SPECIAL SECTION—How To Service CB Radios

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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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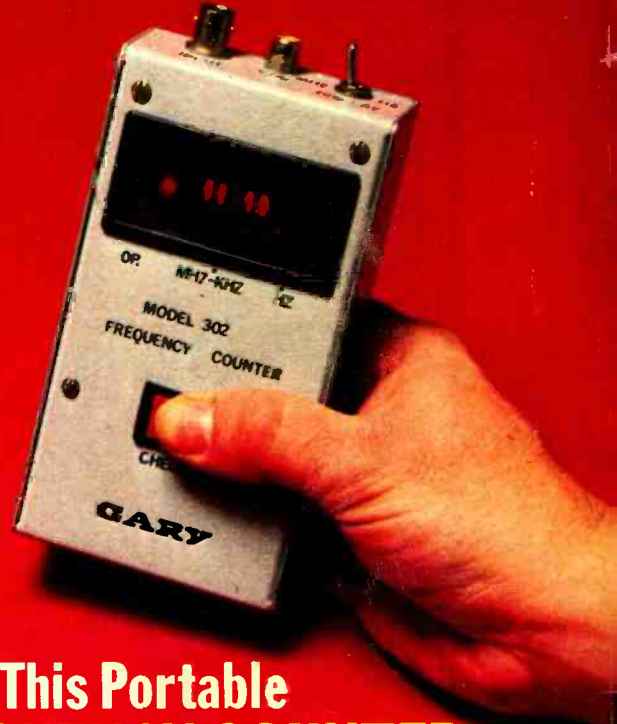
What's New In POLICE-RADAR DETECTORS A Picture Story



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GOULD

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fact: you can choose your microphone to enhance your sound system.

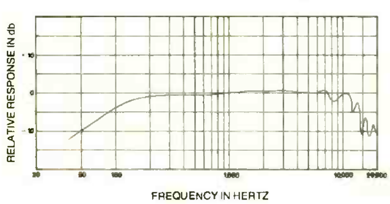
Shure makes microphones for every imaginable use.
Like musical instruments, each different type of Shure microphone has a distinctive "sound," or physical characteristic that optimizes it for particular applications, voices, or effects.
Take, for example, the Shure SM58 and SM59 microphones:

SM59

Mellow, smooth, silent...

The SM59 is a relatively new, dynamic cardioid microphone. Yet it is already widely accepted as a standard for distinguished studio productions. In fact, you'll often see it on TV . . . especially on musical shows where perfection of sound quality is a major consideration. This revolutionary cardioid microphone has an exceptionally flat frequency response and neutral sound that reproduces exactly what it hears. It's designed to give good bass response when miking at a distance. Remarkably rugged — it's built to shrug off rough handling. And, it is superb in rejecting mechanical stand noise such as floor and desk vibrations because of a unique, patented built-in shock mount. It also features a special hum-bucking coil for superior noise reduction!

Some like it essentially flat...

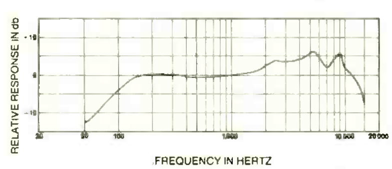


SM58

Crisp, bright "abuse proof"

Probably the most widely used on-stage, hand-held cardioid dynamic microphone. The SM58 dynamic microphone is preferred for its punch in live vocal applications . . . especially where close-up miking is important. It is THE world-standard professional stage microphone with the distinctive Shure upper mid-range presence peak for an intelligible, lively sound. World-renowned for its ability to withstand the kind of abuse that would destroy many other microphones. Designed to minimize the boominess you'd expect from close miking. Rugged, efficient spherical windscreen eliminates pops. Lightweight (15 ounces!) hand-sized. The first choice among rock, pop, R & B, country, gospel, and jazz vocalists.

...some like a "presence" peak.



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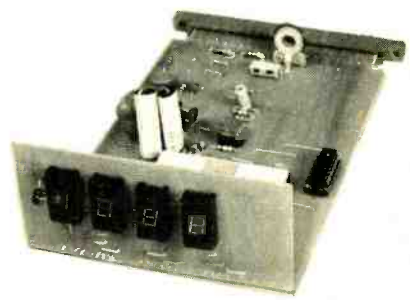
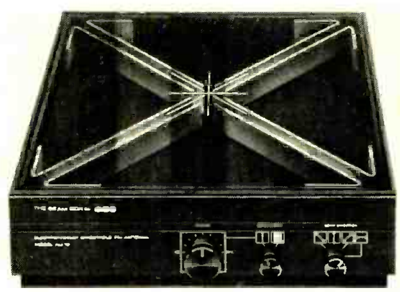
MARCH 1978 Vol. 49 No. 3

ON THE COVER

This month's feature construction project is a hand-held portable frequency counter. The unit measures to 30 MHz with a 90 mV sensitivity. The readout is a 4-digit LED display that provides 6-digit resolution. A must for any workbench. The complete construction details start on page 35.



A BASIC DIGITAL PANEL METER. Turn to page 40 to see how to build this and then turn it into a complete digital multimeter.



B.I.C.'s MODEL FM-10 BEAM BOX indoor FM antenna. R-E's Hi-Fi Lab puts it through its paces. For a complete report, turn to page 66.

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looking ahead

Another videodisc: Matsushita Electric of Japan, the world's largest manufacturer of television sets and parent company of Panasonic and Quasar, has demonstrated a new videodisc system that uses discs strongly resembling standard LP audio records, and made with standard record-pressing equipment and materials. It is a mechanical system with grooves recorded in the "hill-and-dale" method. A twist stylus system uses a piezoelectric material to convert mechanical vibrations into voltage fluctuations.

Matsushita calls its system *Visc* and has developed two variations—both use two-sided 12-inch vinyl records, but one plays for 30 minutes per side, the other for one hour per side. In either variation, the disc revolves at 450 rpm and contains two high-fidelity audio channels as well as a color video program. Matsushita is targeting the player to sell for $480 to $600 on the Japanese market, and discs themselves to sell 20% to 50% more than an audio LP record. The diamond stylus is said to be capable of more than 1,000 hours life.

Matsushita says marketing schedules will depend upon the support of programming companies throughout the world. The specs and parameters of the *Visc* system appear to be so close to those of the RCA capacitance system that the question of potential compatibility was certain to arise—and did. An RCA disc spokesman was asked this question; his reply was that, except for the fact that the center holes on the two discs are different sizes (RCA's is large, Matsushita's is audio-disc size), there should be no reason why Matsushita and RCA discs couldn't be played interchangeably, given some other minor modifications. Both sides insisted their development work was completely independent of each other.

AM stereo closer: An AM stereo system now seems inevitable, and some authorities predict that the parameters of the chosen system could be available before the end of '78. The industry-wide National AM Stereo Radio Committee completed its field-test report as 1977 ended and submitted it to the FCC. The document covered three systems that were submitted for testing (by Belar, Magnavox and Motorola). Although the report made no recommendations, it noted that all three systems were capable of providing good stereo with fidelity close to that of FM, that they all used economically feasible transmitters and receivers, and required little more bandwidth than mono AM and were compatible with existing AM receivers.Two other AM stereo systems, not submitted to the committee for testing, have also been proposed to the FCC by Harris Corporation and by Kahn Communications.

FTC and video games: After a year's investigation, the Federal Trade Commission has tentatively cleared most video games of responsibility for causing injury to TV sets. Based on its inquiry, the FTC stated that "reasonable" use of video games should not damage TV screens. It added the warning, however, that prolonged use of some sets might imprint patterns on some screens, particularly on black-and-white sets. The FTC conceded it had received no consumer complaints, but some special tests conducted by the National Bureau of Standards found that some games with high modulation settings could imprint a pattern on a monochrome set after 100 to 200 hours of use, but these games would not affect color sets until at least 350 hours of use.

The Commission recommended that consumers purchase games with low-modulation video signals, and those that create constantly changing patterns, colors and brightness levels when turned on but not being used in play. Players are urged to adjust the TV for a normal broadcast picture before turning the game on, and to turn the game off when not in use. The FCC said it would continue to monitor TV games—with special emphasis on the new programmable types—for possible imprint problems.

FM car radio costs: Why does the cheapest auto manufacturer's FM-AM radio cost around $140 or $150 when you can buy a portable FM-AM radio for $10 or $15? Why does a monophonic FM-AM car radio cost about twice as much as a standard AM car radio? The National Association of Broadcasters and the Corporation for Public Broadcasting admitted they didn't know the answers, but decided to find out whether there was any hanky-panky involved. Because both of these groups endorse legislation that requires that all radios sold in the U.S. contain both FM and AM bands, they were also interested in determining whether large-scale production could reduce FM car radio prices.

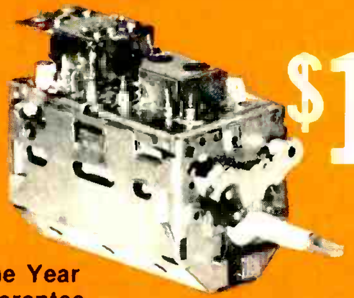
Booz, Allen Applied Research made the study for them. The final report specifically studied original-equipment radios that were supplied with three domestic and two import-band autos. The sticker price for the AM-only radios ran $66 to $80, while the low-end FM-AM radios for the same cars ran $135 to $154. It was discovered that the difference in price between the FM-AM radios and the AM radios didn't represent just profit, but, indeed, the FM section added substantially to the cost.The investigation determined that the markup on an FM-AM radio was about 15% better than that on a low-end AM radio, but that most of the price differential "is directly related to manufacturing cost."

The study didn't offer much hope for any substantial reductions in prices, even if AM-only radios suddenly were outlawed. Additional economies of scale in producing FM-AM radios "are not expected to be significant," said the report, "since AM-FM radio production is currently well over 6 million units per year."

The report did hold out the prospect of price reductions for mono FM-AM radios of from $15 to $30, or an average of 15%, if all radios were FM-AM. The logic was that FM-AM radios would then occupy the bottom of the line and would carry the bottom-of-the-line profit ratios currently experienced by AM-only radios. The eventual increased use of IC's should chop off another $11 to $30, the report forecast.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Tuner Service Corporation



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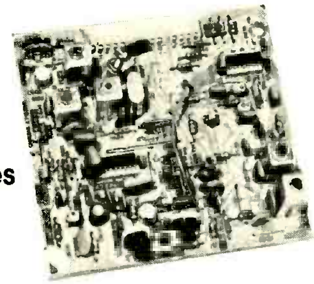

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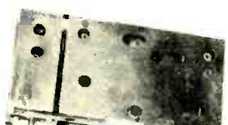

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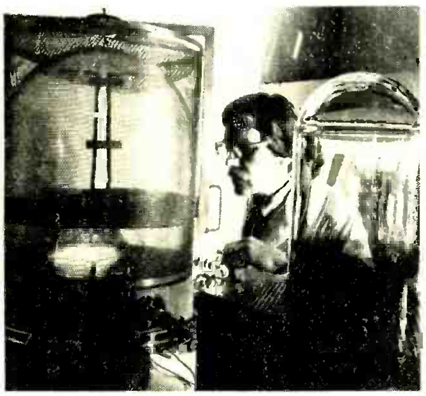
CIRCLE 23 ON FREE INFORMATION CARD

new & timely

RCA receives patent to manufacture amorphous silicon solar cells

Dr. David E. Carlson, head of the Photovoltaic Device Section of the RCA Corporation Energy Systems Research Laboratory, recently was granted a U.S. patent for "a semiconductor device having a body of amorphous silicon." Based on initial lab tests, it is believed that hydrogenated amorphous silicon solar cells will be able to produce electricity at costs competitive with conventional power sources by the mid to late 1980's.

RCA envisions that amorphous silicon cells could be used by developing nations lacking more sophisticated power distribution capabilities. Solar cell power supplies could be adapted to small village areas that receive adequate sunlight but whose electricity requirements are modest. After the technology is improved, amorphous solar cells could be used by more developed nations, particularly where large amounts of DC power are required.



AMORPHOUS SILICON SOLAR CELLS can be produced less expensively than conventional crystalline cells, and are expected to be a cost-effective answer to future power requirements. Shown is Dr. David E. Carlson of RCA laboratories operating the glow-discharge equipment used in manufacturing hydrogenated amorphous silicon solar cells.

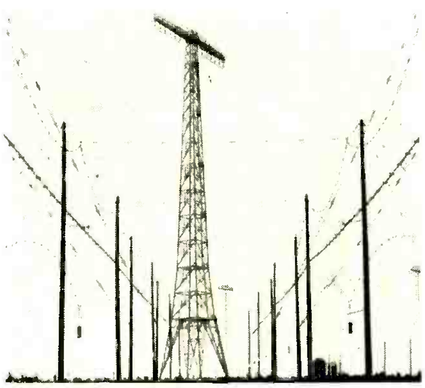
The chief advantage of amorphous silicon cells is their low cost. The material used (a sand derivative) is easily available; a glow-discharge fabrication process is used similar to that used in conventional fluorescent lights; and very thin layers of the material can be spread on large substrates of inexpensive glass or steel sheeting. And because the arrangement of amorphous silicon atoms is not as orderly as that in crystalline solar cells, the material is easier to grow and deposit on inexpensive substrates.

Although conventional silicon cells work more effectively, they are more expensive to fabricate than amorphous silicon cells. Crystalline silicon requires higher processing temperatures (1100°C), compared with the lower 300°C required by amorphous silicon cells. Crystalline cells are also thicker. Amorphous cells can be manufactured in 1-foot-square entities, compared with conventional cells that use 3-inch-diameter wafers.

Last "Radio Central" antenna tower demolished

In 1921, President Harding threw a switch that officially opened "Radio Central," the world's most powerful radio station, and ushered in a colorful era in radio communications. In December, 1977, the last of the 12 giant antenna towers erected in Rocky Point, N.Y., for "Radio Central" by RCA came crashing down . . . the 410-foot tower had become a dinosaur in an age of advanced communications technology.

The Rocky Point facility was the principal station that linked the U.S. with the rest of the world, transmitting messages to Europe, Central and South America. In the early 1920's, longwaves were necessary for such long-distance transmission, and the state-of-the-art mandated the erection of high steel towers to support the antenna structures. The Rocky Point facility had 12 such towers that stretched over a three-mile area on the eastern end of Long Island. Each tower was 410 feet high and weighed 150 tons.



ROCKY POINT, NY, FACILITY as it appeared in the early 1920's.

When shortwave transmission rendered the towers obsolete, they were all taken down except for one, which was used for a while to support aviation beacon lights and high-frequency radio antennas. When this no longer became necessary, the order went out to demolish "the last of the giants," thus closing a chapter in communications history.

TI to have 16K EAROM by mid-1978

Texas Instruments has announced to its customers that it plans to make available in sample quantities by mid-1978, the first American-made Famos-type 16K EAROM (*E*lectrically *A*lterable *R*ead *O*nly *M*emory). The device is reported to have an access time of 450 ns. The EAROM differs from an EPROM in that it can be erased and reprogrammed entirely by electrical signals, whereas an EPROM is erased by ultraviolet light.

Nippon Electric Company presently manufactures an 8K EAROM, but it is not yet available in quantity; and General Instrument Corporation makes EAROM's in the nitride family—the fastest device having an access time of 600 ns. Intel is also reported to be working on an 8K device that is erased by ultraviolet light.

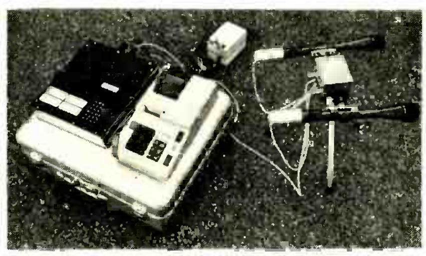
The TI EAROM is organized as 2048 words by 8 bits and requires three power supplies—one each for read, write and erase.

Computerized system used in road testing

Performance-testing wheeled vehicles normally consists of someone sitting on the passenger side taking down data manually under sometimes nerve-racking and uncomfortable conditions.

Lamar Instruments has now produced an automated computerized road test system that eliminates the necessity for a data-taker. It also reduces costs and simplifies data collection for single-seat vehicles such as motorcycles and race cars.

The Lamar road test system weighs only 25 lbs, and consists of a microcomputer, keyboard, cassette tape recorder for program inputs, a fifth wheel for feeding basic speed and distance data to the computer, and a printer. The LCD display reads out speed in mph, time in seconds, distance in feet and the engine's rpm.



COMPUTERIZED ROAD TEST SYSTEM from Lamar Instruments. Also shown is the optional VHS-THT tester consisting of two telescopes with photocells. As the vehicle passes the line of sight of each telescope, the computer is triggered. When used on a slalom run (a weaving course marked by pylons), the computer prints out the elapsed time to pass both photocells and the average speed.

A decided improvement over the old method of data gathering is provided by the printer, which produces a permanent

continued on page 12

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letters

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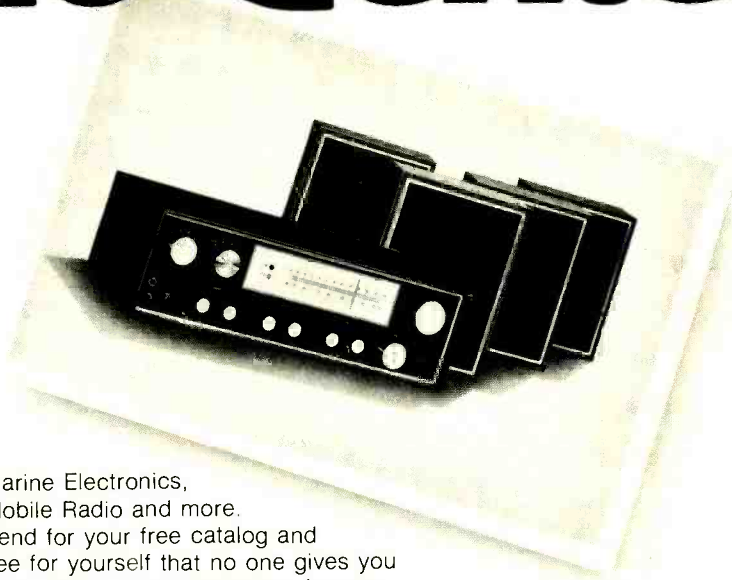

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LED's developed for daytime display

As everyone knows, conventional LED displays are difficult, if not impossible, to read in bright light or in the sun. Now, however, Hewlett-Packard has designed a discrete light-emitting diode that it claims can compete with LCD's, incandescent, gas discharge and other displays used for daytime applications.

The red and yellow 7-segment LED displays can be viewed in direct sunlight or in ambient lighting up to 10,000 foot-candles in intensity. To achieve that performance, a high-contrast gray package was developed along with high-efficiency chips having large, active pn junctions.

For direct viewing in sunlight, a commercially available acrylic neutral-density gray filter blocks out the sun's rays. The LED displays are expected to have many automotive, avionic, instrument and measurement applications.

Casio introduces compact new mini-calculators

At a recent media conference, Casio, Inc., manufacturers of electronic calculators, displayed three new compact, fully

CASIO LC-78 MINI-CARD CALCULATOR is no bigger than a credit card, yet offers four math functions, percent and memory.

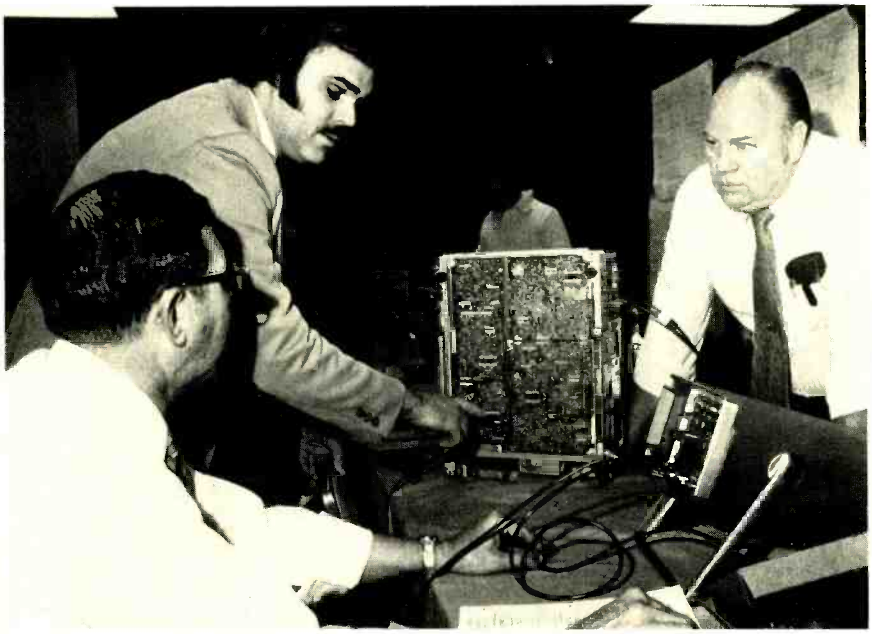
functional mini-calculators: the *model LC-78*, the *model MQ-2* and the *model AQ-810*.

The simplest, and smallest, calculator is the *model LC-78* (shown) which is about the size of an ordinary business card and weighs 1.4 ounces. It features an 8-digit LCD readout, four basic math functions, plus percent and memory.

The *model MQ-2* is slightly larger and weighs 1.6 ounces. Its capabilities include an 8-digit calculator and watch/calendar that displays the year, month, date and day; its time memory can show the exact time in two time zones, and its calculator includes four math functions and percent.

The *model AQ-810* consists of a calculator complete with memory, percent and square root. This unit can perform time calculations. The timer function contains two "beep" reminders. The eight-digit readout displays hours, minutes, seconds and AM-PM. It is powered by two silver oxide batteries that give the user 3000 hours of continuous use.

TRAINING WORKSHOPS FOR MAGNAVOX FIELD-SERVICE PERSONNEL



IN DECEMBER, MAGNAVOX held a series of four, week-long service workshops at its Fort Wayne division headquarters. These seminars were aimed at giving field service personnel "hands-on" experience with Magnavox's new videocassette recorder. Here, Howard Shoudy (rear), service training specialist, shows VCR circuitry to Jim Fritsche (left), Cleveland division and Bill Nurge (right), Dallas division. A January series is planned for dealers and independent service technicians at selected sites throughout the country.

Focusing system uses linear IC

Honeywell, Inc., has recently designed an automatic-focus system for cameras. This focusing system, called the *Visitronic* module, will doubtless find increasing applications in the camera field, particularly in view of the increasing demand for home videotape TV cameras and in automated equipment. The module will be incorporated into the Konica C35AF camera that will be introduced next spring.

The process resembles conventional split-image focusing. In the automatic-focus linear IC, two separate images are focused on a pair of photodiode sensor arrays placed at opposite ends of the body of the IC. Each array receives the image via a separate mirror—one mirror is fixed on one array, the other is linked to the camera lens and scans down the scene. At the point at which the output signals from the detector arrays nearly match, the camera lens moves into focus position.

For this match to take place, each sensor array is divided into four quadrants, each producing a separate current output signal that is fed into one of eight logarithmic amplifiers (which are sensitive to voltage mismatch). The amplifiers feed each signal to four absolute-value circuits, at which point each signal is fed to a summing circuit. The latter then inverts the signal so that when the two images match, a summing circuit output signal known as a correlation signal reaches a peak.

The correlation signal is fed into a peak detector, whose output signal then turns on a solenoid that moves the lens to focus at the best point. The entire process takes place in the instant it takes to press the shutter button.

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editorial

Report From The Winter CES

Having just returned from the 1978 Winter Consumer Electronics Show, I should be brimming with news of the wonderful new consumer electronics products to appear this year. But I was disappointed. There were lots of electronics at what turned out to be the largest show of its kind, but very little that was really new.

Video tape recorders are a boom market. More manufacturers are announcing new models and fantastic sales. Projection TV is another boom area, but the price tag keeps the total numbers down. However, Panasonic has joined this race and several other major brands are expected to climb on the bandwagon shortly.

The home computer is alive and well. Even more new units are appearing and each has its own built-in attractions. However, there is one point that seems to be escaping some buyers. If you want a TV game, *don't buy a home computer*. It's true that you can play some rather elaborate games with a computer, but programmable TV games remain under $200 while home computers start at $595.

There were no flat-screen TV's; no 3-D TV's; very little 4-channel stereo; and no startling breakthroughs. There were smaller calculators; cheaper calculators; more new TV manufacturers; lots of new companies offering me-too products; and hundreds of add-on telephone products.

To summarize, the electronics business is alive and well. Perhaps exciting, really new products will appear this June at the Summer Consumer Electronics Show. Meanwhile, the manufacturers and dealers seem to believe that they are going to sell a bundle of consumer electronics this year, and I think that they are right.

LARRY STECKLER
Editor

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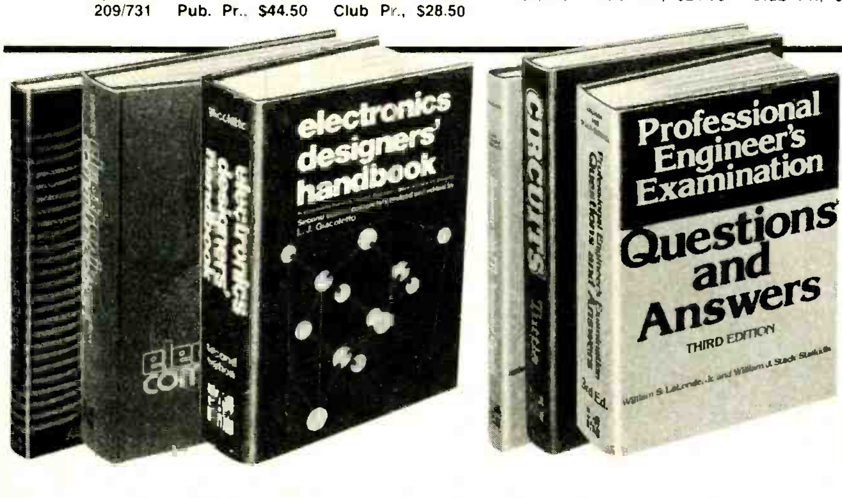

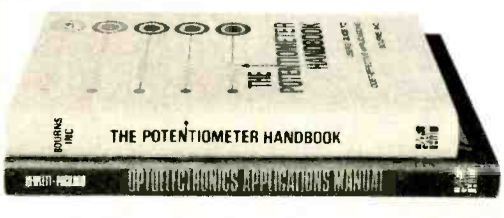

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CIRCLE 12 ON FREE INFORMATION CARD

LETTERS
continued from page 16

one's feelings, moments of efficiency, successes, etc., for several months. This would tend to show where the real peaks occurred. Then the clock could be set on a more rational basis. After all, we are all a *little* different. It would be truly amazing if the most consistent human trait (within a fraction of a percent) would be these Biorhythm Clock cycles.
PETER LEFFERTS
San Martin, CA

Your letter indicates a general lack of enthusiasm for the biorhythm concept, which may be due to your not having been able to investigate the overwhelming amount of material on the subject. Of the 14 books I've run across, I recommend two. They are: Is This Your Day? *by George S. Thommen (Avon paperback) and* The Complete Book of Biorhythm Life Cycles *by Dr. Robert E. Smith (Ardvark Publishers, New York). Both books are available at most bookstores.*

Your comment regarding the extreme accuracy implied in life cycles that start at birth and stay on-schedule throughout one's lifetime is not so "fantastic" when one considers the "accuracy" of the universe, solar system, earth rotation, seasons, endocryne rhythms, etc. The swallows leave and come back to Capistrano on definite days each year. With the overwhelming influence of "rhythms," or cycles, on everything from the infinity of the universe to the tiny atom, it would certainly be surprising if all living things did not exhibit similar effects.

It was not the intention of the article to prove the existence of biorhythm cycles, just to provide an electronic device to display this information without constant calculation or reference to tables.
FRED BLECHMAN

I'll go along with the last paragraph in your letter and acknowledge that you have an interesting electronic project . . . lots of other applications too. Furthermore, I won't credit you with or complain about your "inventing" biorhythms.

Just for discussion, let's consider that most of the cycles in birds, animals, plants, etc., are *not* tied to the DAY they are born (if the swallows at Capistrano came back based on a rhythm starting the day they were *born*, the return would be spaced but over a month or so and wouldn't excite anyone. We have those very same swallows building nests in the eaves of our houses. They come back two to three days after Capistrano . . . but their family-raising is nowhere near that predictable!) According to the *American Scientist* (and other sources), such cycles are "corrected" by the actual daily or seasonal cycles.

Now, how about human cycles? There is no way of predicting the day five years from now when a female will start her "monthly" cycle. Emotion, health, etc., have a *big* effect. The age of maturity is not predictable. The nine-month gestation period is rather erratic.

Here's another thought. Many times "predictions" tend to become self-fulfilling. If a fortune teller, "the stars," or a computer says today is an individual's *good* day, often he gets hyped up . . . and sure enough, he has a good day. (This has been proven with experiments involving teachers' attitudes towards their students.) But . . . fortune tellers (for obvious reasons) emphasize the good possibilities.

It is true I did not research the literature on biorhythms, but commonsense has some place, too.
PETER LEFFERTS
San Martin, CA

AMPAK ERROR

Thank you for featuring Pacer's *Ampak* in the December 1977 issue ("New Products"). But apparently an error was made in setting up the feature. The first line reads: "measures 1-8 amps DC." However, this should read "1-800 amps DC."
MICHAEL HUBER
General Manager, Pacer Industries, Inc.
Chippewa Falls, WI

OOOOPS!

There are errors in the schematic of the digital capacitance meter on page 38 of the December 1977 issue. Capacitor C3 is .001 μF as in the parts list; not .01 μF. The number 6 pins of displays DIS1, DIS3 and DIS4 should go to R42, R43 and R44, respectively, instead of to the points indicated in the diagram.

BRICKLAYING TECHNIQUES

Walter Cardwell's IC bricklaying techniques (December 1977 issue) lend themselves particularly well to an application no one mentioned in the article—computer memory construction.

Memory IC's are usually connected to each other in parallel, except for the input, the output and, sometimes, the chip select pins. To make a 1K × 8 memory using eight 2102's, for example, trim only the input and output pins, as in the article. Stack the IC's one on top of the other, and solder the common leads together.

For nK × 8, trim the IC select pin on the bottom of each 1K × 8 block, and stack the blocks. If you must have sockets, you can use Molex pins soldered to each IC to hold the one above it. However, this technique will not be as sturdy as direct soldering, and the stacks will be taller. On the plus side, this method allows easier cooling. Of course, the heat-sinking methods described in the article should be used where necessary. For memory expansion, Mr. Cardwell's method saves the cost of a rather expensive PC board.
EVERETT B. OGDEN
Delmar, NY

VIDEO MODULATOR

Please advise any of your readers who plan on building the video modulator (**Radio-Electronics,** August, 1977, page 33) that the "complete" kit of parts does not include the printed circuit board for the switch nor the bottom RF shield.

In addition, Delta Electronics also charges postage and handling. This is not mentioned in the parts list on page 34.
ELMER P. VANDENBURGH
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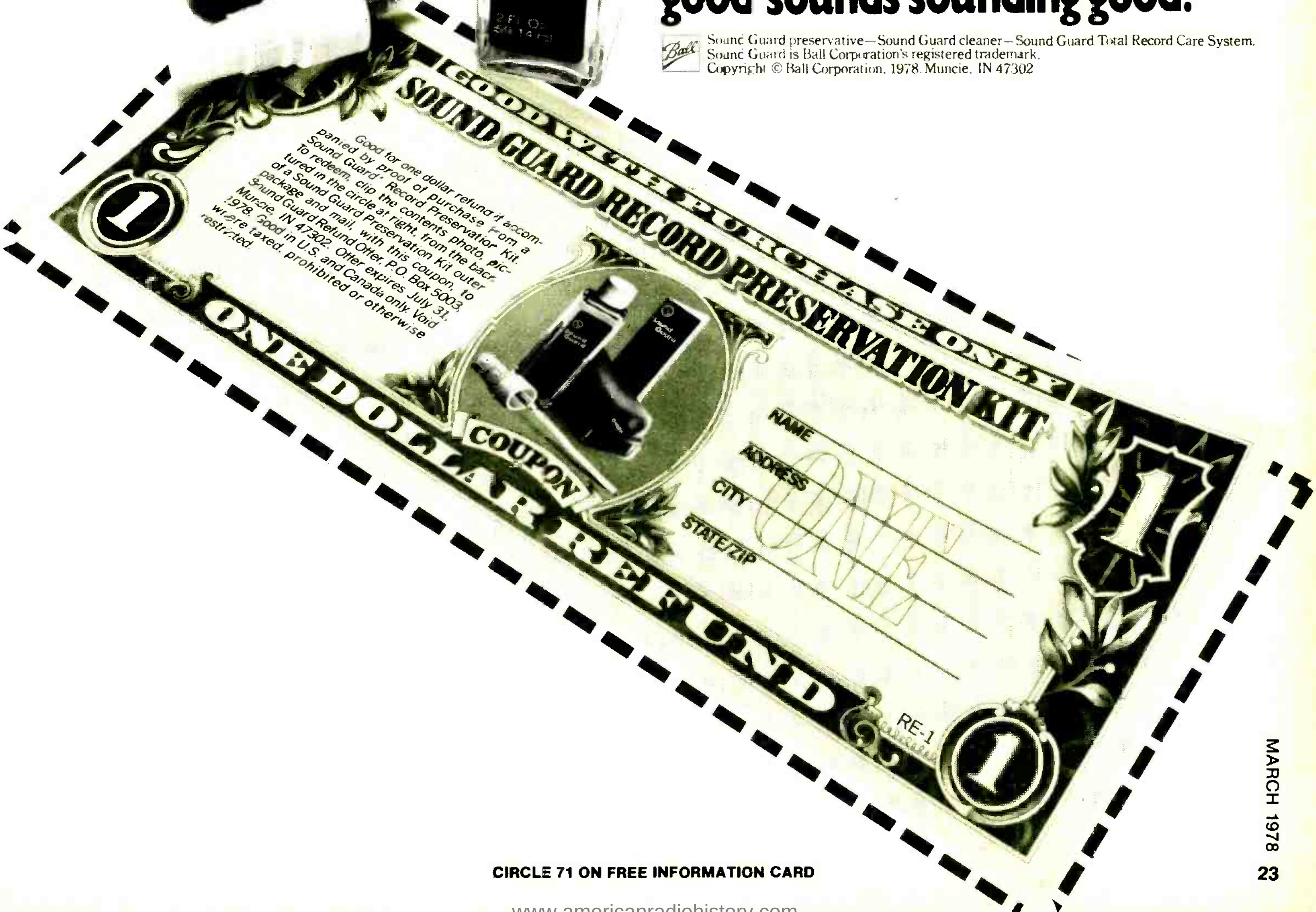


CIRCLE 71 ON FREE INFORMATION CARD

equipment reports

Motorola Educator II Microcomputer Kit

CIRCLE 101 ON FREE INFORMATION CARD

THE MOTOROLA *EDUCATOR II HEP KIT* IS AN M6800 microcomputer system learning tool designed with future expansion in mind. Data is entered through eight toggle switches, and the system is controlled by three additional center-off, spring-loaded toggle switches. The binary data-output display consists of eight discrete LED's. A ninth LED is extinguished when the processor is running. To power the unit an external 5-volt, 1-amp supply such as the Motorola *HK1001* is required. A beginner should start out by confronting data and instructions on a bit-by-bit basis with the toggle switches. As he advances, the computerist will seek more convenient modes of operation, and can add more sophisticated keyboard and display systems through two 44-pin edge connectors.

The *Educator II* microcomputer board uses a HEP version of the M6800 (HEP C4801), two IC's with 512 words of RAM that contain utility programs, 128 words of user RAM and a C4821 peripheral interface adapter (PIA) with 16 inputs and outputs, and some handshaking leads.

The M6800 is a popular microprocessor with a versatile architecture that uses two 8-bit accumulators, a 16-bit index register, a 16-bit program counter, a 16-bit stack pointer and an 8-bit condition code register (CCR).

The ROM firmware, DBUG, has routines for loading, reading and running user programs. It also contains a cassette tape routine. This produces an audio output and deposits specified portions of RAM into an external cassette tape recorder. A complementary read routine is intelligent enough to search a tape for a file number indicated by the data-switch settings.

The M6800 microprocessor recognizes the software interrupt instruction (SWI) code 3F. When the microprocessor encounters this instruction, a vectored jump to DBUG saves the status of the accumulators, index register, program counter and CCR in RAM locations 00F4 through 00FA. This is an invaluable troubleshooting aid. You can, by inserting SWI instructions in crucial locations in the program, interrupt program execution at those places so that you can inspect the registers and memory contents.

The 128 words of RAM provided with the kit are assigned addresses from 0080 to 00FF, with the last 14 locations, F2 through FF, reserved for use by the DBUG firmware. There is enough board space for an additional 128 words from 0000 to 007F. Larger blocks of memory can be added externally using one of the 44-pin connectors and proper address decoding.

To read memory, the upper and lower bytes of the address to be inspected are entered with the data switches and the LOAD LEAST SIGNIFICANT and LOAD MOST SIGNIFICANT switches.

The EXAMINE switch is then used to sequentially inspect memory locations starting at that address. Memory contents are read out in binary by the 8 data LED's. Each time you depress the EXAMINE switch, the lower byte of the address being examined is displayed on the LED readout. Releasing the switch displays the memory contents. Storing programs or data into memory is similar except that the STORE switch is used and data is entered by the data switches. Running a program is a bit more complicated since the program starting address must first be stored in the DBUG program counter storage locations 00F9 and 00FA. Then the GO/HALT switch is toggled to initiate processing.

The manual includes kit assembly instructions, an explanation of the microcomputer hardware, some theory of number systems, suggestions on writing programs, operating instructions and application programs. A schematic and a firmware listing are included. However, only one of the two pages of firmware is listed, but this may be due to the early edition of the manual. The other page is easily read out using the EXAMINE facility.

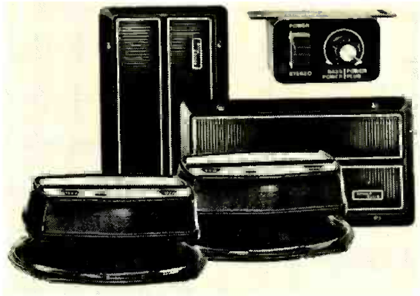
turn page

Kit assembly is straightforward, but, as with all computer kits, it requires meticulous soldering technique. The PIA with its complex control and data-direction register structure is described adequately. Each microprocessor instruction and the six addressing modes are described in detail.

Inevitably, when you debug programs, you must add or delete instructions. Assuming there is sufficient memory space, deleting instructions can be as simple as overwriting with no-operation commands. Adding instructions, though, means moving every instruction following the added instruction. The alternate technique of inserting patches or jumps to other parts of memory is both slow and wasteful of memory. The manual presents one short application program that moves all the instructions down one memory location, starting at the location where the addition is to be made, and inserts the added instruction at that point. The program can be executed repeatedly so multiple word instructions or a series of instructions can be inserted sequentially by depressing GO as many times as required. A delete-data program works similarly, taking out one word at a time by moving all subsequent program steps up one byte and overwriting the instruction being removed. (It's a big help.)

Educator II looks like a good way to get going with a capable microprocessor that has the capability to grow. The *HEP Kit* is priced at $169.95. For more information, write Motorola HEP/MRO Operations, 705 West 22nd Street, Tempe, AZ 85282. **R-E**

Mindblower Model PS-69RD Stereo Speaker/ Amplifier



CIRCLE 102 ON FREE INFORMATION CARD

WHEN I WAS ASKED TO TEST TENNA CORPoration's *Mindblower, model PS-69RD,* car stereo speaker/amplifier system, I took one look at the spec sheet and flinched. At that time, the mere thought of 60 watts of audio—30 watts rms-per-channel—in a car that I would be driving was indeed mindblowing. I couldn't conceive of anyone using, or even wanting, 60 watts of audio for a car stereo setup.

I reluctantly agreed to test the *Mindblower* when I realized that I could install it at the same time as the *model XTAL XA-909* FM stereo radio/cassette player I had just bought to go in my 1973 Gas Guzzler. I had not yet selected the stereo speakers for the rear-deck installation, so why not use the *Mindblower* instead? It could be installed with the same amount of labor.

When the amplifier/speaker system arrived from the factory, I was impressed with its appearance. The system consists of two heavy wide-range 6 × 9-inch speakers, chrome-trimmed black plastic grilles and a small control unit.

The back of each speaker (see photo) has an oblong case that covers and protects the 30-watt amplifier that is arranged around the heavy ceramic speaker magnet. A glance at the owners' instructions showed that the installation would be fairly simple. I'd need help at only one point—someone had to crawl into the trunk and hold the speakers in place while I inserted the mounting screws from inside the car.

Installation was a breeze

Everything went smoothly. The FM radio/cassette player was hung under the dashboard on a *Mount 'n Lock* CB installation bracket. (The bracket is fastened to the dashboard with four heavy bolts. The car stereo is held in the *Mount 'n Lock* bracket by two locking nuts that must be unlocked with a key before the radio can be removed.) The *Mindblower* control box was mounted close by. Each speaker/amplifier unit has four leads. Two leads are for power—one fused for the 12-volt positive supply and one for the power ground; the other leads are for audio. Only three wires run back to the speakers—the +12-volt line and the two hot speaker leads. The negative power lead and the audio return leads are grounded to the car's chassis close to one of the speakers.

The three leads from the control box were tucked up behind the dashboard and run across to one side, down behind one of the kick panels, inside the channel under the door sills and under the rear seat into the trunk area. My car, like many others today, has cutouts for 6 × 9-inch speakers in the metal underside of the rear deck. All I had to do was crawl into the trunk and use an icepick to punch up through the speaker mounting holes into the car. The holes are guides for positioning the grille and for cutting away the pressed board and leatherette finish on the rear deck. With my son in the trunk holding the speakers, I was able to get the four mounting screws for each speaker through the grilles and into the speed nuts on the speaker frames. Tightening the screws was a problem.

(The rear window on my car has a very sharp slope and is quite rounded on the sides. This feature, along with the positions of the speaker cutouts, made it impossible to use any of the standard screwdrivers that I owned.) A borrowed 3-inch stubby Phillips screwdriver enabled me to tighten two screws in each speaker. The other two screws were left loose while I spent several weeks finding and buying an offset (right-angle) screwdriver.

Great sound

The control box has a two-position slide switch to select the output mode and a potentiometer to control bass boost and volume level. The switch, when in the STEREO position, lets you hear your stereo radio or tape player output at about the volume level that would be available minus the *Mindblower*. The output voltage of the radio or tape player is attenuated so that when the signal passes through the *Mindblower*, it emerges at about the normal level. The switch placed in the POWER position lets the full radio or tape deck output voltage drive the *Mindblower* amplifiers up to maximum power output. This voltage is tapped off a frequency-selective network by the potentiometer.

At first, on drives around town, I listened to FM radio and tapes with the switch in the STEREO position. The car-filling sound was great. The sensation was similar to listening through stereo headphones. The bass was solid and the highs crisp—a credit to the *Mindblower* and the FM radio.

On a long drive at highway speeds, road and wind noises intruded on the radio's sound. I was annoyed when I found that outside noises were still interfering even with the volume control set at maximum. Then, I remembered the *Mindblower* mode switch and threw it to POWER. Wow! What a difference. I now had the volume to override outside noises. Maximum power was available with the potentiometer fully clockwise in the POWER PLUS position. Bass boost is added to the output when the control is in its fully counterclockwise BASS POWER position.

The sound is clean at all levels. The maximum volume level can be set with the potentiometer on the control box. You can set intermediate levels with the radio's volume control. I was surprised to find the *Mindblower* very tolerant of audio input driving power. Overload distortion was not noticeable until the set's volume control and the level control on the *Mindblower* were both advanced to maximum. Backing off either control reduced the distortion without appreciably reducing the volume level.

I'm convinced

There is a place for high-power audio in car radio systems. It is a must if you want to listen to music with the same ease and freedom from distractions that you have in your living room. On the road, you seldom realize just how loud you are playing the radio until you stop at a light or toll booth. The sound now is often overpowering. This gives a good indication of the sound level you need to overcome outside noises.

Is high-power audio for you?

If you should ask if high-power stereo in your car is for you, I'd say yes! For no matter how you feel about loud music in the quiet of your listening room, you need more power if you want the same ratio of signal to outside noise that you enjoy at home.

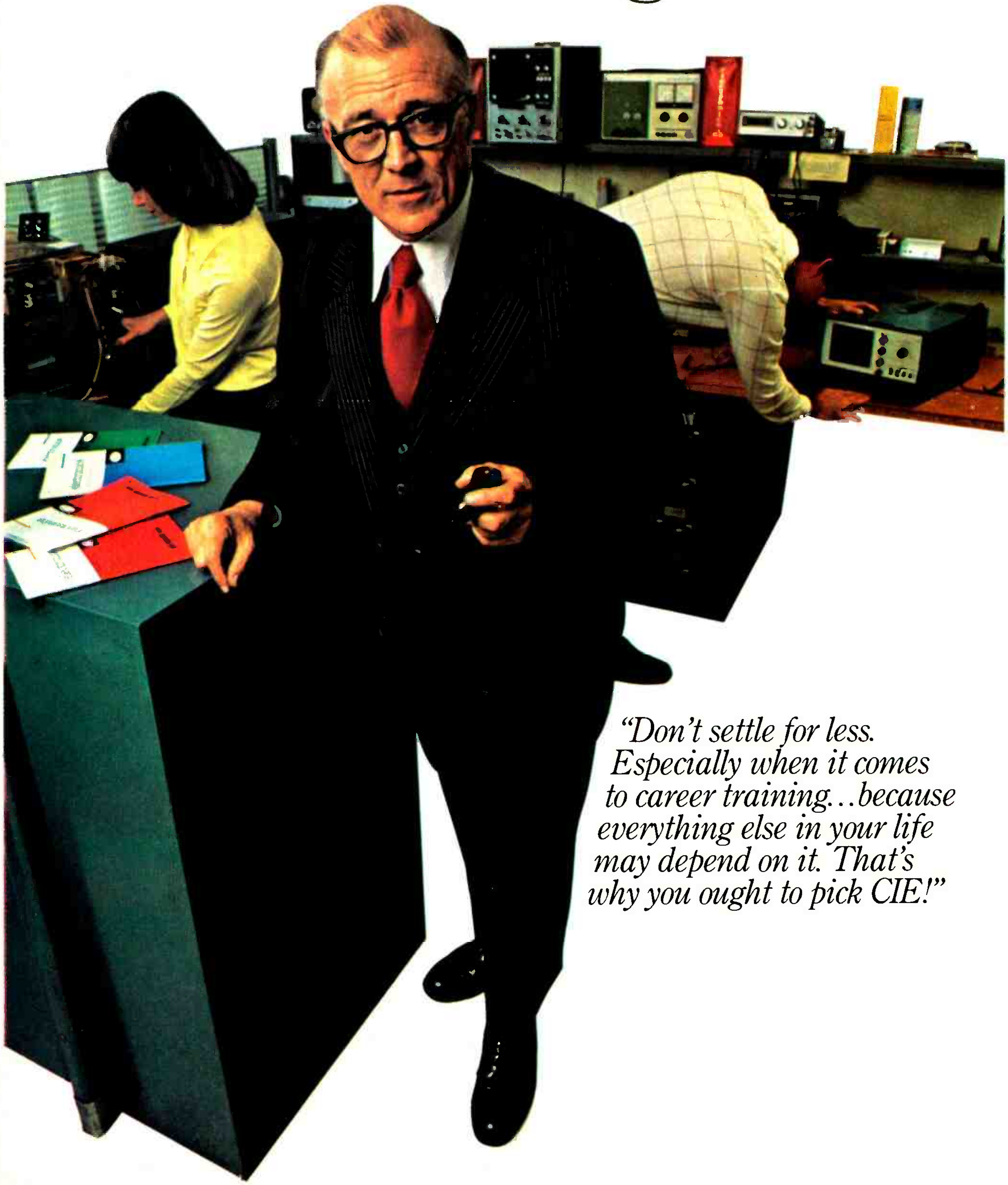
There are other audio power boosters available, but the *Mindblower* is the only one I know of that combines the amplifiers with especially tailored hi-fi speakers. So, if you want boosted audio, consider this system. It goes in real easy and the sound is mighty good. The price is also right at $69.95 from Tenna Corporation, 19201 Cranwood Parkway, Cleveland, OH 44128, or available at your local car stereo dealer.

(Note: If you go for the *Mindblower* or any other audio power booster that requires placing the amplifiers under the seat or in the trunk, **do not** rely solely on the fuse in the car's accessory circuit and the fuse at or in the amplifier. Use an independent fuse just for the amplifier and connect it to the hot supply lead as closely as possible to the car's fuse block. Select a fuse that is just heavy enough to hold up under maximum-volume power drain.)

The *Mindblower* has two fuses: one in the hot line about 6 inches from each speaker/

continued on page 32

"If you're going to learn electronics, you might as well learn it right!"



"Don't settle for less. Especially when it comes to career training...because everything else in your life may depend on it. That's why you ought to pick CIE!"

EQUIPMENT REPORTS
continued from page 27

amplifier. A few days after I installed the system in the car, some rip-off artist broke into the car and tried to steal the FM radio/cassette player. He would have made it if he could have defeated the *Mount 'n Lock* bracket. In his attempt, he yanked on the cabled wires running back from the *Mindblower* control box. The power cable insulation was cut on a sharp metal edge in the channel under the rear door so the 12-volt lead shorted to the chassis. When I turned on the ignition, the current drawn was high enough to melt and ignite the wire insulation for its entire length between the fuse block and the short, but it was not high enough to blow the fuse until after the fire gained headway. An 8-amp fuse in the line directly at the fuse block would have prevented the fire and a costly replacement of much of the wiring behind the dashboard. **R-E**

Sabtronics Model 2000 Digital Multimeter

IF YOU DON'T ALREADY OWN A DMM, OR IF YOU own a bulky bench type and are looking for a battery-powered portable, take a serious look at the Sabtronics *model 2000*. (Sabtronics International Inc., Box 64683, Dallas, TX 75206.) It has impressive specifications and many features that a few years ago could be found only in expensive lab instruments. These include a basic DC accuracy of 0.1%, a 3½-digit readout, automatic polarity, automatic zeroing and automatic overrange indication. The *model 2000* is available only as a kit at $69.95.

CIRCLE 114 ON FREE INFORMATION CARD

The front panel of the *model 2000* is uncluttered and easy to understand. In the upper center-half is the 3½-digit 0.36-inch-high LED display. Directly below this are 9 pushbuttons. The POWER on-off switch is red and located to the far left. Next, from left to right, are the AC, VOLT, AMP and OHM function switches. These switches are grey. The VOLT, AMP and OHM switches are interlocked so only one can be depressed at any one time. The AC pushbutton is not interlocked and selects either AC or DC measurements (AC when depressed). You use the AC pushbutton in conjunction with the VOLT, AMP and OHM pushbuttons to select AC volts, DC volts, AC current, DC current and resistance. (The AC pushbutton has no effect on the ohms function.)

To the right of the function pushbuttons are four range pushbuttons that are white. Three select the full-scale reading and the fourth is a ×10 multiplier. The basic full-scale resistance ranges are 100, 10K and 1M. Using the ×10 multiplier expands the number of resistance ranges to six—100, 1K, 10K, 100K, 1M and 10MEG. There is a 100% overrange capability on all ranges. So, for the 10-megohm resistance range, the upper measurement limit is 19.99 megohms.

The basic full-scale current ranges are 10 μA, 1 mA and 100 mA. The ×10 multiplier extends the number of ranges to six—10 μA, 100 μA, 1 mA, 10 mA, 100 mA and 1 amp. With the 100% overrange capability on all ranges, the 1 amp scale will read to 1.999 amps. Two amperes is also the maximum allowable input current. The ranges and upper measurement limit holds true for both the AC and DC current scales.

Voltage ranges are selected just like the current and resistance ranges, with the basic full-scale ranges being 100 mV, 10 volts and 1 kV. No, the ×10 multiplier won't extend the upper measurement limit to 10 kV. The maximum allowable input voltage is 1 kV. In fact, the 100% overrange capability on the 1 kV scale is academic. Using the ×10 multiplier permits you to select full-scale voltage ranges of 100 mV, 1 volt, 10 volts, 100 volts and 1 kV. This holds true for both the DC and AC voltage ranges.

At the far right of the front panel are the input jacks. The COMMON input jack is black and the volt-ohm-amp input jack is directly above it and red. Both of these jacks accept banana-type plugs. Test leads are extra. An optional set of 36-inch black and red test leads are available from Sabtronics for $3.50, part No. TL-36P. The probes that come with the optional test leads are the standard barrel-type.

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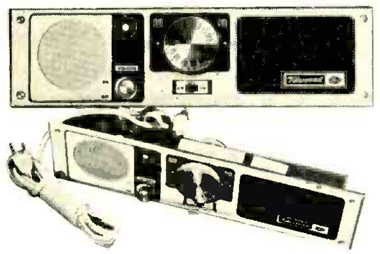
EDMUND SCIENTIFIC



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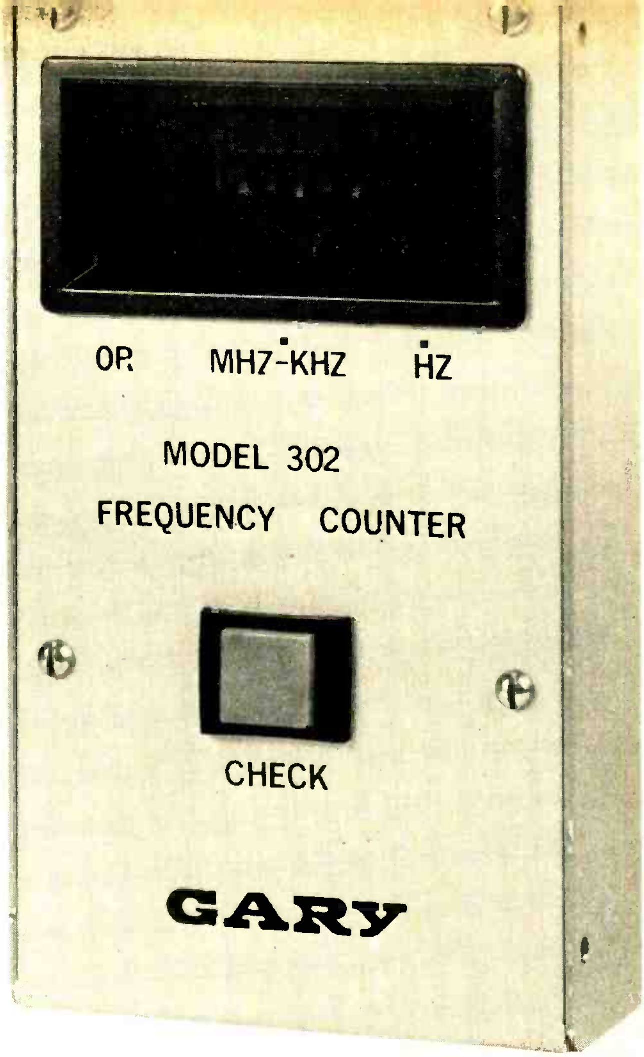
BUILD

Portable 30-MHz Frequency Counter



You can hold it in the palm of your hand. Yet it reads to 28-Mhz and better, has a 70-mV sensitivity and a 4-digit readout that delivers 6-digit resolution.

GARY McCLELLAN

HOW WOULD YOU LIKE TO HAVE A frequency counter that measures frequencies to 30 MHz, and is small enough to fit in your coat pocket! Sure you would, and for good reason; counters are becoming more popular every day.

Our pocket counter may be small, but it has grown-up features. The maximum frequency it will measure is 23 MHz typical, with 70-mV sensitivity. However, you can go as high as 30 MHz with 90-mV sensitivity. The input impedance is the standard 1 megohm, meaning you can use scope probes on this counter for easier circuit checking. Oh yes, overloads can happen and this counter is protected from most of them. It will take 120 volts AC right from the wall outlet without harm! The unit is powered by four rechargeable NiCad batteries, and since the current drain is low, they will last a long time. The batteries also help make this counter portable, like a calculator.

The heart of any counter is its timebase, and this one has a crystal-controlled timebase, just like the big counters. We use a color TV burst crystal (3.58 MHz) in our unit and this gives good accuracy. You can normally expect better than ± 0.005% accuracy with ± 0.003% typical, depending upon the frequency being measured. Like other counters, the higher the frequency you measure, the better the accuracy. The display is all LED—4 digits of 0.112-inch-high display. Don't let that display fool you either! With just a flip of the three-position range switch you can get up to two digits more, for a total of six digits with the power consumption of four digits! Quite a counter!

The pocket counter is easy to build. It has nine IC's, most of which are CMOS and the rest are low-power Schottky. So all of a sudden the counter is easier to build and the power drain is reduced to about a half watt. You should be able to build this project in about three evenings or less. A PC board makes the job easy. And all parts mount on this board, except for a few switches, jacks and the battery that must go on the case. Special arrangements have been made to bring you a low-cost kit to make the construction task easier. Or, if you prefer, the PC layouts are shown so you can roll your own. Nearly all of the parts are available through mail order houses, and the few harder to get parts are available either from the author or from several suppliers mentioned later on.

How it works

The counter uses the classic "window counting" technique that is the basis for almost all frequency counters in use today. Figure 1 is a block diagram of a counter based on this technique. This basic counter has four sections; input amplifier, gate, timebase and decade counter/display section. Here's how it works. Input signals are squared up by the input amplifier and are applied to the gate section. It is necessary to square up the input signals because digital circuitry does not respond too well to analog-type signals such as sinewaves. The *timebase* circuit puts out three synchronized signals in this order: gate-enable, data transfer (latch) and reset. The gate-enable signal is applied to the gate section, causing the signal from the input amplifier to pass through it. This is called the *window*, and the time the gate allows the input signal to pass through is precisely determined.

The gated signal is then counted up by a string of of decade counters, wired in series. Usually, there are at least 4 decades total, with 6 decades being typical. The signals from these counters are then applied to a display latch that transfers the output from the counters to the displays upon command from the transfer line from the timebase. This reading is frozen at the displays while the decade counters are reset to zero and the count sequence is repeated. The latches are very important, because without them you would see the decade counters count up, stop briefly at the correct count, then reset to zero and repeat. This is the basic frequency counter, and there are few

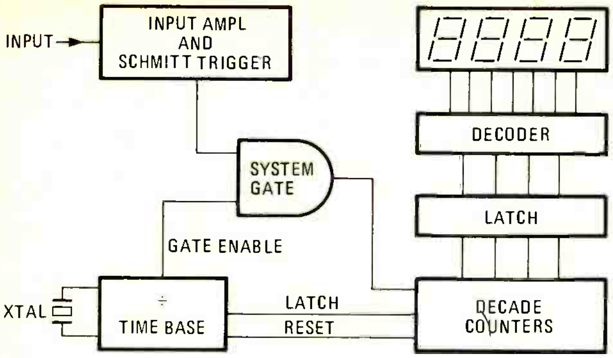


FIG. 1—BLOCK DIAGRAM shows the four sections of the basic counter: input amplifier, gate, timebase, and decade counter display.

designs that are very different.

Now let's take a look at our counter. It is just like the basic counter. Figure 2 is a block diagram of the unit. You should be able to identify the input amplifier, the counter/display and the timebase, but the gate will be difficult. The gate section is part of the input amplifier and will be discussed further on. There are some divider sections following the input amplifier. Their purpose is to divide the input signal so that it will run the counter/display section. A CMOS LSI IC (IC5) handles the counting at this point. Its maximum frequency range is about 2 MHz, so with the dividers (normally called *prescalers*) it is easy for a 2-MHz IC to count over 20 MHz. By the way, that CMOS counter saves you twelve TTL IC's or about 184 soldered connections! This is the secret of a successful counter that anyone can build.

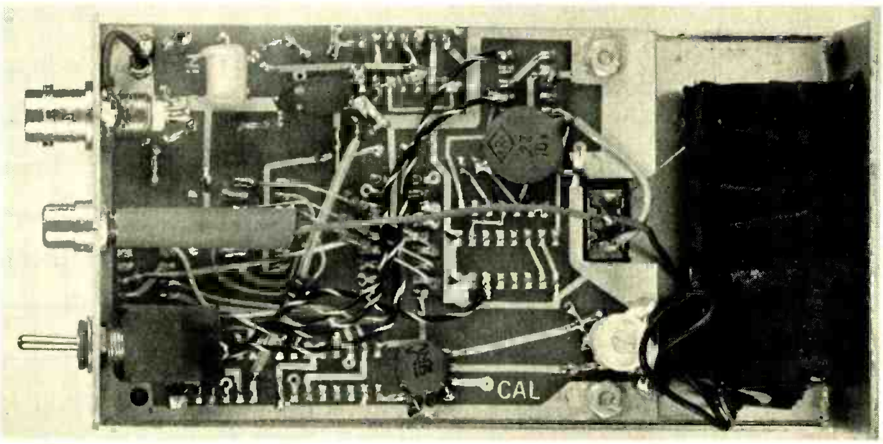
Operation of our counter is just like the window counting method first described. The only difference is the frequency dividers that scale down the input frequency for the CMOS counter/display IC. Normally you don't find them in other counters; instead you change the the timebase frequency by tapping off dividers there to get the different ranges. Our counter provides Hz, kHz and MHz ranges just like the big counters, but with fewer parts and low power drain.

The circuit

Now let's dig deeper into the circuitry. Checking the schematic (Fig. 3) you'll find that the input signal appears at Q1, a FET source follower. Diodes D1 and D2 form the overload protection network. The signal passes from the follower, which is there to give a high-Z input, to IC1, a quad NAND gate. The first section is biased for amplifier operation by R4 and the stage provides about 10× gain or so. Surprisingly, TTL gates make stable amplifiers. Not hi-fi but fine for counters. The next two stages (gates, really) act as the Schmitt trigger, squaring up the signal to proper TTL levels. Resistor R6 sets hysteresis or trigger point. The final section, IC1-d, is the gate, with transistor Q7 and resistor R19 controlling its on and off times. These two parts convert the CMOS (think low current) timebase output to the low-power Schottky TTL (think higher current) gate input. From there, the signal is divided down by 10 in IC2, by 10 again in IC3 and by 100 in IC4. Low-power Schottky 74LS90's in the first two spots insure high-frequency operation and low power drain. A typical 74LS90 will go to 35–40 MHz and draw about 5 mA.

Compare that to a standard 7490 that goes to 20–25 MHz and draws 25 mA! Switch S1 is the RANGE switch. It selects the proper range by switching different places in the divider network. From there, the selected signal goes to IC5, a National Semiconductor MM74C926 counter array that counts the signal, latches it and drives an LED display. This IC houses 4 decade counters, 4 latches, a display driver and multiplex logic.

Now let's take a look at the rest of the counter. The timebase consists of IC6, IC7-a, IC8-a and IC9. A color-TV crystal, XTAL1, generates the reference frequency, with IC6 providing the associated oscillator and counting down to 60 Hz. This signal drives IC7, a divide-by-60 counter, to get the necessary 1-second timebase. IC7 also provides part of the reset and latch signals as well. The 1-Hz output drives IC8, which converts it into a 1-second-on and 1-second-off pulse for the gate section. Finally, the IC9 gates create the reset and latch (or transfer) pulses necessary for proper operation of the counter. Sections IC7-b and IC8-b are wired to form an overrange indicator—that's the circuitry you see wired to LED1. IC7-b acts as an inverter, causing the SR flip-flop of IC8-b to energize on negative edge of the waveform that ap-



INSIDE VIEW OF BASIC COUNTER shows just how easy a construction job it is. Most components go right on the circuit board.

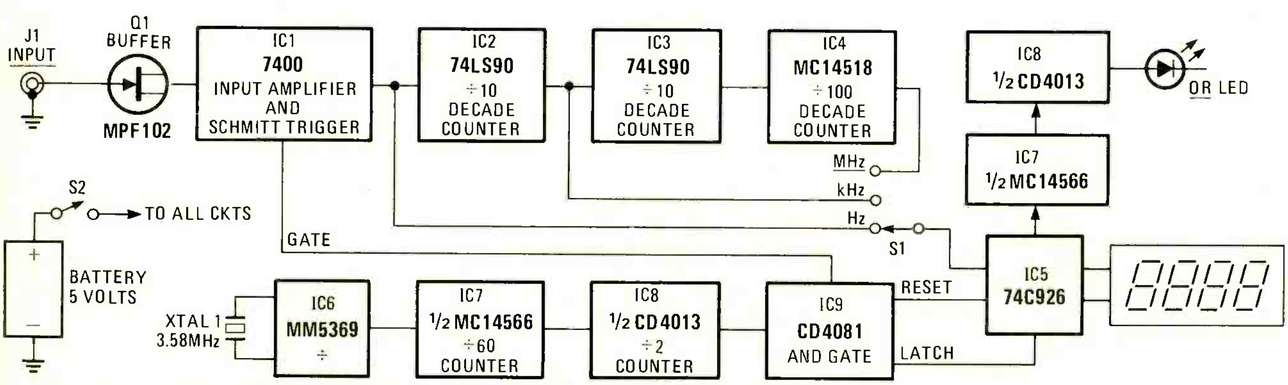


FIG. 2—BLOCK DIAGRAM OF THE COUNTER described in this article. The gate section is different than that shown in Fig. 1 and there are some additional divider stages.

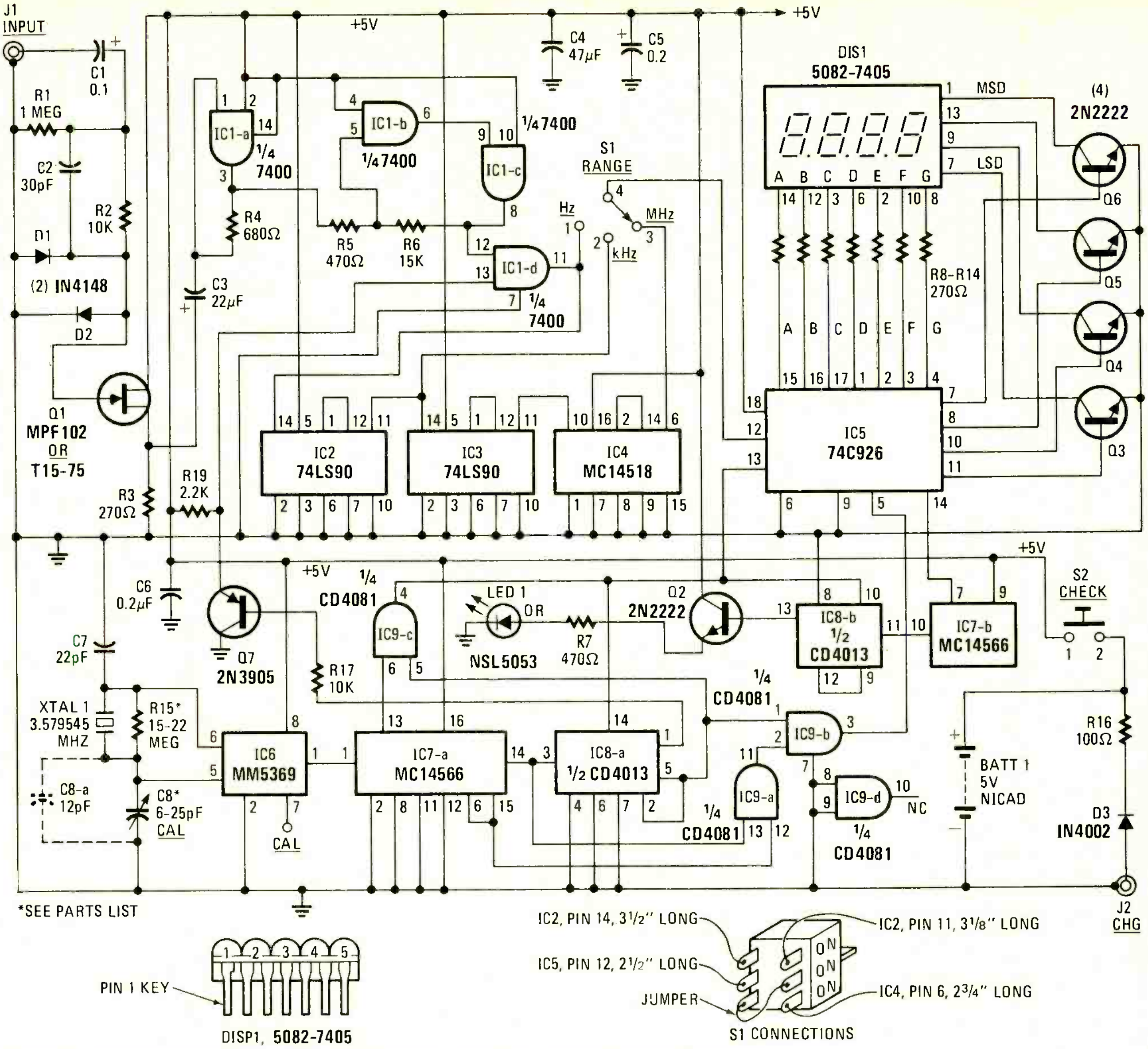


FIG. 3—FULL SCHEMATIC OF THE COUNTER makes it easy to follow the circuit description. Resistor R18 (10K) was inadvertently omitted. It connects between Q2's base and pin 13 of IC8-b.

All resistors ¼-watt carbon film type unless noted.
R1—1 megohm
R2, R17, R18—10,000-ohm resistors
R3, R8-R14—270-ohm resistors
R4—680 ohms
R5, R7—470 ohms
R6—15,000 ohms
R15—15 to 22 megohms
R16—100 ohms, ½ watt
R19—2200 ohms
C1—0.1 μF, 200-volt tubular
C2—30 pF disc
C3—22 μF, 6-volt tantalum
C4—47 μF, 6-volt tantalum
C5, C6—0.2 μF, 10-volt disc (0.1 μF OK)
C7—22 pF mica
C8—either a 6-25-pF trimmer or a 6-18-pF trimmer plus 12-pF mica cap (C8-a)
D1, D2—1N4148
D3—1N4002
DIS1—5082-7405 display (Hewlett-Packard). Poly Paks 92CU3199
LED1—NSL5053 LED National or similar
Q1—MPF102 FET
Q2-Q6—2N2222 transistors
Q7-2N3905 PNP transistor or similar
IC1—SN7400 IC, Active Electronics
IC2, IC3—SN74LS90 IC, Active Electr.
IC4—MC14518P CMOS IC dual BCD up-counter
IC5—MM74C926N CMOS IC (National) Tri-Tek or Liberty Electronics
IC6—MM5369N CMOS IC (National)
IC7—MC14566CP CMOS IC timebase generator (Motorola) or HEP C4055P
IC8—CD4013 CMOS IC
IC9—CD4081 CMOS IC
J1—BNC female coax connector
J2—RCA phono socket
S1—single-pole, 3-position toggle switch, C&K 7211 (Poly Paks 92CU3016)
S2—SPST, normally open pushbutton switch, C&K 8121-J81-3-2 or similar
BATT1—5-volt NiCad battery pack; 4-size AA cells in holder
XTAL1—3.579545-MHz color TV crystal
Misc.—LMB CR531 case, model 302 PC board, display bezel, 12-volt wall plug transformer with RCA plug (battery charger), ⅜-in. threaded spacers, etc.

***Note:* A kit of all above parts is available from Gary McClellan and Co., Box 2085, 1001 West Imperial Hwy., La Habra, CA 90631. Complete kit of all parts and *unpunched* case, $39.95 postpaid. California residents add state and local taxes as applicable. PC board only, $5.95 postpaid. Write for prices on other parts.**

ADDRESSES OF SUPPLIERS LISTED

Poly Paks	PO Box 942 South Lynnfield, MA 01940
Optoelectronics	PO Box 219 Hollywood, FL 33022
Tri-Tek Electronics	6522 North 43rd Ave. Glendale, AZ 85301
Liberty Electronics (Indust. Dist'r)	124 Maryland St. El Segundo, CA 90245
Active Electronics	PO Box 1035 Framingham, MA 01701

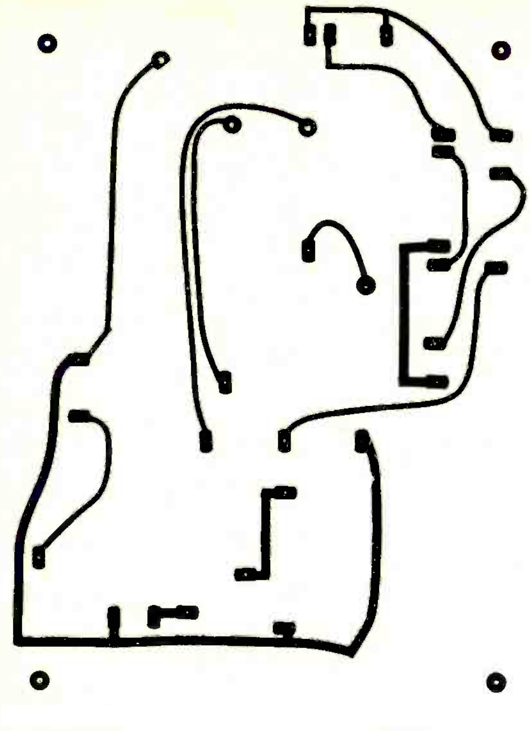


FIG. 4—FULL-SIZE FOIL PATTERN of one side of the 2-sided circuit board. Used with Fig. 5 you can make your own circuit board.

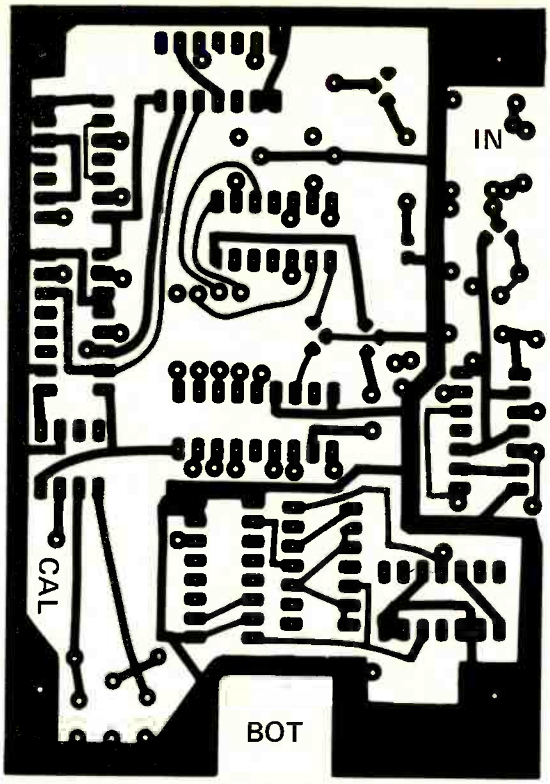


FIG. 5—THE OTHER SIDE OF THE CIRCUIT BOARD. This full-size pattern used with the one on Fig. 4 can be used to make your own circuit board for this instrument.

pears at the overrange output (pin 14) of IC5.

Now that you know how it works, let's get started on the construction!

Put one together

Construction of this counter is pretty easy if you take your time. Also, use of a PC board is strongly recommended. If you wish, you can duplicate one from the patterns in Figs. 4 and 5, or buy one from the author.

The first step is to locate the parts. Sources are given in the parts list for the tougher ones to help you get the components without a lot of problems. Write the sources for more information and prices if you desire. One thing that's important here: *you must use quality parts. That means NO JUNK! Cheap reject "retested" type parts will cause you more problems than you can believe when it's time to check out this counter!* A word to the wise is sufficient.

Start construction by stuffing the PC board. It contains nearly all of the parts, and when you finish stuffing, you can test it prior to putting it into the case.

Study Figs. 6 and 7 before you start. Probably the best way to begin is to install the diodes, D1 and D2. Place the board in the position shown with the side saying "COMP" in the corner face up. Install the two diodes as shown and solder. The next step is to install the transistors. This will require a little extra care, as the holes do not exactly match the leads coming out of the transistors. That means you will have to bend a lead on most of the transistors—an easy task. Install FET Q1 first. Notice how the flat side faces. Next, add the PNP transistor, Q7. This one plugs directly into the three holes with no bending. The same is true of Q2. It mounts near the top of the board. Finish up by installing the four transistors near the center of the board. Bend the emitter lead on two transistors so that it goes between the base and collector leads, then place each transistor in the Q4 and Q5 spots on the board. The emitter leads go to the foil bus on the other side of the board, the collector leads point toward the *center* of the board and the base leads point toward the top *edge* of the board. Transistors Q3 and Q6 are installed last. They go in place without bending. The base leads face the exact center of the board, and the collectors face the top edge. So much for the transistors.

The next step is to install the display. Do LED1 first, noting that the flat spot faces the center of the board. You can substitute almost any LED here, so don't feel stuck with the one specified. Then add DIS1. This is a rather tricky part, and there should be a dot showing pin 1 on the reverse side. If not, you may have to try it and reverse it later if you get strange readings. To make life easier *all readouts supplied with the kit* have an unused pin (pin 4) cut and you simply orient the readout as shown. *(If you use the Hewlett-Packard display specified, pin 1 is notched as shown on the inset in Fig. 3.—Editor)*

Next, you can install the resistors. Stick them in as shown. Leave about 1/8 inch on the 22-megohm resistor leads because the crystal will mount on them. Oh yes, this resistor is part of a $5.95 kit offered by Optoelectronics and others. It is called a "clock timebase" kit and features many other parts you will be using. Keep the rest of the leads short.

Continue with the capacitors. Since only four mount on the component side, no comment is necessary! If your clock timebase kit included a 12-pF mica capacitor, install this transistor at the place marked C8.

Then install the crystal, XTAL1. Bend its leads over so that they can touch R15 (22 megohms). Make sure the plastic body of the crystal is snug against the resistor, then solder the leads. Take a piece of bare wire and *quickly* solder it to the metal case of the crystal. Bend the wire over the end of the board and solder it to the foil. See the illustrations.

The next step is to install the IC's. Use *Molex* pins for IC5, and don't install this part until just before testing the board. Use a low-power grounded-tip soldering iron for all work here; this is especially important. Remember you are working with CMOS! Double-check for proper placement and proper orientation when you are done.

Now turn the board over as there are some components to be installed on the reverse side. See Fig. 7. Start with the capacitors. Install C4 first, with the positive lead on pin 14 of IC1 and the minus lead on the large foil running near this IC. This capacitor is a 47-μF unit. Be sure

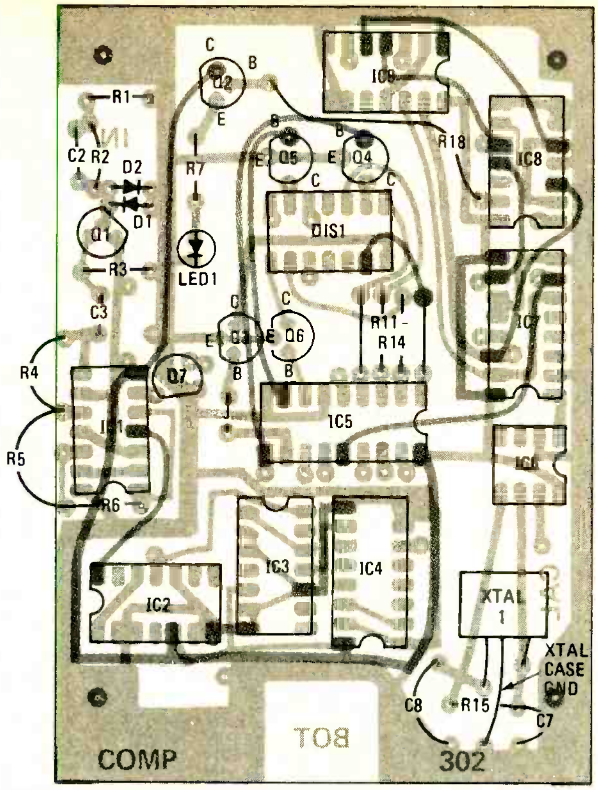


FIG. 6—PARTS PLACEMENT DIAGRAM shows exactly where all the parts mount on the topside of the circuit board. Diagram also shows how the two foil patterns overlap. View is from the top side of the circuit board with the bottom foil pattern shown in the lighter shade of grey.

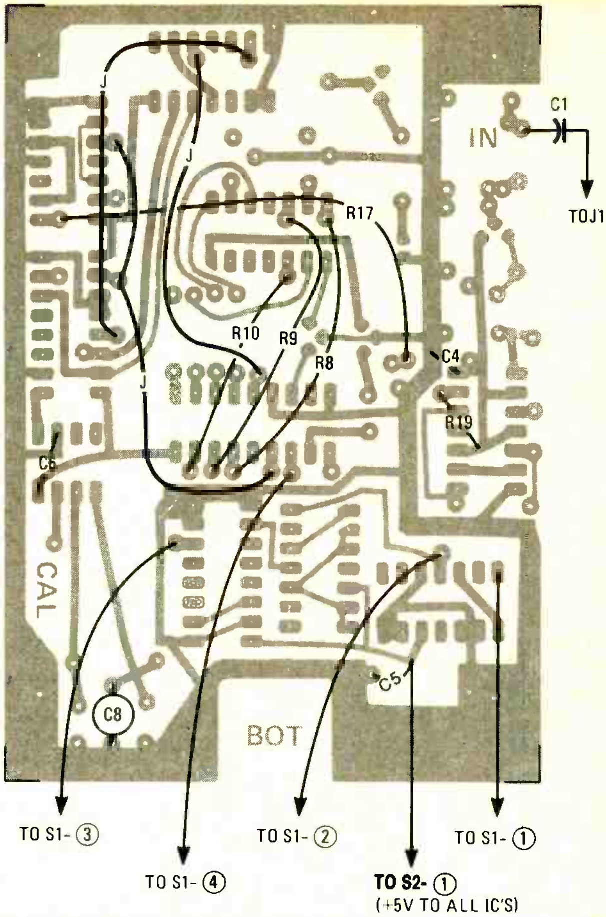


FIG. 7—PARTS PLACEMENT DIAGRAM for the bottom side of the circuit board.

to keep those leads short! Then install C5 (0.2-μF disc) between pin 5 of IC2 and the large foil running near the IC's. *Remember that the large foil running around the edge of the board is ground!* Last, add C6 (0.2-μF disc) between pins 8 and 2 of IC6 (MM5369). Then add trimmer C8 to complete the job.

Now add the jumpers. Even though the board is double-sided, some jumpers are unavoidable. Use insulated wire. Check Fig. 7 carefully.

Next, add the remaining five resistors. Install the three 270-ohm resistors first, from display to IC5 (MM74C926). Then add R19 (2.2K) between pin 4 and pin 13 of IC1. Cut two lengths 1 inch long of spaghetti tubing and slip them over the leads of R17 (10K). Then connect it between pin 1 of IC8 (CD-4013) and the base pad of transistor Q7.

Set the module aside temporarily and turn to switch S1. Check Fig. 3 for details and then attach leads cut to the lengths indicated. Add the jumper. Solder the switch leads to the places indicated. Check over your wiring at this point around the switch, and if everything's OK, proceed to the last step.

Finish up the module by adding a 1½-inch piece of insulated wire to pin 5 of IC2. This is the power lead and it goes to S2. Then add a 2-inch piece of wire from the large foil (ground, remember) nearby. This is the negative battery lead.

That's it for the bulk of the construction. Check your wiring at this point for the usual things—errors and shorts, and correct them if necessary. You may want to proceed to checkout at this point to test the module, then return to finish the box.

Get out the box and lay out the front for the various parts. Use the module you built to determine sizes, etc. Note the cutout in the board. Switch S2 fits in this spot, so don't forget. Turn to the top of the box and lay out the two jacks and switch. Place them as far from the front of the box as you can. This will allow more clearance between the parts and the module when it is installed. Clean up the box and label it.

Install the four ⅜-inch spacers in the box with 4-40 × ¼-inch screws. Then add the display bezel, jacks J1 and J2 and switch S2. Drill holes to match the mounting screws in the module and then drop it in, display facing the box. Secure it with lockwashers and 4-40 nuts. Install S1, noting that the jumper faces the adjacent edge of the box. Then add C1, the 0.1-μF, 200-volt tubular capacitor between J1 and the pad marked IN on the circuit board.

Next, wire switch S2. Attach the short wire that comes from pin 5, IC2 to it. Also, add resistor R16 (100 ohms) and diode D3 (1N4002) between the other switch contact and J2. Cover these parts with a short length of spaghetti tubing. This will prevent problems later! Finish up by installing the four-battery pack between ground on the module and S2. The switch is positive, of course; don't forget!

Checkout and calibration

The checkout part is easy and takes little time. If you have the module only, connect it to a 0–250-mA meter and 5-volt power supply. If all's well, the meter will read about 100 mA and the display will light. It will first show a jumble of numbers and then in a few seconds read 00-00. This is normal and the next step is to touch the pad marked IN with your finger. You will probably get a jumble of numbers and the LED will blink. If not, flip S1 until you get results. Next, connect a signal generator set to around 10 MHz to the IN pad and advance the output level. Flip S1 through its three ranges and you will get a reading close to what the generator is set to. Even without calibration, this counter is surprisingly accurate! If all is well at this point, install the module in the box and proceed to "calibration."

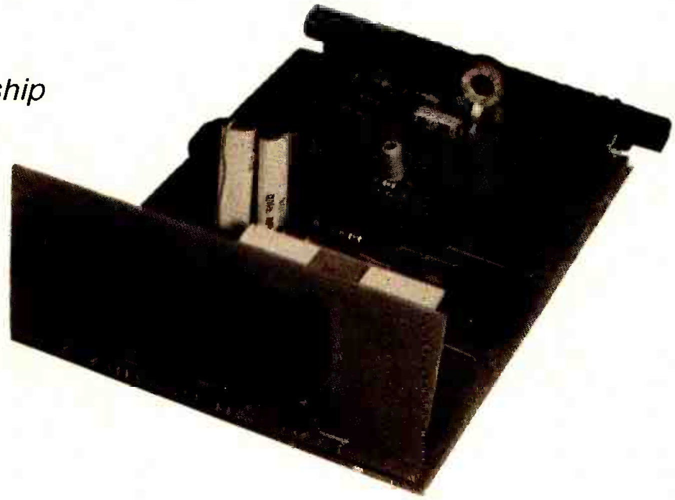
If you already installed your module in the box, you can still perform the simple

continued on page 124

BUILD

3½-Digit DMM

The digital panel meter has the same relationship to the DMM as the D'Arsonval panel meter has to the analog multimeter. Build your own multimeter using a DPM



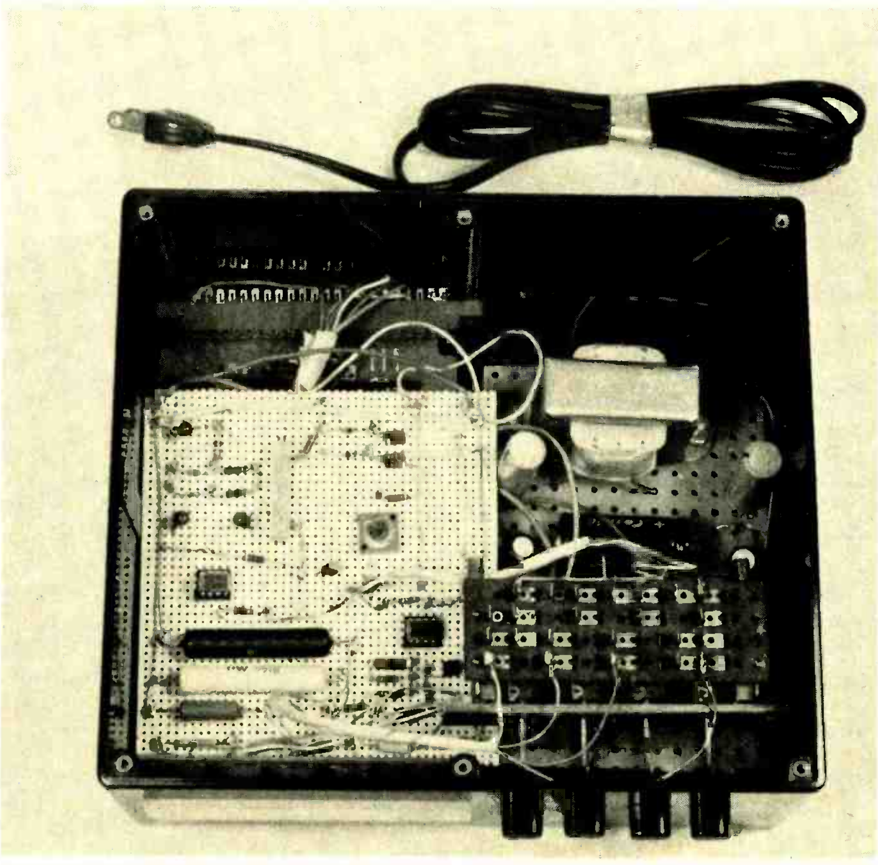
DR. E. H. BORNEMAN AND ROBERT BENWARD

A DIGITAL PANEL METER IS THE HEART OF every digital multimeter. This article describes a relatively simple circuit for a 2-volt DPM (*D*igital *P*anel *M*eter) using readily available IC's that can be easily converted into a digital multimeter (DMM) by adding some voltage-divider and current-shunting circuits. The resulting instrument, including power supply, can be simply packaged to become a very functional and rather attractive digital multimeter.

DPM circuit and operation

The basic DPM circuit is shown in Fig. 1. It uses a minimum number of parts, with most of the circuitry in two IC's; one a signal conditioner, the other a digital processor. These IC's include an onboard clock and a medium quality internal reference (40 ppm/°C). The measuring system uses dual-slope integration with its advantages of noncritical clock frequency, high rejection of AC signals and use of noncritical components.

The 8052 signal conditioner has three phases of signal conversion, these being auto-zero, integrate input and integrate reference. At the end of a measurement the system automatically reverts to autozero mode until a new measurement is started. If no overload has occurred in the previous measurement, it takes 10 milliseconds for the auto-zero to null. At power-on or after an overload it takes 100



INTERIOR OF A DIGITAL MULTIMETER based on a version of the digital panel meter in the head photo above. The DPM (at left) used point-to-point wiring on perforated board. See Fig. 8 for layout drawing.

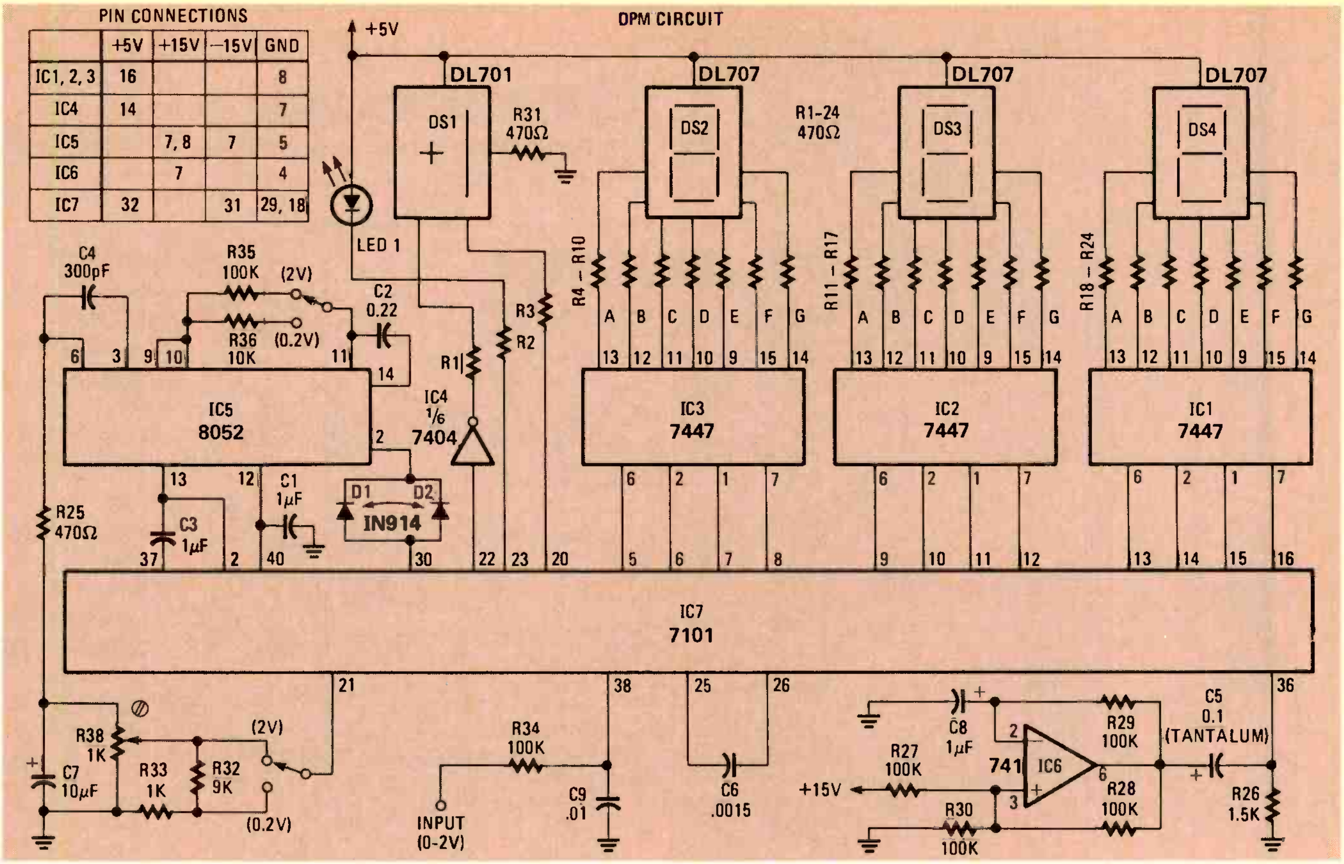


FIG. 1—DIGITAL PANEL METER SCHEMATIC. The unit is simple and easy to construct; using either point-to-point wiring or a couple of PC boards.

DPM PARTS LIST

All resistors ¼ watt, 10% or better
R1, R2, R4–R25, R31—470 ohms
R26—1500 ohms
R27–R30, R34, R35—100,000 ohms
R32—9000 ohms
R33—1000 ohms
R36—10,000 ohms
R38—1000 ohms, miniature potentiometer
All capacitors 10 volts DC or higher
C1, C3—1 μF, Mylar
C2—0.22 μF, polypropylene
C4—300 pF, disc
C5—0.1 μf, tantalum or metallized film
C6—.0015 μF, disc
C7—10 μF, electrolytic
C8—1 μF, electrolytic
C9—0.01 μf, disc
Semiconductors
D1, D2—1N914 diode
DS1—+1 LED digit, Litronix DL701 or equal
DIS2–DIS4—7-segment LED digit, Litronix DL707 or equal
LED1—Red LED, 0.2-in. diameter
Integrated circuits
IC1–IC3—7447 BCD/7-segment decoder/driver
IC4—7404 hex inverter
IC5—8052 signal conditioner
IC6—741 op-amp
IC7—7101 digital processor

milliseconds to null.

None of the circuit component values are critical in determining the accuracy of the instrument. For example, the reference capacitor and auto-zero capacitor (C1 and C3) are both shown as 1.0 μF. These rather large values minimize the effect of PC board leakage. The 0.22-μF value of the integration capacitor C2 is selected for PC board considerations alone, since the very small leakage at the integration input is nulled at auto-zero. It is very important that this capacitor have very low dielectric absorption.

The DPM is calibrated by putting a standard mercury cell across the input (any convenient reference source less than 2 volts can be used) and adjusting the 1K pot until the reference voltage is correctly displayed on the readout.

Initially the DPM circuit was built on a perf board, but the later models were constructed on two PC boards with one board containing the displays and the second, with a 15-pin edge connector, containing all the circuitry.

The foil pattern for the main PC board is in Fig. 2. The parts are positioned as shown in Fig. 3. Figure 4 is the pattern for the display board. Figure 5-a shows the jumpers that are installed from the front side of the board. Figure 5-b shows the locations of three jumpers connected to the 7-segment displays. The drawings in Fig. 5-c show how the jumpers can be added. The main and display boards are joined by 26 jumpers as detailed in Fig. 3 and Fig. 5-d.

Start with scraps of leads clipped off the resistors and other components that have been installed. Insert the leads from the foil side of the display board and solder in place. Insert the unattached lead ends in the holes in the main board, adjust the boards so they are close together and at right angles. Solder one end, check board alignment and then solder the other. Solder the connections between the ends.

Electrical characteristics of the DPM are as follows:

Power supply: +5 V @ 200 mA; +15 V @ 25 mA; −15 V @ 25 mA.
Linearity (full scale): 0.1 count typ.; +1 count max.
Rollover [differential in equal (+V=−V=2V)]: 0.1 count typ.; +1 count max.
Noise (full scale): −0.05 counts
Leakage current into input: 5 pA typ.; 30 pA max.

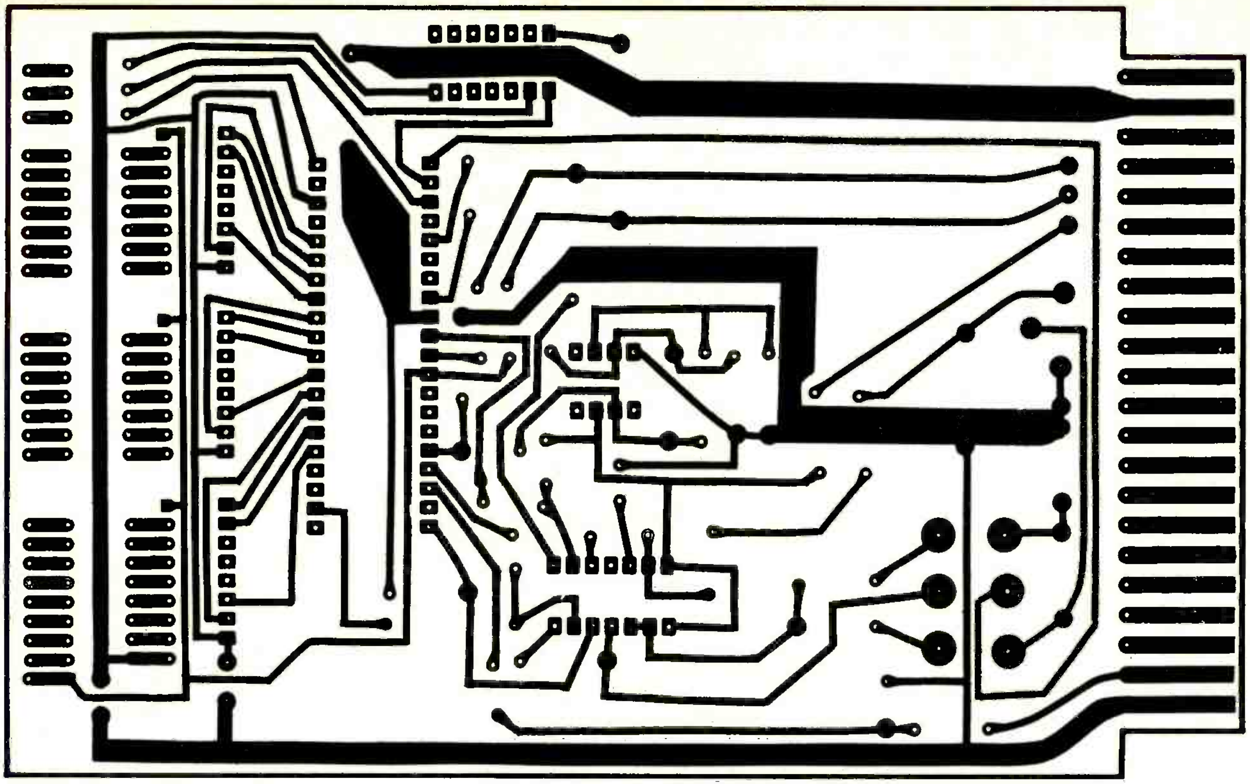


FIG. 2—FULL-SIZE FOIL PATTERN for the main board. The "fingers" on the right fit into a female PC board connector for connections to the DMM switching circuitry.

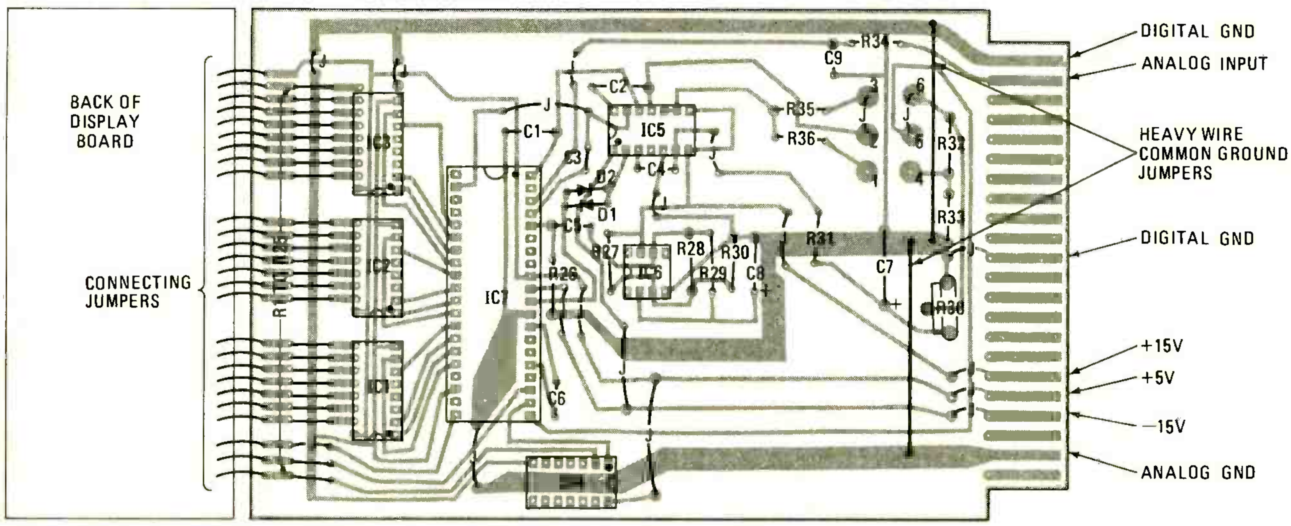


FIG. 3—HOW COMPONENTS ARE PLACED on the main board. Note the location of jumpers, IC positioning and electrolytic capacitor lead polarity.

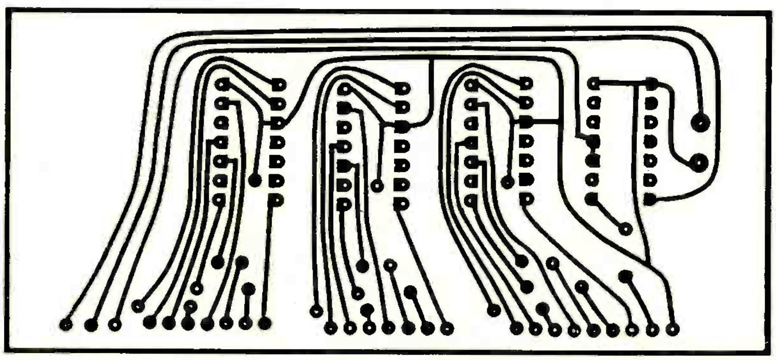


FIG. 4—DISPLAY BOARD foil pattern is full-size. Jumpers must be installed on both sides of the board as detailed in another figure.

The power supply for the DPM must deliver regulated outputs of +5 volts, +15 volts, and −15 volts DC. A circuit diagram for the power supply is shown in Fig. 6.

Although rather low currents are required for the DPM, the output currents supplied by this circuit will operate all the additional functions of the multimeter circuitry to be described. Good regulation is required (0.1%), so three voltage regulator IC's are used.

Conversion of DPM into digital multimeter

The basic DPM can be converted into a

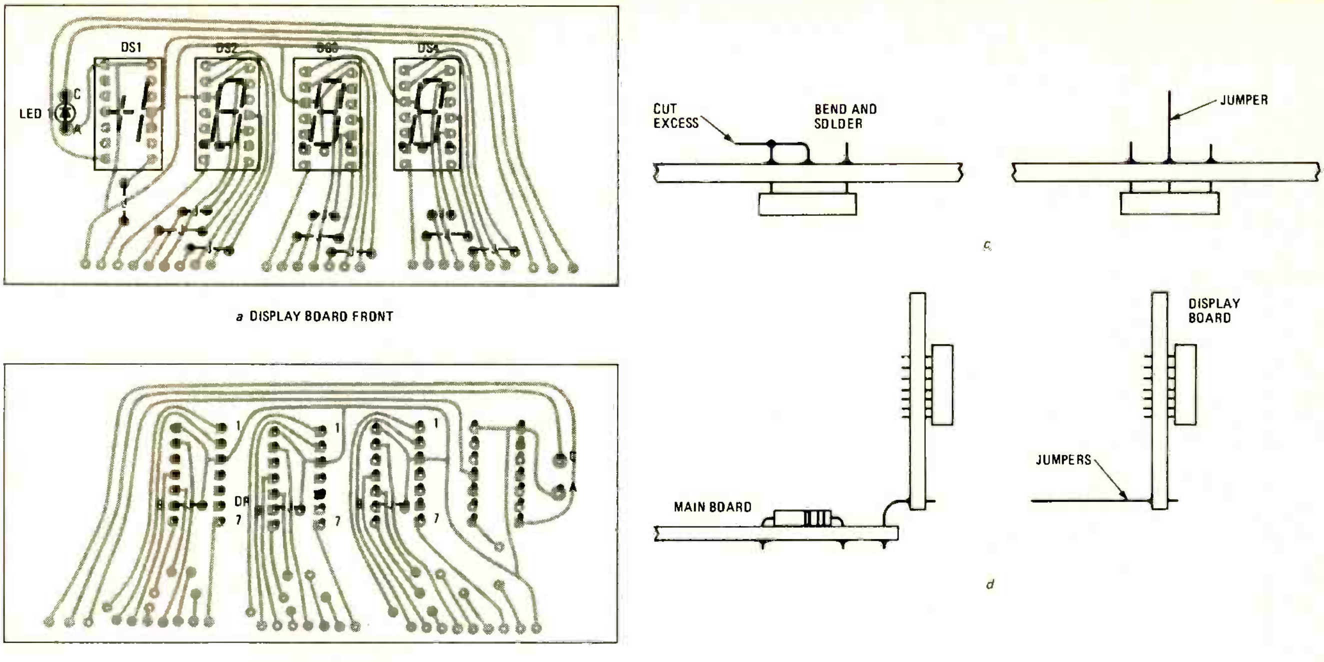
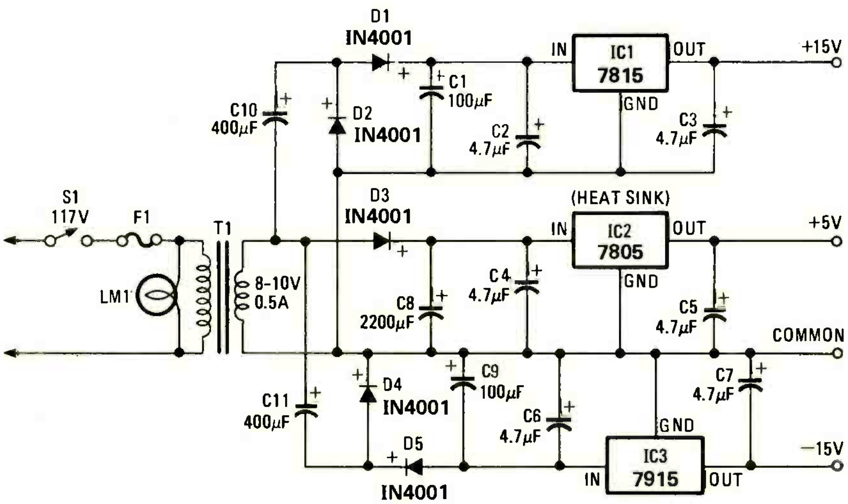


FIG. 5—MOUNTING AND JUMPER DETAILS for display board. Drawing *c* shows how back-of-board jumpers are formed while *d*, along with Fig. 3 shows how boards are joined by jumpers.



POWER SUPPLY PARTS LIST

Capacitors 25 volts DC or higher
C1, C9—100 μF, electrolytic
C2-C7—4.7 μF, tantalum
C8—2200 μF, electrolytic
C10, C11—400 μF, electrolytic
Semiconductors
D1-D5—1N4001 diodes
IC1—7815 positive 15-volt regulator
IC2—7805 positive 5-volt regulator
IC3—7915 negative 15-volt regulator
S1—SPST switch
T1—power transformer, 8-10-volt, 0.5-A secondary
LM1—117-volt pilot lamp
F1—0.25-ampere fuse

FIG. 6—POWER SUPPLY DIAGRAM. Three solid-state voltage regulators set the levels of voltages needed to operate the multimeter.

digital multimeter by adding the circuitry shown in Fig. 7. This circuit uses push-button DPDT switches. However, these can be replaced with a multisection rotary switch. Functions performed by the digital multimeter are listed in the following table.

DC volts: 2, 20, 200, 2000
AC volts: 2, 20, 200, 2000 (RMS)
Ohms: 2K, 20K, 200K, 2 megohms, 20 megohms
Direct current: 200 mA, 2A, 10A
Alternating current: 200 mA, 2A, 10A (RMS)

The circuit shown in Fig. 7 connects directly into the input of the 2-volt DPM.

Accuracy of the multimeter functions depends on the precision resistors used in the voltage-divider and current-shunt circuits. I recommend 1% or better, to take advantage of the inherent high accuracy of the DPM. Unless otherwise indicated, all other resistors in the circuit are ¼ watt, 10%.

ADD-ON MULTIMETER PARTS

All resistors ¼ watt, 5% unless noted
R1—9 megohms, ½ watt, 1% or better
R2—900,000 ohms, ¼ watt, 1% or better
R3—90,000 ohms, ¼ watt, 1% or better
R4—9000 ohms, ¼ watt, 1% or better
R5—1000 ohms, ¼ watt, 1% or better
R6—0.1 ohm, 10 watts (20 watts optional) 1% or better
R7—1.0 ohm, 10 watts, 1% or better
R8—10 ohms, 1 watt, 1% or better
R9—100 ohms, ½ watt
R10, R30—30,000 ohms
R11, R21—1 megohm
R12—10 megohms
R13—6200 ohms
R14—750 ohms
R15—4300 ohms
R16—910 ohms
R17—1000 ohms, miniature potentiometer
R18—4700 ohms
R19, R23—3300 ohms
R20, R22—9100 ohms
R24—470,000 ohms
R25, R26—10,000 ohms
R27, R29—5100 ohms
R28—2500 ohms, miniature potentiometer
All capacitors 25-volts DC or higher
C1—.01 μF, ceramic
C2—150 pF, ceramic
C3-C5—4.7 μF, tantalum
Semiconductors
D1, D2—1N914
D3-D6—1N4003
D7—6.2-volt Zener diode
Q1, Q2—2N3904
IC1, IC2—LM308 op-amps
Miscellaneous
S1, S3-S9—DPDT pushbutton switch or equivalent
S2—4-pole DT pushbutton switch or equivalent

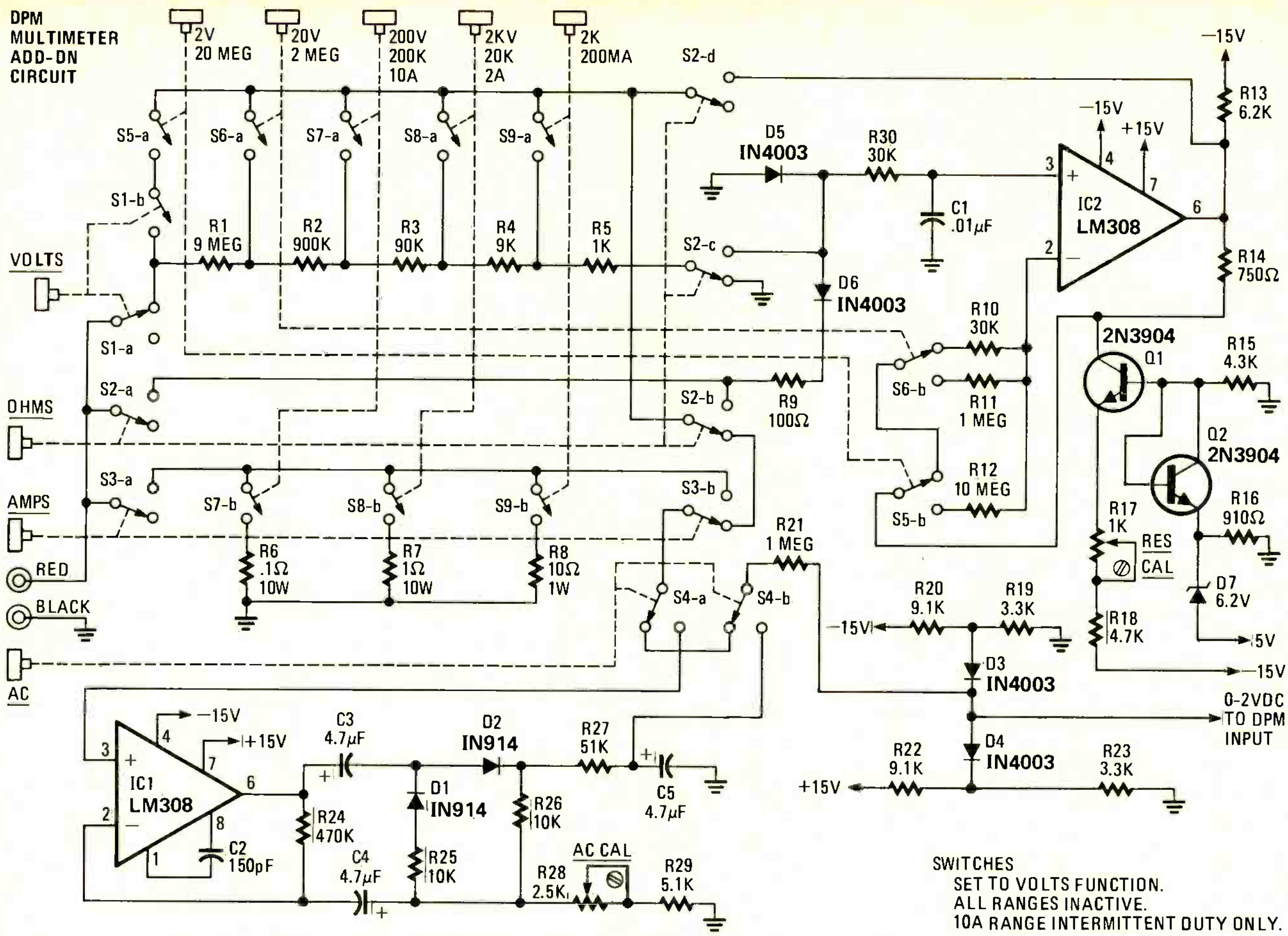


FIG. 7—CIRCUITRY TO CONVERT DPM TO DMM includes function selector switching, multiplier and shunt resistor networks and a few active components.

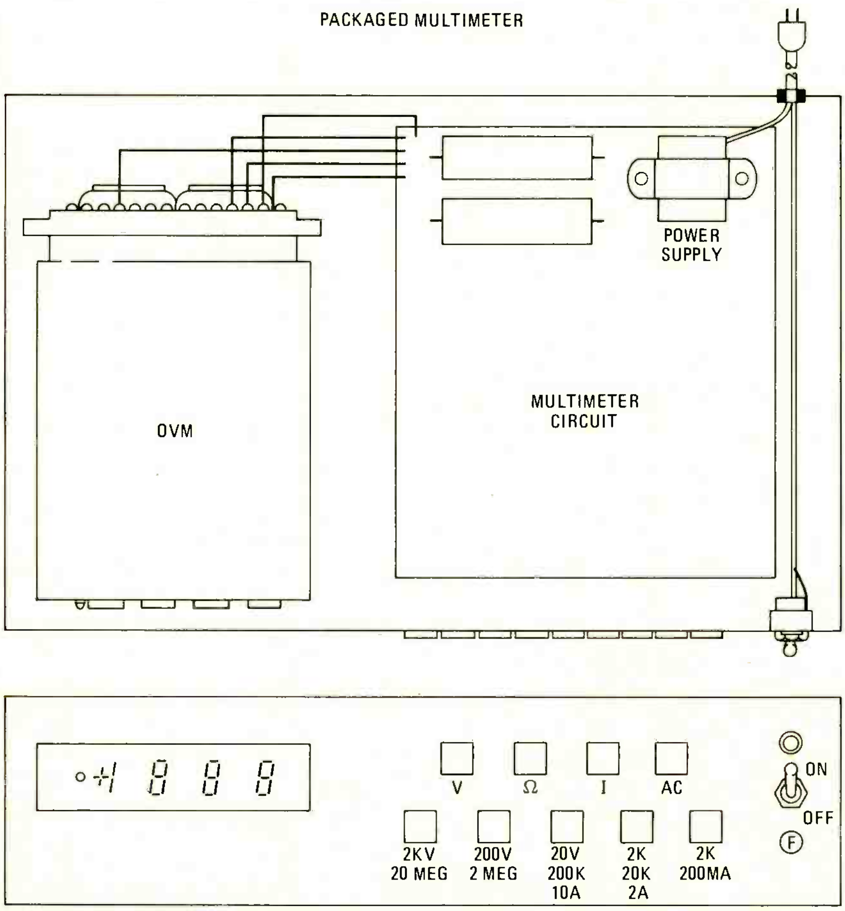


FIG. 8—HOW BASIC PARTS ARE LAID OUT in a typical instrument case. The DPM connects to the multimeter circuit through an edge connector and a short length of cable.

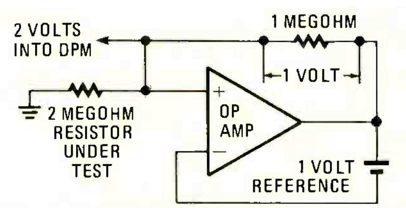


FIG. 9—SIMPLIFIED OHMMETER CIRCUIT. Equal voltages at op-amp inputs are essential to proper ohmmeter operation.

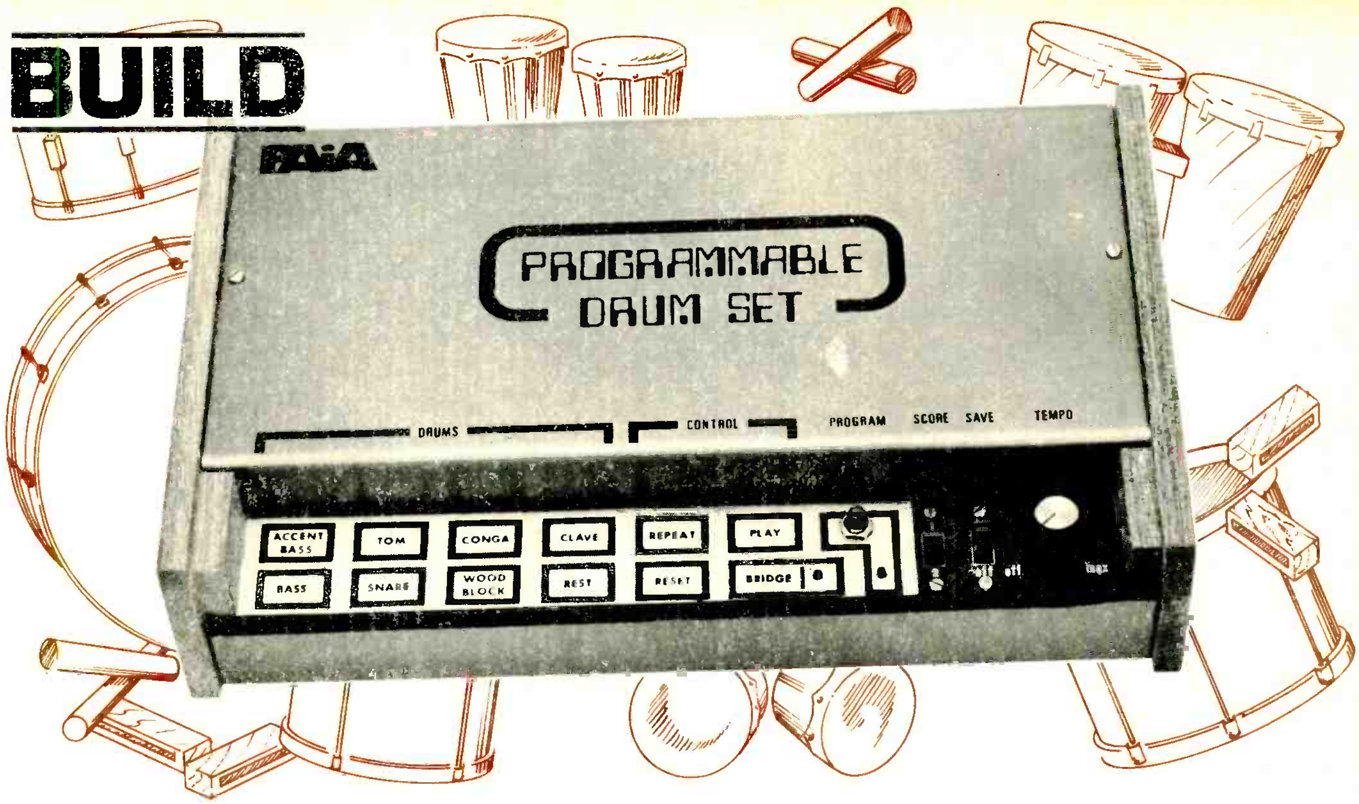
The multimeter can now be made into a finished packaged instrument by housing it in a chassis case similar to that shown in Fig. 8 and the photograph. Here the basic DPM is mounted on the left side of the chassis with the display showing through a tinted red or gray acrylic plastic window, the power supply plus multimeter circuitry being housed in the right side. On-off and function switches are mounted in the right front panel. Such a packaged instrument, though home built, can offer a very attractive and useful meter for both amateur and professional use.

DMM operation

The DMM circuit is built around relatively simple and well-proven circuit principles. The circuit diagram in Fig. 7 shows all functions are fed into the DPM on the 0–2-volt scale. The DC voltage input to the DMM feeds into a precision resistor voltage divider, with the scale

continued on page 103

BUILD



Part II—*An electronic musical instrument accessory with a difference. Novel programming capabilities give you unusual time signatures along with bridges and introductions.*

JOHN S. SIMONTON, JR.

LAST MONTH, AS WE BEGAN THE STORY ON this unique musical instrument accessory, we covered its applications, circuitry and theoretical operation. Now, we'll go forward with construction details. A PC board simplifies construction.

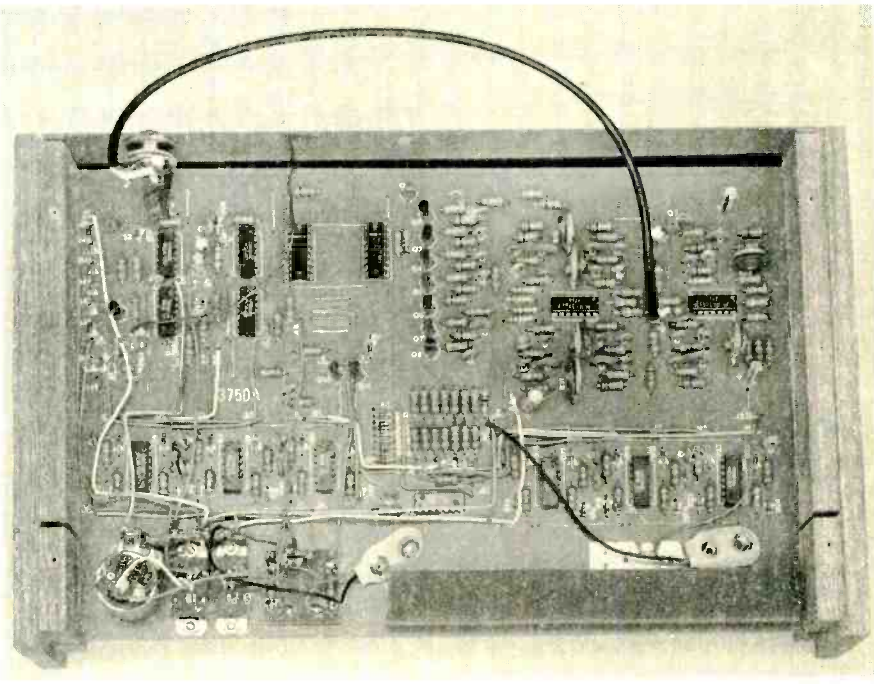
Assembly

For easy assembly, the drum set has been designed so that *everything,* except for the audio output jack and the sync input tip jack, mount directly on the circuit board. This minimizes point-to-point wiring (although there is still some) and produces an exceptionally easy unit to work on. For all practical purposes there are no wires tying the circuit board to panel-mounted controls; in fact, the case is simply a shell to hide the components.

A circuit board is mandatory. You can etch your own PC board using Fig. 5 as a guide. Boards are also available commercially, as are complete kits (see parts list.)

Note that the touch-switch pads that form the bulk of the unit controls are a part of the PC board. In the commercial version of this board, the touch pads are covered with a colored ink; contrasting color designates the control areas. If you make this board at home, transfer lettering can be applied directly to the touch pads and a strip of thin transparent tape applied over that. Since the touch switches do not require direct contact to operate, the insulating layer provided by the tape will suffice but it must be kept as thin as possible.

Once you have the board the way you want it, mount the parts: Resistors and capacitors first; then solid wire jumpers (note there are several of these, as indicated by the solid lines connecting points in Fig. 6); then semiconductors, diodes, transistors, IC's, etc. Observe the orienta-



INSIDE VIEW OF THE UNIT shows how parts are positioned on the circuit board. Note that this is a one-sided board.

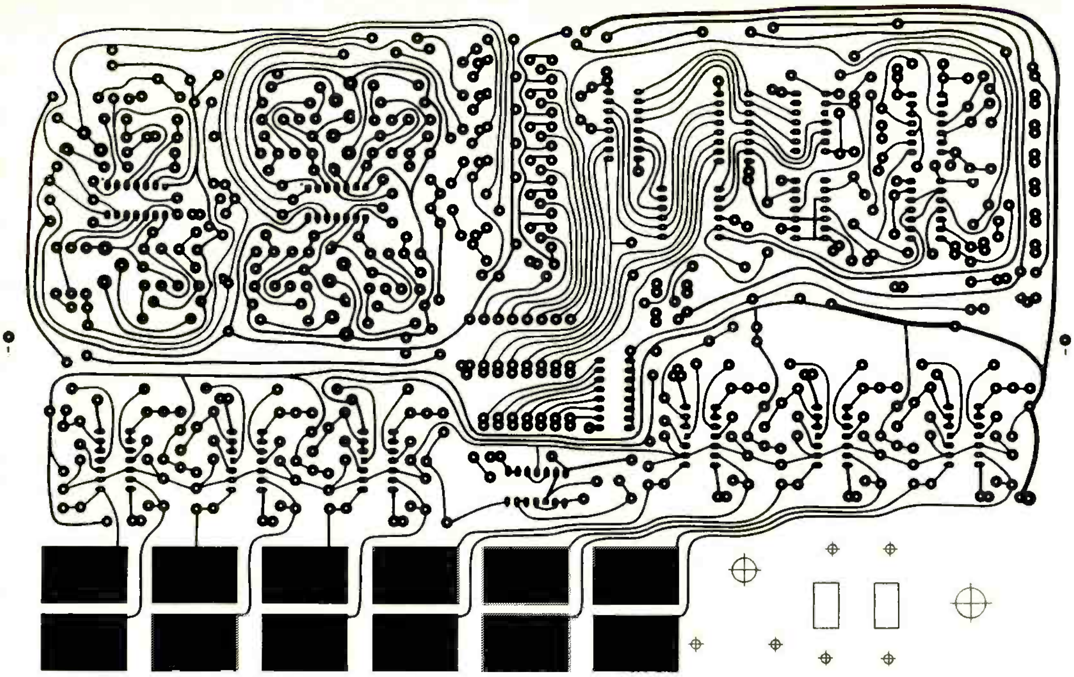


FIG. 5—MAIN PC BOARD foil pattern shown half-size.

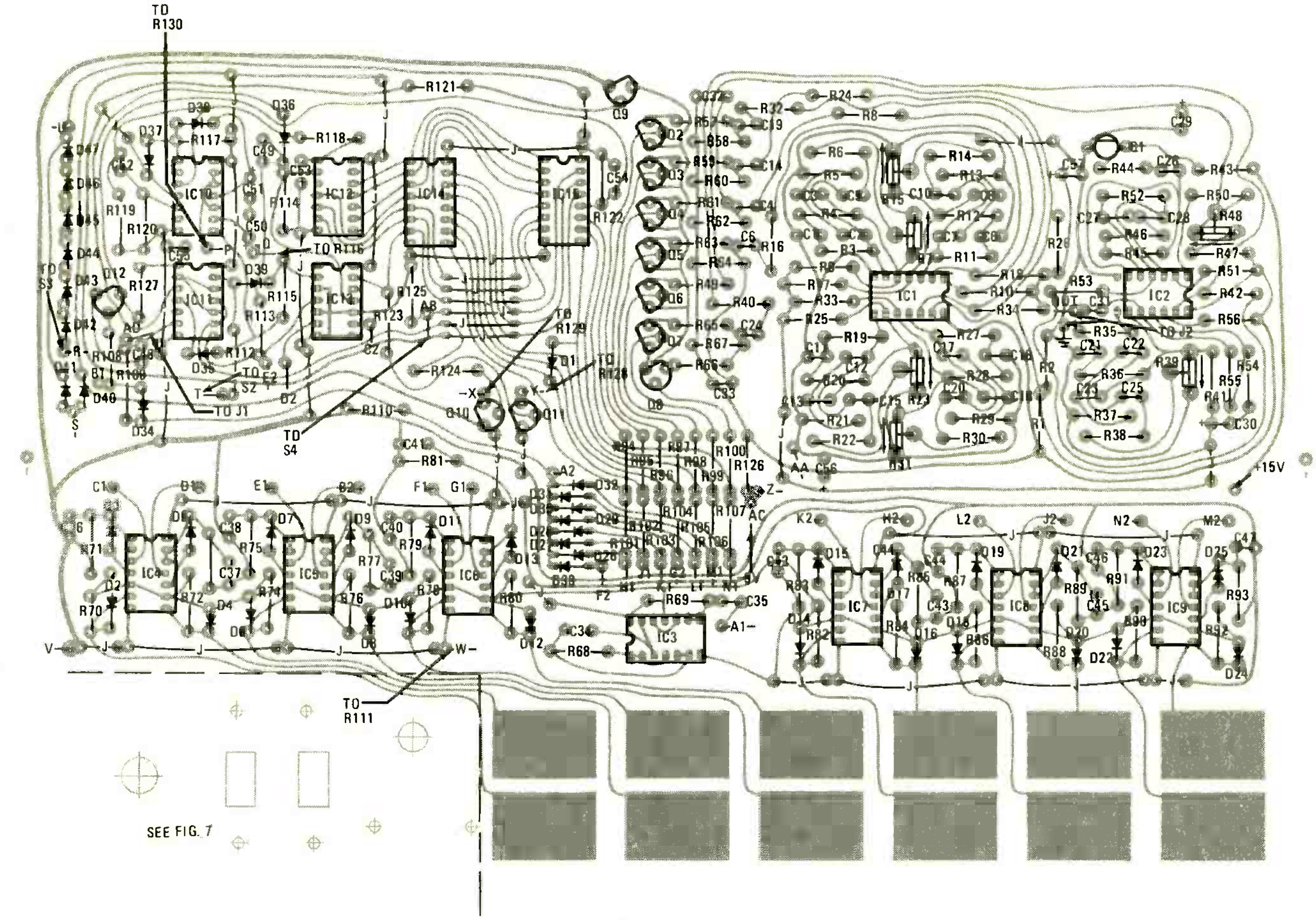


FIG. 6—COMPONENT PLACEMENT DIAGRAM. Wiring of the PC mounted controls and switches are shown in Fig. 7.

tion of electrolytic capacitors, semiconductors and IC's.

Because CMOS logic is used, the common rules of good practice must be followed when installing these parts. In general, avoid static build-up—Do not wear nylon clothes, use a grounded soldering iron and don't run across the carpet before picking up the parts.

After mounting all the electronic components, mount potentiometer R130 and slide switches S3 and S4. Mount a 3-lug tie strip somewhere in the vicinity of these controls (such as under one of the S4 mounting screws as shown in Fig. 7). Note that the two PROGRAM and BRIDGE LED's are mounted on their own circuit board. The foil pattern for the LED board is shown in Fig. 8. This board also mounts resistors R128 and R129 and is held in place by the mounting shaft of PROGRAM pushbutton S2, as shown in Fig. 9.

There are numerous connections that are made with stranded, insulated wire on the component side of the circuit board. Points with the same letter prefix are connected together (A1 to A2, etc.).

All resistors ½ watt, 10% or better, unless noted.
R1, R5, R41, R46, R58, R60, R62, R64, R67, R121, R127—10,000 ohms
R2, R65—6800 ohms
R3, R4, R11, R12, R19, R20, R27, R28, R35, R36, R51—2.2 megohms
R6, R8, R14, R22, R30, R38, R43, R52—1 megohm
R7, R15, R23, R31, R39, R48—50,000-ohm trimmer, PC mount
R9, R17, R25, R33—18,000 ohms
R10, R18, R26, R34, R42—3.9 megohms
R13, R108, R110, R112, R115, R117, R122-R125—33,000 ohms
R16, R24, R32, R56—330,000 ohms
R21—39,000 ohms
R29, R57, R61, R63—68,000 ohms
R37, R101-R104, R106, R107, R118—15,000 ohms
R40, R45, R114—220,000 ohms
R44, R113, R128, R129—2200 ohms
R47, R116—82,000 ohms
R49—100 ohms
R50, R54, R55, R119—150,000 ohms
R53—27,000 ohms
R66, R94-R100—47,000 ohms
R68, R105—4700 ohms
R69-R93—680,000 ohms
R109, R120—470,000 ohms
R126—47 ohms
R130—500,000-ohm log-taper potentiometer with SPST switch
C1, C11, C16, C21, C33, C48, C54, C55—.01μF, 50 volt, ceramic disc
C2, C3, C12, C13, C17, C18, C34, C52—.001μF, 50 volt, ceramic disc
C4, C9, C14, C19, C22, C23, C32, C35-C47, C49—.005μF, 50 volt, ceramic disc
C5, C10, C15, C20, C24-C26, C31—.05μF, 50 volt, ceramic disc
C6-C8, C27, C28—500 pF, 50 volt, ceramic disc
C29, C57—2.2μF, 10 volt, electrolytic
C30, C50, C51-1μF, 10 volt, electrolytic
C53-100 pF, 50 volt, ceramic disc
C56-33μF, 10 volt, electrolytic
D1-D47-1N914 or 1N4148
LED1, LED2-light-emitting diodes (Texas Instruments TIL209B or equal)
Q1-2N2712 specially selected noise transistor
Q2-Q8, Q11, Q12-2N5129
Q9, Q10-2N5139
IC1, IC2-LM3900 or CA3401
IC3-IC11-CD4001 quad NOR gate
IC12-CD4024 seven-stage counter
IC13-CD4013 dual-D flip-flop
IC14, IC15.-2112 256×4 RAM
S1-SPST switch ONR130
S2-SPST momentary-contact pushbutton
S3, S4-SPST slide switches
J1-insulated tip jack, red
J2-2-conductor phone jack
Misc.-two 9-volt battery clips, one battery holder for 4 penlight cells (Keystone type-182 or equiv.), one lug-type terminal strip (one lug grounded, two insulated).

The following are available from Paia Electronics, 1020 Wilshire, Oklahoma City, OK 73116:
Order No. 3750—Complete kit including all parts, case, step-by-step instructions. $79.95 plus $3.00 shipping.
Order No. 3750PC—Set of two etched, drilled and silkscreened circuit boards. $15.00 plus $1.00 shipping.
Oklahoma residents add state and local taxes as applicable.

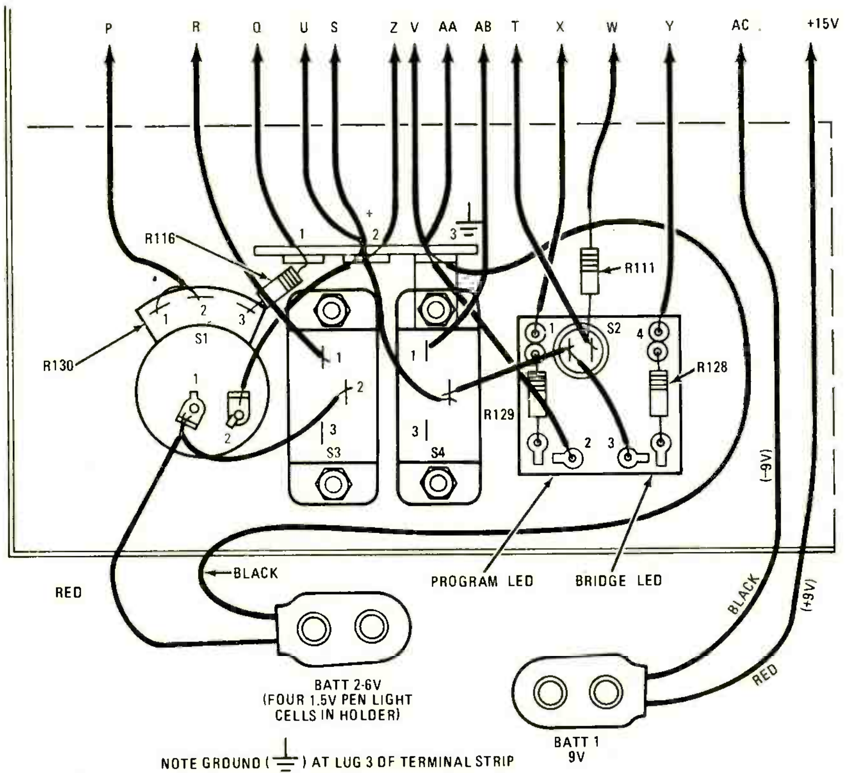


FIG. 7—CONTROLS AND SWITCHES are mounted on the main PC board. Point-to-point wiring to the main board is shown in Fig. 6.

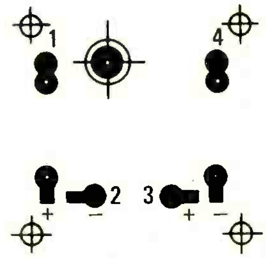


FIG. 8—LED BOARD foil pattern shown full size.

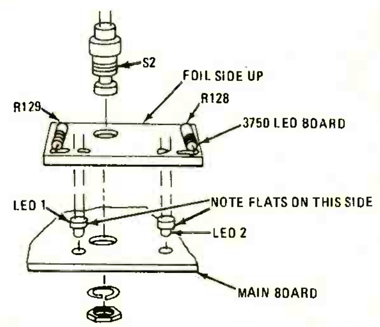


FIG. 9—LED BOARD is mounted directly to the main PC board. Point-to-point wiring to main PC board is shown in Fig. 7. Components are mounted on foil side of board.

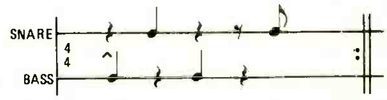


FIG. 10—FOX TROT is used as a programming example in text.

There are 13 pairs of these points, designated from A to N (except for I).

Finally, perform the wiring between the controls and the remaining designated points on the circuit board and install the battery snaps, as shown in Fig. 7.

Testing and calibration

The capacitive touch switches used in the programmable drum set require a moderate-quality earth ground to operate properly. In most cases, the ground established to the amplifier through the audio output cable will suffice.

After carefully checking for misplaced components, solder bridges and cold solder joints, turn the TEMPO control fully counterclockwise past the "click" and turn all six internal trimmer potentiometers (R7, R15, R23, R31, R39 and R48) to their minimum sustain position (*opposite* the direction of the arrows in Fig. 6). Place the SCORE switch in the 1 position and turn the SAVE switch off.

Load the 6-volt battery pack with four AA penlight cells, making sure to observe the orientation of the batteries. Connect this battery pack to the snap attached to the on-off switch on the TEMPO control. Connect another 9-volt transistor radio battery to the remaining snap (see Fig. 7).

Using a jumper cable, connect the phone-jack output of the drum set to an instrument amplifier or the auxiliary input of a hi-fi amplifier.

Turn the power on by advancing the TEMPO control clockwise. When the unit is first turned on, you may (if the volume of the amplifier is set high enough) hear a burst of noise lasting about one second. This is normal.

One or both LED's may also come on when power is first applied. Touching the RESET pad should extinguish these LED's.

To test the drum oscillator circuits sustained-oscillation capability, advance the internal trimmers one at a time in the sustain direction (the direction of the arrows) until the drum circuits start oscillating. Once you have established that an oscillator is capable of sustained operation, retard its trimmer control fully (*opposite* the direction of the arrow) before testing the next oscillator. *Note* that trimmer R48 is an adjustment of the noise source used in the snare drum circuits; it does not produce a tone but rather a steady hiss as it is advanced.

To adjust the drum sound oscillators, touch RESET and then press the PROGRAM button. The PROGRAM LED then indicates that you are in the program mode. Advance the TEMPO control clockwise approximately three-fourths of its total rotation.

At this point, pressing any of the drum sound pads should produce a repeating percussion sound in the amplifier's speaker. Adjust the rate at which this sound repeats with the TEMPO control.

With a finger on the WOOD BLOCK pad, adjust trimmer R7 in the sustain direction (the direction of the arrow) until the sound approximates that of a wood block.

Similarly, touch CLAVE and adjust R15; touch TOM and adjust R23; and touch CONGA and adjust R31. Touch ACCENT BASS and adjust R39; then touch BASS and confirm that the bass drum sound is heard, although at a lower volume level than ACCENT BASS.

Touch the SNARE pad and adjust R48 until the noise source approximates that of a snare drum. It may be necessary to adjust TOM control R23 to obtain the maximum realism from the SNARE generator.

Touch RESET and the PROGRAM LED goes off (this resets the unit's internal event counter to zero); then press PROGRAM again to reactivate the PROGRAM LED. Tap each drum sound control pads in turn, ACCENT BASS, TOM, CONGA, CLAVE, BASS, SNARE, WOOD BLOCK and REST. Do not hold these pads down long enough for the sound to repeat, only long enough for a single drum sound to be generated. Finally, touch the REPEAT pad (to indicate the point at which the pattern is to repeat) and, finally, the PLAY pad. At this point the drum set should begin playing back the entered pattern.

Having verified the unit's ability to store a program, you are ready to test the bridge pattern. Reset the unit, and while resting a finger on the BRIDGE pad, touch RESET again. (Note: The activation of the bridge circuit is sequence-sensitive; this can only be activated by touching RESET *while* the BRIDGE pad is being touched). The BRIDGE LED will come on, indicating that you are in the bridge mode. Push the PROGRAM button (observing that the PROGRAM LED lights), and you are ready to program the bridge.

Program some easily recognized pattern (such as four clave beats) then touch REPEAT and RESET.

Touch PLAY, and the test pattern of all drum sounds programmed previously should be heard. Allow this pattern to play for a couple of cycles, then touch BRIDGE. When the pattern playing reaches the repeat stage, the unit should switch to the bridge pattern (as indicated by the BRIDGE LED lighting) and, as long as the pad is touched, should continue to play. Release the BRIDGE pad. The BRIDGE LED may not immediately extinguish, and the unit may not immediately shift back to the main pattern. This shift should only occur at the point in the bridge pattern where it would ordinarily repeat.

Using the drum set

Before discussing the operation and use of the controls, the following points need mentioning:

1. Battery current drain is a significant 100 mA in full operation and 30 mA in the SAVE mode. Therefore, use the SAVE sparingly and turn the unit off when not in operation. The penlight batteries should be good for ten hours of intermittent operation, and the 9-volt transistor radio battery should have essentially shelf life.

2. There is a natural tendency to enter patterns "in tempo" by beating out the rhythm on the touch switches. *This is not the way that it is done.* Any pattern must have REST's entered with it for proper drum-beat spacing.

The operation of the controls is as follows:

- TEMPO—This knob, at the right-hand edge of the control panel, sets the tempo at which a programmed rhythm pattern plays back. Clockwise rotation of the control increases the tempo.

The power switch is a part of this control, and rotating the control fully counterclockwise past the "click" turns off the power. The power should be turned off any time that the unit is not being played or programmed.

The TEMPO control also sets the rate at which drum sounds are repeated during programming. In the program mode, continuously activating a drum pad will cause that sound to be repeated at a rate set by the TEMPO control. Each drum sound heard will also be entered into memory.

- SAVE—The SAVE switch holds a programmed pattern for short periods of time. Sliding the SAVE switch to the on position allows the TEMPO control to be rotated to the full-power off position without losing the scores currently programmed into memory. The SAVE switch should be left off any time it is not being used to actually save a score.
- SCORE—The SCORE switch allows two independent rhythm patterns (each with its own bridge pattern) to be programmed and selected for playback.
- PROGRAM—Pressing the PROGRAM pushbutton puts the unit into the programming mode for pattern entry or modification. The PROGRAM LED will light anytime the unit is in the programming mode.
- CONTROL—There are four touch pads: RESET, REPEAT, PLAY and BRIDGE. Get in the habit of touching the RESET pad every time before anything else is activated. This control resets the internal event counter that determines the next programmed event; it also takes the unit out of the program or bridge modes.

The primary function of the REPEAT pad is to enter into memory the point at which the currently programmed pattern is to repeat. This pad can also be used during playback to go back to the beginning of a pattern without stopping the unit entirely. This is useful for special effects, introductions, etc.

Touching the PLAY pad reproduces the programmed pattern selected by the SCORE switch at a rate set by the TEMPO control. This control pad latches so that a single tap will start the unit, which will then continue to play until stopped by touching the RESET pad.

The BRIDGE pad is used one of two ways, depending on whether you are programming a score or playing one back. To program the bridge, the following sequence must be followed: RESET (*always* reset before anything else), then while touching the BRIDGE pad, tap the RESET again (the BRIDGE LED should light, indicating the bridge mode); then push PROGRAM (the BRIDGE LED should still be on) and now the PROGRAM LED should light indicating the program mode. The bridge pattern can then be programmed in the same manner as a main score.

During playback, touching the BRIDGE pad *at the time of the repeat* will cause the drum circuitry to begin playing the bridge rather than the main score. The BRIDGE key does not latch, and you must touch it at the time of the repeat in order for the unit to shift to the bridge pattern. When the repeat point of the bridge pattern is reached, the unit will shift back to the main score unless the BRIDGE pad is still being touched, in which case the bridge pattern will be repeated.

- DRUMS—The eight touch pads on the left side of the panel control the drum sounds: BASS, ACCENT BASS (down-beat, etc.), TOM, SNARE, CONGA, WOOD BLOCK, CLAVE and, most important, REST.

continued on page 107

Forest Belt tells...

What You Need To Know About Servicing Citizens Band Radios

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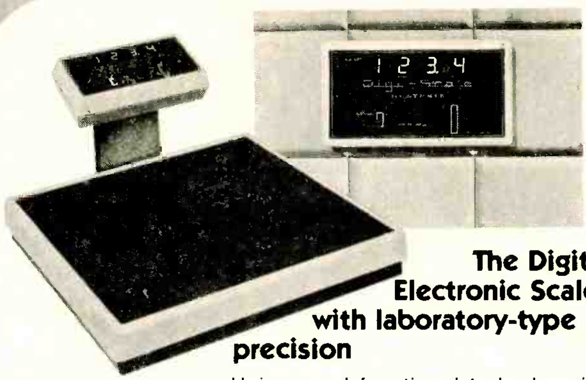

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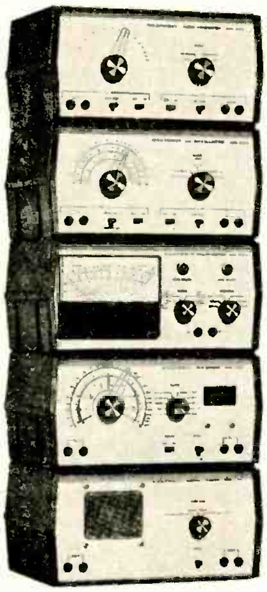

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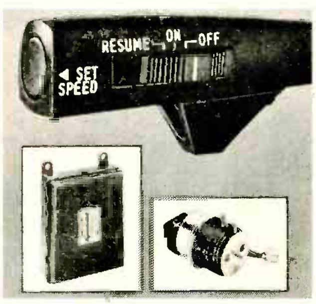

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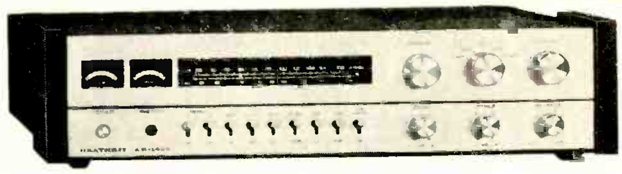

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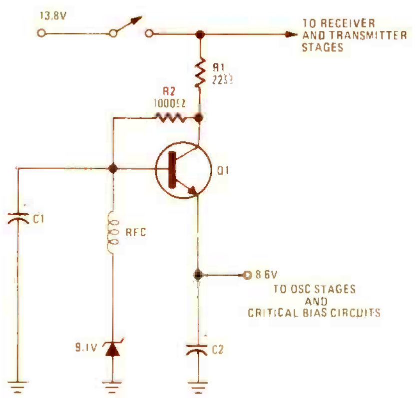


FIG. 3—TRANSISTOR REGULATOR IS rare for inexpensive CB radios, and usually includes a Zener diode.

it's only a half-watt resistor, the heat may change its value. Eventually, the resistor chars or, if the resistance decreases, the current may rise high enough for the fuse to blow.

Second, Zener diodes open. It may not be noticeable unless some critical stage malfunctions because of varying voltage. Hence, in any set with Zener diodes, it is wise to include some measuring voltage across each diode. . . within 5 percent of the Zener rating. Schematic diagrams usually list the voltage to expect across each Zener.

Transistor voltage regulator

Enough low-cost sets use transistor regulators that you should know what to expect of them. Figure 3 is a diagram of the usual transistor circuitry. Actually, the regulating action begins with the Zener diode in the transistor base circuit.

Transistor Q1 operates as a series regulator. The output, which stabilizes at about 8.6 volts, depends on the voltage drops across Q1 and R1. The internal resistance of Q1 is determined, of course, by the emitter-base bias.

Suppose that more current is being drawn at the Q1 output. Emitter voltage tends to become slightly *less* positive. The Zener holds the base voltage steady so that the net bias on NPN transistor Q1 becomes greater in the forward direction. This, in turn, lowers the series resistance of Q1, bringing the output voltage back up to 8.6.

Now, suppose less current is drawn. The voltage at the Q1 emitter rises, thus reducing the forward bias on transistor Q1. Less conduction in Q1 is the equivalent of increasing its effective resistance. Less current can flow and the output voltage drops back to equilibrium at 8.6.

Equally important, this regulator cures input-voltage fluctuations. Even if the input voltage alters, the Zener diode prevents the base bias from varying. The output voltage would tend to follow the input-voltage variation up or down, but it cannot do so because of the regulating action described above.

To troubleshoot, measure the voltage across the Zener diode. If the voltage is high, replace the diode; if low, open the emitter lead of the transistor. If the voltage then rises back to normal across the Zener, the fault may be in the transistor; test it while the lead is loose. Or, you may have to trace a short along the regulated DC supply line.

That about covers what you might find in the DC supply sections of a low-cost transceiver. **R-E**

Transmitter Keying

SWITCHING FROM RECEIVE TO transmit modes (called transmitter *keying*) is relatively simple in low-cost CB transceivers. There are three switching methods: relay switching, simple electronic switching and transistor electronic switching.

Changing from the receive to transmit modes involves four basic operations:

1. Disabling the receiver. Usually, this is done most simply by removing the DC voltage supply from the receive stages. That's how a relay does it. But there are also other means, as discussed later on in this article.
2. Activating the transmitter. A relay can simply apply the DC voltage to the transmit stages. Electronic switching uses other ways to activate the stages.
3. Disconnecting the speaker. The audio stages and output transformer double as modulator components for AM transmitting. And if the speaker were on, it would cause acoustic feedback to the mike.
4. Transferring the antenna connection from the receiver input to the transmitter output. This switchover is simple with a relay. Electronic keying requires a different approach.

These are the fundamental alterations that switch the receive mode to the transmit mode. The CB operator initiates them by pressing the mike button. Figure 1-a shows how this is done when a relay system is used. Roughly one-fourth of low-cost CB transceivers incorporate relay keying.

Most mike push-to-talk (PTT) buttons have two sections. Figure 3-a shows a double-pole single-throw (DPST) version. One set of contacts feeds the mike's output voltage to the mike amplifier stage; the others are *keying contacts*. They ground one end of the keying-relay coil. Since the other end connects to the 13.8-volt DC supply line, closing the mike-switch contacts energizes the relay coil.

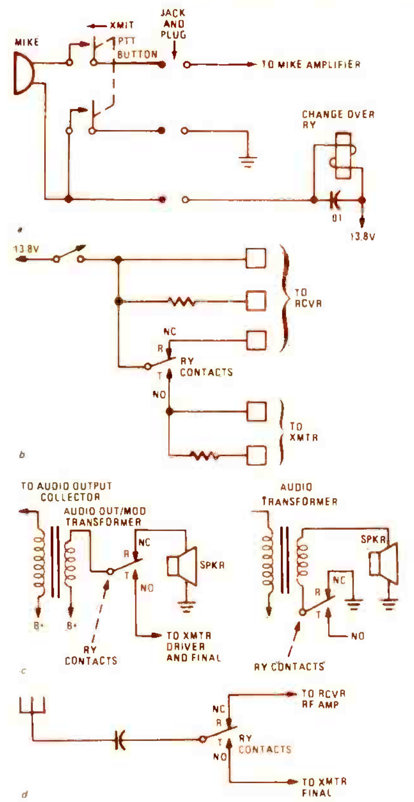


FIG. 1—THREE SETS OF CONTACTS ON relay accomplish the four receive-to-transmit switchover operations.

The keying relay contains at least three sets of contacts. One contact set (shown in Fig. 1-b), transfers the DC supply voltage from the receiver to transmitter stages; this takes care of the first two changeover operations in our list of four. Another set of contacts disables the speaker (Fig. 1-c). In some designs, the relay transfers the output of the audio power stage from the speaker to the transmitter RF section, changing the audio function to modulator. In other schemes, the contacts merely unground the speaker or one transformer winding to eliminate speaker sound.

And finally, Fig. 1-d shows that one set of contacts moves the antenna connection from the receiver input to the transmitter output.

There's a specific procedure you use to troubleshoot different keying troubles. For relay keying, you start by pushing the relay armature, using your finger or an insulated rod. If the transceiver shifts to transmit, the contacts are working; concentrate on the keying circuit.

The coil cord causes more keying trouble than any other component. Open the mike and check the voltage on the relay side of the mike switch. Is it missing? The coil cord or plug may be open. Or the relay or its connection to the DC voltage line are open. Try keying with a jumper lead: First jumper the keying contacts at the coil cord, at the plug and finally right at the relay.

Occasionally, you may find a relay that pulls in OK when you press the mike button; the receiver stops, but the transmitter doesn't start. Yet, pressing the relay with your finger does start the transmitter. Either the relay contacts are dirty and need burnishing, the relay coil is partially shorted or the relay is misadjusted. A new relay proves the surest cure for any of these defects.

Electronic keying

Keying without a relay saves the cost of an expensive component—the relay. Actually, all four changes can be accomplished with one set of switch contacts—in the mike. Figure 2 is a diagram of one design that incorporates a number of techniques found in other models although not always together.

Two principles allow the electronic keying arrangement shown in Fig. 2 to turn the receiver off and the transmitter on: (1) Apply proper DC operating voltage to the transistors in a stage, and the stage operates. Remove the voltages, and the stage stops. (2) In typical circuitry, you can turn off any NPN transistor by applying a high positive voltage to its emitter circuit. This is termed a *kill voltage*. Return the emitter circuit to ground potential, and the stage turns on again.

Figure 2 shows how this happens. This keying design uses one DC voltage bus in two ways. The same voltage serves both as a kill voltage and as a supply voltage. Source point 4 in the Fig. 2 diagram marks the voltage (6.1) used for transmit-receive keying.

SOME MICROPHONES USE A LEAF switch (right), while others use a plunger-type DPDT switch.

Study the supply line bus first. This DC branch supplies voltage to the collector of the receive mixer, as well as bias for the base. It is not necessary to show the other receiver stages on the diagram; the 6.1-volt supply goes to each of them. Note that the emitters of these receiver stages go to ground through the usual resistor.

Pressing the mike switch to its transmit position grounds point 4. The voltage drops to zero. Resistor R4 limits the current so the short doesn't overload the DC input. Of course, the receiver stages can't operate with zero voltage fed to their collectors and bases. Releasing the mike button restores the voltage, and the receiver works.

Turn your attention now to the connections along the bus labeled the "kill line." First, look at the transmit buffer stage. The collector voltage on this transistor comes from source point 1. The bias voltage develops through self-bias. But the stage can't operate—with 6.1 volts positive on the emitter, the stage is dead.

But move that mike-switch contact from the receive mode to the transmit mode, and the voltage goes to zero. Grounding the emitter circuit this way brings the stage to life.

The same operating principle controls the transmit oscillator IC. This IC turns on when the mike switch grounds one of its pins. The rest of the time, during the receive mode, the positive kill-line voltage deactivates the transmit oscillator IC.

Generally, only two or three transmitter stages need to be kept off during the receive mode. The driver and final stages can stay idle and draw a bit of current from their DC voltage supplies with no harm done. These stages do not really operate until driven by the RF drive signal from the transmit oscillator and buffer stage. The mike amplifier is usually included among the switched stages, kept off during the receive mode so that no mike sound can reach the audio stages.

Cutting off the receiver and turning on the transmitter takes care of switchover operations Nos. 1 and 2 listed earlier. Now let's consider a third operation: the antenna.

There's really no need to transfer the antenna. You can connect the transmitter's RF output to the same point as the receiver input, and leave it. However, the receiver input needs protection from the transmitter's RF power. Diode D2 and the kill line (see Fig. 2) provide such protection.

With 6.1 volts on its cathode, diode D2 is reverse-biased and exerts no effect on the base circuit to which it's connected. Closing the mike switch grounds the cathode, and D2 becomes conductive.

The last transfer operation concerns the speaker switchoff. Figure 2 shows how this is done: Pressing the mike switch to the transmit position ungrounds the speaker or the audio transformer.

Switching other stages

The keying setup shown in Fig. 3 probably needs little explanation. You know that applying a positive voltage to the NPN transistor emitters holds them cut off. So, in this system the mike switch grounds the emitters of

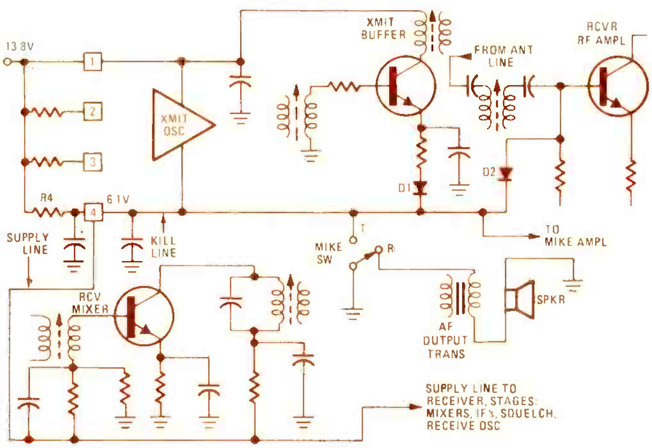


FIG. 2—MIKE SWITCH GROUNDS A COMBINATION SUPPLY and kill bus to change set to transmit mode.

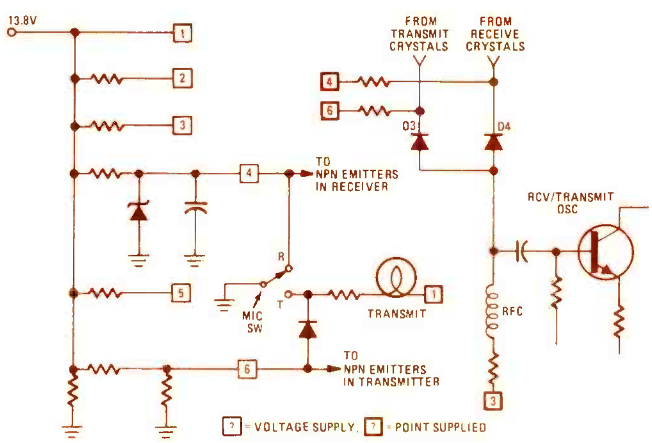


FIG. 3—KILL LINES FOR TRANSMIT OR RECEIVE ARE grounded by mike switch. Same lines connect crystals through diodes.

either the receive or transmit stages.

There's one additional refinement – a transmit lamp connects to the transmit side of the mike switch. The diode keeps the source 6 voltage from reaching the lamp, because the source 1 voltage is more positive, which keeps the diode backward-biased. Grounding the mike switch places the full source 1 voltage across the lamp/resistor, and the lamp glows. The same switch contact takes the source 6 voltage to zero as the diode finds forward bias (cathode-grounded).

In one model, an added trick lets the designer use only one transistor for both the transmit and receive oscillators. Here's how it works.

Consider voltage source 6 first. Applying this voltage to the D3 cathode keeps the diode open. Transmit crystals therefore have no effect on the oscillator. Meanwhile the source 4 voltage is grounded, and diode D4 conducts. Diode D4 connects a receive crystal to the oscillator (whichever crystal the channel selector chooses).

Pressing the mike switch reverses the situations: Source 6 is grounded, D3 conducts and a transmit crystal connects to the oscillator. Source 4, at full voltage, cuts off diode D4, blocking any receive-crystals effect.

Transistor keying

A few transceivers incorporate a transistor to make the change from the receive mode to the transmit mode. One simple arrangement appears in Fig. 4. This diagram shows that PNP transistor Q1 does not conduct as long as the base DC circuit stays open; no bias can develop. Closing the mike switch completes the base return path. Transistor Q1 conducts and places the voltage at source points 4 and 5.

You already know how the two voltages work. Source 4 feeds a DC supply voltage to the transmitter stages. If the mike switch is open, there is no DC voltage at source 4 and the transmitter stays off. Meanwhile, the lack of voltage at source 5 leaves the receiver-stage emitters at near-zero volts, which is about the same as grounding them; and the receiver works.

With the mike switch closed, transistor Q1 conducts, voltage at source 5 kills the receiver stages, and voltage at source 4 activates the transmitter. It's as simple as that.

Some designers prefer switching the DC supply voltage between the receiver and transmitter stages. Yet, they want to avoid the cost, bulk and mechanical problems of a relay. So, you find quite a few low-cost CB models including a transistor and diode or several transistors to accomplish the voltage switchover.

Figure 5 shows another simple arrangement. First, let's suppose the mike switch is open. A connection to the 8.6-volt regulated line places a high positive voltage on the emitter of PNP transistor Q1. However, with the base circuit open, Q1 cannot conduct. Source 5 develops no voltage, which means the transmit stages cannot operate, since they depend on source 5 for their voltage supplies.

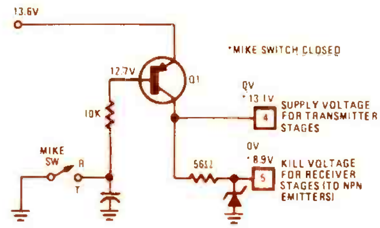


FIG. 4 – ELECTRONIC SWITCHING, WITH transistor turning on supply voltages, appears only in a few low-cost sets.

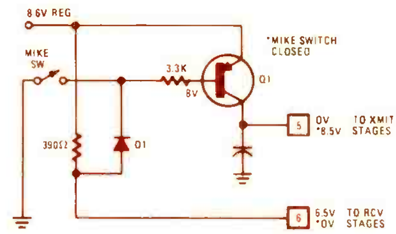


FIG. 5 – WHEN MIKE SWITCH CLOSES, diode grounds receiver supply voltage, and transistor applies voltage to transmitter.

Source 6 obtains voltage through the 390-ohm resistor. Diode D1 cannot conduct, since its cathode faces an open mike switch. Source 6 feeds the receiver stages, and they operate.

Now, with the mike switch closed, two things happen. First, grounding the D1 cathode causes D1 to conduct. This conduction shorts out the 6.5 volts at source 6, dropping it to zero. Without any operating DC voltage, the receiver stages stop working.

Second, completing the base-bias circuit allows Q1 to turn on. The 8.6-volt supply travels easily to source point 5, and from there to the transmit stages; so, the transmitter operates.

About the most complex transistor keying system you'll find, (at least in low-cost radios) is shown in the diagram of Fig. 6. Again, to visualize how this system works, imagine the mike switch is open. A strong positive bias is applied to Q1 through resistor R1. While conducting, Q1 applies a positive DC supply from the 13.6-volt input line to the diode D1 anode. The forward-biased diode applies the voltage to source point 7 and the receiver stages.

Resistor R2 carries the voltage down to the base of Q3. This voltage turns on Q3, which then acts as a short at the base of Q2. With no base bias, Q2 cannot operate. Hence source point 9 develops no DC voltage, and the transmit stages remain inactive. Closing the mike switch shorts the base of Q1 to ground. Without a base bias, Q1 then stops conducting, voltage at source 7 drops to practically zero and the receiver stops operating.

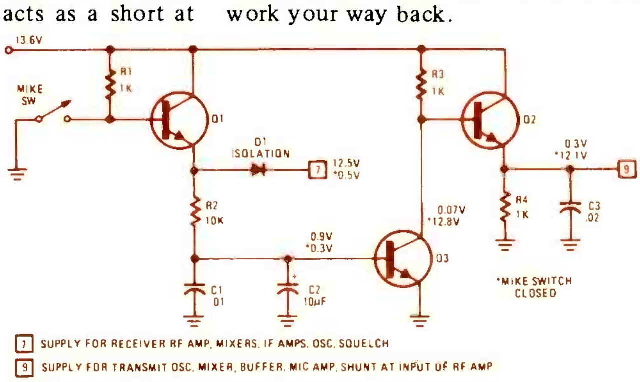


FIG. 6 – MULTITRANSISTOR KEYING SYSTEM FEEDS VOLTAGE to transmit stages (mike switch closed) or to receiver stages (switch open).

With little or no voltage being sent through Q1, the base of Q3 has insufficient bias to turn on, so Q3 appears as if it is open. This "open" condition lets the R3 voltage bias Q2 into conduction. Therefore, source point 9 develops DC voltage, thus turning on the transmitter stages.

Troubleshooting keying circuits

You already know that a broken wire inside the microphone coil cord is the most likely cause when a transmitter won't key. Check the mike switch, too. Burnishing the contacts helps, if they are accessible. But be careful not to warp the contact leaves; they get out of adjustment easily. When you have the set open on the bench, clip a jumper lead across the keying point (where the mike-switch wires connect). This will tell you instantly whether the trouble is in the mike/plug/cord combination or in the transceiver chassis.

Wherever a mike switch grounds certain circuits for transmit keying, test with jumper leads. Where DC voltages are switched, disconnect the mike-switch wire from its DC voltage source. Try jumpering the voltage first to one side, then the other.

Transistors or diodes are usually the cause of improper transistor keying. Fast ohmmeter and/or transistor tester checks may save you a lot of analysis. In a complex system such as that shown in Fig. 6, a clamping voltage can be your best troubleshooting device. Start with the last transistor in the chain (example: Q2 in Fig. 6) and work your way back.

Servicing Synthesizers

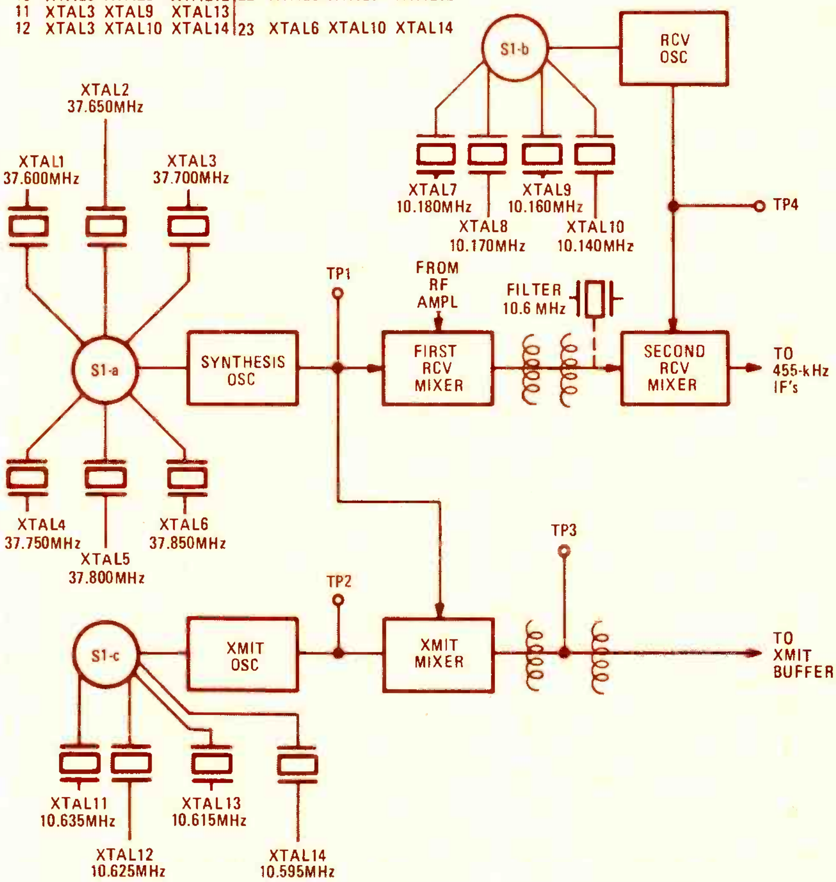
How to troubleshoot both the PLL and the multi-crystal types.

THERE IS ONE SECTION IN A CB transceiver that operates whether you are transmitting or receiving—the frequency synthesizer. This section initiates internal RF signals for both receiver and transmitter.

Inexpensive CB radios are predominantly 23-channel sets. Very few use a phase-locked loop. Some 80 percent incorporate frequency synthesizers, by far the most popular being the 6-4-4 type of synthesizer. This version consists of a master oscillator with six crystals, a receive oscillator with four crystals and a transmit oscillator with another four crystals. A few low-priced transceivers use a 6-4-2 synthesizer, having six and four crystals in two synthesizer oscillators, and one each in the receive and transmit oscillators.

6-4-4 CRYSTAL COMBINATIONS

CH				CH			
1	XTAL1	XTAL7	XTAL11	13	XTAL4	XTAL7	XTAL11
2	XTAL1	XTAL8	XTAL12	14	XTAL4	XTAL8	XTAL12
3	XTAL1	XTAL9	XTAL13	15	XTAL4	XTAL9	XTAL13
4	XTAL1	XTAL10	XTAL14	16	XTAL4	XTAL10	XTAL14
5	XTAL2	XTAL7	XTAL11	17	XTAL5	XTAL7	XTAL11
6	XTAL2	XTAL8	XTAL12	18	XTAL5	XTAL8	XTAL12
7	XTAL2	XTAL9	XTAL13	19	XTAL5	XTAL9	XTAL13
8	XTAL2	XTAL10	XTAL14	20	XTAL5	XTAL10	XTAL14
9	XTAL3	XTAL7	XTAL11	21	XTAL6	XTAL7	XTAL11
10	XTAL3	XTAL8	XTAL12	22	XTAL6	XTAL8	XTAL12
11	XTAL3	XTAL9	XTAL13				
12	XTAL3	XTAL10	XTAL14	23	XTAL6	XTAL10	XTAL14



FREQUENCIES (17/9/10 SYNTHESIZER)

S1-a		S1-b		S1-c	
XTAL1	16.965MHz	XTAL7	9.545MHz	XTAL11	10.000MHz
XTAL2	17.015MHz	XTAL8	9.555MHz	XTAL12	10.010MHz
XTAL3	17.065MHz	XTAL9	9.565MHz	XTAL13	10.020MHz
XTAL4	17.115MHz	XTAL10	9.585MHz	XTAL14	10.040MHz
XTAL5	17.165MHz				
XTAL6	17.215MHz				

(HIGH IF NEAR 10MHz)

FIG. 1—THE 6-4-4 SYNTHESIZER FALLS MAINLY IN TWO FREQUENCY GROUPings: 37/10/10 (the most popular) and 17/9/10, using a 10-MHz high IF signal.

How synthesis works

Synthesizer operation is easy to understand, no matter in what kind of CB radio. It involves simple heterodyning.

The block diagram of Fig. 1 shows the type of syntehsizer used by a majority of low-cost 23-channel CB radios; the most common crystals for this type of radio are shown. You are safe in stocking up on these crystals. . . you'll use them.

First, study the operation of this synthesizer during the transmit function; the receive oscillator is off, and the transmit oscillator is on.

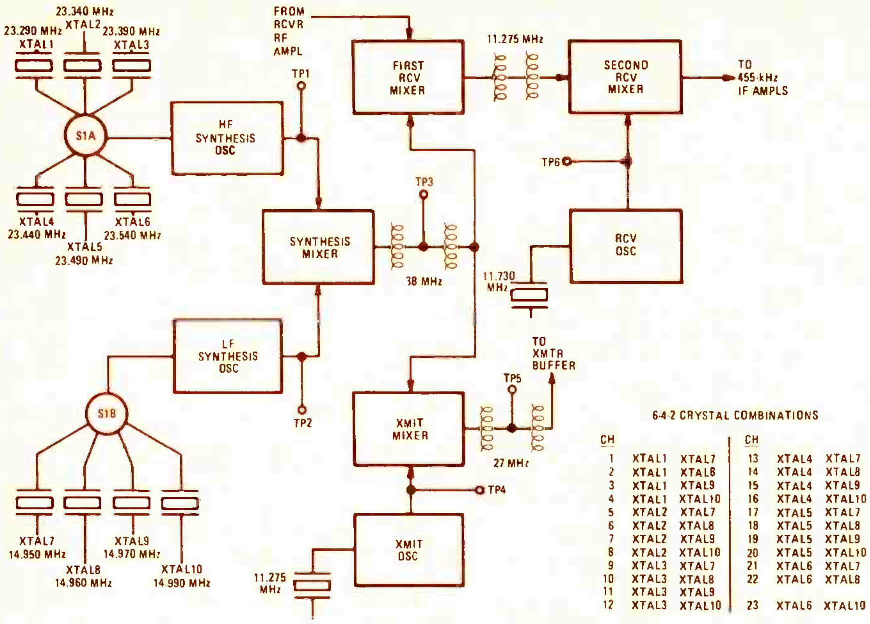
For example, assume the channel selector is set for CB Channel 9. To discover which crystals are activated, consult the crystal combination chart in Fig. 1. (Each Sams *PhotoFact* Schematic contains a similar chart.)

In our example, crystals X3 and X11 are the ones involved in transmitting the Channel 9 signals. (Remember, the receive oscillator is off.) The signals generated by the synthesis oscillator and the transmit oscillator meet in the transmit mixer, where they heterodyne. Subtracting the crystal X11 frequency from the crystal X3 frequency, (37.700 minus 10.635) gives 27.065 MHz—the output of the transmit mixer.

Release the mike button and the set returns to the receive condition. This cuts off the transmit oscillator and activates the receive oscillator. The synthesis oscillator continues to operate. The Channel 9 crystal combination for receive is crystals X3 and X7.

However, the Fig. 1 block diagram shows that the signals from these two crystals do not heterodyne together directly. Instead, the synthesis oscillator signal goes to the first receive mixer, where it heterodynes with whatever incoming CB signals are present. Since the channel selector is set at Channel 9, here's what happens if there is a Channel 9 signal present.

Crystal X3 produces a 37.700-MHz signal. If that signal heterodynes in the first receive mixer with a 27.065-MHz signal the resulting high IF signal is 10.635 MHz. This high IF signal mixes in the second receive mixer with a signal from the receive oscillator. Since crystal X7 is selected when the switch is at Channel 9, the 10.635-MHz signal heterodynes with a 10.180-MHz signal.



6-4-2 CRYSTAL COMBINATIONS

CH			CH		
1	XTAL1	XTAL7	13	XTAL4	XTAL7
2	XTAL1	XTAL8	14	XTAL4	XTAL8
3	XTAL1	XTAL9	15	XTAL4	XTAL9
4	XTAL1	XTAL10	16	XTAL4	XTAL10
5	XTAL2	XTAL7	17	XTAL5	XTAL7
6	XTAL2	XTAL8	18	XTAL5	XTAL8
7	XTAL2	XTAL9	19	XTAL5	XTAL9
8	XTAL2	XTAL10	20	XTAL5	XTAL10
9	XTAL3	XTAL7	21	XTAL6	XTAL7
10	XTAL3	XTAL8	22	XTAL6	XTAL8
11	XTAL3	XTAL9			
12	XTAL3	XTAL10	23	XTAL6	XTAL10

FIG. 2—THE 6-4-2 SYNTHESIZER HAS HIGH- AND LOW-FREQUENCY SYNTHESIS oscillators, and separate single-frequency receive and transmit oscillators.

The difference is 0.455 MHz—of 455 kHz, the low intermediate frequency.

Using the same method, you can figure out how any other channel operates. The crystal combinations chart will show you which crystals are used in any channel position. The 37/10/10 crystal frequency arrangement shown in Fig. 1 is typical and the most common. However, there is another set of frequencies that is used fairly often—17/9/10. Frequencies for each of these crystals are listed in the box in Fig. 1. Crystals in the vicinity of 17 MHz control the synthesis oscillator; crystals near 10 MHz operate the transmit oscillator; and those near 9 MHz control the receive oscillator. If you see many of these sets, it's probably a good idea to carry one each of these crystals also.

Most of these receivers are double-conversion units. On schematic diagrams, the high IF is labeled either 10 MHz or 10.7 MHz, depending on the synthesizer crystals. Either way, the receive oscillator then heterodynes that high IF signal down to the second or low IF, which is always 455 kHz.

The so-called 10.7-MHz high IF signals are actually at 10.6 MHz, but they are listed that way because 10.7-MHz IF coils are common. The coils can be aligned at whatever frequency the synthesis crystals beat the incoming CB signal down to: Slightly above 10.6 MHz in 37/10/10 combinations and barely above 10 MHz in the 17/9/10 arrangement. Occasionally, 37/10/10 models will have a ceramic-tuned filter instead of coils between the two mixers. Almost always, it is listed as a 10.7-MHz filter, but it actually centers a bit below that frequency.

To be sure you understand the synthesis system shown in Fig. 1, use your calculator to go through the following 17/9/10 example: Assume the channel switch is set to Channel 19. Crystals X5 and X9 control the synthesis and receive oscillators, respectively.

Incoming signals mix with the 17.165-MHz synthesis signal to create high IF signals. Only a 27.185-MHz (Channel 19) signal places a 10.020-MHz signal into the second receive mixer. And that's the only high IF signal that can heterodyne 9.565 MHz (from crystal X9) and produce the correct low IF signal of 455 kHz. Any other incoming CB signal produces the wrong intermediate frequencies and is rejected.

In the transmit mode, crystals X5 and X13 heterodyne in the transmit mixer. Together their 17.165-MHz and 10.020-MHz signals produce a 27.185-MHz signal, the carrier for Channel 19.

Another synthesizer

Figure 2 shows a type of frequency synthesizer found in some low-cost CB's. I call it a 6-4-2 synthesizer. But you might also call it a 23/14 system because of the approximate number of crystal frequencies in the two synthesis oscillators. Again, it pays to keep this dozen crystals on hand. (Two crystals belong in the transmit and receive oscillators.)

Both synthesizer oscillators operate continuously when the set is on, for both transmit and receive functions. Let's choose Channel 23 for example. I recommend you run through the heterodyne calculations to see how this synthesizer operates in the transceiver. Fire up your calculator.

For Channel 23, the Fig. 2 chart names crystals X6 and X10. Crystal X6 holds the high-frequency synthesis oscillator at 23.540 MHz. Crystal X10 holds the low-frequency synthesis oscillator at 14.990 MHz. This synthesis mixer is additive; its output signal is 38.530 MHz.

In the transmit mode, the receiver mixer and oscillator are disabled. The transmit stages are all turned on. An 11.275-MHz signal mixes with the 38.530-MHz signal in the subtractive transmit mixer. Subtracting 11.275 MHz from 38.530 MHz gives 27.255 MHz, the carrier frequency for Channel 23.

In the receive mode, the transmit stages are off and the receive stages are on. As in the other systems, the synthesizer frequency beats in the first receive mixer signal with incoming CB signals from the receiver's input RF amplifier. The only CB signal that produces the correct 11.275-MHz high IF is the 27.255-MHz signal. You can check it on your calculator. Just subtract 27.255 MHz from the 38.530-MHz synthesizer signal.

Next, the 11.275-MHz IF signal heterodynes in the second receive mixer stage with an 11.730-MHz signal from the receive oscillator. Your calculator will show the difference is 0.455 MHz—which is the 455-kHz low IF signal.

Just as an exercise in understanding double-superhet receivers, use your calculator to see what happens to any other incoming signal, beating with the Channel 23 synthesizer signal. Suppose that the antenna is receiving signals from Channels 2, 4, 8, 9, 12, 17, 19 and 23. Choose any one of these signals and run it through the two mixers.

For example, try channel 9. Subtracting 27.065 from 38.530 (with the synthesizer set for Channel 23) gives an IF signal of 11.465 MHz. The high IF signal transformer, since it is tuned to 11.275 MHz, tries to reject this signal, but a small portion probably gets through to the second mixer.

In the second mixer, whatever is left of this 11.465-MHz IF signal mixes with the 11.730-MHz signal from the receive oscillator. The difference frequency is 0.265 MHz, or 265 kHz. That's a long, long way from 455 kHz. There is no way a 265-kHz signal can make it through the low IF amplifiers. Thus, the set has rejected the original Channel 9 signal.

If you work out any of the other signals except Channel 23, you'll see that the same thing happens to them. On the other hand, if you change the channel selector switch to choose a new combination of synthesizer crystals, the incoming signal frequency for *that* channel will heterodyne ultimately to exactly 455 kHz.

Troubleshooting synthesizers

Three instruments are all you need

to troubleshoot, diagnose or analyze synthesizer faults: a digital multimeter (DMM), a frequency counter and a calculator.

With synthesizers, only two kinds of components give the most trouble. The worst offenders are transistors; the second most troublesome are crystals. In an oscillator that is running off-frequency, the fault is probably a crystal. If the output voltage is too weak or missing, you can usually blame the transistor. Occasionally, a switch or other component can cause the voltage problem.

Your frequency counter is the first instrument to reach for. Figures 1 and 2 show test points. In some CB models, these test points are brought to test-point posts on the PC board. In other models, you might have to hunt the base of a transistor for the test connection. Be sure your frequency counter is sensitive enough to be locked by the signal, which in some oscillators may not exceed 20 to 40 volts P-P.

Use the crystal combinations chart in Fig. 1 to find the proper arrangement for the 6-4-4 synthesizer. Connect the frequency counter to test point 1. Set the channel selector to enough different channels to verify all six crystal frequencies in the synthesis oscillator. None should vary more than 1000 Hz from the indicated frequency. A crystal with a marginal frequency might leave the transmitter legal but not received well by other CB stations. Likewise, it might make the receiver operate marginally, even while testing OK for sensitivity.

Furthermore, anytime a crystal varies by 1000 Hz, you can expect it to shift more. Replacing such a crystal is your best insurance against a quick callback.

Second, use your frequency counter to test the output of the transmit oscillator (TP2). If no test point is provided, go to the base of the transmit mixer. If the mixer input point is the same for both signals, one may override the other, and the result may confuse the counter. You might conclude that one oscillator is running and the other isn't.

You have two alternatives. Some technicians keep a 0.1 μF capacitor, with test leads attached, for killing an oscillator. You just clip the capacitor jumper from the oscillator base to ground. That lets only the signal from the other oscillator show up at the mixer input.

FOURTEEN CRYSTALS are a sign that the synthesizer is 6-4-4; the 6-4-2 synthesizer needs only twelve crystals.

The other alternative is to move the frequency counter to test point 3. If all six synthesis oscillator crystals are OK, any discrepancy in the 27-MHz output votlage from the transmit mixer must be caused by either a bad mixer or a faulty crystal in the transmit oscillator. If the signal is merely off-frequency, blame the crystal. If the mixer transistor is defective, you might find either no output voltage at all or only from one or the other oscillator.

In any case, these three fast frequency checks show you the condition of the synthesis oscillator, transmit oscillator and mixer.

Test point 4 lets you verify the frequency of the receive oscillator. If it's wrong, the proper low IF cannot be developed by signals in the first mixer.

With a strong input signal and a sensitive frequency counter, you can check the high IF at the first-mixer input. If you don't know what the exact frequency should be, get out your calculator. From the frequency of whatever synthesis crystal the channel selector switch has chosen (see Fig. 1), you subtract the assigned frequency for that CB channel. The difference is the IF you should expect. In a 37/10/10 synthesizer, a normal high IF signal ranges from 10.595 MHz to 10.635 MHz. In the 17/9/10 configuration, the IF frequency is from 10.0 MHz to 10.04 MHz.

If you suspect a transistor is causing the problem, you can check it quickly by analyzing voltages with your DMM or by taking the base lead loose and measuring forward and backward with the ohmmeter. You also save time if you use a quick-check type of in-circuit transistor tester.

Troubleshooting a 6-4-2 synthesizer (see Fig. 2) differs only slightly. First, you check all the crystals in the HF oscillator by connecting the frequency counter at test point 1. Then, check the IF oscillator crystals at test point 2. Finally, verify that these crystals are heterodyning to the right frequencies, by connecting the frequency counter at test point 3. If all crystals are OK in both oscillators, all you have to do is check one combination just to be sure the mixer is working properly. Here's where your calculator comes in handy, because service schematic diagrams seldom list synthesis-mixer outputs.

For example, suppose the channel selector is set at Channel 12. The switch connects crystals X3 and X10 to their respective oscillators. Since the mixer is additive, your frequency counter at test point 3 should read close to 38.380 MHz.

Then, move to test point 4. Any discrepancy in frequency here, with the synthesizer frequency at test point 3 being correct, indicates there is a fault in the transmit-oscillator frequency. Or, perhaps the same 38-MHz frequency shows up at test point 4; that means the oscillator isn't working.

Ordinarily, the best place to start testing the receiver side is at the receive oscillator, in both 6-4-4 and 6-4-2 synthesizers. In Fig. 1, the receive oscillator test point is No. 4; in Fig. 2, it's test point 5. Use a frequency counter to find out whether or not the oscillator is working accurately.

If your frequency counter is not sensitive enough to check the oscillator output directly, try checking at a mixer output. In the receiver, this may still not suffice, because there may be less signal following the mixer than out of the oscillator.

23-Channel PLL

YOU MAY RUN INTO SOME TROUBLE trying to understand how low-cost sets with a phase-locked loop (PLL) work. Many diagrams are misleading. They don't really indicate the way a PLL operates. A block diagram shows separated portions of an integrated circuit, without ever showing the internal connections that interrelate the separate sections. The block diagram shown here will try to circumvent this problem.

You may already know how a PLL operates, but here's an explanation. This circuit is common in low-cost 23-channel sets; it uses either the PLL-01A integrated circuit or the PLL-02A IC. A few other PLL IC's are used;

they work about the same.

The heart of any PLL system is a DC-tuned oscillator, called a *voltage-controlled oscillator* (VCO). The main job of a VCO is to provide the internal signal for the receive and transmit mixers. In 23-channel sets, the same VCO frequency is used for both transmit and receive modes. Only resetting the channel selector switch changes the VCO's output frequency.

A phase-locked loop tuning system takes its name from the loop formed by the stages controlling the VCO frequency. A sample signal from the VCO is fed to a loop mixer and heterodyned against the signal from an overtone oscillator. The overtone oscillator runs on the third overtone of an 11.8066-MHz crystal; its output is therefore nominally 35.42 MHz.

The VCO can run at almost any frequency. But for the sake of example, let it run at 37.66 MHz. This frequency, mixed with the signal from the overtone oscillator, produces a loop signal at 2.24 MHz.

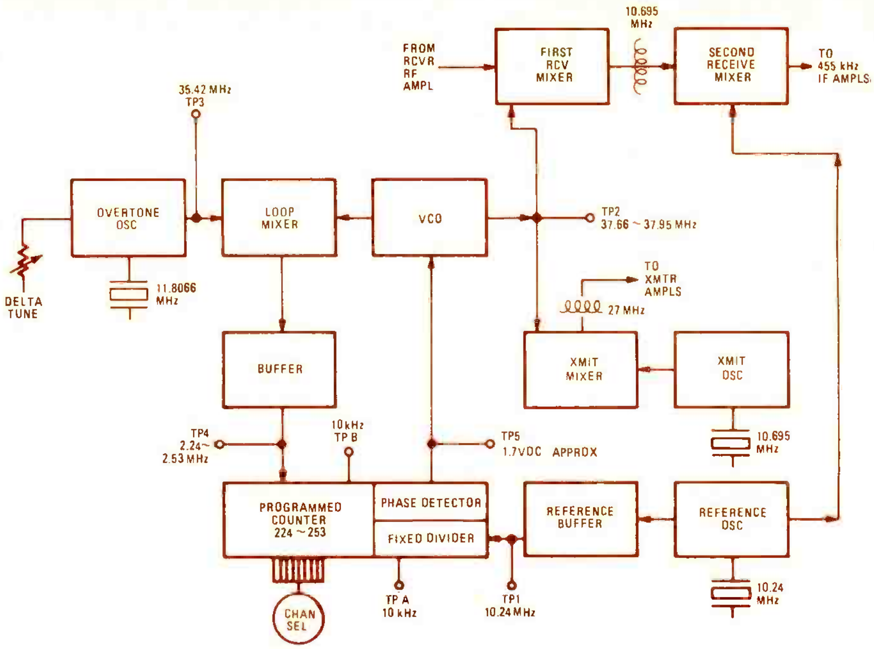
This 2.24-MHz signal is fed through a buffer amplifier, to a programmed downcounter or divider, which is part of a TTL-type IC.

A specially designed channel selector switch connects a particular combination of high and low voltages to certain pins in the IC. In our example, suppose the channel selector is set at CB Channel 1. High and low voltages program the divider to down-count by a factor of 224.

A 2.24-MHz loop signal fed into this 224 down-counter produces an output signal at 0.01 MHz, or 10 kHz. And that output signal is fed to a phase detector.

Meanwhile, a reference signal is being developed by a reference oscillator that is controlled by a 10.24-MHz crystal. Passing through a buffer stage, this signal is fed to another divider, inside the IC, which produces a fixed 1024 down-count. Hence, the reference oscillator and the 1024 divider produce a tightly controlled reference signal at 10 kHz.

This 10-kHz reference signal proceeds—still inside the IC—to the same phase detector that receives the down-counted loop signal. The phase detector checks to see if both signals match precisely in frequency and phase. If they do, as in the example just described, the DC voltage output DC of the phase detector stabilizes. Do not make the mistake of thinking that the voltage output goes to zero; it does not. The phase detector simply holds a ramp voltage at some specific value. This DC voltage is applied to the voltage-controlled oscillator, and determines its frequency.



TYPICAL 23-CHANNEL PHASE-LOCKED LOOP CAN BE TESTED WITH DC CLAMP voltage connected to test point 5, so you can control the voltage-controlled oscillator (VCO) manually.

To understand how this PLL system controls the VCO frequency, let's turn the channel selector switch to Channel 9. As you know, the channel selector switch chooses the high and low voltages that are applied to the programmed divider inside the IC. Rearranging the high and low voltages reprograms the variable divider to a new down-count factor. For Channel 9, because of the divider's inner design this down-count factor is 234.

You know immediately that the 37.66-MHz VCO frequency will not provide the right loop signal. In order for the phase detector to receive a 10-kHz signal from the programmed counter, a 2.34-MHz signal must come down the loop from the loop mixer. Mixing a 37.66-MHz signal from the VCO with a 35.42-MHz signal from the overtone oscillator results in a signal of 2.24-MHz, not 2.34 MHz.

The 2.24-MHz signal on the loop line is now divided by 234 instead of 224. Obviously, this cannot produce a 10-kHz signal for comparison with the reference. The phase detector senses this discrepancy. It sets its ramp voltage in motion, which then starts swinging the VCO frequency. Only when the VCO frequency reaches 37.76 MHz does the phase detector stabilize the ramp voltage.

Why a VCO frequency of 37.76 MHz? Because this is the frequency which, when it is beat against the overtone oscillator signal of 35.42 MHz produces a 2.34-MHz loop signal. And this is the only loop-signal frequency that will divide perfectly to 10 kHz in the programmed down-counter. In addition, the phase detector can lock *only* at that frequency. Any slight shift in the VCO frequency throws the phase detector off, and its ramp voltage automatically corrects the VCO frequency.

The PLL diagram shows where the VCO output goes. When the transmitter is keyed, the output mixes with the transmit oscillator. In the case of Channel 9, in which the VCO is stabilized at 37.76 MHz, the subtractive transmit mixer heterodynes 37.76 MHz and 10.695 MHz to produce a frequency of 27.065 MHz, which is the Channel 9 carrier frequency.

When the receiver is operating, the VCO output mixes with incoming signals from the receiver RF amplifier. From here on, operation is similar to CB receivers using synthesizers. In this case, only a frequency of 27.065 MHz will mix with the 37.76-MHz signal from the VCO to produce a 10.695-MHz high IF signal. And that is the only signal that can beat in the second mixer with a 10.24-MHz signal and produce a 455-kHz low IF signal. You may have noticed, a sample of the 10.24-MHz reference signal is fed to the second mixer instead of a receive oscillator signal.

Troublehunting in PLL

That's how a 23-channel PLL system works. Now, how do you troubleshoot it? Here's a step-by-step procedure that uncovers virtually any defect you are likely to encounter in a PLL.

First, here's a point to remember. Suppose you narrow down a trouble to the inside sections of an IC. This means replacing the entire IC. Some sections are contained in more than one IC, and some discrete stages use transistors. Adapt your techniques to suit.

Start measuring DC voltage at test

point 4. The service schematic should indicate the voltage there within a few tenths of a volt. If this voltage is wrong, the VCO can be far off-frequency or even pushed to the point where it stops oscillating. The PLL system shown in the block diagram states that 1.7 volts is nearly correct. So, the voltage should fall somewhere between 1.3 and 2.1. Much voltage outside that range indicates trouble, but this does not necessarily show where the trouble is.

Next, clamp the DC voltage line at test point 4. Choose a well-filtered and well-regulated DC power supply. Connect its output to test point 4. If there is no test-point post, clip this output to the DC voltage line that feeds the capacitive diode controlling the VCO frequency. Clip your multimeter to the same point and adjust the DC supply to approximately 1.7 volts, or whatever value the schematic calls for.

Now connect a frequency counter to the VCO output (test point 2). The frequency should fall somewhere within the limits specified for that VCO. Sets having PLL-01A IC's run the VCO at a frequency of 21 MHz, and the discrete-reference oscillator operates at 6.4 MHz. The PLL-02A and most other 23-channel systems operate the VCO near a 38-MHz frequency, with a 10.24-MHz frequency reference.

Actually, the VCO shown here operates from 37.66 MHz to 37.95 MHz. If the proper voltage does not bring the VCO into this frequency range or very close, the VCO needs servicing or adjustment.

Next, if the frequency is alsmot correct, adjust the clamp voltage—without regard to its specific value—to make the VCO operate at some steady frequency. The precise frequency doesn't matter much as long as you can measure it and it holds steady.

For example, assume your counter reads 36.710 MHz. Move the counter to test point 3, the overtone oscillator output. If the loop-mixer input is missing or is not precisely at 35.42 MHz, there's your trouble; cure it.

Take out your calculator; it's an important servicing tool. Keep it handy because you'll be doing several calculations.

Whatever frequency comes from the overtone oscillator, subtract that from the measured frequency of the clamped VCO. Suppose, for example, that the DC-clamp voltage has set the frequency of the VCO oscillator at 37.705 MHz. Simultaneously, your frequency counter shows the overtone oscillator output at 35.422 MHz. Your calculator tells you that the difference between the two frequencies, which is or should be the output of the loop mixer, is 2.283 MHz.

Your frequency counter ought to find that 2.283-MHz frequency at the mixer output or at test point 3 following the buffer stage. If it doesn't, there's trouble in the mixer or buffer stages. If this signal is wrong or missing, you'll have to cure the trouble before you proceed.

Next, check the dividing action of the programmed divider or down-counter in the IC. But, you say, the output goes to the phase detector, which is also inside the IC. How can you check this? Most monolithic PLL IC's include internal test points that are brought out to blank pins. Therefore, you can check the divider action with your frequency counter.

Remember that the 2.283-MHz (2283-kHz) frequency is the signal that enters the programmed down-counter. Set the channel selector to any channel you wish. The system is disabled, because of the DC clamp voltage on the VCO control line, so dialing the switch does not affect the VCO. Just for example, set the switch for Channel 1. The divider factor there is 224 for Channel 1. Therefore, the divider should divide by 224 whatever frequency enters.

With your calculator, divide 2283 kHz by the factor the channel switch has selected, which is 224. Your calculator tells you that the output of the programmed divider should be 10.192 kHz. If you had chosen some other channel, the divider factor would be different, and the frequency at test point B would also be different. However, your calculator would tell you *what* it should be. For instance, with Channel 9 and a divider factor of 234, the output frequency should be 2283 kHz divided by 234, or 9.756 kHz.

Now let your frequency counter verify whether or not the programmed down-counter produces the correct frequency (in this case 10.192 kHz). Connect the counter to whichever IC pin corresponds to test point B on the IC you're working with. If the frequency is within a couple of Hz, the programmed divider is working correctly. If the symptom complaint has been that one or two channels are incorrect, verify the down-count for those channels.

When your frequency counter verifies everything your calculator has told you around to this point in the loop, then everything so far is working OK. Now, check out the reference side of the PLL. The frequency counter at test point 1 indicates whether the reference crystal is on-frequency and if the oscillator and buffer are working. Most systems in low-cost 23-channel CB's operate with a 10.24-MHz reference frequency. (An exception is those using the PLL-01A IC, which operates with a 6.4-MHz reference frequency.)

Then, if the reference stages are working, check the fixed divider inside the IC. Again, there is a no-connection pin that forms the output test point (test point A) for the fixed divider. Your frequency counter should verify the exact down-count, whether from 6.4 MHz or 10.24 MHz, always to exactly 10.0 kHz. If this frequency deviates more than 1 or 2 Hz, find the trouble.

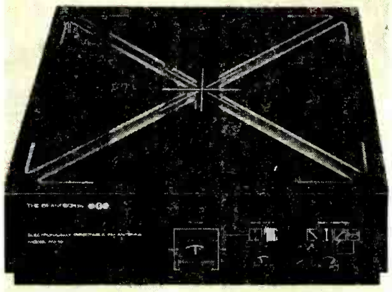
Incidentally, if your frequency counter shows the fixed-divider output test point is 16 kHz, either the wrong IC or a wrong-frequency reference crystal have been installed. By the same token, if the counter reads almost exactly 6.25 kHz, you have the same trouble.

Finally, check the phase detector by first connecting the clamp voltage close to the VCO. Then, break the DC line voltage somewhere between the clamp voltage and the DC voltage output of the IC's phase detector section. Now, with the VCO still held stable by the clamp voltage, connect your DC voltmeter to the phase-detector output; the DC voltage here should be steady, and close to the value shown on the set's schematic.

If everything checks out OK around the PLL, the phase detector should pull the VCO right onto frequency and lock it there when you remove the clamp voltage. If it doesn't, the fault is in the phase detector or ramp-voltage section of the IC. In either case, the IC must be replaced.

However, suppose that earlier troubleshooting found that dividers were defective. It is important that you check both of them if you find one bad. Why? Because the DC voltage input, (Vcc input) might be at fault. Usually, normal voltage is somewhere on the order of 5 or 6. It must be close to correct, or the IC cannot operate normally. If you find that IC action is defective and replace the IC when actually the only trouble was in the Vcc input, the new IC wouldn't work either. **R-E**

Radio-Electronics Tests


1

CIRCLE 95 ON FREE INFORMATION CARD

Model FM-10 Beam Box Antenna

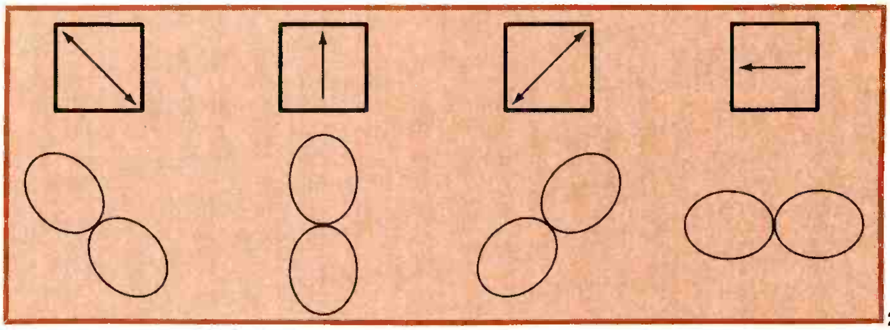
LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

I HAVE FOR MANY YEARS BEMOANED THE FACT that most purchasers of good FM tuners and receivers seldom realize the full potential from their investment. That's because they do not, or cannot, install an adequate directional outdoor antenna specifically designed for FM signal reception. The usual 300-ohm T-wire packed with most hi-fi tuners and receivers, while theoretically suitable for proper FM signal reception, generally suffers in performance because it is seldom positioned for best reception and often ends up casually tossed behind the tuner or under a rug. The so-called "rabbit ear" antennas, although they *can* be oriented for best signal reception, are cumbersome and inconvenient to place properly.

Several FM radio manufacturers have attempted to design and market indoor antennas that incorporate booster RF amplifiers and other electronic schemes. The trouble with most of these schemes is that along with amplifying the desired signal, they amplify background noise as well. Most FM front ends have about as good a noise figure as can be obtained, and increased signal strength is hardly ever a problem unless you live many, many miles from an FM station.

The real problem in FM reception, especially stereo FM reception, lies in trying to feed a proper signal to the antenna terminals—one that is free of interfering reflections, known as multipath. TV viewers are all too familiar with signal reflections, since they cause multiple images to the right of the main picture. In FM reception, such signal reflections cause distortion, loss of stereo separation and, in extreme cases, increased background noise. The solution, of course, is a directional antenna.

B.I.C.'s new *model FM-10, Beam Box*, is, as far as we know, the first indoor FM antenna of its kind. Figure 1 shows it is physically designed to look like other high-fidelity components. In fact, it can be positioned alongside, under or above the rest of the components in your system. One of the key features of this new indoor FM antenna is that its reception patterns can be altered without physically rotating the entire unit. A BEAM DIRECTION switch at the right of the front panel hooks up to pairs of antenna elements so that four Figure 8 reception patterns can be obtained, each displaced from the next by 45 degrees. The reception patterns generated by the different switch settings are shown in Fig. 2.


2

To use *The Beam Box*, connect its rear-panel output terminals to the tuner or receiver antenna terminals either by using the 300-ohm transmission line supplied, or, if 75-ohm coaxial operation is desired, by a suitable length of this type of cable terminated in a standard connector that must be purchased separately. If your tuner is equipped with a signal strength meter, first tune to the desired frequency and then use the BEAM DIRECTION switch to choose the beam pattern that results in the greatest deflection of the signal strength meter. Next, the BANDWIDTH control, next to the BEAM DIRECTION switch, is turned from its broadband position to its narrowband or sharp position. When this is done, a four-section variable-tuning capacitor, with its associated coils and other passive front end parts, is introduced as part of the antenna circuitry.

When the BEAM DIRECTION switch is set to the narrowband position, *The Beam Box* acts, in effect, as a front end in front of your tuner's own front end, and therefore contributes significantly to image rejection, spurious response rejection and, to a lesser degree, selectivity. You simply turn the TUNING control until signal reception is optimized, observing the signal strength meter or, if none is available, listening for the cleanest, least noisy FM reception. The owner's manual suggests that after the initial optimization, it is advisable to recheck using the BEAM DIRECTION switch, since occasionally a different directional pattern can further improve reception once the other controls have been set.

Lab measurements

Two sets of experiments were conducted to determine the usefulness of *The Beam Box*. Our laboratory is equipped with a precision field-strength meter, the Blonder-Tongue *model 4127* that reads directly in microvolts. This meter was first hooked up to a standard 300-ohm wire dipole antenna of the type normally supplied with most tuners or receivers. The dipole antenna was placed in a fixed position and not reoriented during the tests (much as it would be used in a typical installation). Several received signals were tuned to on the field-strength meter and readings were recorded.

Next, *The Beam Box* was connected to the field-strength meter and tuned to the same signal frequencies. The received signal strength was again recorded. Results of these tests are listed in Table I and, as can be seen, in most instances, signal strengths received using an optimally adjusted and tuned *Beam Box* were greater than those received using the nominally positioned standard dipole antenna—despite the fact that *The Beam Box* (by virtue of its 8th-wavelength elements) actually has less theoretical gain than a half-wave dipole antenna. Even in the few instances where signal strengths were greater using the dipole antenna, subsequent listening tests revealed that *reception quality* was superior when *The Beam Box* was used, once again proving that the signal quality counts more than actual signal strength.

Our second experiment involved measuring the residual background noise of an FM received signal. FM noise reduction is not

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Frequency Range: 88 MHz to 108 MHz. **Antenna Gain:** −5 dB (narrowband); −12 dB (broadband). **Receiving Elements:** four 8th-wavelength extruded aluminum elements. **Output Impedance:** 300-ohm balanced or 75-ohm unbalanced (coaxial) connection. **Standing-Wave Ratio** (VSWR): less than 1.5:1, narrowband. Bandwidth, in narrowband position, 3 MHz at −3-dB points. **Dimensions:** 14½ W × 4½ H × 14¾ inches D. **Net Weight:** 8.5 lbs. **Accessories:** 44-inch length of 300-ohm transmission line, terminated at each end with spade-lug connectors. **Suggested Retail Price:** $89.95.

Station Frequency (MHz)	Signal Strength (μV) Using B.I.C. Beam Box Tuned And Set For Best Reception	Signal Strength (μV) Using Fixed Wire-Dipole Tacked To A Wall
89.1	125	50
89.9	62	48*
92.1	60	60*
96.3	100	45*
97.1	250	125
99.9	160	30
101.1	160	70
102.7	80	100
104.3	115	90
106.7	250	30*
107.9	35	5*

TABLE I

* These stations exhibited severe multipath reception problems when the fixed-position dipole antenna was used.

TABLE II
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **B.I.C.** Model: **FM-10 Beam Box Antenna**

OVERALL PRODUCT ANALYSIS

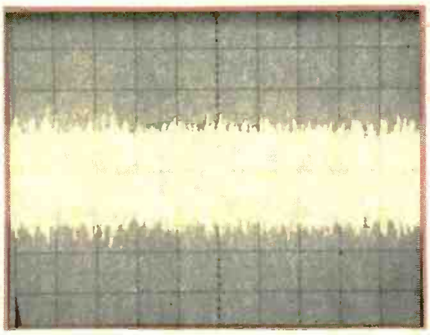
Retail price	**$89.95**
Price category	**Unique, no comparison possible**
Price/performance ratio	**Excellent**
Styling and appearance	**Superb**
Sound quality	**Not applicable**
Mechanical performance	**Excellent**

Comments: This unique product will probably be the answer to many FM enthusiasts' prayers. It is the first indoor FM antenna that really does a good job and is not an eyesore in your listening room. The combination of directionality switching and tuned circuits actually can and does improve FM performance of any tuner or receiver, regardless of its price, since it enables the user who is prohibited from installing a proper directional outdoor FM antenna to receive the least amount of multipath interference and optimum signal quality. It takes a bit of getting used to, since it is necessary to tune *The Beam Box* each time you listen to a new station. But the effort is worthwhile, since each received signal is truly optimized if you use *The Beam Box* properly and the procedure becomes habitual. B.I.C. includes a station log sheet that can be filled in with your favorite station call letters, their frequency and the correct BEAM DIRECTION switch setting for each station. This cuts down the antenna tuning time the next occasion you want to listen to one of the logged stations.

If the desired signal strengths are just too low to provide adequate limiting in your tuner, *The Beam Box* won't help. But if you are plagued with poor FM reception even from nearby signals (because of reflections, etc.) *The Beam Box* could be the next best thing to an expensive directional outdoor antenna array/rotator combination. If installing an outdoor antenna is either prohibited or prohibitive, the B.I.C. *Beam Box* seems to be a viable alternative.

always a function of signal strength. There are a few FM tuners and receivers around (notably, those manufactured by Harman Kardon) that *do* provide what is called a *quieting* meter instead of the usual signal strength meter. To simulate this kind of indication, we connected a bandpass filter (tuned to around 100 kHz) to the detector output of a tuner. The output of the filter was connected to the vertical input of an oscilloscope. Since the filter allows only noise components in the 100-kHz region to pass through, the audio modulation of the received signal does not affect the display. This sort of display gives a good indication of quieting or noise content in a received FM signal.

We tuned to a relatively weak signal, using *The Beam Box*, with the BEAM DIRECTION switch and tuning controls set arbitrarily. Figure 3 shows the high level of background noise (lack of quieting) that resulted. We then optimized the BEAM DIRECTION, switched to the narrowband position, and tuned the tuning control on *The Beam Box* and the noise quickly diminished, as shown in Fig. 4. By way of comparison, we then connected a standard dipole antenna to the same tuner, which



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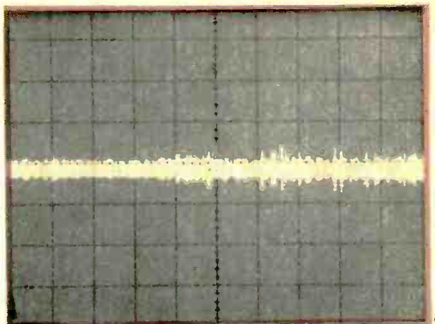

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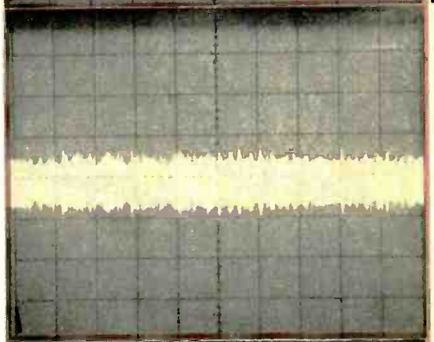

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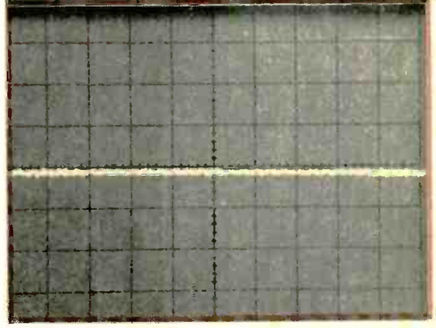

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remained tuned to the same frequency. Figure 5 shows the noise pattern that resulted, which was considerably greater than the noise pattern obtained when the properly tuned *Beam Box* was used. We then connected a six-element outdoor antenna, properly oriented by a rotator, and observed the noise pattern shown in Fig. 6. Obviously, if money is no object, such an installation would still outperform *The Beam Box*, as you might have guessed.

Our overall product summary is found in Table 2, together with summary comments concerning *The Beam Box*. For those who might wonder why we rated the price-performance ratio as excellent, the only thing that beats the performance of *The Beam Box* is a carefully installed, highly directional outdoor antenna. However, the cost of such an installation (including the price of the antenna and accessory parts, cable, mast and, likely a rotator if all your station signals originate from points about the compass) might well be double or triple that of *The Beam Box*. **R-E**

computer corner

Z-80 *A close look at the three different interrupts available in the Z-80*

WILLIAM BARDEN, JR.

LAST MONTH, WE LOOKED AT THE VARIOUS addressing modes of the Z-80. This month, we'll examine three different ways the Z-80 can be interrupted.

Interrupts

The Z-80 has two interrupt inputs—INT, which typically comes from an external device requesting I/O (*I*nput/*O*utput) service; and a nonmaskable interrupt, NMI. The nonmaskable interrupt is the least sophisticated of the two; so, NMI will be examined first.

The NMI interrupt *cannot* be disabled by the DI (*D*isable *I*nterrupt) instruction. This means that even if the NMI line to the Z-80 is brought to a logic 0 level, the CPU will *always* act on the interrupt. The NMI signals important system conditions that must be acted on immediately, such as system power failure or system reset. Whenever the NMI line is brought to a logic-low level by external circuitry, the CPU executes a RESTART instruction to memory location 0066H. You will recall that a RESTART instruction automatically saves the contents of the program counter by pushing it into the stack, and the RESTART instruction initiated by the NMI interrupt performs the same action. The NMI is not implemented in the 8080 microprocessor.

The INT interrupt operates in three modes, selected by prior execution of one of three special mode instructions—IMO, IM1 or IM2. For this type of interrupt to occur, the interrupt enable flip-flop must be set. The interrupt enable flip-flop is set or reset by two interrupt control instructions, EI and DI (*E*nable *I*nterrupts and *D*isable *I*nterrupts). As in the 8080-based and other microcomputers, there are times when interrupts are permitted and other times when interrupts must be inhibited. An obvious example of a time when interrupts must be disabled is when a previous interrupt has *just* occurred and is in the first stages of being processed. If a second interrupt was to occur while the status of CPU flags and registers is being saved in the stack, the second interrupt might destroy the previous contents of the CPU registers and status flags. Another example of an interrupt-disable period is when the system is first initialized. If an interrupt were allowed to occur before system devices were reset and initialized, a spurious or unexpected interrupt might result and be erroneously processed.

If an IMO instruction has been executed, the Z-80 is in mode 0 which is identical to the 8080 interrupt mode. If the interrupt enable flip-flop is set and signal $\overline{INT}$ is brought down to a logic 0 level, the CPU enters an interrupt state and signals the interrupting external device by the $\overline{IORQ}$ signal together with the $\overline{M1}$ signal. When the interrupting device receives these two signals, it responds and the Z-80 behaves in a fashion identical to the 8080. A RESTART instruction is jammed onto the data bus. Encoded within the one-byte RESTART instruction is a three-bit field with a value of 0 through 7 and the CPU transfers control to memory location 0, 8, 10H, 18H, 20H, 28H, 30H, or 38H, depending upon the value of the field (0, 1, 2, 3, 4, 5, 6, or 7). At the same time, the CPU saves the contents of the program counter in the stack. The eight locations typically contain jumps to interrupt processing routines elsewhere in memory, since eight bytes is not really enough memory to process most interrupts. At the end of interrupt processing, a Return (RET) instruction pops the address of the interrupted instruction from the stack and transfers control back to the main program at the point of interruption.

When interrupt mode 1 has been initiated by execution of an IM1 instruction, an interrupt on the $\overline{INT}$ input pin while the interrupt enable flip-flop is set causes a RESTART to location 38H. Why is this mode convenient? Because mode 1 needs no external hardware to jam the RESTART instruction onto the data bus at the proper time. The CPU automatically transfers control to the proper location, as in the case of the NMI interrupt. This mode is not implemented in the 8080 microprocessor.

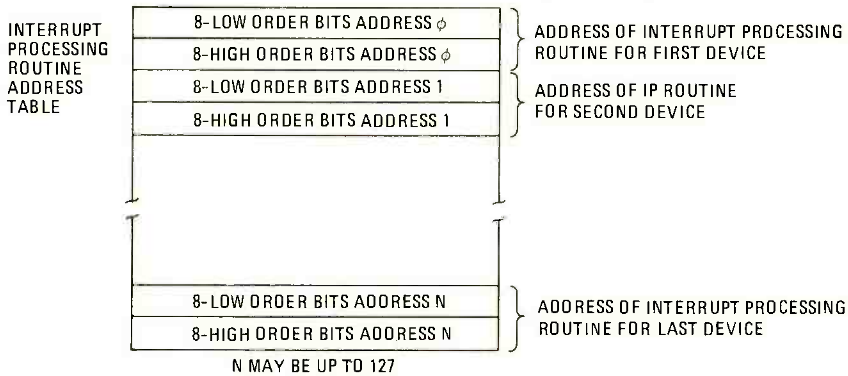


FIG. 1

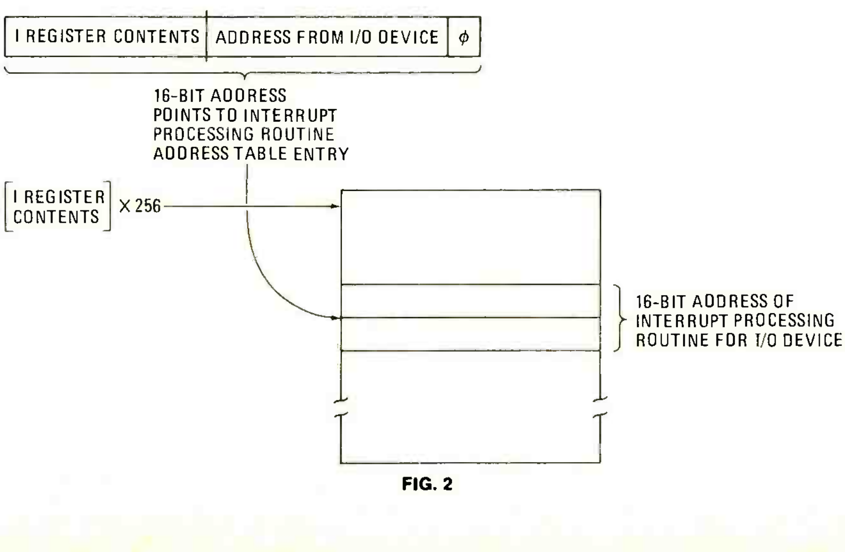
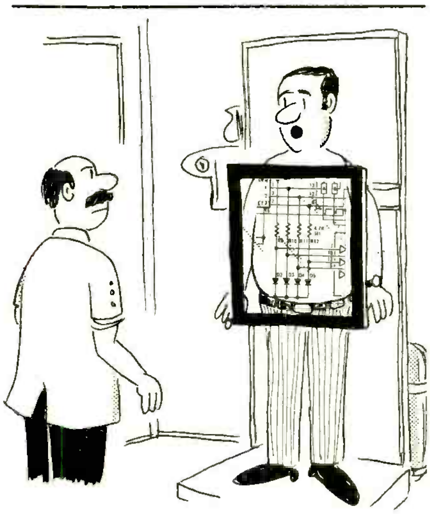


FIG. 2

The remaining interrupt mode, mode 2, is the most powerful interrupt mode of the three. Using this mode, up to 128 interrupt levels can be used in the Z-80 system. A table of addresses representing up to 128 interrupt processing routines is stored anywhere in memory. Figure 1 shows this table, in which each entry consists of two bytes representing the address of the interrupt processing routine. Register I is previously loaded with an eight-bit value representing the address of the start of the table divided by 256_{10}. For example if the table started at 2000H, register I would be loaded with 20H.

With mode 2 previously set by an IM2 instruction and the interrupt enable flip-flop set, an interrupt on the INT pin causes the same IORQ and M1 response as mode 1. The difference is that the interrupting device supplies an eight-bit value representing the lower-order eight bits of the interrupt vector, while register I supplies the eight higher-order bits of the interrupt vector as shown in Fig. 2. The CPU treats the two bytes as a 16-bit memory address and puts the contents of that memory address and that memory address plus one into the program counter, thus effectively transferring control to the interrupt vector address retrieved from the table. Note that the least significant bit of the address from the I/O device must always be a logical 0, so that the resulting address points to the first word of the interrupt vector table entry. Using mode 2, up to 128 external I/O devices could cause 128 unique interrupts with a subsequent transfer of control to 128 different interrupt processing locations. Obviously, external logic is required to properly establish the priority of these devices so that only one interrupt can occur at a time. Mode 2, of course, is not implemented in the 8080.

Next month, we'll discuss how to interface the Z-80 to I/O devices and to additional memory. **R-E**



"That's remarkable, Doc!—How'd you know that I'm an electronics technician?"

Hobby Computer Mainframes

THIS DIRECTORY GREW TOO LARGE TO FIT INTO A SINGLE ISSUE. So this concluding section had to be held over for this month. Before starting this section we have one correction and one addition to last month's section. The address for the Mits Division of Pertec was incorrect; the proper address is PCC Microsystems, 21111 Erwin St., Woodland Hills, CA 91367.

Also, some gremlins resulted in the listing for ECD not appearing in alphabetical order. So here it is now, at the top of this month's list.

ECD

Makes *Micromind*, an assembled ready-to-use machine with 8K of memory built around a 6500A microprocessor. Comes complete with an 80-key software definable keyboard; I/O interface board; high-detail graphics and character display processor; power supply, RF modulator and connections for up to four tape recorders plus TV or monitor. Price, $987.54. Available from ECD Corp., 196 Broadway, Cambridge, MA

Southwest Technical Products

Complete line of hobby computer equipment. Includes 6800 computer complete with 4K of memory. Kit, $395. Additional memory, $100 for 4K; $250 for 8K. Terminal monitor CT-64 features 64-character lines, upper-and-lower-case letters, switchable control character printing, word highlighting, full cursor control, 110–1200 Baud serial interface. Kit, $325; 12-MHz monitor, $175.

MF-60 dual mini-floppy kit with controller, chassis, cover, power supply, two disc drives, $995. MF-6X kit expands unit to four drives, $850. Other peripherals include PR-40 alphanumeric line printer that prints 40 characters per line at 75 lines-per-minute. Price, $250. Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, TX 78216

Space Byte

A single-card self-contained 8085 CPU for the S-100 bus. Operates at 3 MHz using 450-nS memory. Two on-board RS-232C serial I/O ports with software-selectable Baud rates. Also 16K RAM boards with on-board voltage regulators for S-100 systems. Prices not available. Space Byte Corp., 1720 Pontius Ave., Suite 201, Los Angeles, CA 90025

Spectrum 8

Complete in one cabinet, this computer system includes 8085 microprocessor, video terminal that produces 80 characters by 24 lines, cassette drive unit, keyboard and software and 16K RAM. Price, $2195. Spectrum 8, 3750 E. Foothill Blvd., Pasadena, CA 91107

STM Systems

Baby I microcomputer you can fit into an attache case. 6502-based system with 2K of RAM $850, assembled only. With 4K RAM, $1000. 4K RAM add-on, $205. Floppy diskette drive with power supply and controller, $750. STM Systems Inc., P.O. Box 248, Mont Vernon, NH 03057

Szerlip Enterprises

No main frame here, only a PROM setter for 1702A and 2708 PROM's. Plugs into S-100 computer. Complete kit, $210; assembled, $375. Szerlip Enterprises, 1414 West 259 St., Harbor City, CA 90710

Technical Design Labs

ZPU card for S-100 bus machine features Z-80 microprocessor with two on-board clocks. Kit, $269; assembled, $345. Z16 memory module with 16K on board, but can be purchased in 4K increments. Uses 4200 memory IC's. 4K kit, $169; 8K, $295; 12K, $435; 16K, $574; 4K expansion kits, $140. Systems monitor board, $295 for kit, $395 assembled. *Xitan* microcomputer systems. *Xitan Alpha 1* mainframe with ZPU board, system monitor board $769 for kit, $1039 assembled. *Alpha 2* expands *Alpha 1* by including Z16 memory module and software package. Kit, $1369; assembled, $1749. Technical Design Labs, Research Park, Building H, 1101 State Rd., Princeton, NJ 08540

Technico I

Single board 16-bit 9900 microprocessor. Just hook up power supply and terminal. Kit, $299; assembled, $399. Comes with 1K of PROM, 512 bytes of RAM. Expands on-board to 6K, can address up to 32K words. Technico, Inc., 9130 Red Branch Rd., Columbia, MD 21045

Telpar

Model PS-40 printer offered as a silent Teletype alternative. Offered with multifunction interface (F-8 microprocessor). Assembled only, $400. Power supply, $100; case, $100. Telpar, Inc., 4132A Billy Mitchell Rd., P.O. Box 796, Addison, TX 75001

Thinker Toys

Developers of the *WunderBuss*, a 20-slot S-100 busboard that includes a *Noiseguard* noise-squelching system. Kit, $76, with 10 edge connectors, $120; with 20 edge connectors, $154. Also available: an 8080 CPU/front panel kit, $250. Speakeasy I/O board kit (three cassette channels, parallel and serial ports), $120. 8K dynamic RAM kit, $159; assembled, $188. 4K static memory kit, $109. Thinker Toys, 1201 10th, Berkeley, CA 94710

TLF

Assembled microcomputer with 8K of memory, 2K of control PROM, tape controller, buffered external bus and 110 Baud serial interface. Fully assembled and tested for the *Mini 12*, a 12-bit machine, $895. A 24-line parallel interface also available. Digital cassette storage system complete with two tape drives, $795. TLF, P.O. Box 2298, Littleton, CO 80161

Vector Graphic

Hobby computer systems and accessories, including *Vector 1* computer consisting of custom cabinet, 18-slot motherboard S-100 bus, power supply, 8080 CPU board, PROM/RAM board with 1K RAM, room for 2K ROM. Kit, $619; assembled, $849. 8K memory boards assembled, $265 and $275. Vector Graphic, Inc., 790 Hamshire Rd., Westlake Village, CA 91361

Xybek

A *Prammer* memory board on an S-100 bus card. Contains up to 1792 bytes of EPROM, 256 bytes of RAM, an integral EPROM programmer. Kit, $209; assembled, $289. Extension kit, $15. Xybek, P.O. Box 4925, Stanford, CA 94305 **R-E**

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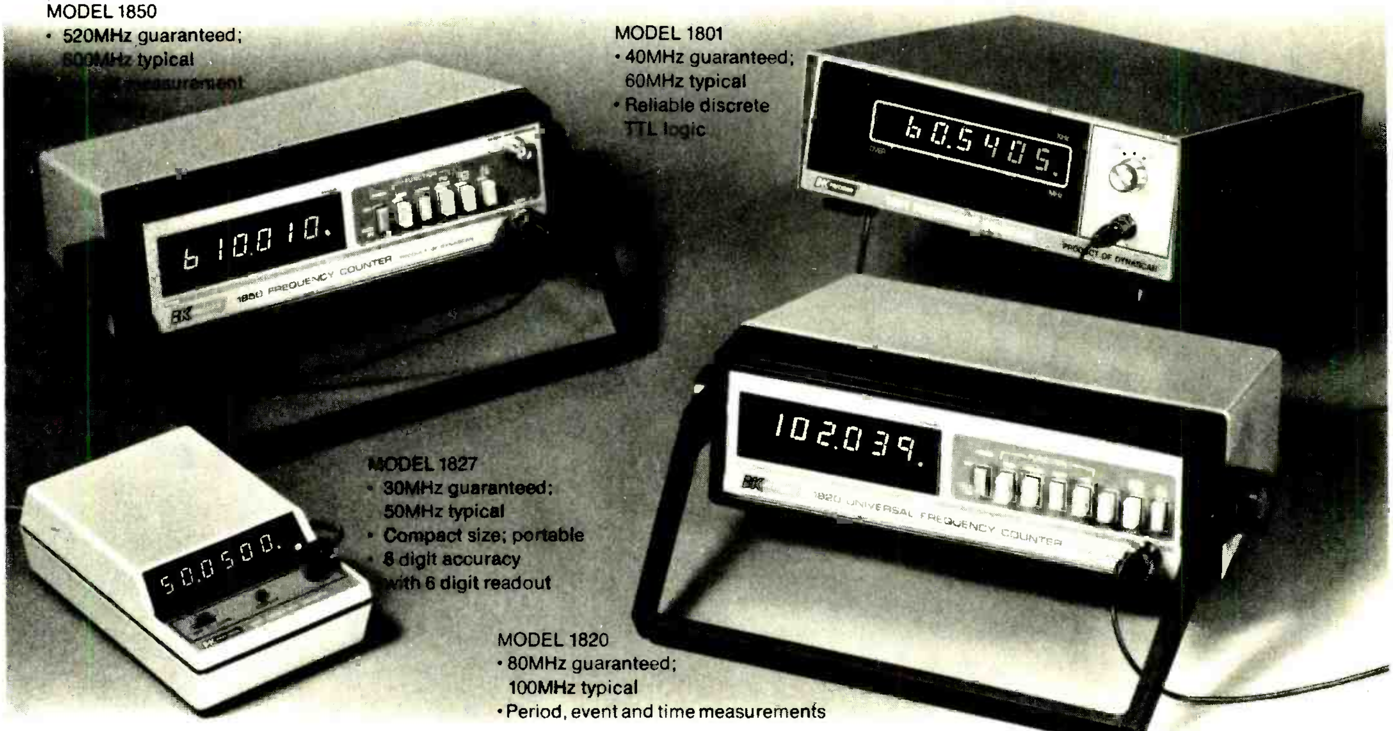

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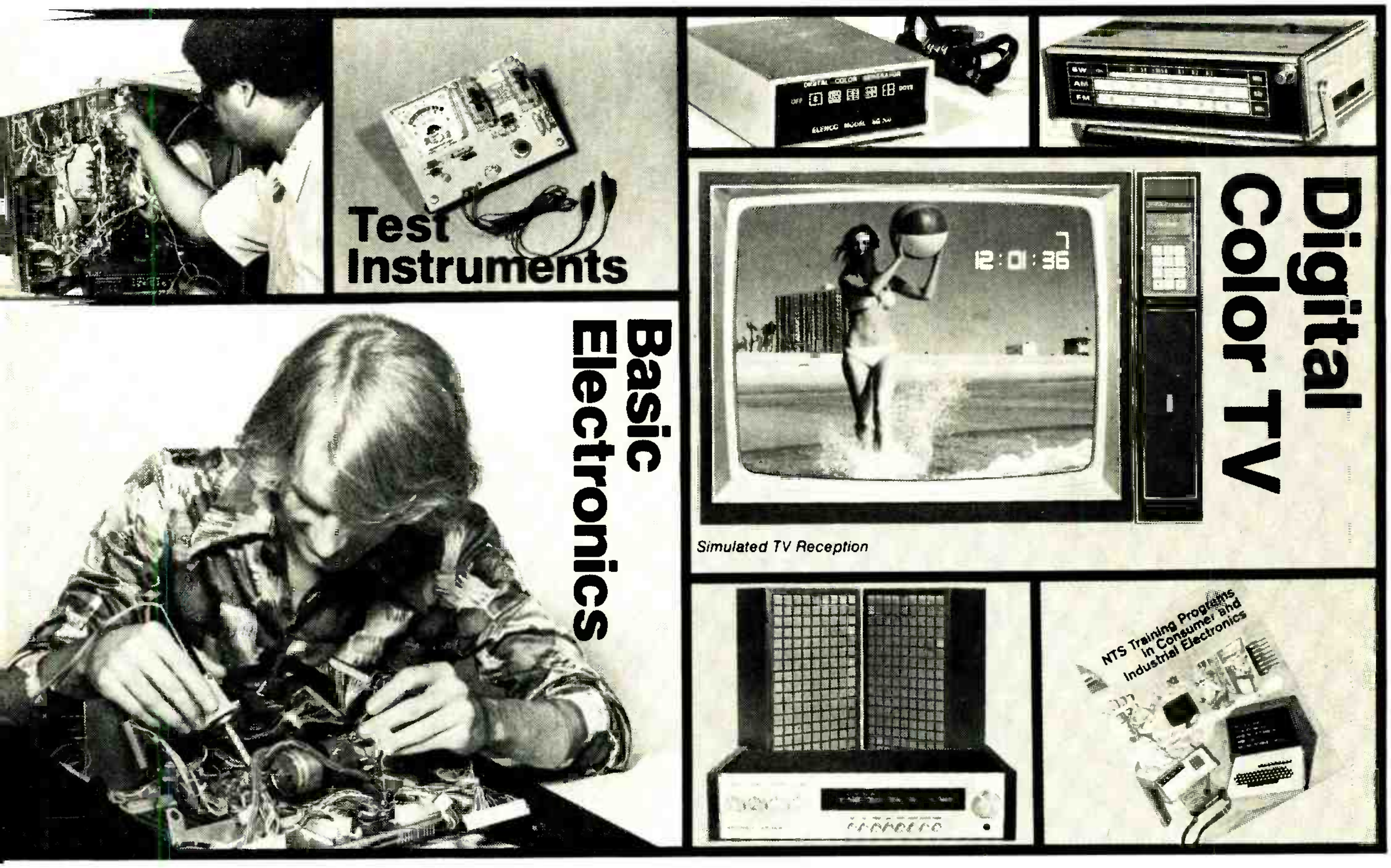

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hobby corner

A basic game roller or chase circuit that's the basis for many games. Plus some simple modifications to change the odds.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

YOU KNOW, HALF THE FUN OF THIS ELECtronics hobby is building a circuit and then seeing what else you can make it do. This month's circuit can be changed in a number of ways.

Many games require a spin of a counter or a toss of the dice to determine the order of play and/or the number of moves per turn. Here is a circuit that will do that job at the push of a button. The parts are few and inexpensive and construction is within the capability of virtually anyone. We'll start with a basic circuit and then change it around.

Game circuit

The basic game roller circuit shown in Fig. 1 uses only three IC's. The 555 timer, an astable multivibrator, produces a very rapid series of pulses whenever switch S1 is open. These pulses are counted in groups of 16 and converted into binary form by the 7493.

Now if you have the facility of reading binary numbers quickly, you could stop with the 7493 and simply put an LED on each output line. Most of us, however, take too much time to convert mentally from binary to decimal numbers, so an electronic converter is added. The 74154 is a 1-of-16 decoder/demultiplexer that is wired here so that each of its 16 output lines goes low sequentially and in step with the binary count delivered by the 7493. When the switch is closed, only one LED remains on. It is only necessary, then, to determine which line is low by noting which of the 16 LED's is glowing. Notice in the schematic that only one current limiting resistor (R3) is used for all the LED's since only one is on at any one time.

Thus, Fig. 1 is a spin counter that indicates any number from 1 to 16. The clock is designed to be fast enough so that the number on which the count stops is quite random. In fact, the LED's are switching on and off so fast that they all appear to be glowing dully. For this reason, the player cannot make the count stop where he would like.

The speed of the clock can be changed easily. Reducing the value of C1, R1 or R2 will *increase* the rate. Increasing one of these values will decrease the rate. You may wish to substitute a pot for R2 to make it easier to change the frequency (a 250K pot will provide a wide adjustment range).

Adaptations

Another interesting use for this circuit is to make a "traveling light" sign. If you line up all 16 LED's and slow the clock, it appears that the light is traveling down the line. Additional LED's would make the device even more eye-catching.

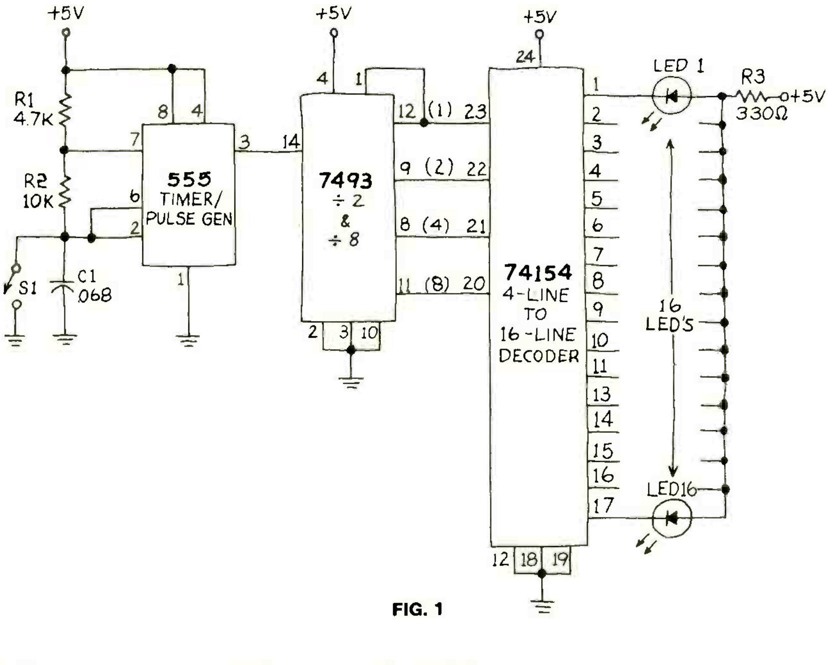


FIG. 1

Fortunately, it happens that each output pin of the 74154 will carry a number of LED's. Since each LED you add will increase the current only about 0.1 mA, you don't even need more limiting resistors. Use two or more LED's on each output and connect them as shown in Fig. 2. (Figure 2 shows the connection for output pin No. 1 only. The other output

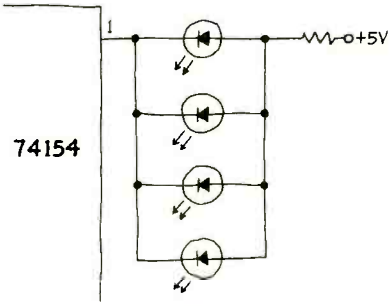


FIG. 2

pins are connected similarly.) The only caution is that you may have to match the LED's on each output. If one LED draws all the current (and light) from the other LED's on the same output, put it on another pin where it is more evenly matched.

Now arrange your LED's in a 1–16, 1–16, 1–16, etc., order. If you have 4 LED's on each pin, it will appear that 4 lights are traveling down the line. Of course, the display is made more interesting if you form a circle or rectangle or some other shape. By turning the pot you've substituted for R2, you can vary the speed with which the lights move.

So far, we have done nothing to change the probabilities or odds that one number (LED) will come up any more often than another. There has been an equal chance for every number. The following modifications will change that.

First, let's connect two outputs together as shown in Fig 3. A low level at *either* output pin No. 1 or No. 2 will light *both* LED's. If both of the LED's represent numbers, your rule of play could call for

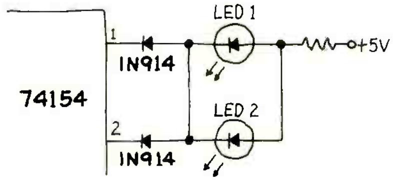


FIG. 3

continued on page 79

is *increased* by 50%. edge of a workbench or surface up to 4 *all work guaranteed 30 days!"*

service clinic

Vertical OTL (Output TransformerLess) output stages adapted from audio amplifier technology—how they work and how to troubleshoot them.

JACK DARR, SERVICE EDITOR

MANY SOLID-STATE TV SETS USE COMPLEmentary-symmetry and stacked ("totem-pole" or quasi-complementary-symmetry) vertical output stages. Basically, these stages are alike, but in the complementary-symmetry stages, transistors of opposite polarity are used. There are variations in the DC power supply, but the circuit operates the same. The advantages are obvious. The circuits don't need a big, expensive vertical output transformer, because they're all OTL (*O*utput *T*ransformer*Less*) circuits.

These simple circuits can develop some peculiar symptoms. For instance, how about a vertical sweep that covers only the top or bottom half of the raster, yet is perfectly *linear*?

The OTL circuits are the same as the output circuit used in so many audio amplifiers, with minor differences. They work in Class B. Each transistor conducts on only one half-cycle of the input signal, and cuts off completely on the reverse-polarity half. One transistor sweeps the top half of the raster and the other transistor, the bottom half. Therefore, the reason it is possible to have a linear half-raster is that one transistor isn't conducting at all! This is usually due to an open transistor or a bad connection.

How it works

A typical example of this comes from the Admiral M45 chassis and is shown in Fig. 1. Note the waveforms in the upper right-hand corner. The top and bottom waveforms (waveforms *a* and *c*) taken across the emitter resistors show very clearly how first one then the other transistor conducts. The center waveform (waveform *b*) is the combination of the top and bottom waveforms, taken to ground from the junction of the emitter resistors where the vertical yoke is connected.

Since the first two signals were taken across a resistor, the voltage peaks are directly proportional to the current through the resistor and yoke winding. These transistors are termed the top ramp and bottom ramp vertical output transistors because they generate a ramp voltage (linearly rising sawtooth), and the two together give the complete sawtooth that is needed to scan the whole screen.

During the top half of the scan, the top transistor is turned on, and the bottom transistor is cut off completely. In the middle of the screen, the top transistor is turned off, and the bottom transistor finishes the job.

The following question has puzzled many technicians, present company included: The top transistor is connected to B+ (145 volts). Current flows through it and the yoke. If this current is cut off during the bottom half of the scan, from what source does the bottom-half transistor get its DC voltage supply?

The answer is simple. Note capacitor C606 (220 μF) in series with the vertical yoke return to ground. While the current flows through the top transistor, capacitor C606 *charges*. When the top transistor cuts off, capacitor C606 discharges through the bottom transistor, and away we go.

This is only one valuable clue in finding problems. If the DC power supply is normal, both transistors are good, but you *still* have no vertical sweep, check the capacitor to see if it is open. Not only will you lose the DC voltage at the midpoint, but the vertical yoke winding will have no return to ground. In normal operation, you will read about +59 volts DC at the junction of the output-transistor emitter resistors. The middle waveform (waveform *b*) in Fig. 1 is a pulse sawtooth waveform with a voltage of about 100 P-P. Your meter reads this voltage as the charge on the capacitor, therefore it is lower.

As in the audio circuit, the crossover (the midpoint in the cycle where the transistors switch conduction) is very important. In audio, you can have a little crossover distortion and maybe not hear it, but you can *see* it in a raster. Several different networks are used in these circuits just for this purpose. Figure 1 shows a familiar circuit: the two series diodes between the output bases correct the bias ratio and provide turn-on and turn-off at just the right time.

A feedback loop taken from the yoke connection (junction of the emitter resistors) is fed back into the first stages for S-correction. This corrects any tendency of the predriver stages to be nonlinear or show a droop in the rising part of the sawtooth. Note also that the vertical yoke winding does not go directly to ground through the return capacitor. A small sawtooth voltage is picked off across a small resistor (R615 and R616 in paral-

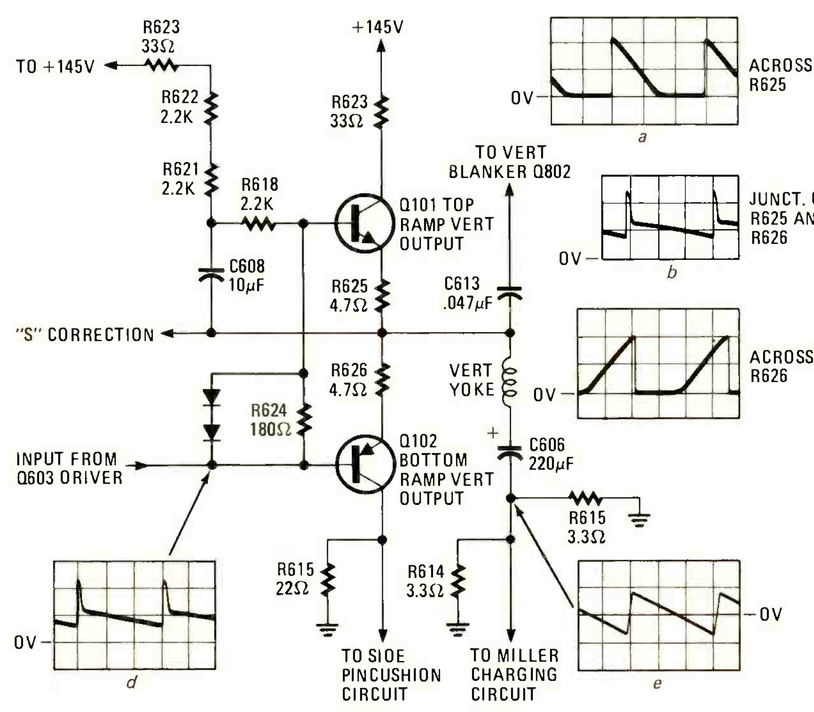


FIG. 1

lel); this is fed back into the Miller charging circuit used in the vertical oscillator circuit, which is not shown in the Fig. 1 diagram.

This circuit develops a very linear sawtooth waveform. The correct signal, shown in waveform *e* of Fig. 1, is a voltage waveform taken across a resistor again so that it is directly proportional to the yoke current.

DC voltage readings plus raster observations help greatly in finding circuit troubles. Check all of them, especially the DC voltage at the junction of the output-transistor emitters. This voltage will read about +59 DC. If this reading approaches normal, the output stages are probably working.

Another odd problem affecting linearity occurs if bootstrap capacitor C608 in the base of the top transistor (Q101) is open. Capacitor C608 provides a little regenerative feedback to raise the gain of transistor Q101. Other linearity problems can be caused by a drift in the value of resistors in the feedback loops or by open bypass capacitors, etc.

You can use a scope to check the waveforms for amplitude and distortion and determine just where the trouble lies. Follow the feedback loops back to where they are used, and you can pin down the cause of any distortion very quickly.

The OTL circuit uses a single-ended DC power supply; the clue is that one of the output transistors always goes to ground. Another clue is the big coupling capacitor (C606) in series with the yoke winding. This will hold true whether the circuit is complementary-symmetry, a "totem pole" using identical NPN or PNP transistors, or a quasi-complementary-symmetry circuit using identical output transistors and complementary-symmetry drivers.

You will also find the same circuit using dual-polarity DC power supplies, which is almost always used with complementary-symmetry transistors. This circuit will *not* have a big yoke-coupling capacitor; the yoke returns directly to ground. Equal and opposite DC voltages are supplied to the output transistors. A circuit similar to the one shown in Fig. 1 would probably show something like +60 volts on the top (NPN) transistor collector, and −60 volts on the bottom (PNP) transistor. These are ballpark figures, or course, since the actual voltages depend on the design, type of transistor, screen size, etc. What is important to remember is the *ratio* between the DC voltages, bias voltage and so forth. Another handy hint is to check all the controls for *reaction*. If you find one that has no reaction at all or an incorrect reaction, check the circuitry around this control thoroughly and find out why.

An OTL is a good circuit, and one in which it is not at all hard to diagnose problems, if you know how it works and what it does when it isn't working! **R-E**

service questions

NO BOOST VOLTAGE

I can't get any boost voltage on this Admiral H1-1A portable. The tubes are good and supply voltage is normal. Any idea?—G.V., E. Hartford, CT

Check the deflection yoke. If it has a light blue plastic mount and is marked "Made In Taiwan," it could be bad as many of these have been.

(Confirmed by reader!)

HIGH-VOLUME SPEED LOSS

When the record is first started on this Panasonic SG-635, everything is fine. When a loud passage comes in, the turntable slows away down! I don't get it!—H.K., Garrettsville, OH

I didn't either until I looked at the schematic. The turntable motor is not driven from the AC line, but from the DC power supply. Apparently it has enough output to keep the turntable running until the amplifier starts to draw more current. This is normal; this type of amplifier takes only small currents no-signal, but current drain goes up drastically on loud passages.

Check the DC power-supply output and motor voltages. They are regulated. You should read 9.1 volts at the power-supply output (at all times) and +3.25 volts across the motor and on the regulator-transistor collector. There may be very low or open input filter capacitor in the DC power supply.

SUDDEN COLOR CHANGE

This Truetone WEG-4419A-47 will intermittently change color to a reddish, bluish, etc., raster. It's never shown the same color twice. The voltage-regulating transistor runs hot, and the DC voltages are off. The +30.7 volt line is only about 20. Also, while checking, my probe slipped and I blew the Zener diode ZD601. Since I can't find a replacement, I could use help.—M.D.O., Mena, AR

Get those DC voltages back up to normal, and your problem will probably go away. The Zener diode is shown as a 31-volt type, but an RCA SK-3095 will replace it. Check the regulator transistor. This can be replaced by an RCA SK-3054. Also, don't overlook the "Regulator Protector" (error-amp) transistor Q602; an SK-3124 will replace this.

The 30.7-volt line feeds the color amplifier transistors. If this voltage is quite low, these transistors will clip the signal badly and distort the colors. Heat-related shifts in the regulated DC voltage cause changes.

TUBE HEATER OUT

Although I have high voltage, sound and so on, I can't get the screen to light on this Sony TV-500U. The picture-tube heater doesn't show any glow; is it supposed to?—C.V., Jessup, PA

This isn't one of those tubes with "dark heaters." I'd say it should definitely show a light. The circuit uses a small tertiary winding on the horizontal *driver* transformer to supply the picture-tube heater. Since you have high voltage, this transformer ought to be good. Check that winding for the voltage, which will be AC. Check the continuity on the picture-tube base, from pin 1 to pin 3, the heater terminals. Try hooking a small 12-volt bulb across the driver transformer tertiary; if the bulb lights up, then the picture tube is open.

POWER TRANSFORMER NEEDED

I need a substitute power transformer for an amplifier made by Aims Amplifiers, Inc., which is not in business any more. This model "Dual Twelve" has two 12AT7's, four 7025's, and two 6550's, and is rated at 120 watts into 4 ohms.—W.M., Newark, DE

From the schematic you sent, plus the ratings on the tube manual, this should be fairly easy. It seems to have a bias winding on the high-voltage secondary, which would be normal for a high-power amplifier using 6550's. I'd recommend using a Thordarson 24R38.

However, the 6550 tubes listed in GE's tube manual are rated at 20 watts *per tube.* This should be about 40 watts push-pull, not 120 watts! Sounds like someone was being a touch optimistic with power ratings. (If so, no wonder the power transformer blew out.)

TRACE PROBLEM

I have a trace problem in a Precision ES-550 scope. After about half an hour, it broadens until the intensity and focus controls won't correct it. What's doing this?—A.M., Lowell, IN

Look at the network of high-value resistors from the high negative voltage supply, to the intensity, focus and astigmatism controls, to ground. Some of these resistors are probably off value. If the 1.0-megohm resistor between the slider of the INTENSITY control and the CRT cathode has gone away up in value, it will cause the symptom you describe.

This is obviously a thermal; you can speed up the process by heating up each resistor with a soldering iron, after a cold start. Alternate: Cool each one after the trouble shows up.

CHECKING OLD TUBES

I'd like to know how you can check the older tube types, like Nos. 80, 43, 45, etc.,

in a late-model tube tester.—K.F., Raleigh, NC

With great difficulty! It is true that these are "only tubes," pentodes, etc. But you'd have to make up a socket panel and then connect it to your present tube tester. You'll have to identify the plate, grid, cathode, etc.

An easier way is to check them in-circuit. For example, if there are 250 volts AC on the plates of an No. 80 tube, but only about 100-volts DC output, the tube is weak or the input filter capacitor is open.

The same thing applies to any amplifier tubes. If the plate voltage is *too high* (supply voltages and load resistors normal), the tube is low in emission. Check the grid voltage to make sure the tube isn't biased-off. (Watch out for tubes like the 45's, which used a very high bias, up to 30–40 volts negative on the grids!).

HORIZONTAL OSCILLATOR

This GE FS-chassis portable won't light up every time it's turned on. However, once you touch anything in the horizontal oscillator circuit, it starts. After it's going, it never stops. What is causing this?—M.M., Chicago, IL

The schematic shows this is the same Colpitts circuit used in several other portable makes. The most common cause of this symptom is the two capacitors across the oscillator coil: C262/C263, .0027 μf and .0068 μf. Try new ones in here.

(Feedback: "These capacitors were both good on the test. However, an eyelet in the PC board at one end of C263 wasn't very good! Same results. Thanks.")

NO VERTICAL SWEEP

This T935 Magnavox came in with no vertical sweep. A new tube didn't help. The DC voltage was very low on the input half-plate. I can inject a signal to the half-plate and get full sweep, floating. All resistance readings look good.—L.N., Philadelphia, PA

All vertical multivibrator sweep circuits are basically the same: A two-stage RC-coupled *audio amplifier* with its tail in its mouth. Translation: A very heavy feedback from output to input to make it oscillate. Since the "amplifier" is obviously working, the problem is one of the parts in the feedback loop.

(Feedback on the feedback: "Yep. Capacitor C410, 0.001 μf to ground, had shorted.")

OUTPUT TRANSFORMER SUB

I need a substitute for the output transformer in an old Motorola record-player console. The part number is 25C60394A03-E. I've checked with the local distributor and parts houses; no luck. Can you help?—L.B., Narragansett, RI

A Triad S-55X is an exact duplicate for that part number.

Solid-State Update

Microcomputers

Microkit has produced the M8-40 *Microemulator* and M8-41 Debug and EPROM programmer as a $1,250 package.

The *Microemulator* plugs into a CPU socket. It can be used for debugging development systems, production testing and maintenance of microprocessor systems in their own environments. The system has a monitor; emulator mode; single step and trace execution; hardware breakpoints; and 2708/2704 EPROM programming.

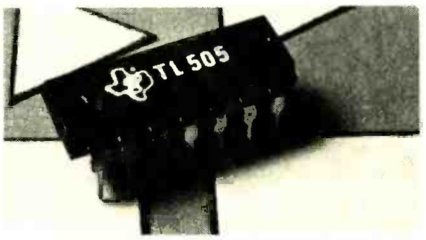
The programmer is available for 8080, 6800 and Z-80 microprocessors. Microkit, Inc., 11205 S. La Cienega Blvd., Los Angeles, CA 90045.

The Signetics 2651 Programmable Communications Interface (PCI) is a combination Universal Synchronous/Asynchronous Receiver/Transmitter (USART) and baud rate generator that is compatible with the 2650, 8080, Z-80 and 6800 microprocessors.

The USART function takes the parallel output data of a microprocessor and converts it into a serial bit stream. Received serial data is converted into a 5- to 8-bit word for entry through the microprocessor's data bus. Asynchronous false starts caused by noise are detected, and the number of start bits, and odd, even or no parity selection is implemented. Baud rates from 50 to 19.2 kilobits-per-second can be program-selected.

The 2651 interface should prove useful in intelligent terminals, communication controllers, data concentrators and front-end processors.

Texas Instruments' TL505 is an A/D converter designed to work with microprocessors such as the TMS1000 in such applications as high-impedance sources, weight scales, and thermal, light and moisture sensors.



The TL505 has 0.1% accuracy, on-chip reference voltage, auto zero and high-impedance MOS inputs. Three-digit BCD conversions are completed in 500 ms by the TL505/TMS1000 combination.

Microprocessors

There have been some recent developments in National Semiconductor's SC/MP 8-bit and PACE 16-bit microprocessors. First, for those who cannot see the logic of hooking a $3000 terminal to a $100 evaluation/development board, a new low-cost SC/MP keyboard kit has been developed. The calculator-like device has a keyboard with hexadecimal and system control keys, and a built-in six-digit hex display. The buffer, decoder and driver circuits mount on the empty portion of the SC/MP kit board. A new ROM replaces the original kit bug ROM.

The ABT (abort) key terminates the command in process and returns the system to a wait loop. The MEM key displays the next memory address and its contents. The TERM key terminates the present mode and then enters data at specified addresses. And the GO key followed by

TERM begins program execution at the last referenced address.

The price of the ISP-8K/400 keyboard kit is $95, including a hand-held wire-wrap tool.

National has also released the $499 ISP-8P/301 low cost development system for the SC/MP microprocessor. The basic LCDS system comes with a 16-key hex keyboard, three control switches and a six-digit hex display. The CPU card supplied with the system plugs into one of four available sockets.

Programs can be entered, examined and run in continuous or single instruction modes, and can operate through a teletype using SC/MP DEBUG.

National's SC/MP II, which is an N-channel version of the older P-channel microprocessor, is twice as fast and uses only one-fourth the power of the earlier type. Only a single +5-volt supply is needed as compared with the +5- and −7-volt supplies used by the PMOS microprocessor. Typical instruction execution time is 5 μs.

The PACE 16-bit microprocessor costs $20 ordered in quantities of 100, and $13 in 5000 lots. These prices represent a 50% price reduction, and prices are expected to drop even more in 1977. The cost of the PACE microprocessor is now one-half that of the General Instruments microprocessor and one-fourth that of the Texas Instruments device.

National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, CA 95051.

Watch circuits

RCA has three new CMOS timing circuits for liquid-crystal watches, the CD22001H, CD22002H and CD22003H.

The first two are two-button, five-function circuits that display hours, minutes, month, date and seconds on a $3\frac{1}{2}$-digit display. The CD22002H can be reset by pressing both switches simultaneously. This resets the watch and disables the high-voltage (4.5 volts) display supply for minimum current drain during storage. The CD22003H also includes a 15-minute stopwatch.

The RUN II mode displays alternating hour/minute and month/date. Thirty and 31-day months are corrected automatically, but February is fixed at 28 days so that resetting is necessary only during leap year.

Schottky TTL's

Motorola has signed a second-source agreement with Fairchild Camera and Instrument Company that provides for a technology exchange.

Motorola plans to produce low-power Schottky TTL products; while Fairchild will second-source Motorola's M6800 microprocessor.

Motorola has been successfully making

Turn page

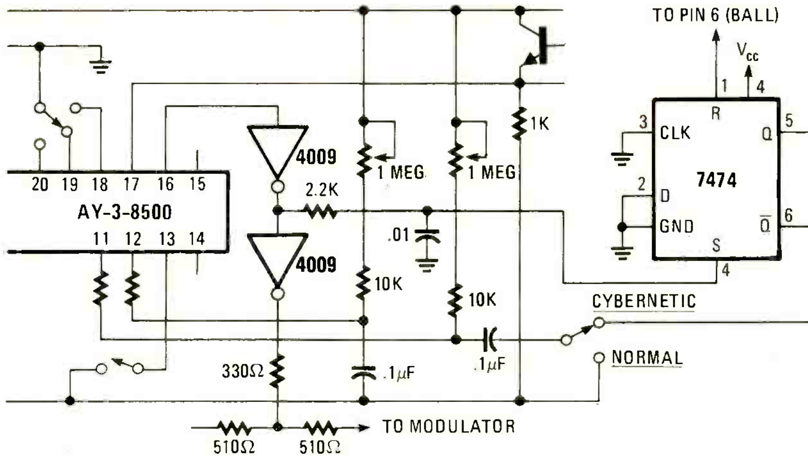


FIG. 1

selected Schottky devices to prove compatibility with Fairchild's LS process, and now plan to produce all Schottky LS products offered by the industry as well as introducing new devices.

BIFET op-amps

Texas Instruments has added four new devices for a full line of five BIFET operational amplifiers. The devices have a high slew rate, low input bias and offset current and offset voltage selection.

The TL080 and TL081 are single amplifiers, that have offset-voltage null capability. The TL081 includes internal frequency compensation.

The dual TL082 and TL083 types have internal compensation, and the TL083 has offset voltage nulling.

The devices add to the previously announced TL084 quadruple operational amplifier. Commercial prices range from 52¢ to $1.30 each in 100 quantity.

Game modification

Those who have been following game circuit developments are no doubt aware of the General Instrument AY-3-8500 TV games IC. Figure 1 shows a modification (courtesy of R. Dowden, Ashland, VA) that lets you play against the machine in the so-called "cybernetic mode." With the switch in the cybernetic position, the ball output on pin 6 of the AY-3-8500 is connected to the reset input of the D-type flip-flop and the filtered junction of the two 4009 inverters is connected to the set input of the flip-flop. The flip-flop is set on each vertical sync pulse and reset by the ball pulse. The output then has a pulse width that is proportional to the vertical deflection of the ball. The complemented output of the flip-flop connects to the return side of the paddle position capacitor and switches it to ground whenever the flip-flop is set. This automatically controls the right-hand paddle to keep it in the same vertical position as the ball.

Using the capacitor connected to the right-hand paddle on pin 11 permits initial adjustment by using "Pelota," one of the IC's six games.

The paddle potentiometer varies the skill of the machine and creates a weak left-side handicap. **R-E**

FOCUS PROBLEM

The picture tube in this Magnavox T935-04 was replaced with an 18VAKP22. Now I can't get any focus. There are three taps on the chassis: +550 volts, +280 volts and ground. It won't focus on any of them!—L.N., Philadelphia, PA

There are two *different* types of picture tubes used in this Magnavox series. Some use the "standard" bipotential tube (25kV high voltage, 5kV of focus), but others use a low-focus voltage Einzel-lens tube.

The 18VAKP22 is a bipotential tube and needs 4 to 5 kV for focus. If you add the stock focus-dropping network it should work. Use the flyback modification kit, No. 171321-1, which uses a voltage tripler.

FM INTERFERENCE TV

I'm an engineer at an FM stereo station operating at 3.2 kilowatts on 97.7 MHz. We were getting complaints from residents that we were upsetting Channel 10 with our second harmonic. We took the station off the air until we could get this checked. The measured second harmonic at the transmitter was something like *100-dB* down!

After much searching, the cause of the problem was found. Broadband TV antenna boosters were being overloaded. The input stages were actually being driven into Class C and doubling our carrier! This not only created problems for the user but it radiated into neighbors' sets.

The cure was to install FM traps between the antenna and the booster input; boosters with built-in FM traps also worked well.

(Many thanks to Tim Metzger, Jewett City, CT, for this information.—Ed.)

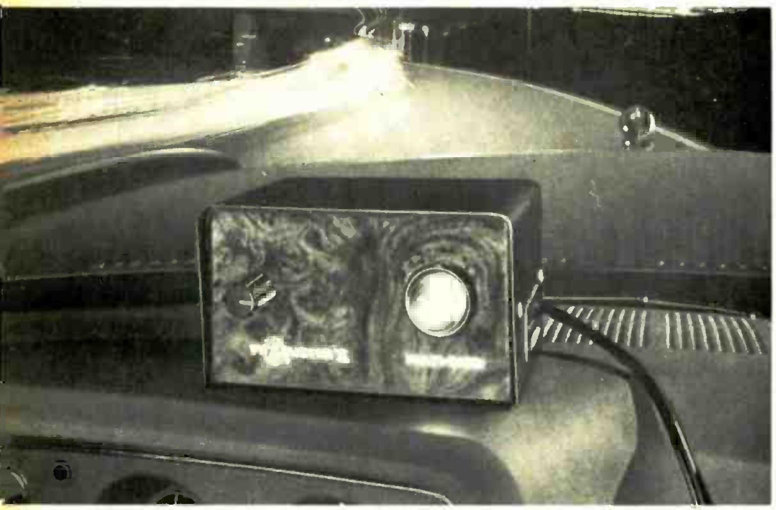
SUB FOR TRANSISTOR

This Sears 518.41960357 chassis blows the 1.5-amp fuse. Transistor Q500 seems to be bad. I can't find a listing for it. I ordered one from Sears but haven't heard from them yet. Can't find any shorts in the DC voltage supply.—W.G., Kingston

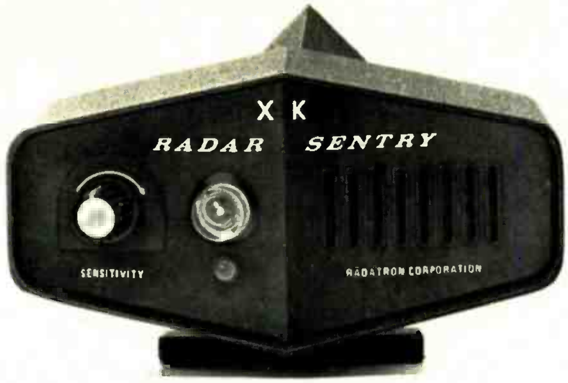
Transistor Q500 is not bipolar! It's a PUT (*P*rogrammable *U*nijunction *T*ransistor). Sylvania shows it under the OEM part number and says to use an ECG-6402 (which *is* a PUT.) The key is that the *gate* goes to the anode, not to the cathode as in an SCR (*S*ilicon *C*ontrolled *R*ectifier).

There is another PUT in the DC regulator circuit. It gates on the SCR to control the +114-volt supply line. I suggest you monitor the +114-volt line. If it goes too high, this will make all the circuits fed from it take too much current, thus possibly causing the blown fuse. We have heard from other technicians who have run into PUT's; one said he had checked it every way he could think of, but when he *changed* it, that fixed it!

Police-Radar Detectors



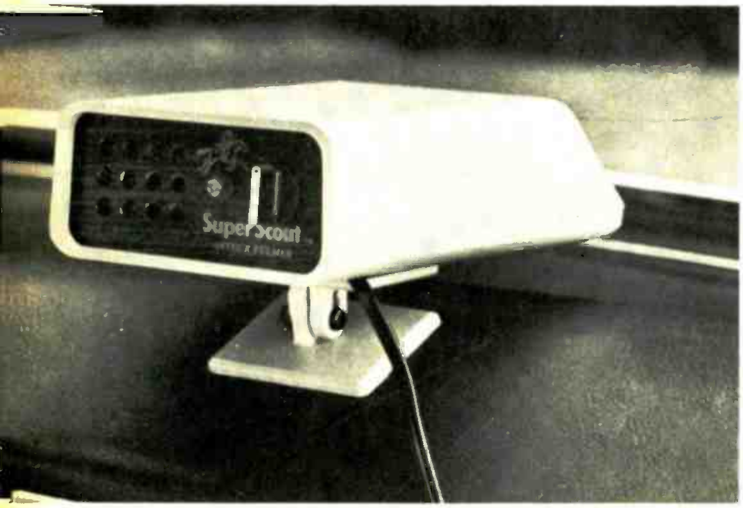
ELECTROLERT FUZZBUSTER II is a multiband detector that covers both the X and K bands. It sells for $129.95, mounts on the dash and plugs into your cars cigarette lighter.



RADATRON XK RADAR SENTRY is two-band unit. Offers both visual and audio warnings; has front-panel sensitivity control.

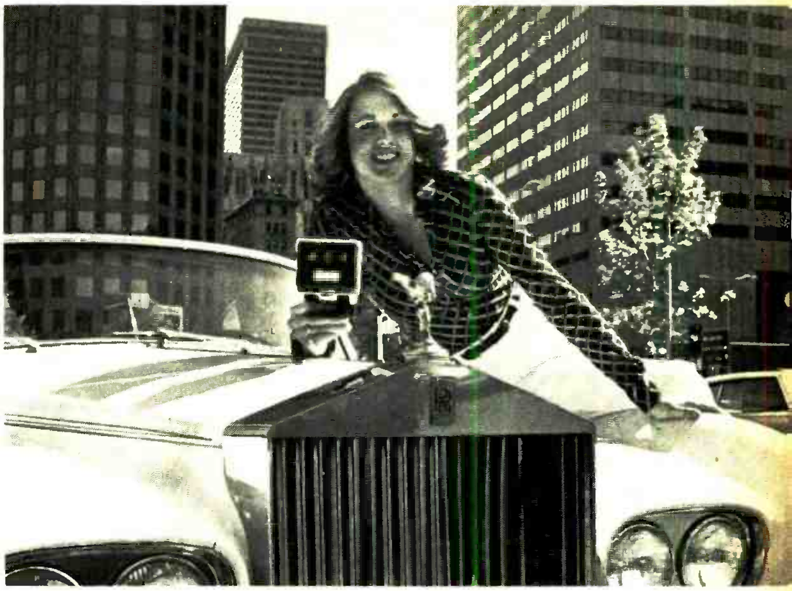
TYPICAL POLICE RADAR UNIT. The antenna can be remotely positioned when necessary. It reads out directly in MPH.

ARTHUR FULMER SUPER SCOUT also covers both K and X bands. Plugs into lighter or permanently wired in with supplied connectors. Red light and beep alarms.



WHISTLER RADAR EYE multi-band detector. The closer the radar the faster the alarm light blinks and the faster the audio beep. Price is $159.95.

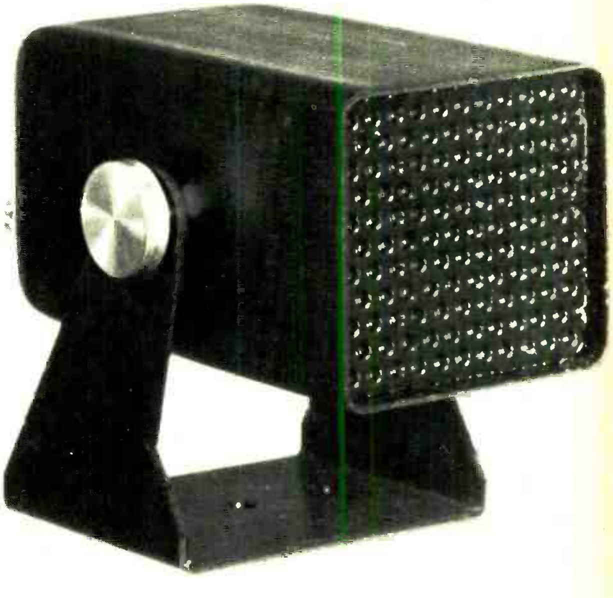
BEARFINDER TWO + TWO uses two separate antennas—one for K band, one for X band to provide maximum sensitivity. Both audio and visual alarms are provided.



WHISTLER RADAR EYE blocks false triggering from 2-way radio, CB and microwave transmissions. It will set you back $99.99.

These radar-sensing devices are intended to warn you of the locations of police-radar. They are not a substitute for staying below the posted speed limit.

AUTOTRONICS SUPER SNOOPER detects all types of police-radar. Automatic sensitivy control and audio alarm with volume control.



RIGEL SIDEWINDER warns of radar either ahead of or behind your vehicle. Price is $129.95. The unit detects both X and K band radar.

Should your career in electronics go beyond TV repair?

CREI prepares you at home for broader and more advanced opportunities in electronics— plus offers you special arrangements for engineering degrees

There is no doubt television repair can be an interesting and profitable career field. TV repair, however, is only one of the many career areas in the fast growing field of electronics.

As an indication of how career areas compare, the consumer area of electronics (of which TV is a part) makes up less than one-fourth of all electronic equipment manufactured today. Nearly twice as much equipment is manufactured for the communications and industrial fields. Still another area larger than consumer electronics is the government area. That is the uses of electronics in such areas as research and development, the space program, and others.

Just as television is only one part of the consumer field, these other fields of electronics are made up of many career areas. For example, there are computer electronics, microwave and satellite communications, cable television, even the broadcast systems that bring programs to home television sets.

As you may realize, career opportunities in these other areas of electronics are mostly for advanced technical personnel. To qualify for these higher level positions, you need college-level training in electronics. Of course, while it takes extra preparation to qualify for these career areas, the rewards are greater both in the interesting nature of the work and in higher pay. Furthermore, there is a growing demand for personnel in these areas.

Unlike most other home study schools, CREI programs are devoted exclusively to preparing you for careers in advanced electronics. All of CREI programs are college level. And CREI gives you both theory and practical experience in advanced electronics.

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A unique feature of CREI training is its Electronic Design Laboratory Program, which trains you to actually design circuits. It also helps you understand the theories of advanced electronics and gives you extensive practical experience in such areas as tests and measurements, breadboarding, prototype construction, circuit operation and behavior, characteristics of electronic components and how to apply integrated circuits.

;areer Training at Home

Only CREI offers this unique Lab Program. It is a complete college lab and, we believe, better than you will find in most colleges. The "Lab" is one of the factors that makes CREI training interesting and effective. And the professional equipment in this program becomes yours to keep and use throughout your professional career after you complete the training.

Engineering Degree

CREI offers you special arrangements for earning credit for engineering degrees at certain colleges and universities as part of your home study training program. An important advantage in these arrangements is that you can continue your full time job while "going to college" with CREI. This also means you can apply your CREI training in your work and get practical experience to qualify for career advancement.

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CREI gives you a choice of specialization in 14 areas of electronics. You can select exactly the area of electronics best for your career field. You can specialize in such areas as computer electronics, communications engineering, microwave, CATV, television (broadcast) engineering and many other areas of modern electronics.

FREE Book

In the brief space here, there isn't room to give you all of the facts about CREI college-level, home study programs in electronics. So we invite you to send for our free catalog (if you are qualified to take a CREI program). The catalog has over 80, fully illustrated pages describing your opportunities in advanced electronics and the details of CREI home study programs.

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CREI programs are approved for training of veterans and servicemen under the G.I. Bill.

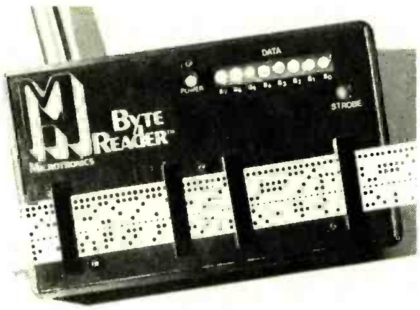
new products

More information on new products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside back cover.

HIGH-FIDELITY SPEAKERS, *models AR-17, AR-18.* Both speaker systems contain an 8-inch acoustic-suspension woofer and 1¼-in. ring-radiator tweeter with a crossover frequency at 2000 Hz. The *model AR-17* has a low-frequency response of −3 dB at 50 Hz and the *model AR-18* is −3 dB at 62 Hz. Power handling capability is 100 watts continuous per channel being driven to clipping 10% of the time. Cabinets each measure 10 × 18½ × 8¾ in. The *model AR-17* comes in oiled walnut veneer and the *model AR-18* (shown) comes in walnut grain vinyl veneer. Manufacturers' suggested retail price for *model AR-17*, $95; *model AR-18*, $65. Speakers are sold only in pairs.—**Teledyne Acoustic Research,** 10 American Dr., Norwood, MA 02062.

CIRCLE 116 ON FREE INFORMATION CARD

PAPER TAPE READER, *Byte Reader,* is designed for the home computer hobbyist. A *Lite Optimizer* circuit senses intensity of external light source and adjusts photo transistor sensitivity levels. LED's visually indicate data being sent to the computer. Kit sells for $69.95; assembled: $84.50. Add $3 shipping and handling; California residents include state or local taxes as applicable.—**Microtronics,** Box 7454N, Menlo Park, CA 94025.

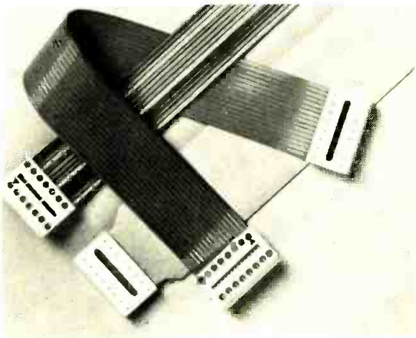


CIRCLE 117 ON FREE INFORMATION CARD

15-FUNCTION TOOL KIT, *model 96006,* comes in a heavy-duty vinyl case imprinted to simplify tool identification. The kit includes an interchangeable screw- and nutdriver series and the *Plike*—a 4-in-1 electrical tool that performs all plier, crimper, stripper and cutter functions. Included in the screwdriver-nutdriver series are a handle, a 4-in. extension, 3/16-in. and ¼-in. slotted screwdrivers, No. 1 and No. 2 Phillips screwdrivers and 3/16-in. through ⅜-in. nutdrivers. Kit measures 6 × 8½ × 1 in. Suggested retail price: $21.19.—**Hunter Tools,** 9674 Telstar Ave., El Monte, CA 91731.

CIRCLE 118 ON FREE INFORMATION CARD

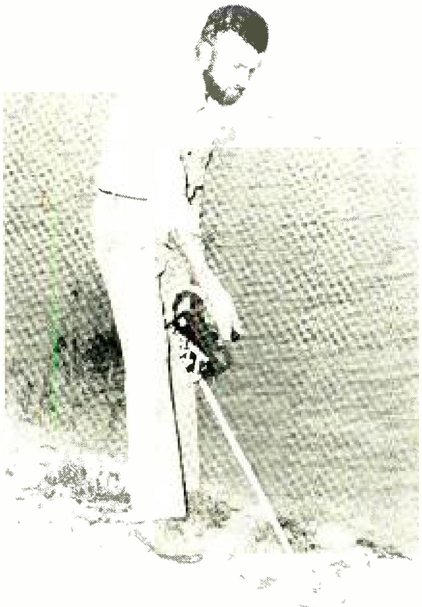
DIP JUMPERS, flat cable/conductors for jumpering within a PC board, making interconnections, interfacing I/O signals, etc. Available in 14-, 16-, 24-, and 40-pin single-ended or double-ended assemblies and in 6-, 12-, 24-, and 36-inch lengths. Copper alloy jumpers mate with standard IC sockets, cable is grooved top and bottom and conductors are made of No. 28 AWG tin-



coated copper.—**A P Products, Inc.,** Ken Braund, 72 Corwin Dr., Box 110, Painesville, OH 44077.

CIRCLE 94 ON FREE INFORMATION CARD

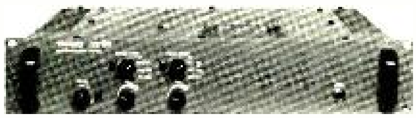
METAL DETECTOR, *TR Earth Challenger* (stock No. 80,262) is a fully transistorized, balanced instrument that combines quality and power with low cost. Made of rugged aluminum and weighing



2 lb., 6 oz., unit features electronic housing and 6-in. waterproofed search coil. Nine-volt transistor battery included. Deluxe version of *TR Earth Challenger* (stock No. 80,251) comes with telescopic shaft and 10-turn metal/mineral tuner. *TR Earth Challenger,* $39.95; *Deluxe TR Earth Challenger,* $59.95.—**Edmund Scientific,** 7782 Edscorp Bldg., Barrington, NJ 08007.

CIRCLE 119 ON FREE INFORMATION CARD

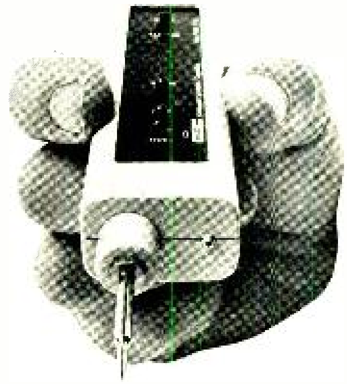
POWER AMPLIFIERS, *models CP120, CP500* and *CP500M,* are dual-channel units that can be operated independently or as a bridged unit. The *model CP120* (shown) is rated at 61 watts-per-channel, 122 watts in the bridged mode. The *model CP500* and *model CP500M* are both rated at 255 watts-per-channel, 510 watts bridged. The model *CP500M* also contains peak-reading meters, a blown-fuse indicator and a thermal protection indicator.



Three *PowerLock* threshold settings (full, half and quarter power) protect against overload and reduce clipping. Other features include ¼-in. phono jack inputs and rugged all-steel construction for on-the-road use. Prices: *model CP120,* $339; *model CP500,* $649; and *model CP500M,* $779.—**Technical Audio Products Corp.,** 3810 148th Ave. N.E., Redmond, WA 98052.

CIRCLE 120 ON FREE INFORMATION CARD

MULTIFAMILY LOGIC PROBE, *model LP-2,* is designed to test and troubleshoot digital circuits such as gates, clocks, CPU's, UART's, etc. Pulse detection and pulse stretching provides instant readout of logic levels, positive and negative transitions, pulse symmetry (duty cycle), and abnormal circuit conditions for major logic families, including TTL, DTL, HTL and CMOS. Gives precise measurements (within 0.15 V) of logic levels and transitions, with positive go/no-go conditions. No adjustments are necessary; just set a single switch for logic family, attach clip leads and touch probe to circuit in question.



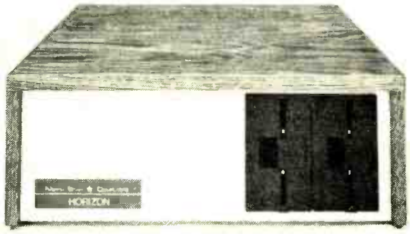
Built-in pulse stretcher can be used to detect pulses as short as 300 ns. Unit probe features plug-in connector system and phono jack, and space is provided in front of the *model LP-2* for interchangeable tips. The unit measures 5.8 × 1.0 × 0.7 inches and bears a manufacturer's resale price of $24.95.—**Continental Specialties Corp.,** 44 Kendall St., Box 1942, New Haven, CT 06509.

CIRCLE 50 ON FREE INFORMATION CARD

MICROCOMPUTER, *Horizon 1,* is a single floppy disc drive mainframe featuring the Z-80A microprocessor and includes 16K bytes of memory and 12-slot mother-board with serial terminal interface. (With a second disc drive, unit is called

CIRCLE 32 ON FREE INFORMATION CARD

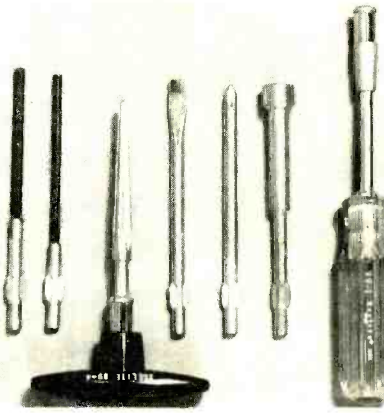
Horizon 2.) System is also S-100 bus-compatible for use with a wide variety of peripheral boards. System includes full extended BASIC, with sequential and random disc files, formated output, line editor, strings and machine language CALL.



Options for the *Horizon* computer include additional disc drives, floating point arithmetic boards, 24-line by 80-character upper and lower case VDC board, and 16K memory board with parity option. Choice of blue metal or wood chassis cover. *Horizon 1* kit, $1599; assembled, $1899. *Horizon 2* kit, $1999; assembled, $2349. Options: 16K RAM kit, $399; assembled, $459. Parity option kit, $39; assembled, $59. Floating point board kit, $259; assembled, $359. Z80 board kit, $199; assembled, $259.—**North Star Computers, Inc.,** 2465 Fourth St., Berkeley, CA 94710.

CIRCLE 82 ON FREE INFORMATION CARD

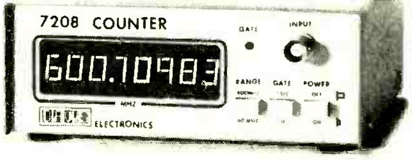
HANDLES, BLADES, KITS, *Series 99.* Complement of five handles accomodate 85 nutdriver, screwdriver and special-use shafts. Series also includes multitool and handy-roll kits and sets in plastic cases, plus high-carbon steel blades and



precision-formed steel head sockets. Patented spring device in handle holds blades firmly for easy insertion and removal.—**Weller Xcelite Electronics Div.,** The Cooper Group, Apex, NC 27502.

CIRCLE 98 ON FREE INFORMATION CARD

FREQUENCY COUNTER, *model 7208,* offers full 8-digit LED display and operation to 60 MHz with 1-Hz resolution. *Model 7208A,* with optional prescaler, can operate to 600 MHz. Unit features selectable gate times (1 sec and .1 sec), and 115



VAC or 12 VDC operation (jack included). Housed in metal cabinet, the instrument measures 5½ × 6 × 2 inches. *Model 7028* (60 MHz) assembled: $169.95; kit: $119.95. *Model 7028A* (600 MHz) assembled: $199.95; kit: $149.95.—**Davis Electronics**, 636 Sheridan Drive, Tonawanda, NY 14150.

CIRCLE 121 ON FREE INFORMATION CARD

DUAL-TRACE 25-MHz SCOPE, *model LBO 515*, offers continuously variable delay from 1 μs to 5 seconds. Sensitivity is 5 mV -per- division and risetime is 14 ns. Unit features rectangular CRT with internal graticule; high accelerating voltages; selectable sync; automatic, normal, single-trace and reset modes with 20-Hz to 10-kHz frequency rejection. Overall accuracy for both channels is ±3%.

Includes beam rotator, trigger for both channels and polarity-inversion switch for Channel 2, front-panel astigmatic control, and ×10 magnification. Priced less than $1400 and is complete with probes and accessories.—**Leader Instruments Corp.**, 151 Dupont St., Plainview, NY 11803. **R-E**

CIRCLE 99 ON FREE INFORMATION CARD

new lit

More information on new products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside back cover.

PARTS CATALOG, *Quality Semiconductors And Electronic Parts, Catalog No. 10,* contains 14 pages of transistors, linear IC's, CMOS units, plugs, test accessories, frequency counters (kit and assembled), clocks (kit and assembled) and many different tools and replacement parts. A handy order form is included.—**Aldelco,** 2281 Babylon Turnpike, Merrick, NY 11566.

CIRCLE 103 ON FREE INFORMATION CARD

CONDENSER MICROPHONES, *MS2420,* brochure describes three condenser replacement mikes specifically designed to cover 97% of today's cassette requirements. Full details and specifications are included.—**Workman,** Box 3828, Sarasota, FL 33578.

CIRCLE 104 ON FREE INFORMATION CARD

COMPUTER PRODUCTS, 30 pages, contains complete descriptions of computer kits, including manufacturer's 6800 system, software, terminal system, audio cassette interface, alphanumeric printer, joystick, etc. All products are designed to be compatible with all computer systems for maximum flexibility.—**Southwest Technical Products Corp.,** 219 W. Rhapsody, San Antonio, TX 78216.

CIRCLE 105 ON FREE INFORMATION CARD

SPEAKERS, *Truth In Listening,* 14-page full-color catalog that defines the characteristics of accurate sound reproduction as well as describing manufacturer's line of hi-fi speakers. Complete specs, charts, photos and drawings accompany the text. Catalog is available from manufacturer or AR dealers.—**Teledyne Acoustic Research,** 10 American Dr., Norwood, MA 02062.

CIRCLE 106 ON FREE INFORMATION CARD

TEST EQUIPMENT "WISH BOOK," 1977-78 Edition, 23 pages, features five new instruments on the front cover: a CB analyzer, video analyzer, DMM, 230-mHz frequency counter and portable tester. Full descriptions of these and other test units are accompanied by large clear photos and complete specs.—**Sencore,** 3200 Sencore Dr., Sioux Falls, SD 57107.

CIRCLE 107 ON FREE INFORMATION CARD

WORD PROCESSING SYSTEMS, *The Microcomputer and Word Processing—A Cost Effective Analysis,* is an article analyzing the cost effectiveness of various microcomputer word-processing systems and compares several popular IBM systems with an MITS microcomputer-based system using a Selectric terminal output. It is estimated that current microcomputer word processing is cost-effective at a correspondence level of from 300 to 400 letters per month. Send a 24¢ SASE.—**Center for the Study of the Future,** Dept. B, 4110 N.E. Alameda, Portland, OR 97212.

AUDIBLE SIGNAL DEVICE BROCHURE describes the *Sonalert* line of signalers that has a wide variety of applications such as in automobile, aircraft, and marine warning systems, airport metal detectors and medical instruments.

Sonalert signalers produce either a soothing pleasant tone or chime, or a more strident blast in cases of emergency. Four tone frequencies, three loudness levels and seven modes or rhythms can be combined to produce more than 30 distinct sound variations. Power requirements are low—a low-power transistor, SCR or integrated circuit can do the trick. The devices are also solid-state, thus ensuring many years of trouble-free service.—**Mallory Capacitor Co.,** Div. P.R. Mallory & Co., Inc., Box 1284, Indianapolis, IN 46206.

CIRCLE 108 ON FREE INFORMATION CARD

1978 ENGINEERING MANUAL AND PURCHASING GUIDE NO. 780 is a 234-page catalog crammed with electronic parts and equipment. It contains such essentials as wire, cable, test equipment, trimmers and pots, switches, timers—even a low-cost microcomputer system. Also included are cross-references and complete manufacturer indexes. Price: $1.—**Allied Electronics,** Dept. C-78, 401 E. 8th St., Fort Worth, TX 76102.

MINI-CATALOG *No. MC-477* shows a full line of silicon rectifier bridges, diodes, high-voltage rectifiers, assemblies and TV high-voltage diodes. Also featured are high-voltage devices, industrial multipliers and X-ray assemblies.—**Electronic Devices, Inc.,** 21 Gray Oaks Ave., Yonkers, NY 10710.

CIRCLE 109 ON FREE INFORMATION CARD

TEST INSTRUMENTS *Catalog No. BK 78* contains 40 illustrated pages of DMM's, frequency counters, high-voltage probes, oscilloscopes and many other test instruments. Each device is thoroughly described and complete specifications are given.—**B&K-Precision,** Dynascan Corporation, 6460 W. Cortland Ave., Chicago, IL 60635.

CIRCLE 110 ON FREE INFORMATION CARD

HEATH/SCHLUMBERGER INSTRUMENTS *Catalog No. 811-23* contains 32 pages of test devices for hobbyists and service personnel. Among new products listed are frequency counters, an FET multimeter, a lin/log swept-function generator and a low-cost voltage-controlled function generator. Oscilloscopes, distortion analyzers, VOM's and VTVM's and color TV service equipment are just some of the many devices described.—**Heath/Schlumberger Instruments,** Dept. 570-010, Benton Harbor, MI 49022.

CIRCLE 111 ON FREE INFORMATION CARD

CATALOG SHEET describes the Kager *KL 3000 Soldering Pistol*, a lightweight, easy-to-operate instrument that permits single-handed operation. The solder is incorporated in the gun and is fed to the tip by squeezing the trigger. The rate of feed and the amount of solder necessary for a particular joint are automatically selected for precision work. The problem of dry joints is almost completely eliminated because the object to be soldered is heated first by the tip prior to applying the solder. Many different brands of solder can be used with this instrument, and nonscaling tips are provided in different sizes and shapes. This pistol is adaptable to both fine soldering and continuous production-line work.—**KAGER International,** 1180 S. Beverly Drive, Los Angeles, CA 90035.

CIRCLE 112 ON FREE INFORMATION CARD

FIVE BROCHURES describing complete test-instrument product lines are designed for point-of-sale and direct mail. Each brochure contains six pages of product benefits, uses and applications, photos and specifications. Titles include: "Digital Multimeters," "Communications & CB," "Oscilloscopes & Power Supplies," "Transistor & Tube Testers," and "TV & Radio Test Equipment."—**Sencore, Inc.,** Promotion Mailing Dept., 3200 Sencore Drive, Sioux Falls, SD 57107. **R-E**

CIRCLE 113 ON FREE INFORMATION CARD

CIRCLE 41 ON FREE INFORMATION CARD

Teaching Digital Counters To Count

Digital displays have uses in most facets of our lives; ranging from watches to home appliances and test instruments. They are all basically counters. Here's a way to make a decade counter count by some number other than 10.

FRED BLECHMAN, K6UGT

DIGITAL COUNTING CIRCUITS ARE BECOMing the standard means for measuring almost any variable, such as time, frequency, voltage, current, resistance, temperature and events. The conventional readouts used with digital devices normally display in decimal format. However, the counting circuits themselves usually count in binary code, a system that is based on powers of 2. Since the count is displayed decimally, typical IC counters automatically reset to 0 after the decimal count of 9, running from 0 to 9 and then repeating. Also, the counter outputs trigger the next highest digit, (whenever more than one digit is used) to carry the count. Thus, 09 becomes 10 on the next count, and 199 becomes 200.

However, if you want the count to go back to 0 at some point other than 9, how do you program the counter to do this? While this is "duck-soup" for the digital engineer, most experimenters and newcomers to digital electronics find this confusing, and there is little information available in recent literature. The explanation and examples that follow should lift the veil of mystery from digital counting circuits and allow you to apply these principles to your own special needs. Just bear in mind that the following explanation is not intended to be all-inclusive.

IC counters

Although different IC counters are available for special purposes, the most popular is the 7490 decade counter. Actually, it contains divide-by-2 and divide-by-5 sections in one package; these sections can be wired, as shown in Fig. 1, to form a divide-by-10. Note that pins 2, 3, 6, 7 and 10 are grounded for normal counting. (Actually, *either* pin 2 *or* pin 3, and *either* pin 6 *or* pin 7 must be grounded; but it's best to ground them all for decade counting.) A logical-high (about 5 volts) output at pin 12 represents a decimal count of 1; pin 9 is a decimal count of 2; pin 8 is a decimal count of 4; and pin 11 is a decimal count of 8. Normally, these pins are a logical low—nearly at ground potential—when off. Now, as the 7490 is triggered at pin 14 with a *negative*-going pulse, a high output appears at pin 12 on the first count, at pin 9 on the second count, and on *both* pin 12 and pin 9 on the third count. On the fourth count, only pin 8 is high; pin 9, pin 11 and pin 12 are low. On the fifth count, pin 8 *and* pin 12 are high. On the sixth count, pins 8 and 9 are high. What is happening is that the counter is "adding" decimally with a single output or combinations of outputs. Figure 2 shows this counting sequence.

The 7490 resets to 0 at the next count after 9 when wired as shown in Fig. 1. Pins 2 and 3 are two reset pins that are normally used to set the counter to 0 when the counter is first turned on. The internal reset circuitry is designed so that when *both* pins 2 and 3 go high, the 7490 resets to 0. For normal counting, either (or both) pins 2 or 3 must be low.

It now becomes simple to reset the 7490 at the desired count. To reset to 0 at

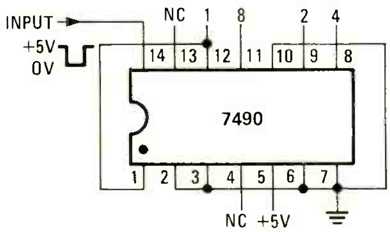


FIG. 1—7490 IC connected as a divide-by-10 counter.

DECIMAL NUMBER	PIN NUMBER			
	11	8	9	12
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

FIG. 2—BCD OUTPUTS from 7490 IC when connected as a divide-by-10 counter as shown in Fig. 1.

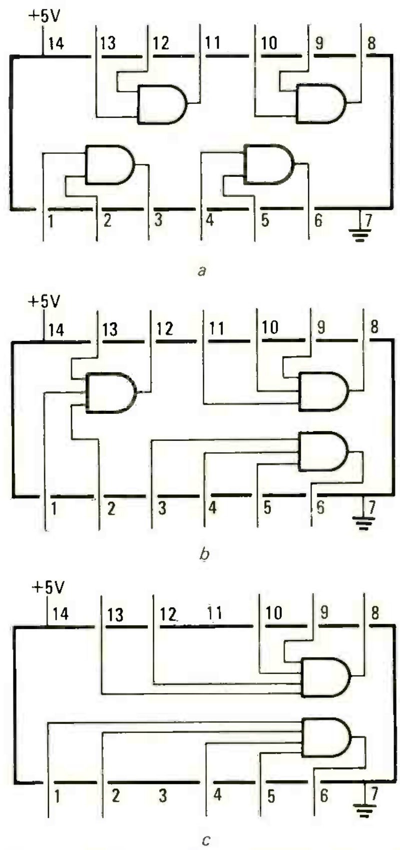


FIG. 3—TYPICAL AND-GATE IC's. The 7408 Quad 2-input AND gate IC is shown in *a*. The 7411 Triple 3-input AND gate IC is shown in *b*, and *c* shows the 7421 Dual 4-input AND gate IC.

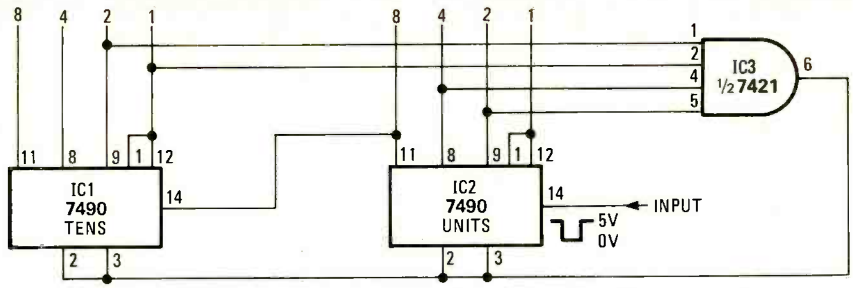


FIG. 4—DIVIDE-BY-36 counter. The 7490's count from 00 to 35 and are then reset to 00.

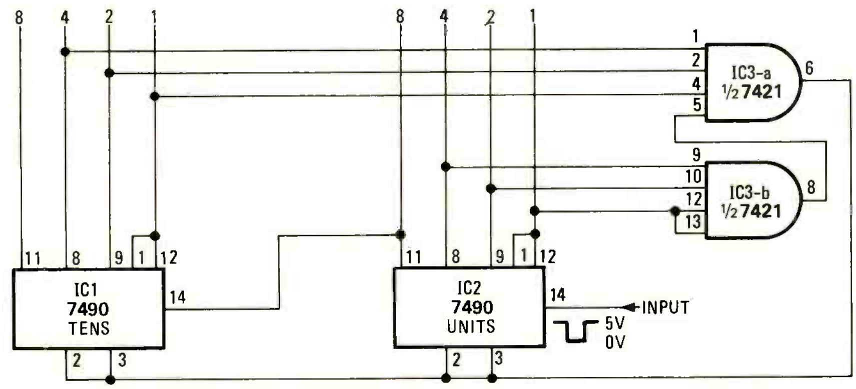


FIG. 5—DIVIDE-BY-77 counter. The counters are reset by the AND gate after they reach a count of 76.

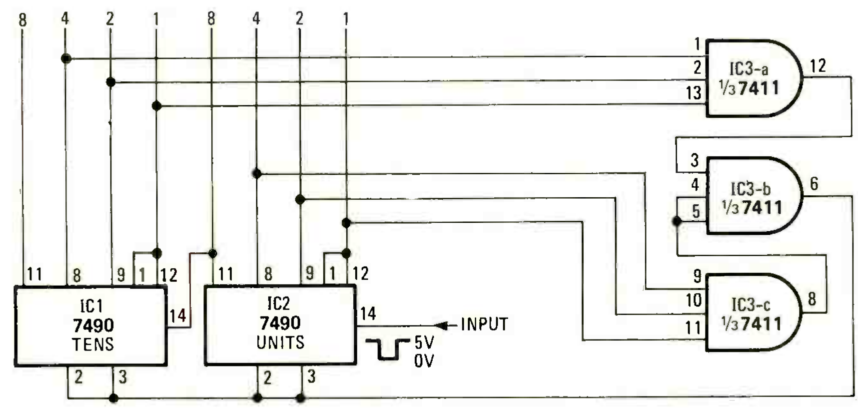


FIG. 6—DIVIDE-BY-77 counter. Same circuit as Fig. 5 except with a different arrangement of AND gates.

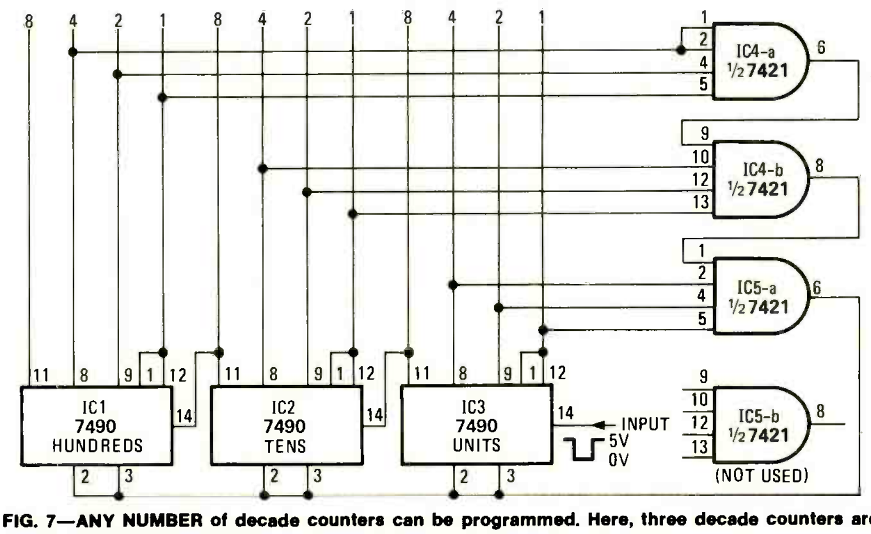


FIG. 7—ANY NUMBER of decade counters can be programmed. Here, three decade counters are connected to divide-by-777.

the second count (so that the 7490 counts 0 to 1 and back to 0), simply connect a jumper from pin 9 to pin 2, and remove the ground from both pins 2 and 3. (Leaving a pin unconnected is the same as connecting it to a high level). For a count of 3 (0 to 2), connect pin 2 to pin 9 and pin 3 to pin 12. For a count of 4, connect pin 2 or pin 3 to pin 8, and leave the other reset pin unconnected. For a count of 5, connect one reset pin to pin 8 and the other reset pin to pin 12. For a count of 6, connect the reset pins to pins 8 and 9.

When you want the decade counter to reset after a count of 7, you need to have some way to sense when *three* pins (pins 8, 9 and 12) are all high at the same time. Although other circuitry could be used, it is easier to use standard AND gates to trigger the reset terminals with a high output when all inputs to the AND gate are high. Figure 3 shows several typical AND gates. You could, for example, connect pins 8, 9 and 12 to the three inputs of one 7411 AND gate (Fig. 3-b), and then use the output from the AND gate to trigger reset pin 2 of the 7490, leaving pin 3 unconnected. This would give you a count from the 7490 of 0 to 6 and back to 0 on the seventh count.

When there is more than one digit, logic gates are a necessity, since you may have to sense the state of several counter-output lines. For example, suppose you wanted to reset to 0 after 35 counts—that is, from 00 to 35 and back to 00. The reset would occur at the 36th count. Figure 4 shows one way to do this. Here's what happens. With each *negative*-going pulse into pin 14 of the units counter, the count advances one count. At the count of 09, output 8 and output 1 (pins 11 and 12) are high. On the very next count, all outputs go low. The *negative*-going output at pin 11 is directly coupled to pin 14 of the tens counter, and it advances one count to 10. This happens again at 20 and 30. A 7421 four-input AND gate is connected to sense when the tens counter is at 3 and the units counter reaches 6. At that instant, all four inputs to the AND gate are high, so the output goes high and directs the reset pins on each counter to return the count to 0. Only at the count of 36 are all four inputs to the 7421 gate high; until then, the 7421 output is low and the 7490's count normally.

Figure 5 shows another example, this time using both sections of the 7421 IC. Here, at the count of 77, the high output on pin 6 of the 7421 resets the counters to 00, so that they count from 00 to 76. Here's how it works: The 4–2–1 outputs of each 7490 are connected to the 7421 inputs, as shown in Fig. 5. When the tens counter is at a count of 7, three inputs of IC3-a are high, but the output at pin 6 is still low since the fourth input (the output of IC 3-b) is still low. When the units counter reaches a count of 7, all the inputs to AND gate IC3-b are high (note that IC3-b pin 13 must be jumpered to any of the other input pins of IC3-b); output pin goes high, providing the last needed high input for IC3-a to output a high on pin 6, thus resetting the 7490's.

This could also be done by using all three AND gates of the 7411 IC. (See Fig.

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EQUIPMENT REPORTS

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The front panel itself is black with white legends, and it's well designed with the human operator in mind. There are just enough legends to know what you've selected without confusing the issue. The ranges are "keyed" to the function switches by white lines, so you can tell instantly which set of ranges goes with each function.

The case is a light blue and measures 8 × 6½ × 3 inches. There's a tilt stand on the underside of the case. When set, the stand raises the front of the instrument for easy viewing on a workbench. With the stand retracted, the instrument lies flat on the work surface.

Power is supplied either by batteries or from an external power supply kit. A plastic battery holder is provided that accepts four C-cells. The *model 2000* draws about 120 mA from a 4 to 6½ volt DC source. This translates into an operating time for standard zinc carbon batteries of 8 hours. Switching to alkaline batteries increases the operating time to 25 hours. If you desire, you can also use a NiCad battery pack. Sabtronics offers two different size NiCad battery packs as optional accessories. The *NB-1200* is a sub-C size NiCad pack that sells for $12.95 and will power the *model 2000* for 10 hours. The *NB-500* pack is made up of AA size NiCad batteries that will power the *model 2000* for 4 hours. The *NB-500* sells for $7.75.

To recharge the batteries, the *EP-12V* External Power Kit is required. It consists of a separate PC board with a voltage regulator, charging circuit and external power jack. The assembly mounts on the inside of the rear panel of the *model 2000*. Access to the external power jack is provided through a hole in the rear panel. External power comes from an AC power adapter. This is one of those calculator-type plug-and-transformer modules with a long wire that has a plug on the end of it. The AC power adapter must supply 8.5 to 15 VDC at 150 mA. Sabtronics offers two AC power adapters as optional accessories: The *AC-115* for 115 VAC and the *AC-230* for 230 VAC. With the External Power Kit and the AC Power Adapter, the sub-C size NiCad battery pack can be recharged in 16 hours. This combination also supplies enough to power the *model 2000* directly from the line voltage.

Specifications

For those readers who like specifications (and who doesn't), here goes: The 100 mV and 1 volt DC ranges have a 100 μV and 1 mV resolution, respectively, and both have a ±0.1% ±1 digit accuracy. At the opposite end of the DC voltage range is the 1000V range with a 1 volt resolution and a ±0.5% ±2 digit accuracy. The input impedance for the DC voltage ranges is 10 megohms and the response time is 0.5 seconds.

The lowest AC voltage range is 100 mV with an accuracy of 0.3% ±2 digits at 60 Hz and a frequency range of 40 Hz to 50 kHz. The highest AC voltage range, 1000 VAC, has an accuracy of 1% ±2 digits at 60 Hz and a frequency range of 40 Hz to 500 Hz. At the two ends of the DC current ranges, 10 μA and 1 amp, the resolution is 10 nA and 1 mA, respectively, while the accuracy is 0.1% ±2 digits and 1% ±1 digit, respectively. The 10 μA AC current range has an accuracy at 60 Hz of 1% ±5 digits and a frequency range of 40 Hz to 500 Hz. The 1 amp range has a 60 Hz accuracy of 0.8% ±2 digits and a frequency range of 40 Hz to 20 kHz. Response time on the AC current ranges is 5 seconds maximum. Maximum input current on all ranges is 2 amps, overcurrent protection provided by a fuse.

Now for the ohms ranges. The lowest ohms range, 100 ohms, has a resolution of 0.1 ohms with an accuracy of 0.1% ±1 digit. This accuracy also holds for the 1K, 10K, 100K ranges. The 100-ohm range uses a measuring current of 1 mA. At the opposite end of the scale is the 10-megohm range with a resolution of 10K ohms and an accuracy of 0.5% ±5 digits. The 10-megohm range uses a measuring current of 100 nA. Open circuit voltage for the ×1 ranges (100, 10K, and 1MEG) is 100 mV. For the ×10 ranges (1K, 100K and 10MEG), the open circuit voltage is 1 volt. All the resistance ranges are protected against a maximum input voltage of 250 VDC and 250 VAC RMS. Input protection is provided by a 2-amp fuse.

Did I forget anything? Oh yes, the input

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3½ DIGIT DMM
continued from page 44

switches arranged so that the maximum coming off the divider into the DPM input is always 2 volts.

The AC volts input goes through the same voltage divider and then into a "precision rectifier circuit" that converts the signal into DC to feed the input to the DPM. The 2.5K pot in this circuit lets you calibrate the output of the precision rectifier on a one-time basis against a standard AC input signal.

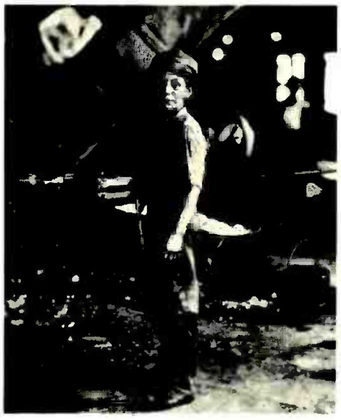
The ohmmeter circuit is shown in simplified form in Fig. 9. Here, one leg of the op-amp contains a standard reference voltage that is adjustable through the 1K pot to exactly 1 volt. The other leg contains the portion of the voltage divider that is active for measuring a particular resistance range. In the illustration the 1-meg resistor shown is used to measure 2 megohms full scale. Since the op-amp operation dictates that the inputs to both legs must be equal, and since the outputs are common, exactly 1 volt must also appear across the 1-meg resistance. This constant voltage forces a constant current through the resistance being measured; in this particular case 2 megohms. The 2 volts developed across the 2-megohm resistor is then fed into the DPM, registering a full-scale reading. Other resistance values for the unknown will, of course, produce proportional voltages feeding into the DPM.

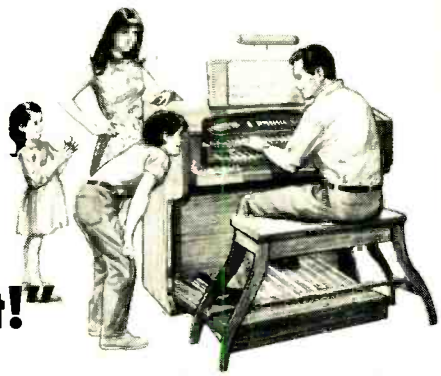
The resistance circuit is calibrated on a one-time basis by adjusting the 1K pot with a standard resistor across the input. When the DPM registers the correct reading of resistance, it has been calibrated. An alternate method is to adjust the pot so that exactly 1 volt appears across the 750-ohm resistor (R14) at the output of the op-amp.

The direct current input is taken off the three shunt resistors, R6, R7 and R8. Each resistor develops exactly 2 volts across it for maximum scale readings. Note that the high current scale is limited to 10 amps only because of the low wattage (10 watts) of the 0.1-ohm resistor (R6). If you make this a 20-watt resistor, you can read 20 A full scale. These resistors should be at least 1 percent tolerance or better for good measurement accuracy.

The multicontact pushbutton switches shown in the circuit diagram are of course the easiest to wire, although layered rotary switches can also be used. The correct decimal point for each scale can be displayed by connecting pin 6 of the appropriate display number (DS-2, 3 or 4) through the appropriate scale switch to ground through a 470-ohm resistor.

The entire DMM circuit can easily be layed out and assembled on a 4½ × 6-inch piece of perforated circuit board with 0.1-inch hole spacings. **R-E**





new books

COUPLING OF EXTERNAL ELECTROMAGNETIC FIELDS TO TRANSMISSION LINES, by Albert A. Smith, Jr. Wiley-Interscience, Div. of John Wiley & Sons, 605 Third Ave., New York, NY 10016. 132 pp. 6 × 9 inches. Hardcover $14.50.

Electromagnetic radiation causes not only disruption in communications but can pose a very real hazard to humans and equipment. This book examines some of the problems involved in coupling electromagnetic fields to transmission lines and offers application data in the form of solved examples and spectrum profiles. The material presented is applicable to coupling problems in communications, data processing, and in power, telephone and control systems. Teachers will find the book useful in graduate or advanced undergraduate classroom work. Several appendices, bibliography and an index make up the back of the book.

CMOS COOKBOOK, by Don Lancaster. Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, IN 46268. 416 pp. 5½ × 8½ in. Softcover $9.95.

This is another in the "Cookbook" series that presents the reader with all the nuts-and-bolts material needed to understand and use CMOS integrated circuits. The material presented is long on real-world applications, is detail-oriented and the easy-to-read style is not overloaded with mathematical formulas and theory.

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A QUICK LOOK AT BASIC, by Donald D. Spencer. Camelot Publishing Co., Box 1317, Ormond Beach, FL 32074. 64 pp. 5¾ × 8¾ inches. Softcover $4.95.

This book presents the BASIC programming language. Written in easy nontechnical style, the material offers those with little or no computer background an opportunity to learn BASIC in just a few hours. Exercises and examples are given to supplement and reinforce the text.

TAPE RECORDING FOR THE HOBBYIST, Fourth Edition, by Art Zuckerman. Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, IN 46268. 160 pp. 5½ × 8½ in. Softcover $4.95.

This book uses nontechnical language to explain the ABC's of how to select and use a tape recorder, add special effects (including instructions on how to create your own effects from everyday household objects), and edit tapes. The reader is instructed in what to look for in the controls and special features of an instrument, and how to match tape with the machine. Chapters also include suggestions on using a recorder to tape parties and special events, and to create sound-track accompaniment for film. The final chapter tells you how to care for your recorder.

COMPUTER DICTIONARY, by Donald D. Spencer. Camelot Publishing Co., Box 1317, Ormond Beach, FL 32074. 160 pp. 5¾ × 8¾ inches. Softcover $5.95; hardcover $9.95.

All students of computer science/data processing in schools and colleges, teachers, businessmen, programmers, systems analysts and other computer users will find this dictionary a handy addition to their reference library. Simple clear, nontechnical language is used to define terms. **R-E**

COUNT TO ZERO

continued from page 101

6.) This illustrates that different gate arrangements can be used—just so long as the output does not go high until the desired count.

For larger numbers—three digits or more—the same approach can be used, but more gates must be used. Figure 7 shows how to count from 000 to 776 and back to 000 at the next count (777). This can be termed a worst-case example, since it requires three outputs from each 7490 counter.

You can use NAND gates, such as the 7400, 7410, 7420 and 7430 instead of AND gates, but inverters (such as the 7404) would be needed between the 7490 and the inputs of the NAND gates. The 7490 outputs are high, and the NAND gate inputs must all be low to get the high output needed to reset the 7490's. A simpler approach, using NAND gates and inverters, is to use an inverter between each NAND output and the reset pins.

Sometimes you can reset two digits without using gates, if the desired reset count is 1, 2, 4 or 8 at each 7490. For instance, a reset at the 18th count to 0 (17 to 00) could be done by separating the reset pins, as shown in Fig. 8. Since *both* reset pins on each 7490 must be high to reset to 0, this occurs only when the count goes to 18. At all other times, one reset pin on each 7490 is low.

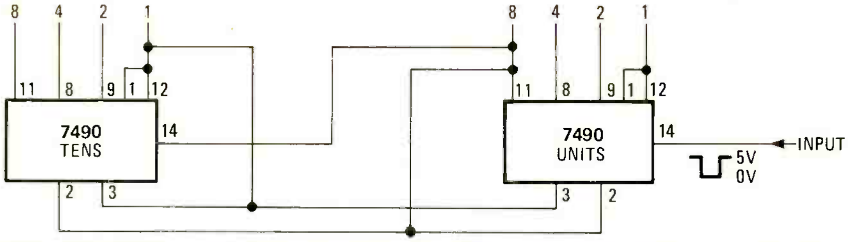

FIG. 8—AND GATES are not always necessary, depending on the desired count. For a divide-by-17 application, the 7490's can be wired as shown.

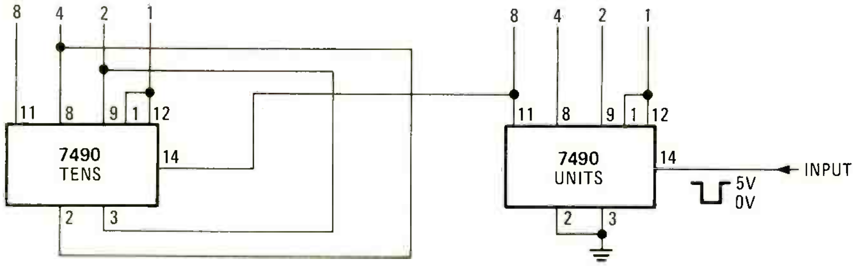

FIG. 9—DIVIDE-BY-60 counters are commonly used in clock circuits. The 7490's can be wired without using AND gates as shown.

Another resetting requirement is needed for minutes and seconds counting in digital clock circuits. Here the next count after 59 is 00 instead of 60. Figure 9 shows the circuit for this. The units counter automatically resets to 0 after a count of 9, but the tens counter will not reset until the 6 count, since only then are both reset pins high.

Common CMOS 4000 series counter IC's do not lend themselves as neatly to this simple system since many of them don't have BCD outputs and dual reset pins. But they too can be programmed to count, if you give it a little thought and have an understanding of the basic techniques discussed in this article. **R-E**

ELECTRONIC DRUMS

continued from page 48

A programming example

For example, Fig. 10 (See page 47.) shows a simple shuffle/fox trot tablature. The most basic principle is that since the shortest note that is used is an eighth note, and since the tempo clock, once set, pulls events out of memory as a constant tempo, each event from memory will represent an eighth note. The quarter-note accented bass will actually be entered into memory as an ACCENT BASS followed by a REST.

To prepare for programming, first touch RESET, press the PROGRAM button (acknowledged by PROGRAM LED), then enter the score on the drum pads like this:

ACCENT BASS/ REST / SNARE / REST / BASS / REST / REST / SNARE and, since this line must be repeated again and again, finish off by touching REPEAT.

Tricks & things

There is more versatility and power in the drum set than the control labeling tends to indicate. Here are some discoveries that we've made; other possibilities are only limited by the imagination of the user.

Using the bridge as an intro—You can begin playing with the bridge rather than the main score by placing the unit in the bridge mode then touching PLAY.

Playing a manual tempo—You can play a score to a manual tempo by tapping on the REST pad in the tempo that you want. Each tap advances the event counter and causes any programmed drum sounds to play. The REST pad can also be used as a nonlatching play key. Simply touch this pad continuously and the unit will play at the rate set by the TEMPO control.

Playing only a portion of a score—The REPEAT pad can be used in the PLAY mode to cause a pattern to begin again before the programmed repeat point is reached. Simply tap the pad. If you are touching the BRIDGE pad at the same time, the unit will switch to the beginning of the bridge.

Editing—Some limited editing is possible by single-stepping to the point to be changed using the REST pad. When you get to the event that is to be changed, put the unit in the program mode (in this case, *do not reset*—simply press the PROGRAM button) and alter the events desired.

External synchronization/manual play—The pin jack on the rear of the case provides a means of either foot-switch controlling the unit or synchronizing to external events. A 5-volt trigger applied to this input causes the clock to run at the rate set by the TEMPO control. If the triggers applied to this input are short, the event counter will advance one event for each pulse. **R-E**

EQUIPMENT REPORTS

continued from page 102

impedance on the AC voltage ranges is 10 megohms shunted by 25 pF. Also, the sample rate is 4 per second.

Assembly and use

Assembling the *model 2000* was a breeze. The instruction manual contains step-by-step procedures with plenty of illustrations. Little is left in the way of guesswork. It took me about 9 hours to assemble the unit. However, you should accept this figure with a grain of salt, since I'm not sure whether my ability with a soldering iron compares with that of the tortoise or the hare.

After the assembly procedures have been completed, the unit must be calibrated. The instruction manual contains two separate calibration procedures. The first calibration procedure is prepared for the kit builder who has no other test equipment other than the *model 2000*. The procedure uses data supplied by Sabtronics on four resistors and a voltage reference. There is also an AC peak detector circuit consisting of a diode and a capacitor that must be built for calibrating the AC voltage scales.

To calibrate the *model 2000* to within published specifications, the second calibration procedure must be followed. This procedure requires a meter calibrator such as the Fluke *model 760*, a 4½-digit DMM such as the Hewlett-Packard *model HP3465A*, and an AC signal generator.

Anytime you acquire a new test instrument, it takes time to get used to it. With the simple front panel layout of the *model 2000*, it took almost no time to become familiar with it. I've used the *model 2000* to troubleshoot numerous circuits and it performed perfectly. The *model 2000* now occupies a permanent corner on my workbench and its sleek blue case adds a little decor. If you're thinking of acquiring a new DMM, take a look at the *model 2000*. **R-E**

Sencore Model CB42 CB Analyzer

CIRCLE 115 ON FREE INFORMATION CARD

EVER SINCE I WAS A TEEN-AGED TECHNICIAN, I've been crazy about "analyzers"—instruments that could make all kinds of tests. Of course, when I was a teen-ager, the sets were simpler and so were the analyzers. I still have several different types on my bench. These versatile instruments can be real timesavers.

The Sencore people have come out with an Analyzer for CB radios, the *model CB42*. This instrument has an RF signal generator that covers from 375 kHz to 12 MHz for IF's and a CB RF signal generator that covers all 40 channels with provisions for five more channels. Both of these generators can be modulated by 400 or 1000 Hz AM, or zero. Or external modulation or a dual-frequency special audio signal (500/2400 Hz). The modulation percentage of both can be set to zero, 30% or 100%. The attenuator will drop the signal level from 1.0 volt to a minimum of 0.1 μV.

There is also a 7-digit frequency counter with dual inputs, one has a 50-ohm impedance (built-in 12-watt dummy load) and the other has a 1.0-megohm impedance for high sensitivity. The counter also indicates the RF or IF output frequency. An RF wattmeter with digital readout, a digital readout plug-in crystal-checker that shows the fundamental frequency of any crystal from 1.0 MHz to 20.0 MHz. A modulation-percentage readout, for both positive and negative modulation percentages and a special readout on any channel that displays the percentage of error of the transmitter frequency. A microphone-tester that doubles as a substitute speaker; a built-in oscillator/mixer circuit that beats the 27-MHz CB frequencies down to about 1.0 MHz. The oscillator/mixer circuit permits you to use just about any narrowband scope. The *model CB42* also features a very simple receiver sensitivity test and an equally simple signal-to-noise ratio receiver test. A switch-selected speaker-load 4, 8 or 16 ohms with an audio wattmeter readout that can read up to 20 watts. I hope I haven't left any out, although I might!

Imagine each of these instruments in its own case. You'd have a stack of boxes that would cover up the average service bench. Sencore has managed to put them all in one 11×14 inch box! The only instrument you would need beside the *model CB42* would be a scope for looking at modulation waveforms. Any scope will do.

Every function and test on the *model CB42* can be selected individually by the controls, which are very plainly marked. Input-output jacks are in a row along the bottom of the panel. The RF signal generator is a crystal-controlled digitally programmed phase-locked-loop with a crystal accuracy of 1.0 ppm. It has a knob that selects either of two bands, Channels 1–23 and 24–40. Actually 45 since there are five spare positions not hooked up, but can be easily connected if they're ever needed. The IF generator covers from 375 kHz to 12.0 MHz in five ranges; the frequency of these are read out on the display. The IF tuning knob is a three-turn pot, for easier setting of exact frequencies. The RF/IF output has its own jack, with 50-ohm output impedance.

For transmitter frequency tests, the CB rig is connected to the 50-ohm input, and the switch set to external frequency/50-ohm load. In the next position of the switch, the 1.0 megohm high sensitivity input of the frequency counter is connected to the jack on the panel. If you set the CB tuning knob of the RF generator to the same frequency as the CB set and turn to the next position of the switch, the readout will give you a direct reading of the percentage off-frequency. The signal generator's PLL is accurate to within 1.0 ppm, and the readout has a rated accuracy of .001%. Since FCC specs call for only .005% tolerance, these are well within limits. These tests work in the same way for SSB transmitters.

A very versatile test instrument that can certainly speed up any kind of CB radio work and pay for itself in the number of jobs you can get out in a day. **R-E**

next month

APRIL 1978

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What to look for and what to look out for when selecting this most basic test instrument.

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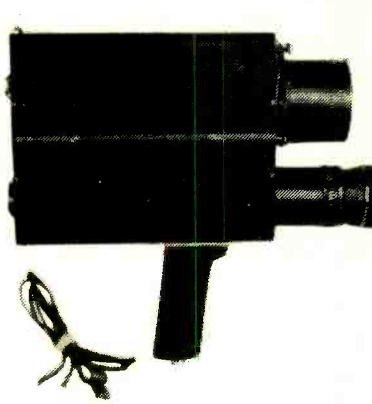

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Prime new units from a major mfg. 450 N.S. access time. Equivalent to 4-1702 A's in 1 package! **450 ns**
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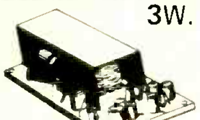

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400	.09	.25	.50	1.40	6.50
600	.11	.30	.70	1.80	8.50
800	.15	.35	.90	2.30	10.50
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7430– .16	74107– .28	74194– .85
7432– .25	74121– .33	74195– .85
7437– .24	74122– .38	74196– .86
7438– .24	74123– .40	74279– .87
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200	.70	1.10	1.75	.60	.70	1.60
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1N753A	6.2v	z	.25
1N758A	10v	z	.25
1N759A	12v	z	.25
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4012	.20
4013	.40
4014	1.10
4015	.95
4016	.35
4017	1.10
4018	1.10
4019	.60
4020	.85
4021	1.35
4022	.95
4023	.25
4024	.75
4025	.35
4026	1.95
4027	.50
4028	.95
4030	.35
4033	1.50
4034	2.45
4035	1.25
4040	1.35
4041	.69
4042	.95
4043	.95
4044	.95
4046	1.75
4049	.70
4050	.50
4066	.95
4069	.40
4071	.35
4081	.70
4082	.45

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7400	.15
7401	.15
7402	.20
7403	.20
7404	.15
7405	.25
7406	.35
7407	.55
7408	.25
7409	.15
7410	.10
7411	.25
7412	.30
7413	.45
7414	1.10
7416	.25
7417	.40
7420	.15
7426	.30
7427	.45
7430	.15
7432	.30
7437	.35
7438	.35
7440	.25
7441	1.15
7442	.45
7443	.85
7444	.45
7445	.65
7446	.95
7447	.95
7448	.70
7450	.25
7451	.25
7453	.20
7454	.25
7460	.40
7470	.45
7472	.40
7473	.25
7474	.35
7475	.35
7476	.30
7480	.55
7481	.75
7483	.95
7485	.95
7486	.30
7489	1.35
7490	.55
7491	.95
7492	.95
7493	.40
7494	1.25
7495	.60
7496	.80
74100	1.85
74107	.35
74121	.35
74122	.55
74123	.55
74125	.45
74126	.35
74132	1.35
74141	1.00
74150	.85
74151	.75
74153	.95
74154	1.05
74156	.95
74157	.65
74161	.85
74163	.95
74164	.60
74165	1.50
74166	1.35
74175	.80
74176	1.25
74180	.85
74181	2.25
74182	.95
74190	1.75
74191	1.35
74192	1.65
74193	.85
74194	1.25
74195	.95
74196	1.25
74197	1.25
74198	2.35
74221	1.00
74367	.85
75108A	.35
75110	.35
75491	.50
75492	.50
74H00	.25
74H01	.25
74H04	.25
74H05	.25
74H08	.35
74H10	.35
74H11	.25
74H15	.30
74H20	.30
74H21	.25
74H22	.40
74H30	.25
74H40	.25
74H50	.25
74H51	.25
74H52	.15
74H53J	.25
74H55	.25
74H72	.55
74H101	.75
74H103	.75
74H106	.95
74L00	.35
74L02	.35
74L03	.30
74L04	.35
74L10	.35
74L20	.35
74L30	.45
74L47	1.95
74L51	.45
74L55	.65
74L72	.45
74L73	.40
74L74	.45
74L75	.55
74L93	.55
74L123	.55
74S00	.55
74S02	.55
74S03	.30
74S04	.35
74S05	.35
74S08	.35
74S10	.35
74S11	.35
74S20	.35
74S40	.25
74S50	.25
74S51	.45
74S64	.25
74S74	.40
74S112	.90
74S114	1.30
74S133	.45
74S140	.75
74S151	.35
74S153	.35
74S157	.80
74S158	.35
74S194	1.05
74S257 (8123)	.25
74LS00	.35
74LS01	.35
74LS02	.35
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74LS09	.35
74LS10	.35
74LS11	.35
74LS20	.35
74LS21	.25
74LS22	.25
74LS32	.40
74LS37	.35
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9309	.35
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1702A	6.95
MM5314	3.00
MM5316	3.50
2102-1	1.75
2102L-1	1.95
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MCT2	.95
8038	3.95
LM201	.75
LM301	.25
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LM309H	.65
LM309K (340K-5)	.85
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LM320T12	1.65
LM320T15	1.65
LM339	.95
7805 (340T5)	.95
LM340T12	1.00
LM340T15	1.00
LM340T18	1.00
LM340T24	.95
LM340K12	2.15
LM340K15	1.25
LM340K18	1.25
LM340K24	.95
LM373	2.95
LM380	.95
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LM739	1.50
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LM1307	1.25
LM1458	.95
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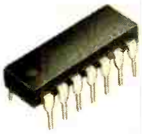

Type	Cat. No.	ONLY
7400	276-1801	35¢
7402	276-1811	39¢
7404	276-1802	35¢
7406	276-1821	49¢
7410	276-1807	39¢
7413	276-1815	79¢
7420	276-1809	39¢
7427	276-1823	49¢
7432	276-1824	49¢
7441	276-1804	99¢
7447	276-1805	99¢
7448	276-1816	99¢
7451	276-1825	39¢
7473	276-1803	49¢
7474	276-1818	49¢
7475	276-1806	79¢
7476	276-1813	59¢
7485	276-1826	1.19
7486	276-1827	49¢
7490	276-1808	79¢
7492	276-1819	69¢
74123	276-1817	99¢
74145	276-1828	1.19
74150	276-1829	1.39
74154	276-1834	1.29
74192	276-1831	1.19
74193	276-1820	1.19
74194	276-1832	1.19
74196	276-1833	1.29

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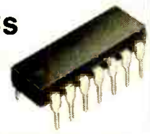

Type	Cat. No.	ONLY
74C00	276-2301	49¢
74C02	276-2302	49¢
74C04	276-2303	49¢
74C08	276-2305	49¢
74C74	276-2310	89¢
74C76	276-2312	89¢
74C90	276-2315	1.49
74C192	276-2321	1.69
74C193	276-2322	1.69
4001	276-2401	49¢
4011	276-2411	49¢
4013	276-2413	89¢
4017	276-2417	1.49
4020	276-2420	1.49
4027	276-2427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

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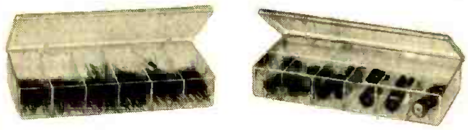
Type	Cat. No.	ONLY
301CN	276-017	49¢
324N	276-1711	1.49
339N	276-1712	1.49
386CN	276-1731	99¢
555CN	276-1723	79¢
556CN	276-1728	1.39
566CN	276-1724	1.69
567CN	276-1721	1.99
723CN	276-1740	69¢
741CN	276-007	49¢
741H	276-010	49¢
3900N	276-1713	99¢
3909N	276-1705	99¢
3911N	276-1706	1.99
4558CN	276-038	79¢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

Resistor and Capacitor Packs



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272-1402	0.22	39¢	272-1408	3.3	45¢
272-1403	0.33	39¢	272-1409	4.7	49¢
272-1404	0.47	39¢	272-1410	6.8	49¢
272-1405	0.68	39¢	272-1411	10.0	49¢
272-1406	1.0	39¢	...	...	...

Nos. 1401-1408, 35WVDC; 1409-1411, 16WVDC.

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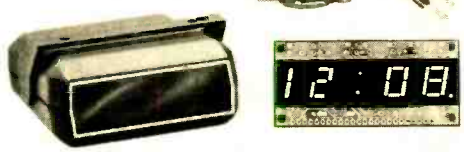
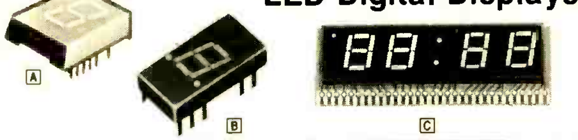
Build an LED Digital Clock



12-HR LED Clock Module. Just add a transformer and switches for a complete clock with 0.5" LED display. **277-1001** **14.95**
Transformer for above. 120VAC 60 Hz. **273-1520** **3.99**
SPST Miniature Pushbutton Switch. 275-1547 .... **5/1.99**
Display Case. 1 13/16x3 7/8x4 7/16". **270-285** **3.95**

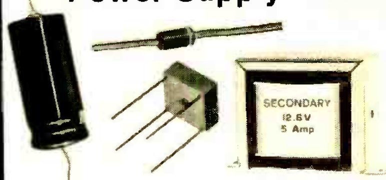
LED Digital Displays



Digits	Size	Drive	Cat. No	ONLY
A 1	0.6"	Anod.	276-056	2.99
A 1	0.6"	Cath.	276-066	2.99
B 1	0.3"	Anod.	276-053	1.99
B 1	0.3"	Cath.	276-062	1.99

Digits	Size	Drive	Cat. No	ONLY
B 1	0.3"	Anod.	276-1210	4/6.99
B 1	0.3"	Cath.	276-1211	4/6.99
C 4	0.5"	Anod.	276-1201	6.95
C 4	0.5"	Cath.	276-1202	6.95

Power Supply Parts



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276-1180 .... 1.99
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276-1141 .... **Pkg. 2/69¢**

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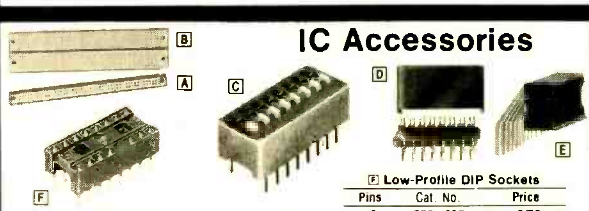
Cat. No.	Volts	Current	Size	Each
273-1512	25.2 CT	2A	2¾x2¼x2"	4.99
273-1513	12	5A	4x2x2½"	8.95
273-1514	18 CT	4A	4x2x2½"	8.95

IC Accessories



A **Bus Strip. 276-173** **1.99**
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C **DIP Switch. 275-1301** **1.99**
D **DIP Header. 276-1980** **1.29**
E **Right Angle 16-Pin Socket. 276-1985** **1.49**

F Low-Profile DIP Sockets

Pins	Cat. No.	Price
8	276-1995	2/59¢
14	276-1999	2/89¢
16	276-1998	2/89¢
28	276-1997	Ea. 89¢
40	276-1996	Ea. 99¢

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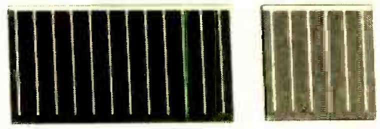

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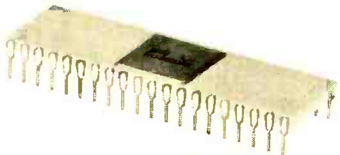
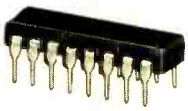
2cmx2cm. 0.5V at 60mA. **276-128** **1.99**

Computer Chips





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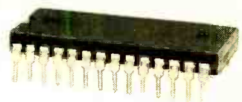

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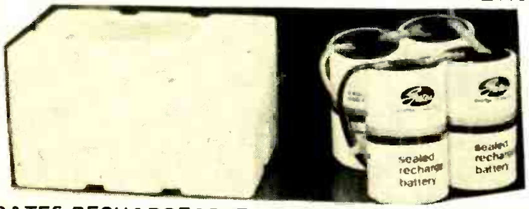

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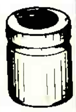
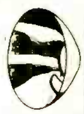


350 mf	330V	1.00
720 mf	360V	1.50
1000 mf	360V	1.75

REFLECTOR



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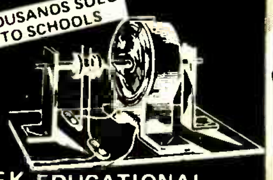

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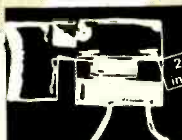

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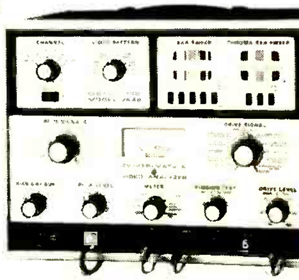

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74LS08	.28	74LS153	.75
74LS09	.28	74LS155	.75
74LS10	.28	74LS156	.75
74LS11	.28	74LS157	.75
74LS13	.49	74LS158	.75
74LS14	.99	74LS160	1.02
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74LS26	.32	74LS168	1.10
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74LS55	.28	74LS195	.85
74LS73	.39	74LS196	.85
74LS74	.39	74LS197	.85
74LS76	.39	74LS251	.85
74LS83	.79	74LS253	.85
74LS85	.69	74LS257	.75
74LS86	.39	74LS258	.75
74LS90	.57	74LS260	.33
74LS92	.57	74LS266	.39
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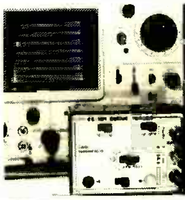

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LARGE QTY AVAILABLE

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Supply voltage 1.5V 12V
Ideal for Alarm or Tone Indicator
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- Continuously variable from 5V to 20V
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- Kit includes all components
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- Case included
- 4400 Mfd of filtering
- One hour assembly

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Same as above but with a 1 Amp output, also with case
ONLY $13.95

LOOK AT THIS SPECIAL FROM RADIO HUT

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- Load regulation 50mV

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Buy 2 for $8.

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B Directly interfaces with all MOS clock chips.
C Super low power consumption (1.5 ma type.)
D Uses latest MOS 17 stage divider IC.
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KIT INCLUDES CRYSTAL, DIVIDER IC, P.C. BOARD PLUS ALL NECESSARY PARTS & SPECS.

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- Punched Case

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7401	.13	7432	.23	7481	.55	74154	.98
7402	.13	7433	.26	7482	.57	74155	.89
7403	.13	7437	.23	7483	.67	74156	.89
7404	.15	7438	.23	7485	.89	74157	.55
74L04	.29	7440	.13	7489	1.25	74160	.55
74S04	.44	7441	.76	7490	.65	74161	.65
7405	.13	7442	.47	7491	.61	74163	.65
7406	.16	7443	.59	7492	.43	74164	.85
7407	.16	7444	.59	7493	.43	74165	.89
7408	.19	7446	.68	7494	.67	74174	.85
7409	.19	7447	.68	7495	.67	74175	.85
7410	.13	7448	.71	7496	.67	74180	.67
7411	.18	7450	.13	74100	.30	74181	1.93
7412	.26	7451	.13	74104	.49	74182	.68
7413	.37	7453	.13	74107	.28	74191	.98
7416	.15	7454	.13	74109	.31	74192	.79
7420	.13	7460	.19	74121	.29	74193	.81
7421	.13	7470	.27	74123	.48	74194	.81
7423	.25	7472	.25	74132	.99	74195	.69
7425	.29	7473	.29	74136	.99	9316	.85
7426	.24	7474	.29	745138	1.95	9601	3/$1
7427	.19	7475	.47	74141	.75	9L04	.35
7428	.26	7476	.31	74151	.61		

74LS00 LOW POWER SCHOTTKY

74LS00	.21	74LS47	.73	74LS136	.37	74LS258	.71
74LS02	.21	74LS51	.26	74LS138	.71	74LS260	.26
74LS03	.21	74LS54	.26	74LS139	.71	74LS266	.26
74LS04	.28	74LS55	.26	74LS145	1.00	74LS279	.55
74LS05	.28	74LS73	.35	74LS151	.70	74LS290	.75
74LS08	.21	74LS74	.35	74LS153	.70	74LS293	.61
74LS09	.28	74LS76	.49	74LS155	.69	74LS295	.95
74LS10	.21	74LS83	.73	74LS156	.70	74LS298	.95
74LS11	.21	74LS85	1.35	74LS157	.75	74LS365	.55
74LS13	.45	74LS86	.36	74LS158	.71	74LS366	.55
74LS14	.99	74LS90	.55	74LS160	.85	74LS367	.55
74LS15	.26	74LS92	.55	74LS161	.85	74LS368	.55
74LS20	.24	74LS93	.55	74LS162	.85	74LS390	1.75
74LS21	.28	74LS109	.38	74LS163	.85	74LS393	1.45
74LS22	.28	74LS112	.38	74LS164	1.49	74LS670	2.30
74LS26	.32	74LS113	.38	74LS168	.85	74LS192	.95
74LS27	.32	74LS114	.38	74LS169	.85	74LS193	.95
74LS30	.26	74LS122	.49	74LS170	1.69	74LS194	.95
74LS32	.32	74LS124	.99	74LS173	1.10	74LS195	.85
74LS37	.32	74LS125	.47	74LS174	1.00	74LS196	.85
74LS38	.32	74LS126	.47	74LS175	.81	74LS197	.85
74LS40	.26	74LS132	.79	74LS190	.95	74LS251	.85
74LS42	.65	74LS133	.35	74LS191	.95	74LS253	.81
						74LS257	.71

74H SERIES TTL

74H00	.18	74H21	.29	74H53	.29	74H73	.39
74H05	.29	74H40	.29	74H61	.25	74H74	.39
74H20	.29	74H50	.20	74H72	.45		

CMOS

CD400	.19	CD4017	.95	CD4040	1.00	CD4071	.19
CD4001	.19	CD4018	.95	CD4041	.69	CD4081	.19
CD4002	.19	CD4019	.19	CD4042	.69	CD4507	.35
CD4006	1.20	CD4020	.97	CD4043	.60	CD4508	2.80
CD4007	.19	CD4021	.97	CD4044	.60	CD4510	1.00
CD4009	.47	CD4022	.97	CD4046	1.39	CD4512	1.10
CD4010	.39	CD4023	.19	CD4047	1.50	CD4516	.79
CD4011	.19	CD4024	.75	CD4049	.35	CD4518	1.10
CD4012	.29	CD4025	.19	CD4050	.39	CD4520	.69
CD4013	.32	CD4027	.39	CD4051	1.19	CD4528	.85
CD4014	.78	CD4028	.85	CD4053	1.19	74C02	.45
CD4015	.78	CD4029	.99	CD4056	1.15	74C04	.32
CD4016	.32	CD4030	.35	CD4066	.78	74C107	.79

TTL SPECIAL!

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9000 series parts prime from ITT Pin for Pin compatible with 7400 series

DTL

932	Dual 4 Input Buffer	8/$1
934	Dual 5 Input NAND Gate	10/$1
941	One Shot Multivibrator	5/$1
945	JK F/F	8/$1
946	Quad 11 Input Gate NAND/NOR	8/$1
948	JK F/F	8/$1
950	F/F	10/$1
951	One Shot Multivibrator	5/$1
1800	(see 934 above)	10/$1
1806	Quad 2 Input NAND Gate	10/$1
9093	Dual JK F/F	8/$1
9094	Dual JK F/F	8/$1
9097	Dual JK F/F	8/$1
9099	Dual JK F/F	8/$1
9109	Hex Inverter	7/$1
9110	Hex Inverter	7/$1
9112	Hex Inverter	7/$1
9601	One Shot	3/$1
9930	Dual 4 Input Ext NAND	8/$1
9932	Quad 2 Input NAND Buffer	8/$1
9945	RS F/F	8/$1
9946	Quad 2 Input NAND	8/$1
9949	Quad 2 Input NAND	8/$1
9951	Monostable Multivibrator	8/$1
9962	Triple 3 Input NAND	8/$1

ITT HIGH LEVEL LOGIC

301	Dual 5 Input NAND Gate	.15
302	Quad 2 Input Buffer open collector	.18
303	Quad 2 Input NAND Buffer	.15
311	Master Slave F/F	.18
312	Dual JK Flip Flop	.18
321	Quad 2 Input NAND Gate	.18
322	Dual 5 Input NAND Gate	.15
323	Quad 2 Input NAND Gate	.18
324	Quad 2 Input NAND Gate	.18
325	Dual 2 Dual 3 Input NAND Gate	.13
326	Dual 2 Dual 3 Input NAND Gate	.13
331	Dual 5 Input Expander	.13
332	Hex Inverter	.18
333	Hex Inverter	.18
334	Hex Inverter	.18
335	Hex Inverter	.18
342	Dual One Shot Multivibrator	.25
343	Dual 4 Bit Comparator	.22
370	Quad D Flip Flop	.22
371	Decode Counter	.30
372	Quad Ripple Counter	.39
380	BCE to Decimal Decoder	.39
381	BCD to Decimal Decoder	.39

ITT LED DRIVERS

ITT 501 Quad Seg. Dr	35
ITT 502 Hex Digit Dr	.49
ITT 503 Quad Seg. Dr	.49
ITT 506 Hex Digit Dr	.49
ITT 508 8 Digit Dr	.49
ITT 509 8 Seg. Dr	.49
ITT 511 Quad Seg. Dr	55
ITT 514 8 Digit Dr	59

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16 Pin Low Profile	.25
18 Pin Low Profile	.30
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Please specify that you are ordering House Number TTL.

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Similar to 2N913
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1,900 MFD 35WVDC (Mini)	3/$2
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68 PFd	50V	680 PFd	50V
100 PFd	100V	.001 Fd	
150 PFd	50V	.002 MFd	50V
220 PFd	50V	.01 MFd	200V
330 PFd	50V	.02 MFd	200V
.001 UFd	500V	3.3 PF	500V
.0015 UFd	500V	4.7 PF	500V
.005 UFd	500V	8.2 PF	500V
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Output voltages variable from 2 volts to 37 volts. A very versatile and popular device. —14 PIN DIP
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LM 307	Operational Amplifier	.30	NE 556	Dual Timer	.95
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INPUT VOLTAGE 25V MAX. OUTPUT CURRENT 1 AMP. MAX. LOAD REGULATION 50mV. OUTPUT VOLTAGE 12V. LINE REGULATION 0.01%. KIT CONTAINS ALL PARTS EXCEPT FOR LINE CORD AND TRANSFORMER.

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S.D. SALES NEW EXPANDABLE EPROM BOARD

16K or 32K EPROM $49.95 w/out EPROM

Allows you to use either 2708's for 16K of Eprom or 2716's for 32K of Eprom.

KIT FEATURES:

1. All address lines & data lines buffered.
2. Quality plated through P.C. Board, including solder mask and silk screen.
3. Selectable wait states.
4. On board regulation provided.
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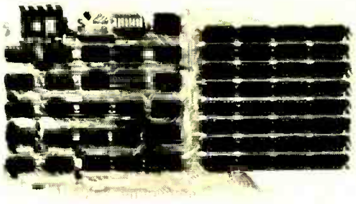
WE CAN SUPPLY 450ns 2708's AT $11.95 WHEN PURCHASED WITH BOARD.

32K FOR $475 EXPANDORAM KIT 24K FOR $367.00



MEMORY CAPACITY
MEMORY ADDRESSING
MEMORY WRITE PROTECTION

8K, 16K, 24K, 32K using Mostek MK4115 with 8K boundaries and protection. Utilizes DIP switches. PC board comes with sockets for 32K operation. Orders now being accepted. Allow 6 to 8 weeks for delivery.

INTERFACE CAPABILITY
Control, data and address inputs utilizes low power Schottky devices.

POWER REQUIREMENTS
+8VDC 400MA DC
+18VDC 400MA DC
−18VDC 30MA DC

on board regulation is provided. On board (invisible) refresh is provided with no wait states or cycle stealing required.

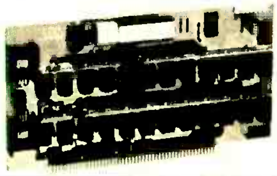
MEMORY ACCESS TIME IS 375ns.
Memory Cycle Time is 500ns.

Buy an S100 compatible 8K Ram Board and upgrade the same board to a maximum of 32K in steps of 8K at your option by merely purchasing more ram chips from S.D. Sales! At a guaranteed price — Look at the features we have built into the board.

16K FOR $259.00 **8K FOR $151.00**

Z-80 CPU BOARD KIT — $139.

CHECK THE ADVANCED FEATURES OF OUR Z—80 CPU BOARD: Expanded set of 158 instructions, 8080A software capability, operation from a single 5VDC power supply; always stops on an M1 state, true sync generated on card (a real plus feature!), dynamic refresh and NMI available, either 2MHZ or 4MHZ operation, quality double sided plated through PC board; parts plus sockets priced for all IC's. *Add $10 extra for Z—80A chip which allows 4MHZ operation. **Z—80 chip with Manual — 29 95**



NEW FROM S.D. "VERSAFLOPPY"™ KIT

THE VERSATILE FLOPPY DISK CONTROLLER

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Features: IBM 3740 Soft Sectored Compatible. S-100 BNS Compatible for Z-80 or 8080. Controls up to 4 Drives (single or double sided). Directly controls the following drives:

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The new "Versafloppy" from S.D. Computer Products provides complete control for many of the available Floppy Disk Drives. Both Mini and Full Size. At the heart of "Versafloppy" is the powerful Western Digital FD1771B-1 Single Density Controller Chip. This allows a great flexibility via Control Software. Listings for Control Software are ncluded in the price.

FD 1771B-1 CHIP ALONE $39.95

4K LOW POWER RAM KIT

Fully Buffered — on board regulated — reduced power consumption utilizing low power 21L02 — 1 500ns RAMS — Sockets provided for all IC's. Quality plated through PC board. *Add $10. for 250ns RAM operation.

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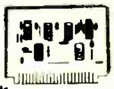
Low Cost Cassette Interface Kit



Features: Play and record K.C. Standard 2400/1200 Hz tapes, 300 Baud, TTL I/0 Compatible, Phase Lock Loop, Both 22 Pin Connector and 8 Pin Molex Connector. Comes partially assembled. Oscillator and phase lock loop pre-tuned to K.C. Standard. Selector switch sends cassette data or auxiliary input data to microprocessor. LED indicates logic 1 level.

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6 DIGIT ALARM CLOCK KIT

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

AC XFMR — $1.50 Case $3.50 **$12.95**

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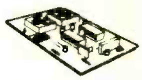
Features: Litronix dual 1/2" displays. Uses Silicoaix LD131 single chip CMOS A/D converter. Kit includes all necessary parts (except case); AC line cord and power supply included. 0-149° F.



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DL 721 8 C.A.	DL 727 - C.A.
99c	$1.29

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$34.95	$26.90	$3.50

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FEATURES:

A. Bowmar Jumbo .5 inch LED array.
B. MOSTEK — 50250 — Super clock chip.
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F. PC board and all parts (less case) inc.

Alarm option — $1.50
AC XFMR — $1.50

$16.95

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21L02 - 500NS	8/11 50
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2114 — 4K	14 95
1101A — 256	8/$4 00
1103 — 1K	35
MK 4115 - 8K	1S 45
74S 200 - 256	3.95

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Z—80 includes manual	29 95
Z—80A includes manual	34 95
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1702A - 1K - 1.5us	3.95 or 10/35.
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Z-80 Programming Manual

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TR 1602B Uart	3.95
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CMOS

4001	19	4029	99
4002	19	4042	69
4011	19	4047	1.50
4013	32	4049	35
4016	32	4069	23
4017	95	4071	19
4020	97	4076	97
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CIRCLE 54 ON FREE INFORMATION CARD

PORTABLE FREQUENCY COUNTER
continued from page 39

checkout. Make sure that the batteries are fully charged, then connect a 0–250-mA meter across S2 and perform the test as described.

There are two ways you can calibrate your counter. Both are pretty easy, but they do require quality equipment that is in calibration. Try to beg or borrow the best equipment to be mentioned you can if you don't have it already. The accuracy of your counter will depend on it!

The first method is probably the best. You'll need a counter that has an accuracy to at least ± 0.001%. Let it warm up for a few minutes (the calibration counter) and attach a X10 scope probe to its input. Ground the probe ground to the case of your counter, and touch the probe tip to the large pad on the board marked CAL. Press S2 and hold it for about a minute. Note that the batteries should be fully charged! Then adjust the trimmer (C8) for a reading of 3,579, 545 Hz. There will be some jitter in the last digit, but try to get it close to a "5" as you can. You must be within ± 179 Hz to meet the accuracy spec. That's it!

The other method is to connect a known signal to the input of the counter and adjust the trimmer until you get a proper reading. Take a signal generator/counter combination and attach it to the input jack J1. Then set the generator to 10,000,000 Hz or exactly 10 MHz. Next, set S1 to the MHZ position, and press S2. The display will show a jumble of numbers and then two seconds later show a reading close to 10 MHz. If not, adjust the output level on the signal generator until it does. Adjust trimmer C8 for a reading of 10–00. Flip S1 to KHZ and you should get 00–00 with the overrange lamp lit. If not, adjust C8 until you do.

Now put it to work

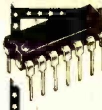
Using this counter is a snap! Simply unsnap it from your belt (get a surplus calculator case) or take it out of your toolbox and connect it to the signal you want to check. Press S2 and hold it for at least six seconds for two readings. Meanwhile, set S1 to MHZ to get a reading, flipping it to KHZ or HZ for a reading if necessary. Presto! In seconds you have a reading of four digits!

If your frequency is 1 MHz or greater, you can get up to six digits of resolution by combining two ranges. Here's how to do it: Say you are measuring a frequency of 10.125 MHz. On the MHZ position of S2 you will get 10–13, with the dash mark indicating the decimal point printed on the case. On the KHZ position you will get a reading of 25–00 plus overrange (OR). Here's how to combine the readings:

```
    10-13
+      25-00
  ---------
  10-125-00
```

That's all there is to it. But remember to always drop the least-significant digit from the MHz range (that's the "3") when combining the two ranges. As you can see, we actually got seven digits of resolution in this digit. But actually, there will be some jitter in this digit during the measurement, making its usefulness rather limited. You can perform the same stunt of combining readings on the kHz and Hz ranges, too. But in this case three numbers will overlap.

A few last words concerning the display of this counter. Decimal points were left out of the display to save power, and as a result, were printed on the case. Also, a digit was blanked in the readout to emphasize a decimal on the MHz and KHz ranges. On the Hz range, the decimal is at the far right end of the display, so you ignore the gap. With a little practice you will get used to this arrangement. **R-E**



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INTEGRATED CIRCUITS

TTL

7400	.21
7401	.21
7402	.21
7403	.21
7404	.21
7405	.21
7406	.25
7407	.25
7408	.21
7409	.21
7410	.21
7411	.21
7412	.21
7413	.25
7414	.89
7416	.25
7417	.25
7420	.21
7421	.25
7423	.35
7425	.35
7426	.25
7427	.33
7428	.28
7430	.21
7432	.25
7433	.30
7437	.25
7438	.25
7439	.50
7440	.21
7442	.53
7445	.70
7446	.70
7447	.70
7448	.70
7450	.21
7451	.21
7453	.21
7454	.21
7460	.21
7470	.30
7472	.30
7473	.30
7474	.30
7475	.49
7476	.32
7480	.70
7483	.70
7485	.89
7486	.28
7489	2.19
7490	.44
7491	.70
7492	.44
7493	.44
7494	.70
7495	.70
7496	.70
74100	1.28
74107	.30
74109	.33
74116	1.26
74121	.35
74122	.44
74123	.61
74125	.40
74126	.40
74128	.48
74132	.70
74141	.88
74145	.70
74147	1.63
74148	1.30
74150	1.16
74151	.70
74153	.65
74154	1.03
74155	.70
74156	.70
74157	.70
74160	.88
74161	.88
74162	.88
74163	.88
74164	.96
74165	1.15
74166	1.15
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
74LS96	.88
74LS107	.39
74LS109	.39
74LS112	.39
74LS113	.39
74LS114	.39
74LS125	.49
74LS126	.49
74LS132	.81
74LS136	.39
74LS138	.73
74LS139	.73
74LS151	.75
74LS153	.75
74LS154	1.10
74LS155	.75
74LS156	.75
74LS157	.75
74LS158	.75
74LS160	1.02
74LS161	1.02
74LS163	1.02
74LS164	1.02
74LS168	1.14
74LS169	1.14
74LS170	1.73
74LS173	1.34
74LS174	1.06
74LS175	.84
74LS181	2.50
74LS190	1.18
74LS191	1.18
74LS192	.98
74LS193	1.06
74LS194	.88
74LS195	.86
74LS196	.86
74LS197	.86
74LS197	.86
74LS221	1.06
74LS240	1.90
74LS241	1.90
74LS242	1.70
74LS243	1.70
74LS244	1.70
74LS247	.79
74LS248	.79
74LS249	.79
74LS251	.84
74LS253	.84
74LS257	.75
74LS258	.75
74LS260	.34
74LS261	2.00
74LS266	.39
74LS273	1.28
74LS279	.62
74LS283	.79
74LS290	.65
74LS293	.65
74LS295	1.12
74LS298	1.30
74LS365	.67
74LS366	.67
74LS367	.67
74LS368	.67
74LS377	1.50
74LS386	.39
74LS395	1.74
74LS670	2.34
81LS95	.77
81LS96	.77
81LS97	.77
81LS98	.77

INTERFACE

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

4000 CMOS

4000	.23
4001	.23
4002	.23
4006	1.23
4007	.23
4008	.79
4009	.44
4010	.44
4011	.23
4012	.23
4013	.40
4014	.96
4015	.96
4016	.40
4017	1.05
4018	1.05
4019	.23
4020	1.14
4021	1.14
4022	.96
4023	.23
4024	.84
4025	.23
4026	1.68
4027	.40
4028	.89
4029	1.14
4030	.23
4033	1.51
4034	3.50
4035	1.14
4040	1.14
4041	.79
4042	.79
4043	.70
4044	.70
4046	1.86
4049	.40
4050	.40
4051	1.26
4052	1.26
4053	1.26
4060	1.58
4066	.79
4071	.23
4072	.23
4073	.23
4075	.23
4081	.23
4082	.23
4502	.79
4510	1.14
4511	1.05
4514	2.80
4515	2.80
4516	1.23
4518	1.14
4520	1.14
4527	1.68
4528	.88
4585	1.23
74C00	.23

LINEAR

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

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MM5314N	3.75

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24 PIN SOLDER	.38	3.60/10	32.25/C
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8 PIN W-W	.24	2.30/10	20.50/C
14 PIN W-W	.25	2.50/10	22.00/C
16 PIN W-W	.30	2.85/10	25.50/C
18 PIN W-W	.53	5.10/10	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
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.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

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VALUE	RADIAL LEADS			AXIAL LEADS		
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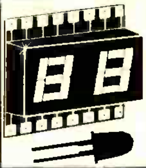
1/50V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
2.2/50V	.08	.65/10	5.41/C	.12	.90/10	7.82/C
3.3/50V	.08	.65/10	5.41/C	.12	1.00/10	8.31/C
4.7/35V	.08	.65/10	5.41/C	.12	.95/10	7.91/C
4.7/50V	.08	.68/10	5.75/C	.12	1.00/10	8.31/C
10/16V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
10/25V	.08	.65/10	5.66/C	.12	1.00/10	8.31/C
10/35V	.09	.70/10	6.12/C	.13	1.10/10	8.94/C
10/50V	.10	.75/10	6.58/C	.14	1.15/10	9.56/C
22/16V	.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
47/50V	.15	1.21/10	11.16/C	.21	1.71/10	14.55/C
100/10V	.10	.77/10	6.58/C	.14	1.13/10	9.56/C
100/16V	.11	.85/10	7.28/C	.17	1.30/10	11.22/C
100/25V	.13	1.10/10	9.15/C	.20	1.55/10	13.30/C
100/35V	.17	1.41/10	11.85/C	.25	1.93/10	16.50/C
100/50V	.21	1.71/10	14.55/C	.29	2.30/10	19.70/C
220/10V	.13	1.08/10	9.15/C	.18	1.42/10	12.05/C
220/16V	.15	1.16/10	9.86/C	.20	1.55/10	13.[illegible]0/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

LED DIGITS AND LAMPS



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

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½ WATT RESISTOR ASSORTMENTS

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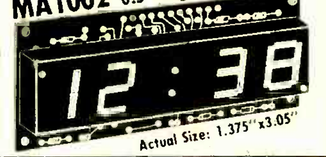
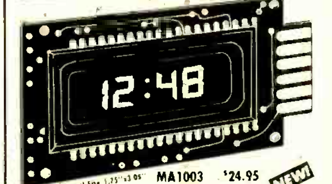
MA1002 0.5" High Digits



Actual Size: 1.375"x3.05"

MA1010 0.84" High Digits

Actual size: 1.75"x3.75"



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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
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MPS3638A	.16	1.55/10	13.60/C	130.00/M
MPS3640	.16	1.55/10	13.60/C	130.00/M
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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
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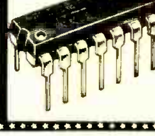

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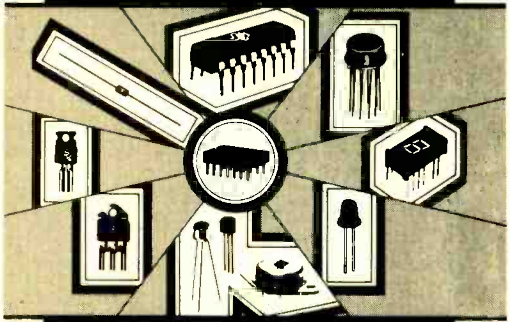

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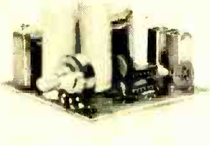

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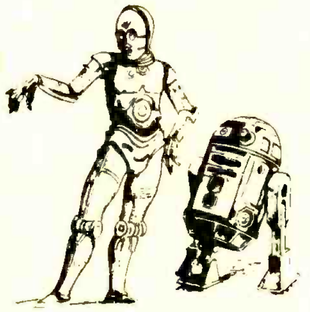

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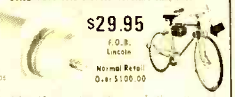

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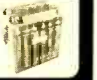

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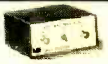

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AM/FM/CB Antenna (mounts like reg. car antenna) List $39.95 now **$29.95**
Medallion 5¼" Co-Axial Speakers 10 oz. magnets List $39.95 pr. now **$19.95 pr.**

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BREAD BOARD JUMPER WIRE KIT

Each kit contains 350 wires cut to 14 different lengths from 0.1" to 5.0".

Each wire is stripped and the leads are bent 90° for easy insertion.

Wire length is classified by color coding.

All wire is solid tinned 22 gauge with PVC insulation.

The wires come packed in a convenient plastic box.

JK1 . . . .$10.00 / kit

SOCKET JUMPERS

Mates with two rows of .025" sq. or dia. posts on patterns of .100" centers and shielded receptacles. Probe access holes in back. Choice of 6" or 18" length.

Part No.	No. of Contacts	Length	Price
924003-18R	26	18"	$ 5.38 ea.
924003-06R	26	6"	4.78 ea.
924005-18R	40	18"	8.27 ea.
924005-06R	40	6"	7 33 ea.
924006-18R	50	18"	10.31 ea.
924006-06R	50	6"	9.15 ea.

JUMPER HEADERS

Solder to PC boards for instant plug-in access via socket-connector jumpers. .025" sq. posts. Choice of straight or right angle.

Part No.	No. of Posts	Angle	Price
923863-R	26	straight	$1.28 ea.
923873-R	26	right angle	1.52 ea.
923865-R	40	straight	1.94 ea.
923875-R	40	right angle	2.30 ea.
923866-R	50	straight	2.36 ea.
923876-R	50	right angle	2.82 ea.

INTRA-CONNECTOR

Provides both straight and right angle functions. Mates with standard .10" x .10" dual row connectors (i.e. 3m, Ainsley, etc.) Permits quick testing of inaccessible lines.

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

INTRA-SWITCH

Permits instant line-by-line switching for diagnostic or QA testing. Switches actuated with pencil or probe tip. Mates with standard .10" x .10" dual-row connectors. Low profile design. Switch buttons recessed to eliminate accidental switching.

Part No.: IS-26 **No. of contacts:** 26 **Price** $13.80 ea.

CRYSTALS

THESE FREQUENCIES ONLY

Part #	Frequency	Case/Style	Price
CY1A	1.000 MHz	HC33 U	$5 95
CY2A	2.000 MHz	HC33 U	$5.95
CY2.01	2.010 MHz	HC33/U	$ .99
CY3A	4.000 MHz	HC18/U	$4 95
CY7A	5.000 MHz	HC18/U	$4 95
CY12A	10.000 MHz	HC18 U	$4 95
CY14A	14.31818 MHz	HC18U	$4 95
CY19A	18.000 MHz	HC18 U	$4 95
CY22A	20.000 MHz	HC18 U	$4 95
CY30B	32.000 MHz	HC18 U	$4 95

CONNECTORS

PRINTED CIRCUIT EDGE-CARD

.156 Spacing-Tin-Double Read-Out

Bifurcated Contacts — Fits .054 to .070 P.C. Cards

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

25 PIN-D SUBMINATURE (RS232)

DB25P	PLUG	$3.25
DB25S	SOCKET	$4.95

SWITCHES

¼" mounting holes

Type	Part	Pole	Action	1-9	10+
TOGGLE (sub-minature)	JMT121	SPDT	on-off-on	$1 95	$1 43
	JMT123	SPDT	on-none-on	1 65	1 21
	JMT221	DPDT	on-off-on	2.55	1 87
	JMT223	DPDT	on-none-on	2 15	1 58
TOGGLE (Printed Circuit)	MPC121	SPDT	on-off-on	$2.05	$1 53
	MPC123	SPDT	on-none-on	1 75	1 31
	MPC221	DPDT	on-off-on	2 65	1 97
	MPC223	DPDT	on-none-on	2 25	1 68
PUSH BUTTON	PB123	SPDT	maintained	1.95	1.47
	PB126	SPDT	momentary	1 95	1 47
PUSH BUTTON Minature	MS102	DPST	momentary open	.35	30
	MS103	SPST	momentary closed	.35	30
DIPSWITCH SPST	206-4	8 pin dip	4 switch	1.75	1 65
	206-7	14 pin dip	7 switch	1 95	1 85
	206-8	16 pin dip	8 switch	2.25	2 15

1/16 VECTOR BOARD

	0 1 Hole Spacing Part No	P-Pattern L	W	Price 1-9	10 up
PHENOLIC	64P44 062XXXP	4 50	6 50	1.72	1 54
	169P44 062XXXP	4.50	17 00	3 69	3,32
EPOXY	64P44 062WE	4 50	6.50	2.07	1 86
GLASS	84P44 062WE	4.50	8 50	2.56	2.31
	169P44 062WE	4.50	17 00	5.04	4.53
	169P84 062WE	8.50	17.00	9 23	8.26
EPOXY GLASS COPPER CLAD	169P44 062WEC1	4.50	17.00	6.80	6.12

INSTRUMENT/ CLOCK CASE

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

$3.95 ea.

MICROPROCESSOR COMPONENTS

8080A	CPU	$16.00	CDP1802	CPU	$19.95
8212	8 Bit Input/Output	4.95	MC6800	8 Bit MPU	24.95
8214	Priority Interrupt Control	15.95	MC6820	Periph. Interface Adapter	15.00
8216	Bi-Directional Bus Driver	6 95	MC6810AP1	128 x 8 Static RAM	6.00
8224	Clock Generator/Driver	9 95	MC6830L8	1024 x 8 Bit ROM	15.00
8228	System Controller Bus Driver	10.95	Z80	CPU	29.95

CPU'S

3080A	Super 8008	16.00
2650	8 BIT MPU	26 50
P8085	CPU	29.95

SR'S

2504	1024 Dynamic	$ 3 95
2518	Hex 32 BIT	7 00
2519	Hex 40 BIT	4 00
2522	Dual 132 Bit SSR	2 95
2524	512 Dynamic	.99
2525	1024 Dynamic	3.00
2527	Dual 256 BIT	3 95
2529	Dual 512 BIT	4 00
2532	Quad 80 BIT	3 95
2533	1024 Static	5 95
3341	Fifo	6 95
74LS670	16 x 4 Reg	3 95

UART'S

AY-5-1013	30K Baud	$5 95

ROM'S

2513(2140)	Char Gen -upper case	$ 9 95
2513(3021)	Char Gen -lower case	9.95
2516	Char Gen	10.95
MM5230	2048 BIT (512 x 4 on 256 x 8)	1.95

RAM'S

1101	256 x 1	Static	$ 1 49
2101	256 x 4	Static	5 95
2102	1024 x 1	Static	1 75
2107 5280	4096 x 1	Dynamic	4 95
2111	256 x 4	Static	6 95
7489	16 x 4	Static	2 49
8101	256 x 4	Static	5.95
8111	256 x 4	Static	6.95
8599	16 x 4	Static	3 49
21L02/91L02	1024 x 1	Static	2 25
74200	256 x 1	Static	6 95
93421	256 x 1	Static	2 95
MM5262	2K x 1	Dynamic	3 for 1.00
UPD414(2104)4K		Dynamic 16 Pin	5.95

PROMS

1702A	2048	Fumos	$ 9 95
5203	2048	Famos	14 95
82S23	32 x 8	Open C	5 00
82S123	32 x 8	Tristate	5 00
74S287	1024	Static	7 95
3601	256 x 4	Fast	3 95
2708	8K	Eprom	19.95
2716	16K	Eprom	34 95
6301-1	1024	Tri-State Bipolar	3 49
6330-1	256	Open Collector Bipolar	2 95

SPECIAL REQUESTED ITEMS

FCM3817	$5 00	11C90	19.95	7205	19.95	9368	3.95
AY-3-8500-1	9.95	4N33	3 95	ICM7045	24.95	LD110/111	25.00/set
AY-5-9100	17.50	8T20	7.50	ICM7207	7.50	95H90	11.95
AY-5-9200	14.95	8T97	2.00	ICM7208	22.00	MC3061P	3.50
AY-5-9500	4.95	HD0165	7.95	ICM7209	7 50	MC4016 (74416)	7.50
AY-5-2376	14.95	MCM6571	13.50	MK50240	17.50	MC1408L7	8.95
9374	1.95	MCM6574	13.50	DS0026CH	3.75	MC1408L8	9 95
82S115	25.00	MCM6575	13.50	TIL308	10 50	74C922	9.95

CLOCK CHIPS

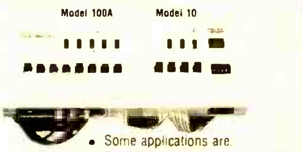
MM5309	$9 95
MM5311	4.95
MM5312	4 95
MM5314	4 95
MM5316	6 95
MM5318	9 95
MM5369	2 95
MM5841	9.95
CT7001	5 95

PARATRONICS

Featured on February's Front Cover of Popular Electronics

Logic Analyzer Kit Model 100A

$229.00/kit



Model 100A Model 10

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

(Model 100A Manual - $4.95)

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

PARATRONICS TRIGGER EXPANDER - Model 10

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

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

B+K PRECISION 3½-Digit Portable DMM

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

Ranges: DC Voltage 0-1000V/ AC Voltage 0-1000V
Freq Response 50-400 HZ
DC/AC Current: 0-100mA
Resistance 0-10 meg ohm
Size 6 4" x 4 4" x 2"

Model 2800 $99.95

Comes with test leads operating manual and spare fuse

Accessories:

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

CSC 100 MHz 8-Digit Counter

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

MAX-100 $134.95

ACCESSORIES FOR MAX 100:

Mobile Charger Eliminator use power from car battery — Model 100 — CLA $3.95

Charger/Eliminator use 110 V AC — Model 100 — CAI $9.95

CONTINENTAL SPECIALTIES

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$15.95
(6" long X 4" wide)

Other CS Proto Boards

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

PROTO CLIPS

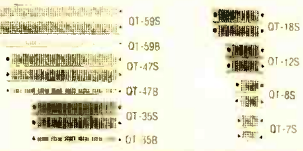
14 PIN	$4 50
16 PIN	4 75
24 PIN	8.50
40 PIN	13.75

DESIGN MATES

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

LOGIC MONITOR for DTL, HTL, TTL or CMOS Devices **$84.95**

CSC QT PROTO STRIPS



QT type	# holes	price
QT-59S	590	12 50
QT-59B	bus strip	2 50
QT-47S	470	10 00
QT-47B	bus strip	2 25
QT-35S	350	8 50
QT-35B	bus strip	2 00
QT-18S	180	4 75
QT-12S	120	3 75
QT-8S	80	3 25
QT-7S	70	3 00

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

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

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Bulb lasts 3 or more times longer
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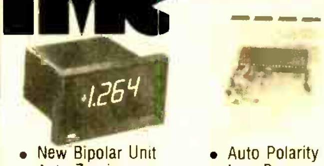
- Crystal Controlled Time Base
- Three Stopwatches in One
  Times Single Event — Split & Taylor
- Size 4.5 x 2.15 x .90 (4½ ounces)
- Uses 3 Penlite Cells

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
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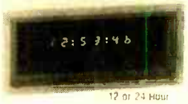
- Single IC Unit

Model KB500 DPM Kit	**$49.00**
Model 311D-5C-5V Power Kit	**$17.50**

JE700 CLOCK



12 or 24 Hour
115 VAC

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

KIT ONLY **$16.95**

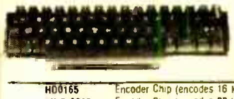
HEXADECIMAL ENCODER 19-KEY PAD

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

$10.95 each

New 63 KEY KEYBOARD

$29.95 IN STOCK



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

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

JE803 PROBE

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

$9.95 Per Kit

printed circuit board

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.56" RHDP

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MAN6640	2 DIG	OR	CC
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MAN6650	1½ DIG	OR	CC
MAN6710	2 DIG	RED	CA
MAN6730	1½ DIG	RED	CA
MAN6740	2 DIG	RED	CC
MAN6750	1½ DIG	RED	CC

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DOUBLE DIGIT LED MIX
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COMMON CATHODE & COMMON ANODE
15/$10.00

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ALUMINUM CASE WITH FILTER. (switches included with clock kit). In Silver, Bronze, Black and Gold. Filter colors — red, blue, green, or yellow. **$5.75**

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4 DIGIT 12 24 HOUR
Includes: PC Board, 5316 Clock Chip, all components and Power Supply.
Displays hours and minutes ... Switch to minutes and seconds ... AM-PM Indicator ... Elapsed Timer ... Fluorescent Display
Options: If alarm function desired add $2.50 (includes speaker and all components)
Plexiglas Case Kit (red or blue) $2.00

Big Bright — 5" LED Alarm Clock
6 Digit AC or DC or Elapsed Timer Kit
$19.95 Complete
PC Board Drilled and silk screened (includes Xtal Time Base Circuitry) ... 5375 Nat. Clock Chip and Fairchild Displays ... includes EVERY part required for clock and all options except Cabinet and Crystal Time Base components if desired.
• Brightness Control • 24 Alarm with snooze • Freeze feat on every mode • 12 Hr 60 Hz oper. • Field Tested over 1 yr. • 0.60 Min Elapsed Timer
Complete Instructions — Schematics, pictorials, layouts
Options – XTAL Time Base Components, $2.95 when purchased with clock. Wood Clock Cabinet, $4 with clock purchase.

Regulated Power Supply Kit, $14.95 complete
2 Amp @ ± 15 and ± 15 volts Current Limiting & Thermal Shutdown Protection.
Includes: Transformer ... Bridge Rectifier ... Filter Caps ... 4-way Binding Posts ... Heat Sink & Line Cord ... Voltage Regulators ... Pass Transistor ... Resistors ... Diodes ... etc ... Complete Instructions and Circuit Diagrams.

Bridges

VOLT	2 AMP	4 AMP	6 AMP	25 AMP
50	$ .60	$ .70	$ .80	$1.30
100	.70	.80	.90	1.40
200	.80	.90	1.00	1.60
400	1.00	1.10	1.20	
600	1.25	1.35	1.40	

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7905, 7912, 7915
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Glass Sealed, 5 amp 115 VAC

1C Sockets $1.00
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24 & 28 Pin 3 $1.00
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MM5314 or MM5316 .... $3.50
MM5387 (H. Cur 5316) or
MM 5375 .... $3.95

Capacitors
500 MFD at 50V .... 4/$1.00
500 MFD at 15V .... 6/$1.00

Sound Actuated Switch $.85

6 Ft. Line Cords 6 for $1.00

6 DIGIT LED STOP-WATCH KIT
$29.95 Complete
Split Time and Taylor Time
Features: Reads mins., secs. and 1/100th sec., 6 bright easily readable digits. Needs only one 9V XISTOR battery. Kit includes: Hand-held case for above, PC board, and all components except battery.

250 K Slide Volume Controls .. 4/$1.00
By Mallory

2 Amp Circuit Breaker .... 2/$1.00
Front Panel Mount through ½ dia. hole. 120 VAC, 32 VDC, Trips at 2.7 amps.

Grain of Wheat type chic. min. Display Lamp — red or white .... 10/$1.00

60 Hz. Crystal Time Base Kit ... $4.95
Use with Digital Clocks for 12 VDC or Portable Operation.
Kit includes: PC Board, 5369 Divider Chip, 3.5795 MHZ XTAL and all other parts plus complete instructions.

70 Volt Line Transformer $2.90
Power Rating — 10 watts. Model TR-1
Primary Volts: 70.7 — Primary Taps: 0.63, 1.25, 2.5, 5, and 10 W. Secondary Impedance: 4 & 8 ohms. Primary and Secondary Terminations: 8" color coded leads. 1⅝"H, ¹¹⁄₁₆D, 2"W. Base 2⅜"W

6" Pioneer Pincushion Speakers $3.95 pair
3.2 ohms, 7½ watts

Heavy Duty Alligator Clip Test Lead Set $2.49
Set of 10 color coded leads with insulated alligator clip on each end.

Jumbo Red LED's ....10/$1.00, 100/$9.00

25 PK. LED's Asstd Sizes & Colors $2.50

Multi-Range Digital Voltmeter Kit $29.95
0 to ± .2 Volts DC — 0 to ± 2 Volts DC
• Latest technology DVM chip set
• High Noise Rejection
• Non Critical Comp.
• Accuracy to within .001
Contains — P.C. Boards; 4-large .50 Fairchild Readouts; Display Drivers; Op-Amps; Inverter; all electronic comp. Switches, Pots; Complete instructions and specs.
Also includes Set/Precision Resistors for increasing Voltage to 200 Volts.
Requirements: Power Supply w ± 5V ± 15V and ± 15V.

Multi-Meter Kit, $49.95
complete with Power Supply

AC/DC Wall Plug Adaptor-Charger $1.00
120 volt input 6VDC 130 MA output.

Transformer, 6.3 volts at 1.2 amps. $1.49

6 Digit LED Alarm Clock Kit and Elasped Timer Indicator . . . $13.95
Red Display
Complete kit includes: National 5375AB Clock Chip; Transformer; PC Boards, Drilled and Silk Screened; SLA-7 Red .33 High Brightness Displays; All components; Instructions and pictorals.
Features: Hrs., Min., and Sec. ... 12 Hr. format with 24 hr. Alarm ... Snooz Feature ... AM PM Indication ... 60 min. elapsed Timer ... Freeze Capability ... Power Fail Indicator.
Options: Wood grain case $4.00 when purchased with kit.

Potentiometer Assortment . 12/$1.00
Includes 1K to 100K. Tab mounts, printed circuit, duals, push-pulls, nylon and metal shafts (long and short)

IN 4148 Switching Diodes ....50/$1.00
Factory prime, taped and reeled

5 Volt, 6 Amp Power Supply Kit .$12.95
Fixed: 6 Amp, 5 volt 1% Regulation. Adjustable: 5-12 volts Unregulated. Short Circuit Protection, Current Limiting.
Complete Kit includes: Transformer, Regulator, Resistors, 4 Way Binding Posts, Heat Sink, Comp. Grade Filter Cap, Output Power Transistors, Capacitors, Bridge Rectifier, Line Cord, complete instructions and Diagrams.

7 SEG LED Displays $.59 ea., 10/$5.00
33" Type 707 MAN-1 14 Pin Dip, Common Annode or Cathode.

Terms and Conditions
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$5.00 Minimum Order.
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Add $1.00 Postage for orders under $10.00.
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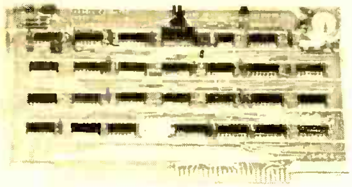
CIRCLE 44 ON FREE INFORMATION CARD

Why Wait?



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- Plugs directly into your IMSAI or ALTAIR*
- Fastest transfer rate: 187 (standard) to 540 bytes/second
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CIRCLE 22 ON FREE INFORMATION CARD

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PRECUT WIRE

Why buy wire on rolls?

PRECUT & STRIPPED WIRE IS:

- **Fast** - No more cutting & stripping by hand
- **Reliable** - Good, clean, uniform strip
- **Economical** - Cheaper than using bulk wire

Precut Wire	Bulk Wire
100 pcs of 3" at $.82 = 3¼¢/ft	50 ft roll at $1.99 = 4¢/ft.
100 pcs of 6" at 1.06 = 2¢/ft.	100 ft roll at 2.95 = 3¢/ft.
Wire Kit 1 at $6.95 = 2 1/3¢/ft.	

30 Kynar stripped 1" on each end. Lengths are overall
Colors: Red, Blue, Green, Yellow, Black, Orange, White
Wire packaged in plastic bags. Add 25¢/length for tubes.

	100	500	1000	5000
2½ in.	.78	2.40	4.30/K	3.89/K
3 in.	.82	2.60	4.71/K	4.22/K
3½ in.	.86	2.80	5.12/K	4.55/K
4 in.	.90	3.00	5.52/K	4.88/K
4½ in.	.94	3.21	5.93/K	5.21/K
5 in.	.98	3.42	6.34/K	5.52/K
5½ in.	1.02	3.65	6.75/K	5.86/K
6 in.	1.06	3.85	7.16/K	6.19/K
6½ in.	1.15	4.05	7.57/K	6.52/K
7 in.	1.20	4.25	7.98/K	6.85/K
7½ in.	1.25	4.45	8.39/K	7.18/K
8 in.	1.29	4.65	8.80/K	7.53/K
8½ in.	1.32	4.85	9.21/K	7.84/K
9 in.	1.36	5.05	9.62/K	8.17/K
9½ in.	1.40	5.25	10.03/K	8.50/K
10 in.	1.45	5.51	10.44/K	8.83/K
Addl. in.	.10	.41	.82/K	.66/K

WIRE WRAP SOCKETS

	1-9	10-24	25-99	100-249	250-999	1K-5K
8 pin*	.41	.38	.35	.31	.29	.27
14 pin*	.42	.39	.36	.32	.29	.27
16 pin*	.46	.43	.39	.35	.32	.30
18 pin*	.63	.58	.54	.47	.44	.41
20 pin	.84	.78	.71	.63	.59	.54
22 pin*	1.30	1.20	1.10	.95	.90	.84
24 pin	.91	.84	.78	.68	.64	.59
28 pin	1.25	1.15	1.08	.95	.89	.82
40 pin	1.65	1.55	1.42	1.25	1.15	1.09

Gold 3-level Closed Entry Sockets
* End & Side Stackable — All prices include gold
Tin sockets and 2-level sockets available

WIRE WRAP TOOLS

$34.95

HOBBY WRAP
Model BW 630
With Free Wire Kit 1
($6.95 Value)

Batteries & Charger	$11.00
WSU 30 Hand Wrap-Unwrap Strip Tool	5.95
WSU 30M, for Modified Wrap	6.95
BT 30 Extra Bit	2.95

WIRE KITS

# 1	$6.95			# 2	$19.95				
250	3"	100	4½"	250	2½"	250	4½"	250	6"
250	3½"	100	5"	500	3"	250	5"	100	6½"
100	4"	100	6"	500	3½"	100	5½"	100	7"
				500	4"	1 250 ft. Roll Bulk			

Choose One Color or Assortment

INTERCONNECT CABLES

Ribbon cable connectors for connecting boards to front panels, or board to board.

	SINGLE ENDED 14 pin	16 pin	24 pin	DOUBLE ENDED 14 pin	16 pin	24 pin
6"	1.24	1.34	2.05	2.24	2.45	3.37
12"	1.33	1.44	2.24	2.33	2.55	3.92
24"	1.52	1.65	2.63	2.52	2.76	4.31
48"	1.91	2.06	3.40	2.91	3.17	5.08

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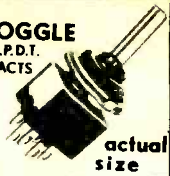
MINI MINI TOGGLE

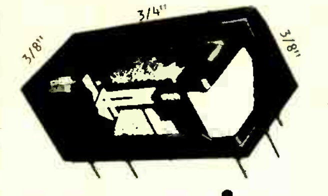


EXTRA SMALL D.P.D.T.
3A 125VAC CONTACTS
each $1.50
8 — 10.
100 —$105.
actual size

ACTUAL SIZE

$1.35 10·$12
C & K #7103
Single pole double throw center off (3 position) toggle switch..........

BISTABLE RELAY



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1 AMP 20 WATT DC CONTACTS
LONG LIFE (1×10^9) OPER.
HIGH SPEED (500 HZ)
HERMETICALLY SEALED

$2.95 ea.

COUNTER DISPLAY KIT

Ideal module for home built counter projects. Includes 7490 decade counter 7475 latch, 7447 driver, and RCA .6" NUMITRON display. PCB with plated thru hole and instructions supplied....... KITS SUPPLIED FROM ONE TO TEN DIGITS PER BOARD (all interconnects plated)..

$5.89 per digit

ELEC-TROL REED RELAY

12 vdc
440 Ω coil
dpst n.o.

PICTURE IS APPROXIMATION, RELAY HAS FOUR PINS ON ONE END AND TWO ON OTHER, PINS ARE SPACED .1" X 1". 1/2A CONTACTS.

$1.75 ea. - ten $15

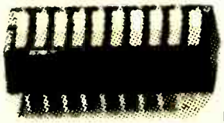
ultra sensitive relay

Single pole normally open dry reed relay. Unbelievable sensitivity, 1800 ohm coil with 3 volt pull-in (that's less than 3 ma.) A TTL gate will drive many of these. A CMOS buffer will directly actuate this nifty relay.... MFG. unknown, but I was told they came from IBM. 600 available

$2.95 ea.

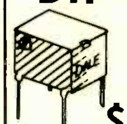
DIP SWITCH

AMP ten pole



$2.40 each

DIP TRIMMER



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DIAC 27 TRIGGER DIODE . . .	.20
PULSE XFMR. 1/1 TOROID-ENCASED	.25
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SP425 SPERRY 9 digit ¼" HV multiplexed 7 seg.	1.25
MM5369 time base osc. chip	1.75
T.V. crystal for above.....	1.75
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7402 TTL nor gate	.16
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78L2.6 2.6V TO92 .1A +regul.	.29
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78L6.2 6.2V " " "	.29
78L12 12V " " "	.29
78L15 15V " " "	.29
78M05 5V tab .5A + regul.	.59
78MG 4 term. adj. .5A + reg.	1.29
79MG " " " " - reg.	1.39
7805T tab 1A 5v regul	.89
7812 to-3 1A +12V regul.	.59

TRANSISTORS- TRIACS - SCR's	each	ten
MJE1091 PNP Darlington 60V 5A TAB	$1.50	$14.
2N5559B NPN (HEP707) 400 10 TO-3	2.50	22.50
TIP31A NPN (HEP245) 60 3 TAB	.30	2.50
2N6101 NPN (S5004) 80 10 TAB	.65	5.00
D41D1 PNP GE 30 1 TAB	.25	2.00
40536 TRIAC 400V 2.5A on 10W heat sink	.75	6.00
40374 NPN 250V 2A on 6W heat sink TO-66	.75	6.00
C106D1 SCR 400V, 4A. .2ma. gate TAB	.65	5.00

Hal's Goodies

Hal's computer really popped it's stack on these prices. We cannot allow any quantity discounts or bonus credits on these items. Quantities are limited and at these prices- order now............

2708 8K EPROM Sig., Nat., Intel prime 450NS	ea. $14.95	8/$112
2504T Sig. 1024 bit dyn. shift register TO-99	ea. $.75	10/$6.
93410 Fairchild 256x1 RAM bipolar 45NS DIP	ea. .75	10/$6
TR1602B 5V Wesern Digital UART 40 pin DIP	ea. 3.00	
7402 Nat. quad 2 in NOR gate marked DEC7402	10/$1.50	100/$12
40 pin gold solder tail IC socket, Augut	ea. .55	
Capacitor- .01mf 50V monolithic ceramic, sealed in glass DO-7 diode package	10/$.90	100/$8
1/8W carbon comp. resistors ten each of 2.4, 390, 1.8K, 3.9K, 6.8K, 11K, 43K, 68K, 240K, ohms	90/$4.	

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CIRCLE 63 ON FREE INFORMATION CARD

Mutual radio programs via Westar satellite

The Mutual Broadcasting System and Western Union have recently agreed to allow Mutual's network radio programs be broadcast over Western Union's Westar satellite system. The agreement, which is awaiting FCC approval, will enable Mutual to transmit its radio programs via satellite to more than 500 100-foot receiving antennas, connected directly or indirectly to the broadcast company's 780 affiliate stations.

The advantage of satellite transmission, as opposed to land-line transmission, is that "radio signals will have a 15 kHz quality equalling that of FM stereo," states Gary J. Worth, Mutual's executive vice president in charge of the satellite program. Transmission quality would be substantially improved, since present land transmission typically involves a 5-kHz signal, with some branches receiving only 3.5 kHz signals. The agreement will let Mutual use up to six 15-kHz program audio channels.

Both Mutual and Western Union asked the FCC to allow programs to start being transmitted from Washington, DC, to its nationwide affiliates. If the FCC gives its consent, it is expected that this service could start around mid-1978.

Future stereo recordings to use digital techniques

Digital techniques will very soon replace analog techniques in stereo recordings. Even now, several Japanese manufacturers are marketing laser-based systems that play back discs whose audio signal has been pulse-code modulated (PCM).

It is expected that mass-produced PCM-based recordings will use standard 30-cm discs because they can be produced as inexpensively as in analog recordings. However, the key lies in system standardization, and until unanimity is reached on specifications, PCM discs will be impractical and tape will be the medium used.

Alex DeKoster, senior acoustic engineer at Acoustic Research, Inc., Norwood, MA, feels that although mass-market PCM systems will start off being expensive, "demand will force the price down." However, he predicts that it will take about three or four years for the system first to catch on, then another five or six years for the price to come down.

In digital recording systems, frequency response and dynamic range are independent of the characteristics of disc or tape, and there is no channel crosstalk. Signals are retimed during playback, eliminating wow and flutter. In all PCM systems announced thus far, frequency response is flat within a fraction of a dB to 20 kHz, and the dynamic range is at least 85 dB, or better than that of any listening room and 20 dB better than that of most analog systems.

The chief virtue of PCM techniques is that all the necessary components are available. For instance, video tape recorders have reached a stage of development where they can be used as a basic building block; semiconductor lasers appear ready to be mass produced; and phase-locked-loop synthesizers and crystals are in good supply. There is even the possibility of a price reduction on key components. **R-E**

CIRCLE 33 ON FREE INFORMATION CARD

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DISCOUNT ON ALL IC'S AND LED'S
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TTL

7400	.11	7451	.20	74155	.75
7401	.18	7453	.20	74156	.75
7402	.14	7454	.20	74157	.85
7403	.14	7460	.20	74158	1.39
7404	.16	7464	.35	74160	1.23
7405	.19	7465	.35	74161	.95
7406	.29	7470	.38	74162	1.39
7407	.28	7472	.35	74163	.95
7408	.22	7473	.35	74164	.95
7409	.17	7474	.31	74165	.95
7410	.16	7475	.49	74166	1.19
7411	.25	7476	.34	74170	1.90
7413	.43	7483	.68	74173	1.49
7414	.65	7485	.88	74174	1.19
7415	.25	7486	.38	74175	.95
7416	.35	7489	2.25	74176	.84
7417	.35	7490	.43	74177	.84
7420	.16	7491	.75	74180	.95
7423	.37	7492	.48	74181	2.30
7425	.35	7493	.48	74182	.85
7426	.22	7494	.75	74185	2.20
7427	.35	7495	.75	74190	1.25
7430	.20	7496	.75	74191	1.15
7432	.23	74100	1.15	74192	.89
7437	.25	74107	.37	74193	.85
7438	.25	74121	.37	74194	1.15
7439	.50	74122	.38	74195	.74
7440	.15	74123	.45	74196	.98
7441	.85	74125	.54	74197	.95
7442	.59	74126	.58	74198	1.69
7443	.65	74132	.75	74199	1.69
7444	.73	74141	.85	745200	3.95
7445	.65	74145	.90	74279	.79
7446	.81	74150	.98		
7447	.59	74151	.68		
7448	.79	74153	.60		
7450	.17	74154	1.20		

LINEAR CIRCUITS

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LM301CN	29	LM376CN	59	LM739N	99
LM302H	65	LM380N	1 29	LM741CN(8)	32
LM304H	80	LM380-8CN	95	LM741CN(14)	32
LM307CN	26	LM381N	1 75	LM741CH	35
LM307H	30	LM382N	1 75	LM747H	79
LM308H	89	LM385K	45	LM747N	71
LM309H	1 05	NE531V	2 90	LM748CN	35
LM309K	99	NE540L	2 90	LM1310N	2 80
LM310CN	1 07	NE546A	1 09	LM1414N	1 59
LM311CN	89	NE550A	75	LM1456CN	1 29
LM311H	89	LM555CN	39	LM1458CN	59
LM311N	89	NE556A	85	LM1496N	89
LM319N	1 13	LM560N	2 95	LM1800N	2 48
LM320K		LM561N	2.95	ULN2208	89
5 5 2, 12, 15	1 29	LM565N	1 19	ULN2209	89
LM320T		LM565H	1 39	CA3046	1 19
5, 12, 15	1 19	LM566H	1.39	CA3081	1 49
LM322N	1 59	LM566CN	1 19	LM3900N	49
LM324N		LM567CN	1 29	LM7524	79
(LM2902N)	1 52	LM567H	1 49	LM7525	79
LM339N	1 58	LM703H	59	8038B	4 59
LM340K		LM703CN	39	75451CN	35
5, 6, 8, 12,		LM709N	25	75452CN	35
15, 18, 24	1 29	LM709H	.29	75453CN	35
LM340T		LM710N	59	75454CN	35
5, 6, 8, 12,		LM711N	39	75491N	71
15, 18, 24		LM723H	55	75492N	85
(78 — — Equiv)	1 19	LM723N	52		

XR320	1 15	XR2567	1.99	XR4212	1 75
XR2206	2.95	XR4136	1 75	XR4739	1.15
XR2207	2 95	XR4202	1.75		

CMOS

4000A	.26	4018A	1.39	4066A	.89
4001A	.25	4020A	1.72	4068A	.44
4002A	.25	4021A	1.18	4069A	.44
4006A	1.35	4022A	.94	4071A	.26
4007A	.26	4023A	.25	4072A	.35
4008A	1.52	4024A	.89	4073A	.39
4009A	.57	4025A	.25	4075A	.39
4010A	.54	4027A	.59	4078A	.39
4011A	.29	4028A	.98	4082A	.35
4012A	.25	4030A	.44	4518A	1.56
4013A	.45	4035A	1.27	4528A	1.56
4014A	1.27	4040A	1.39	4585A	2.10
4015A	1.27	4042A	1.47		
4016A	.48	4049A	.59		
4017A	1.01	4050A	.59		

IC SOCKETS
Solder Tail - low profile

8 pin	$ .17	24 pin	.42
14 pin	.20	28 pin	.59
16 pin	.22	40 pin	.69
18 pin	.29		

CERAMIC DISC CAPACITORS

1pf 50V	56pf 50V	270pf 50V	01uf 1000V
5pf 50V	68pf 50V	390pf 50V	022uf 50V
7pf 50V	82pf 50V	470pf 50V	030uf 50V
10pf 50V	100pf 50V	600pf 50V	050uf 50V
22pf 50V	120pf 50V	820pf 50V	1uf 50
27pf 50V	150pf 50V	001uf 50V	
33pf 50V	180pf 50V	0047uf 50V	
47pf 50V	220pf 50V	01uf 50V	

	(each)	(Minimum 10 per value)
0-100	$.10 ea	$.05 ea
100-		$.04 ea

SPECIAL SALE

TTL BARGAINS

7416	$ .19
7430	.16
7432	.19
7437	.19
7438	.19
7440	.13
7445	.49
7495	.55
74123	.25
74141	.59
75LS60	.99

LINEAR SPECIALS

LM300 TO-5	$ .49
LM302 TO-5	.39
LM307 mDIP	.19
LM308 TO-5	.59
LM311 TO-5	.49
LM311 mDIP	.49
340T-5V	.79
340T-6V	.79
340T-15V	.79
LM380-8 mDIP	.69
LM565 DIP	.89
LM723 DIP	.39
LM739 DIP	.79

5738 CALC. CHIP 5 FUNCT WITH MEMORY **$2.95**

MARK I CLOCK KIT
6 DIGIT CLOCK KIT WITH ONE PC BOARD. ACCOMMODATES MM5314 CLOCK CHIP AND 6 - FND359 DISPLAYS, CONTAINS ALL COMPONENTS, 3 SWITCHES AND ASSEMBLY INSTRUCTIONS. HAS TERMINALS FOR ADDITIONAL REMOTE DISPLAY. **$10.95**
WITH 12V/300 MA PC MT. TRANSFORMER **$13.95**

SHIFT REGISTERS

2510	$1.75
2511	1.95
2518	2.50
2522	1.95
2532	2.29
5016	.89

CERAMIC DISC CAPACITOR PACKAGE
10 EA. OF FOLLOWING VALUES — 50 VOLT

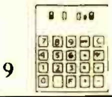
1pf	33pf	82pf	220pf	820pf	.022uf
5pf	47pf	100pf	270pf	.001uf	.030uf
10pf	56pf	150pf	470pf	.0047uf	.050uf
22pf	68pf	180pf	600pf	.01uf	.1uf

24u CAPACITORS **$10.95**
SUPPLIED IN 60 DRAWER CABINET . **$24.50**

8038 FUNCTION GENERATOR
Voltage controlled oscillator — sine, square, triangular output. **$3.95**

MM 5330
4½ DIGIT DVM LOGIC **$ 4.95**

SIGNAL DIODES — 400 MW
20/$1.00

KEYBOARD


20 KEYS
2 SLIDE SW
3" x 3¼"
$ .59

LED DISPLAYS

FND359	RED CC .375" RHD	$ .59
FND500	RED CC .50" RHD	.79
FND507	RED CA .50" RHD	.79
DL10A	RED CA .27" LHD	.99
DL702	RED CC .30" LHD	.99
DL707	RED CA .30" RHD	.99
DL747	RED CA .60" LHD	1.49
MAN5	GREEN CA .27" LHD	.89
MAN8	YELLOW CA .27" LHD	.69
MAN82	YELLOW CA .30" LHD	.99
MAN6610	ORANGE DOUBLE DIG. CA .56" RHD	.99
MAN6630	ORANGE 1½ DIG. CA .56" RHD	.99
MAN6740	RED DOUBLE DIG. CC .56" RHD	.99
MAN6750	RED DOUBLE DIG. CC .56" RHD	.99
MAN4630	RED CA .40" RHD	.89
NSN74R	RED CC .30" RHD	.89

CALCULATOR KIT
LITRONICX 1502 MEMORY

CALC. KIT ONLY **$7.95**
ADAPTER -60Hz **$3.95**

Jumbo LED'S
green - yellow
amber - clear 16¢ ea.

ZENER DIODE — 400MW
3.6V 5.1V 6.8V 15V
4.7V 5.5V 10V **$ .15 EA.**
8/$1.00 ANY MIX

PRECISION RESISTOR PACKAGE
METAL FILM ±1% ¼ WATT | 240 RESISTORS **$21.95**
4 EA. OF FOLLOWING VALUES SUPPLIED IN 60 DRAWER CABINET **$39.50**

10.5	100	499	1.65K	4.53K	7.50K	13.0K	22.1K	44.2K	80.6K
20.0	130	604	2.00K	5.11K	8.45K	14.0K	24.9K	48.7K	90.9K
30.1	162	750	2.49K	5.49K	9.09K	15.0K	27.4K	52.3K	100K
49.9	200	1.0K	3.01K	6.04K	10.0K	16.2K	30.1K	57.6K	147K
60.4	301	1.21K	3.48K	6.49K	11.0K	17.8K	34.0K	63.4K	210K
76.8	402	1.40K	4.02K	6.98K	12.1K	20.0K	40.2K	69.8K	464K

2708
FULL SPEED EROM **$10.95**

5314 6 DIGIT
CLOCK CHIP **$2.95**

1702A
$ 4.75

74S200
256 BIT RAM TRI-STATE **$3.25**

8080A, 8008
$16.95

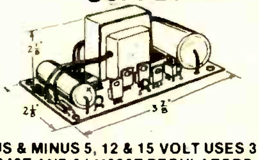
UART
AY51013A **$6.95**

LD110, LD111
3½ DIGIT A/D CONVERTER
SET **$24.75**

2513
CHARACTER GEN 64 x 8 x 5 ASCII **$8.95**

82S23
256 BIT PROM **$2.95**

Clock Kit
MM5314 with 6 NS71 .27" displays 2 P.C. boards — Display board may be remote. Internal or wall transformer can be used. 50-60 Hz, 12-24 hour. Includes all necessary transistors, resistors, capacitors, diodes, 3 switches and complete assembly instructions.
CK6-3 .... **$12.95**

REGULATED POWER SUPPLY KIT


PLUS & MINUS 5, 12 & 15 VOLT USES 3 LM340T AND 3 LM320T REGULATORS. 115V/29VCT TRANSFORMER PLUS PC BOARD, CAPACITORS & DIODES +5V PROVIDED WITH SINK TO SUPPLY 1 AMP. WITH ALL PARTS, SCHEMATIC AND INSTRUCTIONS — PS-29 ... **$11.95**
SHIPPING $1.00

MINIATURE SOLID STATE ELECTRONIC BUZZER
LONG LIFE — HIGH RELIABILITY
LOW CURRENT DRAIN
NO MOVING CONTACTS
NO ARCING — NO RF NOISE
RICH & CLEAR SOUND
78 dB min AT 1 FT. — 450 Hz

				EA
EB-106	6V	15mA	4-9 VDC	$1.99
EB-112	12V	15mA	8-20 VDC	1.99

MM5369 Divider mDIP	2.49
Crystal 3.58 MHZ color TV	1.75
Crystal 2.010 MHZ	1.95

ADD SHIPPING & HANDLING AS NOTED IN US & CANADA. OTHER COUNTRIES AS REQUIRED.

ELECTRONIC DOOR CHIME KIT

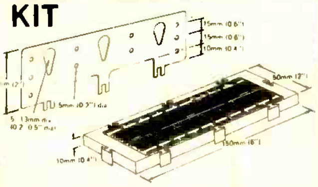

WITH TI TMS 1000 MICROPROCESSOR CHIP PROGRAMMED TO PLAY 24 DIFFERENT TUNES

INTERNATIONAL FLAVOR — PLAYS NATIONAL ANTHEMS OF U.S., BRITAIN, FRANCE AND WEST GERMANY PLUS OTHER FOLK TUNES, CLASSICAL AND TRADITIONAL MELODIES.
- SUPPLIED WITH ALL PARTS INCLUDING PC BOARD, SPEAKER, CASE AND COMPLETE INSTRUCTION MANUAL WITH FULL CIRCUIT DETAILS.
- USES 2-9V TRANSISTOR BATTERIES (NOT SUPPLIED)
- LOW POWER CONSUMPTION.
- INTERNAL SELECTION OF TUNE, VOLUME, TEMPO AND TIMING FUNCTIONS.
- PROGRAMMED MATHEMATICALLY TO PLAY IN PERFECT PITCH PERMANENTLY.
- ATTRACTIVE CASE, CONVENIENT WALL MOUNT.

$39.50 SHIPPING $1.00

TANTALUM CAPACITORS
Solid dipped +20%

.1 mfd	35V	$ .25	10 mfd	16V	$ .40
.33 mfd	35V	.25	10 mfd	25V	.45
1 mfd	35V	.25	15 mfd	10V	.40
2.2 mfd	20V	.25	15 mfd	20V	.45
2.2 mfd	35V	.30	22 mfd	16V	.45
3.3 mfd	35V	.30	33 mfd	10V	.40
4.7 mfd	16V	.30	47 mfd	6V	.40
6.8 mfd	6V	.30	56 mfd	6V	.45
6.8 mfd	50V	.40	150 mfd	15V	1.50

HAMMOND "BIMBOARD" BREADBOARD KIT


Accepts DIP packages, without adaptors or damaging component leads.
Accepts diodes, transistors, IC's, resistors, capacitors, etc. with leads between 0.01" (0.25 mm) and 0.035" (0.85 mm) diameter on a 0.1" (2.54 mm) matrix.
Breadboard Section has 47 horizontal rows of five interconnected sockets set each side of the central channel.
Bus Strip Section runs up each side of the Bimboard for carrying ground and Vcc etc.
Component Bracket (included with each Bimboard) will fit on any of the four edges or down the centre.
$11.95

DISCRETE LEDS

ME4 Infrared Clear	.17" dig.	$.29
MV10B Clear TO-18	.17" dig.	.25
MV50 Clear - axial	.09" dig.	.12
NSL100 Red - point	.19" dig.	.12
RL209 Red diff.	.12" dig.	.12
RLT-T1-03 White diff. no flange	.124" dig.	.15
RLC200 Red diff Current reg.	.19" dig.	.25
RL4403 Red diff.	.19" dia.	.15
Jumbo Green, yellow amber or clear - diff.	.19" dia.	.18

RESISTOR PACKAGE
CARBON FILM ±5% ¼ or ½W
15 EA. OF THE FOLLOWING VALUES
100, 220, 470, 1K, 1.5K, 3.3K, 4.7K, 6.8K, 10K, 33K, 100K, 1M
180 RESISTORS **$5.45**

RESISTOR PACKAGE
CARBON FILM ±5% ¼ OR ½ W
USAGE EVALUATED ASSORTMENT
455 RESISTORS, 44 VALUES
$12.95

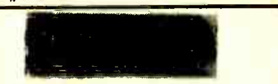
CARBON FILM RESISTORS 5%
¼W — ALL STANDARD VALUES FROM .56 OHMS TO 5.6M OHMS
½W — ALL STANDARD VALUES FROM 1 OHM TO 15M OHMS

QTY.	PRICE (each)	PRICE (Minimum 10 per value)
0-10	$.10 ea	
10-100	$.10 ea	$.05 ea
100-1000		$.04 ea

METAL FILM RESISTORS 1%
STANDARD DECADE VALUES FROM 10.5 OHM TO 464K OHM

	EACH	MINIMUM 10 PER VALUE	MINIMUM 100 PER VALUE
0 - 10	$.20		
10 - 100	.20	$.15	
100 -		.10	$.09

UNIVERSAL BREADBOARD
Silver plated copper circuit board 3-3/16" x 5-1/16". 2 rows of 27 holes for DIP IC's - space for transistors, resistors & capacitors. Versatile and simple for breadboarding IC circuitry **$1.50 ea.**



IC BREADBOARD
Accommodates 5 16 pin IC's with additional interconnection holes. 1/16" phenolic with silver plated copper circuits. 2 5/16" x 6 9/16" **$1.50 ea.**

Satisfaction guaranteed. Parcels shipped within 3 days after receipt of order. Pay with personal check, charge card or COD. Minimum COD or charge order is $15.00. Add $1.00 service charge if order is less than $10.00. Include 10% of order total to cover shipping and handling outside US or Canada. California residents add sales tax.

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IF YOU'RE NOT DESIGNING WITH A CSC PROTO-BOARD®, LOOK AT ALL YOU'RE MISSING.

Accessibility—All parts are instantly and easily accessible, for quick signal tracing, circuit modifications, etc.

Utility—Models are available with or without built-in regulated power supplies (fixed or adjustable).

Variety—A wide variety of models are available with capacities ranging from 630 to 3060 solderless tie-points (6 to 32 14-pin DIP's), to fit every technical and budget requirement.

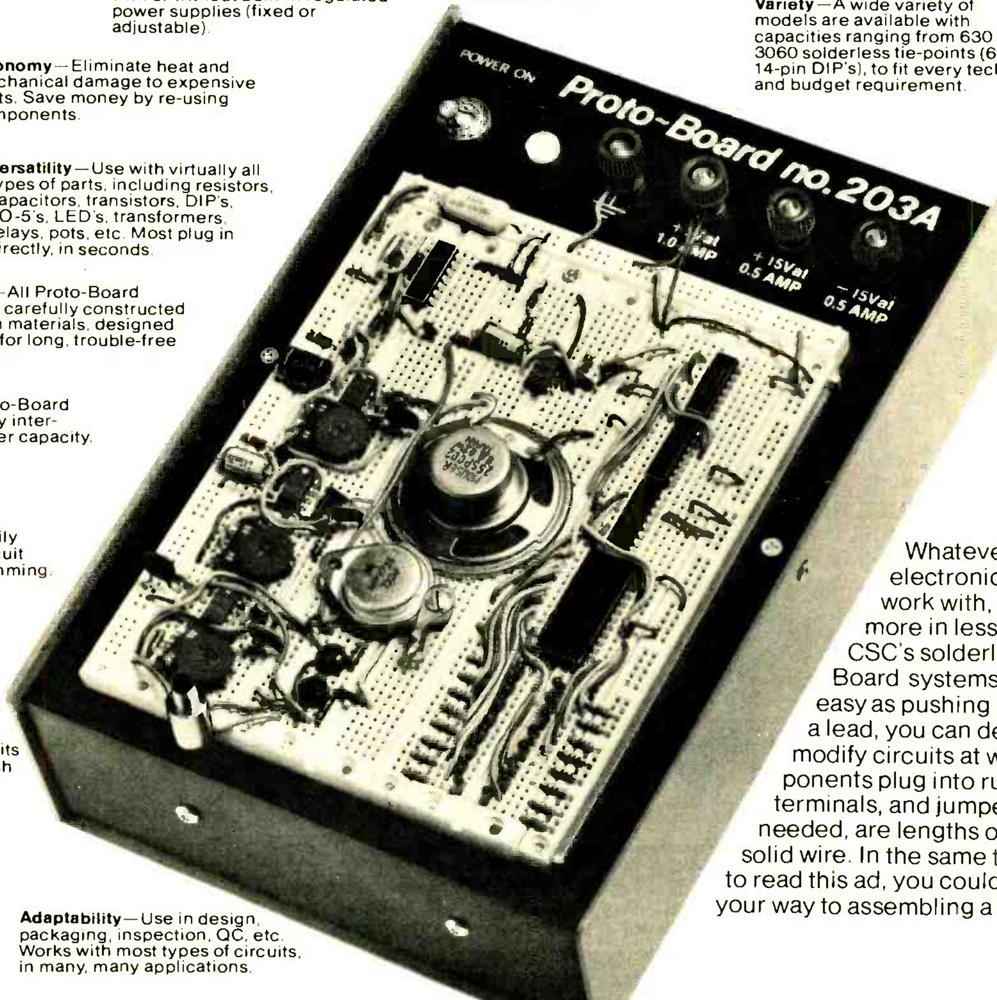
Economy—Eliminate heat and mechanical damage to expensive parts. Save money by re-using components.

Versatility—Use with virtually all types of parts, including resistors, capacitors, transistors, DIP's, TO-5's, LED's, transformers, relays, pots, etc. Most plug in directly, in seconds.

Durability—All Proto-Board models are carefully constructed of premium materials, designed and tested for long, trouble-free service.

Expandability—Proto-Board units can be instantly inter-connected for greater capacity.

Visibility—All parts are instantly and easily visible, for quick circuit analysis and diagramming.



Speed—Assemble, test and modify circuits as fast as you can push in or pull out a lead. Save hours on every project.

Adaptability—Use in design, packaging, inspection, QC, etc. Works with most types of circuits, in many, many applications.

Flexibility—Use independently, or in conjunction with other accessories, such as scopes, counters, CSC Proto-Clip™ connectors, Design Mate™ test equipment, etc. One Proto-Board unit can serve a thousand applications.

Whatever type of electronic circuits you work with, you can do more in less time with CSC's solderless Proto-Board systems. As fast and easy as pushing in or pulling out a lead, you can design, test and modify circuits at will. Components plug into rugged 5-point terminals, and jumpers, where needed, are lengths of #22 AWG solid wire. In the same time you took to read this ad, you could be well on your way to assembling a new circuit.

CSC PROTO-BOARD SOLDERLESS BREADBOARDS

MODEL NUMBER	NO. OF SOLDERLESS TIE-POINTS	IC CAPACITY (14-PIN DIP'S)	MANUFACTURER'S SUGG. LIST	OTHER FEATURES
PB-6	630	6	$15.95	Kit — 10-minute assembly
PB-100	760	10	19.95	Kit — with larger capacity
PB-101	940	10	29.95	8 distribution buses, higher capacity
PB-102	1240	12	39.95	Large capacity, moderate price
PB-103	2250	24	59.95	Even larger capacity, only 2.7¢ per tie-point
PB-104	3060	32	79.95	Largest capacity, lowest price per tie-point
PB-203	2250	24	80.00	Built-in 1%-regulated 5V, 1A low-ripple power supply
PB-203A	2250	24	129.95	As above plus separate ½-amp +15V and −15V internally adjustable regulated power supplies

Order today. Call 203-624-3103 (East Coast) or 415-421-8872 (West Coast): 9 a.m.-5 p.m. local time. Major credit cards accepted. Or see your CSC dealer. Prices slightly higher outside USA.

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CIRCLE 29 ON FREE INFORMATION CARD

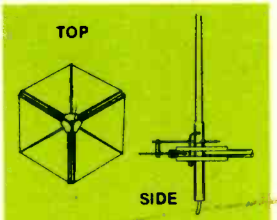
Photo courtesy of Edmund Scientific Co.

AVANTI Invents the Saturn™ Base

The reason the "Saturn" is so revolutionary is that it is absolutely the only **combination vertical *and* horizontal omni-directional antenna.** That's right, it needs no rotor! You can pick up mobiles (which are vertical) or horizontal and vertical beams.

The "Saturn", invented after years of research by Avanti engineers, is the latest development using AVANTI's unique CO-INDUCTIVE principle to give you the performance of two antennas combined into one.

The "Saturn" not only works on both polarities, but pounds out signals like an air hammer and picks them up like a magnet. Both polarities offer high gain figures.



Height 22'
Radials 9'
Weight 25 lbs.
Omni-directional — No rotor
AV-501 Switchbox included

PATENT PENDING

Those of you who are worried about sun spots and "skip" can relax too. This antenna really helps. When the sun spots cause a signal shift, you can often change polarity (just like our P.D.L. or Moonraker) and still pick up the desired channel with no loss of transmission.

The P.D.L. and Moonraker made dual polarity famous as the only antennas to have during the last sun spot cycle, and this time around any serious C.B.'er will want to have the "Saturn."

In fact, having a "Saturn" and a "P.D.L." or "Moonraker" will put you in the elite group of C.B.'ers who "always seem to get out better."

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