 ohms
R2, R6—12,000 ohms
R3, R7—8200 ohms
R4, R8—1 megohm
R9—470 ohms
R10—2200 ohms
R11—100 ohms
S1—Spst momentary-action pushbutton switch
T1—12-volt, 300-mA power transformer
Misc.—IC and transistor sockets (optional); heat sink for IC5; perforated board; suitable box to house circuit; line cord; hookup wire; chassis-mounting ac receptacle; sheet of insulating plastic; materials for making light source (see text); rubber grommet; machine hardware; solder; etc.

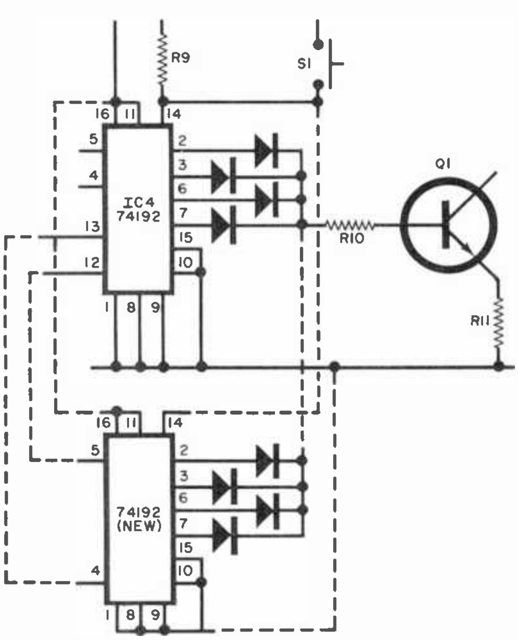


Fig. 2. Count can be increased by adding another up/down counter.

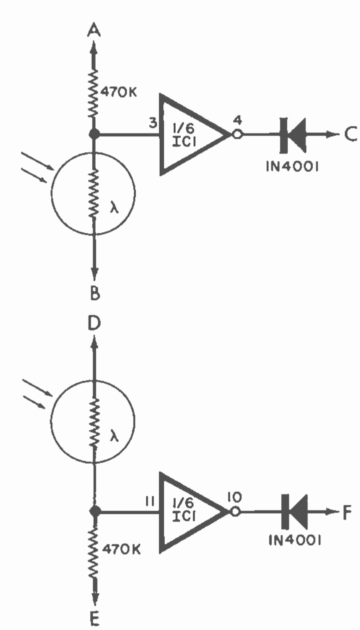


Fig. 3. Second pair of counting inputs can cover another entry.

ate panel lamp connected across its secondary winding. By wiring a 100-ohm potentiometer in series with one of the transformer's secondary leads and the lamp, you can vary the intensity of the beam to suit conditions. The lamp can be set into an ordinary flashlight reflector to focus the light into a narrow beam.

If it is necessary to cover a second doorway, the system will accommodate an extra pair of UP/DOWN counting inputs, connected as described in Fig. 3. This will use up the remaining two inverters in the 7404 hex inverter used for *IC1*. In the event that more than two doorways must be covered, extra UP/DOWN counting inputs can be used, provided that you add as many inverter pairs as there are LDR pairs.

Construction. There is nothing critical about circuit layout or lead routing. The entire circuit can be assembled on a 5" × 4" (12.7 × 11.4 cm) piece of perforated board, as shown in Fig. 4. It is

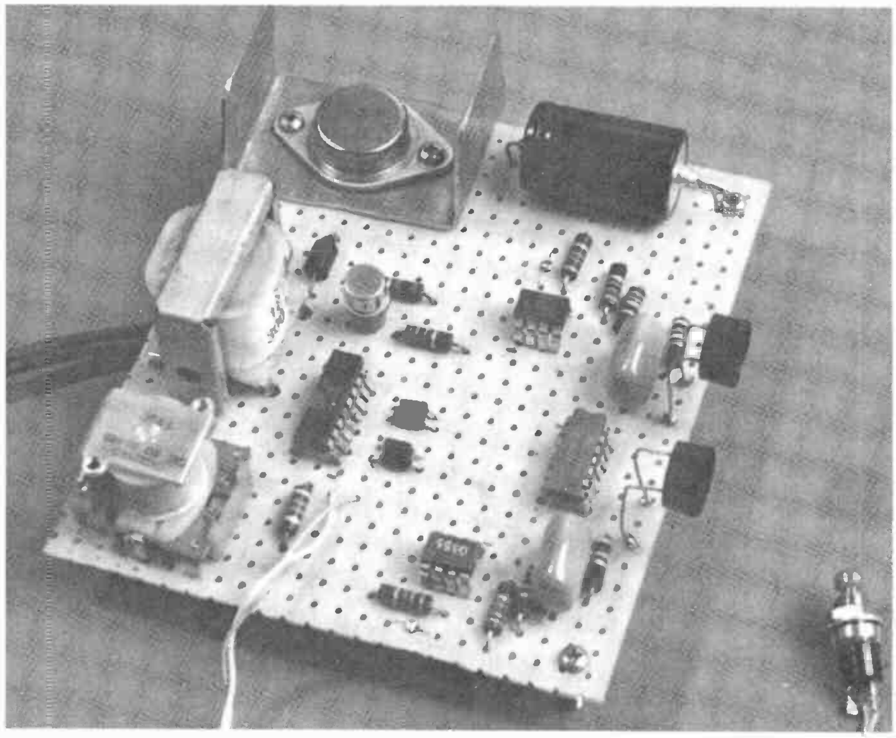


Fig. 4. The prototype of the photoelectric sensor was assembled entirely on perforated board. LDR's are on right side of board. CLEAR switch is connected by twisted leads.

advisable to use sockets for the IC's and transistor. Note also the need for a heat sink with *IC5*.

Light-dependent resistors *LDR1* and *LDR2* should be mounted about 1" (2.54 cm) apart so that a single light beam will suffice for both. If you are using extra UP/DOWN counting inputs, mount their LDR's on a small piece of perforated board. Cut holes in a small box to allow light-beam access to the LDR pair, mount the LDR board inside the box, and interconnnect this assembly with the main board via twisted cable.

The box that houses the main circuit board should be large enough to accommodate the main circuit board, a chassis-mounting ac receptacle, and CLEAR pushbutton switch *S1*. Drill holes in the box as required to mount all components in place and to provide light-beam access to *LDR1* and *LDR2*. Mount *S1* and the receptacle in their respective holes. You can use ordinary hookup wire to interconnect *S1* with the circuit board, but it is advisable that you use a length of regular line cord to interconnect the relay contacts and the receptacle. Slip the free end of the line cord through a rubber-grommet-lined hole in the case and solder it to the appropriate points in the circuit. A sheet of insulating plastic should be placed between the box and the bottom of the board before the latter is finally bolted down. This will obviate the possibility of the live ac on the primary side of *T1* from shorting out against the metal box.

Testing the Circuit. Plug the system's line cord into a convenient ac receptacle and direct a beam of light onto *LDR1* and *LDR2*. The relay should immediately energize. Depressing the CLEAR button (*S1*) should cause the relay to immediately deenergize. Now, block the light beam by passing your hand in front of first *LDR1* and then *LDR2*. The relay should again energize. With the relay still energized, passing your hand in front of first *LDR2* and then *LDR1* should cause *K1* to drop out.

Pass your hand several times from *LDR1* to *LDR2*. The relay should immediately energize on the first pass and remain energized with each successive pass. Now pass your hand an equal number of times from *LDR2* to *LDR1*. The relay should remain energized for all but the last pass. On the last pass, the relay should deenergize. This procedure checks the up and down counting operation of the circuit.

The relay specified for *K1* in the Parts List can safely handle up to 3 amperes of current. If you wish to operate a device that requires a greater amount of current, you will have to substitute a low-voltage, low-current relay whose contacts can handle the current drain. Alternatively, you can use the specified relay to drive a higher-current relay. ◇

HOW TO FULLY DEBOUNCE LOW-COST KEYBOARDS

Inexpensive approach to properly interfacing calculator keyboards to microcomputers

BY RALPH TENNY

KEYBOARDS for home-brew calculators or even minicomputers are available from many sources (such as those advertising in this magazine). Unfortunately, most of these keyboards lack two important features—contact debouncing and key encoding. Without debouncing, each key closure can produce multiple signals, while encoding makes it possible to determine just which key has been operated.

There are many different types of debouncing circuits, but most of them are applicable to just one contact. Debouncing a full keyboard can be very expensive. Also, when debouncing a keyboard, encoding is very complex since each key closure must result in a unique code output.

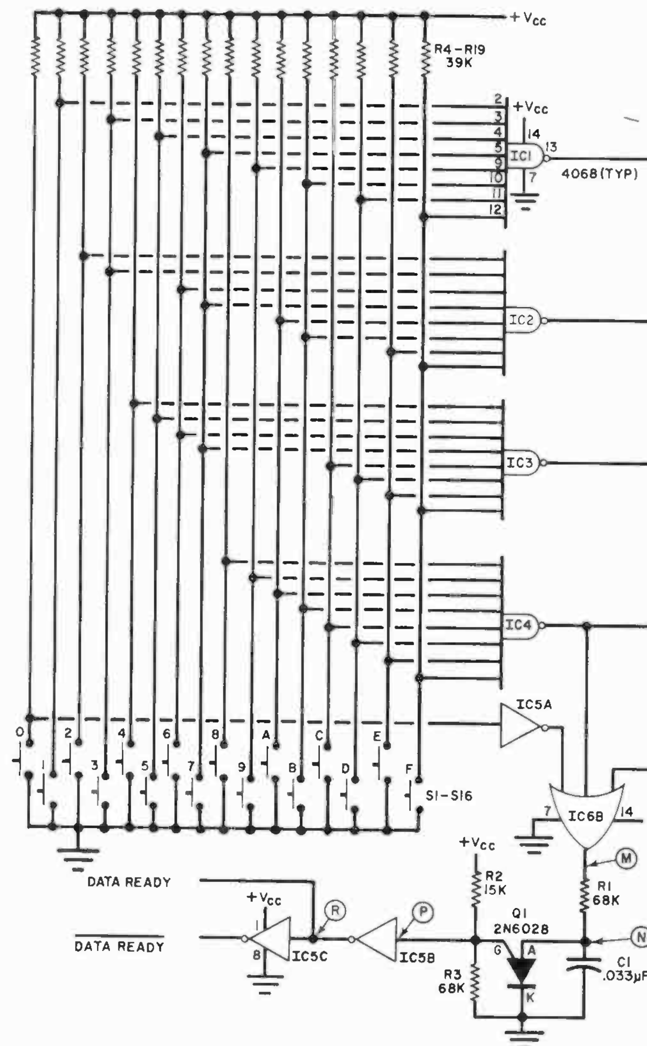
A simple, low-cost way to overcome these problems is shown in the circuit in Fig. 1. It produces a binary-coded output, fully debounced, from any low-cost 16-key board. The keys are labelled in hexadecimal so that the board can communicate with a microprocessor.

Four 8-input NAND gates (*IC1* through *IC4*) encode all the keys except 0. All of these gates are held high by resistors *R4* through *R19*. When a key is depressed (except 0), that input is brought to ground and its associated NAND gate output goes high. For example, if key **D** is depressed, the outputs of *IC1*, *IC3*, and *IC4* go high to produce 1101, the hex code for D.

Because it is necessary to know when any key, including 0 is depressed, OR gates *IC6A* and *IC6B* detect the presence of any key closure. When a 0 comes on, *IC5A* passes the signal to gate *IC6B*.

Although we can now detect all key closures and encode them on the 1-2-4-8 lines, contact bounce remains a problem. The waveforms in Fig. 2 show what happens when a key is depressed and bounces one time. The output of *IC6B* is waveform M, which drives the *R1*-*C1* combination to produce waveform N. When the key stops bouncing, *C1* can be charged up enough to cause *Q1* to fire. Resistor *R1* is low enough so that *Q1* latches in and stays on. As a result, point P is held low, and the two sections of *IC5* produce high or low Data Ready signals. The latter is indicated by a rule over the words in Fig. 1.

When *Q1* latches in, it provides some protection against multiple-key closures. If a second key is depressed after *Q1* fires, the output code will be correct but no Data Ready strobe will be produced.



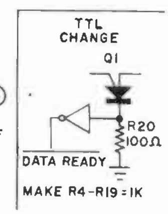


Fig. 1. The circuit produces a 1-2-4-8 binary code and provides a debounced data-ready strobe.

PARTS LIST

C1—0.033-μF, 15-V capacitor
IC1-IC4—CD4068 8-input NAND gate (for TTL, use 7430)
IC5—CD4049 inverting hex buffer (for TTL, use 7404)
IC6—CD4075 triple 3-input OR gate (for TTL, use 7432)
Q1—2N6028 programmable unijunction transistor
R1,R3—68,000-ohm, ¼-watt resistor
R2—15,000-ohm, ¼-watt resistor
R4-R19—39,000-ohm, ¼-watt resistor
R20—100-ohm, ¼-watt resistor (TTL only)
S1-S16—Normally open switch/keyboard

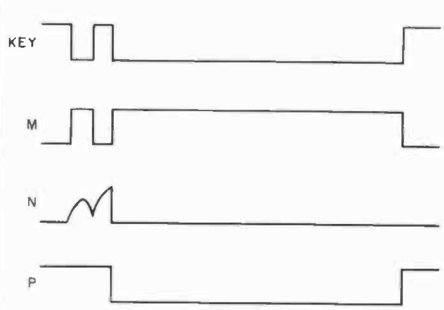


Fig. 2. Waveforms show how bouncing key can produce a clean single output.

The UJT will reset only after all the keys are released, and the output of *IC6B* returns to zero. If a second key is closed within a few milliseconds (while the first key is still bouncing), an erroneous output can be produced.

The keyboard can be battery powered if the CMOS devices are used. If you are going to drive TTL logic with this adaptor, change the IC's to their TTL counterparts (see Parts List), change the values of *R4* through *R19* to 1000 ohms, and add a 100-ohm resistor in the cathode of *Q1*. The Data Ready signal is then available as shown in Fig. 1. ◇

THE VOICE OF EXPERIENCE COMES TO CB.

MOTOROLA®

1930

Motorola® puts sound on wheels
with the introduction of
the first commercial car radio.

1942

Motorola engineers create the hand-held
Walkie-Talkie—the first miniaturized
AM transceiver small enough
to be cradled in a hand.

1950

Motorola is clearly the leader
in professional communications
as police, fire departments,
taxis, and industry put the tool
of 2-way radio to work.

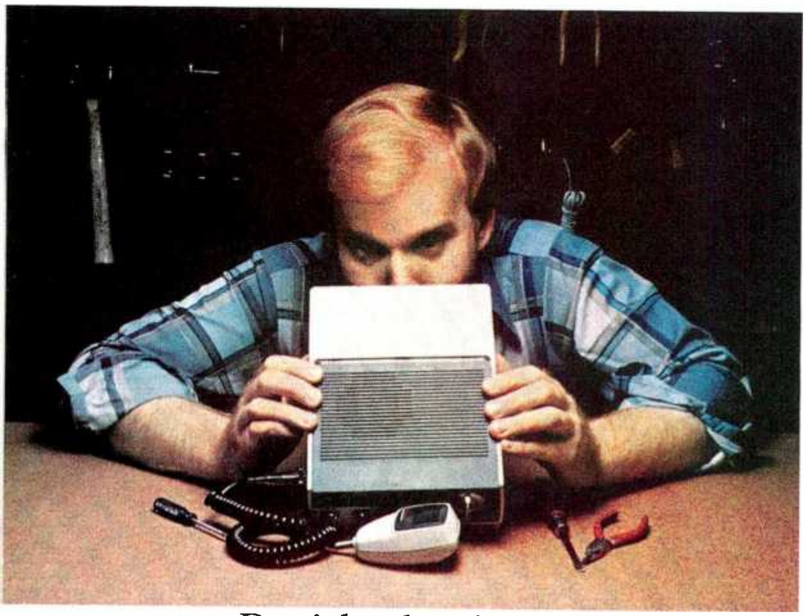
1971

Motorola puts the first FM
receiver on wheels
on the moon.

1977

Motorola introduces the 40-channel CB radio
that only 40 years of experience could produce.

The Motorola Series 4000 CB radio: a look under the hood.



Don't be deceived by the simple, uncluttered styling of the Motorola CB radio.

Tucked under that hood are many built-in, fully automatic circuits that result in truly superior talk/listen performance—instead of unnecessary dials and switches.

Our microphone ❶, for instance. A built-in pre-amp makes it a power mic. But you don't need batteries. And it doesn't cost an extra 50 bucks.

What you do get is full legal modulation, at a very low level of distortion. Which means people *will* hear you, sounding like you, not some relative of Donald Duck's.

Built-in audio compression and a high level splatter filter ❷ improve audio fidelity, maximize "talk" power —while making sure all your signal stays on channel.

And a highly effective TV interference filter ❸ will help keep peace in the neighborhood should you operate as a base station (see Accessories, pg. 6).

On the listening side, the Motorola CB boasts a professional-quality 3½-inch top-fire speaker ❹. Top-fire directs the sound up at you (or rebounds it to you). Bottom-fire sends it down into the sound-absorbing carpet.

Automatic Gain Control ❺ (built-in, naturally) protects you from being "blasted" or blocked by a signal that's too strong, too close. Yet it boosts weak, distant signals.

Automatic Noise Limiting ❻ on a Motorola CB is truly automatic—limiting only when necessary and only the noise, not the signal.

Every Motorola CB utilizes a sophisticated digital phase lock loop synthesizer ❼ for on-frequency transmissions without the need for features like delta tuning.

Selected models offer an L.E.D. channel readout display ❽ that can be read at a glance.

Two models (the 4005 & 4020) give you the additional advantage of an Extender® ❾, a super-sensitive noise blanker that "extends" your range in weak signal/high noise areas.

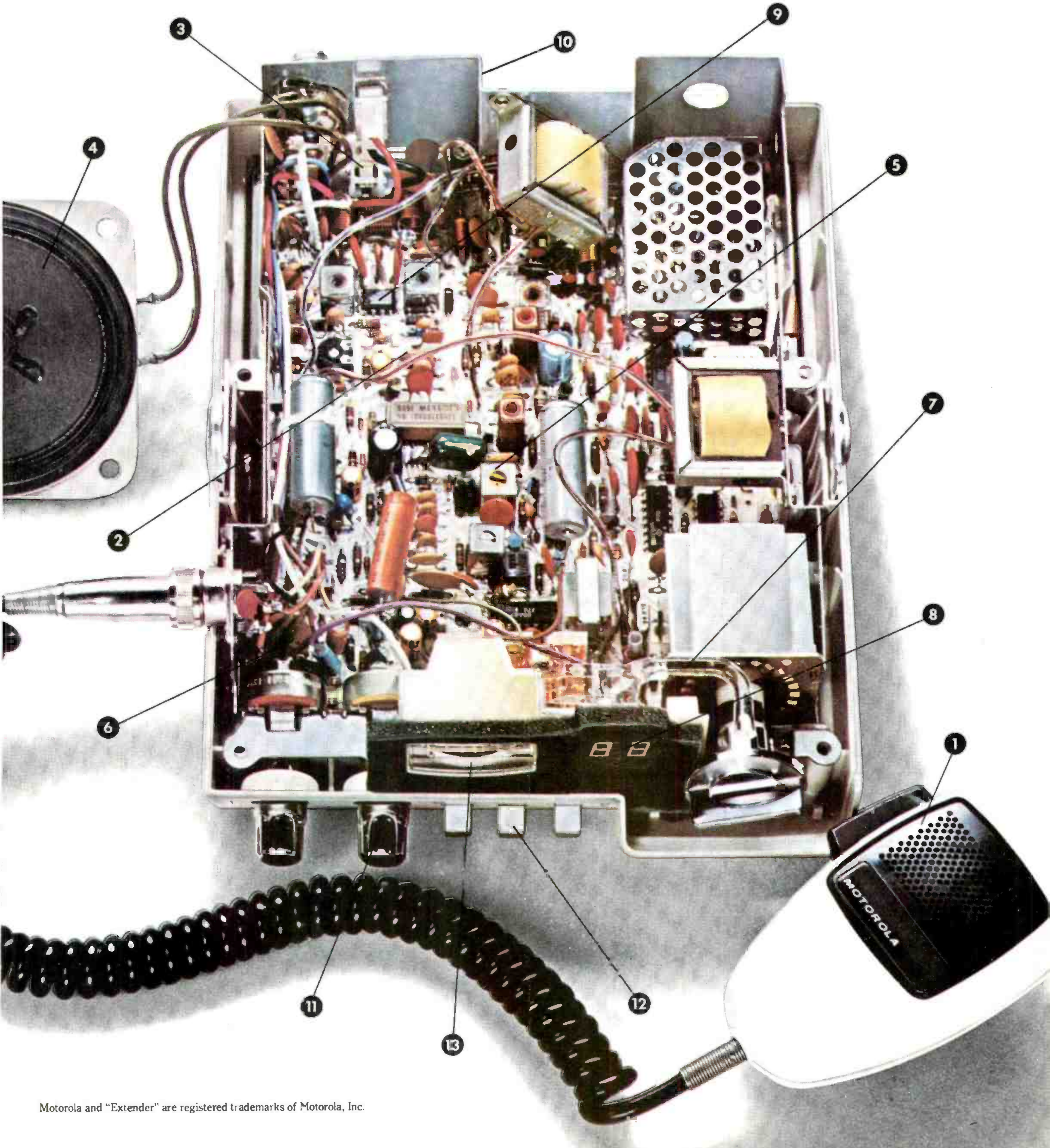
All Motorola CB models are completely solid state. All offer an external speaker jack ❿, squelch control ⓫, PA switch ⓬, and S/Rf meter ⓭.

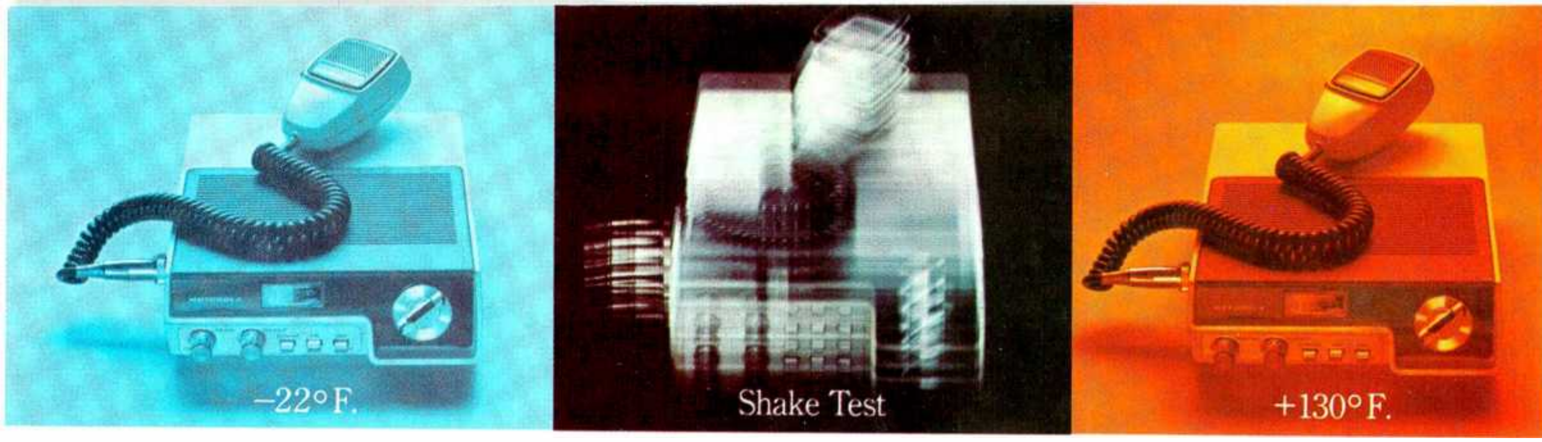
All provide burn-out protection for your radio in the event the radio is operated with a damaged antenna. Your radio is protected, too, if the set is accidentally wired backwards during installation.

But for all the state-of-the-art technology that goes into our radio, it's really performance that counts.

We believe the Motorola CB will outperform any of its competitors.

Put one under your dash and you'll believe, too.





A Motorola CB isn't just tested. It survives.

Each Motorola CB is 100% tested and inspected at each step in the manufacturing process.

We even station Motorola inspectors at suppliers' plants to inspect parts before they're shipped.

This kind of attention to quality control has made Motorola 2-way radios the standard of dependability in professional communications.

So we make sure our CB radios will live up to their reputation by making them live through the same tests our professional radios survive.

Motorola Service.

Should a Motorola CB ever require service, there's a national network of highly qualified technicians ready to handle your problem.

Motorola service center personnel are experienced and knowledgeable (many handle our Automotive Sound Products as well).

What's more, Motorola CB radios are made in America and all parts are stocked here in America.

Motorola Accessories.

Motorola CB antennas combine truly superior efficiency with heavy-duty construction for the best possible performance from your radio (whether it's a Motorola or not).

Each comes pre-tuned, packaged with all the necessary cable, hardware, and mounting instructions. You just mount, plug in, and enjoy.

A base station converter turns any Motorola Series 4000 CB into a home or office unit. A stand-up mic is also available. A Motorola external speaker gives your CB a Public Address capability. A variety of Motorola accessories is also available at most dealers that handle Motorola CB radios.

Motorola CB

From the voice of experience in 2-way radio.

Sale or lease of Motorola 40-channel CB radios is subject to FCC type acceptance.
To find the dealer nearest you, write: Customer Relations Manager, Motorola, Inc., Automotive Products Division, 333 Northwest Ave., Northlake, Illinois 60164.

Build a Low-Distortion Low-Cost Audio Generator

Generates sine waves with less than 0.02% distortion, or acts as a gyrator.

BY DAVID R. LANG

MOST function generators use operational amplifiers to generate the basic square and triangle waveforms. The sine waveform is not generated directly; instead, a passive or active shaping network is generally used to "soften up" the triangle wave to produce an approximation of the sine wave, which means that the distortion level leaves much to be desired.

The least expensive way to generate precision sine waves, at only 0.02% distortion, is to use a "gyrator." Using the gyrator, only a single potentiometer is required to cover a 15:1 frequency range. A pair of switch-selectable capacitors can then be used to establish the desired frequency range.

In addition to serving as a precision low-distortion oscillator, the gyrator circuit can also be used as a high-quality variable inductance and as a narrow-band audio pass/reject filter. The schematic is shown on the following page.

About the Circuit. As shown in the schematic diagram, the generator's circuit is arranged as a gyrator, one side of which is referenced to the common or ground point of the split power supply. Operation of the circuit is best understood by observing that *IC3* has a gain of $1/(R4C1\omega)$ and that *IC3* is followed by a current generator made up of *Q1* and *Q2*, which has a transfer function of $1/Rk$. Integrated circuit *IC1* is used as a voltage follower whose gain is unity and input impedance is very high. Integrated circuit *IC2* is operated as a unity-gain inverter, where *R1* and *R2* have similar resistance values.

An input voltage, *E1*, to *IC1* generates a current specified by the formula $I1 = 1/(R4RkC1\omega)$, which can be written as $E1/L = I1$, since dimensionally $L = R^2C$. The statement $1/Rk$ is simply the ratio of the input voltage (from *IC3*) to the total collector current changes referenced to the common point of the power supply. Ignoring the input resistance to the transistors and assuming $\alpha = 1.00$, $Rk = [R7(R6+R5)]/2R5$ and $L = R4RkC1$.

When the circuit is operated as an oscillator, *C2* performs as a low-pass parallel-resonant *LC* network that is driven by *IC5* through *R11*, where the feedback level is determined by the setting of *R9*. Switch *S1* is used to disconnect *IC5* from the inductance to disable the oscillator when only an inductance or an *LC* network is desired. The inductance is linear as long as the peak-to-peak voltage at the junction of the collectors of *Q1* and *Q2* does not exceed about 6 volts for the 18-volt supply illustrated.

With *S2* open, *IC5* serves as a comparator that clips the sine wave to produce a square-wave output from the system. Potentiometer *R3* is used to adjust the square wave's duty cycle.

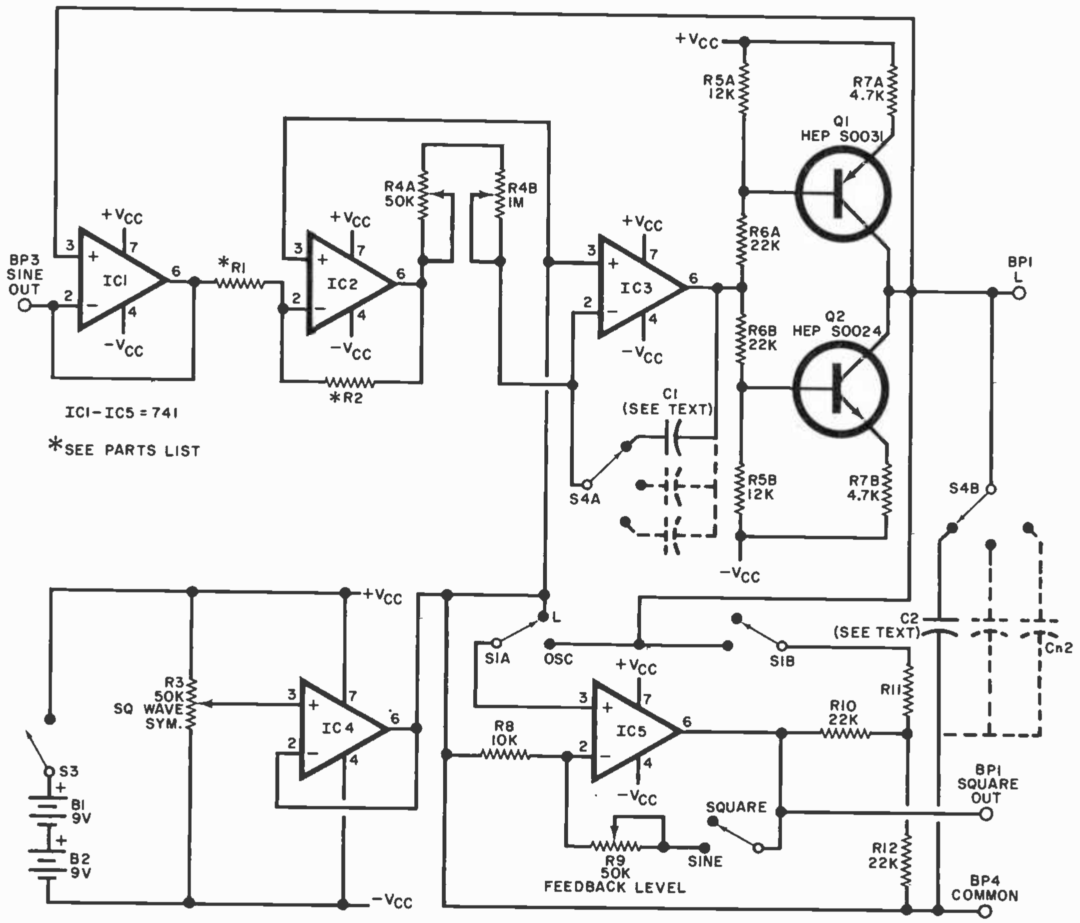
Construction. The circuit can be assembled on perforated board with sockets for the IC's and transistors or on a printed circuit board of your own design. Be sure to note that the pin designation numbers for the IC's in the schematic diagram are for an eight-pin DIP device. You can use any other package style of 741 op amp, but be sure to observe proper pin designations.

For best temperature stability, all fixed resistors should be of metal-film or wire-wound construction, and polystyrene, mica, or Mylar capacitors should be used for *C1, C2,* and any other range-determining capacitors. For *Q1* and *Q2,* any reasonable low-leakage, high-gain silicon transistors can be used.

Complementary sine-wave outputs are available from *IC1* and *IC2,* since the 741 op amp is not designed to deliver substantial output power, a buffer should be used if a load impedance of less than 1000 ohms is anticipated.

Range capacitors *C1* and *C2* should be mounted on a multi-position two-deck rotary switch (*S4*), along with any other range capacitors you might decide to use. RANGE switch *S4,* POWER switch *S3,* FEEDBACK control *R9,* FREQUENCY control *R4B,* L/OSC switch *S1,* SINE/SQUARE switch *S2,* and output binding posts *BP1* through *BP4* should all mount on the front panel of the box in which the circuit is to be housed. Mount a piece of heavy white paper or stiff cardboard behind the hex nut that holds *R4B* in place; it will become a scale for the FREQUENCY control. Slip over the shaft of this control a knob with a pointer. Then label all controls and switch positions according to function and/or range.

Setting It Up. For best results, a frequency counter should be used to set trimmer potentiometer *R4A* to provide



Sine-wave generator also serves as a-f filter or simulates inductor from 1 to 1000 H.

PARTS LIST

B1, B2—9-volt battery
BP1 through BP4—Four-way binding post
C1, C2—0.15-μF Mylar capacitor (for 13-to-130-Hz range); 0.015-μF capacitor (for 130-to-1300-Hz range); 0.0015-μF capacitor (for 1300-to-13,000-Hz range)
IC1 through IC5—741 operational amplifier
Q1—HEP S0031 (Motorola) or similar pnp silicon transistor
Q2—HEP S0024 (Motorola) or similar npn silicon transistor
R1, R2—6800-to-8200-ohm, 1% tolerance film resistor (value not critical)
R3, R4A—50,000-ohm trimmer potentiometer
R5A, R5B—12,000-ohm, 1% tolerance film resistor
R6A, R6B—22,000-ohm, 1% tolerance film resistor
R7A, R7B—4700-ohm, 1% tolerance film resistor
R8—10,000-ohm, 5% tolerance resistor
R9—50,000-ohm potentiometer
R10, R12—22,000-ohm, 5% tolerance resistor
R11—470,000-to-600,000-ohm film resistor (Stability more important than absolute value)
S1—Dpdt switch
S2, S3—Spst switch
S4—Two-pole, three-position nonshorting rotary switch.
Misc.—Battery connectors (2); suitable case; perforated board (or pc board); IC sockets (5); transistor sockets (2); control knobs (two round one pointer type); heavy white paper or cardboard; dry-transfer lettering kit; machine hardware; hookup wire; solder; etc.

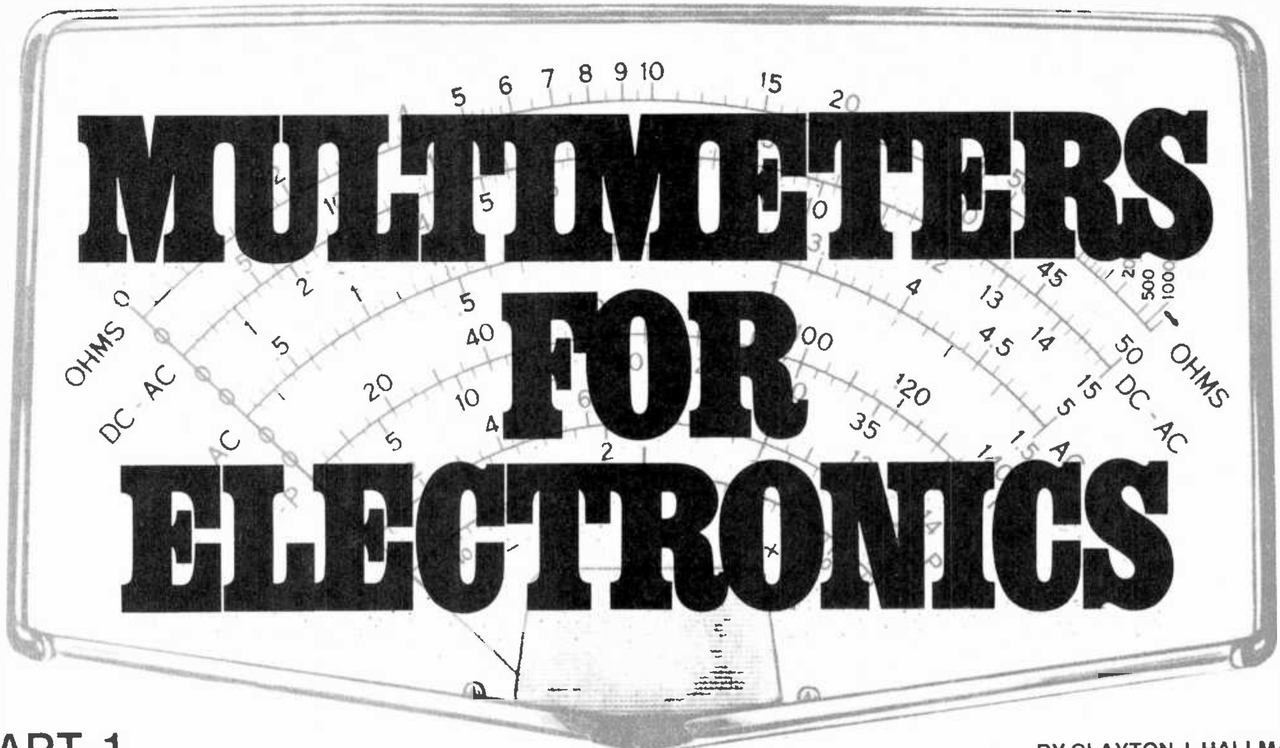
an exact 10:1 frequency spread over *R4B*'s range, which corresponds to an inductance range of 100:1 (*R4A* = *R4B*/99). Starting at the highest frequency, where the scale is compressed, use the frequency counter to establish convenient frequency intervals on the FREQUENCY control's dial. A different color ink can be used to label the inductance values in accordance with the relationship $L = 1/\omega^2C$. With the component values specified, the inductance range is from 1 to 1000 H.

When *R4B* is a 1-megohm potentiometer, the values of 0.0015, 0.015, and 0.15 μF for the *C1* and *C2* components provide ranges of 1300 to 13,000 Hz, 130 to 1300 Hz, and 13 to 130 Hz, respectively. If these sets of capacitors are accurately related by powers of 10, switching between ranges should yield frequencies within a few percentage points of the expected values. The frequencies at the scale endpoints can be changed for all ranges simultaneously by trimming the value of *R2*.

FEEDBACK control *R9* should be set to just beyond the point where oscillation begins, at the lowest-frequency setting. The oscillations will rapidly increase in amplitude until *IC5* goes into clipping, establishing an operating point. The value of resistor *R11* must be large to suppress harmonic distortion by minimizing the parallel resistive shunt across *L/C2*, thereby increasing its Q. When the circuit is operating properly, the dc potential at *BP1* is within a few millivolts of COMMON binding post *BP4*, and the current demand on the power supply will be approximately 8 mA.

The least distortion occurs when the FEEDBACK control is adjusted to the point where it just barely sustains oscillation. If *R9* were a fixed value to enable operation on all ranges and at all frequencies, the maximum distortion would be about 0.1%. Stray capacitance limits the oscillations to about 40,000 Hz if *R4A* is unchanged from its low-frequency value. ◇

MULTIMETERS FOR ELECTRONICS



PART 1

BY CLAYTON J. HALLMARK

Focus on traditional VOM's and analog-type electronic multimeters.

THE MULTIMETER, the workhorse of electronics servicing and experimenting, is usually the first instrument you reach for and the last you put away. What makes this instrument so popular is its versatility in performing tests and making measurements of a number of different electrical parameters. Needless to say, there is a wide variety of multimeters on the market, ranging from the traditional VOM to sophisticated digital instruments. Selecting a multimeter, therefore, requires a basic understanding of what each instrument can and cannot do. Even more important, you must understand how to use the instruments to obtain the maximum benefit from them.

Examined here will be problems common to all electronic measurements, including some of the lesser known, but very important pitfalls to be avoided. We will also discuss the problems often encountered in making measurements in modern state-of-the-art circuits.

In this first part, we focus on the traditional VOM and analog-type electronic multimeters.

Technical Details. Multimeters can be classified into two general categories. In one category we have passive VOM's. All other types of multimeters—VTVM's, TMM's, and DMM's—are classified as electronic or active types. The big difference between the two categories is that passive instruments must extract current from the circuit under test to deflect the meter movement, while electronic instruments have their own power supplies to drive the display.

In extracting current from a circuit, a VOM can upset circuit conditions. This "loading" effect on the circuit can cause inaccurate measurements. How much the conditions are upset depends on the resistance between the meter's test leads. The circuit shown in Fig. 1 demonstrates the effects of meter loading. Without the meter connected across *R2*, total circuit resistance is 200,000 ohms, divided equally between the two resistors. The actual voltage drop across each resistor is 30 volts without the meter connected to the circuit. When it is connected as shown, the meter's 100,000-ohm resistance is in parallel with the 100,000-ohm value of *R2*, which yields a net resistance of 50,000 ohms for the parallel combination and a total circuit resistance of 150,000 ohms. Because of the meter's loading on the circuit, the measured voltage across *R2* will be 20 volts, a 33.3% inaccuracy.

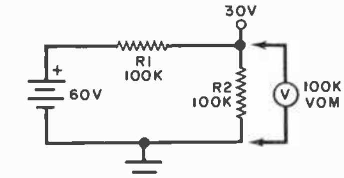


Fig. 1. The VOM here loads down the circuit, causing 33.3% inaccuracy.

With all conditions remaining the same in the Fig. 1 circuit, using a meter with an 11-megohm input resistance, the parallel resistance of *R2* and R_m would for all practical purposes be 100,000 ohms. Hence, the voltage dropped across *R2*, with minimal meter loading, would register roughly 30 volts.

The resistance of a VOM depends on the full-scale voltage. Hence, the meter's sensitivity is specified in ohms/volt. To determine resistance, the meter's sensitivity is multiplied by the full-scale voltage. This means that the resistance of a 1000 ohms/volt meter on the 100-volt range is 100,000 ohms, while for a standard 20,000 ohms/volt meter on the 100-volt range, the resistance would be 2 megohms. For a high-resistance circuit like that in Fig. 1, a 20,000 ohms/volt meter would be acceptable, but a 1000 ohms/volt meter would be unacceptable. (The ohms/volt rating is generally specified for the dc function only. The sensitivity on the ac function is typically only 20% to 50% of the dc sensitivity, or 5000 ohms/volt versus 20,000 ohms/volt.)

Loading can occur in low-voltage as well as high-resistance circuits. The resistance of a 20,000 ohms/volt meter is only 10,000 ohms on the 0.5-volt range. For service measurements, the meter's resistance should exceed 10 times the source impedance of the voltage to be measured to avoid excessive errors. This means that a 20,000 ohms/volt meter would be unsuitable for measuring 0.4 volt if the source impedance is more than 1000 ohms, but a 100,000 ohms/volt meter could measure a 0.4-volt potential across impedances up to 5000 ohms. Circuits with both low voltages and high impedances place critical demands on the meter.

For very accurate measurements, the resistance of the meter should exceed 25 times the source impedance. The loading error will then be maintained at less than 2%, which would be in the range of the meter's accuracy.

The inherent accuracy of meters is commonly expressed as a percentage of the full-scale reading. A reading on the 250-volt range of a 3% meter could be off by as much as 7.5 volts (250 volts × 0.03 = 7.5 volts). A 200-volt reading could indicate anywhere between 192.5 and 207.5 volts.

On the ac ranges, the accuracy might vary with frequency and range. For example, the rated accuracy of a good VOM might apply up to 100,000 Hz on all ranges up to 50 volts but only to 20,000 Hz on the 250-volt range.

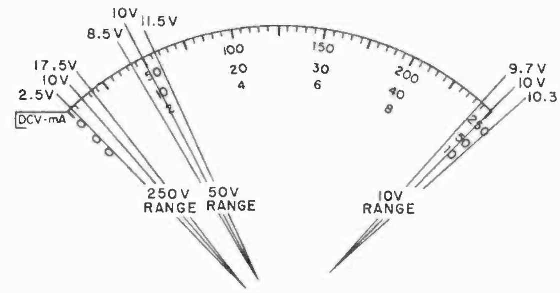


Fig. 2. Reading of 10 volts may indicate 9.7 to 10.3, 8.5 to 11.5, or 2.5 to 17.5 volts depending on the range setting.

In taking a voltage or current measurement, always start out on a higher range than necessary to protect the meter from possibly damaging overloads. For best accuracy, however, take your final reading on the lowest usable range so that the meter's pointer indicates in the upper portion of the scale where it is most accurate. As Fig. 2 demonstrates, a reading of 10 volts on a 3% meter can be between 9.7 and 10.3 volts on the 10-volt range, between 8.5 and 11.5 volts on the 50-volt range, and between 2.5 and 17.5 volts on the 250-volt range. In the last case, the inaccuracy is so great that the reading would be meaningless.

Worst-case accuracy occurs when the voltage to be measured just exceeds full-scale on one range so that the next higher range must be used. For a 3% meter with ranges of 3, 12, 60 volts, etc., the worst-case accuracy is ±15%, obtained when measuring just over 12 volts on the 60-volt range. Using a 3% meter with 1.5-, 5-, 15-volt, etc., ranges provides an improvement in the worst-case accuracy of ±9%. Needless to say, the scaling sequence can have an important effect on accuracy.

An Old Favorite. The VOM, or volt-ohm-milliammeter, was probably the first instrument most of us learned to use and the first one we bought. In many cases, we still reach for it when we must measure a voltage, current, or resistance. The VOM is extremely versatile, capable of measuring just about any ac or dc parameter that can be related to Ohm's law. And it is rugged and

Sencore's FF27 "Big Henry" is a field-effect multimeter with P-P and RMS ac scales.

B&K Precision's Model 177 vacuum-tube voltmeter has a large 7" mirrored meter and a special 0.5-V dc scale.

High-voltage multiplier probe made by B&K Precision.

also battery powered. Add to this its operating ease and low cost, and it is no wonder that the VOM has retained its high popularity.

A typical VOM has 0.25- and 1.0-volt full-scale ranges in both the ac and dc functions; dc current ranges as low as 50 μA to as high as 500 mA full-scale; and resistance ranges of up to 30 megohms. The decibel ranges cover from −20 to +50 dB, with 0 dB specified as 1 mW into 600 ohms.

Most VOM's are rated at 20,000 ohms/volt and will range between $25 and $125. There are still some VOM's around with a 1000-ohm/volt sensitivity, but these are of very limited usefulness for electronics measurements. Sensitive VOM's with ratings of 100,000 ohms or even 1 megohm/volt are also available for between $65 and $250.

The accuracy of the typical VOM is within 2% of full-scale on the dc ranges, 3% on the ac ranges, and 2% to 3% of scale length on the resistance ranges.

All VOM's come with separate red and black test leads. The black lead is inserted into the common, or reference, jack on the meter (marked COM, NEG, or −). The red lead goes into the "hot" jack (marked V, Ω, MA, or +). For the very highest and lowest voltage ranges and current ranges, the red lead is inserted into an extra positive jack that is appropriately labelled.

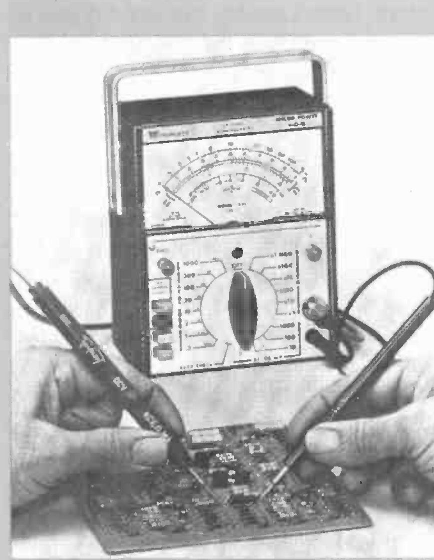
Most VOM's are similar in the way they operate. A polarity-reversing switch, usually labelled +DC/−DC) provides a convenient means of transposing test lead polarity on dc and resistance measurements. For normal operation, this switch is set to the +DC position. Then, using the black test lead as the reference, positive-polarity signals produce an up-scale deflection. Conversely, negative signals are accommodated without transposing test probes simply by switching to −DC.

The uppermost scale on a typical VOM unit is for resistance and is usually color coded in black. If the RANGE switch is set to any position other than R×1, the reading obtained must be multiplied by the resistance multiplier indicated by the switch setting. For resistance, the scale is inverse and nonlinear. The most accurate measurements are obtained when the pointer is in the lower one-third to one-half of the scale, where the calibrations have the widest separation. All other VOM scales are most accurate at their high ends.

Second from the top is often the dc scale, which is usually coded black. This scale has several sets of numbers at the major calibration marks, with each set applying to one or more settings of the RANGE switch. For the Simpson Model 160, for example, the numbers from 0 to 50 apply to range/function settings of 50 μA, 50 volts, 500 volts, and 500 mA. (On the 500-volt and 500-mA ranges, the indication provided by the meter's pointer must be multiplied by 10.)

There are usually two ac scales, both marked in red. The same scale numbers used for the dc scale are used for the upper red ac scale, while the bottom red scale, used for low ac voltage measurements, has its own numbers. Below this is the decibel (dB) scale.

Using the VOM is very simple. You just insert the test leads into their appropriate jacks, switch to the proper range and function, connect the leads to the circuit under test, and observe the position of the pointer on the scales. Note that for voltage measurements, the test probes are connected in parallel with the circuit or element under test. For current measurements, the circuit must be broken to allow the meter to be connected in series with it.



Tripplett's Model 603 solid-state VOM has switchable isolation resistor in probe for dc and low-power-ohms function.

Hickok's pushbutton-operated Model 370 has automatic polarity indicator and anti-parallax mirror-backed scale with automatic polarity indicator and FET input.

The Leader Model LEM-75, a transistor multimeter, has a temperature scale that is used with an accessory probe.

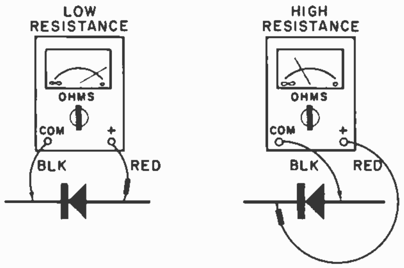


Fig. 3. In checking a diode, resistance in one direction should be 100 times more than in the other direction.

Ohmmeter Use. Resistance measurements are only a little less simple to perform than voltage measurements with a VOM. Always bear in mind that the ohmmeter must *never* be connected to a powered circuit or it will be damaged. Make sure all power is shut off and that all electrolytic capacitors, if any, are discharged.

Since the ohmmeter incorporates a battery to supply current to the measurement circuit, it is necessary to correct for battery and other circuit changes. You do this by setting the selector switch to the desired range, shorting together the test probes, and operating the ZERO ADJUST control until the meter pointer is resting exactly at 0 on the scale. If the meter cannot be zeroed, the battery must be replaced. Repeat this procedure whenever you change ranges.

The ohmmeter can also be used to check the condition of diodes out-of-circuit, as shown in Fig. 3. You simply measure the diode's resistance in one direction, reverse the test leads (or flip the polarity-reversing switch) to measure its resistance in the other direction, and compare your readings. For a good diode, the readings should differ by 100 or more times. If the resistance is zero in both directions, the diode is shorted; if it is infinity in both directions, the diode is open.

Though it is not usually recommended as a safe procedure, transistor junctions can also be tested with an ohmmeter—if certain precautions are exercised. Always bear in mind that some ohmmeters and some ranges on all ohmmeters can damage low-voltage semiconductors and electrolytic capacitors. In testing semiconductors, use the R×100 range of the ohmmeter. Avoid using the highest and lowest ranges because they can supply excessive voltage and excessive current, respectively, to the device under test.

The resistance of nonlinear components, such as diodes, will measure different values on different ranges. For example, a diode could measure 80 ohms on the R×1 range and 300 ohms on the R×100 range. This is normal and is the result of the diode characteristic.

In-circuit resistance measurements can be misleading as well as damaging, as follows. Assume that in the Fig. 4 circuit you took a measurement across R_B with the positive test probe touching ground. Since R_E is also connected to ground, the voltage applied by the ohmmeter would forward bias the emitter-base junction of the transistor. In effect, R_E would be in parallel with R_B. One way around this problem would be to disconnect one end of R_B from the circuit for the test. Another way would be to use an ohmmeter with a low-power-ohms circuit. Such an instrument applies a voltage that is too low to bias on or damage a junction. The Simpson low-power-ohms probe adds this feature to any VOM with a 250-mV (50-μA) jack and a 12-ohm center-scale meter. An open-circuit voltage of only 30 mV or less is applied to the circuit under test.

Ac Problems. Another problem with VOM's concerns ac measurements. In a VOM, the ac voltage is rectified to provide a pulsating dc voltage that can be measured by a dc-only meter movement. Unfortunately, the VOM responds to, or measures, the average value of the ac voltage rather than the rms value in which we are more interested. Since the ratio of the rms value to the average value of a sine wave (its form factor) is known to be a constant 1.11 (Fig. 5), meter manufacturers skirt the problem by calibrating their meter scales to give the rms value of a sine wave. This means, for example, that if 100 volts is applied, the meter's pointer actually registers 63.7 volts but is registering 70.7 volts on the doctored scale. For waveforms other than the sine wave, only an approximate rms value is obtained.

Electronic Multimeters. The next step up from the VOM in sophistication, price, and performance is the electronic multimeter. Instruments in this category represent a marriage of a solid-state amplifier in the TMM or a vacuum-tube amplifier in the VTVM to a basic electrical metering circuit.

Using built-in amplification results in a sensitive instrument that is capable of measuring ac and dc voltages and resistance over a much wider range than is possible with a VOM. It also results in a much higher input resistance, typically a constant 10 megohms, and a much higher frequency limit. This makes the electronic multimeter useful in high-impedance, low-voltage circuits and r-f circuits in which a VOM would be highly inaccurate. (In circuits within the frequency and impedance limits of the VOM, however, the passive multimeter's accuracy is similar to that of most electronic multimeters.)

The electronic multimeter category includes service-type VTVM's that cost between about $65 and $120 and TMM's that range in price from about $65 to $240. (This category also includes the digital multimeter, or DMM, which we will discuss in Part 2.)

A typical modern VTVM with an extra-long meter scale that provides maximum readability and accuracy is the Triplett Model 850. This VTVM can measure dc voltages and ac rms voltages up to 1500 volts in ranges that are similar to those of a sensitive VOM. In addition, it measures resistances to 1000 megohms and peak-to-peak voltages. VTVM's do not measure current.

As is the case with other electronic multimeters, the Triplett VTVM employs an isolation probe that is connected to the input via a coaxial cable. A coaxial cable is required because the high input impedance makes the instrument susceptible to stray-field effects, especially on the low-voltage ranges. The isolation probe has a 1-megohm resistor that is placed in series with the input on the dc voltage ranges by operating a slide switch. This resistor minimizes the effective input capacitance of the coaxial cable and permits dc measurements in oscillator and r-f tuned circuits without disturbing circuit conditions. Other probes can be used to extend the frequency range of the VTVM to 250 MHz and the voltage range to 30,000 volts such as B&K Precision's shown here.

The solid-state revolution created some new measurement problems. Fortunately, it also provided the solution by making possible the versatile transistor multimeter, or TMM. This instrument has

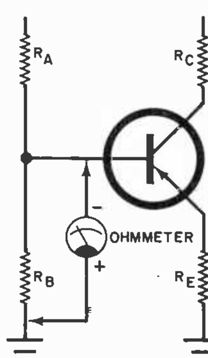


Fig. 4. This setup may cause wrong reading for base resistor.

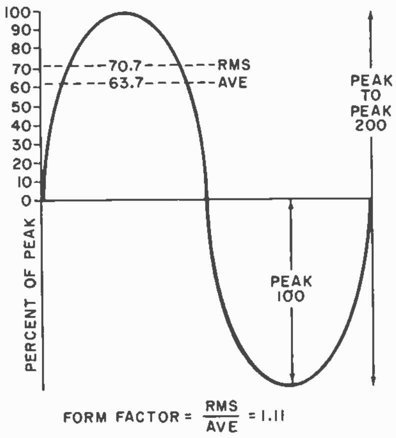


Fig. 5. The various ac values that can be measured by a meter.

the sensitivity of a VTVM, plus the advantages of solid-state design: instantaneous operation with no warmup; no heat generation and, hence, less aging and better accuracy in the long run; and cordless operation. Also, the TMM measures current. FET's ensure high input impedance.

An example of the TMM is Leader's versatile Model LEM-75. It offers a stable accuracy of 3% to 4% for almost any electronics application. The instrument features dc and ac rms voltage ranges of from 0.3 to 1000 volts full-scale; dc and ac current ranges from 30 μA to 300 mA full-scale; and resistance ranges from 0.5 ohm to 500 megohms full-scale. There is even a temperature scale, for use with an optional thermistor probe. The minimum sensitivities of 10 mV and 1 μA on both ac and dc make it possible to check the tiny bias and signal levels in the most advanced solid-state circuits.

On most TMM's and VTVM's, a ZERO control is used to set the meter pointer to 0 on the scale with the input probes shorted together and the power turned on before measurements are made. It is advisable to check for zero indication whenever you change either range or function or both. Before making a resistance measurement, it is also necessary to adjust the OHMS control to set the meter's pointer at infinity, with the probes not touching each other.

The scales on VTVM's and TMM's are similar to those on VOM's with two notable exceptions. First, the electronic multimeter usually has a zero-center scale that is useful for aligning discriminator and other balanced circuits. Secondly, the resistance scale increases in the same direction as the other scales, not inversely as on VOM's.

Some disadvantages of electronic multimeters, with respect to VOM's, are warm-up time and drift, higher battery drain, slightly more complicated operation, stray pickup, and grounding requirements. For many, however, the much lower loading effect of the electronic multimeter makes it a favored instrument.

Electronic multimeters are fitted with a ground lead that must be connected to the ground or lowest-potential point of the circuit under test. The ground lead must not be connected to a point at a potential in excess of that recommended by the manufacturer, which is typically 400 volts ac or 600 volts dc.

The ground lead is often internally connected to the power line ground. Accordingly, you must not touch the ground lead to a test point at power-line potential or the line fuse will blow. When making measurements on a line-powered circuit, check the circuit ground to determine if it is isolated from circuit ground. If it is not, orient the circuit ground so that it is at the same potential as line ground.

The Circuits. Electronic multimeters can be classified according to whether the amplifier or the rectifier comes first.

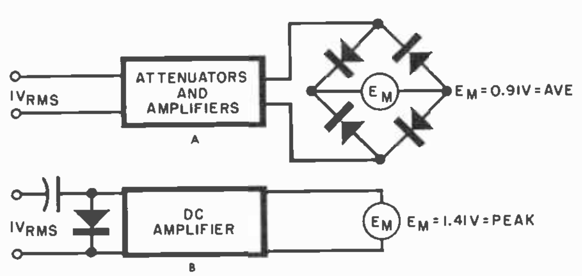


Fig. 6. Arrangement at (A) gives a sensitive, average-responding meter. (B), used in service-type DVM's, gives a peak-responding meter.

The amplifier-rectifier arrangement shown in Fig. 6A is used in very sensitive laboratory instruments that can measure potentials on the order of microvolts. As with the VOM, these are average-responding meters, calibrated to indicate rms values of sine waves. Since average-responding meters can give useful rms indications for waveforms with 10% or greater distortion, they are widely used as substitutes for expensive instruments that are true rms responding.

In the rectifier-amplifier, or peak-responding, circuit shown in Fig. 6B, a storage capacitor charges up through a diode to the peak value of the input voltage. The capacitor voltage is amplified by a dc amplifier to drive a meter movement. The high input impedance of the amplifier means that only a very small current is drawn from the circuit under test to keep the capacitor charged. The input impedance has been pretty much standardized at 10 megohms—11 megohms with the probe resistor.

Without the diode and storage capacitor, the peak-responding meter serves as a dc voltmeter and, by adding shunts and an internal dc source, as a milliammeter and ohmmeter. Most VTVM's and TMM's use this principle.

One big advantage of the peak-responding meter is that the diode and capacitor can be placed in the probe so that the measured ac signal has to travel no farther than the probe. This reduces the loading caused by the capacitance of the test leads and input circuit.

With an r-f probe, available as an accessory item, the electronic multimeter can measure voltages at frequencies in the hundreds of megahertz range with tolerable loading. The input impedance decreases to between 50,000 and 100,000 ohms at 100 MHz. The error becomes especially serious for the higher voltages at high frequencies.

If the waveform measured by a peak-responding instrument is not symmetrical, a different reading will be obtained if the leads are reversed, thereby charging the capacitor to the alternate peak value. This turnover effect is eliminated in some instruments by using a voltage doubler circuit that rectifies both alternations of the input signal voltage and gives a peak-to-peak response. The rms scales of these meters are accurate for sine waves, while the peak-to-peak scales are accurate for nonsinusoidal and complex waveforms. This permits accurate measurement of TV sweep and video waveforms, which are often specified in peak-to-peak voltages.

The zero-center scale on electronic multimeters is useful in solid-state servicing when it is not known whether the voltage being measured is positive or negative with respect to ground. Also, VTVM's and TMM's normally use a 1.5-volt cell in the ohmmeter section, which is relatively safe for semiconductor measurements.

Coming up. The major focus in Part 2 will be on digital multimeters. ◇

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ALL CLOCK CHIPS ARE NOT ALIKE

BY MICHAEL S. ROBBINS

NOT ALL digital clock chips are alike. But you would expect that those with the same part number from one manufacturer would all function in the same circuit. This is not the case with the popular line of PMOS clock IC's from *National Semiconductor.*

National introduced its MM5300 series of clock circuits in 1972 and has since expanded it to include six different numbers, all employing the same basic silicon chip. Each variation employs a different metalization pattern to bring out the required functions. The table details how the clock chips differ and lists the functions of each.

Looking over the table, everything looks simple enough, but watch out. You may find that replacing the chips in a three- or four-year-old clock with a chip that has a late 1975 or 1976 code date causes your clock to display only one digit! National has made the new chips smaller, which affects how they operate. The new IC's will work in all of your favorite clock circuits if you change the values of the multiplex resistor. In many circuits employing the old chip, the resistor value was 100,000 ohms. If you change that to 220,000 or 330,000 ohms, the new chips will work as well as the older ones did. Also, if the multiplex rate is too slow with the new resistor, use a smaller-value capacitor with it. Cut the capacitance in half when using a 220,000-ohm resistor and by two-thirds when using a 330,000-ohm resistor.

This change should be made in all projects that have appeared in POPULAR ELECTRONICS and other magazines in the past, including the author's "A Digital Stopclock for Short & Long Event Timing," in the January 1976 issue of POPULAR ELECTRONICS. ◇

	MM5309	MM5311	MM5312	MM5313	MM5314	MM5315
4 OR 6 DIGITS	•	•		•	•	•
4 DIGITS ONLY			•			
1 pps OUTPUT			•	•		
12-HOUR FORMAT, LEADING-ZERO BLANKING	•	•	•	•	•	•
24-HOUR FORMAT	•	•	•	•	•	•
HOLD-COUNT CONTROL		•		•	•	•
RESET TO 00:00 OR 12:00:00	•					•
50- OR 60-Hz INPUT	•	•	•	•	•	•
BCD OUTPUT	•	•	•	•		•
7-SEGMENT OUTPUT	•	•	•	•	•	•
24-PIN PACKAGE			•		•	
28-PIN PACKAGE	•	•		•		•
OUTPUT-ENABLE CONTROL	•	•			•	

BY STEPHEN M. FREEMAN

HANDY CIRCUIT for CHECKING PHONO PREAMPS and FM TUNERS

Low-Cost pre-emphasis network simplifies frequency response tests.

THIS circuit, (Fig. 1) makes it easy to perform frequency response tests on phono preamplifiers and FM tuners. Previously, such tests were very difficult because of built-in de-emphasis characteristics. Depending on the tolerance of the parts used, the circuit can be assembled for about $25, and will adhere fairly closely to the RIAA and FM pre-emphasis characteristics.

Pre-emphasis is a system of noise reduction often used in communications equipment. Since most noise that creeps into high-fidelity circuits is high frequency in nature, the signal highs are boosted in strength before transmission or recording. Along the way (before "playback"), this noise joins up with the signal. However, if the overall level of the highs is reduced in the receiver (or preamp), the flat frequency response at the signal source will be obtained, along with an improved S/N ratio. This occurs because the high-frequency noise is dramatically attenuated.

FM and Disc Characteristics. The combination of pre-emphasis and de-emphasis appears in FM and recorded disc media. The pre-emphasis characteristics are easily synthesized using passive RC networks. These are preceded and followed by op amps giving gain or isolation.

Placing switch *S1* in the FM position will feed the input signal for jack *J1* to the noninverting input of amplifier *A1*, an op amp. (To reduce parts count, 747 op amps, which are two 741's in one pack-

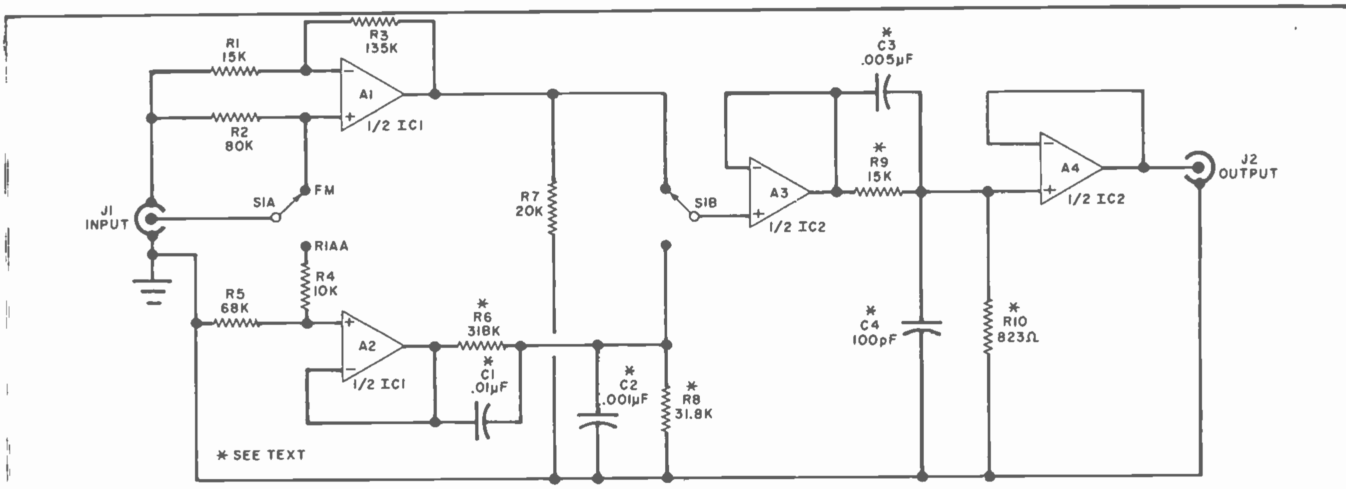


Fig. 1. Passive RC networks provide desired time constants. Op amps yield isolation and/or gain.

PARTS LIST

C1—0.01-μF capacitor* (polystyrene, mica, ceramic, or Mylar)
C2—0.001-μF capacitor* (polystyrene, mica, ceramic, or Mylar)
C3—0.005-μF capacitor* (polystyrene, mica, ceramic, or Mylar)
C4—100-pF capacitor* (polystyrene, mica, ceramic, or Mylar)
IC1,IC2—747 dual op amps
J1,J2—RCA phono jacks
Following resistors are ½-watt.
R1—15,000-ohm resistor*
R2—80,000-ohm resistor*
R3—135,000-ohm resistor*
R4—10,000-ohm 5% resistor
R5—68,000-ohm 5% resistor
R6—318,000-ohm resistor*
R7—20,000-ohm 5% resistor
R8—31,800-ohm resistor*
R9—15,000-ohm resistor*
R10—823-ohm resistor*
S1—Dpdt switch
*See Text

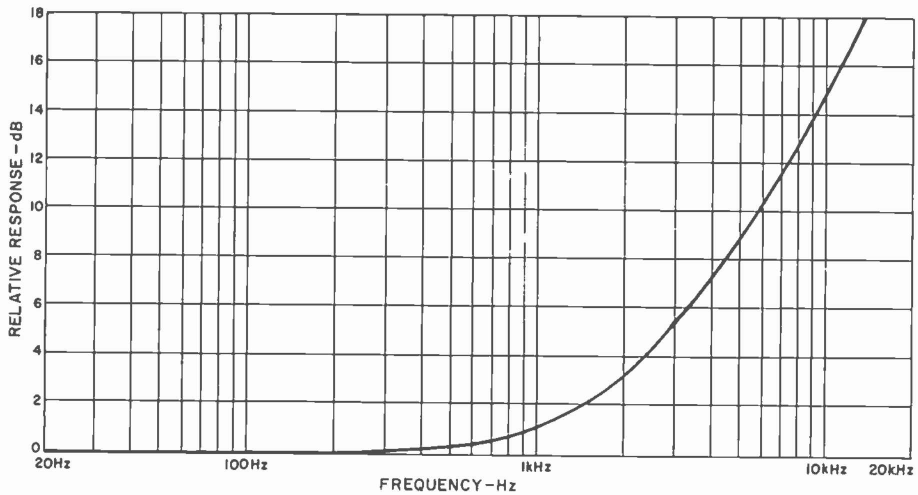


Fig. 2. FM 75-microsecond pre-emphasis curve. High frequencies are boosted in strength to improve S/N.

age, will be used.) This stage provides 20 dB of gain. Its output drives *A3*, a voltage follower used as a buffer. Resistor *R9* and capacitor *C3* provide the desired 75-µs pre-emphasis time constant (T=RC). Very high frequencies are rolled off by the *R10-C4* combination. Another voltage follower, *A4*, adds unity gain and isolation between the RC network and the output. The circuit's frequency response will be a good approximation of the 75-µs pre-emphasis curve shown in Fig. 2.

When *S1* is in the RIAA position, the input signal is applied to *A2*, an op amp buffer. This, in turn, drives the RC network consisting of *R6, R8, C1* and *C2*. The RIAA time constants of 3180 and 318 µs are provided by this network. The signal is then routed through *A3* and the 75-µs RC network. Voltage follower *A4* isolates the sensitive RC combination from the output. The prototype's RIAA pre-emphasis curve of amplitude versus frequency is shown in Fig. 3.

Construction. For the most part, construction of the pre-emphasis network is not critical. Either pc or perforated board can be used. One area is critical however—parts tolerance of the asterisked components in Fig. 1. To provide the desired time constants, these values should be as close to the published values as possible. This does *not* mean that you'll have to spend lots of money for precision parts—assuming you're lucky enough to find a source. However, there's a much easier way. Buy lower-tolerance parts (say 5% resistors and caps) and use small trimmer (or padder) pots and capacitors. For example, several surplus dealers are offering high-quality rectangular pc trimmer pots for less than $1 each. If they are available in the correct ranges, you can use them alone for the resistive components, after adjusting them with a quality digital or analog multimeter. Also, a regulated bipolar 15-V dc supply is required for best results.

Using the Pre-emphasis Network. To test a phono preamp, connect a frequency-sweep function generator to the input of the pre-emphasis network. Then, connect the output of the pre-emphasis network to the phono input using a short patchcord. Monitor the preamp output on an oscilloscope. Connect the output to the vertical amplifier and the main sweep sawtooth output of the function generator to the horizontal amplifier. When the generator sweep range and the preamp circuitry are properly adjusted, you'll get a pictorial image of the preamp's "flat" response on the CRT.

For FM measurements, you can use one of two techniques. If you have an FM generator, connect the swept function generator's output to the modulation input of the FM generator through the FM pre-emphasis network. Then attach the FM output to the antenna terminals of the tuner, observing the output on the scope (using the vertical and horizontal amps as above).

If you don't have an FM generator, connect the function generator (through the pre-emphasis network) to the FM detector output—at the input of the tuner's de-emphasis network. You should then observe a flat response (up to 15 kHz) at the tuner output.

Signal Levels. The pre-emphasis network will provide 30 dB of attenuation at 1000 Hz in the RIAA mode and 5 dB in the FM mode. This allows the use of a high (line) level driving signal without additional padding. If 0-dB attenuation is desired, you can simply crank up the function generator output. Alternatively, you can use an op amp preamplifier at the INPUT jack with switchable gain—selecting the feedback resistor to provide 5 or 30 dB of gain for FM and RIAA, respectively. ◇

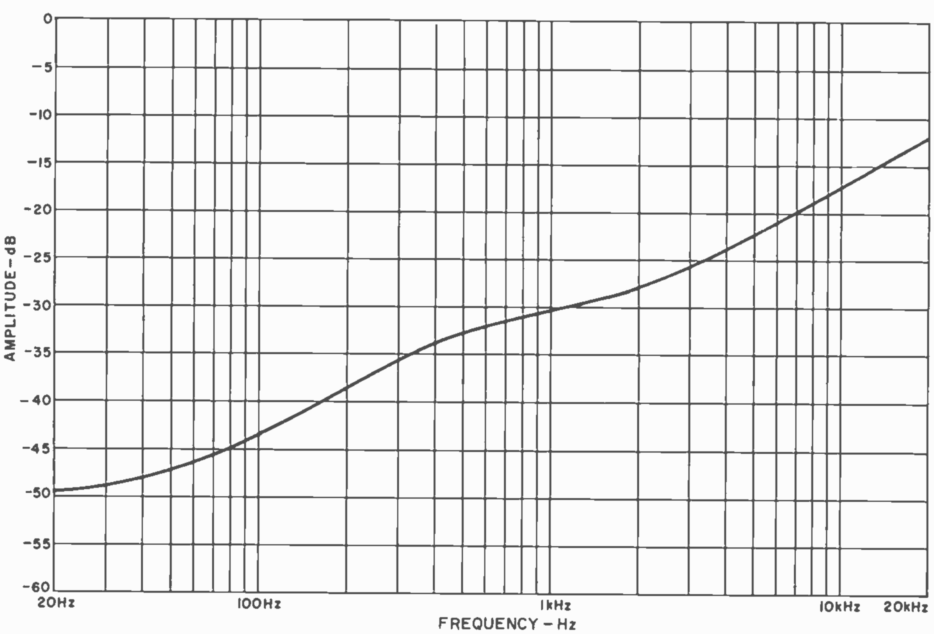


Fig. 3. RIAA pre-emphasis response. The circuit produces a close approximation of the standard RIAA curve.

BY ROBERT MEIJER

AN "RFI-FREE" SOLID-STATE THERMOSTAT

Noise-free thyristor circuit is triggered by thin-film temperature sensor.

AN ELECTRONIC circuit including a triac and/or an SCR (connected to a suitable sensor) is often considered a desirable substitute for a bimetallic thermostat. However, the radio frequency interference (RFI) generated by such a circuit has impeded any large-scale movement toward its use. Presented here is a thyristor thermostat which generates no RFI, uses inexpensive components, and is mechanically stable.

The circuit, which employs one of the new Moxie™ thin-film thermal sensors, has other interesting features:

- Uses true zero firing of the thyristor.
- Provides symmetrical line loading (an even number of half cycles).
- Is adaptable to any size triac and load.
- Has essentially no deadband (hysteresis).

Circuit Operation. As the power line's phase angle increases from 0°, the voltage at point A in Fig 1 becomes progressively more positive with respect to point B. Diodes *D1* and *D2* are both forward biased, and the voltage across *R1* (the thermal sensor) continues to rise as the phase angle approaches 90°. The value of *R2* is chosen so that, at some point before 90°, sufficient voltage develops across *R1* to turn it on, and its impedance drops from a high to a low value. The lower the Moxie's temperature, the higher the voltage across it must be to turn it on. Thus, the value of *R2* is determined by the minimum control temperature required.

When *R1* turns on, the cathode of *D1* becomes highly positive with respect to point A. The value of the voltage developed on the cathode of *D1* depends on the required "firing" voltage of *R1*. This in turn depends only on sensor temperature.

If a sufficiently positive voltage develops on the cathode of *D1* (referenced to point A) and voltage divider

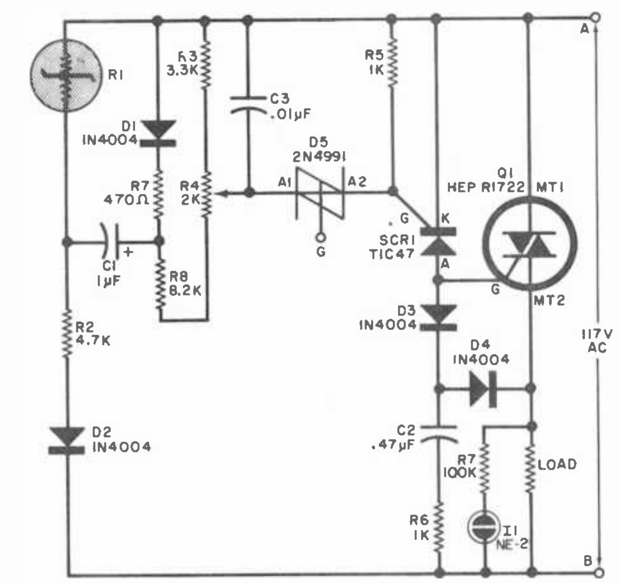


Fig. 1. Sensor R1 triggers thyristor firing circuit when heat is needed

PARTS LIST

C1—1-µF, 200-WVDC electrolytic capacitor
C2—0.47-µF, 200-WVDC Mylar film capacitor
C3—0.01-µF, 25 WVDC disc capacitor
D1 to D4—1N4004 rectifier
D5—2N4991, ECG6404 (Sylvania) silicon bilateral switch
I1—NE-2 neon indicator
Q1—HEP R1723 triac (see text)
R1—TS3-57S Moxie™ thermal sensor
R2—4700-ohm, 2-watt resistor
R3—3300-ohm, ¼-watt resistor
R4—20,000-ohm, 1-watt, linear taper, 10% tolerance potentiometer
R5—1000-ohm, ¼-watt resistor
R6—1000-ohm, 2-watt resistor
R7—100,000-ohm, ¼-watt resistor
R8—8200-ohm, ¼-watt resistor
SCR1—TIC47, ECG5404
Misc.—Printed circuit or perforated board, solder, hookup wire, suitable enclosure, thermal paste, machine hardware, etc.
Note—The Moxie thermal sensor is available for $1.09 from Elcom Sales, Box 9112, Rochester, NY 14625, and from Multi-State Devices Ltd., 1330 Trans Canada Highway S., Dorval, P. Q., Canada, H9P 1H8.

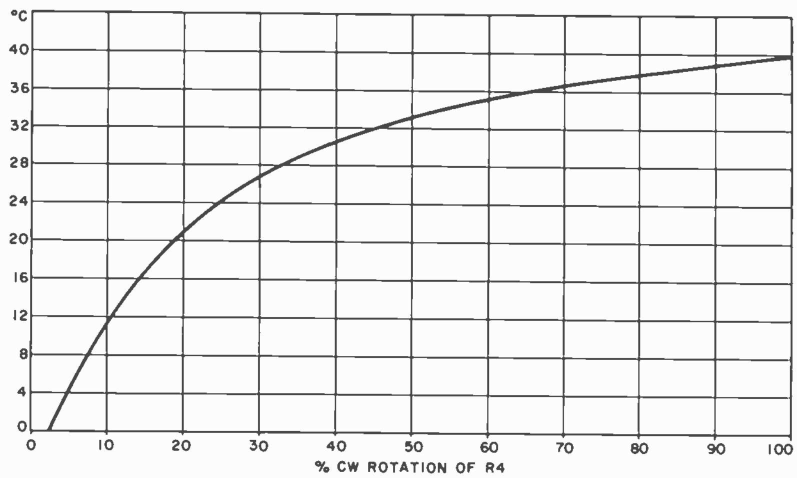


Fig. 2. Curve shows how thermostat setting is affected by R4.

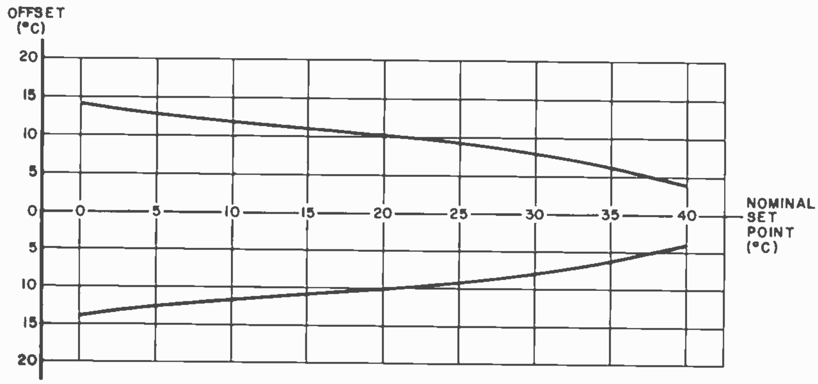


Fig. 3. Worst-case recalibration curve for a nontypical D5.

R4 is set properly, then the diac *D5* (also called a silicon bilateral switch, or SBS) will turn on and latch. Capacitor *C1* is sufficiently large to hold *D5* in its on state from the firing point of *TDR1* (less than 90°) to at least 180°. Of course, if *TDR1* fires at a sufficiently low voltage (sensor hot), then there will not be enough voltage to fire diode *D5*.

But if *D5* does fire, it will do so prior to 90° and remain in this state through 180°. Therefore, *SCR1* has positive gate current at 180°. Prior to this phase angle, *SCR1* remains off since its anode is negative with respect to its cathode. As soon as the phase angle passes 180°, *SCR1* conducts current into the gate of the triac *Q1*. The current through *SCR1* is limited to the minimum turn-on current of *Q1*, as it serves as a shunt around *SCR1*.

So, the triac is on from 180° to 360°, when the current through it falls below its holding point. The slaving circuit consisting of *D3*, *D4*, *C2*, and *R6* serves to store the peak voltage across the load on *C2*. This stored voltage provides the triac with gate current between 270° and 450°, insuring zero-cross firing at 360°.

In this way, the load will be energized for at least two half cycles when heat is required. If still more heat is needed, two more half cycles will follow to keep the load energized.

Construction. Since the circuit is fairly simple, either pc or perforated-board techniques can be used. In any event, the circuit should be mounted in a suitable enclosure, observing the safety practices that are necessary when dealing with line-powered equipment. Thermal sensor *TDR1* should be mounted so that it samples the average temperature of the room, not that of any heat-generating component in the circuit. For example, it could be mounted in one corner of the enclosure away from triac *Q1*, with numerous holes drilled around it for unimpeded air flow. Alternatively, it could be mounted in a small metal box a short distance away from the rest of the circuit, with short interconnecting leads between the two. Thermal paste could then be used to keep sensor and enclosure at the same temperature.

Calibration and Use. Potentiometer *R4* acts as the thermostat's sensitivity control. Figure 2 shows how the thermostat's set point varies as *R4* is rotated. This curve is valid when all components are at their "typical" values. Of course, solid-state and thin-film devices are subject to some variations. Figure 3 shows the worst-case recalibration required with a "non-typical" *D5*. Worst-case variations of the thermal sensor will affect the calibration curve as well, and the resulting recalibration is shown in Fig. 4. All thermostats can be calibrated to within 2° C of Fig. 2 by trimming *R3* and *R8*.

You will most probably want to make a calibrated dial for adjusting *R4* to the desired room temperature. This is best done empirically. Thermally couple a good-quality thermometer to *R1* and adjust *R4* until the neon indicator *I1* flickers or glows. At that point current is flowing through the heating element (LOAD), and the temperature of the sensor can be read off the thermometer. For temperatures higher than the room temperature, *R1* can be *gently* heated.

One final note—the triac specified for *Q1* (HEP R1722) is rated at 10 amperes forward current. If your heating element draws more current, simply use a higher-power triac. Of course, adequate heat-sinking is necessary for *any* thyristor. ◈

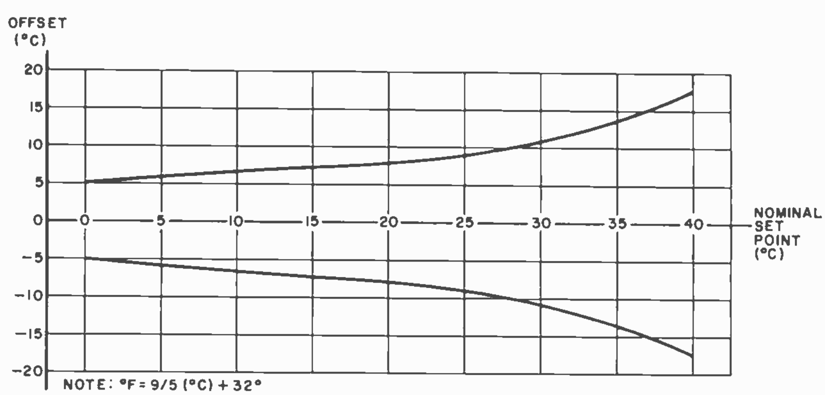


Fig. 4. Variations in R1 can be corrected using these curves.

MAC'S SERVICE SHOP

SWR—FACTS AND FALLACIES

By John T. Frye, W9EGV

"'MAC," Barney said, pulling a little notebook from his shirt pocket, "lay down your solder gun for a minute and bend an ear to these comments about SWR I've heard on the CB and ham bands recently. So help me, I'm quoting these gems verbatim! Just listen:

"'You've a strong carrier but low modulation—get your SWR down and the signal will be fine. . . . You can't get out unless your SWR is below 2:1. . . . If you have a high SWR, reflected power will go back into the tank circuit and bum out your final tubes or transistors. . . . This 75-meter mobile whip is a lot better than my old one because its SWR is lower. . . . A high SWR makes your feedline radiate and causes TVI. . . . Subtract your reflected power from your transmitter output power and what's left is all that's going into your antenna. . . . Reflected power is not power at all because the voltage and current are 90 degrees out of phase. . . . My signal should be much better now because I put a new balun in the middle of the antenna and it lowered the SWR here. . . . I can't put up an antenna for 80 meters because the lot is only 80' deep. . . . I'd like to work down around 3.5 MHz, but this antenna is cut for 3.75 MHz and the SWR is 'way too high down there for me to get out. . . . SWR readings don't mean anything unless you take them right at the antenna or a multiple of a half wavelength away from it.'

"Each one of those statements," Barney said to his employer, "displays ignorance of the true nature of SWR and its effects, but an amazing number of hams and CB operators believe at least some of them. More misconceptions about SWR are floating around than any other aspect of station operation. I get mad when I hear a guy smugly mouthing that drivel into a microphone because I know many listeners without a technical background will accept those fallacies as gospel and spread the same garbage."

"Ah, would that I were young enough again to become that indignant about ignorance," Mac said with a sigh as he leaned back against the wall and lighted his pipe. "But I can see you're about to lecture me on SWR, so get on with it. Let's see you shatter those clay pigeons you've tossed up."

Theory Is Not Simple. "Delighted," Barney replied, "but it's only fair to admit many uttering those foolish things are only repeating what they've read. Their chief sin is gullibility, as they believe anything they read without regard for who wrote it. Ignorant, careless writers are the chief culprits. A writer should *know* his subject matter before he undertakes to instruct. Antenna and transmission line theory is not simple, and anyone who pretends otherwise is not being honest. Most of the half-baked articles I've read containing implicit or explicit errors about SWR usually carry titles like 'SWR Made Easy,' or 'All You Need to Know about SWR.' Other irresponsible writers, too lazy to dig out the facts for themselves, quote from these articles and so perpetuate the fallacies.

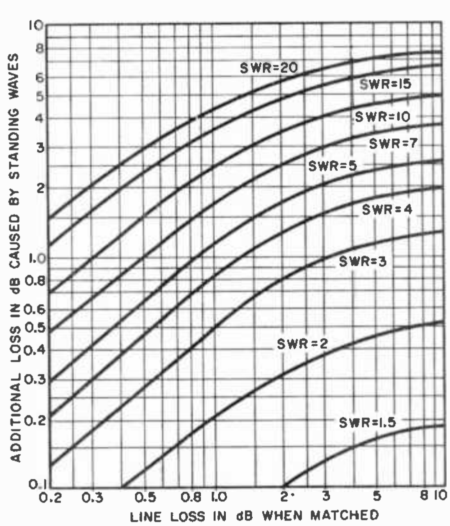
"Actually the truth about SWR is not difficult to find. *The Radio Amateur's Handbook* and *The ARRL Antenna Book* have presented it in time-tested edition after edition. So have such writers as George Grammer, retired technical editor of *QST*, and Dr. Yardley Beers, senior scientist of the Quantum Electronics Division of the National Bureau of Standards. But the most recent, lucid, and complete discussion of the subject is contained in an on-going nine-part series in *QST* called 'Another Look at Reflections' by M. Walter Maxwell, W2DU. He's the engineer in charge of the antenna laboratory and test range at RCA's Space Center in Princeton, NJ. More than 30 earth-orbiting spacecraft, including Echo I and all Tiros-ESSA weather satellites, carry antennas designed by Mr. Maxwell. If you think *I* get hot under the collar about published SWR fallacies, you should read his reaction! As of now, parts of the series appeared in the *QST* issues of April, June, August, and October, 1973, April and December, 1974, and August, 1976. Each part runs about 5,000 words and a 61-item bibliography is included."

"You're not going to cover all that, I hope!"

"No, but I want you to have reliable sources to check any statement that you question. All conclusions in the cited works are supported by quoted authority, sound logic, mathematical proofs, and laboratory experiments using top-notch equipment. There's *no* disagreement among these authors.

"But before we start pigeon-busting, I must define three terms: *source power* is the power a transmitter delivers to the input of the transmission line; *incident power* is power flowing up the transmission line towards the antenna; and *reflected power* is unabsorbed power appearing at the junction of the antenna and a mismatched line, power that flows in a separate wave back down the line towards the transmitter.

Reflected Power. "Reflected power isn't 'imaginary,' 'wattless,' or 'lost.' It's just as real as incident power, but the current direction reversal at the antenna mismatch causes a 180° phase shift between current and voltage in the reflected wave. This is in contrast to current and voltage in the incident wave, which, seeing only the resistive impedance of the line, are in phase with a 0° phase angle. For power in the reflected wave to be reduced to wattless, reactive volt-amperes, their phase difference would have to be 90°. Furthermore, if reflected power *were* wattless, it couldn't deflect a



Increase in line loss due to standing waves (ARRL Antenna Book).

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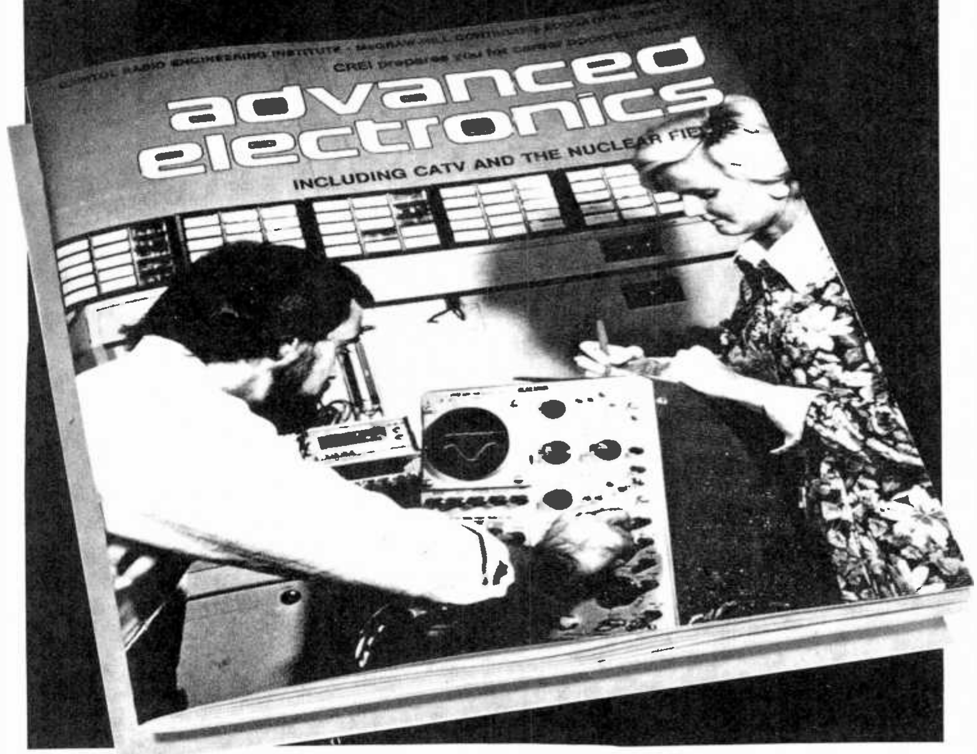

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meter connected to the output of a directional coupler—as it certainly does.

"Neither is reflected power mysteriously 'lost,' breaking the law of the conservation of energy. When the downgoing reflected wave encounters a conjugate match at the transmitter end of the line, it is again totally reflected and its voltage and current go through another 180° phase shift which brings them into step with the 0° phase angle of the incident waves continuously travelling up the line. The reflected power thus adds to the source power; and the fortified incident power combination is sufficient, with a lossless line, to override the mismatch at the top and deliver the full source power to the antenna. You might say the reflected power is salvaged and recycled!"

"What's a 'conjugate match'?" Mac asked.

"It's a condition of system resonance that establishes a unilateral match between the transmitter and the line. Such a match creates a "one-way mirror" at the bottom of the line. The transmitter sees only the resistive component of the line-input impedance, as it would if there were no reflected power. At the same time, the down-coming wave sees a perfectly reflecting mirror that again reverses its direction. The proper adjustment of the transmitter's ouput circuit will provide a conjugate match if the pi-network has sufficient range to cancel the reactive component of the line's input impedance produced by standing waves on the line. If not, an antenna tuner or "transmatch" can supplement the limited impedance matching range of the transmitter output circuit."

"Don't standing waves on the line waste power?"

"Yes, but not nearly so much as many believe. Remember a perfectly flat line suffers some signal-attenuating losses. The amount of attenuation depends on the type and length of the transmission line and on the operational frequency, as shown in the table giving loss per 100 feet in dB for popular transmission lines at selected frequencies. The 28-MHz figures can be applied to the CB 27-MHz band. When there are standing waves on the line caused by a mismatched load, there's an additional loss of reflected power during its round trip down to the transmitter and back again because the line attenuates the reflected wave to the same degree it attenuates the incident wave. The higher the line attenuation, the less reflected power reaches the source where it is turned around and added to the incident power. This simply means less reflected power is recycled and eventually radiated.

"Both the line attenuation and the SWR must be high, however, for this additional loss to be serious, as is shown in the diagram. For example, 100 feet of RG-8/U perfectly matched to an antenna resonant at 3.75 MHz would have a 0.32-dB loss. At either 3.5 or 4.0 MHz the SWR of such an antenna would rise to about 5:1, but the extra loss because of this high SWR at 4 MHz would only be 0.46 dB. Even a 1-dB drop in signal strength is barely noticeable, so the extra loss due to SWR would be insignificant; but use the chart and the graph to see how SWR-induced losses climb as you go up in frequency or use a higher-loss cable, such as RG58/A-AU.

"A lower SWR doesn't *always* mean a stronger radiated signal. If reactive currents saturate the core of an underrated balun when operating far from the antenna's resonant frequency, the SWR might read lower. But power heating the saturated core is subtracted from the radiated signal. A similar effect can be caused by a high-resistance connection in the antenna-feedline system. Be suspicious if a thin-wire 80-meter antenna fed with 50-ohm coax doesn't display an SWR of around 5:1 when tuning more than a few hundred kHz from the resonant frequency.

"A vertical antenna with lots of radials has a combined ground-and-radiation resistance that is considerably lower than the surge impedance of a 50-ohm line, as evidenced by a fairly high SWR. Reducing the number of radials increases the ground resistance in series with the radiation resistance, thus lowering the SWR, but power now heating the ground is subtracted from the radiated signal. A center-loaded whip for 80 meters has a radiation resistance of about one ohm and an average "ground" resistance of 7 ohms. The resistance of a high-Q loading coil is around 8 ohms, but this may go as high as 31 ohms for a lossy coil. The good coil will thus produce an SWR of about 3:1, while the worst coil will give an SWR of about 1.3:1. Power wasted in heating the lossy coil will far exceed the small loss caused by the higher SWR on the short length of RG8/U feeding the antenna."

"Don't you believe in baluns?" Mac asked.

"Certainly, but not for lowering SWR! A good balun eliminates current flowing on the outside of the coax, the result of directly feeding a balanced antenna with an unbalanced line. This current can cause feedline radiation and TVI, as can 'antenna current' induced onto a feedline that is brought away from the antenna at an acute angle. Keep in mind that voltages and currents produced by standing waves are confined to the inside of the coax, and cannot radiate.

TRANSMISSION LINE CHARACTERISTICS

Type of line	Zo ohms	Velocity %	Attenuation in dB per 100 ft 3.5 MHz	14 MHz	28 MHz	144 MHz
RG58/A-AU	53	66	0.68	1.5	2.2	5.7
RG58 Foam	50	79	0.52	1.1	1.7	4.1
RG8/A-AU	52	66	0.30	0.66	0.98	2.5
RG8 Foam	50	80	0.27	0.62	0.90	2.2
RG59/A-AU	73	66	0.64	1.3	1.8	4.2
RG59 Foam	75	79	0.48	1.0	1.4	3.4
#12 Open wire line, ignoring radiation		97	0.03	0.07	0.10	0.25

"Antenna current flowing on the outside of the coax makes it impossible to measure the true SWR. So does leakage between the forward and reflected circuits of a directional coupler, or use of an instrument not accurately matched to the impedance of the line. If these conditions exist, alone or in concert, SWR readings may change significantly when adding or subtracting a few feet of transmission line; but this *does not* mean the SWR is changing with line length. With a reliable instrument and no current on the outside of the coax, the SWR reading will be virtually the same anywhere in the line except for a gradual small decrease as you move away from the antenna, which is caused by attenuation of the reflected wave as it moves down the line."

"Aren't there any valid reasons for keeping the SWR down?"

"Of course there are, but they're chiefly concerned with the effect of SWR on line input impedance and not on lost power or TVI. For example, solid-state CB transceivers have very limited antenna matching ranges; so you can't obtain a conjugate match with their unaided output circuits if the SWR is much greater than 2:1. With a high SWR on the line, the transceiver's final amplifier may be grossly over- or under-loaded when working into a complex line input impedance whose value is dependent on line length. This can easily blow the transistors, but note the damage is not done 'by reflected power backing up into the rig.'"

"How about voltage breakdown on the line with high SWR?"

"The flat-line rms voltage equals the square root of line impedance times power. This would be $\sqrt{50 \times 100}$ or 70.7 volts for 100 watts into a 50-ohm line. With standing waves, the voltage maximum becomes the flat-line voltage times the square root of the SWR. With a 5:1 SWR this would be $\sqrt{5} \times 70.7$ or 158 volts. At 4.0 MHz, RG8/U will handle 700 watts CW continuously within ratings even when an SWR of 5:1 exists on the line. With the duty cycle of SSB, you'll be well below the maximum ratings at 2000 watts PEP. But this kind of power is not recommended for the closer-spaced RG58/U or RG59/U."

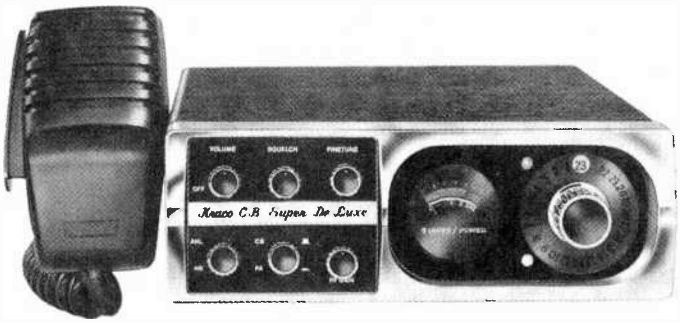
"As I get it," Mac interrupted, ticking the points off on his fingers, "you're saying many operators restrict their activities unnecessarily because of unwarranted fear of misunderstood SWR. An antenna doesn't have to be resonant to radiate all the power delivered to it, and with a conjugate match, a high SWR will not prevent all real power available at the feed point from being absorbed by the radiator. With the aid of a transmatch you can work the full width of the 3.5-4.0-MHz band without any significant loss of power from resulting SWR on an RG8/U line. Much higher values of SWR on an open wire line will cause no appreciable loss of radiated power. Mismatch-produced SWR does not cause TVI. You don't have to measure SWR at a multiple of a half wavelength from the antenna if you have a quality instrument. Reflected power is not irretrievably "lost". Lower SWR doesn't necessarily mean a more efficient antenna or a stronger signal, and reflected power doesn't flow backwards into a pi-network-coupled transmitter."

"You're a good listener," Barney said, clapping his hands, "and I hope you'll spread the gospel. It would be nice if the truth could just be stated once and that would be the end of misunderstanding, but that's not the way it is. Fallacies, like dandelions, keep sprouting up, going to seed, and blowing in the wind. They must be sprayed repeatedly with the truth to keep them from taking root and multiplying." ◇

Product Test Reports

KRACO MODEL KCB-2330 MOBILE AM CB TRANSCEIVER

23-channel mobile provides clean/crisp transmit signal.



THE Kraco Model KCB-2330 is a full 23-channel AM CB transceiver designed for mobile use. It employs crystal frequency synthesis and can be powered from 11.5-to-14.5-volt dc sources with either negative- or positive-grounding systems. Built in are a dual line filter and reverse-polarity protection. Voltage regulation is provided for the critical circuits in the transceiver.

A full-time automatic noise limiter (anl) with a switchable noise blanker and an r-f gain control back up the usual features. These features include a channel selector, fine tuning (Delta tune), squelch and audio gain controls, transmit and receive indicators, S/r-f meter, PA operation, external-speaker jacks, detachable dynamic microphone, and automatic modulation control (amc).

The transceiver measures 8½"W × 7"D × 2¼"H (21.6 × 17.8 × 5.7 cm). Supplied with mobile mounting hardware, it retails for $219.95.

The Receiver. The dual-conversion receiver provided a measured sensitivity of 0.4 μV (rated 0.7 μV) for 10 dB (S + N)/N at 30% modulation, using a 1000-Hz test tone. The first i-f is at 11.275 MHz, obtained by heterodyning the incoming CB signal with the summed mixture of one of six crystals in the 23.290-to-23.540-MHz range and one of four crystals in the 14.950-to-14.990-MHz range. The 455-kHz second i-f is obtained with an 11.730-MHz crystal signal.

The second i-f strip consists of two active stages preceded by a ceramic filter to provide selectivity. This setup yielded an adjacent-channel rejection and desensitization of nominally 60 dB, while allowing an overall bandpass—including the response of the audio section—of 500 to 2700 Hz at the 6-dB points.

The r-f front-end circuits and bandpass coupling between the mixers held the primary image rejection to at least 70 dB. However, a spurious signal around 26 MHz, which appeared to be a secondary image, was only 35 dB down. Otherwise, the unwanted-signal rejection, including that of the i-f, was 60 dB minimum.

The diode detector also provides the agc, which held the audio output variation to within 6 dB with an r-f input change of 20 dB at 1 to 10 μV and to within 10 dB with an input change of 80 dB at 1 to 10,000 μV. A 30-μV signal was required to produce an S9 reading on the meter. The amplified squelch arrangement had a threshold sensitivity range of 0.5 to 1000 μV. The anl is a series-gate circuit that operates full-time.

The audio section employs an IC that includes a class-B output amplifier, which also functions in the usual manner as the transmitter modulator. A maximum sine-wave audio output for both receive and PA operation of 3 watts was measured at 4% THD with a 1000-Hz signal into an 8-ohm load.

The noise blanker picks the noise pulses off the first mixer's output and detects them with a voltage-doubling diode scheme. Coupling is to a transistor across the second mixer's output circuit, momentarily shorting out this circuit to disable the signal path during each pulse. The anl itself is quite effective, but the additional insertion of the noise blanker significantly enhances the impulse-noise attenuation, making for good reception of weak signals under noisy conditions.

Current drain for the receiver is nominally 200 mA.

The Transmitter. The transmitter's frequency is obtained by combining the synthesizer's output (in the 38.240-Hz range) with an 11.275-MHz crystal signal and using the difference frequency at a transmitter mixer. The mixer employs the usual output filtering for minimizing spurious responses.

An emitter-follower stage is then coupled to a buffer, following which are the driver and power-amplifier stages. The latter employs a dual-section output circuit for harmonic attenuation and 50-ohm antenna matching. The carrier output measured up to 4 watts during operation from a 13.8-volt dc source.

The driver and power amplifier are conventionally collector modulated, and an excellent amc system is employed, providing a high degree of compression for maintaining full modulation under varying voice level conditions. This system involves a rectified audio feedback setup that varies the collector-to-emitter resistance of a transistor connected across the speech-input circuit. It then acts as an automatic microphone-gain control.

Using a 1000-Hz test tone with a 40-dB level increase above that required for 50% modulation (40 dB of compression), the modulated waveform held to a sine wave at 100% modulation with only 5% THD and adjacent-channel splatter down 55 dB. Under dynamic (voice) conditions, modulation still remained at 100%, indicating good time constants, with splatter averaging 55 to 60 dB down. The overall response was 550 to 4500 Hz, referred to 1000 Hz, with a 2.5-dB peak at 1700 Hz.

The microphone appears to be a noise-cancelling design inasmuch as it was quite directional. One must speak directly into the front of the mike to obtain maximum signal level. The output dropped considerably when we spoke into it more than slightly off-axis.

The r-f tolerance of the transmitter was within 0.0022% on any channel. Current drain on transmit measured 0.85 to 1.5 amperes, depending on modulation.

User Comment. The transceiver is in a metal case with a wood-grain finish. A chromed bezel surrounds three black panels. Except for the channel selector, the chrome-finished control knobs are small and spaced closely together. The ANL/NB and PA/CB switches are pushbutton types. The meter is fairly large and round faced, but its illumination is rather low in level, which might make it difficult to read under bright ambient lighting conditions.

The microphone connector is located on the bottom of the transceiver's case, about halfway back toward the left rear. The 3" (7.6-cm) speaker produces good quality sound, even though it faces the bottom of the case.

The range of the RF GAIN control circuit is somewhat limited. The same is true of the VOLUME control when operating on PA.

With no antenna, or during the absence of a signal, the receiver is exceptionally quiet, so quiet, in fact, that it gives the impression that the rig has gone dead. Nevertheless, we determined that the receiver has somewhat better than average sensitivity for a given S/N ratio than the average transceiver and is plenty lively even when weak signals are present. We might also add that the exceptionally fine performance of the amc system ensures a well-rounded and clean transmit signal with plenty of pep.

DRAKE MODEL SSR-1 AM/SSB COMMUNICATION RECEIVER

Latest SWL receiver fills performance-price void.

THE R.L. Drake Company's Model SSR-1 is a moderately priced general-coverage AM/SSB communication receiver that is especially suited to the needs of the SWL and good enough for a beginning radio amateur. The 0.5-to-30-MHz receiver employs triple conversion in a superheterodyne design and has a drift-cancelling local oscillator system that is not normally found in inexpensive consumer receivers.

The compact receiver measures 13"W × 11"D × 5½"H (33 × 28 × 14 cm) and weighs 14 lb (6.4 kg). It retails for $350.

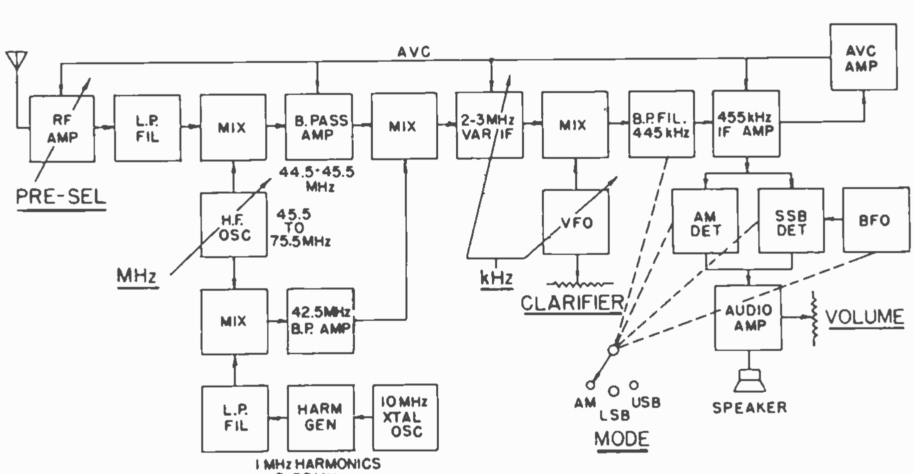
General Description. An understanding of the operation of the receiver can be obtained from the block diagram. Front-end selectivity is provided by a single tuned circuit that is controlled by a front-panel PRE-SELECTOR control and a four-position BAND switch whose positions are labelled 0.5-1.5, 1.5-5, 5-12, and 12-30 in MHz.

A single r-f stage is followed by a 30-MHz low-pass filter and the first mixer. (All mixers in the receiver are diode types.) The signal is heterodyned against an HF oscillator that covers 45.5 to 75.5 MHz and is tuned by a MHZ knob on the control panel. The associated MHz dial is calibrated from 0 to 30 in 1-MHz intervals.

The first i-f is a 1-MHz-wide bandpass amplifier that covers a range of from 44.5 to 45.5 MHz. The second conversion oscillator signal is obtained in an unconventional manner. A 10-MHz crystal oscillator signal is frequency divided by an IC that also contains the active circuitry for the crystal oscillator. It generates a "comb" of signals at integral megahertz frequencies. A bandpass filter passes the comb components from 3 to 30 MHz to a mixer, where the frequencies are combined with the output of the HF oscillator, and the mixer output is passed through a 42.5-MHz bandpass amplifier. The output of this amplifier combined with the 44.5-to-45.5-MHz first i-f signal to produce a second i-f in the 2-to-3-MHz range.

Although the HF oscillator is subject to drift and other instabilities, it can be seen that an increase in its frequency will simultaneously increase the frequency of the first i-f component and the second conversion oscillator frequency so that the frequency of the signal in the 2-to-3-MHz second i-f is unchanged. The main tuning control, labelled KHZ, tunes the second i-f amplifier and a third conversion oscillator that covers a range of 2.455 to 3.455 MHz to produce a third i-f signal at 455-kHz. The dial that corresponds to the KHz knob is calibrated from 0 to 1000 kHz in 10-kHz increments.

The selectivity of the receiver is provided by the third i-f amplifier, with two stages of ceramic filtering whose bandwidth can be changed by the setting of the MODE switch (labelled AM, USB, LSB). For AM reception, a conventional



Block diagram of SSR-1 Receiver

full-wave diode detector is used, while for SSB and CW a four-diode balanced modulator is used as a product detector, with a separate bfo for the final detection. The MODE switch changes the frequency of the bfo for upper- or lower-sideband (USB or LSB) selection. The outputs of the two detectors are also switched, by diodes, in accordance with the mode setting. The frequency of the third conversion oscillator can be varied over a range of ±2 to ±5 kHz by a CLARIFIER control to simplify tuning of SSB signals. The entire audio amplifier section is a single integrated circuit.

A telescoping whip antenna screws into the receiver through a hole in the top of the cabinet. There are also terminals on the rear apron for a 75-ohm unbalanced external antenna. The built-in ac power supply can be operated from 117- or 240-volt, 50-to-60-Hz ac lines, as well as on internal D cells or an external 12-volt dc source. Even with the cells installed in the receiver, the ac power takes over when line power is available and the receiver is plugged into it, thus avoiding unnecessary battery drain. The signal meter and dial scale are illuminated when the receiver is operated on line power. However, during battery operation, a button on the front panel must be pressed to light them.

Also on the front panel are the audio VOLUME control/power switch, headphone jack, and front-facing built-in loudspeaker. Jacks on the rear apron provide access to an internal muting circuit for silencing the receiver during transmit in ham radio applications and to bring out a constant-level audio signal for connection to a tape deck. A slide switch changes the power supply from 117- to 240-volt operation, while a second switch inserts a 20-dB attenuator in the antenna circuit to prevent overloading by very strong signals.

The receiver's sensitivity is rated at 0.3 μV for SSB and 1 μV for AM between 2 and 30 MHz for a 10-dB (S+N)/N. From 0.5 to 2 MHz, the sensitivity is about 10 dB lower. The dial calibration accuracy is 5 kHz over the full tuning range, and the −6-dB bandwidth is 3 kHz for SSB and CW and 5.5 kHz for AM. Image and i-f rejection are rated at 50 dB. (The i-f rejection reduces to 40 dB above 20 MHz.) The audio output is 2 watts at 5% THD, and the internal loudspeaker is silenced when headphones or an external speaker are plugged into the front-panel jack. The entire receiver, exclusive of pilot lamps, is rated to draw less than 100 mA of quiescent current at 12 volts.

Laboratory Measurements. The AM sensitivity for a 10-dB (S+N)/N was 2.8 μV at 1 MHz, 2.4 μV at 3 MHz, and between 1.6 and 1.85 μV from 4 to 30 MHz. The SSB sensitivity could not be measured accurately because the agc could not be disabled; the signal output never rose more than 8 dB above the background noise level in the absence of a signal. Rough checks suggested that the SSB sensitivity was 0.6 to 0.7 μV over most of the frequency range. Tuning across a single band, 3 to 4 MHz, the sensitivity varied slightly, from 2.4 μV at the low end to 1.9 μV at the high end of AM.

The agc action was very good. The audio output level varied less than 2 dB from 0.5 μV input to the strongest signal we could apply. Selectivity could not be measured, again because the agc could not be defeated. The signal meter, which is uncalibrated and has three major divisions, reached the first division at 0.3 μV, the second at 0.75 μV, and the third at 11 μV.

The i-f rejection at the first i-f (45 MHz) was 57 dB. The second i-f rejection (2.5 MHz) was 61 dB. And the third i-f rejection (455 kHz) was in excess of 100 dB. Image rejection, against a 52.5-MHz signal when the receiver was tuned to 3.5 MHz, was 93 dB. The dial calibration was accurate to within the 5-kHz rating; the typical error was less than 3 kHz. The clarifier range was typically about ±3 kHz.

User Comment. The sensitivity of the receiver is more than adequate for most SWL and amateur radio work, and the triple-conversion design makes the receiver effectively immune to most sources of image interference. The receiver's stability was excellent, and we could never detect any drift, even from a cold start.

The dial calibration is certainly good enough for any SWL application and acceptable for amateur operation, except near the edge of a band. The CLARIFIER control makes tuning in SSB signals an easy matter. Even without it, the KHZ tuning dial is fairly smooth and free from backlash to serve as a clarifier. The skirt selectivity of the i-f filter is obviously no match for that of the multi-pole crystal filters used in good amateur equipment because we could hear interference from strong signals just off frequency that was undetectable on a good amateur communications receiver.

The agc time constant is rather short, producing an annoying "pumping" effect on SSB signals. It could benefit from a selectable long time constant and perhaps from a disabling switch.

The manual that came with the receiver points out the existence of strong spurious "marker" signals at integral megahertz intervals from the first oscillator synthesizer comb filter. These are useful as a check on dial accuracy, but they also prevent the reception of any signals within a couple of kilohertz of the integral megahertz points. There are also occasional low-level "birdies" when adjusting the MHz tuning control, but the tuning point is not critical and a slight readjustment eliminates the spurious response.

Although the receiver operated well with the built-in telescoping antenna, it should be used with an external all-band dipole or equivalent antenna for best results.

We judge this receiver to be a fine choice for the fairly serious SWL with limited funds. Although a noise blanker, slot filter and other such amenities are absent, the solid-state SSR-1 fills a total void in its class that was formerly held by Drake's no-longer-made SW-4A $300 tubed model.

CIRCLE NO. 105 ON FREE INFORMATION CARD

Solid State

By Lou Garner

THE GREAT GUESSING GAME

REGULAR readers of this column know that each January I like to challenge the semiconductor industry to a guessing game, predicting what new products will be introduced during the coming year, price trends, and possible technological breakthroughs. In many ways, it's a tough game. If I guess right, there are many who will say, in hindsight, "why that was obvious!" If I'm wrong, just as many will say, "even I could have done better." So goes it in every game. But it's still a lot of fun.

About my predictions. I use a variety of techniques. Some are straightforward extrapolations of present trends; if, for example, preliminary research work is being done in a certain technical area, we can predict with fair success that a commercial product based on that research will be introduced within a reasonable period. If a product with mass appeal, such as a digital calculator or watch, is introduced, we can anticipate expanding sales which, in turn, will lead to reduced prices. Other predictions are based on existing needs which, I feel, can be filled . . . a sort of "wouldn't it be nice if somebody made. . . ." type of prediction. Still others are outright guesses based, if you will, on an intuitive "gut feeling" (oddly enough, these are often the most successful).

Virtually all of the predictions I've made within the last two decades have been fulfilled, although not always within the predicted time frame. In January, 1975, for example, I predicted two new products for that year which didn't materialize . . . *a digital MPG (miles-per-gallon) meter for automotive applications* and *low-cost electronic games based on calculator technology.* Yet both products were introduced during 1976, just a few months late. The digital MPG meter was announced by the Heath Company (Benton Harbor, MI 49022) as their Model CI-1078, while the calculator based games were introduced by Texas Instruments, as described in last month's column ("Calculator Squares" and "Check Out," both priced at under twenty dollars).

Let's see, now, how well I did with the predictions made in last January's column. In case you've forgotten, I predicted:

● *The introduction of additional special-purpose calculators utilizing nonvolatile memories.* Unless I missed a new product announcement somewhere, I score a big fat "zero" on this prediction. But it seemed like a good idea. Maybe next year!

● *Digital electronic watches retailing for less than $25.* Oh, boy, did I hit this one on the button! In fact, TI almost beat me to the punch, announcing their new "under twenty dollar" digital LED watches within days after my column was published. Several other manufacturers, including Fairchild and National Semiconductor, met TI's challenge during the year, with a plethora of digital watches offered during the holiday sales for less than $25 each.

● *More so than in previous years, 1976 should be the year of the programmable calculator, with an expansion in the variety of types offered, a general drop in prices, and the possible use of nonvolatile memories to retain programs.* Right on! Programmable types are now available from virtually all calculator manufacturers, with some models retailing for under fifty dollars each. Both Hewlett-Packard and Texas Instruments cut the prices of their magnetic card programmable calculators during the year and, *as predicted,* a programmable model featuring a nonvolatile memory was announced last summer . . . HP's Model HP-25C. Featuring a CMOS "Continuous Memory," the HP-25C Scientific Programmable Calculator will retain an entered program or memory data for weeks, even when switched OFF. Priced at $200, the HP-25C also offers a choice of fixed decimal, scientific or engineering notation as well as a RPN logic system with 4-memory stack, 8 addressable memories, 72 pre-programmed functions and operations, and full editing, branching and conditional test capabilities.

● *The introduction of pocket calculators featuring internal access connectors or jacks.* Although this concept hasn't caught on in a big way as yet, TI offers two pocket calculators (SR-52 card programmable and SR-56 key programmable) which have access connectors permitting their use with an optional external thermal printer, the PC-100. In operation, the PC-100 may be used to produce a "hard copy" (printed form) of data, intermediate results, calculation steps, or final answers. If desired, the unit will even produce a complete print-out of the calculator's program for permanent reference or checking purposes.

● *The development of higher density memory chips.* Check! Several semiconductor manufacturers are now offering memory chips with expanded capabilities and, as reported in *Circuits Manufacturing* last August, Siemens of Germany is now using a unique "lift-off" production process to produce higher-density IC's.

● *The use of microprocessor IC's in automotive applications, at least on an experimental basis.* Another winner! General Motors has scooped the auto industry by introducing a microprocessor-based electronic spark-timing system in their 1977 Oldsmobile Toronados. Dubbed *MISAR* (for Microprocessed Sensing and Automatic Regulation), the new system receives input data from several engine sensors on vacuum, coolant temperature, engine speed and crankshaft position. Using this data, the microcomputer calculates the best spark-firing position, then signals the ignition system's distributor to fire the spark at precisely the proper instant. According to a GM spokesman, the MISAR system should improve the auto's responsiveness and smoothness of ride, while increasing mileage by approximately 10%.

● *A substantial drop in the prices of microprocessor and*

memory IC's. On target again! Costing hundreds of dollars each when first introduced, μP prices have dropped steadily over the years, with the really big break coming, as predicted, in 1976. Today, a Fairchild type 3850 CPU (Central Processing Unit) costs less than fifteen dollars each in unit quantities, with the companion 3851 program storage memory IC priced similarly.

● *The introduction of a moderately priced thermoelectric module for the experimenter and hobbyist market*. Oops! Bombed out on this prediction! Despite tremendous hobbyist interest, there is not, as yet, a really large market for thermoelectric devices, and without a mass market, manufacturers cannot achieve the production economies needed to make substantial price cuts. Guess we'll have to wait another year or two on this one.

Things to Come. As the two-faced god Janus, who could observe both the past and future, I must now turn to 1977. Taking my slightly cracked crystal ball in hand and peering into its misty depths, I foresee:

● *A drop in the price of simple pocket calculators to the "five-dollar" range*. Frankly, I can see no reason why a simple four-banger calculator can't be manufactured at a price competitive with pocket-sized AM receivers. Both products require about the same number of similarly priced components, and both require comparable labor for assembly.

● *Similarly, basic digital electronic watches, probably 3-function LED types, retailing in the ten-dollar range*. This may require another manufacturing breakthrough similar to the one made by TI in breaking the twenty dollar price barrier, but I think it can be done.

● *Basic microcomputer kits for less than fifty dollars each in small quantities, greatly expanding their appeal to hobbyists and experimenters*. Currently, the lowest priced kit with which I am familiar nets for about a hundred dollars. However, I'm confident that continued reductions in μP and memory prices as the automotive and other mass markets develop will make a $50 kit a practical reality. Of course, this is without power supply or input/output peripherals.

●*Commercial digital multimeters selling in the fifty dollar, or less, price bracket*. During mid-1976, Siliconix, Inc. (2201 Laurelwood Road, Santa Clara, CA 95054) introduced a new low-cost 3-digit monolithic digital voltmeter chip which should make possible such an instrument. Identified as the LD130, the Siliconix IC is a self-contained analog-to-BCD converter capable of driving standard CMOS or TTL display decoder/drivers. With an input impedance greater than 1000 megohms, the device offers a typical accuracy of ±0.5% ±1 count, with built-in temperature compensation, automatic polarity and range changing, internal oscillator and analog stages, and a total power requirement of only 25 mW. Supplied in an 18-pin DIP, the LD130 can be operated with either a split or single-ended dc power supply.

● *A marked increase in the availability and use of analog (linear) devices*. Although the major emphasis in recent years has been on digital devices and their applications, some rather interesting developments have been taking place in the design and manufacture of linear or analog circuits. More important, the real world operates on an analog rather than digital basis, except at the micro or atomic level. Temperatures rise and fall gradually, not in discrete steps. Velocities, whether of natural phenomena, such as the wind, or of man-made vehicles, change gradually, not in sudden steps. Even growth itself is a gradual, rather than stepped, process.

● *A breakthrough in solar-cell technology, leading to price reductions of up to fifty percent in the dollar/watt cost ratio of solar powered electrical systems.* Considerable research effort has been expended in this field and a technical/economic breakthrough is long overdue. For the immediate future, I envision a price drop to about $10/watt . . . and, within a few years, to below $5/watt. As the cost of solar powered electrical systems approaches a figure of $1/watt, such systems will become competitive with general utility power for commercial and residential use.

● *The development of fast response liquid crystal displays, paving the way for the eventual development of practical flat-screen TV receivers.* In many respects, LCD's are perfect display devices, for they are thin, flat, light-weight, relatively easy to manufacture, operate on comparatively low voltages, and require minuscule amounts of power, while providing a quite acceptable image contrast ratio. Unfortunately, most currently available types have one serious limitation—a relatively long response time which makes it difficult to present moving images without excessive smearing and blurring. Eliminate this handicap and the LCD's potential applications will expand tremendously.

● *Increasing sophistication and complexity in solid-state video and calculator-based games.* Riding a popularity crest, video games have several limitations. No matter how fascinating the presentation, only limited skill is required to manipulate a knob or lever control. As the initial novelty wears off, I feel that users will demand—and get—games which require the simultaneous operation of two or more controls, which have more play variation options, and which add a random element of "chance." Possible variations include the addition of foot pedal controls to be operated simultaneously with the hand control as well as controls with multiple operating planes. Naturally, such games will require new and more complex IC's.

● *Solid-state/fiber-optic control and/or communication projects and kits for experimenters and hobbyists.* With a LED at one end as a transmitter, a photosensor at the other as a receiver, a fiber optic "light conduit" offers a number of advantages over copper wire for transmitting communications data

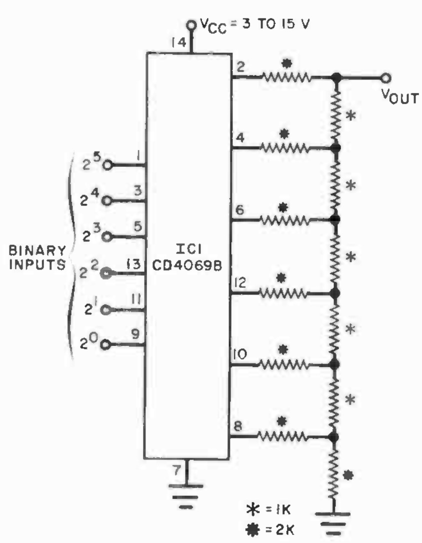


Fig. 1. Digital/analog converter uses COSMOS inverter.

or control information. Among these are freedom from hum and noise pickup, minimal phase shift, little or no distortion, and superb high-frequency response. Though a number of firms are developing commercial applications in this area, little or nothing has been offered to the experimenter/hobbyist. I feel that such projects and/or kits will be offered during 1977 with, perhaps, the first project a simple application, such as an intercom with a fiber-optic link between the master and remote station.

Readers' Circuits. Reviewing Robert Schuman's digital-to-analog (D/A) converter circuit in the June column, reader Keith Lawler (21 W. 264 Coronet, Lombard, IL 60148) suggests that his approach, illustrated in Fig. 1, may offer advantages over the earlier design in many experimenter applications. As in Robert's D/A converter, Keith has used a hex inverter *(IC1)* as a buffer and a weighted resistor network to combine the buffer's outputs and develop an analog signal. Keith's improvements consist of using a COS/MOS rather than a TTL inverter and an R-2R ladder network rather than a series of resistors with doubled and redoubled values. According to Keith, the COS/MOS device delivers more consistent "1" and "0" outputs than does the TTL unit, while the R-2R ladder network is easier to assemble, requiring only two resistance values and a lower total parts count.

Referring to the schematic diagram, *IC1* is an RCA type CD4069B, while the resistors are standard ¼- or ½-watt types; for optimum results, precision (low-tolerance) resistors should be used in the ladder network. While neither parts placement nor the wiring arrangement are critical, customary care should be exercised when installing *IC1* to avoid damage, remembering that this is a MOS device. The dc source is not critical and may range from 3 to 15 volts, furnished either by batteries or a well regulated and filtered line-operated power supply.

Ted Reiter (1442 Brook Drive, Titusville, FL 32780) suggests that the ubiquitous 555 timer can be used effectively as a CMOS-logic-to-TTL interface device. Given in Fig. 2, his circuits illustrate the use of the 555 as a CMOS/TTL buffer, Fig. 2A, and as an inverter, Fig. 2B. Neither design requires external resistors nor capacitors, and both can be operated on standard 5-volt dc power sources. In addition to serving as a CMOS/TTL interface, the 555 can be used as an interface driver between CMOS logic and relays, etc.

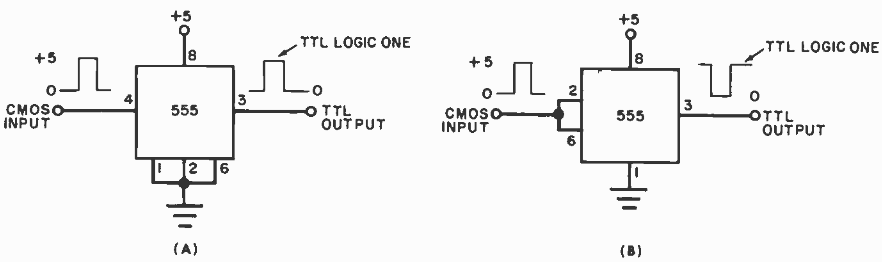


Fig. 2. Suggested CMOS-to-TTL interfaces using the 555. In a buffer circuit (A); and in an inverter circuit (B).

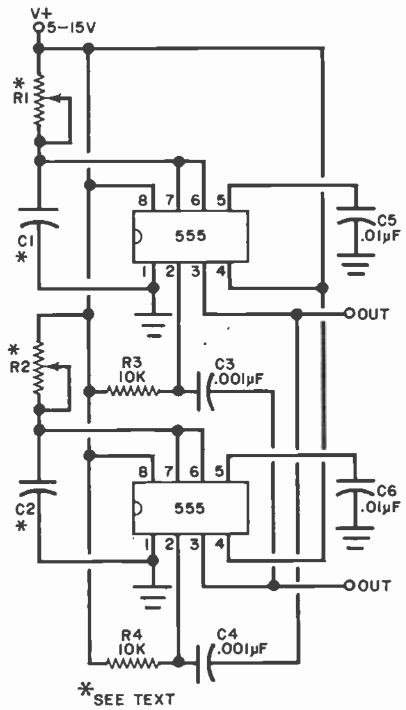


Fig. 3. A 555 complementary multivibrator.

Another interesting technique for using the 555 timer (or its dual version, the 556) is illustrated in Fig. 3. Submitted by Evan Williams (6995 Anglers Lane, RR1 Brentwood Bay, British Columbia VOS 1AO), the circuit features a pair of 555's interconnected to form a symmetrical multivibrator with a moderate output current capability. Evan developed the circuit for use as a low-power inverter, driving the primary of a small transformer through a series current limiting resistor (needed only if the transformer primary has a low dc resistance). For higher power inverter applications, Evan recommends that the circuit be used to drive power transistors connected to a center-tapped output transformer. In addition to its use as an inverter, Evan indicates that the design can serve in such applications as a two-phase clock for logic circuits, as a lamp flasher, and as a "coin flipper." He also suggests that a number of 555's can be interconnected in similar fashion to form a free-running ring oscillator which could be used in such projects as animated displays, games, or even for an electronic "roulette wheel."

Referring to Fig. 3, each 555 is connected for operation as a monostable multivibrator (or one shot), but is triggered by the negative edge of a signal from the other, coupled through differentiation networks C3-R3 and C4-R4. Each, then, is either "ON" or "OFF" alternately, with the duty cycle and operating rate (frequency) determined by timing networks *R1-C1* and *R2-C2*. When one is serving as an output current sink, the other acts as a current source, thus providing true complementary operation and high overall efficiency.

When duplicating the circuit, neither layout nor lead dress should be critical as long as good wiring practice is followed, and the circuit can be assembled on a suitable pc or perf board using point-to-point wiring, as preferred. Resistors *R3* and *R4* are ¼- or ½-watt types, while capacitors *C3, C4, C5* and *C6* may be either small ceramics, paper tubulars, or plastic film types. The values of *R1-C1* and *R2-C2* are determined by the desired frequency of operation, but each *RC* time constant must be *greater* than that of the input differentiator network (*R3-C3* or *R4-C4*). If potentiometers are used for *R1* and *R2* (typically, 10k to 50k), connect a 1,000-ohm resistor in series with each to prevent reducing either resistance to zero. The supply voltage is not critical and the circuit should operate on sources of from 5 to 15 volts.

Device/Product News. On the West Coast, both the Fairchild Camera and Instrument Corp. (Digital Products Division, 464 Ellis St., Mountain View, CA 94042) and the National Semiconductor Corp. (2900 Semiconductor Drive, Santa Clara, CA 95051) have announced new products of potential interest to hobbyists and experimenters. If you're high on digital, you'll want to check into the newest additions to Fairchild's Isoplanar family of CMOS IC's, including the 4528 dual retriggerable, resettable monostable multivibrator, the 4511 BCD-to-7-segement latch/decoder/driver, the 4006 18-stage shift register, the 4041 quad true/complement buffer, the 4043 quad NOR R/S latch, 3-state, the 4044 quad NAND R/S latch, 3-state, the 4510 BCD up/down counter, and the 4516 binary up/down counter. All of the devices are designed to meet or exceed the new industry standard "B" Series CMOS specifications. On the other hand, if you're also (or more) interested in analog circuits, then you'll want to investigate National's new zinc and plastic package designs for their LX1700 series of pressure transducers as well as their new inexpensive AF100 series of active filters. Suitable for pressure measurements from ±5 psi to 0-300 psi, the LX1700 devices are assembled in packages featuring key-locked cables and 5-pin connectors. Available in either 16-pin plastic DIP's or 12-pin TO-8 metal cans, the AF100 devices comprise three interconnected and one uncommited op amps in a single package. Designed for use at frequencies up to 10 kHz, the devices can be programmed with external resistors to form virtually any filter network needed. ◇

Experimenter's Corner

By Forrest M. Mims

THE LM339 QUAD COMPARATOR

Multiple integrated circuitrs are a real boon to the electronics experimenter. They reduce a project's parts count, and are less expensive than the equivalent number of single-function IC's. Furthermore, they make the assembly of projects requiring several IC's of the same type much easier.

A particularly useful multiple circuit IC is the LM339 quad comparator. This versatile chip contains four independent voltage comparators which can be operated from a single-ended power supply. The pin diagram for this IC (Fig. 1) shows how each of the comparators is connected.

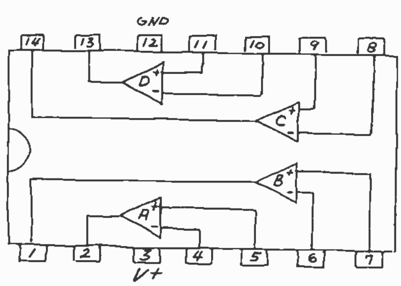


Fig. 1. Pin diagram of the LM339.

Before examining some practical applications for the LM339, let's briefly review comparator operation. As its name implies, a comparator literally compares two voltages. In a typical application, one voltage is supplied by a fixed reference and the other by a variable input signal. Whenever the signal voltage exceeds the reference voltage, the comparator switches on.

You can understand how a comparator works by thinking of it as an op amp without a feedback resistor, and therefore, having the highest possible gain. If you have used an op amp in this mode, you know that a relatively small input signal will cause the output to swing fully on. Actually, a comparator is merely a modified op amp, and you can often operate an op amp as a comparator.

VCO Circuits. National Semiconductor has published a number of circuit applications for the LM339 in application note AN-74 (R.T. Smathers, *et al.*, "LM139/LM239/LM339: A Quad of Independently Functioning Comparators," January 1973). One of the most interesting circuits is the voltage controlled oscillator (VCO) shown in slightly modified form in Fig. 2.

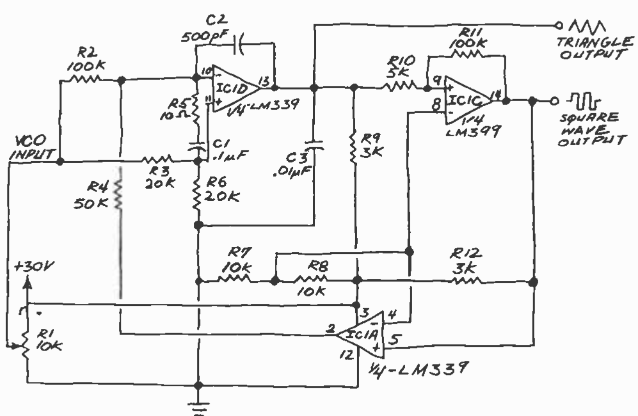


Fig. 2. Voltage-controlled oscillator using the LM339.

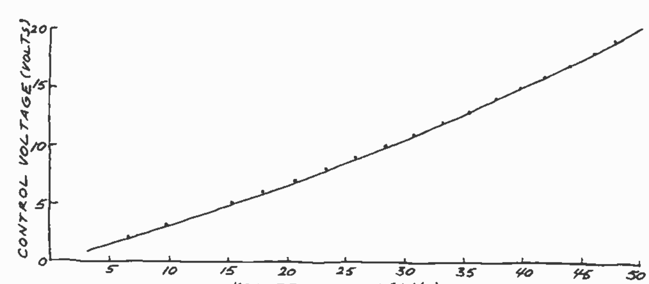
A VCO is an oscillator whose frequency is governed by an input voltage. Two important applications for VCO's are phase locked loops and analog telemetry systems. In the latter role, the variable voltage from a sensor is used to control the frequency of a transmitted tone. Changes in the tone frequency can be analyzed with a decoder circuit to determine variations in the sensor voltage.

The VCO of Fig. 2 provides both square and triangle wave outputs. The input control voltage is provided by potentiometer *R1* which is connected as a voltage divider. But you can use any variable voltage source by removing *R1* from the circuit and applying the control voltage between the input of the VCO and pin 12 (ground) of the LM339.

Figure 3 is a graph I plotted for the circuit of Fig. 2. The graph shows the VCO frequency versus the input voltage. Note that the relationship between the two variables is nearly linear. The graph also illustrates the wide dynamic range of the circuit. With an input of 1 volt, the output frequency was 3447 Hz and the square waves at pin 1 were 150 µs wide. With an input of 20 volts, the frequency was 50,869 Hz and the square waves at pin 1 only about 10 µs wide.

With the values specified, the VCO will accept a minimum control voltage of about 40 millivolts, resulting in an output frequency of 8 Hz. You can increase *C1* to 1 µF for even lower frequencies.

Fig. 3. Control voltage vs operating frequency of LM339 vco.



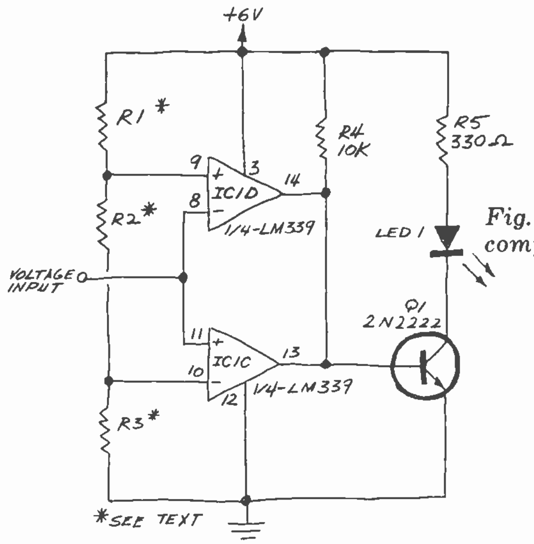


Fig. 4. LM339 Limit comparator.

Though all the results given here were made when a 30-volt power supply was used, the circuit will operate at much lower voltages.

Limit Comparators. Another interesting circuit is the limit comparator shown in Fig. 4. The circuit uses two of the comparators in the LM339, and its operation is straightforward. When both comparators are off, *Q1* is turned on by the base bias from *R4*. In turn, *Q1* activates *LED1*. If either comparator turns on, *Q1*'s base is shorted to ground, and the LED turns off.

This circuit has a variety of voltage sensing and indicator applications. The voltages at pins 9 and 10 of the LM339 determine if either comparator will be turned on. They are established by the resistance ratios in the voltage divider *R1 R2 R3*.

Resistors *R1* and *R3* determine the voltage levels at which the LED switches on and off. Because *R2* is connected between pins 9 and 10, reducing its resistance causes the switching voltages of the two comparators to approach one another. Increasing *R2*'s resistance causes the switching voltages of the comparators to diverge. Accordingly, the resistance of *R2* can be changed to adjust the input voltage range over which the LED stays on.

By using potentiometers for *R1*, *R2*, and *R3*, I was able to adjust the circuit so that the LED turns on when very small input voltages are applied. For example, when *R1* is about 500 ohms, *R2* is about 1200 ohms, and *R3* is about 1 megohm, the LED will begin to turn on when the input signal is only 4 millivolts! The LED will reach maximum brightness at 6 mV and turn off at 8 mV. When *R1* and *R3* are both about 15,000 ohms and *R2* is 25,000 ohms, the LED will turn on at an input signal of 1.5 volts and turn off when the input reaches 4.2 volts.

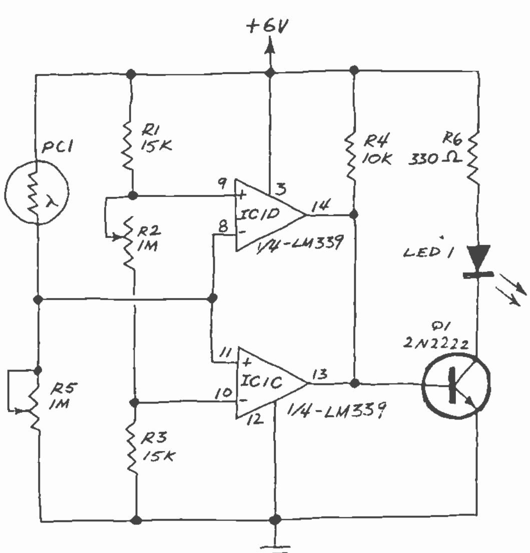


Fig. 5. Limit comparator operated as a programmable light meter

Be sure to experiment with the values of *R1*, *R2* and *R3*. Also, you might want to try replacing *Q1* with a PNP transistor (2N2907, 2N3906, etc.) to reverse the operation of the LED. A PNP transistor will cause the LED to be normally on and to turn off when a desired voltage appears at the input. If you try this substitution, reverse the emitter-collector connections for *Q1* shown in Fig. 4.

I mentioned earlier that the limit comparator of Fig. 4 has a variety of voltage sensing and indicator applications. Fig 5 shows one such application, a programmable light meter. The light sensor is a standard cadmium sulfide (CdS) photocell with a high dark resistance and a low light resistance.

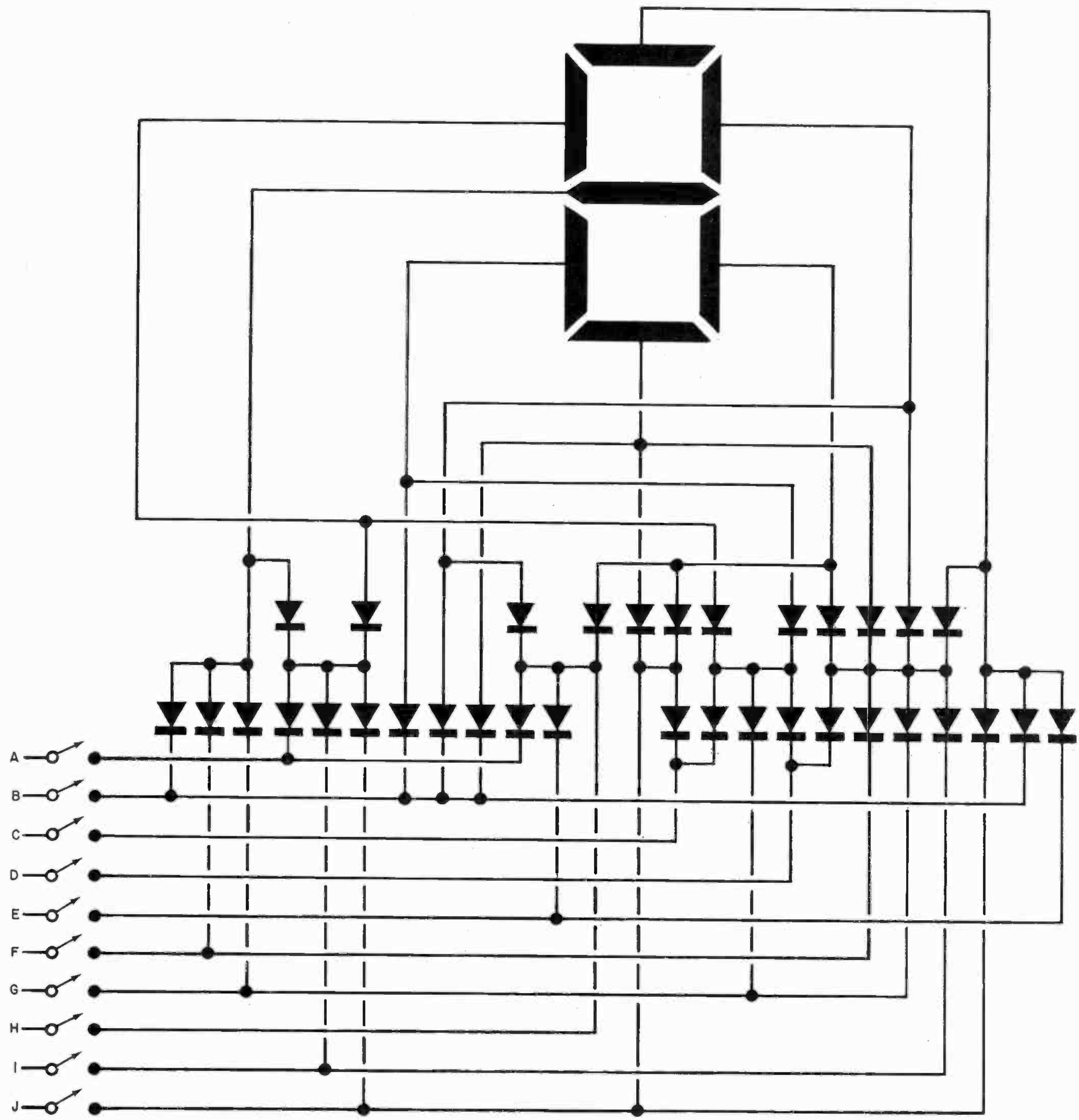
Potentiometers *R2* and *R5* can be adjusted to cause the LED to glow only at a desired light level, or to glow when the light either exceeds or falls below a preset level. Incidentally, note that photocell *PC1* and *R5* of Fig. 5 are simply added to the circuit of Fig. 4. Since these two components form a voltage divider, you might want to try experimenting with their location in the circuit to reduce the component count. For example, try substituting *PC1* for *R1* and *R5* for *R3*. ◇

LED CIRCUIT QUIZ

BY ROBERT P. BALIN

The seven-segment LED digital readout has become a popular and important addition to many electronic devices. But getting them to light up may not always be a simple matter.

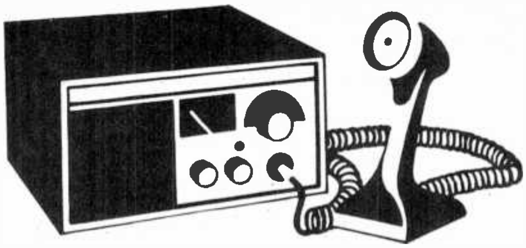
For example, in the circuit shown here, as each of the switches (A-J) is closed, providing the segments with the proper voltage, a different digit is displayed. To test your ability at circuit tracing, see if you can determine what the numbers will be.



Answers

A-4
B-2
C-6
D-0
E-7

F-3
G-8
H-1
I-9
J-5



CB Scene

By Ray Newhall, KWI6010

CB'S BUSIEST YEAR

IT HAS BEEN the biggest year ever for CB, with well over 7½ million new sets sold during 1976, and new license applications pouring into the FCC offices at Gettysburg, PA at more than ½ million each month. We have seen many technical advances in CB equipment and many new FCC Rules to govern its use in the past year or so. The most significant changes involved the liberalization of operating rules and procedures, increasing the number of channels available from 23 to 40, and affirmation by the FCC that CB is here to stay.

The new 40-channel rules, which go into effect on January first, do not obsolete the older 23-channel rigs in any way. In fact, there will never be better buys in CB gear than you can get right now.

The 40-channel rigs, when they become available, promise to be at least 20% more costly than older 23-channel units. Moreover, technical emission requirements are stiffer, a step taken to reduce interference to other types of electronic equipment as well as to adjacent channels. In addition to requiring greater attenuation of spurious harmonics from the transmitter, a receiver certification must be obtained for the first time to minimize signal radiation from local oscillators.

The radiation standard of 5 μV has been stretched to 8 μV in actual FCC tests. Moreover, the limit for production-model sampling is an unofficial 15 μV. This leniency may be decried by some people, but it's difficult to lower the boom in one fell stroke without seriously impairing production or increasing prices, as witness auto pollution devices.

For those owners of older CB transceivers with individual channel crystals, the FCC does not permit changing crystals to receive or transmit on any of the new 17 channels. Twenty-three-channel (or less) units can still be manufactured, you should know. However, manufacture must cease by August 1, 1977 if they do not meet the new standards. Furthermore, sales of old type-accepted units that are not certified for new standards must stop after January 1, 1978, although persons owning such rigs are permitted to continue to use them.

Present owners of 23-channel rigs shouldn't bite their wrists because they do not own 40-channel ones. As observed at other times, there won't be many people to talk to for a while. Channel 9 is still the emergency channel, and it'll be about three years before land-mobile communicators, which share four of the new CB channels (channel 24 at 27.235, channel 25 at 27.245, channel 26 at 27.265 and channel 27 at 27.275) must stop operation. With up to 30 watts input power permitted to these Industrial, Land Transportation and Public Safety Radio Services licensees, some of the new channels will be exposed to the possibility of interference that users never expected.

Looking Back. The two 1976 articles in this column that stirred the strongest reader response were those about (1) "Avoiding CB Ripoffs" (June) and (2) "Is Class E Dead" (August). Here are some of these reader comments, and other points which have come to our attention.

CLASS D CB FREQUENCIES

(Effective Jan. 1, 1977)

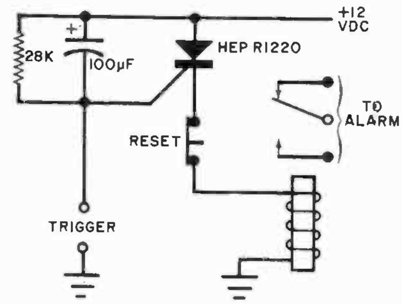
MHz	Channel	MHz	Channel
26.965	1	27.215	21
26.975	2	27.225	22
26.985	3	27.255	23
27.005	4	27.235	24
27.015	5	27.245	25
27.025	6	27.265	26
27.035	7	27.275	27
27.055	8	27.285	28
27.065	9	27.295	29
27.075	10	27.305	30
27.085	11	27.315	31
27.105	12	27.325	32
27.115	13	27.335	33
27.125	14	27.345	34
27.135	15	27.355	35
27.155	16	27.365	36
27.165	17	27.375	37
27.175	18	27.385	38
27.185	19	27.395	39
27.205	20	27.405	40

(1) Many of the responses to the CB theft article were from CBers who wanted to relate how their own rigs were ripped-off.

We received several responses from readers who were inquiring about the best way that they could register the serial numbers of their rigs in order to increase the chances of recovery in case of theft. In our article, we recommended against such registration programs because such lists, if published, might provide excellent shopping lists for would-be thiefs. However, one company came up with a plan which showed promise. They planned to list subscriber's serial numbers in their computer in such a manner that they could quickly recover the name and address of the registered owner upon request of bonafide law enforcement agencies who could make use of a confidential toll-free number.

This plan has stirred the interest of several law enforcement agencies. It should be especially useful now that all new rigs must include a permanently-affixed, unique serial number. Unfortunately, we have not been able to contact that particular company recently to confirm the fact that they are still in business at the original address.

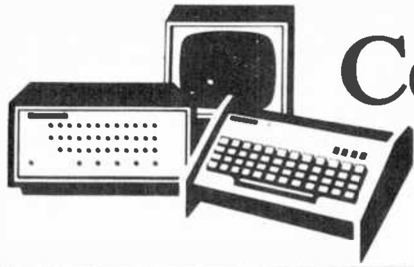
We received many announcements from commercial interests plugging anti-theft products, but one of the more interesting devices brought to our attention was sent in by an electronics experimenter, Dave Medlin of Northfield, MN, who sent us a simple circuit diagram for an SCR trigger device which will sound an alarm when the ground circuit from the rig is broken (see diagram). It only draws about ½ mA of idle current and should not discharge a vehicle's battery even over an extended period of time; or it could be rigged to include an independent battery.



(2) The "Class E" article, which described a proposed class of CB radio in the high VHF frequencies and utilizing frequency modulation, drew a deluge of angry letters from Hams who are understandably concerned that they may lose a part of their frequency allocations to CB for the second time. But not all the letters, not even all of those from Hams, disagreed with the Class E proposal. It has now become evident that a new band must eventually be established to provide our citizens with high-quality personal communications. Whether or not the "Class E" band is the way to go is another question.

Keep Letters Coming. This type of feedback from our readers is very important because it lets us know who is reading our column and what they'd like to see covered.

We know that many CBers are reading our column and subscribing to POPULAR ELECTRONICS by the tremendous response we have had to the offer to send a Form 555-B to anyone who will send us a self-addressed, *stamped* envelope (more than 500 received). We'll continue to supply these forms and will also keep a supply of license applications (Form 505) on hand as well, even though they will be packed with all new sets sold after January 1, 1977. Please send requests to REST MARINE, Box 170, Old Greenwich, CT 06870. ◇



Computer Bits

By Hal Chamberlin

TEXT EDITING

TEXT EDITING is a fundamental function that almost every hobby computer will be called upon to perform. Even an operation as simple as typing a command into a monitor program and then backspacing to correct an error is a form of text editing. Preparing programs in assembly language or BASIC is primarily program text editing. In fact, most BASIC language systems have a built-in text editor. A good program editor can greatly increase the speed, accuracy, and fun of writing large programs.

An editor designed for English text would be useful to non-computer-oriented family members as well. For people who hate to write letters, a text-editor program makes it so easy that the relatives will be swamped with mail. Maybe your sister types dissertations and reports for students at a nearby university. A good text-editing program could increase her speed and accuracy to the point of making it a lucrative business. An author is much more productive (at least this one is) when sentences and paragraphs can be rearranged on the spot to make the work "sound right."

Hardware. Every microprocessor in common use by hobbyists is ideal for text editing applications. The amount of memory required is not great; 4k bytes is adequate for a useful system but 8k allows a sophisticated editor program, as well as a full single-spaced page of text, to fit in memory at once.

If the goal is quality editing of English text for reports, then an upper- and lower-case keyboard is needed. A good "feel" is helpful if a touch typist will be using the system. A useful keyboard feature is a shift-lock key that affects only the letters of the alphabet. There are many suitable keyboards on the surplus market. The best ones for text editing are those made by Microswitch and Clare-Pendar.

Since the goal of most text editing is to produce letter-perfect printed pages, some kind of printer is necessary. For informal work a Teletype, either ASCII or Baudot, is acceptable. For higher quality *upper-* and *lower*-case reproduction, about the only present possibilities for the hobbyist are a used Selectric terminal (golf-ball printer) or a manual Selectric typewriter converted to computer operation. In a year or so, used "daisy wheel" printers made by Diablo and others, should be appearing on the surplus market. These are an absolute "dream come true" in a text-editing application. A printer is the biggest obstacle to overcome in setting up a text-editing system.

Having a CRT display on a text-editing system is like having a picture with your TV sound. Usually the text being typed in or edited is shown on the screen exactly as it would appear when printed out. When editing, finding the exact phrase or word to be changed is very rapid and the result of the change is instantly visible. If the change involves an insertion or deletion, the editing software automatically moves words from line to line to maintain an even right margin. Similarly, if a sentence or paragraph is moved elsewhere on the page, the movement appears immediately on the screen.

By far the best kind of video-display interface to use for text editing is one that generates the display from directly addressable computer memory. Here, merely moving bytes around in memory will also move the text around on the screen. If your computer has an "ALTAIR" bus, the VDM-1 from Processor Technology or the PolyMorphic Systems video interface are ideal. In addition they offer both upper- and lower-case characters and a line length of 64 characters, as wide as a typewritten page with one-inch margins. The typical "TV typewriter," although excellent for communicating with the computer, is less suited to editing applications, because most changes to text on the screen require retransmission of the whole page through a serial I/O port. Also, the 32-character line with upper-case only is awkward in most cases.

Video monitor driven by computer displays first lines of this column.

A mass-storage device, while not required, can greatly increase the usefulness of an editing system. Without mass storage you are limited to editing what can fit in your available memory. For short reports this might not be much of a restriction since one page at a time can be typed in, edited, and printed. With long reports or programs, mass storage allows editing and updating to be done days or weeks later. Because of frequent insertions, deletions, and updates, a floppy disk is better suited to text editing than the low-cost tape cassette approach. However two high-speed program-controlled cassette decks can be successfully used. A sophisticated system with mass storage allows text to be appended from one page onto another as well as provide for maintaining full pages during insertions. In fact, a good editing program also makes a dandy general-purpose information storage and retrieval system.

Software. Once the needed hardware has been assembled, the key to a useful system is the editing software. Unlike most other applications, very little specialized knowledge is required to write an editing system; only a good knowledge of programming techniques. In most cases common sense and experience with manual editing of text will be sufficient to keep system development on the right track.

One of the fundamental decisions to be made is whether a program editor or an English-text editor is desired. The main difference is that programs are line-oriented (each line of text is independent) and English text is sentence- and paragraph-oriented, with little importance attached to actual lines. A strict program editor is easier to write but is of limited use on English text. On the other hand, a good English text editor can handle programs well also.

A related decision is whether text stored in the system is page-oriented or handled as a long scroll. A page is the amount of text that fits on a standard typewritten page; about 50 lines single-spaced or 25 lines double-spaced. A scroll has a variable number of lines according to the particular text being edited. Programs are best handled as a long scroll, since actual printed-page boundaries are of little significance. One scroll might be an entire program of hundreds or thousands of lines. A page-oriented system is better suited to English text, since one could not expect titles and paragraph breaks to come out right if a long scroll were printed simply as 50 lines per page.

When text is stored on a mass storage device, a software-maintained *index* is quite helpful to both the operator and the software in locating the desired page or scroll. Each index entry could give a name, a sequence number , and the location on the storage medium for each page or scroll stored. The name identifies and briefly describes the associated text. The sequence number might be a page number in a particular report. The storage location gives a record number or a track and sector number of the text depending on whether a tape or disk is used. Software could be written so that a user command such as "GET (name)" would search the index for the requested name and read the text into memory for display and editing. Additional commands and associated software would be available for creating new pages, deleting unwanted pages, and renaming or resequencing pages. Some of these index-manipulation commands may not be needed with a program editor.

One very useful feature in an English text-editing system which alone increases typing speed substantially is called *word wrap*. With an ordinary typewriter, the user is constantly listening for the end-of-line bell and worrying about fitting words into the right margin. With word-wrap software the computer automatically moves any words that don't fit within the right margin to the next line while they were being typed in. Thus the user simply types away without having to type carriage returns and need not stop until the end of a paragraph.

Within the software there will be a number of elementary subroutines for handling the display. The most basic are the cursor-movement routines. For example, with the VDM-1 display, a cursor is displayed by setting the eighth bit in a byte to one. When this is done the character is shown as black on a white background. Normally only one character will have this bit on and the cursor is said to be at that character position. There is a switch on the VDM-1 board that causes the cursor to flash if desired. Besides having the bit set, there are two numbers to be maintained in memory; one is the line number of the cursor and the other is the character number. Four cursor-movement routines are needed: left, right, up, and down. The routines would be fairly simple; cursor left deletes the cursor bit in the character pointed to by the cursor, decrements the cursor character number, and then sets the cursor bit in the character at the new cursor location. Cursor right is the same except that the character number is incremented. Up and down are also the same except that the line number is manipulated. Note that checking will have to be done to prevent the cursor from going off the page. If the keyboard being used has some extra keys, a good use for them is cursor movement.

Even if the editor is page-oriented, a scrolling routine will be needed to allow the user to see all of the page with a 16-line display. Normally there would be a text buffer in memory to hold the entire page being edited. One k-bytes of that buffer would be stored in the display memory and show up on the screen. One approach simply divides the page into 16-line segments and provides a command to display the desired segment. A better approach would constantly adjust the display and text buffers so that the line the cursor is on is in the middle of the screen. Then in all cases the user could see several lines of text before and after the line being edited. Most microprocessors are fast enough so that the text movement associated with display scrolling is essentially instantaneous.

The actual editing of text is done with a fairly small number of commands. Mostly one wants to insert, delete, and move basic elements of text such as characters, words, lines, sentences, and paragraphs as well as simply type over mistakes. The cursor is very important in performing these fuctions. To perform a typeover, the user positions the cursor at the first character to be changed and starts typing. Actually, simple entering of new text can be considered as typing over blanks. For deleting characters, the cursor is placed at the first unwanted character and a "delete character" key is pressed. For maximum usefulness, the text to the right of the deletion moves left to fill the hole created and the cursor winds up on the next character. Thus multiple characters are deleted by using the "repeat" key with the delete-character key. For insertions, the cursor is placed where the insertion is to be made and an "insert mode" key is pressed.

Now, as each character is typed, text to the right of the cursor moves right and down to make room for the next piece of inserted text.

For larger elements of text the concept of "designation" is helpful. First there are commands to designate a word, a line, a sentence, and a paragraph. To perform a designation, the cursor is placed anywhere in the element to be designated and the appropriate command given. The software then searches forward and backward, applying rules for the text element to determine which characters are within the element. The rules for a sentence, for example, might be any string of characters starting with a capital and ending with a period. Designation might be shown on the screen by turning the cursor bit on in the designated block. Once a block is designated, it could be either deleted or moved somewhere else.

In a system with mass storage, a useful function is appending text from one page to another. A simple implementation would allow text from another page to be placed at the bottom of the page being edited. The converse operation would split one page into two or more pages. With these functions, text can be easily moved around in a report. Also, documents can be assembled from previously stored paragraphs.

Finally, there is a large number of possibilities for "justifying" edited text for final printout. The simplest is to make sure that the maximum number of words possible are on each line. This will give a standard typewriter appearance with ragged right margin. If a flush-right margin such as in newspapers is desired, a method that is compatible with standard printers is to distribute the blanks at the end of the line between the words. Unfortunately the word spacing may become a little erratic, but many people prefer the "blocked-off" appearance of the text. In both cases the appearance can be improved by hyphenating long words at the end of the line. Automatic hyphenation according to the rules of English is difficult to program. A good compromise is to have the software ask the user how words that need to be broken should be hyphenated. A very impressive demonstration is provided by a justification routine moving words around on the display screen.

A useful editing program need not have all of these features, but one nice property of text-editing applications is that new functions can be easily added when desired up to the limits of available memory. ◇

Operation Assist

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)

Nemsclarke (Div. of Vitro Corp.) Model 1432 Phase Lock receiver. **Air Associates** Model CR3-G receiver. Coil data for Air Associates manuals and schematics for both. Rudy Rutenber, 20632 Hartland #2, Canoga Park, CA 91303.

RCA Model WO54B 3-inch oscilloscope. Need schematic and alignment instructions. Henry M. Gort, Box 289 Chloride Star Rt., Kingman, AZ 86401.

Signal Corps Model BC-348L receiver built by Belmont. Schematic and/or manual. Darhl Boucher, R.D. 1, Falls Creek, PA 15840.

General Electric GE-93 multi-band radio. Schematic and alignment instructions. **Ballantine** Models 220 ac VTVM and 314 decade amplifier. Schematics and operating instructions. Rad Smith, 3188 Rumsey Drive, Ann Arbor, MI 48105.

Atwater Kent Model 60. Schematic and any info on restoring, source for tubes, and speaker rebuilding. Bruce Boyes, 976 River Hts. Blvd., Logan, UT 84321.

U.S. Govt-National R-651/URR39 receiver model NC183MR. Schematic and/or service manual. Sal Ruggieri, 345 Aldrich Rd., Howell, NJ 07731.

Tube source for 19X8 and 12AL5. W. Clumm Entwood, R.R. 1, Amesville, OH 45711.

Precision Apparatus Model EV-10 VTVM, **Precise** r-f/a-f/TV marker/bar generator Model 630. Schematics and/or manuals. David Houston, 1076 Williston Road, Burlington, VT 05401.

Cariole Model 19545 cassette recorder. Schematic and any other information. Max Hatwig, Alexander, IA 50420.

Phone King Model J36 telephone answering device. Schematic and parts list or maintenance manual. Mosha Comfeld, Apt. 2, 1261 N. Laurel Ave., Los Angeles, Ca 90046.

Auditon Model 2515-1 AM/FM/8-track/phonograph. **Matter** SP-200 100-W/ch audio power amp. Schematics, service manuals, or Auditon address. G.D.C., Box 824, Huntsville, AL 35804.

Analab Model 1120 oscilloscope main frame with #700 plug-in. Schematic needed. Ken Lesniak, 15 Academy Road, Somerset, NJ 08873.

Precision Apparatus Co. Series EV-10A VTVM. Schematic. George F. Oelkers, 609 St. James Rd., Newport Beach, CA 92663.

Bradford Model S52506 portable stereo cassette recorder. Schematic and/or service manual and source for replacement heads and switch contacts. Tim Melton, Box 1738, Cave Creek, AZ 85331.

Western Electric Model RU-17 aircraft radio receiver. Built for BuShips contract 84530 21 April 1941. Maintenance and operating manuals, and source for plugs and jacks used on this equipment. S.E. Stokes, 26006 Crenshaw Blvd. #115-B, Torrance, CA 90505.

Keystone Model 2000-CSR stereo cassette deck. Service manual or schematics. Roy Cantu, 1980 Flora Place, Eureka, CA 95501.

Capehart Deluxe Model 411M AM/FM/SW radio and phonograph manufactured by Capehart Division, Farnsworth TV and Radio Serial 18507F. Company address, schematics, and any manuals available. Scott Stockwell, R.R. 1, Box 102, Riley, KS 66531.

Motorola Model AN/VRC-19 transceiver containing transmitter T-278/U and receiver R-394-U. Any available information. Mel Swanberg, 1037 Scripps, Claremont, CA 91711.

RCA Victor Model 8-V-151 Victrola radio phonograph. **Navy** surplus receiver type CAY-46077-A. Schematics needed. Roger Ream, Rte. 5, Box 62-H, Melbourne, FL 32935.

Electronic Tube Corp. Model K470 oscilloscope. Service manual and/or schematics for scope, power supply, and plug-ins. L. Beecroft, 5913-54th Ave., Red Deer, Alta., Canada T4N 4M7.

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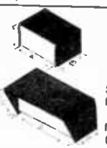

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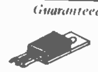

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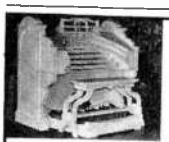

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10. Extent and nature of circulation	Average no. copies each issue during preceding 12 months	Actual no. copies of single issue published nearest to filing date
A. Total No. Copies Printed (Net Press Run)	456,093	478,148
B. Paid Circulation		
1. Sales through Dealers and Carriers, Street Vendors and Counter Sales	80,464	82,975
2. Mail Subscriptions	322,418	342,530
C. Total Paid Circulation (Sum of 10B1 and 10B2)	402,882	425,505
D. Free Distribution by Mail, Carrier or Other Means Samples, Complimentary, and Other Free Copies	7,695	8,462
E. Total Distribution (Sum of C and D)	410,577	433,967
F. Copies not distributed		
1. Office Use, Left Over, Unaccounted, Spoiled After Printing	2,767	2,663
2. Returns from News Agents	42,749	41,518
G. Total (Sum of E, F1 and 2—should equal net press run shown in A)	456,093	478,148

11. I certify that the statements made by me above are correct and complete.
WILLIAM L. PHILLIPS, Assistant Treasurer

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39 U. S. C. 3626 provides in pertinent part: "No person who would have been entitled to mail matter under former section 4359 of this title shall mail such matter at the rates provided under this subsection unless he files annually with the Postal Service a written request for permission to mail matter at such rates."
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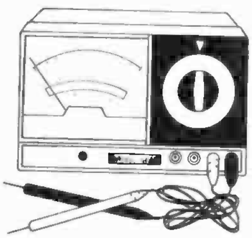

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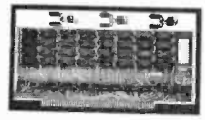

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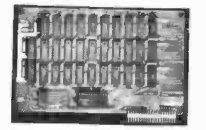

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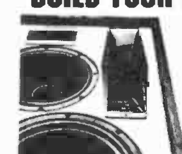

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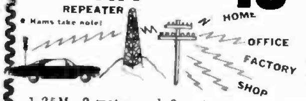

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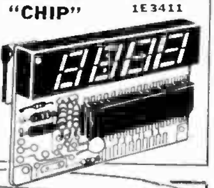

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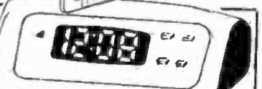

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KIT INCLUDES
- INSTRUCTIONS
- QUALITY COMPONENTS
- 50 or 60 Hz OPERATION
- 12 or 24 HR OPERATION

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13-Transistors
3-Switches
6-Capacitors
5-Diodes
9-Resistors
24-Molex pins for IC socket

LARGE .4" DIGITS!
ORDER KIT #850-4
AN INCREDIBLE VALUE!

"Kit #850-4 will furnish a complete set of clock components as listed. The only additional items required are a 7-12 VAC transformer, a circuit board and a cabinet, if desired."

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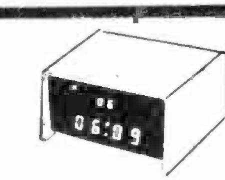
Molded Plug Transformer 115/10 VAC (with cord) 2.50
NOTE: Entire Clock may be assembled on one PC Board or Board may be cut to remote display.
Kit # 850-4 will fit Plexiglas Cabinet II.



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Great for Clocks or any LED Digital project. Clear-Red Chassis serves as Bezel to increase contrast of digital displays.

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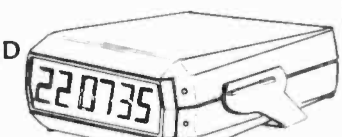
MOBILE LED CLOCK

12 OR 24-HOUR OPERATION
12 VOLT AC or DC POWERED FOR FIXED OR MOBILE OPERATION.
SIX LARGE .4" DIGITS!

KIT OR ASSEMBLED — MODEL 2001



ACCURATE TIME WITH ADJUSTABLE XTAL TIME BASE

Approx. Size: 1¾"H x 4"W x 4½"D

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WIRED FOR 12 HR OP IF NOT SPECIFIED OTHERWISE

JUMBO RED LED's 12/$1.00 50/$3.95

6 Digit-LED Clock-Calendar-Alarm Kit

This is a complete, top of the line, Kit for the person that wants the best. Some of the many features and options are: 12/24 time, 28-30-31 day calendar, alternates time (8 sec) and date (2 sec) or can display time only and date on demand, 24 hr alarm - 10 minute snooze, alarm set indicator, 50/60 HZ. line operation or use with Xtal time base (#TB-1), built in OSC for battery back-up / AC failure, Aux. timer. CHOICE OF DIGITS.

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Kits are complete (less cabinet) including PC boards, power supply, IC socket, 9 switches, 16 transistors and all parts required for above features and options [All #7001 Kits Will Fit Cabinet I Above]

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Will enable Digital Clock or Clock-Cal. Kits to operate from 12VDC. Uses MM5369 and 3.58MHZ. XTAL. Req. 5-15VDC/2.5 MA. 1"x2" PC Board. Easy 3 wire hookup Accuracy: + - 2 PPM

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A complete Kit (less Cabinet) featuring: six .5" digits, MM5314 IC, 12/24 Hr. time, 50/60 HZ., Plug-Transformer, Line Cord, Switches, and all Parts.
[Ideal Fit in Cabinet II]
Kit #5314-5 .... $19.95 ea. 2/$38.

JUMBO DIGIT CONVERSION KIT

Convert small digit LED clock to large .5" displays. Kit includes 6-.5" LED's, Multiplex PC Board & easy hook-up info.
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Kit #JD-1CA For common Anode
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74S15	.56
74S20	.50
74S22	.45
74S40	.45
74S50	.45
74S51	.56
74S60	.86
74S64	.56
74S73	1.25
74S74	.86
74S75	1.75
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LM 309 K	TO-3	1.25
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7815	TAB	1.25
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7824	TO-3	1.25
723	DIP	.75
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14	.25	.22	.20
16	.28	.25	.23
18	.31	.28	.26
24	.50	.45	.40
28	.60	.56	.50
40	.75	.70	.66

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21L02 IK RAM $1.95

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OP AMPS 3/$1.00

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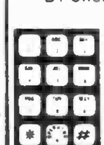

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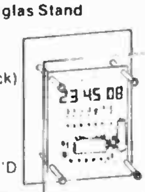

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7-SEG LED

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DL-750	RED	.6"	LHDP	$2.95
XAN-654	GREEN	.6"	NDP	$2.95
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COMMON ANODE

DL-747	RED	.6"	LHDP	$2.95
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XAN-81	YELLOW	.3"	RHDP	$1.75
XAN-351	GREEN	.3"	RHDP	$1.50
XAN-361	RED	.3"	RHDP	$1.50
XAN-362	RED	.3"	LHDP	$1.50
XAN-662	RED	.6"	NDP	$2.50
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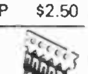

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7408	.18	7473	.35	74162	1.39
7409	.19	7474	.28	74163	1.09
7410	.16	7475	.49	74164	.99
7411	.25	7476	.30	74165	.99
7413	.43	7483	.68	74166	1.25
7414	.65	7485	.88	74170	2.10
7416	.35	7486	.40	74173	1.49
7417	.35	7489	2.25	74174	1.23
7420	.16	7490	.43	74175	.97
7422	.30	7491	.75	74176	.89
7423	.29	7492	.48	74171	.84
7425	.27	7493	.48	74180	.90
7426	.26	7494	.78	74181	2.45
7427	.29	7495	.79	74182	.79
7430	.20	7496	.79	74184	1.90
7432	.23	74100	.98	74185	2.20
7437	.25	74105	.44	74187	5.75
7438	.25	74107	.37	74190	1.15
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7441	.89	74122	.38	74192	.95
7442	.59	74123	.65	74193	.85
7443	.73	74125	.54	74194	1.25
7444	.73	74126	.58	74195	.74
7445	.73	74132	.89	74916	1.25
7446	.81	74141	1.04	74197	.73
7447	.79	74145	1.04	74198	1.73
7448	.79	74150	.97	74199	1.69
7450	.17	74151	.79	74200	5.45

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16 pin	.22	40 pin	.69
18 pin	.29		

WIRE WRAP - gold plate
14 pin .49

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301	.29	339	1.58	562	3.39
302	.51	340k	1.69	565	1.18
304	.80	370	1.20	566	1.95
305	.71	372	2.93	567	1.95
307	.26	373	2.42	709	.26
308	.89	376	.68	710	.35
309k	1.35	380	1.30	711	.26
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319	1.13	382	1.75	747	.71
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7437	.20	307	DIP	.22	MV50	.20
7474	.22	565	DIP	.97	5020 RED	.12
74121	.29	741	mDIP	.22	DL10A	1.69
9602	.49	739	DIP	.89	MAN5	.98

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2.2 mfd	20V	.25	15 mfd	20V	.45
2.2 mfd	35V	.30	22 mfd	16V	.45
3.3 mfd	35V	.30	33 mfd	10V	.40
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6.8 mfd	6V	.30	56 mfd	6V	.45
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546	AM Radio Receiver Subsystem DIP	.75
1310	FM Stereo Demodulator DIP	2.90
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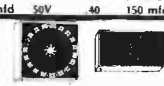
1800	Stereo multiplexer DIP	2.48
ULN2208	FM Gain Block 34db (typ) mDIP	1.18
ULN2209	FM Gain Block 48db (typ) mDIP	1.35
2513	Character Generator 64x8x5 DIP-24	10.20
3046	Transistor Array DIP-14	.73

AUTO CLOCK KIT

6 digits .375" red led's
Operates from 12V DC or AC
Crystal control for high accuracy
Supplied with case & mounting bracket
Contains internal 9V battery for operation of timing circuit (without display) when removed temporarily from power.
Uses 5314 clock circuit
Supplied with all necessary components and assembly Instructions

$33.95

COMPLETELY ASSEMBLED **$44.95**



Electronic Games
A great gift idea or for your own family entertainment center. We have available in kit form **Electronic Roulette** and **Electronic Craps**. Both kits contain P.C. boards, LED's, all necessary components, transformer, case and instructions for easy assembly. Included with each kit is a 55 page booklet explaining the entire game.

Electonic Roulette
Dimensions 6½" x 6½" x 1½" **$23.95**

Electronic Craps
Dimensions 6½" x 3½" x 1½" **$14.95**

Mark I
A six digit clock kit with one double sided P.C. board accommodates MM5314 clock chip and 6 FND359 .375" displays. 12-24 hour, 50-60 Hz. Contains all necessary components, 3 switches and complete assembly instructions with schematics. Connections for remote displays.

Mark I **$13.95**

Transformers
117VAC — 12V 300 ma PC Mount. **$3.95**
117 VAC — 12V 300 ma wall mount **$4.95**

Optional case **$4.95**
Unfinished redwood
Internal or wall transformers may be used.

CMOS

4000A	.26	4018A	1.39	4066A	.89
4001A	.25	4020A	1.72	4068A	.44
4002A	.25	4021A	1.18	4069A	.44
4006A	1.35	4022A	.94	4071A	.26
4007A	.26	4023A	.25	4072A	.35
4008A	1.52	4024A	.89	4073A	.39
4009A	.57	4025A	.25	4075A	.39
4010A	.54	4027A	.59	4078A	.39
4011A	.29	4028A	.98	4082A	.35
4012A	.25	4030A	.44	4518A	1.56
4013A	.45	4035A	1.27	4528A	1.56
4014A	1.27	4040A	1.39	4585A	2.10
4015A	1.27	4042A	1.47		
4016A	.48	4049A	.59		
4017A	1.01	4050A	.59		
74C00	.19	74C74	1.04	74C162	2.49
74C02	.26	74C76	1.34	74C163	2.66
74C04	.44	74C107	1.13	74C164	2.66
74C08	.68	74C151	2.62	74C173	2.22
74C10	.35	74C154	3.15	74C195	2.26
74C20	.35	74C157	1.76	80C95	1.15
74C42	1.61	74C160	2.48	80C97	.96
74C73	1.04	74C161	2.49		

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CT5002	1.95	MM5311	4.45
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MM5725	1.98	MM5314	4.45
MM5736	2.95	MM5316	4.95
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MM5739	3.95	CT7001	5.95

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MAN5	2.25	NSL101	.12
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MAN7	1.49		
MAN8	2.25	MV5020	
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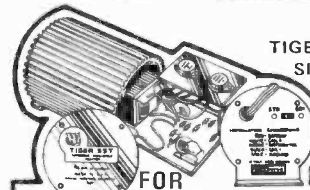

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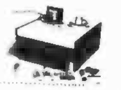

6-DIGIT ALARM CLOCK

THE KING FEATURES:

1) 6 digit, 12 hr, 60 cycle or 24 hr, 50 cycle alarm clock.
2) Time sharing capability for display of additional information
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4) AM PM and automatic power failure indications
5) 10 minute snooze
6) Intensity control of LEDs.

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TANYA 60 HZ CRYSTAL TIME BASE

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2.) Directly Interfaces with King MOS Clock Chip.
3.) 60 Hz output with crystal time base accuracy
4.) Ideal for Cars, Boats, & Campers.

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FND 70 RED, .25 In. Char. 15mA per segment. Common Cathode. $1.25

DL727 One of our best readouts .5 in. high, 20mA per segment. Common anode. $3.75

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BURROUGHS 12 DIGIT .25 in high orange digit 160v dc Free socket $2.50

LEDS

Mini red	.12
Jumbo red	.15
Jumbo green	.20
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7007	4 digit counter/latch decoder with BCD output only. 16 pin dip w/spec	$ 7.00
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2102	1K static RAM for 8008	$ 2.25
MM5203	2K UV eraseable PROM	$12.25
75491	segment driver	$ 0.35
75492	digit driver	$ 0.45
7020	6 function calculator chip with direct segment drive. 8 digit	$ 2.25

TTL

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7408	.21	7475	.70	74163	1.24
7410	.21	7476	.44	74164	1.94
7413	.54	7483	.90	74165	1.54
7420	.21	7489	2.50	74174	1.34
7427	.29	7490	.74	74175	1.44
7430	.21	7492	.80	74181	2.80
7437	.44	7493	.80	74192	1.30
7438	.39	7495	.80	74193	1.30
7440	.21	7496	.80	74195	.84
7442	.74	74121	.43		
7447	.94	74123	.80		

CMOS

4000	.24	4018	1.49	4037	4.50
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4010	.55	4025	.24	4049	.59
4011	.24	4027	.59	4050	.59
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4014	1.49	4030	.49	74C04	.29
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PC Board for 4 digit display FND 800 or 807	$2.75
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PC Board for 6 digit display MAN series or DL707	$2.25
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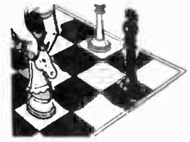
PC Board for 6 digit display DL727	$3.00
PC Board for 4 digit display FND70	$1.75

All PC display boards are multiplexed for adding additional digits.

MSI Wise move



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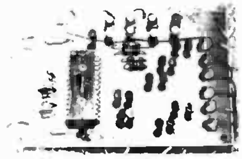
The heart of the system is our 4 digit Decade Counter (Kit 012) which features a full 4 digit LED readout (you choose the size best suited to your application). Combine this with a 5 volt regulated power supply (Kit 030) and you have the basis of a wide range of sophisticated electronic instruments, including:

A Digital Voltmeter (DVM)	Kit 012 • Kit 030 • Kit 017
Frequency Counter	Kit 012 • Kit 030 • Kit 016 • Time Base
RPM Counter	Kit 012 • Kit 030 • Kit 020 • Kit 018



4-DIGIT DECADE COUNTER KIT $19.95 KIT 012

One chip 4 digit decade counter kit, with both 7 segment and BCD output.

1. Chip features internal oscillator for scanning speed.
2. Overflow and count extent outputs.
3. Transfer, reset, count, blanking and true compliment control inputs.
4. PC Boards can be cascaded to 8-12-16, etc. digits.
5. Kit includes counter chip, drive circuit for 4 cathode type displays and PC Board. (For readout board see (FND70-FND503)

KIT 016 FREQ. COUNTER

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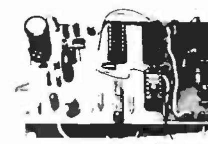

KIT 030 POWER SUPPLY

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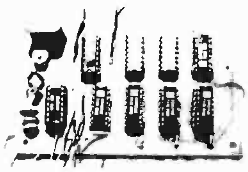
(Contains all parts except transformer)



KIT 017 DVM

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Buffer Circuit for TTL Interfacing

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Kit 018 60Hz chain time base using line frequence for Kit 020 RPM counter.

*Outputs: .6 sec = 100th of RPM
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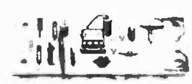

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Counts from 1 to 100,000 RPM. RPM counter kit contains components and PC board. $8.95

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KIT INCLUDES COMPONENTS, PC BOARD, TRANSFORMER, and CONSTRUCTION MANUAL.

$$$ SAVE! 4-DIGIT ALARM CLOCK

KIT NO.1 $13.95 (with PC Board)

FEATURES:

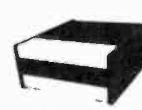
Direct drive display outputs, Current control regulation on chip, * Low power brightness control on chip, RFI eliminating slowup circuitry, * Sleep Radio feature, * 24 hr. snooze alarm, Independent digit setting, Non multiplexed output circuitry. 12VAC CT 1/2 amp transformer for Kit No. 1 $2.00

*KIT NO. 2

Complete kit with components, PC Board, Transformer, wood grain case and filter for display window. Includes .25 in readouts. $21.50

KIT NO. 3

Complete kit with components, PC Board, Transformer, wood grain case, and filter for display window. Includes .5 inch readouts. $22.50



* Components for Kit No. 2 or Kit No. 3 sleep radio feature, add $.95

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Load regulation 50mV

Kit includes Components, PC Board, Transf., Fuse, Pilot Light
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Part #	Frequency	Case/Style	Price
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CY2A	2.000 MHz	HC33/U	$5.95
CY3A	4.000 MHz	HC18/U	$4.95
CY7A	5.000 MHz	HC18/U	$4.95
CY12A	10.000 MHz	HC18/U	$4.95
CY14A	14.31818 MHz	HC18U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

XR-2260KB Kit $27.95 — XR-2206KA Kit $17.95

EXAR

WAVEFORM GENERATORS

XR-205	$8.40
XR 2206CP	4.49
XR-2207CP	3.85

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XR-1310CP	$3.20
XR-1310EP	3.20
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XR-2211CP	$6.70
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XR-555CP	$ .9
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PRINTED CIRCUIT EDGE-CARD

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

15/30	PINS (Solder Eyelet)	$1.95
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25 PIN-D SUBMINIATURE

DB25Plug	$3.25
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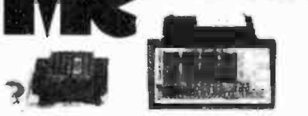
IMC 3½ DIGIT DVM KIT



This 0-2 VDC .05 per cent digital voltmeter features the Motorola 3½ digit DVM chip set. It has a .4" LED display and operates from a single +5V power supply. The unit is provided complete with an injection molded black plastic case complete with Bezel. An optional power supply is available which fits into the same case as the 0-2V DVM allowing 117 VAC operation.

A. 0-2V DVM with Case $49.95
B. 5V Power Supply $14.95

VECTOR WIRING PENCIL

Vector Wiring Pencil P173 consists of a hand held featherweight (under one ounce) tool which is used to guide and wrap insulated wire fed off a self-contained replaceable bobbin onto component leads or terminals installed on pre-punched "P" Pattern Vectorbord. Connections between the wrapped wire and component leads pads or terminals are made by soldering. Complete with 250 FT of red wire. **$9.95**

REPLACEMENT WIRE — BOBBINS FOR WIRING PENCIL

W36-3-A-Pkg 3	250 ft	36 AWG GREEN	$2.40
W36-3-B-Pkg. 3	250 ft	36 AWG RED	$2.40
W36-3-C-Pkg 3	250 ft	36 AWG CLEAR	$2.40
W36-3-D-Pkg 3	250 ft	36 AWG BLUE	$2.40

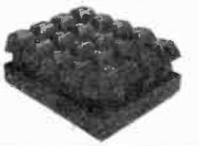
1/16 VECTOR BOARD

	0.1" Hole Spacing Part No.	P-Pattern L	W	Price 1	2-Up
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 062XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44 062	4.50	6.50	2.07	1.86
	84P44 062	4.50	8.50	2.56	2.31
	162P44 062	4.50	17.00	5.04	4.53
	169P84 062	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062C1	4.50	17.00	6.80	6.12

HEAT SINKS

205-CB	Beryllium Copper Heat Sink with Black Finish for TO-5	$ .25
291-.36H	Aluminum Heat Sink for TO-220 Transistors & Regulators	$ .25
680-.75A	Black Anodized Aluminum Heat Sink for TO-3	$1.60

HEXADECIMAL ENCODER 19-KEY PAD



- 1 - 0
- ABCDEF
- Return Key
- Optional Key (Period)
- — Key

$10.95 each

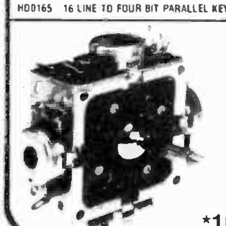
63 KEY KEYBOARD

This keyboard features 63 unencoded SPST keys, unattached to any kind of P.C.B. A very solid molded plastic 13 x 4 base suits most applications.

$19.95

HD0165 16 LINE TO FOUR BIT PARALLEL KEYBOARD ENCODER $7.95

JOYSTICK



These joysticks feature four potentiometers, that vary resistance proportional to the angle of the stick. Sturdy metal construction with plastics components only at the movable joint. Perfect for electronic games and instrumentation.

*5K Pots $6.95
*100K Pots $7.95

MICROPROCESSOR COMPONENTS

8080 SUPPORT DEVICES

8080A $29.95 — 8080 $24.95

8212	8 BIT INPUT/OUTPUT PORT FOR 8080	$ 4.95
8216	NON INTERRUPT BI-DIRECTIONAL BUS DRIVER	6.95
8224	CLOCK GENERATOR AND DRIVER FOR 8080	12.95
8228	SYSTEM CONTROLLER AND BUS DRIVER FOR 8080	12.95

CPU'S

8008	8 BIT CPU	$19.95
8080	Super 8008	24.95
8080A	Super 8008	34.95

SR'S

2504	1024 Dynamic	$ 9.00
2518	Hex 32 BIT	7.00
2519	Hex 40 BIT	4.00
2524	512 Dynamic	2.49
2525	1024 Dynamic	6.00
2527	Dual 256 BIT	3.95
2529	Dual 512 BIT	4.00
2532	Quad 80 BIT	3.95
2533	1024 Static	7.95
3341	Fifo	6.95
74LS670	16 x 4 Reg	3.95

UART'S

AY-5-1013	30K Baud	$5.95

ROM'S

2513	Char Gen	$ 9.95
2516	Char Gen	10.95
74S387	1024-Bit Programmable	1.95

RAM'S

1101	256 x 1	Static	$ 2.25
1103	1024 x 1	Dynamic	1.00
2101	256 x 4	Static	5.95
2102	1024 x 1	Static	1.75
2107	4096 x 1	Dynamic	9.95
2111	256 x 4	Static	6.95
7010	1024 x 1	MNOS	29.95
7489	16 x 4	Static	2.49
8101	256 x 4	Static	6.95
8111	256 x 4	Static	6.95
8599	16 x 4	Static	3.49
91L02	1024 x 1	Static	2.25
74200	256 x 1	Static	6.95
93421	256 x 1	Static	2.95
MM5262	2K x 1	Dynamic	.99

PROMS

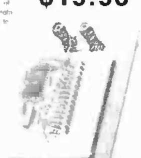
1702A	2048	Famos	$12.95
5203	2048	Famos	14.95
82S23	32 x 8	Open C	5.00
82S123	32 x 8	Tristate	5.00
74S287	1024	Static	7.95
3601	256 x 4	Fast	3.95

BIPOLAR PROM SPECIAL

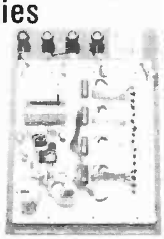
6330-1	256 Bit (32 x 8) Open Collector	2.95
6331-1	256 Bit (32 x 8) Three State	2.95
6300-1	1024 Bit (256 x 4) Open Collector	3.49
6301-1	1024 Bit (256 x 4) Three State	3.49
6305-1	2048 Bit (512 x 4) Open Collector	9.95
6306-1	2048 Bit (512 x 4) Three State	9.95
6340-1	2048 Bit (512 x 8) Open Collector	19.95
6341-1	2048 Bit (512 x 8) Three State	19.95
6352-1	4096 Bit (102 x 4) Open Collector	19.95
6353-1	4096 Bit (1024 x 4) Three State	19.95

Continental Specialties

Proto Board 100 $19.95



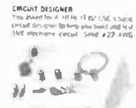
THE MINI-BREADBOARD BUDGET KIT



Proto Board 101 ... 29.95
Proto Board 102 ... 39.95
Proto Board 104 ... 79.95
Proto Board 103 ... 59.95

COMPLETE KIT

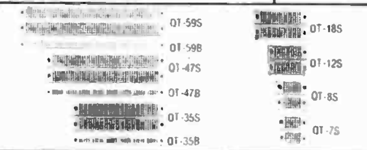
DESIGN MATE 1



Proto Board 6 $15.95

SPECIAL!

LOGIC MONITOR
Simultaneously displays static and dynamic logic states of DTL, TTL, HTL or CMOS DIP ICs.
Pocket size $84.95.



QT Proto Strips

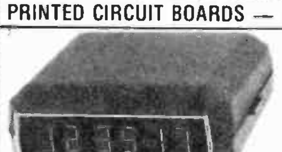
QT type	# holes	price
QT-59S	590	12.50
QT-59B	bus strip	2.50
QT-47S	470	10.00
QT-47B	bus strip	2.25
QT-35S	350	8.50
QT-35B	bus strip	2.00
QT-18S	180	4.75
QT-12S	120	3.75
QT-8S	80	3.25
QT-7S	70	3.00

Grab Bag Specials

CAPACITORS — 100 ea. Ceramic Disc	$2.00/lot
CAPACITORS — 60 ea. Mylar	4.00/lot
CAPACITORS — 60 ea. Electrolytics	4.00/lot
CAPACITORS — 40 ea. Dipped Tantalum	4.00/lot
DELAY LINE — 10 ea.	3.00/lot
DIODES — 100 ea. Germanium	2.00/lot
DIODES — 100 ea. Rectifiers Silicon	2.00/lot
DIODES — 100 ea. Silicon	2.00/lot
IC's — 100 ea. Unmarked or House #	4.00/lot
LEDS — 100 ea. Asst. Sizes & Colors	5.00/lot
LAMPS NEON — 40 ea. NE2 Type	3.00/lot
POTENTIOMETERS — 10 pcs. P.C. Mount Asst.	4.00/lot
RESISTORS — 100 ea. Values & Wattages	1.00/lot
RESISTORS — 40 ea. wire-wound 3-10 W/.1-100 ohm	$5.50/lot
RESISTORS — 40 ea. wire wound 3-10 W/100-25K	5.00/lot
SWITCHES — 12 ea. Micro Switches	3.00/lot
SWITCHES — 25 Miniature Slide	3.00/lot
SWITCHES — 12 each Rocker	3.00/lot
SWITCHES — 20 ea. Reed-Coil & Magnetics	5.00/lot
THERMISTORS — 20 ea.	3.00/lot
TRIMMERS — 40 ea. Miniature	4.00/lot
TRANSISTORS — 100 ea. Plastic & Power	3.00/lot
TUBING, SHRINK — 30 pcs. 6" Asst. Sizes & Colors	4.00/lot

PRINTED CIRCUIT BOARDS — Min. 50 ea. Various Components $2.00 each

DIGITAL QUARTZ CAR CLOCK



Complete kit from mounting bracket of the injection molded case down to the three conductor power cord and all components including MM5314 clock chip. Features quartz accuracy of .01%, six digit, .35" high LED display, and P.C. Boards. Works on any 12 volt system — motorcycles, boats, vans, motorhomes, autos, and trucks.

DIMENSIONS 4½" x 4" x 2" — 12 OR 24 HOUR MODE.

Kit: $29.95 Assembled: $39.95

CASE ONLY (includes hardware, mounting bracket and bezel) $5.95

DIGITAL CLOCK KIT — 3½ INCH DIGITS

This clock features big 3½" high digits for viewing in offices, auditoriums, etc. Each digit is formed by 31 bright 0.2" LED's. The clock operates from 117 VAC, has either 12 or 24 hr. operation. The 6 digit version is 27" x 3½" x 1¾", and the 4 digit is 18" x 3½" x 1¾". Kits come complete with all components, case and transformer.

4 DIGIT KIT $49.95 — 4 DIGIT ASSEMBLED $59.95
6 DIGIT KIT $69.95 — 6 DIGIT ASSEMBLED $79.95
Specify 12 Or 24 Hr. When Ordering

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax
Spec Sheets - 25¢ — Send 24¢ Stamp for 1977 Catalog
Dealer Discount Available — Request Pricing

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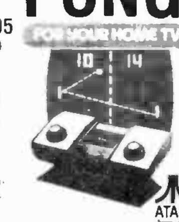
PHONE ORDERS WELCOME — (415) 592-8097
All Advertised Prices Good Thru January

PONG

PONG SINGLE GAME $55.00
SUPER PONG 4 GAMES IN ONE $79.95
(Pong, Super Pong, Catch, Handball)



- Incremental speed on volleys increases excitement.
- Game appears in color or in black & white, depending on television set.
- Digital scoring flashes on the screen between each point.
- Hooks up simply to any model television set: the screen actually becomes the playing field.
- Battery operated by 4 size "D" flash-light batteries included with the Unit.

AC Adaptor (Eliminates Batteries) $9.95

DIGITAL WATCHES

Ladies Watch
- 6 Function
- Bracelet Styling
- 1 Year Guarantee
- Model 900
- Specify Gold or Chrome

$69.95

EXELAR Mens Watch
- 5 Function
- Quartz Crystal
- Black Leather Band
- Manufacturer Guarantee
- Specify Gold or Chrome

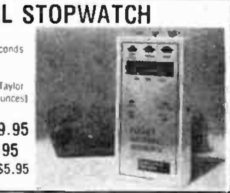
$29.95

5 FUNCTION ELECTRONIC CALCULATOR RADOFIN MODEL 8P

$8.95

FEATURES:
- 8 Digit Display
- 5 Functions consists of addition, subtraction, multiplication, division, percentage, with constant on all functions, with full floating decimal point
- Power source is 1 piece 9V DC Battery 006P, jack for AC adapter
- Black superfine grained finish plastic cabinet

DIGITAL STOPWATCH

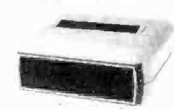


- Bright 6 Digit LED Display
- Times to 59 minutes 59.59 seconds
- Crystal Controlled Time Base
- Three Stopwatches in One: Times Single Event — Split & Taylor
- Size 4.5" x 2.15" x .90" (4½ ounces)
- Uses 3 Penlite Cells

Kit — $39.95
Assembled — $49.95
Heavy Duty Carry Case $5.95

DIGITAL ALARM CLOCK

Novus



This 4 digit Novus Alarm Clock is a very reliable and smartly styled unit. It provides such features as an alarm settable to any minute of the day, a 7 minutes snooze alarm, a power failure indicator, and even an A.M., P.M. indicator.

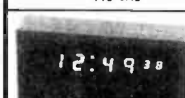
$19.95 — NOT A KIT

JE700 CLOCK

12 or 24 Hour — 115 VAC

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 2¼" x 1". It utilizes a MAN72 high brightness readout, and the MM5314 clock chip.

$17.95



This large digit clock (.6" hours & minutes, .3" seconds) features the MM5314 clock chip. It operates from 117 VAC, and will operate in either a 12 or 24 hour mode. The clock is complete with a walnut grain case, and has fast set, slow set, and hold time set features.

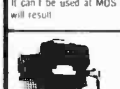
KIT - ALL COMPONENTS & CASE $34.95
WIRED & ASSEMBLED $39.95

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

$9.95 Per Kit

± 5 VOLT POWER SUPPLY

$39.95

Completely Assembled
- +5 Volts @ 6 Amps Regulated Output
- −5 Volts @ 6 Amps Regulated Input
- 6.3Volts @ 5 Amps Unregulated Output

Length 8⅝" x Width 6½" x Height 4"

Limited Supply

7400N TTL

SN7400N	.16	SN7459A	.25		
SN7401N	.16	SN7460N	.22	SN74154N	1.00
SN7402N	.21	SN7470N	.45	SN74155N	.99
SN7403N	.16	SN7472N	.39	SN74156N	.99
SN7404N	.18	SN7473N	.37	SN74157N	.99
SN7405N	.24	SN7474N	.32	SN74160N	1.25
SN7406N	.20	SN7475N	.50	SN74161N	.99
SN7407N	.29	SN7476N	.32	SN74163N	.99
SN7408N	.25	SN7479N	5.00	SN74164N	1.10
SN7409N	.25	SN7480N	.50	SN74165N	1.10
SN7410N	.18	SN7482N	.98	SN74166N	1.25
SN7411N	.30	SN7483N	.70	SN74167N	5.50
SN7412N	.33	SN7485N	.89	SN74170N	2.10
SN7413N	.45	SN7486N	.39	SN74172N	8.95
SN7414N	.70	SN7488N	3.50	SN74173N	1.50
SN7416N	.35	SN7489N	2.49	SN74174N	1.25
SN7417N	.35	SN7490N	.45	SN74175N	.99
SN7420N	.21	SN7491N	.75	SN74176N	.90
SN7421N	.33	SN7492N	.49	SN74177N	.90
SN7422N	.49	SN7493N	.49	SN74180N	.99
SN7423N	.37	SN7494N	.79	SN74181N	2.49
SN7425N	.29	SN7495N	.79	SN74182N	.95
SN7426N	.29	SN7496N	.89	SN74184N	1.95
SN7427N	.37	SN7497N	4.00	SN74185N	2.20
SN7429N	.42	SN74100N	1.00	SN74186N	15.00
SN7430N	.26	SN74107N	.39	SN74187N	6.00
SN7432N	.31	SN74121N	.39	SN74188N	3.95
SN7437N	.27	SN74122N	.39	SN74190N	1.19
SN7438N	.27	SN74123N	.50	SN74191N	1.25
SN7439N	.25	SN74125N	.60	SN74192N	.89
SN7440N	.15	SN74126N	.60	SN74193N	.89
SN7441N	.89	SN74132N	1.09	SN74194N	1.25
SN7442N	.59	SN74136N	.95	SN74195N	.75
SN7443N	.75	SN74141N	1.15	SN74196N	1.25
SN7444N	.75	SN74142N	4.00	SN74197N	.75
SN7445N	.75	SN74143N	4.50	SN74198N	1.75
SN7446N	.81	SN74144N	4.50	SN74199N	1.75
SN7447N	.69	SN74145N	1.15	SN74200N	5.59
SN7448N	.79	SN74147N	2.35	SN74279N	.90
SN7450N	.26	SN74148N	2.00	SN74251N	1.79
SN7451N	.27	SN74150N	1.00	SN74284N	6.00
SN7453N	.27	SN74151N	.79	SN74285N	6.00
SN7454N	.20	SN74153N	.89	SN74367N	.75

MANY OTHERS AVAILABLE ON REQUEST
20% Discount for 100 Combined 7400's

CMOS

CD4000	.25			74C04N	.75
CD4001	.25	CD4035	1.85	74C10N	.65
CD4002	.25	CD4040	2.45	74C20N	.65
CD4006	2.50	CD4042	1.90	74C30N	.65
CD4007	.25	CD4044	1.50	74C42N	2.15
CD4009	.59	CD4046	2.51	74C73N	1.50
CD4010	.59	CD4047	2.75	74C74	1.15
CD4011	.25	CD4049	.79	74C90N	3.00
CD4012	.25	CD4050	.79	74C95N	2.00
CD4013	.47	CD4051	2.95	74C107N	1.25
CD4016	.56	CD4053	2.95	74C151	2.90
CD4017	1.35	CD4060	3.25	74C154	4.00
CD4019	.55	CD4066	1.75	74C157	2.15
CD4020	1.49	CD4069	.45	74C160	3.25
CD4022	1.25	CD4071	.45	74C161	3.25
CD4023	.25	CD4081	.45	74C163	3.00
CD4024	1.50	CD4511	2.50	74C164	3.25
CD4025	.25	CD4518	2.50	74C173	2.60
CD4027	.69	CD4566	3.00	74C193	2.75
CD4028	1.65	74C00N	.39	74C195	2.75
CD4029	2.90	74C02N	.55	MC4044	4.50
CD4030	.65			MC14016	.56

LINEAR

LM300H	.80			LM1310N	2.95
LM301H	.35			LM1351N	1.65
LM301CN	.35			LM1414N	1.75
LM302H	.75			LM1458C	.65
LM304H	1.00	LM370N	1.1.5	LM1496N	.95
LM305H	.95	LM373N	3.25	LM1556V	1.85
LM307CN	.35	LM377N	4.00	LM2111N	1.95
LM308H	1.00	LM380N	1.39	LM2901N	2.95
LM308CN	1.00	LM380CN	1.05	LM3065N	.69
LM309H	1.10	LM381N	1.79	LM3900N	.55
LM309K	.99	LM382N	1.79	LM3905N	.60
LM310CN	1.15	NE501K	8.00	LM3909	1.25
LM311H	.90	NE510A	6.00	LM5556N	1.85
LM311N	.90	NE531H	3.00	MC5558V	1.00
LM318CN	1.50	NE536T	6.00	LM7525N	.90
LM319N	1.30	NE540L	6.00	LM7535N	1.25
LM320K-5	1.35	NE550N	.79	8038B	4.95
LM320K-5.2	1.35	NE555V	.9	LM75450	.49
LM320K-12	1.35	NE560B	5.00	75451CN	.39
LM320K-15	1.35	NE561B	5.00	75452CN	.39
LM320T-5	1.75	NE562B	5.00	75453CN	.39
LM320T-5.2	1.75	NE565H	1.25	75454CN	.39
LM320T-8	1.75	NE565N	1.75	75491CN	.79
LM320T-12	1.75	NE566CN	1.25	75492CN	.89
LM320T-15	1.75	NE567H	1.95	75494CN	.89
LM320T-18	1.75	NE567V	1.50	RCA LINEAR	
LM320T-24	1.75	LM703CN	.45	CA3013	2.15
LM323K-5	9.95	LM709H	.29	CA3032	2.56
LM324N	1.80	LM709N	.29	CA3035	2.48
LM339N	1.70	LM710N	.79	CA3039	1.35
LM340K-5	1.95	LM711N	.39	CA3046	1.30
LM340K-6	1.95	LM723H	.55	CA3059	3.25
LM340K-8	1.95	LM723H	.55	CA3060	3.25
LM340K-12	1.95	LM733N	1.00	CA3080	.85
LM340K-15	1.95	LM739N	1.00	CA3081	2.00
LM340K-18	1.95	LM741CH	.35	CA3082	2.00
LM340K-24	1.95	LM741CN	.35	CA3083	1.60
LM340T-5	1.75	LM74114N	.39	CA3086	.85
LM340T-6	1.75	LM747H	.79	CA3089	3.75
LM340T-8	1.75	LM747N	.79	CA3091	10.20
LM340T-12	1.75	LM748H	.39	CA3123	2.15
LM340T-15	1.75	LM748N	.39	CA3130	1.39
LM340T-18	1.75	LM1303N	.90	CA3140	1.25
LM340T-24	1.75	LM1304N	1.19	CA3600	1.75
LM350N	1.00	LM1305N	1.40	RC4194	5.95
LM351CN	.65	LM1307N	.85	RC4195	3.25

74LS00 TTL

74LS00	.39			74LS139	1.95
74LS02	.39			74LS151	1.55
74LS03	.39	74LS74	.65	74LS153	1.89
74LS04	.45	74LS75	.79	74LS157	1.55
74LS05	.45	74LS76	.65	74LS162	2.25
74LS08	.39	74LS83	2.19	74LS163	2.25
74LS10	.39	74LS85	2.49	74LS164	2.25
74LS13	.79	74LS86	.65	74LS175	1.95
74LS14	2.19	74LS90	1.25	74LS181	3.69
74LS20	.39	74LS92	1.25	74LS190	2.85
74LS26	.49	74LS93	1.25	74LS191	2.85
74LS27	.45	74LS95	2.19	74LS192	2.85
74LS28	.49	74LS96	1.89	74LS193	2.85
74LS30	.39	74LS107	.65	74LS194	2.25
74LS32	.45	74LS109	.65	74LS195	2.25
74LS40	.49	74LS112	.65	74LS257	1.89
74LS51	.39	74LS132	1.55	74LS260	.55
74LS55	.39	74LS136	.65	74LS279	.79
74LS73	.65	74LS138	1.89	74LS670	5.95

CLOCK CHIPS

MM5309	6 Digit, BCD Outputs, Reset PIN	$9.95
MM5311	6 Digit, BCD Outputs, 12 or 24 Hour	4.95
MM5312	4 Digit, BCD Outputs, 1 PPS Output	4.95
MM5314	6 Digit, 12 or 24 Hour, 50 or 60 Hz	4.95
MM6316	4 Digit, Alarm, 1 PPS Output	6.95
MM5318	Video Clock Chip, For Use With MM5841	9.95
CT7001	6 Digit, Calendar, Alarm, 12 or 24 Hour	5.95

DATA HANDBOOKS

7400	Pin-out & Description of 5400/7400 ICS	$2.95
CMOS	Pin-out & Description of 4000 Series ICS	$2.95
Linear	Pin-out & Functional Description	$2.95

ALL THREE HANDBOOKS $6.95

FAIRCHILD TECHNOLOGY KITS FAIRCHILD

- Complete Specifications on back of each kit
- Packaged for WALL DISPLAY APPEARANCE
- Dealer's Inquires Invited — Price List Available

DIGITS

FTK0001	0.5" High Common Cathode Digit	$1.00
FTK0002	0.5" High Common Anode Digit	1.00
FTK0003	.357" High Common Cathode Digit	.75
FTK0004	0.8" High Common Cathode Digit	2.00
FTK0005	0.8" High Common Anode Digit	2.00

0.8" HIGH DISPLAY ARRAYS

FTK0010	12 Hour, 3½ Digit Clock Display	7.00
FTK0011	24 Hour, 4 Digit Clock Display	8.00

LED LAMPS

FTK0020	10 Red LED Lamps	1.00
FTK0021	5 Mixed Colored LED Lamps	1.00
FTK0022	10 LED Mounting Clips	1.00
FTK0023	5 Three Piece LED Mounting Adapters	1.00

PHOTO TRANSISTORS

FTK0030	5 Flat Lens Photo Transistors	1.00
FTK0031	5 Round Lens Photo Transistors	1.00
FTK0032	3 Flat Lens Photo Darlingtons	1.00
FTK0033	3 Round Lens Photo Darlingtons	1.00

PHOTO ARRAYS

FTK0040	9-Element Tape Reader Array	16.00
FTK0041	12-Element Card Reader Array	24.00
FTK0042	Reflective Opto Coupler	4.00

COUPLERS

FTK0050	3 General Purpose Opto Couplers	1.00
FTK0051	Darlington Opto Coupler	1.00

MOS CLOCK CIRCUITS

FTK0400	Digital Clock/Calendar Circuit (FCM7001)	7.00
FTK0401	Digital Clock/Calendar with BCD Outputs (FCM7002)	7.00
FTK0402	Direct Drive Digital Clock Circuit with AC Output (FCM3817A)	5.00
FTK0403	Direct Drive Digital Clock Circuit with DC Output (FCM3817D)	5.00
FTK0405	Direct Drive Digital Clock/Calendar Circuit (FCM7015)	6.00

KITS

FTK0106	Automobile Clock Kit	40.00

DISCRETE LEDS

.125" dia.			.90" dia.		
XC209	Red	10/$1	XC111	Red	10/$1
XC209	Green	4/$1	XC111	Green	4/$1
XC209	Orange	4/$1	XC111	Yellow	4/$1
			XC111	Orange	4/$1

.200" dia			.185" dia.			.200" dia.			.085" dia.
XC22	Red	10/$1	XC526	Red	10/$1	XC556	Red	10/$1	MV50
XC22	Green	4/$1	XC526	Green	4/$1	XC556	Green	7/$1	.085" dia. Micro
XC22	Yellow	4/$1	XC526	Yellow	4/$1	XC556	Yellow	7/$1	red LED
XC22	Orange	4/$1	XC526	Orange	4/$1	XC556	Orange	7/$1	6/$1
SSL-22	RT	4/$1	XC526	Clear	4/$1	XC556	Clear	7/$1	

DISPLAY LEDS

DL707   DL338

TYPE	POLARITY	HT		TYPE	POLARITY	HT	
MAN 1	Common Anode	270	2.95	MAN 3620	Common Anode-orange	300	1.75
MAN 2	5 x 7 Dot Matrix	300	4.95	MAN 3640	Common Cathode-orange	300	1.75
MAN 3	Common Cathode	125	.39	MAN 4710	Common Anode-Red	400	1.95
MAN 4	Common Cathode	187	1.95	DL701	Common Anode-red	300	.99
MAN 7	Common Anode	300	1.25	DL704	Common Cathode	300	.99
MAN 7G	Common Anode-green	300	1.95	DL707	Common Anode	300	.99
MAN 7Y	Common Anode-yellow	300	1.95	DL 728	Common Cathode	500	1.95
MAN 52	Common Anode-green	300	1.75	DL 747	Common Anode	600	2.25
MAN 64	Common Anode-red	400	1.75	DL 750	Common Cathode	600	2.49
MAN 72	Common Anode	300	1.25	DL 338	Common Cathode	110	.50
MAN 74	Common Cathode	300	1.50	FND70	Common Cathode	250	.75
MAN 82	Common Anode-yellow	300	1.75	FND503	Common Cathode	500	1.00
MAN 84	Common Cathode-yellow	300	1.75	FND507	Common Anode	500	1.00

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

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

SOLDERTAIL STANDARD (TIN)

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

SOLDERTAIL STANDARD (GOLD)

8 pin	$.30	.27	.24	24 pin	$.70	.63	.57
14 pin	.35	.32	.29	28 pin	1.10	1.00	.90
16 pin	.38	.35	.32	36 pin	1.75	1.40	1.26
18 pin	.52	.47	.43	40 pin	1.75	1.59	1.45

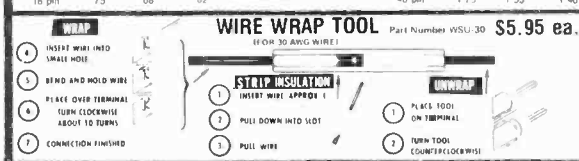
WIRE WRAP SOCKETS (GOLD) LEVEL #3

10 pin	$.45	.41	.37	24 pin	$1.05	.95	.85
14 pin	.39	.38	.37	28 pin	1.40	1.25	1.10
16 pin	.43	.42	.41	36 pin	1.59	1.45	1.30
18 pin	.75	.68	.62	40 pin	1.75	1.55	1.40

WIRE WRAP TOOL

Part Number WSU-30 **$5.95 ea.**

(FOR 30 AWG WIRE)



WIRE WRAP WIRE

30 AWG — 25 ft. min. - $2.10 50 ft. - $2.75 100 ft. - $3.50 1000 ft. - $24.00

SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

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

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$10.95 ea.**

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DPDT				SWT	1	2-9	10-29	30-99
	ON	OFF	ON	221	2.95	2.55	1.87	1.70
	ON	NONE	ON	223	2.95	2.15	1.58	1.43
	ON	OFF	ON	121	2.25	1.95	1.43	1.30
	ON	NONE	ON	123	2.05	1.85	1.21	1.10

PUSH BUTTON

SPDT - SERIES PB PBI
Maintained Action Switch
Push To Make Contact And Push Again To Reverse Action
Momentary Action Switch
Normally Open or Normally Closed (N.O. or N.C. circuit use terminals 2 & 1) for N.O. 2 & 3, for N.C. and N.O. 1,2 & 3

PB-123 $1.75

PB-126 $1.75

5 AMP RATINGS

THUMBWHEEL SWITCHES

THUMBWHEEL SWITCH ONLY

Part No.	Description	Price
SF 12	Single Pole 10 Position	$2.50
SR 12	Decimal	3.00
SF 21	10 Position BCD only	2.50
SR 21		3.00

Ordering: Order desired switch or switches and add necessary accessories for your particular application.

SF — Front Mount SR — Rear Mount

SERIES SF Front Mount Assembly

SERIES SR Rear Mount Assembly

ACCESSORIES

Part No.	Description	Price
SF EP	End Plate (Pair)	.50
SF DP	Divider Plate (each)	.40
SF BB	Blank Body (each)	.40
SF HB	Half Body (each)	.40

ACCESSORIES

Part No.	Description	Price
SR EP	End Plates (pair)	$.50
SR DP	Divider Plate (each)	.40
SR BB	Blank Body (each)	.40
SR HB	Half Body (each)	.40

DIP SWITCH

These switches feature seven SPST slide switches in a molded dip. They are ideally suited for microprocessor applications. $1.95

CLIPLITE !! 4/$1.00

NEW LED MOUNTING SYSTEM

- CLIPLITE mounts from the front of the Panel in a .250 hole on 3/8" centers. Panel thickness from 1/16" to 1/8".
- CLIPLITE equalizes and increases the brightness of commonly used wide beam LEDS.
- CLIPLITE is to be used with XC556 LEDS.
- Specify colors—red, green, amber, or yellow when ordering.

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400mm	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	8/1.00	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	6/1.00	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	1.50
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

C35D	15A @ 400V	SCR	$1.95
C38M	35A @ 200V	SCR	1.95
2N2328	1.6A @ 200V	SCR	.50
MDA 980-1	25A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	25A @ 200V	FW BRIDGE REC	1.95

TRANSISTORS

MPS A05	5/$1.00	PN3567	3/$1.00	PN4249	4/$1.00
MPS A06	5/$1.00	PN3568	4/$1.00	PN4250	4/$1.00
2N2219A	3/$1.00	PN3569	4/$1.00	2N4400	4/$1.00
2N2221	4/$1.00	2N3704	5/$1.00	2N4401	4/$1.00
2N2222A	5/$1.00	2N3705	5/$1.00	2N4402	4/$1.00
2N2369	5/$1.00	2N3706	5/$1.00	2N4403	4/$1.00
2N2369A	4/$1.00	2N3707	5/$1.00	2N4409	5/$1.00
FN3415	5/$1.00	2N3711	5/$1.00	2N5086	4/$1.00
2N2484	4/$1.00	2N3724	$ .65	2N5087	4/$1.00
2N2906A	4/$1.00	2N3725	$1.00	2N5088	4/$1.00
2N2907A	5/$1.00	2N3903	5/$1.00	2N5089	4/$1.00
2N2925	5/$1.00	2N3904	4/$1.00	2N5129	5/$1.00
2N3053	2/$1.00	2N3905	4/$1.00	2N5138	5/$1.00
2N3055	$ .89	2N3906	4/$1.00	2N5139	5/$1.00
MJ3055	$1.00	2N4013	3/$1.00	2N5209	5/$1.00
MJ2955	$1.25	2N4014	3/$1.00	2N5951	$1.00
2N3392	5/$1.00	2N4123	10/$1.00	C106B1SCR	2/$1.00
2N3398	5/$1.00			2N5432	$2.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
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	.15	.13	.10	1.0/16V	.15	.13	.10
4.7/25V	.16	.14	.12	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.12
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.11
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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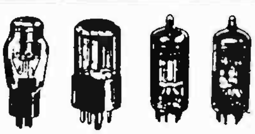

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1B3GT	1.58	6AV6	1.11
1K3	1.58	6AW8A	1.79
1S2A	2.27	6AX4GTB	1.52
1U4	1.58	6AY3B	1.52
1V2	.96	6AZ8	2.30
1X2B	1.56	6BA6	1.34
2AH2	1.59	6BA11	1.95
2AV2	1.26	6BE6	1.47
2D21	1.95	6BH11	1.77
2GK5	1.58	6BJ6	1.65
3A3C	1.61	6BK4C6	2.98
3A5	2.50	6BK7B	2.07
3AT2B	1.56	6BL8	1.10
3BS2	1.70	6BM8	1.10
3CU3A	1.95	6BN6	1.97
3CY3	1.76	6BN8	1.56
3DJ3	1.70	6BN11	2.46
3GK5	1.55	6BQ5	1.56
3HA5	1.53	6BQ7A	2.09
3HQ5	2.27	6BR8A	2.12
3JC6A	2.06	6BX6	1.49
3V4	1.83	6BZ6	1.26
4AU6	1.58	6C4	1.58
4BL8	.92	6CA4	1.60
4BZ6	1.41	6CA7	2.04
4CB6	1.10	6CB6A	1.32
4DT6	1.56	6CG3	1.58
4EH7	1.46	6CD6GA	2.83
4EJ7	1.46	6CG7	1.22
4HS8	1.50	6CG8A	1.73
4JC6A	2.04	6CJ3	1.50
4JD6	1.88	6CL3	1.61
4KE8	2.48	6CL6	2.07
4LJ8	1.80	6CL8	1.95
5AQ4	4.50	6CM7	1.71
5EW6	1.63	6CU5	1.65
5GH8A	1.88	6CW4	3.30
5GJ7	1.11	6CW5	1.02
5GS7	1.17	6DJ8	2.25
5GX7	1.68	6DL4	2.39
5HZ6	1.20	6DQ6	2.15
5JK6	1.47	6DT6A	1.32
5JL6	1.47	6DW4	1.50
5KE8	2.48	6DX8	1.01
5LJ8	1.76	6EA8	1.58
5U4GB	1.23	6EB8	2.40
5Y3GT	1.32	6EH7	1.53
5Y4GT	1.14	6EJ7	1.43
6A8	4.69	6EM7	2.25
6AB4	1.53	6EU7	1.61
6AC7	2.36	6EW6	1.43
6AC10	1.73	6EW7	2.38
6AD10	3.68	6F6GT	3.49
6AF4	2.21	6FG6	1.19
6AF9	2.13	6FG7	2.28
6AH6	2.94	6FM7	1.85
6AJ8	1.74	6GE5	2.16
6AL3	.92	6GF7A	2.12
6AL5	1.31	6GH8A	1.26
6AN8A	1.82	6GJ7	1.11
6AQ5	1.35	6GK5	1.86
6AQ8	.98	6GK6	1.41
6AR5	.81	6GM6	1.68
6AS8	2.48	6GM8	3.30
6AU4GTA	1.97	6GS7	1.38
6AU5GT	2.41	6GU7	1.67
6AU6A	1.31	6GW8	.98

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6H6	2.71	6JM6A	2.16
6HA5	1.53	6JN6	2.03
6HB7	1.55	6JR6	3.54
6HE5	1.91	6JS6C	2.95
6HF5	3.78	6JT6	2.40
6HF8	2.16	6JT8	1.91
6HQ5	2.03	6JU6	2.84
6HS5	2.94	6JU8	1.77
6HS6	1.46	6JV8	1.80
6HS8	1.91	6JW8	1.35
6HV5	3.54	6K6GT	1.64
6HZ6	1.28	6K7GT	2.24
6J5	1.89	6K8	4.69
6J7	2.31	6KA8	1.95
6J10	2.45	6KD6	3.38
6JB6	2.42	6KE8	2.45
6JC6A	1.79	6KM6	3.38
6JD6	1.85	6KT8	2.18
6JE6C	3.35	6KV6A	2.67
6JG6A	2.67	6KZ8	1.64
6JH6	1.43	6L6	4.86

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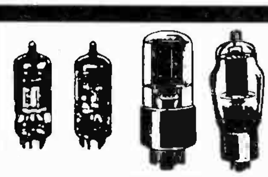

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6LB6	3.23	12BY7	1.43
6LE8	2.27	12DQ6B	2.10
6LF6	3.20	12FX5	1.34
6LF8	2.34	12GN7	2.22
6LJ8	1.76	12HL7	1.95
6LM8	1.95	12JB6A	2.55
6LN8	1.05	12MD8	1.77
6LT8	1.64	12SL7	2.31
6LU8	1.92	13GF7A	2.09
6LX8	1.05	13Z10	2.55
6M11	2.76	14BL11	3.11
6MB8	1.52	15BD11A	2.25
6MD8	2.34	15CW5	.87
6SA7	2.04	15KY8A	2.91
6SG7	2.30	16A8	1.23
6SJ7	2.19	16LU8A	2.97
6SK7	2.03	17AY3A	1.52
6SL7GT	2.30	17BE3	1.52
6SN7GT	1.52	17BF11	2.39
6SQ7	2.01	17BR3	1.23
6T8A	1.92	17BS3	1.52
6T10	2.25	17CK3	1.31
6U8A	1.56	17CU5	1.26
6U10	1.62	17DW4	1.41
6V6	3.57	17JN6	2.16
6X4	1.46	17JQ6	1.85
6X5GT	1.47	17JZ8	1.43
6X9	1.82	19CG3	1.58
7F8	6.00	20AQ3	1.17
7V7	3.00	21GY5	2.01
8A8	.93	21HB5	1.92
8AC9	1.88	21JS6	4.30
8AR11	2.46	21JZ6	2.10
8B10	1.80	21LR8	1.89
8BA11	2.25	21LU8	1.86
8BM11	2.30	22JF6	2.66
8BQ11	1.98	22JR6	2.73
8BU11	2.30	22KM6	3.08
8CG7	1.12	23Z9	1.91
8JV8	1.86	24JE6C	3.20
8LT8	1.61	25CG3	1.38
9AQ8	2.31	29KQ6	3.53
9GH8	1.67	30AE3	1.17
9JW8	1.26	31JS6C	2.89
10CW5	1.02	31LQ6	3.05
10DX8	.98	31LZ6	3.38
10GK6	1.82	33GY7A	2.42
10GN8	1.92	35C5	1.31
10JT8	2.06	35W4	.89
10JY8	1.50	35Z5GT	1.41
10KR8	2.04	36KD6	3.36
11AF9	2.13	38HE7	2.92
11AR11	2.46	38HK7	2.86
11BM8	1.86	40KG6A	3.26
11FY7	1.52	42EC4A	1.59
11KV8	2.20	42KN6	2.75
11MS8	1.53	50B5	1.21
12AB5	1.41	50C5	1.23
12AT6	1.13	50EH5	1.47
12AT7	1.37	50GY7A	3.60
12AU7A	1.23	50L6GT	1.95
12AV6	1.02	80	1.88
12AX7A	1.13	6267	2.10
12AZ7A	1.74	6973	1.85
12B4A	1.77	7025A	1.13
12BA6	1.16	7189A	1.73
12BE6	1.22	7199	2.06

EDLIE ELECTRONICS, INC. 2700-JP HEMPSTEAD TPKE., LEVITTOWN, N. Y. 11756

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ARIES brought you the first calculator kit, and the first digital clock kit . . . and now brings you three of the most innovative electronic kits ever made. The System 300 Electronic Music Synthesizer kit is the most advanced in the world today, regardless of price. The AR-781 is a space-age beauty for any decor. And the wholly solid state AR-830 does the work of a $400.00 tape memory unit.

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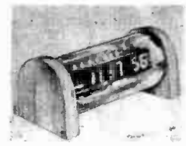

A clear, ruby-red cylinder shows off all six digits of this modern calendar clock. Easy-to-read numbers show the hours, minutes, and seconds, as well as the month and day every ten seconds. Red LED 7-segment numerals are 0.33" high, in a sturdy cylinder 2-1/2" in diameter and 4-3/4" long, with finished hardwood ends. Time and calendar are controlled by 60 Hz line frequency, with a 12-month movement. Separate time and calendar adjustments. Includes all the components, PC boards, housing, and instructions. Shipping weight 2 lbs.

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Add finger-touch operation to your old-fashioned dial telephone with an ARIES AR-830 Automatic Digital Telephone Dialer. This has the same layout and convenience as Ma Bell, plus other features she doesn't offer yet. For instance . . . AR-830 always remembers the last number you dialed, in case the line was busy and you want to try again later. Not only that, but the Dialer's memory can store as many as ten of your favorite numbers for one-touch dialing. AR-830 uses standard dialing and muting contacts; consult local tariffs before connecting. Sh. wt. 2 lbs.

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Popular Electronics

JANUARY 1977
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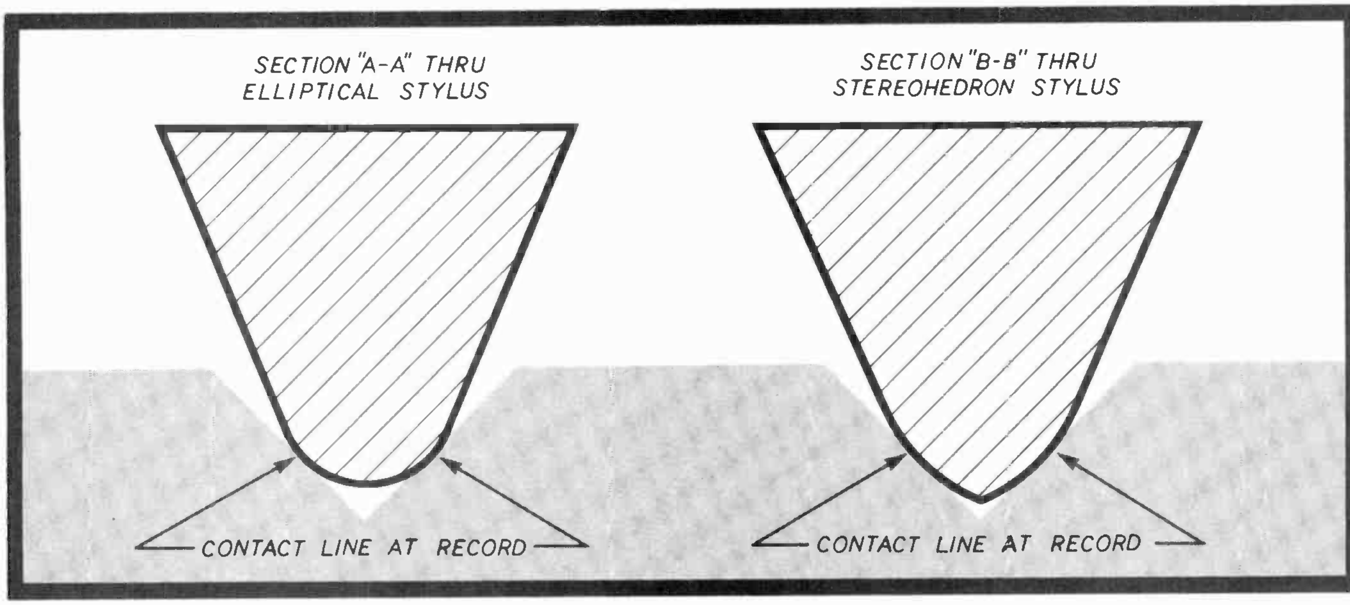

Conventional elliptical styli have a relatively limited bearing radius at the contact area with the groove. The Stereohedron combines the elliptical and Quadrahedron concepts to create a stylus having a larger bearing contact radius at the area in order to reduce stylus wear and prolong record life.

what is a Stereohedron™ stylus tip?

...it is the unique, new development in stylus tip design.

It makes possible a wider, more open, finer sound — because it maximizes stereo tracing capabilities with the slightest, lightest touch a record ever had. It adds to the useful life of each record groove because force is spread over a greater contact area. And that means the least record wear — and longest stylus life — achievable in these times (with a stereo cartridge).

Buy it? Yes you can in the new Pickering XSV/3000. It's the source of perfection in stereo sound.

For further information write to: Pickering & Co., Inc., Dept. PE
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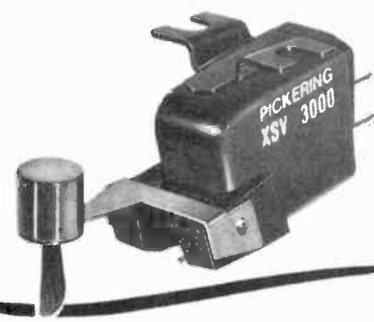

TECHNICAL DESCRIPTION

October 29, 1976

The XSV/3000 with STEREOHEDRON® TIP

The Stereohedron diamond is mounted in a thin-wall tubular alloy cantilever for extremely low effective tip mass and optimum coupling to a tiny, yet powerful rare earth permanent magnet.

An unusual suspension design affords very high compliance and highly linear motion for distortionless reproduction of high amplitude low frequency modulation while supplying the precise amount of damping at all frequencies.

Results:

1. An extraordinarily smooth and flat frequency response with uniformly excellent channel separation across the entire audio band.
2. Near perfect transient response for superb definition.
3. Accurate tracing of complex waveforms for low intermodulation distortion.

Engineering Dept., Pickering & Co., Inc.

PICKERING
"for those who can hear the difference"

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If you take a creative approach to recording, you'll appreciate the special versatility of the new Dual C919 cassette deck. Four separate slide controls for the line-level and microphone inputs allow you to mix and record signals from disc, tape or FM with live voices and instruments. Output level controls eliminate the need to readjust your amplifiers volume when switching programs, such as to tuner or record player. (These and additional features are shown below.)

The Dual C919 is so versatile, you might think of it as a miniature recording console.

What about performance? The C919 uses the highly reliable Continuous Pole synchronous motor, tapeheads electronics and a uni-directional version of the transport system of our new Auto/Reverse deck which *Audio* magazine reported as "...another outstanding example of the great strides in cassette deck technology in recent years. Wow and flutter was indeed extremely low, measuring 0.065% (WRMS)...total harmonic distortion...well below the 1.5% claimed...about the fastest and smoothest [wind] we have encountered...we also found that the Dual deck was able to handle [C-120 cassettes] smoothly...A distinct feeling of quality...seems well worth the price."

Thus, whether you have special program-mixing requirements, or simply want superb over-all performance, both are available in the C919 cassette deck. Less than $450.00.

United Audio Products, 120 So. Columbus Ave., Mt. Vernon, N.Y. 10553
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Dual

Wow and flutter; 0.07%. Frequency response (±3dB): ferric-oxide, 20-16,500 Hz, chromium-dioxide, ferrichrome, 20-17,000 Hz.

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