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WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

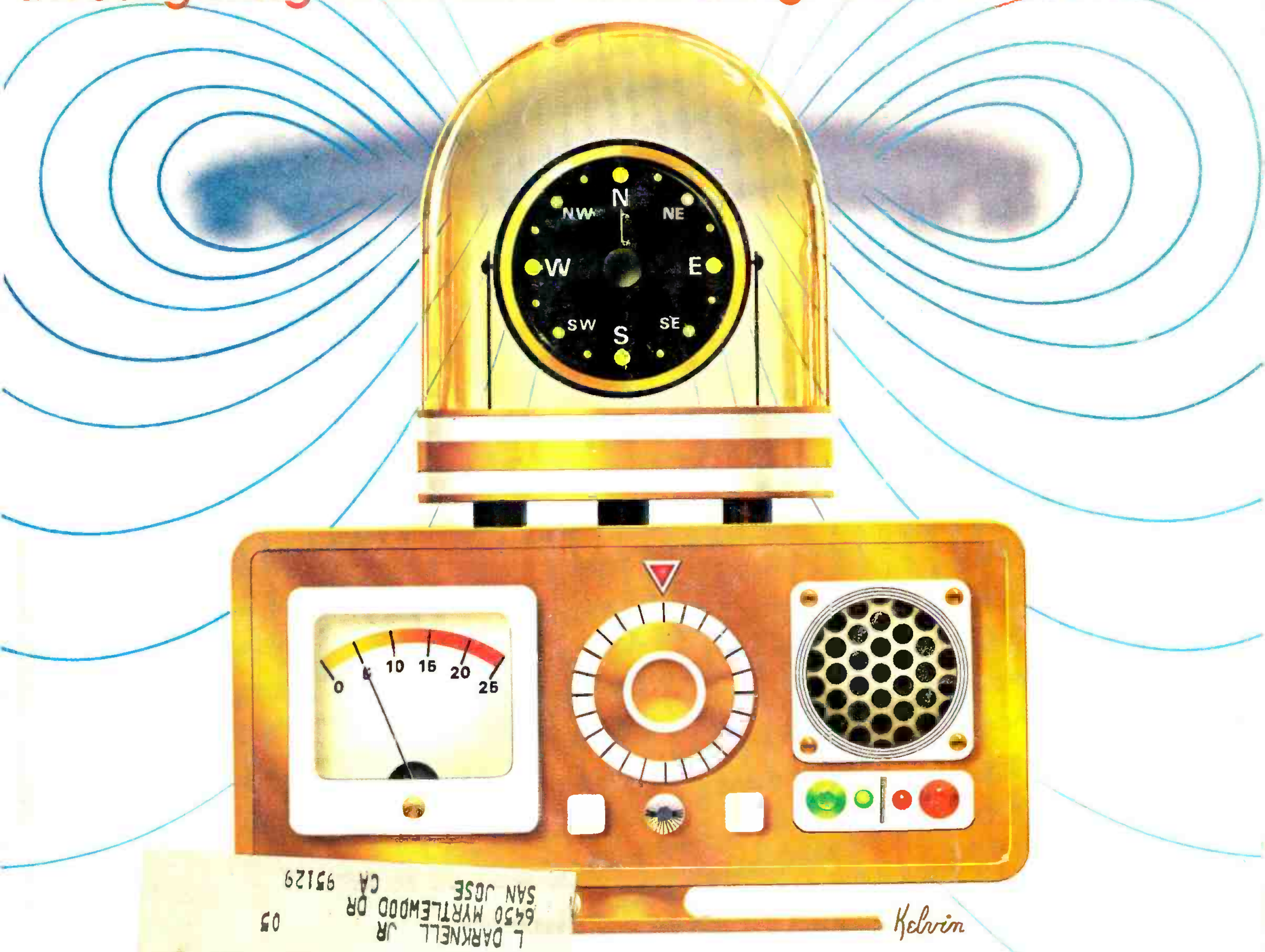
MAY 1978/$1

Preview of New Stereo/Hi-Fi Equipment

How to Add Triggered Sweep to Oscilloscopes

Microprocessor Microcourse, Part III

Investigating UFO's and Other Magnetic Phenomena



In This Issue

L L110 Speaker System

Philips AH673 AM/Stereo FM Tuner

Dynaco Stereo 416 Power Amplifier

The Cobra 50XLR CB has it all. AM/FM Stereo. Cassette. And CB. All in one compact unit. All engineered to bring you the same loud and clear sound Cobra is famous for.

The remote mike houses the channel selector, squelch control, and channel indicator. So all you need for talking CB is right there in your hand. The cassette player features through the dial loading and four-way fader control.

Because they're only five inches deep, there's a Cobra in-dash radio to fit almost any car with little or no modification to the dash. This feature, plus the step-by-step Installation Manual and Universal Installation Kit makes them the easiest in-dash radios to install. And our Nationwide network of Authorized Service Centers makes them the easiest to service.

There are four Cobra in-dash models to choose from including AM/FM/Stereo/8-track/CB. But no matter which you choose you can be sure of getting the best sounding radio going. The ultimate car radio.

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CIRCLE NO 8 ON FREE INFORMATION CARD

THE ULTIMATE CAR RADIO.

Telephone Answering Breakthro

Let a new remote control answering computer free you from your next telephone call.

The new Ford Code-A-Phone 1400 answering computer.

It's a telephone answering computer. The Ford Code-A-Phone 1400 has the first large-scale integration of solid-state componentry —a major change in telephone answering systems since the first mass consumer models appeared five years ago. This means more features, lower cost and greater dependability. Here are some of its exciting features:

Forget about tapes There are no tapes to buy. The Ford unit has a special polymer-based magnetic tape that will record over 25,000 phone calls without replacement. That's over five solid years of use. There are no cassette tapes to buy, wear out or replace.

Forget about microphones When you want to change or record your message, just press a red button, record your message and let go. The message (any length up to 20 seconds) will record and be immediately ready to playback since the message tape does not have to recycle. There are no separate microphones or level controls since the built-in microphone automatically adjusts to your voice.

Forget about touching it You can adjust your unit to answer on either one or four rings. When the unit is set on four rings and you reach the phone before the 1400 answers, you will not activate the unit. But let us say you're outside or indisposed. No problem. Code-A-Phone will automatically answer after four rings. This means that your unit can always be "alive" in the four-ring position so you never have to remember to set it whenever you leave your home or office.

Forget about going home Just bring your optional remote control pager with you. If you want your messages while you're on vacation or away, call your number and the coded pager will remotely signal your unit to play back all your messages.

Forget about service If you've owned a telephone answering device for more than a year, there's a good chance that it's been in for service at least once. The Code-A-Phone, however, is solid state and built with the same heavy duty components used in commercial units. It should dependably stand up to years of heavy usage. (Ford Industries is the world's largest supplier of telephone answering equipment for the Bell system.) If service is ever required, there are over 200 authorized service centers plus a service-by-mail center. There's also a toll-free "Help-Line" number to call 24 hours a day for advice or suggestions, and your unit has a limited ninety day parts and labor warranty.

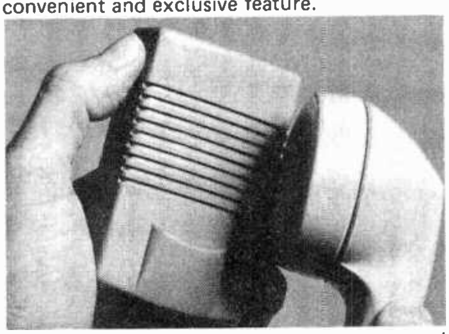
The entire printed circuit-board with its integrated circuits is easily replaceable and contains the "Brains" required to control the audio amplifier and tape transport system.

PLENTY MORE FEATURES

Code-A-Phone has a monitor feature—you can listen to the caller leave his message and pick up the phone to intercept the call. If you want to skip over a message on the tape, just tap a button and it fast-advances to the start of the next call. It has a selectable erase feature that lets you erase a specific message or the entire tape if you wish.

KNOW HOW MANY CALLS

With other answering machines, you never know how many calls you receive until you play them back. With Code-A-Phone you have a call counter—a device that displays the exact number of calls you've received when you arrive home. If you now own another answering machine, you can really appreciate this convenient and exclusive feature.



Hold the small pocket-sized remote-control pager up to any telephone in the world and you can playback all your messages.

Code-A-Phone is the first really versatile answerer that works equally well at home or in the office. It's perfect for the busy or working housewife who spends little time at home. And, if she's home and just plain busy when the phone rings, she can always call back later without offending the caller.

The executive can now leave his office, call from the field and get all his messages. An inefficient operator at a telephone answering service may offend your customers by putting them on hold. Code-A-Phone, however, takes your message quickly—without delay.

There are very few people who haven't left a message on a telephone answering machine, and callers really appreciate the convenience.

NO PHONE COMPANY TARIFFS

Code-A-Phone is equipped with an FCC-registered interconnect device so your unit is actually welcome on your phone line. The 1400 comes with a four-pronged plug so you just plug it into your phone jack. If you don't have a phone jack, just call your phone company and tell them you are purchasing an approved Code-A-Phone and that you want a four-pronged jack for your phone. They'll know exactly what you want and charge you around $12 for the installation, depending on where you live. If you have a multi-line phone, they can install a jack to tie into any or all of the lines you wish. There are no additional monthly charges.

STANDING BEHIND A PRODUCT

JS&A lets you use the 1400 in your home or office for one full month. Use it to screen your calls, take messages while you're gone or as a back up system when you're busy. Use the remote pager and retrieve calls while you're out. See how easy it is to change the message in seconds, and see how much it uncomplicates your life. Use it under your everyday conditions at home or at your office and then decide after one month whether or not you want to keep it. If you decide to keep it, you'll own the best. If not, return your unit for a full and prompt refund. There is no risk. Even if you already own a phone answerer, it would pay for you to see how much better the Code-A-Phone performs.

JS&A is America's largest single source of space-age products and a substantial company —assurance that your purchase is protected.

The Code-A-Phone comes in two models: the Remote Control unit for $249.95 called the 1400 and the same unit without the pager but with all the other features for $169.95 called the 1200. Simply select the unit you want and send your check for the correct amount to the address shown below. Credit card buyers may phone in their orders by calling our toll-free number below. (Illinois residents add 5% sales tax.) There are no **postage and handling charges.**

By return mail, you'll receive a Code-A-Phone complete with all connections and instructions (extra pagers are available for remote unit) plus your ninety day limited parts and labor warranty. The unit measures 3¼"x 8½"x 12" and weighs six pounds.

Code-A-Phone compares to units that sell for much more but do not have the simplicity and the advanced electronics. Don't be confused. Code-A-Phone is the finest telephone answerer you can buy at any price and is years ahead of all other conventional systems.

JS&A gives you everything you could possibly expect from a telephone answering system: 1) A unit years ahead of every other unit at a very reasonable price. 2) A service network that covers the United States with repair centers and free telephone assistance. 3) The chance to buy a unit in complete confidence, knowing that you may return it without being penalized with a postage and handling charge if it's not exactly what you want. You can't lose.

Computer technology has even touched the telephone answerer. Now is the best time to get the finest system available. Order your Code-A-Phone without obligation, today.

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MAY 1978

Popular Electronics®

VOLUME 13, NUMBER 5

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

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- COMPRESSOR GUARD FOR YOUR AIR CONDITIONER
- FUZZ BOX FOR ANY ELECTRIC GUITAR

TEST REPORTS:
- Shure V15 Type IV Stereo Cartridge
- Fisher CR 4025 Stereo Cassette Deck
- Tram D-62 AM/SSB Mobile CB Transceiver

Cover Art by George Kelvin

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Editorial

BIG BROTHER IN ELECTRONICS

George Orwell may yet earn the distinction of being one of the most prescient writers of our time. Witness the bureaucratic hands now meddling in electronics. For example, Michigan State Senator Brown introduced Bill #499 last year, calling for a $2 annually renewable permit for anyone whose vehicle is equipped with a CB receiver or transmitter. It provides for violators to be punished by imprisonment for not more than one year or by a fine of not more than $500, or both.

Why this effort to single out one group for harassment, especially when the Federal Government has authorized and promoted CB Radio in vehicles? Is it viewed as an easy way to pick up more than $1-million (as of October 1977, Michigan had 551,560 licensed CB'ers)? Or does the Senator want the government's NEAR program (to expand the ability of CB'ers and highway police to communicate with each other) to be stillborn in his state?

Docket 21117 before the FCC represents another disturbing government proposal. It concerns a new requirement for type-acceptance of amateur-radio equipment. If adopted, it would squash ham experimentation and damage the used amateur-radio gear market. The FCC, of course, has already diminished some aspects of electronics experimenting by its stance on r-f modulators and isolation switches, prohibiting use unless certified in conjunction with the equipment to which it is being attached. And certification costs thousands of dollars.

The Department of Justice also feels impelled to stick its hand into the electronics cookie jar. Recently, for example, I was lectured on the impropriety of PE carrying advertisements of "tie tack" or wireless microphones among other products, though ad copy mentioned only innocuous applications such as electronic babysitting. The Justice Department, however, saw some dark covert uses. If this view were to be accepted (it was not!), I suppose that butchers could be hassled about advertising meat since buyers might poison the merchandise and feed it to some unsuspecting people.

Now let's take a look at police traffic radar. I commissioned an engineer to investigate its accuracy. He discovered that there's reasonable room for error, purposeful or not. For example, a small foreign car going about 55 mph was clocked at 65 mph when a bus passed it in the opposite direction. There proved to be a host of other factors that could cause an erroneous speeding ticket to be issued on the basis of a radar reading, including questionable accuracy and the need for visual observation of speeding. (Radar is only a backup to this conclusion.) Consequently, radar detectors may well serve a useful and fair protective purpose for motorists.

In brief, electronics enthusiasts appear to be facing increased efforts by government agencies at all levels to stifle interest in these fields. And it's being done in an inexpert, costly manner.

Art Salsberg

Letters

EMPLOYING THE HANDICAPPED

Your Editorial on electronics and the handicapped in the January 1978 issue of POPULAR ELECTRONICS brought to my attention your concern with social problems. The Electronic Industries Foundation has undertaken a joint effort with the Department of Health, Education, and Welfare that is called "A Project With Industry." Its purpose is to employ the handicapped in the electronic industries. It is now being pilot-tested in the Los Angeles and San Francisco Bay areas, with a third project planned for New England this year. —*J.T. Magee, Electronic Industries Foundation, Washington, DC.*

PC PATTERN TRANSFERRING

"Transfer Printed PC Patterns With No Camera or Chemicals" (February 1978) was a well-presented article. However, the process described was awarded a U.S. Patent (3,791,905) in 1974. In 1976, we at Circolex reinvented the process using Mylar sheets with a special adhesvie backing. We did not feel disposed to promote the process because we did not have the legal right to do so. Instead, we later offered our own "Liquineg" system, which similarly copies artwork from the printed page. Unlike adhesive-backed Mylar sheets, Liquineg releases from the printed page immediately upon exposure to water. We offer dozens of printed-circuit products for the hobbyist and experimenter. —*I.L. Cannon, Circolex, Box 198, Marcy, NY 13403.*

TELETYPEWRITER INFO

The article, "Teletypewriter Fundamentals for Hams, SWL'ers, and Computer Hobbyists," in the October issue, was excellent in its coverage of baud rates, frequency shift and audio frequency shift keying, but neglected to mention that the majority of teletypewriter systems in hobby or ham use are Teletype Corp. model 28 or 33 series units. The model 28 differs greatly in the methods of signal generation and printing. The keyboard uses a lever system, which drives a contact arm, similar to automobile distributor points, back and forth to interrupt the dc loop. The printer relies on a signal which can be in one of several forms, depending on the type and wiring. It may be driven with a neutral 0.060 A or 0.020 A signal or several types of polar signals, such as +6 volts. Printing is accomplished by the positioning of a typebox in front of a single print hammer, all controlled by the selector magnets. Typebox styles may vary in surplus equipment, so it would be wise to examine, if possible, the typebox to be sure that it is a "communication" arrangement, rather than weather, etc., which may be full of unintelligible symbols. The 33 series is a self-contained setup, which works in a similar manner, but uses a rotating type wheel rather than a typebox. My firm will be glad to accept operation and theory inquiries and answer them in detail, provided a SASE business-size envelope is included. We also have schematics, wiring diagrams, parts lists, exploded views, and theory and operation manuals and courses at nominal costs.—*Karl M. Wahala, P.O. Box 19154, Honolulu HI 96817.*

A QUESTION OF SENSITIVITY

Readers who build the "Solar Radiometer" (December 1977) may obtain very low meter readings. Presumably, this is due to variations in production lots of the specified meter movement. The article indicated a 0.3-ohm circuit resistance, which would correspond with a 0.75-ohm meter resistance. My readings were so low in our Arizona sunshine that I checked and discovered that my instrument had a resistance of 1.4 ohms. To use the published instrument scale, I would need a 0.93-ohm meter resistance, which is not readily available. With 1 ohm, I get a noon reading of 45 mA at right angles to the sun. Assuming 320 BTU/hr, this would correspond to 1.45 Langleys/min. —*John H. Langford, Rimrock, AZ.*

POWER PHASE NOTES

A minor error in the "Computer Remote Control Project" (February 1978) requires clarification. It is stated that many residences are wired for 220-volt, three-phase power. This is not correct. Most U.S. homes are wired with 120/240-volt, *single*-phase power and would require the 0.01-μF capacitor as stated. If a three-phase wye system is provided, two capacitors would be required to bridge all three hot lines. In this case, the phase-to-phase potential is 208 and 120 volts to ground and loads on opposite phases are being controlled. If a delta system is employed, the voltage on the "high leg" would be in excess of 208 volts to ground; naturally, this leg would not be used for switching purposes in this project. —*Gary R. Knight, Tampa, FL.*

STOPPED AT THE GATE

Is there an error in the schematic diagram of "To the Electronic Races" (December 1977)? In checking the schematic out, I discovered that *IC5A* and *IC5B* both have the same pin designations. —*C.T. Anson, Shasta, CA.*

The circuit shown in Fig. 1 of the article is logically correct. However, as you surmised, part of IC5 is mislabeled. The pins for IC5C should be labeled 1 and 2 for the inputs and 3 for the output of the gate.

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Qualified technicians are urgently needed for careers in the exciting new field of digital and computer electronics . . . and the best way to learn digital logic and operations is now available to you in NRI's Complete Computer Electronics Course.

This exclusive course trains you at home on your own digital computer! This is no beginner's "logic trainer", but a complete programmable digital computer that contains a memory and is fully automatic. You build it yourself and use it to define and flow-chart a program, code your program, store your program and data in the memory bank. Press the start button and the computer solves your problem and displays the result instantly.

The NRI digital computer is one of 10 kits you receive in the NRI Complete Computer Electronics Course. You build and use your own TVOM, and experiment with NRI's exclusive Electronics Lab. You perform hundreds of experiments, building hundreds of circuits, learning organization, operation, trouble-shooting and programming.

New NRI Memory Expansion Kit

The Model 832 NRI Digital Computer now comes with a new Memory Expansion Kit. Installed and checked out in 45 minutes, it doubles the size of the computer's memory, significantly increasing the scope and depth of your knowledge of digital computers and programming. With the large-scale IC's you get the only home training in machine language programming . . . experience essential to trouble-shooting digital computers.

electronics at home.

NRI offers you five TV/Audio Servicing Courses

NRI can train you at home to service Color TV equipment and audio systems. You can choose from 5 courses, starting with a 48-lesson basic course, up to a Master Color TV/Audio Course, complete with designed-for-learning 25" diagonal solid state color TV and a 4-speaker SQ™ Quadraphonic Audio System. NRI gives you both TV and Audio servicing for hundreds of dollars less than the two courses as offered by another home study school.

All courses are available with low down payment and convenient monthly payments. All courses provide professional tools and "Power-On" equipment along with NRI kits engineered for training. With the Master Course, for instance, you build your own 5" wide-band triggered sweep solid state oscilloscope, digital color TV pattern generator, CMOS digital frequency counter, and NRI electronics Discovery Lab.

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NRI's Complete Communications Course includes your own 400-channel VHF transceiver

NRI's Complete Communications Course will train you at home for one of the thousands of service and maintenance jobs opening in CB; AM and FM transmission and reception; TV broadcasting; microwave, teletype, radar, mobile, aircraft, and marine electronics. The complete program includes 48 lessons, 9 special reference texts, and 10 training kits. Included are: your own "designed-for-learning" 400-channel VHF transceiver; electronics Discovery Lab™; CMOS digital frequency counter; and more. You also get your all important FCC Radio-telephone License, or you get your money back.

CB Specialist Course also available

NRI also offers a 37-lesson course in CB Servicing with your own CB Transceiver, AC power supply, and multimeter. Also included are 8 reference texts and 14 coaching units to make it easy to get your Commercial Radiotelephone FCC License.

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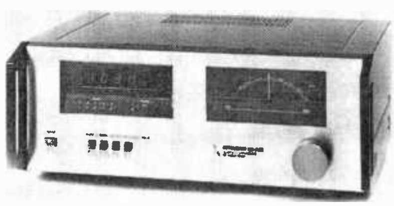
New Products

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

Mitsubishi Digital FM Tuner

The DA-F20 is a frequency synthesizer, quartz-locked FM tuner with both digital readout and circular frequency dial. It fea-



tures wide/narrow i-f selection, a recording-level check button, and LED analog-array displays for signal strength and center-tuning. Rated specifications are 80 dB S/N in mono, 75 dB stereo; THD of 0.05% in mono, and 0.08% in stereo; and 100-dB spurious, image and i-f response ratios. Stereo separation at 1 kHz is rated as 50 dB at the wide-band i-f setting, and 45 dB at the narrow setting. $380.

CIRCLE NO 91 ON FREE INFORMATION CARD

VideoBrain Family Computer

VideoBrain TM is said to be the first home computer that can be used to implement

high-level computer tasks even if you have no computer programming skills. This is made possible by the use of pre-programmed software cartridges. Programs currently available include Finance 1, Cash Management, Music Teacher 1, Math Tutor 1, Wordwise TM 1 and 2, and video games Gladiator, Blackjack, Checkers, Pinball, and Video Artist. Fifty additional programs are being developed; individual program cartridges will retail for $19.95. The self-contained computer with keyboard is built around an F-8 MPU. Incorporated into VideoBrainTM are basic text and timekeeping programs, and video output for connection to color or B&W TV receivers. It comes with two joy sticks, three cartridge programs, and a TV-connection cord and antenna switch. $500.

CIRCLE NO 100 ON FREE INFORMATION CARD

Sony Cassette Deck

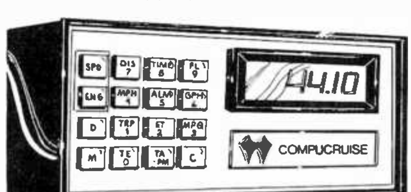
The Sony TC-K7II is a front-loading, Dolby-equipped stereo cassette deck with a two-motor drive, including a dc servo-controlled capstan motor. Transport func-

tions are solenoid-operated, and controlled by light-touch pushbuttons; a remote control is optional. Features include: timer start for record or play, LED overload indicators for 0, +4 and +8 VU levels, separate level controls for headphone and line out, memory tape counter for start or stop, a front-panel line in jack, 3-position bias and equalization switches, and a record mute switch. Stated performance with ferrichrome tape is 60 dB S/N without Dolby, frequency response of 30-16,000 Hz ±3 dB, and 1.3% THD. Wow and flutter are rated at 0.045%. $500.

CIRCLE NO 93 ON FREE INFORMATION CARD

Automobile Computer

"Compucruise" is a multi-function automobile system monitor and controller with 18-button keyboard and a 5-digit fluorescent display. With appropriate sensors installed



in the car, it monitors battery voltage, speed, fuel flow, distance, time and air temperatures both inside and outside the car. (Engine temperature may be substituted for either of these.) As a fuel management system, it can indicate instantaneous and average fuel consumption, fuel used and remaining, plus distance and time to fuel exhaustion at current speeds. It can also display time of day, elapsed time, accurate road speed, and estimated time of arrival. As a cruise control, it can maintain the car at any predetermined speed. Metric and English units may be switch-selected for all functions. Address; Zemco, Inc., 1136 Saranap Ave., Suite L, Walnut Creek, CA 94595.

JVC Equipment Racks

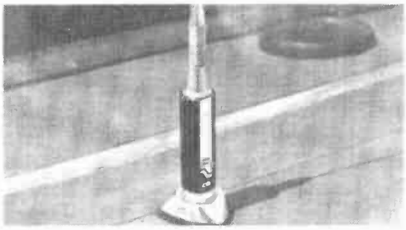
The JVC "MusicTowers" are rack cabinets, available in three models. Smallest is the LK-33/MK-33, a pair of walnut-look cabinets each measuring 44.2"H × 18.2"W × 14.2"D (112.0 × 46.2 × 36.0 cm) with equipment shelves and a glass-doored

record-storage area. The LK-905 MusicTower is a black wood unit 49.5"H × 21.7"W × 17.8"D (127.7 × 55.0 × 45.2 cm), also with a record storage compartment. The LX-3000, for EIA-standard, 19" rack-mount equipment is in three sections that resemble a studio tape recorder console. It includes a turntable well surmounting a base with a rack-mounting area about 19" (48.2 cm) high and 21" (53.4 cm) deep. Mounted on pillars above the turntable (with ample clearance for the turntable dustcover) is an additional rack area, about 18" (45 cm) high × 14" (36 cm) deep. The LX-3000 has overall dimensions of 63.6"H × 22.6"W × 22.3"D (161.8 × 57.4 × 56.5 cm).

CIRCLE NO 94 ON FREE INFORMATION CARD

Channel Master CB Mobile Antenna

Channel Master's Model 5061 trunk-lip, base-loaded CB antenna employs a spring-loaded, bayonet-mount locking feature that enables it to be quickly removed when the vehicle is left unattended. The triple chrome-plated triangular cup allows

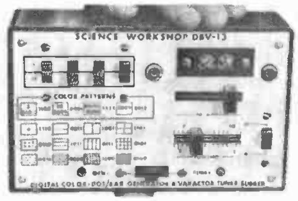


the antenna to fit onto trunk lips with only ½" (12.7 mm) clearance to window. The cup features a Neoprene gasket to protect the finish of the vehicle on which it is mounted and an internal support bridge for added strength and stability. The quick-lock antenna comes with 17' (5.2 m) of preassembled RG-58/U harness and a positive-contact miniature connector. It is weatherproofed and has a rated SWR of 1.3:1. $28.95.

CIRCLE NO. 98 ON FREE INFORMATION CARD

Science Workshop Tuner Subber

Said to be the first of its kind, the Varactor Tuner-Subber Model DVB-13 from



Science Workshop uses variable-capacitance diodes to provide continuous electrical, rather than mechanical, channel tuning. It has a MOSFET r-f stage and four Varactor-tuned circuits. A built-in MOS-LSI chip provides 16 video patterns for testing and aligning color circuits and convergence. Patterns include: rainbow, color bars, noise-free raster for purity and grey-scale adjustments, dots, lines, and cross-hatches. A modulator provides r-f and video output signals. Featured are: 1.5-volt p-p output at 470 ohms; r-f output adjustability from channel 2 through 4; crystal-controlled master and color oscillators; digital matrix switching; and battery power. $74.95, kit; $89.95, wired. Address: Science Workshop, Box 343, Bethpage, NY 11714.

Exact Lin/Log Sweep Generator

The Model 117 is a line- or battery-operated linear/logarithmic sweep function generator from Exact Electronics Inc. It offers sine, square, triangle, ramp, and pulse outputs, with the main output variable up to 15 volts p-p open circuit and 7.5 volts p-p into 600 ohms. Independent auxiliary triangle, ramp, pulse, and low sine-wave outputs are available simultaneously, with an independent amplitude control on the low-sine output. Operating frequency is 2 Hz to 200 kHz in three ranges. External capacitors can be added to modify the ranges as desired. Control of frequency can be internal (via the frequency dial) or automatic sweep over a 1000:1 linear or log range. Selectable sweep ranges are 25 s, 250 ms, and 2.5 ms, or the sweep rate can be modified by connecting an external capacitor to the ramp timing terminals.

CIRCLE NO. 99 ON FREE INFORMATION CARD

(More New Products on page 14)

Electronic Golf-Swing Timer

How fast is your golf swing? It's one of the factors affecting the length of your drives. The GT100 Swingtimer monitors clubhead speed photoelectrically to 1/50,000 of a second at tee level, enabling quick comparison of speed developed with different clubs and techniques. The device includes a battery-operated, swivel lantern light source and timer with a three-digit LCD readout, usable in daylight. The display also signals when light source and timer are properly aligned. Powered by a 9-volt battery, the portable device measures about 6" × 3" × 2½" (15.2 × 7.6 × 6.4 cm). $74.95. Address: G.T. Golf Products, Box 370847, Miami, FL 33137.

Palomar AM/SSB CB Transceiver

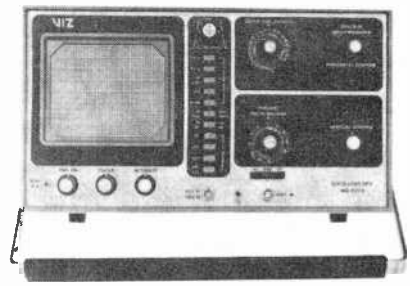
Palomar Electronics recently introduced the Palomar SSB-500, a 40-channel AM/SSB mobile CB transceiver. The Palomar SSB-500 features LED numeric channel display as well as all standard operating controls, including a-f gain, squelch, clarifi-

er, switchable automatic noise limiter and noise blanker, switchable r-f gain, a LED dim/brite switch, and an S/r-f meter. LED transmit and receive indicators round out the Palomar SSB-500 front panel. The receiver section is said to feature increased protection against cross-modulation and strong adjacent channel signals.

CIRCLE NO 95 ON FREE INFORMATION CARD

VIZ Triggered-Sweep Scope

The VIZ WO-527A is a 15-MHz, triggered-sweep, oscilloscope with several special functions for use in TV broadcast and service work. These include a special TV line selector, for line-by-line display of video frames and TV vertical and horizontal sweep settings selectable by pushbutton.

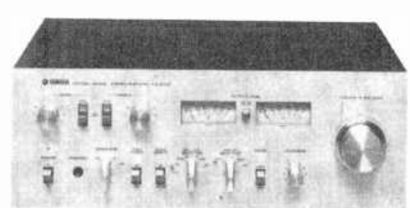


Other features include LED trigger-polarity indicators. Calibrated time bases from 0.5 μs/cm to 0.5 sec/cm, plus 10X sweep magnification; 0.4V peak-to-peak square-wave calibration and probe-compensation signal, and divide-by-ten trigger source function. Specifications include a horizontal bandwidth of dc to 1 MHz; horizontal input impedance of 1 megohm, shunted for trace expansion of 30 pF; sensitivity from 10 mV/cm to 20 V/cm in 11 ranges; 23 μs rise time. Dimensions are 13.5" × 7.5" × 17.5" (34.3 × 11.1 × 44.5 cm). Weight is 21 lb (9.5 kg). $479.

CIRCLE NO 96 ON FREE INFORMATION CARD

Yamaha Integrated Amplifier

Yamaha's model CA-610 II is a moderately priced integrated amplifier that's rated at 45 Wrms/channel into 8 ohms at 0.05% harmonic distortion. The preamp section features a separate recording output selector, allowing the user to tape from any of the inputs—or dub directly from either deck to the other—regardless of which input is feeding the main amplifier. Bass and treble controls each have switchable turnover



frequencies, plus defeat, and the entire tone-control/filter stage can be bypassed with a MAIN/DIRECT switch. The latter reduces the gain 6 dB, and also reduces THD and IM from 0.02% at half power to 0.01%. Other features include individual-channel output meters calibrated in watts and dB, separate controls for volume and loudness-compensation level, high- and low-frequency filters, and speaker selector, plus RIAA-equalization accuracy rated at −0.3 dB, and 97 dB S/N. Dimensions are 17⅛"W × 6¼" H × 13 3/16" D (435 × 160 × 335 mm).

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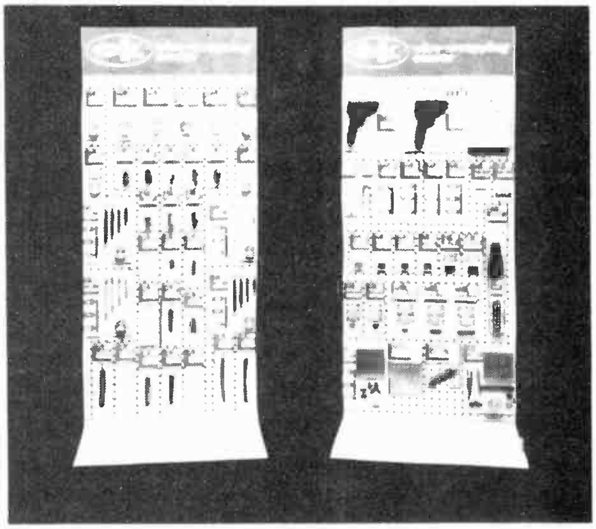

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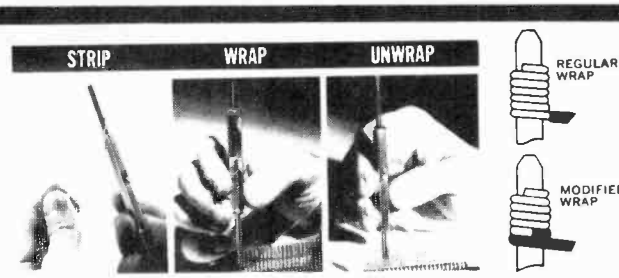


HOBBY WRAP TOOL

Wire-wrapping, stripping, unwrapping tool for AWG 30 on .025 (0,63mm) Square Post.

Regular Wrap	WSU-30	$6.95
Modified Wrap	WSU-30M	$7.95

WIRE-WRAPPING TOOL

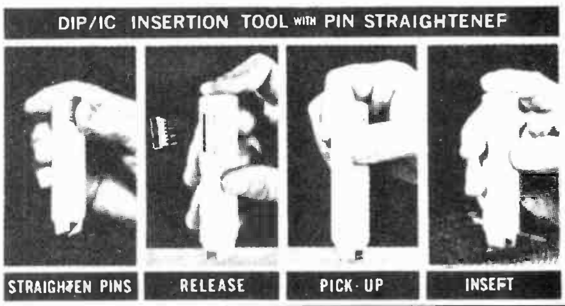
For .025" (0,63mm) sq. post "MODIFIED" wrap, positive indexing, anti-overwrapping device.

For AWG 30	BW-630	$34.95*
For AWG 26-28	BW-2628	$39.95*

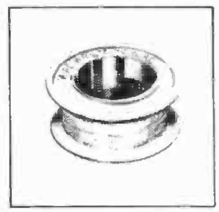
Bit for AWG 30	BT-30	$3.95
Bit for AWG 26-28	BT-2628	$7.95

*USE "C" SIZE NI-CAD BATTERIES (NOT INCLUDED)

DIP/IC INSERTION TOOL WITH PIN STRAIGHTENER



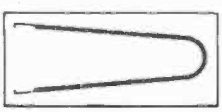
14-16 Pin Dip IC Inserter	INS-1416	$3.49



ROLLS OF WIRE

Wire for wire-wrapping AWG-30 (0.25mm) KYNAR* wire, 50 ft. roll, silver plated, solid conductor, easy stripping.

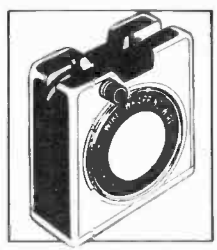
30 AWG Blue Wire 50ft Roll	R 30B-0050	$1.98
30 AWG Yellow Wire 50ft Roll	R 30Y 0050	$1.98
30 AWG White Wire 50ft Roll	R 30W-0050	$1.98
30 AWG Red Wire 50ft Roll	R 30R 0050	$1.98



DIP/IC EXTRACTOR TOOL

The EX-1 Extractor is ideally suited for hobbyist or lab engineer. Featuring one piece spring steel construction. It will extract all LSI, MSI and SSI devices of from 8 to 24 pins.

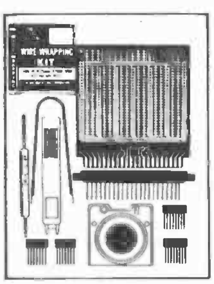
Extractor Tool	EX-1	$1.49



WIRE DISPENSER

- With 50 ft. Roll of AWG 30 KYNAR* wire-wrapping wire.
- Cuts the wire to length.
- Strips 1" of insulation.
- Refillable (For refills, see above)

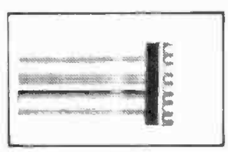
Blue Wire	WD-30-B	$3.95
Yellow Wire	WD-30-Y	$3.95
White Wire	WD-30-W	$3.95
Red Wire	WD-30-R	$3.95



WIRE-WRAPPING KIT

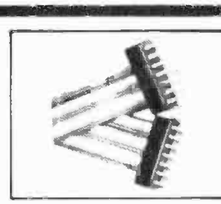
Contains: Hobby Wrap Tool WSU-30 M, Wire Dispenser WD-30-B, (2) 14 DIP's, (2) 16 DIP's, Hobby Board H-PCB-1, DIP/IC Insertion Tool INS-1416 and DIP/IC Extractor Tool EX-1

Wire-Wrapping Kit	WK-4B (Blue)	$25.99



RIBBON CABLE ASSEMBLY SINGLE ENDED

With 14 Pin Dip Plug 24" Long (609mm)	SE14-24	$3.55
With 16 Pin Dip Plug 24" Long (609mm)	SE16-24	$3.75



RIBBON CABLE ASSEMBLY DOUBLE ENDED

With 14 Pin Dip Plug - 2" Long	DE 14-2	$3.75
With 14 Pin Dip Plug - 4" Long	DE 14-4	$3.85
With 14 Pin Dip Plug - 8" Long	DE 14-8	$3.95
With 16 Pin Dip Plug - 2" Long	DE 16-2	$4.15
With 16 Pin Dip Plug - 4" Long	DE 16-4	$4.25
With 16 Pin Dip Plug - 8" Long	DE 16-8	$4.35

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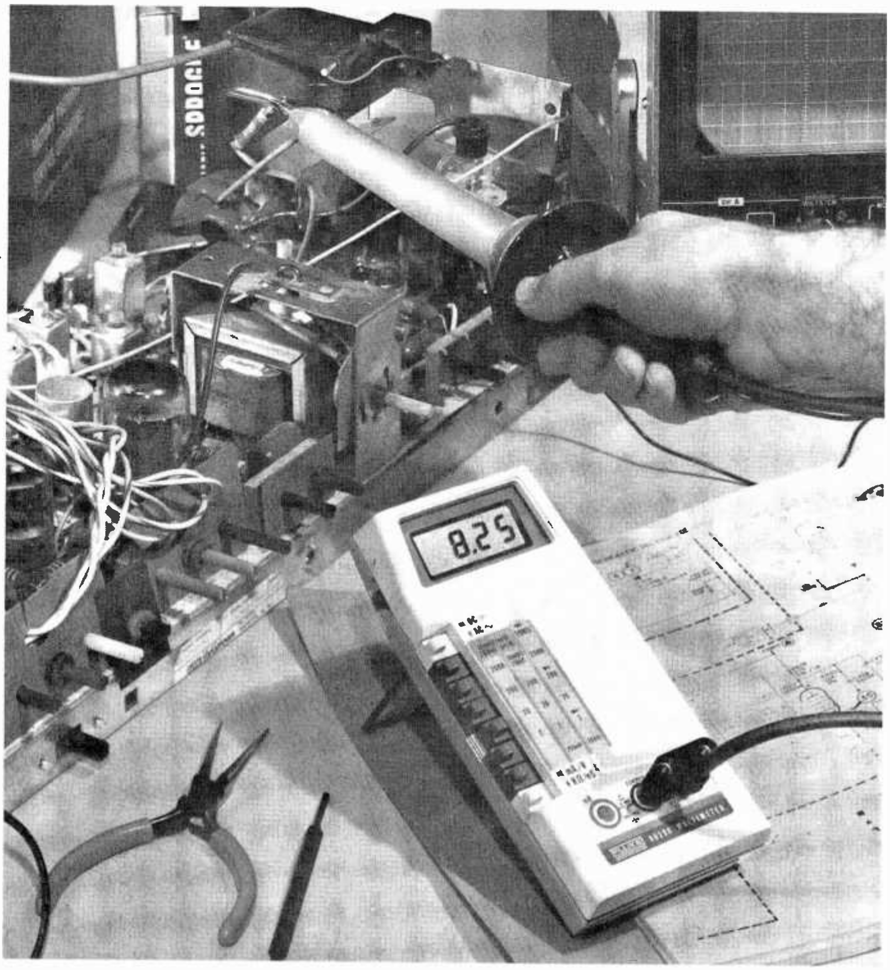

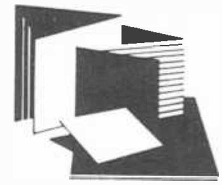

New Literature

NIKKO AUDIO PRODUCTS CATALOG

Its full line of stereo receivers, separates and professional products are described in Nikko Audio's new 32-page catalog. To assist audio shoppers, a comparison chart of technical specs for receivers is included. The catalog also features a brief history of Nikko and its background in the electronics field. Address: Nikko Audio, 16270 Raymer St., Van Nuys, CA 91406.

CHERRY "PRO" KEYBOARD HANDBOOK

Now available from Cherry Electrical Products Corp., is an 8-page catalog and handbook, "Meet the PRO", describing the new "PRO" keyboard for personal and hobbyist computers. It includes instructions on how to customize the keyboard, a schematic drawing, charts, diagrams and standard and optional specifications. Address: Cherry Electrical Products Corp., Box 718, Waukegan, IL 60085.

STATIC AWARENESS BOOKLET

Available from Controlled Static Company is a booklet on the nature and control of static electricity, particularly where it concerns electronic components. Since some components are more static sensitive than others, the booklet is designed particularly to alert those in the electronics industry concerned with such problems. Address: Controlled Static Company, 9846 Jersey Ave., Santa Fe Springs, CA 90670.

MOTOROLA HF-SSB COMMUNICATIONS HANDBOOK

The "Triton High Frequency Single Sideband Handbook," by Modar Electronics, a subsidiary of Motorola, Inc., discusses high-frequency, single sideband marine communications. It covers SSB radios and marine radiotelephones in the 1.6-to-18-MHz range. Address: Motorola Literature Distribution Center, 1301 E. Algonquin Road, Schaumburg, IL 60196.

MALLORY SEMICONDUCTOR PRODUCT GUIDE

This 148-page cross-reference and product guide lists Mallory's complete line of semiconductor products. It describes the company's transistors, complementary pair transistors, zener diodes, diodes, high-voltage components, color crystals, integrated circuits, and field effect transistors. Address: P.R. Mallory & Co. Inc., 3029 East Washington St., Indianapolis, IN 46206.

Stereo Scene

By Ralph Hodges

FOR THE RECORD

THE AUDIO accessories business would seem to be going like gangbusters, although it's a little hard to understand why. Could there possibly be room in the marketplace, one wonders, for yet another variant of the Discwasher system, the Ball Corporation's Sound Guard, or the classic Watts Dust Bug? Yet still they come, some of them managing to carve out niches of distinction for themselves. For example, Recoton's handheld Clean Sound system recently won an award for design aesthetics, so if you can't be entirely sure of its effectiveness, you can at least be certain it won't offend the eye.

What any of these products will do to the record remains the crux of the matter; and, as ever, the effects—particularly the long-term ones—of their continued use are exasperatingly difficult to evaluate. Along with others, I have noted that some of the spray-on dry-lubricant substances such as Sound Guard tend to cause a subtle but perceptible change in the sound. Is it for the better or the worse? I think that question could be debated loudly and at length. But more important, does it occur because the record itself has been physically altered, perhaps as the result of accumulations of the substance filling in fine groove detail? To a man, the manufacturers deny this, and I can only take their word for it. However, it would appear that other mechanisms could be responsible for the audible change. An alteration of the stylus-groove coefficient of friction could materially affect any pattern of resonances tending to be excited within the stylus assembly, as well as the vertical tracking angle. (A previous column discussed the audible effects of small changes in vertical tracking angle at some length.) Thus, it becomes next to impossible to determine precisely what it is you're hearing under any given set of conditions.

If we can't tell a great deal by ear, perhaps we can augment our understanding by eye; and, thanks to the scanning electron microscope of Stanton Magnetics' George Alexandrovitch, we may soon be getting our first comprehensive look at the minuscule world of the record groove in all its vicissitudes. I hope to be able to report on that work as soon as it has run its (very lengthy) course. Meantime, every few minutes there is a new accessory to raise more controversy. Here are a few of the latest.

(continued on page 22)

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06	Popular Electronics	12 issues	$7.97	Reg. Rate: 12 iss. $12
11	Stereo Review	12 issues	$4.99	Reg. Rate: 12 iss. $9.98
48	Business Week	51 issues	$26 Reg. Rate	Newsst. Rate: 51 iss. $63.75
63	Golf	12 issues	$3.97	Reg. Rate: 12 iss. $7.94
07	Popular Photography	12 issues	$5.99	Reg. Rate: 12 iss. $11.98
40	Time	26 issues	$12.97	Newsst. Rate: 26 iss. $26
02	Car and Driver	12 issues	$4.99	Reg. Rate: 12 iss. $9.98
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41	TV Guide	32 issues	$8.35	Newsst. Rate: 32 iss. $9.60
87	Crawdaddy	12 issues	$7.95	Newsst. Rate: 12 iss. $12
28	Mechanix Illustrated	18 issues	$5.96	Reg. Rate: 18 iss. $11.90
37	Redbook	18 issues	$11.93	Newsst. Rate: 18 iss. $22.50
99	TV Guide	52 issues	$13.56	Newsst. Rate: 52 iss. $15.60
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43	Field & Stream	18 issues	$5.97	Reg. Rate: 18 iss. $11.93
31	New Times	26 issues	$7.50	Reg. Rate: 26 iss. $15
68	Sphere	10 issues	$4.95	Reg. Rate: 10 iss. $7.50
12	Yachting	12 issues	$12.00	Newsst. Rate: 12 iss. $24

STEREO SCENE
(continued from page 18)

A Shock Absorber for Tonearms. First reports are coming in on Discwasher's new DiscTraker device ($29), and some of the more authoritative ones are quite positive. The DiscTraker is in effect a pneumatic suspension for the tonearm, consisting of a dashpot that affixes to the cartridge holder and a soft velvet pad that contacts the record surface. The intent of the mechanism is to ward off the effects of vertical record warps (including warp wow and flutter, and generation of high-level infrasonic signals) on a compliant stylus assembly.

During a recent get-together with Douglas Sax, a principal at the Mastering Labs disc-cutting studio and president of the Sheffield Labs direct-to-disc recording project, he indicated to me, that after extensive experience, he found the device did "nothing bad" and very probably helped in many cases. Needless to say, there are few people who are quite as discerning and demanding as Sax when it comes to record-playing equipment, so his comments amount to high prasie.

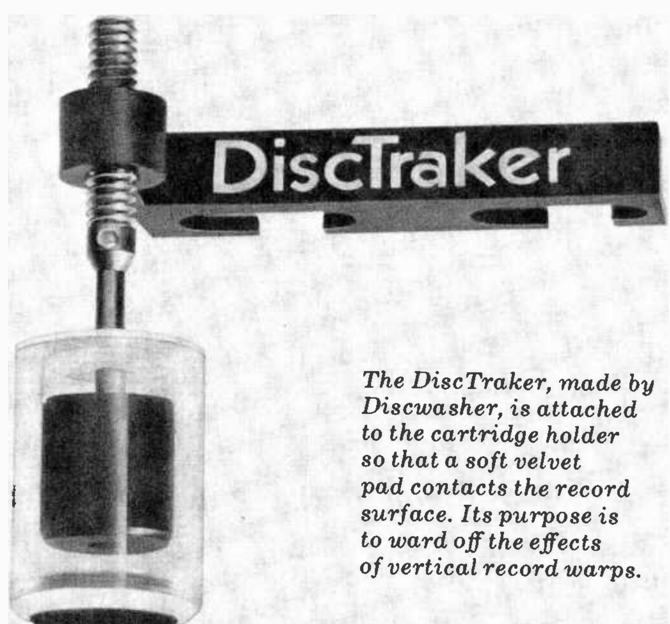
Tomlinson Holman of Apt Corp. has done some original work on warp effects, which he now believes to be the major causative mechanism of audible Doppler distortion in loudspeakers. Up to now, Doppler-distortion researchers have largely confined themselves to test signals of a sort likely to be found as part of the actual recorded program on records. Few of them have really heard anything they were inclined to complain about. Holman wonders if they ever will. But in any case, he is able to demonstrate Doppler effects with modulating signals below 15 Hz at levels typical of what you'd get from a warped record and a poorly matched arm-cartridge combination. To quote from a private communication:

"There are several reasons why infrasonic-generated Doppler distortion is more severe than distortion arising from in-band signals intermodulating one another.

"(1) With decreasing frequency the speaker excursions become longer. This fact combines with radiation resistance to result in a flat response in the operating range of the speaker and a 12-dB-per-octave rolloff below (assuming the speaker is of the acoustic-suspension type). *But*, the speaker still makes long excursions at frequencies well below its acoustic cutoff; it is not the acoustic output that produces distortion but the cone excursion, and the excursions at infrasonic frequencies are long.

"(2) The ear is most sensitive to pitch fluctuation at rates between 5 and 10 Hz. This unhappy fact shows up in the weighting curves for flutter meters that are required for good subjective correlation. This means that the ear is twice as sensitive to 5-Hz modulation as it is to 30-Hz modulation.

"(3) The warp content is not musically related to the program material and is thus likely to be more obvious, since it occurs at unlikely—but not random—times.



The DiscTraker, made by Discwasher, is attached to the cartridge holder so that a soft velvet pad contacts the record surface. Its purpose is to ward off the effects of vertical record warps.

"(4) Most of the warps are vertical more than they are horizontal, giving rise to out-of-phase signals. This means that one speaker cone is going to be coming toward you while the other is going away. In a stereo system, I think this is likely to disturb the perception of direction during the warp, causing image shifts. I cannot yet say I've heard this effect clearly, however."

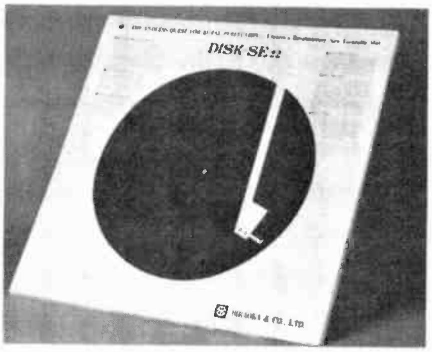
Holman builds a sharp infrasonic filter into his preamplifier to nip Doppler distortion in the bud. But this is only one possible solution to the problem.

If the DiscTraker can cure a record player perturbed by serious warp effects, it should be more than worth its price. But aside from its efficacy as a "Band Aid™," there remains the question of whether it will help, harm, or not affect at all a tonearm already well-suited to its cartridge.

Incidentally, getting back to Sheffield Labs for a moment, their two latest direct-to-disc releases—excerpts from Prokofiev's *Romeo and Juliet* and Wagnerian orchestral selections (Los Angeles Philharmonic with Erich Leinsdorf conducting)—may be destined to mark some sort of milestone in modern-day symphonic recordings. The pickup was a single stereo microphone—as purist and straightforward as you can get. Furthermore, the dynamic range is shockingly uninhibited, the musicianship supremely fine (Leinsdorf is reported to have said that, all told, the Wagner may be the best thing he's ever recorded), and the records seem genuinely difficult to play. After hearing the Prokofiev reproduced with stunning effect on Sax's system, I took a copy to a friend's house and listened in disbelief as his top-quality record player got into about as much trouble as a record player can get into. These records can tax any playback system in a number of ways, and if your copies turn out sounding terrible, don't say you haven't been warned.

Laying Rubber. The lowly rubber or plastic mat that supports the record on the turntable platter has come in for its share of dispute over the years. Intermittently, voices are raised to proclaim that all turntable mats should be electrically conductive so as to bring opposing charges into the closest possible proximity to any static charges on the record. (This idea has never really caught on with manufacturers, and it's next to impossible to find a conductive mat today.) Jack Rabinow, designer of the Rabco tonearms and turntables, among other distinctions, has asserted that a record not completely supported by its underlying mat becomes a microphone that feeds back into the sound system via the phono cartridge. (Rabinow suggests you lower your pickup onto a stationary record, turn up the gain, and shout at the record to find out how much trouble you're in. So far I've gotten nothing but raw vocal cords from this test, but I'll keep trying.) Similarly, for some time Thorens has molded its mat to provide strategic spaces and "channels" beneath the record to break up any mechanical resonances.

Now we have turntables that come with fluid-filled and pigskin (if you purchase it in Japan) mats, and a burgeoning crop of accessory mats as well. Faced with a situation in which I was going to have to operate a turntable not five feet from a trio of loudspeakers intended to pack quite a wallop, I acquired one of these mats, as much out of curiosity as anything else. It happened to be the DISK-SE22 ($20), distributed by Osawa and claimed to be just the thing for adding mass (and therefore, presumably, speed stability) to the platter, and for isolating the record from any structural resonances in the platter's metal casting. I had noted that the platter emitted a sustained "ping" when flicked with a finger—nothing that would bother me ordinarily, but I was looking for insurance.



The DISK-SE22 is said to add mass to platter, isolating record from structural resonances.

The mat turned out to be a substantial item, weighing more than a pound and tapered so that it was somewhat thicker at the circumference than at the middle. (According to Rabinow this is not a good idea, because it denies support to most of the record's area. The mat's accompanying literature made a virtue of this design feature, so I went ahead anyway.)

To my astonishment, I was immediately pleased with the result. To use subjective terms, a certain subtle "shudderiness" was gone from the sound, and the silences between the notes in the program material seemed more profoundly silent. A return to the mat originally supplied with the turntable seemed to point up the difference even more.

Now caution is certainly in order here before any conclusions are drawn. This simple comparison changed more factors than are immediately apparent, including (because of the mats' markedly different thicknesses) that critical vertical tracking angle. Still, *under the specific circumstances existing*, the mat seemed to afford an improvement—something that is worth knowing about. I suspect that the Osawa mat is best categorized as a useful item when all is not as it should be, but by-and-large superfluous if this is not the case. It's also important to note that the mat is probably massy enough to give some turntables with low starting torque a bit of a struggle, and it could cause some platters supported by soft suspensions to tilt off-level. However, if you suspect this item could be of benefit to you, giving it a try is recommended, especially if you can manage to borrow one. ◇

The super fidelity receiver that someone paid a million for.

A lot of money? You bet it is. But that's what it cost Sansui to develop the world's most advanced receiver. The Sansui G-9000 super fidelity DC receiver. Never before has music reproduction been so clean, brilliant and true. When you listen to a G-9000 you'll actually hear a difference. When you look at the specifications, you will understand why.

The amplifier section is DC and direct coupled to achieve a frequency response of zero Hz to 200 kHz (from main-in, – 3dB). A slew rate of 80V/μsec., achieved through the unique Sansui amplifier circuitry (patent pending), ensures ultra-fast transient response. And we've virtually eliminated distortion. THD is all the way down to 0.02% at full rated power, 160 watts per channel min. RMS, both channels driven into 8 ohms from 20-20,000Hz.

The FM section offers selectable IF bandwidth, for greatest selectivity in crowded signal areas and lowest distortion (0.08% stereo) under normal listening conditions. Sensitivity is 1.5μV (8.7dBf), and capture ratio is a very low 0.9dB.

More advanced than nearly every separate amplifier and tuner available today, the Sansui G-9000, with simulated woodgrain cabinet, is certainly more convenient, especially when you look at and handle its full complement of "human engineered" controls. They are beautifully positioned, superbly smooth and outstandingly accurate. We've even placed all the input, output and speaker terminals at the sides with rails for hiding the cables.

Interested? Then visit your nearest Sansui dealer today. You'll be surprised to learn that our suggested retail price is only $1,050. And that we also offer the G-8000 pure power DC receiver, with nearly all the advantages of the G-9000, but with slightly less power, at a suggested retail price of only $900. Which isn't a lot when you consider that these super fidelity components are easily worth a million.

The Sansui G-9000 pure power DC receiver.

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Sansui

CIRCLE NO. 45 ON FREE INFORMATION CARD

Julian Hirsch

HIRSCH/HOUCK LABORATORIES

Audio Reports

LOUDSPEAKER EFFICIENCY AND AMPLIFIER POWER

IT IS interesting to compare the changes in loudspeaker efficiency over the past two decades or more with the corresponding trends in amplifier power ratings. These seemingly unrelated parameters are actually two sides of the same hi-fi coin; but since they are the result of totally different design efforts, that coin sometimes assumes the appearance of a quarter on one side and a dime on the other!

Efficiency, as it applies to a loudspeaker, has a precise technical meaning, but no speaker system sold for home use (to my knowledge) is actually rated for efficiency according to either EIA or any other standard method. When speaking of efficiency, we usually mean sensitivity—how loud a sound the speaker will make with a given electrical input. For convenience, however, I will continue to refer to it as efficiency.

Published speaker efficiency ratings usually state the sound pressure level, or SPL, that will be measured at a distance of one meter from the front of the speaker, in an anechoic environment, when it is driven by one watt of electrical input. Since the impedance of a speaker is complex, consisting of both resistive and reactive components, it is customary to assume that it is a pure resistance of the nominal rating (such as 8 ohms). In this case, an applied voltage of E volts would correspond to an input of $E^2/8$ watts.

There is still considerable room for variation in the test conditions, which can make it difficult to compare speakers rated by different standards. For example, if a sine-wave input signal is used, what frequency should it be? Almost any speaker varies so widely in its output, even over a narrow range of frequencies, that any sine-wave test signal would give meaningless results. Random noise is better, but it can be in the form of "white" noise (equal energy per cycle of bandwidth) or "pink" noise (equal energy per octave bandwidth). The pink-noise spectrum slopes downward with increasing frequency at a 3-dB-per-octave rate. It is thus less likely to exaggerate the high-frequency properties of a speaker than the white-noise signal, whose energy is concentrated at the higher frequencies.

However, even a wide-band pink-noise signal may not correlate too well with the subjective loudness of the sound of a speaker. Its major weakness, as I see it, is the exaggerated contribution to the total measurement caused by any response peak in the speaker's output. It is my feeling that the mid-range output is the most important criterion in rating the loudness of a speaker, and I use an octave of random noise centered at 1000 Hz for a test signal. This is derived by passing interstation FM tuner hiss through an octave band equalizer, with the 1000-Hz octave slider at maximum and the others at minimum. The signal is sufficiently random to avoid problems with narrow-band speaker resonances, yet is limited to the most audible portion of the audio band.

In a normally "live" room, such as my test/listening room, a sound-level meter placed one meter from the front of the speaker will read higher than it would in an anechoic chamber. Nevertheless, measurements made in this way can be used for comparisons between speakers without serious error. I hold the sound-level meter on the center axis of the speaker's grille and one meter from it for this measurement. Often, there will be a considerable variation in the meter reading if it is moved to face a different portion of the grille; but in the interests of consistency, I try to stay in the center.

The range of SPL readings I have obtained on speakers tested in this way covers from less than 80 dB to as much as 98 dB. This means that one speaker required 100 times as much power as the other to produce the same sound volume in the room. Most acoustic suspension speakers fall in the 85-to-88-dB range, and small ported systems are typically in the 88-to-90-dB range. The JBL L110 tested for this month's reports produced a 92-dB SPL, indicating above-average efficiency. The Wharfedale E50 tested last month had a 95-dB efficiency rating, requiring only half as much drive power as the JBL for the same sound level.

When the first acoustic suspension speaker appeared in 1954, a typical hi-fi amplifier delivered 10 to 20 watts, and few could exceed 30 watts. Those speakers (such as the original Acoustic Research

AR-1) would probably receive an efficiency rating in the low 80's if tested to our current standards, and it is remarkable that they were so well received at that time in view of the low amplifier powers available. (We recall that there were problems with dealer demonstrations of the AR-1, which was one of the few speaker systems of the time that could cause a 50-watt amplifier to clip, even at moderate levels.)

Since power outputs much in excess of 50 watts were difficult to obtain with vacuum tubes without excessive penalties in size, weight and cost, the early audiophiles managed to get along with woefully insufficient power reserves (by current standards). The appearance of solid-state amplifiers, and eventually high-power transistors, has changed that situation drastically. Now, 50 watts per channel is considered moderate power even for a receiver; 100 watts per channel is not at all unusual, and many systems are capable of well over 200 watts per channel.

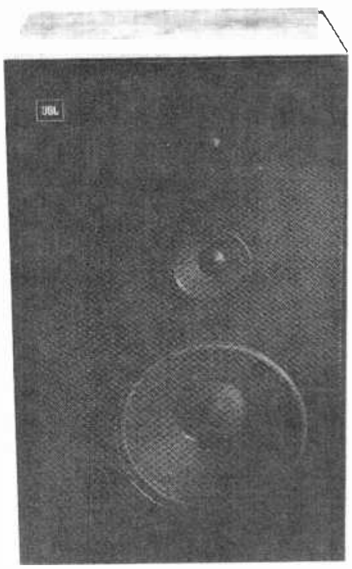
Simultaneously with this change in the amplifier power picture there has been an unmistakable trend toward higher speaker efficiency. One might think of this as a boon to the audiophile beset by inflationary trends. How nice it is not to have to invest in a $500 to $1000 amplifier when the audio section of the most modest receiver can now create a full-volume listening situation in the home, thanks to high-efficiency speakers. Alas, this is not the way things are. With few, if any, exceptions, the high-efficiency speakers are expensive as well as (often) large. The reasons are not difficult to appreciate—efficient drivers require large and powerful (and thus expensive) magnetic systems, and one of the other ways to achieve efficiency is to use a large cabinet volume, which requires more expensively veneered wood.

High speaker efficiency at low cost is usually obtained by restricting bandwidth (The "lo-fi" speakers in automobiles and in most compact home systems are examples.) This has the unfortunate effect of restricting the person with limited funds to a combination of a narrow-band speaker and a low-power (as well as probably "lo-fi") amplifier. His more affluent friends can, if they wish, team up a wide-band, high-efficiency speaker with a super-power amplifier, whose power capabilities they will almost certainly never approach.

The advantages of a wide-range, high-efficiency speaker were brought home to me forcefully in the testing of an auto radio. Its output of a couple of watts per channel would hardly produce listenable results with typical low-efficiency speakers, but when coupled to a pair of the highly efficient Wharfedale E50's (costing almost $400 each) this tiny radio delivered a full-volume sound, definitely of "hi-fi" caliber. It was an unlikely combination to be sure; but it did serve to illustrate the quality inherent in the radio, which would have gone unnoticed (or at least unappreciated) through a typical car-speaker installation.

JBL MODEL L110 BOOKSHELF SPEAKER SYSTEM

New three-way, high-efficiency system with uncolored sound.



The JBL Model L110 is, to all external appearances, a standard bookshelf speaker system. Indeed, the system's special performance qualities are the result of an evolutionary process, rather than any radical design changes. But the end result is certainly not conventional. Roughly speaking, the Model L110 fills the spot in the JBL line that has for so many years been covered by the Model L100 (which is still available but will probably be replaced by the Model L110).

The new speaker system can perhaps best be described as a very flat, smooth-sounding reproducer with above-average efficiency, and compact enough to fit on a bookshelf without precluding its ability to be placed on the floor. Though these qualities have often been ascribed to other speaker systems, they have rarely been realized with the success of the Model L110. The careful integration of three new drivers and a sophisticated crossover network enables the Model L110 to produce sound with remarkable fidelity.

The speaker system measures 23½"W × 14¼"H × 11¼"D (60 × 36.2 × 28.6 cm) and weighs 45 lb (20.5 cm). Its nationally advertised value is $348.

General Description. The three-way speaker system is rated at a nominal 8-ohm impedance. The low frequencies are handled by a newly designed 10" (25.4-cm) diameter woofer housed in a ported enclosure. The woofer's 3" (7.6-cm) diameter voice coil is formed of edge-wound copper ribbon.

The system crosses over at 1000 Hz to a 5" (12.7-cm) cone-type midrange driver that has a ⅞" (22.2-mm) voice coil. The midrange driver is housed in an acoustically isolated subchamber to prevent interactions with the woofer. Because it is much more efficient than the woofer, the midrange driver operates at a small fraction of its full capacity.

At 4000 Hz, a second crossover occurs to a 1" (2.54-cm) dome-type tweeter that has a 1" voice coil and is wound with aluminum to reduce mass. The

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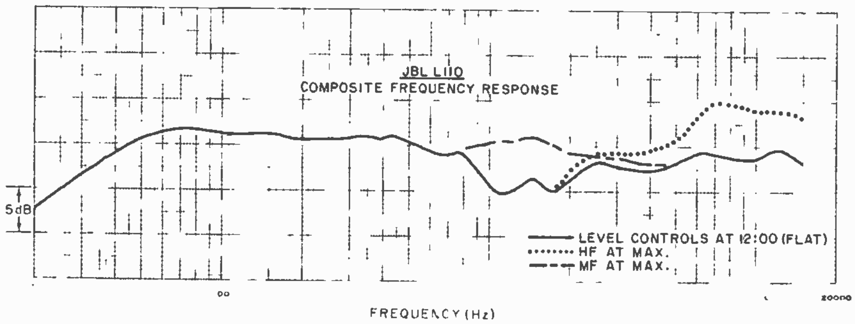


Frequency response curves for various settings of level controls.

dome is molded of two layers of phenolic-impregnated linen. A 1.5-lb (0.68-kg) magnet contributes to the tweeter's high efficiency and power-handling ability.

JBL's literature does not describe the crossover network used in the speaker system. However, it does make it clear that this critical part employs sophisticated impedance- and phase-correcting circuits to keep the drivers operating near their theoretical abilities throughout the crossover regions. The three drivers are vertically aligned to give the sound a more uniform horizontal dispersion pattern over the full frequency range of the speaker system.

The wooden cabinet in which the drivers and crossover network are housed is finished in oiled walnut. The front panel is flat black and is normally covered by an acoustically open snap-on grille. Continuous level controls for midrange and high-frequency drivers are located on the speaker panel near their corresponding drivers.

The insulated connectors on the enclosure's rear panel are unusually effective and easy to use. A quarter turn of the terminals in the counterclockwise direction allows the bare ends of the speaker cable to be inserted. Then a quarter turn in the clockwise direction locks the connections in place.

Laboratory Measurements. We made our initial frequency-response measurements with the midrange and high-frequency controls set to their 12 o'clock positions (the starting points recommended by JBL for setting up the system in a home listening environment). We spliced the smoothed semi-reverberant response curve to a combined woofer/port curve made from a separate microphone at close range. With this setup, the total composite response curve was extraordinarily flat, except for a broad dip of about 5 dB between 1000 and 2000 Hz. It exhibited none of the usual signs of midbass peaking or high-frequency irregularities. We noted, too, that the midrange level could be increased by 4 to 5 dB or cut by 5 to 10 dB in the range between 1000 and 2000 Hz by changing the 12 o'clock setting of the frequency control.

The output of the tweeter could be boosted by some 5 dB or rolled off completely, starting at about 10,000 Hz. According to the manual that accompanied the speaker system, laboratory flat response can be achieved by setting the controls to their 3 o'clock positions.

In our more usual listening room environment, we determined that a maximum midrange setting and a 12 o'clock tweeter setting yielded the flattest overall response, which was a most impressive ±2 dB from 36 to 15,000 Hz!

We verified the claimed high efficiency of the system, in spite of our very different test conditions. JBL states that the system will develop an 89-dB SPL at a distance of 1 meter when driven by 1 watt of power under anechoic conditions. In a listening room, the SPL can be expected to be from 1 to 3 dB greater. Our tests revealed a 92-dB SPL at 1 meter with 1 watt of random noise in the octave centered at 1000 Hz.

The impedance of the speaker system was about 7 to 8 ohms over most of the audio range. It was 12 ohms at 4000 Hz, 40 ohms at the 55-Hz bass resonance, and 20 ohms at 20 Hz.

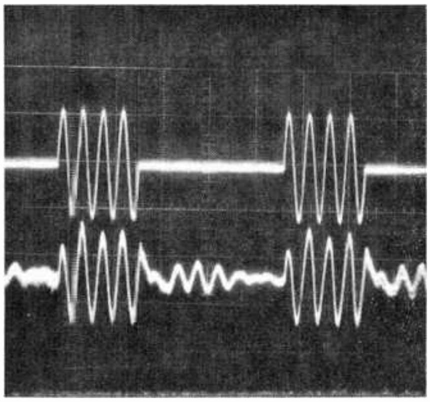
The low-frequency distortion at a 1-watt drive level was less than 1% down to 60 Hz. It rose gradually to 5% at 42 Hz and to 8% at 30 Hz. When we adjusted the driving power to maintain a constant sound pressure level, equivalent to 90 dB at 1 meter, the distortion was about the same as at 1 watt down to 60 Hz. It rose slightly faster at lower frequencies, where the drive level had to be increased to maintain a constant output level. Even so, the distortion did not exceed 10% until the frequency went below 33 Hz.

The tone-burst response of the system was good at all frequencies. It revealed no signs of sustained ringing or other evidence of unwanted resonances, confirming the essential flat-

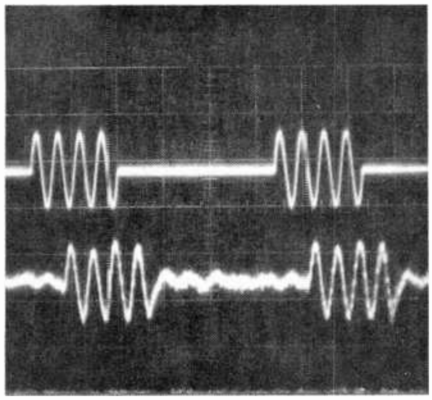
PERFORMANCE SPECIFICATIONS

Specification	Rating
Power capacity	75 W (continuous program) (amplifier ratings from 10 to 150 watts)
Nominal impedance	8 ohms
Dispersion	150 degrees at 15,000 Hz 90 degrees at 20,000 Hz
Crossover frequencies	1000 Hz; 4000 Hz
System sensitivity	89 dB (1 W, 1 meter)
Finish	Oiled walnut
Grille	Semi-transparent black fabric

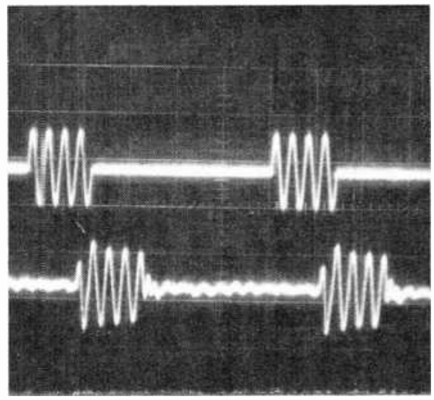
Note: Except for the impedance and sensitivity ratings, none of the above were measured. JBL does not publish response data, since there is no standardization; and the speaker's controls allow for much variation.



Tone burst responses at: 100 Hz . . .



1000 Hz . . .



5000 Hz.

ness indicated by our frequency-response measurements in the lab.

User Comment. When we subjected the speaker system to a simulated live-versus-recorded listening test, we encountered the usual problem of establishing a "flat" response with a system that contains user-adjustable controls. With the suggested 12 o'clock control settings, the sound was not grossly different from the sound of our reference speaker system. But there were still some minor differences that prevented perfect reproduction. The nominally flat settings at approximately 3 o'clock came closer to yielding a flat response at our listening position.

As the correct control settings were approached, the sound of the speaker system became almost undetectable and eventually disappeared for all practical purposes. We were left with the sound of the music itself, rather than the sound of the speaker system. This reassuring subjective effect pleasantly confirmed the verdict of our tests.

PHILIPS MODEL AH673 AM/STEREO FM TUNER

Touch-operated controls are activated by finger resistance.

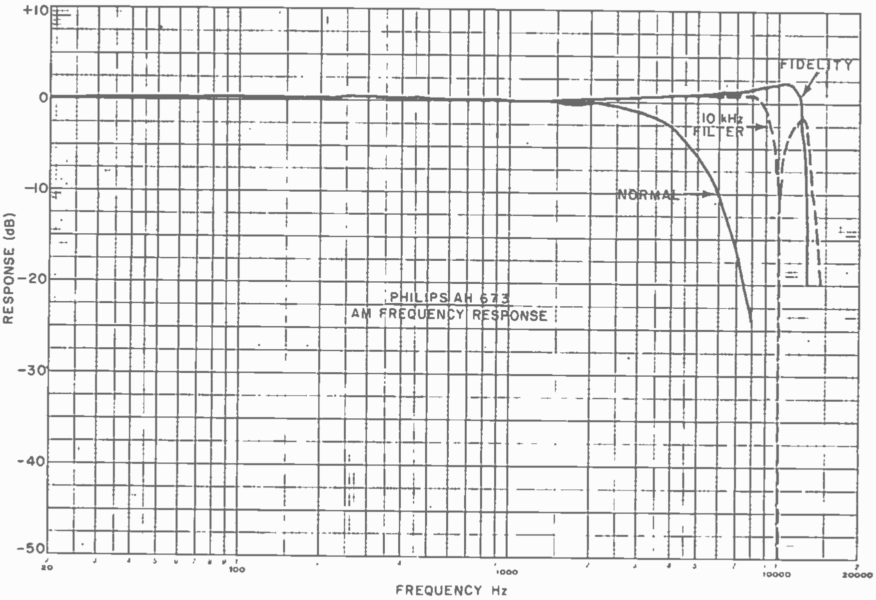
HIRSCH-HOUCK LABS REPORT

In spite of its relatively conventional external appearance, Philips Model AH673 is a very unconventional AM/stereo FM tuner. Its most distinctive external feature is a set of momentary-contact, touch-operated controls for those functions usually handled by pushbutton or toggle switches. There are five touch-operated switches in all, including the POWER switch.

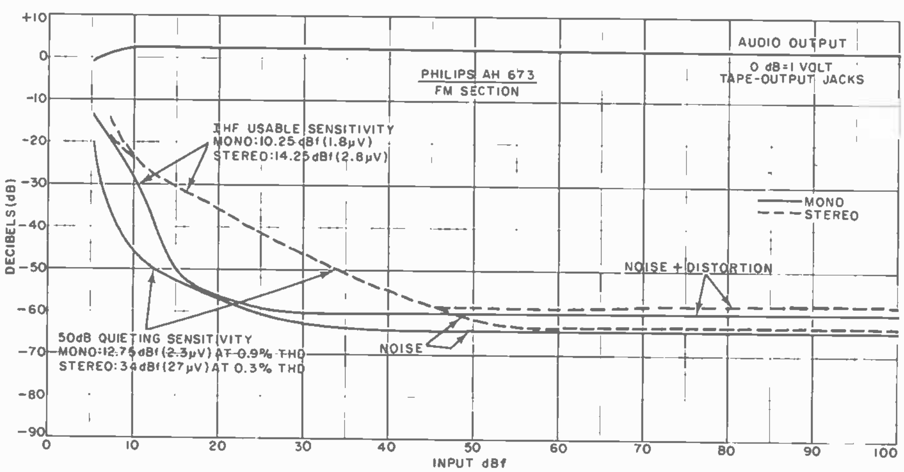
The tuner measures 18" W × 13½" D × 5½" H (45 × 33 × 14 cm) and weighs 25 lb (11.5 kg). Its nationally advertised value is $499.95.

General Description. Since the touch-operated controls are activated by the resistance of a finger shunting two closely spaced contact bars, the power must be on for any of them to operate. Hence, a separate 12-volt power supply that is always on to permit energizing the POWER touch switch circuit is built into the tuner. A touch on the POWER contacts turns on the main power supply to all circuits, rendering all the other controls operative.

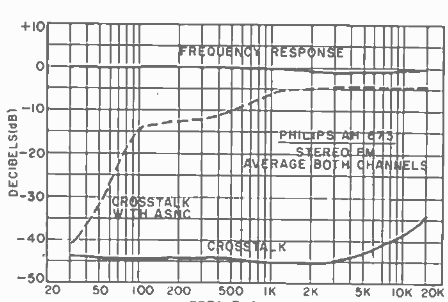
The MULTIPATH switch can be used to convert the FM center-channel tuning meter to a multipath-distortion indicator. A rather elaborate circuit that contains 10 transistors and a large number of passive components is used here to process the output of the discriminator and the output of a separate AM detector located ahead of the limiter. The resulting dc signal causes the pointer of the meter to deflect up-scale during modulation if multipath distortion is present. As with the other touch-contact switches, the MULTIPATH switch returns to its normal FM tuning state when it is touched a second time. A red LED glows above each switch as it is activated.



AM frequency response shows effect of filter at 10 kHz.



Noise and sensitivity curves for FM section of receiver.



Frequency response and crosstalk averaged for both FM sections, with dashed line showing effect of Automatic Stereo Noise Canceling. Active signal level is less than 32 dBf.

The MUTE switch operates in conjunction with a muting threshold knob control. On mute, a relay interrupts the audio path between the multiplex circuit and the audio section. Another touch switch, labelled ASNC (for Automatic Stereo Noise Cancelling), automatically blends the stereo channels at high frequencies to reduce audible noise when it becomes excessive in the received signal (such as when the signal strength drops below a certain level). However, the actual operation of the ASNC is determined by the noise in the multiplex circuits rather than by the agc or another signal-strength related function. Blending is accomplished positively, rather than gradually, through a FET switch that is gated by a Schmitt-trigger circuit.

The remaining touch control inserts the 10-kHz whistle filter for AM reception. The AM section of the tuner is in many ways the Model AH673's most extraordinary feature. It has been designed for full fidelity, with an audio bandwidth comparable to that achieved in FM reception, making a good 10-kHz trap filter vitally important. Since a more restricted bandwidth will be necessary much of the time, the AM tuner has two i-f filters to provide NORMAL and FIDELITY response characteristics. They are selected by the same front-panel knob that also gives a choice of MONO, AUTO mono/stereo, and STEREO only reception in FM. Illuminated legends below the dial scales identify the mode in use.

An interesting and unique by-product of the wide-band AM tuner design is the provision of center-channel meter tuning for AM as well as FM. It is very difficult to tune the AM section accurately by ear (or even with the signal-strength meter) with such a wide i-f bandwidth, and the center-channel meter is a genuine convenience. It requires a separate i-f section and a ratio detector in the AM tuner just for this function, but this sort of lavishness is apparent throughout the design of the tuner. It is obvious that certain performance goals were set and then met by whatever means were necessary.

Separate AM and FM volume controls are on the front panel. Both fixed and variable level outputs are on the rear apron, as are vertical and horizontal oscilloscope outputs for an external multipath display. The tilting and pivoting AM ferrite antenna is much larger than those used on most AM tuners and can be oriented in nearly any attitude. To meet safety requirements, a master

PERFORMANCE SPECIFICATIONS

Specification	Rated	Measured
FM usable sensitivity		
Mono	1.6 μV (9.75 dBf)	1.8 μV (10.25 dBf)
Stereo	3.0 μV (14.75 dBf)	2.8 μV (14.25 dBf)
THD		
Mono	0.09%	0.10%
Stereo	0.10%	0.11%
Capture ratio	1.0 dB	1.36 dB
I-f rejection	110 dB	N/A
Image rejection	110 dB	Less than 106 dB
Selectivity	83 dB	88.5 dB (Alt. Ch.) 8.8 dB (Adj. Ch.)
Pilot-carrier suppression	65 dB	85 dB
Frequency response	20-15,000 Hz +0.5/−1 dB	30-15,000 Hz +0/−1 dB
Stereo separation		
100 Hz	45 dB	43.5 dB
1 kHz	45 dB	44.5 dB
10 kHz	38 dB	38 dB
Hum & noise (65 dBf, 100% mod.)	70 dB (mono)	64 dB (mono) 63.5 dB (stereo)
Muting threshold	2-20 μV	2-33 μV
AM frequency response ($\pm$2 dB)		
Normal	20-3000 Hz	20-4300 Hz
Fidelity	20-10,000 Hz	20-12,000 Hz

power switch located on the rear of the tuner cuts off all power, including the 12-volt touch-switch power supply.

Laboratory Measurements. As the test data reveals, the Model AH673 met or surpassed virtually every one of its performance ratings, often by a wide margin. The only respect in which the FM performance fell short of meeting "super-tuner" standards was in its S/N, which was slightly degraded by a residual hum level. Even if hum were disregarded, the noise component of the tuner's output would have been about −67 dB, certainly a very adequate figure but one which is surpassed by some other top-ranking tuners we have tested.

In its selectivity and ability to reject interference of all kinds, the tuner was a super performer. Its distortion was comparable to the residual levels in our signal generator, and the channel separation was nearly uniform at 43 to 44 dB over most of the audible range, and still a very good 38 dB, as rated, at 10,000 Hz. The most important tuner sensitivity rating is its 50-dB quieting sensitivity; here the tuner excelled. The ASNC blending occurred when the signal dropped below about 24 μV (33 dBf). It reduced the channel separation to only a few decibels above 1000 Hz but left enough stereo effect to distinguish the program from pure mono. In the noise reduction it afforded, it proved to be an ideal intermediate state between full stereo and full mono, and it operated without any other side effects.

User Comment. The real forte of the Model AH673 is its AM tuner, which is the most "hi-fi" AM tuner we have ever heard. Its response was flat to 12,000 or 13,000 Hz, which is, for all practical purposes, the equal of FM audio bandwidth. The 10-kHz bridged-T filter was incredibly sharp. It produced more than 50 dB of attenuation at 10,000 Hz, while attenuating the response at 9000 and 11,000 Hz by only 1.5 and 3 dB, respectively.

The real problem in AM reception is noise—the various buzzing sounds that are generated by a multitude of electrical appliances. No matter how good the frequency response, if it is marred by these noises it is not high fidelity. By careful placement of the tuner, we were able to get quiet backgrounds on a few stations. When walking into a room while playing one of those AM stations, there was no clue as to whether one was hearing AM or FM. You could hardly ask for better than that!

The dial calibration was accurate to within 100 kHz on FM, tuning was smooth and noncritical, and the muting was positive and noise-free. In fact, the tuning was a bit *too* positive. We would have preferred a little softer unmuting action, since there was a definite "click" introduced when the relay closed.

Connecting an oscilloscope to the multipath outputs in the rear of the tuner confirmed the validity of the tuner's multipath meter indications. However, the meter was not very sensitive, which made it necessary to watch it very closely to detect the movement of the pointer. It never indicated more than about 20% of full-scale, even on a fairly distorted signal (as shown on the scope). On the other hand, when the meter did not indicate anything, the signal was indeed free of multipath distortion.

In summary, the Philips Model AH673 is an exceptional tuner. Although it is not inexpensive, much of its cost is represented by the superb AM section and the advanced control features. It explodes any notions that AM is a narrow-band, "lo-fi" medium (except for the noise problem, which is largely a matter of the individual installation). It should satisfy the most critical FM reception requirements, too.

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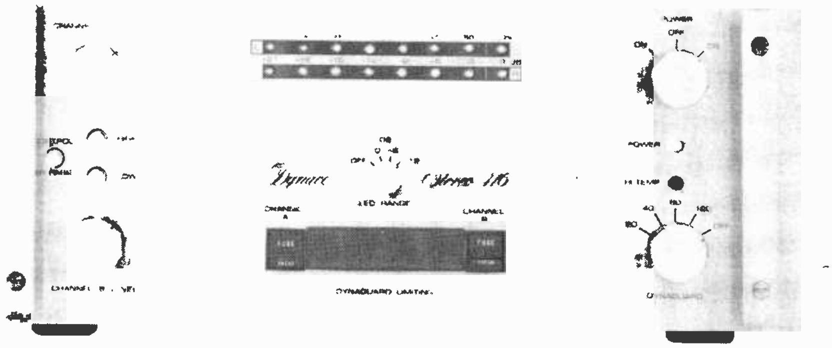
DYNACO STEREO 416 POWER AMPLIFIER

High-power amplifier has highly effective protective system.



HIRSCH-HOUCK LABS REPORT

Dynaco's "Stereo 416" basic power amplifier is rated, according to FTC standards, to deliver 300, 200, or 100 watts/channel into 4, 8, or 16 ohms. The specified ratings are for a frequency range of 20 to 20,000 Hz at less than 0.25% THD. The amplifier features Dynaco's proprietary "Dynaguard" protective circuit. Instantaneous output power for each channel is indicated by fast-responding LED's on the front panel.

The direct-coupled amplifier has extensive built-in protective systems in addition to Dynaguard. These include an ac line circuit breaker, electronic volt-ampere limiting for the output transistors, separate high-temperature cutouts for each channel, two-speed cooling fan, delayed turn-on, relay cutoff when dc appears in the output signal, and speaker fuses.

The rack-mounted amplifier measures 19"W × 14"D × 7"H (48.3 × 35.6 × 17.8 cm) and weighs 53 lb (24.1 kg).

Available as an option to improve the amplifier's low-frequency transient capability is the Model C-100 Energy Storage System, which adds 100,000 μF of capacitance to the amplifier's power supply. This accessory has the same width and depth as the amplifier but is only 3½" (8.9 cm) high. The Stereo 416 is available in both kit form ($649) and factory wired and tested ($949).

General Description. The Stereo 416 has a surprisingly full complement of controls and indicators for a basic power amplifier. Two rows of LED's that indicate the output power separately for each channel are calibrated in 3-dB steps from full power at 0 dB to −21 dB as well as percentages of rated power. A control is provided for increasing the sensitivity of the LED display by 6 or 12 dB and for completely switching off the display. In the most sensitive condition, the display can indicate power output levels as low as 100 mW.

Behind a plastic window on the front panel are two Dynaguard lights that come on when the selected power threshold in their respective channels has been exceeded. Also on the front panel are holders for the fuses that protect the speakers.

Separate level-adjust controls are provided for the right and left channels. Three pushbutton switches give a means for switching in and out HIGH and LOW cut filters and for completely bypassing all controls, including the Dynaguard system and level controls. With the bypass button pushed in, the only capacitance in the signal path is a single input blocking capacitor per channel.

The POWER switch is a three-position rotary affair. Its two ON positions to the left and right of the center-OFF position eliminate the need to turn the line cord plug to correct hum loops. A red POWER indicator glows when the amplifier is turned on, and a HI TEMP indicator comes on when the heatsink temperature exceeds 85° C, at which time the amplifier automatically shuts off. The Dynaguard control has settings for 20, 40, 80, and 120 watts as well as for shutting off the protective system.

The very large heatsink fins for the output transistors are cooled by a fan. Under normal conditions, the fan operates at a low speed and makes little noise. However, should the temperature of the heatsink rise beyond 55° C, the speed of the fan automatically increases to provide additional cooling.

The heavy-duty binding posts for the speaker outputs and the phono-type input jacks are located on the rear apron, just below the heatsink assembly. On the right side of the amplifier is the socket for connection of the Model C-100 En-

Product Focus

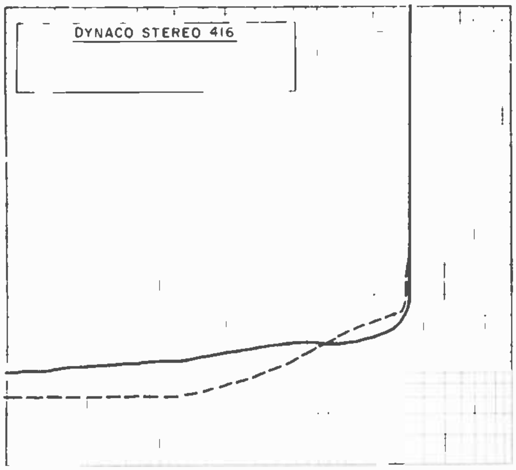
Excellent though the Dynaco Stereo 416 is as a high-fidelity power amplifier, power is not its most notable feature. The two truly unique features are the Dynaguard protective system and the optional Model C-100 Energy Storage System.

Together with its undeniable sonic benefits, a high-power amplifier presents special hazards to the user. A single careless mistake, such as a poor signal or ground connection or over-enthusiastic use of the volume control can easily destroy a pair of expensive speaker systems. Any protective device that reduces the maximum power capability of an amplifier to a "safe" value is likely either to negate the advantages of high power or introduce audible distortion.

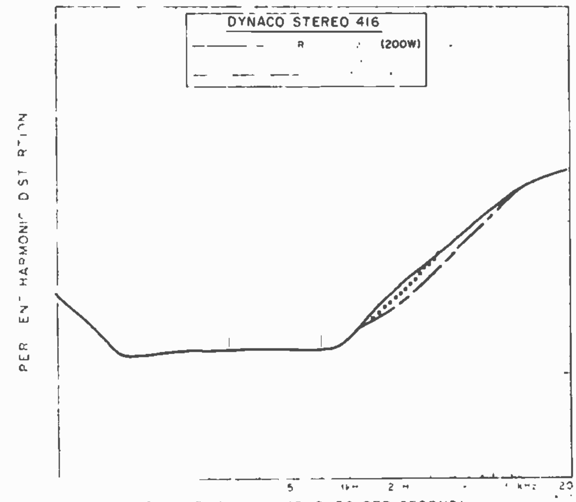
Dynaco's Dynaguard system, is a highly effective solution to this problem. Under normal conditions, it has absolutely no effect on the performance of the amplifier. When it is triggered by an excessive signal level, it rapidly attenuates the signal ahead of the input to the amplifier to limit the output to the preset value. The control action is not a sudden clipping, with its harsh distortion, but a soft clamping action that produces a rounded square wave from an excessive sine-wave input.

Obviously, this action produces distortion (though less objectionable than that resulting from hard clipping). It is easily tolerated in a hi-fi system, however, because it affects only the portion of the program waveform that exceeds the preset level. Lower-level signal components are unaffected by the Dynaguard system so that most of the program dynamics are unmodified. Only the potentially dangerous peak signal level is reduced.

The Dynaguard circuit can be set to go into action at outputs equivalent to 20, 40, 80, or 120 watts into 8 ohms, or it can be shut off entirely. The amplifier output (each channel is monitored and controlled separately) is integrated and rectified, and the resulting dc control voltage operates the gain-reducing circuit. This is a resistive attenuator, controlled by diodes. A momentary peak, even up to the full power of the amplifier, will not trigger the Dynaguard circuit, even at its most sensitive setting. Depending on the duration of the overload, the operating response time of the circuit may be as brief as a fraction of a second or as long as several seconds, since it integrates the overload and acts only when the average power exceeds the selected threshold. An indicator flashes when the circuit is triggered and remains on for as long as the peaks are attenuated.



Total harmonic distortion and 60/7000-Hz distortion.



Harmonic distortion at three power levels.

ergy Storage System accessory.

The Model C-100 has no controls. It does, however, have two indicators labelled CHARGE and ON. The first comes on when the amplifier is first switched on. Then, about a minute later, when the capacitors are charged, a relay in the accessory energizes and the ON indicator lights. The Model C-100 can be placed directly atop the Stereo 416 power amplifier without causing interference with the latter's cooling; if anything, the cooling seems to be improved due to the tunnel effect created.

Laboratory Measurements. The cooling effectiveness of the Stereo 416 heat transfer system is quite remarkable for an amplifier of its power capabilities. After the full hour of preconditioning at one-third rated power and five minutes at full power, the heatsinks were the coolest part of the amplifier. They were actually cool to the touch! The perforated metal cover over the amplifier boards and the power supply was the warmest part of the exterior surface (and only mildly warm at that). Even the front panel was warmer than the heatsinks. The cooling fan never switched to high-speed operation, during either the preconditioning or the subsequent testing.

With both channels driving 8-ohm loads, the 1000-Hz clipping output was 253 watts/channel. The 4- and 16-ohm outputs were 386 and 150 watts, respectively. The 1000-Hz THD was 0.002% (the residual of our test equipment) at 0.1 watt, from 0.007% to 0.01% between 1 watt and 100 watts. It was 0.016% at 240 watts, just before clipping occurred. The IM distortion was 0.012% at 0.1 watt, 0.005% in the range of a few watts, 0.015% at the rated 200 watts, and still only 0.20% at 240 watts. The distortion at power outputs between 20 and 200 watts was about 0.01% from 50 to 1000 Hz. It rose to 0.023% at 20 Hz and 0.013% at 20,000 Hz.

For a reference output of 10 watts, an input of 0.35 volt was needed. The unweighted wide-band noise in the output was a very low 85 dB below 10 watts, or 98 dB below rated power. The frequency response was flat within ±0.1 dB from 20 to 20,000 Hz and was down only 0.4 dB at the lower measurement limit of 5 Hz. The −3-dB frequency was 210 kHz. With the HIGH and LOW filters in use, the −3-dB response frequencies were 41 and 16,500 Hz. (They are nominally 50 and 15,000 Hz.) The filters had 6 dB/octave slopes.

PERFORMANCE SPECIFICATIONS

Specification	Rated	Measured
Output power (20-20,000 Hz, 0.25% THD)	200 W (8 ohms) 300 W (4 ohms) 100 W (16 ohms)	200 W (8 ohms) Less than 0.13% THD
Clipping power	235 W (8 ohms) 350 W (4 ohms) 135 W (16 ohms)	253 W (8 ohms) 386 W (4 ohms) 150 W (16 ohms)
IM Distortion	Less than 0.1% up to 200 W/8 ohms	Less than 0.03%
Frequency response	8-50,000 Hz +0/−1 dB	5-50,000 Hz −0.8 dB
Hum & noise	−95 dB (200 W)	−98 dB (200 W)
Input sensitivity	1.6 V (200 W)	1.6 V (200 W)
Slewing rate	8 V/μs	15 V/μs
Damping factor	Less than 80 (1000 Hz) Less than 30 (10 kHz)	N/A
Channel separation	Over 60 dB (IHF)	N/A

The rated slew rate of the Stereo 416 is a rather low 8V/μs and even our measurement of 15 V/μs will probably seem too low for those people who are concerned about slew-rate-induced distortions and transient intermodulation effects. Regardless of the significance of these distortions, about which there is considerable disagreement, Dynaco has made it possible to eliminate them at the source by means of the HIGH cut filter ahead of the amplifier section. The amplifier's risetime of 1μs was consistent with its measured frequency response.

When set at 20 watts, the Dynaguard circuit operated with a steady-state output of 12.5 watts, although it took several seconds for it to respond at that level. The LED power calibrations were generally within 1 dB of the actual power output that caused each indicator to glow. Its range switch accuracy was also within 1 dB. Using actual program material, we confirmed that it was not unusual for the 0-dB (200-watt) indicator to flash on program peaks when the average program level did not even operate the 20-watt level of the Dynaguard. As Dynaco suggests, the 20-watt setting offers maximum protection without compromising output or dynamic range.

The effect of adding the Model C-100 to the Stereo 416 was measurable in its low-frequency performance, essentially as claimed by Dynaco. At 1000 Hz, it made no difference. When the amplifier was driven with a tone burst of one cycle on and four cycles off, the output clipped at 312 watts with or without the Model C-100. However, a 20-Hz tone burst with the same duty cycle clipped at 231 watts without the Model C-100 and 276 watts with it. These measurements were made with 8-ohm loads. Dynaco points out that the advantages of the added capacitance are greater with lower load impedances, especially the 2 ohms for which the amplifier is rated. It should deliver about 450 watts to 2 ohms at the clipping point.

User Comment. As an amplifier, the Stereo 416 "sounded" no different from any other amplifier with equivalent power and distortion ratings. This is as it should be, since the sound quality is ultimately determined by factors outside the amplifier once a certain level of performance has been reached. The Stereo 416 goes beyond that level by one or more orders of magnitude.

It is in its protective features that the amplifier excels, and we use that term advisedly. Although it may seem akin to wearing suspenders *and* a belt, the multiple protective systems in this amplifier pay off in security and potential long life for all parts of the music system. Anyone who has "blown up" speakers or amplifiers will appreciate the importance of this quality. We deliberately drove the amplifier to levels that turned on the 20-watt Dynaguard indicator, and the peak levels frequently exceeded 200 watts. None of our speaker systems, few of which were rated for use with 200-watt amplifiers, was damaged. But we could rarely hear any effects from the operation of the Dynaguard system. An occasional flash of the indicator does not result in audible distortion, although on bench tests we confirmed the effect it has on the waveform (as shown in the Dynaco instruction manual). Only when the Dynaguard system is driven into full-time operation, a gross overload condition to say the least, does its sound become objectionable. If you prefer to listen at such levels, the cure is simple—set the Dynaguard system to a higher power threshold or shut it off entirely. If you do this, be sure that your speaker systems can take everything the amplifier can deliver.

We also noted that the fan could be heard only at close range (within a couple of feet) in a quiet room. In normal playing, it could not be heard at all.

We could detect no change in sound quality when using the Energy Storage System. It is difficult to imagine a home listening condition that could demand such huge reserves of very low frequency transient power that an improvement of about 1 dB would be audible and worthwhile. (It isn't even that easy to *measure*, being a transient phenomenon.) Perhaps, if the amplifier is used with a 2-ohm load, this would be a useful addition (and more than one Model C-100 can be "stacked" if desired).

The amplifier we tested was a factory-wired unit. Judging from the assembly manual and the $300 price differential between the kit and wired versions, building the stereo 416 is no job for a beginner. Either way, though, this is one of the better high-power amplifiers we have seen—"better" meaning in its ruggedness, safety, and potential reliability, as well as its performance. It does not have to be "babied," and we doubt that it could be damaged in normal home service. It would be less likely to damage one's speaker systems than almost any high-power amplifier known to us. In all, this is a very fine product.

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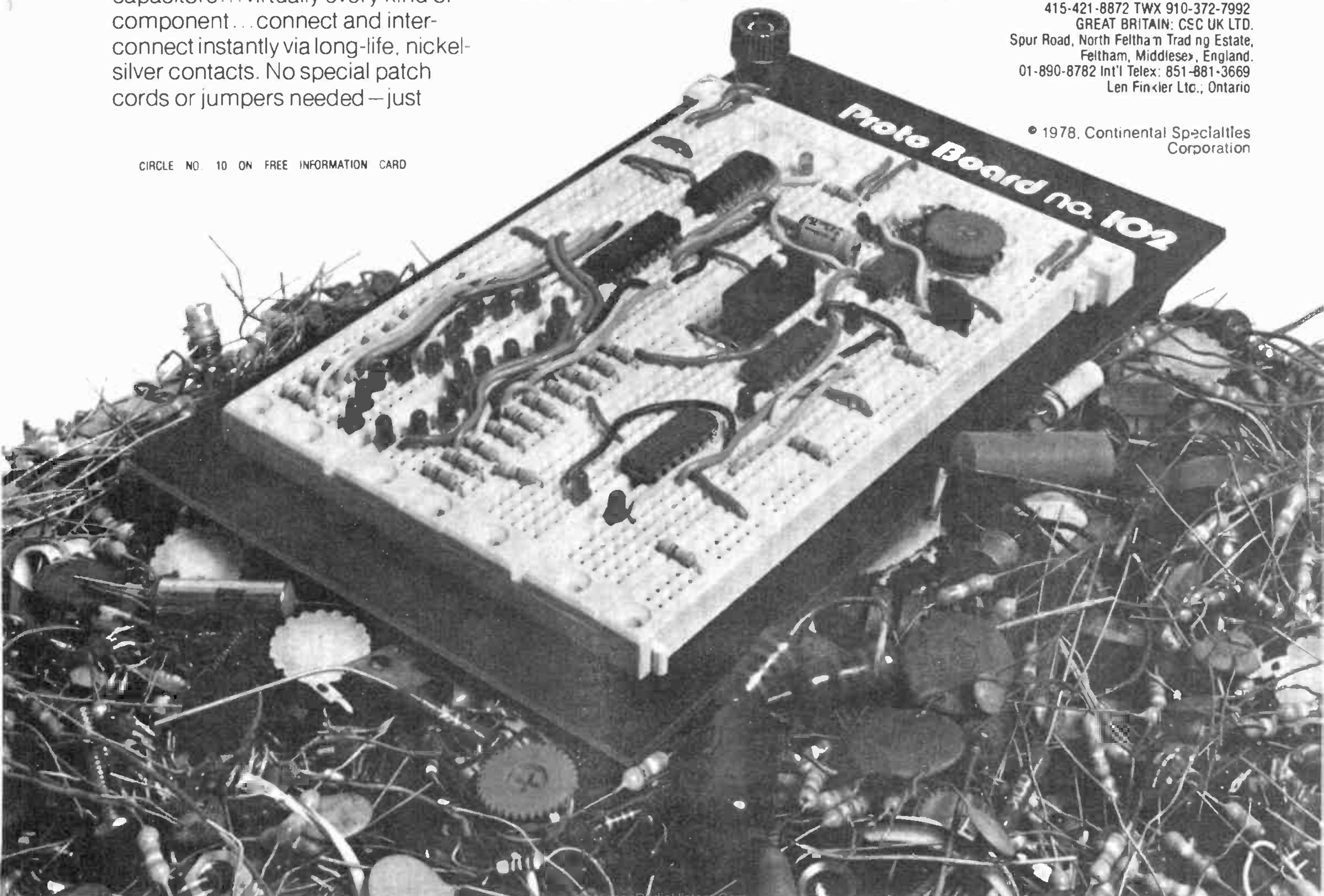

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Dipped Tantalum
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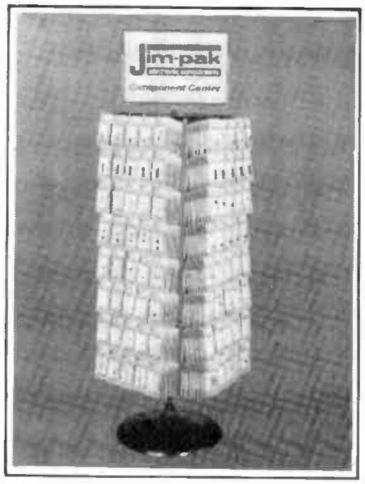

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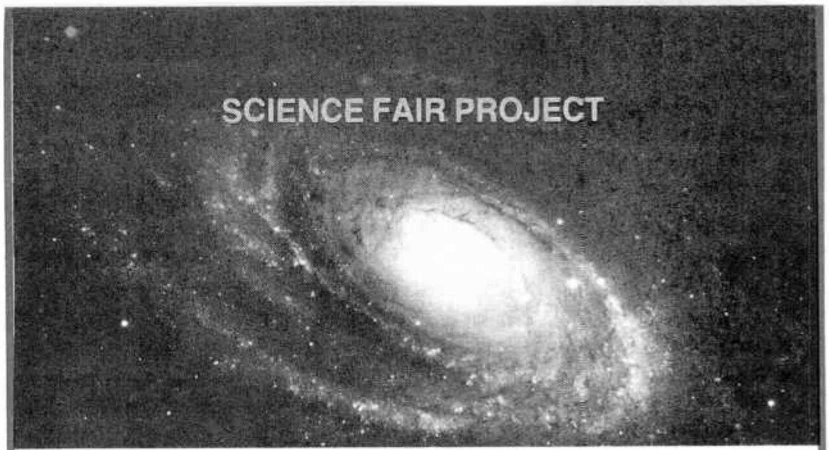


Popular Electronics
MAY 1978

BY L. GEORGE LAWRENCE

Magnetometers FOR INVESTIGATING UFO's AND OTHER MAGNETIC PHENOMENA

A variety of home-built detectors to indicate magnetic disturbances such as those reported to accompany UFO sightings

OVER the past 30 years, thousands of UFO sightings have been reported to and investigated by government and scientific researchers. Most have been readily attributed to such things as aircraft, the planets, meteors, and luminescent swamp gas. A small but significant number of incidents remain unexplained. The possible extraterrestrial nature of UFO's therefore is still an open question.

Common to many reported UFO incidents are magnetic disturbances which affect compasses, auto speedometers, electric power meters, etc. Presented in this article are various types of sensing circuits which will detect such magnetic anomalies. The circuits are inexpensive to build and use readily available parts and materials. Their use, however, is not limited to amateur UFO investigations. These magnetometers will be of interest to anyone who wants to explore magnetic phenomena, and—students take note—make fine Science Fair projects.

All the magnetic-detection systems presented here employ audio and/or visual intrusion alarms.

Home Magnetometers. Although professionals monitor magnetic fields with such sophisticated devices as proton free-precession magnetometers, good results can be obtained using the inexpensive home-built magnetometers described here. These devices have low power consumption and can be battery-powered for lengthy periods. Although they have less sensitivity than the proton magnetometer, which measures the precession (wobble) of protons in the presence of a magnetic field, the inertia-less CRT and electro-induction magnetometers are faster by a factor of about 1,000.

Sky Magnetometer. Shown in Fig. 1 is a field-induction magnetometer designed to have its sensor mounted on the exterior of a building. Two separate detection principles are employed.

The high-speed sensor, shown schematically in Fig. 1A and photographically in Fig. 2, is of the electromagnetic induction type. The actual sensor is comprised of a 2' (61-cm) long mu-metal (a soft iron alloy) bar that serves as a flux concentrator for the coils. The larger of the two coils *(LI)* is a 10,000-ohm coil slipped over the bar and positioned at its center. Inductor *L2* consists of 30 turns of No. 24 enamelled wire wound over the main coil. Coil *L2* is used to induce a voltage across *L1* for testing.

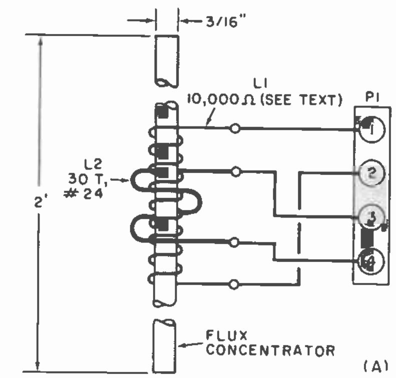
Signals induced across *L1* are amplified by emitter follower *Q1* (Fig. 1B). (Transistor *Q1* is a Darlington pair with a beta of at least 12,000.)

When IMPULSE TEST switch *S1* is depressed, capacitor *C1* discharges through potentiometer *R3* and coil *L2*, inducing a current pulse in main sensing coil *L1*. Potentiometer *R2* is used to adjust the sensitivity threshold. The amplified current pulse is indicated on meter *M1* and can be passed to a paper chart recorder via resistor *R9*.

The current pulse at the emitter of *Q1* is also passed via TRIGGER LEVEL control *R7* to the gate of *SCR1*. When *SCR1* fires, it activates alarm *A1*. Because the power source is dc, *A1* will remain on even after the triggering signal has passed. Normally closed RESET pushbutton switch *S2* must be momentarily depressed to silence the alarm.

Operating power is obtained from a conventional line-operated, regulated 9-volt dc supply. If line power should fail, relay *K1* automatically switches to *B2*, a back-up battery supply.

TRIGGER ADJUST control *R7* should be set to prevent the alarm from being triggered during lightning storms. Meter *M1* is not critical, but it should be able to indicate the triggering threshold for the SCR, which is about 0.8 mA. A superimposed current of about 50 μA, the output of *L1* amplified by *Q1*, will trigger the

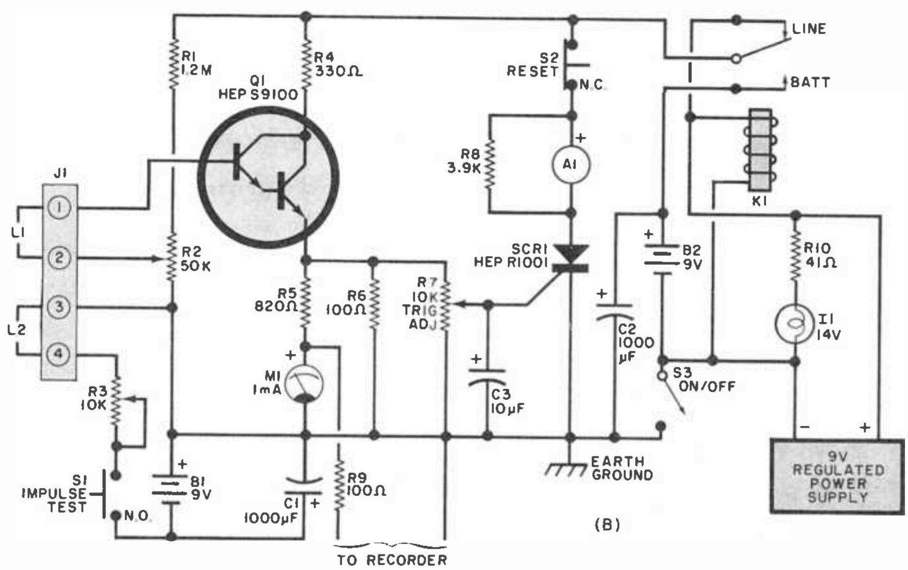


PARTS LIST FOR FIG. 1

A1—Electronic alarm (Mallory Sonalert® No. S-628 or similar)
B1, B2—9-volt transistor battery
C1, C2—1000-µF, 15-volt electrolytic

Fig. 1. Circuit of the inductive sensor for the sky magnetometer is at left. (See also Fig. 2.) The electronics portion of the magnetometer (below) can be mounted separately.

C3—10-µF, 15-volt electrolytic
I1—No. 1815 lamp (14 volts, .2 amperes, T-3¼ configuration)
J1—Four-contact male connector (Amphenol No. 91-859 or similar)
K1—12-volt, 250-ohm spdt relay
L1—10,000-ohm, ¼" inner-diameter reed relay coil
L2—See text
M1—1-mA meter (Calectro No. D1-912 or similar)
P1—Four-contact female connector to mate with J1 (Amphenol No. 91-458 or similar)
Q1—HEP S9100 Darlington transistor (Motorola)
The following are ½-watt, 10% tolerance resistors:
R1—1.2 megohms
R4—330 ohms
R5—820 ohms
R6, R9—100 ohms
R8—3900 ohms
R10—41-ohm, 4-watt resistor
R2—50,000-ohm linear-taper potentiometer
R3—10,000-ohm linear-taper potentiometer
R7—10,000-ohm linear-taper, screwdriver-adjustable potentiometer
S1—Spst normally open pushbutton switch
S2—Spst normally closed pushbutton switch
S3—Spst switch (part of R2)
SCR1—HEP R1001 silicon controlled rectifer (or any 200-µA gate-current SCR)
Misc.—2' (61-cm) × 3/16" (4.8-mm) mu-metal or soft iron rod; miniature test magnet; PVC plastic tube with plastic terminal containers; aluminum or brass hardware; suitable enclosure; wall feedthrough; cement for mounting L1; 9-volt dc line-powered supply; etc.



magnetometer. Near-trigger conditions can be observed on the meter, providing a built-in test facility in addition to *L2*.

The instrument's construction and packaging, including the external sensor shown in Fig. 2, are not critical. The flux concentrator and coils can be protected from the elements by a length of magnetically neutral PVC plastic pipe, supported by aluminum brackets. The upper part of the sensor is enclosed in a glass or plastic container which can house another (optional) sensing coil made from an automotive ignition coil with its metal shield removed to provide full magnetic exposure.

The lower end of the pipe contains the electrical connections to the coils and is also protected by a glass or plastic enclosure. Connections between the coils and electronics console are made via shielded cables that pass through the support structure. Ground the cable shields to a true earth ground to avoid the danger of lightning strikes.

Compass Magnetometer. The second sensing system comprises a compass-needle assembly and a geared compass of the automotive or marine type and is used for detecting slow magnetic field variations.

The compass-needle assembly is shown in Fig. 3A. The primary sensor is a 6" (15.2-cm) magnetic needle mounted on a low-friction agate bearing. Two equally balanced opaque paper extensions are attached to the needle.

Once the magnetic needle settles down to a stable state, optical coupler *OC1* must be positioned so that one of the opaque paper extensions fits into the narrow gap of the module. This module consists of a LED and a Darlington phototransistor, the two separated by a narrow gap into which the opaque paper extension is fitted. When the paper is in the gap, the light path is interrupted. This approach affords contactless and friction-free sensing of the needle's motion, and can also be used with meter pointers, cursor devices, eddy-current disks and mechanical indicators.

As shown in Fig. 3B, potentiometer *R1* and current-limiting resistor *R2*, determine the light output of the LED in the pickup assembly. Only a minimal amount of LED output is required.

With the LED illuminating the phototransistor, the potential between *Q1* pins 3 and 4 is typically about one volt. Comparator *IC1* is wired so that its output is high when the light path inside *OC1* is blocked, and goes low when the motion of the magnetic needle moves to allow an uninterrupted light path. Since *IC1* is powered by a 5-volt supply, its output is TTL compatible. If desired, the output from *IC1* can be used to power a relay *(K1)*. Because the voltage comparator used is limited to a 20-mA output, the coil resistance of the relay must be at least 250 ohms.

If desired, the compass needle can be mounted vertically so that it dips up and down in the presence of a magnetic anomaly or disturbance.

CRT Detector. The inertialess cathode-ray tube instrument shown in Fig. 4 is an extremely sensitive, high-speed magnetometer. Professional CRT magnetometers can measure extremely weak magnetic fields. The sensitivity of

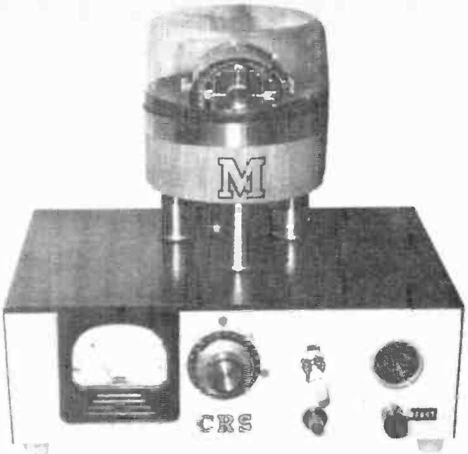
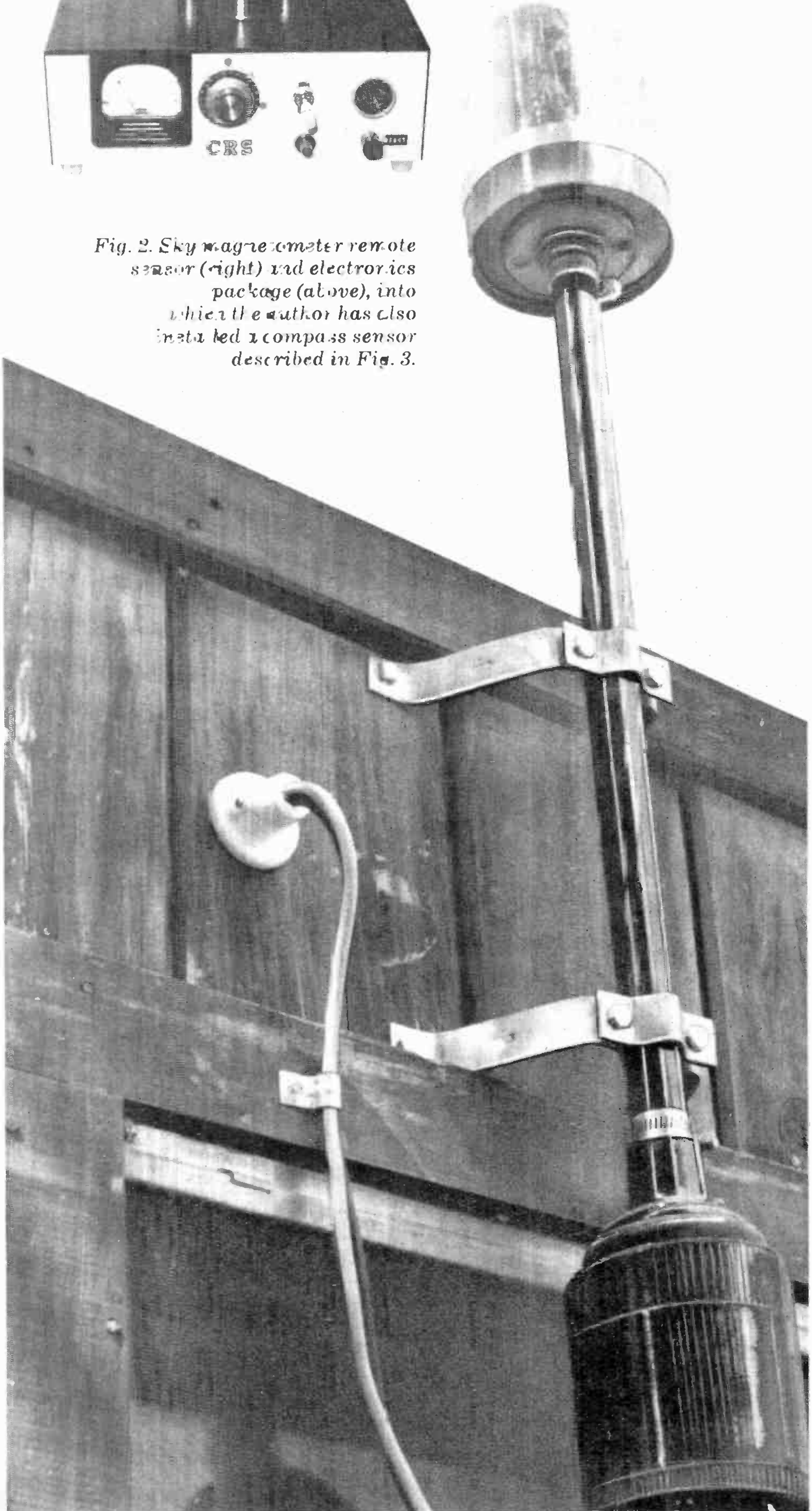


Fig. 2. Sky magnetometer remote sensor (right) and electronics package (above), into which the author has also installed a compass sensor described in Fig. 3.



these CRT detectors exceeds that of both nuclear and rubidium-vapor magnetometers by a factor of two to four. However, commercial CRT systems are very expensive. This forces the experimenter to fashion a home-brew CRT magnetometer such as that shown in Fig. 4. The display speed of this system is contingent only on the signal-transfer time of the electronics package.

The CRT can be obtained from an oscilloscope or similar instrument. It should be an electrostatic—*not* electromagnetic—system. Because the CRT must be operated 30′ (9.1m) or more from its parent housing, lengthy cables are required to deliver the filament, centering, focus, and high voltages.

Attached to the glass faceplate of the CRT is light-dependent resistor *LDR1* and an opaque mask with a tiny aperture cut in it. The size of the aperture should be about the same diameter as the focused spot on the CRT screen. The photocell/aperture mask assembly should be secured to the center of the CRT's faceplate in an opaque retainer cup. Do not use a permanent cement when attaching this assembly to the CRT because it may have to be moved somewhat if a phosphor burn (dark spot) developes on the screen.

The CRT must be operated without any type of shielding and should be supported by a nonmagnetic structure. Use well-insulated cables for the various CRT operating potentials. Set the brightness to produce a relatively low intensity spot, and then focus the spot. Using the horizontal and vertical centering controls, position the spot directly in the hole in the aperture mask. You can tell when the spot is properly positioned with the aid of an ohmmeter. Connect the meter across the leads of the photocell and operate the centering controls. The photocell's resistance will be very low when the spot is properly positioned.

When *LDR1* is illuminated, the circuit in Fig. 4B causes *K1* to close, applying power to READY lamp *I1*. If for any reason the CRT's beam moves away from the small aperture, *K1* will momentarily deenergize and extinguish *I1*. This triggers an alarm circuit composed of *SCR1* (whose gate is protected by *D3*) and audible alarm *A1*. Even if the beam returns to the aperture in the mask, the alarm will continue to sound until RESET switch *S1* is momentarily depressed to interrupt the dc path through *SCR1*. Diode *D2* protects transistor *Q3* from voltage transients generated by *K1* during switching.

Excursions of the CRT's electron

beam can easily be calibrated in terms of gauss by using a small calibrating permanent magnet of known field strength and a square-ruled paper interface or plastic grid on the CRT's screen.

With the beam intensity set low and the spot's focus adjusted, *R1* can be used to control the system's sensitivity. The CRT sensor can be given some directionality by housing it in a steel container whose sky-facing side has been removed. If the CRT is mounted outdoors, use a nonmagnetic weather cover to protect the CRT and high-voltage cables from the elements.

As is the case with proton-precession and field-induction magnetometers, the inertialess CRT instrument is a total-field magnetometer, rather than an incremental field device.

Ground-Loop Sensing System. The chopper-interrogated ground-loop approach shown in Fig. 5 can be used to augment a magnetometer setup. The inductor, typically consisting of two turns of insulated copper wire measuring from 2′ to 200′ (0.6 to 61 m) in diameter, employs a 330-Hz chopper in which *Q1* and *Q2* operate as an astable multivibrator.

The chopper converts dc or low-frequency ac signals induced across the loop by an airborne magnetic agent into a serrated ac signal train. The train can then be processed by conventional audio systems. The nulling circuit consisting of *B1*, *R2*, *R3*, and nulling potentiometer *R4* sets the quiescent state of the detector. An optional alarm circuit, shown in the dotted box, can be connected to the output of the audio amplifi-

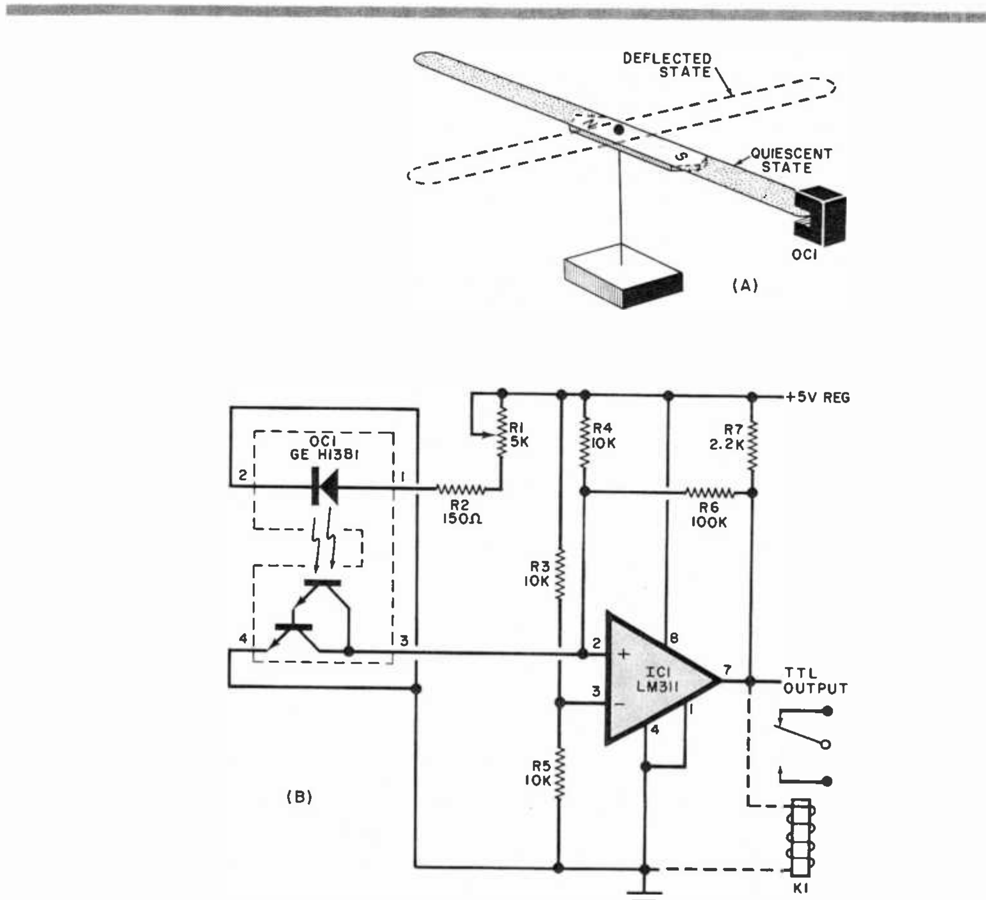
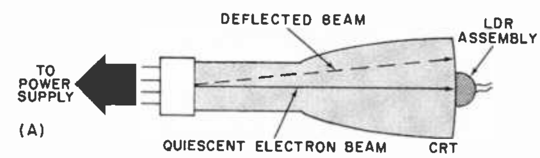
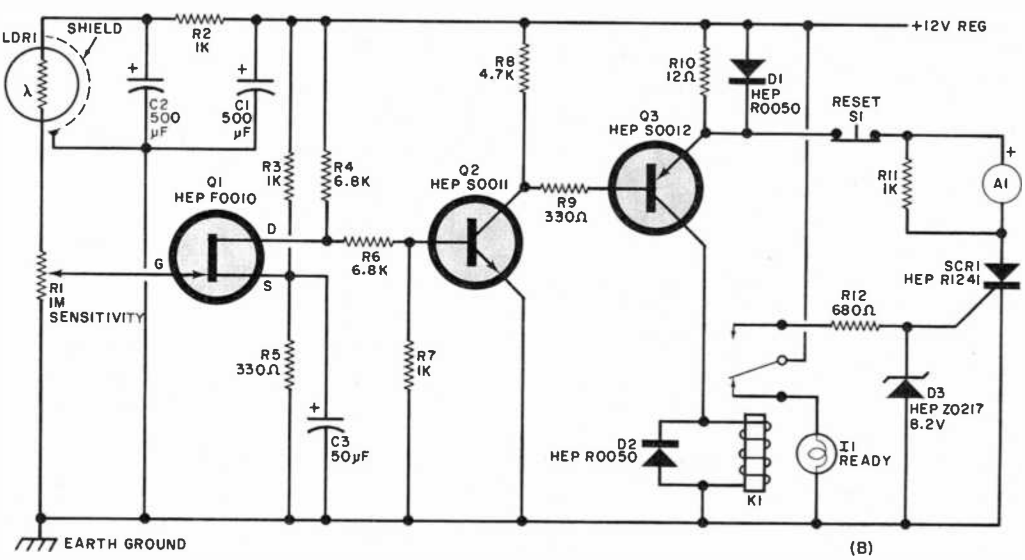


Fig. 3. Compass magnetometer's sensor (A) is a magnetic needle whose motion is sensed optically. Circuit (B) provides a TTL-compatible output and, if desired, activates a relay.

Fig. 4. Cathode-ray tube magnetometer is very sensitive. Details of sensor are at (A); detector's circuit at (B).





PARTS LIST FOR FIG. 3

IC1—LM311 voltage-comparator integrated circuit (National)
K1—Spdt relay with 250-ohm or greater coil resistance
OC1—GE H13B1 optoelectronic coupler (Poly-Paks No. 92CU 2784, 2 for $1.19)
R1—5000-ohm screwdriver-adjustable wire-wound potentiometer
The following are ½-watt, 10% tolerance resistors:
R2—150 ohms
R3, R4, R5—10,000 ohms
R6—100,000 ohms
R7—2200 ohms
Misc.—6" (15.2-cm) compass needle with agate bearings and support stand (No. A2-1871 for $10.50 plus $1.00 postage from Sargent-Welch Scientific Co., 7300 N. Linder Ave., Skokie, IL 60076); nonmagnet housing with cover; aluminum or brass hardware; two stiff paper extensions; suitable enclosure for electronics package; hookup wire; solder; etc.

PARTS LIST FOR FIG. 4

A1—Electronic alarm (Mallory Sonalert® or similar)
C1, C2—500-µF, 15-volt electrolytic
C3—50-µF, 15-volt electrolytic
CRT—Electrostatic cathode-ray tube
D1, D2—1-ampere, 50-PIV diode (Motorola HEP R0050 or similar)
D3—8.2-volt zener diode (Motorola HEP Z0217 or similar)
I1—No. 756 lamp (14-volt, 8.2-mA in T-3¼ configuration)
K1—12-volt spdt relay
LDR1—CdS light-dependent resistor with 100-ohm light and 5-megohm dark resistance (Radio Shack No. 276-116 or similar)
Q1—HEP F0010 n-channel FET (Motorola)
Q2—HEP S0011 npn transistor (Motorola)
Q3— HEP S0012 pnp transistor (Motorola)
R1—1-megohm linear-taper screwdriver-adjustable potentiometer
The following are ½-watt, 10% resistors:
R2, R3, R7, R11—1000 ohms
R4, R6—6800 ohms
R5, R9—330 ohms
R8—4700 ohms
R10—12 ohms
R12—680 ohms
S1—Spst normally closed pushbutton switch
SCR1—HEP R1241 silicon controlled rectifier (Motorola)
Misc.—Power sources for acceleration and filament voltages, brightness, focus and centering controls and high-voltage cables; aperture mask and opaque cup for LDR1; nonmagnetic mount for CRT; 12-volt power supply; suitable enclosure for electronics; machine hardware; hookup wire; etc.

er. Diode *D2* provides the rectification required by the gate of *SCR1*. The magnitude of this gate signal is determined by the value of *Rd*.

Diode *D1* "despikes" chopper coil *K1*, and *C4* maintains the frequency stability of the multivibrator. The circuit should be housed in a small, earth-grounded metal enclosure. The loop can be wound around suitably spaced wooden pegs and connected to the circuit via

claimed that electrically disabled speedometers have indicated high road speeds while the vehicle was stationary. Similarly, there have been reports that home power meters exhibit sudden bursts of high speed without any increase in energy consumption.

Shown in Fig. 6 is an instrument that can detect anomalous eddy currents. The heart of the device, shown in A, is an aluminum disk that rotates above an

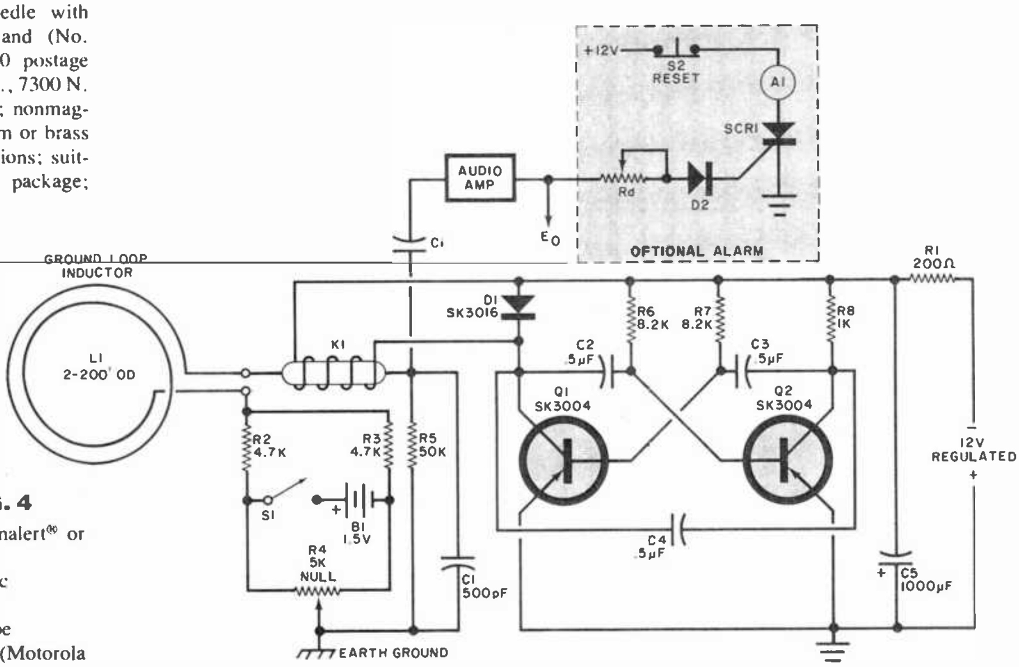


Fig. 5. Ground-loop magnetic detector responds to dc and low-frequency ac signals.

PARTS LIST FOR FIG. 5

B1—1.5-volt D cell
C1—500-pF capacitor
C2, C3, C4—0.5-µF, 50-volt capacitor
C5—1000-µF, 15-volt electrolytic capacitor
D1—SK3016 (RCA) or similar diode
K1—Reed switch (Hamlin No. MRMF-2-206, ¾" size or similar) fitted with 600-ohm coil (COTO coil No. U-12 or similar)
L1—Induction coil (see text)
Q1, Q2—SK3004 (RCA) or similar transistor
R1—200-ohm, 2-watt resistor
The following are ½-watt, 10% resistors:
R2, R3—4700 ohms
R5—50,000 ohms
R6, R7—8200 ohms
R8—1000 ohms
R4—5000-ohm linear-taper potentiometer
S1—Spst switch
Misc.—Metal enclosure; shielded cable; insulated wire for L1; machine hardware; external audio system; hookup wire; solder; hardware, etc.

shielded cable. If the loop is installed indoors, it should be mounted against a ceiling. Alternatively, it can be mounted on the roof.

Eddy-Disk Magnetometer. According to some sources, one presently unexplained phenomenon influences the behavior of eddy-disk devices like those in automotive speedometers and domestic power meters. It has been

iron-core coil containing 15 turns of 3/32" (2.38-mm) wire connected to a pair of receptor stubs formed from 0.25" (6.35-mm) diameter copper tubing. A small, thin iron "flag" that opposes a relatively weak permanent magnet provides a force sufficient to prevent the disk from rotating under unenergized conditions. The overall design resembles that of a standard home power meter. The permanent magnet used for the brake should be positioned near the flag so that the disk is stationary under ambient conditions.

The motion of the disk is detected by optical means (see Fig. 6A). Exciter lamp *I1* generates a luminous output which passes through a small aperture in the disk. Light passing through the aperture falls on *LDR1* on the other side of the disk. The light path should be confined to the aperture in the disk. A small opaque tube can be used on either side of the disk to confine the light. These tubes will keep the light emitted by *I1* from spilling over the edge of the disk and possibly biasing *LDR1*. The tubes should not contact the disk surface.

As shown in Fig. 6B, *LDR1* triggers monostable multivibrator *IC1A* which clocks flip-flop *IC1B* on and off as the disk rotates. Two outputs are provided. One, at the emitter of *Q1*, can be changed in level to produce a TTL-compatible output for driving conventional decade counters. The other output is via relay *K1*, which can be used to activate a mechanical counter or an alarm.

Potentiometer *R2* allows the experimenter to adjust the sensitivity of the sensing circuitry. Because of *Q1's* limited current-handling ability, the coil resistance of *K1* must be at least 250 ohms. Control *R1* provides a means for adjusting the intensity of *L1*.

To keep out any extraneous light, a nonmagnetic, opaque cover can be mounted over the disk, *L1*, and the *I1*/*LDR1* assembly. A larger nonmagnetic (glass or plastic) dome is recommended to safeguard the package against moisture and air currents. The receptor stubs can be mounted outside the package.

In Closing. The various home magnetometers that have been presented in this article should be operated as far away as possible from any contaminating magnetic fields produced by electrical machines, permanent magnets, etc. They should also be housed in nonmagnetic structures. Armed with these detectors and scientific curiousity, you will be well equipped to investigate magnetic phenomena—whether they are produced by natural, man-made, or perhaps even extra-terrestrial causes. ◇

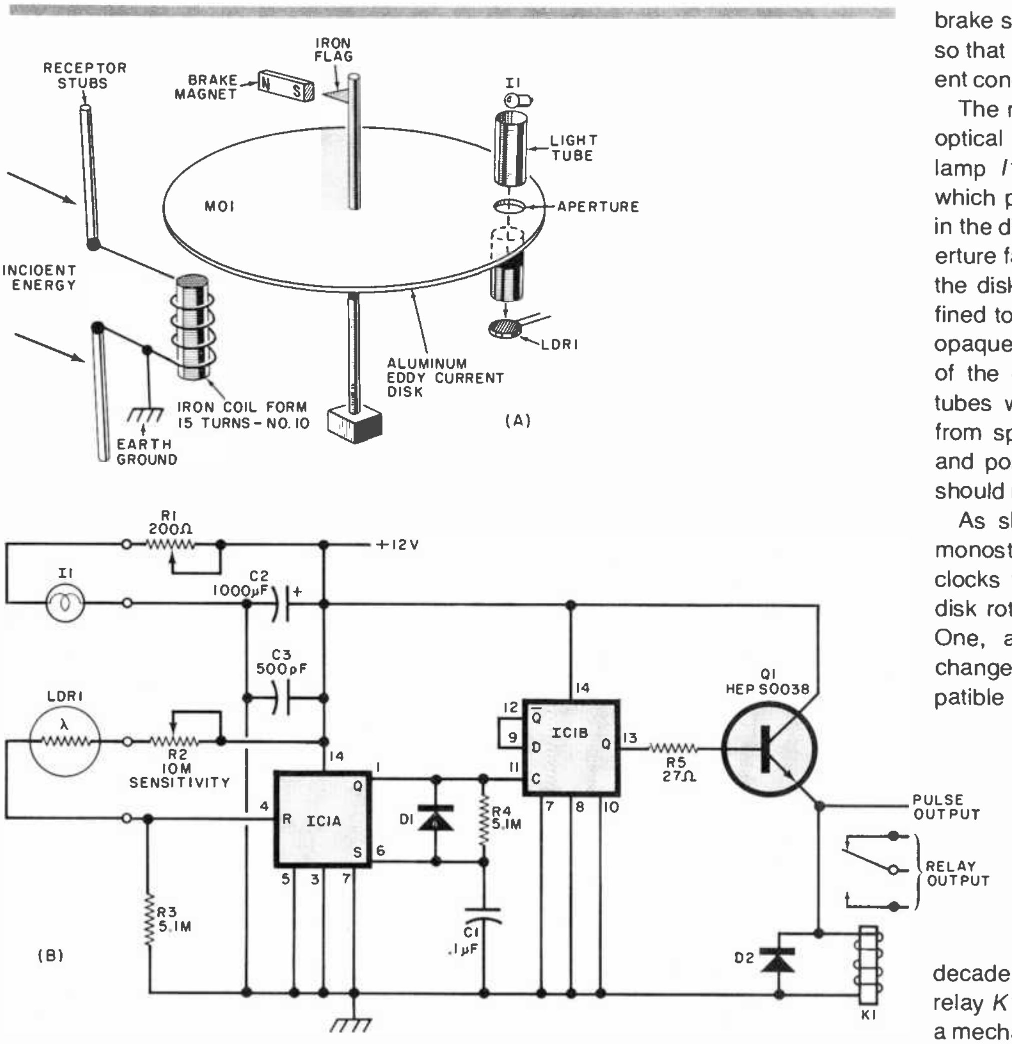
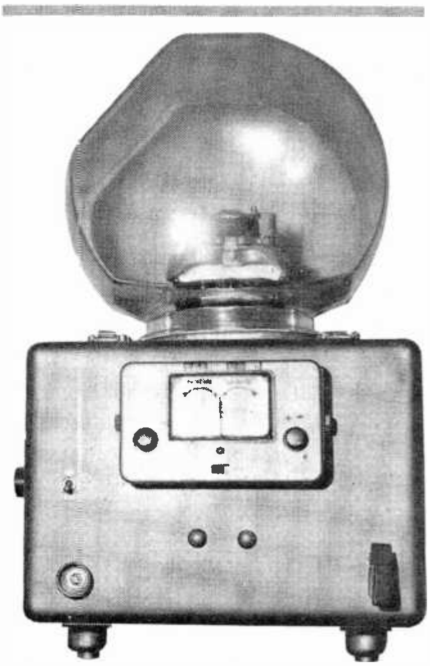


Fig. 6. Eddy-disk magnetometer is similar to power meter in action. Disk sensor is at (A); circuit schematic shown at (B).

PARTS LIST FOR FIG. 6

C1—0.1-μF capacitor
C2—1000-μF, 15-volt electrolytic
C3—500-pF ceramic capacitor
D1, D2—HEP R0050 (Motorola) or similar diode
I1—No. 1815 lamp (14 volts, 0.2 amperes, T-3¼ size)
IC1—HEP C4020P (Motorola) dual-D flip-flop
K1—Spdt relay with 250-ohm or greater coil resistance
LDR1—CdS light-dependent resistor with 50,000:1 dark-to-light resistance ratio (Radio Shack No. 276-116 or similar)
MO1—Converted power meter eddy-disk assembly (see text)
Q1—Transistor (Motorola HEP S0038 or similar)
R1—200-ohm, 5-watt variable resistor
R2—10-megohm linear-taper screwdriver-adjustable potentiometer
R3, R4—5.1-megohm, ½-watt resistor
R5—27-ohm, ½-watt, 10% tolerance resistor
Misc.—Iron-core (mu-metal) form; No. 10 insulated wire; copper tubing; brake magnet; opaque light tubes; protective covers; machine hardware; hookup wire; etc.

At right is author's prototype of eddy-disk magnetometer.



BY RICHARD GOODPASTURE

How to Add TRIGGERED SWEEP TO AN OSCILLOSCOPE

Increase the performance capabilities of your scope by permitting expansion of waveforms.

WORKING with an oscilloscope that uses recurrent sweep can be frustrating when it comes to getting the sync locked in—and keeping it there. The situation is particularly touchy when one is trying to observe fast pulses that have low repetition rates. A much more practical approach to the problem is to use triggered sweep, where the sweep is synchronized by the actual signal that is being observed.

If you have a scope that does not have built-in triggered sweep, there is no need to trade up to a new scope. Instead, you can adapt it for triggered-sweep observation of waveforms, using the circuit shown in the schematic. This add-on circuit can convert virtually any recurrent-sweep scope into a modern triggered-sweep instrument.

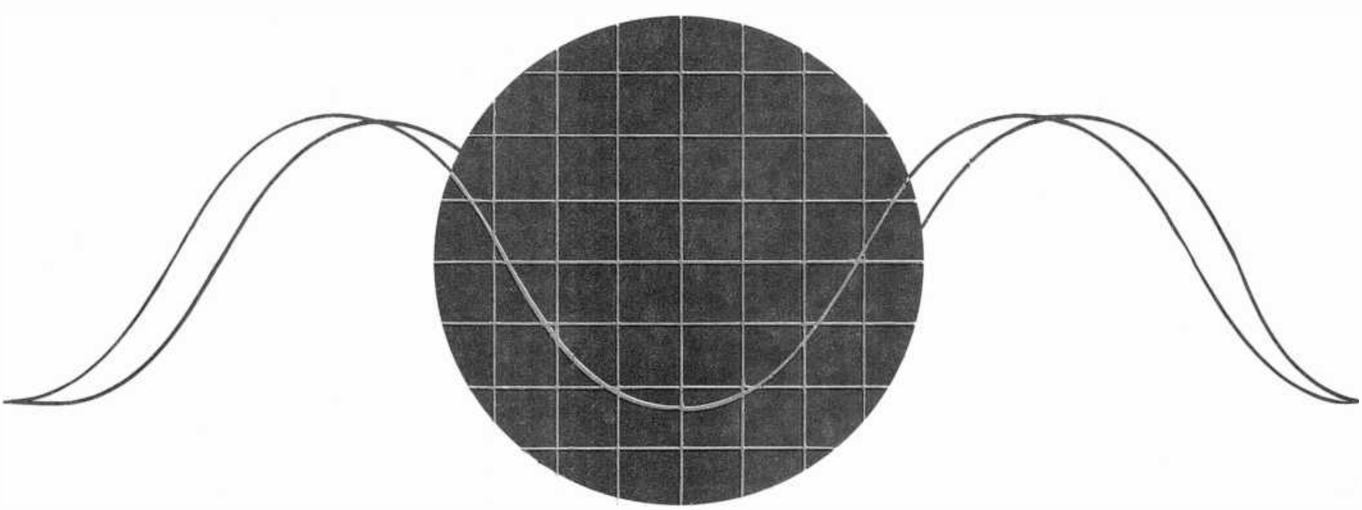
About the Circuit. Transistor *Q1* and resistors *R3*, *R4*, and *R5* make up a constant-current source for charging the sweep-range capacitor selected by switch *S1B*. Resistor *R1* determines the voltage to which the selected capacitor is to charge. The value of *R1* plus the charging current selected by *S1A* determine the sweep frequency. Resistor *R1* also determines the triggering sensitivity; and, with the 3300-ohm value specified, the sweep amplitude is 5 volts peak-to-peak. Omitting *R1* increases the sweep to 10 volts but decreases triggering sensitivity. (The value of *R1* can be changed without affecting the scope's sweep calibration.)

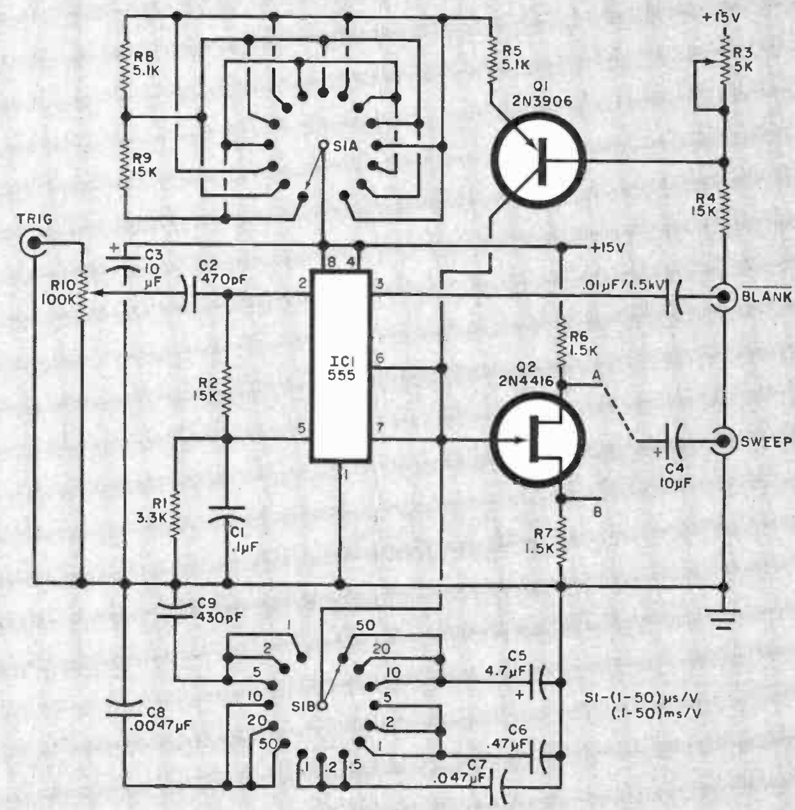
The unblanking pulse from pin 3 of *IC1* is coupled through an isolation capacitor with a typical value of 0.01 μF at 1.5 kV to the control grid of the CRT to intensify the trace during the sweep. Adjusting the scope's brightness control keeps beam intensity low while waiting for the next sweep.

The actual trigger signal can be taken from any point in the vertical amplifier channel where there is sufficient signal amplitude to trigger the sweep circuit.

The new triggered-sweep circuit is substituted for the existing sweep system that now drives the horizontal amplifier in your oscilloscope.

Construction. Just about any method of construction, from fabricating a printed circuit board to Wire Wrapping, can be used to assemble the circuit. Resistors *R8* and *R9* and capacitors *C5* through *C9* mount directly on switch *S1*.





Constant-current source Q1 and timer IC1 combine to form a low-cost triggered sweep circuit.

PARTS LIST

C1—0.1-µF, 50-volt ceramic capacitor
C2—470-pF ceramic capacitor
C3,C4—10-µF, 25-volt electrolytic
C5—4.7-µF, 16-volt tantalum capacitor
C6—0.47-µF, 16-volt tantalum capacitor
C7—0.047-µF, 50-volt polystyrene or Mylar capacitor
C8—0.0047-µF, 50-volt polystyrene or Mylar capacitor
C9—430-pF polystyrene, Mylar, or silver mica capacitor
IC1—555 or 1455 timer
Q1—2N3906 or similar pnp transistor
Q2—2N4416 or similar n-channel FET

The following are ¼-watt, 10% tolerance resistors:
R1—3300 ohms
R2,R4,R9—15,000 ohms
R5,R8—5100 ohms
R6,R7—1500 ohms
R3—5000-ohm trimmer potentiometer
R10—100,000-ohm potentiometer
S1—2-pole, 15-position nonshorting rotary switch
Misc.—Printed circuit board and socket (optional) for IC1; connectors (optional) for input and outputs; machine hardware; hookup wire; solder; etc.

The 15 volts required to drive the triggered-sweep circuit can be obtained from the power supply in the scope.

Calibration and Use. Potentiometer *R3* must be adjusted to provide a voltage drop of 2.35 volts across *R5* when *S1* is set to the 1-µs/V position and the collector of *Q1* is grounded. A more accurate setting for *R3* can be had by using a signal whose frequency is accurately known once the sweep has been coupled to the scope.

The best place to inject the new sweep signal is via the scope's EXT HORIZ input, after first determining which polarity of the sweep output produces a left-to-right deflection on the CRT. If a negative voltage produces the appropriate deflection, couple the sweep output to jumper point A. On the other hand, if your scope requires a positive voltage, connect to point B.

The TRIG input requires a negative-going pulse of about 2.5 volts to trigger the circuit. The width of the pulse can be as short in duration as 100 ns if a greater amplitude pulse is available. Use potentiometer *R10* to adjust the trigger amplitude to obtain a stable waveform. ◇

BY IVAN BERGER

What's New **IN HI-FI EQUIPMENT**

Highlights of audio equipment introduced at the Winter Consumer Electronics Show.

THE Consumer Electronics Show began as an exhibition of radios, TV sets, calculators and CB equipment, with a little hi-fi thrown in for variety. By now, the hi-fi tail is almost wagging the electronic dog. Nearly a third of the exhibitors presented true high-fidelity equipment—and if you included all makers of audio gear and accessories, the figure would be nearer to half. Trends in audio tend to surface here. Ralph Hodges outlined many of them—more groundswells than tidal waves—in PE last month. But in a show this vast, no single account can catch all of them. And many models which signified no clear trend were nonetheless interesting in themselves.

Receivers. The main trend in receivers, as Ralph Hodges noted in his report on CES last month, is toward ever higher power. But there were a number of interesting receivers at more moderate power levels. Kenwood introduced three new receivers, less notable for their power levels (80, 60, and 26 watts per channel) than for internal refinements intended to deliver better performance at less cost. Examples include a current-mirror type of differential amplifier in the power stage, a more efficient heatsink on the top two models, better S/N and more headroom, and a "floating" local oscillator to resist drift caused by changes in temperature and humidity. Hitachi introduced a new Class "G" receiver, the SR-804 ($399.95), which is rated at 50 watts per channel, but is claimed to deliver up to 100 watts of unclipped power during transient peaks, a function of its Class G design. Its dial scale is unusually long, too, for easier tuning, and is tilted slightly upward for easier viewing from above.

Philips showed four new receivers, the first in its U.S.-built electronics line (speakers and turntables, however, are imported.) Sherwood added two new receivers to its "Certified Performance" line, a series of individually-lab-tested components delivered with notarized documents attesting to individual performance. Both new receivers also have "digital detectors" (the pulse-counting type described in Julian Hirsch's January article on "How FM Tuners Work").

New, black-color receivers caught my eye. One was a new Sonab with a conventional linear dial. (The previous model had a circular dial like an old-fashioned radio, but with an ultra-modern look due largely to the decorative placement of its cooling ribs on the top of the case.) Harmon-Kardon's 230e ($180) was another attractive design departure: its edgewise tuning wheel is also on top of its cabinet, and there are duplicate tuning dials on the top and front of the unit for easy viewing from a variety of angles. And Optonica introduced its new SA-5205 receiver (and some other components) in both black and brushed aluminum versions.

Amplifiers. The recent trend toward receivers seems to be slowing down slightly. Despite the greater power receivers now can offer, I saw more new separate amplifiers than receivers at CES, and almost as many tuners. BGW has a new amplifier, the 250C, with a bit more power (100 watts per channel vs 90) than its previous 250B, and with a Cannon-plug input for use with professional balanced lines. Denon amplifiers made their first appearance, including the PMA-700Z, a 70-watt/channel rms integrated amplifier, and the HA-1000 head amp for moving-coil cartridges. The PMZ-700Z (which has a built-in head amp of its own) has a GAIN switch to raise or lower gain by 10 dB, as well as the usual −20-dB muting switch. The HA-1000 has its power supply in a separate box, and is shielded in iron, both to prevent noise pickup. A few more items attracted my attention in Denon's catalog after I got back from the show: Its POA-1001 power amplifier uses a new type of power-output transistor, which allows output of 100 W continuous power per channel with just two output transistors in push-pull instead of the many parallel transistors usually used at this power level. Even more unusual was its PCC-1000, designed to cancel phono crosstalk. It apparently operates by feeding user-controllable amounts of each signal, with phase reversed, into the opposite channel.

Hitachi, whose new MOSFET amplifiers Ralph Hodges mentioned last month, also brought out a lower-powered MOSFET amp, the HA330 integrated amplifier (40 W/ch, $200) and a matching preamplifier, the HCA 7500, for $350. Its most unusual feature is a pair of front-panel cartridge-load controls, one each for capacitance (100-400 pF) and resistance (0.1-100 kilohm). Nikko has a MOSFET amplifier, too, the Alpha III (80 watt/channel). Kenwood

What's New In Hi-Fi *continued*

continues its line of amplifiers having separate power supplies for each channel with the KA-6100, 50 watt/channel amplifier ($250.) The KA-5700 (40 watt/channel, $190) like its new receivers (and like the KA-6100), uses current-mirror differential circuitry. And the new KA-2700, 20 watt/channel, offers such specifications as 0.08% maximum distortion and a 72-dB S/N through the phono input, despite its $140 price.

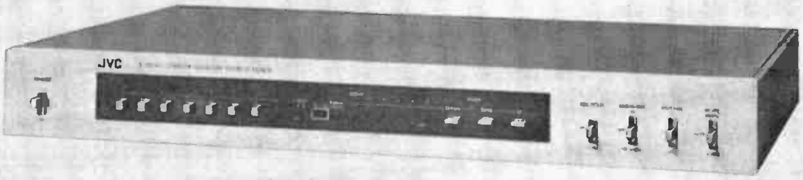
Marantz has joined the ranks of those designing amplifiers for low TIM (transient intermodulation distortion) with its new Model 300DC stereo power amplifier. As its name implies, the 300DC delivers 150 watts per channel. Dual power supplies are also featured.

Phase Linear's attractively restyled line includes a revised version of the Model 4000 Autocorrelation Preamplifier ($650)—it no longer has the SQ decoder and "joystick" quadraphonic balance control of the original version. Its RIAA phono stage has also been redesigned to reduce CB interference and hum.

Setton had a booster amplifier, the HBS 500, designed to amplify the output from a low-powered receiver or other system. Though such products are common enough in the car-stereo field, this is only the second one we've seen for the home. Designed for use with receivers or amplifiers of up to 30 watts/channel output, it produces 55 watts per channel at 0.03% distortion, with a 1-volt input. With an input impedance of 50,000 ohms, it turns amplifiers into voltage sources, drawing minimum power from them, and hence getting a cleaner signal from them, too. (It can also work as a conventional amplifier from a preamp output.) A sensing circuit turns the unit on when it receives a signal, and turns it off after 2 minutes when there is no input signal.

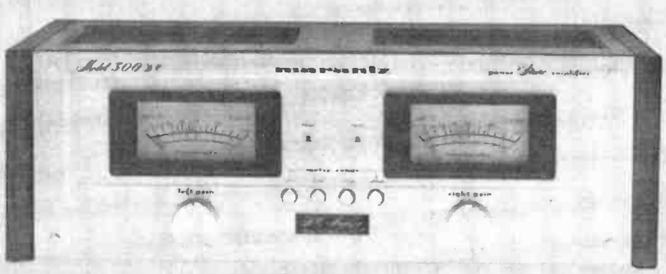
Tuners. The growth of "separates" which has swelled the ranks of power amplifiers and preamps hasn't brought too many tuners in its wake, but a few new ones did make their CES debuts. One of the more unusual ones was the Denon TU-500, whose four dials make it look more like a receiver. The tuning dial is wrapped around a drum, which allows Denon to fit slightly more than 11 inches of dial into an opening about 3½ inches wide. Flanking the tuning drum and center-tuning meter are two VU-scale level meters—one for each stereo channel—with additional scales for signal strength on one meter, and for "null balance" on the other. The latter scale is used to balance the channels of the tuner's output, and can check balance of external signals as well. The external signal input has a 6-step attenuator switch covering a 50-dB range. The tuner also has two i-f sections; the second one is for such auxiliary circuits as the signal meter, the multipath output terminal and the muting circuit.

Digital tuners were not as prevalent as I had been expecting. But Nikko did introduce its Gamma V digital tuner, and JVC announced availability of its T-3030, a low-profile (2 inches high) model with seven station presets and two-speed, bi-directional scanning, which had been shown as a trial balloon last summer.



JVC T-3030 digital tuner has two-speed, up/down tuning, plus 7 station presets.

Phase Linear's line has been restyled, as illustrated by its Model 4000 preamp.



Marantz's 300DC power amplifier boasts 150 watts per channel output.

Phase Linear restyled its 5000 FM tuner to match the company's other "Series Two" components. Kenwood and Sanyo also displayed new tuners, as did Wintec, a new brand.

Record Playing Equipment. Turntables are becoming more and more alike these days: the standard format is now a direct-drive or belt-drive single-play unit with an S-shaped tonearm and interchangeable shell (usually interchangeable between brands.) Such models were shown by Marantz, Sanyo, Visonik, Optonica, Sonab, and Hitachi. One of the new Sanyo models, the TP728, did break the pattern slightly by coming complete with an Audio-Technica magnetic cartridge for just $99.95—and with viscous cueing both up and down plus a built-in strobe, to boot. Hitachi's new HT460 featured its UniTorque drive design, which they claim delivers smoother power than other direct-drive motors. The new HT 550 featured a quartz-locked UniTorque motor.

Pioneer's three new turntables (one model each in direct-drive, servomotor belt-drive and belt-drive with synchronous motor) fit the general mold, all following the new trend toward extra-heavy bases to minimize acoustic feedback. But their universal headshells were different—made of glass fiber, rather than metal, to eliminate resonances above 75 Hz. Their counterweights had anti-resonance damping, as well.

Lux quietly showed two new turntables designed for easy tonearm interchangeability. The tonearm mounts are metal platforms sliding in metal tracks, with lever-operated camlocks to hold them firmly in place once the arm position is properly adjusted. The only difference between the models was that one of them had two such arm tracks, one in the usual position and the other behind the platter, to allow the use of two arms at the same time.

Monitor Audio's ET1000 electronic turntable, which was exhibited last summer in hopes of finding a U.S. importer, has now found one (AudioSource). To minimize hum, the stepdown transformer for its power supply is located at the plug. The ET1000 appears to have no standard controls, merely silvery legends (33, 45, ON,, OFF and right and left arrows) on a black band. These are actually touch-control sensors. The two arrows are for fine-speed adjustment, a binary system whose count changes at a rate of approximately one per second as long as one stays in contact with the arrow. Available with or without arm, the turntable does come with the "Stylift," a passive device which automatically raises the tonearm when the record has finished playing.

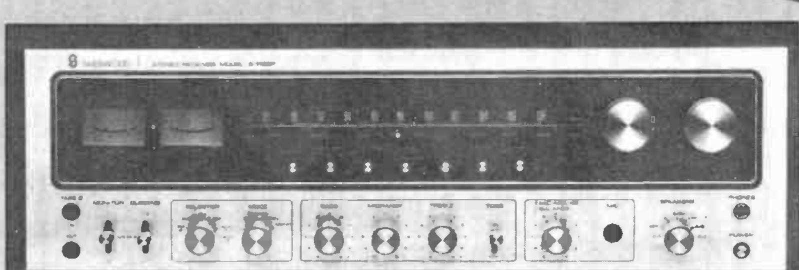
We noted no new cartridges, except the new Ortofon FF15 XE MkII. But this CES was the first at which we saw such audiophile brands as Satin, Supex, Sonex and Grace.

More intriguing were the variety of new phono accessories. Ortofon's CAP 210 is a capacitor which slips onto the output pins of Ortofon cartridges, allowing its cartridges—with a recommended load capacitance of 400 pF—to be used without frequency-response errors in systems using low-capacitance cables. It will be available at no extra cost with Ortofon's M20 cartridges, and will also be available separately for mounting on its Mark II magnetic cartridges.

Lenco offered two other interesting audio oddities: the Lencolamp is a tiny, ac-powered lamp which clips to the inside of a turntable dustcover, automati-

Kenwood KR-6030 AM/FM receiver delivers 80 watts per channel.

Optonica's SA-5205 receiver with black cabinet option is shown.



Sherwood's "Certified-Performance" line includes the S-110CP 100-W/channel receiver.

cally turning on when the cover is raised, and off when it is lowered. Those who have tried cueing closely cut bands on black records with black cartridges will appreciate this. The Lencofix, which also clips to the dustcover, is a compact rack to hold the dust jacket of the record being played—insurance against its being lost. Discwasher introduced a new Discorganizer, a compact wooden rack to hold its Discwasher and fluid, Zerostat anti-static gun, SC-1 stylus cleaner, an extra headshell, and screwdrivers or other accessories, all in a neat walnut block with a transparent dust cover. Sumiko exhibited the Howland-West HFS-75 turntable set-up kit, which includes a protractor for accurate tonearm alignment and a test record. Sound Guard added a lint-free work-surface pad for record cleaning. And Transcriber introduced its own new line of recording care accessories.

Tape. The biggest news, technically, was Hitachi's announcement of a forthcoming cassette deck with a Hall-effect head. Its output is said to stay constant right down to dc (output from conventional heads rises at 6 dB per octave from dc to the head's upper frequency limit). This will be a three-head deck, of course—Hall-effect heads are suitable only for playback, not for recording. Another new Hitachi three-head deck, the D900 ($495) has conventional heads, with separate record and playback heads in one headshell. An illuminated diagram shows the signal path through the deck, a handy aid for those unfamiliar with the intricacies of three-head recorder operation. The model features touch-button solenoid controls and a remote-control option. Yet other three-head decks, the D850($350) and the two-head D550($212), also made their debuts.

Sony made a big splash with three new front-loading decks and one portable model, the first decks to be marketed here by Sony itself. (Previous decks were sold in the U.S. by Superscope. All use servomotors, and the decks all have timer recording facilities. The top-of-the-line, two-motor TC-K710 ($500) allowed use of an optional remote control (surprisingly, the same remote control unit as Hitachi uses, though the two machines seem to have nothing else in common). The other two decks were the TC-K4 ($280) and TC-K3 ($220). The new TC-158SD portable has Dolby, VU meters plus a peak-reading LED, and a switchable microphone attenuator. It is priced at $380.

Also shown was the Sony PCM audio attachment for Betamax and other American-standard video recorders. Dynamic range is 85 dB, which would normally indicate a data word length of approximately 14 bits, but Sony squeezes it out to only 12. Total bit rate is more than 1.4 million bits per second, which probably includes clock and error-correction bits. Sony does mention that a drop-out compensation circuit, "99.8% effective," was included in the system. Alas, it's still just a prototype—no price or delivery date announced yet.

Mitsubishi did, however, predict a price of "about $2000" and a possible late-'78 delivery date for its PCM cas-

Pioneer PL-518 direct-drive turntable is one of its three new turntable models.

Touch-sensor controls double as control markings on the Monitor turntable.

A slip-on capacitor matches Ortofon cartridges to low-capacitance cables.

sette deck. This uses a "helical-scan, rotary head." It is, in other words, basically a video recorder, and in fact uses VHS cassettes. The specifications were more detailed than Sony's: response dc to 20 kHz, ±0.5 dB; 80-dB dynamic range; less than 0.03% distortion, and undetectable wow and flutter. The unit has a sampling frequency of 47.52 kHz and uses 13-bit logical compression. There are two channels for PCM signals, plus a clock channel.

Uher showed two new models in Las Vegas: the CR 240 was a slick-looking stereo portable cassette recorder, a trifle larger than its CR 210, with Dolby and with separate level meters for each channel (the CR 210 had just one); the level controls for the two channels could be used independently or could be electrically ganged. However, the 240 does not have the 210's automatic reverse, or film sync provisions. The other new Uher was the CG 332, a cassette deck with Dolby noise reduction and a lower profile than most front-loading decks.

Fisher debuted its CR 4025, so far as we know the first cassette deck with wireless remote pause control, so you can edit out commercials without getting out of your chair. Optonica had a microprocessor cassette deck, the RT-6501, with features similar to those of the Sharp RT-3388 reviewed in PE last month, but with improved performance specifications.

Denon displayed two new tape decks, the DR-350 and DR-750, both front-loading types, with the latter a tall, shallow unit (303 mm H × 226 mm deep), rather than the usual format. The 350 has a front-panel bias adjust. The 750 has two motors and touch-button control. Sanyo, Kenwood and Panasonic also had new, front-loading decks, and both Harman-Kardon and Marantz offered restyled models: HK's 2000 is now all black, while Marantz's "B" series (5030B, 5025B and 5010B) have been re-dimensioned to match other Marantz components.

Some interesting new tapes made their debuts in Las Vegas. Fuji introduced its new "Beridox" FX-II cassette and the more-conventional FX-I. Originally introduced for videotape, "Beridox" is an iron oxide not existing in nature, whose properties lie between those of hematite and magnetite. Compounds like this were first hypothesized about 300 years ago, Fuji says, but were only recently made stable. The FX-I and FX-II have spaces where the user can mark whether the tape has been recorded with noise reduction.

Ampex introduced its Grand Master tape line, in reel, cassette and cartridge forms. Ampex also boasts of a new oxide—"highly orientable ferric oxide particles (HOP)"—plus a new binder system and a conductive-carbon backcoating to improve mechanical handling while minimizing electrostatic pickup.

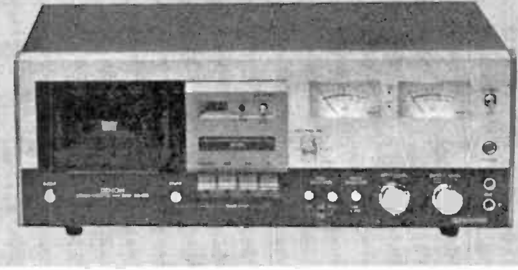
Sony announced a new line of cassettes, elcasets and microcassettes. Elsewhere on the microcassette front, Olympus showed a transcriber with foot-pedal start/stop and backspace. The 3M Company announced improvements in its Scotch line of Dynarange cassettes, with greater high-frequency output. New packaging—silver with a diagonal banner—identifies the tapes.

New accessories for the tape recordist were also rife. Both Rotel and Sansui showed mixers. Rotel's RZ-8 had built-in rhythm generator and solid-state reverb, Sansui's AX-7 had reverb and panpots. Audio-Technica had two new, miniature electret condenser mikes. And

Sony's PCM recording adapter works with all U.S.-standard color video recorders.

Hitachi's latest 3-head deck, Model D-900, has remote-control capability.

New Denon decks include tall, shallow Model DR-750 (left) and more conventional looking DR-350 (below).



What's New In Hi-Fi *continued*

Russound showed a rack-mounting version of their QT-1 control center.

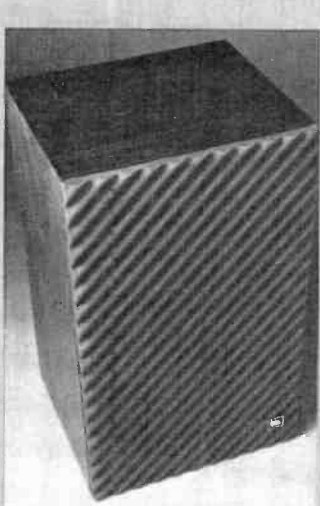
Speakers. As usual, there were so many new speakers that we can mention only a smattering of them. The three-piece configuration of two tall mid/high-range panels plus a joint subwoofer box—already familiar from the Phase Linear Andromeda III and JBL L212—has also been adopted by Petroff Labs, with its PL-1 "Positive Bipolar" system at $795. Synergistics showed a prototype of a similar system at about $2000. Fairly efficient (98 dB SPL for 1 watt input at 1 meter's distance), the Synergistics model will be rated to handle up to 600 watts per channel. Subwoofers were also available separately from Petroff (the bass commode from their PL-1, at $600), Visonik (whose Sub-1 is available for $550 in a unique cabinet of gray, black and silver or for $360 in walnut), and from Miller & Kreisel. M&K's offerings included a series of subwoofers with dual voice coils (one coil per channel), plus a series of crossovers (included with some subwoofer models) and "Bottom End Ramps" designed to adjust the high end to compensate for the efficiency difference between a subwoofer and various high-efficiency speakers without bi-amping.

One reason for the recent popularity of subwoofers is the presence of a number of ultracompact speakers, many of which have excellent sound but little low bass. Such names as ADS, Braun and Visonik are already familiar in this area. New entries were shown by Canton, Mesa, and Isophon. Slightly larger (12 × 7½ × 6½ inches) is the BBC-licensed Chartwell "Baby Monitor" LS3/5A, imported by Osawa.

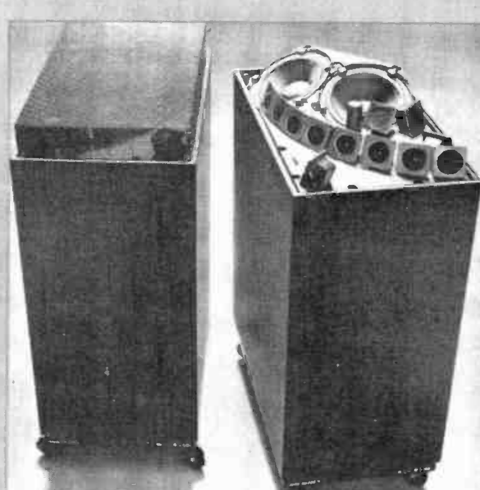
AudioSource showed another British line—Monitor Audio—plus a new Swedish speaker, the Mirsch. The Mirsch OM 3-29 (the only one so far for which specifications are in English) has angled front panels which make the sound converge more on the listening area, plus additional upward-firing tweeters. But the unique feature is a network in each speaker which apparently combines both channel signals (a wire connects the two speaker cabinets) out of phase, sending the difference information through side-firing speakers. The latter's output then reflects off room walls to produce "panorama" effect. The degree of panorama "reflex-sound" is adjustable by the user.

The Audionics T52 speakers use another type of electronic network, which is called "a Parametric Integration Network," to "cancel driver-cone resonance...stabilize the system impedance (reducing IM distortion) and to effect acoustical matrixing." Sonab introduced a new speaker, the OA-2212 ($840), using the "Ortho Acoustical" principle of blending direct and reflected sound. Tannoy has two new models, the Buckinham and Windsor, with coaxial design of mid and high range, plus a double woofer in the Buckingham and a single one in the Windsor. And Philips introduced a new motional feedback speaker system, the bi-amplified RH 567. Its bass amplifier delivers 40 watts from 35 to 1000 Hz, while the treble amplifier delivers 20 watts from 400 to 20,000 Hz.

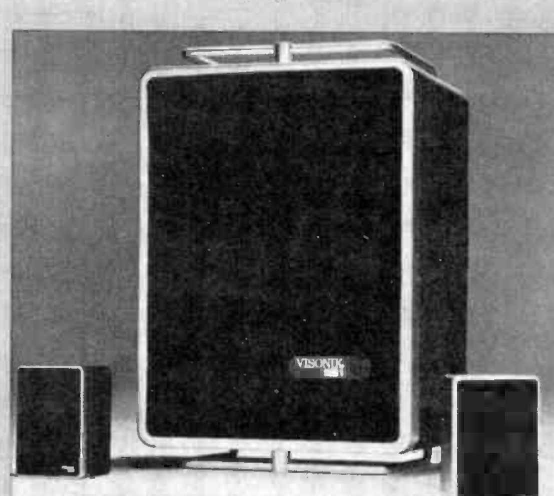
At least three new speaker cables were introduced at CES. Miller & Kreisel



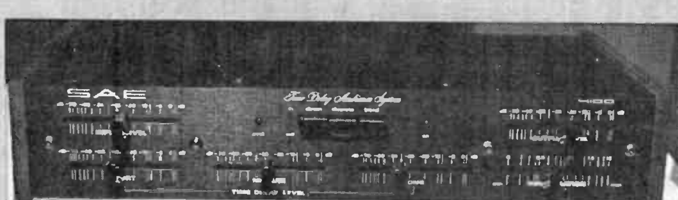
JBL L-50 is its least expensive 3-way system.



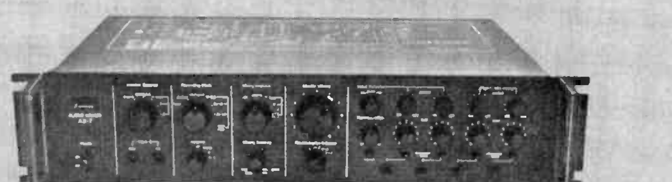
Tilted driver arrays are shown atop Sonab's OA-2212.



Visonik subwoofer Sub-1 matches popular small-cabinet speakers.



SAE 4100 time-delay system has versatile controls of delay times and levels.



Sansui AX-7 combines four-input mike mixer with reverb unit.

showed the M&K Mogami cable, a coaxial design with 8 ohms impedance. Sansui had a coaxial speaker cable, too. AudioSource had a braided, flat "High Definition Speaker Cable"; and Discwasher introduced their braided "Smog-Lifters." All claim to improve the sound beyond that of conventional lamp cord.

...And the Rest. Accessories and other items that don't quite fit the basic component categories often get lost in the shuffle, especially at a show the size of CES. But I ran into a few worth noting.

Delay units, for one, are gaining in importance, as more and more audiophiles begin using them to gain from their existing stereo records the "big-room" ambience that four-channel systems originally promised. The ADS 10 Acoustic Dimension Synthesizer Ralph Hodges described last month was only one of the new introductions at the show. Audio Pulse, the first to offer digital delay for home use, showed its Model Two, using RAM IC's as storage. It's smaller and mas fewer controls than the Model One, but adds bass and treble controls and 25-watt/channel amplifiers. Maximum delay time is 100 milliseconds, and delay time is adjustable from 0.2 to 1.2. S.A.E. also showed a delay system, the Model 4100.

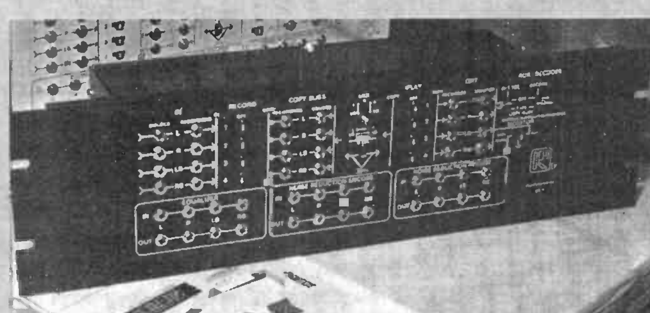
There are still those who prefer to get their ambience from quadraphonic equipment and recordings. (If quadraphonic FM finally arrives, their number should increase.) But there was little new four-channel equipment to be seen. One notable exception was the first production version of the Tate-System SQ decoder, a $300 component from Audionics of Oregon. Design features include an 8-pole matrix phase shifter which helps to yield as much as 40 dB of channel separation and active circuitry to suppress IM distortion by cutting attack time. Distortion is rated at 0.1% or less, with a signal-to-noise ratio of 80 dB. The system allows for SQ matrix decoding, ambience synthesis from stereo material, and monitoring of four-channel tapes, plus a master level control. On a more modest dimensional scale, JVC showed its "Biphonic" portable radio cassette recorders, which simulate through speakers the effect of binaural recordings heard through headphones.

Audio Technology and Hitachi both showed LED amplifier-power monitors. The Audio Technology Model 510 ($130) has 16 LED's per channel, reading a 45-dB range in 3-dB steps. It can read in dBm (for preamp-level signals) or dBW (for amplifier outputs), with sensitivity adjustments allowing it to measure peak outputs up to 1600 watts. The display is horizontal, but a vertical-reading front panel is one of the available options. Hitachi didn't say much about its power monitor, but did have it on display; so you can probably expect to see it, but not soon.

Sansui had a whole catalog of interesting accessories: a directional FM antenna with omnidirectional AM reception; a coaxial speaker cable; new microphones and a versatile mike-stand system; and heavily-shielded, low-resistance, low-capacitance cables that are now available with gold or nickel-plated contacts.

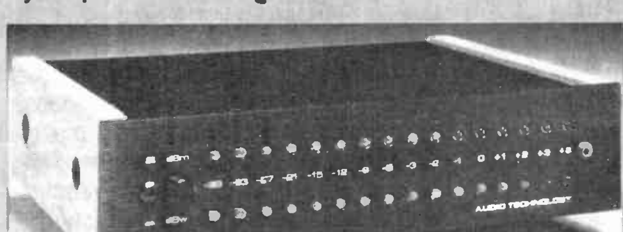
There's still one major trend we haven't covered: car sound. At this year's CES, there was substantial activity in this area. And though by no means all of these were true high-fidelity types by home-component standards, more and more of them appear to be. But that merits a story of its own. ◇

Small speaker trend is typified by Isophon's 7½"-high DIA2000.



Russound QT-1 4-channel patchboard now comes in black rack-mount, too.

Discwasher Discorganizer stores record-care accessories.



Audio Technology display shows output level of power amplifiers or preamps.

BY FORREST M. MIMS

Micro-PROCESSOR MICROCOURSE

PART 3. MEMORIES, BUS ORIENTED LOGIC, AND MICROPROCESSOR ORGANIZATION.

IN PRECEDING parts of this course, we learned about binary, octal, and hexadecimal number systems. We also covered basic logic gates and combinational and sequential logic circuits.

This installment will describe semiconductor memories and show how three-state logic allows a logic circuit to transfer data to one or more other circuits over a common array of conductors called a *bus*. It will conclude with a look at the basics of microprocessor (or MPU) organization.

Memories. A microprocessor alone is merely a collection of logic circuits on a silicon chip, and must be provided with a detailed list of instructions called a *program* before it can perform useful work. The program, along with input data and even output data from the microprocessor, is stored in a memory.

Memories store information as individual bits (0's and 1's) or bit patterns (words). As we learned in Part 1, a binary word can indicate a numerical value (data), a memory address, or a computer instruction. This makes a memory device an exceptionally versatile component and an indispensable partner to the microprocessor.

Microprocessors can be used in conjunction with any kinds of memories ranging from magnetic bubbles and cores to cassette tapes and floppy disks. The two most important microprocessor memories, however, are semiconductor ROM's and RAM's.

ROM's are *read-only memories*, since they contain information that can only be read out, and not modified or erased. RAM's are *read/write memories*, and they generally store temporary data. The data they store can be easily modified or erased.

Both ROM's and RAM's are available as integrated circuits with dozens to thousands of individual binary storage cells printed, etched, diffused, and interconnected with an aluminum metalization pattern on a silicon chip. Thanks to the ingenious use of on-chip combinational logic decoders, it's possible to access all the storage cells in even a very large memory with relatively few input lines. A simplified view of how an *address decoder* accomplishes this is shown in Fig. 1. As you can see, simply applying the appropriate address to the memory's address lines causes the designated bit or word to appear on the output lines.

ROM's and RAM's store data as individual bits or multiple bit words (usually 4-bit nibbles or 8-bit bytes). Either way, the address decoder insures a fixed and very rapid time to access *any* bit or word in the memory. This feature is called *random access*. *Serial access* memories, like magnetic tape and high-capacity shift registers, are slower since their contents must be searched bit-by-bit to find a specified address.

ROM. The typical ROM is an array of intersecting conductors as shown in Fig. 2. A diode connecting two intersecting conductors represents a logic 1. The absence of a diode at an intersection is a logic 0. Information is stored in a ROM when it is manufactured and is therefore permanent. The information can be read out, but new information can never be written into the ROM.

ROM's can store binary data, addresses, or instructions. They can even simulate a logic circuit. Figure 3, for example, shows a diode ROM programmed with the truth table of the Exclusive-OR circuit. This circuit normally requires at least four logic gates, each containing several transistors. As you can see, the ROM version is considerably simpler.

It's easy to program a ROM to simulate virtually any combinational logic circuit, and to illustrate this, Fig. 4 shows a ROM programmed as an octal-to-binary encoder, a circuit usually designed with a network of OR gates. Designing this encoder using logic gates is both tedious and time consuming, but anyone can design a ROM encoder. All that's needed is the appropriate truth table, such as that shown below:

Octal Input								Binary Output		
0	1	2	3	4	5	6	7	2^2	2^1	2^0
1	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	1	0
0	0	0	1	0	0	0	0	0	1	1
0	0	0	0	1	0	0	0	1	0	0
0	0	0	0	0	1	0	0	1	0	1
0	0	0	0	0	0	1	0	1	1	0
0	0	0	0	0	0	0	1	1	1	1

Looking at Fig. 4, notice how the placement of the diodes in the ROM corresponds to the 1's in the output half of the truth table? The ROM is now programmed as an octal-to-binary encoder.

Using a ROM is as easy as programming it. Just activate the appropriate input line and the designated bit pattern appears on its output lines.

ROM's are available as reasonably priced standard parts programmed for such roles as encoders, decoders, and look-up tables of trigonometric and other mathematical functions. Semiconductor companies will also make custom ROM's upon request, a rather costly procedure unless thousands of identical ROM's are ordered. But how about a few one-of-a-kind custom ROM's for prototype or hobbyist applications?

The best solution here is the *pro-*

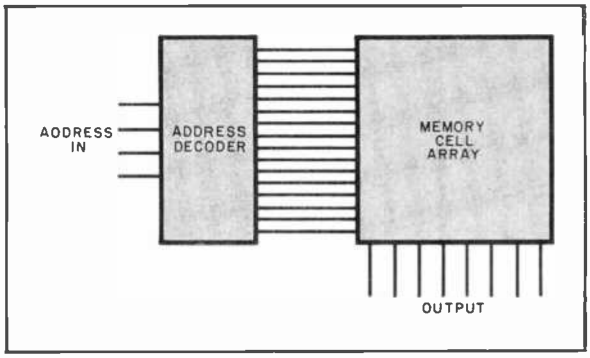


Fig. 1. How an address decoder simplifies access to a word stored in a ROM or R/WM.

grammable ROM or PROM. A PROM is a ROM with diodes at *all* its storage locations. A truth table is loaded into the PROM by applying brief, high-current pulses to the inputs connected to the diodes that are *not* wanted. This vaporizes a thin layer of metalization called a *fusible link* that connects the diode to the PROM's conductors.

PROM's, like ROM's, cannot be erased once they are programmed (though additional fusible links can be blown). A special *erasable* PROM, however, is available. It's programmed electrically and erased with ultra-violet radiation beamed through a quartz window that covers the silicon chip.

Various kinds of ROM's and PROM's can store from hundreds to thousands of bits. Since ROM's with storage capacities of from 2^8 (256) to 2^{16} (65,536) bits are the most common, ROM's (and RAM's) are often designated with a "k" factor that gives an approximation of their storage capacity—k comes from *kilo* and means 1,000. Thus a 1k memory stores 1,024 (2^{10}) bits, and a 4k memory stores 4,096 (2^{12}) bits.

Some memories store data as single bits. Therefore, a 1 × 256-bit ROM stores 256 bits of data, and an 8 × 256-bit ROM stores 256 8-bit bytes.

RAM. A RAM, like a ROM, consists of an intersecting grid of conductors on a silicon chip. However flip-flops, not diodes, are placed at the intersections in the grid. Since flip flops can be made to change states, this means the data stored in a RAM can be electrically altered or erased. It also means RAM's are more complicated and therefore more expensive than ROM's.

ROM's are classified as nonvolatile memories since they store information without the presence of electrical power. RAM's are volatile. Remove the operating power from a RAM (even momentarily) and its stored information is lost since the internal flip-flop can assume either state at random.

RAM's are sometimes used to store the kind of information stored in ROM's. More frequently, however, they're used for microprocessor data and program storage, temporary data storage, and for any application that requires a quickly alterable truth table.

A simple 4-bit register can be thought of as a RAM that can store a single 4-bit word (a 1 × 4-bit RAM). But practical RAM's have substantially more data storage capacity. Today, RAM's capable of storing 16k (16,384) bits are available and 64k (65,536) bit RAM's will soon be along. Large-capacity RAM's like these can be operated in parallel to provide storage for multiple bit words.

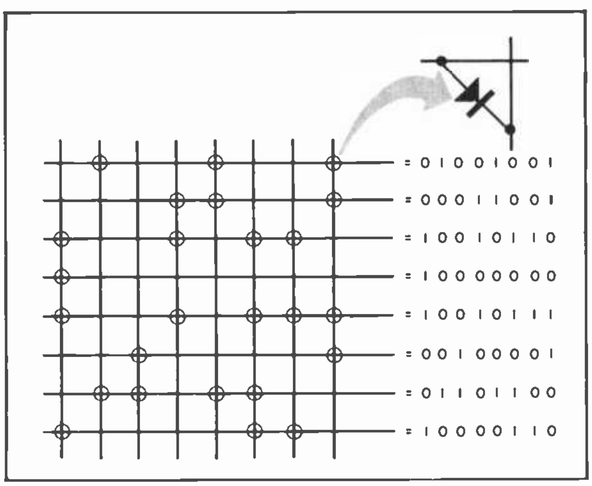


Fig. 2. A ROM is an array of intersecting conductors. When a diode connects the conductors, a logic 1 is represented.

Other Memories. Semiconductor RAM's AND ROM's are by far the most important microprocessor memories in use today. Other kinds of memories are also available, and since memories play such a vital role in the operation of a microprocessor you should at least be aware of them.

An important new semiconductor memory is the charge-coupled device (CCD). This device stores data as an electrical charge that can be moved from one memory cell to the next like a pail of water moving down a bucket brigade. The presence of a charge is logic 1 while no charge is logic 0. Since they must be accessed serially, CCD's are slower than ROM's and RAM's. However, CCD's can store more data on a silicon chip than a similar size ROM or RAM because the elaborate address decoders needed for random access aren't used. CCD's are read/write devices.

Magnetic bubble memories provide high-capacity read/write, nonvolatile data storage. Bits are stored as the presence (1) or absence (0) of microscopic magnetic cylinders called *domains* in a thin film of magnetic garnet or orthoferrite. The cylinders, which resemble bubbles when viewed on end through a microscope, can be rapidly moved along a path defined by a pattern of metalized bars, chevrons, or other shapes. The metal shapes are magnetized in different directions by a rotating magnetic field, and this causes the bubbles to move from one bar to the next.

Magnetic tape and floppy disk memories are commonly used with sophisticated microprocessor systems such as computers. There are several ways to store bits of data on magnetic tape, one of which is to encode logic 0 and 1 as two different audio frequency tones. Cassette recorders are inexpensive, readily available, and ideal for loading programs into the RAM of a microprocessor-based computer.

The floppy disk is a record-like disk of flexible plastic coated with the same magnetic substance used to make recording tape. Bits are stored as the presence or absence of magnetized spots on as many as a hundred or more concentric data tracks around the surface of the disk. The disk is spun at high speed, and a read/write head on a movable track permits access to any data track. Floppy disks provide very high capacity storage

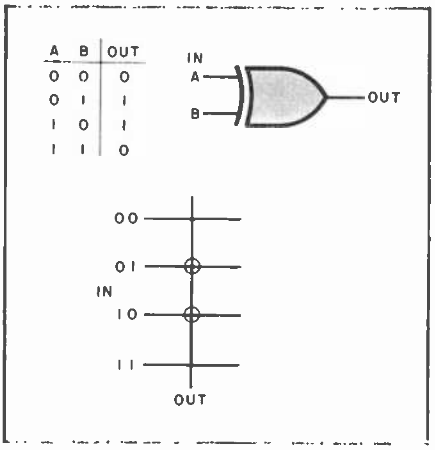


Fig. 3. At upper right is the logic symbol for Exclusive-OR, with its truth table at left. Below is the diode ROM for the same function.

with considerably faster access times than magnetic tape. But floppy disk systems are expensive; they often cost more than the computer.

Three-State Logic. Thus far we've learned something about basic logic gates, combinational and sequential logic circuits, and memories. We're almost ready to begin using these various devices as electronic building blocks to design a microprocessor. All that remains is to introduce a new kind of logic circuit called the *three-state gate*.

As you will recall from Part 1, the output of *all* the logic gates and circuits we've covered so far is various combinations of 0's and 1's. This is known as two-state logic.

A third output called the high-impedance (high-Z) state is available in three-state logic. In the high-Z state the output of a three-state gate is electronically disconnected from the gate. It's as if an on-off switch between the gate and its output line were turned off. In conventional operation, when the switch is on, 0's and 1's appear at the output.

A simple three-state buffer is shown in Fig. 5. When the *control* (or enable) input is logic 1, the buffer transmits the logic state (0 or 1) at its input to its output. When the control input is logic 0, the output enters the high-Z state.

All the basic gates are available in three-state versions. And many kinds of more advanced circuits such as flip-flops, counters, registers, and combinational networks are available with three-state outputs.

Three-state logic makes it possible to connect the output of two or more logic circuits to a common conductor called a bus. It's not possible to connect the outputs of two or more two-state gates to the same bus since some outputs may be logic 0 and others logic 1. Three-state logic means many gates can be connected to the same bus so long as the output of all but one of the circuits is in the high-Z state.

Several three-state buffers are connected to a common bus as shown in Fig. 6. Look at this circuit for a moment. Notice how the array of control inputs (C) allows data to be guided from any of the three inputs to either or both of the outputs. This operation is similar to that of a multiplexer, and three-state logic is sometimes used to simulate a multiplexer. More importantly, the circuit allows data to travel along the bus in either direction. That's why a three-state bus is often called *bidirectional*.

Register-to-Register Data Transfers. A typical microprocessor contains several data storage registers. Three-state logic provides an efficient way to transfer data from one of these registers to another.

Figure 7 shows three 4-bit registers connected to a common 4-conductor bus. The output of each register is connected to the bus through a 4-bit three-state buffer. This is why both the input *and* output lines from a register can be connected to the same bus.

Each register in Fig. 7 has three control inputs: Read, Write, and Clock. A logic 0 at its Read input places a register's output in the high-Z state and isolates the data stored in it from the bus—and therefore the other registers. A logic 1 at the Read input enables the three-state buffer and places the data in the register on the bus. Note that only *one* register can be in the Read mode at any one time; otherwise two or more registers will conflict with one another.

Data on the bus can be written into one or more registers by applying a logic 1 to the appropriate Write inputs. When the next clock pulse arrives, the data will be written into the selected register (s).

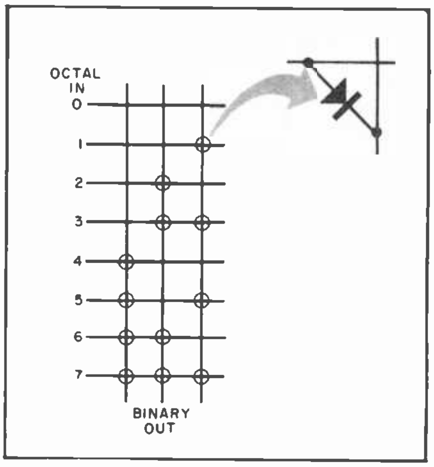


Fig. 4. A ROM programmed as an octal-to-binary encoder, a circuit usually designed with OR gates.

Let's try a data transfer from register A to register C in Fig. 7. First, place A's Read input at logic 1. Then place C's Write input at logic 1. When the next clock pulse arrives, the contents of A will be copied into C. Register A will continue to retain its data, but the data in C will be lost.

You can use this simple procedure to transfer the contents of register A, B, or C to either or both of the remaining registers. What control inputs would you place at logic 1 to transfer the data word in register C to registers A and B?

The Concept of Control. We're almost ready to see how a microprocessor is put together. First, let's think about the control inputs to the three registers in Fig. 7.

There are nine authorized ways to transfer data among these registers: A into B; A into C; B into A; B into C; C into A; C into B; A into B and C; B into A and C; and C into A and B. A convenient way to categorize these data transfer options is to list them next to the bit pattern required at each of the control inputs as shown in the box below.

Operation	Control Inputs					
	A/R	A/W	B/R	B/W	C/R	C/W
A → B	1	0	0	1	0	0
A → C	1	0	0	0	0	1
B → A	0	1	1	0	0	0
B → C	0	0	1	0	0	1
C → A	0	1	0	0	1	0
C → B	0	0	0	1	1	0
A → B & C	1	0	0	1	0	1
B → A & C	0	1	1	0	0	1
C → A & B	0	1	0	1	1	0

Now each of the transfer possibilities is identified by its own binary control word. In a microprocessor, the control words that transfer data between registers and perform many other operations are called microinstructions.

Often it's necessary to make several transfers, one after another, between registers. For instance, one possible sequence using the circuit in Fig. 7 is A into B; B into C; and C into A. From the table above, the microinstructions required for these operations are:

100100
001001
010010

In a microprocessor, a sequence of microinstructions that carries out a specific series of operations like this is called a microroutine.

Microprocessors have a special control section that automatically generates the microroutines necessary to transfer data inside the microprocessor and perform many other operations as well.

The Microprocessor. The function of a conventional digital logic circuit cannot be significantly changed without extensive rewiring. The microprocessor is radically different. It can be made to perform many different functions simply by changing a sequence of binary words or instructions stored in one or more memory chips which are external to the microprocessor.

Its programmable nature makes the microprocessor essentially identical to the central processing unit of a digital computer. Add an external memory chip to store instructions and data, and a microprocessor becomes a microcomputer. Some recent microprocessors include on-chip memory for instructions and data and are called single-chip microcomputers.

Though a microprocessor can be used as part of a computer, there are numerous, less glamorous but equally important, applications ranging from traffic-light controllers and electronic scales to "smart" test instruments and pocket calculators. In many of these applications the microprocessor's program is permanently stored in a ROM. Several of these types of memories containing different programs can be used with the same microprocessor to accomplish various applications.

Microprocessor Organization. A minimal microprocessor contains a control section, a program counter that steps through the instructions and data stored in an external memory, several data and instruction registers, and an arithmetic logic unit (ALU). One way these circuits can be organized with respect to one another and to both a control and an address/data bus to form an ultra-simple microprocessor is shown in Fig. 8.

There's nothing remarkable or unusual about any of these circuits. What's important is the way they're connected to the two buses. Let's look at some of the operations performed by each of the sections in our basic microprocessor.

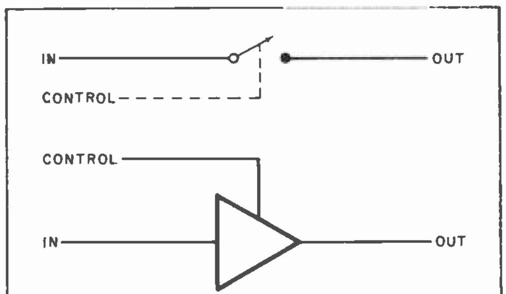
Control Section. The control section is the nerve center of a microprocessor. A typical microprocessor can execute perhaps fifty or more different instructions in almost any combination or sequence. (We'll look at some representative instructions later.) It's the role of the control section to fetch instructions one at a time from the ROM or RAM program memory connected to the microprocessor's address/data bus, decode and then execute them with a sequence of microinstructions; after which, it fetches the next instruction.

Program Counter. The program counter keeps track of a program that's being executed. It's simply a counter whose outputs are used as address inputs to the external memory containing the program and data being processed by the microprocessor.

The program counter and the address/data bus control how many words of external memory can be accessed by a microprocessor. Thus a 4-bit program counter can access a 16-word (2^4) memory. An 8-bit program counter can access 256 (2^8) words, and a 16-bit program counter can access 65,536 (2^{16}) words.

Normally the program counter sequences through a program one step at a time in ascending numerical order. Certain instructions, however, can load the program counter with a new data word which it will then use as the next external memory address. This allows the microprocessor to *branch* or *jump* to different parts of a program or loop through a specified section of program more than once.

Branching and looping can be unconditional or conditional. In the latter case, the program counter will receive a new address *only* if a specified condition is



CONTROL	IN	OUT
0	0	HI-Z
0	1	HI-Z
1	0	0
1	1	1

Fig. 5. Simple three-state buffer can be represented by switch as shown at top. Below is its logic symbol and truth table.

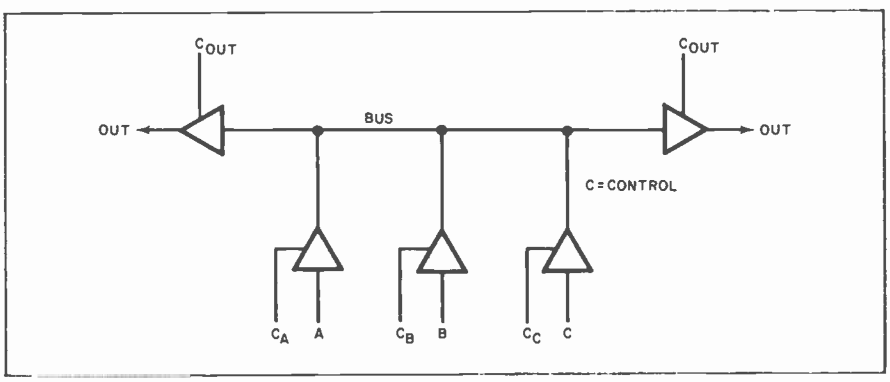
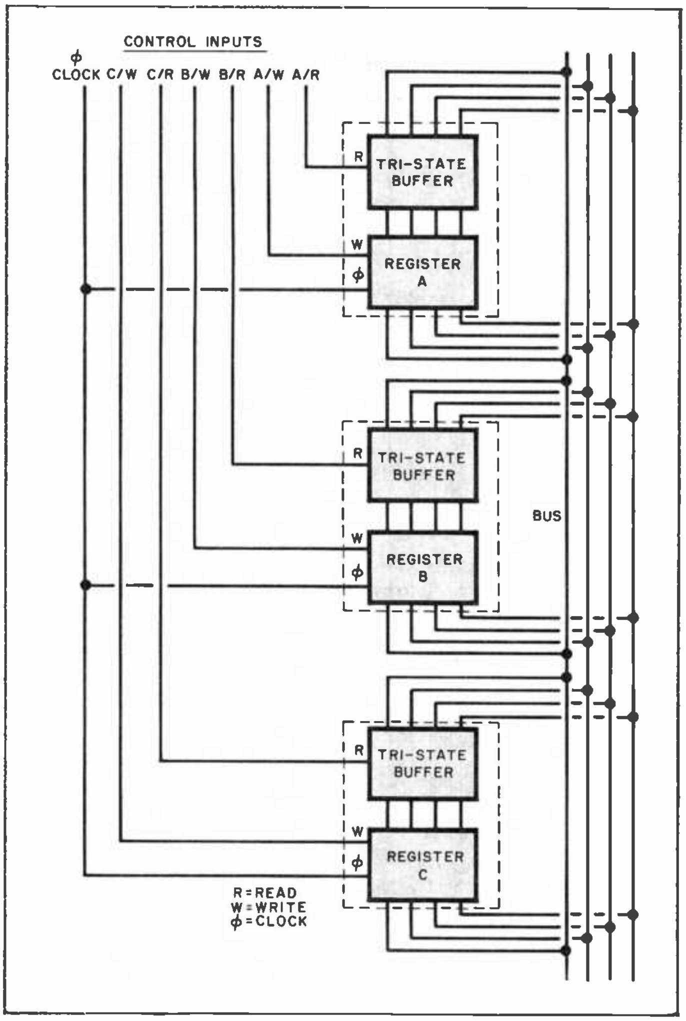


Fig. 6. Three-state buffers connected to a common bus. Since data can travel either way, the bus is called bidirectional.



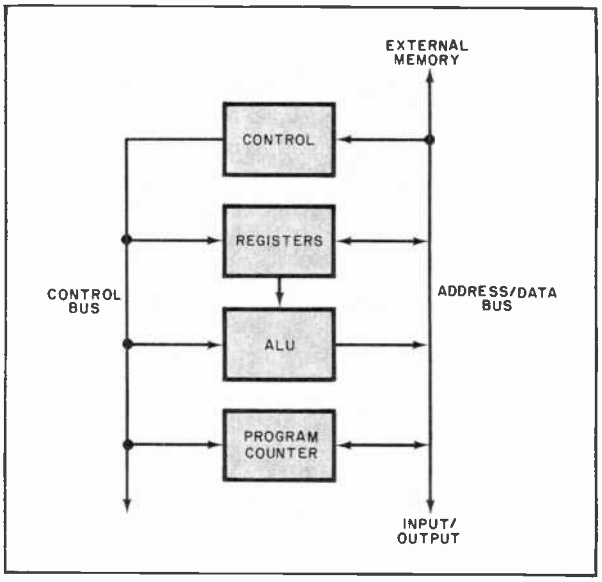


Fig. 8. Organization of a basic microprocessor. The control section is the nerve center. Counter sequences through a program one step at a time. Register is for storage, and ALU performs arithmetic or logic operations.

Fig. 7. Three 4-bit registers connected to a common 4-conductor bus through 4-bit three-state buffer. The three control inputs are: Read, Write, and Clock.

met (for example, a negative result of a previous calculation, etc.).

Registers. A microprocessor has several registers for the temporary storage of data, addresses, and instructions. The memory address register stores the address from the program counter until it's time for the control section to fetch a new address. The instruction register stores the instruction fetched from the external memory until it's been executed and a new instruction has been fetched. Various data registers store words awaiting further processing and act as output buffers.

The accumulator register stores intermediate and final results of operations by the ALU. It may have the ability to increment (add 1 to) or decrement (subtract 1 from) a word as well as shift a word left or right a bit at a time. Often data entering and leaving a microprocessor must pass through the accumulator. Therefore it's the most important register in a microprocessor.

Arithmetic Logic Unit. The ALU can perform arithmetic or logic operations on one or two data words. The accumulator is closely associated with the ALU. Typically, the accumulator supplies one of the words to be processed by the ALU. The result is then fed from the ALU's output back to the accumulator over the address/data bus.

MPU Programming. So far we've emphasized the *hardware* aspects of microprocessors. Hardware is important; but without software, the programs that tell a microprocessor what to do, a microprocessor is of no practical use. You might say software is to a microprocessor what recipes are to a cook.

A microprocessor has dozens of instructions in its instruction set, and it's the job of the programmer to combine some or all of them in a way that will cause the microprocessor to accomplish a given task.

One common microprocessor instruction is load the accumulator or simply LDA. This instruction loads the accumulator with the data word which follows it in the program. Incidentally, LDA is an abbreviated form of the instruction called a *mnemonic* by programmers.

Other common microprocessor instructions are JMP (jump unconditionally to the specified address); JZ (jump *only* if a zero is loaded in a special flip-flop); JP (jump *only* if the result of an operation is postive); CLA (clear the accumulator to 0); ADD (add contents of accumulator and data register and place sum in accumulator); MOV (move data from one specified register to another); RAL or RAR (rotate the bits in accumulator left or right); and HLT (halt the microprocessor).

Of course these instructions are only representative of those available with real microprocessors. Nevertheless, they provide an excellent illustration of the computer-like power of the microprocessor.

Next Month. We'll introduce PIP-2, a simple *P*rogrammable *I*nstruction *P*rocessor that demonstrates many fundamentals of microprocessor operation. We'll study PIP-2's operation in detail and learn how to program it. ◇

BY JOSEPH CARR

HOW TO DESIGN & BUILD POWER SUPPLIES

PART 2

Some typical, easy-to-build circuit applications.

LAST MONTH, we discussed the elements of power supplies, especially the low-voltage, high-current types used in microcomputers and other large-scale digital electronic projects. This month, we will give some advice on the overall circuit design of such supplies and discuss several construction projects.

Some Basics. The transformer for the supply should have a current rating higher than that required by the electronics system it is powering. Many transformers will operate excessively hot when operated at their rated current, so a safety margin is a good investment. Also, keep in mind that, when a transformer is specified, a bridge-rectified supply can safely draw only one-half of the transformer's rated secondary current without exceeding the transformer's primary VA (volts times amperes) rating. In some cases the secondary rating can be exceeded, but it is risky.

A filtered power supply will produce an output that is close to the peak voltage appearing across the transformer secondary, but the transformer ratings are likely to be in terms of the rms voltage, which is defined as 0.707E *peak*. The voltage that appears across the filter capacitor will be between 0.9E *peak* and the peak voltage, rather than the rms voltage.

You may conclude then, that the output voltage will approach 1.4 times the rms voltage rating of the transformer secondary. For a typical power supply designed for the Altair (S-100) bus systems, a 6.3-volt transformer with a bridge rectifier will generate the "nominal 8 volts" required with this approach. Alternatively, a 12.6-volt transformer and a conventional full-wave rectifier will also do the trick. These secondary voltages are popular in high-power transmitter filament supplies, so it is relatively easy to locate both 6.3- and 12.6-volt transformers having high current ratings at electronics surplus dealers, hamfests, and auctions. One transformer manufacturer, Triad, makes three transformers that power-supply builders should investigate. The F-22U is rated at 6.3 volts at 20 amperes; the F-24U at 6.3/7.5 volts at eight amperes; and the F-28U at 6.3/7.5 volts at 25 amperes. The last two models offer the advantage of a tapped primary so that either 6.3 or 7.5 volts appear across the secondary, depending on which tap is used.

Do not skimp on the rectifiers. Always use individual rectifier diodes, or molded bridges with current ratings greater than the expected requirements. If possible, a rectifier having a rating 150 to 200% higher than the current predicted should be used.

The peak inverse voltage (piv) or peak reverse voltage (prv) as it is sometimes called, is critical. The peak voltage is defined as 1.4 times the rms rating of the transformer, and this is the voltage to which the filter capacitor charges.

Once during each power-line cycle, the capacitor voltage is in series with the entire rectifier voltage, so the reverse voltage applied to the diodes is two times 1.4 rms, or 2.8 times rms. This means that the piv rating of the rectifier diode should be 2.8 times the applied rms voltage. Some designers prefer three times rms for safety.

When using a 6.3-volt transformer, there are few problems since the lowest piv rating for most rectifier diodes is about 25 volts. However, consider the case when a 12.6-, 18-, or 24-volt transformer is used. In the first case, a 50-volt piv diode rating is adequate; but in the second, this rating is marginal; and in the third case, it is unsatisfactory. In the latter two cases, a 100-volt piv rectifier is required.

When using regulator transistors, or three-terminal IC voltage regulators, be generous with the size of the heatsink. This is not an area in which to skimp, since getting rid of heat is essential to the long life and reliability of the circuit. Keep in mind that a shorted series-pass transistor in a power supply can easily destroy the circuit it is powering. Even if an associated overvoltage protection circuit works properly, it might not operate fast enough to protect certain types of semiconductors.

8-Volt, 15-Ampere Supply. The Altair bus, also called the S-100 bus by non-Altair manufacturers, uses the concept of distributed voltage regulation. In this case, the computer mainframe power supply generates a well-filtered but unregulated +8 volts. Each circuit board that "plugs" into the bus has its own 5-volt regulator, usually of the 1-A type.

Most three-terminal regulators require an input voltage 2 to 3 volts higher than the output voltage rating. If a lower voltage is applied to the input, the voltage will drop and become unregulated.

The power dissipated by a regulator is $(V_{in} - V_{out})I$. Thus, with an 8-volt input, a regulator that delivers 5 volts at its full rated current of 1 ampere will dissipate 3 watts of heat. The S-100 bus 8-volt supply then, is proper for the +5 volts required by TTL devices. Up to +35 volts could be used as the input for such regulators, but that is unwise since it would increase the dissipation of the regulator to the danger point.

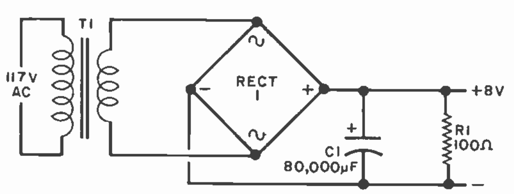
The circuit for an 8-volt, 15-ampere power supply is shown in Fig. 1. Transformer *T1* is rated at 6.3 volts and 25 amperes. The rectifier is a 25-ampere bridge stack mounted on its own heatsink. The filter capacitor (*C1*) is rated at 80,000 μF and reduces the ripple to a few millivolts. Resistor *R1* across the output is required for static testing since the unloaded voltage approaches 14 volts—common with high-current, low-voltage transformer supplies. Resistor *R1* solves the problem at a cost of only 80 mA of current drain. Transformer *T1*, like many high-current units, comes with "solderless" terminals. These did work loose during construction so a good lesson to learn is: always solder solderless connections. This becomes imperative in high-current supplies.

Since the major expense in this (and other) high-current power supplies is the transformer, it may pay to shop judiciously through various surplus stores that handle electronic equipment, in search of transformers in the 15-to-30-ampere range.

5-Volt, 4-Ampere Regulated Supply. Most digital circuits use many TTL logic units, and therefore require a power source of 5 volts at a couple of amperes. The circuit shown in Fig. 2 can deliver well-regulated 5 volts at 4 amperes (or 5 amperes with regulator and rectifier heatsinking).

The circuit is powered from a transformer rated at 6.3/7.5 volts at 8 amperes. Capacitor *C1*, the main filter, was selected according to the rule requiring 2000-μF/output ampere. This produced a value of 8000 μF. Tantalum capacitors are used for *C2* and *C3* to reduce the susceptibility of the voltage regulator to noise pulses on the power line. For best results, these capacitors must be mounted as close as possible to the input and output connectors of the regulator. Capacitor *C4* is used to improve the transient response of the regulator under highly dynamic current changes while the digital circuit is operating (see Part 1). The value of *C4* is determined by the 100-μF/output ampere rule, so it should be 400 μF but the next highest standard value of 500 μF is used.

The voltage regulator is a three-terminal device that can deliver 5 volts at 5 amperes. In this case, it was a Lambda type LAS-1905 (Lambda Electronics, 515 Broad Hollow Road, Melville, NY



C1 RECT1 T1

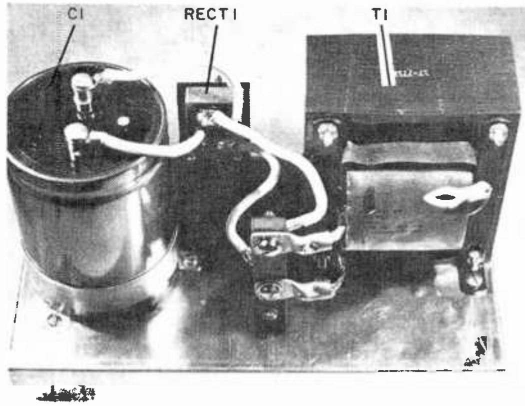


Fig. 1. Basic 8-volt, 15-ampere dc source. Note heavy wiring between elements.

PARTS LIST

C1 — 80,000-μF, 15-V electrolytic
R1 — 100-ohm, 2-W resistor
RECT1 — 25-A bridge rectifier (GE GEBR-425 or similar)
T1 — 6.3-V, 25-A transformer (Triad F-28U or similar)

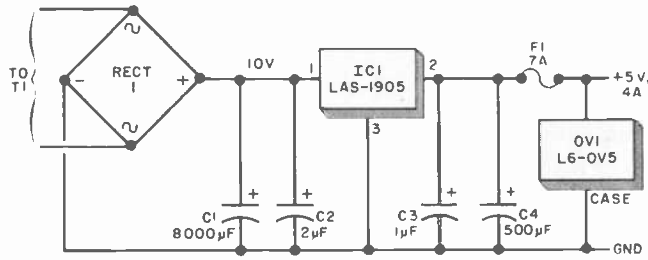
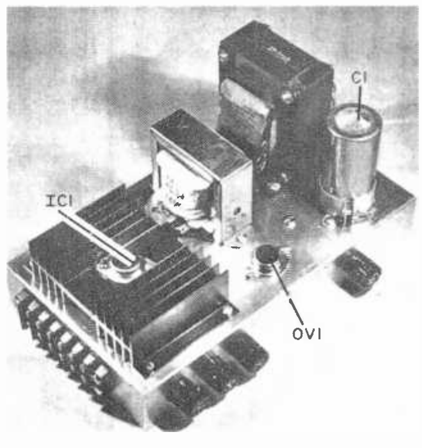


Fig. 2. Five-volt, 4-A dc supply with overvoltage protection. Extra transformer is for an unregulated supply whose components are not shown.

PARTS LIST

C1 — 8000-μF, 25-V electrolytic
C2 — 2-μF, 25-V tantalum capacitor
C3 — 1-μF, 25-V tantalum capacitor
C4 — 500-μF, 15-V electrolytic
F1 — 7-A, fast-blow fuse and holder
IC1 — 5-V, 5-A regulator (Lambda LAS-1905 or similar)
OV1 — 5-V overvoltage protector (Lambda L6-OV5 or similar)
RECT1 — 25-A bridge rectifier (GE GEBR-425 or similar)



11746). Although the single-unit price is about $14, this one device does save the several components that would be required to use a low-current regulator drive with a series-pass transistor. It is also much simpler to use.

As usual, provide a suitable heatsink for the voltage regulator so that it will run cool at its full rated current.

The over-voltage protection (*OV1* in Fig. 2), is an SCR crowbar type (see Part 1) also manufactured by Lambda. This TO-3 size protection circuit will fire the crowbar at 6.6 volts. Note that pin 1 of this circuit is left floating for proper operation in this application.

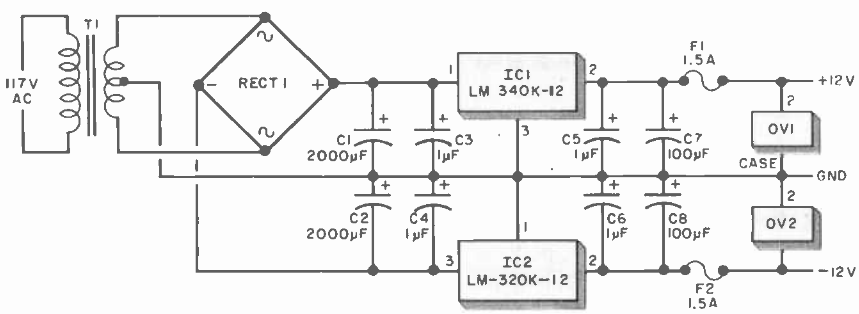
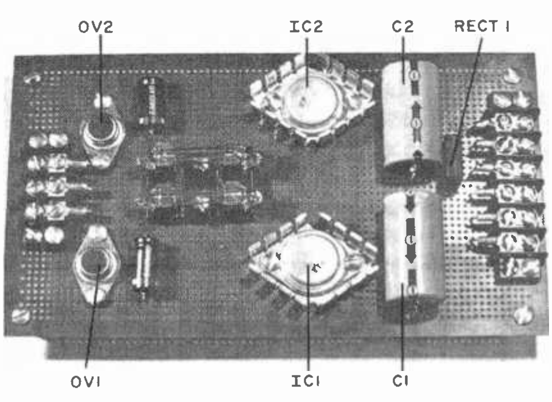


Fig. 3. Dual-polarity 12-volt supply includes optional overvoltage protection. Note use of barrier strips for power-supply connections.



PARTS LIST

C1,C2 — 2000-μF, 25-V electrolytic
C3 through C6 — 1-μF, 25-V electrolytic
C7,C8 — 100-μF, 15-V tantalum capacitor
F1,F2 — 1.5-A 3AG fuse and holder
IC1 — +12-V regulator (LM340K-12 or similar)
IC2 — −12-V regulator (LM320K-12 or similar)
OV1,OV2 — 12-V overvoltage protector (Lambda L2-OV12 or similar)
RECT1 — 1-A, 200-piv bridge rectifier
T1 — 25.2-V, 2.8-A transformer (Triad F-56X or similar)

12-Volt, 1-Ampere Supply. Many circuits, including those using linear IC's (especially op amps), and S-100 boards require dual-polarity supplies at reasonable current. The circuit shown in Fig. 3 features two supplies driven from a common transformer, delivering +12 and 12 volts to ground at 1 ampere each.

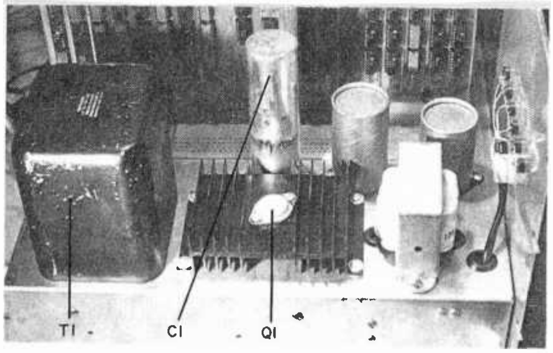
The transformer is a 25-volt center-tapped unit rated (at the least) at 2 amperes. However, if you intend to operate close to the 1-ampere output, the transformer may either run hot, or not deliver the current, so a unit rated at 3 amperes is preferable.

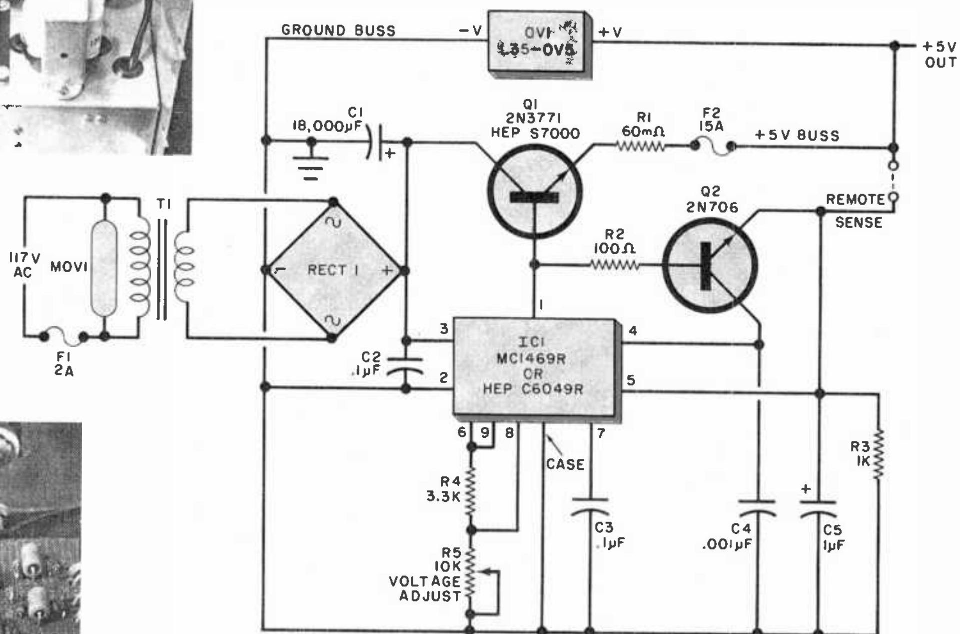
The circuit uses a full-wave bridge stack (with a minimum rating of 1 ampere), but it is actually wired as two half-wave rectifiers since the transformer center tap is the common ground. The negative terminal of the bridge feeds the negative supply, while the positive terminal feeds the positive supply.

The filter-regulator portions of the supply are the same as those previously used, except that independent regulators are used for each side. As usual, provide heatsinks for the regulators to keep them operating cool. Note also that over-voltage protection modules (OV1 and OV2) are used. Since these modules are available in only one polarity, the negative supply protector is used "upside down," making it necessary to "float" the case above ground.

5-Volt, 10-Ampere Supply. The circuit shown in Fig. 4 delivers regulated 5 volts at 10 amperes. The transformer delivers 6.3 volts at 20 amperes. The series-pass transistor (*Q1*) and the IC voltage regulator are conventional HEP types. Two versions of the IC regulator are available, but only the one having the "R" suffix is suitable for this application. (The low-power version, having the "G" suffix, may work properly heatsinked). Capacitors *C2*, *C3*, and *C4* should be mounted as close as possible to the appropriate pins of the IC voltage regulator.

Pin 5 of the regulator is the output-sense terminal and is used to provide means for remotely sensing the level of the output voltage. Ordinarily, this is not a requirement for low-current supplies, but at high output currents (several amperes), the voltage drop in the wiring between the power supply and load can re-





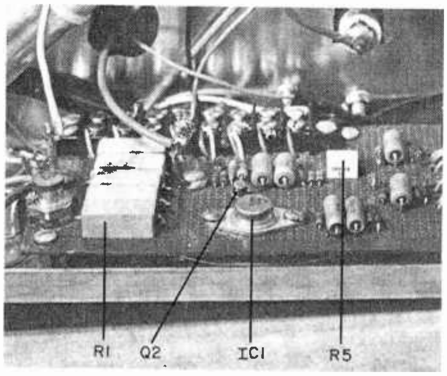


Fig. 4. Typical regulated supply for 5 V at 10 A. Circuit includes a line over-voltage protector and current limiting regulator. Photo at top shows top of chassis. Underneath view is directly above.

PARTS LIST

C1 — 18,000-μF, 15-V electrolytic
C2,C3 — 0.1-μF, 50-V capacitor
C4 — 0.001-μF, 50-V capacitor
C5 — 1-μF, 25-V tantalum capacitor
F1 — 2-A, 3AG fuse and holder
F2 — 15-A, fuse and holder
IC1 — MC1469R, HEP C6049R (Motorola) voltage regulator
MOV1 — Metal oxide transient suppressor (GE)
OV1 — 5-V overvoltage protector (Lambda L35-OV5 or similar)
Q1 — 2N3771, (Motorola) HEP S7000
Q2 — 2N706 or similar
R1 — 60-milliohm (use five 0.33-ohm in parallel)
R2 — 100-ohm, ½-W resistor
R3 — 1000-ohm, ½-W resistor
R4 — 3300-ohm, ½-W resistor
R5 — 10,000-ohm trimmer potentiometer
RECT1 — 25-A bridge rectifier (GE GEBR-425 or similar)
T1 — 6.3-V 25-A transformer (Triad F-28U or similar)

duce the voltage at the load below the 4.75 volts specified for proper operation of TTL devices. In one test, 18 inches of #12 wire dropped the 5-volt output of the power supply to 4.5 volts at the TTL devices, resulting in erratic operation.

The remote sense line, connected to pin 5, is connected to the same point on the TTL board as the +5-volt line from the main power source. Thus, the IC regulator is using the actual board voltage as the reference, and can compensate the power supply for the unwanted voltage drop. This means that the actual output of the power supply is higher than the nominal 5 volts. If wiring voltage drop is not a problem in your system, simply connect the remote sense line (pin 5) to the actual output (+5 volts) of the supply. Again, overvoltage protection is provided by a crowbar circuit.

A new element can be added to this circuit—a line over-voltage protector across the transformer primary. This particular device (called a MOV) is made by General Electric and "looks" like a pair of back-to-back zeners, having a 117-125-volt ac voltage rating. It clips any high-voltage line transients that exceed the rated voltage. These line transients, which can reach many hundreds of volts, can be generated by local lightning storms or by inductive loads being switched somewhere on the common power line. Keep in mind that semiconductor junctions fail catastrophically when excessive voltage is applied, in many cases for only a very brief time. The use of the MOV does not guarantee that you will have complete protection, but it does give the system a chance to survive such a transient.

Another feature of the supply shown in Fig. 4 is current limiting with auto shutdown. Pin 4 of the IC regulator (the current limiting input) is controlled by transistor *Q2*. The base bias of *Q2* is controlled by the voltage drop across the small-valued series resistor *R1*. (This resistor, a 60-milliohm unit, can be fabricated from five 0.33-ohm resistors connected in parallel.) The value of this resistor for other current-limiting levels can be calculated (approximately) from $R1 = 0.6/I$.

At an output current of 8.5 amperes, series-pass transistor *Q1* started to operate uncomfortably hot after about 20 minutes. A 50-cfm "muffin" fan was used to blow air across the heatsink of *Q1* and solved this problem. Without the fan, the case temperature of *Q1* is too hot to touch after one hour of operation, but with the fan, it remains comfortably warm. The cooler operation of the voltage regulator will prolong its life. ◇

BY HAL LEFKOWITZ

Build a FAIL-SAFE TIMER

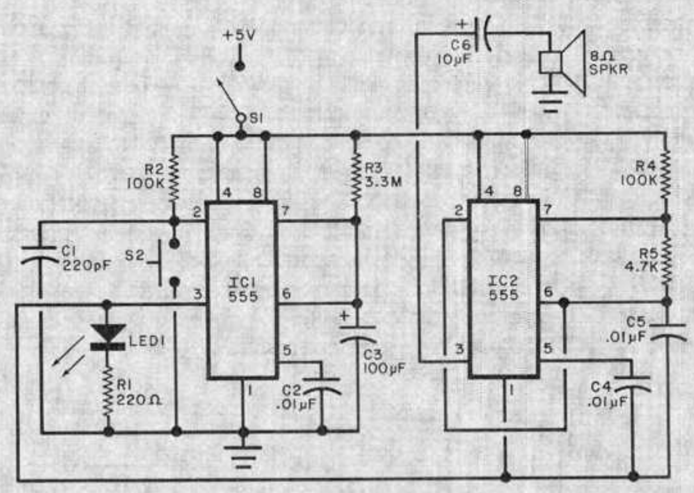
Easy-to-construct circuit lets you know if a timer should fail.

ONE OF THE integrated circuits most commonly used by electronics enthusiasts is the 555 timer. A typical application for this ubiquitous chip is as an elapsed time indicator. Here, the 555 functions in the monostable mode and drives either a beeper or LED to indicate the end of a time period. Unfortunately, such a circuit usually has no way of alerting the user when the timer is not working properly. This problem is circumvented by the use of the Fail-Safe Timer. A simple project, the timer will not only notify you when the specified period has elapsed, but will also tell you at a glance if it is still "ticking."

About the Circuit. As shown in the diagram, two 555 IC timers (or a 556 dual timer) form the heart of the circuit. The first (*IC1*) operates in the monostable mode. When triggered by *S2*, the one-shot output goes high and *LED1* glows to indicate the timing cycle. When the timing interval is over, the output of *IC1* goes low, darkening the LED and grounding pin 1 of *IC2* and the lower plate of timing capacitor *C5*. The second timer is an astable multibrator whose output is capacitively coupled to a small 8-ohm speaker. When pin 1 of the IC and the lower plate of *C5* are grounded, *IC2* generates a 1300-Hz tone.

If for any reason the one-shot (*IC1*) output goes low *before* the timing cycle is finished, the LED will darken to alert you. Of course, you can use a LED or relay at the output of *IC2* if you prefer a visual indication of elapsed time. Connect a diode in parallel with the relay coil (cathode to pin 3 of the IC, anode to ground) to protect the chip's output transistor from voltage spikes.

As mentioned earlier, the Fail Safe Timer is triggered by closing *S2*. This switch can be replaced with a touch switch. Simply connect a length of hookup wire to pin 2 of *IC1* and another wire to ground. Remove ½" (1.3 cm) of the insulation from the free ends of the wires, and fasten them to a flat, nonconducting surface. The wires should be spaced about ¼" (6.4 mm) apart, parallel to each other but not in electrical contact. The lightest touch of your finger across the exposed conductors will initiate the timing interval.



One IC timer (IC2) sounds an alarm after the other has timed out.

PARTS LIST

C1—220-pF disc ceramic capacitor
C2,C4,C5—0.01-μF disc ceramic
C3—100-μF, 16-V tantalum
C6—10-μF, 16-V electrolytic
IC1,IC2—NE555V timer (or 556 dual timer)
LED1—TIL-32 light emitting diode
The following are ¼-watt, 10% tolerance carbon composition resistors.
R1—220 ohms
R2,R4—100,000 ohms
R3—3.3 megohms
R5—4700 ohms
S1—Spst switch
S2—Normally open, momentary contact pushbutton switch
SPKR—8-ohm dynamic speaker
Misc.—Printed circuit or perforated board, suitable enclosure, hook-up wire, machine hardware, etc.

Uses and Modifications. The circuit as shown is used by the author as a callsign identifier alarm during his conversations via amateur radio. Of course, you can adapt the timer for many other applications.

The length of the timing period can be changed by varying the values of *C3* and *R3* according to the equation $T = 1.1(R3)(C3)$, where T is the timing interval in seconds, *R3* is in ohms and *C3* is in farads. Note, however, that the tolerance of many electrolytic capacitors is −50%, +100%. Unless you use a close-tolerance tantalum capacitor, you might end up with a timing interval anywhere from one half to twice the calculated duration.

The pitch of the warning tone can be raised by increasing the value of *R4* or *C5*, or both. Similarly, it can be reduced by using a smaller value of resistance or capacitance. ◇

Solid State

By Lou Garner

THE LIGHT CONNECTION

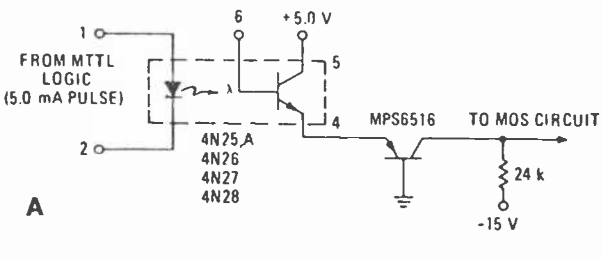
WHETHER you're a dedicated experimenter or a casual hobbyist, chances are you're always looking for something new to try—a new circuit to breadboard, perhaps, a new device to work with, or a new project to assemble. Certainly, anything new is exciting, different and challenging; but in the search for "newness" one shouldn't neglect older devices. If you haven't looked at optoelectronic couplers recently, for example, you may be in for a big surprise. Using infrared or visible light as a coupling medium, the early devices were relatively simple, comprising a LED light source and a low-voltage phototransistor or photodiode in a single package. Today, however, you can obtain off-the-shelf devices offering high-voltage transistors, high-gain Darlington pairs, and even thyristor outputs as well as conventional diodes and transistors. The expanding array of optoelectronic couplers can be used in a whole galaxy of interesting projects, with the number of potential applications limited only by the imagination, skill and knowledge of the circuit designer.

Let's look at a few of the many different circuits in which optoelectronic couplers can be used. Abstracted from device data sheets published by Motorola Semiconductor Products, Inc. (Box 20912, Phoenix, AZ 85036), these designs feature standard commercial components available through franchised local as well as mail order distributors. Intended primarily for interface applications—that is, to provide isolation between a signal or control source and another stage or load—the circuits are suitable for use in a variety of worthwhile and exciting projects, including computers, data processors, communication systems, alarms, remote controls, data transmission links, electronic musical instruments, test equipment, and electronic games. Depending on the specific application, the individual circuits may be incorporated into complete equipment designs or used primarily as interface elements between subsystems. Generally, the circuits can be duplicated using conventional assembly and wiring techniques, for neither layout nor lead dress should be overly critical as long as good construction practice is observed.

Featuring the Motorola 4N25 series (4N25, 4N25A, 4N26, 4N27, and 4N28), the circuits shown in Fig. 1 represent typical applications for a low-voltage LED/phototransistor coupled pair. Supplied in 6-lead miniDIP's, each device comprises a gallium-arsenide infrared LED optically coupled to an npn silicon photo transistor. In each, the LED has a maximum V_R rating of 3.0 volts and a maximum continuous forward current rating of 80 mA, although it can tolerate narrow pulse peak currents of up to 3.0 A, while the phototransistor has a maximum V_{CEO} rating of 30 volts and a maximum power dissipation of 150 mW (at 25°C). All devices in the series have a typical frequency response of 300 kHz and offer a minimum isolation voltage of 7500 V.

Suitable for applications in equipment and system designs using a combination of TTL and PMOS IC's, the TTL to PMOS logic translator circuit given in Fig. 1A uses a 4N25 series device in conjunction with an MPS6516 pnp common-base buffer amplifier. A typical subsystem interface application is shown in Fig. 1B; here, a pair of optoelectronic couplers serve as interconnection line drivers between a computer and one of its peripheral instruments (such as a data logger), providing both line and dc isolation. Quite versatile, the basic optoelectronic coupler also can be used to drive a power amplifier or to gate an SCR, controlling the power delivered to an inductive load such as a motor or solenoid.

Fig. 1. Optoelectronic applications:
(A) Logic level translator; and
(B) Computer/peripheral interface.



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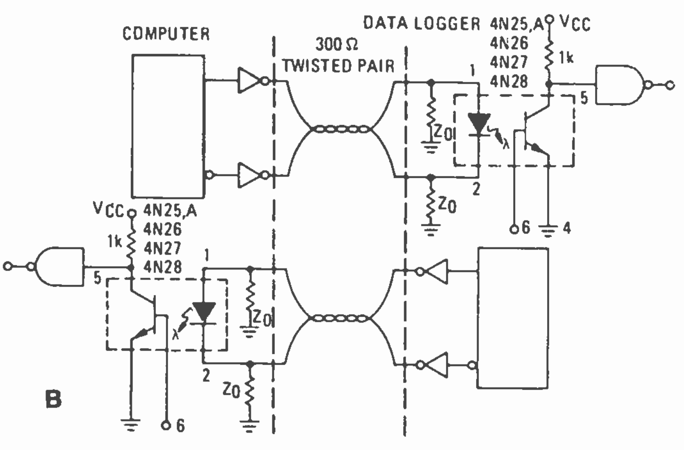

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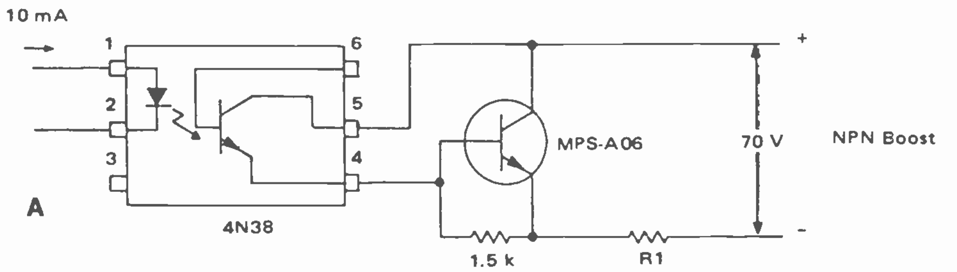


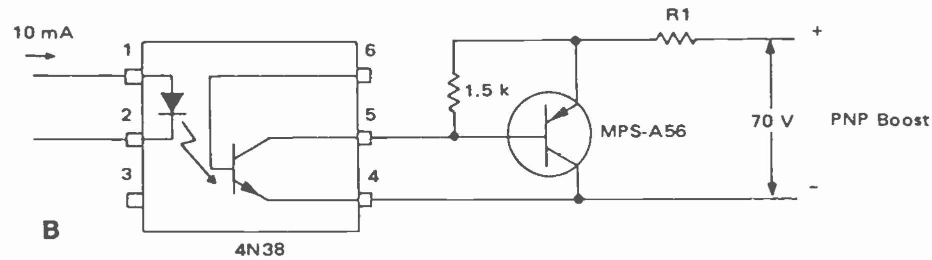


Fig. 2. Typical teletypwriter interface circuit featuring npn (A) and pnp (B) drivers.

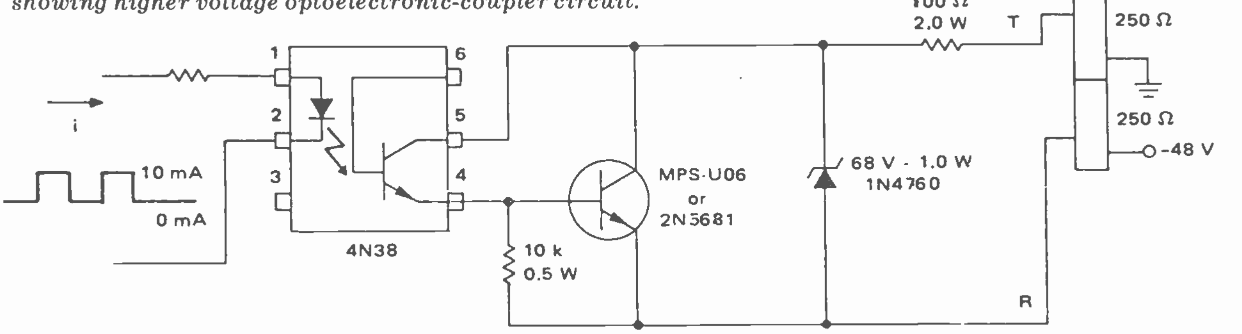
Typical application circuits for a higher voltage optoelectronic coupler, the 4N38/4N38A, are given in Figs. 2 and 3. As the 4N25 series, the 4N38 offers a minimum isolation voltage of 7500 volts, comprises a gallium-arsenide infrared LED optically coupled to an npn silicon phototransistor, and is supplied in a 6-lead miniDIP. The phototransistor, however, has a maximum V_{CEO} rating of 80 volts, permitting the device to be used in such applications as a teletype (TTY) interface, telephone line pulser, and as a driver for high-voltage relays. Two typical TTY interface circuits are shown in Fig. 2, one featuring an MPS-A06 npn output stage (Fig. 2A), and the other an MPS-A56 pnp buffer amplifier (Fig. 2B). In both, *R1* should be a 3300-ohm, 2-W resistor for 20-mA systems or an 1100-ohm, 5-W resistor for 60-mA systems. A telephone line pulse circuit is shown in Fig. 3, with the optoelectronic coupler driving an npn transistor shunted by a zener diode to eliminate transient spikes caused by the inductive (relay) load.

In optoelectronic couplers, higher current transfer ratios—a measure of overall sensitivity—may be achieved by replacing a simple phototransistor with a photo-sensitive Darlington pair. Typical Motorola devices featuring Darlington outputs are the 4N29 series (4N29, 4N29A, 4N30, 4N31, 4N32, 4N32A, and 4N33), the MOC8050, and the MOC8030. All of these devices employ gallium-arsenide infrared LED light sources and npn silicon photo-Darlington transistors and are supplied in 6-lead miniDIP's. The LED characteristics are similar: V_R rating of 3 volts, a maximum continuous forward current of 80 mA, and a maximum peak current of 3 A. The isolation voltages also are comparable—7500 volts for the 4N29 series and 700 volts for the MOC8050/MOC8030. The 4N29 series output transistors, however, have a maximum V_{CEO} of 30 volts compared to 80 volts for the MOC8050/MOC8030. Representative application circuits for these devices are given in Figs. 4, 5, and 6.

In Fig. 4A, a 4N29 series photo-Darlington coupler has been combined with an MPS6515 npn transistor to form an optically coupled one shot. Feedback is provided from the transistor's collector to the photo-Darlington's base (pin 6) by a 100,000-ohm resistor. Operation is initiated when a control voltage is applied to the LED, causing the photo-Darlington to conduct heavily and effectively shorting the external transistor's base bias to ground through capacitor C. The transistor's collector voltage rises as the device stops conducting and remains at a peak until capacitor *C* is charged through *R*, permitting base bias to be restored; the transistor starts conducting again and its collector voltage drops. Since the output pulse width depends on the time required for the capacitor to charge, its duration is determined by the RC time constant.

An optically isolated zero-voltage ac line switch circuit is shown in Fig. 4B. Here, the 4N29 series photo-Darlington coupler controls a zero-crossing detector which, in turn, switches a 2N6342 triac through a 2N3906 pnp buffer amplifier stage. Zero-voltage line switches are used for controlling heavy electrical loads, such as high-power incandescent lamps or heaters, which may appear as virtual short circuits when power is first applied. In an incandescent lamp, for ex-

Fig. 3. Telephone line pulser is an application showing higher voltage optoelectronic-coupler circuit.



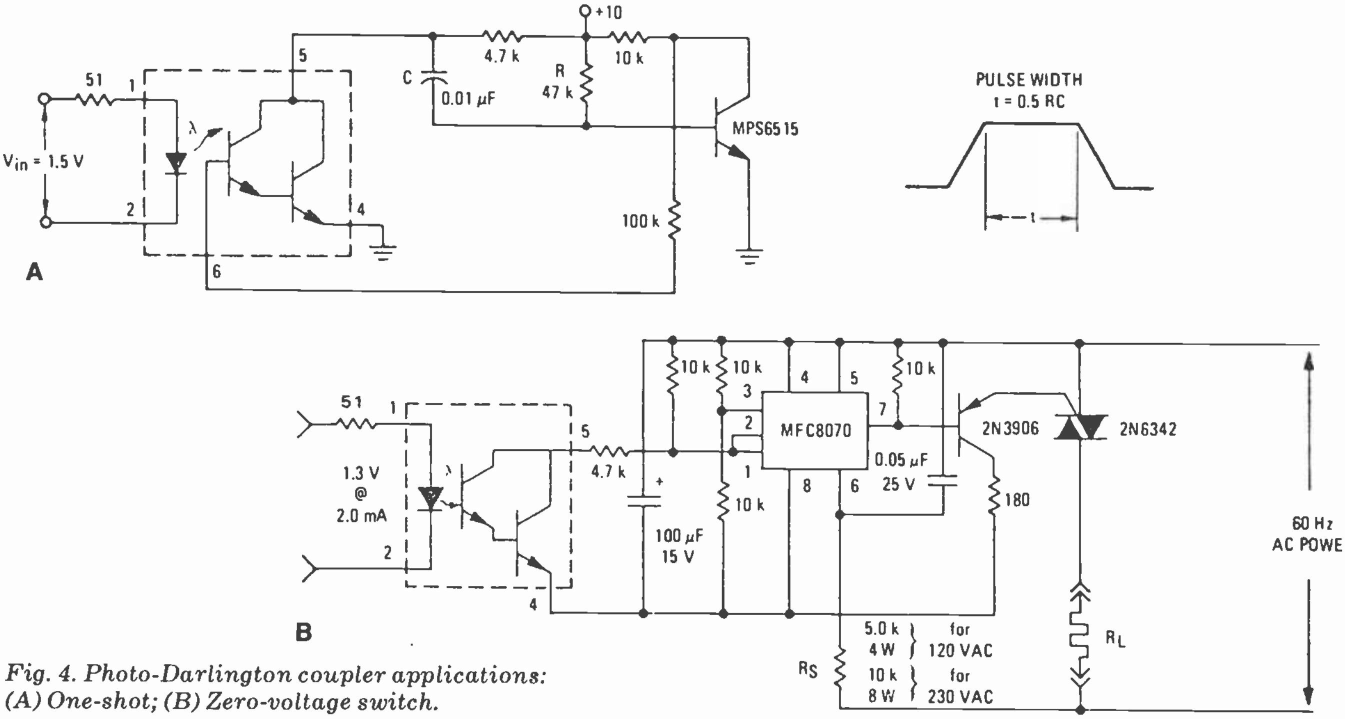


Fig. 4. Photo-Darlington coupler applications: (A) One-shot; (B) Zero-voltage switch.

ample, the filament's cold resistance is but a small fraction of its hot resistance, resulting in a large current surge if peak voltage is applied suddenly. With ordinary household lamps, this characteristic is not a serious problem, although lamps may tend to "burn out" most often when first switched on. Where high power levels are involved, however, a zero-voltage switch may be essential to avoid blown fuses, tripped circuit breakers, and fused relay or switch contacts.

Two additional optically isolated ac switch or solid-state relay circuits are provided in Fig. 5. Both use 4N29 series photo-Darlington couplers. In the first, Fig. 5A, the optoelectronic coupler serves to trigger a 2N5060 SCR which controls a 2N6155 triac through an MDA920-2 full-wave bridge rectifier. In operation, the unloaded bridge rectifier acts as an open circuit, preventing the application of a gate voltage to the triac and thus holding this device in a nonconducting state. When loaded by the conducting SCR, however, the bridge rectifier becomes a bidirectional conductor, applying an ac gate signal which switches on the triac, thereby supplying power to the external load.

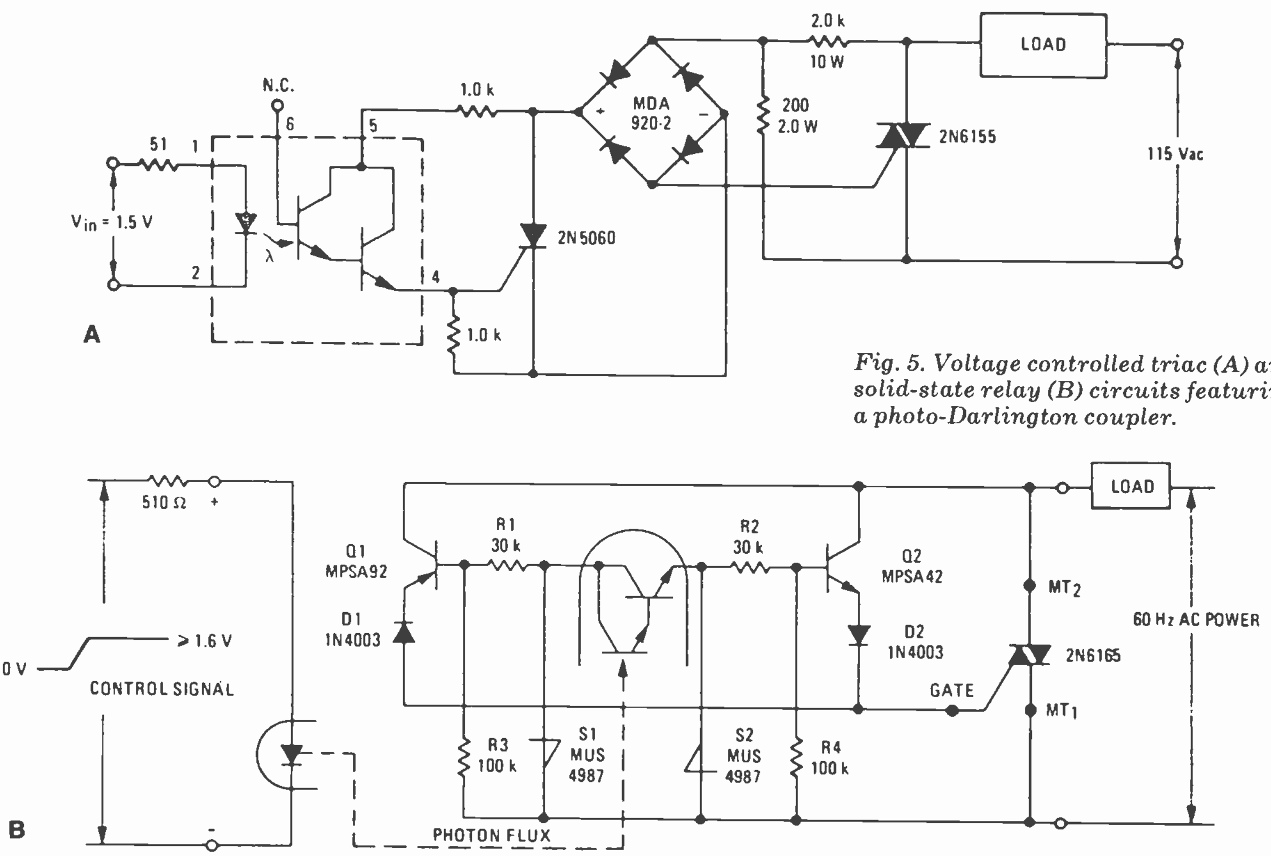


Fig. 5. Voltage controlled triac (A) and ac solid-state relay (B) circuits featuring a photo-Darlington coupler.

In the second circuit, Fig. 5B, the triac's ac gate signal is supplied on alternate half cycles through pnp and npn transistors *Q1* and *Q2* and isolation diodes *D1* and *D2*, respectively. The transistors, in turn, are controlled by the optoelectronic coupler.

Figure 6 illustrates a technique for using a high-voltage photo-Darlington coupler, the MOC8050, to interface positive CMOS or TTL logic circuits to a negative-voltage actuated telephone relay. In operation, the optoelectronic coupler provides electrical isolation while, at the same time, achieving an effective change in both control voltage level and dc polarity.

Yet another optoelectronic coupler and representative circuit applications are given in Fig. 7. Motorola's MOC3010/MOC3011 series comprises a gallium-arsenide infrared LED source and a photosensitive silicon bilateral switch, as shown in Fig. 7A. The LED is similar to the type used in the other optoelectronic couplers, having a maximum V_R rating of 3.0 volts and a maximum continuous forward current rating of 50 mA. Intended as a triac driver, the bilateral switch has an *off*-state voltage rating of 250 V and is able to supply a maximum rms current of 100 mA in its *on* state, although it can furnish a nonrepetitive peak surge current of 1.2 A. Supplied in a 6-lead miniDIP, the MOC3010/MOC3011 series has an isolation surge voltage rating of 7500 V and a maximum rated power dissipation of 330 mW per device at 25°C. With a modest current handling capability, the MOC3010/MOC3011 devices may be used alone as drivers for medium-power ac loads, as in the logic-controlled lamp circuit shown in Fig. 7B.

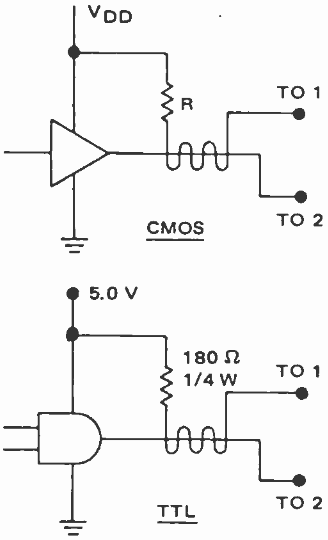
Reader's Circuit. Submitted by Lee Wright (8531 E. Laredo Lane, Scottsdale, AZ 85253), the digital frequency-divider circuit illustrated in Fig. 8 offers an interesting advantage over more familiar designs—it delivers a *symmetrical output waveform* even when dividing by odd numbers such as 3, 5, 7, 9, 11, etc. Most conventional dividers deliver symmetrical outputs *only* when used for *even* division (2,4,6,etc). Symmetrical signal waveforms are not only desirable for optimum performance in many applications, but are an absolute necessity for some digital circuit systems. Requiring only three active CMOS devices, Lee's design can be duplicated quite easily in a single evening for breadboard tests and experiments. It may be used, typically, in such projects as electronic musical instruments, test equipment, counters, alarms, decoders, and control systems.

Referring to the schematic and timing diagrams, Figs. 8 and 9, respectively, the frequency divider comprises an exclusive-OR circuit, *IC1*, a five-stage Johnson decade counter, *IC2*, and a type-D flip-flop, *IC3*. The Johnson counter is operated in its standard modulo-N configuration. In operation, each successive output, starting with Q_0, goes high on the rising edge of the clock input, with the preceding output going low. As Q_N goes high, the *reset* also goes high, causing counter *IC2* to return to Q_0 and to continue counting. The D flip-flop, *IC3*, is connected as a divide-by-2 counter, delivering a symmetrical output signal. The key capability of dividing by an odd number is achieved by the use of an exclusive-OR gate (*IC1*) at the counter input which serves, essentially, as a controlled inverter. When the Q output of *IC3* is low, *IC1* is on, permitting the input signal, f_{IN}, to be applied to *IC2* unchanged. When the *Q* output of *IC3* is high, however, *IC1* effectively inverts f_{IN}, causing *IC2* to be triggered on the negative edge of the input signal, as illustrated in the timing diagram. The net result is a symmetrical output signal equal to $f_{IN}/(2N-1)$. If the Q3 output of *IC2* is used, for example, f_{OUT} is then $f_{IN}/[2(3)-1] = f_{IN}/5$, or one-fifth the input frequency. Since the Johnson counter (*IC2*) has outputs up to Q_9, the circuit can be used for any *odd* number frequency division from 1 to 17. If greater division ratios are needed, two or more counters may be cascaded.

With neither layout nor lead dress critical, the frequency-divider circuit can be assembled on perf or a suitable pc board. However, the customary wiring precautions governing CMOS devices should be observed to avoid damaging the IC's. The specified devices are inexpensive and readily available through local as well as mail order parts distributors. *IC1* is one section of a type 4070 quad exclusive-OR gate, *IC2* is a type 4017 Johnson decade counter, and *IC3* is one section of a type 4013 dual D flip-flop. Depending on the individual semiconductor manufacturer's specifications, dc-supply voltages may range from 3 to 18 volts. As a general rule, the higher the dc source voltage, within maximum limits, the higher the switching speeds of CMOS devices, hence the higher the signal frequencies that can be processed by the circuit. Lee writes that his design is capable of handling input frequencies up to the megahertz range with an adequate dc supply.

Device/Product News. Providing all the functions of a comprehensive FM i-f system for applications in high-fidelity, automotive and communications receivers, a new IC, the CA3189E, has been introduced by the RCA Solid State Division (Box 3200, Somerville, NJ 08876). Supplied in a 16-lead plastic DIP, the device includes a three-stage limiting amplifi-

(Continued on page 74)



SOLID STATE *(Continued from page 69)*

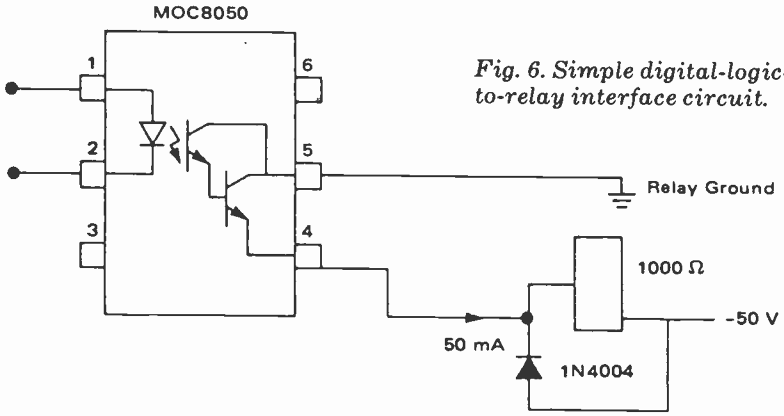


Fig. 6. Simple digital-logic-to-relay interface circuit.

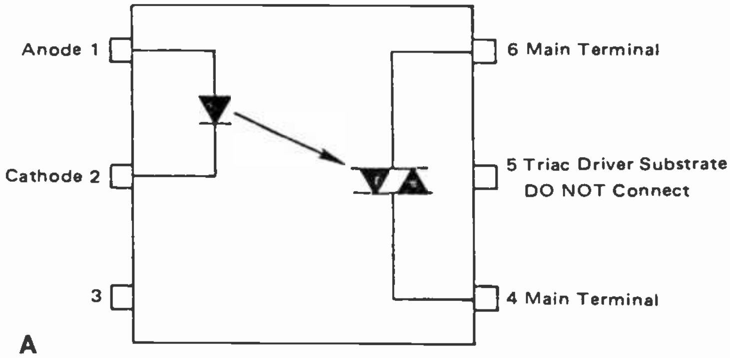
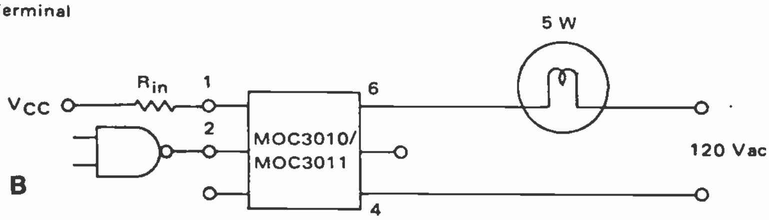


Fig. 7. Optically coupled triac driver: (A) Internal schematic and lead connections; (B) Lamp driver circuit.



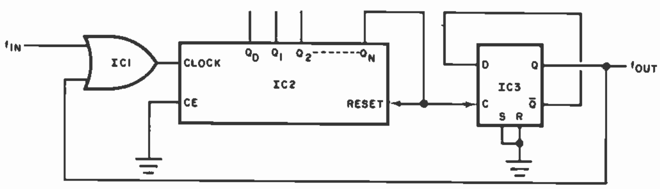


Fig. 8. Frequency divider circuit from a reader provides symmetrical output waveform even when dividing by odd numbers.

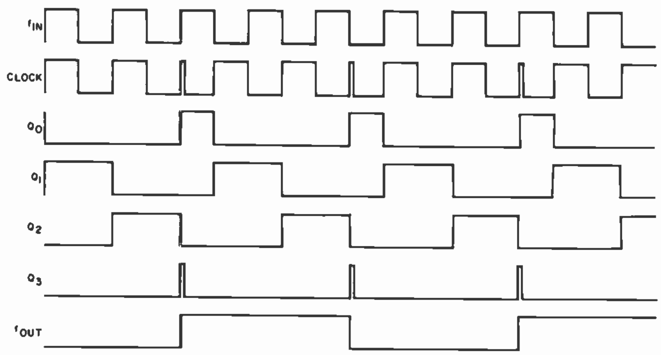


Fig. 9. Timing diagram for the frequency divider circuit in Fig. 8.

er, doubly balanced quadrature FM detector, audio amplifier, afc drive circuit, tuning meter drive circuit, zero-point tuning meter output, and an agc r-f stage control circuit. Other features of the unit are a deviation mute (squelch) drive combined with a signal-to-noise mute function which, if desired, may be used to provide an "on channel" step voltage. With internal power supply regulators, the CA3189E can be operated on dc source voltages of 8.5 to 16 volts.

RCA also has introduced another series of devices of potential interest to experimenters and hobbyists—the CA810 family of 7-watt monolithic audio amplifiers. Intended for class-B service in mobile equipment using 12-volt dc power supplies, the units can operate on dc sources from as low as 4 to as high as 20 volts with very low harmonic and crossover distortion. With a maximum repetitive peak output current of 2.5 A, the IC's feature an integral thermal limiting circuit which shuts down operation in case of output overload or excessive package temperature. Four versions of the CA810 are available, all furnished in special 16-lead quad-inline plastic packages with built-in wing tab heat sinks. Of these, two versions have tabs for insertion in a pc board, the other two pierced flat tabs for attaching an external heat sink. All four types have similar electrical characteristics, but two versions, identified by an "A" suffix, include overvoltage protection circuits. ◇

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CIRCLE NO. 38 ON FREE INFORMATION CARD

Experimenter's Corner

By Forrest M. Mims

THE MONOSTABLE MULTIVIBRATOR

MULTIVIBRATOR is an old-fashioned term for a circuit that vibrates or oscillates between two different output states. You're probably already familiar with one member of the multivibrator family, the *bistable* multivibrator or flip-flop. As you know, the flip-flop has two outputs occupying complementary logic states. A single toggle pulse applied to the flip-flop will reverse the status of the two outputs. Another member of the multivibrator family is the *astable* or *free-running* multivibrator. This circuit functions like an oscillator

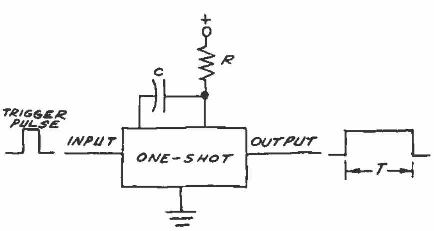

Fig. 1. Connections to a monostable multivibrator.

with two outputs continually and automatically occupying alternate states.

The multivibrator we'll be concerned about this month is the *monostable* multivibrator. As its name implies, this circuit has only one stable state. An input pulse will trigger the output into a temporary unstable state. After a fixed time interval, the output will automatically return to its stable state. This is why the monostable multivibrator is often called a "single-shot" or "one-shot."

Figure 1 will help you understand the operation of a one-shot. As you can see, the one-shot requires an external capacitor and resistor to control the width (*T*) of the output pulse. The output pulse width is approximately *R* times *C* ($T=RC$) when *R* is given in megohms and *C* in microfarads. Thus, a 100,000-ohm resistor and a 0.01-microfarad capacitor will give an output pulse width of approximately one millisecond.

One-shots are often used in circuits that require either fixed or variable time delays. Switch debouncing is one common application. The output pulse of a one shot is adjusted to exceed the maximum bounce time of the switch contacts, providing a clean output pulse.

Although one-shots have many applications, you should think twice before using them as design shortcuts in many digital applications. The dependence on an external capacitor and resistor can make one-shots less precise than the circuit to which they're connected. That makes them unsuitable for many applications in computers, counters, etc.

A One-Shot Demonstration Circuit. It's possible to make all three types of multivibrators from simple gates. However, there is an ample variety of integrated versions of each multivibrator available to the experimenter.

Figure 2 shows how you can connect a 74121 integrated TTL one-shot to demonstrate monostable operation. You can plug the five components and assorted leads into a solderless breadboard and have the circuit running in a couple of minutes. Test the one-shot by disconnecting pin 5 from ground. (Open the normally closed switch by pushing it.) The LED will immediately turn on and continue to glow for about half a second if you use the values for *R1* and *C1* shown in Fig. 2. For briefer output pulses, reduce the value of either *R1* or *C1* or both.

The 555 One-Shot. The 555 timer is far superior to the 74121 when long time delays are required. The 555 was originally designed as an integrated timing circuit; but because a one-shot is essentially a timer, the 555 is well suited for many monostable applications. It can produce very long time delays with a suitable timing capacitor and operates with a wide range of power supply voltages (4.5-16 volts).

Figure 3 shows the connections necessary to use the 555 as a one-shot. The timing cycle is initiated by grounding the chip's trigger input (pin 2). The output (pin 3) immediately goes to the positive supply voltage, and remains there until timing capacitor *C1* charges up to two-thirds of the power supply voltage. The output then goes to ground and *C1* is discharged.

A convenient feature of the 555 is the reset function. It's sometimes necessary, particularly during long time delays, to reset the circuit for another timing cycle. This is easily done by applying a negative-going pulse to the trigger (pin 2) and the reset (pin 4) inputs. This discharges *C1* and prepares the chip for a new timing cycle which commences on the positive edge of the reset pulse.

Capacitor *C2* is a bypass used to pre-

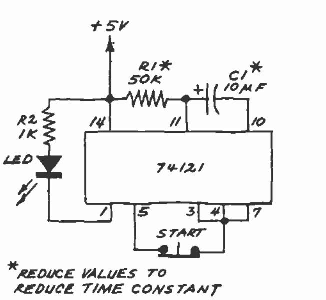

Fig. 2. A 74121 TTL monostable multivibrator.

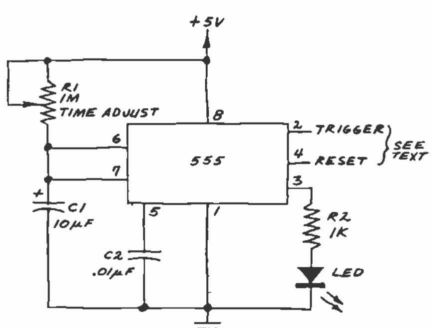

Fig. 3. A 555 in monostable mode.

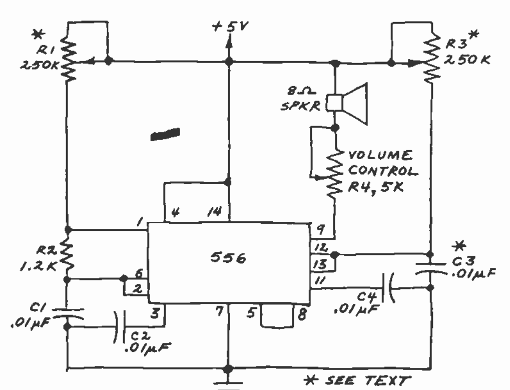

Fig. 4. Astable-monostable divider.

vent external noise from upsetting the operation of the timer.

You can build the circuit shown in Fig. 3 on a solderless breadboard in a few minutes. The LED will glow when the 555 output is high and turn off when the output goes low.

One-Shot Sound Effects Generator. Figure 4 shows a simple circuit you'll want to build if you like the far-out sound effects of movies like "Star Wars." The circuit uses a dual version of the 555 timer, the 556. One half of the 556 operates as an astable multivibrator. Its output is connected to the input of the other timer, which functions as a monostable multivibrator.

In operation, the astable feeds pulses to the one-shot at a rate determined by the values of *R1* and *C1*. The one-shot responds by producing an output pulse for each incoming pulse.

The pulse width of the one-shot's output is determined by the time constant of *R3* and *C3*. What happens when the width of the pulses exceeds the spacing between incoming pulses? The one-shot simply ignores any trigger pulse or pulses that occur during the timing cycle. In short, the monostable acts as a *frequency divider*.

The audible effects of frequency division can be quite striking. By experimenting with the frequency of the astable while changing the width of the pulses from the one-shot, you'll hear some very unusual, science fiction-type sounds. Connect a capacitor substitution box (Heathkit IN-3147 or similar) in place of *C3* to experiment with different one-shot time constants. For really dramatic effects, replace both *R1* and *R3* with cadmium-sulfide photocells (Radio Shack 276-116 or similar). Turn off the room lights and play the beam from a flashlight across the cells to produce the sound effects. You can experiment with the position of the cells relative to one another and hand movements in the path between the light source and the cells for best results.

Incidentally, if you have access to a dual-channel oscilloscope, you can observe what happens during frequency division. Connect one probe to pin 5 or pin 8 and the second probe to pin 9. Adjust potentiometers *R1* and *R3* (or vary the intensity of the light shining on photocells you've substituted for these pots) while viewing the screen. You'll find the resulting display quite fascinating, especially if you leave the speaker connected while making the adjustments. ◇

Product Test Reports

SENCORE MODEL CB41 AUTOMATIC CB PERFORMANCE TESTER

Measures output power, percent modulation, and SWR.

THE Sencore Model CB41 automatic CB performance tester conveniently checks the operation of CB transmitters. It provides measurements of r-f output power directly in watts, peak-envelope power (PEP) on SSB and AM, percent modulation for AM, and the standing-wave ratio (SWR) presented by the transmitter load or antenna system.

Only two connections are required to install the tester in the CB system. No initial adjustments are needed, making parameter readings possible in a matter of seconds. The tester is entirely automatic. The user simply depresses one of three pushbutton switches to select the parameter he wishes to measure. The tester can accommodate up to 12 watts average power and 25 watts PEP into 50 ohms. If desired, it can remain connected to the CB system to provide continuous monitoring of the signal.

The tester itself measures 8½" × 5½" × 3⅜" (21.6 × 14 × 8.6 cm), while its companion sensor measures 4¼" × 1⅝" × 1⅝" (10.8 × 4.1 × 4.1 cm). Nationally advertised value is $148.

General Description. The tester does not simply employ the basic circuitry sometimes used for measuring the various functions. It contains an r-f sensing unit, IC buffer, IC integrator, IC comparator, 60-Hz clock oscillator, peak-to-peak diode detector, and transistor amplifier that drives a 100-μA meter movement. Operation is from a pair of internal 9-volt batteries.

The sensor produces reference signals from three loops that are oriented parallel with its internal transmission-line conductor. Each sensing loop is sensitive to a "travelling wave" in only one direction (forward power, reverse power, or modulation). The reference voltages derived from these loops are converted to dc and applied to the inputs of the comparator, either directly or through an integrator, as required. This circuit controls the meter's pointer, switching on and off the meter at a 60-Hz rate.

The meter is turned on as the integrator starts to produce a ramp signal, the slope of which depends on the reference voltage applied to the integrator. This ramp voltage is compared with one of the reference voltages; when both signals are equal, the meter is shut off. The meter indication, therefore, is proportional to the reference voltage that controls the slope of the ramp and the voltage at the dc input of the comparator. The duty cycle lengthens as the reference voltages rise, with a resulting increase in the meter indications. The circuits are reset at a 60-Hz rate by the clock oscillator.

It is specified that the r-f response of the tester for power readings is flat for 20 to 30 MHz, which makes it suitable for covering all 40 class-D CB channels. Calibrated at 3 watts, the specified accuracy of the tester is ±3° of arc.

For SWR tests, the system is self-calibrating; you do not have to set a calibration control as with most other SWR indicators. The forward and reverse power are compared with an accuracy of ±5° of arc for SWR's of 1:1 to 3:1 when used with an unbalanced nonreactive load over a power range of 1 to 15 watts.

The percent-modulation indication covers a 0-to-100% range. It is self-calibrating for AM and refers the peak-to-peak detected audio to average power. Accuracy is rated at ±5% of full-scale with inputs of 1 to 12 watts PEP (also SSB). Initial calibration is performed with continuous-tone monitoring.

In addition to the sensing loops, the unit contains a 50-ohm dummy load. A switch terminates the sensing section in either the dummy load or the CB antenna system. Except for SWR readings, all tests can be made into the dummy load to prevent on-the-air interference. On the other hand, the CB antenna system can be left in the circuit for continuous monitoring of the signal.

Test Results. Tests against several of our professional power meters indicated that the readings of the Model CB41 come within about 0.25 watt at 4 watts and within 0.5 watt or less at all other power levels when working into low SWR's.

Testing the SWR function, we determined that the indications obtained when working into the dummy load were fine. The dummy load's resistance measured 53.3 ohms (instead of 50 ohms), but the tester was satisfactorily calibrated against this resistance for a 1:1 SWR. Working into a true 50-ohm load located externally, the SWR was a little less than 1.1:1. It was also slightly off with a 25-ohm load, for an SWR of 2:1. However, the calibration was close enough to ensure indication of best antenna matching and power indications within its published specifications.

Our modulation readings were within 5% of the rated figures. R-f power and modulating power into the dummy load must be limited to an average of 12 watts (25 watts PEP on a 30-second on/off duty cycle). Maximum modulation indications being limited to 100% prevent the tester from registering overmodulation accurately, particularly on the negative peaks. Additionally, modulated waveforms cannot be observed for waveform distortions.

User Comment. This tester is quite handy to use. Detailed instructions are included with the tester. (The instructions are also given on a cassette tape that is fumished with the tester.) The manual also details how the instrument can be recalibrated should this ever become necessary.

The price of the tester may appear to be a bit high for the CB operator, but it is less than would be required for the separate testers that would be needed to perform all the tests this instrument can perform. This compact multipurpose tester is ideal for mobile installation servicing, where its cost for a virtual all-in-one test station is very modest indeed. Furthermore, its accuracy is more than adequate for this purpose.

HEATHKIT MODEL HW-2036 2-METER TRANSCEIVER

VHF/FM mobile amateur transceiver features synthesized coverage.

THE Model HW-2036 is the Heath Company's latest and most sophisticated vhf FM amateur transceiver. Among its features are synthesized coverage of any 2-MHz segment from 143.5 to 148.5 MHz in 5-kHz increments, true FM transmitter circuitry, dual-conversion receiver with MOSFET front end, and a 10-watt minimum-output power amplifier designed to operate into an infinite VSWR without failure.

The transceiver is housed in a rugged metal cabinet that measures 9⅞"D × 8¼"W × 2¾"H (24.5 × 21 × 7.1 cm) and weighs 6¼ lb (2.8 kg). Available as options and tested here are the Model HWA-2036-3 ac power supply (housed in the same size cabinet as the transceiver) and the Model HD-1984 Micoder II microphone/Touch Tone encoder pad. Available only in kit form, the transceiver is catalog priced at $269.95 with standard microphone or $289.95 with the Micoder II. Separate purchase price of the Micoder II kit is $34.95, while the optional power supply kit price is $37.95.

General Description. Although the transceiver's circuit is fairly complex, the layout of the front panel is simple. Three lever switches with the numerals 0 through 9 are provided for setting the operating frequency in a MHz/kHz × 100/kHz × 10 format, while a separate toggle switch permits selection of either 0 or 5 kHz. In a typical setup, the switches might be set for 6.250 to obtain an operating frequency of 146.250 MHz. Note that the most significant digits, 1 and 4, are implied.

Two rotary switches provide for selection of transmitter offsets and continuous-tone coded squelch signals. Splits of −600, 0 (simplex), and +600 kHz are determined by the setting of the MODE switch, which also has an AUX position for use of nonstandard offset (such as +1 or −1 MHz) when a suitable crystal is installed.

The TONE switch controls a low-frequency IC oscillator for CTCS purposes. When this switch is OFF, the tone circuit is disabled. In the A, B, or C position, the switch connects a multiturn trimmer potentiometer to the IC timer. These pots can be adjusted to produce tones from 70 to 200 Hz.

The front panel also has two potentiometers, two LED's, and a meter movement. The pots are for controlling receiver VOLUME and SQUELCH. An amber LED comes on when the receiver is unsquelched, while a red SYNTH LOCK LED comes on when the frequency synthesizer is not phase-locked. The meter, whose scale is numbered 0 through 5, indicates relative signal strength or r-f output power. It is back-lighted for easy viewing in the dark.

Two phono jacks, a slide switch, and heatsinks occupy the rear panel of the transceiver. One jack is the antenna input, while the other is for an external speaker. The slide switch routes the audio output to the built-in or external speaker.

Five printed circuit board assemblies and a wiring harness make up the transceiver's circuitry. The synthesizer section receives an 833.33-Hz reference signal from a crystal oscillator and IC dividers on the transmitter board. It also receives the voltage-controlled oscillator's (vco's) output signal. The accuracy and stability of the vco depend on the accuracy and stability of two temperature-compensated, crystal-controlled oscillators. One oscillator operates at 10 MHz; its output is divided down to produce the 833.333-Hz reference signal, while the other (offset) oscillator operates in the region of 20 MHz.

The vco is phase-locked to the two oscillators. The output of the offset oscillator is mixed with the output of the vco. Then a low-pass filter feeds the difference signal to a Schmitt trigger that shapes the waveform so that it is compatible with the programmable dividers. The dividers are programmed by the BCD output of the frequency selector switches. When the output of the vco corresponds to the frequency selected by the switches, the output of the divider chain is close to 833.333 Hz. A phase comparator then compares this frequency with the divided output of the reference oscillator. If the two are equal, no error voltage is developed, the frequency of the vco is unchanged, and the loop is phase-locked.

If the two compared frequencies are not equal, the comparator generates pulses that are integrated (averaged) by a loop filter into an error voltage. This voltage is applied to the vco and shifts the output of the programmable divider chain toward 833.333 Hz to bring the loop into the phase-locked condition.

If the loop becomes unlocked, the red SYNTH LOCK LED glows. Ordinarily, loop lock-up time is less than 50 ms. If the loop does not relock within 500 ms, the transmitter is disabled to prevent radiation of out-of-band signals. The inhibit circuit also disables the transmitter if the switches on the front panel are set below 4.000 or above 7.995. This feature can be defeated for operation on CAP and MARS frequencies by removing a jumper on the synthesizer circuit board.

The heart of the vco is an ECL IC that is tuned by a fixed coil, a capacitor, and a Varactor diode. In the receive mode, two more fixed capacitors are switched into the circuit to compensate for the receiver's i-f and lower the output frequency of the vco. In the transmit mode, frequency modulation is accomplished by applying the modulating signal to a second Varactor diode.

An active low-pass filter on the vco board removes any residual 833.333-Hz

(Continued on page 84)

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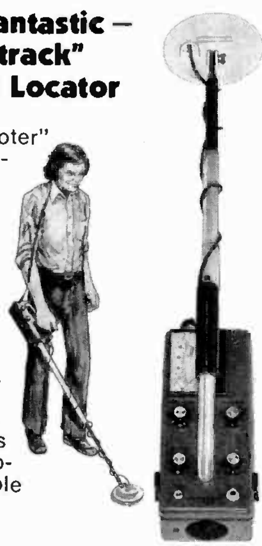

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CIRCLE NO. 5 ON FREE INFORMATION CARD

(Continued from page 79)
component from the error signal before it is applied to the first Varactor diode. A 5-volt regulator supplies only the ECL oscillator and active filter, isolating them from the rest of the transceiver.

Transmitter and Receiver. Signals from the antenna pass through a double-tuned circuit to a MOSFET r-f amplifier in the receiver section. The output of the amplifier circuit is also double-tuned. The amplified signal is then passed to a MOSFET first mixer. A tripler on the synthesizer board multiplies the output frequency of the vco and its output is further multiplied by a doubler on the receiver board. Hence, the sixth harmonic of the vco's output frequency is applied to the MOSFET mixer.

The 10.7-MHz i-f signal from the mixer goes to an eight-pole crystal filter. It is then amplified by an op-amp IC i-f stage and mixed with the output of a crystal-controlled oscillator to produce a 455-kHz second i-f signal. A tuned FET then boosts the level of the 455-kHz i-f signal.

Modulation is recovered from the i-f signal by an IC limiter/quadrature detector. It is then passed through a deemphasis network and finally boosted by an audio IC amplifier to drive the speaker.

On transmit, audio from the microphone is fed through a preemphasis network to two cascaded op-amp stages, the second of which saturates at relatively low speech levels. This limits the possible deviation for a given setting of the DEVIATION control at the output of the second op amp. This results in symmetrical clipping of the audio peaks and produces harmonic distortion that is attenuated prior to modulation by a post-limiter RC rolloff network.

The subaudible tones required to access some repeaters are generated by a 555 timer IC operated in the astable mode. Its operating frequency is determined by one of three multiturn trimmer pots. Because the output of the 555 is a square wave, an RC rolloff network is used to shunt unwanted harmonics to ground. Audio signals from the op-amp stages and IC timer are mixed and routed to the vco board where they frequency modulate the output signal of the vco.

A double-tuned circuit couples the output of the vco to a tripler, whose double-tuned output network passes signals to a frequency doubler. A driver amplifies the output of the doubler to the level required to drive the power amplifier.

Also on the transmitter board are the hash filter to suppress alternator whine and ignition noise on the positive supply line, an 11-volt regulator, and silicon diode to protect the transceiver from reversed supply polarity.

R-f from the transmitter board is coupled to the power amplifier by a toroidal transformer. An LC impedance matching network passes the output of the transmitter to the driver transistor. Two other LC networks provide interstage coupling between the driver and final amplifier and impedance matching between the collector of the class-C final amplifier and the 50-ohm antenna output. A low-pass filter is inserted between the impedance-matching network and the antenna change-over relay. A diode rectifies a portion of the r-f output to provide relative power indication on the meter.

The optional ac power supply is designed to operate from 117- or 240-volt ac lines at the builder's option. It has a full-wave bridge rectifier, smoothing capacitor, and a regulator IC. This IC has an internal reference zener diode. The IC samples the power supply's output voltage, compares it to the reference, and makes corrections to keep the output voltage fixed. The power supply's regulated dc output is adjustable from 12.5 to 14.5 volts. Output current is rated at 2.7 amperes at 13.8 volts dc with a 40% duty cycle.

The combination microphone and Touch Tone encoder pad Micoder II is powered by an internal 9-volt battery (not supplied). A crystal-controlled IC oscillator and dividing network generates autopatch tones. When a button on the tone pad is pressed, the tone oscillator is activated and a monitor LED comes on. The output of the tone-generator IC is attenuated by a LEVEL control and is then applied to the transmitter modulator via the microphone line. The microphone comprises an electret element and FET preamplifier. A resistor couples signals to the mike line and isolates the tone encoder's output stage.

About the Kit. Heath's excellent assembly manuals simplified kit building. We assembled the Micoder II and power supply first in about six hours. The power supply is well laid out and presented no assembly problems. The Micoder II, on the other hand, is densely packed and requires a bit of care in parts placement. Both kits operated perfectly the first time they were powered.

The transceiver is a fairly complex kit to assemble. One begins assembly by soldering connectors to many of the conductors in the wiring harness and mounting the switches and controls on the front panel and chassis. Once the initial assembly and wiring are done, most of the mechanical work is finished.

The vco, receiver, synthesizer, transmitter, and power-amplifier boards are wired and mounted on the chassis in this order. Although some are crowded, wiring is fairly simple, thanks to the silk screening on the boards and the detailed instructions. After each board is installed, it is interconnected with the others by pushing the wiring harness connectors onto pins on the board.

During assembly, we took note of the great lengths to which Heath has gone to minimize unwanted signal coupling. Ferrite beads, r-f chokes, bypass and feedthrough capacitors are used profusely. The chassis has been designed to provide maximum shielding, and the vco is mounted in a small metal box that is then soldered shut.

Another thing we noted during assembly is that a medium-power (37½ to 50 watts) soldering iron was required to properly solder connections on the double-sided, plated-through-hole pc boards with extensive ground planning.

After assembly we performed initial tests. Heath suggests two alignment methods, one with and the other without test instruments. We decided to have the rig aligned by our local Heathkit service center, a service performed free of charge for properly assembled transceivers. (Few hams will have all the test gear required for full instrument alignment.)

Test Results. We performed our laboratory measurements with the transceiver powered by its optional accessory ac power supply, with the output voltage set to 13.8 volts dc. Our tests were made on the 145.6-to-147.8-MHz segment of the 2-Meter band. (The transceiver was aligned for a center frequency of 146.6 MHz.)

We noted that loop lock could be established up to 147.85 and to well below 145 MHz. The measured output power of the transmitter was 12 watts into a 50-ohm dummy load over most of the band segment. It fell to 10 watts, the rated output, near the ±1-MHz points.

The frequency deviation was within ±5 kHz at the existing setting of the control and it was adjustable up to ±7.5 kHz. Deviation produced by the CTCS tones measured slightly more than ±1 kHz, and the Micoder II tones caused ±3 to ±5 kHz deviation. Transmitter preemphasis conformed closely to the

+6-dB/octave characteristic specified by Heath. The difference in signal level between the rig's microphone input and the output of the mike preamp was 0 dB at 300 Hz, +6 dB at 600 Hz, +12 dB at 1100 Hz, and +18 dB at 2400 Hz.

The measured sensitivity of the receiver was 0.5 μV for 15 dB of quieting and a 0.25-μV squelch threshold. A 10-μV input signal was required for a full-scale pointer deflection on the meter. Image rejection measured 48 dB, spurious signal rejection more than 50 dB, and i-f rejection 78 dB. Internal "tweets" were found at 146.000 and 147.000 MHz, with equivalent signal strengths, for 15 dB of quieting, of 1.5 and 0.5 μV, respectively. All others had equivalent signal strengths of less than 0.25 μV, the squelch threshold.

Selectivity measured −6 dB at ±7.5 kHz and −60 dB at ±15 kHz, exactly as specified. The receiver provided 1.3 watts of audio output power at 0.8% THD into 8 ohms and 1000 Hz. At an output of 2.0 watts, positive-peak clipping occurred and THD increased to 10%. The deemphasis of the receiver measured 0 dB at 300 Hz, −6 dB at 900 Hz, −12 dB at 1650 Hz, and −18 dB at 3000 Hz. This measurement was made across an 8-ohm load connected to the external speaker jack.

User Comment. We have used the transceiver and its accessories over a period of several months and in both fixed and mobile installations. Their performance to date has been very satisfactory and reliable.

The receiver is both sensitive and selective. It has enough audio output power to be heard even in the noisy environment of a convertible car. The speaker cone, which is larger than those usually found in mobile transceivers, produces a well-balanced sound. Almost every QSO brings us compliments about the transmitter's audio quality and "punch."

The r-f output power is sufficient to key every open repeater in the New York metropolitan area. We confirmed this with a ⅝-wave whip antenna while driving around the city.

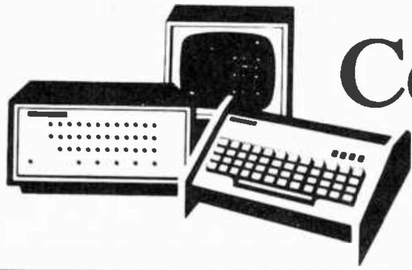
The synthesizer is very stable and always accurate. Loop lock-up time is very short. On cold winter days, the inhibit circuitry never disabled the transmitter for nonlock when the mike's PTT switch was keyed, even though the transceiver had spent hours in the trunk. The autopatch and CTCS tone encoders have also proved very stable. The final's immunity from the effects of an infinite VSWR was verified, albeit accidentally!

We find three minor faults with this transceiver. The first is with the frequency selection switches. Although the white-on-black numerals are of high contrast in moderate lighting, they cannot be interpreted in a car at night. (We solved this problem by mounting a 12-volt map light below the dashboard where the transceiver is installed.)

Instead of the phono jack used for the antenna input connector, we would feel more secure with a BNC or SO-239 connector. Finally, we prefer a front-panel microphone connector instead of the permanently wired-in scheme employed by Heath.

Despite these minor faults, we find the HW-2036 to be a rugged rig with many attractive features. A moderate price belies operating flexibility and high level of performance. It's a fine choice for any ham who wants multiple-channel coverage on 2 Meters without the restrictions and expense of a crystal pack.

CIRCLE NO. 105 ON FREE INFORMATION CARD



Computer Bits

MICROCOMPUTER INPUT/OUTPUT

By Hal Chamberlin

FROM THE point of view of user convenience, the input and output devices and how they are interfaced to a microcomputer are the most important part of the system. The best processor in the world with a full 64K of memory would still be difficult to use if the only I/O devices were a hexadecimal keyboard and a 6-digit display. Many people would not consider a system complete unless it had a full alphanumeric keyboard, CRT display, printer, and floppy disk although most live with less.

At the actual programming level, the words "input" and "output" simply refer to the hardware and programming technique used to get data from the outside world into the accumulator or memory, and from memory or the accumulator to the outside world respectively. Usually the I/O device—be it a keyboard, printer, or display—makes a conversion between data in TTL logic-level form and data in physical form such as a key depression or print hammer strike. The I/O interface makes a conversion between this data in logic level form and the needs of the microprocessor bus itself. Usually the I/O interface logic connects directly into the computer while the I/O device is physically placed at any convenient location at the end of a cable connected to the interface.

Direct And Memory-Mapped I/O. Any practical microcomputer system can have a number of I/O interfaces. More complex interfaces may have several subsystems, each with its own interface register. Accordingly, a method must be found to address the desired interface register when an I/O operation is performed. A common method used on earlier computers involved specialized input/output instructions. Typically, the instructions were READ, WRITE, CONTROL and TEST. In addition to the operation code, there was an address field of 4 to 8 bits in these instructions. This address field allowed from 16 to 256 different interface registers to be addressed. The READ instruction would read a data word from the addressed interface register into the accumulator of the computer while WRITE would do the opposite. CONTROL specified an operation to be performed with the data and TEST was used to determine if the addressed interface subsystem was still busy completing the previous operation. TEST usually functioned by skipping the next instruction if the subsystem was free.

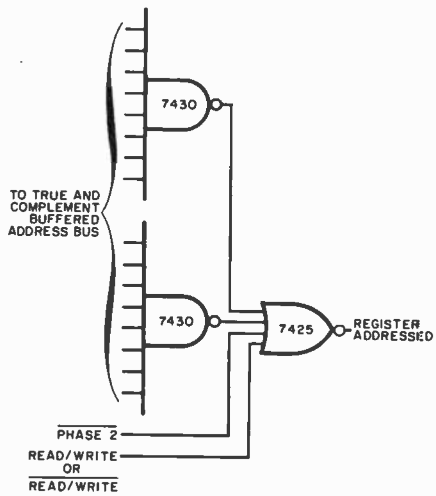


Fig. 1. Address recognizer.

Many microcomputers also have specialized I/O instructions although usually only READ and WRITE are provided. CONTROL is accomplished by writing a code into a control register while status testing is performed by reading a status register and looking at the status bits with normal machine instructions. Frequently any I/O register, regardless of its function, is called a *port*.

The 8080 for example has only an IN and an OUT instruction. An 8-bit field in the instruction allows up to 256 interface registers to be addressed. This sounds like a lot until you realize that a complex interface such as a floppy-disk controller might use 8 interface registers. Nevertheless, 256 is almost always ample.

About half of the available microcomputers do not use specialized I/O instructions. Instead, each port register is interfaced to the system bus as if it were a memory location. This is called *memory-mapped* I/O because each I/O interface register corresponds to a memory address. There are several advantages to this method. One is that some operation codes are freed for what may be more useful instructions. Another is that any of the machine's memory reference instructions may be used for manipulating I/O registers, not just load and store. For BASIC language users, the typical PEEK and POKE functions, which are normally used for reading and writing memory, can now be used to operate any I/O device from a BASIC program.

The system bus is somewhat simplified because I/O read and I/O write control signals are no longer needed. Finally, as many I/O addresses as desired may be provided. Typically from 256 to 4096 addresses are set aside from the 65,536 possible memory addresses for I/O functions. Note that processors that normally utilize specialized I/O instructions can also use memory-mapped I/O with its attendant advantages.

Although with memory-mapped I/O each interface register appears as a memory location to the programmer, they often do not act as memory locations. To simplify the circuitry, many of the registers may be *read-only* or *write-only*. An input register from a keyboard, for example, is usually read-only since it does not make much sense to write data to a keyboard. Control and status registers are often write-only and read-only respectively. However if a program needs to know what was last written to a control register, it can save that information somewhere else in regular memory.

I/O Interfacing With Logic. Generally, a bus interface consists of two parts, the address recognizer, and the output latches or input buffers depending on whether it is an output or an input interface.

The typical address recognizer shown in Fig. 1 is basically one multi-input (16) AND gate and can be used on a memo-

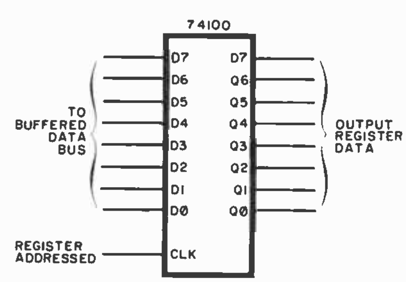


Fig. 2. Simple output port.

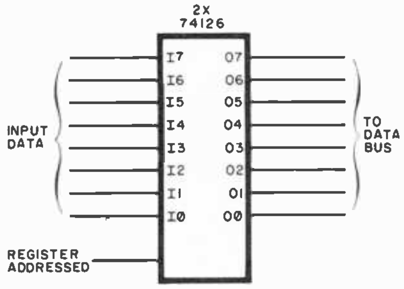


Fig. 3. Simple input port.

ry-mapped I/O system such as a KIM 6502. When the proper address pattern is present, and clock phase-2 is high (signifying a valid address), the gate output becomes high. Usually the Read/Write line is also factored in to distinguish between read-only and write-only registers that might be sharing the same address. If several interface registers are on the same board, most of the address bits may be AND'ed together once and factored into several smaller gates, or a decoder, to reduce the number of IC packages required.

An output register is interfaced as shown in Fig. 2. The clock input is triggered at the end of clock phase-2 after the data bus has stabilized.

An input interface is shown in Fig. 3. Data from some source such as a keyboard, or other TTL register, is gated onto the system data bus through the 3-state buffers whenever the interface is addressed during a read cycle. A read/write interface register may be made by connecting an output register to an input interface.

Often in process control and other applications, it is necessary to read and write individual bits that may correspond to separate solenoids, valves, switches, etc. This may be accomplished with ordinary 8-bit input and output ports and the machine's AND, OR, and SHIFT instructions. A simpler way from both software and hardware standpoints however is to use multiplexer and addressable latch elements as shown in Fig. 4A.

Again using the 6502 processor as an example, 16 individually addressable input bits may be interfaced with one IC in addition to the usual address decoder. Note that each bit has its own address and that when read, the bit will appear in position 7 where it may be easily tested. In fact with the 6502, the bit can be tested directly by executing an ASL ADDR where ADDR is the address of the input bit to be tested. This "shift memory" instruction causes the addressed bit to be copied into the carry flag without disturbing the accumulator or other registers. Following this, a conditional branch may be executed. The circuit may be easily expanded to more inputs, each still individually addressable. A large number of inputs may be scanned by using the indexed addressing form of the ASL instruction.

Shown in Fig. 4B, is a one-IC circuit (in addition to the address decoder) for implementing 8 independently controllable output bits. The key to its operation is a relatively inexpensive addressable latch IC—the 9334. The device essentially operates like an 8-bit write-only memory in which the status of each cell is available at a package pin. A particular bit may be controlled by storing the accumulator into the desired bit address with bit-0 of the accumulator set to the desired state. Because of the choice of bit-0 for the data connection, there are easier ways to manipulate the addressed bit. For example, the instruction ASL ADDR will set the addressed bit to zero because bits shifted in on a left shift are zeroes. Similarly, ASR ADDR will set it to one because the data bus will float to ones (a 10,000-ohm resistor from DATA 1 to +5 volts will insure this) during the read prior to shifting. Clearly, memory mapped I/O interfacing is very powerful on a processor like the 6502.

I/O Interface Chips. Another popular method of parallel I/O interfacing, particularly in very small systems, is the use of specialized I/O interface IC's.

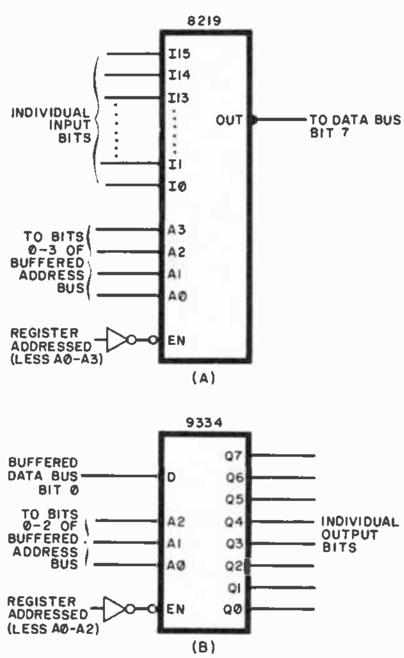


Fig. 4. Individual bit input and output.

Sixteen I/O lines in two groups of eight are provided with the other pins used for connection to the system data bus, addressing, and other functions.

A unique feature of the device is that the function, either input or output, of each of the 16 I/O lines is *programmable*. Two "data direction registers", one for each group of eight I/O lines, may be written into using program instructions to determine whether a line is an output or an input. If a direction bit is a zero, then the corresponding I/O line is an input, otherwise it is an output. Usually these direction bits are set at power-up by the monitor, but some interface designs may make them do double duty by switching between input and output.

A convenient feature of the chip is that *all* registers are read/write. In a memory-mapped I/O system, this allows operations such as incrementing, decrementing, or shifting of output registers directly without loading them into the accumulator. Additional circuitry on the chip handles the generation and acknowledgement of interrupts without the need for external circuitry. Newer versions of parallel I/O chips even have a built-in interval timer. ◇

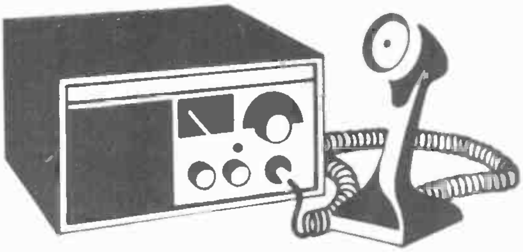
Software Sources

8080 Cassette Operating System. COS, an adaptation of the CP/M disc operating system, is intended for use on microcomputers with Micro Designs' digital cassette systems. The systems maintain a file directory and permit directory listout, file erasure, save, output and renaming—plus file open, close, search, delete, read, write and create. Write: Micro Designs, Inc., 499 Embarcadero, Oakland, CA 94606.

6800 Basic Printer Routine. Designed to load over SWTPC 8K BASIC Ver. 2, this interrupt-driven printer routine buffers output in a 132-character FIFO buffer, and sends it to the printer under interrupt control. This adds less than ½k to the 8k BASIC's memory requirement, and is said to increase speeds of any BASIC programs using the printer by up to 50%. It is available with source listing in Motorola-format paper tape ($8.50), and KC cassette ($8.50). Write: Applied Microcomputer Systems, Box 68, Silver Lake, NH 03875.

New BASIC for CP/M. CBASIC, a commercial business language upward-compatible from BASIC-E, is available for diskette systems using the CP/M Disc Operating System. CBASIC includes a number of business-oriented facilities not found in BASIC-E, including decimal computations with 14-digit precision, data formatting with the PRINT USING statement, LPRINTER and CONSOLE statements, new file-handling capabilities, and others. CBASIC is available on diskette for $90. The CBASIC manual is $15, and both diskette and manual are available together for $100. Write: Digital Research, Box 579, Pacific Grove, CA 93950.

6800 Disassembler. This 3k program disassembles 6800 machine-code programs, to produce readable listings with labels, opcode mnemonics and operands. It generates source tapes which may be loaded by the SWTPC Co-Res Editor/Assembler, and can define any number of FCC, FCB, and/or program areas in the target program. Output is directable to the control terminal or to a separate printer. The M68 Disassembler is available on Kansas-City-standard cassette for $19.95, and on Smoke-Signal Broadcasting BFD-68 format diskette for $24.95. Write: Shifting Sands Microcomputer Products Corp., Box 441, Fairborn, OH 45324.



CB Scene

By Gary Garcia

PURAC ACTS

FIRST fruits of the labors of PURAC (the Personal Use Radio Advisory Committee) were seen at the Committee's fifth meeting, held on December 7 in Gettysburg. Reports and recommendations of five of PURAC's 10 Task Areas were presented by their respective Task Coordinators, followed by discussion (and sometimes amendment) to each. PURAC members then voted to adopt four of the five reports (and accompanying amendments) and forward them to the FCC. Here are some highlights of the recommendations.

Operator Training. The responsibility of this Task Area is to develop recommendations of syllabus, methods, and training programs for CB operators. Task Coordinator David Garner reported to PURAC members that his group's investigation revealed existing CB operator training programs often contain large amounts of outdated information—a result of poor coordination between the FCC and training program administrators. Additionally, the report noted that the emphasis placed on certain facets of CB by existing courses varied widely. It was suggested that, to overcome these problems, the FCC develop a standardized CB operator training program with provision for systematic updating of the material covered. The proposed two-hour course would consist of six lessons:

- Introduction to CB
- Equipment Installation and Safety
- Operation of CB Equipment
- Fundamentals of Transceivers
- Fundamentals of Antennas
- Accessory Items and Test Equipment

Optional advanced lessons would be offered covering Interference and Noise, and Optimizing the CB System. Oddly, the last mentioned (optional!) lesson includes information on emergency communications, traveler's information, and helping fellow CB'ers. In this writer's opinion, these are the most important aspects of CB and should be made part of the standard course—not optional.

The proposed course is a thorough one; each lesson goes into a good amount of detail. For example, the Fundamentals of Antennas lesson includes a discussion of the value of a good antenna system, offers a brief explanation of frequency and wavelength, gives advice on selecting the location and polarization of antennas for best results, explains grounding, etc.

Another interesting feature of this course is its intended audience: young people attending high schools, colleges, and technical schools. In fact, it is suggested that educational credits be given to those who complete the course. The members of this Task Area believe young people to be more receptive to such training, while it would be difficult to entice adults to take the course because they have neither the time nor the inclination to do so. To reach the adult CB population, it was recommended that one CB channel be used as a public information channel.

Dissemination of Information. How can the public obtain the latest FCC CB-related information most efficiently? This is what the Dissemination of Information Task Area must determine, and a number of recommendations in this area were presented to the Committee by Task Coordinator Gerald Reese. Among them was the recommendation that the FCC assign press relations functions to a member of the Commission who is a CB information specialist. Another proposal called for the development of distribution systems which are conducive to efficient distribution of information. For example, one interesting proposal called for the establishment of a CB newsletter by the FCC. All the latest Rules decisions, licensing statistics, PURAC actions, FCC personnel changes, etc., would be covered in the newsletter.

Mr. Reese also pointed out there is more than one government agency distributing information concerning CB to the public, and that the need existed for coordination of efforts in this area. The Task Area recommended that the FCC cooperate with the Department of Transportation, the Law Enforcement Assistance Administration, and the Commerce Department in the distribution of CB-related information to the public.

Public Safety Uses of Personal Radio. Three proposals were presented by Task Coordinator Nathan Maryn, the first concerning the use of CB transceivers as the only communications facility aboard small boats. The problem here is that the Coast Guard requires the installation of vhf/FM Marine communications facilities on larger vessels, but no such requirement exists for boats smaller than a certain size. So small-boat owners have been using CB transceivers as an economical alternative to vhf/FM equipment. Recently, the U.S. Coast Guard agreed to monitor CB channel 9, so the 1978 boating season will be the first during which the CG officially monitors the CB channels for marine distress communications. But make no mistake about it, vhf/FM and 2182 kHz are still the prime radio communications links to the Coast Guard, and they recommend that serious boaters use these services. In fact, this PURAC Task Area recommended that the FCC follow the Coast Guard policy of supporting the use of the vhf/FM service for emergency purposes, and discourage the use of CB in this application. CB Radio, however, is fine for idle chatter, whereas vhf/FM cannot be legally used in this manner.

To make it easier for CB'ers to contact state law enforcement agencies, this Task Group supports the use of special callsigns by these state agencies. They consist of the letter K, followed by the two-letter postal abbreviation of the state's name, and then by 0911, the nationally recognized emergency number. Some states have already adopted this idea, among them being Colorado (KCO0911), Illinois, Iowa, Maryland, Michigan, Missouri, New York, South Carolina, West Virginia, and the District of Columbia.

The last recommendation of Mr. Maryn's group was that the FCC develop and implement an enforcement policy specifically aimed at channel 9, the emergency and motorist assistance channel. Noting that it is much easier to establish and maintain communication on channel 9 than on other channels, the Task Area recommended that the FCC take special measures to keep channel 9 and adjacent frequencies free of illegal interference. The need for an effective emergency channel is evident, and this is a worthwhile proposal.

User Rule Compliance. Task Coordinator Stuart Lipoff presented a recommendation calling for the use of automatic transmitter identifier systems (ATIS). This proposal has been discussed here before (January 1978 POPULAR ELECTRONICS). This was the only recommendation defeated; ATIS was shot down by a vote of 35 to 9.

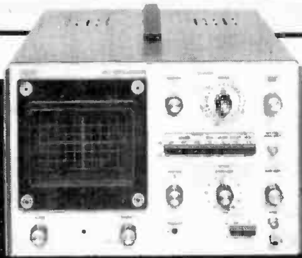
Local Interference. Task Coordinator Stuart Meyer presented his Task Area's interim report containing a number of observations, but no recommendations. An interesting description of a CB-related TVI problem was related to PURAC members. Apparently, a half-dozen CB'ers were causing the television receivers of their neighbors to experience TVI. All concerned lived in a housing complex, and after much battling, the landlord finally prohibited the use of CB transceivers on his property. A filter manufacturer heard about the case and offered to donate filters to all parties involved in the hope of clearing up the problem once and for all. Low-pass filters were installed on all CB transceivers in the housing complex as well as on all affected television sets. TVI ceased, except for that caused by a single CB'er operating a few hundred feet from the complex who was reputed to be using excessive illegal power in conjunction with twin four-element yagi beam antennas atop a tower!

The final report and recommendations of this Task Area will not be completed until the next meeting of PURAC, at which time they will be formally considered for adoption.

Two more meetings of PURAC are scheduled before its statutory life expires. One will be held February 22-23 in Washington, DC, and the other is set for April 19-20 in Philadelphia. So by the time you read this, PURAC may formally adopt all recommendations it intends to make to the FCC. It will be interesting to see how the FCC responds to these recommendations and what effects, if any, they have on the CB Radio Service. ◇

MAY-AUGUST ENGLISH-LANGUAGE SW B'CASTS by Richard E. Wood

TO EASTERN NORTH AMERICA				
TIME-EDT	TIME-GMT	STATION	QUAL*	FREQUENCIES, MHz
6:28 a.m.-8:00 p.m.	1028-2400	**Montreal, Canada (Northern Service)	G	9.625, 11.72 (includes French, etc.)
7:00-7:25 a.m.	1100-1125	Tirana, Albania	F	9.50, 11.985
7:00-9:00 a.m.	1100-1300	Melbourne, Australia	G	9.58
7:00-9:30 a.m.	1100-1330	London, England	G	5.99 (via Sackville) 6.195, 11.775 (both via Antigua), 15.07
7:00-10:00 a.m.	1100-1400	**VOA, Washington, USA	G	5.955, 6.185, 9.565, 9.73
8:00-8:45 a.m.	1200-1245	**Berlin, Ger. Dem. Rep.	F	17.88, 21.54
8:00-8:30 a.m.	1200-1230	Jerusalem, Israel	G	11.655, 15.405, 15.415, 17.815, 21.50
8:00-8:55 a.m.	1200-1255	Peking, China	F	11.685
8:05-8:35 a.m.	1205-1235	Trans-World Radio, Bonaire, N.A.	G	11.815
8:15-8:30 a.m.	1215-1230	Athens, Greece	F	11.73, 15.345, 17.83
		HCJB, Quito, Ecuador	G	11.745
8:30-9:00 a.m.	1230-1300	Stockholm, Sweden	G	17.79
8:30-10:30 a.m.	1230-1430	Trans-World Radio, Bonaire, N.A.	G	15.255 (Sat., Sun.)
8:30 a.m.-12:30 p.m.	1230-1630	HCJB, Quito, Ecuador	G	11.745, 15.115
9:00-9:30 a.m.	1300-1330	Helsinki, Finland	G	15.105 (Sun. to 1455)
9:15-9:45 a.m.	1315-1345	Berne, Switzerland	G	15.14
10:00-10:30 a.m.	1400-1430	Oslo, Norway	G	15.175 (Sun.)
		Stockholm, Sweden	G	17.79
10:00-10:45 a.m.	1400-1445	**Berlin Ger. Dem. Rep.	F	17.88, 2.154
11:00 a.m.-12 noon	1500-1600	London, England	G	9.58 (via Sackville, Sat., Sun.)
11:45 a.m.-12 noon	1545-1600	**Montreal, Canada	F	15.325, 17.82
12 noon-12:30 p.m.	1600-1630	Oslo, Norway	F	17.80 (Sun.)
12 noon-1:09 p.m.	1600-1709	London, England	G	9.58 (via Sackville; Sat., Sun. to 1745)
12:05-12:55 p.m.	1605-1655	**Paris, France	G	11.705, 11.845, 15.155, 15.20, 15.30 15.315, 17.72
1:00-4:00 p.m.	1700-2000	**Kuwait, Kuwait	G	12.085
2:00-2:30 p.m.	1800-1830	**Montreal, Canada	F	15.26, 17.82
		Oslo, Norway	F	15.175 (Sun.)
2:00-3:30 p.m.	1800-1930	**Lagos, Nigeria	F	11.77, 15.12 (variable)
3:00-4:00 p.m.	1900-2000	**Jiddah, Saudi Arabia	F	11.855
3:30-4:00 p.m.	1930-2000	**Abidjan, Ivory Coast	F	11.92
4:00-4:30 p.m.	2000-2030	**Montreal, Canada	F	11.865, 11.945, 15.325, 17.82
		**Tehran, Iran	G	9.022 (time variable)
		Jerusalem, Israel	G	9.815, 11.655, 11.96, 15.105
4:00-5:15 p.m.	2000-2115	London, England	G	5.96 (via Ascension), 6.195 (via Antigua), 11.75, 15.26
4:10-4:50 p.m.	2010-2050	**Havana, Cuba	G	11.865, 17.885
4:30-5:20 p.m.	2030-2120	**Hilversum, Holland	G	11.73, 15.22 (both via Talata), 17.81, 21.64 (both via Bonaire)
4:30-5:30 p.m.	2030-2130	**Hanoi, Vietnam	F	10.04
4:50-5:20 p.m.	2050-2120	**Havana, Cuba	G	11.865, 17.75, 17.885
5:00-5:50 p.m.	2100-2150	**Johannesburg, S. Africa	F	5.98, 9.585, 11.90
5:15-6:45 p.m.	2115-2245	London, England	G	5.96 (via Ascension), 9.58, 11.75, 15.26
5:30-6:00 p.m.	2130-2200	**Montreal, Canada	F	11.945, 15.15, 15.325, 17.82
		**R. Clarin, Santo Domingo, D.R.	F	11.70 (time variable)
5:30-6:20 p.m.	2130-2220	Hilversum, Holland	G	9.715, 11.73 (exc. Sun.)
5:30-6:30 p.m.	2130-2230	**Baghdad, Iraq	G	9.745
5:30-7:00 p.m.	2130-2300	Ankara, Turkey	G	9.515
6:00-6:15 p.m.	2200-2215	**Montevideo, Uruguay	P	9.515, 11.885 (time variable)
		**Belgrade, Yugoslavia	F	6.10, 7.24, 9.62
6:00-6:30 p.m.	2200-2230	Oslo, Norway	G	11.87, 17.795 (Sun.)
6:00-8:00 p.m.	2200-2400	Montreal, Canada	G	5.96 (exc. Sat., Sun.)
6:30-7:00 p.m.	2230-2300	Moscow, U.S.S.R.	G	9.60, 9.665, 9.685, 9.72, 11.75, 11.85, 11.96
		Jerusalem, Israel	G	9.435, 9.815, 11.655, 11.96, 15.105, 15.485
6:30-7:20 p.m.	2230-2320	Johannesburg, S. Africa	F	5.98, 9.585, 11.80, 11.90
6:45-7:00 p.m.	2245-2300	London, England	G	5.975, 7.325, 9.58, 11.75, 15.26
7:00-7:30 p.m.	2300-2330	London, England	G	5.975, 6.175, (via Sackville), 7.325, 9.51 (via Sackville), 9.58 (via Ascension), 11.75, 15.26
		Stockholm, Sweden	G	6.12, 9.695, 11.705
		Vilnius, U.S.S.R.	G	9.61, 9.72, 11.77, 11.79
7:00-7:55 p.m.	2300-2355	**Buenos Aires, Argentina	G	11.71 (exc. Sat., Sun.)
7:00-8:00 p.m.	2300-2400	Moscow, U.S.S.R.	G	9.60, 9.655, 9.685, 11.75, 11.87, 11.96



		**R. Clarin, Santa Domingo, D.R.	G	11.70 (time variable)
7:00-8:50 p.m.	2300-0050	Pyongyang, P.D.R. Korea	F	9.977, 11.535
7:15-7:30 p.m.	2315-2330	**Santiago, Chile	F	15.13, 15.15, 17.80 (all variable)
7:30-7:55 p.m.	2330-2355	Helsinki, Finland	F	11.755
7:30-8:30 p.m.	2330-0030	London, England	G	5.975, 6.175 (via Sackville), 7.325, 9.51 (via Sackville), 9.58, (via Ascension), 11.75 (from 0000)
7:45-8:45 p.m.	2345-0045	Tokyo, Japan	F	15.27, 15.30.
8:00-8:25 p.m.	0000-0025	Tirana, Albania	G	7.065, 9.75
8:00-8:30 p.m.	0000-0030	Oslo, Norway	F	11.86 (Sun.)
8:00-8:55 p.m.	0000-0055	Peking, China	F	15.06, 17.68, 17.86
8:00-9:00 p.m.	0000-0100	Sofia, Bulgaria	G	9.705
8:00-10:00 p.m.	0000-0200	**VOA, Washington, USA	G	6.13, 9.64, 11.74, 15.205
		**Luxembourg, Luxembourg	F	6.09
8:00 p.m.-1:06 a.m.	0000-0506	**Montreal, Canada (Northern Service)	F	6.195, 9.625 (includes French, etc.)
8:15-8:30 p.m.	0015-0030	Athens, Greece	F	9.76, 11.73
8:15-9:00 p.m.	0015-0100	Brussels, Belgium	G	9.73
8:30-9:00 p.m.	0030-0100	London, England	G	5.975, 6.175, (via Sackville), 7.325, 9.51 (via Greenville), 9.58 (via Ascension), 11.75
		Stockholm, Sweden	F	11.905
		Kiev, U.S.S.R.	G	7.15, 7.205, 7.40, 9.61, 9.72, 11.72
		Moscow, U.S.S.R.	G	9.53, 9.60, 9.655, 9.685 11.85, 11.87, 11.96
8:30-9:30 p.m.	0030-0130	**Trans-World Radio, Bonaire, N.A.	G	11.925
8:40 p.m.-1:00 a.m.	0040-0500	HCJB, Quito, Ecuador	G	9.56, 11.915
8:45-9:00 p.m.	0045-0100	Prague, Czechoslovakia	F	9.505
9:00-9:15 p.m.	0100-0115	**Montevideo, Uruguay	P	9.515, 11.855 (time variable)
		Vatican, City	G	5.995, 9.605, 11.80
9:00-9:20 p.m.	0100-0120	Rome, Italy	G	9.575, 11.91
9:00-9:30 p.m.	0100-0130	Montreal, Canada	G	9.535
		Moscow, U.S.S.R.	G	9.53, 9.60, 9.655, 9.685, 11.85, 11.87, 11.96
9:00-9:45 p.m.	0100-0145	Berlin, Ger. Dem. Rep.	P	9.73
9:00-9:55 p.m.	0100-0155	Prague, Czechoslovakia	G	5.93, 7.345, 9.54, 9.63, 11.99
		Peking, China	G	7.12, 9.78 (both via Albania) 15.06, 15.52, 17.68
9:00-11:00 p.m.	0100-0300	Melbourne, Australia	G	15.32, 17.795
9:00-10:30 p.m.	0100-0230	London, England	G	5.975, 6.12, 6.175 (both via Sackville), 7.325, 9.51 (via Greenville), 9.58 (via Ascension), 11.75
9:00-11:30 p.m.	0100-0330	Havana, Cuba	G	11.725, 11.93
9:00 p.m.-12 mdt.	0100-0400	Madrid, Spain	G	6.065, 11.88
9:10-9:30 p.m.	0110-0130	**Santiago, Chile	G	9.566, 11.705, 15.13, 15.15 (variable)
9:30-9:50 p.m.	0130-0150	Cologne, Ger. Fed. Rep.	G	6.04, (via Antigua), 6.075, 6.085, 6.10 (via Malta), 9.545 (via Montserrat), 9.565 (via Germany and Malta), 9.605, 11.865 (via Malta)
9:30-9:55 p.m.	0130-0155	Tirana, Albania	G	6.20, 7.30
		Vienna, Austria	P	6.155, 9.77
9:30-10:00 p.m.	0130-0200	Moscow, U.S.S.R.	G	9.53, 9.60, 9.665, 9.685, 9.70, (via Sofia), 11.85, 11.87, 11.96
9:30-10:25 p.m.	0130-0225	Bucharest, Romania	F	5.99, 6.19, 9.57, 9.69, 11.735, 11.94
9:45-10:15 p.m.	0145-0215	Berne, Switzerland	G	6.135, 9.70, 9.725, 11.715
10:00-10:25 p.m.	0200-0225	Budapest, Hungary	G	6.08, 6.115, 9.585, 11.91 15.225, 17.71 (exc. Mon.)
10:00-10:30 p.m.	0200-0230	Montreal, Canada	G	6.185, 9.535
		Oslo, Norway	F	6.18 (Sun.)
		Warsaw, Poland	G	6.09, 6.135, 7.27, 9.525 11.815, 15.12
10:00-10:55 p.m.	0200-0255	Peking, China	P	12.055, 15.06, 15.435, 17.68
10:00-11:00 p.m.	0200-0300	Moscow, U.S.S.R.	G	9.53, 9.60, 9.665, 9.685, 9.70, (via Sofia), 11.85, 11.87, 11.96
10:00-11:30 p.m.	0200-0330	Cairo, Egypt	G	6.23, 9.475
10:10-10:30 p.m.	0210-0230	**Santiago, Chile	G	9.566, 11.705, 15.13
10:30-10:45 p.m.	0230-0245	**Montevideo, Uruguay	F	9.515, 11.885, (time variable)
10:30-10:55 p.m.	0230-0255	Tirana, Albania	G	6.20, 7.30
10:30-11:00 p.m.	0230-0300	Stockholm, Sweden	F	9.505, 11.85
		Beirut, Lebanon	F	9.68 or 11.755
10:30-11:15 p.m.	0230-0315	Berlin, Ger. Dem. Rep.	P	9.73
10:30-11:20 p.m.	0230-0320	Hilversum, Holland	G	6.165, 9.59 (both via Bonaire)
10:30-11:30 p.m.	0230-0330	London, England	G	5.975, 6.175, (via Sackville), 7.325, 9.51 (via Greenville), 9.58 (via Ascension)
11:00-11:25 p.m.	0300-0325	Budapest, Hungary	G	6.08, 6.105, 9.585, 11.91, 15.225, 17.71

11:00-11:30 p.m.	0300-0330	Montreal, Canada	G	5.96, 6.185, 9.535, 9.605
		Warsaw, Poland	G	6.095, 6.135, 7.27, 9.525, 11.815, 15.12
		Lisbon, Portugal	G	6.025, 11.935
		Kiev, U.S.S.R.	G	7.205, 7.40, 9.61, 9.72, 11.79
11:00-11:55 p.m.	0300-0355	Peking, China	G	7.12, 9.78 (both via Albania)
		Prague, Czechoslovakia	G	5.93, 7.345, 9.54, 9.63, 11.99
11:00 p.m.-12 mdt.	0300-0400	Buenos Aires, Argentina	F	9.69 (exc. Sat., Sun.)
		Baghdad, Iraq	G	11.905
11:10-11:30 p.m.	0310-0330	**Santiago, Chile	G	9.566, 11.705, 15.13
11:30-11:55 p.m.	0330-0355	Tirana, Albania	G	6.20, 7.30
		Vienna, Austria	P	6.155, 9.77
11:30 p.m.-12:30 a.m.	0330-0430	London, England	G	5.975, 6.175 (via Antigua)
11:30 p.m.-12:50 a.m.	0330-0450	Havana, Cuba	G	11.725, 11.76, 11.93
12 mdt. 12:30 a.m.	0400-0430	Montreal, Canada	G	5.96, 9.535
		Budapest, Hungary	G	6.00, 6.105, 9.585, 11.91, 15.225, 17.71 (Tues., Fri.)
		Bucharest, Romania	F	5.99, 9.57, 9.69, 11.735, 11.94
12:30-1:00 a.m.	0430-0500	London, England	G	6.175 (via Antigua)
12:50-2:00 a.m.	0450-0600	Havana, Cuba	G	11.725, 11.76
1:00-1:15 a.m.	0500-0515	Jerusalem, Israel	G	7.412, 9.835, 11.655, 11.96, 15.105, 15.415
1:00-2:30 a.m.	0500-0630	London, England	G	6.175, 9.51 (both via Antigua)
1:00-3:00 a.m.	0500-0700	HCJB, Quito, Ecuador	G	6.095, 9.56
1:55-3:40 a.m.	0555-0740	**Lagos, Nigeria	F	7.275
2:30-3:30 a.m.	0630-0730	London, England	G	6.175 (via Antigua)

TO WESTERN NORTH AMERICA

TIME-PDT	TIME-GMT	STATION	QUAL*	FREQUENCIES, MHz
4:00-4:15 a.m.	1100-1115	Tokyo, Japan	P	5.99
4:00-5:50 a.m.	1100-1250	Pyongyang, P.D.R. Korea	G	9.977, 11.53
4:00-6:30 a.m.	1100-1330	London, England	G	5.99 (via Sackville), 6.195, 11.775 (both via Antigua)
5:00-5:15 a.m.	1200-1215	Tokyo, Japan	G	9.505
5:00-5:30 a.m.	1200-1230	Tashkent, U.S.S.R.	G	11.73, 11.925, 15.115, 15.46
5:15-5:30 a.m.	1215-1230	HCJB, Quito, Ecuador	G	11.745
5:30-7:30 a.m.	1230-1430	HCJB, Quito, Ecuador	G	11.745, 15.115
6:00-6:15 a.m.	1300-1315	Tokyo, Japan	G	9.505
7:00-7:30 a.m.	1400-1430	**Berlin, Ger. Dem. Rep.	F	17.88, 21.54
		Tokyo, Japan	G	9.505
		**Tashkent, U.S.S.R.	G	11.73, 11.925, 15.46
8:00-8:15 a.m.	1500-1515	Tokyo, Japan	G	9.505
8:15-8:30 a.m.	1515-1530	Athens, Greece	F	11.73, 15.345, 17.83
8:30-9:00 a.m.	1530-1600	Seoul, Rep. Korea	F	9.64, 11.85
9:00-9:15 a.m.	1600-1615	Tokyo, Japan	G	9.505
9:00-9:30 a.m.	1600-1630	Oslo, Norway	F	15.175 (Sun.)
9:05-9:55 a.m.	1605-1655	**Paris, France	F	11.705, 11.845, 15.155, 15.20, 15.30, 15.315, 17.72
10:00-10:15 a.m.	1700-1715	Tokyo, Japan	F	9.505
10:00 a.m.-1:00 p.m.	1700-2000	**Kuwait, Kuwait	G	12.085
11:00-11:15 a.m.	1800-1815	Tokyo, Japan	F	9.505
11:00-11:30 a.m.	1800-1830	**Seoul, Rep. Korea	F	9.64, 11.85
12 noon-12:15 p.m.	1900-1915	Tokyo, Japan	G	15.105
12:30-1:00 p.m.	1930-2000	**Abidjan, Ivory Coast	F	11.92
1:00-1:15 p.m.	2000-2015	Tokyo, Japan	G	15.105
1:00-1:30 p.m.	2000-2030	Jerusalem, Israel	F	11.665, 9.815
1:00-2:15 p.m.	2000-2115	London, England	F	5.96 (via Ascension), 6.195 (via Antigua)
1:10-1:50 p.m.	2010-2050	**Havana, Cuba	G	17.885
1:30-2:20 p.m.	2030-2120	**Hilversum, Holland	G	11.73, 15.22 (both via Talata), 17.81, 21.64 (both via Bonaire)
1:50-2:40 p.m.	2050-2140	**Havana, Cuba	G	11.865, 17.75, 17.885
2:00-2:15 p.m.	2100-2115	Tokyo, Japan	G	15.105
2:15-3:45 p.m.	2115-2245	London, England	G	5.96 (via Ascension)
2:30-3:00 p.m.	2130-2200	**R. Clarin, Santo Domingo, D.R.	F	11.70 (time variable)
2:30-4:00 p.m.	2130-2300	Ankara, Turkey	F	9.515
2:40-3:40 p.m.	2140-2240	**Taipei, Taiwan	F	11.825, 11.86, 15.225, 17.72, 17.89
3:00-3:15 p.m.	2200-2215	Tokyo, Japan	G	15.105
3:00-5:00 p.m.	2200-2400	**VOA, Washington, USA	G	15.25, 17.82, 17.895, 21.61
3:30-4:00 p.m.	2230-2300	Jerusalem, Israel	G	9.815, 11.655, 15.485
3:30-4:20 p.m.	2230-2320	Johannesburg, S. Africa	G	5.98, 9.585, 11.80, 11.90
3:30-7:00 p.m.	2230-0300	Moscow, U.S.S.R.	G	9.635, 12.02, 12.05, 15.10, 15.21, 15.425

4:00-4:30 p.m.	2300-2330	Tokyo, Japan	G	15.105
		Vilnius, U.S.S.R.	G	11.72, 15.18, 15.404
4:00-5:00 p.m.	2300-2400	**R. Clarin, Santo Domingo, D.R.	G	11.70 (time variable)
4:00-5:30 p.m.	2300-0030	London, England	G	6.175, 9.51 (both via Sackville)
4:00-5:50 p.m.	2300-0050	Pyongyang, P.D.R. Korea	G	9.977, 11.535
5:00-5:15 p.m.	0000-0015	Tokyo, Japan	G	15.105
5:30-6:00 p.m.	0030-0100	Kiev, U.S.S.R.	G	11.72, 15.18, 15.405
5:30-8:30 p.m.	0030-0330	London, England	G	6.12, 6.175 (both via Sackville), 9.51 (via Greenville), 9.58 (via Ascension)
5:40-10:00 p.m.	0040-0500	HCJB, Quito, Ecuador	G	9.56, 11.915
6:00-6:30 p.m.	0100-0130	Montreal, Canada	G	9.535, 11.94
6:00-6:55 p.m.	0100-0155	Peking, China	G	15.06, 15.52, 17.68
6:00-7:00 p.m.	0100-0200	Taipei, Taiwan	F	11.825, 15.345, 15.425, 17.89
6:00-8:00 p.m.	0100-0300	Melbourne, Australia	G	15.32, 17.795
6:00-9:00 p.m.	0100-0400	Madrid, Spain	F	6.065, 11.88
6:30-7:30 p.m.	0130-0230	Tokyo, Japan	G	15.195, 15.42, 17.725, 17.825
7:00-7:15 p.m.	0200-0215	Tokyo, Japan	G	15.105
7:00-7:30 p.m.	0200-0230	Montreal, Canada	G	6.185, 9.535
		Seoul, Rep. Korea	F	9.64, 11.85
		Oslo, Norway	F	9.645 (Sun.)
7:00-8:30 p.m.	0200-0330	Cairo, Egypt	F	6.23, 9.475
7:10-7:30 p.m.	0210-0230	**Santiago, Chile	F	9.566, 11.705, 15.13
7:30-8:00 p.m.	0230-0300	Beirut, Lebanon	F	9.68 or 11.755
		Stockholm, Sweden	F	9.505, 11.85
8:00-8:15 p.m.	0300-0315	Tokyo, Japan	G	15.105
8:00-8:25 p.m.	0300-0325	Budapest, Hungary	F	6.08, 6.105, 9.585, 11.91, 15.225, 17.71
8:00-8:30 p.m.	0300-0330	Montreal, Canada	G	5.96, 6.185, 9.535, 9.605
		Kiev, U.S.S.R.	G	9.61, 9.72, 11.79
8:00-8:55 p.m.	0300-0355	Peking, China	G	7.12, 9.78 (both via Albania), 12.055, 15.06, 15.385, 17.735, 17.885
8:00-9:00 p.m.	0300-0400	Buenos Aires, Argentina	G	9.69 (exc. Sat., Sun.)
		Prague, Czechoslovakia	G	5.93, 7.345, 9.54, 9.63, 11.99
		Baghdad, Iraq	F	11.905
		Taipei, Taiwan	F	15.345, 17.89
8:10-8:30 p.m.	0310-0330	**Santiago, Chile	G	9.566, 11.705, 15.13
8:25-8:30 p.m.	0325-0330	Erevan, U.S.S.R.	G	11.69, 12.00, 15.10, 15.18 (Tues., Wed., Fri., Sat.)
8:30-9:15 p.m.	0330-0415	Berlin, Ger. Dem. Rep.	F	11.84, 11.89
8:30-9:30 p.m.	0330-0430	London, England	G	6.175 (via Sackville)
8:30-11:00 p.m.	0330-0600	Havana, Cuba	G	11.76
8:30 p.m.-12:30 a.m.	0330-0730	Moscow, U.S.S.R.	G	9.635, 9.71, 11.69, 11.72, 12.00, 12.02, 12.05, 15.10, 15.18
9:00-9:15 p.m.	0400-0415	Tokyo, Japan	G	15.105
9:00-9:25 p.m.	0400-0425	Budapest, Hungary	F	6.00, 6.105, 9.585, 11.91, 15.225, 17.71 (Tues., Fri.)
		Bucharest, Romania	F	5.99, 6.19, 9.57, 9.69, 11.735, 11.94
9:00-9:30 p.m.	0400-0430	Montreal, Canada	G	5.96, 9.535
		Seoul, Rep. Korea	F	9.64, 11.85
		Oslo, Norway	F	11.86 (Sun.)
9:30-10:00 p.m.	0430-0500	Berne, Switzerland	F	9.725, 11.715
		Vienna, Austria	P	6.015
		Sofia, Bulgaria	G	9.53, or 9.765
		London, England	G	6.175 (via Antigua)
10:00-10:15 p.m.	0500-0515	Jerusalem, Israel	G	7.412, 9.835, 11.96
		Tokyo, Japan	G	15.105
10:00-10:30 p.m.	0500-0530	Lisbon, Portugal	F	6.025, 11.935
10:00-11:30 p.m.	0500-0630	London, England	G	6.175, 9.51, (both via Antigua)
10:00 p.m.-12 mdt.	0500-0700	HCJB, Quito, Ecuador	G	6.095, 9.56
10:30-10:50 p.m.	0530-0550	Cologne, Ger. Fed. Rep.	G	5.96 (via Antigua) 6.10, 6.135 (via Montserrat), 6.185, 9.545, 9.59 (via Montserrat)
10:30-11:20 p.m.	0530-0620	Hilversum, Holland	G	6.165, 9.715, (both via Bonaire)
10:55 p.m.-12:40 a.m.	0555-0740	**Lagos, Nigeria	F	7.275
11:00-11:15 p.m.	0600-0615	Tokyo, Japan	G	15.105
11:00 p.m.-12 mdt.	0600-0700	Buenos Aires, Argentina	G	9.69 (exc. Sat., Sun.)
11:30 p.m.-12:30 a.m.	0630-0730	London, England	G	6.175 (via Antigua)
11:30 p.m.-1:00 a.m.	0630-0800	Havana, Cuba	G	9.525
11:45 p.m.-12:15 a.m.	0645-0715	**Bucharest, Romania	G	11.94, 15.25, 15.38, 17.825
12 mdt.-12:15 a.m.	0700-0715	Tokyo, Japan	G	9.505
12:30-1:20 a.m.	0730-0820	**Hilversum, Holland	G	9.715, 9.77 (both via Bonaire)
1:00-1:15 a.m.	0800-0815	Tokyo, Japan	G	9.505
2:00-2:15 a.m.	0900-0915	Tokyo, Japan	G	9.505
3:00-3:30 a.m.	1000-1030	Tokyo, Japan	G	5.99

*Reception quality, East Coast (West Coast) location: G-good, F-fair, P-poor
**Not intended for North America, but receivable satisfactorily
Days refer to local date in target area.

MORE THAN 20,000 DIFFERENT COMPONENTS

7400 TTL

7400	.18	7442	1.08	74107	.49
7401	.21	7448	1.15	74121	.55
7402	.21	7450	.26	74122	.49
7404	.21	7451	.27	74123	1.05
7405	.24	7453	.27	74125	.60
7407	.45	7454	.41	74126	.81
7408	.25	7460	.22	74132	3.00
7409	.25	7472	.39	74141	1.15
7410	.20	7473	.45	74150	1.10
7411	.30	7474	.45	74151	1.25
7413	.85	7475	.80	74153	1.35
7416	.43	7482	1.75	74154	1.54
7417	.43	7483	1.15	74157	1.30
7420	.21	7485	1.12	74161	1.45
7422	1.50	7486	.45	74164	1.65
7425	.43	7489	2.49	74165	1.65
7427	.37	7490	.69	74166	1.70
7428	.35	7491	1.20	74174	1.95
7430	.26	7492	.82	74175	1.95
7432	.31	7493	.82	74180	1.05
7437	.47	7494	.91	74181	3.55
7438	.40	7495	.91	74191	1.50
7440	.21	7496	.91	74195	1.00
7441	1.10	74100	1.25	74197	1.00

74L SERIES TTL

74L00	.33	74LS04	.45	74LS113	.98
74L10	.33	74LS10	.39	74LS138	1.89
74L30	.33	74LS20	.39	74LS174	2.50
74L42	1.50	74LS51	.39	74LS386	5.50
74L86	.69	74LS74	.65	74S153	2.25
74LS00	.39	74LS112	.65	74S387	1.95

74H00 TTL

74H00	.33	74H11	.33	74H53	.39
74H01	.33	74H20	.33	74H55	.39
74H04	.33	74H21	.33	74H73	.59
74H05	.35	74H30	.33	74H74	.59
74H10	.33	74H40	.33	74H76	.65

MOTOROLA

MC663P	2.50	MC1460	3.95
MC666P	1.60	MC1469R	2.50
MC670P	1.60	MC1489	4.60
MC679P	2.50	MC1496	1.65
MC725P	1.50	MC1510G	8.00
MC789P	1.50	MC1514L	4.50
MC790P	1.50	MC1595L	6.25
MC817P	1.30	MC1723CL	3.60
MC836P	1.35	MC1741CG	1.20
MC844	1.25	MC1810P	1.25
MC853P	2.25	MC3004L	2.25
MC876P	2.25	MC3007P	2.25
MC1004L	1.25	MC3021L	2.15
MC1010L	1.25	MC3060L	2.65
MC1305	1.95	MC3062L	3.00
MC1352P	1.55	MC4024P	2.20
MC1357	1.70	MC4044P	4.80
MC1371	1.85	MC14507CP	1.25
MC1439	2.65	MC14511CP	2.76
MC1458P	.50	MC14512CP	1.70

C MOS

4001AE	.29	4023AE	.29
4002AE	.29	4024AE	1.50
4007AE	.29	4025AE	.35
4010AE	.58	4028AE	1.60
4011AE	.29	4029AE	2.90
4012AE	.29	4030AE	.65
4015AE	1.25	4037AE	4.50
4016AE	.65	4040AE	2.40
4018AE	1.10	4044AE	1.50
4019AE	.65	4049AE	.75
4020AE	1.75	4050AE	.75
4021AE	1.50		

LINEAR

75450BP	.49	LM301H	.35	LM741CH	.45
75451BP	.39	LM307H	.35	LM747	.90
75452BP	.39	LM309K	1.25	LM748H	.45
75453BP	.39	LM311H	.90	LM1458N	.80
75454BP	.39	LM318N	1.50	N5556V	1.50
75491BP	.79	LM339N	1.85	NE5558	1.00
75492BP	.85	LM351AN	.65	NE555V	.60
CA3005	1.60	LM370N	1.25	NE556	1.50
CA3006	3.50	LM380N	1.45	UA702	.80
CA3018	1.10	LM566	2.25	UA703CH	.45
CA3018A	1.60	LM711CH	.60	UA709CH	.30
CA3026	1.50	LM723H	.75	UA749CH	.45
CA3046	.35	LM741CN	.45		

IC's ON THE MOVE

BBD BUCKET BRIGADE DEVICE

MM3001 19.50 MN3002 11.70
MM3003 9.45

HALL IC: DN834 1.25 DN837 1.50
DN835 1.35 DN838(NEW)

ZENER DIODES

½ Watt, ± 10% .... $.30 each to 33 V
1 Watt, ± 10% .... $.40 each to 33 V
Voltages to 200V, and ± 5% Available

1 Megohm Potentiometer · Made by Clarostat. ⅞" diam., split, knurled shaft ½" long.
NT544 $.39 Three for $1.00

5400 SERIES

5400	1.00	5475	1.50
5404	1.25	5486	1.90
5410	1.00	5493	2.00
5426	1.25	54100	1.80
5473	1.50	54LS04	1.00

VOLT.REG

LM340K-5	1.70
LM340K-6	1.70
LM340K-8	1.70
LM340K-15	1.70
LM340K-18	1.70
LM340K-24	1.70
LM340T-5	1.50
LM340T-6	1.50
LM340T-8	1.50
LM340T-12	1.50
LM340T-15	1.50
LM340T-18	1.50
LM340T-24	1.50

RESISTORS

¼ Watt ± 5% Packed 5 of any one value .... $.25
½ Watt ± 5% Packed 5 of any one value .... $.30
STANDARD RESISTANCE VALUES

SEE OUR AD ON JAPANESE TRANSISTORS AND IC's IN THIS ISSUE.

MINIMUM ORDER $5.00
All orders add 1.00 Postage and Handling.
Canada $1.50
N.J. Residents add 5% sales tax

ELECTROLYTIC CAPACITORS

2.2MF50	Axial Leads	.15	30MF25	Axial Leads	.18
3.3MF10	Axial Leads	.15	47MF25	Radial Leads	.19
3.3MF10	No Polarity	.15	47MF50	Radial Leads	.24
10MF25	Axial Leads	.15	100MF16	Radial Leads	.19
10MF50	Axial Leads	.16	100MF25	Radial Leads	.24
10MF150	Axial Leads	.20	500MF50	Axial Leads	.60
25MF35	Axial Leads	.18	1000MF35	Axial Leads	.65

MICROPROCESSOR

C1702A	9.95	2708	34.95	8008	19.95
2101	5.75	C5101-3	4.50	8080A	19.95
2102	1.75	MM5013	3.25	8224	10.45

Contact us for all your microprocessor needs.

RECTIFIERS

	10 For	100 For
1N4001	.60	5.00
1N4002	.70	6.00
1N4003	.80	7.00
1N4004	.90	8.00
1N4005	1.00	9.00
1N4006	1.10	10.00
1N4007	1.20	11.00

UNIJUNCTIONS

2N2160	.65	MU4892	.50
2N2646	.45	MU4893	.50
2N2647	.55	MU4894	.50
2N4851	.75	2N6027	.55
2N4852	.75	2N6028	.70
2N4870	.50	D5E37	.35
2N4871	.50	MU10	.35
MU4891	.50	MU20	.40

HARDWARE - SOCKETS

Nylon Screws, Nuts and Rivets - 50 piece assortment $1.99
MK 20 TO-3 Mounting Kit 5 for $.99
NT-505 Mica and bushing. Specify TO-3, TO-66 or TO-220 10 sets for $.99
IC Socket 14-Pin DIL $.25 each
IC Socket 16-Pin DIL $.27 each
Wire Wrap 16-Pin DIL $.32 each

POPULAR JEDEC TYPES

1N34	.25	2N1540	.90	2N2712	.18	2N3394	.17	2N3856	.20	2N4402	.16
1N60	.25	2N1544	.80	2N2894	.40	2N3414	.17	2N3866	1.25	2N4403	.20
1N270	.25	2N1554	1.25	2N2903	3.30	2N3415	.18	2N3903	.16	2N4409	.20
1N914	.25	2N1560	2.80	2N2904	.25	2N3416	.19	2N3904	.16	2N4410	.16
1N4148	.25	2N1605	1.75	2N2904A	.30	2N3417	.20	2N3905	.16	2N4416	.75
1S1555	.35	2N1613	.50	2N2905	.25	2N3442	1.85	2N3906	.16	2N4441	1.00
		2N1711	.50	2N2905A	.30	2N3553	1.50	2N3954A	3.75	2N4442	1.15
2N173	1.75	2N1907	4.10	2N2906	.25	2N3563	.20	2N3955	2.45	2N4443	1.35
2N338A	1.05	2N2102	1.70	2N2906A	.30	2N3565	.20	2N3957	1.25	2N4852	.55
2N404	.75	2N2160	.65	2N2907	.25	2N3638	.20	2N3958	1.20	2N5061	.30
2N443	2.50	2N2218	.25	2N2907A	.30	2N3642	.20	2N4037	.60	2N5064	.50
2N508A	.45	2N2218A	.30	2N2913	.75	2N3643	.20	2N4093	.85	2N5130	.20
2N706	.25	2N2219	.25	2N2914	1.20	2N3645	.20	2N4124	.16	2N5133	.15
2N718	.25	2N2219A	.30	2N3019	1.00	2N3646	.14	2N4126	.16	2N5138	.15
2N718A	.30	2N2221	.25	2N3053	.30	2N3731	3.75	2N4141	.20	2N5294	.50
2N918	.60	2N2221A	.30	2N3054	.70	2N3740	1.00	2N4142	.20	2N5296	.50
2N930	.25	2N2222	.25	2N3055	.75	2N3771	1.75	2N4143	.20	2N5306	.20
2N956	.30	2N2222A	.30	2N3227	1.00	2N3772	1.90	2N4220A	1.00	2N5400	.40
2N1302	1.25	2N2270	.40	2N3247	3.40	2N3773	3.00	2N4234	.95	2N5401	.50
2N1305	.75	2N2369	.25	2N3250	.50	2N3819	.40	2N4400	.16	2N5457	.35
2N1420	.20	2N2484	.32	2N3393	.20	2N3823	.70	2N4401	.16	2N5458	.35

ALL PARTS GUARANTEED WRITE FOR FREE CATALOG

NEW FROM NEWTONE

Regulated Power Supply Components Kit · Contains the components needed to build a fixed-voltage regulated supply including: 117/17V- 1 ampere Transformer, Bridge Rectifier, 2000 uF Capacitor, and a 1 ampere LM340 3-terminal IC Regulator. Makes a fine "on board" supply or use it for breadboarding. Components only. Specify 5, 6, 8, 12 or 15 volts. **NT525 $4.99**

Pioneer 6" Speaker · 7½-watt, 3.2-ohm speaker made the way speakers should be made. Has heavy-duty treated paper cone, protected magnet housing, and a ceramic terminal strip marked with polarity. A beautiful speaker at half the price you'd expect. **NT526 $2.39 Three for $6.00**

PC Boards · MIL grade, $^1/_{16}$" glass-epoxy boards with 2-ounce copper on one side.
NT521 6"x3" $.50, NT522 6"x6" $.90' NT523 6"x8" $1.20

Dry Transfer Patterns for PC Boards · Includes 0.1" spaced IC pads, donuts, angles, and 3-and 4-connector pads. Over 225 patterns on a 2" x 7¼" sheet. **NT520 $1.49**

3PDT · 24 Vold DC Relay · Potter & Bromfield KU14D57. Each contact can handle 10 amperes at voltages to 240 Vac. Coil resistance is 450 ohms. A super buy! Limited quantities. **NT508 $.99**

5" Taut-Band Meter · One milliampere full scale, 3½", scale length. Coil resistance 465 ohms. Made by Modutec for Bose. Meter scale in VUs (-20 to +3). Meter is designed to be mounted coil up. Complete with "smoke" plastic cover. Over-all 5⅛" x 4". Meter face mounts in a 5⅛" x 2⅞" cutout: A beautiful meter. **NT539 $4.89**

Aluminum Knob · Solid machined aluminum knob with fluted sides made for Bose. Black front-face insert, black pointer line. Fits flat ¼" shaft, does not require set screws. .8 high, .7 diam. Easily worth $1.50 **NT540 $.82 2 for $1.50**

We have been informed by the Bose Corporation that the original BOSE 301™ speaker system has not been discontinued as we stated in our previous ad. The BOSE 301 is available through Bose dealers.

We still have a small quantity of speakers originally made for Bose. These speakers have been tested with the Bose "Tone Standard" as a reference and subjected to the Bose power-handling test which includes both fixed and sweep-frequency testing.

8-Inch Woofer (Bose Part No. 102606) has a free-air resonant frequency of 25-35 Hz., and has a 1.5", 8.5-ounce magnet. The upper tested-frequency is 4000 Hz.

3-Inch Tweeter (Bose Part No. 107376) has a free-air resonant frequency of 1200-1500 Hz., and has an upper tested-frequency of 16.5 kHz.

Supplies are limited. We urge you to take advantage of these prices and stock up for your future needs.

Sorry, we have no information about the Bose enclosures or the crossover networks, nor do we have more specs. Bose says these data are proprietary information.

8" Woofer NT541 $10.95
3" Tweeter NT542 $ 3.95

NEW-TONE ELECTRONICS

PO BOX 1738A BLOOMFIELD, N.J. 07003
PHONE: (201) 748-6171, 6172, 6173

CIRCLE NO 31 ON FREE INFORMATION CARD

7400 TTL

SN7400N	16				
SN7401N	18	SN7472N	29	SN74160N	89
SN7402N	18	SN7473N	35	SN74161N	89
SN7403N	18	SN7474N	35	SN74162N	1 95
SN7404N	18	SN7475N	49	SN74163N	89
SN7405N	20	SN7476N	35	SN74164N	89
SN7406N	29	SN7479N	5 00	SN74165N	89
SN7407N	29	SN7480N	50	SN74166N	1 25
SN7408N	20	SN7482N	99	SN74167N	1 95
SN7409N	20	SN7483N	59	SN74170N	1 59
SN7410N	18	SN7485N	79	SN74172N	6 00
SN7411N	25	SN7486N	35	SN74173N	1 25
SN7412N	25	SN7489N	1 75	SN74174N	89
SN7413N	40	SN7490N	45	SN74175N	79
SN7414N	70	SN7491N	59	SN74176N	79
SN7416N	25	SN7492N	43	SN74177N	79
SN7417N	25	SN7493N	43	SN74179N	1 95
SN7420N	20	SN7494N	65	SN74180N	79
SN7421N	29	SN7495N	65	SN74181N	1 95
SN7422N	39	SN7496N	65	SN74182N	79
SN7423N	25	SN7497N	3 00	SN74184N	1 95
SN7425N	29	SN74100N	89	SN74185N	1 95
SN7426N	29	SN74107N	35	SN74186N	9 95
SN7427N	25	SN74109N	59	SN74188N	3 95
SN7429N	39	SN74116N	1 95	SN74190N	1 25
SN7430N	20	SN74121N	35	SN74191N	1 25
SN7432N	25	SN74122N	39	SN74192N	79
SN7437N	25	SN74123N	49	SN74193N	79
SN7438N	25	SN74125N	49	SN74194N	89
SN7439N	25	SN74126N	49	SN74195N	69
SN7440N	20	SN74132N	75	SN74196N	89
SN7441N	89	SN74136N	75	SN74197N	89
SN7442N	49	SN74141N	79	SN74198N	1 49
SN7443N	75	SN74142N	2 95	SN74199N	1 49
SN7444N	75	SN74143N	2 95	SN74200N	5 59
SN7445N	75	SN74144N	2 95	SN74251N	1 79
SN7446N	69	SN74145N	79	SN74279N	79
SN7447N	59	SN74147N	1 95	SN74283N	2 25
SN7448N	79	SN74148N	1 29	SN74284N	3 95
SN7450N	20	SN74150N	89	SN74285N	3 95
SN7451N	20	SN74151N	59	SN74365N	69
SN7453N	20	SN74153N	59	SN74366N	69
SN7454N	20	SN74154N	99	SN74367N	69
SN7459A	25	SN74155N	79	SN74368N	69
SN7460N	20	SN74156N	79	SN74390N	1 95
SN7470N	29	SN74157N	65	SN74393N	1 95

20% Discount for 100 Combined 7400's

CMOS

				74C00 Series	
CD4000	23			74C00	39
CD4001	23	CD4049	49	74C02	55
CD4002	23	CD4050	49	74C04	75
CD4006	1 19	CD4051	1 19	74C08	75
CD4007	25	CD4053	1 19	74C10	65
CD4009	49	CD4056	2 95	74C14	3 00
CD4010	49	CD4059	9 95	74C20	65
CD4011	23	CD4060	1 49	74C30	65
CD4012	25	CD4066	79	74C42	2 15
CD4013	39	CD4068	39	74C48	4 75
CD4014	1 39	CD4069	45	74C73	1 50
CD4015	1 19	CD4070	55	74C74	1 15
CD4016	49	CD4071	23	74C89	6 49
CD4017	1 19	CD4072	49	74C90	3 00
CD4018	99	CD4076	1 39	74C93	2 00
CD4019	49	CD4081	23	74C95	2 00
CD4020	1 19	CD4082	23	74C107	1 25
CD4021	1 39	CD4093	99	74C151	2 90
CD4022	1 19	CD4098	2 49	74C154	3 00
CD4023	23	MC14409	14 95	74C157	2 15
CD4024	79	MC14410	14 95	74C160	3 25
CD4025	23	MC14411	14 95	74C161	3 25
CD4026	2.25	MC14419	4 95	74C163	3 00
CD4027	69	MC14433	14 95	74C164	3 25
CD4028	89	MC14506	75	74C173	2 60
CD4029	1 19	MC14507	99	74C192	3 49
CD4030	49	CD4508	3 95	74C193	2 75
CD4035	99	CD4510	1 39	74C195	2 75
CD4040	1 19	CD4511	1 29	74C922	9 95
CD4041	1 25	CD4515	2 95	74C923	8 95
CD4042	99	CD4518	1 29	74C925	14 95
CD4044	89	CD4520	1 29	74C926	11 95
CD4046	1 79	MC14562	14 50	80C95	1 50
CD4047	2 50	CD4566	2 25	80C97	1 50
CD4048	1 35	MC14583	3 50		

LINEAR

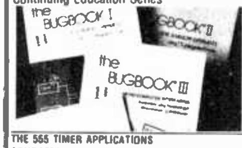
78MG	1 75			LM733N	1 00
LM300H	80			LM739N	1 19
LM301H	35			LM741CH	35
LM301CN	35			LM741CN	35
LM302H	75	LM340T-8	1 25	LM741-14N	39
LM304H	1 00	LM340T-12	1 25	LM747H	79
LM305H	60	LM340T-15	1 25	LM747N	79
LM307CN/H	35	LM340T-18	1 25	LM748H	39
LM308H	1 00	LM340T-24	1 25	LM748N	39
LM308CN	1 00	LM350N	1 00	LM1303N	90
LM309H	1 10	LM351CN	65	LM1304N	1 19
LM309K	1 25	LM370N	1 15	LM1305N	1 40
LM310CN	1 15	LM373N	3 25	LM1307N	85
LM311H	90	LM377N	4 00	LM1310N	2 95
LM311N	90	LM380N	1 25	LM1351N	1 65
LM317K	6 50	LM380CN	99	LM1414N	1 75
LM318CN	1 50	LM381N	1 79	LM1458CN/H	59
LM319N	1 30	LM382N	1 79	MC1488	1 95
LM320K-5	1 35	NE501N	8 00	MC1489	1 95
LM320K-5 2	1 35	NE510A	6 00	LM1496N	95
LM320K-12	1 35	NE529A	4 95	LM1556V	1 75
LM320K-15	1 35	NE531H	3 00	MC1741SCP	3 00
LM320K-18	1 35	NE536T	6 00	LM2901N	2 95
LM320K-24	1 35	NE540L	6 00	LM3053	1 50
LM320T-5	1 25	NE550N	1 30	LM3065N	89
LM320T-5 2	1 25	NE555V	39	LM3900N(3401)	49
LM320T-8	1 25	NE556	99	LM3905N	89
LM320T-12	1 25	NE560B	5 00	LM3909	1 25
LM320T-15	1 25	NE561B	5 00	MC5558V	1 00
LM320T-18	1 25	NE562B	5 00	LM7525N	90
LM320T-24	1 25	NE565H	1 75	LM7534N	75
LM323K-5	5 95	NE565N	1 25	80388	4.95
LM324N	1 80	NE566CN	1 75	LM75450	49
LM339N	99	NE567H	1 25	75451CN	39
LM340K-5	1 35	NE567V	99	75452CN	39
LM340K-6	1 35	NE570	10 50	75453CN	39
LM340K-8	1 35	LM703CN/H	45	75454CN	39
LM340K-12	1 35	LM709H	29	75491CN	79
LM340K-15	1 35	LM709N	29	75492CN	89
LM340K-18	1 35	LM710N	79	75494CN	89
LM340K-24	1 35	LM711N	39	RC4151	5 95
LM340T-5	1 25	LM723H	55	RC4194	5 95
LM340T-6	1 25	LM723N	55	RC4195	4 49

74LS00 TTL

74LS00	23			74LS155	69
74LS02	23			74LS157	69
74LS03	23	74LS74	35	74LS160	89
74LS04	29	74LS75	49	74LS161	89
74LS05	29	74LS76	35	74LS162	89
74LS08	23	74LS83	75	74LS163	89
74LS10	23	74LS85	99	74LS164	99
74LS13	49	74LS86	35	74LS175	79
74LS14	99	74LS90	49	74LS181	2 49
74LS20	23	74LS92	59	74LS190	89
74LS26	29	74LS93	59	74LS191	89
74LS27	29	74LS95	79	74LS192	89
74LS28	29	74LS96	89	74LS193	89
74LS30	23	74LS107	35	74LS194	89
74LS32	29	74LS109	35	74LS195	89
74LS40	29	74LS112	35	74LS253	79
74LS42	69	74LS123	99	74LS257	69
74LS47	69	74LS132	79	74LS260	55
74LS51	23	74LS136	39	74LS279	59
74LS55	23	74LS138	69	74LS367	59
74LS73	35	74LS139	69	74LS368	59
		74LS151	69	74LS670	1 95

BUGBOOK®

Continuing Education Series



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SW7427	1 50	12 00	110 00	SW74100	6 90	66 00	650 00
SW7430	1 50	12 00	110 00	SW74104	2 20	19 00	180 00
SW7432	1 50	12 00	110 00	SW74105	2 20	19 00	180 00
SW7437	1 50	12 00	110 00	SW74107	2 20	19 00	180 00
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SW7440	1 20	9 00	80 00	SW74123	2 50	22 00	200 00
SW7443	3 50	31 00	300 00	SW74145	5 50	51 00	500 00
SW7444	3 50	31 00	300 00	SW74150	6 90	66 00	650 00
SW7445	3 50	31 00	300 00	SW74151	3 50	31 00	300 00
SW7446	4 00	36 00	350 00	SW74153	4 00	36 00	350 00
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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
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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
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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

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3 3/50V	14	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	.11
10/50V	16	14	12	4.7/16V	15	13	10
22/25V	17	15	12	4.7/25V	15	13	10
22/50V	24	20	18	4 7/50V	16	14	.11
47/25V	19	17	15	10/16V	14	12	.09
47/50V	25	21	19	10/25V	15	13	10
100/25V	24	20	18	10/50V	16	14	.12
100/50V	35	30	28	47/50V	24	21	19
220/25V	32	28	25	100/16V	19	15	14
220/50V	45	41	38	100/25V	.24	20	18
470/25V	33	29	27	100/50V	.35	.30	28
1000/16V	55	50	45	220/16V	23	17	16
2200/16V	70	62	55	470/25V	.31	28	.26

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923875-R	40	right angle	2.30 ea.
923866-R	50	straight	2.36 ea.
923876-R	50	right angle	2.82 ea.

INTRA-CONNECTOR

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Part No.: 922576-26 No. of contacts: 26 Price $6.90 ea.

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				1-9	10-
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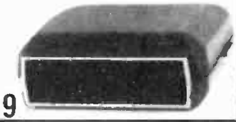
	JMT221	DPDT	on-off-on	2.55	1.87
	JMT223	DPDT	on-none-on	2.15	1.58
TOGGLE (Printed Circuit)	MPC121	SPDT	on-off-on	$2.05	$1.53
	MPC123	SPDT	on-none-on	1.75	1.31
	MPC221	DPDT	on-off-on	2.65	1.97
	MPC223	DPDT	on-none-on	2.25	1.68
PUSH BUTTON	PB123	SPDT	maintained	1.95	1.47
	PB126	SPDT	momentary	1.95	1.47
PUSH BUTTON Minature	MS102	DPST	momentary open	.35	.30
	MS103	SPST	momentary closed	.35	.30
DIPSWITCH SPST	206-4	8 pin dip	4 switch	1.75	1.65
	206-7	14 pin dip	7 switch	1.95	1.85
	206-8	16 pin dip	8 switch	2.25	2.15

1/16 VECTOR BOARD

	0.1 Hole Spacing Part No.	P-Pattern L	P-Pattern W	Price 1-9	Price 10 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 062WE	4.50	6.50	2.07	1.86
	84P44 062WE	4.50	8.50	2.56	2.31
	169P44 062WE	4.50	17.00	5.04	4.53
	169P84 062WE	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062WEC1	4.50	17.00	6.80	6.12

INSTRUMENT/ CLOCK CASE



Injection molded unit. Complete with red bezel. 4½" x 4" x 1-9/16"

$3.49

MICROPROCESSOR COMPONENTS

8080A	CPU	$10.95	Z80	CPU	$24.95
8212	8 Bit Input/Output	4.95	CDP1802	CPU	19.95
8214	Priority Interrupt Control	7.95	MC6800	8 Bit MPU	19.95
8216	Bi-Directional Bus Driver	4.95	MC6810AP1	128 x 8 Static RAM	5.95
8224	Clock Generator/Driver	5.95	MC6820	Periph. Interface Adapter	7.95
8228	System Controller Bus Driver	5.95	MC6830L8	1024 x 8 Bit ROM	14.95

CPU'S

8080A	Super 8008	$10.95
2650	8 Bit MPU	26.50
P8085	CPU	29.95

SR'S

2504	1024 Dynamic	$ 3.95
2518	Hex 32 BIT	4.95
2519	Hex 40 BIT	4.00
2522	Dual 132 Bit SSR	2.95
2524	512 Dynamic	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit	2.95
2528	Dual 250 Bit Static	4.00
2529	Dual 512 BIT	4.00
2532	Quad 80 Bit	2.95
2533	1024 Static	2.95
3341	Fifo	6.95
74LS670	16 x 4 Reg	1.95

UART'S

AY-5-1013	30K Baud	$ 5.95

ROM'S

2513(2140)	Char. Gen. upper case	$ 9.95
2513(3021)	Char. Gen. lower case	9.95
2516	Char. Gen.	10.95
MM5230	2048 BIT (512 x 4 on 256 x 8)	1.95

MM5262 2K x 1 Dynamic RAM 3 for 1.00

RAM'S

1101	256 x 1	Static	$ 1.49
2101	256 x 4	Static	5.95
2102	1024 x 1	Static	1.75
2107/5280	4096 x 1	Dynamic	4.95
2111	256 x 4	Static	6.95
TMS4044-45NL	4K	Static	14.95
7489	16 x 4	Static	1.75
8101	256 x 4	Static	5.95
8111	256 x 4	Static	6.95
8599	16 x 4	Static	3.49
21L02/91L02	1024 x 1	Static	1.95
74200	256 x 1	Static	6.95
93421	256 x 1	Static	2.95
MK4116(UPD416)	4K	Dynamic 16 Pin	5.95
MK4027(UPD414)	16K	Dynamic 16 Pin	29.95

PROMS

1702A	2048	Famos	$ 5.95
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
2708	8K	Eprom	10.95
2716 T.I.	16K	Eprom	29.95
2716 Intel	16K	Eprom	59.95
6301-1	1024	Tri-State Bipolar	3.49
6330-1	256	Open Collector Bipolar	2.95

SPECIAL REQUESTED ITEMS

FCM3817	$5.00	11C90	19.95	7205	19.95	9368	3.95
AY-3-8500-1	7.50	4N33	3.95	ICM7045	24.95	LD110/111	25.00/set
AY-5-9100	14.95	8T20	7.50	ICM7207	7.50	95H90	11.95
AY-5-9200	14.95	8T97	1.50	ICM7208	19.95	MC3061P	3.50
AY-5-9500	4.95	HD0165	7.95	ICM7209	7.50	MC4016 (74416)	7.50
AY-5-2376	14.95	MCM6571	13.50	MK50240	17.50	MC1408L7	4.95
9374	1.50	MCM6574	13.50	DS0026CH	3.75	MC1408L8	5.75
82S115	19.95	MCM6575	13.50	TIL308	10.50	74C922	9.95

CLOCK CHIPS

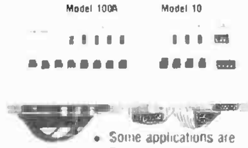
MM5309	$9.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5841	9.95
CT7001	5.95

PARATRONICS

Featured on February's Front Cover of Popular Electronics

Logic Analyzer Kit Model 100A

$229.00/kit



- Analyzes any type of digital system
- Checks data rates in excess of 8 million words per second
- Trouble shoot TTL, CMOS, DTL, RTL, Schottky and MOS families
- Displays 16 logic states up to 8 digits wide
- See ones and zeros displayed on your CRT, octal or hexadecimal format
- Tests circuits under actual operating conditions
- Easy to assemble — comes with step-by-step construction manual which includes 80 pages on logic analyzer operation.

(Model 100A Manual - $4.95)

- Some applications are
- — Troubleshooting microprocessor address, instruction, and data flow
- — Examine contents of ROMS
- — Tracing operation of control logic
- — Checking counter and shift register operation
- — Monitoring I/O sequences
- — Verifying proper system operations during testing

PARATRONICS TRIGGER EXPANDER - Model 10

Adds 16 additional bits. Provides digital delay and qualification of input clock and 24-bit trigger word. — Connects direct to Model 100A for integrated unit).

Model 10 Kit - $229.00
Baseplate — $9.95
Model 10 Manual — $4.95

B&K PRECISION 3½-Digit Portable DMM

- Overload Protected
- 3½ high LED Display
- Battery or AC operation
- Auto-Zeroing
- 1mv 1Va 0.1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage 0-1000V
AC Voltage 0-1000V
Freq. Response 50-400 HZ
DC/AC Current 0-100mA
Resistance 0-10 meg ohm
Size 6.4" x 4.4" x 2"

Model 2800 $99.95

Comes with test leads, operating manual and spare fuse

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

CSC 100 MHz 8-Digit Counter

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

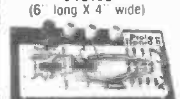
MAX-100 $134.95

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

CONTINENTAL SPECIALTIES

PROTO BOARD 6

$15.95
(6" long X 4" wide)



Other CS Proto Boards

PB100 - 4.5" x 6"	$ 19.95
PB101 - 5.8" x 4.5"	29.95
PB102 - 7" x 4.5"	39.95
PB103 - 9" x 6"	59.95
PB104 - 9.5" x 8"	79.95
PB203 - 9.75 x 6½ x 2¾	80.00
PB203A - 9.75 x 6½ x 2¾	129.95

(includes power supply)

PROTO CLIPS

14 PIN	$4.50
16 PIN	4.75
24 PIN	8.50
40 PIN	13.75

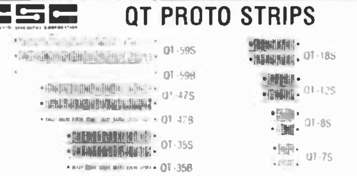
DESIGN MATES

DM1 - Circuit Designer $69.95
DM2 - Function Generator $74.95
DM3 - RC Bridge $74.95

LOGIC MONITOR

for DTL, HTL, TTL or CMOS Devices **$74.95**

CSC 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	6.50
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

Experimentor 300	$ 9.95
Experimentor 600	$10.95

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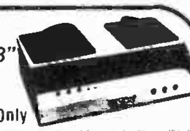
The Incredible "Pennywhistle 103"



$129.95 Kit Only

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

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

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

The Original the 3rd Hand

$9.95 each

- Leaves two hands free for working
- Clamps on edge of bench, table or work bench
- Position board on angle or flat position for soldering or clipping
- Sturdy, aluminum construction for hobbyist, manufacturer or school rooms

DIGITAL STOPWATCH

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

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

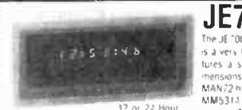
Stop Watch Chip Only (7205) $19.95

IMC 3½ DIGIT DPM KIT

- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

Model KB500 DPM Kit $49.00
Model KB503 5V Power Kit $17.50

JE700 CLOCK



The JE700 is a low cost digital clock but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6" x 2½" x 1". It utilizes a MAN72 high brightness readout and the MM5314 clock chip.

12 or 24 Hour

115 VAC KIT ONLY **$16.95**

HEXADECIMAL ENCODER 19-KEY PAD

- 1 – 0
- ABCDEF
- Shift Key
- 2 Optional Keys

$10.95 each

New 63 KEY KEYBOARD

$29.95 IN STOCK

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.

HD0165	Encoder Chip (encodes 16 Keys)	$7.95 ea.
AY-5-2376	Encoder Chip (encodes 88 Keys)	$14.95 ea.

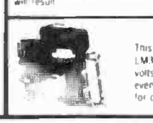
JE803 PROBE

The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test, drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols: (HI) 1, (LOW) 0, (PULSE) P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.

$9.95 Per Kit

printed circuit board

T²L 5V 1A Supply



This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only JE225 $9.95 Per Kit

ELECTRONICS Market Place

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Deluxe Model (in hundredths to 99.99")

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Used at AAU, NCAA, and the Olympics this two function stopwatch times single segments of events with time in/out delays. Press the button and stopwatch displays time action stopped — then resumes with next button press. Accurate to 1 sec./yr.; bright LED display reads to 59:99.99, runs on disposable batts. (incl.); lanyard; 1-yr. warranty.

No. 1695AV **$39.95** Ppd.

Hand-held electronic digital stopwatch counts up, down, and sounds alarm. Full range (9 hr. 50 min. 59 sec.); bright LED display; matrix keyboard; start/stop reset buttons. Batteries. Size: 2¾x4¼x1⅛"

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No. 72,275AV (READY TO PLAY!) **$17.50** Ppd.

GET EARLY STORM WARNINGS ON BOTH LAND AND SEA...

SAVE $10

STORMALARM warns you about storms the way a smoke alarm warns you about fire. This sensitive weather radio lets you track tornadoes, hurricanes, severe thunderstorms, and other inclement weather conditions by sounding an alarm. Unlike standard weather radios that must be constantly monitored, STORMALARM monitors itself! Regularly $46.50 you can save $10 by ordering now. Triggered by a signal from the National Weather Service Stations, it sounds a full blast in the event of emergency weather conditions. Also has 3 standard weather channels for detailed reporting. Features 40-50 mile range, continuous beeper alarm, flashing warning light, 2¼" dia. speaker, antenna, external antenna input, 117VAC to 9VDC converter, instr. Size 3x5x1¼"

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☐ 50	$ .55	$ .56
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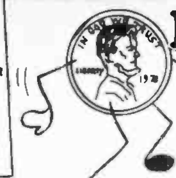

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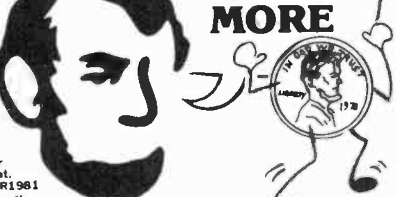

Order By Cat. No. 5R1981 & type No.

Type	Each	2 for
☐ SN7400	$.19	$.20
☐ SN7401	.19	.20
☐ SN7403	.19	.20
☐ SN7404	.25	.26
☐ SN7405	.19	.20
☐ SN7406	.19	.20
☐ SN7408	.21	.22
☐ SN7410	.19	.20
☐ SN7413	.39	.40
☐ SN7414	.65	.66
☐ SN7416	.29	.30
☐ SN7420	.19	.20
☐ SN7423	.29	.30
☐ SN7426	.25	.26
☐ SN7427	.25	.26
☐ SN7430	.29	.30
☐ SN7432	.25	.26
☐ SN7437	.25	.26
☐ SN7438	.29	.30
☐ SN7440	.19	.20
☐ SN7442	.69	.70
☐ SN7443	.69	.70
☐ SN7444	.65	.66

Type	Each	2 for
☐ SN7445	.99	1.00
☐ SN7446	1.35	1.36
☐ SN7447	1.25	1.26
☐ SN7448	1.35	1.36
☐ SN7450	.19	.20
☐ SN7451	.19	.20
☐ SN7453	.19	.20
☐ SN7454	.19	.20
☐ SN7455	.19	.20
☐ SN7460	.19	.20
☐ SN7462	.19	.20
☐ SN7464	.19	.20
☐ SN7465	.19	.20
☐ SN7470	.25	.26
☐ SN7471	.25	.26
☐ SN7472	.25	.26
☐ SN7473	.55	.56
☐ SN7474	.29	.30
☐ SN7475	.79	.80
☐ SN7476	.59	.60
☐ SN7478	.59	.60
☐ SN7480	.29	.30
☐ SN7482	.39	.40

Type	Each	2 for
☐ SN7483	.99	1.00
☐ SN7485	1.49	1.50
☐ SN7486	.39	.40
☐ SN7488	1.95	1.96
☐ SN7490	.69	.70
☐ SN7491	.79	.80
☐ SN7492	.45	.46
☐ SN7493	.49	.50
☐ SN7494	.69	.70
☐ SN7495	.69	.70
☐ SN7496	.69	.70
☐ SN7498	.69	.70
☐ SN74100	1.49	1.50
☐ SN74107	.39	.40
☐ SN74112	.25	.26
☐ SN74113	.19	.20
☐ SN74114	.25	.26
☐ SN74121	.49	.50
☐ SN74123	.69	.70
☐ SN74125	.59	.60
☐ SN74126	.39	.40
☐ SN74132	1.25	1.26
☐ SN74140	.99	1.00
☐ SN74141	1.49	1.50
☐ SN74145	1.25	1.26
☐ SN74148	1.75	1.76
☐ SN74150	.99	1.00
☐ SN74151	.99	1.00
☐ SN74153	.99	1.00
☐ SN74154	1.75	1.76
☐ SN74155	.79	.80
☐ SN74156	.69	.70
☐ SN74157	.99	1.00
☐ SN74158	.99	1.00
☐ SN74160	1.25	1.26
☐ SN74161	1.25	1.26
☐ SN74163	1.19	1.20
☐ SN74164	.99	1.00
☐ SN74165	1.25	1.26
☐ SN74166	1.25	1.26
☐ SN74173	1.25	1.26
☐ SN74174	1.49	1.50
☐ SN74175	.99	1.00
☐ SN74177	.79	.80
☐ SN74179	1.49	1.50
☐ SN74180	.49	.50
☐ SN74182	.69	.70
☐ SN74190	1.49	1.50
☐ SN74191	1.75	1.76
☐ SN74192	.85	.86
☐ SN74193	.85	.86
☐ SN74194	1.25	1.26
☐ SN74195	.49	.50
☐ SN74197	.75	.76
☐ SN74199	1.75	1.76
☐ SN74200	5.50	5.51
☐ SN74251	1.75	1.76
☐ SN74284	4.50	4.51
☐ SN74285	4.25	4.26

POP-AMPS AT "CENT-CIBLE" PRICES

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

Type	Each	2 for
☐ LM300H	$.49	$.50
☐ LM301H-V	.45	.46
☐ LM308V-H	.79	.80
☐ LM309K	1.29	1.30
☐ LM311H-V	.79	.80
☐ LM318V	1.29	1.30
☐ LM320H-5, 12. 15	1.29	1.30
☐ LM320K- 15	1.29	1.30
☐ LM320T-6, 5	1.29	1.30
☐ LM322N	1.19	1.20
☐ LM324N	1.75	1.76
☐ LM339N	1.09	1.10
☐ LM340K-5, 6, 8, 12, 15, 18,	1.29	1.30
☐ LM340T-5, 6, 8, 12, 15, 18. 24	1.29	1.30
☐ LM350N	.59	.60

Type	Each	2 for
☐ LM370N-H	1.29	1.30
☐ LM374H	1.79	1.80
☐ LM376V	.29	.30
☐ LM377N	2.25	2.26
☐ LM381N	1.69	1.70
☐ LM531H	1.49	1.50
☐ LM532H-N	.29	.30
☐ LM555V	.75	.76
☐ LM558V	.79	.80
☐ LM561N	1.00	1.01
☐ LM565N	.99	1.00
☐ LM703H	.49	.50
☐ LM704H	.29	.30
☐ LM709N-H	.25	.26
☐ LM710N	.39	.40
☐ LM733N	.79	.80
☐ LM739N	.89	.90

Type	Each	2 for
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☐ LM1304	.80	.79
☐ LM1310	1.00	.99
☐ LM1312	2.00	1.99
☐ LM1414V	.80	.79
☐ LM1458V	.70	.69
☐ LM1800H	1.00	.99
☐ LM3028H	.66	.65
☐ LM3900H	.50	.49
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☐ 5E2380	1N4004	400	10 for .99	20 for 1.00
☐ 5E2381	1N4005	600	10 for 1.29	20 for 1.30
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☐ 15.V	5 for 1.	10 for 1.01

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☐ 6.2V	3 for 1.	6 for 1.01
☐ 8.2V	3 for 1.	6 for 1.01
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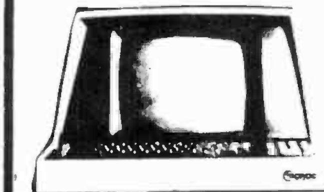

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6502	12 95
6800	19 95
8008 1	8 75
8080A	15 95
TMS-9900TL	89 95

6800 SUPPORT

6810P	4 9.
6820P	8 00
6828P	11 25
6834P	16 95
6850P	9 95
6852P	11 95
6860P	14.95
6862P	17 95
6880P	2 70

Z80 SUPPORT DEVICES

3881	12 95
3882	12 95

F-8 SUPPORT DEVICES

3851	14 95
3853	14 95

8080A SUPPORT DEVICES

8212	3 95
8214	9 95
8216	4 50
8224	4 95
8228	8 75
8238	8 00
8251	12 00
8253	28 00
8255	12 00
8257	25 00
8259	25 00

CHARACTER GENERATORS

2513 UP	6 75
2513 DOWN	6 75
2513 UP (5v)	9 95
2513 DOWN(5v)	10 95
MCM6571	10 80
MCM6571A	10 80
MCM6572	10 80
MCM6574	14 75
MCM6575	14 75

STATIC RAMS		1-24	25-99	100
21L02	(450)	1 50	1 40	1 25
21L02	(250)	1 95	1.80	1 50
21L11		4 25	4 10	3 95
1101A		1 49	1 29	1 10
2101 1		2 95	2 75	2 60
2102		1 25	1 15	1 00
2102 1		1 50	1 30	1 15
2111 1		4 00	3 50	3 25
2112 1		3 00	2 80	2 69
2114		17 95	16.95	16 50
4200A		12 95	12 50	11 95
5101C E		11 95	11 25	10 25

WAVEFORM GENERATOR

8038	4 00
MC4024	2 50
566	1 75

KEYBOARD CHIPS

AY5 2376	13 95
AY5 3600	13 95

LATE ADDITIONS

TMS 4044	$14.00
TMS 5501	$24.95

FLOPPY DISC CONTROLLER

1771B	55 95
1771B 01	59 95

PROM'S

1702A	5 00
2704	15 00
2708	13 00
2716	38 00
3601	4 50
5203AQ	4 00
5204AQ	6 00
6834	16 95
6834 1	14.95
82S23B	4 00
82238	2 70

DYNAMIC RAMS

1103	1 50
2104	4 50
2107A	3 75
2107B	4 50
2107B 4	4 00
TMS4050	4 50
TMS4060	4 50
4096	4 50
4116	42 00
MM5270	5 00
MM5280	6 00
MCM6605	6 00

UART'S

AY5 1013A	5 50
AY5-1014A	8 95
TR 1602A	5 50
TMS 6011	6 95
IM-6402	10 80
IM 6403	10 80

MISC. OTHER COMPONENTS

NH0025CN	1 70
NH0026CN	2 50
NBT20	3.50
NBT26	2 45
74367	.90
DM8098	.90
1488	1 95
1489	1 95
D 3207A	2.00
C 3404	3.95
P 3408A	5.00
P 4201	4.95
MM 5320	7 50
MM 5369	1 90
DM 8130	2 90
DM8131	2 75
DM-8831	2.50
DM 8833	2 50
DM-8835	2 50
SN74LS367	.90
SN74LS368	.90

KIM

KIM-1	245 00
6502	12 95
6520	9 00
6522	9 25
6530-002	15 95
6530-003	15 95
6530-004	15 95
6530-005	15 95

USRT

S 2350	10 95

TV-1 VIDEO INTERFACE

You will want to know about the TV-1 Video to Televisior Interface Kit. No need to buy a separate Video Monitor if you already own a TV set. Just connect the TV-1 between your system video output and the TV set antenna terminals - that's all there is to it - to convert your TV set to a Video Monitor, and at a much lower cost! PRICE $8.95

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INTEGRATED CIRCUITS

TTL

7400	.21
7401	.21
7402	.21
7403	.21
7404	.21
7405	.21
7406	.25
7407	.25
7408	.21
7409	.21
7410	.21
7411	.21
7412	.21
7413	.25
7414	.89
7416	.25
7417	.25
7420	.21
7421	.25
7423	.35
7425	.35
7426	.25
7427	.33
7428	.28
7430	.21
7432	.25
7433	.30
7437	.25
7438	.25
7439	.50
7440	.21
7442	.53
7445	.70
7446	.70
7447	.70
7448	.70
7450	.21
7451	.21
7453	.21
7454	.21
7460	.21
7470	.30
7472	.30
7473	.30
7474	.30
7475	.49
7476	.32
7480	.70
7483	.70
7485	.89
7486	.28
7489	2.19
7490	.44
7491	.70
7492	.44
7493	.44
7494	.70
7495	.70
7496	.70
74100	1.28
74107	.30
74109	.33
74116	1.26
74121	.35
74122	.44
74123	.61
74125	.40
74126	.40
74128	.48
74132	.70
74141	.88
74145	.70
74147	1.63
74148	1.30
74150	1.16
74151	.70
74153	.65
74154	1.03
74155	.70
74156	.70
74157	.70
74160	.88
74161	.88
74162	.88
74163	.88
74164	.96
74165	1.15
74166	1.26
74170	2.64
74174	.98
74175	.93
74176	.79
74177	.79
74180	.70
74180	.70
74181	2.15
74182	.79
74184	2.15
74185	2.19
74189	3.50
74190	1.23
74191	1.23
74192	.88
74193	.88
74194	.88
74195	.88
74196	.88
74197	.88
74198	1.49
74199	1.49
74221	.86
74251	1.09
74279	.55
74298	.94
74365	.67
74366	.67
74367	.67
74368	.67

74LS00

74LS00	.28
74LS01	.28
74LS02	.28
74LS03	.28
74LS04	.29
74LS05	.29
74LS08	.29
74LS09	.29
74LS10	.28
74LS11	.28
74LS12	.28
74LS13	.47
74LS14	1.02
74LS15	.28
74LS20	.28
74LS21	.28
74LS22	.28
74LS26	.33
74LS27	.33
74LS28	.33
74LS30	.28
74LS32	.33
74LS33	.33
74LS37	.33
74LS38	.33
74LS40	.28
74LS42	.67
74LS47	.79
74LS48	.77
74LS51	.28
74LS54	.28
74LS55	.28
74LS73	.39
74LS74	.39
74LS74	.39
74LS75	.53
74LS76	.39
74LS78	.39
74LS83	.79
74LS85	.49
74LS86	.39
74LS90	.57
74LS92	.57
74LS93	.57
74LS95	.88
74LS96	.88
74LS107	.39
74LS109	.39
74LS112	.39
74LS113	.39
74LS114	.39
74LS125	.49
74LS126	.49
74LS132	.81
74LS136	.39
74LS138	.73
74LS139	.73
74LS151	.75
74LS153	.75
74LS154	1.10
74LS155	.75
74LS156	.75
74LS157	.75
74LS158	.75
74LS160	1.02
74LS161	1.02
74LS163	1.02
74LS164	1.02
74LS168	1.14
74LS169	1.14
74LS170	1.73
74LS173	1.34
74LS174	1.06
74LS175	.84
74LS181	2.50
74LS190	1.18
74LS191	1.18
74LS192	.98
74LS193	1.06
74LS194	.88
74LS195	.86
74LS196	.86
74LS197	.86
74LS197	.86
74LS221	1.06
74LS240	1.90
74LS241	1.90
74LS242	1.70
74LS243	1.70
74LS244	1.70
74LS247	.79
74LS248	.79
74LS249	.79
74LS251	.84
74LS253	.84
74LS257	.75
74LS258	.75
74LS260	.34
74LS261	2.00
74LS266	.39
74LS273	1.28
74LS279	.62
74LS283	.79
74LS290	.65
74LS293	.65
74LS295	1.12
74LS298	1.30
74LS365	.67
74LS366	.67
74LS367	.67
74LS368	.67
74LS377	1.50
74LS386	.39
74LS395	1.74
74LS670	2.34
81LS95	.77
81LS96	.77
81LS97	.77
81LS98	.77

INTERFACE

8093	.40
8094	.40
8095	.67
8096	.67
8097	.67
8098	.67
75450	.88
75451	.61
75452	.61
75453	.61
75454	.61
75491	.81
75492	.84
75493	1.09
75494	1.19
MC1488N	.90
MC1489N	.90

4000 CMOS

4000	.23
4001	.23
4002	.23
4006	1.23
4007	.23
4008	.79
4009	.44
4010	.44
4011	.23
4012	.23
4013	.40
4014	.96
4015	.96
4016	.40
4017	1.05
4018	1.05
4019	.23
4020	1.14
4021	1.14
4022	.96
4023	.23
4024	.84
4025	.23
4026	1.68
4027	.40
4028	.89
4029	1.14
4030	.23
4033	1.51
4034	3.50
4035	1.14
4040	1.14
4041	.79
4042	.79
4043	.70
4044	.70
4046	1.86
4049	.40
4050	.40
4051	1.26
4052	1.26
4053	1.26
4060	1.58
4066	.79
4071	.23
4072	.23
4073	.23
4075	.23
4081	.23
4082	.23
4502	.79
4510	1.14
4511	1.05
4514	2.80
4515	2.80
4516	1.23
4518	1.14
4520	1.14
4527	1.68
4528	.88
4585	1.23

LINEAR

CA3046	.75
CA3086	.50
LF351N	.76
LF356N	1.20
LF357N	1.20
LF13741	.76
LM301AN	.44
LM307N	.64
LM308N	1.00
LM309K	1.80
LM311N	.90
LM317T	3.00
LM317MP	1.90
LM318N	2.70
LM320MP-5	1.30
LM320MP-6	1.30
LM320MP-8	1.30
LM320MP-9	1.30
LM320MP-12	1.30
LM320MP-15	1.30
LM320MP-18	1.30
LM320MP-18	1.30
LM320MP-24	1.30
LM323K	7.50
LM324N	.72
LM325N	2.70
LM326N	2.70
LM327N	2.70
LM339N	1.15
LM340T-5	1.25
LM340T-6	1.25
LM340T-8	1.25
LM340T-10	1.25
LM340T-12	1.25
LM240T-15	1.25
LM340T-18	1.25
LM340T-24	1.25
LM341P-5	.98
LM341P-6	.98
LM341P-8	.98
LM341P-10	.98
LM341P-12	.98
LM341P-15	.98
LM341P-18	.98
LM341P-24	.98
LM348N	1.60
LM349N	1.60
LM358N	.72
LM1310N	.84
LM1800N	.94
LM1801N	1.70
LM1812N	4.80
LM1830N	1.30
LM1889N	2.00
LM2111N	1.25
LM2907N	1.50
LM2917N	1.50
LM3089N	1.30
LM3900N	.88
LM3900N	.88
LM3905N	1.40
LM3909N	.69
LM3911N	1.50
MC1456V	1.00
MC1458V	.53
MC1496N	.70
MC3302P	1.15
NE536T	2.50
NE540L	2.04
NE555V	.48
NE556A	.88
NE558N	2.40
NE559N	2.40
NE560B	2.50
NE561B	2.50
NE562B	2.50
NE565A	1.25
NE566V	1.28
NE567V	1.36
UA709CV	.44
UA710CA	.44
UA711CA	.53
UA723CA	.60
UA733CA	.75
UA741CV	.44
UA747CA	.70
UA748CV	.49
UA7805CU	1.25
UA7806CU	1.25
UA7808CU	1.25
UA7812CU	1.25
UA7812CU	1.25
UA7815CU	1.25
UA7818CU	1.25
UA7824CU	1.25
UA78L05ACZ	.40
UA78L06ACZ	.40
UA78L08ACZ	.40
UA78L1oACZ	.40
UA78L12ACZ	.40
UA78L15ACZ	.40
UA78L18ACZ	.40
UA78L24ACZ	.40
UA7905CU	1.70
UA7906CU	1.70
UA7908CU	1.70
UA7909CU	1.70
UA7912CU	1.70
UA7915CU	1.70
UA7918CU	1.70
UA7924CU	1.70

MISC IC

MM5314N	3.75

MICROPROCESSORS

8080A	8-BIT CPU, 2 USEC CYCLE	$ 9.95
8212	8-BIT I/O PORT	$ 3.25
8216	BI-DIRECTIONAL BUS DRIVER	$ 3.25
8224	CLOCK GENERATOR	$ 3.25
8228	SYSTEM CONTROLLER	$ 6.00
8251	COMMUNICATIONS INTERFACE	$10.50
8255	PERIPHERAL INTERFACE	$10.50
1702A	2K EPROM 1 USEC	$ 5.75
2708	8K EPROM 450 NSEC	$15.75
2102AN-4L	1K LOW POWER 450 NSEC RAM	$ 1.69
SC/MP	5 VOLT SC/MP CPU	$ 9.95
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14 PIN SOLDER	.20	1.90/10	17.00/C
16 PIN SOLDER	.22	2.10/10	18.75/C
18 PIN SOLDER	.29	2.75/10	24.50/C
20 PIN SOLDER	.30	2.85/10	25.25/C
22 PIN SOLDER	.33	3.15/10	27.75/C
24 PIN SOLDER	.38	3.60/10	32.25/C
28 PIN SOLDER	.45	4.25/10	38.25/C
40 PIN SOLDER	.63	6.00/10	53.50/C
8 PIN W-W	.24	2.30/10	20.50/C
14 PIN W-W	.26	2.50/10	22.00/C
16 PIN W-W	.30	2.85/10	25.50/C
18 PIN W-W	.60	5.70/10	51.00/C
20 PIN W-W	.70	6.65/10	59.50/C
22 PIN W-W	.84	8.00/10	71.50/C
24 PIN W-W	.96	9.10/10	81.50/C
28 PIN W-W	1.12	10.00/10	95.20/C
40 PIN W-W	1.36	12.50/10	115.00/C

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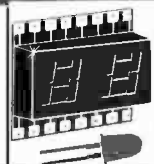
.001	.14	1.15/10	9.00/C	.033	.15	1.25/10	10.00/C
.0022	.14	1.15/10	9.00/C	.047	.15	1.25/10	10.00/C
.0033	.14	1.15/10	9.00/C	.068	.15	1.25/10	10.00/C
.0047	.14	1.15/10	9.00/C	.1	.17	1.35/10	11.00/C
.0068	.14	1.15/10	9.00/C	.22	.23	1.85/10	15.00/C
.01	.14	1.15/10	9.00/C	.33	.30	2.50/10	20.00/C
.022	.15	1.25/10	10.00/C	.47	.36	3.00/10	24.00/C

ELECTROLYTIC CAPACITORS

VALUE	RADIAL LEADS			AXIAL LEADS		
.47/50V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
1/50V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
2.2/50V	.08	.65/10	5.41/C	.12	.90/10	7.82/C
3.3/50V	.08	.65/10	5.41/C	.12	1.00/10	8.31/C
4.7/35V	.08	.65/10	5.41/C	.12	.95/10	7.91/C
4.7/50V	.08	.68/10	5.75/C	.12	1.00/10	8.31/C
10/16V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
10/25V	.08	.65/10	5.66/C	.12	1.00/10	8.31/C
10/35V	.09	.70/10	6.12/C	.13	1.10/10	8.94/C
10/50V	.10	.75/10	6.58/C	.14	1.15/10	9.56/C
22/16V	.10	.75/10	5.66/C	.12	1.00/10	8.31/C
22/25V	.09	.70/10	6.09/C	.13	1.05/10	8.74/C
22/35V	.11	.85/10	7.29/C	.15	1.19/10	9.98/C
22/50V	.12	1.00/10	8.46/C	.17	1.32/10	11.22/C
33/16V	.09	.75/10	6.90/C	.12	1.00/10	8.48/C
33/25V	.10	.81/10	7.50/C	.14	1.15/10	9.56/C
33/35V	.13	1.05/10	9.65/C	.17	1.34/10	11.23/C
33/50V	.14	1.13/10	10.41/C	.19	1.52/10	12.89/C
47/10V	.09	.71/10	6.52/C	.13	1.04/10	9.50/C
47/16V	.10	.81/10	7.47/C	.14	1.15/10	9.56/C
47/25V	.13	1.05/10	9.65/C	.17	1.30/10	11.22/C
47/35V	.14	1.13/10	10.41/C	.19	1.51/10	12.89/C
47/50V	.15	1.21/10	11.16/C	.21	1.71/10	14.55/C
100/10V	.10	.77/10	6.58/C	.14	1.13/10	9.56/C
100/16V	.11	.85/10	7.28/C	.17	1.30/10	11.22/C
100/25V	.13	1.10/10	9.15/C	.20	1.55/10	13.30/C
100/35V	.17	1.41/10	11.85/C	.25	1.93/10	16.50/C
100/50V	.21	1.71/10	14.55/C	.29	2.30/10	19.70/C
220/10V	.13	1.08/10	9.15/C	.18	1.42/10	12.05/C
220/16V	.15	1.16/10	9.86/C	.20	1.55/10	13.30/C
220/25V	.21	1.71/10	14.55/C	.29	2.35/10	19.96/C
220/35V	.25	2.03/10	17.26/C	.35	2.79/10	23.70/C
220/50V	.29	2.35/10	19.96/C	.40	3.23/10	27.44/C
330/6V	.14	1.12/10	9.50/C	.19	1.48/10	13.71/C
330/10V	.15	1.16/10	9.83/C	.21	1.64/10	15.13/C
330/16V	.21	1.66/10	14.14/C	.31	2.45/10	22.70/C
330/25V	.23	1.86/10	15.79/C	.38	3.07/10	28.38/C
330/35V	.33	2.66/10	24.59/C	.43	3.43/10	31.68/C
330/50V	.54	4.30/10	39.73/C	.60	4.81/10	44.45/C
470/6V	.15	1.21/10	11.16/C	.20	1.64/10	15.13/C
470/10V	.21	1.71/10	14.55/C	.31	2.45/10	22.70/C
470/16V	.23	1.81/10	15.39/C	.33	2.66/10	24.59/C
470/25V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
470/35V	.41	3.27/10	30.26/C	.47	3.78/10	34.99/C
470/50V	.54	4.30/10	39.73/C	.75	6.03/10	55.80/C
1000/6V	.22	1.90/10	16.50/C	.35	2.76/10	25.54/C
1000/10V	.24	1.96/10	16.62/C	.38	3.07/10	28.38/C
1000/16V	.33	2.35/10	19.96/C	.43	3.43/10	31.68/C
1000/25V	.42	3.33/10	28.27/C	.68	5.42/10	50.13/C
1000/35V	.60	4.81/10	44.45/C	.75	6.03/10	55.81/C
2200/6V	.36	2.86/10	26.48/C	.43	3.43/10	31.68/C
2200/10V	.42	3.33/10	28.27/C	.60	4.81/10	44.45/C
2200/16V	.54	4.30/10	36.58/C	.68	5.42/10	50.13/C

LED DIGITS AND LAMPS



FND357	.375" Single Digit, CC, Red	$1.35
FND500	.5" Single Digit, CC, Red	1.35
FND507	.5" Single Digit, CA, Red	1.35
FND800	.8" Single Digit, CC, Red	2.50
FND807	.8" Single Digit, CA, Red	2.50
NSN373	.3" Dual Digits, CC, Red	2.20
NSN374	.3" Dual Digits, CA, Red	2.20
NSN583	.5" Dual Digits, CC, Red	2.60
NSN584	.5" Dual Digits, CA, Red	2.60
NSN783	.7" Dual Digits, CC, Red	3.00
NSN784	.7" Dual Digits, CA, Red	3.00
NSL5053	Diff. Red T-1¾ Lamp w/Mtg. Hdwe $1.80/10	$16.00/100
NSL5056	Diff. Narrow Angle Red T-1¾ Lamp w/Mtg. Hdwe $1.80/10	$16.00/100

5% CARBON FILM RESISTORS

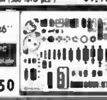
¼ WATT RESISTOR ASSORTMENTS

Catalog Number	Description	PRICE
RS125	Set of 5 each of the 73 standard 5% ¼ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 megohm (365 total pcs.)	$9.90
RS225	Set of 5 each of the 72 standard 5% ¼ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pcs.)	$9.90

½ WATT RESISTOR ASSORTMENTS

Catalog Number	Description	PRICE
RS150	Set of 5 each of the 73 standard 5% ½ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 megohm (365 total pcs.)	$9.90
RS250	Set of 5 each of the 72 standard 5% ½ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pcs.)	$9.90

Bishop Graphics 5" x 6"



The Digi-Key Catalog features many more quality Bishop Graphics products. 3365-Nd **12.50**

CLOCK MODULES

The MA1002 and MA1010 series clock modules by National Semiconductor are fully assembled and tested clocks using a 4 digit LED display and an MOS integrated circuit on the same board. Simply connect switches and our special transformer and you have a fully functioning clock.

The MA1003 clock module is a fully assembled and tested 12 hour clock using a high brilliance green flourescent display and crystal time base making it perfect for car, boat or other portable use. It operates directly from 12 volts DC so no transformer is needed. Our price includes three push button switches for setting the time.

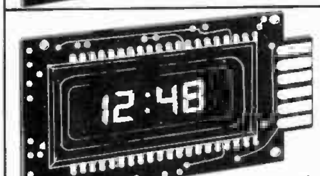
MA1002A	.5" LED 12 Hour AM-PM Clock Module	$10.50
MA1002A SET	Module with Transformer & Switches	$13.95
MA1002C	.5" LED 24 Hour Clock Module	$10.50
MA1002C SET	Module w/Transformer & Switches	$13.95
MA1003	12 Volt Car Clock with Switches	$17.50
MA1010A	.84" LED 12 Hour AM-PM Clock Module	$13.00
MA1010A SET	Module w/Transformer & Switches	$16.45
MA1010C	.84" LED 24 Hour Clock Module	$13.00
MA1010C SET	Module w/Transformer & Switches	$16.45

MA1002 0.5" High Digits

Actual Size: 1.375"x3.05"

MA1010 0.84" High Digits

Actual size: 1.75"x3.75"



.3" Digits Actual Size 1.75"x3.05" MA1003 $17.50 NEW!

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POWER TRANSISTORS, 151 P, NAT. SEMI.	9013B	$3.00
MEMORY DATA BK, 592 P, NAT. SEMI.	9014B	$3.00
MOS/LSI DATA BK 713 P, NAT. SEMI.	9015B	$4.00
INTERFACE DATA BK, 464 P, NAT.	9016B	$4.00
VOLTAGE REG. BK, 128 P, NAT. SEMI.	9017B	$3.00
LIN. APPLIC. BK, VOL. 1, 432 P, NAT. SEMI.	9018B	$4.00
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SC/MP MICRO. APP. HANDBK, NAT. SEMI.	9022B	$5.00
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SIGNETICS ANALOG MANUAL, 637 P	9031B	$5.95

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1N5227B	3.6V	1N5243B	13V
1N5228B	3.9V	1N5244B	14V
1N5229B	4.3V	1N5245B	15V
1N5230B	4.7V	1N5246B	16V
1N5231B	5.1V	1N5247B	17V
1N5232B	5.6V	1N5248B	18V
1N5233B	6.0V	1N5249B	19V
1N5234B	6.2V	1N5250B	20V
1N5235B	6.8V	1N5251B	22V
1N5236B	7.5V	1N5252B	24V
1N5237B	8.2V	1N5253B	25V
1N5238B	8.7V	1N5254B	27V
1N5239B	9.1V	1N5255B	28V
1N5240B	10V	1N5256B	30V
1N5241B	11V	1N5257B	33V

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NO 6 LOCKWASHER	.45/C
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MPS930	.16	1.55/10	13.60/C	130.00/M
MPS2222A	.16	1.55/10	13.60/C	130.00/M
MPS2369A	.16	1.55/10	13.60/C	130.00/M
MPS2907A	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3394	.16	1.55/10	13.60/C	130.00/M
MPS3395	.16	1.55/10	13.60/C	130.00/M
MPS3563	.16	1.55/10	13.60/C	130.00/M
MPS3565	.16	1.55/10	13.60/C	130.00/M
MPS3638A	.16	1.55/10	13.60/C	130.00/M
MPS3640	.16	1.55/10	13.60/C	130.00/M
MPS3641	.16	1.55/10	13.60/C	130.00/M
MPS3643	.16	1.55/10	13.60/C	130.00/M
2N3904	.16	1.55/10	13.60/C	130.00/M
2N3906	.16	1.55/10	13.60/C	130.00/M
2N4124	.16	1.55/10	13.60/C	130.00/M
2N4126	.16	1.55/10	13.60/C	130.00/M
2N4401	.16	1.55/10	13.60/C	130.00/M
2N4403	.16	1.55/10	13.60/C	130.00/M
2N4410	.16	1.55/10	13.60/C	130.00/M
2N5087	.16	1.55/10	13.60/C	130.00/M
2N5089	.16	1.55/10	13.60/C	130.00/M
2N5210	.16	1.55/10	13.60/C	130.00/M
2N3055	.99	9.20/10	85.00/C	800.00/M
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74C00N	.25	74C154N	2.90
74C02N	.25	74C157N	1.90
74C04N	.27	74C160N	1.18
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74C10N	.25	74C162N	1.18
74C14N	.90	74C163N	1.18
74C20N	.25	74C164N	1.10
74C30N	.25	74C165N	1.10
74C32N	.25	74C173N	1.30
74C42N	.98	74C174N	1.16
74C48N	1.28	74C175N	1.16
74C73N	.72	74C192N	1.38
74C74N	.48	74C193N	1.38
74C76N	.72	74C195N	1.10
74C83N	1.38	74C221N	1.90
74C85N	1.38	80C95N	.48
74C86N	.40	80C96N	.48
74C90N	.98	80C97N	.48
74C93N	.98	80C98N	.48
74C95N	1.10	74C901N	.48
74C107N	.70	74C902N	.48
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20 ga PVC	2.50/100'	10.00/500'
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24 ga PVC	2.10/100'	8.50/500'
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Digi-Key Stocks the Entire AP Line

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1N4001	.64/10	5.50/C
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1N4003	.68/10	5.80/C
1N4004	.70/10	5.95/C
1N4005	.82/10	7.05/C
1N4006	.90/10	7.75/C
1N4007	.99/10	8.60/C
1N4148	.40/10	3.50/C

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SPDT	.19	1.70/10	13.00/C
DPDT	.23	2.00/10	19.00/C

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100 PF	.40/10	3.50/C
220 PF	.40/10	3.50/C
470 PF	.40/10	3.50/C
.001 UF	.40/10	3.50/C
.0022 UF	.40/10	3.50/C
.0047 UF	.40/10	3.50/C
.01 UF	.45/10	3.65/C
.022 UF	.50/10	4.00/C
.047 UF	.70/10	5.60/C
.1 UF	1.35/10	11.50/C

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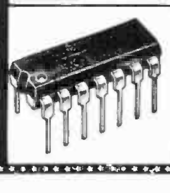

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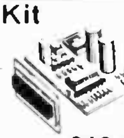
Jumbo LED Car Clock Kit



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- B. MOSTEK — 50250 — Super clock chip.
- C. On board precision crystal time base.
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- E. Perfect for cars, boats, vans, etc.
- F. PC board and all parts (less case) inc.

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Assembled & Tested $29.95

Automatically Starts & Stops Tape Recorders

Surreptitious interception of telephone conversation is a violation of Federal Law and this device is not intended for such use.

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Features: Litronix dual 1/2'' displays, Mostek 50250 super clock chip, single I.C. segment driver, SCR digit drivers. Kit includes all necessary parts (except case). Xfmr optional. Eliminate the hassle.

AC XFMR — $1.50 **Case $3.50** **$12.95**

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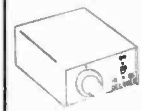

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- Full instruction included
- Drilled fiberglass P.C. Board
- One Hour Assembly

12V 1 AMP POWER SUPPLY

INPUT VOLTAGE 25V MAX. OUTPUT CURRENT 1 AMP. MAX. LOAD REGULATION 50mV. OUTPUT VOLTAGE 12V. LINE REGULATION 0.01%. KIT CONTAINS ALL PARTS EXCEPT FOR LINE CORD AND TRANSFORMER.

ONLY **$4.50**

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7400	11	7442	47	7490	65	74156	89
7401	13	7443	59	7491	.61	74157	55
7402	13	7444	59	7492	.43	74160	55
7403	13	7447	.68	7493	43	74161	65
7404	15	7448	71	7494	.67	74163	65
74L04	29	7450	13	7495	67	74164	.85
74S04	44	7451	.13	7496	.67	74165	.89
7406	16	7453	13	74100	30	74174	85
7408	19	7460	19	74104	49	74175	.85
7410	13	7470	.27	74107	28	74180	67
7411	18	7472	.25	74109	31	74181	1.93
7412	26	7473	29	74121	29	74182	68
7416	15	7474	29	74123	.48	74191	98
7420	13	7475	.47	74132	99	74192	.79
7423	.25	7476	.31	74136	.99	74193	.81
7425	29	7480	31	74S138	1 95	74194	.81
7433	26	7481	.55	74141	75	74195	69
7437	.23	7482	.57	74151	.61	9316	.85
7438	.23	7483	.67	74153	.61	9601	3/$1
7440	13	7485	.89	74154	98	9L04	.35
7441	76	7489	1.25	74155	.89		

74LS00 LOW POWER SCHOTTKY

74LS00	.21	74LS47	73	74LS136	.37	74LS258	71
74LS02	21	74LS51	26	74LS138	.71	74LS260	.26
74LS03	.21	74LS54	.26	74LS139	71	74LS266	26
74LS04	.28	74LS55	.26	74LS145	1 00	74LS279	55
74LS05	28	74LS73	.35	74LS151	70	74LS290	75
74LS08	.21	74LS74	.35	74LS153	70	74LS293	61
74LS09	.28	74LS76	.49	74LS155	69	74LS295	95
74LS10	.21	74LS83	.73	74LS156	70	74LS298	95
74LS11	.21	74LS85	1.35	74LS157	.75	74LS365	55
74LS13	.45	74LS86	.36	74LS158	71	74LS366	55
74LS14	.99	74LS90	55	74LS160	.85	74LS367	55
74LS15	.26	74LS92	.55	74LS161	.85	74LS368	55
74LS20	.24	74LS93	.55	74LS162	.85	74LS390	1 75
74LS21	.28	74LS109	.38	74LS163	.85	74LS393	1 45
74LS22	.28	74LS112	.38	74LS164	1.49	74LS670	2 30
74LS26	.32	74LS113	.38	74LS168	.85	74LS192	95
74LS27	.32	74LS114	.38	74LS169	.85	74LS193	95
74LS30	.26	74LS122	.49	74LS170	1 69	74LS194	95
74LS32	.32	74LS124	.99	74LS173	1.10	74LS195	85
74LS37	.32	74LS125	.47	74LS174	1.00	74LS196	85
74LS38	.32	74LS126	.47	74LS175	81	74LS197	85
74LS40	.26	74LS132	79	74LS190	.95	74LS251	85
74LS42	.65	74LS133	.35	74LS191	.95	74LS253	81
						74LS257	71

CMOS

CD400	.19	CD4017	95	CD4040	1.00	CD4071	19
CD4001	19	CD4018	95	CD4041	.69	CD4081	.19
CD4002	.19	CD4019	19	CD4042	.69	CD4507	.35
CD4006	1.20	CD4020	97	CD4043	.60		
CD4007	.19	CD4021	97	CD4044	.60	CD4510	1 00
CD4009	.47	CD4022	.97	CD4046	1.39	CD4512	1 10
CD4010	.39	CD4023	19	CD4047	1 50	CD4516	79
CD4011	19	CD4024	75	CD4049	35	CD4518	1 10
CD4012	29	CD4025	19	CD4050	.39	CD4520	69
CD4013	.32	CD4027	39	CD4051	1 19	CD4528	.85
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CD4016	.32	CD4030	35	CD4066	.78	74C107	79

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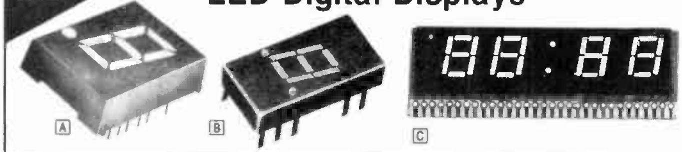

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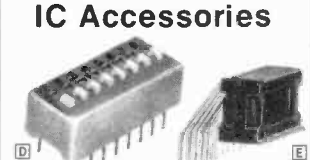

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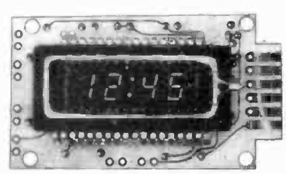

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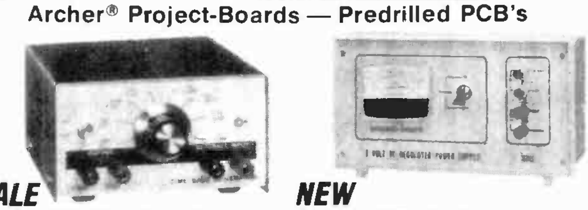

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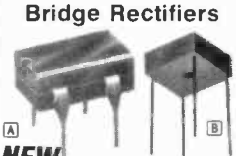

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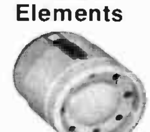

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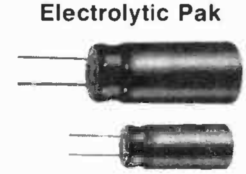

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74LS02	.21	74LS139	.70
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74LS14	.85	74LS157	.62
74LS20	.23	74LS160	.82
74LS21	.23	74LS161	.82
74LS22	.23	74LS162	.82
74LS30	.23	74LS163	.82
74LS32	.30	74LS164	.98
74LS37	.31	74LS174	.75
74LS38	.31	74LS175	.79
74LS42	.60	74LS190	.90
74LS47	.75	74LS191	.90
74LS48	.72	74LS192	.90
74LS73	.35	74LS196	.80
74LS74	.35	74LS197	.80
74LS75	.53	74LS221	1.06
74LS76	.37	74LS257	.71
74LS86	.36	74LS258	.70
74LS90	.52	74LS266	.26
74LS92	.52	74LS283	.72
74LS93	.52	74LS365	.55
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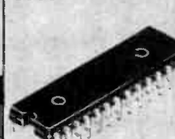

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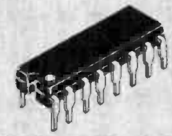

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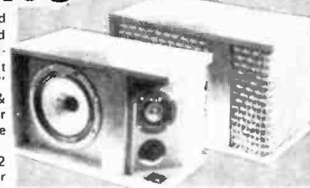

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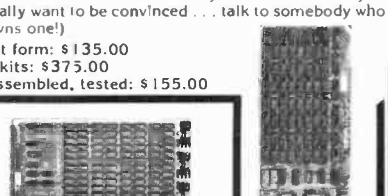

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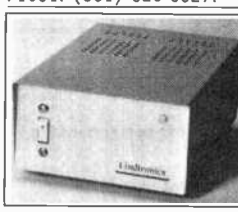

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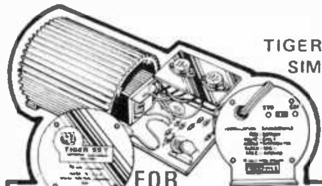

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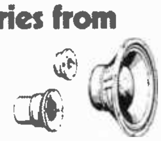

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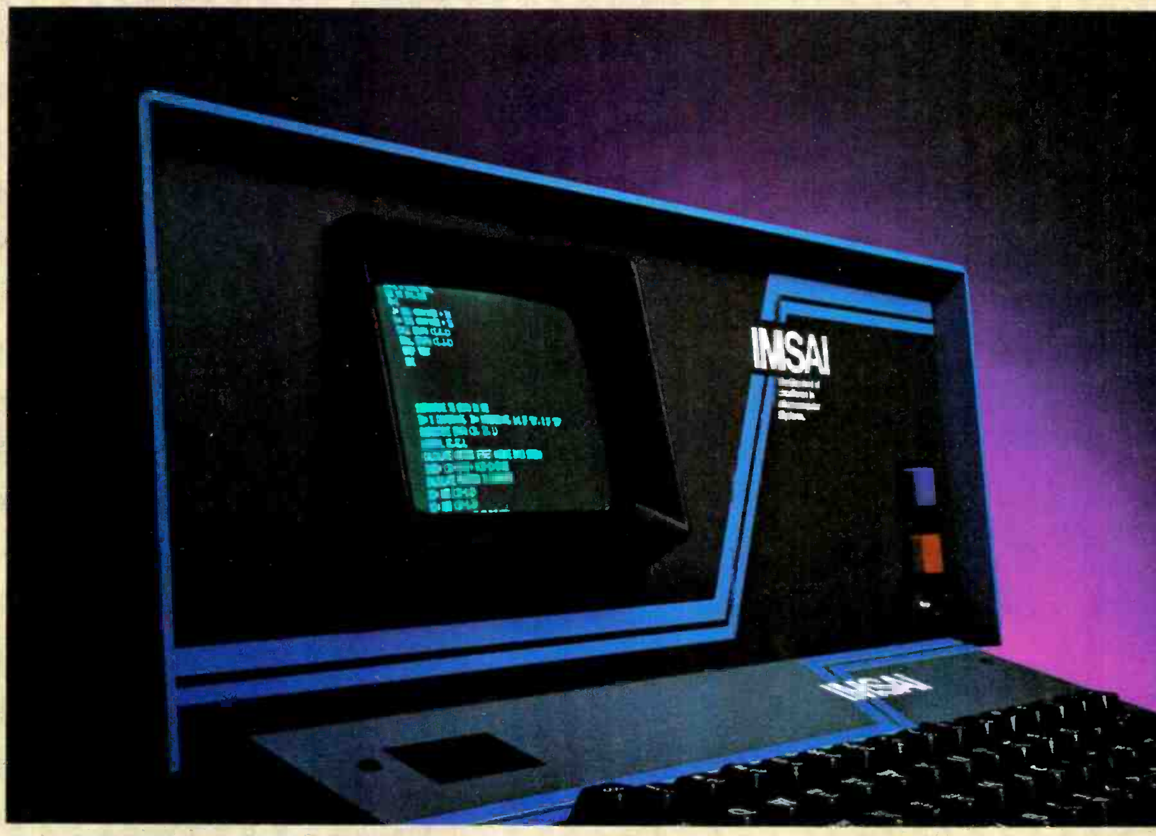

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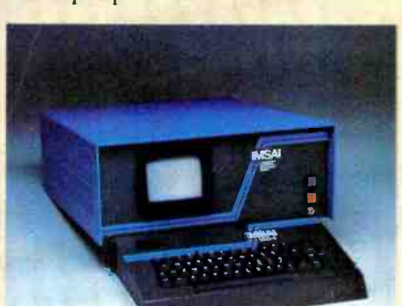

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