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UPWARD MOBILITY.

Pocket CB

New integrated circuit technology and a major electronic breakthrough brings you the world's smallest citizens band transceiver.

The PocketCom measures approximately ¾" x 1½" x 5½" and easily fits into your shirt pocket. The unit can be used as a personal communications link for business or pleasure.

Scientists have produced a personal communications system so small that it can easily fit in your pocket. It's called the PocketCom and it replaces larger units that cost considerably more.

MANY PERSONAL USES

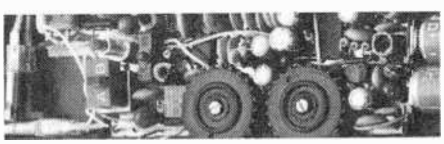
An executive can now talk with anybody in his office, his factory or job site. The housewife can find her children at a busy shopping center. The motorist can signal for help in an emergency. The salesman, the construction foreman, the traveler, the sportsman, the hobbyist—everybody can use the PocketCom.

LONG RANGE COMMUNICATIONS

The PocketCom's range is limited only by its 100 milliwatt power and the number of metal objects between units or from a few blocks in the city to several miles on a lake. Its receiver is so sensitive, that signals several miles away can be picked up from stronger citizens band base or mobile stations.

VERY SIMPLE OPERATION

To use the PocketCom simply turn it on, extend the antenna, press a button to transmit, and release it to listen. And no FCC license is required to operate it. The PocketCom has two Channels—channel 14 and an optional second channel. To use the second channel, plug in one of the 22 other citizens band crystals and slide the channel selector to the second position. Crystals for the second channel cost $7.95 and can only be ordered after receipt of your unit.



The PocketCom components are equivalent to 112 transistors whereas most comparable units contain only twelve.

A MAJOR BREAKTHROUGH

The PocketCom's small size results from a breakthrough in the solid state device that made the pocket calculator a reality. Scientists took 112 transistors, integrated them on a micro silicon wafer and produced the world's first transceiver linear integrated circuit. This major breakthrough not only reduced the size of radio components but improved their dependability and performance.

BEEP-TONE PAGING SYSTEM

You can page another PocketCom user, within close range, by simply pressing the PocketCom's call button which produces a beep tone on the other unit if it has been left in the standby mode. In the standby mode the unit is silent and can be kept on for weeks without draining the batteries.

SUPERIOR FEATURES

Just check the advanced PocketCom features now possible through this new circuit breakthrough: 1) Incoming signals are amplified several million times compared to only 100,000 times on comparable conventional systems. 2) Even with a 60 decibel difference in signal strength, the unit's automatic gain control will bring up each incoming signal to a maximum uniform level. 3) A high squelch sensitivity (0.7 microvolts) permits noiseless operation without squelching weak signals.

EXTRA LONG BATTERY LIFE

The PocketCom has a light-emitting diode low-battery indicator that tells you when your 'N' cell batteries require replacement. The integrated circuit requires such low power that the two batteries, with average use, will last weeks without running down.

The PocketCom can be used as a pager, an intercom, a telephone or even a security device.

MULTIPLEX INTERCOM

Many businesses can use the PocketCom as a multiplex intercom. Each employee carries a unit tuned to a different channel. A citizens band base station with 23 channels is used to page each PocketCom. The results: an inexpensive and flexible multiplex intercom system for large construction sites, factories, offices, or farms.

NATIONAL SERVICE

The PocketCom is manufactured exclusively for JS&A and is the unit currently used on the hit TV show, Charlie's Angels. JS&A is America's largest supplier of space-age products—further assurance that your modest investment is well protected. The PocketCom should give you years of trouble-free service, however, should service ever be required, simply slip your 5 ounce PocketCom into its handy mailer and send it to our prompt national service-by-mail center.

GIVE IT A REAL WORKOUT

Remember the first time you saw a pocket calculator? It probably seemed unbelieveable. The PocketCom may also seem unbelieveable so we give you the opportunity to personally examine one without obligation. Order only two units on a trial basis. Then really test them. Test the range, the sensitivity, the convenience. Test them under your everyday conditions and compare the PocketCom with larger units.

After you are absolutely convinced that the PocketCom is indeed that advanced product breakthrough, order your additional units, crystals or accessories on a priority basis as one of our established customers. If, however, the PocketCom does not suit your particular requirements perfectly, then return your units within ten days after receipt for a prompt and courteous refund. You cannot lose. Here is your opportunity to test an advanced space-age product at absolutely no risk.

A COMPLETE PACKAGE

Each PocketCom comes complete with mercury batteries, high performance Channel 14 crystals for one channel, complete instructions, and a 90 day parts and labor warranty. To order by mail, simply mail your check for $19.95 per unit (or $39.95 for two) plus $2.50 per order for postage, insurance and handling to the address shown below. (Illinois residents add 5% sales tax). But don't delay.

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ANNUAL EDITORIAL INDEX FOR 1977

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Editorial

SNIFFING OUT SMOKEYS

Great Britain zapped the Luftwaffe through the use of radar during World War II! In the afteryears, highway police departments adopted the same principle to catch speeding motorists—with better than a 99 percent conviction rate on radar evidence. This was countered, with typical American ingenuity, by radar detectors for the motorist to spot radar signals before they reached him and had time to return to the police for readout. Thus, he was warned to slow down in advance.

As the ownership of these detectors increased (now reported to be more than 500,000), the police increased their radar setups tenfold—to some 50,000 throughout the nation. Furthermore, whereas most police radar uses the X band (10.52 GHz), there is growing use of K-band radar (24.125 GHz), now said to constitute about 5 percent of the total in speed-enforcement work. Radar-detector manufacturers countered with K-band detectors and combined X- and K-band detectors. The police, in turn, introduced radar that's tuned slightly outside the standard bands so that the detectors can't give the alarm. This was followed by the introduction of radar detectors that scan from 9 to 25 GHz (FCC police frequency allocation is actually 9.445 to 24.445 GHz). With all of these moves and countermoves, it's now the police departments' turn to tip the balance.

Now if this little game isn't sufficient to make you gasp, consider state laws concerning the use of radar detectors by motorists. Until recently, the use of detectors was illegal in a handful of states, users being subject to fines and/or equipment confiscation. In some instances, there were no laws against use of radar detectors, but state police issued tickets for them anyway. In the past year, nine states voted down bills prohibiting radar detectors. This was not truly surprising since the airwaves are "free" for listeners. Besides, electromagnetic communications is the reserve of the Federal Government, not the states. Nonetheless, there is still one state with an anti-radar-detector law—Virginia. (The state's house and senate voted to repeal it recently, but the governor vetoed the repeal.) Of course, all this doesn't mean that you won't be ticketed in a state other than Virginia. There might be some local statutes that indicate it's illegal to pick up police signals—though they might not hold up in court.

Therefore, the main consideration regarding the use of radar detectors is now one of morality. Is it morally correct to outfox the law (for the purposes of exceeding the speed limit)? That's just what the speeding motorist is doing when he uses a radar detector. He's set up so that he can be alerted to a police radar net lurking ahead, enabling him to slow down before he is caught. Can you think of another reason for having a radar detector mounted in a car?

Proponents of radar detectors can whip up some other justifications, of course. One argument is that the system reminds the driver that he is going too fast and he slows down. Other "pro" views reflect the feeling that no one should rule us: we have highly efficient highway networks so why not take advantage of them? . . . The police are spending too much time on an unimportant matter when other pressing problems are largely ignored . . . An unpopular law is being enforced, so let the people's will reign . . . And so on.

The 55-MPH speed limit was established to decrease the amount of gasoline used, thereby saving a much-needed resource. An important byproduct has been the reduction of automobile fatalities on the highways. Furthermore, we all, I believe, have a social responsibility to obey our laws in order to strengthen our society. If an individual (or group of people) objects to a law, there are legal ways to eliminate it. In fact, that's just what has been done with radar-detector prohibitions! They've been virtually overcome legally, though I must admit that I find this broad interpretation of the Communications Act of 1934 (U.S.C. Title 47) unsettling.

Art Salsberg

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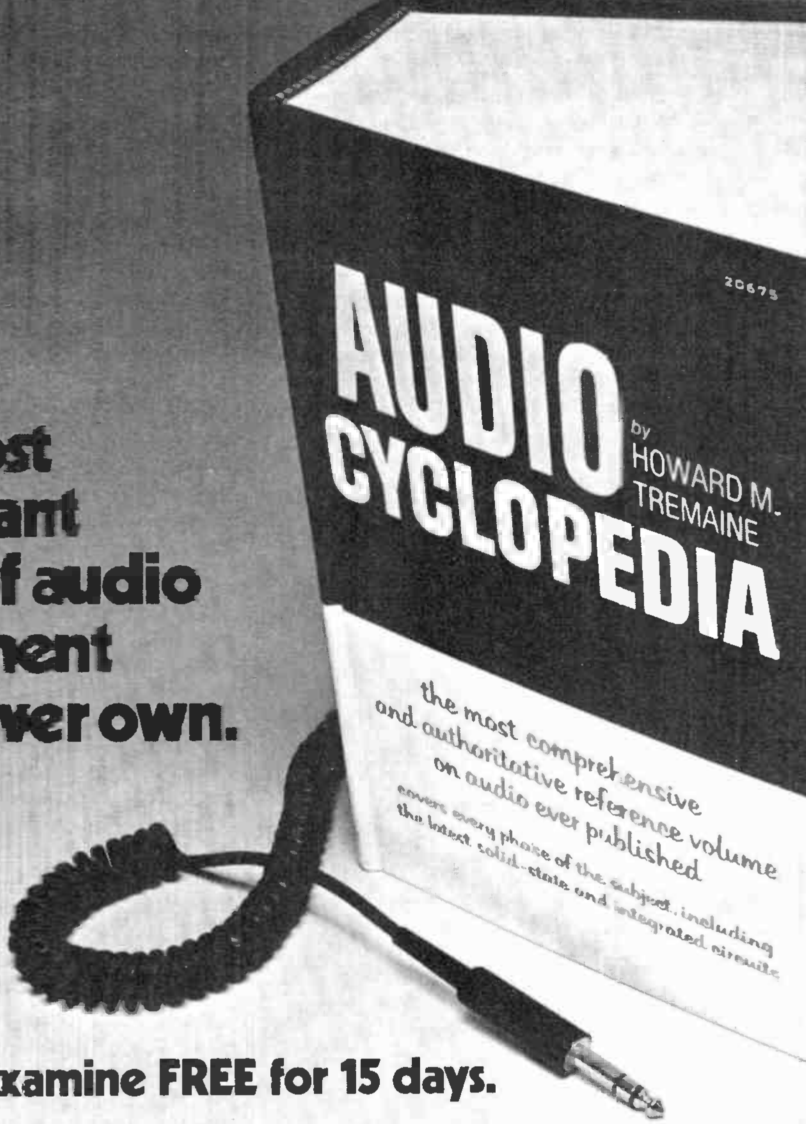

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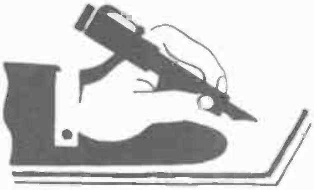

Letters

GETTING MANUFACTURERS' INFO

In the August 1977 Solid State column, it was stated that a lot of good ideas and manufacturers' information can be obtained from the pamphlets published by manufacturers. What I would like to know is how one goes about receiving these pamphlets. —*Kenneth J. Goodnow, Tucson, AZ*

Each of the manufacturers mentioned in the Solid State column is accompanied by an address to which you can write to obtain more information (pamphlets, specifications sheets, etc.).

MOS STATIC DAMAGE

In "How to Avoid Static Damage to MOS Devices" (August 1977), a number of companies that market products for safe handling of MOS devices were mentioned. We noted, however, that Walter G. Legge Company, Inc. (101 Park Avenue, New York, NY 10017), one of the oldest firms in this field, was not mentioned. We manufacture very sophisticated "Personnel Grounding Devices." All are insulated and have resistors to protect both the MOS devices and the personnel who handle them.

We also make conductive coatings in various colors that can be used on benches, floors, containers, etc. This product costs about 5¢ per square foot to apply and eliminates tripping hazards from mats and trailing wires. —*Ralph C. Ohlbach, Walter H. Legge Co., Inc., New York, NY.*

USING LIFT-IT ON GRAPH PAPER

I read with interest "New 'No Camera' Printed Circuit Board Methods" (May 1977). I would like to know whether or not the Lift-It emulsion will remove any of the ruled lines on the graph paper I am using. —*Len Buchanan, Scarborough, Ontario, Canada*

The Lift-It emulsion works best when lifting the etching and drilling guides for pc boards from printed magazine pages. However, if you use it on home-made guides on graph paper, be aware that the paper must not have a glazed surface or be of "vellum" material. Also, the ink used must be printer's or similar type. You need not worry about lifting the grid lines of the graph paper if the lines are relatively fine and light blue or light green in color. Neither of these colors is opaque to the ultraviolet light used when making exposures.

OPTIMIZING PERFORMANCE

I noticed with great interest the "Portable 60-Hz Clock Oscillator" article in the July 1977 issue. I have design experience using the MM5369 IC used in this application at 3.58 MHz and have found the IC to be unstable at 5 volts V_{CC}. We found, after consulting the manufacturer, that the MM5369 is specified for a minimum oscillating frequency of 2 MHz at 6 volts. I recommend applying at least 8 volts for proper operation at 3.58 MHz, rather than the 3 to 15 volts specified in the article. —*Stan Apel, Torpey Controls & Engineering Ltd., Toronto, Canada.*

I would like to pass on a few hints for adjusting the MM5369 for proper operation. Start off by setting the trimmer to the middle of its range, rather than matching the divided crystal frequency to the 60-Hz power line. While the ac line is very accurate over a 24-hour period, it is considerably less accurate over shorter periods of time. If a frequency counter is used to calibrate the circuit, be aware that connecting it to pin 7 of the IC will yield a slight frequency shift, even though the output is buffered. You do not really want the 3.579545 MHz marked on the crystal; you want either 3.579600 MHz for early production MM5369's or 3.579540 MHz for the current MM5369's.

The Parts List is misleading. Capacitors *C2* and *C3* must be relatively stable. Use NPO

(Continued on page 12)

Only NRI 25" DIAGONAL designed-Color TV Quadraphonic

Two home training schools give you a hobby-kit Color TV to assemble. Two others give you a commercial set right off the shelf. Neither was designed to teach you how to repair Color TV's. Only NRI invested the time and money to design equipment with learning in mind!

No other home training school gives you both a solid state Color TV and SQ™ Quadraphonic Receiver complete with four speakers . . . all in one course. In fact, to even match this kind of thorough training at another school, you'd have to take an extra course costing hundreds of dollars more. And only NRI courses in Color TV/Audio servicing let you learn on equipment designed specifically for training.

It's the only way you can (1) get the feel of typical commercial circuitry, (2) learn bench techniques while building complete units from the "ground" up, (3) perform over 35 "in-set" experiments during construction, and (4) end up with a 25" diagonal solid state Color TV with cabinet and a 4-channel Audio Center.

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NRI engineering eliminates the cost of buying from an outside source. We pay no salesman's commission. Students are enrolled by mail only. The savings are passed on to you in the form of low tuition fees, extras like the TV's console cabinet and the Quadraphonic System; professional test instruments like a 5" triggered sweep oscilloscope, CMOS digital frequency counter, and integrated circuit Color TV pattern generator. You can pay hundreds of dollars more for similar courses and not

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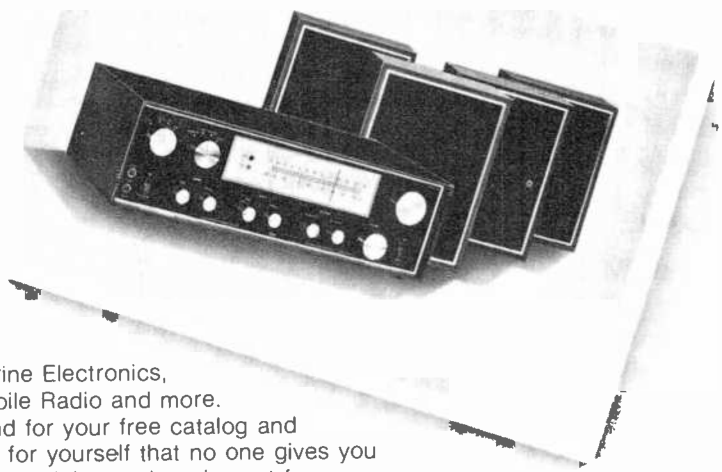

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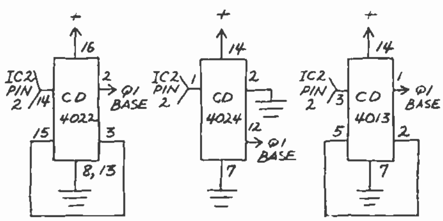
LETTERS *(Continued from page 6)*

ceramic, mica, or polystyrene. Anything else will cause the frequency to drift with temperature changes. Resistor *R1* need not be rated at 20 megohms and 5% tolerance; any resistor value between 5 megohms and 500 megohms will work fine. Also, *C1* can be an ordinary 0.1-µF ceramic or 10-µF electrolytic capacitor instead of the expensive tantalum capacitor specified. Finally, we recommend at least 5 volts V_{CC}, with 9 volts appearing to be the optimum. Going as high as 15 volts can sometimes cause the crystal to oscillate on its third harmonic. *—Clive Tobin, Tobin Cinema Systems, Seattle, WA.*

ADDENDUM TO "READER CIRCUIT"

Many thanks for publishing my circuit for the calculation/stopwatch adapter in the April 1977 Solid State column. I note, however, that I omitted the connection from pin 13 of *IC2* to ground. This connection must be made to enable the chip. Also, the debounce circuitry in some calculators apparently does not respond properly to the commands given at the 10-Hz rate. The solution to this is to put another divider into the circuit so that the switch operates at a 5-Hz rate. Some circuits that can be used to accomplish this are shown below. Using these circuits, it may be



necessary to experiment with the value of *C4*, which determines the time the switch remains closed; I found 0.033 µF to work best on one of my slow calculators. With the slower rate, naturally, the calculator should be keyed ., 2, +, but the rest of the operation is the same. *—Will Hobbs, Eugene, OR*

GREATER VISIBILITY

Many thanks for the "Morse-A-Letter" (January 1977). When I built mine, I incorporated a matrix of ¼" (6.35-mm) high-brightness discrete LED's for the seven-segment displays specified. My 5 × 7 matrix measures approximately 3" × 2" (7.6 × 5.1 cm), which is much easier to read and excellent to use in code classes. My display can be read from 20′ (6.1 m) away.*—Martin J. Forrest, WA6EWC/WB6VPC, San Jose, CA.*

GETTING STARTED IN ATV

Your "TV For Radio Amateurs" Editorial in the June 1977 issue interested me enough to want to know more about Amateur TV. Now I would like to know how one goes about finding out if there is an ATV group operating in his area. Also, is there a magazine published for or by the Amateur TV community?*—Melvin D. Carpenter, Virginia Beach, VA.*

To locate an ATV group operating in your area, contact the ARRL (American Radio Relay League, Inc., Newington, CT 06111). There is also a bimonthly magazine, "Amateur Television Magazine," available for $4.00 per year by subscription. (Write: "A5: Amateur Television Magazine," P.O. Box 128, Whitmore Lake, MI 48189.)

IT WORKS!

After reading "Zap New Life Into Ni-Cd Batteries" (July 1977), I decided to give the procedure outlined a try. My grass trimmer's battery had given out just as described in the article. So, I had a good test for the zapping procedure. It works!*—Charles DeVoe, Painted Post, NY*

WANTS MORE SWL ARTICLES

I am writing this letter to express my pleasure with POPULAR ELECTRONICS, particularly for the seasonal articles on SWL'ing by Glenn Hauser and Dr. Richard E. Wood. I urge you to devote more space to shortwave listening articles; PE is one of two publications that feature regular SWL articles, but it is a long time between such articles. *—David Jerard Duke, WDX5DJD, El Paso, TX*

The column will be increased to six times a year, as will Amateur Radio.

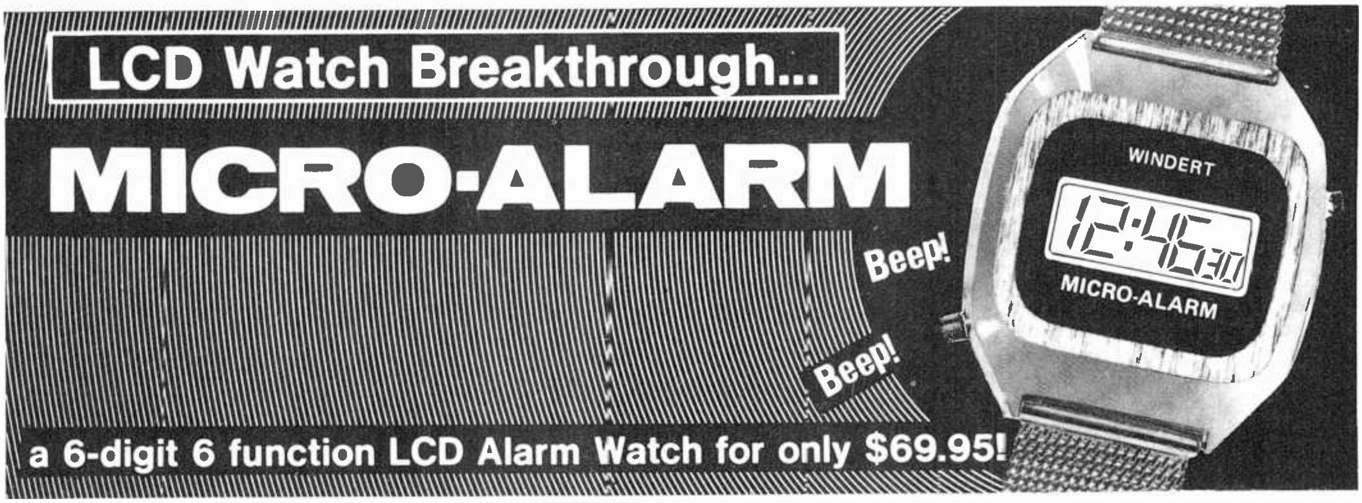
OPENING STATEMENT CONTRADICTED

The opening statement of "Battery Charge Monitor" by W.J. Prudhomme (June 1977) is contradicted by information contained in "Characteristics and Uses of Nickel-Cadmium Batteries," third edition, by the International Nickel Co., Inc. I have, however, seen a number of examples of the failure with shorting described in the article. On the other hand, it is sometimes recommended that the "memory" phenomenon sometimes observed in NiCd cells that are repeatedly charged after only partial discharge can be overcome by complete discharge, then recharging.*—Milford S. Brown, Albany, CA.*

Out of Tune

In "Build a Digital Camera Shutter Timer" (August 1977), *DIS1* through *DIS5*, DL-04 seven-segment LED displays, are common-cathode types, not common-anode as described in the Parts List.

In "Build 'Cabonga' Part 2" (September 1977), Fig. 6, the anode of *D4* and the cathode of *D2* should not be grounded, but should be connected only to the secondary of *T1*, as in Fig. 7, the guides for the Combiner/Power Pack pc board.



At last, a constant readout (no buttons to push) precision quartz electronic watch with a built-in 24 hour alarm system.

A quiet revolution has been taking place in the electronic watch industry during the last few years. Push-button LED's are being replaced with continuous-display LCD watches; 4-digit displays are being replaced by 6-digit readouts. This year there will be many such LCD watches available.

However, Winthrop-Rogers prides itself on offering not only the most technologically-perfect products available, but also on introducing the most technologically-advanced products on the electronic market before they are readily available. Therefore, we are pleased to announce the most remarkable achievement in electronic watch technology to-date.

By combining the quartz-accuracy precision of the LCD watch with miniaturized alarm technology, we proudly introduce the first CONTINUOUS DISPLAY ALARM WATCH. A watch that may not be available from other sources for years can now be yours at a price hundreds of dollars less than you would imagine.

And now consider the incredible convenience of a portable alarm clock handsomely adorning your wrist at all times ! ! !

- *Never again missing an appointment because you lost track of time.*
- *Never again missing a plane or a train because you didn't relize how late it had become.*
- *Never again forgetting to make that all-important phone call.*
- *Never having to worry about forgetting to take important medication on time.*
- *Never worrying about waking up from that catnap, or at a hotel if your wake-up call isn't on time.*
- *Always being aware of when you should be coming or going or doing all that your hectic schedule demands – without devoting your valuable time to trying to remember it all.*

7:55AM SET TO RING AT 7:55 A.M.

THE ALARM

The MICRO-ALARM has a 24 hour Alarm System, allowing you to set your watch to signal at any minute of the day or night (1,440 settings per day are possible). Once set, you need not be concerned about your next appointment or train, plane or phone call. The MICRO-ALARM will remember for you and remind you when you need to be reminded.

SNOOZE/REMIND CONTROL

For your convenience the MICRO-ALARM will give one short beep prior to its full alarm cycle, allowing you to turn it off without disturbing others. If not deactivated after the first short beep, the alarm will then beep for 15 continuous seconds. Push the deactivate button twice and the alarm is off. However, should you want a further reminder, then push the deactivate button only once and the alarm will go through its cycle again in exactly 5 minutes, allowing you to continue your current activity whether it be a snooze or phone call without fear of forgetting your next commitment.

12:34 AND 56 SECONDS 12:34 56

6-DIGIT LCD DISPLAY

The MICRO-ALARM has a 6-digit readout showing hours, minutes and seconds at a glance. Since the readout is by Liquid Crystal Display (LCD) and not by Light Emitting Diode (LED), no button has to be pushed, the time is continuously displayed! A built in night-light functions at the push of a button for reading in darkness.

AUGUST 15th FRIDAY 8:15 FR

CALENDAR DISPLAY

Just one push of the control button converts the display into a 3-function calendar; displaying the month, date of the month, and day of the week. The remarkable memory built into the module knows each month and the number of days in that month and resets automatically on the first day of the new month.

QUARTZ ACCURACY

The MICRO-ALARM is extraordinarily accurate. Its module is manufactured by Hughes Aircraft Company, one of the world's foremost manufacturers of microelectronics, and is guaranteed accurate to within 3 minutes a year (averaging less than 15 seconds per month). You can depend on the accuracy year after year. There are no moving parts, so there is nothing to wear out or even require servicing. The result of this accuracy is that you can set your watch to the second.

THINK ABOUT IT!

Even if you have no consistant need for a watch with a built-in electronic alarm, the MICRO-ALARM is a valuable investment for its watch features alone:

1. It is the most up-to-date fully-functioning electronic watch available today.
2. It is accurate to +/- 15 seconds per month, and never has to be wound – put it on, and the time and date are correct even if it has been in a drawer for a month!
3. Its elegant styling will compliment any attire – and elicit compliments from your associates and friends.
4. At this price you can not find a better buy.
5. One day you will have a critical need to be reminded of a vital appointment – and then, having used the alarm function once, you will never again return to any other reminder system.
6. Why buy an ordinary watch when you can own a MICRO-ALARM?

ELEGANT MESH BRACELET

Each MICRO-ALARM comes with a 1 year limited warranty. You may order in your choice of goldtone or silvertone case. Each for only $69.95 plus $1.99 for shipping and handling. Each MICRO-ALARM comes with a matching, elegant, thin mesh bracelet, more handsome and much more practical than those "pull over-snap" type bracelets. This band adjusts comfortably and easily, eliminating cumbersome link adjustments.

15 DAY TRIAL

Wear the MICRO-ALARM for 15 days to assure yourself that this is no ordinary watch. If at the end of that time you are dissatisfied for any reason you may return it for a prompt refund, no questions asked.

To order by credit card please phone our 24-hour toll-free number:

800-325-6400 ask for Oper. 36

In Missouri: 800-342-6600 ask for Operator 36

or mail the attached coupon with your payment and the MICRO-ALARM will be on its way to you.

Allow 3-4 Weeks For Delivery

Winthrop-Rogers Ltd. V5411

Box A69, 1135 Greenridge Rd., Buffalo Grove, Il 60090

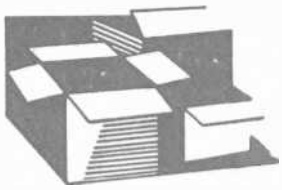
Please send___MICRO-ALARMS @ $69.95 each plus $1.99 for shipping and handling.
_____Silvertone MICRO-ALARM
_____Goldtone MICRO-ALARM

If I am not completely satisfied I may return it for a full refund. Total amount enclosed $_____, check or money order. (Illinois residents please add 5% sales tax.) No C.O.D.s please.

Charge: ☐ Amer. Exp. ☐ Bank Amer./Visa ☐ Master Charge MCBK#____

Card #__________ Exp.____
Signature__________
Name__________
Address__________ Apt.____
City__________ State____ Zip____

To expediate shipping by UPS, please provide street address rather than P.O. Box number.



New Products

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

J.I.L. CB/AM-FM STEREO/CASSETTE UNIT

J.I.L.'s Model 615CB CB/car stereo/cassette unit features a 40-channel CB transceiver, an AM stereo FM receiver, and stereo cassette player in a single in-dash package. An easy-to-use control microphone puts all the CB functions at hand: thumbwheel channel selector, PTT control, r-f gain, LED channel readout. Complementing the controls on the mike are front-panel controls for CB/Radio-Tape mode selector, variable squelch, RX and TX indicator lights, and a stand-by control. The latter monitors CB while listening to cassettes or radio. Whenever a message comes through on a selected CB channel the circuit interprets the program then returns to it automatically at the end of the CB transmission. The cassette section includes controls for fast forward/eject and tape play indicator. The audio section delivers 5 W/ch rms power output at a frequency range of 50-10,000 Hz. $369.95.

CIRCLE NO. 89 ON FREE INFORMATION CARD

ASTATIC POWER MICROPHONE

The Astatic Corporation has announced the introduction of its Model 1104C preamplified base-station communication microphone. Available in five colors, the new microphone features base-mounted slide controls for adjusting the gain of the amplifier for the proper modulation level and tone quality for individual voices. An adjustable master gain control is provided for preventing overmodulation and distortion. The mike is powered by a 9-volt battery and has a six-conductor coiled cord that can be wired for virtually any type of switching system in a transceiver. $83.00.

CIRCLE NO. 91 ON FREE INFORMATION CARD

MICRO-ACOUSTICS PHONO CARTRIDGE

The new Model 530-mp is the top-of-the-line phono cartridge offered by Micro-Acoustics Corp. Each cartridge is supplied with an individual frequency curve. Rated frequency response is 5 to 20,000 Hz ± 1¼ dB. Tracking force range is 0.7 to 1.4 grams, and cartridge weight is 4 grams. Claimed channel separation is 30 dB at 1000 Hz, 15 dB at 10,000 Hz. Output voltage is 3.5 mV each channel at 5 cm/s peak recorded velocity. Load requirements and cable capacitance are specified at 10,000 to 100,000 ohms and 100 to 1500 pF, respectively. Each stylus is light-beam oriented under a microscope. $200.

CIRCLE NO. 92 ON FREE INFORMATION CARD

SBE MOBILE CB TRANSCEIVER

SBE's new Tahoe 40-channel AM CB transceiver measures only 7.25"D × 4.5"W × 1.4"H (18.4 × 11.4 × 3.6 cm) so that it can be installed in locations where space is at a premium, such as in a minicompact or sports car. The transceiver includes all the standard features and controls available with large rigs, including a large LED channel display. Included in the front panel are volume and squelch controls, channel selector, a PA switch, and a red transmit (TX) indicator that lights up when the transmitter is keyed. The transceiver includes PLL frequency synthesis and a double-conversion receiver circuit that employs a tiny four-pole bandpass filter.

CIRCLE NO. 93 ON FREE INFORMATION CARD

SANSUI STEREO FM RECEIVER

Sansui's Model G-3000 AM/stereo FM receiver has a rated power output of 26 watts per channel minimum rms with both channels driven into 8 ohms from 20 to 20,000 Hz, with a THD of 0.15%. The power amplifier features a differential input, Class A driver, and push-pull OCL output stages. Overall frequency response is said to be 10 to 50,000 Hz, +1, −2 dB. The tuner section includes a PLL differential demodulator, quadrature detector, and a low-pass filter to suppress the ultrasonic carrier. Harmonic distortion is rated a 0.18% monaural, 0.25% stereo. The phono preamp uses low-noise pnp Darlington transistors. Other features include microphone mixing with level control, signal strength and zero-center tuning meters, AM beat filter, loudness switch, tape monitor, FM muting, headphone jack, and a speaker selector switch. Measures 17 1/16" W × 13 15/16" D × 6 1/16" H (43.3 × 35.4 × 15.4 cm). $280.

CIRCLE NO. 94 ON FREE INFORMATION CARD

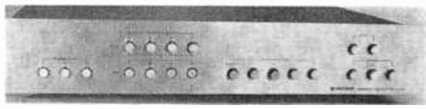
HICKOK DUAL-TRACE 15-MHZ SCOPE

Hickok's Model 517 is a dual-trace, triggered-sweep oscilloscope with 15 MHz response to within 3 dB and claimed fool-proof triggering to 27 MHz (30 MHz typical). Vertical sensitivity varies from 10 mV/cm to 50 V/cm in 12 calibrated steps, and is continuously variable (uncalibrated) from 5 mV/cm to 50 mV/cm. Risetime is said to be 24 ns, and overshoot 3% or less. Input impedance is 1 megohm shunted by 30 pF. Operating modes are channel A only, B only, A and B chopped, A and B alternate, A + B (single trace algebraic sum), and B − A (single trace algebraic difference). The Model 517's time base has sweep rates of 0.5 μs/cm to 0.2 s/cm in 18 calibrated steps. A X5 expander is switch selectable. Among the Model 517's features are internal, line, external, auto, slope, and TV sync triggering, TV sync separators, TTL-compatible Z axis (intensity) modulation, an 8- × 10-cm display, and a regulated power supply. Includes two probes (10:1/direct and 10:1) and vectorscope overlay. Measures 17½" D × 14-⅝" W × 7" H (44.5 × 37.2 × 17.8 cm) and weighs 13.5 lb (6.1 kg). $695.

CIRCLE NO. 95 ON FREE INFORMATION CARD

PIONEER PROGRAM SOURCE SELECTOR

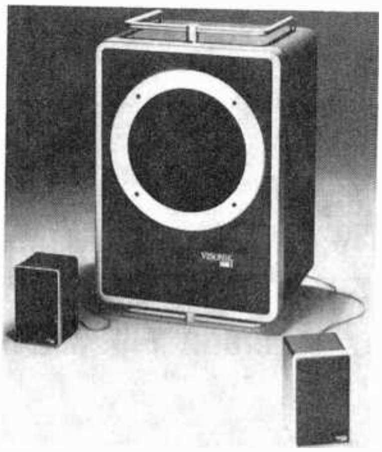
The Model U-24 program source selector from Pioneer adds to the number of inputs and outputs usually available in conventional preamplifiers and integrated amplifiers. It makes available two AUX inputs; three phono inputs; four tape input/output jacks; tape-to-tape dubbing facilities; and three power amplifier outputs. All functions are pushbutton selectable. The switching circuits of the Model U-24 are positioned near the rear panel, adjacent to the actual input/output terminal board, to reduce the use of shielded cable and cut down on high-frequency losses due to stray capacitance.



CIRCLE NO. 96 ON FREE INFORMATION CARD

VISONIK SPEAKER SYSTEM

The Sub-1 subwoofer from Visonik of America, Inc., is designed to match the company's David 502 speaker system. The Sub-1 fea-



tures a 12" (30-cm) woofer and matrix crossover. The D-502, an improved version of the David 50, is said to have an improved woofer and crossover network. A LED in the D-502 flickers when the tweeter reaches its power-handling limit to warn the user of an overdrive condition. The Sub-1/D-502 combination is rated to handle up to 200 watts/channel, while minimum driving power is specified to be 40 watts/channel. Frequency response of the system is rated at ±2 dB from 28 to 20,000 Hz. Crossover is nominally at 160 Hz. The Sub-1 is available in a walnut wood cabinet with dark brown grille ($450) or dark gray cabinet with handles, black foam grille, and bright metal surround ($500). The D-502 and Sub-1 are available separately.

CIRCLE NO 97 ON FREE INFORMATION CARD

HAMMOND AUDIO EQUIPMENT RACK

The Audio-File equipment rack from Hammond Industries, Inc. is designed to house

stereo equipment in a rack that takes up 22" × 19" (55.9 × 48.3 cm) of floor space and stands 48" (121.9 cm) high. The brushed aluminum mainframe is accented with black Plexiglass side panels. The Audio-File is available in kit form for $350. It is also available in a Decor Matching Kit of aluminum-only design for about $210, which gives the buyer the opportunity of selecting panels and shelves to color match existing decor. Address: Hammond Industries Inc., 155 Michael Dr., Syosset, NY 11791

CIRCLE NO 98 ON FREE INFORMATION CARD

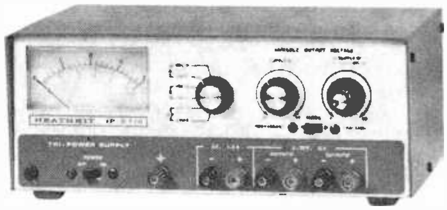
SENCORE CB SCOPE CONVERTER

Sencore's Model CB44 27-MHz CB scope frequency converter allows the display of CB modulation envelopes on any oscilloscope having a 1-MHz vertical bandwidth. In operation, the CB44's input cable is attached to the transceiver's antenna output jack and the scope probe is attached to universal output loops on the converter's enclosure. Power for the converter circuity is taken from the incoming CB signal. An internal dummy load dissipates the transceiver's r-f output. A 1.2-V p-p max. output at the transmitted frequency is also provided for use with frequency counters. The CB-44 can be used on any of the 40 CB channels. $75.

CIRCLE NO. 99 ON FREE INFORMATION CARD

HEATH TRI-OUTPUT POWER SUPPLY

The Heath Company's new Model IP-2718 experimenter's power supply kit has three

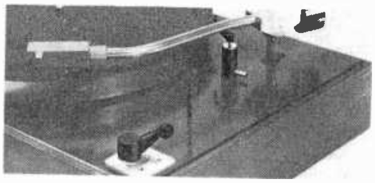


floating outputs that can be interconnected as the user desires. A fixed 5-volt output at 1.5 A dc and two variable 0-to-20-volt outputs at 0.5 A dc each are available at front-panel binding posts. The two variable outputs can be tracked to "follow" each other at any specified voltage difference. All outputs are short-circuit protected with current limiting. They can be operated independently, in series, or in parallel. A switchable front-panel meter monitors output voltages and currents. The supply is also available factory assembled, Model SP-2718. Prices are $80 (IP-2718) and $140 (SP-2718).

CIRCLE NO. 90 ON FREE INFORMATION CARD

AUDIO-TECHNICA TONEARM LIFT

The Model AT6005 pneumatic tonearm lift from Audio-Technica is designed to add a built-in cueing feature to turntables not so equipped. The arm operates by air pressure

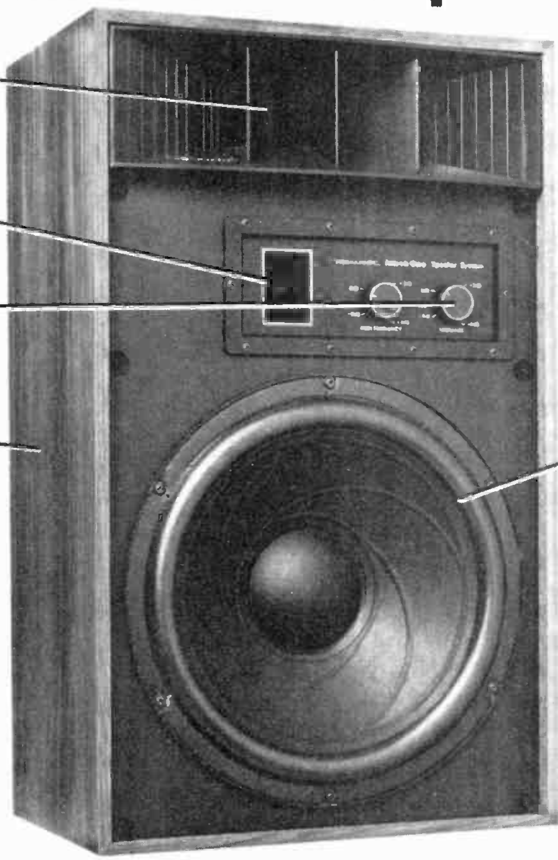


rather than fluid to eliminate leakage and pressure changes that often occur as a result of changes in temperature. The lift mechanism is said to be easily mounted on most turntable bases and raises the tonearm 9/64" (3.6 mm). For flexible mounting, the lift comes with a 20" (50.8-cm) rubber tube that permits placing the lift actuator on any turntable base location. $30.

CIRCLE NO 100 ON FREE INFORMATION CARD

THE FEEL OF MUSIC

The Realistic® Mach One isn't just for your ears!



Multicell midrange horn
Provides a true spatial image. Smooth 800-8000 Hz response for a "live" presence.

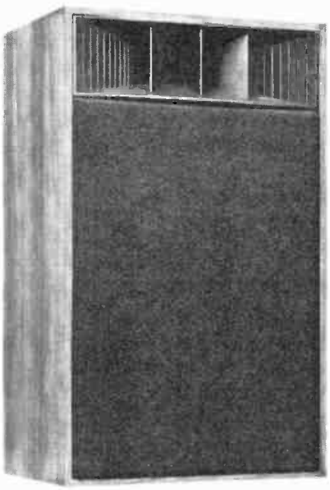
Heavy-duty tweeter horn
Delivers crisp and clean highs from 8000 to 25,000 Hz.

Treble, midrange L-pads
Calibrated controls for precise adjustment of response to suit room acoustics.

Oiled walnut veneer
We make speaker positioning easy by including a cabinet with the look and feel of fine furniture — so the Mach One looks great anywhere!

Massive 15″ woofer

The acoustic suspension, large-excursion cone has an effective radiating area of over 100 square inches—the equivalent of a huge air-pump — for bass you can feel all the way down to 20 Hz. The four-layer voice coil is wound on a brass form for heavy power handling capacity—over 100 watts peak program material.



Removable grille
The sturdy grille frame snaps on and off for easy access to the response controls.

A great loudspeaker doesn't just please your ears. It reproduces deep bass with a power and punch your entire body feels . . . it recreates the live ambience so accurately that when you close your eyes, you're "on location" in that auditorium, concert hall or night spot . . . and it delivers top performance with both moderate and high-powered amplifiers. If you think we're talking about a $400 speaker, you haven't experienced the Mach One. For under $200 each*, you get incredible "live theatre" sound from a name you can depend on: Realistic. Backed by 56 years in audio design, manufacture, sales and service. So bring in your favorite record for a Mach One audition, and discover the feel of music.

FREE! New '78 Catalog
Come in for your copy and see what's *really* new in electronics. 164 pages, 100 in full color. 2000 exclusive items.

* Retail price may vary at individual stores and dealers.

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A TANDY COMPANY • FORT WORTH, TEXAS 76102
OVER 6000 LOCATIONS IN NINE COUNTRIES

New Literature

ALLISON SPEAKER CATALOG

Allison Acoustics' new catalog describes its line of loudspeaker systems. An introductory section explains the operating principle of Allison's convex-diaphragm, mid-range and tweeter drivers and how its room-matched speaker systems generate flat power output. Comprehensive mechanical, electrical and performance specifications for each model are included. Address: Allison Acoustics, Inc., 7 Tech Circle, Natick, MA 01760.

UL SAFETY REQUIREMENT SPECS

"How to Specify Products That Meet UL Safety Requirements" is a new brochure from Underwriters Laboratories, Inc. Written in a question and answer format, the guide provides information on the specification of products, materials and systems that meet UL requirements. Address: Underwriters Laboratories, Inc., Public Information Office, 207 E. Ohio St., Chicago, IL 60611.

CITIZENS BAND BOOKLET

"The ABC's of CB" by Sparkomatic discusses the components of a CB system and what to check before buying them; FCC rules and regulations; and the advantages of owning a CB radio. A glossary of code terms and a list of sample "handles" are also included. Price, 50 cents. Address: Sparkomatic Corp., Milford, PA 18337.

ALEXANDER BATTERY CATALOG

An 8-page catalog from Alexander Manufacturing describes its line of batteries for communications and portable video equipment. Nickel-cadmium and alkaline-mercury batteries are listed, including a line of replacement batteries for ENG video tape recorders and cameras. Comprehensive electrical specifications are provided. A section describing the company's automatic battery chargers is also included. Address: Alexander Manufacturing Co., Box 1645, Mason City, IA 50401.

CONSUMER GUIDE TO METRICS

The Commerce Department's National Bureau of Standards has revised and updated its guidebook "What About Metric?" The new edition includes changes that resulted from the passage of the Metric Conversion Act of 1975, and explains how the metric system will be used on a daily basis with common measures and weights problems. Price, 35 cents. Address: Consumer Information Center, Pueblo, CO 81009.

Stereo Scene

By Ralph Hodges

NEW TESTS FOR LOUDSPEAKERS

THE MORE I think about it, the more convinced I become that your typical little neighborhood hi-fi test lab is nowhere without—at the very least—a spectrum analyzer. A colleague dropped in the other day with his Hewlett-Packard 3580A, in order to examine a lacquer disc he had just had mastered at a downtown studio. The ease with which he rocketed through a series of tests that would have taken me endless time and interconnecting cables (only to find out, much later, that what I had measured was the hum from some faulty ground) was most depressing.

With practice my friend has become a fair hand with his instrument, so that he was halfway finished with his work before I had abandoned my search for an unused ac wall outlet (not realizing that the H-P has a self-contained battery pack). So now, contemplating my only recently acquired and quite conventional THD and IM analyzers, I know how a modern commando might feel when he must face the world armed only with a stone axe. Furthermore, things have gotten to the point where some people feel that even a spectrum analyzer is primitive equipment. "Your basic spectrum analyzer is okay, to be sure, but it doesn't begin to achieve its full usefulness until interfaced with your basic laboratory computer." And etcetera.

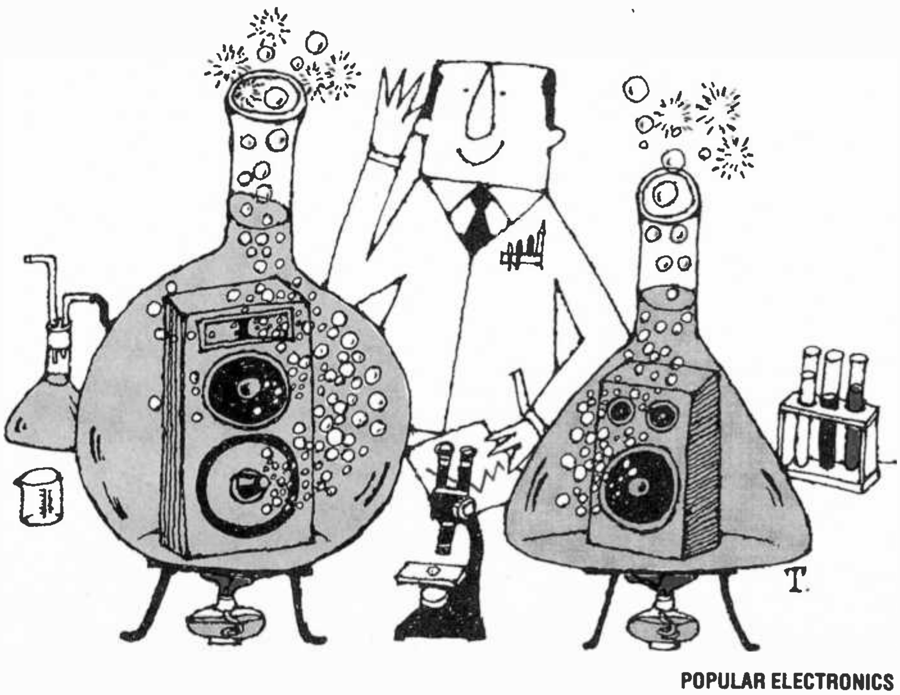
The Well-Tested Speaker. What the new shape of test instrumentation will mean to the development and evaluation of loudspeakers is as yet a little hard to say. Several speaker manufacturers and even a few speaker reviewers have embraced the new technology for its awesome power, particularly in studies relating to loudspeaker performance in the time domain. Here, there appears to be much remaining to be accomplished. To date their work has generally shown that, yes, in the objective sense, the typical loudspeaker's performance is every bit as bad as we all suspected. Thus, we have been left to puzzle out why devices that measure so bad can manage to sound so good to our ears.

On the other hand, the new measurement techniques have permitted some appreciable (objective) improvements in these areas of speaker performance, and the products embodying them have been marching into the marketplace in steadily increasing numbers. So far, most reviewers have found that the best of these is every bit as good as the best speaker systems designed without benefit of the new techniques. However, they have not as yet had any universally persuasive or consistent reason to declare them any *better*.

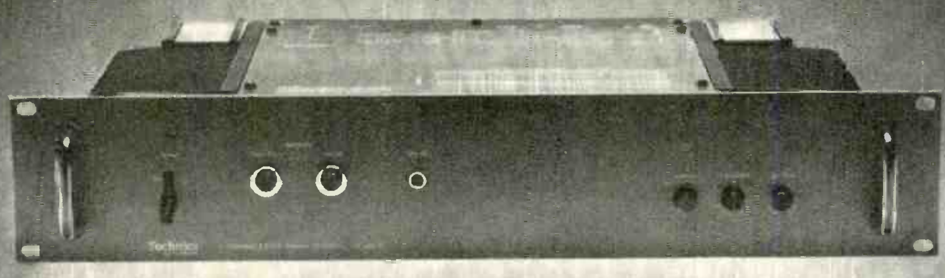
For example, in recent years holography has provided a whole new way of studying the behavior of loudspeaker diaphragms. And, sure enough, coherent-light photographs have shown time and again that speaker cones move as ideally rigid pistons a lot less of the time than we would like. In particular, photographs of tweeter domes have revealed that as frequency increases, there is often a tendency for the central region of the dome to physically decouple from the periphery near the voice coil. In effect, under high accelerations the center of the dome tries to stand still, turning the diaphragm into a ring radiator instead of an integral piston. Since a ring radiator of this type has undesirable dispersion characteristics, it has been suggested that a cone tweeter with a small-diameter voice coil is likely to exhibit better dispersion at very high frequencies than a dome. However, the plausibility of this case notwithstanding, you'll notice that the popularity of the dome device has not perceptibly declined with speaker designers. For many applications it apparently remains the best *compromise* between power-handling ability and acceptable dispersion, and the sophistication with which its misbehavior can be measured has not yet changed the situation very much.

Isolating Meaningful Distortion. Elsewhere, the new techniques and instrumentation show signs of leading to immediate and meaningful progress. In the August 1977 *Stereo Review,* Peter Fryer of Rank HI FI in England describes investigations into several postulated loudspeaker faults (Doppler distortion, for example) that no one has yet really succeeded in pinning down. These were all phenomena that are difficult to measure, and hence their effects on the music-listening experience have not been characterized or quantified. Instead of trying to measure them as they exist in available products, Fryer artificially generated these distortions through various means and injected them (in known amounts) into speakers he had reason to believe were acceptably free of them to begin with.

When Fryer was finished, the "mys-



There are few DC amplifiers in the world with THD as low as 0.02%. But there's only one priced under $400.



Introducing the Technics SE-9060 stereo/mono DC amplifier. Its concept is simple: amplification with inaudible distortion.

How Technics achieved this elusive goal is not quite so simple. Like the difference our newly developed dual FETs make in the current mirror-load differential amplifier. They enable the SE-9060 to achieve the DC stability necessary for the highest gain in the crucial first stage.

Another difference is the constant current load and current feedback used in the voltage amplifier to reduce distortion to a minimum. A minimum so low it is barely detectable with the most advanced measuring equipment.

But inaudible distortion was not the engineers' only goal. That's why Technics SE-9060 is a DC amplifier. Each amp section and the NFB loop is direct coupled without the use of any capacitors. So the SE-9060 not only has inaudible distortion, it also boasts flat frequency response from DC to 100 kHz with almost nonexistent phase shift.

In addition to all the improvements in the amplifier stages, Technics also eliminated all signs of transient distortion with completely independent power supplies for each channel.

Compare specifications and prices. And you'll realize there's no comparison for the SE-9060.

POWER OUTPUT: 70 watts per channel (stereo), 180 watts (mono) min. RMS into 8 ohms from 20 Hz to 20 kHz with no more than 0.02% THD. INTERMODULATION DISTORTION (60 Hz: 7 kHz, 4: 1): 0.02%. FREQUENCY RESPONSE: DC-100 kHz, +0 dB, −1 dB. POWER BANDWIDTH: 5 Hz-50 kHz, −3 dB. S/N: 120 dB (IHF A). RESIDUAL HUM & NOISE: 100 µV. INPUT SENSITIVITY & IMPEDANCE: 1V/47kΩ. SUGGESTED RETAIL PRICE: $399.95.*

Technics SE-9060. A rare combination of audio technology. A new standard of audio excellence.

*Technics recommended price, but actual retail price will be set by dealers.

Technics *Professional Series*
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tery distortion" that stood out as being most irritating to listeners, even in relatively small amounts, was a rather prevelant distortion that he calls "delayed resonance." Delayed resonance is simply whatever "sound" of a resonance persists after the input signal to the loudspeaker has ceased. *Because* it persists, it is presumably less subject to psychoacoustic masking than a distortion that cuts off with the input. Fryer reports he confidently expected the sharp, "high-Q" type of resonance to be the most objectionable to listeners. It wasn't. It seems such resonances involve so narrow a band of frequencies that most program material sets them off relatively rarely. Nor were broadband low-Q resonances a problem; they tended to be heard as equalization errors, and could be equalized out effectively. No, it was the intermediate conditions that raised the most objection—something that would not have been obvious without these investigations.

Measuring Delayed Resonances. From the evidence of Fryer's work, it appears that something quite definite is now known about a rather elusive loudspeaker fault. Where can we go with this knowledge? Very shortly, if not immediately, we can go into newly instrumented laboratories well equipped to examine complicated acoustic phenomena on a real-time basis. The sort of work done by JVC in computer-derived acoustic-wave-form representations (as reported in this column last year) has been continuing rapidly. And it happens that Fryer's work largely coincided with the development at Acoustic Research of a computer system that draws frequency-response plots of a loudspeaker's output at time intervals as closely spaced as fifty millionths of a second (as shown in the diagrams). AR refers to this process as the "fingerprinting" of a speaker system, and the result as a transient decay plot. It begins with the speaker's stimulation by an impulse—a "gunshot" type of input, well-defined in duration and involving all audio frequencies. The test microphone's pickup then undergoes spectrum analysis which goes to a computer to evolve the frequency-response plots shown, advancing along a time axis that extends into the paper and begins at the top of the diagrams.

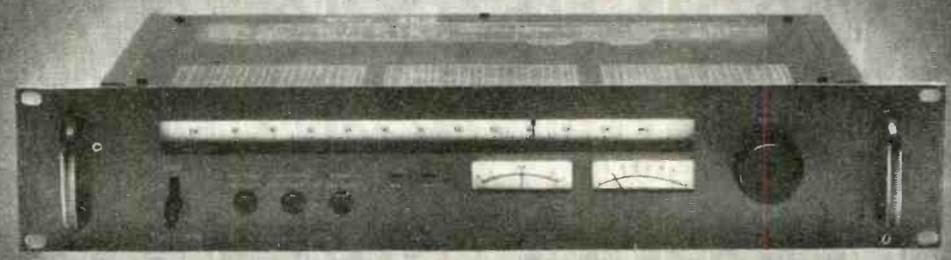
Part A of the figure shows the poorer loudspeaker, and the response irregularities are precisely those delayed resonances studied by Fryer. Note that they occupy small-to-medium bandwidths, tending to confirm Fryer's view that moderate-Q resonances are the worst degraders of audio quality.

Interestingly, the AR computer will provide these graphical data in three dimensions (using the overlaid red and green lines once employed by 3-D comic books), so that a sort of landscaped profile of response plots receding into the page can be viewed. Our editorial budget does not provide for this kind of printing (or for the red- and green-lensed goggles that would have to be bound into the magazine in order for you to see it properly), so you'll have to take my word for it.

Doppler Distortion Revisited. After all these years there seems still to be no agreement about Doppler distortion. Can it be heard? If so, under what circumstances? And is it likely to be troublesome with real program material played on real audio systems? While Fryer's investigations were busy disproving the importance of Doppler distortion as an audio "problem," other voices were raised to indict it once again.

Doppler distortion is a frequency modulation of a high frequency or frequencies by a low frequency, taking place

Introducing the Technics ST-9030 tuner. Purists would feel better if it cost over $1,000.



To some, tuners that offer 0.08% THD, 50 dB stereo separation, a capture ratio of 0.8 dB and waveform fidelity should demand a price tag of over $1,000. But with the ST-9030 this performance can be yours for under $400.*

That's quite a feat for a tuner. But then the ST-9030 is quite a tuner. It has two completely independent IF circuits: A narrow band, for ultra-sharp selectivity. And a wide band, for ultra-high separation and ultra-low distortion. It even selects the right band, depending on reception conditions, automatically.

Both bands give you the same extended flat frequency response. Because, unlike conventional tuners, the ST-9030 utilizes an electronic pilot cancel circuit that cuts the pilot signal, without cutting any of the high end. It's ingenious. And a Technics innovation.

The Technics ST-9030 has one of the quietest, most sensitive front ends of any tuner. With an advanced linear frequency 8-ganged tuning capacitor and 3 double-tuned circuits, plus dual-gate MOS FETs in the 2-stage RF amplifier and balanced mixer circuit. What's more, there's a servo tuning circuit that locks into the tuned frequency, regardless of minor fluctuations. The result: Negligible drift distortion and maximum stereo separation.

Technics ST-9030. Compare specifications. Compare prices. And you'll realize there's really no comparison.

THD (stereo): Wide—0.08% (1kHz). Narrow—0.3% (1kHz). S/N: 80 dB. FREQUENCY RESPONSE: 20Hz—18 kHz + 0.1, − 0.5 dB. SELECTIVITY: Wide—25 dB. Narrow—90 dB. CAPTURE RATIO: Wide—0.8 dB. Narrow—2.0 dB. IF, IMAGE and SPURIOUS RESPONSE REJECTIONS (98 mHz): 135 dB. AM SUPPRESSION (wide): 58 dB. STEREO SEPARATION (1 kHz): Wide—50 dB. Narrow—40 dB. CARRIER LEAK: Variable — 65 dB (19 kHz). Fixed — 70 dB (19 kHz, 38 kHz). SUGGESTED RETAIL PRICE: $399.95.*

Technics ST-9030. A rare combination of audio technology. A new standard of audio excellence.

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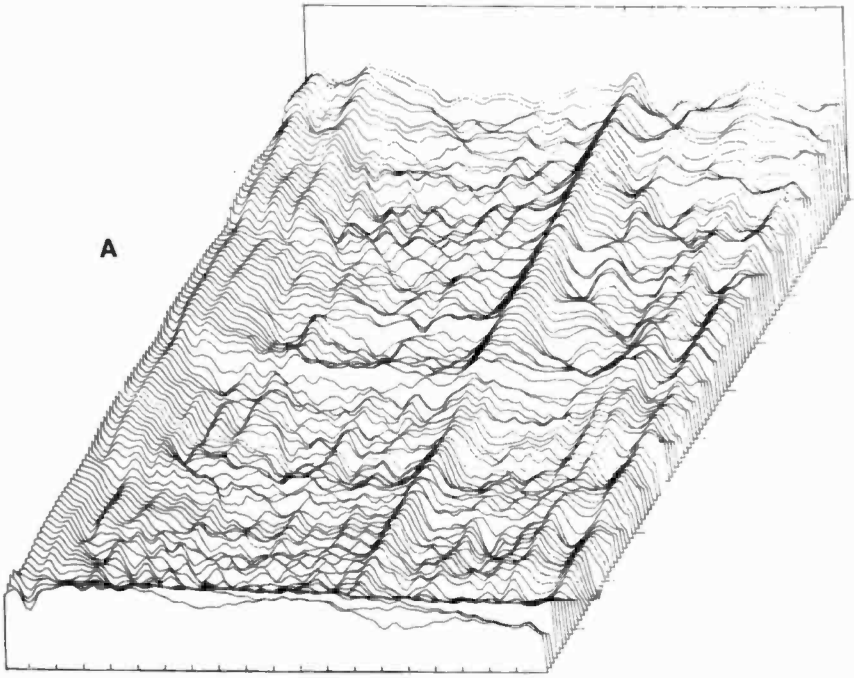
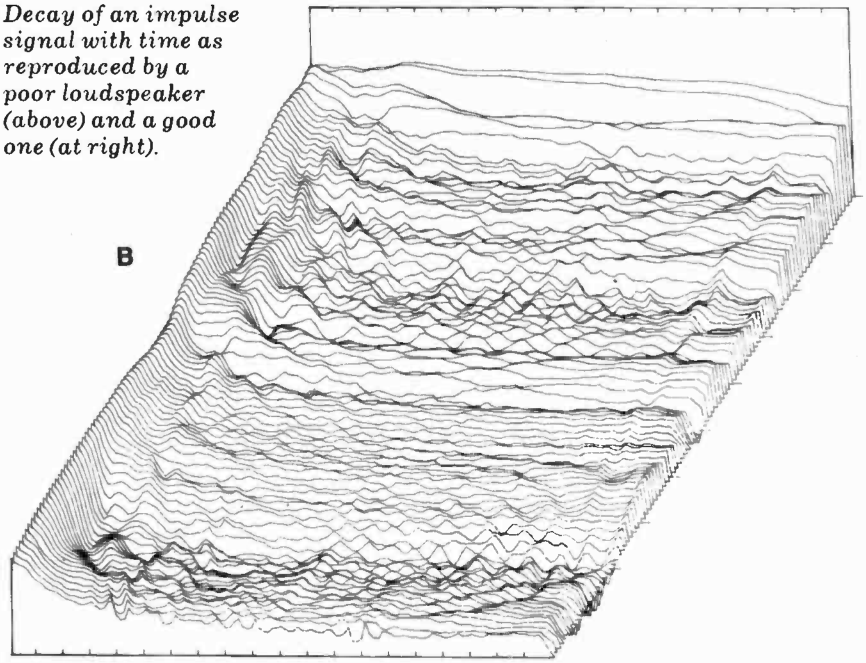
when a single loudspeaker diaphragm is called upon to reproduce both. Woofers are usually the accused agents when Doppler distortion is cited, because theirs are the only diaphragms making large enough in-and-out excursions to make the effect possible at all.

Fryer used frequencies within the audio range in experiments that seemed to prove that Doppler effects virtually never achieve sufficient magnitude to be audible with typical hi-fi speakers. Now, Tomlinson Holman of Apt Corporation reports that it is precisely those frequencies *outside* the audio range that are going to cause the trouble: specifically, frequencies from record warps and deformations, which peak in energy around 4 to 6 Hz on many record players (as a result of arm-cartridge resonance). It happens that the ear's sensitivity to flutter also peaks at about 4 Hz. Moreover, it is certain that the woofer of an air-suspension or ported speaker system will be undergoing very large excursions if it is being stimulated by any significant amount of 4-Hz energy.

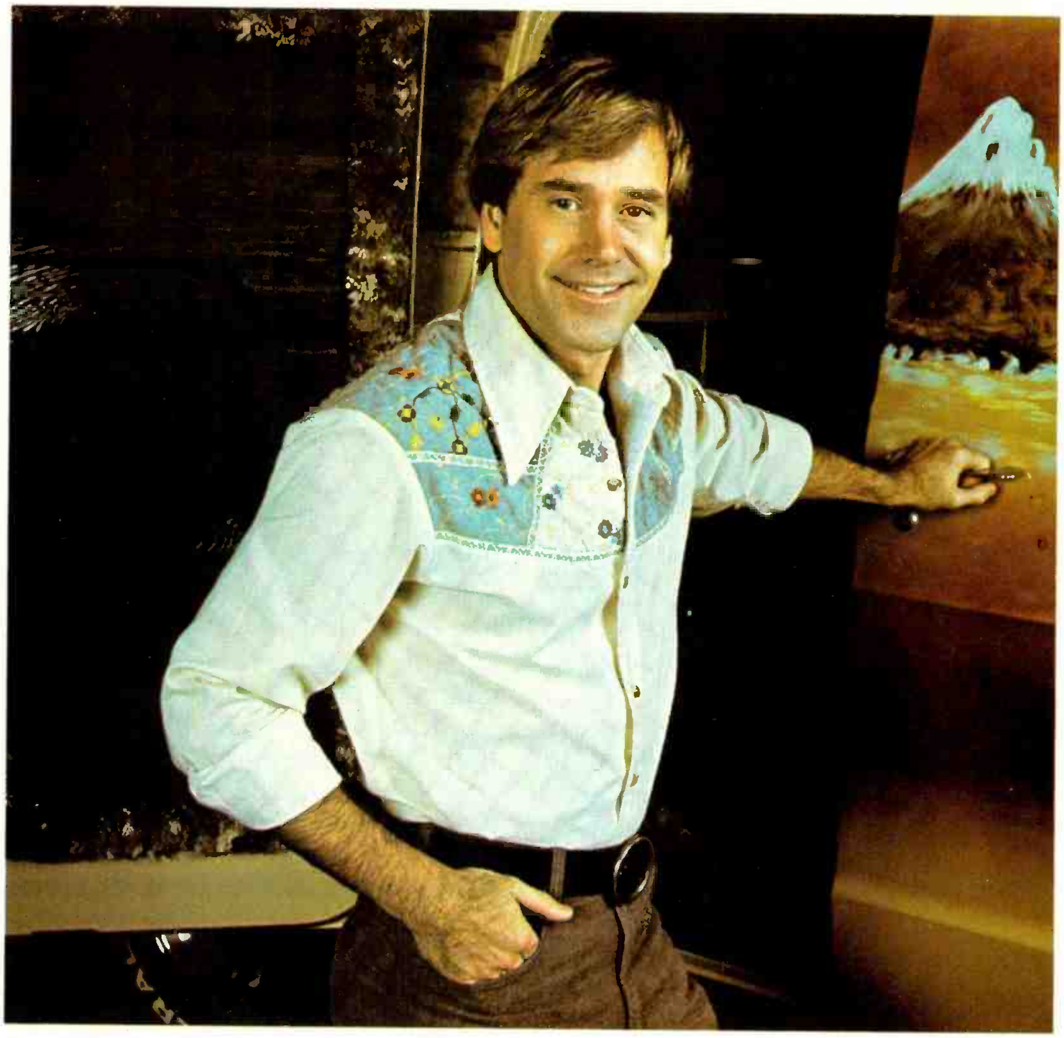
Holman confidently claims that he has heard and demonstrated Doppler effects produced by infrasonic signals any number of times, and that this is the primary reason for the steep low-cut filter he builds into his phono preamplifiers. I cannot yet report on this matter from first-hand experience, but I can at least pass along the information for the benefit of those readers who would like to look into it themselves. ◇



Decay of an impulse signal with time as reproduced by a poor loudspeaker (above) and a good one (at right).



You gotta shop around.



When you do, you'll probably pick CIE. You can't afford to settle for less when it comes to something like electronics training that could affect your whole life.

When you shop around for tires, you look for a bargain. After all, if it's the same brand, better price—why not save money?

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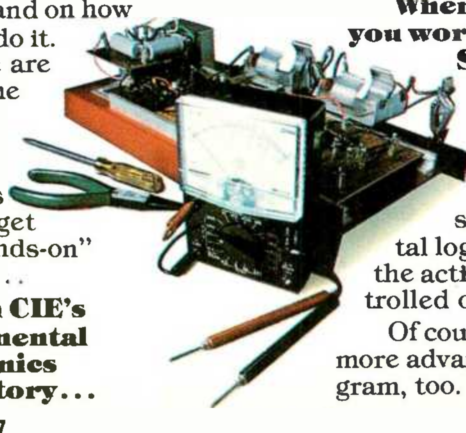

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Julian Hirsch Audio Reports

HIRSCH/HOUCK LABORATORIES

DYNAMIC CROSSTALK

TO ANYONE who remembers when 1% distortion was considered to be "negligible," the refinement of modern amplifiers is nothing less than amazing. Conventional distortion measurements, either of harmonic or intermodulation components, can now be made only with the aid of the most sophisticated test instruments, and few people would seriously claim that a total harmonic distortion measurement of 0.002% implies a better sounding amplifier than one of 0.02%.

Nevertheless, amplifier designers continue to search for ways to improve the performance of their products. Admittedly, the audible benefits of most recent "improvements" are quite subtle, and in some cases debatable. Usually, the "improvement" is not measurable by established techniques, necessitating the creation of new measurement methods or instrumentation. A case in point is the so-called "dynamic crosstalk" effect, which has received attention from a number of amplifier manufacturers. This is a very-low-frequency phenomenon in which a powerful transient at a low audio or subaudible frequency is present in one stereo channel but influences the output of the other channel. It is the result of a common power supply impedance, where a large current drawn by one channel causes a temporary shift of the operating voltages in the other channel. In an extreme case, it is claimed, this can modulate the program in the second channel with the low-frequency transient in the first channel.

One might ask, how does this differ from ordinary intermodulation distortion? As I see it, it differs in two basic respects: First, the low- and high-frequency signals are not present in the same program channel, so that the intermodulation occurs only through interactions via the common power supply impedance. Second, the IM effect is not caused by a direct modulation of one waveform by another, but rather by the *envelope* of a low frequency transient affecting higher-frequency signals. This being so, no IM would be detectable in a conventional steady-state measurement, but only when a low-frequency transient occurs.

If this effect exists, the most logical way to eliminate it is by separating the power supplies for the two channels (assuming that the amplifier circuits have already been designed to minimize the effects of transient supply voltage changes). This can be done at minimum expense by using separate rectifier and filter systems with a common power transformer. A more complete isolation results from using separate power transformers as well for the two channels.

This was the approach taken by the designers of the Mitsubishi Model DA-A15 amplifier reviewed here. Of course, this use of separate power supplies and transformers is not new. Harman-Kardon has employed separate power transformers for some years in its receivers and amplifiers and, more recently, this feature has been used in amplifiers from Kenwood, Pioneer, and other well-known manufacturers.

Two questions naturally come to mind. Can the effect of separate power supplies (or the lack thereof) be measured, and can it be heard? Dynamic crosstalk can be measured by applying a low-frequency transient signal (such as a pulse, square wave, or tone burst) to one channel and a high-frequency continuous signal, or no signal at all, to the other channel. The magnitude of low-frequency output in the second channel, compared to that in the first, is a measure of the crosstalk between channels, and the modulation imposed on the high-frequency signal, if any, is a measure of the probable effect of such crosstalk on program material.

In our laboratory tests, the crosstalk on amplifiers with dual power supplies has been too low to measure, and the tests were not applied to enough conventional amplifiers to provide a basis for comparison. Another test, potentially more sensitive, is to drive one channel with a low-level, high-frequency signal (we used 10,000 Hz at 0.1 watt) and the other channel with a 10-Hz square wave at full power, such as 100 watts. When the high-frequency signal is displayed on a spectrum analyzer, using a narrow, high resolution scan, it should be possible to see the sidebands resulting from even very low modulation percentages. (Our Hewlett-Packard Model 3580A analyzer can reveal such sidebands down to a −90-dB or lower level, corresponding to less than 0.003%). Even with this technique, no modulation effects have been visible on dual power supply amplifiers.

Much more pertinent is the second question, however. If it cannot be heard on conventional amplifiers, "dynamic crosstalk" can hardly be considered a serious problem in sound reproduction, and its elimination, however praiseworthy, is of secondary importance. I have never heard anything that could be identified as "dynamic crosstalk." To me, amplifiers lacking such crosstalk sound exactly like others that presumably are not immune to the effect.

This is not to say that dynamic crosstalk does not exist. Under laboratory measurement conditions, with the appropriate test signals, it certainly does (or can) exist. However, a little thought will reveal why it is not, and cannot be, a significant effect from the listener's viewpoint. Stereo channel separation at very low frequencies is drastically degraded compared to the midfrequency separation in stereo discs (and sometimes in FM tuners). This is of little importance, since real music has little or no separation (directionality) at very low frequencies. Thus, a low frequency transient, should it exist, will be present in both playback channels at the same time, at nearly the same level. Any direct crosstalk will be masked by the high-level signal already present in the other channel, and intermodulation of higher frequencies will be masked by the high level of those signals. It is difficult to imagine any "real world" condition, as opposed to contrived laboratory conditions, in which dynamic crosstalk might be heard (unless it were of extraordinary amplitude).

As things stand, I must conclude that "dynamic crosstalk" is one of the lesser aberrations with which we have to cope in sound reproduction and is hardly worth the effort and expense lavished by some manufacturers on its elimination.

MITSUBISHI MODEL DA-P10 PREAMPLIFIER AND MODEL DA-A15 BASIC POWER AMPLIFIER

Preamp and power amplifier can be combined for 150 watts/channel integrated amplifier.

HIRSCH-HOUCK LABS REPORT

Mitsubishi, a major manufacturer in Japan, has entered the U.S. market with a line of unusual deluxe high-fidelity components. Two of these, tested here, are the Model DA-P10 preamplifier and Model DA-A15 basic power amplifier. They are sold as separate components but are physically and electrically designed so that they can be joined to form a single integrated amplifier. The power amplifier is rated to deliver 150 watts/channel into 8 ohms at 20 to 20,000 Hz with less than 0.1% harmonic and IM distortion when driven by a 1-volt input. The preamplifier has a nominal 1-volt output but can actually deliver up to 9 volts output to drive any amplifier on the market.

The handles supplied with the amplifier can be installed at the user's option. When in place, they permit the preamplifier to bolt into place to form a single rigid and heavy unit. Another option, not tested here, is a peak-indicating power meter in place of the preamplifier. In this case the latter must be used as a separate component.

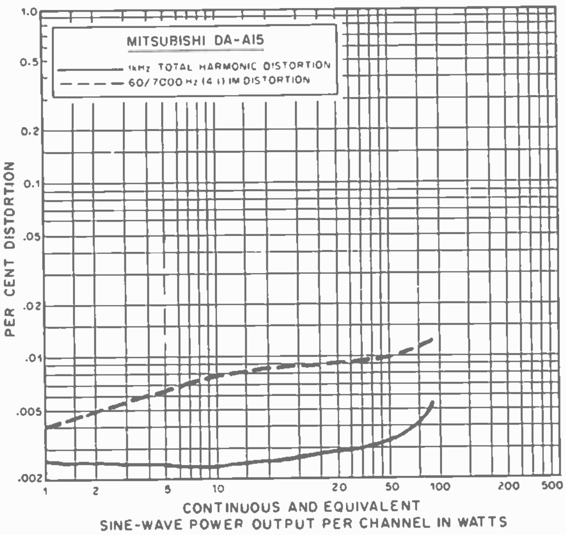
The Model DA-P10 preamplifier measures 16¾"W × 8"D × 6¾"H (42.5 × 20.4 × 17 cm) and weighs 13 lb (15.8 kg). The Model DA-A15 power amplifier has the same width and height dimensions and is 11¾" (28.5 cm) deep and weighs 40 lb (18 kg). The nationally advertised value of the preamplifier is $290; the power amplifier is $590.

General Description. The most interesting feature of the two units is their complete separation of the two signal channels. Mitsubishi calls this design approach "Dual Monaural" construction. The Model DA-P10 is literally two independent monaural preamplifiers that share only a common transformer (separate regulated power supplies are used for the two channels), function selector, volume control, and chassis. In the power amplifier, the separation is even more complete, since each channel has its own power transformer as well.

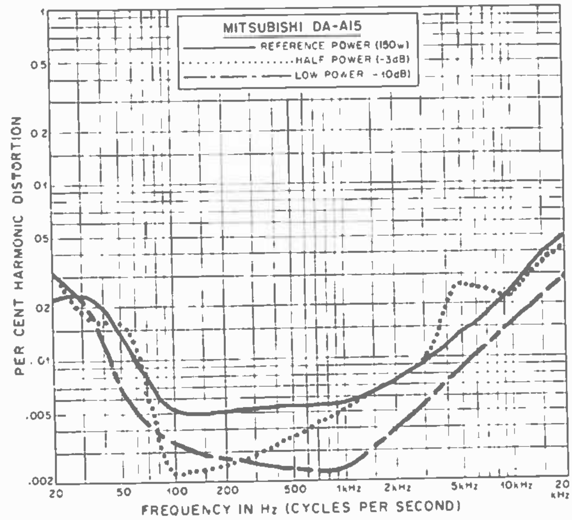
The controls for each of the preamplifier's channels are arranged in a horizontal row. They include a switch for a subsonic filter with a 12-dB/octave rate below 18 Hz, 11-position BASS and TREBLE tone controls (with center DEFEAT settings), and a LEVEL control. The large ATTENUATOR knob, common to both channels, is lightly detented at 2-dB intervals over much of its range, with the steps increasing in magnitude as the control nears its −60-dB setting. In the final counterclockwise position, the ATTENUATOR control shuts off the signal entirely.

Lever switches along the bottom of the control panel permit selection of stereo or mono MODE, activating and deactivating the TAPE MONITOR function, and turning on and off the POWER. The input SELECTOR at the upper right of the panel has positions for two magnetic phono cartridges and two high-level sources (TUNER and AUX). There is a PHONES jack that is designed to drive low-impedance (8-ohm) phones from a separate amplifier stage within the preamplifier.

At the upper left of the panel is a SPEAKERS switch that can connect either of two pairs of speaker systems but not both to the power amplifier or silence all speakers for headphone listening. To accomplish this, the power amplifier's speaker outputs are not brought into the



Total harmonic distortion and 60/7000-Hz distortion



Harmonic distortion at three power levels

preamplifier as is sometimes done. Instead, the switch controls relays within the power amplifier. The relays then control speaker switching and are part of the amplifier's protective system that disconnects the outputs in the event of a malfunction and provides a few seconds of delay when power is initially applied.

The signal connectors are recessed into the right side of the preamplifier. The power amplifier has no operating controls other than a pair of screwdriver-adjustable input level controls near the input connectors and a speaker selector slide switch that is used when the amplifier is driven by preamplifiers other than the Model DA-P10. Two pairs of insulated screw-type speaker terminals are provided. The large heat sinks for the output transistors occupy the two sides of the chassis, while the two power transformers and power supply filter capacitors occupy the space between the heat sinks.

When the power amplifier and preamplfier are joined together, a remote-control cable links their speaker selector sockets and a short cable joins the preamplifier outputs to the power amplifier inputs. The power cord of the power amplifier plugs into one of the switched ac receptacles on the preamplifier. The various cables can be folded and concealed in special channels along the side of the power amplifier. The channels are styled to resemble the heat sink fins above them.

The electrical performance specifications of the amplifier and preamplifier are impressive. In addition to being rated to deliver 150 watts/channel at very low distortion, the amplifier's specified channel separation is 90 dB at 1000 Hz and 80 dB at 20,000 Hz, while the unweighted hum and noise in the output is rated at less than 0.3 mV with a shorted input. The preamplifier's specified 1-volt output is actually rated to deliver a maximum of 9 volts. Depending on the frequency and input source, its channel separation is rated at 80 to 100 dB, and its phono input overload level at 1000 Hz is specified as 270 mV.

Laboratory Measurements. We laboratory tested the power amplifier and preamplifier separately, but for listening tests, we joined the two and used them as an integrated amplifier. The tone controls of the preamplifier had a variable bass turnover frequency. The bass boost or cut began at frequencies from 100 to 400 Hz, depending on how far the control was moved from its center position. The treble response curves were hinged at about 2000 Hz. The maximum range of the tone controls was about ±12 dB, which is more than sufficient for their purpose but not so great as to invite the possibility of misuse. At their DEFEAT settings, the tone controls produced a completely flat response, within ±0.5 dB from 20 to 20,000 Hz.

The RIAA equalization was equally accurate, well within the normal limits of measurement error. It measured within ±0.5 dB from 20 to 20,000 Hz, including the effect of the response of the basic amplifier with tone controls defeated. It did not change detectably when measured through the inductance of typical phono cartridges. The subsonic filter dropped the output by 2.3 dB at 20 Hz and 14 dB at 5 Hz.

The rated 1-volt output of the preamplifier was developed with a high-level input of 145 mV or a phono input of 1.95 mV. The phono overload point was an excellent 310 mV. The unweighted noise output of the preamplifier was below our measurement capability of 100 μV (80 dB below 1 volt) through the high-level inputs and measured −79.2 dB through the phono inputs. This is the lowest phono preamplifier noise level we have yet measured.

The outputs of the preamplifier clipped at 10.3 volts. At the rated 1-volt level, the THD was 0.0025% at 1000 Hz (approximately the instrument residual distortion level), 0.0056% at 15,000 Hz, and 0.047% at 20 Hz. At 3 volts output, which is more than sufficient to drive any power amplifier to its full output, the distortion at these three frequencies was 0.0063%, 0.01%, and 0.05%. The IM distortion rose from 0.012% at 1 volt to 0.03% at 3 volts output.

The power amplifier passed the one-hour preconditioning period at one-third rated power without difficulty. A novel feature is the use of temperature sensors on the amplifier's heat sinks that change color from red to black at 140° F (60° C). This alerts the user to the fact that the heat sinks should not be touched with the bare hand. This is all academic because at no time during our tests did the sensors change color.

The outputs clipped at 178 watts/channel into 8-ohm loads at 1000 Hz. The 4- and 16-ohm outputs measured 267 and 112 watts, respectively. The distortion of this amplifier was among the lowest we have yet measured and, under most conditions, it was apparently less than the residual of our test instruments, which is approximately 0.002%. At 1000 Hz, the measured THD was 0.0022% to 0.0027% from 0.1 watt to 10 watts output. It rose to 0.0036% at 100 watts and to 0.0056% at 180 watts, just at the clipping point. The IM distortion was 0.004% to 0.008% up to 10 watts and 0.013% at 180 watts. Unlike almost every other amplifier we have tested, the distortion of this amplifier did not rise at very low power levels. Although the IM measurements indicated an apparent rise from 0.004% in the vicinity of 1 watt to 0.032% at a few milliwatts, this proved to be the random noise within the intermodulation analyzer.

At the rated 150-watt output, the THD was about 0.02% between 20 and 30 Hz and about 0.005% from 100 to 1000 Hz. It rose smoothly to 0.04% at 20,000 Hz. At lower-power outputs the shape of the distortion curve was similar, although the percentages were generally less. The amplifier was driven to a reference output of 10 watts by a 0.27-volt input, and the unweighted noise output was a very low −87 dB referred to 10 watts. The square-wave rise time of 0.7 μs was exactly as rated, and the measured slew rate of 20 V/μs was slightly better than the rated 15 V/μs.

We also measured the interchannel crosstalk, since it is claimed to be a special quality of the amplifier. With the aid of our Hewlett-Packard Model 3580A spectrum analyzer, we were able to verify that the crosstalk was −120 dB at 20 Hz, −110 dB at 1000 Hz, and −80 dB at 20,000 Hz. These figures not only meet or surpass the manufacturer's claims, they are well-nigh unmeasurable without the use of sophisticated and expensive test equipment.

User Comment. Both the power amplifier and the preamplifier are handsomely finished in semigloss black, and the latter has a satin-finished aluminum front panel with matching metal knobs. The power amplifier's major components—power transformers, filter capacitors, and heat sinks—are exposed to view instead of being hidden by a dust cover or cabinet, resulting in a most attractive piece of equipment. When the two units are joined together, they form an integrated amplifier system of exceptional power and performance, with a combined depth of only 16 ¾" (42.4 cm).

In its S/N, distortion, flatness of response, and interchannel isolation, the system is far above the norm. A few other amplifiers can match one or more of its individual characteristics, but none we have yet tested show the overall perfection of performance exhibited by this preamplifier/power amplifier system.

In the quest for certain levels of electrical performance, Mitsubishi engineers have chosen to eliminate some functions commonly found on lesser amplifiers. We concur with the omission of "loudness compensation," although the separate level controls on each preamplifier channel, in addition to their channel balance functions, would also have made it possible to add a well-designed loudness compensation system to its maximum effectiveness. Similarly, the absence of a high-cut filter is hardly a drawback, in view of the ineffectiveness of most such filters. On the other hand, we were surprised to see an amplifier of this quality and price with provision for only one tape recorder, since even medium-priced receivers often can control two tape decks, thus providing cross-dubbing capability.

No stereo program will have more than 30 dB or so of midrange isolation between channels (considerably less at the frequency extremes), which would make the 100-dB isolation of the Mitsubishi amplifier a case of "overkill." However, if normal crosstalk levels are a source of audible signal degradation, as it is sometimes claimed, the Mitsubishi amplifier certainly sets a standard for the industry. Interestingly, the channel isolation is so great here that it would be possible to use the DA-P10/DA-A15 combination as two independent mono amplifiers with completely different programs and have no audible interaction or crosstalk between them.

We have said nothing about the sound of the Mitsubishi preamplifier/ amplifier for the simple reason that, like other fine amplifiers, it has no sound. The special appeal of this system lies in its superb construction, uncompromising quality standards, and general aura of elegance. For those who have no need for the full power of the Model DA-A15, the company's Model DA-A10 is available at a lower price. Except for its 100 watt rating, it is identical to the Model DA-A15.

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DUAL MODEL 1245 AUTOMATIC TURNTABLE

Belt-driven automatic player provides extremely quiet operation.

HIRSCH-HOUCK LABS REPORT

The Dual Model 1245 is a two-speed, belt-driven automatic player. It boasts features such as the improved tonearm used on the company's expensive Model CS721. The tonearm is 8.7" (22.1 cm) from stylus to pivot and has a dual counterweight structure, with an inner mass suspended elastically from the outer shell. This reduces the effect of the bass resonance of the mass of the tonearm and cartridge compliance, lowering its amplitude and distributing it over a wider frequency range.

The player is supplied installed on a wood-trimmed plastic base, with a hinged clear plastic cover that remains open at intermediate angles. Even the platter is mounted in place, leaving only the cartridge to be installed to make the player ready to be put into service. The record player in its base measures 14¾"W × 14½"D × 5⅞"H (37.5 × 36.8 × 15 cm) and weighs 14 pounds (6.4 kg). Nationally advertised value is $230.

General Description. The tracking force dial, located on the side of the tonearm's gimbal pivot structure, is calibrated from 0 to 3 grams at 0.1-gram intervals over the lower half of the range. On the motorboard, next to the base of

CIRCLE NO. 1 ON FREE INFORMATION CARD

the tonearm, is an antiskating dial that has separate scales for conical, elliptical, and CD-4 styli. The cueing lever raises and lowers the pickup with a slow, damped motion in both directions. A small knob can be set to play a record only once or to repeat it indefinitely until the player is manually shut off.

The operation of the record player is initiated and controlled by a single lever near the front of the motorboard. When moved to START, it turns on the motor and causes the pickup to index to the lead-in groove of a 12" (30.5-cm) record if the player is set for 33⅓ rpm. When the 45 rpm speed is selected, the tonearm indexes to a 7" (17.8 cm) diameter. After playing the record, the pickup automatically returns to its restpost and the motor shuts off. This action can be initiated at any time by moving the control lever to STOP. Alternatively, the pickup can be lifted from its rest by hand, which starts the motor, and placed on the record manually.

For multiple play operation, the short single play spindle, which rotates with the record, is removed and replaced with the multiple-play spindle supplied. Up to six records of the same size and speed can be loaded and will be played automatically and in sequence.

The 3-pound (1.3-kg) cast nonferrous platter is driven through a soft belt by an eight-pole (900-rpm) synchronous motor. The speed selector, located at the left front of the platter, shifts the belt to a different diameter of the pulley on the motor shaft, and a concentric knob expands the pulley slightly to vary each speed over a nominal ±3% range.

A single ring of stroboscope marks is cast into the edge of the platter, with an unconventional pattern that allows a single set of markings to be used with either 50- or 60-Hz power sources. (The drive pulley must be changed to match the line frequency). The marks are illuminated through a small window near the edge of the platter and are stationary only when the turntable is operating at 33⅓ rpm when that speed has been accurately set. Switching to 45 rpm will also produce the correct speed.

Laboratory Measurements. The record player uses the same easily removable cartridge mount that has been part of every Dual record player for a number of years. We installed a Pickering Model XV-15/750E cartridge in the tonearm for our tests. With the arm balanced according to instructions, the calibrations of the tracking force dial were exact. The tracking error of the tonearm was less than 0.4° per in. of radius at all playing diameters. The measured arm mass without cartridge was 19.4 grams, which is typical of the better automatic record players we have tested recently. The resonance of the tonearm mass and cartridge compliance combination was at 10 Hz, at an amplitude of 6 to 7 dB.

The unweighted rumble of the turntable was typical of medium-priced belt-driven record players, measuring −32 dB, essentially all in the lateral plane. With ARLL audibility weighting, the rumble was −53 dB, which is also a satisfactory and typical figure for a player of this type and price range. The wow and flutter were respectively 0.03% and 0.04%, giving a very good combined reading of 0.045%.

The turntable speed could be varied over a +5.5% to −4.7% range at 33⅓ rpm. When it was set to exact speed, changing the speed selector to 45 rpm resulted in a negligible error of 0.2%. At 45 rpm, the turntable could be varied over a +2.4% to −1.3% range. The speed was unaffected by line voltage changes from 95 to 135 volts.

The calibration of the antiskating dial was reasonably accurate, although we found the best compensation, to produce equal distortion on both channels, occured when the dial was set 0.5 to 1 gram higher than the tracking force. The cueing device operated with exceptional smoothness and freedom from lateral pickup drift. In multiple-play operation, the change cycle required 14 seconds, a typical figure for record changers. However, automatic single-play operation required considerable patience on the part of the user, since it took 16 seconds from the time the lever was moved to START to the time the pickup touched the record. At the end of play, another 14 seconds was required to return the arm to its rest and shut off the motor.

The capacitance to ground of the tonearm wiring and signal cables was 168 pF/channel. Although the manual states that the record player is compatible with CD-4 cartridges, it evidently refers only to the internal wiring of the tonearm. A special low-capacitance cable should be obtained from the importer (United Audio) and substituted for the standard cable if CD-4 operation is planned for the future.

The entire record player is suspended from its mounting base by soft spring mounts, which proved to be very effective in isolating it from subsonic vibration conducted through the mounting surface. In fact, the entire unit could be jarred rather violently wihout causing groove jumping. However, the transmission of vibration in the region of 50 to 60 Hz was observable. It was about the same as we have measured on other record players from Dual and most competitive manufacturers. Hence, the Model 1245 should not be placed too near speakers systems to avoid acoustic feedback problems.

User Comment. Because of the continuity of basic design and performance that has characterized Dual products over the years, we noted little difference in operation between the Model 1245 and earlier Dual record players we have tested and used. It is not necessary to make comparisons between the measured performance of the Model 1245 and its predecessors to appraise its worth. The Model 1245 is a first-rate record player, judged objectively on its own merits. It was also mechanically one of the quietest automatic record players we have used.

The convenience of buying an almost ready-to-play package such as this cannot be overstated. Many record players, including some previous Dual models, required the removal of numerous screws, cable ties, and plastic shipping restraints before the player mechanism could be installed on its base. Then, the belt (if it was a belt-driven unit) and platter had to be installed. Finally, after installing and adjusting the cartridge, cover, and cables, the record player was ready for use.

When the Model 1245 is unpacked, only the installation of the cartridge and the counterweight is needed to put it into service. Of course, there is still the balancing of the tonearm and the overhang adjustment of the cartridge position to be done, but these apply to any record player that does not include a factory-installed cartridge. Dual makes these tasks as easy and foolproof as possible, and in our experience, when the directions are followed, the result is a properly set up record player.

We should point out, however, that the instruction manual lacks clear information on the channel orientation of the cartridge wiring and the color coding of the cartridge wires in the mounting slide. An illustration does show the cartridge connections; but with no clue as to whether it is a top or bottom view, there is only a 50% chance of the left-right channel orientation's being correct. (We were lucky in our guess.)

Aside from this minor inconsistency, the Dual Model 1245 is as good a record player as one can find in its price range.

CIRCLE NO 102 ON FREE INFORMATION CARD

BURWEN MODEL DNF 1201A NOISE REDUCER

"Swishless" dynamic low-pass noise filter is very effective in reducing hiss.

HIRSCH-HOUCK LABS REPORT

The Burwen Model DNF 1201A dynamic low-pass filter is designed to reduce the high-frequency noise (hiss) in any program with little or no effect on the audible frequency response. Unlike the Dolby and ANRS systems, it does not require that the program material be previously processed.

The Model DNF 1201A is basically similar to the Model DNF 1201 sold by Burwen before the company was acquired by KLH, but the time constants and other characteristics in the new model have been modified to make the filter more effective and less obtrusive. In the 1201A, the bandwidth of the filter varies between 500 and 30,000 Hz, depending on the level and frequency content of the program. The rated cutoff slope is 9 dB/octave.

The filter comes in a physically flat package that measures 17½"W × 8¼"D × 2⅞"H (44.5 × 21 × 7.3 cm) and weighs 8 lb (3.6 kg). The walnut finished wood cabinet is complemented by a silver-colored front panel. Nationally advertised retail value is $379.

General Information. Like any "open-ended" noise reducing system, the Model DNF 1201A is faced with the seemingly impossible task of determining whether the high-frequency energy in the program is part of the recorded material or is noise. Having made the determination, the bandwidth of the filter must be reduced as much as possible without sacrificing the higher-frequency program components. The variation of the bandwidth must also be done at such a rate that it cannot be audibly detected by the listener. That this can be accomplished successfully is due to the phenomenon of "masking," which means that certain frequencies can be rendered inaudible by the presence of others, even though by themselves they can be plainly heard. Hence, the presence of the program is used to mask noise, leaving the filter with the task of removing the noise during quiet intervals in the program.

In the Model DNF 1201A, if the program has significant amounts of high-frequency energy, the bandwidth of the filter opens up to pass it. If there are no highs present, or if the overall level of the program drops, the bandwidth of the filter reduces to decrease the noise. The four variables that control the operation of the Model DNF 1201A are the level and frequency distribution of the incoming signal and the attack and decay times (rates at which bandwidth increases and decreases).

Front-panel controls on the filter give the user considerable latitude in his selection of its operating parameters. Hence, the action of the filter can be optimized for any program. The basic operation of the filter is controlled by four pushbutton switches and a slide-type control. The buttons are labelled OFF, MAX, MED, and MIN. With the OFF button pressed, the incoming program bypasses all the circuitry in the filter and is delivered directly to the outputs. Operation of any of the three remaining buttons adjusts the manner in which the bandwidth controller circuit, which supplies the control voltage to the filter circuits, responds to signals of different frequency and attack times. MAX is used for very noisy programs, such as 78-rpm discs and poor quality broadcasts and tapes. It provides a slow response time to minimize the "swish" of noise that can accompany a rapid change in bandwidth with a noisy background. MED provides a shorter attack time, and MIN gives the fastest filter response and the least severe filter action, making it suitable for relatively high quality program material.

At low program signal levels, the bandwidth changes rather sedately, tracking the signal without introducing excessive background noise modulation. However, a sudden transient can open up the filter in as little as 600 μs.

The decay time, during which the bandwidth closes down, is determined by the dynamic characteristics of the program and can vary between 50 ms and 1.5 seconds.

Proper use of the SENSITIVITY slide control is vital to the successful operation of the filter. At its left limit is a red SUPPRESSION LED and at the right limit is a green WIDEBAND LED. The LED's glow in accordance with the instantaneous condition of the voltage controlled filter. When the green LED is on, the program passes with its full bandwidth; when the red LED is on, the bandwidth reduces. In use, the control is adjusted until the two LED's flash alternately or if the program is highly complex, until both LED's appear to be illuminated simultaneously.

The filter normally connects in the tape monitoring path of an amplifier or receiver. The tape recording input and output jacks are duplicated in the rear of the filter, activated by a pushbutton MONITOR switch on the front panel, so that none of the tape monitoring flexibility of the system is lost. In addition, there is a PRE/POST button that places the filter in the signal path either ahead of the tape recorder or in its playback output. This permits the program to be "de-noised" before it is recorded, and (if desired) again upon playback. In addition, other noise-reduction systems, such as Dolby or ANRS, can be used in the tape recorder itself.

The filter operates on both channels. Its control voltage is derived from a mixture of the two channels. This assures that there will not be any interchannel bandwidth variations.

The filter is a unity-gain device (screwdriver adjustment on the rear panel permits some variation about gain). It has nominal rating of 1 volt in/1 volt out. The filter can handle signal output levels up to 6 volts without distortion. The internal noise is rated at 100 μV, or 80 dB below 1 volt. The total harmonic distortion (THD) is rated at less than 0.2%. The amount of noise reduction can be from 5 to 14 dB above 400 Hz, and as much as 30 dB above 5000 Hz.

Laboratory Measurements. Very few conventional measurements can be made on the Model DNF 1201A, because the presence of a test signal itself affects the filter bandwidth. At the factory, the dc control loop is opened and the filter characteristics are measured with an external control voltage.

We made frequency-response measurements with different signal levels at a fixed setting of the SENSITIVITY control and at a fixed signal level with different settings of the SENSITIVITY control. The results in general confirmed the manufacturer's ratings. (Since they were static measurements, they did not reveal anything about the dynamic properties of the unit.) We noted, however, that although the "full-cut" filter response had the rated 9 dB/octave slope, beginning at about 500 Hz, when the filter was partially activated by the swept input signal the *apparent* slope was much steeper—about 24 dB/octave.

Distortion was measured with a 400-Hz input signal at a level of 1 volt. With the OUT button pressed, the THD was 0.014%. With full suppression (MAX) maximum distortion was only 0.11%. And when the SENSITIVITY control was moved to turn on the WIDEBAND LED, the THD was only 0.031%.

User Comment. Since the measurements we were able to perform can do little more than suggest the performance of the filter, we depended largely on use tests for its evaluation.

We tested one of the original Burwen Model 1201 filters several years ago and found a tendency for a noise "swish" to be audible. Thus, we were curious to learn if this problem had been solved in the 1201A. It has! Only by the most obvious misuse of the new filter, on very hissy programs, could a swish be heard. Such incorrect operation of the filter is unlikely in practice, since its controls are meant to be adjusted to provide the maximum possible noise reduction without unacceptable side effects.

When the two LED's flashed alternately, the filter operation was almost never detectable, but the hiss reduction was quite impressive. Like any open-ended noise reduction system we have used, the technique employed by Burwen is most effective with a relatively noise-free program. But though a good, quiet program might seem to be an unlikely candidate for noise reduction, the filter can usually convert it from merely quiet to dead silent.

Neither did the 1201A produce any dulling of the highest frequencies when properly adjusted. Here, too, the end result is under the user's control.

In conclusion, we feel that Burwen has proved the worth of its basic concept. The redesigned filter has eliminated all of our former reservations about the original filter. In its present form, the DNF 1201A is a highly useful adjunct to any good music system.

CIRCLE NO. 103 ON FREE INFORMATION CARD

Up your organization.

The Basic Box (left) and the Peripheral Plate.

With no-nonsense organizers from the Digital Group.

Not so long ago, the microcomputer domain belonged to a special group of creative, inventive folks — the inveterate hardware hackers who delighted in making a thing work and didn't really care all that much about how it looked.

The Digital Group was a part of it. Our original microprocessor systems were designed not to require any cabinets at all — they simply worked well.

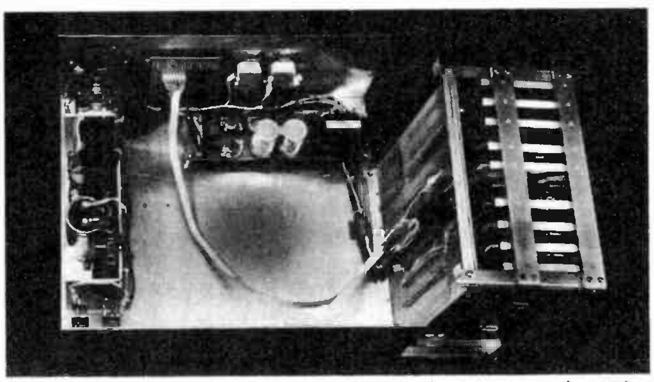
Of course, along the line we couldn't resist making a good thing look good too . . . and we added our complete line of custom, deluxe cabinets to cover up.

Well, we haven't forgotten those no-nonsense computer builders who just want a way to organize their systems. So the Digital Group has taken a step back to come up with a basic answer: The Organizers — the *Basic Box* and the *Peripheral Plate*.

Beautifully simple. No paint. No anodizing. No frills. Just exactly what you need.

The Basic Box houses your CPU, power supplies, fan, switches and I/O connectors in one tight little 16" by 17" package. It's available completely naked — a metal box with a card rack so you can add to it from your own parts supply; or we'll spiff it up for you with optional equipment.

The Peripheral Plate is a piece of bent metal with room for your keyboard, video monitor, two Philips decks or an audio cassette recorder. All at your fingertips. For organization.



Card rack swings out for service.

Naturally, our basics have down-to-earth prices, too. The Peripheral Plate is a mere $19.50 . . . the basic Basic Box goes for $45 (a little more depending on options).

Want to up your organization? It's simple. Just call or write the Digital Group for details.

the digital group

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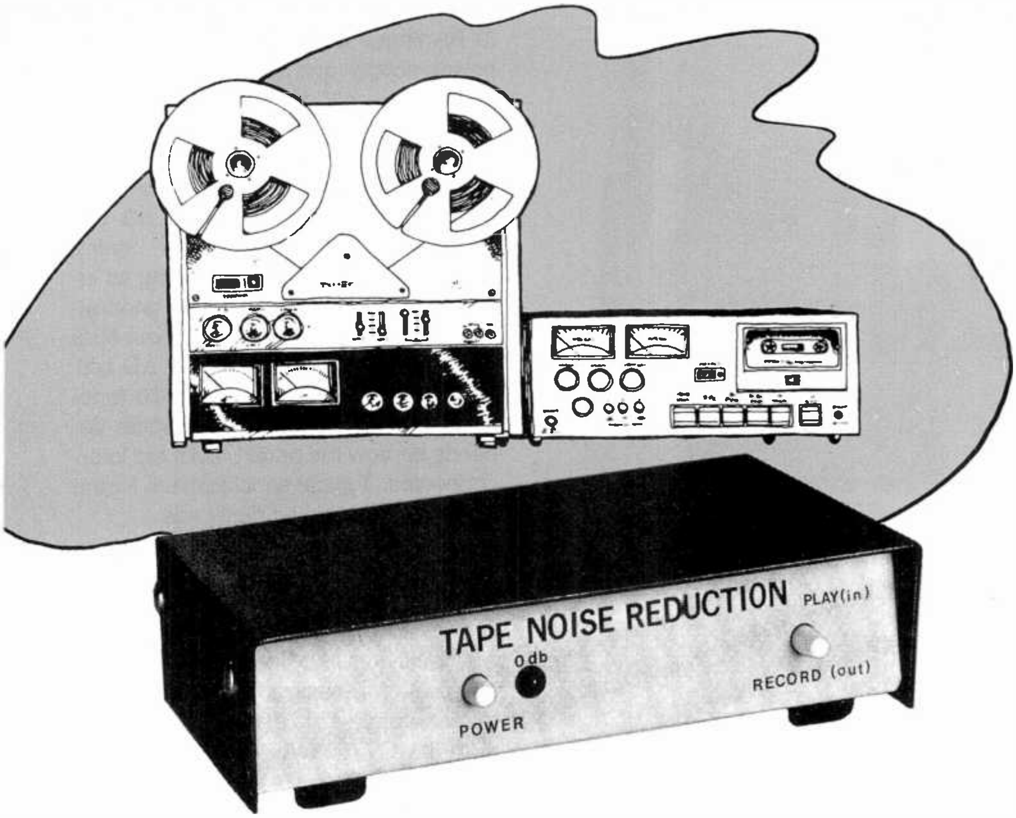
CIRCLE NO. 19 ON FREE INFORMATION CARD



BUILD AN AUDIO COMPANDER

Provides greater dynamic range and reduces noise.

BY JOHN ROBERTS

PERHAPS the last frontier yet to be crossed by high-fidelity program sources is dynamic range. For example, the best consumer tape decks have a dynamic range of about 65 dB when used with premium tape formulas. Compare that to the 115-dB range of music produced by a symphonic orchestra at a live performance.

This project—a 2:1/1:2 compander—will allow you to record live music on your existing tape deck and later play it back without losing its original dynamic range. Other benefits of compansion are increased tape headroom during record and noise reduction during playback. These advantages can be realized whether the program material is being recorded live or transcribed from another format. The compander is easy to build and use, employs a new Signatics IC, and has a low parts count. A stereo compander is available in kit form as described in the Parts List.

Compansion involves compressing a signal's amplitude before it is committed to the recording medium, and then expanding it in a complementary fashion when it is recovered. This is typically accomplished by inserting a fixed-slope (2:1) compressor in the signal path before the tape deck's record preamp and a fixed-slope (1:2) expander at the output of the deck's playback preamp. The process is shown graphically in Fig. 1. Practicalities of electronic circuitry in preamps and power amplifiers limit their dynamic range to 100 to 120 dB. However, this approaches the dynamic range of live music and (comfortable) human hearing, easily attainable by a good tape deck working with a 2:1/1:2 compander.

The improvement in S/N becomes apparent when we look at a specific example. Let's assume that we have a tape deck with a noise floor of −45 dBm and that we want to record a piece of music with passages as low as −50 dBm. In the absence of any processing, the soft passages would disappear into the hiss. However, if we pass the signal through a 2:1 compressor before recording it, the minimum amplitude recorded is −25 dBm, a full 20 dB above the noise. On playback, passing the tape output through a 1:2 expander restores the −25-dBm signal to its original −50 dBm. Simultaneously, the noise drops by the same −25 dB to −70 dBm.

Improvements are also realized in the upward direction. That is, headroom is increased. A tape that previously saturated (causing distortion) at +10 dBm can now handle a +20-dBm signal at the compressor input. Although compansion increases S/N and headroom, it places more stringent requirements on the medium's frequency response and amplitude stability. Because the expander's gain depends on the level of the compressed signal applied to it, any amplitude errors will be magnified. In the case of a 2:1/1:2 compander, any frequency response errors or amplitude anomalies will be doubled.

A Compander IC. Signetics Corporation has recently developed an IC called the NE570. It is a dual-channel linear IC, and either section can be used independently of the other as a compressor or expander. A block diagram and pinout of the NE570 is shown in Fig.

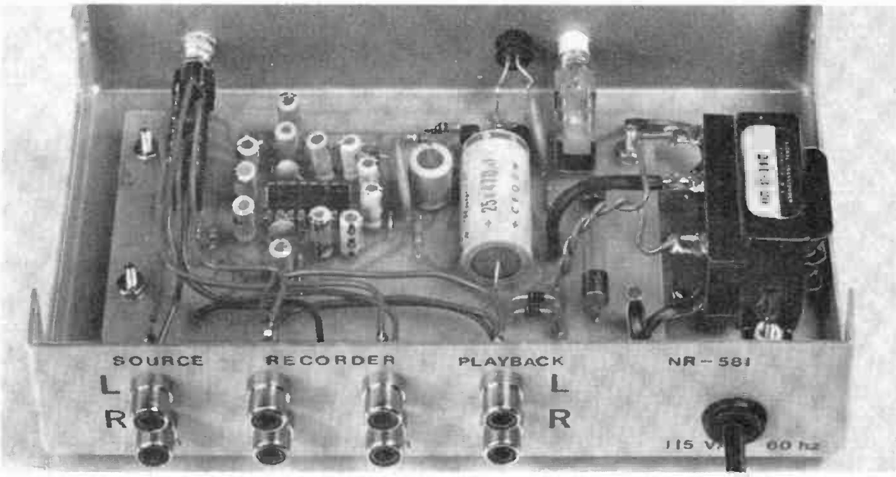


Photo shows prototype assembled on pc board and mounted in metal chassis.

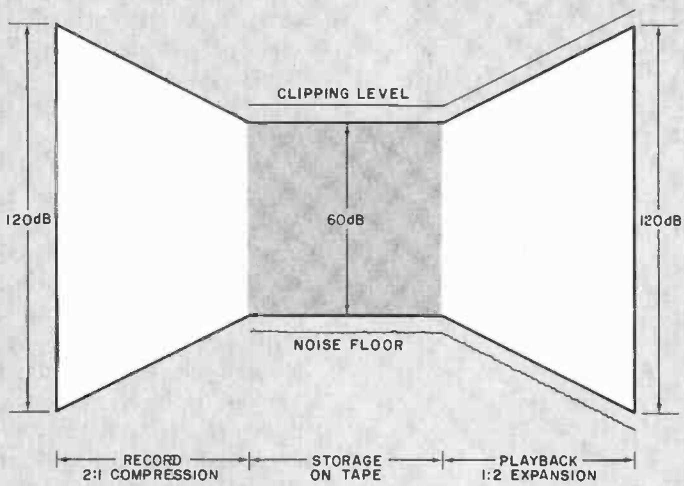


Fig. 1. Compression is used during recording, expansion on playback.

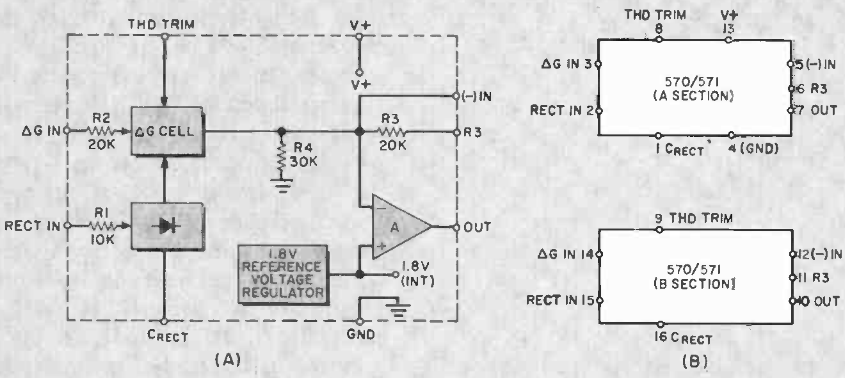


Fig. 2. Block diagram (A) and pinout (B) of the NE570 IC.

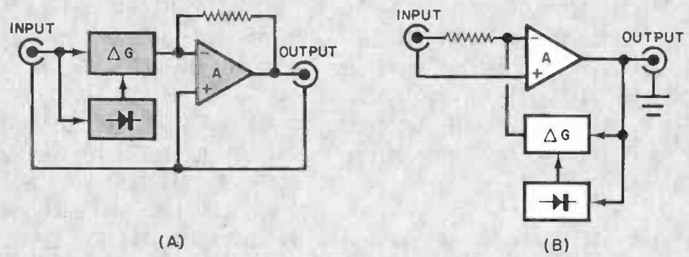


Fig. 3. Using the NE570 as an expander (A) and compressor (B).

2. Packaged in a 16-pin DIP, only the power supply and ground connections and an internal 1.8-volt bias regulator are shared by the two companders.

Each compander comprises a ΔG (variable gain) cell, a full-wave rectifier, and an output amplifier. The ΔG cell governs compander gain. Its control voltage is developed by rectifying an input signal. The output signal is generated by the op amp, which is driven by a scaled current supplied by the ΔG cell. Whether a section of the NE570 functions as a compressor or expander depends on how the basic blocks are interconnected. Typical specifications for the NE570 are in table on next page.

A 1:2 dynamic range expander (Fig. 3A) is formed by placing the ΔG cell at the input of the op amp. Its control signal is generated by sampling the input signal, rectifying and filtering it. The fixed feedback impedance sets the overall gain at unity when the input signal is 0 dBm or 0.775 volt. As the input increases or decreases from this level, the gain increases or decreases proportionally. For example, if the input level increases by a factor of two (+ 6 dB), the output level is quadrupled (+12 dB). If the input decreases by one half (−6 dB), the output drops to one quarter (−12 dB) of its previous value.

Rearranging the blocks to form the network shown in Fig. 3B results in a 2:1 dynamic range compressor. Here, the ΔG cell is connected as a feedback impedance, and its control signal is derived from the op amp output. The fixed input network sets overall gain at unity for a 0-dBm signal. If the input signal level increases by a factor of four (+12 dB), the output amplitude is doubled (+6 dB). If the input amplitude is decreased by a factor of four (−12 dB), the output signal decreases by a factor of two (−6 dB).

About the Circuit. The schematic diagram of the compander is shown in Fig. 4. A conventional full-wave rectifier and RC filter supply the required operating voltages. Note that only one compander channel is shown. The components with the suffix "A" are for the channel A compander only. Integrated circuit pin numbers in parenthesis are the corresponding inputs and outputs of the channel B compander. For example, pin 1 is connected to *C4A*, and pin 16 should be connected to *C4B*.

Diodes *D3* and *D4*, *LED1*, transistors *Q1* and *Q2*, and their associated components form a level indicator. The LED glows when input signal peaks exceed 0 dBm. Switch *S2* interconnects the

TYPICAL SPECIFICATIONS NE570 COMPANDER

Maximum input/output level:	+12 dBm
Maximum output current:	±20 mA
Unity gain level:	0 dBm ±1 dB
Tracking error:	±0.2 dB
Gain change with temperature (0° to 70° C):	±0.1 dB
Output slew rate:	±0.5 V/μs
THD* (compressor or expander only):	0.3%
Expander noise output (measured with input shorted):	−96 dBm "A" weighting
Frequency response;	
Compressor:	20 to 20,000 Hz, +0, −1.5 dB at 0 dBm
Expander:	20 to 20,000 Hz, +0.5, −1 dB at 0 dBm

*—Harmonic distortion is caused primarily by ΔG cell offsets and modulation of the cell by control voltage ripple. When the recorded signal is expanded by the same ΔG cell that compressed it, the distortion cancels out, leaving tape noise or tape distortion dominant. Note—a phase inversion in the record/playback path will affect the accuracy of this cancellation.

blocks of each section of the NE570 so that the IC functions as a compressor on record and an expander on playback. Pulsating dc from the full-wave rectifier is smoothed into the ΔG cell's control signal by capacitor *C4A*. Capacitors *C5A, C6A, C8A*, and *C9A* provide ac coupling between various parts of the compander circuit.

Construction. The compander is best assembled using a printed circuit board. Suitable etching and drilling and parts placement guides are shown in Fig. 5. When mounting electrolytic capacitors and semiconductors, be sure to observe polarity and pin basing. An IC socket or Molex Soldercons are preferable to soldering the compander IC directly to the circuit board. Use the minimum amount

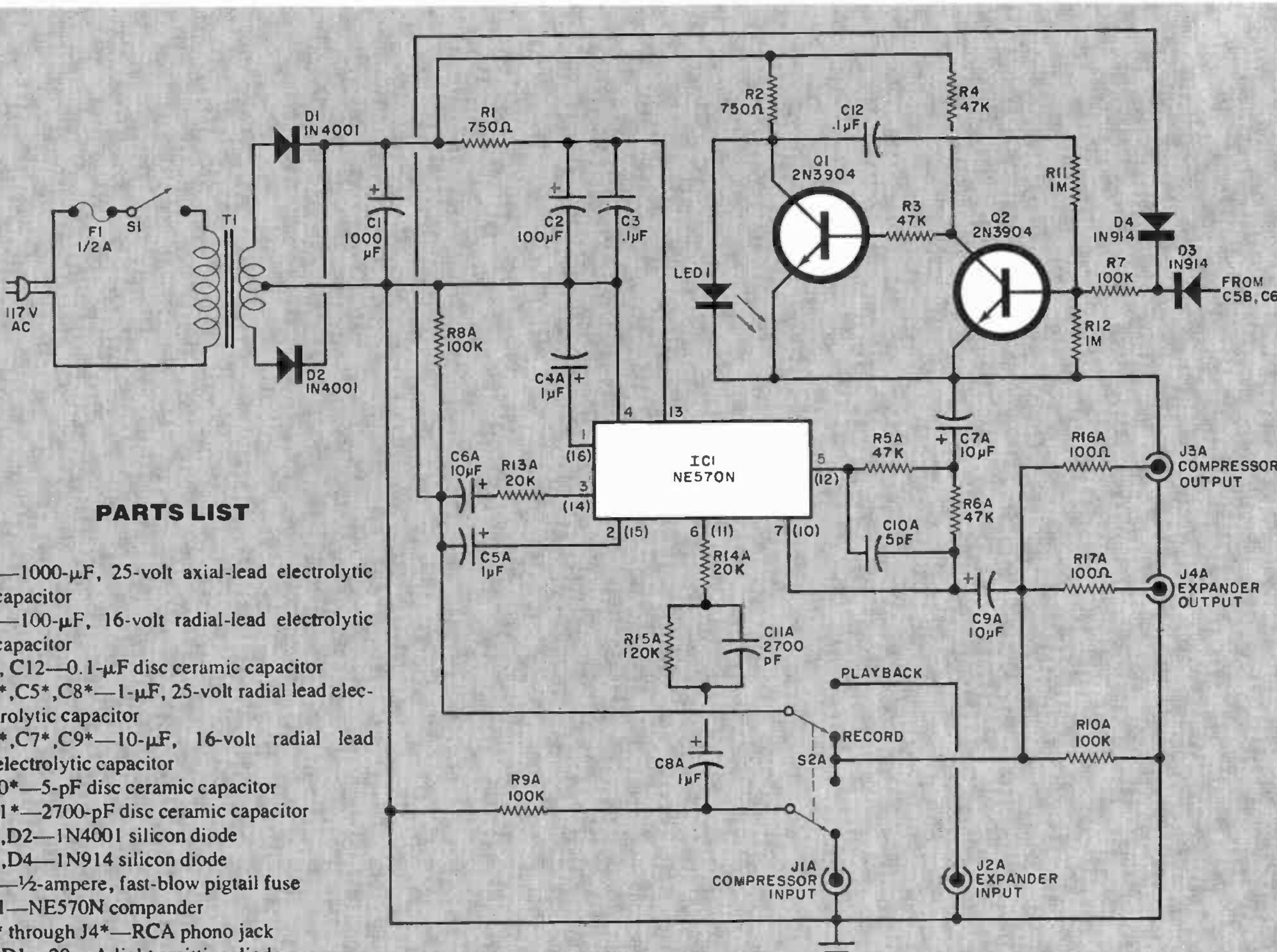
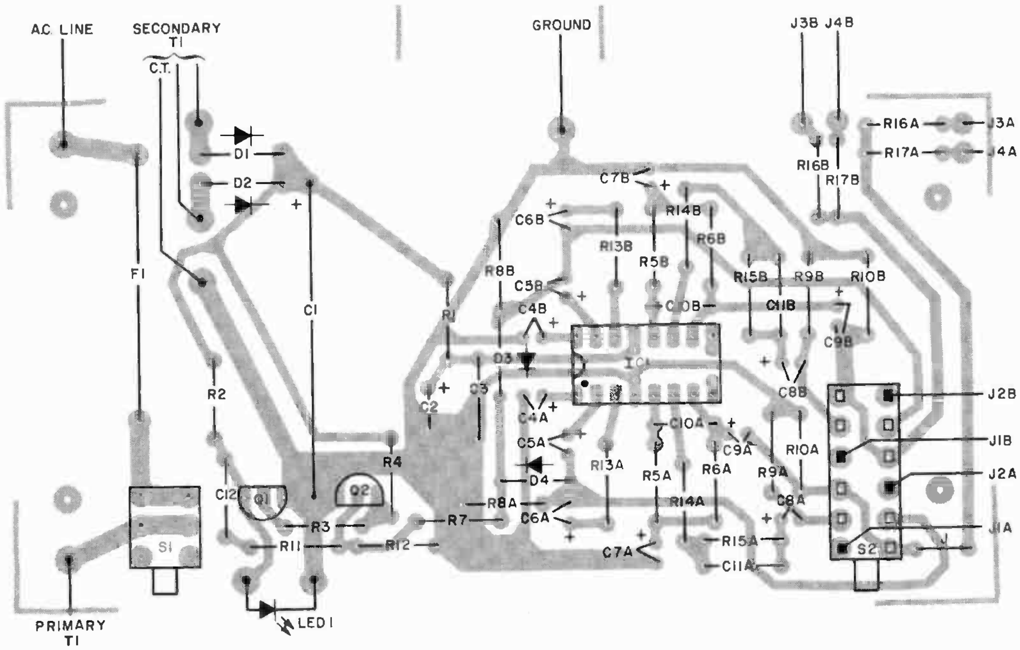


Fig. 4. In schematic of the compander, the "A" suffix is for one channel only. Duplicate components are needed for "B" channel.

PARTS LIST

C1—1000-μF, 25-volt axial-lead electrolytic capacitor
C2—100-μF, 16-volt radial-lead electrolytic capacitor
C3, C12—0.1-μF disc ceramic capacitor
C4*,C5*,C8*—1-μF, 25-volt radial lead electrolytic capacitor
C6*,C7*,C9*—10-μF, 16-volt radial lead electrolytic capacitor
C10*—5-pF disc ceramic capacitor
C11*—2700-pF disc ceramic capacitor
D1,D2—1N4001 silicon diode
D3,D4—1N914 silicon diode
F1—½-ampere, fast-blow pigtail fuse
IC1—NE570N compander
J1* through J4*—RCA phono jack
LED1—20-mA light emitting diode
Q1,Q2—2N3904 npn silicon transistor
The following are ¼-watt, 5% tolerance carbon composition resistors:
R1,R2—750 ohms
R3,R4,R5*,R6*—47,000 ohms
R7,R8*,R9*,R10*—100,000 ohms
R11,R12—1 megohm
R13*,R14*—20,000 ohms
R15*—120,000 ohms
R16*,R17*—100 ohms
S1—SPST switch
S2—4PDT switch
T1—34.5-volt, 50-mA center-tapped transformer (Signal Transformer Co. No. 241-3-28 or equivalent)
Misc.—Line cord, strain relief, suitable enclosure, hookup wire, printed circuit board, metal spacers, machine hardware, solder, etc.
Note—The following are available from Phoenix Systems, 375 Springhill Road, Monroe, CT 06468: complete kit of parts including case (No. P-518-S), $59.00; NE570N compander IC (No. P-518-C), $12.50; power transformer T1 (No. P-518-T), $5.00; etched and drilled pc board (No. P-518-B), $4.50. Connecticut residents please add 7% sales tax. Canadians please add $2.50 handling and shipping charges.
*—One component required for each compander channel.



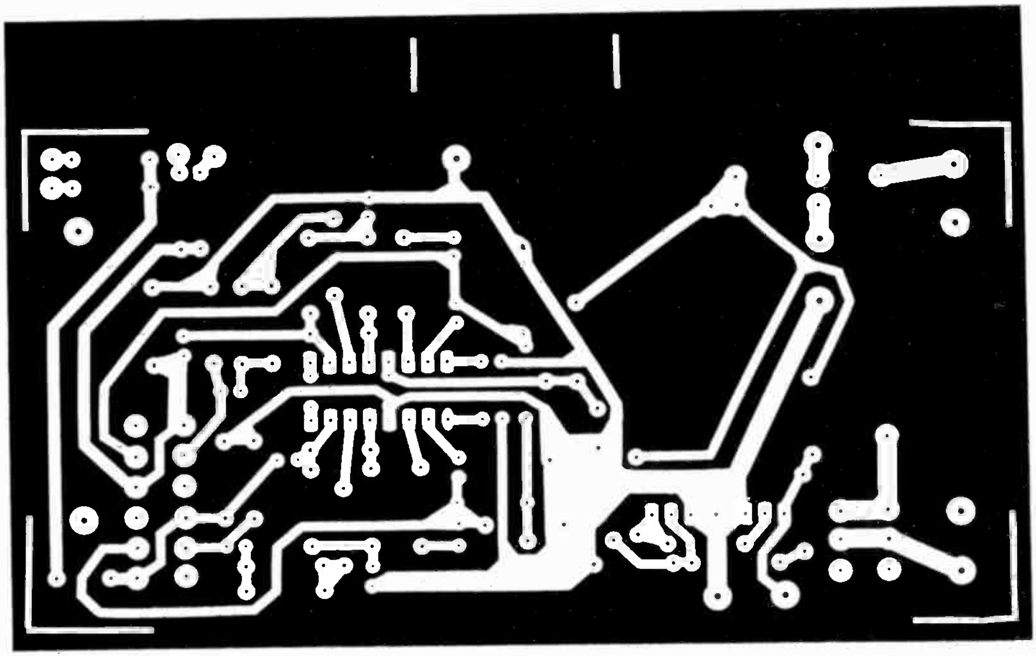


Fig. 5. Etching and drilling guide (left) and component placement (above) guides for the pc board.

of heat and solder consistent with the formation of good solder joints at each pc board pad.

If an alternate construction technique is used, care must be taken to keep all signal leads, especially those to switch *S2*, as short as possible. In any event, the circuit should be mounted in a metal enclosure that is connected to the audio system ground.

Using the Compander, Interconnect each channel of the compander and your system's tape deck and amplifier as shown in Fig. 6. Place *S2* in the RECORD position and adjust the deck's record preamp level controls for a reasonable record level. With the added dynamic range supplied by the compander, you can afford to trade a few dB of the deck's S/N for reduced distortion levels. (Some tape machines are set to run very close to saturation to get the highest S/N possible.) Indicator *LED1* is included not to alert you of clipping, but as an aid in setting record levels. The compander has at least 10 dB of headroom above the threshold at which the LED glows.

To play back a compressed tape, simply place *S2* in the PLAYBACK position and put the deck in its playback mode. You will then retrieve the recorded program with its original dynamic range. ◇

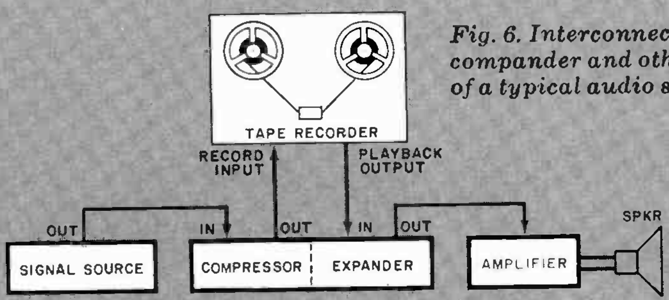


Fig. 6. Interconnection of the compander and other components of a typical audio system.

SELECTING THE BEST CASSETTE TAPE FOR YOUR RECORDING NEEDS

BY CRAIG STARK

IT'S not easy to pick the best cassette tape for your recording needs from the dozens of "name brands" and hundreds of unknowns on the market today. Naturally, there is some correlation between price and performance, reflected not only in the tape itself, but also in the plastic shell containers and their assembly. These can affect performance more than the differences between oxide formulations of the same type. But high price alone will not guarantee satisfaction if your tape deck has not been adjusted for the cassette you select.

Almost all high-fidelity cassette recorders have "bias and equalization" switches designed to accommodate at least two basic tape types: ferric oxide and chromium dioxide. Unfortunately, there are at least *four* major cassette types on the market, and very few cassette decks have switch positions for all. Let's look at their characteristics.

Ferric Oxides. All pure gamma ferric oxide cassettes today use the same playback equalization (often identified as "120 microseconds"). In terms of their recording needs, however, they tend to fall into two different categories. The first are tapes designed to use "standard," "LN," or "DIN" bias, and include almost all American and European ferric oxides (e.g. 3M, Capitol, Ampex, BASF), as well as such Japanese tapes as Sony, Maxell LN, and TDK SD and TDK D. This is the largest group of ferric oxides, and includes all quality levels.

The other major ferric group is designed to use about 5% to 10% more record bias current than the DIN standard. This group consists almost entirely of premium-quality Japanese tapes (Maxell UD and UD XL I, TDK AD, Nakamichi, and Fuji FX and FL). A recorder that is properly biased for a tape in this latter group will be over-biased for tapes requiring DIN-standard bias, while recorders set up for DIN-standard tapes will be under-biased for Japanese tapes in the "high-bias" group. Figure 1 shows the effects of such mismatching.

Under-biased tapes have exaggerated treble response; over-biased ones

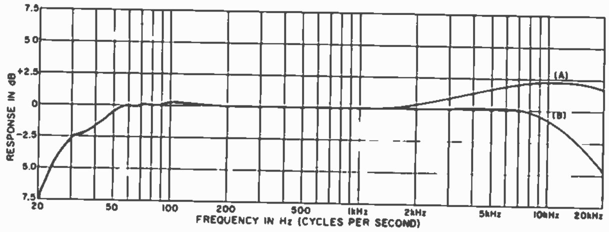


Fig. 1. Results of improper bias vary: (A) DIN bias settings used with typical Japanese ferric tape over-emphasize highs due to underbiasing. (B) Correct bias for same tapes over-biases DIN ferric tapes.

suffer unnecessary treble loss. If you've found the upper frequencies a little "soft" when using a top-quality domestic or European cassette tape on a high-priced Japanese deck, or found the treble too "hot" when using Japanese tapes on European or U.S. recorders, mismatched bias is almost certainly the reason. And while there are many fine tapes in the DIN group, the trend is toward higher-bias ferrics.

Chromium Dioxide. All CrO_2 cassettes use a "70-microsecond" playback equalization curve, which provides about 4.5 dB less treble boost in playback than the 120-microsecond equalization used for ferric oxides. This is made possible by CrO_2's inherently greater treble output. The decreased treble boost makes possible, in turn, a 4.5-dB reduction in tape hiss.

However, this distinct advantage is partially offset by CrO_2's lower output in the rest of the frequency range, as well as higher distortion levels compared to the performance of top-grade ferrics. A better known CrO_2 disadvantage—rapid head wear—is actually a myth at cassette speeds and pressures. Believe it only when you find someone who has actually worn out a cassette head using any kind of tape.

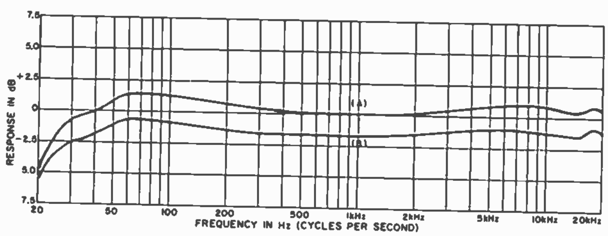
Ferrichrome. When ferrichrome cassettes were introduced several years ago, they seemed to offer the best of both worlds: high overall output (provided by a relatively thick layer of ferric oxide) and abundant high-frequency energy (provided by a thin, top layer of CrO_2). The drawback is that there is no standard for ferrichrome; Sony and 3M make radically different FeCr tapes. So even when a recorder has a "ferrichrome" switch position, the only way to find which tape it matches is to consult the instruction book. To add to the confusion, some machine makers recommend that you record ferrichromes with "ferric" bias and equalization and "chrome" playback, while others recommend exactly the opposite. (Neither is really optimum.) Nonetheless, when ferrichrome tapes *are* correctly biased and equalized, they yield spectacularly good results, as the test section of this survey shows.

Cobalt-Treated Ferrics. Another attempt to combine the virtues of two different magnetic materials is represented by the cobalt-treated (or "cobalt-doped") ferric oxides. Here, the two materials are not layered, as ferrichromes are. Instead, each ferric oxide particle is enriched with cobalt ions through a complex molecular-binding process. The result is a tape with much greater overall output than chrome, but with equal high-frequency energy. These new tapes also take advantage of the standard bias and equalization settings used for chrome tapes; that's why they're referred to in our test table as "CrO_2-equivalent" ferrics. TDK's SA ("Super Avilyn") was the first of these tapes, and was followed by Nakamichi SX and Maxell UD XL-II. (3M's Master II is another tape in this category, but was not available for test at this writing.)

What Makes a Tape "New and Improved?" Improvements to a tape's performance can take many forms. Two of them are shown in Fig. 2a and b. Figure 2a shows the frequency response of Maxell's now-venerable UD and its new UD XL-I, both recorded with the same signal. Both tapes have the same frequency response, but the higher curve for the UD XL I indicates greater output at all points in the audio spectrum—with a correspondingly improved signal-to-noise ratio.

A second kind of improvement, and one you're likely to see more and more of these days, is an increase in tape coercivity. This raises high-frequency response, as illustrated by the output-vs-frequency curves of Fig. 2b (which compares TDK's older Audua with its brand new "AD" tape). This rising high-end response can be accepted as a "brighter" sound, if you prefer, but it's really intended to be traded off for other benefits. Decks with adjustable equalization and bias let you trade it off for reduced distortion and a slight reduction in noise by diminishing treble boost in the recording. Also, the rising high end can compensate for the drooping treble of an inexpensive system's speakers. (It won't compensate for playback-head limitations, though.) In other stereo systems, turning down your amplifier's treble control will at one stroke restore proper frequency balance and reduce audible tape hiss.

Test Results. The results obtainable



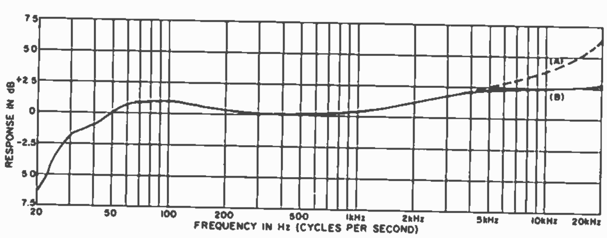


Fig. 2a and b. In (a), at top, Maxell gave its new UD XL-I tape (A) more output than older UD (B), but same response. In (b), below, new TDK AD tape has more high-end response (A) than earlier Audua (B).

CASSETTE TAPE TEST RESULTS

	Sensitivity: (333 Hz "0 VU")	Distortion: (3rd Harm. Dolby level)	Maximum Output: (3% HD 333 Hz)	Signal-to-Noise Ratio Unweighted	Weighted	Saturation: (db below "0 VU" 10kHz)	Frequency Response (see text for code)
DIN bias ferrics							
DIN Std. cass.	±0.0	0.44%	+2.5	51.3	52.9	−11.2	A
Ampex 20/20+	±0.0	0.32%	+4.1	53.0	55.3	−12.8	B
Ampex Plus	+0.4	0.39%	+4.6	53.4	55.2	−11.3	A
Ampex 370	−1.8	2.35%	−0.8	49.0	50.9	−18.2	D
BASF Studio	±0.0	0.38%	+4.4	53.4	55.7	−13.3	B
BASF Performance	−1.8	1.22%	+1.1	50.3	53.0	−14.5	C
Capitol "Music"	+0.5	0.25%	+3.9	52.8	55.4	−13.6	B
Capitol 1	−1.1	1.9 %	+0.4	49.3	51.2	−19.8	D
Memorex MRX_2	−0.7	1.2 %	+0.8	49.7	52.1	−11.6	A
Maxell LN	−1.8	1.95%	−0.1	48.8	50.9	−14.5	B
Scotch Master I	+0.1	0.6 %	+2.8	51.9	54.2	−10.2	A
Scotch LN/HD	−0.6	1.75%	+1.2	50.4	52.9	−13.8	D
Scotch Highlander	−1.1	1.65%	+0.4	49.5	52.0	−17.5	D
Sony UHF	−0.5	0.72%	+2.7	51.4	53.3	−10.1	A
Sony Plus 2	−2.3	2.28%	−0.7	48.1	50.2	−13.0	B
TDK SD	−0.9	0.65%	+2.8	51.7	53.6	−12.8	C
TDK D	−0.5	0.8 %	+1.6	50.1	51.4	−12.5	B
"High" bias ferrics							
Fuji FX	−0.1	0.28%	+4.0	52.4	53.4	− 9.8	A
Fuji FL	−2.4	2.5 %	−1.7	47.9	49.9	−12.8	C
Maxell UD	−0.8	1.1 %	+2.5	51.1	52.8	−10.4	A
Maxell UD XL-I	+1.0	0.35%	+6.1	54.7	56.3	− 9.8	A
Nakamichi EX	−0.6	0.74%	+2.6	51.2	52.8	−10.2	A
Nakamichi EX-II	+0.9	0.28%	+5.7	54.3	55.8	−10.2	A
TDK Audua	−0.8	1.15%	+1.5	49.7	50.7	− 8.7	A[r]
TDK "AD"	−0.7	0.37%	+3.7	52.4	54.2	− 7.2	A[r]
CrO_2							
BASF CrO_2	−1.5	1.9 %	+0.2	52.6	54.8	− 9.2	A
Capitol CrO_2	−1.0	1.85%	+0.2	52.6	54.6	−10.5	A
Fuji FC	−1.4	2.2 %	−0.2	52.4	55.5	−10.5	A
Memorex CrO_2	−2.2	3.2 %	−2.1	50.3	52.5	−11.5	B
Scotch Chrome	−1.9	2.4 %	−0.8	51.9	54.4	−11.1	B
Sony CRO_2	−1.9	2.45%	−0.7	51.5	53.3	− 8.4	A[r]
CrO_2 Equivalent ferrics							
Maxell UD XL-II	+1.9	0.6 %	+4.0	55.6	57.4	− 8.2	A
Nakamichi SX	+1.3	0.85%	+2.8	54.5	55.7	− 8.7	A
TDK SA	+1.0	0.9 %	+2.3	53.7	55.6	− 8.8	B
FeCr bias & eq							
Scotch Master III	−1.7	0.45%	+4.9	57.2	59.4	−11.2	A
Sony FeCr	−2.6	0.71%	+3.2	55.5	57.5	− 9.4	A
Ferrichromes, DIN*							
Scotch Master III	+0.8	0.64%	+3.0	51.8	53.9	− 6.5	*
Sony FeCr	−1.2	1.52%	+1.2	49.8	52.2	− 5.4	*
Ferrichromes, "High"*							
Scotch Master III	+1.2	0.52%	+4.5%	53.2	55.5	− 6.8	*
Sony FeCr	−0.8	1.03%	+2.9	51.5	53.7	− 5.0	*

*Neither ferrichrome tape is designed for this bias/equalization, but it may be all the consumer has to use with them. Frequency response, however, rises from 1 kHz to 19 kHz, to between +10 and +12 dB.

from any tape depend as much upon the recorder and its settings as upon the tape itself. Differences between my test recorder and your recorder make it almost inevitable that the cassettes I tested would produce somewhat different results if tested on your deck. Where differences between tapes are small, a slight adjustment of bias or equalization can turn the scale in favor of one or the other. So ignore small differences in the results. Only the larger ones give grounds for definitely judging that one tape has a higher performance potential than another, regardless of the machine used.

Selecting a Tape. The test results here can be used as a starting point in selecting the right cassette for your own use. A glance at the table will reveal which tapes are of the same type as the tapes your recorder's instructions recommend. The table will also help you weed out those tapes whose requirements differ significantly from that of the factory-recommended tape.

In the last analysis, the most significant tests are those you make on your own machine. To check frequency response for yourself, the interstation hiss from an FM tuner is an excellent and handy test signal. Record and play back

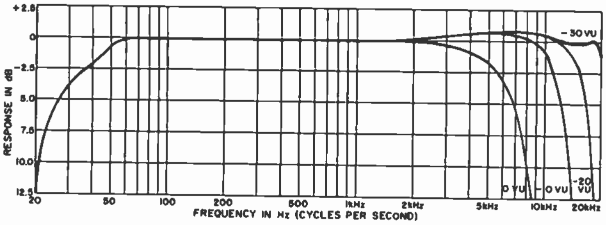


Fig. 3. Measured at low recording levels, modern cassettes are capable of extended frequency response.

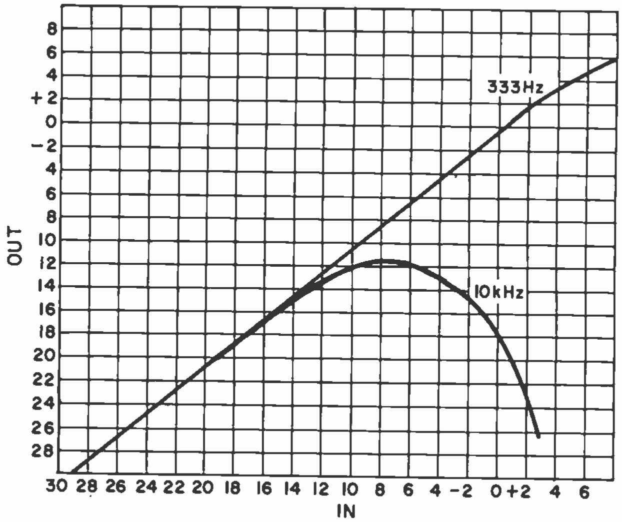


Fig. 4. When saturation occurs, high-frequency output actually declines if the input signal increases further.

a few moments of it, flipping between "source" and "tape;" see which tape comes closest to matching the original sound. If you try this, however, remember to maintain the record level 10 to 20 dB below 0 VU on your recording meters. The high-frequency energy in the hiss signal would otherwise drive the tape into saturation and thereby invalidate the test.

Note that the "best" cassette is not always the best choice for every application! As the results in the chart show, several low- and mid-priced tapes have been improved (some very recently) to the point where they can challenge the premium tapes for anything that doesn't require the full sizzle of a cymbal. But avoid cheap, unbranded cassettes, unless you really enjoy cleaning up the loose oxide they so often shed.

HOW TESTS WERE MADE

In making these tests, three C-60 samples of each cassette were checked, and an average of the two more similar samples is reported. In most cases, where the thickness of the oxide coating is the same, C-90 versions of the same tapes should perform essentially identically. Where a manufacturer chooses to use a thinner oxide layer in his long-play length, however, low-frequency sensitivity and distortion figures may suffer.

The tapes in this survey were tested on a new Technics RS-9900US cassette deck. In addition to its three-head design (a practical necessity where machine-run frequency response curves are to be made), this deck offers continuously variable bias and equalization controls on the front-panel, as well as the usual fixed bias and EQ switch positions. It would thus have been possible to "optimize" the deck for every tape tested; but since this would represent an unrealistic picture of the performance to be expected from typical home cassette decks, a practical compromise was employed. For the tapes listed in the charts as "DIN bias and equalization," the machine was optimized for the new DIN Standard Blank Cassette (TP 18 LHS), a special cassette made for test purposes. For the "high bias" Japanese ferrics, the deck was set up using Maxell UD XL-I. For CrO_2 and the cobalt-treated "chrome equivalent" ferrics, the set-up tape was Fuji FC.

How to Interpret Test Results. Because tape test results are so dependent upon the equipment used to make the tests, you won't find final full specifications listed for tape as often as you will for components. So, many of the specifications listed below will be unfamiliar, while others may seem unfamiliar in their current form. Here is what the numbers in our table mean:

Sensitivity: Here we compare the output of each tape with the output of the DIN Standard Blank test cassette, with each fed an identical input signal. This signal is a mid-frequency tone (333 Hz) of sufficient strength to record a magnetic flux level of 250 nanoWebers per meter on the DIN tape. This particular flux level, higher than the "0 VU" of most (but not all) home cassette decks, is an internationally accepted comparison level. All else being equal, the larger the number in this column, the better.

Distortion at Dolby Level: This is a comparison of the harmonic distortion levels of the various tapes at a standard level of recorded signal. Since tape-deck manufacturers are free to set their "0 VU" point at any level of recorded flux they choose, a measurement made at any one deck's "0 VU" point would not be too meaningful. But as the "Dolby level" marks found on nearly every manufacturer's VU meters is a standard level (200 nWb/m), we used that as our reference point for this test. Since this is only 1.9 dB less than DIN "0 VU" level, it's at least *near* most manufacturers' "0 VU" markings.

The distortion levels may look lower than you're used to seeing for tape. That's because conventional "total harmonic distortion" meters measure everything that isn't signal—which includes not only all harmonics, but also hum and noise. Since the hum and noise on the tape are often greater than the distortion at this recording level, you will rarely see THD measurements of less than 1%. But since tape produces only odd harmonics, of which the 3rd harmonic is the lowest (and hence most prominent), a General Radio 1900-A Wave Analyzer was used to read only the tape's output at 999 Hz, the 3rd harmonic of the 333-Hz input signal.

Maximum Output Level: It is standard practice to consider a tape's Maximum Output Level (MOL) to be, for all practical purposes, the point at which its third harmonic distortion just reaches 3%. Beyond this level, moderate increases in input signal lead to very rapid increases in distortions. Consequently, saturation—at which point the tape's output will increase no further in spite of increases in input—is only a few dB away.

The number shown in this column is the "signal" part of each tape's signal-to-noise ratio, in decibels above the 250 nWb/m reference level. The higher the number, the better.

Unweighted S/N Ratio: This column indicates the ratio, in decibels, between the Maximum Output Level (MOL) of the tape and the output from a section of the tape which has been recorded with no input signal at all. The higher this number, the better, too.

Weighted S/N: Since the frequency response of the human ear at the low volume levels of tape noise is not "flat," a more meaningful measure of noise audibility is obtained by weighting its various frequency components according to the ear's sensitivity to each.

There are several weighting filters for this purpose. The most common is the NAB "A" weighting curve, which is derived from the famous Fletcher-Munson "equal-loudness" curves. More recent studies, however, suggest that a slightly different weighting curve, the CCIR curve, corresponds more closely to the perceived obtrusiveness of noise such as tape hiss. This weighting system, widely adopted abroad (and used by Dolby measurements of noise-reduction effectiveness), was used for our measurements in this column. The larger the number, the less perceptible tape hiss will be. This makes it a slightly more significant measure of tape performance than the unweighted S/N in the preceding column.

Saturation (10 kHz): Tape saturation level varies with signal frequency. At high frequencies, saturation occurs much earlier (Fig. 3). For this reason, and because the high-frequency content of most program material is far below the "0 VU" level, frequency response (next column) is usually measured at a level far below "0."

While dramatic in itself, Fig. 3 does not tell the whole story about high-frequency saturation. Although a tape's middle- and lower-frequency output will not increase past saturation even if input level increases, its high-frequency output actually *declines* when input levels are increased beyond the saturation point (Fig. 4).

Consequently, the figure shown in the "10-kHz Saturation" column represents the tape's absolute peak response and the onset of saturation. Distortion occurs long before this point (by about 10 dB), but is difficult to measure because the third harmonic generated (30 kHz) is outside the recorder's passband. The audible distortion products caused by high-end saturation are all too obvious, however, so the closer the negative number (in decibels below DIN "0" level) is to zero, the better.

Frequency Response: Individual frequency-response charts were made for each tape tested; but since the response patterns were so similar, they have been summarized in five categories here. An "A" curve indicates a response within ±1 dB over the 100 to 20,000-Hz range. Three tapes (Sony CrO_2, TDK Audua, and TDK AD) showed a response that rose gradually above 1 kHz, reaching a maximum between +3 and +5 dB at approximately 19 kHz. Because, as explained previously, this may be looked upon as an advantage rather than as a defect, these tapes have been given an "Ar" (A, rising) denomination. Category "B" covers a span of ±2 dB over the same range. With only minor adjustments of the bias and/or equalization, any of these tapes could have been made to show an "A" characteristic. Class "C" encompasses a ±3 dB variation over the 100-to-20,000-Hz range, but would certainly be suitable for all but very critical applications. Class "D" tapes are definitely "limited performance" products whose response (even at the −30 VU test level employed on all the frequency response measurements) was typically down by about 5 decibels at 10 kilohertz. ◇

SWTPC announces first dual minifloppy kit under $1,000

Now SWTPC offers complete best-buy computer system with $995 dual minifloppy, $500 video terminal/monitor, $395 4K computer.

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You need dual drives to get full benefits from a minifloppy. So we waited to offer a floppy until we could give you a dependable dual system at the right price.

The MF-68 is a complete top-quality minifloppy for your SWTPC Computer. The kit has controller, chassis, cover, power supply, cables, assembly instructions, two highly reliable Shugart drives, and a diskette with the Floppy Disk Operating System (FDOS) and disk BASIC. (A floppy is no better than its operating system, and the MF-68 has one of the best available.) An optional $850 MF-6X kit expands the system to four drives.

$500 Terminal/Monitor
The CT-64 terminal kit offers these premium features: 64-character lines, upper/lower case letters, switchable control character printing, word highlighting, full cursor control, 110-1200 Baud serial interface, and many others. Separately the CT-64 is $325, the 12 MHz CT-VM monitor $175.

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Enclosed is:
_____ $1,990 for the full system shown above (MF-68 Minifloppy, CT-64 Terminal with CT-VM Monitor).
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_____ $395 for the 4K 6800 Computer
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CIRCLE NO. 57 ON FREE INFORMATION CARD

HOW TO DRESS UP YOUR PROJECTS

Tips on how to make your home-made equipment look professional.

BY ROBERT DEVOE

IF YOU'RE like many electronics hobbyists, the projects you value most are the ones you built from scratch without using a kit. Unfortunately, they are also usually the projects that have an obviously home-made look. You probably took great pains to make the printed circuit boards "just so," and then had to make do with available utility boxes and panel marking equipment. The result is most likely a plain metal or wood-grain vinyl control panel with the controls and inputs and outputs labelled with a Dymo tape machine.

In this article, we will explore some techniques you can use to design and fabricate professional-looking panels that will do justice to your projects. With a little practice, these suggestions should have you designing and fabricating control panels that look every bit as good as those turned out by industrial designers for commercial products.

The Preliminaries. The best approach to designing control panels is to do the layout work at the same time you design the printed-circuit board. In fact, in many cases, it is often advantageous to do the control panel layout first and then design the circuit board accordingly. This is especially true if you are using pc-type switches and controls.

By designing the control panel and circuit board at the same time, you will have a good idea of the size and shape of the case in which to house your project, and you will know how much panel space will be required for the various controls, switches, jacks, indicators, etc. You will also be able to arrange the various panel-mounted items according to function, frequency of use, and size to present a visually pleasing appearance.

If your project requires electrical or rf shielding or that the control panel serve as a ground conductor, you can use a sheet of soft aluminum for the panel. For the great majority of projects, however, the best material to use is acrylic plastic sheets that are easy to cut, drill, and shape with ordinary wood tools. White translucent acrylic with black lettering and graphics are a good choice. Of course, you can also use color-tinted transparent or translucent acrylic sheets with complementary-color lettering and graphics for special visual effects.

In this article, the emphasis is on acrylic plastic sheets for front panels. The sheets are available in thicknesses ranging from 1/16" (1.6 mm) on up, but the minimum recommended thickness for a front panel that measures up to 12" × 12" (30.5 × 30.5 cm) is ⅛" (3.2 mm). You can use thicker sheets, but they are not necessary; they will also increase cutting, drilling, and shaping times.

Acrylic plastic sheets come with protective paper on both sides. Do not remove this paper until you have completed all drilling and cutting. The paper itself serves as convenient means for pencilling in all cutting and bending lines and drill-hole centers (Fig. 1). (If you must use an aluminum panel, it is a good idea to place over it a layer of protective masking tape. The tape also provides a convenient drawing surface, similar to that provided by the paper on the acrylic sheets.)

Preparing the Panel Surface. After your panel has been drilled and cut to size, peel off the protective paper. If it is a complicated panel, try to peel away the paper on which you drew the cutting lines and drill holes without tearing it so that you have a reference from which to work when it comes time to mount the various items on the panel.

Sand the panel with very fine sandpaper. Sand in only one direction, preferably parallel to the long dimension, to give the surface of the panel a "tooth" for the lettering and graphics. Now, scrub the sanded panel with steel wool and scouring powder, again working in only one direction. This scrubbing gives the panel a velvety, matte finish that is pleasant to look at and is also free from oily residue.

Working Up a Panel Design. Part of your arsenal of tools for electronics work should be a minimum drafting instrument set that contains a ruling pen and an inking compass. To master the proper use of these tools, all you have to do is follow a few simple rules.

First, fill the pen with india ink using the filler/stopper that comes with the bottle to a depth of only 3/16" (4.8 mm). Next, use the thumbscrew on the side of the pen to adjust the width of the line. When you use the pen and a straightedge to draw lines, hold the pen flat against the straightedge and perpendicular to the surface of the panel as shown in Fig. 2. Finally, lean the pen slightly in the direction of the line you are drawing; 15° to 30° is sufficient (Fig. 3).

If you have never used a drafting pen or inking compass before, practice with them on paper and scrap acrylic sheet (surface finished as above) to get the "feel" of the tools. Be sure to clean the pen and compass tips before each filling. Bear in mind that a light touch is all that is required when drawing ink lines with a drafting pen or compass. If you must press down, you are doing something wrong.

In addition to drafting tools, you should have on hand a dry-transfer lettering kit. There are generally two types of dry-transfer kits—the type that you cut out and stick down and the type that you rub down directly from the carrier sheet. The latter is recommended. Dry-transfer type can be obtained from art supply, office supply, and drafting equipment stores in a wide range of type styles, sizes, and colors. Some manufacturers of printed circuit materials also offer transfer sheets of electronic symbols, pc patterns, and control-labelling kits with commonly used legends.

When you use a dry-transfer lettering kit, do the following. First, draw a light pencil line on the panel about 1/8" away from the bottom of the letter line you want to produce, as shown in Fig. 4. You

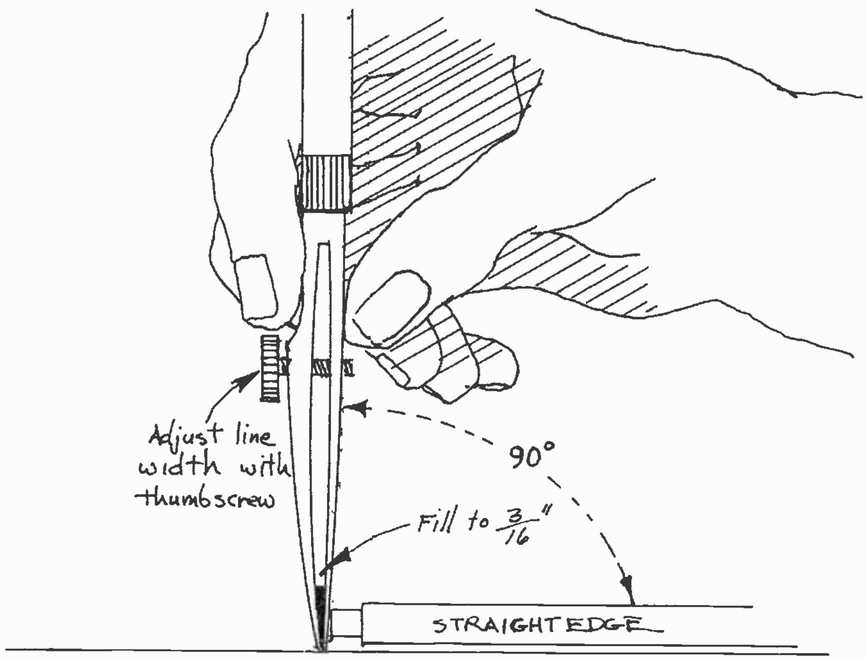
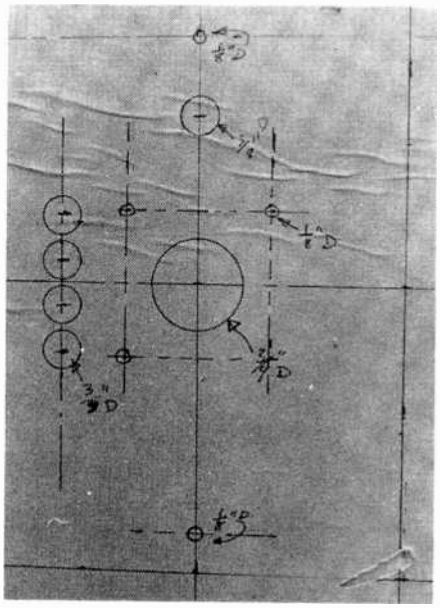


Fig. 2. When you use a pen and straightedge to draw lines, hold pen perpendicular to panel as shown here.

Fig. 1. Protective paper on acrylic sheets is used to draw guidelines and dimensions.



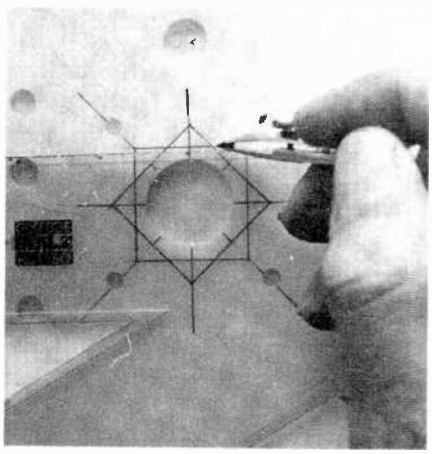


Fig. 3. To make a final line, hold the pen slightly in the direction of the line drawn.

After all letters for a given panel legend have been transferred, carefully erase the guide line.

When labelling your control panel, keep it simple. Shown in Fig. 6 are examples of the right and wrong ways of labelling panels. If one word will do to convey the function of a control, switch, jack, etc., never use two words. Also, group related items together by boxing them in. Use arrows or other graphics to indicate signal or traffic flow—but only if they are necessary to clarify things. A well-designed and properly labelled con-

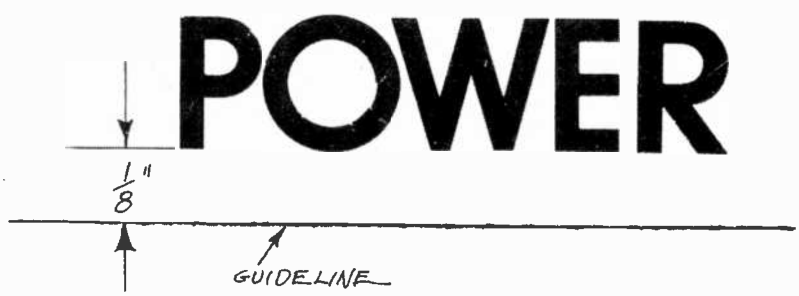


Fig. 4. In using dry-transfer letters, first draw a light line 1/8" from bottom of line you want to produce.

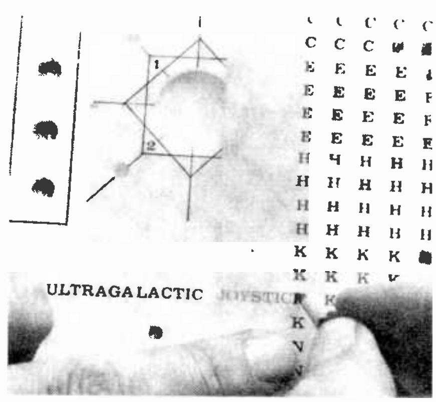


Fig. 5. Transfer each letter by rubbing with a blunt pencil. Too much pressure may ruin the letter.

should be able to see through the transfer sheet clearly enough to line up your letters parallel with the guide line. As each letter is properly positioned, transfer it by rubbing with a soft, blunt pencil over the area of the letter to be transferred, as shown in Fig. 5. Practice transferring letters on scrap to determine the optimum rub pressure to use to assure a good transfer. Do not press too hard, or the letters will spread, crack, and flake.

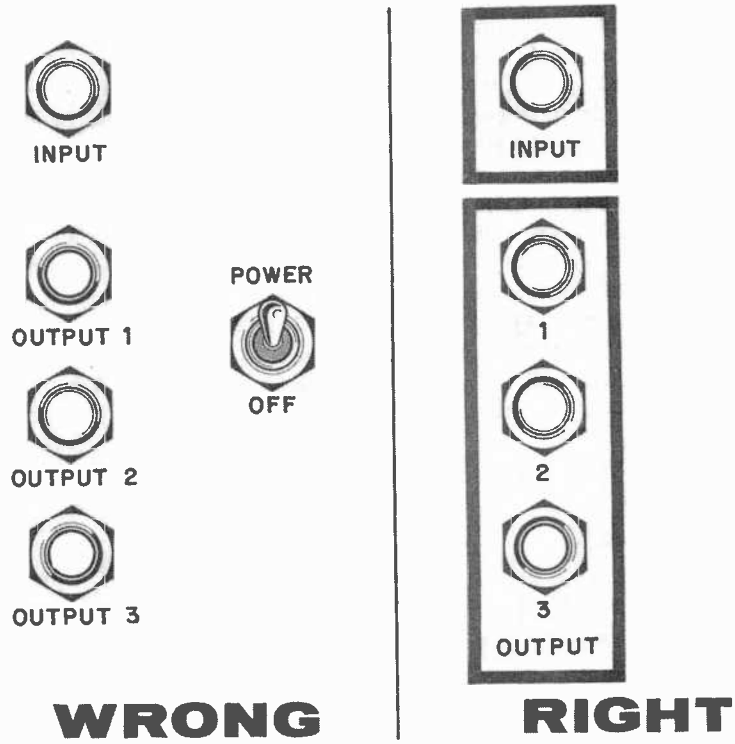


Fig. 6. Examples of the right and wrong ways to label a panel. Group related items, and if one word will describe a group, never label each unit separately.

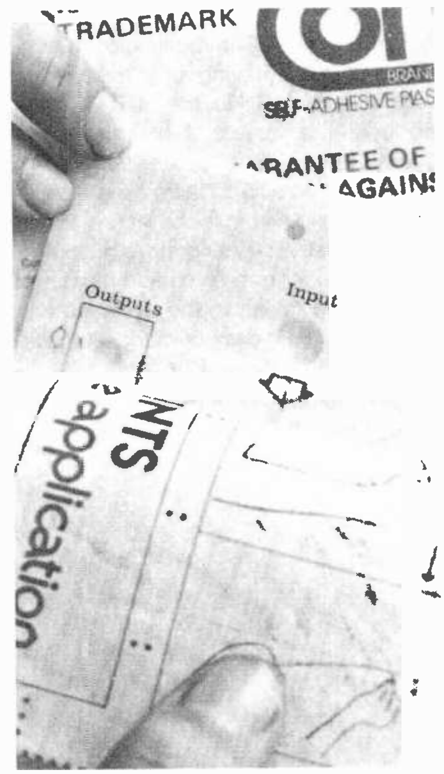


Fig. 7. In using plastic film for protecting a panel, peel the paper from the film slowly. It can't be lifted, once it is down.

trol panel is not only pretty to look at, it is functional and completely lacking in confusion and ambiguity.

Finishing Up. Transfer lettering and inked lines scratch easily and very quickly deteriorate if they are not protected. While it may at first appear that a couple of coats of clear spray lacquer will provide the required protection, its use can be very tricky. For example, you cannot be assured of perfectly even coating over the entire panel surface. Also, if the first coat of lacquer is too thick, it will in all likelihood lift up or even dissolve the lettering.

The best protection for a control panel's lettering and graphics is clear transparent ConTact plastic film, obtainable from most hardware stores. To use this film, cut it about ½" (12.7 mm) longer and wider than the panel to be covered with it. Do NOT remove the entire paper backing from the film. Instead, peel it back gradually as you apply the film to the panel. Bear in mind that you cannot put the film down, change your mind, lift it again, and reapply it. If you do this, you will dislodge the transfer lettering and graphics.

The best technique to use in laying down the clear film is to work very slowly, peeling away only enough of the paper backing to assure that the work progresses at a manageable rate (see Fig. 7). Small air bubbles should be chased to an edge or a hole; larger bubbles should be lanced with a razor blade or X-acto knife. When the film is down, go over every square inch of it with the back of a table spoon, tongue depressor, or other blunt instrument to burnish it down solidly. Then cut the film away from all holes and mount the various components on the panel. An example of a completely assembled control panel is shown in Fig. 8.

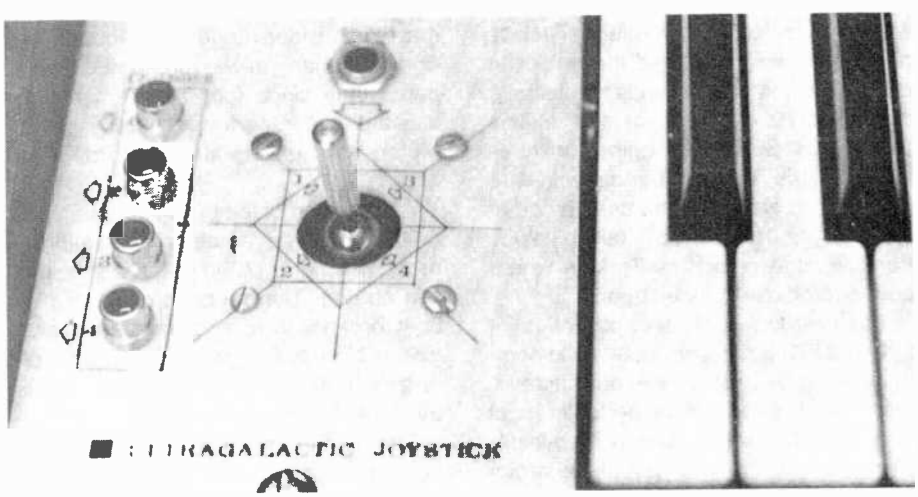


Fig. 8. An example of a completed control panel. The film has been cut away from all holes and the various components have been mounted in proper locations.

Closing Remark. We have given only the basic techniques to use for designing and fabricating professional-quality control panels. By applying these techniques and gaining some experience in design, you can make projects you will value and be proud to display. ◇

Piracy on the Airwaves

The state of illegal broadcasting is explored.

BY Harry L. Helms

THE Federal Communications Commission is having problems these days with pirates. No, the FCC isn't taking over the duties of the Navy and Coast Guard. These pirates are known as WCPR, WHGC, "Radio King Kong," "Wild Turkey Radio," and even "Radio Clandestine." More and more adventurers, either ignorant or contemptuous of the law, are taking to the airwaves and setting up their own broadcasting stations.

Bootlegging is not a new development. Even in the early days of radio, when communication was by Morse code and spark transmitters, an occasional wireless enthusiast would "borrow" another callsign, usually of rare or distant locations, to attract more replies. Amateur radio in the 1930's jokingly had what was called the "bootlegger" class of license, which allowed the holder to use all the power and bands he pleased, plus select his own call—at least until he was caught! Such bootlegging continues today on the amateur bands, with rare DX station callsigns often used by other stations, and operation taking place from countries (such as Turkey) where amateur radio is frowned upon.

The new breed of radio pirates is interested in broadcasting, but not in communicating with other stations. Indeed, there is no shortage of perfectly legal avenues for communication if your desire is to talk with other people by radio. However, if you want to broadcast, you're limited to a mere 100 milliwatts of power in the AM and FM broadcasting bands under Part 15 of the FCC rules. For a growing number of pirates, that simply isn't enough power. Note that neither the author nor POPULAR ELECTRONICS advocates that anyone set up a pirate station. The FCC rules provide for a maximum penalty of $10,000 fine and/or a year imprisonment for those caught broadcasting illegally.

Where Pirates are Found. Almost any frequency in the standard broadcast band (540 to 1600 kHz) is fair hunting ground for pirate broadcasters. However, recent years have found pirates to be more commonly using frequencies in the upper end and just above the standard broadcast band, say from 1550 to 1650 kHz. This range is becoming popular with pirates because many old AM phone transmitters which cover the 160-meter ham band (1800 to 2000 kHz) can be easily retuned to cover 1550 to 1650 kHz. Much of the available surplus AM gear will cover this range as well.

A second favorite place for pirates is the 49-Meter international shortwave broadcasting band (5900 to 6200 kHz). The upper end of 49 meters, around 6200 kHz and just above, has long been favored by pirate broadcasters in Europe. A big advantage of this band is that much wider range can generally be obtained than on the broadcast band, particularly since fully resonant antennas are generally more feasible on 49 Meters than on the standard broadcast band.

A final good place to look for pirates is in the 41-Meter amateur/international-broadcast band (7000 to 7300 kHz and just above). This range is populated by both broadcasters and amateur operators. A big advantage of this band for pirates is that plenty of AM equipment is available for the band ready to use without any further modification. A big disadvantage is that interference is often tremendous, and the relatively flea-powered pirates often can't cut the mustard.

Those readers in urban areas might also want to keep an ear on the 88-to-92-MHz segment of the FM broadcast band. This portion of the band is normally reserved for educational stations, some of which use powers as low as 10 watts. Quite often, a "pirate" station of sorts will pop up here, generally for a day or two. These are almost always the result of students at a school using a legitimatey licensed transmitter in an unauthorized manner. Due to the highly sporadic nature of such operations, and their limited range, we will not deal with them in this article.

Strictly Hobby Pirates. The major portion of pirate activity in the United States falls into the category of "hobby" activity. These stations are operated solely for the amusement and diversion of the pirates, who have no political cause to advocate. A typical example was WHGC, operating on a varying frequency around 1610 kHz, in Charlottesville, Virginia. This station first popped up in late 1975, and was reported by members of the National Radio Club as far away as Delaware. Programming consisted of gospel music and religion (quite a contrast from the rock music and obscenities that many pirates put out). When the station was contacted by members of the National Radio Club, the operator claimed that it was operated on a limited-radiation carrier-current basis that was legal under FCC rules Part 15, and that he couldn't imagine how the station was being heard so far. One resourceful NRC member even managed to extract a verification from the station that specified power as 100 milliwatts.

On March 4, 1976, however, FCC agents from the Commissions's Norfolk office raided and shut down WHGC. Far from being a mere 100 milliwatts, the station was actually operating at 50 watts. The gospel music programing was explained by the fact that the station was built and run by the son of a minister, with the station itself being located in the back of a church in Charlottesville! Luckily for the young operator, the FCC merely issued a warning, suspending further action on the condition that no more illegal operation take place.

A bizzare operation was the "WDRC-FM" relay that operated on 1630 kHz. This station did nothing more than relay the programs of station WDRC-FM in Hartford, Connecticut. In late December, 1974, various BCB DX'ers noted a station on 1630 kHz that identified as

WDRC-FM. In fact, the station itself got a report from a frequency monitoring and checking service in Cleveland, Ohio about the strange signal. An NRC member and WDRC's chief engineer used direction-finding techniques to determine that the illegal transmitter was in Meriden, Connecticut. In mid-January, 1975, Federal Communications Commission agents, alerted by DX'ers and the WDRC staff, shut down the illegal transmitter. The station operator turned out to be a former employee of WDRC. WDRC-AM, by the way, transmits on 1360 kHz—and the pirate used 1630 kHz!

The grandaddy of all hobby pirates, however, has to be the WCPR operation. WCPR used a varying frequency of around 1620 kHz from its location in Brooklyn, New York. The station was first noted in late December 1975 and was quickly reported over a wide area from the Southeastern states to the Midwest. Station programming consisted of rock music and listener phone-ins weekend nights from approximately 0430 to 0700 GMT. The station announcer called himself, somewhat unoriginally, "John Doe."

Callers to WCPR's announced numbers were given an address to which to send reports. Unfortunately, reporters only received "thank you for tuning in" letters instead of detailed verifications. Meanwhile, some DX'ers noted that the numbers that WCPR announced were some of those that the telephone company uses for internal purposes, and speculation arose that someone inside the telephone company was aiding in the operation, because when the WCPR numbers were called when the station was not operating, nothing happened—no busy signal, no dial tone.

WCPR continued along, featuring calls from DX'ers and casual listeners from all over the eastern half of the United States, until it was raided and closed by the FCC on February 7, 1976. Transmitter power was only 100 watts, and FCC agents expressed amazement that it had been heard in the Midwest. As is usually the case, the operators of the station turned out to be rather young, in their late teens and early twenties. Although the FCC apparently decided not to prosecute the persons involved for operating a transmitter illegally, problems still remain. Prosecution may still result from the tampering with telephone company circuits.

A glance at our "sampler" of pirate activity will show similar operations scattered throughout the three main pirate bands. Of particular note, however, is the "Radio King Kong" operation reported around 6025 kHz in February and March of 1974. Many pirate broadcasters over the years have called themselves "Radio King Kong," as one of the "pioneer" pirate broadcasters used that name. However, it is not believed that any of the various "King Kong" operations are related. Don't be too surprised if another "Radio King Kong" pops up sometime in the future!

SAMPLER OF RECENT PIRATE BROADCASTING ACTIVITY

Frequency (kHz)	Comments
850	WHBL, Bayonne, New Jersey (announced location), rock music and identifications as "The Music Machine, WHBL, Radio 86, Bayonne." Active mid-January 1975, poor technical quality.
1580	Menomonee Warriors' Station, near Keshena, Wisconsin, active during unrest in area, early Spring 1975.
1610v*	WHGC, Charlottesville, Virginia, gospel music and religion, pretended to be carrier current, 50 watts of power, run by son of a minister, active late Autumn 1975 until closed by FCC March 4, 1976.
1620v	WCPR, Brooklyn, New York, used rock music and telephone call-ins, widely heard from December 1975 until closed by FCC in early February 1976. Transmitter was 100 watts.
1629	WCPU, location unknown but believed to be in the Midwest, announced 1615, urged listeners to write FCC and Congress to open up frequencies for hobby broadcasters, excellent signals, active mid-February 1976 following WCPR closing.
1630	"WDRC-FM Relay," Meriden, Connecticut, relayed WDRC-FM programming from late December 1974 until closed by FCC in mid-January 1975.
5035v	"Wild Turkey Radio," location unknown, English talks, much profanity, DX items from radio club bulletins. Even verified reports of its reception in club bulletins! Active December 6 through 10, 1973.
6025v	"Radio King Kong," announced as being 20 miles off coast but believed to be in middle Atlantic states, rock music and obscenities, February and March, 1974.
6030	"Radio Clandestine," announced as being on a ship but believed to be in New York-Pennsylvania area, rock and political commentary, requested reports to NYC address, active mid-December 1973.
6158v	Unidentified station, believe USA location, programs against telephone and other excise taxes (a favorite target of anti-Vietnam War groups), active early autumn 1972.
7229	Unidentified, believed to be in Philadelphia area, rock music and dedications, active early September 1973.
7415	WTIT, location unknown, "The Sound of Young America," rock music, announced 50 watts, mid-February 1973.

*v=frequency varies somewhat

Political Pirates. Political pirate broadcasters are much more common in Europe than here. Much of the political pirate broadcasting activity is government run. Relatively little such activity has occurred in the United States.

In the early Spring of 1975, an illegal station showed up on 1580 kHz near Keshena, Wisconsin. Operated by sympathizers of the Menomonee Indians, the station billed itself as the Menomonee Warriors' Station and announced its frequency as 1600 kHz, despite its actual frequency. It was strong enough to interfere with reception of WAPL, Appleton, Wisconsin on 1570 kHz.

The most recent political pirate was WCPU on 1629 kHz, which appeared in mid-February 1976 shortly after the FCC closure of WCPR. The announcer urged listeners to write the FCC and Congress urging them to open up frequencies above 1610 for hobby broadcasters. WCPU claimed to be the most powerful pirate broadcaster ever, and its signals gave credibility to that claim. Location was believed to be somewhere in the Midwest.

"DX" Pirates. Many DX'ers and SWL's get a big kick out of hearing a pirate. Do they ever get the urge to put a pirate station on the air themselves?

Many members of various radio clubs who are known to have somewhat sympathetic "live and let live" views toward pirate broadcasting have at times received advance notification that a pirate was about to take to the air. But since many DX clubs publish membership lists, complete with addresses, such advance notification did not prove that any DX'ers or SWL's were guilty of pirate activity.

Many pirates show a surprising knowledge of DX'ing. One example is the case of "Radio Clandestine," which showed up in mid-December 1973 on 6030 kHz. Reception was good throughout the Northeast, with programming consisting of rock music and political jokes. The host gave his name as "R.F. Burns," claimed to be operating from a ship off the Atlantic coast, and requested reports to a New York City address in care of the "SINPO code foreman." Quite obviously, the operators of this station were aware of clandestine activity (a favorite subject with many DX'ers) and were well aware of that favorite SWL reporting code, the SINPO system.

The "clincher" to link some SWL's and DX'ers to pirate activity came in December of 1973. From December 6 through 10, a station was heard around 5035 kHz announcing as "Wild Turkey Radio, the Voice of the Pilgrim Underground." Programming consisted of English language talks spiced with much profanity. One feature was a "DX corner" that featured items straight out of "FRENDX," the monthly DX bulletin of the North American Shortwave Association. A DX'er in Ottawa, Canada heard the station and reported reception of it to the January, 1974 issue of "FRENDX." He did not send a report to the station because no address was given.

A surprise arrived a few months later for the Canadian DX'er. It was a verification letter for "Wild Turkey Radio," signed by "Pullet" and "Gobbler," and airmailed from Turkey! Despite the postmark, Canadian government monitors believed the station to be located somewhere in the Winnipeg, Manitoba area. Quite clearly, though, the operators of "Wild Turkey Radio" had connections with the SWL community and access to "FRENDX." More probable, in the opinion of many people, was the notion that "Pullet" and "Gobbler" were members of NASWA!

Hearing Them Yourself. Most broadcast-band pirate activity takes place on weekends, usually after midnight, and many DX'ers scan 1600 to 1650 kHz every weekend night in the early hours. Activity on the 49- and 41-Meter bands tends to be concentrated in the afternoon hours, as heavy interference from legal broadcasters often makes evening and night reception on these frequencies difficult for low-power stations. ◇

Making Digital Electronic Clocks Immune to AC Flicker

BY ANDREW FRASER

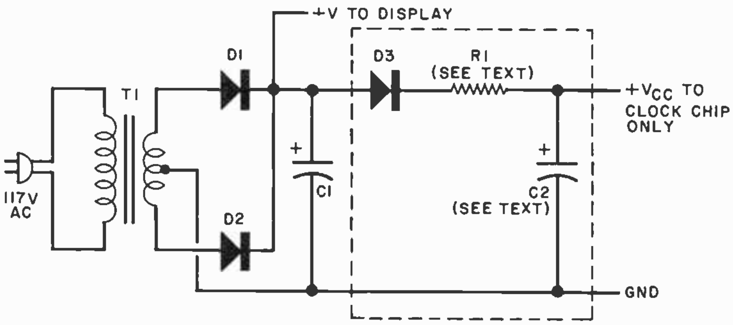
AN OCCASIONAL "flicker" on the ac line can interrupt power to a digital clock for up to a second. This can cause the filter capacitor in the clock's power supply to discharge through the displays to the point where the clock must be reset for accurate time. If you have encountered this problem, the circuit we present here can correct it.

A typical power supply for a digital clock consists of transformer *T1*, diodes *D1* and *D2*, and filter capacitor *C1*. The flicker-eliminator modification in this circuit consists of the components inside the dashed-line box. Now, power for the clock chip is obtained via *D3, R1,* and *C3*. When the ac line flickers, the current drawn by the displays will begin to discharge *C1* but the charge on *C2* will not go to the displays because under this condition *D3* will be in reverse bias.

MM5316 clock chip that draws 5 mA and can operate down to 8 volts, *C2* can keep the clock chip (but not the displays) operating for several minutes. Most line flickers do not last this long. Also, this means that you can unplug your clock and move it to another location without having to reset it.

Resistor *R1* in the add-on circuit limits the current flow to *C2* during the charge cycle. If the power supply delivers 12 volts, a value of 100 ohms at 12 watts for *R1* will limit charging current to 120 mA. This allows *C2* to become fully charged in several seconds. If you use a lower-value capacitor for *C2, R1*'s value and power-handling capabilities can be reduced proportionately, or *R1* can be eliminated altogether.

This flicker-eliminator technique can also be used with low-power RAM's in



This circuit provides power to a clock chip to prevent flicker.

Hence, while the charge on *C1* might be quickly drawn off by the displays, the power delivered to the clock chip from the charge on capacitor *C2* will remain relatively constant.

If a power supply normally delivers 12 volts and capacitor *C2* is a very high value (say 10,000 μF) and you are using an

computer memory systems to prevent loss of stored data when a transient flicker occurs. The amount of "safety" time again depends on the value of *C2* and the current demands of the memory system. Therefore, the higher the value of *C2* and the lower the current demand, the longer the safety time. ◇

4 great magazines

For The CBer

S9's the oldest, biggest and most widely read CB magazine in the world. Edited by Tom "Tomcat" Kneitel, it's got all the best writers in the CB field, plus great extras for the swl, vhf buff, or would-be ham. S9 not only tells you what's happening now, but what's going to happen in the future and why. Must reading for every CBer from 18 to 80.

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For the Electronic Hobbyist

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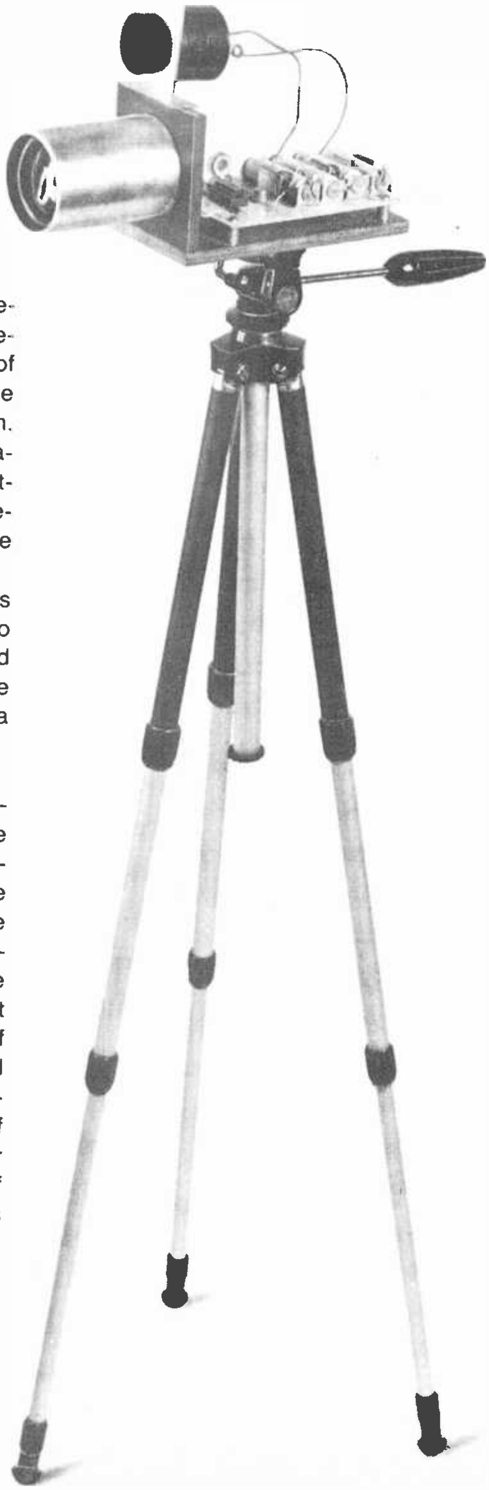
CIRCLE NO. 14 ON FREE INFORMATION CARD

BUILD A FIELD DISTURBANCE SENSOR FOR SECURITY

Inexpensive alarm device detects light changes in its field of view.

BY KEN POWELL



The Field Disturbance Sensor presented here is a useful security device wherever a reasonable amount of ambient light exists, such as in an office supplies area or a store showroom. Since it does not radiate an r-f or ultrasonic signal, it cannot be easily detected. Featuring a quasi-memory, it can detect removal of an object as well as the addition of one within its field of view.

Thus, the Field Disturbance Sensor is difficult to defeat, versatile and easy to build owing to a low parts count, and readily available components can be used. Initial adjustments require only a multimeter.

Theory of Operation. The Field Disturbance Sensor functions like a simple camera, with two light-dependent resistors (LDR's) or photocells taking the place of film. A lens projects the image or field of view onto the sensitive surfaces of the photocells. The resistance of each cell is determined by the amount of light reaching it. When the field of view is normal (that is, when desired conditions in the field exist), the cell resistances will assume specific values. If an object passes through, is added to, or removed from the field, the intensity of light impinging on the cells, and thus their resistance values, deviates from the chosen norm. Any change in the ambient light level also changes the photocells' resistances.

Two IC comparators monitor the LDRs' resistances and activate an audible alarm if they vary by more than a predetermined amount. The alarm will continue to sound as long as the field is disturbed. Thus, if a person is moving through the field, the comparators activate the alarm as long as he is in view. If an object is added or removed from the field, the alarm continues to sound until the object is withdrawn or replaced, respectively.

About the Circuit. The schematic diagram of the Sensor is shown in Fig. 1. Cadmium-sulfide photocells *LDR1* and *LDR2* are connected in series to form a voltage divider and placed behind a lens (see Fig. 2). As the field of view is altered, the resistances of the photocells vary inversely in proportion to the amount of light striking their sensitive surfaces. An object entering the right side of the field of view produces a greater effect on the left photocell, and vice versa. A change in resistance of either cell causes a variation in the voltage at the junction of the two cells. This voltage is called V_{IN}.

A second voltage divider comprising *R2*, *R3*, and *R4* provides reference voltages for comparators *IC1* and *IC2*. These references are designated V_{UT} and V_{LT}. The upper threshold (V_{UT}) is applied to the noninverting input of *IC1* and the lower threshold (V_{LT}) is applied to the inverting input of *IC2*. Voltage from the junction of the photocells (V_{IN}) is applied to the inverting input of *IC1* and the noninverting input of *IC2*. Potentiometer *R1* is placed in parallel with *LDR1* so that V_{IN} can be trimmed to one

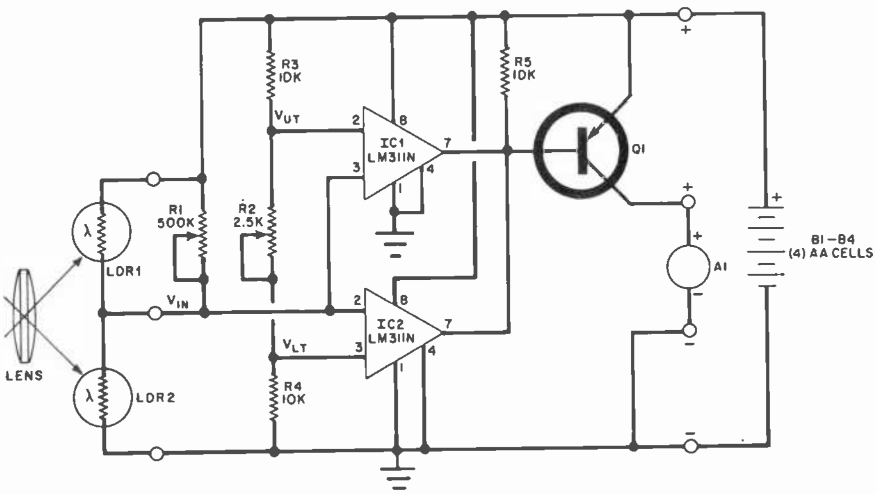


Fig. 1. Light hitting LDR's determines inputs to op amp comparators.

PARTS LIST

A1—Mallory SC628P Sonalert, or similar
B1 through B4—AA cells
IC1, IC2—LM311N comparator
LDR1, LDR2—Cadmium-sulfide photocell (Radio Shack 276-116)
Q1—Pnp silicon switching transistor (Radio Shack 276-2024)
R1—500,000-ohm trimmer potentiometer (Radio Shack 271-221)
R2—2500-ohm trimmer potentiometer (Radio Shack 271-228)
R3, R4, R5—10,000-ohm, ¼-watt, 5% tolerance resistor
Misc.—Bi-convex 50.8 × 50.8 mm lens (available for $19.50, No. 01 LDX 115, from Melles Griot, 1770 Kettering Street, Irvine, CA 92714); rubber "O" rings; cement; suitable wood, plastic or metal stock and tubing; IC socket or Molex Soldercons; battery holders (Radio Shack 270-1433); printed circuit board (available from J. Oswald, 1436 Gerhardt Ave., San Jose, CA 95125, for $3.50); hookup wire, etc.

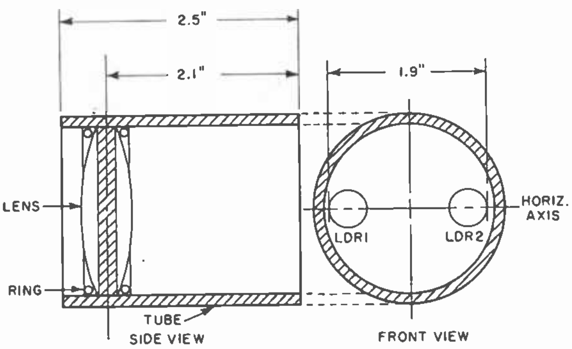


Fig. 2. Dimensions for cutting PVC pipe to make lens assembly

half the supply voltage (3 V). Potentiometer *R2* adjusts the reference voltage divider so that V_{UT} will be slightly greater than V_{IN} and V_{LT} will be slightly less than V_{IN}. When this occurs, the outputs of both comparators (uncommitted collectors on-chip) are high and *Q1* is cut off. No current flows through alarm *A1*.

Any change within the field of view will cause variations in the resistances of *LDR1* and *LDR2* and in the magnitude of V_{IN}. If the change decreases the resistance of *LDR1* or increases the resistance of *LDR2*, V_{IN} will exceed its initial value. When V_{IN} is greater than V_{UT}, *IC1* will change state and its output will go low. This will forward bias *Q1* and energize the alarm. If the photocells are affected in the opposite manner, V_{IN} will drop below its initial value. When V_{IN} is less than V_{LT}, the output of *IC2* will go low, forward biasing *Q1*, which in turn sources current for the alarm.

In effect, we have set up a voltage window by adjusting *R2*. This window is centered around V_{IN}. Any variation in V_{IN} which exceeds this voltage window activates the alarm. The window can be made very narrow—on the order of a few millivolts at the maximum sensitivity of the Sensor.

Construction. The project comprises a lens assembly, a printed circuit board, and a base. The lens is 2" in diameter and has a focal length of 2" (50.8 × 50.8 mm). A lens tube can be fabricated from a cardboard mailing tube, aluminum or PVC pipe. Two-inch I.D. PVC pipe is easily cut to size and cements readily to other plastics and wood. Dimensions for the lens tube are shown in Fig. 2. The lens is mounted in the tube with a pair of rubber "O" rings (available from hardware stores). When the rings and lens are properly positioned in the tube, the rings should be secured in place with a few drops of cement.

The base assembly can be constructed from plastic, wood or metal. Suggested dimensions are shown in Fig. 3. The prototype has a hole centered on the bottom side of the base tapped for ¼" × 20 threads. This facilitates mounting the project on a camera tripod. A small "L" bracket to hold the alarm can be formed from a 2" × 3" (5.1 × 7.6 cm) piece of steel or aluminum stock.

Photocells *LDR1* and *LDR2* are mounted on the base assembly after a preliminary test. Place the cells side by side on a flat surface about 6" (15.2 cm) from a light-colored wall which is il-

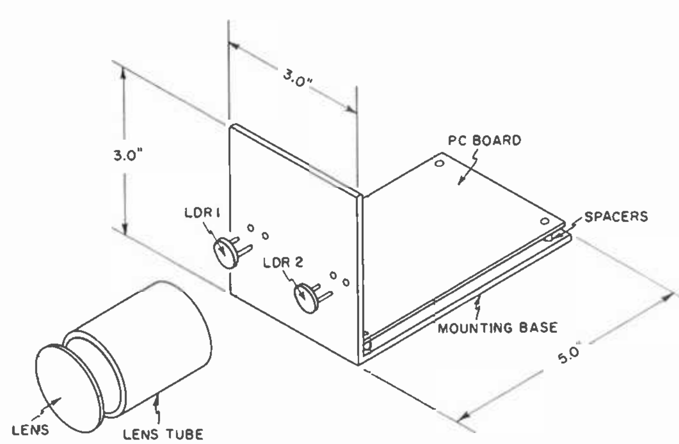


Fig. 3. Instructions and dimensions for assembling the base. A hole in the bottom can be used for tripod mounting.

luminated with normal ambient light. Measure the resistance of each cell and denote the one with the higher resistance *LDR1*. Then mount the LDR's on the base assembly, securing them with cement. The photocells should be spaced as far apart as possible, but be sure they can be encompassed by the lens tube. Then cement the lens tube to the base assembly.

Suitable etching and drilling and parts placement guides for the printed circuit board are shown in Fig. 4. Both IC's can be mounted in a single 16-pin socket, or Molex Soldercons can be used. Connect lengths of hookup wire to the pc pads for the LDR's and the Sonalert. Be sure to leave enough wire for the leads to reach their respective components when the printed circuit board is installed. Battery holders for the four AA cells can be mounted directly on the board. When all components and leads are in place, the pc board is mounted on the base assembly with ½" (1.27-cm) spacers and No. 4 hardware. Double check your wiring and orientation of semiconductors. Then install the batteries in their holder. The project should start beeping loudly.

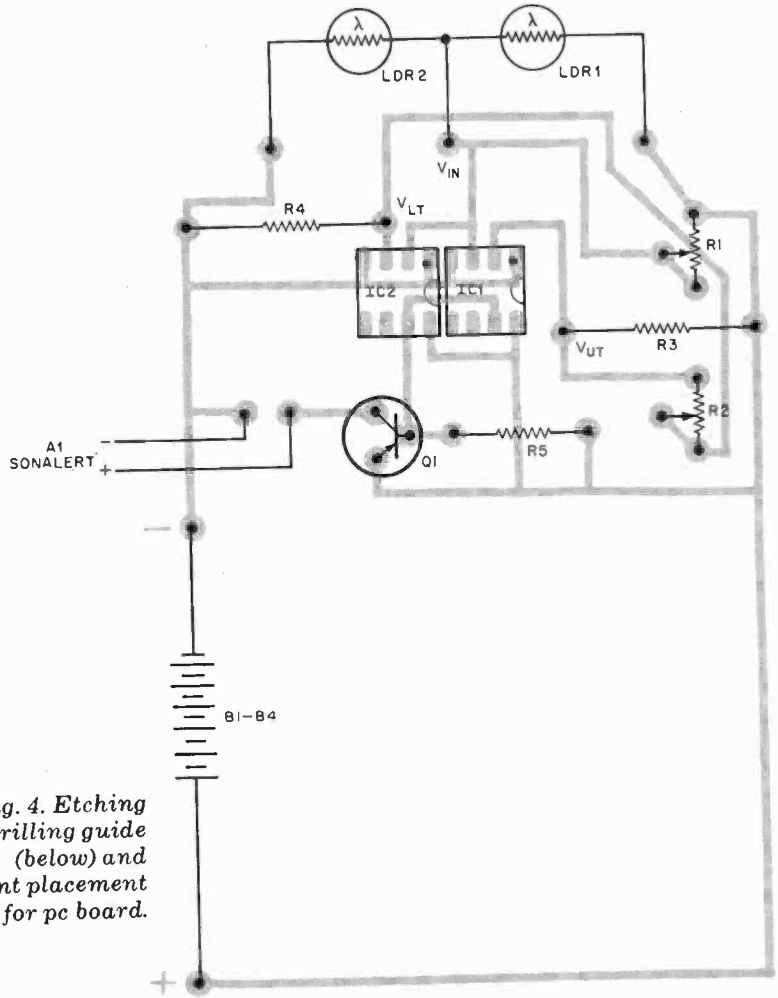
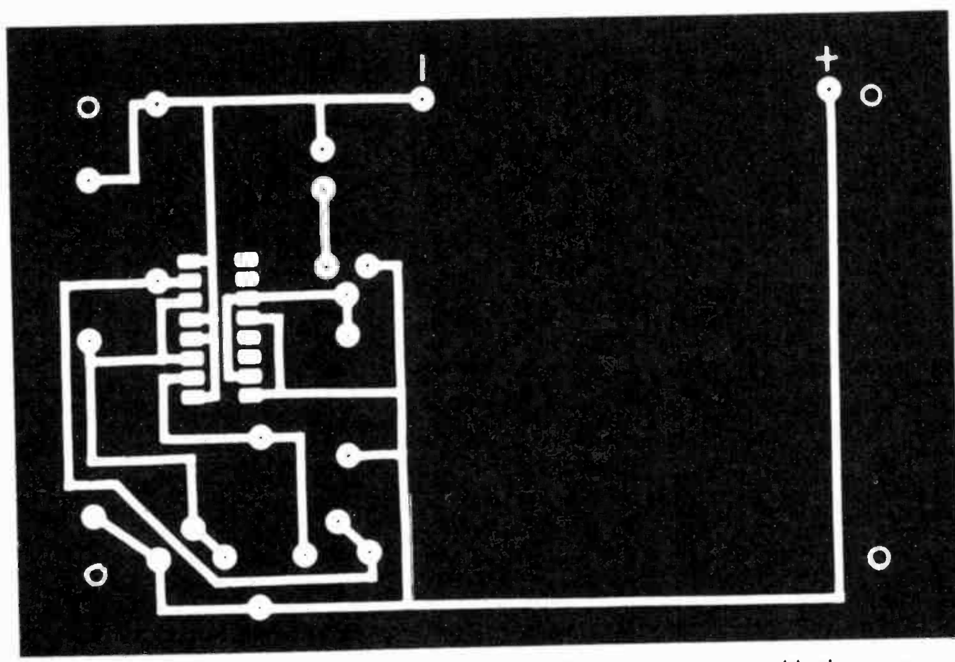


Fig. 4. Etching and drilling guide (below) and component placement for pc board.



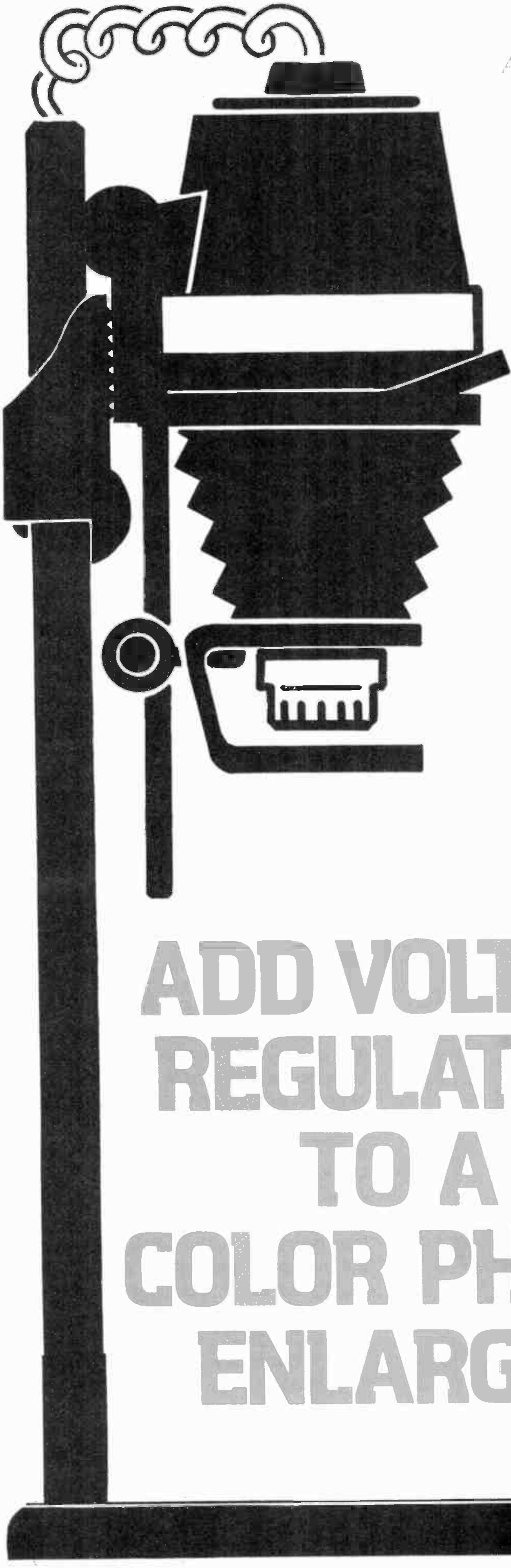
Adjustment. Place the Sensor in position to cover the desired field of view. (Remember that adequate ambient light is required for correct operation of the project.) Apply the positive probe of a voltmeter to point V_{IN} and the negative lead to ground (battery negative). Adjust *R1* for a reading of approximately 3 volts. Then move the negative probe to point V_{IN} and the positive probe to V_{UT}. Adjust *R2* for the smallest voltage possible without activating the alarm. When these adjustments are performed, V_{UT} will be slightly positive with respect to V_{IN}, and V_{LT} slightly negative.

The sensor is now operational. Have some fun trying to outwit it!

Use. Keep in mind that the project operates on ambient light. Accordingly, adequate lighting must be maintained where the Sensor is to be used. Under good lighting conditions, as found in most offices and showrooms, the Sensor functions over a distance of 25 feet (8 m) or more if the intrusion or change provides a moderate contrast to the existing background. Closer in, the project will detect such changes as smoke or fire.

To alter the pattern of the field or to gain greater light-gathering power, different lenses could be used. Also, more sensitive photocells could be employed. The audible alarm could be supplemented or replaced by a relay for interconnection with an existing alarm system. There are obviously many possibilities for those inclined to experiment!

Battery life will depend on the number and duration of alarms. Quiescent current drain is only four milliamperes, so long life can be expected from the AA cells, especially if alkaline batteries are used. Of course, you could also use NiCd cells or a line-powered, regulated *low-ripple* dc supply with back-up batteries. No matter how you power the Sensor, you will find it fun to build, even more fun to attempt to defeat, and in proper applications, a very good and useful security device. ◇



Allows color enlargers to give consistent quality in spite of line-voltage fluctuations.

ADD VOLTAGE REGULATION TO A COLOR PHOTO ENLARGER

BY D. W. SCHNEIDER

HAVE YOU ever matched your color enlarger's filter pack to a negative, only to discover that the resulting color print's color quality was imperfect? This is often due to fluctuations in line voltage, which occur when high-power appliances turn on or off.

This problem can be solved by using an inexpensive voltage regulator, such as the one presented here.

The project to be described will maintain dc voltage for the enlarger's lamp at line level within ± 1%, even if the ac line voltage varies ± 10%. The regulator circuit uses readily available parts and can be built for approximately $20.

About the Circuit. The voltage regulator is shown schematically in Fig. 1. Isolation transformer *T1* applies 117 volts rms ac to modular bridge rectifier *RECT1*. Pulsating dc from the bridge is filtered by electrolytic capacitors *C1* and *C2* into a fairly smooth 160-volt dc level. Zener diodes *D1* and *D2* together with resistor *R2*, form a voltage regulator. The series zener combination produces a regulated output of 118 volts dc. Resistor *R2* limits zener current to a safe value and provides base current for *Q1*.

The voltage at the base of *Q1* is governed by the zener action of *D1* and *D2*, and is thus substantially independent of variations in line voltage. Even if the line voltage drops 10 volts, the filtered output of the rectifier is greater than the combined zener voltages. This is so because the filter output is approximately equal to the peak value of the ac line's waveform, not its rms value. Unless the line voltage decreases greatly, there will always be enough current in the zener diodes to keep them operating in the avalanche region. The zener voltages will therefore remain constant within ± 1% or so.

Most enlargers use incandescent

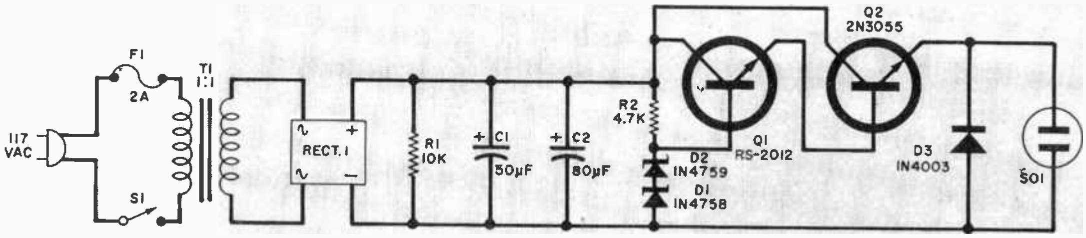


Fig. 1. Circuit has zener diode regulation and amplifier pair.

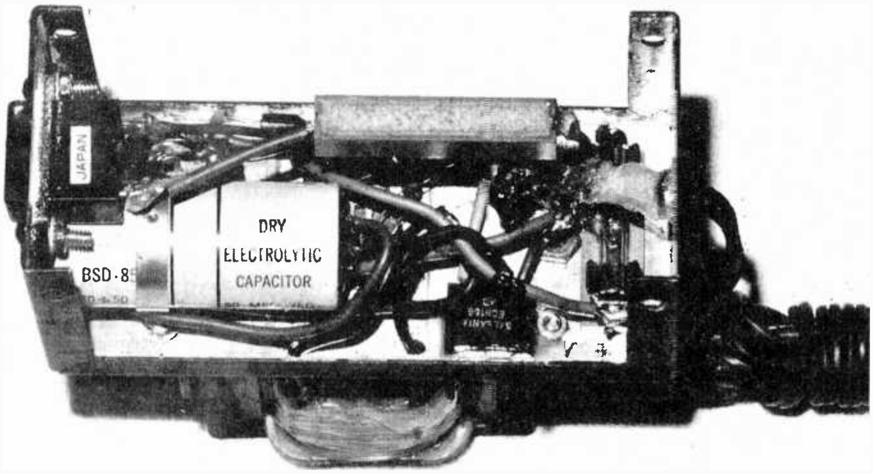


Fig. 2. Photo shows how prototype was made with point-to-point wiring.

PARTS LIST

C1, C2—Dual (80- and 50-μF, 250-volt) electrolytic capacitors or equivalent.
D1—1N4758 56-volt, 1-watt zener diode
D2—1N4759 62-volt, 1-watt zener diode
D3—1N4003 silicon diode
F1—2-ampere fuse
Q1—RS-2012 (Radio Shack) npn silicon transistor
Q2—2N3055 npn silicon power transistor (Radio Shack 276-1634. See text.)
R1—10,000-ohm, 10-watt wirewound resistor
R2—4700-ohm, ½-watt carbon composition resistor
RECT1—400-PIV modular silicon bridge rectifier (Radio Shack 276-1173 or equivalent)
S1—SPST switch
SO1—Ac power socket
T1—25.2-volt, center-tapped, 2-ampere transformer (Radio Shack 273-1512) or 117-volt isolation transformer (Stancor No. 6410). See text.
Misc.—Suitable enclosure, TO-3 heat sink, mica washers, and transistor socket, zinc oxide silicone heat sink compound, line cord, strain relief, terminal strips, fuse holder, magnet wire, solder, insulated sleeving, machine hardware, fiber shoulder washers, flat black paint, etc.

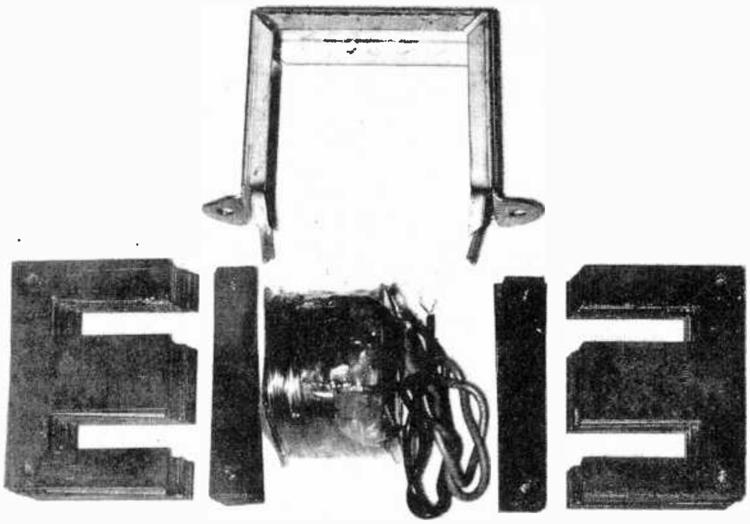


Fig. 3. Transformer T1 can be made by modifying a readily available model. This shows the parts of the transformer disassembled and ready for re-winding.

Fig. 4. Photo of assembled prototype shows transformer. mounted on heat sink.

lamps drawing 75 or more watts. If zener diodes alone were used as voltage regulators, they would have to have very large power dissipation ratings. The cost of such diodes is prohibitive. However, the Darlington amplifier composed of *Q1* and *Q2* allows the use of small (1-watt) zener diodes. The diodes present a regulated voltage which drives the Darlington pair. Two diode voltage drops (approximately 1.2 volts) cause the output voltage at the emitter of *Q2* to be slightly less than the combined zener voltages.

The voltage regulator as shown has been successfully used with enlargers containing 75-watt incandescent bulbs. If your enlarger has a lamp that requires more than 100 watts, output transistor *Q2* should be a premium 2N3055 rather than the hobby-grade component specified in the Parts List.

Construction. The regulator can be

assembled using point-to-point wiring and terminal strips. The project should be housed in a 5" x 2¼" x 2¼" (12.7 x 6.4 x 6.4 cm) aluminum utility box. When you have procured all necessary parts, lay them out in the box as in Fig. 2. Drill mounting holes for those parts which are directly attached to the box (fuseholder, terminal strips, power switch, retaining band for the electrolytic capacitor, etc.) Holes must also be drilled for *Q2*'s heat-sink and isolation transformer *T1*. Make a cutout in the box to allow clearance for the socket used with *Q2*.

Mount all components in the utility box except for *T1* and the transistor/heat sink assembly. Wire the components according to the schematic diagram. (Use insulated sleeving liberally.) Be sure to observe polarities of *C1, C2, D1* through *D3*, and *Q1*. Next, mount *Q2* on the heat sink in the following manner. Spread a layer of zinc-oxide silicon heat sink compound on the bottom of *Q2*'s case, on each side of the two TO-3 mica washers, and on top of the heat sink where *Q2* will sit. Pass the two washers over the pins of *Q2*, and position the transistor on the heat sink.

Holding the transistor in place, turn the heat sink over and lay two fiber shoulder washers on the holes drilled in the heat sink for the transistor's retaining screws. Then mount a TO-3 socket by pushing it down over the protruding transistor pin leads. Secure the assembly with 6-32 machine screws. (It might be necessary to enlarge the threads in the transistor socket with a 6-32 tap to accommodate the machine screws.) Be sure that the shoulder washers isolate the machine screws from the heat sink.

Mount the transistor/heat sink assembly on the utility box with machine hardware. Wire the transistor socket according to the schematic. To maximize the project's ability to dissipate heat, all exterior surfaces of the utility box and heat sink should be coated with a layer of flat black enamel spray paint.

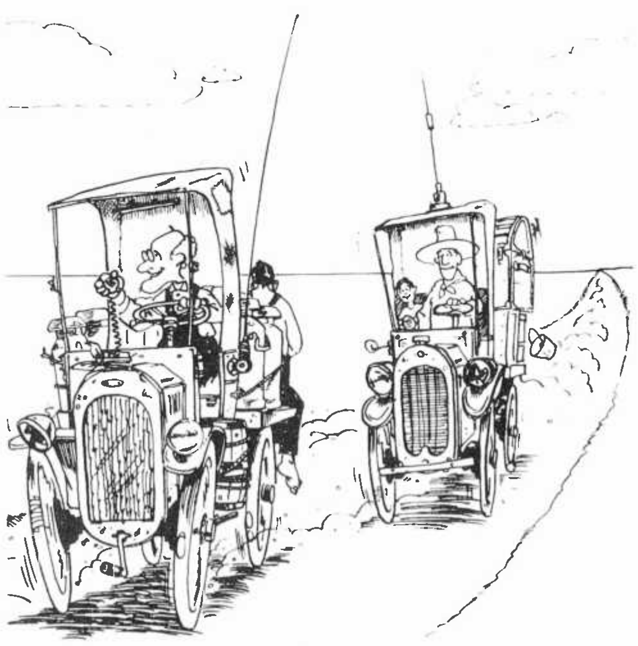
Transformer *T1* can be made by modifying a Radio Shack 25.5-volt, center-tapped power transformer. Separate the transformer mounting bracket from the laminated iron core by bending the two metal tabs on the bottom of the bracket outward. This will allow the core to slip out. The "E" and "I" shaped laminations can then be removed one at a time from the plastic bobbin on which the transformer windings are wound. Tapping the laminations with a small hammer will loosen the varnish between them, allowing the end laminations to be slid out. A photo of the disassembled transformer is shown in Fig. 3.

When the wound plastic bobbin is free, remove the outer, larger diameter (approximately No. 20) copper secondary winding. Do not disturb the inner primary winding or its insulated leads. Wind approximately 670 turns of No. 26 or 28 enamelled magnet wire in place of the secondary just removed. Scrape some enamel from the new secondary wires and solder insulated leads to them. If desired, seal the windings with coil dope. Wrap a few turns of vinyl electrical tape (Scotch No. 33 or equivalent) over the windings. Then paint the transformer bracket with flat black enamel and reassemble the transformer.

In the prototype, the transformer was mounted on the heat sink over *Q2*, as shown in Fig. 4. If preferred, a more expensive and slightly larger isolation transformer such as the Stancor No. 6410 can be used in place of the modified 25.2-volt transformer.

Use. Plug the line cord from the regulator into the power socket on the exposure timer. Then plug the power cord from the enlarger into power socket *SO1*. The voltage regulator is now ready for use in the production of prints. ◇

PE COMICS CORNER By Frank Bolle



"Hey, four wheeler. Looks like we got us a convoy!"

Solid State

By Lou Garner

BACK TO THE (CIRCUIT) MINES

READER response to my prospecting trip among the circuit mines of manufacturers' literature in the August issue (*A Circuit Medley*) has been so gratifying that I've decided to pay a return visit to the "diggings." The results of my latest expedition are shown in Figs. 1 through 4. Like the circuits discussed previously, these nuggets are, of course, but a minuscule sampling of the thousands of designs suggested in manufacturers' periodicals, product bulletins, catalogs, application notes, data sheets, brochures, and reference handbooks. The major sources for circuits, naturally, are the publications released by the semiconductor manufacturers, but other component manufacturers—particularly those offering more expensive components such as transducers, transformers, and relays—are excellent secondary sources of information.

Intended for use as sampling gates, the Schottky diode switching circuits in Fig. 1 were abstracted from Application Bulletin 16, published by Hewlett-Packard Components (640 Page Mill Road, Palo Alto, CA 94304). Sampling is essentially a time-stretching technique by which a high-frequency, repetitive signal is duplicated at a lower frequency to permit observation and/or measurement with standard test instruments, such as an oscilloscope or vector voltmeter. The gates sample the instantaneous amplitude of the test signal at different points on successive cycles until the original waveform can be reconstructed. Depending on the sampling rate, as compared to the frequency of the test source, the reconstructed waveform may have an equivalent frequency one-tenth or less than that of the original.

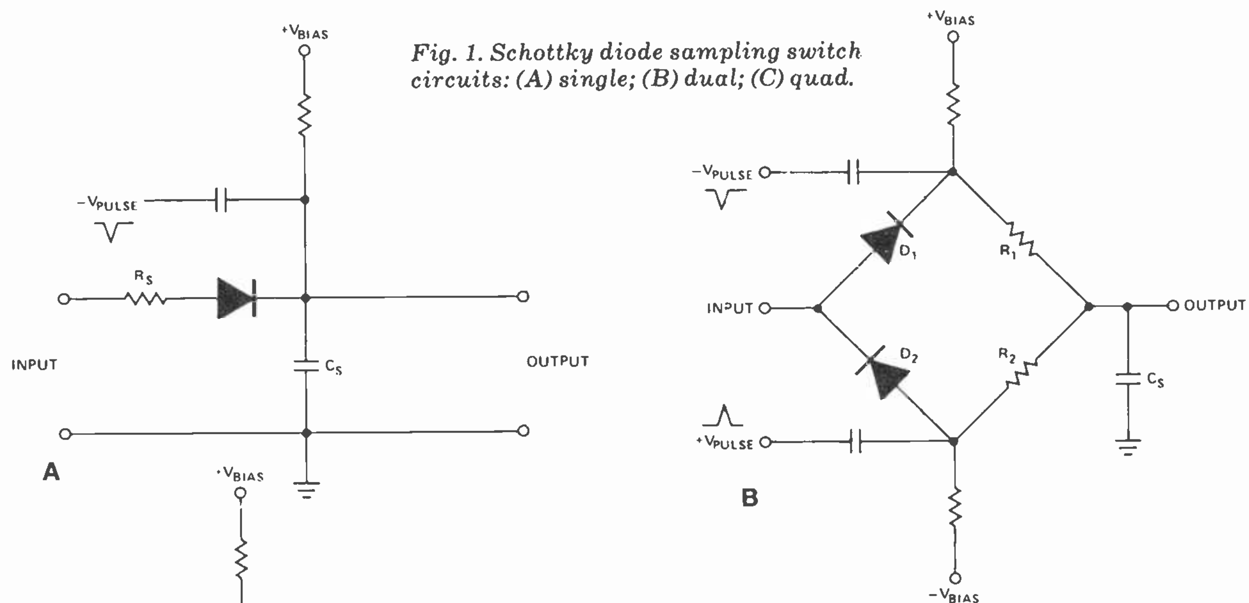
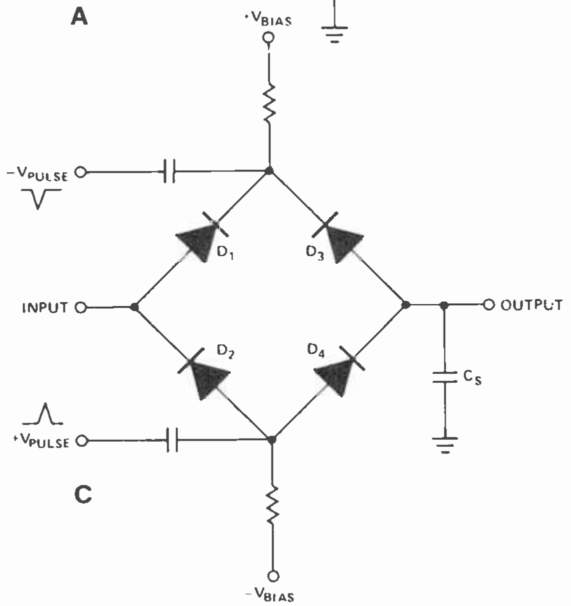


Fig. 1. Schottky diode sampling switch circuits: (A) single; (B) dual; (C) quad.



The basic sampling gate, Fig. 1A, uses a single diode. The diode normally is reverse biased by a steady dc voltage and thus acts as an open circuit. During the sampling period, a negative-going pulse is applied to the cathode, momentarily cancelling the reverse bias and allowing the diode to conduct. Sampling capacitor, C_S, then charges up to the instantaneous amplitude of the test signal through isolating resistor R_S.

During each successive sample, the voltage across the capacitor changes to reflect the new amplitude of the test signal. However, since the capacitor acts to hold the signal voltage level between samples, it "stretches out" and effectively reconstructs the original waveform at a much lower frequency. Naturally, the sampling pulse width must be quite narrow compared to the input signal so that the sample corresponds to a specific portion of the applied waveform. Also, the capaci-

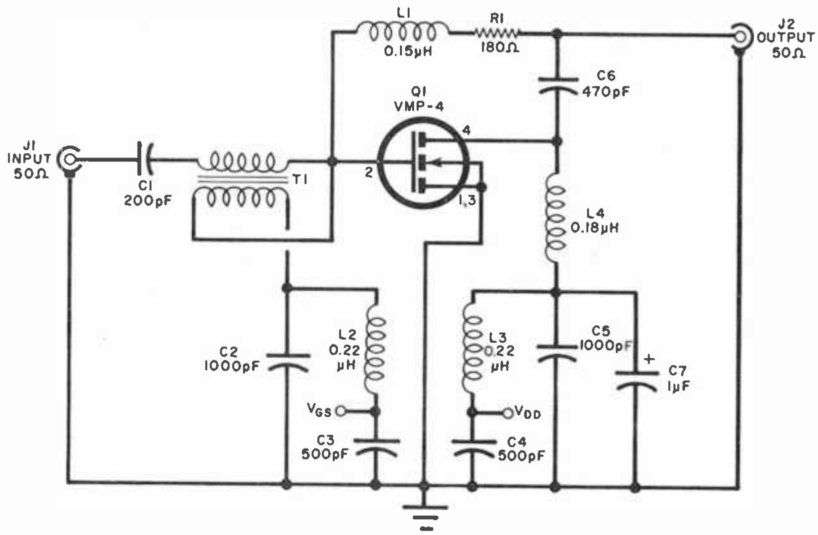


Fig. 2. This broadband vhf amplifier circuit, using a VMP-4 FET has a reasonably flat freaquency response from 40 to over 200 megahertz.

tor's charging time must be short enough to charge or discharge during this interval.

Although the basic single-diode sampling gate provides acceptable performance in some applications, it has a number of limitations. If the isolation resistor, R_S, is made too small, it is relatively ineffective. If it is too large, it reduces efficiency by introducing an excessive voltage drop and increasing the charging time constant. There is always the problem of the reverse bias developing a steady charge on the sampling capacitor. These limitations can be reduced somewhat by using a symmetrical dual diode sampling gate, as shown in Fig. 1B. Here, the diodes are arranged to form a bridge in conjunction with two fixed resistors, R_1 and R_2. Equal, but opposite, reverse bias voltage sources are required and both positive- and negative-going sampling pulses must be used to initiate operation. Superior to the single diode sampling gate, the dual diode design is also relatively inefficient due to the voltage drops across the bridge resistors.

The most efficient design as well as the most common in commercial equipment is one using four diodes arranged in a full-wave bridge, as illustrated in Fig. 1C. For optimum performance, the four diodes must have matched characteristics, the two reverse bias voltages must be equal and opposite, and the control signals must be identical in waveform except for polarity. The value of the reverse bias voltage is somewhat critical in that it must be large enough to prevent input signals from driving the diodes into conduction, yet small enough to permit the gating control pulses to forward bias the diodes during the sampling interval.

Typical Schottky diodes suitable for use in these circuits are the 1N6263 and HSCH-1001, or, for the bridge circuit, the HSCH-1004, 5082-2805, and 5082-2813 diode arrays. In practical systems, the sampling gate generally is placed between the input signal source and the following amplifier's input capacitor.

Included in the 4-page technical data bulletin for the VMP 4 MOSPOWER™ FET manufactured by Siliconix, Inc. (2201 Larelwood Road, Santa Clara, CA 95054), the broadband vhf amplifier circuit shown in Fig. 2 offers a reasonably flat response from 40 to over 200 MHz. With power gains approach-

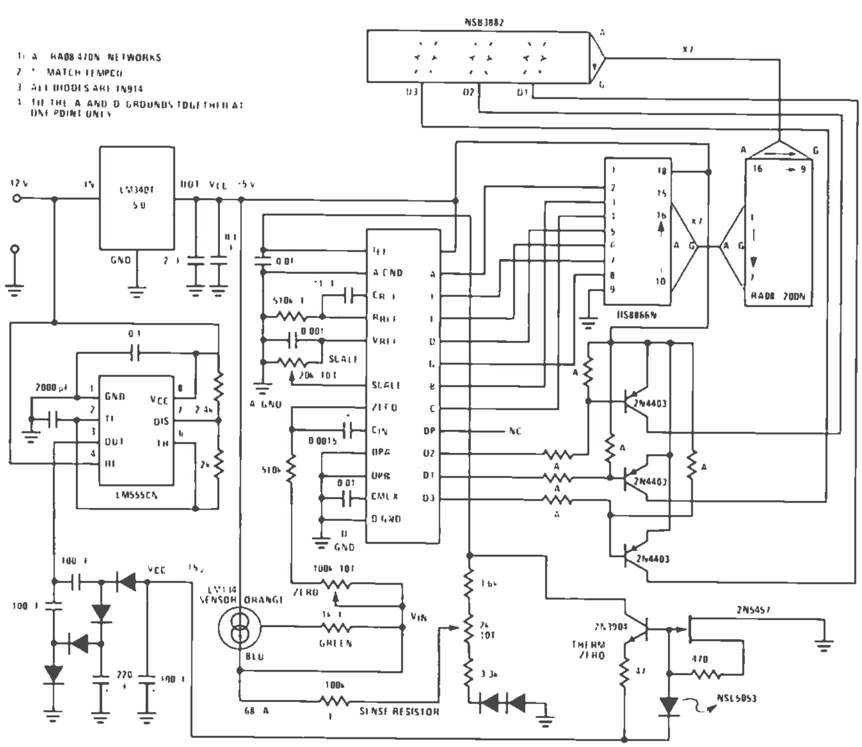


Fig. 3. Digital thermometer circuit uses an LM134 programmable current source as temperature sensor, a 2½-digit DPM chip for A/D conversion and display decoding, and an NSB3882 readout driven by a DS8866N and three 2N4403 pnp transistors.

ing 15 dB, it can deliver from a few milliwatts to several watts output, depending on the dc supply voltage and drive signal amplitude.

Standard components are used in the design, with all capacitors good-quality ceramics or micas except for *C7*, which is a 50-V tantalum unit. The broadband input r-f transformer, *T1*, consists of 4 turns of #22 AWG twisted pair on an Indiana General type F625-902 core. Naturally, layout and lead dress are somewhat critical and good vhf wiring practice must be followed for optimum performance. A 24-volt dc source is used as the amplifier's power supply, with the gate bias voltage (V_{GS}) adjusted for the minimum drain current to meet power output requirements within Q1's maximum ratings. Supplied in a four-terminal, flange-mounted strip-line package, the VMP4 transistor (*Q1*) is an n-channel, enhancement-mode MOSFET with a maximum drain-source breakdown voltage rating of 60 volts, a maximum drain current rating of 1.6A, and a maximum power dissipation (at 25° C) of 35 watts.

Suitable for use either in hobbyist or commerical designs, the digital thermometer circuit in Fig. 3 is one of a number of items in a recent issue of the *National Anthem*, a publication issued periodically by the National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, CA 95051). Using an LM134 programmable current source as its temperature sensor, the instrument features an ADD2500 2½-digit DPM chip for analog/digital conversion and display decoding and an NSB3882 readout driven by a DS8866N and three 2N4403 pnp transistors. Two RA08 resistor networks are used in the circuit in addition to quarter-watt fixed resistors and small potentiometers. Requiring a single unregulated 12-volt dc source, the design includes an LM340 3-terminal, 5-volt regulator and a dc/dc converter consisting of an LM555 and a four-diode rectifier network. The converter drives a negative current regulator comprising an NSL-5053 LED, a 2N3904 npn transistor, and a 2N5457 FET. Although neither parts placement nor wiring dress are critical, good layout and wiring techniques should be observed when duplicating the circuit. If desired, the LM134 may be used for remote sensing.

Described by Hans Palouda in Volume 4, Number 2, of *Progress*, a bimonthly journal published by the Marketing Services Department of the Fairchild Camera and Instrument Corporation's semiconductor operations (464 Ellis Street, Mountain View, CA 94042), the complementary audio power amplifier circuit in Fig. 4 features inexpensive, TO-220 monolithic Darlington transistors (types SE9301 and SE9401) in its output stage. Because of the inherent high gain of the Darlington units, only one other transistor, *Q1*, is needed to complete the design. Designed for operation on a 40-volt single-ended supply, the circuit offers an input impedance of 10,000 ohms. Requiring an input signal of only 1.2 V rms to deliver a full 20 watts output to a matched 8-ohm load, it can be used with any standard preamplifier. According to Fairchild, the amplifier's frequency response is essentially flat within 1 dB from 30 Hz to 200 kHz, while its harmonic distortion is typically less than 0.2%. In operation, *Q1*'s base serves as the tie point for both ac and dc feedback as well as for signal input. A bootstrap circuit is used to boost *Q1*'s effective collector voltage, insuring an adequate drive signal for Q2 and developing a constant voltage across *R7*, which acts as a current source and, in conjunction with diodes *D1*, *D2*, and *D3*, serves to reduce low-level crossover distortion.

While any standard construction technique can be used, a suitably designed etched circuit board is easiest, provided reasonable care is exercised in developing a clean layout. Dc polarities must be observed, of course, and heat sinks should

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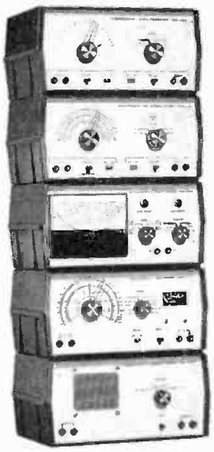

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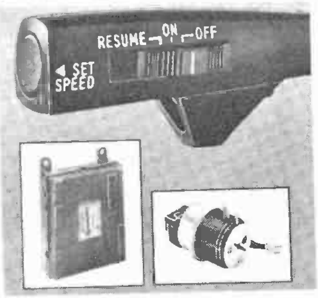

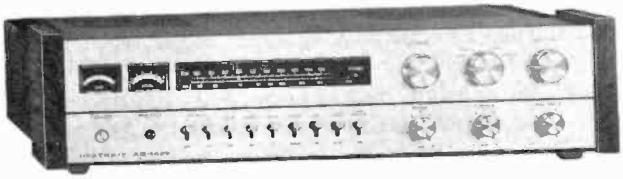

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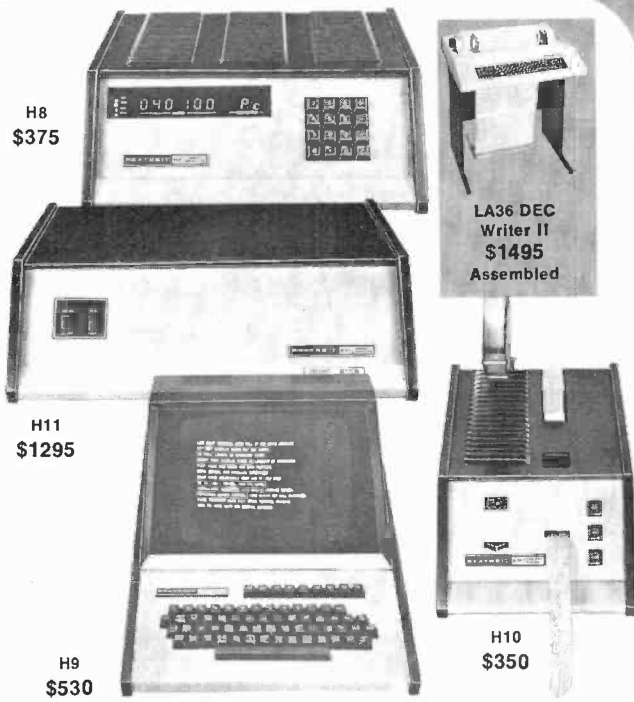

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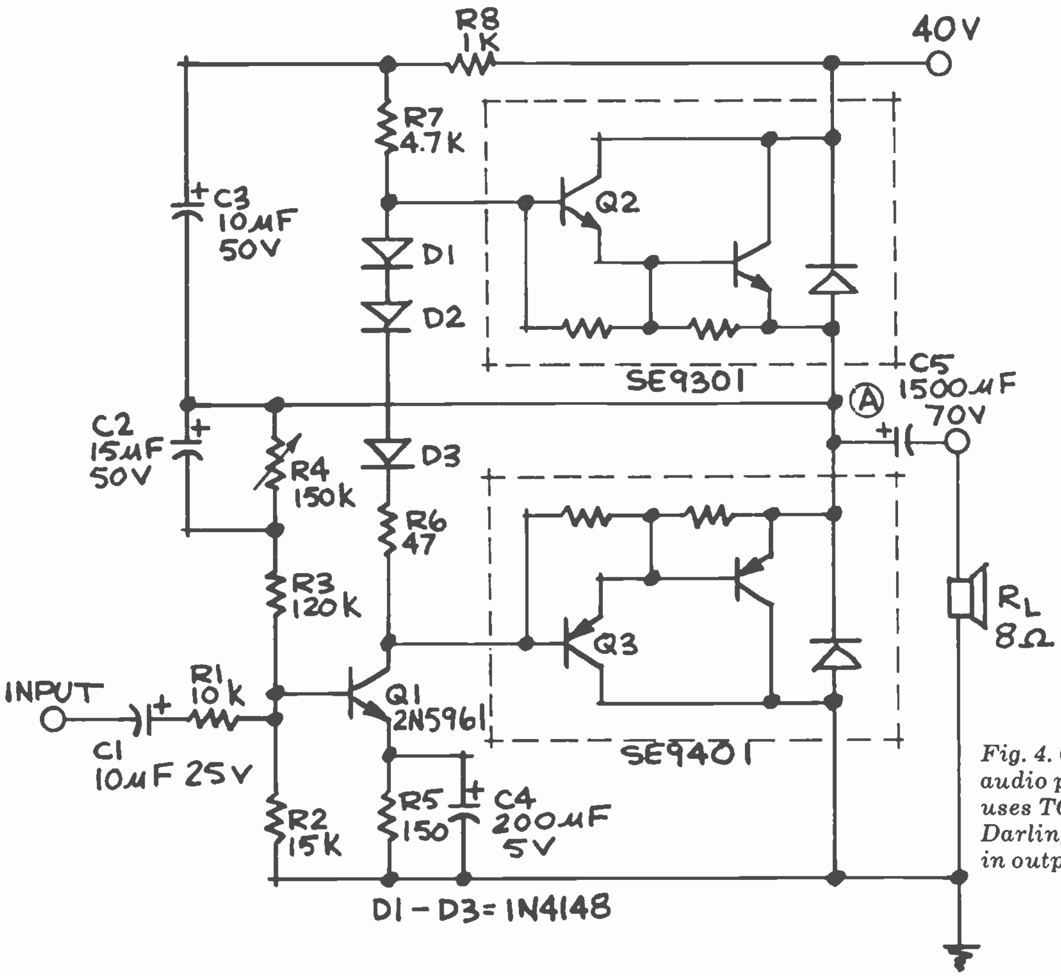

Fig. 4. Complementary audio power amplifier uses TO-220 monolithic Darlington transistors in output stage.

be provided for the output Darlingtons, *Q2* and *Q3*. After checkout, the center voltage at test point A is set by adjusting potentiometer *R4*. If desired, the basic design can be modified to provide output powers of up to 60 watts by using different output Darlingtons. More complete details are furnished in Fairchild's Application Note 334.

Readers' Circuits. The readily available 555 timer is among the most versatile of the special-purpose integrated circuits. It seems to have more applications than the proverbial dog has fleas. Hardly a week passes that one doesn't learn of some new application for this inexpensive and interesting device. The digital thermometer circuit discussed earlier (Fig. 3) had a 555 timer in its dc/dc converter and a number of readers have submitted circuits using this intriguing IC.

As an example, the dual-purpose timer circuit shown in Fig. 5 can be used either to energize or deenergize an external device for a preset, but adjustable, time interval, depending on which pair of output terminals is used. Contributed by reader A. R. Goldsworthy (14 Edgemont Rd., Braintree, MA 02184), the design requires a minimum of components. It can be assembled on either a perf or etched circuit board and can be operated on virtually any 6-volt dc power source, including series-connected flashlight or penlight cells. In operation, output 1 is energized and output 2 is deenergized when power is first switched on by *S1*. Depressing and releasing momentary contact pushbutton switch *S2* will deenergize output 1 and energize output 2 for an interval proportional to the *R1-C1* time constant. At the end of the time interval, output 1 will be reenergized and output 2 deenergized.

The current available from either output is adequate to trigger an external control circuit, actuate a sensitive relay, power a small incandescent lamp (such as a #47 bulb) or LED. A 330-ohm current-limiting resistor should be used in series with standard LED's to prevent damage. With the component values specified, the maxiumum time delay is approximately 15 seconds, according to reader Goldsworthy. If desired, the timing interval may be increased by replacing *C1* with a 25-μF, 50-μF, 100-μF, or even larger capacitor. The lower (minimum) time limit is determined by *R1*'s adjustment and component characteristics.

A valuable accessory for both amateur and professional photographers, the automatic remote (slave) flash control circuit illustrated in Fig. 6 utilizes a 555 timer, a phototransistor, operational amplifier, and silicon controlled rectifier to achieve

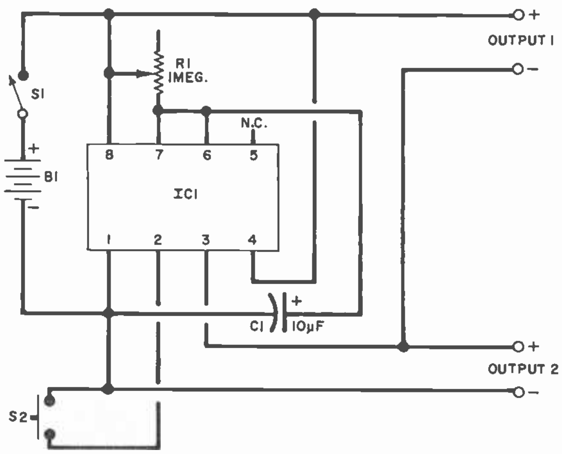

Fig. 5. Dual-purpose timer has preset interval.

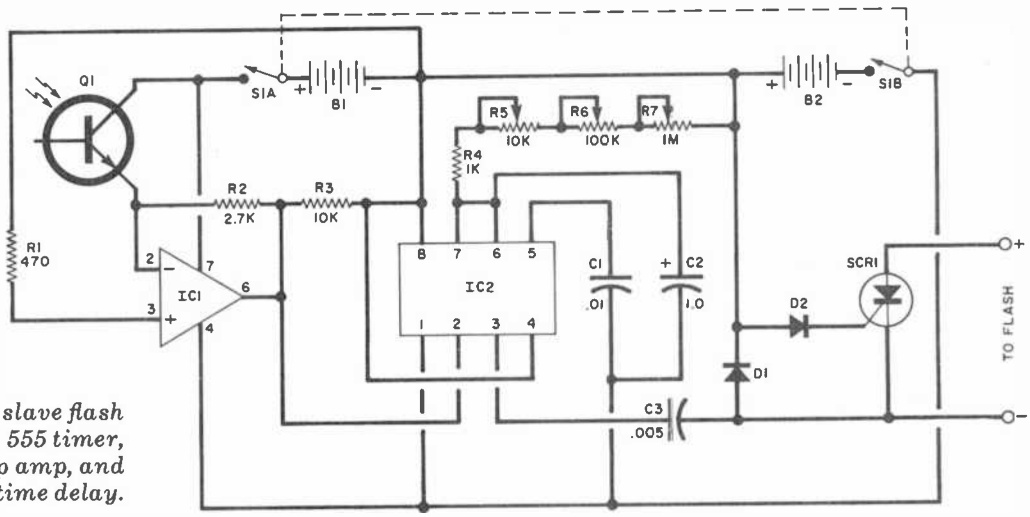

Fig. 6. Automatic slave flash control circuit uses 555 timer, a phototransistor, op amp, and SCR for adjustable time delay.

an adjustable time delay. Submitted by Richard C. Gribble (220 East First St., Kannapolis, NC 28081), who has employed several identical units for "stop motion" multiple-flash photography, the control can be used with any standard flash blub or electronic flash assembly. Light from the main flash striking phototransistor *Q1* delivers a pulse to op amp *IC1*. Amplified by *IC1*, this pulse is used to trigger the 555 timer, *IC2*. After a time delay determined by the *R4/R5/R6/R7-C2* time constant, *IC2* triggers the silicon controlled rectifier, *SCR1*, through coupling capacitor *C3*, switching this device to a conducting state and activating the external flash assembly. Circuit operating power is supplied by a pair of 9-volt batteries, *B1* and *B2*, controlled by dpst switch *S1*. Transistor *Q1* is a type FP100 or FPT100 phototransistor; *IC1* a 741 op amp; *IC2*, of course, a "555" timer; diodes *D1* and *D2* type 1N4005, and *SCR1* any standard 400-V, 1.5-A unit. Except for potentiometers *R5*, *R6* and *R7*, all resistors are quarter- or half-watt types, while *C1* and *C3* are ceramic disc; and *C2* a 10-V tantalum capacitor. Although Richard assembled his original models on perf board, other construction techniques can be used for duplicating the circuit provided all dc polarities are observed and professional assembly and wiring procedures are followed. With the parts values indicated, the time delay can be adjusted from (approximately) 1 millisecond to 1.1 seconds, with *R5*, *R6* and *R7* used to set the delay in thousandths, hundredths, and tenths of a second, respectively.

Where several controls are used simultaneously for multiple exposure stop-motion flash photography, each unit is adjusted for successively longer delays. Naturally, the photographer must take the flash duration into account which, although relatively short for electronic units, can range up to several milliseconds for flashbulbs. If flash units with different guide numbers are used, the distances to the subject must be adjusted to achieve the correct illumination for the f-stop employed. With a little practice and experimentation, however, quite professional results can be achieved, even using relatively inexpensive cameras and flash assemblies.

Device/Product News. With an eye on the booming home security market, Siliconix, Inc. (2201 Laurelwood Road, Santa Clara, CA 95054) has recently introduced a pair of smoke detector integrated circuits. Designated as types SM110 and SM120, the new units are monolithic bipolar-PMOS devices packaged in standard 14-pin DIP's. With low standby supply current requirements to insure long battery life (typically, 1 year), the two units feature on-chip MOSFET input comparators and will interface directly with ion chamber as well as photoelectric detectors. Both include low battery detection and reverse polarity protection circuits, adjustable trip points, provision for either latching or nonlatching alarm modes, and can supply output currents up to 30 mA to external discrete horn drivers. The SM110 is designed primarily for operation on 9-volt dc sources while the SM120 is designated for operation on 10-to-13-volt supplies.

If you'd like to be in tune with electronic musical instruments, then you'll be be interested in a new 7-stage counter integrated circuit announced by Fairchild's Linear Division (464 Ellis St., Mountain View, CA 94042). The new device, type F4727, is designed to generate all of the tones of the chromatic scale across eight octaves of the musical spectrum. Based on a primary chromatic scale, the IC can generate each of the twelve flats, sharps and natural notes of the seven additional octaves of the primary scale. Twelve type 4724 devices can cover the entire musical spectrum.

For CB enthusiasts, The Exetron Division of Fairchild (3105 Alfred St., Santa Clara, CA 95050) is now offering an IC citizen's band radio controller that combines channel selection with automatic scanning and a drive for 7-segment displays. The new unit, type FCB8010, is programmable for use with domestic 40-channel CB transceivers and can furnish either serial or parallel BCD coding for channel selection, eliminating the need for a BCD-coded rotary switch. It also can provide externally selectable search and scan modes, as well as increment up or down modes. The search mode is selectable for either busy or vacant channels, while the scan mode will remain on a busy channel for three seconds before advancing to the next busy channel. Slow up or down operates at two channels per second, increasing to six channels per second starting with the third channel. Emergency channel 9 is externally selectable for immediate reception, but transmitting on channel 9 is inhibited unless specifically selected.

Teledyne Semiconductor (1300 Terra Bella Ave., Mountain View, CA 94043) has expanded its line of monolithic data conversion products with the addition of three new A/D converters featuring three binary outputs. Type numbers are 8703CJ, 8704CJ, and 8705CN for the 8-, 10-, and 12-bit devices, respectively. All three devices utilize low-power CMOS technology and are fully self-contained in single 24-pin DIP's, requiring only passive support components. Conversion speed is 1 to 20 ms. The three-state binary output (latched) makes the units ideal for direct microprocessor interfacing and for multiplexing the outputs of multiple A/D converters. ◇

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Experimenter's Corner

By Forrest M. Mims

PROGRAMMABLE READ-ONLY MEMORIES

SEMICONDUCTOR memories are among the most important electronic circuits. They are found in almost all digital devices, ranging from pocket calculators to computers. Besides their obvious application in the storage of information, these memories can be used in the synthesis of unusual waveforms, music, and even human speech.

There are two basic types of semiconductor memories. *Read-only memories* (ROM's) are those from which data is normally only retrieved. *Read/write memories* (R/WM's) or *Random-access memories* (RAM's) are those into which data can be loaded or from which information can be retrieved, each with equal facility. ROM's are factory programmed with fixed data which cannot be changed.

Some ROM's, called PROM's, can be permanently programmed by the user. Others, called EPROM's, can be programmed by the user and then erased by exposure to ultraviolet light. After erasure, EPROM's can be reprogrammed. RAM's can be loaded with information, read, or reloaded electronically, depending on the logic states of the memory cell's READ and WRITE control lines.

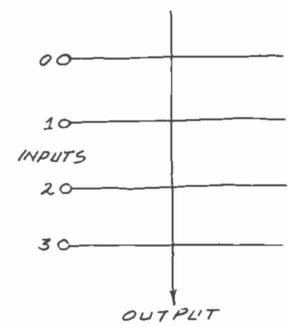


Fig. 1. PROM grid that can be used to simulate a NAND gate.

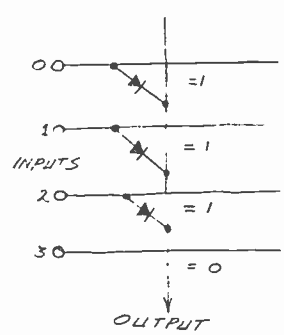


Fig. 2. 4X1 PROM programmed for 2-input NAND gate.

Both types of semiconductor memories store information in the form of binary digits, abbreviated as bits, which have two possible states—logic 0 or logic 1. The stored data can be arranged as hundreds or even thousands of bits or combinations of bits called words. Words comprising four bits (*nibbles*) or eight bits (*bytes*) are the most common, but many other word lengths are also used.

Programmable Diode ROM's. An excellent way for the novice to learn more about ROM's is to assemble a programmable ROM or PROM that uses diode memory elements. A PROM of this type consists of a grid or array of input and output wires called *lines.* A logic 1 is loaded into the ROM by bridging the intersection of an input and output line with a diode. The absence of a diode at an intersection yields a logic 0.

You can use a simple diode PROM to simulate logic gates and combinational logic networks. The first step in designing a PROM for this purpose is to write the truth table for the gate you want to simulate. The truth table for a two-input NAND gate, for example, is

	Inputs		Output
	A	B	
0	0	0	1
1	0	1	1
2	1	0	1
3	1	1	0

This truth table has four possible input combinations and only one output for each set of inputs. Therefore, our PROM will be a 4 by 1 grid of lines as shown in Fig. 1. The truth table is loaded (programmed) into the PROM by placing a diode at the intersection of the output line and the line for each input, which results in a logic-1 output. The programmed array is shown in Figure 2. Figure 3 shows how to demonstrate the operation of the PROM with the help of a

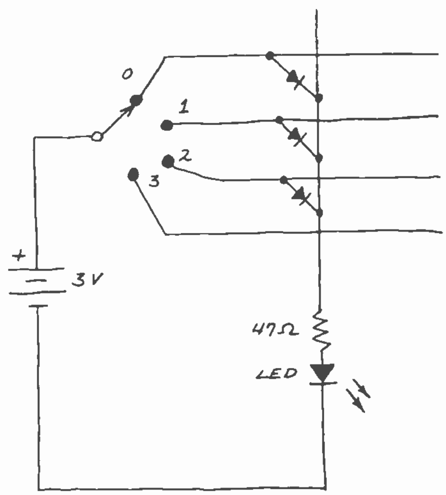
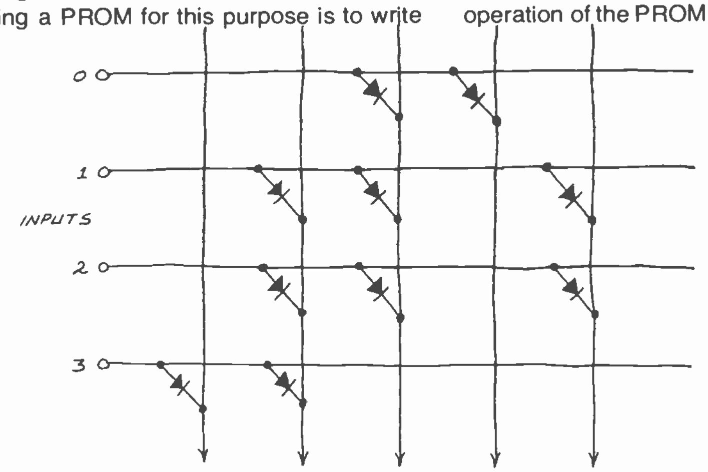


Fig. 3. Circuit to demonstrate the PROM in Fig. 2.



INPUTS	AND	OR	NAND	NOR	XOR
0--00	0	0	1	1	0
1--01	0	1	1	0	1
2--10	0	1	1	0	1
3--11	1	1	0	0	0

Fig. 4. Multiple function diode PROM.

battery, a LED, and a four-position switch.

Of course, our simple PROM version of the NAND gate is a trivial example of a read-only memory application. This is particularly true because the diodes aren't even necessary! Logic 1's can be represented simply by connecting the appropriate input lines to the output line. However, diodes are essential when the PROM becomes more sophisticated. For example, Fig. 4 shows a diode PROM that simulates the AND, OR, NAND, NOR, and EXCLUSIVE OR gates. Mass confusion would result without diodes because electrical current would thread its way through the wrong sections of the PROM via *sneak paths*. Diodes eliminate sneak paths because they pass current in only one direction.

Diode PROM Character Generator. Do you want to gain some hands-on experience with PROM's? Then invest some spare time and about three dollars building the diode PROM shown in Fig. 5. This simple PROM is connected as a seven-segment character generator. It allows you to generate up to ten characters including the digits 0 through 9, many letters of the alphabet, and a variety of unusual symbols.

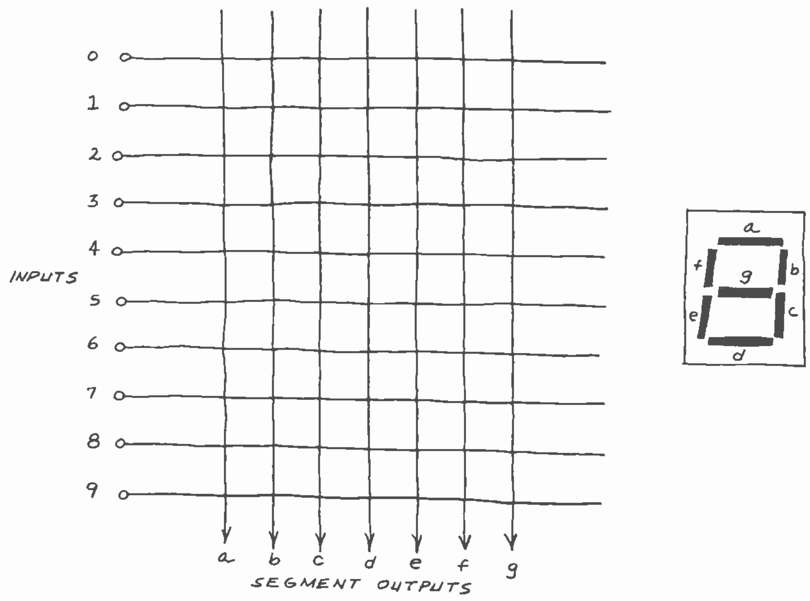


Fig. 5. Seven-segment display character generator diode PROM.

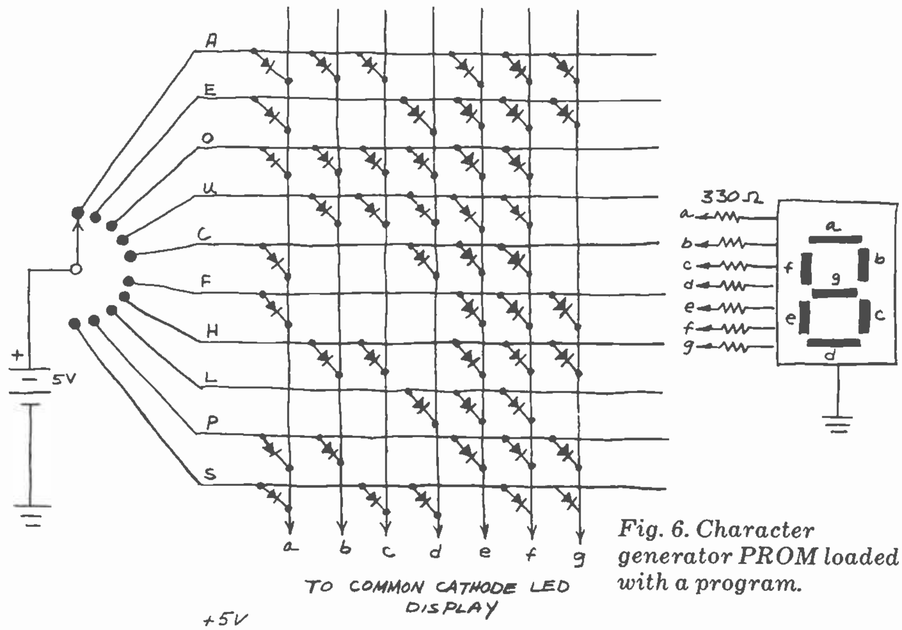


Fig. 6. Character generator PROM loaded with a program.

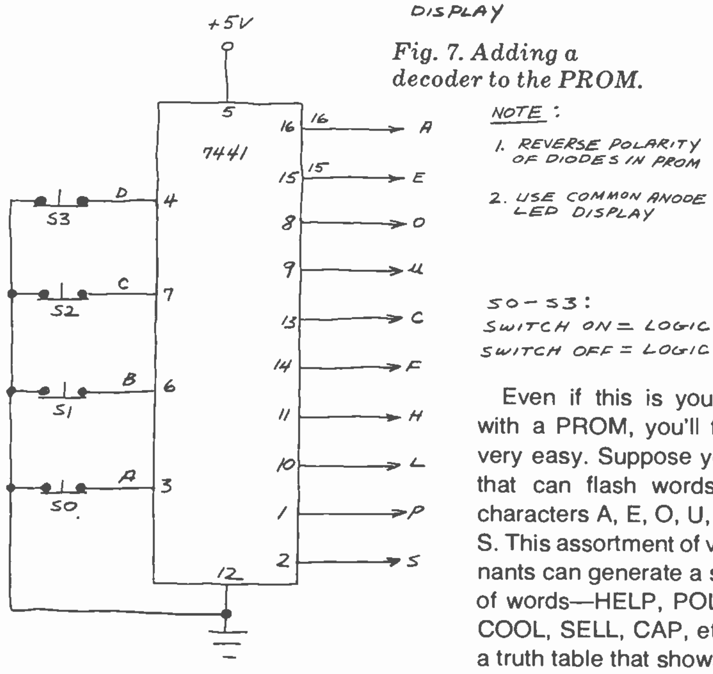


Fig. 7. Adding a decoder to the PROM.

Even if this is your first experience with a PROM, you'll find programming very easy. Suppose you want a display that can flash words made from the characters A, E, O, U, C, F, H, L, P, and S. This assortment of vowels and consonants can generate a surprising number of words—HELP, POLE, PULL, HOLE, COOL, SELL, CAP, etc. First, you write a truth table that shows the segments of the display that must be illuminated to produce each character.

Character	a	b	c	d	e	f	g
A	1	1	1	0	1	1	1
E	1	0	0	1	1	1	1
O	1	1	1	1	1	1	0
U	0	1	1	1	1	1	0
C	1	0	0	1	1	1	0
F	1	0	0	0	1	1	1
H	0	1	1	0	1	1	1
L	0	0	0	1	1	1	0
P	1	1	0	0	1	1	1
S	1	0	1	1	0	1	1

(Segments)

This prom has ten input and seven output lines, so it requires a grid of 10 by 7 wires. The PROM is programmed by inserting a diode at the intersection of each character and segment line where a logic 1 exists in the truth table (Fig. 6). Simple, isn't it? If you're not convinced, try designing the same character generator with logic gates!

We can improve the character generator PROM by replacing the manual selector switch with a BCD-to-decimal decoder. True, this adds an IC, but reduces the number of input lines from ten to four and makes it possible to interface the PROM with other circuits. Figure 7 shows how the decoder is connected to the PROM.

You can assemble a working version of this diode PROM on a perforated board. Insert flea clips at each bit position and run the input and segment lines on opposite sides of the board to prevent shorts. The flea clips will allow you to insert and remove diodes. If you want to go first class, permanently wire a diode in series with an spst toggle switch at each bit position. Turning the switch on will load a logic 1. Placing the switch in the off position will load a logic 0. If you choose to do this, you'll need seventy switches, so be sure to shop around for a good price.

In any event, I hope you'll build a working diode PROM if you're interested in learning about the practical aspects of ROM's and PROM's. You'll learn something about *hardware* (the PROM and decoder), *software* (the truth table you plan to load into the PROM), and *firmware* (the truth table loaded in the PROM in the form of diodes). You'll also learn about *addressing* (the 4-bit character select word applied to the input of the decoder). All of these topics are fundamental to an understanding of advanced digital logic devices like microprocessors, calculators, and hobby computers. ◇

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Hobby Scene

By John McVeigh

SHORTWAVE DIRECTORY

Q. ***I'm an SWL'er and would like to know where I can obtain a book listing the addresses of shortwave broadcasting stations in the U.S. and foreign countries. —Todd Gerard, Scarsdale, NY.***

A. One of the most complete shortwave directories I've seen is the *World Radio TV Handbook*. It is published by Gilfer Associates, Box 239, Park Ridge, NJ 07656, is updated annually, and is available for $10.95 postpaid. The Handbook not only lists the addresses of shortwave broadcasters, but also contains data on station power, antennas, etc.

MUSICAL CALCULATOR

Q. ***Recently, I made an accidental discovery. When I placed my calculator near the rod antenna of my AM receiver, I found that I could produce tones by pressing the keys. Can you tell me what I was doing?—Robert Morog, Jr., Lorain, OH.***

A. Inside the calculator are all kinds of switching waveforms from a clock oscillator, counters, flip-flops, etc. These waveforms (usually square waves) contain many harmonics. What you heard were harmonics that were high enough in frequency to be within the AM broadcast band. If you have a programmable calculator, and some patience, you can probably write program sequences to play "melodies."

DRY TRANSFER LETTERING

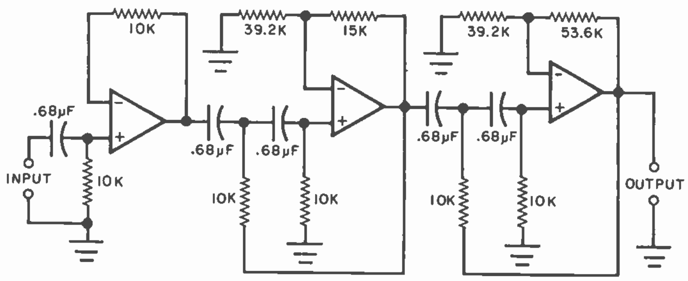
Q. ***Where can I buy the lettering that is often used on the projects in your magazine?—Dennis Glatting, Cincinnati, OH.***

A. The lettering you refer to is called "dry transfer lettering." It is not a decal, and transfers from the sheet it is supplied on by burnishing the face of the transfer sheet with a pencil or similar object. Once it is transferred to the project panel, it should be sprayed with a lacquer fixative to prevent it from wearing off. One line of dry transfer lettering, produced by the Datak Corp., 65 71st Street, Guttenburg, NJ 07093, is available at many electronics supply houses. A mail order source of dry transfer lettering (available in two sizes, and in black or white for $3.50 a pack) is Amidon Associates, 12033 Otsego Street, North Hollywood CA 91607.

SUBSONIC FILTER

Q. ***I need a subsonic filter for my stereo system. I would like to insert it in the tape monitor loop or between the preamp and power amp. A very sharp cutoff below 20 or 25 Hz is required.—Joseph Hance, Richmond, IN.***

A. A fifth-order, high-pass filter is shown in the figure. It has a cutoff frequency of 25 Hz and a rolloff of 30 dB (!) per octave. I hope that's steep enough for your application. Passive components should have tight tolerances—no more than 5%. Op amps such as the 741 or LM318 are suitable. Be sure to connect the op amps to a low-ripple, regulated bipolar dc supply at about ±9 volts.



LINE NOISE

Q. ***I have a serious problem with static interference on my CB radio (a mobile used with a line-powered supply). It's not there all the time, but close to it. The interference usually comes on around 6:45 AM, increasing the ambient noise level from about S2 to S8. I think the source is on the ac line, because it is on or off at regular intervals. It's not caused by any of the appliances in my house. Can you recommend a filter that I can use to block the signal?—Jeff Brown, Akron, OH.***

A. First, try powering your transceiver from a 12-volt battery. If the noise is no longer present (which I doubt), it is reaching the transceiver via the ac line. This can be prevented by installing a "brute force" filter such as those manufactured by Sprague, J.W. Miller, Cornell Dubilier, etc.). If the interference persists, it is being radiated by the ac power line. There is *no* filter you can install between the antenna (which is picking up the noise) and the transceiver that will eliminate the noise but not the desired signal. The way to cure this problem is to sniff out the source of the radiation, which can be anything from a brush-type motor to an aquarium heater thermostat. Use the CB transceiver or a small AM radio to locate the source. A directional antenna like a small loop or ferrite loopstick can help isolate the offending appliance. If the interfering unit can be located, bypass capacitors or a line filter, (or even shielding) should be used to suppress the noise.

Sometimes, noise is generated by a component in the power line itself—a leaky insulator, intermittent contact, or loose hardware. Noise sources can be hard to locate, because the noise can travel along the line for some distance. Many power companies have interference-tracking programs, and will follow up complaints from hams, SWL's, and CB'ers. This type of interference can be continuous or intermittent, sometimes linked to the weather. Your problem suggests not a power line disorder but an electrical component drawing power from the line. However, your local power company might be able to offer more detailed information or some assistance.

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

Product Test Reports

REALISTIC MODEL TRC-449 MOBILE AM/SSB CB TRANSCEIVER

Company's top-of-line 40-channel mobile.

THE Realistic Model TRC-449 from Radio Shack is an AM/SSB transceiver designed for mobile communication on the Citizens Band. Its 40-channel coverage is obtained from the now-familiar phase-locked-loop (PLL) digital frequency-synthesis system. Large red LED-type seven-segment numeric indicators are used to identify the channel selected.

The Model TRC-449 features: RF GAIN, VOLUME, CLARIFIER, and SQUELCH controls; AM/USB/LSB mode selector; LED's to identify the mode selected; a switch that inserts and removes a noise blanker (NB)/automatic noise limiter (anl); bottom-facing speaker; PA/CB/MON switch; external-speaker jacks; illuminated S/r-f meter; LED DIM control; low-level clipper with filter; automatic modulation control (amc); automatic level control (alc) for SSB; electronic voltage regulation; and reverse-polarity protection and line filter. Operation is specified at 12 to 16 volts dc, negative or positive ground.

The transceiver measures 10½"W × 7⅞"D × 2⅜"H (26.6 × 20 × 6 cm) and weighs 6 lb (2.7 kg). Price is $299.95.

Technical Details. The receiver section employs a single-conversion design. A transistor r-f stage is followed by a FET mixer in which the CB signal is heterodyned with the PLL's voltage-controlled oscillator (vco) and the difference frequencies produce a 7.8-MHz i-f. AM selectivity and sideband selection are obtained with a crystal filter. Following the filter are four amplifier stages, a dual-diode AM detector, agc and meter rectifiers, and a series-gate anl. A product detector is provided for SSB operation, with carrier reinsertion obtained from a nominal 7.8-MHz beat-frequency oscillator (bfo).

Amplified agc and squelch systems are employed in the receiver. The audio section has a transistor amplifier and an IC that contains the power-output stage and provides modulation on AM transmit. The noise blanker operates at 23 MHz and gates the output of the mixer. It is switched on and off simultaneously with the audio anl.

The PLL system employs the customary 10,240-kHz crystal-controlled oscillator from which the standard 10,000-Hz reference signal is derived with the aid of digital dividers. An 11,285-MHz crystal signal is tripled and then difference-mixed with the output of the vco, after which it is divided according to the setting of the channel selector to provide a nominal 10,000-Hz signal for the vco comparison signal. Both 10,000-Hz signals are then applied to an IC phase comparator for controlling the vco.

On transmit, the output of the vco is difference-mixed at a transmitter mixer with the nominal 7.8-MHz bfo signal for generating the AM carrier for the r-f amplifiers. On SSB, this signal first goes to the usual balanced modulator and sideband-filter system. The output of the vco and the 7.8-MHz signal are slightly shifted to place the signal at the proper point on the required sideband for SSB or sidebands for AM.

Following the transmitter mixer are r-f amplifier, predriver, driver, and power-amplifier stages. A multisection output filter with a TVI trap minimizes harmonics and other spurious responses. It also provides matching to 50-ohm loads.

The customary collector-modulation of the driver and power-amplifier stages is engaged for AM. On SSB, all r-f stages function as linear amplifiers. Amc is provided by an agc circuit around an IC microphone preamplifier plus a low-level clipper that has a low-pass audio filter at its output to minimize distortion and other products outside the audio passband. Alc is used on SSB. Transmit/receive switching is accomplished with a relay and electronic switches.

Laboratory Measurements. The receiver's sensitivity measured 0.5 µV for 10 dB (S + N)/N on AM at 30% modulation and with a 1000-Hz test tone. It was at least 0.2 µV on SSB, again at 1000 Hz. Image and i-f rejection were 80 dB minimum. Other unwanted-signal and adjacent-channel rejection and desensitization were 65 dB.

The squelch threshold range was 0.3 to 1000 µV. The agc held the audio output level to 10 dB with an r-f input change of 20 dB at 1 to 10 µV and to 14 dB with an 80-dB input variation at 1 to 10,000 µV. The meter indicated S9 with a nominal 100-µV input signal and S4 with a 5-µV input signal.

The overall 6-dB audio response was 500 to 2300 Hz on AM, 500 to 3600 Hz on LSB, and 600 to 3700 Hz on USB, peaking 3 dB at 2800 Hz. Maximum audio sine-wave output power at the onset of clipping was 3.75 watts at 2% THD with 1000 Hz into 8 ohms and 2.5% THD with 400 Hz.

Operated from a 13.8-volt dc source, the transmitter developed an AM carrier output of slightly more than 3.5 watts. Modulation at levels 16 to 25 dB greater than that required for 50% modulation, using a 1000-Hz test tone, was nominally 90% at 4.25% THD. Maximum modulation with a 400-Hz tone was about 70% at 3% THD.

Adjacent-channel splatter at more than ±5000 Hz from the carrier was greater than 60 dB down at 1000 Hz and 50 dB down at 2500 Hz. On voice, full modulation was obtainable with splatter well in excess of 60 dB down. The 6-dB response on AM was 475 to 2700 Hz.

The maximum SSB output power measured 10.5 watts using single-tone modulation and 12 watts PEP with voice modulation. The alc prevented overmodulation and flattopping, holding the third-order distortion products to 28 dB below two test tones or 34 dB below maximum PEP. Unwanted-sideband suppression was greater than 60 dB at 1000 Hz and was the same on receive. Carrier suppression was nominally 55 dB. The overall audio response at the 6-dB down points was 350 to 2800 and 400 to 2750 Hz on USB and LSB, respectively.

The transmitter frequency was ±14 Hz from −15 Hz on channel 21.

User Comment. If you like lots of shiny chrome, the Model TRC-449 has it. The case is black but the front panel is chrome and simulated wood with chrome knobs. The channel selector knob has a bar grip. The other rotary controls (including the LED DIM control, which is concentric with the SQUELCH control) are small and arranged in a row along the lower half of the front panel. The SQUELCH control extends beyond the other knobs for easy location while driving. An overhanging upper section of the front panel can obscure the control legends when the transceiver is installed well below eye level.

A miniature toggle switch is used for inserting and removing the noise blanker/anl. A similar switch gives the user a choice of CB or PA operation and includes a MON (monitor) position for disabling the internal speaker to allow signals to be monitored on a remote PA speaker.

The edgewise meter is illuminated in white on receive and in red on transmit. Its calibrating numerals are quite small and therefore difficult to read at most distances encountered in mobile installations. Also, meter indications greater than S9 tend to be somewhat compressed, making it difficult to discern the actual-signal levels in this range.

Bench tests with our impulse-noise generator indicated that the noise-attenuation system (NB/anl) permitted undisturbed readability of signals as low as 0.5 to 10 μV in strength that were otherwise completely obliterated by the noise pulses. In our noisy test vehicle during SSB operation, however, we noted that ignition spikes from our car with the blanker switched on were not altogether eliminated—though diminished. In any case, noise interference did not reach bothersome levels.

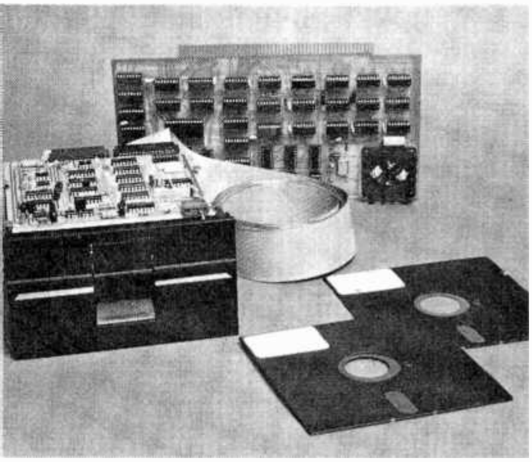
Switching from USB to LSB on SSB operation on the sample unit caused the transmitter frequency to drop by about 160 Hz, requiring corrective retuning at the receiving end. But this situation can be eliminated by having a licensed technician readjust the LSB crystal.

The overall performance of the transceiver was excellent, as confirmed by our laboratory measurements and on-the-air tests. It provided good receiver sensitivity, selectivity, and signal-handling capabilities. It exhibited clean, crisp audio on both receive and transmit. There was no splatter or overmodulation or discernible distortion from the low-level clipper. The unwanted-sideband suppression was fine, and the SSB distortion products were low.

In sum, the Realistic TRC-449 is a fine AM/SSB CB transceiver for its price. The SSB function will permit users to reach extra miles of communication.

NORTH STAR MODEL MDS-A MICRO DISK SYSTEM

Floppy disk system provides 92k mass storage per diskette.



ALMOST every computer hobbyist dreams of owning a mass-storage facility with high access speed, such as the floppy disk systems used by the big guys. Unfortunately, the expense of a floppy disk system was prohibitively high at one time. Now, however, several floppy disk manufacturers have introduced a physically small drive mechanism that uses a "diskette" that measures about 5" (12.7-cm) in diameter and costs only a fraction of the full-size disk systems. These minidisks can store between 90 and 100k bytes at an attractively moderate price.

The Model MDS-A micro disk system from North Star Computers, Inc., is one such floppy. It's built around the Shugart Associates Model SA400 minifloppy TM drive mechanism. For $699, you get the assembled and tested Shugart drive, disk system controller kit that occupies one Altair bus slot, all cables and connectors, two diskettes, and complete hardware and software documentation. One of the 5", 90-k byte diskettes contains the disk operating system (DOS) software and disk BASIC, while the other is supplied blank. The system requires 16k of resident RAM in the computer to support the DOS and BASIC.

The Model MDS-A requires 5 volts at 0.9 ampere and 12 volts at 1.6 amperes, both of which can be obtained from the host computer. Alternatively, you can use a home-built supply or North Star's optional power supply kit ($39.00). North Star also offers an optional case for the system for $39.00.

General Details. The DOS board, which occupies one slot in an Altair 100-contact motherboard system, went together in a couple of evenings of relatively easy work. Once it was assembled, we used the hardware manual to test it. This manual provides complete test data, including pertinent waveforms, to ensure that the board is properly wired and works. The manual also covers system integration, interconnections, and details of the optional power supply and includes the schematic diagram of the DOS board assembly.

The software manual deals only with the DOS software. It completely explains all 16 commands used in the DOS software and uses examples to explain how to interface the DOS and BASIC software with the user's computer, whether the computer has an operating system or not.

Once the DOS and BASIC are up and running, the prerecorded diskette containing the DOS and BASIC software is removed from the drive mechanism and replaced by the blank diskette. The DOS and BASIC and their personalized instructions are then recorded on the new diskette so that the next time the system is to be used, the computer is simply started up at the DOS entry point. Within a few seconds, the system is ready.

North Star BASIC (version 6 is provided) is very powerful. It includes multiple-dimensioned arrays, strings, multiple-lined functions, formatted outputs, and machine-language subroutine capability. Of course, it also has all the required disk functions.

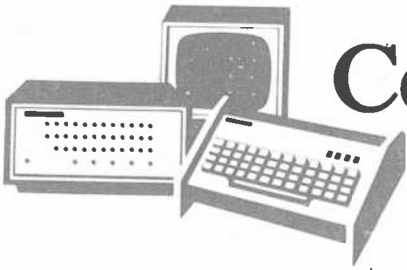
In addition to all the better BASIC commands, calculator mode, etc., North Star BASIC has a REN (renumber) command that allows changing line numbers at the beginning and within a line. There is also an EDIT function that has seven editing commands to facilitate the required line changes. One very useful operation within the BASIC itself, called "compatibility," minimizes the effort required for converting programs written in other BASICs so that they can be used with North Star BASIC. For example, left bracket, right bracket, colon, and semicolon are converted into left parenthesis, right parenthesis, reverse slash, and comma, respectively. This conversion does not occur within quoted strings in a program. The conversion is automatic. Hence, you no longer have to worry about a program not running because some wrong (for North Star BASIC) symbol was typed in.

There are many other powerful commands in North Star BASIC, but space does not allow us to discuss or even enumerate them here.

User Comment. Since we put the Model MDS-A into operation, our computing has certainly been made easier. From a cold start, we can now turn on our computer, execute at E900, the DOS entry point, and have the DOS, BASIC, and any other program on the disk on our monitor screen ready to go. The whole sequence takes about 10 to 15 seconds.

We found that, with the MDS-A system, it is very easy to save BASIC and machine-language programs with only a couple of touches on the keyboard. If we sound enthusiastic about this new mini-floppy system, we are. For little more than the cost of a 16-k RAM board, we have 90k of mass storage. This may not sound like much, but when you consider that it costs only $5 more for each blank diskette, which adds 90k of storage per diskette, the cost is impressively low.

CIRCLE NO. 105 ON FREE INFORMATION CARD



Computer Bits

By Hal Chamberlin

HIGH-LEVEL LANGUAGES

DURING the short 30-year history of computers in general and even shorter 4-year history of microcomputers, the most significant software development has been the availability and use of high-level computer languages. The term "high level" is used because these languages allow a programmer to interact with the machine on a less detailed and more meaningful basis than does a so-called "low-level" machine language. The high-level languages permit the average person to use a computer system effectively without having to acquire a large amount of specialized knowledge about binary number systems, memory mapping, character codes, and other such nonsense. Also a given high-level language tends to be the same regardless of the particular type of computer involved. This, of course, is not true with machine or assembly language, which is entirely different when going from one computer type to another.

High-level languages can be broken down into two basic groups. The first group consists of *general-purpose* programming languages. These are intended for use in writing computer programs, both casual and professional. They are called general purpose because they can be used, at least in theory, to write any kind of computer program. Some specialization does exist however. For example, FORTRAN is best suited for complex scientific calculation but has been used for business data processing. COBOL is the most widely used language for business programming but it also has scientific applications although it is very inefficient in that field.

Members of the second group are called "application languages". These are associated with particular "application package" programs. One example is ECAP which stands for Electronic Circuit Analysis Program which is used to simulate and analyze the behavior of electronic circuits. The ECAP language is used to describe the circuit of interest and to instruct the program on what to do with the circuit just described. Another is COGO standing for Civil Engineering Coordinate Geometry, which is used to aid surveyers in evaluating and mapping parcels of land. Using an application program and associated language for its intended purpose is vastly simpler than writing a program to do the same thing from scratch with a general-purpose language.

Of course, all of these advantages of high-level computer languages do not come free. A given program written in a high-level language invariably requires more computer memory and more execution time. The differences generally are not trivial either. On a large machine the difference in memory requirements can easily be 3 to 1 and execution time 5 to 1. On a microprocessor, the memory difference might actually be smaller but the time difference can be 10 to 1 to over 100 to 1.

The difference in programming effort swings to the other extreme with high-level languages requiring as little as one-tenth the effort from inexperienced programmers. Professional programmers cope better with machine-level languages but the difference is still substantial. In effect, machine language gives the programmer complete control over the details of programming thus providing the opportunity to write an *efficient* program, one that takes a minimum of memory and execution time. The situation is analogous to automatic versus manual transmissions in cars. Better gas mileage, quicker acceleration, and better handling in snow is possible with a 4-speed manual transmission but the automatic is more convenient and easier to learn.

Most hobbyists want to run BASIC on their systems and are willing to pay a premium in order to do so. BASIC is a well-known, very easy to learn, general-purpose computer language that works well on small systems. It is particularly effective for small- to medium-sized programs involving mathematics and character string manipulation.

Several other languages are now slowly being implemented on microcomputers. Probably the most widely desired is FORTRAN which is better suited than BASIC for writing large or complex programs. Accordingly, larger systems with more main memory and mass storage devices are required to run FORTRAN. Many application packages such as ECAP mentioned earlier are written in FORTRAN. Actually BASIC was modelled after FORTRAN with many of its difficult or confusing features omitted or modified.

Another language generating much interest among advanced hobbyists is APL. This is a highly symbolic language that is very adept at handling arrays of numbers and other structured data.

Inside High-Level Languages. Actually a high-level language package is nothing more than a program itself, although it is very complex. Simply stated, the "language processor program" looks at statements in the particular high-level language and translates them into equivalent machine-language operations. Such language processor programs are called "compilers" and "interpreters" according to the two distinctly different methods of translation. Incidentally, most language processors are written in machine language to maximize efficiency of the translation process which, as will be shown later, is very important.

When using the compiler type of translator program, it is really a two-step process to take a program written in the high-level language and get it running on the computer. First the compiler program takes the high-level language statements, which as a group are called the *source program*, and translates them, one at a time, into equivalent machine-language instructions. The collection of generated machine-language instructions is sent to a storage device (such as a cassette or floppy disk) and is called the *object program*. Now we have an equivalent program in machine language written on the storage device which completes step one.

Before the object program can be run, it must be loaded into memory. Along with it are loaded some utility subroutines which are called the *run-time package*. These subroutines perform generally needed functions such as binary/decimal conversion, mathematical functions, and others. Usually a special loader program is required to read the object program and run-time package into memory and get them properly linked together. After the loading process is complete, the program may actually be run just as though it had been written in machine language in the first place.

Using the interpreter type of translator is generally much simpler. The main idea is to make the programmer believe that the computer is actually executing the high-level language directly. Accordingly a portion of the interpreter is actually a text editor which aids the programmer in entering the high-level language program into memory and changing it. The source program in this case is stored in memory as ASCII character strings which is simply the original program text or a slightly modified version of it. After the program is typed in, it may be run directly by using the second portion of the interpreter.

In effect the interpreter looks at the first program statement, translates it to machine language, executes it, and then forgets the translated version. Then the second statement is processed in the same manner. If a group of statements constitutes a loop, each is translated, executed, and thrown away in turn, even though these statements may have been translated hundreds of times previously. Actually most interpreters do not generate real machine language and then execute it. Instead, they scan the high-level language statement, extract the important information from it and act directly on the basis of that information. Thus the impression is given of a machine with a very powerful instruction set that actually executes the high-level language directly.

Now what about the relative merits of the two techniques? The interpreter certainly sounds simpler and more convenient to use and indeed it is. But what is gained in ease of use is lost in execution speed. Most programs spend nearly all of their time in one or more short loops. With an interpreter, the statements of the loop are repeatedly scanned and translated. Usually the translation process for a statement takes longer than the actual work specified by the statement. With a compiler, all of the statements of the program are translated once so that, during execution, only the time necessary to perform the useful work is needed. Storage space for the user program is not significantly different between a compiler and an interpreter. However, since the compiler program is not in memory when the object program is executing, it is likely that a larger program could be accommodated with a compiler.

The choice between interpreter and compiler depends heavily on the language. BASIC is nearly always implemented as an interpreter in order to maximize its convenience. FORTRAN, on the other hand, is usually compiled. APL, due to its very structure, is always interpreted. Actually, since APL programs are so compact, the overhead associated with interpretation is much less than with a verbose language such as BASIC.

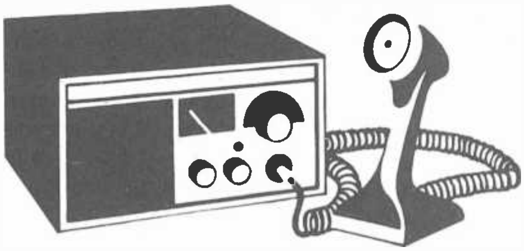
Hardware Required. Using BASIC as an example, how large must a system be to use it effectively? Usually the only input/output device required is a terminal of some sort. A mass storage device is handy for saving programs but is not necessary to run them. Thus the important measure of system size is simply the amount of memory present. Accordingly, BASIC interpreters are usually rated by the amount of memory required by the interpreter and the number of language "features" supported. Memory requirement figures often include a small area for storage of the user program but this generally amounts to only a few lines of BASIC.

The smallest BASIC interpreters can be as small as 2k bytes. Being so small, they offer only the most important language features and are often given the name *Tiny* BASIC. The most distinguishing feature of a Tiny BASIC system is that only integer numbers are allowed, usually constrained to values between −32,768 and +32,767. So-called "full-featured" BASIC interpreters can run in as little as 4k. These support normal floating point (scientific notation) arithmetic and common mathematical functions but lack the features for character string manipulation. The most common interpreter size is 8k. All useful mathematical functions are allowed, two dimensional arrays are permitted, and statements are provided for handling character strings. The ultimate is variously called Disk BASIC, 12K BASIC, Extended BASIC, and other similar names. In addition to all of the features just mentioned, these interpreters allow user programs to set up and access files of data on a floppy disk or cassette tape. If any kind of home accounting or small business applications are expected to be written in BASIC, then this is the version that is needed.

As noted above, additional memory is required for all but the most trivial programs. Although it is difficult to judge how much memory a given program will require without actually trying it, a good rule of thumb is to allow 1k per 50-line page of sparsely commented BASIC statements. If long statements with a lot of comments are more your style, 2k per page might be a better figure. Also, many interpreters allow the mathematical functions to be deleted if not needed thus freeing 500 to 1000 more bytes of memory.

Speed is even harder to pin down than memory requirements; but compared to machine language, BASIC is quite slow. Simple arithmetic operations such as addition and subtraction generally take about 5 milliseconds each while multiply and divide take a little longer. Of course the floating point arithmetic, which itself is a complicated subroutine in the interpreter, is partially responsible but tests have shown that even integer-only Tiny BASIC's are not much faster. Thus the conclusion is that the interpretation process takes a lot of time. In many cases of course, speed is of no consequence, but if a lot of calculation is to be done the time can add up quickly. An excellent article in the June, 1977 issue of *Kilobaud* magazine compares the speed capabilities of several BASIC interpreters.

Increased use of high-level languages is definitely a wave of the future which will be spurred on by the development of microprocessors specifically designed to support such languages. ◇



CB Scene

By Walter Salm

THE FORGOTTEN CB SERVICE

IF YOU'VE been involved with personal communications for a while, or are a student of radio history, you know that the 11-meter band does not house the only CB service. The popular and overcrowded CB radio in use since 1958 is called "Class D" because it was actually the *fourth* CB radio service authorized by the FCC. First there was Class A in 1947, followed by the now-defunct Class B. Class C is allocated for model radio control use and is still operational. So is Class A, the "forgotten" CB service which, at last count, had about 5000 licensees nationwide. The tally for Class D, on the other hand is approaching 12 million.

Why is Class A so underpopulated? For one thing, equipment has been much more expensive; so people who are geared to thinking of CB in terms of $150 for a transceiver may not want to plunk down $400 or more for a Class A radio. What do you get for that $400?

(1) You can have a transmitter power output up to 50 watts (though it may be limited to 15 watts in some areas).

(2) There will be only one or two channels on the radio. If you want to switch to other channels, you'll need a new pair of crystals and a new frequency authorization from the FCC. This is because you request specific frequencies when you make an application for a license. All that good-buddy type of CB'ing goes out the window. If you buy Class A, you're buying it to communicate with specific parties.

(3) Class A is FM, so it has inherent freedom from noise interference.

(4) It's also uhf, using the 460–to–470–MHz part of the spectrum, and this makes it strictly line-of-sight. But line-of-sight isn't all that bad when you consider the overcrowding, sunspot skip and higher noise levels of today's AM Class D CB.

How much usable distance can you get mobile-to-mobile on AM CB today? Three miles? Maybe four? When you get stepped on by some joker running an illegal linear, forget about talking entirely.

On uhf, you get clear, reliable communications for a distance of about 20 miles mobile-to-base if there are no obstructions. With a repeater, you can reach 60 miles or more, and community repeaters are going to become popular for this service very soon.

"Breaker, Watson, do you copy? This here's rubberduck. Over."

Equipment. One company, Standard Communications, is doing something about the sad state of Class A. Until this year, if you wanted Class A, you had to buy uhf equipment that was designed for business radio use and plug in crystals for Class A. Standard introduced a unit last spring designed specifically for Class A service and priced at $399. Sure, that's 10 times the price of a Class D rig, but look at the advantages you're getting. If you want to communicate with your home or office, you can really do it with clear, noise- and interference-free channels.

Standard says that its distributors are selling Class A radio briskly now, and there's a great interest in repeaters as well. Chances are that community repeaters will be set up the way they are now for business users. The dealer who sells you the equipment also owns a repeater and will rent you air time on the station for a monthly fee. Business radio users typically pay $25 to $30 a month for this. There's no reason why CB clubs can't get involved in Class A and set up their own repeaters. This would work out to be a real bargain for the CB'er who goes into Class A, and would certainly stimulate interest in the service.

Class A has been so neglected, in fact, that it has been losing channels to business radio services. Today's Class A has just 16 channels (often referred to as "eight pairs" because duplex operation is common), but at one time, there were many more channels assigned to Class A—as many as 75. When nobody is using a service, it seems fairly easy for the FCC to say, "Let's take a few channels from that service and give them to another." That's exactly what happened.

Here's what is left for the Class A user, organized by the FCC into properly spaced pairs for the duplex user:

Base and Mobile (MHz)	**Mobile Only** (MHz)
462.550	467.550
462.575	467.575
462.600	467.600
462.625	467.625
462.650	467.650
462.675	467.675
462.700	467.700
462.725	467.725

Notice that the "matched pairs" have 5-MHz spacing between them, making duplex operation possible. It also provides more than enough channel isolation for repeater use.

Licensing. If you're afraid to approach Class A because of licensing, bear in mind that it's still CB, and you don't need any more qualifications for a license than you do for Class D. The application form is different and slightly more complicated, and there's no temporary operating permit.

Also, it's unlikely that your favorite CB store will have the equipment on hand. The dealer will have to order it for you, and this could take from a few days to a few weeks, depending on whether he can get the transceivers from a nearby distributor. Another possible delay can develop when you want crystals. As things stand now, Class A crystals are not items that even the most complete CB shop is likely to stock. Again, a special order will probably be required.

There's a different license form to fill out for Class A—Form 400. Also, you have to get something called a construction permit from the FCC. This is combined with the Form 400 and all it really requires is that you tell the FCC how high an antenna you plan to erect for your base station (200 ft max), give the exact location, and certify that it's not near enough to any airports that it would be under FAA restrictions.

If the proposed installation does come under FAA restrictions, it's a whole different ballgame, with formulas to determine how high the antenna can be, etc.

The Future. There's little danger of channel crowding on FM CB, at least for now; it's that under utilized. Also a lot more power is permitted—legally—than on Class D. A typical Class A transceiver has an r-f output of 25 watts, and most installations can legally go as high as 50 watts.

But high power levels aren't really needed here. Line-of-sight operation means that relatively modest transmitter power will be adequate. Because there's no possibility of working skip, no advantage is gained by using illegal, high-powered amplifiers. On the other side of the coin, there is hardly any possibility of getting skip interference.

Back in 1947, when Class-A CB was first legalized by the FCC, the uhf spectrum was still a no man's land. Little was known or understood about it, and many people believed that it would be totally unusable for everyday communications. In later years, when Class-D CB was legalized, it was plopped right in the middle of the "noise band"—a group of frequencies prone to man-made radio interference (from industrial electrical equipment and radio diathermy machines in particular).

More recently, uhf business-band users have proven that this once-useless radio band is very usable, but the government has taken away much of what was given in 1947.

Will the remaining 16 channels be grabbed up for business radio? Probably not, because there's so much renewed interest in these frequencies. Besides, there are 5000 licensees currently using it, and they have made fairly sizable investments in equipment. But to preserve these few channels, we'll have to see more people using them. They're there, just waiting for us. ◇

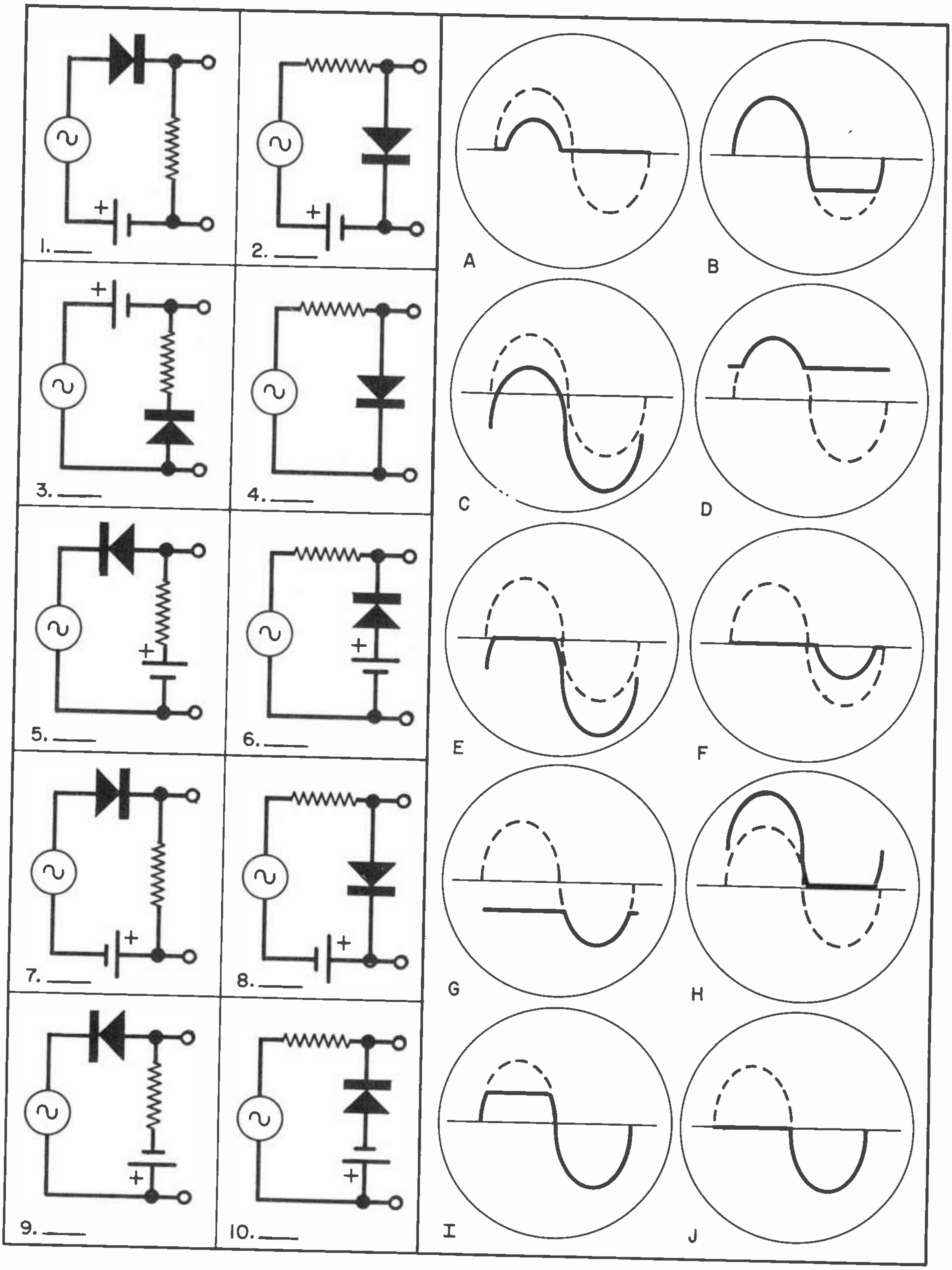
CLIPPER CIRCUIT QUIZ

BY ROBERT P. BALIN

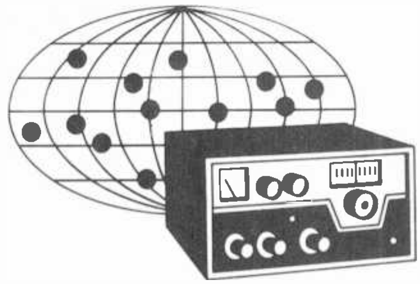
A SIMPLE circuit consisting of a diode, resistor, and battery can be used as a clipper or limiter, or to shift the zero reference level of a waveform. Just what a particular arrangement will do is predictable if you observe the polarity of the net circuit voltage, diode biasing, and each voltage drop.

See if you can match the output waveforms (A-J) with the circuits (1-10) below. In each case, the input is a sine wave with a peak voltage twice the cell's voltage. The resistor is large compared to the forward resistance of the diode yet small compared to its reverse resistance. The dotted lines represent the undistorted output waveform.

Hint: Assume a cell voltage of three volts and see what happens as the input sine wave goes to +6 and −6 volts in 1-volt steps.



Answers: 1-H, 3-C, 5-I, 7-A, 9-G, 2-F, 4-J, 6-D, 8-E, 10-B



DX Listening

By Glenn Hauser

SHORTWAVE PROGRAMS

IT'S EASY for DX listeners to fall into the trap of getting so involved in the *process* of tuning in distant countries, that we lose sight of the purpose of the broadcasts in the first place—*programs* to be listened to for their content. Here is a selection of several different types of programs. To avoid confusion, all times and *days* are in GMT, which means that most programs after 0000 are heard in North America on the *previous* day. (And no doubt some stations will make schedule changes after we go to press.)

Mailbags. These are replies to listener letters on the air. Most try to answer questions about the country. Some give the full address of writers. The *BBC* program is about *BBC* programs only.

BBC Letterbox—Sat. 2315, Sun. 0515, 2015. Lots of cute, clever touches.

Moscow Mailbag—Sat. 2315, Sun. 0115, 0315, 0445, 0645; repeated 24 hours later. Joe Adamov achieves more credibility than on any other Moscow program.

R. Sweden Mailbag—on all Sunday broadcasts.

R. Nederland Letterbox—about one hourafter the start of alternate Thursday broadcasts. But after November it will disappear or move to another day.

R. Australia Mailbag—Sun. 0140, 0740, 1240, 1940. Probably the most popular of all, emphasizing international friendship. Host Keith Glover provides lots of personal touches.

VOA Letters from Listeners—Sat. 1115, 1915, Sun. 0015. It's interesting to see how our official Voice fields questions from listeners; has a really catchy theme. Americans are forbidden to participate.

IBA Calling All Listeners—Sun. 2015, 2245. Hosts don't hesitate to disagree with writers hostile to Israel.

WINB Mail Call—Sun. 2230. The station's *only* locally produced, live program. It proves people really do listen to this rather dull evangelistic and music-fill station, if only to get a QSL. This may move to 1845 in November.

Belgium—toward the end of Wed. and Fri. program, *BRT4* schedules a Mailbag. You may have better luck getting the transcript they mail out.

RCI replies to letters irregularly on the Sunday edition of Weekend Magazine.

Science and Technology. All these programs try not to get too technical.

CBC Northern Service Quirks and Quarks. An excellent popular science series, hosted from Vancouver by Dr. David Suzuki. Each week, Isaac Asimov is one of the guests, explaining a science word. Sat. at 1710-1800 (an hour earlier by GMT when on daylight time). Also on the CBC AM network.

BBC World Service has several programs with different approaches and emphases: Discovery, Tue. 1030, Wed. 1715, Thu. 0030. New Ideas, Sun. 0445, 2315. Science in Action, Fri. 1030, 1615, Mon. 2115. Nature Notebook, Wed. 0430, Fri. 2145. Farming World, Wed. 1130. Some of these take a break during part of the year, but always come back, often at new times.

SBC, Switzerland, had an Agricultural Index program on the first Sunday of each month earlier this year, but may replace it in November.

R. Moscow Science and Engineering, Thu. 2315, Fri. 0115, 0315, 0445, 0645.

VOA New Products, USA, Sun. 1307, 1707, 2107, Mon. 0107; New Horizons, Sun. 1115, 1915, Mon. 0115.

Drama and readings. A rare commodity, but not as rare as on domestic radio!

BBC World Service is way out in front, with one or two dramatic serials running at changeable times, and two regular drama blocks: Theatre of the Air (the only BBC program which may last as long as 90 minutes), Sun. 0030, 1130; and Radio Theatre, 45 minutes, Fri. 0030. World Service Short Story—readings of original stories submitted by listeners—Mon. 0145.

CBC Northern Service has blocks reserved for drama Mon-Fri at 1903 (summers 1803). Also, the newsmagazine As It Happens regularly includes comedy or drama during its final half hour (0030 in winter, 2330 in summer). During busy periods it's on Fridays only; in December and summer it's every weeknight; heavy on old-time radio.

VOA Critics Choice, an arts magazine, often features dramatic readings: Sun, 1313, 1713, 2113; Mon. 0013.

Classical Music. Many stations feel shortwave isn't a suitable medium; few can spare the time to play full works. But some include at least a token amount. It's nice to have when you can't find any on domestic radio—and some of these stations have strong, clear signals.

VOA Concert Hall, Sundays at 1215-1300, 2015-2100. Other days, Willis Conover's first-rate jazz show.

CBC Northern Service Gilmour's Albums, Sun. 1705-1800 (summers 1605). Mainly vocal music, with lots of opinion by music critic Clyde Gilmour from Toronto.

HCJB En la Sala de Conciertos, only in their Spanish service—but the music is what counts. Mon.-Fri. 1830–1900; Sat. and Sun. 1800–1900. Check in the 19m band.

R. Nederland, with only half an hour, this cultural magazine, The Monday Programme, may still work in some short pieces.

BBC World Service broadcasts Promenade Concerts live at 1830 during the summer, but not in winter, and not to North America. There are a number of 15-to-30 minute music or musical commentary programs running at any given time in a variety of slots. Dependable times for longer works are Sun. 1515–1600, Mon. 0100–0145, and Fri. 0630-0700.

RAI. A traditional come-on for SW radio buyers is "hear opera direct from Italy!" Well, you won't find *any* on RAI's 20-minute English programs, and only excerpts on the Italian programs, Wed. and Thu. 2325-2350, Sat. 0025-0035, Sun. 0005-0025 and 2255-2325. Check 9575 kHz.

Radiodifusora Nacional de Colombia has large blocks of classical concerts all day long. The drawbacks: off-frequency from 15,335 kHz, single sideband, and distorted audio.

Musical Requests. This is another popular way for listeners to participate.

BBC World Service The Pleasure's Yours, exclusively classical, recently expanded to 45 minutes, Tues. 2030. The rest in this listing are pop and rock. Bob

(Continued on page 119)

ENGLISH LANGUAGE SHORTWAVE BROADCASTS FOR NOVEMBER 1977 THROUGH FEBRUARY 1978

BY RICHARD E. WOOD

TO EASTERN NORTH AMERICA

TIME-EST	TIME-GMT	STATION	QUAL*	FREQUENCIES, MHz
6:00-6:25 a.m.	1100-1125	Tirana, Albania	F	9.50, 11.985
6:00-7:25 a.m.	1100-1225	Trans-World Radio Bonaire, N.A.	G	11.815
6:00-8:00 a.m.	1100-1300	Melbourne, Australia	G	9.58
		London, England	G	5.99 (via Sackville)
6:00-9:00 a.m.	1100-1400	**VOA, Washington, USA	G	5.955, 9.73
6:28-9:00 a.m.	1128-1400	**Montreal, Canada (Northern Service)	G	6.065, 9.625 (includes French, etc.)
7:00-7:30 a.m.	1200-1230	Jerusalem, Israel	G	11.655, 12.025, 15.10, 15.485
7:00-7:55 a.m.	1200-1255	Peking, China	F	11.688
7:10-7:30 a.m.	1210-1230	**Santiago, Chile	F	9.566, 11.81, 15.15
7:15-7:30 a.m.	1215-1230	Athens, Greece	F	15.345, 17.83
		HCJB, Quito, Ecuador	G	11.745
7:30-8:00 a.m.	1230-1300	Stockholm, Sweden	F	15.305
7:30-8:20 a.m.	1230-1320	Trans-World Radio, Bonaire, N.A.	G	15.255 (Sat., to 1420 Sun.)
7:30-11:30 a.m.	1230-1630	HCJB, Quito, Ecuador	G	11.745, 15.115
8:00-8:30 a.m.	1300-1330	London, England	G	5.99 (via Sackville), 6.195 (via Antiqua), 11.775 (via Antiqua; Sat., Sun. from 1200)
		**Bucharest, Romania	G	11.94, 15.25
8:15-8:45 a.m.	1315-1345	Berne, Switzerland	G	15.14
8:30 a.m.-3:00 p.m.	1330-2000	**London, England	G	9.41, 15.07
8:30-9:00 a.m.	1330-1400	Helsinki, Finland	G	11.755, 15.105
9:00-9:30 a.m.	1400-1430	Stockholm, Sweden	G	15.305
9:00 a.m.-7:00 p.m.	1400-2400	**Montreal, Canada (Northern Service)	G	9.625, 11.72 (includes French, etc.)
9:30-10:00 a.m.	1430-1500	Helsinki, Finlad	G	11.755, 15.105
10:00-11:00 a.m.	1500-1600	London, England	G	17.84 (via Ascension), 9.58 (via Sackville Sat., Sun.)
10:15-10:30 a.m.	1515-1530	Athens, Greece	F	11.73, 15.345, 17.83 (last 2 freq. not on Tues.)
11:00-11:15 a.m.	1600-1615	London, England	G	9.58 (via Sackville) 17.84 (via Ascension)
11:00-11:30 a.m.	1600-1630	Oslo, Norway	G	15.175 (Sun.)
11:15 a.m.-12:09 p.m.	1615-1709	London, England	G	9.58 (via Sackville; Sat., Sun. 1745)
11:42-11:50 a.m.	1642-1650	Hilversum, Holland	G	15.19, 17.775, (Mon.-Fri., via Bonaire)
11:45 a.m.-12 noon	1645-1700	**Montreal, Canada	F	15.325, 17.82
12 noon-3:00 p.m.	1700-2000	**Kuwait, Kuwait	G	9.58, 12.085
12:04-12:56 p.m.	1704-1756	**Paris, France	G	9.52, 9.63, 11.705, 11.73, 11.735, 11.745, 11.89, 11.905, 11.93, 15.30, 15.425, 17.72
1:00-1:30 p.m.	1800-1830	**Montreal, Canada	G	11.865, 15.325, 17.82
1:45-3:00 p.m.	1845-2000	**Abidjan, Ivory Coast	G	11.92 (irreg.)
2:00-5:00 p.m.	1900-2200	**Jeddah, Saudi Arabia	F	11.855
2:30-3:00 p.m.	1930-2000	**Montreal, Canada	G	11.855, 15.325
		**Baghdad, Iraq	F	9.745
3:00-3:30 p.m.	2000-2030	Jerusalem, Israel	G	5.90, 7.4125,
		**Tehran, Iran	F	9.022
3:00-4:00 p.m.	2000-2100	Accra, Ghana	P	11.85
3:00-4:15 p.m.	2000-2115	London, England	G	15.26 (via Ascension)
3:50-4:50 p.m.	2050-2150	**Havana, Cuba	G	11.865, 17.75
4:00-4:30 p.m.	2100-2130	**Berne, Switzerland	G	6.165, 9.535, 9.59
4:00-4:50 p.m.	2100-2150	**Johannesburg, S. Africa	G	7.27, 9.585, 11.80, 11.90
4:15-5:00 p.m.	2115-2200	London, England	G	5.975, 15.26 (via Ascension)
4:30-5:00 p.m.	2130-2200	**Sofia, Bulgaria	G	6.07, 9.70
4:40-5:20 p.m.	2130-2220	Hilversum, Holland	G	9.715, 11.73 (Sun.: Dutch; time tentative)
5:00-5:15 p.m.	2200-2215	**Belgrade, Yugoslavia	F	6.10, 7.24, 9.62
5:00-5:30 p.m.	2200-2230	Tokyo, Japan	F	15.105
5:00-5:45 p.m.	2200-2245	London, England	G	5.975, 6.175 (via Sackville), 6.195 (via Antiqua) 9.51 (via Sackville), 15.26 (via Ascension)
5:00-6:15 p.m.	2200-2315	**Cairo, Egypt	G	9.805
5:00-7:30 p.m.	2200-0030	Ankara, Turkey	G	9.515, 11.88
5:30-6:00 p.m.	2230-2300	Jerusalem, Israel	G	5.90, 7.4125, 9.435, 9.815
		Vilnius, U.S.S.R.	G	5.915, 5.94, 7.31, 7.355 7.44 (Sat., Sun.)
5:30-6:20 p.m.	2230-2320	Johannesburg, S. Africa	G	5.98, 9.585, 11.80, 11.90
5:45-6:00 p.m.	2245-2300	London, England	G	5.975, 6.175, (via Sackville), 7.32, 9.51 (via Sackville), 15.26 (via Ascension)
5:50-6:10 p.m.	2250-2310	**Santiago, Chile	F	9.566, 11.81, 15.15
6:00-6:30 p.m.	2300-2330	Stockholm, Sweden	F	6.045, 6.12, 9.695
		London, England	G	5.975, 6.175 (via Sackville), 7.32, 9.51 (via Sackville), 9.58 (via Ascension), 15.26 (via Ascension)

		Moscow, U.S.S.R.	G	5.94, 6.02, 6.125, 7.205, 7.235, 7.355, 7.44, 9.635, 9.79, 9.80, 12.05, 15.14, 15.18, 15.45, 17.72
		Tokyo, Japan	F	15.105
6:00-6:50 p.m.	2300-2350	**Buenos Aires, Argentina	G	11.71 (Mon.-Fri.)
6:00-8:00 p.m.	2300-0100	Montreal, Canada	G	6.04 (alternate 5.96; Mon.-Fri.)
6:30-7:00 p.m.	2330-2400	Moscow, U.S.S.R.	G	4.86, 5.94, 6.02, 6.125, 7.105, 7.115, 7.15, 7.205, 7.235, 9.635, 9.79, 9.80, 12.05, 15.14, 15.18, 15.45, 17.72
6:45-7:30 p.m.	2345-0030	London, England	G	5.975, 6.175 (via Sackville), 7.32, 9.51 (via Sackville), 9.58, 15.26 (both via Ascension)
6:45-7:45 p.m.	2345-0045	Tokyo, Japan	P	9.525, 11.705
7:00-7:25 p.m.	0000-0025	Tirana, Albania	G	7.065, 9.75
7:00-7:30 p.m.	0000-0030	Oslo, Norway	F	6.18, 9.55, 9.645 (Sun.)
		Tokyo, Japan	F	15.105
		Moscow, U.S.S.R.	G	4.86, 5.94, 6.125, 7.105, 7.15, 7.185, 7.205, 7.355, 7.44, 9.80, 12.05, 15.14, 15.18, 15.45, 17.72
7:00-7:55 p.m.	0000-0055	Sofia, Bulgaria	G	7.115
		Peking, China	F	9.94, 11.675, 11.945
7:00-8:00 p.m.	0000-0100	**VOA, Washington, USA	G	6.19, 9.67, 11.83, 11.895
7:00-9:00 p.m.	0000-0200	**Luxembourg	F	6.09
7:00 p.m.-12:06 a.m.	0000-0506	**Montreal, Canada (Northern Service)	F	6.195, 9.625 (includes Eskimo, etc.)
7:15-7:30 p.m.	0015-0030	Athens, Greece	G	9.75, 9.76, 11.73
7:15-7:40 p.m.	0015-0040	Brussels, Belgium	F	6.08 (9.725 alternates)
7:30-7:55 p.m.	0030-0055	Prague, Czechoslovakia	F	6.055, 9.74
7:30-8:00 p.m.	0030-0100	Stockholm, Sweden	F	6.045
		Kiev, U.S.S.R.	G	6.02, 7.15, 7.205, 7.26, 9.78, 12.05, 15.14, 15.18, 15.455
		Vilnius, U.S.S.R.	G	5.94, 7.355 (Sat., Sun.)
7:30-10:15 p.m.	0030-0315	London, England	G	5.975, 6.12, 6.175 (both via Sackville), 7.32, 9.51 (via Greenville), 9.58, 15.26 (both via Ascension)
7:30 p.m.-2:00 a.m.	0030-0700	HCJB, Quito, Ecuador	G	6.095, 9.56, 11.915 (includes some Eskimo)
8:00-8:15 p.m.	0100-0115	Vatican, City	G	5.995, 6.015, 9.605
8:00-8:20 p.m.	0100-0120	Rome, Italy	F	6.01, 9.575
8:00-8:30 p.m.	0100-0130	Montreal, Canada	F	9.535
		Moscow, U.S.S.R.	G	4.86, 5.94, 6.02, 6.125, 7.105, 7.115 (via Bulgaria), 7.15, 7.205, 7.355, 7.44, 9.635, 9.78, 9.79, 9.80, 12.05, 15.14, 15.45
8:00-8:45 p.m.	0100-0145	Berlin, Ger. Dem. Rep.	P	9.73
8:00-8:55 p.m.	0100-0155	Prague, Czechoslovakia	G	5.93, 7.345, 9.54, 9.63, 9.74
		Peking, China	G	7.12, 9.78 (both via Albania) 9.94, 11.945, 12.055
8:00-10:00 p.m.	0100-0300	Melbourne, Australia	P	15.32, 17.795
8:00-10:30 p.m.	0100-0330	Havana, Cuba	G	9.685, 11.725
8:00-11:00 p.m.	0100-0400	Madrid, Spain	G	6.065, 11.88 (exc. Sun.)
8:10-8:30 p.m.	0110-0130	**Santiago, Chile	F	9.566, 11.81, 15.15
8:30-8:50 p.m.	0130-0150	Cologne, Ger. Fed. Rep.	G	6.01, 6.04 6.075, (both via Antigua), 6.10 (via Malta), 9.565, 9.59 (via Antigua or Montserrot) 9.69, 9.745 11.685 (via Malta)
8:30-8:55 p.m.	0130-0155	Tirana, Albania	G	6.20, 7.30
		Vienna, Austria	P	6.155, 9.77
8:30-9:00 p.m.	0130-0200	Moscow, U.S.S.R.	G	4.86, 5.94, 6.02, 6.125, 7.105, 7.115, (via Bulgaria), 7.15, 7.205, 7.355, 7.44, 9.635, 9.78, 9.79, 9.80, 11.86, 12.05, 15.14
8:30-9:25 p.m.	0130-0225	Bucharest, Romania	F	5.99, 6.19, 9.57, 9.68, 11.775, 11.94
8:45-9:15 p.m.	0145-0215	Berne, Switzerland	G	5.965, 6.135, 9.725, 11.715
9:00-9:30 p.m.	0200-0230	Budapest, Hungary	G	6.00, 7.215, 9.585, 11.91 (Exc. Sun.)
		Oslo, Norway	F	6.18, 9.55, 9.645 (Sun.)
		Warsaw, Poland	P	6.095, 6.135, 7.27, 9.675, 11.815, 15.12
9:00-9:50 p.m.	0200-0250	Hilversum, Holland	G	6.165 (via Bonaire; time tentative)
9:00-9:55 p.m.	0200-0255	Peking, China	P	7.06, 9.94, 12.055
9:00-10:00 p.m.	0200-0300	Moscow, U.S.S.R.	G	4.86, 5.94, 6.02, 6.125, 7.105, 7.115 (via Bulgaria), 7.205, 7.25, 7.355, 9.635, 9.78, 9.79, 9.80, 11.86, 12.05, 15.14
9:00-10:30 p.m.	0200-0330	Cairo, Egypt	F	7.12, 9.475
9:10-9:30 p.m.	0210-0230	**Santiago, Chile	F	9.566, 11.81, 15.15
9:15-9:30 p.m.	0215-0230	Athens, Greece	G	9.75, 9.76, 11.73
9:30-9:55 p.m.	0230-0255	Tirana, Albania	G	6.20, 7.30
9:30-10:00 p.m.	0230-0300	Stockholm, Sweden	F	6.045, 9.695
10:00-10:30 p.m.	0300-0330	Budapest, Hungary	G	6.00, 7.215, 9.585, 11.91
		Kiev, U.S.S.R.	G	5.98, 6.02, 7.245, 7.26, 7.40, 9.58, 9.78, 11.86

10:00-10:35 p.m.	0300-0335	Warsaw, Poland	P	6.095, 6.135, 7.27, 9.675, 11.815, 15.12
10:00-10:55 p.m.	0300-0355	Peking, China	G	7.12, 9.78 (both via Albania)
10:00-11:00 p.m.	0300-0400	Buenos Aires, Argentina	G	9.69 (Mon.-Fri.)
		Prague, Czechoslovakia	G	5.93, 7.345, 9.54, 9.63, 9.74
		Moscow, U.S.S.R.	G	4.86, 5.94, 6.125, 7.115 (via Bulgaria), 7.205, 7.355, 9.70 (via Bulgaria)
10:00-11:25 p.m.	0300-0425	**Johannesburg, S. Africa	G	3.995, 5.98, 7.27, 9.585
10:15-10:30 p.m.	0315-0330	London, England	G	5.975, 6.12, 6.175 (both via Sackville), 7.32, 9.51 (via Greenville), 9.58 (via Ascension)
10:30-10:55 p.m.	0330-0355	Tirana, Albania	G	6.20, 7.30
		Vienna, Austria	P	6.155, 9.77
10:30-11:00 p.m.	0330-0400	Helsinki, Finland	P	9.55
10:30-11:30 p.m.	0330-0430	London, England	G	5.975, 6.175 (via Antigua)
10:30-11:50 p.m.	0330-0450	Havana, Cuba	G	9.685, 11.725, 11.76
11:00-11:15 p.m.	0400-0415	Budapest, Hungary	G	6.00, 7.215, 9.585, 11.91 (Tues., Fri.)
11:00-11:25 p.m.	0400-0425	Bucharest, Romania	F	5.99, 6.155, 6.19, 9.57, 9.68, 11.775, 11.94
11:00-11:30 p.m.	0400-0430	Oslo, Norway	P	6.18, 9.55 (Sun.)
11:30 p.m.-12 mdt.	0430-0500	London, England	G	6.175 (via Antiqua)
11:50 p.m.-1:00 a.m.	0450-0600	Havana, Cuba	G	11.725, 11.76
12:00 mdt.-12:15 a.m.	0500-0515	Jerusalem, Israel	G	5.90, 7.425, 9.009
12:00 mdt.-12:30 a.m.	0500-0530	Lisbon, Portugal	G	6.025, 11.935
12:00 mdt.-1:30 a.m.	0500-0630	London, England	G	6.175, 9.51 (both via Antigua)
1:30-2:00 a.m.	0630-0700	London, England	G	6.175 (via Antigua)
1:45-3:35 a.m.	0645-0835	**Lagos, Nigeria	G	7.275, 15.12

TO WESTERN NORTH AMERICA

TIME-PST	TIME-GMT	STATION	QUAL*	FREQUENCIES, MHz
3:00-3:15 a.m.	1100-1115	Tokyo, Japan	G	5.99
3:00-4:25 a.m.	1100-1225	Trans-World Radio, Bonaire, N.A.	G	11.815
3:00-5:00 a.m.	1100-1300	London, England	G	5.99 (via Sackville)
		Melbourne, Australia	G	9.58
3:00-6:00 a.m.	1100-1400	**VOA, Washington, USA	G	5.955, 9.73
4:00-4:15 a.m.	1200-1215	Tokyo, Japan	P	5.99
4:00-4:30 a.m.	1200-1230	**Tashkent, U.S.S.R.	F	9.60, 11.925
4:10-4:30 a.m.	1210-1230	**Santiago, Chile	F	9.566, 11.81, 15.15
4:15-4:30 a.m.	1215-1230	HCJB, Quito, Ecuador	G	11.745
5:30-6:00 a.m.	1230-1400	Trans-World Radio Bonaire, N.A.	G	15.255 (Sat., Sun.)
4:30-8:30 a.m.	1230-1630	HCJB, Quito, Ecuador	G	11.745, 15.115
5:00-5:15 a.m.	1300-1315	Tokyo, Japan	P	5.99
5:00-5:30 a.m.	1300-1330	London, England	G	5.99 (via Sackville), 11.77 (via Antigua; Sat., Sun. from 1200)
5:30-7:00 a.m.	1330-1500	**Delhi, India	F	11.81, 15.335
6:00-6:30 a.m.	1400-1430	Tokyo, Japan	G	5.99
		**Tashkent, U.S.S.R.	F	9.60, 11.925
6:00-8:55 a.m.	1400-1655	Manila, Philippines (VOP)	F	9.58 (Closes 1555 Sun.)
7:00-7:15 a.m.	1500-1515	Tokyo, Japan	G	5.99
7:00-8:00 a.m.	1500-1600	London, England	G	17.84 (via Ascension) also 9.58 (via Sackville Sat., Sun.)
8:00-8:15 a.m.	1600-1615	London, England	G	9.58 (via Sackville), 17.84 (via Ascension)
8:15-9.09 a.m.	1615-1709	London, England	G	9.58 (via Sackville, Sat., Sun. to 1745)
8:42-8:50 a.m.	1642-1650	Hilversum, Holland	G	15.19, 17.775 Mon.-Fri., via Bonaire)
9:00-9:15 a.m.	1700-1715	Tokyo, Japan	G	5.99
9:00 a.m.-12 noon	1700-2000	Kuwait, Kuwait	G	9.58, 12.085
9:04-9:56 a.m.	1704-1756	Paris, France	G	9.52, 9.63, 11.705, 11.73, 11.735, 11.745, 11.89, 11.905, 11.93, 15.30, 15.425, 17.72
10:00-10:15 a.m.	1800-1815	Tokyo, Japan	F	5.99
10:00-10:30 a.m.	1800-1830	Oslo, Norway	F	11.895, 15.345 (Sun.)
10:30-11:30 a.m.	1830-1930	Taipei, Taiwan	F	9.51, 11.86, 15.37
11:00-11:07 a.m.	1900-1907	**Papeete, Tahiti	F	11.825, 15.17 (exc. Sun.)
11:00-11:15 a.m.	1900-1915	Tokyo, Japan	G	9.505
12:00-12:15 p.m.	2000-2015	Tokyo, Japan	G	9.505
12 noon-2:00 p.m.	2000-2200	London, England	G	15.26 (via Ascension)
1:00-1:15 p.m.	2100-2115	Tokyo, Japan	G	9.505
2:00-2:15 p.m.	2200-2215	Tokyo, Japan	G	15.105
2:00-3:00 p.m.	2200-2300	London, England	G	6.175, 9.51 (both via Sackville), 15.26 (via Ascension)
2:00-4:00 p.m.	2200-2400	**VOA, Washington, USA	G	17.82, 17.895, 21.61
2:30-3:00 p.m.	2230-2300	Jerusalem, Israel	F	5.90, 7.4125, 9.435, 9.815
2:30-3:20 p.m.	2230-2320	Johannesburg, S. Africa	G	5.98, 9.585, 11.80, 11.90
2:50-3:10 p.m.	2250-2310	**Santiago, Chile	F	9.566, 11.81, 15.15
3:00-3:30 p.m.	2300-2330	Tokyo, Japan	G	15.105
		Vilnius, U.S.S.R.	G	9.61, 11.69, 15.10

3:00-4:30 p.m.	2300-0030	London, England	G	6.175, 9.51 (both via Sackville), 9.58, 15.26 (both via Ascension)
3:00-5:00 p.m.	2300-0100	Montreal, Canada	G	6.04, (5.96 alt.; Mon.-Fri.)
4:00-4:15 p.m.	0000-0015	Tokyo, Japan	G	15.105
4:00-5:00 p.m.	0000-0100	**VOA, Washington, USA	G	11.83, 11.895, 15.40
4:30-5:30 p.m.	0030-0130	**Trans-World Radio Bonaire, N.A.	G	11.925
4:30-7:15 p.m.	0030-0315	London, England	G	6.12, 6.175 (both via Sackville), 9.51 (via Greenville), 9.58, 15.26 (both via Ascension)
4:30-11:00 p.m.	0030-0700	HCJB, Quito, Ecuador	G	6.095, 9.56, 11.915 (includes some Eskimo)
5:00-5:15 p.m.	0100-0115	Tokyo, Japan	G	15.105
5:00-7:00 p.m.	0100-0300	Melbourne, Australia	G	15.32, 17.795
5:00-8:00 p.m.	0100-0400	Madrid, Spain	F	6.065, 11.88 (exc. Sun.)
5:10-5:30 p.m.	0110-0130	**Santiago, Chile	F	9.566, 11.81, 15.15
5:30-6:30 p.m.	0130-0230	Tokyo, Japan	G	11.84, 15.195, 15.42, 17.825
6:00-6:15 p.m.	0200-0215	Tokyo, Japan	G	15.105
6:00-7:50 p.m.	0200-0350	Taipei, Taiwan	G	15.345, 17.89
6:10-6:30 p.m.	0210-0230	**Santiago, Chile	G	9.566, 11.81, 15.15
6:30-7:00 p.m.	0230-0300	Stockholm, Sweden	F	6.045, 9.695
7:00-7:30 p.m.	0300-0330	Kiev, U.S.S.R.	G	5.98, 6.02, 7.245, 7.26, 7.40, 9.58, 9.78, 11.86
		Montreal, Canada	G	5.96, 6.00, 9.605, 9.655
7:00-7:55 p.m.	0300-0355	Peking, China	G	7.12, 9.78 (both via Albania) 9.46, 9.94, 11.65, 12.055
7:00-8:25 p.m.	0300-0425	**Johannesburg, S. Africa	G	3.995, 5.98, 7.27, 9.585
7:10-7:30 p.m.	0310-0330	**Santiago, Chile	G	9.566, 11.81, 15.15
7:15-7:30 p.m.	0315-0330	London, England	G	6.12, 6.175 (both via Sackville), 9.51 (via Greenville), 9.58 (via Ascension)
7:20-8:25 p.m.	0320-0425	**TIFC, San Jose, Costa Rica	F	6.035, 9.645, (opens 0300 Sat., Sun.)
7:22-7:28 p.m.	0322-0328	Erevan, U.S.S.R.	G	11.69, 11.96, 15.13, 15.18, 15.455 (Sat./Tue./Wed./Fri.)
7:30-8:00 p.m.	0330-0400	Moscow, U.S.S.R.	G	5.905, 6.02, 7.26, 9.54, 9.58, 9.61, 9.635, 9.735, 9.78, 11.69
7:30-8:15 p.m.	0330-0415	Berlin, Ger. Dem. Rep.	P	5.955, 6.08, 9.73
7:30-8:30 p.m.	0330-0430	London, England	G	6.175 (via Antigua)
8:00-8:15 p.m.	0400-0415	Tokyo, Japan	G	9.505
8:00-8:30 p.m.	0400-0430	Oslo, Norway	P	9.645 (Sun.)
		Budapest, Hungary	P	6.00, 7.215, 9.585, 11.91 (Tue., Fri.)
		Montreal, Canada	G	5.96, 9.655
8:00-8:55 p.m.	0400-0455	Peking, China	G	9.46, 9.94, 11.65, 12.055
8:00-9:00 p.m.	0400-0500	Moscow, U.S.S.R.	G	5.905, 6.02, 7.175, 7.26, 9.54, 9.58, 9.61, 9.635, 9.735, 11.69
8:30-9:00 p.m.	0430-0500	Berne, Switzerland	F	6.045, 9.725
		Vienna, Austria	P	6.015
		Sofia, Bulgaria	F	9.53
9:00-9:15 p.m.	0500-0515	Jerusalem, Israel	F	5.90, 7.4125, 9.009
		Tokyo, Japan	G	9.505
9:00-9:30 p.m.	0500-0530	Lisbon, Portugal	P	6.025, 11.935
9:00-9:50 p.m.	0500-0550	Hilversum, Holland	G	6.165, 9.715, (via Bonaire; time tentative)
9:00-9:30 p.m.	0500-0530	Moscow, U.S.S.R.	G	5.905, 6.02, 7.11, 7.26, 9.52, 9.54, 9.58, 9.61, 9.635, 9.735
9:00-10:30 p.m.	0500-0630	London, England	G	6.175, 9.51, (both via Antigua)
9:30-9:50 p.m.	0530-0550	Cologne, Ger. Fed. Rep.	G	5.96 (via Antiqua) 6.10 (via Malta), 6.185, 9.545, 9.605, 11.765
9:30-10:00 p.m.	0530-0600	Moscow, U.S.S.R.	G	5.905, 6.02, 7.11, 7.175, 7.22, 7.26, 7.30, 9.52, 9.54, 9.58, 9.635, 9.735
10:00-10:30 p.m.	0600-0630	Oslo, Norway	P	6.18, 9.645 (Sun.)
		Moscow, U.S.S.R.	G	6.02, 7.11, 7.15, 7.175, 7.22, 7.26, 7.30, 9.54, 9.58, 9.635, 9.735
10:00-11:00 p.m.	0600-0700	Buenos Aires, Argentina	G	9.69 (Mon.-Fri.)
10:30-11:00 p.m.	0630-0700	London, England	G	6.175 (via Antigua)
10:30-11:30 p.m.	0630-0730	Moscow, U.S.S.R.	G	602, 7.11, 715, 7.175, 7.22, 7.26, 7.30, 9.54, 9.58, 9.635, 9.735
10:30 p.m.-12 mdt.	0630-0800	Havana, Cuba	G	9.525
10:30 p.m.-12:55 a.m.	0630-0855	**Kuala Lumpur, Malaysia	G	7.22, 11.90, 15.275
11:00-11:15 p.m.	0700-0715	Tokyo, Japan	G	9.505
11:30 p.m.-12:20 a.m.	0730-0820	**Hilversum, Holland	G	9.63 (via Bonaire)
11:30 p.m.-2:30 a.m.	0730-1030	**Wellington, New Zealand	G	6.105
12 mdt.-12:15 a.m.	0800-0815	Tokyo, Japan	G	9.505
12 mdt.-6:00 a.m.	0800-1400	**Port Moresby, Papua-New Guinea	G	4.89
1:00-1:15 a.m.	0900-0915	Tokyo, Japan	G	9.505
2:00-2:30 a.m.	1000-1030	Tokyo, Japan	G	5.99
2:00-2:50 a.m.	1000-1050	Pyongyang, Dem. Rep. Korea	G	7.213

*Reception quality, East Coast (West Coast) location: G-good, F-fair, P-poor
**Not intended for North America, but receivable satisfactorily
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Electronics Library

TELEPHONE ACCESSORIES YOU CAN BUILD

by Jules H. Gilder

The telephone has the potential of being much more than a simple communication device. It can, for example, remotely control other appliances, automatically dial any number when tripped by an alarm, code phone conversations to insure privacy, and even act as an intruder alarm when equipped with the proper accessories. This book illustrates with schematics and text how to build a number of accessories at very low cost. Included are two chapters devoted to telephone basics and pertinent telephone regulations. Among the accessories described are a "hands-free" system, security scrambler, automatic dialer, answering machine, and burglar alarm.

Published by Hayden Book Co., Inc., 50 Essex St., Rochelle Park, NJ 07662. Soft cover. 84 pages. $3.95.

RADIO OPERATORS LICENSE HANDBOOK (THIRD EDITION)

by Edward Noll

The laws, rules, regulations, and accepted operating procedures for licensed (up to Second Class) and nonlicensed persons are covered in this book. The first four chapters give information and explanations on the materials needed to obtain lower-grade FCC operating licenses. The last three chapters contain Q&A's based on FCC Elements I, II, and IX.

Published by Howard W. Sams & Co., 4300 W. 62nd St., Indianapolis, IN 46206. 224 pages $5.50, soft cover.

SC/MP MICROPROCESSOR APPLICATIONS

This handbook contains detailed information for building, checking out, and operating a host of National Semiconductor SC/MP-microprocessor-based systems. It is conveniently organized to enable the designer to expand, modify, and customize a particular application with minimum effort. Chapter one deals with general design data and contains such basic SC/MP application parameters as instruction sets, addressing structures. (Additional information on general-purpose applications is given in the appendix. Chapter two has applications data organized into sections according to class: A/D and D/A systems, keyboard and display systems, multiprocessor systems, etc.

Published by National Semiconductor Corp., Marketing Services (520), 2900 Semiconductor Dr., Santa Clara, CA 95051. Soft cover. $5.00.

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	84P44 062	4.50	8.50	2.56	2.31
	169P44 062	4.50	17.00	5.04	4.53
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2111	256 x 4	Static	6.95
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8111	256 x 4	Static	6.95
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74200	256 x 1	Static	[illegible]
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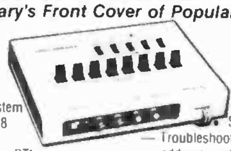

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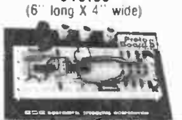

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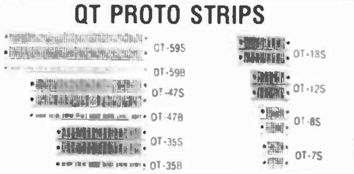

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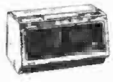

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Woodgrain Case
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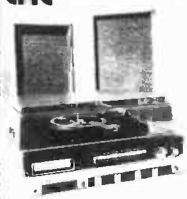
- High intensity lamp
- Lamp shuts off when collapsed

Model C-590 (Ivory) $29.95

ERC AM/FM 8-Track Stereo Receiver With BSR Changer



- PLL System
- BSR Record Changer
- Slide Controls
- Automatic AFC Control
- 4 Speaker Output
- Walnut finish vinyl covered wood veneer with smoke dust cover

Size: 20"W x 9⅜"H x 15¼"D

Model 8365 $149.95

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 311D-5C-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.

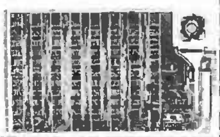
12 or 24 Hour

115 VAC

KIT ONLY **$17.95**

Rejected ATARI GAME BOARDS

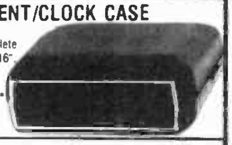
Over 60 Reusable IC's, misc. transistors, resistors, diodes, caps, crystals, switch, etc. (8½" x 16"). Limited Quantity.



$4.95 ea.

INSTRUMENT/CLOCK CASE

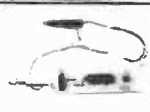
Injection molded unit. Complete with red bezel. 4½" x 4" x 1-9/16".



$3.95 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

$9.95 Per Kit

7400N TTL

SN7400N	16	SN7472N	39	SN74160N	1 25
SN7401N	18	SN7473N	39	SN74161N	99
SN7402N	20	SN7474N	35	SN74162N	1 95
SN7403N	20	SN7475N	50	SN74163N	99
SN7404N	20	SN7476N	35	SN74164N	99
SN7405N	20	SN7479N	5 00	SN74165N	99
SN7406N	35	SN7480N	50	SN74166N	1 25
SN7407N	35	SN7482N	99	SN74167N	3 25
SN7408N	20	SN7483N	70	SN74170N	2 10
SN7409N	25	SN7485N	89	SN74172N	6 00
SN7410N	20	SN7486N	39	SN74173N	1 50
SN7411N	30	SN7488N	3 50	SN74174N	1 25
SN7412N	35	SN7489N	2 49	SN74175N	99
SN7413N	69	SN7490N	45	SN74176N	79
SN7414N	70	SN7491N	75	SN74177N	79
SN7416N	35	SN7492N	49	SN74179N	2 49
SN7417N	35	SN7493N	49	SN74180N	99
SN7420N	20	SN7494N	79	SN74181N	2 49
SN7421N	39	SN7495N	79	SN74182N	95
SN7422N	49	SN7496N	79	SN74184N	1 95
SN7423N	37	SN7497N	3 00	SN74185N	1 95
SN7425N	29	SN74100N	1 25	SN74186N	15 00
SN7426N	29	SN74107N	39	SN74187N	6 00
SN7427N	37	SN74109N	39	SN74188N	3 95
SN7429N	42	SN74116N	1 95	SN74190N	1 79
SN7430N	25	SN74121N	39	SN74191N	1 25
SN7432N	25	SN74122N	39	SN74192N	89
SN7437N	35	SN74123N	50	SN74193N	89
SN7438N	35	SN74125N	50	SN74194N	1 25
SN7439N	25	SN74126N	60	SN74195N	75
SN7440N	21	SN74132N	1 25	SN74196N	1 00
SN7441N	89	SN74136N	95	SN74197N	1 00
SN7442N	69	SN74141N	1 15	SN74198N	1 75
SN7443N	75	SN74142N	2 95	SN74199N	1 75
SN7444N	75	SN74143N	3 25	SN74200N	5 59
SN7445N	75	SN74144N	3 00	SN74251N	1 79
SN7446N	89	SN74145N	1 15	SN74279N	90
SN7447N	69	SN74147N	2 35	SN74283N	2 25
SN7448N	89	SN74148N	2 00	SN74284N	6 00
SN7450N	25	SN74150N	1 25	SN74285N	6 00
SN7451N	25	SN74151N	79	SN74365N	75
SN7453N	25	SN74153N	89	SN74366N	75
SN7454N	25	SN74154N	1 25	SN74367N	75
SN7459A	25	SN74155N	89	SN74368N	75
SN7460N	25	SN74156N	89	SN74390N	2 25
SN7470N	45	SN74157N	89	SN74393N	2 25

20% Discount for 100 Combined 7400's

CMOS

CD4000	23			MC14562	14 50
CD4001	23			CD4566	2 25
CD4002	23	CD4044	89	MC14583	3 50
CD4006	1 19	CD4046	1 79		
CD4007	25	CD4047	2 50	74C00 Series	
CD4009	49	CD4048	1 35	74C00	39
CD4010	49	CD4049	69	74C02	55
CD4011	23	CD4050	49	74C04	75
CD4012	25	CD4051	1 19	74C10	65
CD4013	39	CD4053	1 19	74C14	3 00
CD4014	1 39	CD4056	1 49	74C20	65
CD4015	1 19	CD4059	9 95	74C30	65
CD4016	49	CD4060	1 49	74C42	2 15
CD4017	1 19	CD4066	79	74C73	1 50
CD4018	99	CD4068	39	74C74	1 15
CD4019	49	CD4069	45	74C89	4 00
CD4020	1 19	CD4070	55	74C90	3 00
CD4021	1 39	CD4071	23	74C93	2 00
CD4022	1 19	CD4076	1 39	74C95	2 00
CD4023	25	CD4081	23	74C107	1 25
CD4024	79	CD4082	23	74C151	2 90
CD4025	23	MC14409	14 95	74C154	3 00
CD4026	2 25	MC14410	14 95	74C157	2 15
CD4027	69	MC14419	4 95	74C160	3 25
CD4028	89	MC14506	75	74C161	3 25
CD4029	1 19	MC14507	99	74C163	3 00
CD4030	49	CD4508	3 95	74C164	3 25
CD4035	99	CD4510	1 39	74C173	2 60
CD4040	1 19	CD4511	1 29	74C193	2 75
CD4041	1 25	CD4515	2 95	74C195	2 75
CD4042	99	CD4518	1 29	80C95	1 50
CD4043	89	CD4520	1 29	80C97	1 50

LINEAR

LM300H	80			LM723N	55
LM301H	35			LM733N	1 00
LM301CN	35			LM739N	1 19
LM302H	75	LM340T-8	1 25	LM741CH	35
LM304H	1 00	LM340T-12	1 25	LM741CN	35
LM305H	60	LM340T 15	1 25	LM741 14N	39
LM307CN	35	LM340T-18	1 25	LM747H	79
LM308H	1 00	LM340T-24	1 25	LM747N	79
LM308CN	1 00	LM350N	1 00	LM748H	39
LM309H	1 10	LM351CN	65	LM748N	39
LM309K	1 25	78MG	1 75	LM1303N	90
LM310CN	1 15	LM370N	1 15	LM1304N	1 19
LM311H	90	LM373N	3 25	LM1305N	1 40
LM311N	90	LM377N	4 00	LM1307N	85
LM317K	6 50	LM380N	1 25	LM1310N	2 95
LM318CN	1 50	LM380CN	99	LM1351N	1 65
LM319N	1 30	LM381N	1 79	LM1414N	1 75
LM320K-5	1 35	LM382N	1 79	LM1458CN	59
LM320K-5 2	1 35	NE501K	8 00	LM1496N	95
LM320K 12	1 35	NE510A	6 00	LM1556V	1 75
LM320K-15	1 35	NE529A	4 95	LM2111N	1 95
LM320T-5	1 25	NE531H	3 00	LM2901N	2 95
LM320T-5 2	1 25	NE536T	6 00	LM3053	1 50
LM320T-8	1 25	NE540L	6 00	LM3065N	69
LM320T-12	1 25	NE550N	1 30	LM3900N(3401)	49
LM320T-15	1 25	NE555V	39	LM3905N	89
LM320T-18	1 25	NE560B	5 00	LM3909	1 25
LM320T-24	1 25	NE561B	5 00	LM5556N	1 85
LM323K-5	5 95	NE562B	5 00	MC5558V	1 00
LM324N	1 80	NE565H	1 75	LM7525N	90
LM339N	99	NE565N	1 25	LM7534N	75
LM340K-5	1 35	NE566CN	1 75	8038B	4 95
LM340K-6	1 35	NE567H	1 95	LM75450	49
LM340K-8	1 35	NE567V	1 49	75451CN	39
LM340K-12	1 35	LM703CN	45	75452CN	39
LM340K-15	1 35	LM709H	29	75453CN	39
LM340K-18	1 35	LM709N	29	75454CN	39
LM340K-24	1 35	LM710N	79	75491CN	79
LM340T-5	1 25	LM711N	39	75492CN	89
LM340T-6	1 25	LM723H	55	75494CN	89

74LS00 TTL

74LS00	29			74LS153	1 25
74LS02	29			74LS155	1 25
74LS03	29			74LS157	1 50
74LS04	35			74LS160	1 95
74LS05	35			74LS161	1 95
74LS08	29	74LS76	49	74LS162	1 95
74LS10	29	74LS83	1 75	74LS163	1 95
74LS13	69	74LS85	2 49	74LS164	1 95
74LS14	1 75	74LS86	49	74LS175	1 95
74LS20	29	74LS90	89	74LS181	3 69
74LS26	39	74LS92	89	74LS190	2 49
74LS27	39	74LS93	89	74LS191	2 49
74LS28	39	74LS95	1 50	74LS192	2 49
74LS30	29	74LS96	1 89	74LS193	2 49
74LS32	39	74LS107	59	74LS194	1 89
74LS40	39	74LS109	59	74LS195	1 89
74LS42	1 25	74LS112	59	74LS253	1 75
74LS47	1 25	74LS123	1 25	74LS257	1 75
74LS51	29	74LS132	1 25	74LS260	55
74LS55	29	74LS136	59	74LS279	79
74LS73	49	74LS138	1 25	74LS367	99
74LS74	49	74LS139	1 25	74LS368	1 99
74LS75	69	74LS151	1 25	74LS670	3 95

Grab Bag Specials

CAPACITORS

GB100	100 ea	Ceramic Disc	$2 00/lot
GB101	60 ea	Mylar	4 00/lot
GB102	60 ea	Electrolytics	4 00/lot
GB103	40 ea	Tantalum (tubular)	4 00/lot
GB104	20 ea	Ceramic Trimmers (marked)	6.00/lot
GB105	20 ea	Ceramic Trimmers (house # or unmarked)	3 00/lot

DIODES

GB106	100 ea	Germanium	2 00/lot
GB107	100 ea	Silicon	2 00/lot

INTEGRATED CIRCUITS

GB108	50 ea	Marked TTL Series	4 00/lot
GB109	30 ea	Marked Linear	4 00/lot

LEDS LAMPS - Readouts

GB110	100 ea	ASST LEDS	6 00/lot
GB111	40 ea	NE2 Type Lamps	3 00/lot
GB112	20 ea	Multiple Readouts Calculators Watches, Timers Leds to Panaplex New — Used — Rejects	6 00/lot

RESISTORS

GB116	200 ea	¼ watt Assortment	$2 00
GB117	200 ea	½ watt Assortment	2 00
GB118	40 ea	Wirewound 3-10 watt 1-100 ohm	5 50
GB119	40 ea	Wirewound 3-10 watt 100Ω-25K	5 00

SWITCHES

GB120	25 ea	Miniature Slide	3 00
GB121	12 ea	Rocker	3 00
GB122	20 ea	Reed-Cor & Magnetic	5 00

MISC.

GB123	30 ea	Heat Sinks Asst Sizes	2 50
GB124	6 ea	Calculator Type Keyboards	5 00
GB125	300 ea	Molex Pins (8,9,14 sections)	3 00
GB126	50 ea	Opto Isolators (L-1 Series (untested)	2 00
GB127	100 ea	Transistors Plastic & Power	3 00
GB128	30 ea	Toroids Cores Iron & Tape	4 00
GB129	50 ea	Photo Transistors	4 00
GB130	1 ea	Tape Drive - 6 volt Motor with Erase Head & 2 Cassette Tapes (no amplifier)	5 00
GB131	30 ea	6" Shrinktubing Asst Sizes & Colors	4 00
GB132		Wire Asst Sizes & Colors — 1lb	2 95

POTENTIOMETERS

GB113	30 ea	Minature Trimmers 100Ω-1meg	4 00
GB114	10 ea	10 Turn P C Mount (rectangular marked)	4 00
GB115	10 ea	10 Turn P C Mount (rectangular mismarked)	2 00
GB133	15 ea	¾" sqaure Single Turn P C Mount (mismarked)	3 00

DISCRETE LEDS

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

.190" dia.		
XC111	Red	10 $1
XC111	Green	4 $1
XC111	Yellow	4 $1
XC111	Orange	4/$1

.200" dia			.185" dia.			.200" dia.		
XC22	Red	10 $1	XC526	Red	5 $1	XC556	Red	5/$1
XC22	Green	4 $1	XC526	Green	4 $1	XC556	Green	4 $1
XC22	Yellow	4 $1	XC526	Yellow	4/$1	XC556	Yellow	4 $1
XC22	Orange	4 $1	XC526	Orange	4 $1	XC556	Orange	4/$1
SSL 22	RT	4 $1	XC526	Clear	4 $1	XC556	Clear	7 $1

.085" dia.
MV50 - Red - 6 $1

INFRA-RED LED
¼ x ¼ x 1 16
Flat 5/$1.00

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode	270	2 95
MAN 2	5 x 7 Dot Matrix	300	4 95
MAN 3	Common Cathode	125	39
MAN 4	Common Cathode	187	1 95
MAN 7	Common Anode	270	1 25
MAN 7G	Common Anode-green	270	1 95
MAN 7Y	Common Anode-yellow	270	1 95
MAN 52	Common Anode-green	300	1 00
MAN 71	Common Anode	300	1 25
MAN 72	Common Anode	300	1 25
MAN 74	Common Cathode	300	1 50
MAN 81	Common Anode-yellow	300	1 00
MAN 82	Common Anode-yellow	300	1 00
MAN 84	Common Cathode-yellow	300	1 00
MAN 3620	Commmon Anode-orange	300	1 00
MAN 3640	Common Cathode-orange	300	1 75
MAN 4610	Common Anode-orange	300	1 00
MAN 4640	Common Cathode-orange	400	1 00
MAN 4710	Common Anode-red	400	1 00
MAN 4730	Common Anode-red	400	1 00
MAN 4740	Common Cathode-red	400	1 00
MAN 4830	Common Anode-yellow	400	1 00
MAN 6610	Common Anode-Double Digit-orange	560	1 25
MAN 6630	Common Anode-orange	560	1 25
MAN 6640	Common Kathode-Double Digit-orange	560	1 25
MAN 6650	Common Cathode	560	1 25
MAN 6660	Common Anode	560	1 25
MAN 6680	Common Cathode	560	1 25
MAN 6710	Common Anode-Double Digit-red	560	1 25
MAN 6730	Common Anode-Double Digit-red	560	1 25
MAN 6740	Common Cathode-Double Digit-red	560	1 25
MAN 6750	Common Cathode	560	1 25
MAN 6760	Common Anode-red	560	1 25
MAN 6780	Common Cathode-red	560	1 25
DL701	Common Anode-red ± 1	300	1 00
DL702	Common Cathode-red	300	1 25
DL704	Common Cathode	300	1 50
DL707	Common Anode	300	1 50
DL728	Common Cathode	500	2 95
DL741	Common Anode	600	1 95
DL746	Common Anode	630	1 95
DL747	Common Anode	600	2 25
DL749	Common Cathode	630	1 95
DL750	Common Cathode	600	2 49
DL338	Common Cathode	110	69
FND70	Common Cathode (FND359)	250	75
FND503	Common Cathode (FND500)	500	1 29
FND507	Common Anode (FND510)	500	1 29

RCA LINEAR

CA3013	2 15	CA3083	1 60
CA3023	2 56	CA3086	85
CA3035	2 48	CA3089	3 75
CA3039	1 35	CA3091	10 20
CA3046	1 30	CA3102	2 95
CA3053	1 50	CA3123	2 15
CA3059	3 25	CA3130	1 39
CA3060	3 25	CA3140	1 25
CA3080	85	CA3401	49
CA3081	2 00	CA3600	1 75
CA3082	2 00	RC4194	5 95
		RC4195	3 25

HP 5082-7400 Series — Multi-Digit

- ⅛" ht. • Common Cathode Red
- 3-5 volts @ 5 mils/second
- 7 segment Monolithic
- Dip Package

		10 or more
2 Digit	$ 79	.69
3 Digit	89	.79
4 Digit	99	89
5 Digit	1.19	.99

TV GAME CHIP SET — $9.95

Includes AY-3-8500-1 Chip and 2.010 mhz crystal
(2 010 crystal — $1.95 ea/AY-3-8500-1 chip — $8.95 ea.)

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1 24	25 49	50 100		1 24	25 49	50 100
8 pin	$ 17	16	15	24 pin	$ 38	37	36
14 pin	20	19	18	28 pin	45	44	43
16 pin	22	21	20	36 pin	60	59	58
18 pin	29	28	2`	40 pin	63	62	61
22 pin	1`	36	35				

SOLDERTAIL STANDARD (TIN)

14 pin	$ 27	25	24	28 pin	$ 99	90	81
16 pin	30	27	25	36 pin	1 39	1 26	1 15
18 pin	35	32	30	40 pin	1 59	1 45	1 30
24 pin	49	45	42				

SOLDERTAIL STANDARD (GOLD)

8 pin	$ 30	27	24	24 pin	$ `0	63	57
14 pin	35	32	29	28 pin	1 10	1 00	90
16 pin	38	35	32	36 pin	1 `5	1 40	1 26
18 pin	52	4`	43	40 pin	1 `5	1 59	1 45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

10 pin	$ 45	41	37	24 pin	$1 05	95	85
14 pin	39	38	37	28 pin	1 40	1 25	1 10
16 pin	43	42	41	36 pin	1 59	1 45	1 30
18 pin	75	68	62	40 pin	1 75	1 55	1 40
22 pin	95	85	75				

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 ea	10 OHM, 27 OHM	12 OHM, 33 OHM	15 OHM, 39 OHM	18 OHM, 47 OHM	22 OHM, 56 OHM	1/4 WATT 5%	50 PCS.
ASST. 2	5 ea.	68 OHM, 180 OHM	82 OHM, 220 OHM	100 OHM, 270 OHM	120 OHM, 330 OHM	150 OHM, 390 OHM	1/4 WATT 5%	50 PCS
ASST. 3	5 ea	470 OHM, 1 2K	560 OHM, 1 5K	680 OHM, 1 8K	820 OHM, 2 2K	1K, 2 7K	1/4 WATT 5%	50 PCS
ASST. 4	5 ea	3 3K, 8 2K	3 9K, 10K	4 7K, 12K	5 6K, 15K	6 8K, 18K	1/4 WATT 5%	50 PCS.
ASST. 5	5 ea	22K, 56K	27K, 68K	33K, 82K	39K, 100K	47K, 120K	1/4 WATT 5%	50 PCS
ASST. 6	5 ea	150K, 390K	180K, 470K	220K, 560K	270K, 680K	330K, 820K	1/4 WATT 5%	50 PCS
ASST. 7	5 ea	1M, 2 7M	1 2M, 3 3M	1 5M, 3 9M	1 8M, 4 7M	2 2M, 5 6M	1/4 WATT 5%	50 PCS.

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

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets - 25¢ — Send 35¢ Stamp for 1978 Catalog
Dealer Information Available

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

WIRE WRAP CENTER

HOBBY-WRAP TOOL-BW-630

$34.95
(batteries not included)

- Battery Operated (Size C)
- Weighs ONLY 11 Ounces
- Wraps 30 AWG Wire onto Standard DIP Sockets (.025 inch)

Complete with built-in bit and sleeve

WIRE-WRAP KIT — WK-2-W

WRAP • STRIP • UNWRAP

- Tool for 30 AWG Wire
- Roll of 50 Ft. White or Blue 30 AWG Wire
- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped wire

$11.95

WIRE WRAP TOOL WSU-30

WRAP • STRIP • UNWRAP - $5.95

WIRE WRAP WIRE — 30 AWG

25 ft. min. $1.25 50 ft. $1.95 100 ft. $2.95 1000 ft. $15.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

WIRE DISPENSER — WD-30

- 50 ft. roll 30 AWG KYNAR wire wrap wire $3.45 ea.
- Cuts wire to desired length
- Strips 1" of insulation

Specify — Blue-Yellow-White-Red

B&K PRECISION New 3½-Digit Portable DMM

Comes with test leads, operating manual and spare fuse

- Overload Protected • 3" high LED Display
- Battery or AC operation • Auto Zeroing
- 1mv, 1Va, 0 1 ohm resolution • Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage ±0-1000V/AC Voltage 0-1000V
Freq Response 50-400 HZ/DC-AC Current 0-1000mA
Resistance 0-10 meg ohm
Size 6 4" x 4 4" x 2"

Model 2800	$99.95
AC Adapter BC-28	8.00
Rechargeable Batteries BP-28	20.00
Carrying Case LC-28	6.00

DATA HANDBOOKS

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

ALL THREE HANDBOOKS $6.95

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3 3	400mm	4/1 00	1N4005	600 PIV	1 AMP	10/1 00
1N751A	5 1	400m	4/1 00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5 6	400m	4/1 00	1N4007	1000 PIV	1 AMP	10/1 00
1N753	6 2	400m	4/1 00	1N3600	50	200m	6/1 00
1N754	6 8	400m	4/1 00	1N4148	75	10m	15/1 00
1N959	8 2	400m	8/1 00	1N4154	35	10m	12/1 00
1N965B	15	400m	4/1 00	1N4305	75	25m	20/1 00
1N5232	5 6	500m	28	1N4734	5 6	1w	28
1N5234	6 2	500m	28	1N4735	6 2	1w	28
1N5235	6 8	500m	28	1N4736	6 8	1w	28
1N5236	7 5	500m	28	1N4738	8 2	1w	28
1N456	25	40m	6/1 00	1N4742	12	1w	28
1N458	150	7m	6/1 00	1N4744	15	1w	28
1N485A	180	10m	6/1 00	1N1183	50 PIV	35 AMP	1 60
1N4001	50 PIV	1 AMP	12/1 00	1N1184	100 PIV	35 AMP	1 70
1N4002	100 PIV	1 AMP	12/1 00	1N1185	150 PIV	35 AMP	1 50
1N4003	200 PIV	1 AMP	12/1 00	1N1186	200 PIV	35 AMP	1 80
1N4004	400 PIV	1 AMP	12/1 00	1N1188	400 PIV	35 AMP	3 00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR	$1 95
C38M	35A @ 200V	SCR	1 95
2N2328	1 6A @ 200V	SCR	50
MDA 980-1	12A @ 50V	FW BRIDGE REC	1 95
MDA 980-3	12A @ 200V	FW BRIDGE REC	1 95

TRANSISTORS

MPS A05	5 $1 00			PN4249	4 $1 00
MPS A06	5 $1 00			PN4250	4 $1 00
2N2219A	3 $1 00	PN3567	3 $1 00	2N4400	4 $1 00
2N2221	4 $1 00	PN3568	4 $1 00	2N4401	4 $1 00
2N2222A	5 $1 00	PN3569	4 $1 00	2N4402	4 $1 00
2N2369	5 $1 00	2N3704	5 $1 00	2N4403	4 $1 00
2N2369A	4 $1 00	2N3705	5 $1 00	2N4409	5 $1 00
2N2484	4/$1 00	2N3706	5/$1 00	2N5086	4 $1 00
2N2906A	4 $1 00	2N3707	5/$1 00	2N5087	4 $1 00
2N2907A	5 $1 00	2N3711	5 $1 00	2N5088	4 $1 00
2N2925	5 $1 00	2N3724	$ 65	2N5089	4 $1 00
2N3053	2 $1 00	2N3725	$1 00	2N5129	5 $1 00
2N3055	$ 89	2N3903	5 $1 00	2N5138	5 $1 00
MJE3055	$1 00	2N3904	4 $1 00	2N5139	5 $1 00
MJE2955	$1 25	2N3905	4 $1 00	2N5209	5 $1 00
2N3392	5 $1 00	2N3906	4 $1 00	2N5951	5 $1 00
2N3398	5 $1 00	2N4013	3 $1 00	C106B1SCR	2 $1 00
		2N4014	3 $1 00	2N5432	$2 00
		2N4123	10/$1 00		

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	05	04	03	001µF	05	04	035
22 pf	05	04	03	0047µF	05	04	035
47 pf	05	04	03	01µF	05	04	035
100 pf	05	04	03	022µF	06	05	04
220 pf	05	04	03	047µF	06	05	04
470 pf	05	04	035	1µF	12	09	075

100 VOLT MYLAR FILM CAPACITORS

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

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

1/35V	28	23	17	1 5/35V	30	26	21
15/35V	28	23	17	2 2/25V	31	27	.22
22/35V	28	23	17	3 3/25V	31	27	22
33/35V	28	23	17	4 7/25V	32	28	23
47/35V	28	23	17	6 8/25V	36	31	25
68/35V	28	23	17	10/25V	40	35	29
1 0/35V	28	23	17	15/25V	63	50	40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
47/50V	15	13	10	47/25V	15	13	10
1 0/50V	16	14	11	.47/50V	16	14	11
3 3/50V	15	13	10	1 0/16V	15	13	10
4 7 25V	16	14	12	1 0/25V	16	14	11
10/25V	15	13	10	1 0/50V	16	14	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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MINNESOTA RESIDENTS 218-681-6674

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DATA BOOKS • HEAT SINKS • WIRE • TOOLS . . . AND MORE . . . WRITE FOR FREE CATALOG . . . .

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	1.15
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
74LS86	.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	.53
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
74LS283	.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
74C00	.23

LINEAR

CA3046	.75
CA3086	.50
LF351N	.76
LF356N	1.20
LF357N	1.20
LF13741	.716
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

I.C. SOCKETS

8 PIN SOLDER	.17	1.60/10	14.50/C
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

MOLEX I.C. SOCKET PINS

.85/C 8.20/M 38.20/5M 275.00/50M

SLIDE SWITCHES

SPST	.15	1.25/10	10.00/C
SPDT	.19	1.70/10	13.00/C
DPDT	.23	2.00/10	19.00/C

STRANDED HOOK UP WIRE

20 ga PVC	2.50/100'	10.00/500'
22 ga PVC	2.80/100'	11.25/500'
24 ga PVC	2.10/100'	8.50/500'
26 ga PVC	2.10/100'	8.50/500'

50 VOLT DISCS

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

8080A CHIP SET

ONE EACH 8080A, 8212, 8224 and 8228 PLUS SIXTEEN 2102-1's — ALL FOR

$49.95

MICROPROCESSORS

Best Values Yet!

8080A	8-BIT CPU, 2 USEC CYCLE	$12.95
8212	8-BIT I/O PORT	$ 3.95
8216	BI-DIRECTIONAL BUS DRIVER	$ 4.25
8224	CLOCK GENERATOR	$ 3.95
8228	SYSTEM CONTROLLER	$ 6.95
8251	COMMUNICATIONS INTERFACE	$12.95
8255	PERIPHERAL INTERFACE	$11.95
1702A	2K EPROM (256x8)	$ 6.95
2708	8K EPROM (1Kx8)	$29.50
2102-1	1K RAM 500 NS.	$ 1.79
SC/MP	5 VOLT SC/MP CPU	$ 9.95
2650	MICROPROCESSOR 1.25 MH-2 CLOCK 40 DIL	$24.95

WIRE WRAPPING WIRE IN BULK

Red or Black 30 ga. Kynar

100' $2.00 500' $8.50 1000' $15.00

5% CARBON FILM RESISTORS

¼ & ½ WATT SIZE

5 pcs/value 5¢ ea., 100 pcs/value 1.7¢ ea., 1000 pcs/value 1.2¢ ea.

PLESSEY SAMPLER

AN ASSORTMENT OF METALIZED POLYESTER CAPACITORS

300 CAPS 18 VALUES $26.00

METALIZED POLYESTER CAPACITORS

.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	.68/10	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	.08	.67/10	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	8.48/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
45/50V	.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	3.07/100	28.38/C
1000/16V	.29	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

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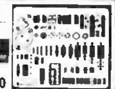

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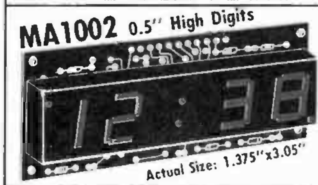
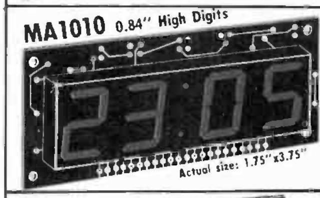


Actual Size: 1.375"x3.05"

MA1010 0.84" High Digits



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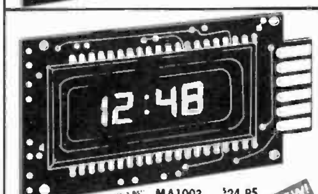

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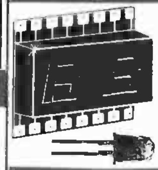

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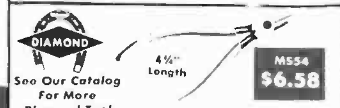

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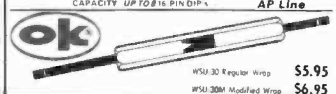

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MPS2369A	.16	1.55/10	13.60/C	130.00/M
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MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3394	.16	1.55/10	13.60/C	130.00/M
MPS3395	.16	1.55/10	13.60/C	130.00/M
MPS3563	.16	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
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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
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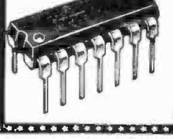

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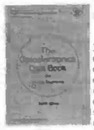

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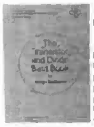

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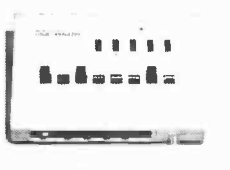

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LM317K (TO-3)	$3.70

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This circuit is a dual polarity tracking regulator designed to provide balanced positive and negative output voltages at currents up to 100 mA. It is internally set for positive and negative 15 volt outputs but a single external adjustment can be used to change both outputs simultaneously from 10 to 23 volts. This device can be used with input voltages up to + and −30 volts and also has provision for adjustable current limiting, and utilization at currents in excess of 2 amps with the aid of external power transistors.

	1–24	25 UP	100 UP
SG4501J	$4.45	$3.55	$2.95

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- Adjustable power consumption to less than 20 microwatts
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- Internally compensated

	1–24	25 UP	100 UP
SG3250T	$4.90	$3.90	$3.25
SG3250M	$4.50	$3.10	$2.55

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SG1524J	$10.15	$8.10	$6.75

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SN 7400N	$.16	$.12	SN 7474N	$.31	$.25	SN 74160N	$1.20	$1.10
SN 7402N	.21	.15	SN 7483N	.69	.54	SN 74161N	.99	.95
SN 7404N	.18	.17	SN 7486N	.38	.30	SN 74162N	1.80	1.70
SN 7407N	.29	.23	SN 7489N	2.40	1.95	SN 74163N	.99	.80
SN 7408N	.25	.19	SN 7490N	.44	.37	SN 74164N	1.10	.90
SN 7410N	.18	.14	SN 7493N	.49	.40	SN 74165N	1.10	.90
SN 7411N	.27	.24	SN 7495N	.79	.64	SN 74166N	1.25	.99
SN 7413N	.45	.35	SN 74100N	1.00	.79	SN 74170N	2.00	1.85
SN 7414N	.70	.55	SN 74104N	.50	.49	SN 74173N	1.50	1.18
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SN 7417N	.35	.27	SN 74107N	.38	.31	SN 74175N	.99	.80
SN 7420N	.21	.16	SN 74109N	.56	.54	SN 74177N	.90	.70
SN 7425N	.29	.22	SN 74121N	.39	.31	SN 74178N	1.30	1.20
SN 7427N	.26	.20	SN 74123N	.49	.39	SN 74180N	.98	.90
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CMOS 7 SEGMENT DECODER/ DRIVER LATCH

Again for military and commercial display applications. The 4311B offers hexadecimal code while the 4511B offers decimal code. They are pin-for-pin compatible.

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MD4311BE	$2.80	$1.76
MD4511BE	$2.80	$1.76

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MD4055BE	$1.87	$1.58
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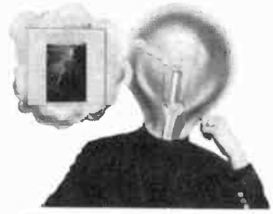

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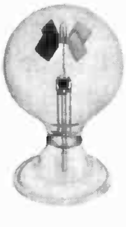

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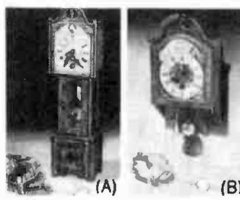

(A) (B)

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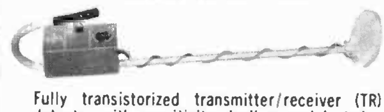

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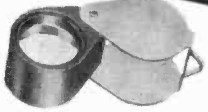

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7411	.18	74107	.28
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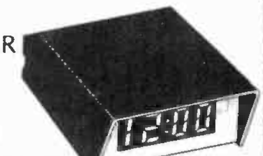

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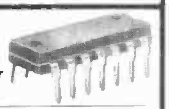
7400	276-1801	$ 49	35¢
7402	276-1811	$ 49	39¢
7404	276-1802	$ 59	35¢
7406	276-1821	$ 69	49¢
7410	276-1807	$ 49	39¢
7413	276-1815	$1 19	79¢
7420	276-1809	$ 49	39¢
7427	276-1823	$ 69	49¢
7432	276-1824	$ 69	49¢
7441	276-1804	$1 59	99¢
7447	276-1805	$1 99	99¢
7448	276-1816	$1 99	99¢
7451	276-1825	$ 49	39¢
7473	276-1803	$ 79	49¢
7474	276-1818	$ 79	49¢
7475	276-1806	$1 19	79¢
7476	276-1813	$ 79	59¢
7485	276-1826	$1 59	1.19
7486	276-1827	$ 69	49¢
7490	276-1808	$1 19	79¢
7492	276-1819	$1 19	69¢
74123	276-1817	$1 69	99¢
74145	276-1828	$1 49	1.19
74150	276-1829	$1 79	1.39
74154	276-1834	$1 79	1.29
74192	276-1831	$1 69	1.19
74193	276-1820	$1 69	1.19
74194	276-1832	$1 69	1.19
74196	276-1833	$1 69	1.29

74C and 4000 Series CMOS ICs

Type	Cat No	Last Year	NOW ONLY
74C00	276-2301	$ 69	49¢
74C02	276-2302	$ 69	49¢
74C04	276-2303	$ 69	49¢
74C08	276-2305	$ 69	49¢
74C74	276-2310	$1 29	89¢
74C76	276-2312	$1 59	89¢
74C90	276-2315	$2 29	1.49
74C192	276-2321	$2 49	1.69
74C193	276-2322	$2 49	1.69
4001	276-2401	$ 69	49¢
4011	276-2411	$ 69	49¢
4013	276-2413	$1 29	89¢
4017	276-2417	$2 49	1.49
4020	276-2420	$2 49	1.49
4027	276-2427	$1 29	89¢
4049	276-2449	$ 99	69¢
4050	276-2450	$ 99	69¢
4511	276-2447	$2 69	1.69
4518	276-2490	$2 48	1.49

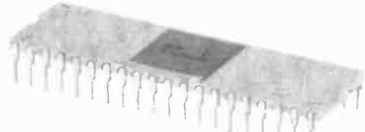
Linear ICs

First Quality Devices by National Semiconductor and Motorola



Type	Cat. No.	Last Year	NOW ONLY
301AH	276-017	$ .69	49¢
324N	276-1711	$1.99	1.49
339N	276-1712	$1.99	1.49
386CN	276-1731	$1.99	99¢
555CN	276-1723	$1.49	79¢
556CN	276-1728	$2.79	1.39
566CN	276-1724	$2.99	1.69
567CN	276-1721	$2.99	1.99
723CN	276-1740	$ 99	69¢
741CN	276-007	$ .69	49¢
741H	276-010	$ 69	49¢
3900N	276-1713	$1.39	99¢
3909N	276-1705	$1.29	99¢
3911N	276-1706	$2.19	1.99
4558CN	276-038	$ 99	79¢
75491	276-1701	$1.49	99¢
75492	276-1702	$1.49	99¢
7805	276-1770	$1.59	1.29
7812	276-1771	$1.59	1.29
7815	276-1772	$1.59	1.29

Microcomputer Chip

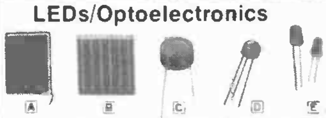


8080A Microprocessor. With a 16-bit address bus capable of addressing up to 65k bytes of memory and up to 256 I/O ports. "TRI-State" data bus gives it DMA and multiprocessing capability. All buses TTL compatible. Up to 244 variable length instructions, with 6 general purpose registers plus an accumulator. 40-pin DIP. *100% Prime.* **276-2510** 17.95

RS2102 Static RAM. 1024-word by one bit random access read/write memory. Under 750 nS access. Single +5V power supply. **276-2501** .... **2.49 each or 8/14.95**

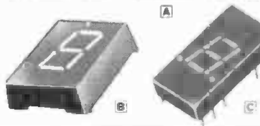
17.95

LEDs/Optoelectronics



Item	Cat. No.	Reg.	Now Only
A Solar Cell	276-115		1.59
B Silicon Solar Cell	276-128		1.99
C Photocell	276-116		99¢
D FPT 100	276-130		79¢
E Lg Red LED	276-041	2/69¢	2/49¢
E Lg Clr LED	276-047	2/69¢	2/49¢
E Med Red LED	276-026	2/69¢	2/49¢
E Med Clr LED	276-040	2/69¢	2/49¢
E Sm Red LED	276-042	2/69¢	2/49¢

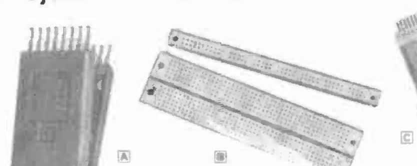
Digital Displays

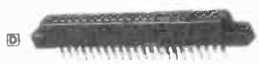


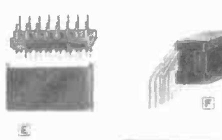
Digits	Size	Drive	Cat. No.	Last Year	NOW ONLY
A 4	0.5"	Anod.	276-1201	$9.95	6.95
A 4	0.5"	Cath.	276-1202	$9.95	6.95

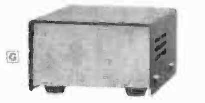
Digits	Size	Drive	Cat. No.	Last Year	NOW ONLY
B 1	0.6"	Anod.	276-056	$3.99	2.99
B 1	0.6"	Cath.	276-066	$3.99	2.99
C 1	0.3"	Anod.	276-053	$2.99	1.99
C 1	0.3"	Cath.	276-062	$2.99	1.99
C 1	0.3"	Anod.	276-1210	4/$8.97	4/6.99
C 1	0.3"	Cath.	276-1211	4/$8.97	4/6.99

Project Accessories









A **IC Troubleshooting Test Clip.** Test up to 14 pins with probes or clips. Reg. 4.59
276-1950 **Sale 2.99**

A **IC Troubleshooting Test Clip.** Test up to 16 pins with probes or clips. Reg. 4.99
276-1951 **Sale 3.49**

B **Experimenter Socket.** 2x47 rows of 5 connected tie points. **276-172** 9.95

B **Bus Strip.** 2x40 connected tie points. Clips to socket above. **276-173** 1.99

C **Standard Edge-Card Board.** 22-pin 1295 mounting holes **276-152** 2.99

C **2-Voltage Source Edge-Card Board.** 1368 mounting holes. **276-154** 2.99

C **3-Voltage Source Edge-Card Board.** 1368 mounting holes **276-153** 2.99

D **22-Pin Edge-Card Board Connector.** 44-terminals. **276-1551** 2.99

D **100-Pin Edge-Card Board Connector.** For standard S-100 hobby computer bus.
276-1554 4.99 each or 5/19.95

E **DIP Header.** 16-pin spacing
276-1980 1.29

F **Right Angle IC Socket.** Mount LED's vertically 16-pin spacing
276-1985 1.49

G **Metal Cabinet.** $3^1/_4$x$2^3/_{16}$x4"
270-251 2.59

G **Metal Cabinet.** 4x$2^3/_4$x6"
270-252 3.49

G **Metal Cabinet.** $6^1/_4$x$2^3/_4$x$7^1/_4$"
270-253 4.49

Transformers

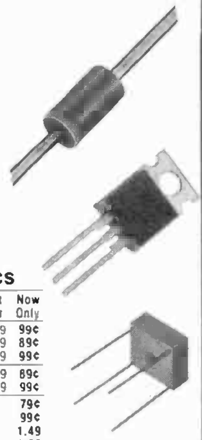
6-3 Volts 1.2 Amps. $1^1/_4$x$1^{15}/_{16}$x$1^9/_{16}$".
273-050 .... 2.29

6-3 Volts, 3 Amps. $2^9/_{16}$x2x$1^3/_4$".
273-1510 .... 3.99

12 Volts 5 Amps. 4x2x$2^1/_2$". Reg. 8.95.
273-1513 .... Sale 6.95

18 Volts (Center Terminal), 4 Amps. Ideal for 5V (using CT), or 12V solid-state regulators. 4x2x$2^1/_2$". Reg. 8.95.
273-1514 .... Sale 6.95

Selected Diodes



Type	Cat. No.	Last Year	Now Only
1N4001	276-1101		2/39¢
1N4003	276-1102	2/59¢	2/49¢
1N4004	276-1103	2/69¢	2/59¢
1N4005	276-1104	2/79¢	2/69¢
1N4735	276-561		2/89¢
1N4739	276-562		2/89¢
1N4742	276-563		2/89¢
1N4744	276-564		2/89¢
Trigger Diode	276-1050	$.49	39¢
1N5401	276-1141		2/69¢
1N5402	276-1142	2/89¢	2/79¢
1N5403	276-1143	2/99¢	2/89¢
1N5404	276-1144	2/$1 19	2/99¢
PTC205	276-1114		3/1.39¢

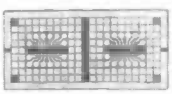
SCR's and Triacs

Device	Rating	Cat No	Last Year	Now Only
LASCR	200V, 1.6A	276-1095	$1 59	99¢
SCR	200V, 6A	276-1067	$1.39	89¢
SCR	400V, 6A	276-1020	$1 49	99¢
Triac	200V, 6A	276-1001	$1 39	89¢
Triac	400V, 6A	276-1000	$1 49	99¢
BR	50PIV, 1.4A	276-1151		79¢
BR	100PIV, 1.4A	276-1152		99¢
BR	100V, 4A	276-1171		1.49
BR	200V, 4A	276-1172		1.69
BR	400V, 4A	276-1173		1.89
BR	50PIV, 6A	276-1180		1.99

Digital Car Clock Module

Just add switches and install! Type MA1003, with MOS/LSI clock circuit chip, green fluorescent display with four 0.3" digits. Has 2.09 MHz crystal, blinking colon activity indicator. Six-pin edge-connector. For any 12VDC source. **277-1003** **24.95**

Experimenter's PC Board



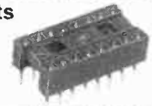
Simplifies IC Projects

Ideal for two-circuit projects. Fire-retardant copper-clad board is only $2^1/_2$x5x$^1/_{16}$". Really simplifies integrated circuit projects by extending leads for easy soldering.
276-151 .... **2.99**

IC Socket Wrapping Tool

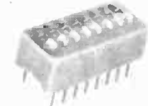
For making superior, precision connections — without soldering. Wraps, unwraps, and strips 30-gauge wire. Modified wrap for extra security. No bits, sleeves or special skills needed. Balanced, $4^1/_2$" long. All-metal. **276-1570** 6.95
14-Pin Wire-Wrapping Sockets. 276-1993 ...... **Pk. 2/1.29**
16-Pin Wire-Wrapping Sockets. 276-1994 ...... **Pk. 2/1.39**
50' Red Wire. #30 Gauge Kynar. **278-501** **1.99**
50' White Wire. #30 Gauge Kynar. **278-502** **1.99**
50' Blue Wire. #30 Gauge Kynar. **278-503** **1.99**

Low-Profile DIP Sockets



8-Pin. 276-1995. Reg. 2 for $.69 . 2/59¢
14-Pin. 276-1999. Reg. 2 for $1.19 2/89¢
16-Pin. 276-1998. Reg. 2 for $1.19 2/89¢
28-Pin. 276-1997. Reg. $1.19 Each . 89¢
40-Pin. 276-1996. Reg. $1.39 Each . 99¢

8-Rocker DIP Switch



Incorporates 8 on-off switches. For easy change of preset logic states. Fits any 16-DIP socket. **275-1301** ... **1.99**

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Operation Assist

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

Precise Model 300 triggered sweep oscilloscope with magnifier feature and Model 111 Em and Gm tube tester. Need schematics and instruction manuals. Also means to generate set-up data for tubes after 1955. Len Kerchner, 96 Cryan St., Chicopee, MA 01020.

Hickok Model 800 tube tester. Instruction manual and schematic. James G. Miller, 4951 Glenalbyn Dr., Los Angeles, CA 90065.

Sentinel military oscilloscopes (circa 1960's). Instruction and repair manuals. Lester Neal, Route 5, Seymour, IN 47274.

Gretch electronic guitar amplifier. Schematic or information on output coupling transformer. Jack H. Frazier, 1063 Wilson, University City, St. Louis, MO 63130.

Coastwise Electronics "Ferret" Model 600 r-f signal generator. Schematics, technical and calibration information. Jim Conaway, B-105 University Village, Athens, GA 30601.

Tektronix Model 535 oscilloscope, type K module. Operation manual and schematic. Terry Garrity, 326 W. Blvd., Bismark, ND 58501.

Hammarlund Model DX-215 receiver. Schematics or owners manual. Karl Williamson, Box 251, Fenton, MO 63026.

Lafayette Model HA-225 shortwave receiver. Schematic, operation manual or alignment information. David Norton, R 811 Taylor Ave., Scranton, PA 18510.

HFE Model T-4214 transistorized oscilloscope. Manual or schematic needed. Jack D. Generaux, 2919 Formay Ave., Grand Junction, CO 81501.

Aiwa Model 75T-01 "Commander" television. Need schematic. Harry Werner, 555 Casey Rd., E. Amherst, NY 14051.

Central Electronics Model B sideband slicer, multiphase Q multiplier. Schematic and alignment information. Charles Segar, Rt.1, Box 94, Sawyer, MI 49125.

Triumph oscilloscope. Need instruction manual. Tim Wagar, 266 40th Street Way #E, Oakland, CA 94611.

Jackson Model 640 test oscillator and Model 633 dynamic tube tester. **Supreme** Model 550 deluxe tube tester. Need schematic diagrams. Jaime Joel Varela G., Box 2000 (c.g.), San Salvador, El Salvador.

RCA Model 8K superheterodyne receiver. Schematic or any available information. Warren W. Painter, 9613 La Tuna Canyon Rd., Sun Valley, CA 91352.

Diasound Model MC-50A stereo (serial number 5000190880). Need component No. AN272U. Oliver K. Brown, Rt.1, Glen Flora, WI 54526.

Philco Model 42-380, code 121, superheterodyne receiver. Schematic, parts list and source of tube. Robert J. Galligan, Box 326, Niantic, CT 06357.

Apelco Model AR-9 CB transceiver. Schematic and service manual. T.E. Huxhold, Box 36, Frederick Acres, Hardy, VA 24101.

Cossor Model 4100 oscilloscope. Instruction manual and schematic. Elliott Lea, 14 Jonathan Ln., Chelmsford, MA 01824.

Western Electric Model 1-BA telephone answering set. Operation and repair manuals. P. Dounson, 914 W. Mistletoe, San Antonio, TX 78201.

Solar capacitor analyzer Model CE. Schematic or any available information. John Strada, 8110 Colegio Dr., Los Angeles, CA 90045.

Lamba Model LA50-30B power supply. Owner's manual and schematic. J.L. Van Over, 5488 Lance Rd., Medina, OH 44256.

U.S. Army Signal Corps Model BC-348-P receiver. Operator's manual and circuit diagram. Owen Scotland, Box 356, Grand Cayman, Cayman Islands, B.W.I.

Hickok Model 532-533DM-534A-534B-600 tube tester. Instruction manual, schematic or any available information. Frank R. Crim, 1321 S.W. 95h Ave., Deerfield Beach, FL 33441.

Nekermann A Korting West German radio/stereo (NR 828/43). Service manual and/or schematic. Rex Faulkner, 2677 Estelle Ct., Smyrna, GA 30080.

National Model NC-100X receiver. Schematic or manual. Edward S. Sears, 174 Charles Dr., Valparaiso, FL 32580.

Bell Model 2425 AM/FM stereo amplifier. Service manual and/or schematic. Paul Parkhill, 1094 So. 5th Ave., Kankakee, IL 60901.

RME multi-band communications receiver. Schematic and any available information. Scott Brissey, 414 Bloom, 1st Flr., Highland Park, IL 60035.

Tech Model TO-3 oscilloscope. Information, schematic and manual. John Visser, 12627 98th Ave., Surrey, British Columbia, V3U 2K7 Canada.

National Electronics Labs Type CA-1267 voice operated relay. Schematic and operations manual. Mike Roman, 930 State St., Grinnell, IA 50112.

UMC Model 24A-C oscilloscope. Need technical manual. Sgt. Ron Hathcock, C Co 32 Sig BN Box 107, APO 09757.

Lafayette Model KT-320 shortwave receiver. Operation manual. David B. Stancel, 99 Morris Dr., Ringgold, GA 30736.

Tektronix Model 514-D oscilloscope. Need manual. Anthony Matlosz, 419 Rahway Ave., Elizabeth, NJ 07202.

Teac Model 505-3 reel-to-reel tape recorder. Need service manual. Melvin McDaniel, 1822 N. Appleton St., Baltimore, MD 21217.

W.T. Grant Model 1004B30 9-inch TV receiver. Schematic and service information. James E. Saffin, 919 Ford Ave., Ogdensburg, NY 13669.

Midland Model MID 7040A07 cassette recorder. Need schematic. Fabian Velazquez V. Virrey de Mendoza, 937 Morelia, Michoacan, Mexico.

Lexington (Div. Concord Electronics) Model LE-1 stereo receiver. Schematic and service information. Frank, 217 Ridgedale Ave., Florham Park, NJ 07932.

Rider radio manuals Vol. I through XXIII. D.A. Swindal, 1112 San Jose Ln., Hanahan, SC 29406.

Ampex Model 008 stereo console. Need schematic. K.G. Brown, 5032 Gilbert Dr., Fort Worth, TX 76116.

Eico Model 753 transceiver. Need source of No. 751 ac power supply. R.J. Hickey, Box 673, Corner Brook, New Foundland, Canada.

Heath Model EV805A universal digital instrument. Schematics, instructions and/or manuals. J. Baker, 1718 E. Galer, Seattle, WA 98112.

Bell & Howell Model 2295 tape recorder. Need schematic.
IT&T Model 6521 FX stereo combination equipment. Schematic. G.W. Farr, 85 Violet Ln., Lakeland, FL 33801.

Magnatone Model 200 hi-fi stereo vibrato. Schematic, tube

(Continued on page 118)

OPERATION ASSIST

(Continued from page 117)

diagram and service information. Gus A. Green, 12692 Green St., Boron, CA 93516.

Paco Model ST-45 AM/FM tuner. Schematic and multiplex module. T. Turbak, 947 Ludlow St., New Bedford, MA 02745.

Hallicrafters Model S-38C ham receiver. Schematic and owner's manual. Mark Joseph, 9104 Bennett Ave., Evanston, IL 60203.

Gulf Coast Electronics Model AF 28 51 1604000-114 power supply training aids E.A.F.B. Owner's manual, operation manual and schematic. **Trav-ler Radio Corp.** Model TS-382B/U audio oscillator. Schematic and maintenance manual. Jack Aquilar, Apartado 11-407, Mexico 11, Mexico City, Mexico.

Phone-King Model J36 phone answering machine. Schematic or address of manufacturer. Tri-Town Electric Co., Willow Creek Rd., Lenox, MA 01240.

B&K Precision Model 960 transistor radio. Owner's manual, schematic and any available information. Wilfrid J. Cote III, 704 S. Filbert St., Stockton, CA 95205.

Hallicrafters Model SX-99 shortwave receiver. Schematic needed. **Sony** Model TV-74, Serial No. 15382. Schematic with voltages and oscilloscope waveforms. Mike Carter, 400 Home Dr., Trafford, PA 15085.

Precise Model 308-C oscilloscope. Need schematic and/or manual. Steven Housholder, 227 S. Third Ave., Lombard, IL 60148.

Multi-Products CitiFone CB transceiver. Need schematic and tube line-up. Billy L. Nielsen, Rt. 2, Box 253E, Radcliff, KY 40160.

National Model NC-173 receiver. Schematic needed. Ron Bondy, Jr., Box 1176, 67 Alice, Essex, Ontario, Canada NOR IEO.

Knight-Kit Model 400A tube checker. Need tube chart. H.A. Davis II, 8803 Montery Ct., Indianapolis, IN 46226.

Bendix Model PATR-10A flightweight transceiver. Schematic and operation manual. **Motorola** Model FMTRU 5-V transceiver. Schematic and operation manual. **Gulf Coast Electronics** Model AF 28 51 1604000-114 power supply.

Schematic and owners manual. Joaquin A. Araujo, 225 Lavaca St., San Antonio, TX 78210.

Wards Model JWR764A airline phonograph. Need tube #35L6 GT and schematic. Van Duncan, 2338 Woodhurst Dr., Richmond, VA 23233.

Precision Apparatus Series 10–54 tube and set tester. Operating instructions, schematic and parts list. Martin A. Weiner, 16 Judith Ln., Monsey, N.Y. 10952.

RCA Model RBC-1/CRV-46148 receiver and Model CRV-20130 power supply. Schematic and alignment instructions. Paul E. Solheim, 1115 1st Ave. N., Great Falls, MT 59401.

Estey Electronics Orcoa concert organ. Need power transformer #66–0003A. Howard Watts, 3040A Whittier, St. Louis, MO 63115.

United Scientific Labs Contact—23 CB radio. Schematic and operation manual. Charles McKinney, 1115½ Speedway, Parimont, WV 26554.

Astrodata Model 6190 time code generator. Operation and maintenance manuals. Michael Schulsinger, 1002 Woodlawn Ave., Springfield, OH 45504.

Hallicrafter Model RBY-1, Type CHL-46195 receiver. Need schematic, service information and operation manual. George A. Mikulka, 42 Roseleah Dr., Waterford, CT 06385.

Truetone Model DC-4850 auto radio. Schematic and parts list. **Sylvania** Model 4315M hi-fi record player. Need model number and manual for record changer used with player. Charles D. Prater, Edna, KY 41419.

Solar Model CE capacitor checker. Need manual and schematic. Maurice Trego, 1612 E. 31st Court, Des Moines, IA 50317.

Zenith Model E1345 black and white television and G. E. Trimline 500 stereo. Need schematics. Michael Persic, 18021 Karen Dr., Encino, CA 91316.

Tektronix Model 585A oscilloscope and I.T.&T Model 1735D oscilloscope. Schematics and manuals. A.F. Carlson, University of Miami, Chemistry Dept., Box 249148, Coral Gables, FL 33124. ◇

DX LISTENING

(Continued from page 93)

Holness, Fri. 1130, Sat. 0330. A Jolly Good Show, Wed. 0030, Thu. 2030. Sarah Ward, Fri. 2115, Sun. 0630.

R. Australia takes requests on Countdown, Mon-Fri at 0900–1100, an hour not intended for North America, but when it can be heard if you're up; try 5995 kHz.

R. Budapest once had 0300 broadcasts on Sunday set aside for music requests, and may still have.

R. Moscow does the same Wed. 2315, Thu. 0115, 0315, 0445, 0645.

RCI accepts requests for Canadian music for Saturday broadcasts.

R. Nederland is adding a special edition of His and Hers for North America on Wednesday.

Folk Music. Most stations include some of their ethnic music throughout their transmissions. *Switzerland* is instantly recognizable because of this. *BBC World Service* is more methodical, with various 15-minute series at changing times. *Radio Finland* promises Finnish music of all kinds on Voices of Finland, the last Tuesday of each month.

VOA has two especially good programs of music not of the US, but from the target area—Music Time in Africa, Sun. 1635, 1935; and in the Spanish service, Triunfos Musicales Latinoamericanos, Sun, 0035.

Week in Review. Many stations take this approach, realizing that many listeners join them on weekends who can't listen every day.

AFRTS Washington carries several weekly reviews from the domestic commercial networks. You may well never have heard them on your local affiliate, because they are unsponsorable. World of Religion (CBS), is on Sat. 0235, 0835, 1435, 2035. Voices in the Headlines (ABC), with dramatic music, is reminiscent of movie newsreels, Sun. 1635, 2235, Mon. 0435, 1035, 1635. Washington Week (CBS), Sun. 0005, 0605, 1205, 1805. The World This Week (CBS), Mon. 0305 and 1116. This Week at the UN (Mutual), Sun. 0315, 0915, 1515, 2115. All these appear an hour earlier by GMT during daylight time. And about half the times are usually, but not always, pre-empted for sports coverage!

CBC Northern Service Sunday Morning, "a week in the life of the world," really in depth, but entertaining, 1400-1700 (summer 1300-1600).

SBC Saturdays, 2 or 3 minutes of a show called The Week in Switzerland.

VOA This Week, Sat. 1310, 1710, 2110, Sun. 0110.

UN Radio 15-minute English UN news summaries weekly on Sat., but five days a week while the General Assembly is in session, 0230, 0545, 0845.

IBA, Israel This Week, on Sat.

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BBC World Service can afford to specialize: About Britain, Sat. 0145, 0515, 1015; Europa, Sat. 1115, Sun. 0215, 2115; This Week and Africa, Sat. 0335, 0515, 1500; From the Weeklies, Fri. 2315, Sat. 0715.

R. Japan Weekly News Review, Sun. 0905, 1605, 2005, 2205; Mon. 0005 in the general services; Sun. 2355, Mon. 0140 in regional services.

R. Australia The Week in Business, Sat. 0210, 0810, 1410.

R. Cairo This Week in History, Sun. 2255.

Belgium The Week That Was, Sat. 0015.

Austria The Week in Austria, Sat. 0130, 0330, 0430.

Radio RSA History in the Making, last item on Friday broadcasts.

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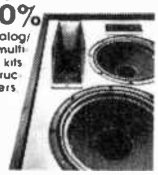

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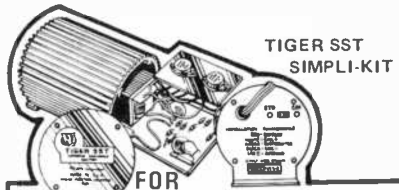

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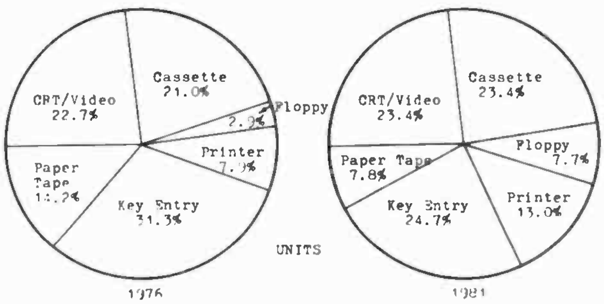
news HIGHLIGHTS

Home Computer Sales Forecasts

A recent study compiled by the Venture Development Corp., Wellesley, Mass., reveals that purchases of computers and related products for home use will increase at an average 37% annual rate for the period 1976–1981. The study, "The Home Computer," cites that software



will represent the fastest growing submarket of the hobby computer industry, averaging 81% growth through 1981. Among peripherals, the floppy disk is expected to exhibit the fastest growth, rising 63% annually in units sold. Cassettes, CRT/video and printer sales are also expected to rise substantially. Computer stores will account for 61.6% of hobby computer sales in 1977, according to VDC's analysis, increasing at an average 47.8% annually in units.

New-Fangled IC's

Small, compact integrated circuits that can be clipped off a roll of film is the new style of IC being introduced by Siemens. The familiar beetle-like DIP, unmistakable shape of the IC, now has a challenger. The new production process involves mounting the silicon chips in the "windows" of polyimide ribbon similar to "super 8" motion picture film, with a potential of 1000 IC's per roll. Before the chips are mounted, the film surface is coated with copper, tinned and etched to produce conductors and terminal points. The inner ends of the conductors protrude into the "windows" of the film to provide both physical support and electronic binding. Known as the "Micropack System," the new circuits are expected to be used in compact units such as film cameras and flat desk-top computers.

Protection for Sensitive Equipment

General Electric's Tube Products Department introduced a self-contained plug-in Voltage Spike Protector, Model GESP-752. The device, not to be confused with a lightning arrester, is designed to protect TV receivers, stereo equipment and other sensitive electronic equipment from brief high-voltage surges from lightning strikes near power lines or switching "off" and "on" of major appliances. The GESP-752 plugs into a 120-V grounded receptacle and acts like a safety valve, absorbing transients before they reach the equipment. It does not interfere with normal circuit flow nor add to energy cost.

RCA Pledges Free TV Labor . . . If

RCA has a new consumer program to assure customer satisfaction with television set repairs. According to a company spokesman, if RCA has made a date to visit a customer's home and fails to keep the appointment, the customer will pay no labor charge. The same promise of free labor if a service appointment is broken is also being offered to RCA's Whirlpool customers.

Energy Fair 1977

"Energy Fair 1977" is scheduled for November 3–6 at the Anaheim Convention Center, Anaheim, CA. The show will highlight alternative energies, and energy conservation techniques and products with the intention of bringing industry, science and the public together for meaningful communication and a positive approach to the energy problem. Features of the fair will be an Energy Career Center with a job-opening section, a slide show, a children's exhibition area, leisure parks, an energy literature information center, and a do-it-yourself area with energy-conservation and alternative-energy booths.

LCD Is Victor Over LED in Watches

If you've noticed that there are fewer watches on the market with LED readouts and more with LCD's these days, you were right. Ashley-Butler, Inc, which makes LCD readouts and various timekeeping devices using them, says that a recent watch industry projection showed that 56 percent of the approximately 15-million digital watches produced in the U. S. this year will have liquid crystal readouts. It is believed that the preference for LCD's is partly due to the availability of new inexpensive and efficient decoder-drivers. The new circuits provide a capability of driving digits from 2 inches to over 6 inches and makes LCD's practicable for what are expected to be broader applications.

Radio Prospects by 1985

Notes from a study, "Radio in 1985," made for the National Association of Broadcasters: FM will attract 51.7% of the radio audience due to the increase in quadraphonic broadcasting and a reduction in FM signal reception problems. . . . AM stereo may be ready to provide competition by 1980. . . . There will be 560-million radio sets of 2.4 per person compared to 401.6 million today. . . . The government may require all radiosets to be AM/FM. . . . CB is not expected to have a major impact on radio. . . . Satellites will be used increasingly for interconnection of stations or networking, yielding better audio quality. . . The darkest cloud on radio's horizon is proliferating cable systems carrying radio as well as television.

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