PROJECTS–HI-FI–COMPUTERS

$1.00 ■ DEC. 1977

Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

for your workbench build
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for 3D patterns galore

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for music between CB calls

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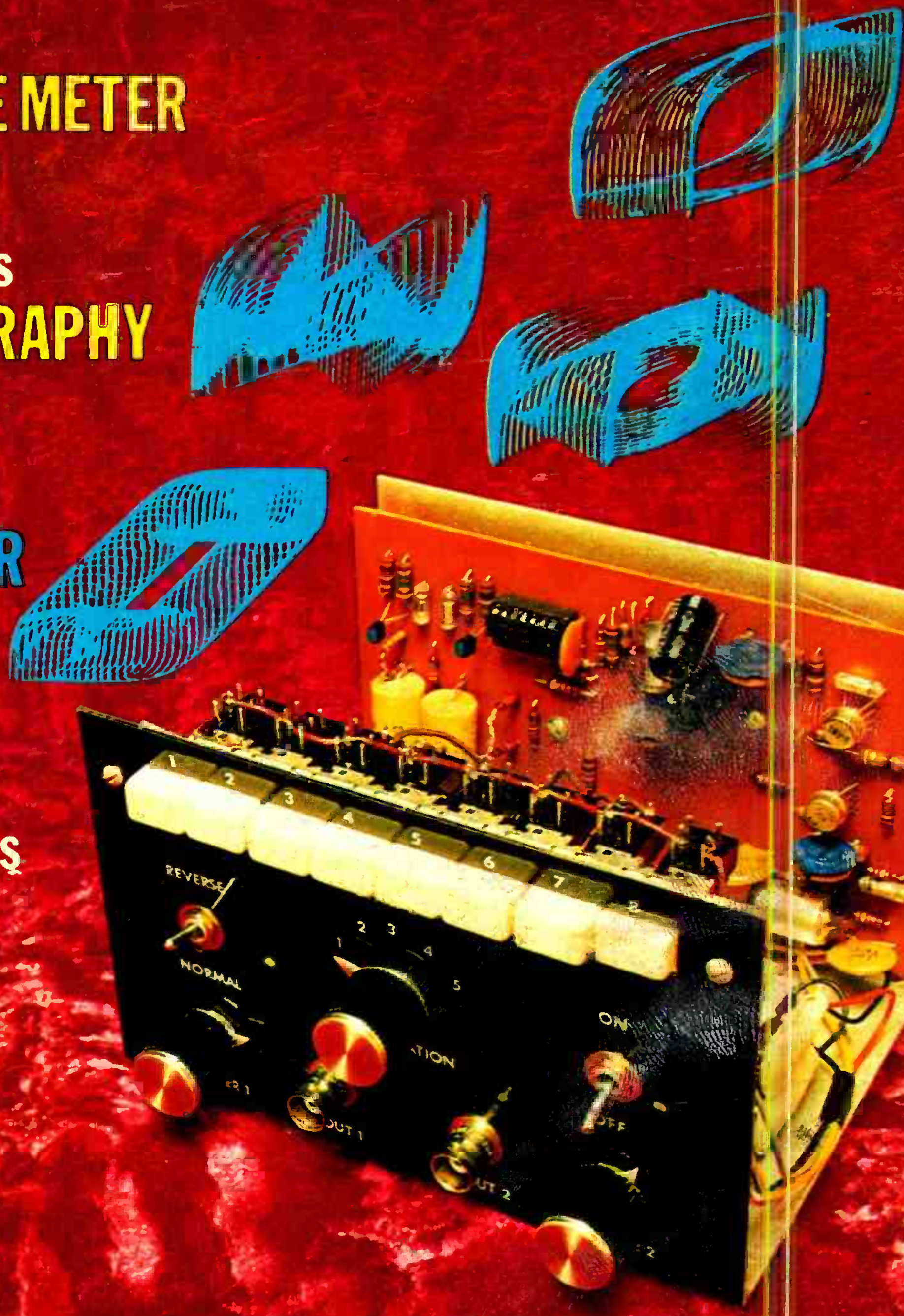

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Weller® controlled output soldering station

Model WTCPN. New convenience-features. Striking contemporary appearance. Completely new design. Now more than ever in a class by itself. Only Weller's advanced engineering could have improved on its own predecessor WTCPL Station, popular standard of the electronics industry.

- new heat shield for cool operator comfort
- new plug-in iron design for zero down-time
- new integral tip-storage tray
- new larger sponge for easier tip cleaning
- improved, unitized rocker switch and neon indicator light
- new impact-resistant case

And add to these new features Weller's unique, proven, closed-loop, low-voltage circuit, with its "interchangeable brains" in the tip . . . a ferromagnetic sensor that controls the temperature at 600, 700, or 800°F., protecting sensitive workpieces. To change temperatures, simply change tips with knurled thumb-screw. More than 50 options in configuration, tip size, reach, and temperature! Exclusive-process triple-plating prevents tip oxidation and "freezing".

With all these new features and exclusive principles, Model WTCPN is still all function . . . no frills! It's UL-listed and OSHA-compliant, of course. And now it's available at leading electronic distributors . . . coast-to-coast. See it there. For technical information, write on your letterhead.

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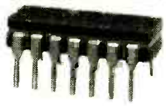

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First Quality Devices Made by National Semiconductor and Motorola

Type	Cat No	Last Year	NOW ONLY
7400	276-1801	$.49	35¢
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7432	276-1824	$.69	49¢
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7447	276-1805	$1.99	99¢
7448	276-1816	$1.99	99¢
7451	276-1825	$.49	39¢
7473	276-1803	$.79	49¢
7474	276-1818	$.79	49¢
7475	276-1806	$1.19	79¢
7476	276-1813	$.79	59¢
7485	276-1826	$1.59	1.19
7486	276-1827	$.69	49¢
7490	276-1808	$1.19	79¢
7492	276-1819	$1.19	69¢
74123	276-1817	$1.69	99¢
74145	276-1828	$1.49	1.19
74150	276-1829	$1.79	1.39
74154	276-1834	$1.79	1.29
74192	276-1831	$1.69	1.19
74193	276-1820	$1.69	1.19
74194	276-1832	$1.69	1.19
74196	276-1833	$1.69	1.29

74C and 4000 Series CMOS ICs

Type	Cat No	Last Year	NOW ONLY
74C00	276-2301	$.69	49¢
74C02	276-2302	$.69	49¢
74C04	276-2303	$.69	49¢
74C08	276-2305	$.69	49¢
74C74	276-2310	$1.29	89¢
74C76	276-2312	$1.59	89¢
74C90	276-2315	$2.29	1.49
74C192	276-2321	$2.49	1.69
74C193	276-2322	$2.49	1.69
4001	276-2401	$.69	49¢
4011	276-2411	$.69	49¢
4013	276-2413	$1.29	89¢
4017	276-2417	$2.49	1.49
4020	276-2420	$2.49	1.49
4027	276-2427	$1.29	89¢
4049	276-2449	$.99	69¢
4050	276-2450	$.99	69¢
4511	276-2447	$2.69	1.69
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Linear ICs

First Quality Devices by National Semiconductor and Motorola

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386CN	276-1731	$1.99	99¢
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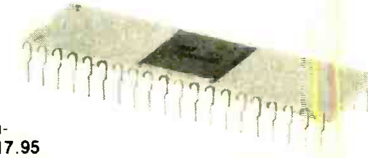
556CN	276-1728	$2.79	1.39
566CN	276-1724	$2.99	1.69
567CN	276-1721	$2.99	1.99
723CN	276-1740	$.99	69¢
741CN	276-007	$.69	49¢
741H	276-010	$.69	49¢
3900N	276-1713	$1.39	99¢
3909N	276-1705	$1.29	99¢
3911N	276-1706	$2.19	1.99
4558CN	276-038	$.99	79¢
75491	276-1701	$1.49	99¢
75492	276-1702	$1.49	99¢
7805	276-1770	$1.59	1.29
7812	276-1771	$1.59	1.29
7815	276-1772	$1.59	1.29

Microcomputer Chip

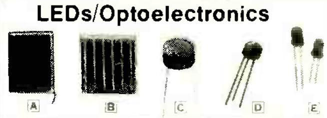


8080A Microprocessor. With a 16-bit address bus capable of addressing up to 65k bytes of memory and up to 256 I/O ports. "TRI-State" data bus gives it DMA and multiprocessing capability. All buses TTL compatible. Up to 244 variable length instructions, with 6 general purpose registers plus an accumulator.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

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

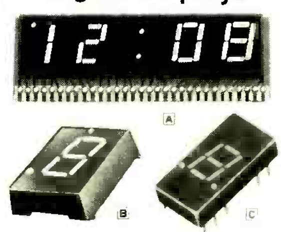
17.95

LEDs/Optoelectronics



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

Digital Displays



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

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

Project Accessories

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

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

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

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

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

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

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

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

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

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

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

G **Metal Cabinet.** 3¼x2³⁄₁₆x4"
270-251 2.59

G **Metal Cabinet.** 4x2⅜x6"
270-252 3.49

G **Metal Cabinet.** 6¼x2¾x7¼"
270-253 4.49

Transformers

6-3 Volts 1.2 Amps. 1¼x1¹⁵⁄₁₆x1⁹⁄₁₆"
273-050 .... 2.29

6-3 Volts, 3 Amps. 2⁵⁄₁₆x2x1¾".
273-1510 .... 3.99

12 Volts 5 Amps. 4x2x2½". Reg. 8.95.
273-1513 .... **Sale 6.95**

18 Volts (Center Terminal), 4 Amps. Ideal for 5V (using CT), or 12V solid-state regulators. 4x2x2½". Reg. 8.95.
273-1514 .... **Sale 6.95**

Selected Diodes

Type	Cat No.	Last Year	Now Only
1N4001	276-1101		2/39¢
1N4003	276-1102	2/59¢	2/49¢
1N4004	276-1103	2/69¢	2/59¢
1N4005	276-1104	2/79¢	2/69¢
1N4735	276-561		2/89¢
1N4739	276-562		2/89¢
1N4742	276-563		2/89¢
1N4744	276-564		2/89¢
Trigger Diode	276-1050	$.49	39¢
1N5401	276-1141		2/69¢
1N5402	276-1142	2/89¢	2/79¢
1N5403	276-1143	2/99¢	2/89¢
1N5404	276-1144	2/$1.19	2/99¢
PTC205	276-1114		3/1.39¢

SCR's and Triacs

Device	Rating	Cat No	Last Year	Now Only
LASCR	200V 1.6A	276-1095	$1.59	99¢
SCR	200V, 6A	276-1067	$1.39	89¢
SCR	400V, 6A	276-1020	$1.49	99¢
Triac	200V, 6A	276-1001	$1.39	89¢
Triac	400V, 6A	276-1000	$1.49	99¢
BR	50PIV, 1.4A	276-1151		79¢
BR	100PIV, 1.4A	276-1152		99¢
BR	100V, 4A	276-1171		1.49
BR	200V, 4A	276-1172		1.69
BR	400V, 4A	276-1173		1.89
BR	50PIV, 6A	276-1180		1.99

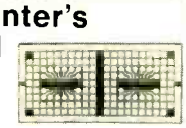
Digital Car Clock Module

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

Low-Profile DIP Sockets

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

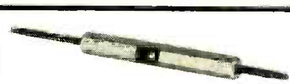
Experimenter's PC Board



Simplifies IC Projects

Ideal for two-circuit projects. Fire-retardant copper-clad board is only 2½x5x¹⁄₁₆". Really simplifies integrated circuit projects by extending leads for easy soldering.
276-151 .... **2.99**

IC Socket Wrapping Tool



For making superior, precision connections — without soldering. Wraps, unwraps, and strips 30-gauge wire. Modified wrap for extra security. No bits, sleeves or special skills needed. Balanced, 4½" long. All-metal. **276-1570** **6.95**
14-Pin Wire-Wrapping Sockets. 276-1993 ...... **Pk. 2/1.29**
16-Pin Wire-Wrapping Sockets. 276-1994 ...... **Pk. 2/1.39**
50' Red Wire. #30 Gauge Kynar. **278-501** **1.99**
50' White Wire. #30 Gauge Kynar. **278-502** **1.99**
50' Blue Wire. #30 Gauge Kynar. **278-503** **1.99**

8-Rocker DIP Switch

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

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When it comes to replacement tubes, nobody has as many types as Sylvania—from power amplifiers to Nuvistors.

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GTE SYLVANIA

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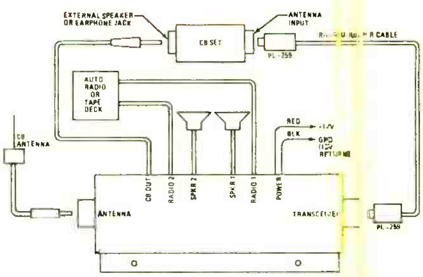
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

DECEMBER 1977 Vol. 48 No. 12

SEASON'S GREETINGS

The editors and staff of Radio-Electronics join in sending holiday greetings and our best wishes for a happy new year



CB SWITCHER lets you listen to music between CB calls . . . automatically. Complete construction details start on page 40.

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looking ahead

Super TV: If money were no object, what would television be like? Every two years, at the Berlin International Radio and Television Exhibition, we get a chance to find out. This huge show features displays by all the major western European consumer electronics manufacturers. It includes such exhibits as large "walls" consisting of color TV sets showing pictures with all having exactly the same color, tint and brightness values, thanks to the PAL color system, which, after many years, we must concede works better than the U.S. system.

Do you have any idea what this year's sensation is in European TV! It's a system that lets you watch two channels simultaneously. It is called "picture-in-the-picture," and lets viewers watch their favorite program without missing the soccer game. On a 25-inch color set, a black-and-white picture is inserted in a corner of the screen. A remote-control tuning device allows you to program any channel in the main part of the screen and any other channel in the corner. The receiver circuitry consists of virtually the equivalent of one color set and one monochrome set, with special IC's for isolation. (The next trend may be a TV set that lets you watch three channels at a time!)

Another significant trend is complex microprocessor circuitry. Since more than 50% of German TV sets sold today feature remote controls, most of the new microprocessor circuitry is used to implement remote-control tuning schemes. Some remote systems are almost unbelievably sophisticated. For example, one system that has 30 pushbuttons and performs 48 functions (according to the manufacturer) can program the set for up to four years in advance; as many as 20 events can be stored—turn on, turn off, change channel, etc. You can lock the set to prevent children from handling the tuning—they can watch only the shows that have been preprogrammed for them!

Almost every German TV manufacturer offers at least one model that can accommodate built-in or plug-in video games, thus eliminating an RF antenna connection because the game is connected directly to video circuits. Some other sets provide for wireless infrared headphones.

Super cassettes: Every few months some manufacturer devises something new to extend the potential of the audio cassette, which was originally developed to record speech only, but is now recognized as capable of high-fidelity recording. At the Berlin International Radio and TV Exhibition, Austria's Eumig formally entered the cassette recorder field with a tape deck that uses an unusual "electronic flywheel" speed control. Speed is maintained by 15,000 corrections-per-second, based on optical readings of markings on a clear plastic flywheel. Eumig specifications state that the deck has a frequency response of 20 to 20,000 Hz $\pm$ 3 dB, a 0.08% wow and flutter and an S/N ratio of 73 dB with Dolby. The unit goes on sale this year in Europe at around $1000 for the deck; a complete system with AM/FM and a 50-watt-per-channel amplifier will cost $1500. American marketing is scheduled for next year.

A microprocessor-based cassette recorder, manufactured by Sharp, contains a 10-pushbutton programming panel that can automatically turn on the unit for unattended recording and that allows you to play selections in any sequence, or to repeat any selection as many times as you want. A back-lighted liquid-crystal panel displays the time in either 12-hour or 24-hour modes, and acts as a memory-rewind counter, a tape counter, an elapsed-time indicator and program-selection indicator. The cassette recorder will be available soon in the U. S. for about $300.

VTR price war: Repercussions of RCA's $1000 list price on its Matsushita-built, four-hour-per-cassette videocassette recorder (**Radio-Electronics,** November, 1977) are still being felt throughout the industry, and it appears that a full-scale price war could occur, even though there is still a shortage of home VTR's. RCA's price was $300 below the established price of the Sony *Betamax* and other units. By press time, Sony and Zenith were sticking with the $1300 list price for their Beta-format units, but some competing VTR's were definitely down in price.

Magnavox introduced its own VTR, also made by Matsushita in the same four-hour VHS format as RCA's; this unit has a suggested list price of $1075 to $1095, depending on the section of the country. Although this price is nominally higher than RCA's, it will probably be discounted to about the same level.

The Quasar *Great Time Machine*, which until now was the lowest-priced home VTR with a list of $995, is apparently coming down to about the $795 level, although the suggested list price was officially unchanged at press time. There is some speculation that most prices can hold until Christmas because of the short supply, but after the New Year, a new and lower price structure is expected to develop.

Price isn't the only battleground for videotape recorders. Another major dispute is raging over recording and playing time. You may recall that when it was first introduced in 1976, the Sony *Betamax* cassette had a maximum recording/playing time of one hour. The VHS system, developed somewhat later by Japan Victor, could record two hours with a slightly larger cassette. Then, Sony's half-speed version of *Betamax* (the one currently being sold) could record for two hours on the same cassette that originally could only record one hour of program material.

Matsushita Electric (Japan Victor's parent company) responded by doing to the VHS what Sony did to Betamax—they cut the speed in half, which in this case results in four hours-per-cassette. Now, Sony has announced two new developments—a cassette with thinner (and more) tape that can record up to three hours; and a cassette-changer accessory that accommodates two cassettes, making possible six hours of unattended recording. At this rate, the week-long cassette should be available within the year!

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Your computer system needn't cost a fortune.

Some computer kits include little more than a mother board and a front panel, and you pay extra for everything else you need to make an operating computer.

SWTPC doesn't do it that way, so you can get your Southwest Technical 6800 Computer up and running at a bargain cost compared with most other systems. It comes complete at $395 with features that cost you extra with many other systems.

The Extras You Get

These extras include 4K of random-access memory, a mini-operating system in read-only memory, and a serial control interface. They give you 1) a considerable amount of working memory for your programs, 2) capability through the mini-operating system to simply turn on power and enter programs without having to first load in a bootstrap loader, and 3) an interface for connecting a terminal and beginning to talk with your computer immediately.

Low-Cost Add-Ons

Now that you have a working computer, you'll probably want to add at least two features soon, more memory and interfaces for needed accessory equipment. Memory for our 6800 is another bargain. You can get 4K memory boards for just $100 and 8K boards for only $250.

Our interfaces cost little compared with many other systems. For just $35 you can add either a serial or parallel interface board. (And you won't have to buy several interfaces or a costly board to get just the one you want.)

Peripheral Bargains

Your computer is no good without at least a terminal for entering data and viewing computer output, and you will probably want a good method of storing programs and data.

We offer you a line of high-quality peripherals at low prices. (You can prove this by just comparing prices.)

Buy our CT-64 Video Terminal for only $325 and our CT-VM Monitor with matching cover for $175. Our MF-68 Dual Minifloppy costs just $995, complete with Disk BASIC and a disk operating system. For cassette storage our AC-30 Cassette Interface gives simple control for one or two cassette recorders.

You can get inexpensive hard copy with our PR-40 Alphanumeric Line Printer.

We back up the 6800 system with low-cost software, including 4K and 8K BASIC.

Compare the value you get with our computer and peripherals before you buy. We think you'll find that SWTPC gives you more for your money in every way.

SWTPC Southwest Technical Products Corp.
219 W. Rhapsody, San Antonio, Texas 78216
London: Southwest Technical Products Co., Ltd.
Tokyo: Southwest Technical Products Corp./Japan

Enclosed is:

- ______ $995 for the Dual Minifloppy
- ______ $325 for the CT-64 Terminal
- ______ $175 for the CT-VM Monitor
- ______ $395 for the 4K 6800 Computer
- ______ $250 for the PR-40 Line Printer
- ______ $79.50 for AC-30 Cassette Interface
- ______ Or BAC # ____________ Exp. Date ______
- ______ Or MC # ____________ Exp. Date ______

Name ____________________ Address ____________________

City ____________________ State ____________________ Zip ________

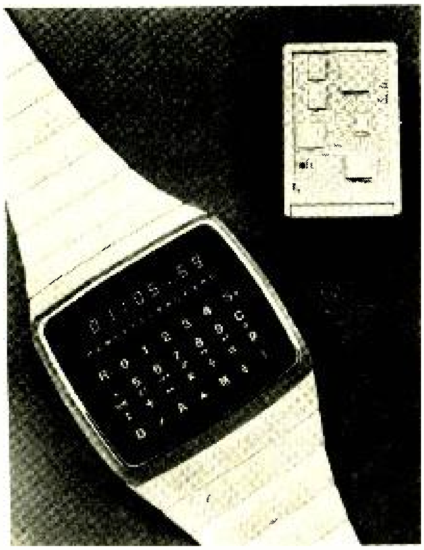
CIRCLE 63 ON FREE INFORMATION CARD

new & timely

Calculator/watch performs more than 36 functions

A six-ounce calculator, designed by Hewlett-Packard, looks like a digital watch but has some unique features not found in other electronic timepieces.

The *model HP-01* has six basic interactive functions (time, alarm, timer/stopwatch, date/calendar, calculator and memory), controlled by 28 keys (six finger-activated, 22 stylus-operated). A bright LED readout displays 12 different modes or indicators. What makes this instrument truly unusual is that you can use its six functions to perform an astounding number of different operations. For instance:



CALCULATOR/WATCH has 28 keys to perform more than 36 different operations using six basic interactive functions.

1. Just press the time key once to show hours, minutes and seconds. You can use either a 12-hour or a 24-hour format, or convert to and from decimal hours. Add or subtract the time and the date is automatically adjusted.

2. A beep alarm can be set up to 24 hours ahead; a second timer-controlled alarm counts down from a preset time. Another pushbutton displays setting time. Whether the alarm is on or off is indicated automatically.

3. A timer/stopwatch shows elapsed time in hours/minutes/seconds, or in minutes/seconds/hundredths of seconds. You can store elapsed-time readings in memory.

4. The 200-year calendar, set to either month/day/year or day/month/year (useful outside the U.S.), can be used to calculate past or future dates, the number of days between dates, or the day of the week or year for any date.

5. The calculator performs the usual functions of add, subtract, multiply, divide, percentage, net amount, change and repeat, with the additional feature that if an answer is greater than 10^{+7} or less than 10^{-4}, the instrument switches to scientific notation.

6. The memory key stores time of day, stopwatch interval, calendar date or numbers. Data can then be recalled for use in calculations or entered into time, date, stopwatch or alarm memories. Two additional memories hold information to be used in calculations or to perform arithmetic operations. This information can be exchanged by pressing a button.

The *model HP-01* costs $650 (stainless steel) and $750 (gold-filled case).

Radio Club of America announces 20 new Fellows

The Board of Directors of the Radio Club of America, the oldest communications organization in the world, recently voted in 20 new Fellows. The distinguished roster of engineers, scientists and executives includes:

Alan Armitage, Rex Bassett, Robert L. Batts, John Daly, Charles Davison, Gary Gray, Ray Griese, George Jacobs, R.W. Johnson, James McLean, Morgan McMahon, Tom McMullin, Travis Marshall, George Mitchell, Nat Pfeffer, Richard Quantz, Jôhn Robinson, Ray Spence, Ben Tongue, and Val Williams.

Use of CB by police increases nationwide

According to a recent survey conducted by Inspector Robert Ellis of the Washington, D.C., Metropolitan Police force, 94% of all state police organizations in the U.S. have now established CB radio public-safety programs with an eye to providing highway motorists direct access to police in emergencies. The survey reveals that 36 states have installed CB radios in 48% of all police vehicles, six states report CB's are in all state patrol cars and an additional five states plan such installations in the near future. Only three states do not use CB radio communications or have arrangements with volunteer groups.

"State public service agencies are not the only agencies using CB radios," Inspector Ellis notes. "Small towns, county and city public safety organizations are also interfacing with CB radio users."

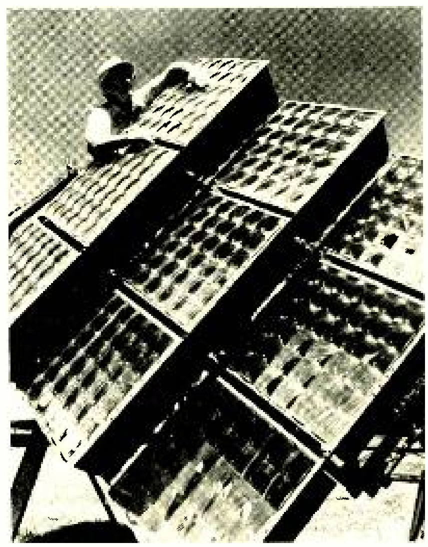
Geomagnetic storms caused by solar holes now predictable

For a long time, attempts have been made to attribute the occurrence of geomagnetic storms to solar phenomena. Now, observers have determined that these storms (which are responsible for some spectacular auroral displays as well as considerable radio interference) are produced by holes in the sun's corona.

These coronal holes are areas in which the magnetic-field lines open outward, the density decreases, and a larger-than-usual amount of solar material is released into the solar wind. The speed and the density of the solar-wind material are increased, and the wind passes the earth about seven days after the holes appear in the sun's corona. Therefore, observers have discovered they can get a week's warning before a magnetic storm strikes.

RCA solar power converter uses low-cost plastic lenses

RCA Laboratories of Princeton, NJ, under contract to the U.S. Energy Research and Development Administration (ERDA), has been developing their answer to the energy crisis. Their 300-watt solar module's inexpensive, 4-inch-square plastic lenses, contained in a 6-foot-square module, concentrate the sunlight onto silicon solar cells. The system is self-powered to drive the tracking mechanism that keeps the module continually pointing directly at the sun to maximize output.



EXPERIMENTAL SOLAR SYSTEM from RCA uses inexpensive plastic lenses to concentrate sunlight directly onto silicon solar cells. The lenses concentrate the sunlight by a factor of 300, thus permiting the use of smaller and less expensive solar cells than normally used in conventional solar applications.

Although it is still too early to determine the system's eventual size and total output, RCA believes it can be mass-produced to serve areas having little or no conventional power supplies. A small group of the solar modules could power a radio transmitter; while a larger group could service a home or office in a sunny location.

Chances are, someone you know just bought a professional 3½ digit DMM kit for less than $70.

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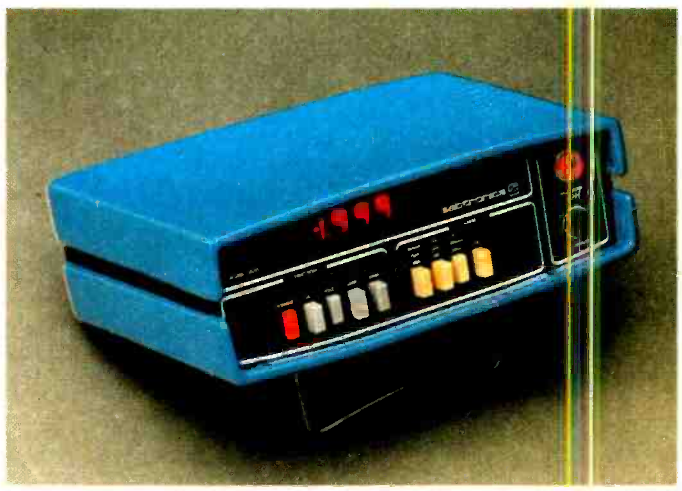
The result is a professional quality 3½ digit DMM that you could have paid a lot more than $69.95 for . . . possibly receiving a lot less. But this one's from Sabtronics, specialists in digital technology.

Maybe you should order yours before you turn the page.



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

editorial

For the want of a nail . . . .

We all know that story. How the battle was lost because of one horseshoe nail. But what many of us don't seem to know is that many construction projects don't work because of one ¼-watt carbon resistor . . . . or one PNP transistor . . . . or one MOS IC . . . . or one . . . .

Radio-Electronics publishes more than 25 construction articles every year. Some are simple and almost foolproof. Many are complex, state-of-the-art machines. And all it takes is one out-of-spec component, or one wiring error to keep it from working.

A while back we got a letter from a reader who had built an audio mixer. He complained that it was noisey. He couldn't understand the problem. He had followed the article precisely. Except for the transistors, he used only the parts specified in the parts list. Too bad he hadn't used low-noise transistors like the ones specified. He did not have to use the specific ones we listed, but in making a substitution to use available parts, he forgot one of the most important specifications for the device he was building. He remembered the collector voltages, he didn't forget to obtain an NPN device, he watched for the output power ratings, but he forgot about the noise specification. More recently a reader completed our 2650 computer. It worked well, except . . . . To make a long story short, a memory IC inserted backwards was the problem.

The point of this all is that we select construction projects to provide you with the latest, most interesting devices to build that we can find. In many instances, if you didn't build them, you couldn't own one. Most are a real challenge, yet they will work as soon as you hook up the power supply and turn on the switch. But when they don't, consider the possible problems carefully. Make sure there are no solder bridges on the circuit board and that there are no cold solder joints. Check the symptoms and the parts involved. Double check wherever you have made a substitution or a modification to the circuit, because that is one of the most likely trouble spots. Don't lose your project for the want of a nail.

Larry Steckler

LARRY STECKLER
Editor

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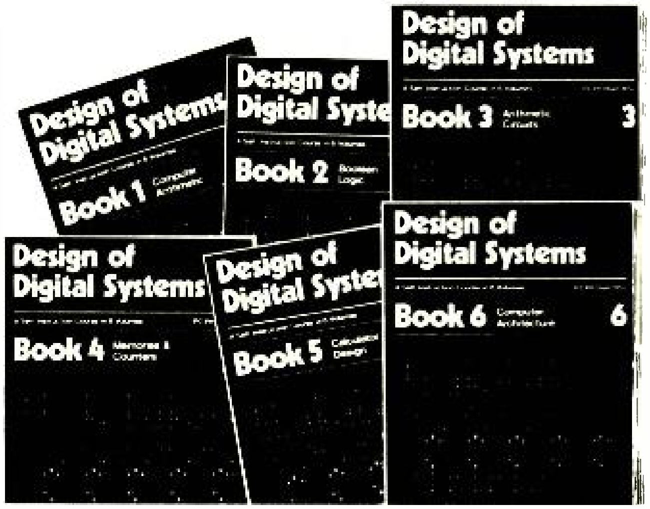

Design of Digital Systems is written for the engineer seeking to learn more about digital electronics. Its six volumes — each 11-1/2" x 8-1/4" are packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra to memories, counters and simple arithmetic circuits, and finally to a complete understanding of the design and operation of calculators and computers.

The contents of Design of Digital Systems include:

Book 1 Octal, hexadecimal and binary number systems; conversion between number systems; representation of negative numbers; complementary systems; binary multiplication and division.
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Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.
Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).
Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.
Book 6 Central processing unit (CPU); memory organization; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.

Digital Computer Logic and Electronics is designed for the beginner. No mathematical knowledge other than simple arithmetic is assumed, though the student should have an aptitude for logical thought. It consists of four volumes — each 11-1/2" x 8-1/4" — and serves as an introduction to the subject of digital electronics. Everyone can learn from it — designer, executive, scientist, student, engineer.

Contents include: Binary, octal and decimal number systems; conversion between number systems; AND, OR, NOR and NAND gates and inverters; Boolean algebra and truth tables; De Morgans Laws; design of logic circuits using NOR gates; R-S and J-K flip flops; binary counters, shift registers and half adders.

In the years ahead the products of digital electronics technology will play an important part in your life. Calculators and digital watches are already commonplace. Tomorrow a digital display could show your automobile speed and gas consumption; you could be calling people by entering their name into a telephone which would automatically look up their number and dial it for you.

These courses were written by experts in electronics and learning systems so that you could teach yourself the theory and application of digital logic. Learning by self-instruction has the advantages of being faster and more thorough than classroom learning. You work at your own pace and must respond by answering questions on each new piece of information before proceeding.

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letters

TRS-80 USERS GROUP

A new TRS-80 Users Group is in the process of being formed. The group is dedicated to the exchange of programs and technical data for Radio Shack's new Z-80-based system. For information, write to R. Gordon Lloyd, 7554 Southgate Rd., Fayetteville, NC 28304.
R. GORDON LLOYD
Fayetteville, NC

DESIGN ERROR

In the September 1977 "Hobby Corner," Earl Savage makes the statement that since he has built all the circuits shown in the column and they worked, any problems a reader has cannot be traced to bad circuit designs. In making the statement, he neglects the device-to-device variability allowed by the spec sheets. In fact, the pulse switch shown in Fig. 6 contains a design error, as well as a typographical error.

The typographical error concerns the red LED. This LED is connected backwards. The more subtle error involves the green LED. This LED is designed to be on when the NAND gate has a high-state output. The TTL data sheets show that in the high state, an output is only required to source 10 × 40 μa = 0.4 mA of current. If the gate is putting out 2 volts, (the absolute minimum safe voltage for the high state) and the LED voltage drop is near maximum at 1.6 volts, the current required is still (2.0 − 1.6)/ 270 = 1.5 mA. Thus, the required current is almost four times what the spec sheets require the device to provide. The result is that perfectly good 7400 IC's will yield an output voltage below 2 volts, and this voltage may or may not be interpreted by another gate as a logic 1. In fact, the other NAND gate in the circuit may be affected this way since it is connected to the output.

The solution is quite simple. Connect the green LED to the output of the other NAND gate in the circuit in the same manner as the correct connection of the red LED. Although a TTL output only has to source 0.4 mA, it is required to be able to sink 16 mA.
PROF. WILLIAM D. OHLSEN
The University of Utah
Salt Lake City, UT

1. As soon as one says something won't go wrong, it does! Several sharp-eyed readers called attention to the reversed LED.

2. The hobbyist, technician or engineer who ignores possible device variability is asking for trouble, as was stated in the caution regarding component tolerance.

3. The matter of the design calling for a gate to source sufficient current for the LED is correct, up to a point. Much depends on whose specs you accept for your calculations. Published specs do not always agree for a given IC. However, the underlying point is that of the proper mix of theory and practice in circuit design (which was also behind my statement that all circuits had actually been constructed).

First, understand that I am not antagonistic toward theory; in fact, I use it to the limits of my knowledge. Yet, I am of a practical turn of mind, and you sent me to my books to double-check your specs, where I found two different specs for I_{OH} for 7400's, and then to my workbench. I had to find out if the circuits I had built, including one I have used for over two years, were only flukes.

I designed a circuit to check 7400 gates for both the ability to source sufficient LED current and at the same time produce highs and lows acceptable to other gates. In summary, each of the one hundred and thirty-six 7400 gates I had on hand demonstrated the capability of performing both functions. Not one failed in the test procedure which required some 140,000 state changes. *(As I write this, there are two 7400's in the test circuit that have been continuously operating for the last 42 hours—or over 60 million state changes for each gate!) A number of gates did have some current leakage through the red LED and in eight of these, the optical performance was marginal although usable (these two ceramic IC's were quite functional electronically—there was no observable distortion of the square-wave output pattern). Furthermore, the average source voltage (V_{OH}) was +3.34 VDC (per specs), and the average source current (I_{OH}) was 3.3 mA. Quite obviously, the latter is impossible according to the published specs! Why does it work? I don't know, unless the specs deliberately understate the capability of the upper transistor in the totem-pole output by a considerable factor.*

In any case, I do not believe that all these 7400's are similarly atypical, especially since my stock has been purchased at various times and from several suppliers. Therefore, based on my past experience and upon these tests, I feel justified in my design. This is another case in which theory and practice apparently do not agree and that further emphasizes that they must be judiciously mixed.
EARL R. SAVAGE
Hobby Editor

NO AM DATA

I recently picked up a copy of your June issue and saw your Lab Test article on a Fisher *model RS-1080* AM/FM receiver. You had very extensive test results on both the FM tuner section and the amplifier section. The written comments were also useful to the average consumer.

As an engineer of an AM radio station in a large metropolitan market, I was appalled to note that not *one* measurement was

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LETTERS
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taken on the AM tuner section, with only vague written references that pertained to that section. How can a consumer make an intelligent selection on a receiver when they are given no data on half of it?

In Canada, AM captures by far the majority of the listening audience. Perhaps you feel that AM is not of sufficient quality to justify sophisticated tests on an AM tuner. If so, I would question why. Are you aware that stations like ours broadcast clean signals with less than .5% THD from 50 to 10 KHz ±2 dB? I realize that these are only two specs but they are very important ones. They were obtained by sampling RF from each of the towers in the array, and feeding them into a phase monitor and then feeding the output to a storage scope with a spectrum analyzer contained within it. From these and many other tests, we know that our signal is good.

Naturally, we don't sound like an FM signal simply because AM material is generally processed for a loud signal with high average modulation levels with positive peaks reaching the legal limit of 120%.

I have done several tests on various types of AM receivers. I will, for the sake of space, discuss only one test—frequency response. I have found that due to inexpensive IF sections and other glaringly bad design errors in AM tuners, this spec has suffered. I believe that this occurs mainly due to "cost engineering," not the inability to make good AM tuners.

If these problems are inherent in the majority of AM tuners, the public should know about it. I think that a reputable magazine such as yours has the ability and the duty to do something about this. I am sure that if consumers were shown that they could have better sound quality for only small increases in product price, they would soon demand it. If they are kept in the dark, they will not expect better AM quality from their tuners and accept what they now have, which I feel is, in some cases, deplorable.

My motives for this letter are obvious—as FM continues to make inroads into the AM market, we must improve our own product to combat this. As a broadcasting engineer, I feel that presently one of the weakest links in the system is the tuner, and therefore, feel that if improvements can be made, they should be. I also think that this must begin with consumer education which only *you* can do.

KEN DITTRICK, Assistant Engineer
Radio Station CHED Ltd.
Edmonton, Canada

We are in complete agreement with your comments regarding the generally poor design practices followed by manufacturers of high-fidelity receiver components in the AM tuner sections of their products. It is precisely for this reason that we pay so little attention to AM performance in testing and reporting upon various tuners and receivers. From time to time, we do run across an AM tuner section that merits additional mention, and, in those instances, we do refer to the AM section in somewhat greater detail. In general, however, most AM tuner sections we have tested have poor frequency response above around 3 kHz or 4 kHz, and also exhibit high harmonic distortion at 30% modulation levels. As you have stated, a great many AM stations consistently modulate to much higher average levels than that, and so you can just imagine what horrendous distortion levels are delivered by "typical" AM tuner sections under these circumstances.

There is one glimmer of hope, however. As you know, the FCC has recently issued a notice of inquiry that may well lead to the promulgation of broadcast standards for stereo AM. If such standards are formulated, and if stereo AM broadcasting begins in this country in the near future, perhaps more U.S. stations will find it economically feasible to lease 15,000-Hz lines from our phone companies to feed their programs from studio to transmitter. (Presently, most use "standard" 5,000-Hz lines, which limit broadcast fidelity to begin with.) If enough stations start "cleaning up" their signals and begin to transmit a wider audio bandwidth, perhaps hi-fi manufacturers will then have the incentive to improve their circuit designs. If and when such improvements are noticed by our testing staff, you can be certain that we will offer more definitive data regarding AM performance of the products we test and evaluate.
LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

equipment reports

Electrolert Fuzzbuster and Fuzzbuster II Radar Detectors

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PERHAPS THE BEST KNOWN OF ALL THE RADAR detectors on the market is the *Fuzzbuster*, manufactured by Electrolert, Inc., 4949 South 25A, Troy, OH 45373. This company has most recently introduced the multiband *Fuzzbuster II*.

Police radar units operate on either one of two frequencies: a primary frequency of 10.5 GHz (X-band) and a secondary frequency of 24 GHz (K-band). Approximately 90% of all police radar units operate on the X-band. However, the remainder operate on the K-band frequency. The *Fuzzbuster II* monitors both frequencies automatically without your having to flip a band switch. The original *Fuzzbuster* monitors only the X-band. Otherwise, the units are identical.

Both *Fuzzbusters* are housed in a black metal $5^1/_8 \times 3^7/_8 \times 2^7/_8$-inch case with a simulated woodgrain front panel. The front panel contains a 1-inch-diameter indicator light and a sensitivity control. The receiving antenna is located behind a plastic-covered diamond-shaped cutout on the back panel. An audible indicator is also located behind several holes in the back panel.

Selectivity and sensitivity

Selectivity and sensitivity are the two most important performance specifications for radar detectors. Sensitivity is the minimum signal that is needed to trigger the detector. In effect, sensitivity is a measure of the distance from the police radar unit that the motorist will be alerted to its presence. Police radar units have an approximate ½-mile range. They emit a narrow beam for a much greater distance, but can only measure speed at a ½-mile distance or closer.

Electrolert claims that the *Fuzzbuster* and *Fuzzbuster II* have a sensitivity that is six times better than that of the police radar units. This does not necessarily mean, however, that the *Fuzzbuster* can detect the radar unit at a distance of three miles. You must keep in mind that the radar emits a narrow beam. The *Fuzzbuster* must receive energy from the beam to detect its presence. Your car must be either within the narrow beam or depend on beam reflections (scattering) from other vehicles or stationary objects along the road. Also, because the *Fuzzbuster* cannot detect the beam through a hill or around a curve, you must depend again on beam scattering to receive a signal. The operators' manual provided with the *Fuzzbuster* and *Fuzzbuster II* contains several illustrative examples of such situations.

Selectivity is the other important performance specification. If the radar detector is too broadly tuned, it is subject to false triggering from RF sources other than the police radar. For the X-band, both *Fuzzbusters*, according to Electrolert, will detect a signal in the 10.45- to 10.6-GHz range.

Since the *Fuzzbusters* are not waterproof, they should not be mounted externally such as

continued on page 22

At CIE, you get electronics career training from specialists.

If you're interested in learning how to fix air conditioners, service cars or install heating systems – talk to some other school. But if you're serious about electronics, come to CIE – The Electronics Specialists.

John E Cunningham

Special Projects Director
Cleveland Institute of Electronics

My father always told me that there were certain advantages to putting all your eggs in one basket. "John," he said, "learn to do one important thing better than anyone else, and you'll always be in demand."

I believe he was right. Today is the age of specialization. And I think that's a very good thing.

Consider doctors. You wouldn't expect your family doctor to perform open heart surgery or your dentist to set a broken bone, either. Would you?

For these things, you'd want a specialist. And you'd trust him. Because you'd know if he weren't any good, he'd be out of business.

Why trust your education and career future to anything less than a specialist?

You shouldn't. And you certainly don't have to.

FACT: CIE is the largest independent home study school in the world that specializes exclusively in electronics.

We have to be good at it because we put all our eggs in one basket: electronics. If we hadn't done a good job, we'd have closed our doors long ago.

Specialists aren't for everyone.

I'll tell it to you straight. If you think electronics would make a nice hobby, check with other schools.

But if you think you have the cool – and want the training it takes – to make sure that a sound blackout during a prime time TV show will be corrected in seconds – then answer this ad. You'll probably find CIE has a course that's just right for you!

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Learning electronics is a lot more than memorizing a laundry list of facts about circuits and transistors. Electronics is interesting because it's based on some fairly recent scientific discoveries. It's built on ideas. So, look for a program that starts with ideas – and builds on them.

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behind the front grill of the car. The best location is on top of the dashboard inside the vehicle. Four self-adhesive *Velcro* fasteners permit easy removal of the detector when necessary.

Electrical connection is simple. The power cord comes complete with a plug that fits into most dashboard cigar lighters. Both *Fuzzbusters* work on 12-volt positive or negative ground electrical systems with no modification necessary.

To set the sensitivity control, rotate it fully clockwise. The indicator will light up and a tone will be heard. Now, rotate the control counterclockwise until the light goes out and the audible tone turns off.

If the unit does not operate properly, check the indicator light. Remove the plastic lens from the front panel and replace the No. 47 indicator lamp. (A spare indicator lamp comes with the unit.) **R-E**

Triplett Model 60-NA Ruggedized VOM

THE TRIPLETT CORP., BLUFFTON, OH 45817, MANufacturers of the *Series 60* ruggedized VOM's, have expanded the *Series 60* line by adding the *model 60-NA*, which sells for $136.

The *model 60-NA* resembles the original *model 60* VOM, and possesses all the ruggedness of the earlier unit, but is designed for even greater versatility.

The *model 60-NA* has a total of 50 separate ranges. (I counted them!) You can read AC or DC voltages and DC current on four handy meter scales of the 0–5, 0–15 type. Readings start at 0.5 volt, then proceed to 1.5 volts, 5.0 volts, 15 volts, etc. (Actually, there is a lower range; wait a minute.) The range goes to 500 volts and a multiplier switch doubles the full-scale reading on each range so that the top range is 1000 volts or 1000 mA. The first set of readings is at 20,000 ohms-per-volt, and doubled readings are at 10,000 ohms-per-volt. Extra scales for the 0–3 (0–1.5 volts doubled) and 0–10 ranges permit direct reading of these ranges. The AC voltage ranges are frequency-compensated from 20 Hz to 20 kHz.

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For the other DC voltage range (0–0.15 volt, or 150 mV), simply set the range switch to the 0–0.5 DCMA position. The meter then becomes a 0–150 mV DC voltmeter. Set the multiplier switch to ×2 to move this reading to 0–300 mV.

Six resistance ranges start at ×1, with a 6-ohm center scale, and go to a ×100K range at 100 megohms. This increased number of ranges makes the instrument more useful wherever high-value resistors are found. The high-resistance values can be read in the center half of the scale.

The model 60-NA has an improved accuracy of ±1½% of full scale on all voltage ranges; the AC accuracy is ±3% of full scale on all voltage ranges. A polarity-reversing switch on the panel works on both DC voltages and DC current, as well as on the ohmmeter. This switch is handy for transistor junction tests.

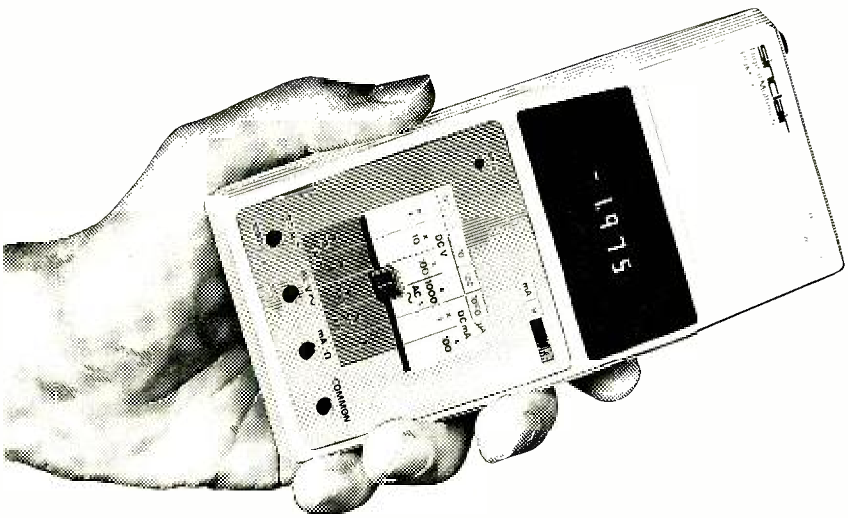
All the safety and construction features of the earlier *model 60* have been retained. This unit is drop proof; it will withstand an accidental drop from five feet onto a cement floor or even a deliberate drop, and there are no exposed metal parts on the case. Even the test-lead jacks are recessed so that no wires are exposed. The meter movement has a special suspension.

The *model 60-NA* is well protected electronically. A diode unit protects the meter movement. A ⅛-amp fuse and a 1.0-amp fuse, used in series with the inputs, insure that all ranges are as safe from damage as possible. Therefore, while you still can't read the AC line voltage on the ×1 ohms scale, it will not affect anything except the ⅛-amp fuse.

A separate 2-amp fuse protects the instrument and the operator against damage if overvoltage blows the small fuses and arcs over the holders. This additional fuse is a special 1-kV, Bussman HVA-2 or Littelfuse 621002 fuse.

continued on page 24

The Sinclair PDM35.
A personal <u>digital</u> multimeter for only $49.95



Technical specification

DC Volts (4 ranges)
Range: 1 mV to 1000 V.
Accuracy of reading 1.0% ± 1 count.
Note: 10 MΩ input impedance.
AC Volts (40 Hz-5 kHz)
Range: 1 V to 500 V.
Accuracy of reading: 1.0% ± 2 counts.
DC Current (6 ranges)
Range: 1 nA to 200 mA.
Accuracy of reading: 1.0% ± 1 count.
Note: Max. resolution 0.1 nA.
Resistance (5 ranges)
Range: 1Ω to 20 MΩ.
Accuracy of reading: 1.5% ± 1 count.
Also provides 5 junction-test ranges.
Dimensions: 6 in x 3 in x 1½ in.
Weight: 6½ oz.
Power supply: 9 V battery or Sinclair AC adapter.
Sockets: Standard 4 mm for resilient plugs.
Options: AC adapter for 117 V 60 Hz power. De-luxe padded carrying wallet. 30 kV probe.

Now everyone can afford to own a digital multimeter

A digital multimeter used to mean an expensive, bulky piece of equipment.

The Sinclair PDM35 changes that. It's got all the functions and features you want in a digital multimeter, yet they're neatly packaged in a rugged but light pocket-size case, ready to go anywhere.

The Sinclair PDM35 gives you all the benefits of an ordinary digital multimeter – quick clear readings, high accuracy and resolution, high input impedence. Yet at $49.95 it costs less than you'd expect to pay for an analog meter!

The Sinclair PDM35 is tailor-made for anyone who needs to make rapid measurements. Development engineers, field service engineers, lab technicians, computer specialists, radio and electronic hobbyists will find it ideal.

With its rugged construction and battery operation, the PDM35 is perfectly suited for hand work in the field, while its angled display and optional AC power facility make it just as useful on the bench.

What you get with a PDM35

3½ digit resolution.
Sharp, bright, easily read LED display, reading to ± 1.999.
Automatic polarity selection.
Resolution of 1 mV and 0.1 nA (0.0001 µA).
Direct reading of semiconductor forward voltages at 5 different currents.
Resistance measured up to 20 MΩ.
1% of reading accuracy.
Operation from replaceable battery or AC adapter.
Industry standard 10 MΩ input impedance.

Compare it with an analog meter!

The PDM 35's 1% of reading compares with 3% of full scale for a comparable analog meter. That makes it around 5 times more accurate on average.

The PDM35 will resolve 1 mV against around 10 mV for a comarable analog meter – and resolution on current is over 1000 times greater.

The PDM35's DC input impedance of 10 MΩ is 50 times higher than a 20 kΩ/volt analog meter on the 10 V range.

The PDM35 gives precise digital readings. So there's no need to interpret ambiguous scales, no parallax errors. There's no need to reverse leads for negative readings. There's no delicate meter movement to damage. And you can resolve current as low as 0.1 nA and measure transistor and diode junctions over 5 decades of current.

The Sinclair credentials

Sinclair have pioneered a whole range of electronic world-firsts – from programmable pocket calculators to miniature TVs. The PDM35 embodies six years' experience in digital multimeter design, in which time Sinclair have become one of the world's largest producers.

Tried, tested, ready to go!

The Sinclair PDM35 comes to you fully built, tested, calibrated and guaranteed. It comes complete with leads and test prods, operating instructions and a carrying wallet. And getting one couldn't be easier. Just fill in the coupon, enclose a cheque (10 for the correct amount (usual 10-day money-back undertaking, of course), and send it to us.

We'll mail your PDM35 by return!

Sinclair Radionics Inc, Galleria, 115 East 57th Street, New York, N.Y. 10022, U.S.A.

To: Sinclair Radionics Inc, Galleria, 115 East 57th Street, New York, N.Y. 10022, U.S.A.

Please send me ______ (qty) PDM35(s) @$49.95 plus $1.05 postage and insurance each: .... $______
______ (qty) De-luxe padded carrying case(s) @$4.95 each: .... $______
______ (qty) AC adapter(s) @$4.95 each: .... $______
I enclose check/MO order made out to Sinclair Radionics Inc (indicate total order value.
Add 4% sales tax for NYS deliveries): .... $______
I understand that if I am not completely satisfied with my PDM35, I may return it within ten days for a full cash refund.

Name ....
Address ....
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EQUIPMENT REPORTS

continued from page 22

The fuses are easily accessible; just remove the battery cover from the back of the VOM. They are contained in spring-clip holders, together with spare fuses for each one.

One D-cell battery is used for the lower ohms ranges, and a 30-volt (NEDA No. 210) battery is used for the two high ohms ranges. Both batteries are accessible; the battery compartment, which is separate from the circuit board, is sealed to protect the rest of the meter from any possible leakage. (If you've ever had to clean up a VOM after a battery has leaked, you'll appreciate this feature.)

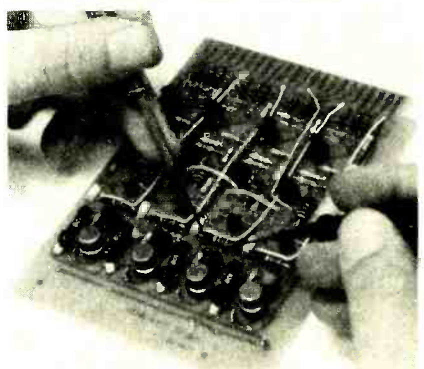
Several accessories extend the *model 60-NA's* ranges. The *model 10-C* Clamp-On Adaptor reads AC current. The *model 101* Line Separator allows you to read AC currents at any regular outlet. For DC current readings greater than the 1-amp range, a separate shunt adapter can be used. Currents up to 30 amps can be read. For DC high voltages, the model 79-380 probe extends the range to 30 kV; for AC high voltage, the model 79-381 probe gives 30 kV AC.

The instruction manual gives full details of ranges, scales (a useful chart on page 11 shows exactly how to read all those ranges), and calibration tests and adjustments. Four calibration adjustments are used on the 3-VAC and 150-VAC ranges, on the 50-mV range and on the μA range. The mirror-scale meter movement has a 4.5-inch arc to eliminate parallax. The modular design of the meter makes it easy to repair in an emergency.

For minor troubleshooting, there is a built-in "confidence test." Just set the range switch to ×1K, short the test leads and adjust the ohms scale to zero. Remove the slip-on test clip from the red lead and touch the test jack on the panel. The meter should read exactly half-scale; there is a small red block on the top scale for this purpose. If the needle stops inside this block, everything is OK.

The manual contains a few handy hints, such as: "Don't move the range switch without disconnecting the load." This protects the switch contacts from possible arcs, etc., and makes them last longer. This tough and accurate little instrument should provide full value for the money in long, dependable service. **R-E**

Huntron Micro-Probes Telescopic Test Leads



CIRCLE 82 ON FREE INFORMATION CARD

THE LITTLE THINGS IN LIFE ARE ALWAYS IMportant. You can have a fine, accurate and expensive voltmeter, but if you can't connect it to the circuitry you want to check, it's as much use as an empty cigar box. So, in such a case, what can you use? The answer is—test leads!

I'm much impressed with something new—some ordinary-looking test leads called *Micro-Probes* that are manufactured by Huntron Sales, Inc., 15123 Pacific Highway North, Lynnwood, WA 98036. One lead is red and the other lead is black, but the similarity ends there. The lead tip is very sharp and consists of a well-insulated rod. You can telescope the tip to an extension of 2.75 inches beyond the end of the probe body. A locking collar holds the tip tightly in the desired position. The ¼-inch-diameter probe body has a small collar that makes them easier to hold. The leads are made of 18-gauge *Superflex* wire, and can be terminated in any type of connector. Mine have banana plugs that fit most of my equipment.

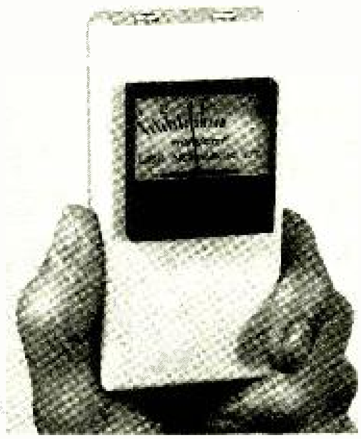
Since so many TV sets have their transistors, resistors and other parts so tightly packed on the circuit board that only a small part of the lead is visible, a very long, thin test-probe is essential to check test points. Because a great many parts are always in the way, the probes must be very well insulated. The *Micro-Probes'* insulation covers all but the very end of the tip. This allows you to take readings between two adjacent IC pins on any two transistor leads, etc.

I've rigged some items to do this sort of job in the past, but none perform as easily and safely as the *Micro-Probes*. **R-E**

UCE, Inc., 245M Microwave Monitor

MICROWAVE OVEN LEAKAGE HAS LONG BEEN the subject of heated discussion. (I sometimes think that more heat has been generated outside the ovens than inside.) To help settle the controversy, a compact, accurate leakage detector is needed.

UCE, Inc., 20 North Main St., Norwalk, CT 06854, has now produced a portable radiation detector, the Microwave Monitor *model*



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245M, priced at $49.95. This detector is no larger than the palm of your hand, and is completely self-powered, no batteries are needed. It is calibrated to 5.0 mW/cm^2 center scale, and levels as low as 0.5 mW can be read. The *model 245M* is factory-calibrated against a U.S. Bureau of Standards secondary standard, and certified by the manufacturer.

It is very simple to operate; even I did it right the first time. Just turn the oven on, remembering to put a glass of water inside as a dummy load. Now, holding the meter 2 inches (5 cm) from the door near the seals, move the meter all the way around the door. Any leakage will show up instantly. We checked it out on several units, including commercial ovens. The maximum reading was about 1.0 mW, which is well within safe limits. The standard maximum reading set by the U.S. Department of Health, Education and Welfare is 5.0 mW/cm^2.

The *model 245M* is self-powered; an educated guess is that it uses a microammeter with a 2,450-MHz detector circuit.

Microwave oven technicians would find this instrument very useful since it takes only 30 seconds to run a complete leakage test after repair and reassembly. The test results could even be noted on the statement. Even the concerned consumer could use this detector to check his own microwave oven for safety. It is reasonably priced, and with minimal care should last a long time. **R-E**

Audiovox MA-30 Electric CB/FM-AM-MPX Antenna

THE THOUGHT OF BEING ABLE TO REPLACE my factory installed AM/FM car radio antenna with a single antenna that will work on AM, FM and CB was like a dream come true. I could get rid of the magnetic CB whip on the roof, not have any antenna at all visible when parked on the street and still get good performance.

turn page

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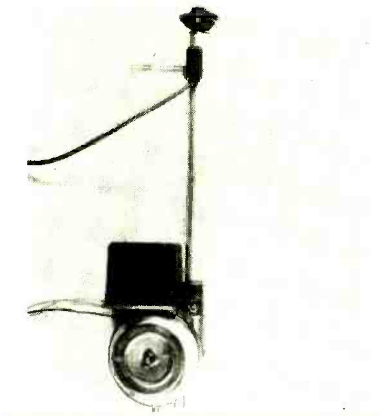

CIRCLE 78 ON FREE INFORMATION CARD

For my car I was able to simply replace the existing antenna with the new one. In some models this may not be possible. The problem is the 14-inch long antenna housing that must go under the fender. So in some instances, the original antenna position is not the place for the *MA-30*. But aside from this, mounting and hookup is easy and goes quickly.

The *MA-30* is equipped with a built-in safety relay that prevents damage or burnout to CB output transistors by allowing the CB to operate only when the antenna is at the correct height (fully extended) for proper SWR. There is a manual switch that adjusts antenna height for optimum AM/FM reception as well as a signal-splitting coupler with fine-tuning capabilities. For CB operation, a loading coil is provided at the top of the antenna.

The manufacturer states that the antenna can be mounted on either the front or the rear of the car. I mounted it on the front simply because it was more convenient for me. The unused rear-mount cable was just added to my stock of electronics supplies for future use.

Once installed (the antenna comes with a tunable coupler, front and rear mount cable, wiring harness, hardware, wrench, and instructions), hooked up to the CB and radio, and coupler tuned and radios adjusted, it really became the problem solver the package promised.

AM and FM reception were just as good as they had been with the factory installed antenna that came with the car. That includes FM stereo too. CB was just as good as it was with the magnetic roof mount I used to use. The only difference I could detect was some slight falloff on the top three channels 38-39-40, but it was so slight that it could have been my imagination. Besides, being able to completely retract that antenna and not having to open the trunk to dump the magnetic roof mount was worth it. **R-E**

Sencore TF46 Super Cricket Transistor And FET Tester

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SENCORE'S CRICKET TRANSISTOR TESTERS ARE familiar to us. The original was introduced quite a while ago, and it's still around. The latest in the line is the *model TF46* Super Cricket made by Sencore, 3200 Sencore Drive, Sioux Falls, SD 57107.

The basic circuit is simple: The transistor is hooked up as a common-emitter low-voltage amplifier. Then, a signal is applied, and a special selector switch changes the leads to all of the possible combinations. When the correct combination is selected, the transistor amplifies and *inverts* the signal. A phase detector then opens a circuit that allows the signal through to the speaker, with a simultaneous readout on the meter.

Since practically all bipolar transistors will operate with the collector and emitter reversed, two selector-switch positions give a reading. To identify the correct reading, press the GAIN pushbutton. One position will show a very low reading, the other indicates a much higher reading. The selector-switch position that gives the high reading is correct and this also gives a beta reading of the transistor.

The selector switch has 12 positions: six positions on the left-hand side are for NPN and six on the right are for PNP. The dial is labelled in various combinations of RGY to match the three red, green and yellow test leads. The pointer is marked EBC: when the right switch positions give you a reading, it shows the transistor is good and the leads are connected to the elements shown.

The *model TF46* Super Cricket has an audible readout of the 2-kHz tone used for the test signal. It also has a good-sized meter for testing bipolar and FET transistor gain, etc., and for leakage readings, which should be made out-of-circuit for accuracy.The three test leads use handy color-coded miniature clips that can be connected to most transistors in-circuit if there is even a little bit of the leads showing. You can use a special three-pin probe hooked to the three clips to make in-circuit tests on the foil side of PC boards. The three pins are also color coded and *very* sharp to penetrate any board coatings.

The two banks of four pushbutton switches do not have to be used for the good/bad and lead-identification tests. After the reading, just leave the transistor hooked up; you can do everything else by switching. You can verify the correct hookup by simply pushing the GAIN pushbutton. The right position will show a higher reading. In a typical test, the reversed collector-emitter position showed a reading of about 3 and the right one showed a beta of about 75, which was correct for the general-purpose audio transistor being tested. Two pushbuttons to the left of the switch are used for either signal transistors or output (power) types.

Leakage can be read out-of-circuit for bipolar or FET transistors. Just press the LEAKAGE button. The meter is calibrated from 0 to 2.500 μA for bipolar transistors (upper scale) and 0 to 50 mA for I_{dss} readings of FET's. In the correct "test" position, you read I_{cbo}, one of the critical leakages. By moving the switch to the remaining five positions, you can read *all* the other important leakage paths by pushing the LEAKAGE button! A chart in the *model TF46* manual shows this. I checked my collection of bad transistors, and the results came out exactly right. (At times, I believe that I have more bad transistors in stock than good ones!)

For diode testing, connect the red and green leads to the diode and set the switch to the two DIODE positions on the dial; press the LEAKAGE pushbutton. A good diode will read high one way and low the other. The color of the leads indicates the cathode, which is very useful for identifying the invisible glass diodes.

The unit can also be used for matching dual-diode units, which can be valuable in sets with AFC, ACC, killer, demodulator and similar problems.

In checking FET's of all types, pushbuttons select either junction FET's or enhancement FET's. Dual-gate transistors can also be checked. All the possible FET leakages can be read using the method just descrbed. Transconductance may be read up to 25,000 μmho's.

When the unit is used to check SCR's, an unusual reading results. A good SCR will show a GOOD reading in one position as an NPN transistor, and another reading as a good PNP transistor! To check leakage, connect the red and green leads to the cathode and anode and run the diode leakage test. If the SCR does not leak, both positions will show no leakage at all. If it *is* leaky, both will show high leakage.

To determine whether you are testing a bipolar transistor or a FET, run the lead-identification and gain test. If the GAIN check shows a reading of one high and one low the transistor is bipolar. If *both* positions of the selector switch show exactly the same gain reading, it is a FET. Source and drain can be reversed on practically all FET's.

The *model TF46* is powered by six AA batteries for portability. For bench work, the *model PA202* AC Power Adapter can be plugged into the back. This is helpful if NiCad batteries are used, since the adapter will recharge them so that the instrument is always ready to go into the field.

The *model TF46* has a special circuit that ends your worries about leaving it on all night (or, in my case, over the weekend!). When you turn it on, a timer circuit starts; after it is on for 10 minutes, it turns itself off! Just push the ON/OFF switch to reactivate it. When the AC Power Adapter is used, this circuit is disabled.

A 250-page *Transistor Reference Book* is also available, listing over 25,000 transistors; a special FET section appears in the back of the book. Cross-references to most major replacement transistor lines are included. The listings show EIA and JEIA type numbers, basing, polarity, typical gain and leakage values, and whether the transistor is a signal or a power unit.

A kit is available that includes *model TF46*, *model PA202* AC Power Adapter, *model 39G85* Touch-Test probe, and the *Transistor Reference Book*. **R-E**

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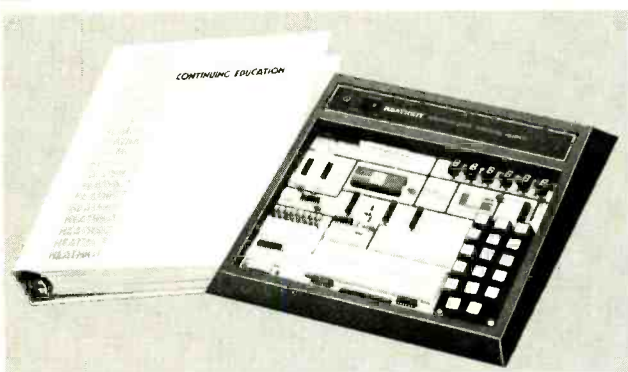

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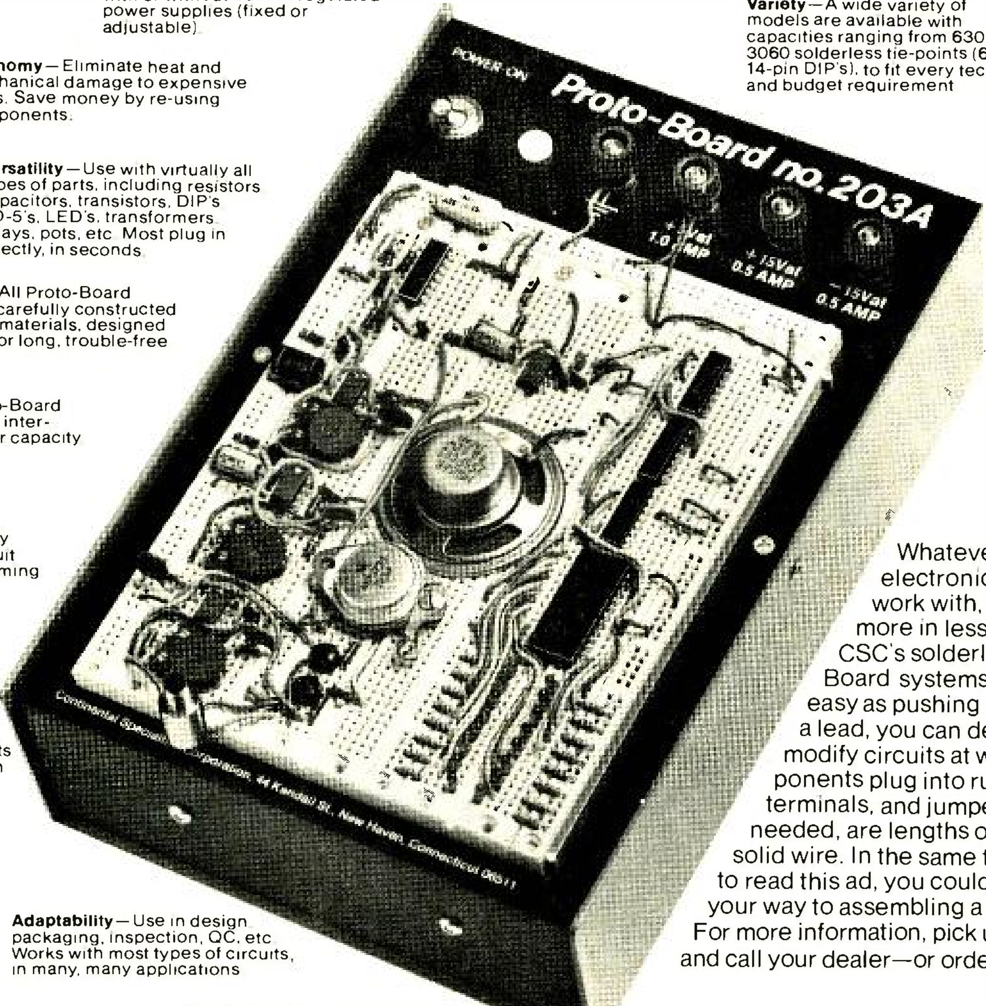

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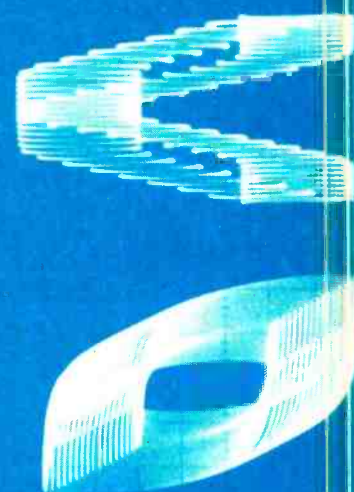


With you at the controls of this oscilloscope add-on, an enormous variety of seemingly three-dimensional traces can be displayed

WALTER SIKONOWIZ

ANYONE WITH A NEW OSCILLOSCOPE HAS observed a Lissajous figure, which is a line pattern that is generated by various harmonically related waveforms applied to an oscilloscope's X and Y inputs. This article describes an Optical Synthesizer that uses Lissajous principles to create seemingly three-dimensional figures of extraordinary beauty and intricacy. Front panel controls are provided that vary these figures and permit the user to create an enormous variety of effects. The cost of the Optical Synthesizer is approximately $30.

About the circuit

The secret lies in summing together one low-frequency and one high-frequency Lissajous figure. The low-frequency Lissajous figure comprises a fundamental frequency f and its harmonic mf, while the high-frequency figure is defined by frequency components nf and pf. Here m, n and p are integers, with n and p both much larger than m. Imagine that the low-frequency Lissajous figure is a large circle and that the high-frequency figure is a small square. When the two are summed, as the electron beam rapidly traces small squares, it also slowly describes a large circle, resulting in a "doughnut" shape with a square cross section. The low-frequency Lissajous pattern determines the overall shape, while the high-frequency figure defines the cross section.

A great variety of complex figures can be generated by changing the waveforms used and their phase relationships. Furthermore, if the high-frequency pattern is amplitude-modulated by a frequency qf,

OPTICAL SYNTHESIZER has pushbuttons and rotary switch to select different patterns. Two potentiometers rotate the pattern about the vertical and horizontal axis.

in which q is some small integer, the cross-sectional area can be made to vary through space. To sum the two Lissajous patterns, the two X components and the two Y components must be summed independently. These two composite signals are then applied to the oscilloscope's X (horizontal) and Y (vertical) inputs, respectively.

How it works

The schematic diagram of the Optical Synthesizer is shown on Fig. 1. Transistors Q1 and Q2, and associated components comprise an astable multivibrator. The output of the multivibrator appears at Q2's collector, which drives IC1, a CD4024BE binary ripple divider. There are seven synchronized, harmonically related squarewaves that appear at IC1's output pins 3, 4, 5, 6, 9, 11 and 12. Pin 12 has the highest frequency signal (3840 Hz), and pin 3 has the lowest frequency signal (60 Hz). From pin 12 down to pin 3, signal frequencies are successively divided by two. This provides a set of even harmonics from which to construct the Lissajous patterns. Odd harmonics can also be used, although trying to obtain a more complete harmonic spectrum is more costly. Besides, there are sufficient harmonics to make an excellent Optical Synthesizer.

The squarewaves from IC1 must be shaped into waveforms that can be used to create Lissajous patterns. Six synthesized waveforms are shown at points A through F in Fig. 1. Triangular waves, formed by integrating the squarewaves, are available at points B, D and E. At points A and C the triangular waves have been clipped, but Fig. 2 shows that these waveforms are not only clipped but also

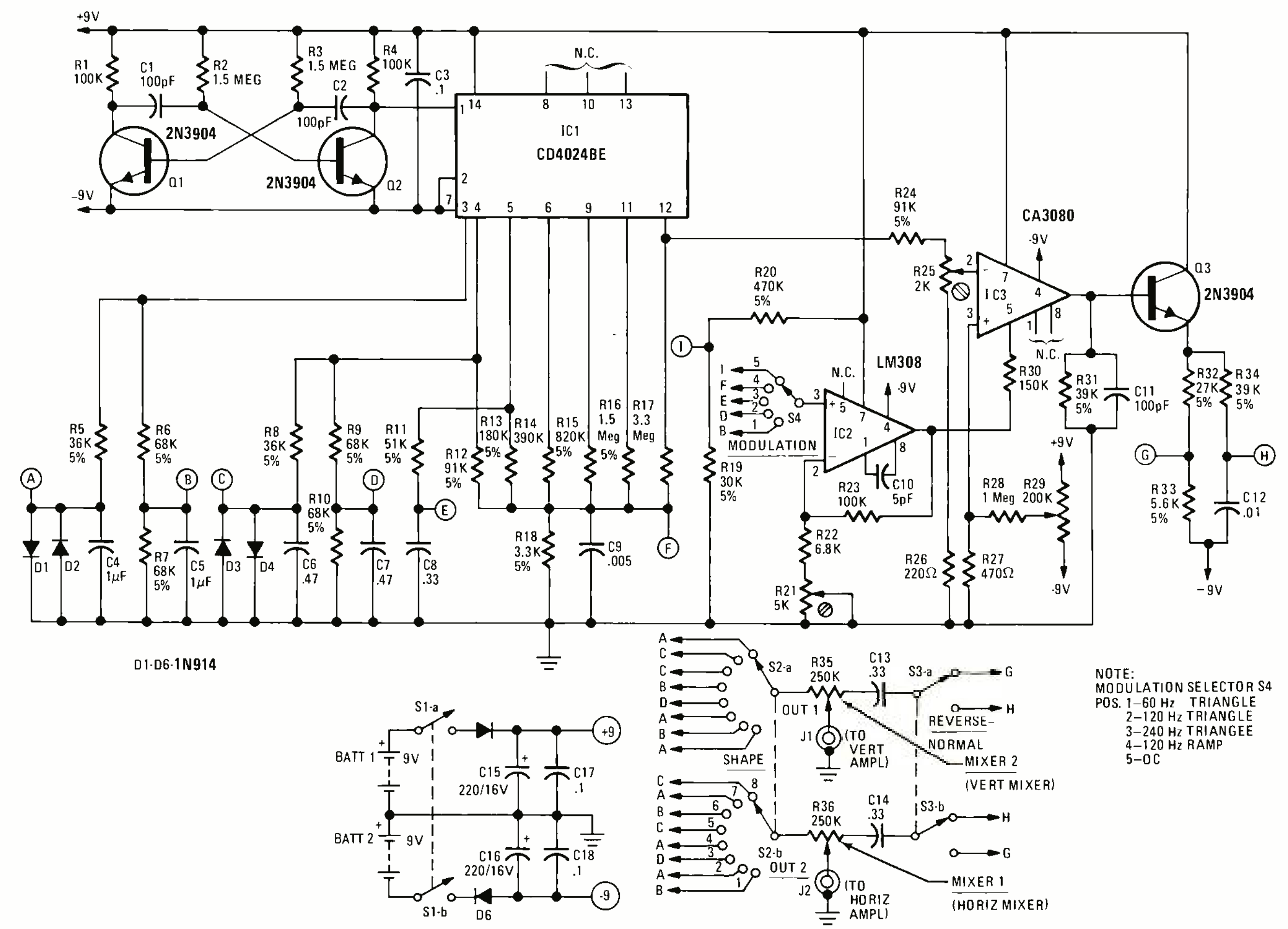


FIG. 1—OPTICAL SYNTHESIZER uses oscillators, mixers, waveshaping and phase shifting techniques.

PARTS LIST

All resistors are ½-watt, 10%, unless noted.

R1, R4, R23—100,000 ohms
R2, R3, R16—1.5 megohms, 5%
R5, R8—36,000 ohms, 5%
R6, R7, R9, R10—68,000 ohms, 5%
R11—51,000 ohms, 5%
R12, R24—91,000 ohms, 5%
R13—180,000 ohms, 5%
R14—390,000 ohms, 5%
R15—820,000 ohms, 5%
R17—3.3 megohms, 5%
R18—3,300 ohms, 5%
R19—30,000 ohms, 5%
R20—470,000 ohms, 5%
R21—5,000-ohm trimmer
R22—6,800 ohms
R25—2,000-ohm trimmer
R26—220 ohms
R27—470 ohms
R28—1 megohm
R29—200,000-ohm trimmer
R30—150,000 ohms
R31, R34—39,000 ohms, 5%
R32—27,000 ohms, 5%
R33—5,600 ohms, 5%
R35, R36—250,000-ohm linear potentiometer
C1, C2, C11—100 pF, polystyrene
C3, C17, C18—0.2 μF, ceramic
C4, C5—1.0 μF, paper or Mylar, 10%
C6, C7—0.47 μF, paper or Mylar, 10%
C8, C13, C14—0.33 μF, paper or Mylar, 10%
C9—.005 -μF, paper or Mylar
C10—5 pF, polystyrene
C12—.01 μF, polystyrene
C15, C16—220 μF, 16-volt, electrolytic
D1-D6—IN914 diode
Q1-Q3—2N3904
IC1—CD4024BE ripple divider
IC2—LM308 op-amp
IC3—CA3080 op-amp
J1, J2—BNC or binding-post output jacks
S1—DPST toggle
S2—double-pole 8 position, rotary or pushbutton
S3—DPDT toggle
S4—single-pole 5 position rotary
BATT 1, BATT 2—9-volt transistor batteries

phase-shifted. Finally, there is a digitally synthesized staircase waveform at point F.

The low-frequency Lissajous patterns discussed earlier will have waveforms A, B, C and D as the X and Y components. For example, if waveform A is used as the X component and waveform B is used as the Y component, plotting the result on a piece of paper would show the Lissajous figure to be a parallelogram. Other combinations of A, B, C and D yield more complex and unusual images.

Only one high-frequency Lissajous figure is used in the synthesizer. This figure is generated by amplitude-modulating the 3840-Hz squarewave (IC1 pin 12). This squarewave signal is fed via R24, R25 and R26 to input pin 2 of IC3, which is a CA3080 operational amplifier. The gain of IC3 is a function of the current passing through R30 into pin 5; this current is, in turn, a function of the voltage at output pin 6 of IC2, which is connected as a noninverting feedback amplifier. Operational amplifier IC2 is an LM308 chosen because of its low-supply current drain. The modulating signals, routed to the input of IC2, consist of triangular waveforms B, D and E;

WAVEFORM TABLE

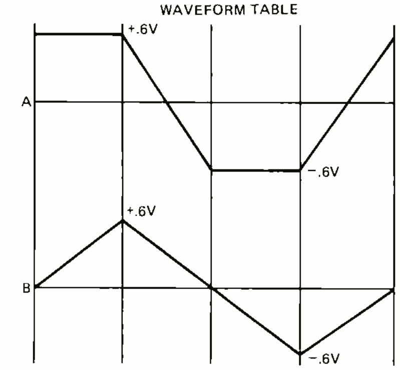


FIG. 2—PHASE RELATIONSHIPS between the 60-Hz signals at circuit points A and B.

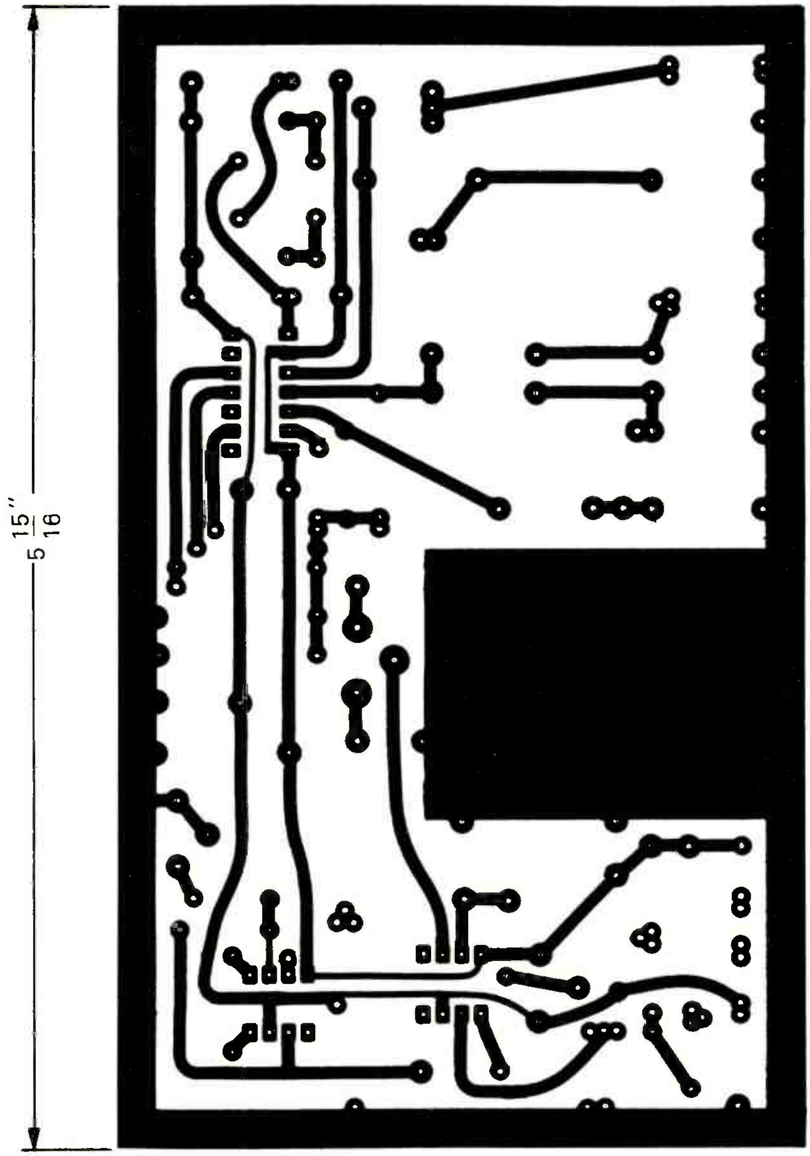
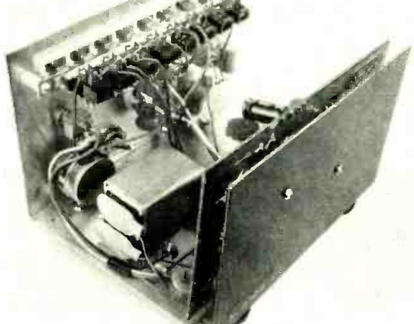


FIG. 3—FOIL PATTERN of single-sided board shown full-size.

staircase waveform F; and fixed DC potential I.

An amplitude-modulated squarewave appears at output pin 3 of IC3. When switch S4 selects the DC voltage from point I, IC3's output will be a squarewave of constant amplitude, i.e., unmodulated. Resistors R28 and R29 cancel IC3's input offset voltage. Capacitor C11, connected across R31, lengthens the transition times of the modulated squarewave in order to improve the display. In addition to being part of IC3's load, resistor R31 supplies bias current to emitter follower Q3. Transistor Q3 is necessary to reduce IC3's very high output impedance.

The load for transistor Q3 consists of R32, R33, R34 and C12. An amplitude-modulated, slightly rounded squarewave is available at point G, and at point H there is an amplitude-modulated triangular waveform. If modulation is constant and if points G and H are connected to the X and Y inputs of an oscilloscope, a rectangle with two rounded corners appears.



REAR VIEW OF FRONT PANEL shows pushbuttons, switches and potentiometers. Battery holder is formed from an aluminum strap.

Now, all that remains is the summation of the low-frequency and high-frequency Lissajous patterns. The Y components of the two figures are mixed in R35, while the X components are summed in R36. Capacitors C13 and C14 block the DC supply so that only AC signals are mixed. Switch S2, the SHAPE selector, chooses various low-frequency waveform combinations, and switch S3 reverses the high-frequency signal connections. Output jacks J1 and J2 must feed high-impedance loads (1 megohm or greater) for proper mixing action, and although J1 connects to the vertical scope channel and J2 connects to the horizontal scope channel, the connections to the scope can be reversed. When the mixers are terminated with a high-impedance load, each output is the weighted average of the two input signals. All such input signals (waveforms A through G) have the same nominal 1.2-volt peak-to-peak magnitude. Therefore, the peak-to-peak output of each mixer remains a constant 1.2 volts as each potentiometer is rotated. This means that the area occupied by the display on the oscilloscope screen also remains constant, regardless of mixer settings.

Two 9-volt transistor batteries power the circuit. Diodes D5 and D6 protect against incorrect battery installation and, at the same time, slightly reduce the supply voltage since fresh 9-volt batteries may actually supply 10 volts. The diodes insure that the maximum supply voltage limit of IC1 is never exceeded, even with fresh batteries. Capacitors C15 and C16 provide a low-frequency supply bypass, and capacitors C17 and C18 provide high-frequency bypassing.

Construction

It is relatively easy to build the Optical Synthesizer, but you must be careful because any errors will be visible on the display. The safest procedure is to use a printed-circuit board. The foil pattern is shown in Fig. 3 and the component placement diagram is shown in Fig. 4. If you don't use a printed circuit board, it is important that you follow the layout shown in Fig. 4 as closely as possible.

A socket should be installed for IC1, which, since it is a CMOS unit, should be installed only after all soldering is completed. Furthermore, be sure to use a CD4024BE for IC1; devices with an "AE" suffix cannot supply enough output current. Install capacitor C10 as close as possible to IC2. Although most components mount on the PC board, capacitors C13 and C14 are wired point-to-point.

Pay attention to polarities for all IC's, transistors and diodes as well as electrolytic capacitors C15 and C16. In addition, do not confuse IC2 with IC3; the former is an LM308, and the other is a CA3080. For best results use 5%-tolerance resistors and 5% polystyrene capacitors where specified.

The front panel layout is not critical. Switch S2 in the prototype was a pushbutton unit that happened to be around at the time of construction. You can just as well use a rotary switch that will probably be more readily available and less expensive. Output jacks J1 and J2 should match the oscilloscope connectors. Generally, these connectors will be either BNC or binding-post types.

Make a battery holder for BATT1 and BATT2 with a 16-gauge aluminum strap, bent to fit the battery dimensions. Use two fresh, high quality batteries. If the battery voltages are unequal, triangular waveforms B, D and E will not be symmetrical with respect to ground, and some signal clipping will result. While this sort of clipping may produce some interesting visual effects, battery voltages should be as equal as possible when the initial adjustments are made on the synthesizer.

Note how switch S2 is wired. One position of the switch may send waveform signal A to the vertical mixer and waveform signal B to the horizontal mixer, but the next switch position will reverse these connections. Such a connection reversal results in an image reversal on the screen. This doubles the number of possible displays. By means of switch S3, the high-frequency mixer inputs can also be reversed. Interchanging the high-frequency components produces interesting and sometimes dramatic changes in the display, depending upon the settings of the mixers and of S2.

When wiring mixer potentiometers R35 and R36, connect them so that their actions are similar. Wire them so that when each wiper advances fully counterclockwise, it directly contacts a low-frequency input. Advancing both controls together in a clockwise direction then causes the simultaneous increase in high-frequency content of both outputs. Of course, the controls will usually be manipulated independently, but they are easier to correlate if the actions have a similar effect.

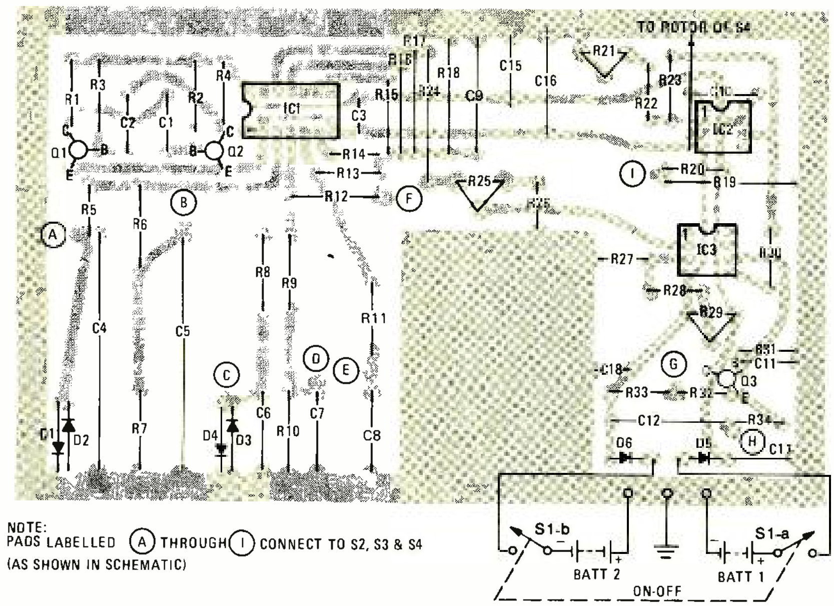


FIG. 4—COMPONENT PLACEMENT diagram for the PC board.

PC BOARD is mounted vertically against rear panel and held in place with stand-offs. Trimmer adjustments are easily accessible.

Calibration

After construction is complete, install IC1 and apply power. Use your oscilloscope to verify waveform signals A through F, which should all have a peak-to-peak amplitude of about 1.2 volts. Now, adjust S4 so that the 60-Hz triangle waveform B is applied to IC2. Attach a probe to IC2 output pin 6 and adjust trimmer R21 for the largest possible unclipped triangular waveform, which will have an amplitude of around 15 volts peak-to-peak.

Now, leaving S4 where it is, ground IC3 pin 2 using a short jumper lead. Attach your scope probe to IC3 output pin 6 and adjust trimmer R29 to eliminate the 60-Hz triangular waveform. You will probably be picking up some low-level, high-frequency signals at the same time. This pickup is unavoidable and should be ignored. After the 60-Hz triangular wave has been cancelled, disconnect the probe and remove the ground lead from IC3 pin 2.

Reconnect the scope probe to point G in the circuit. Set S4 so that the DC potential at point I is applied to IC2. Adjust trimmer R25 so that the peak-to-peak voltage of the 3840-Hz squarewave at point G is 1.2. Since the potential at point G is always more negative than ground, set the vertical amplifier for a DC input signal. When a 1.2-volt peak-to-peak signal has been obtained at point G, check point H, where you should observe a triangular wave of the same magnitude. Now dial in the various modulating waveforms via S4, and verify that modulation occurs at points G and H. This completes the calibration procedure and the synthesizer is ready for use.

Using the synthesizer

The Optical Synthesizer is easy to use. First, connect the outputs to the X and Y scope inputs. After the scope has warmed up, center the dot on the screen. If you wish, remove the scope's graticule, as it can be distracting.

Set modulation selector S4 so that the IC2 input connects to point I. Turn both mixing potentiometers fully counterclockwise so that their wipers directly contact low-frequency inputs A, B, C or D. Now apply power to the synthesizer, and adjust the scope's X and Y sensitivity controls so that the image fills the oscilloscope screen.

Use the focus and astigmatism controls on the oscilloscope to obtain a sharp display over the entire screen. Use all eight positions of shape-selector switch S2 to obtain the four low-frequency Lissajous patterns plus their four reversed counterparts.

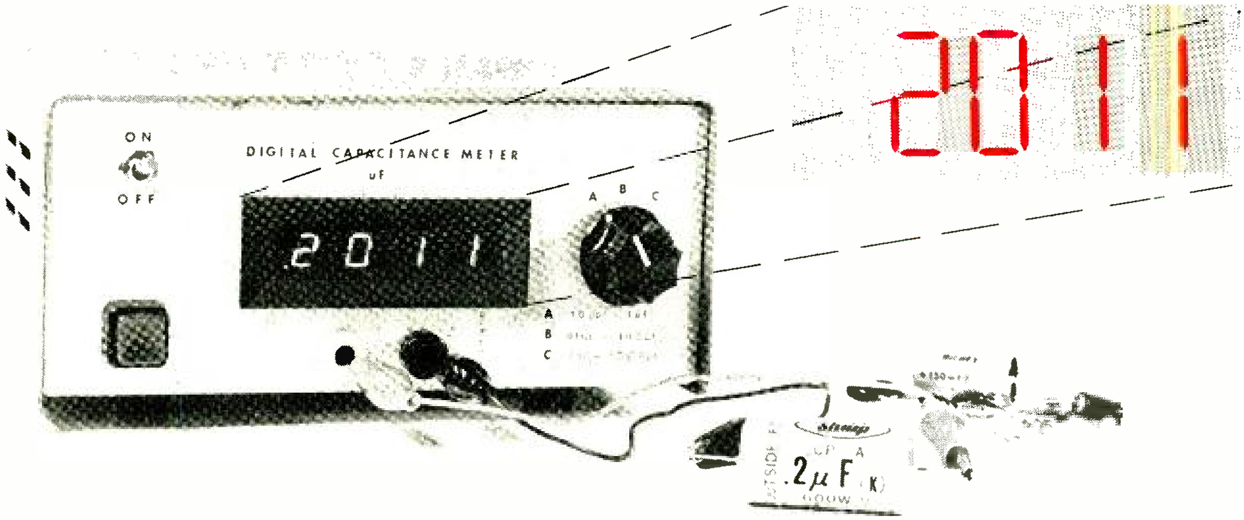
Set S2 so that there is a parallelogram on the screen, and rotate the scope's intensity control to maximum. Advance both mixers, stopping when you have some degree of three-dimensionality in the display. Next, dial in the various modulating waveforms via switch S4 to notice the effects. You can now experiment with the rest of the controls to note their effect on the display.

The mixers are the most important controls on the synthesizer, and careful mixing will yield many fascinating displays. The visual effects include a change in the size relationships between various parts of an image plus apparent rotations about two axes. As a display rotates, certain lines may coincide, causing the display to take on a whole new character.

As more of the high-frequency signal is mixed with the low-frequency signal, various sections of an image overlap. Consequently, the distinction between the overall shape of the image and the shape of the cross section is lost as a new pattern emerges.

When you have become familiar with the mixing procedure, you can create dynamic displays that twirl and change shape on the screen as the two mixers are slowly rotated. Experiment with the controls until you become familiar with their effects. **R-E**

Build This Test Meter



Measure Capacitance On A Digital Readout

Localizing troubles in electronics can be difficult when caused by off-value capacitors. This digital checker lets you pinpoint them quickly

JAMES VERNON

CAPACITORS ARE AMONG THE MOST COMmon components used in electronics today. They are also among the most difficult parts to measure inexpensively with any accuracy. Good capacitance measuring equipment is quite costly.

The digital capacitance meter described in this article can accurately measure any unknown capacitors (including electrolytics) from 100 pF to 1000 μF in three ranges; and it can be built for less than $40. Just pressing a button gives an instantaneous digital reading of capacitance in microfarads.

SPECIFICATIONS

Range	100 pF - 1000 μF in three ranges **A** 100 pF - .9999 μF **B** .01 μF - 99.99 μF **C** 0.1 μF - 999.9 μF
Capacitor Voltage Rating	Any value above 4 volts DC recommended. (The 556 will charge the capacitor with 3 or 4 volts maximum.)
Accuracy	Depends slightly upon the quality of the internal components. Normally ±5%; maximum error approximately 7%.
Cost	Approximately $40 (including the power-supply circuitry).
Construction Time	Around two evenings.
Power Requirements	117 VAC (or an optional 5-volt NiCad pack). Drain: approximately 600 mA at 5 VDC (depending upon the size and type of the LED's used).

A built-in overflow indicator tells you when the capacitor is too large for the scale used. You can easily modify the circuit to include four 5-volt NiCad AA batteries for portable operation.

How it works

The circuit shown in Fig. 1 determines the value of the test capacitor by measuring the time required to charge the capacitor to a predetermined voltage. When the TEST button is pressed, one-half of dual timer IC12 acts as a one-shot, activating the 100-kHz oscillator (the other half of IC12) while the test

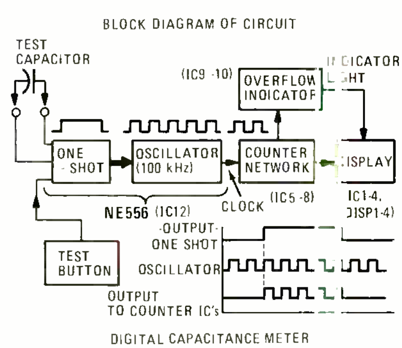


FIG. 1—CAPACITANCE METER measures the time required to charge a capacitor to a predetermined voltage. Waveforms show that the pulses from the oscillator are only fed to the counter IC's when the output of the one-shot is at a logic high level.

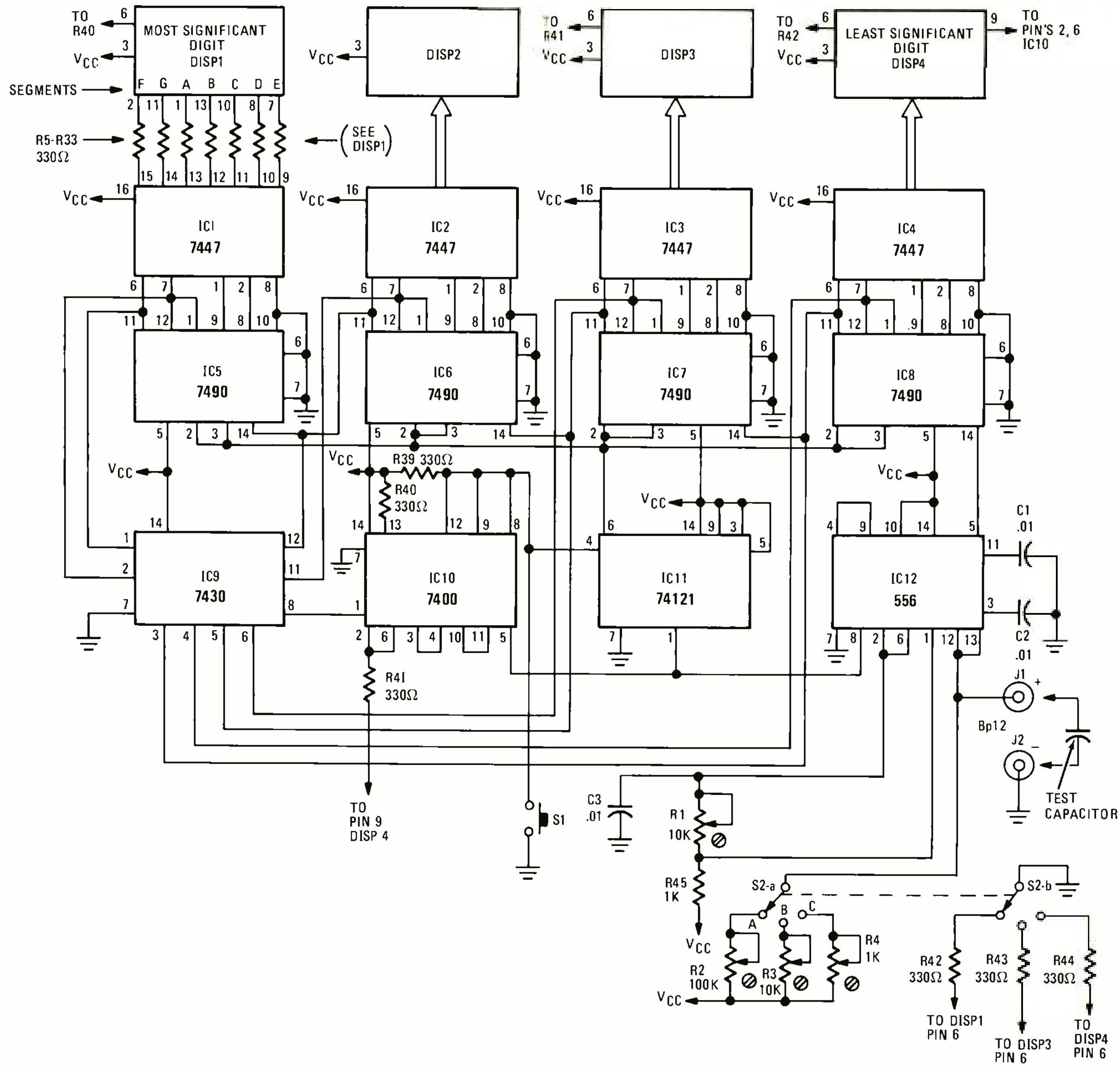


FIG. 2—CAPACITOR UNDER TEST is charged to Vcc through resistor selected by range switch S2-a. Overrange condition is indicated by the right-hand decimal point of the least-significant digit of the display.

PARTS LIST

All resistors ½ watt, 10%, unless noted.
R1, R3—10,000-ohm, 23-turn trimmer, 5% (Fairchild)
R2—100,000-ohm, 23-turn trimmer, 5% (Fairchild)
R4—1000-ohm, 23-turn trimmer, 5% (Fairchild)
R5-R44—330 ohms
R45—1000 ohms, 5%
C1, C2—.01 µF, mica, 5%
C3—.001 µF, mica, 5%
C4, C5—1000 µF, 16-volt, electrolytic
IC1-IC4—7447—7-segment LED driver
IC5-IC8—7490—decade counter
IC9—7430—8-input NAND gate
IC10—7400—2-input quad NAND gate
IC11—74121—monostable multivibrator (one-shot)
IC12—556—dual timer
IC13—LM309K, 5-volt regulator
J1, J2—banana jacks
S1—momentary pushbutton SPST switch, normally open (Radio Shack No. 275-618, or equal)
S2—2-pole, 3-position rotary switch
S3—SPST toggle switch
T1—12-volt, 1.2-amp transformer (Radio Shack No. 273-1505, or equal)
RECT1—4-amp, 50-volt, PIV bridge rectifier
DSP1-DSP4—.3-inch, common-anode, 7-segment LED display (Radio Shack No. 276-053, or equal)
Misc.—metal cabinet, 6¼ × 2¾ × 7¼-inches (Radio Shack); hardware; line cord; banana plugs and clip leads; optional heat sink for voltage regulator IC.

capacitor begins to charge. These 100-Hz pulses from IC12 are counted and displayed on the digital readout. Once the test capacitor is charged, the output of the one-shot drops low, causing IC12 to stop pulsing and the digital readout to display the total count. This provides an almost instantaneous capacitance display that is accurate to four decimal places.

Switch SI, shown in Fig. 2, activates the pulsing oscillator and the one-shot multivibrator. Switch S2-a changes the range of the meter in three steps from 100 pF to 1000 µF, while switch S2-b changes the position of the decimal point for a direct readout. Integrated circuits IC9 and IC10 detect a counter overflow and display the "overflow message" by lighting up the fourth-digit left-hand decimal point. One-shot IC11 shortens the pulse from S1 to 40 ns for better reliability within the given test cycle. The power supply (see the circuit shown in Fig. 3) provides enough current to power the capacitance meter.

Build your own

The entire circuit, including the power supply, can be built on a 6¼ × 4½-inch piece of perforated board. While parts placement is not critical, you may wish to follow the design shown in Fig. 4. Be sure to orient each IC correctly before inserting it into the circuit. The prototype was assembled in a 6¼ × 2¾ × 7¼-inch metal cabinet with a four-digit LED holder in the front. Drill holes for the display, line cord, all switches, optional heat sink and test button. The front binding posts are polarized (red is positive; black is negative) so that electrolytics and other polarized capacitors can be tested easily. Run the power cord for the capacitance meter through a hole in the back of the cabinet with a strain relief.

Wire-wrap IC sockets are very helpful during circuit construction. Although these sockets may cost a little more than standard solder sockets, they are worth the extra expense. All the IC's used in the capacitance meter are simple hobby components that can be purchased from most local electronics parts stores. Resistors and capacitors should be ±5% tolerance for better meter accuracy. Keep the wiring as short as possible (especially the external test leads from IC12) to prevent any stray capacitance from being picked up. No problems were encountered during construction.

Because the inexpensive pushbutton switch selected for the prototype meter gave many varied readings for a given capacitor, replacing switch S1 with a better switch significantly increased reading accuracy and repeatability. Actual circuit wiring took about two evenings and considerable time was spent carefully checking each pin against the schematic for correct connections.

Calibration

Use an ohmmeter to preset R1 (as closely as possible) to 6715 ohms. (Note: once R1 is set, it does not have to be adjusted again.) Preset R2 to 90,900 ohms, R3 to 9090 ohms and R4 to 910 ohms. Place a capacitor with a known value (5% or better) between the terminals, and, with the range switch set in position A (100 pF—1 μF), adjust R2 for an accurate readout when switch S1 is pressed. Follow the same procedure (using larger capacitors) for range-switch position B (.01 μF—100 μF) and range-switch position C (0.1 μF—1000 μF). A midrange capacitor calibrates the scale quite well. With quality components, the meter has an accuracy of ±5% to 7%.

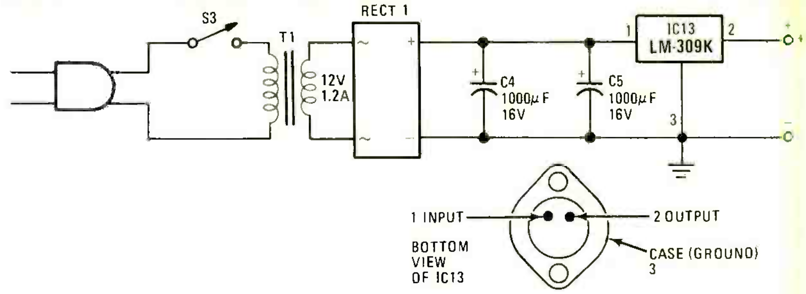


FIG. 3—POWER SUPPLY for capacitance meter. NiCad batteries can also be used for portable operation.

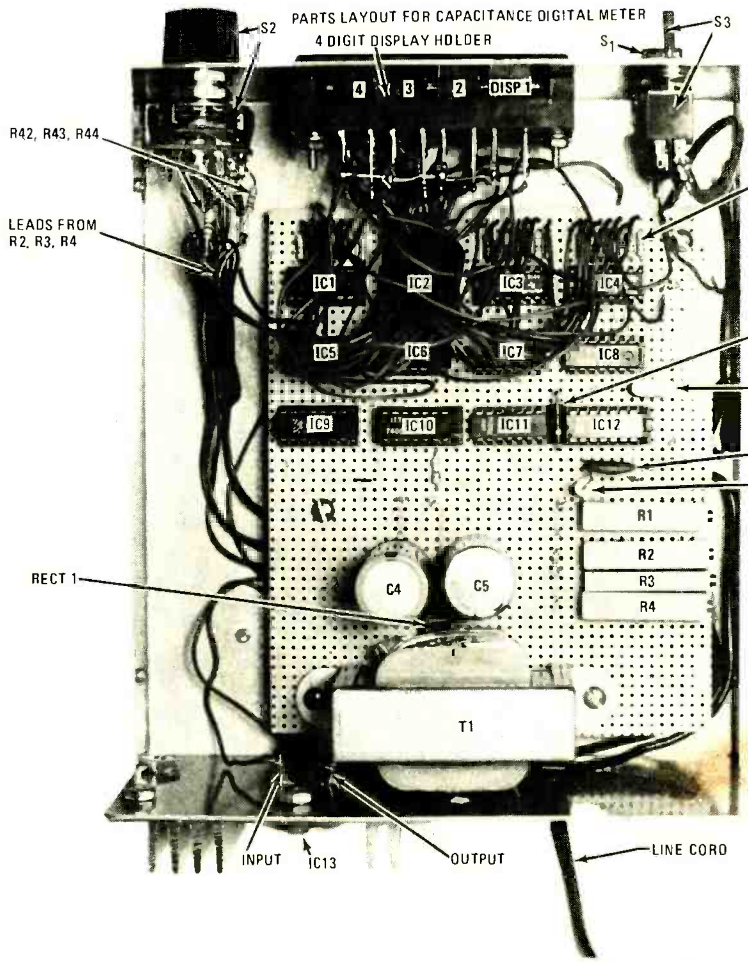


FIG. 4—PERFORATED BOARD and wire-wrapping was used to build the prototype.

The meter is now calibrated and ready to use.

Measuring capacitors

(Before testing an electrolytic that's been on the shelf or unused for several months, give it a quick ohmmeter check. But before you do, it is best to make sure the capacitor is discharged by shorting it. Then connect the ohmmeter test leads and watch for the needle to fly over to zero and then slowly rise and stabilize at a point up-scale. This is a rough indication of the capacitor's ability to hold a charge. If the needle stays on zero, the capacitor is shorted.—*Editor*)

The actual operation of the digital capacitance meter is straightforward. Connect an unknown capacitor to banana jacks J1 and J2 (with correct polarity, if known) and with switch S2-a set to position A, press the test button. The value of the unknown capacitor will immediately be displayed in microfarads. If the overflow light goes on, change to the next higher range position and test again. This procedure insures that the right range is used for any size capacitor.

When testing an electrolytic capacitor, discharge it completely by shorting the leads before connecting it to the meter to prevent any circuit damage. A shorted capacitor activates the overflow light and all 8's should appear on the display. A capacitor of less than 100 pF still indicates .0001 μF on the lowest scale. When the meter is first turned on, a random number may be displayed. Each time switch S1 is pressed, the counters are automatically reset to zero, which clears the initial display and charges the test capacitor for a new reading. **R-E**

Build

CB Switcher for Music Between Calls

CB radio and some other form of radio or entertainment audio are common in todays cars. This electronic switch lets you enjoy both while driving safely

GEORGE SANTE

ON THE ROAD TODAY, YOU HAVE A CHOICE of listening to the car radio or tape player or monitoring a CB channel. It is hard to do both simultaneously with any degree of satisfaction. When the car radio is turned up to a comfortable level, its volume may make you miss a weak, but important, CB transmission. If you turn up the CB volume and set the squelch for weak-signal reception, the radio will be drowned out by the almost continuous roar from the CB speaker. Also, if you want to make a transmission, you must turn down the radio volume before keying the mike. All this distracts from your driving and can lead to an accident or a hazardous situation.

For safer driving and CB operating convenience, add this automatic CB Switcher to the equipment in your car. It lets you listen to the car radio or tapes and insures that you won't miss a weak CB call because of the radio's high volume. If you want to transmit, you don't have to turn down the radio. When a CB signal is received, the car radio is muted and the CB radio takes over. Press the push-to-talk button on the mike and the radio quiets as the transmission begins. Release the pushbutton and you'll hear the radio if there is no reply to your call.

The circuit

The CB Switcher is basically an electronic-relay switching system that is actuated by either the RF output from your CB rig or the AF output from its speaker terminals. When the relays are ener-

PARTS LIST

All resistors ¼ watt, 5%, unless noted.
R1,R2,R3,R4–10 ohms, 1 watt
R5–1 megohm
R6–10,000 ohms
R7–3300 ohms
R8–1000 ohms
C1–.001 disc
C2–.05 disc
C3–10 μF, 6 volt, electrolytic
D1, D2–1N4001
D3, D4–1N914
Q1–2N4124
Q2–2N4126
RFC1–56 μH, RF choke
RY1, RY2–12 VDC relay, 320 ohms, DPDT contacts
Misc.–Case, 2-lug terminal strip, wire, cable, coaxial connectors, hardware.

The following parts are available from Guardsman Electronics, Box 215, Brooklyn, NY 11207.
Printed-circuit board, $3.00 postage paid.
Set of 2 relays, $8.00 postage paid.
Complete kit, including case, $14.95 postage paid.
Assembled unit, $29.95 postage paid.

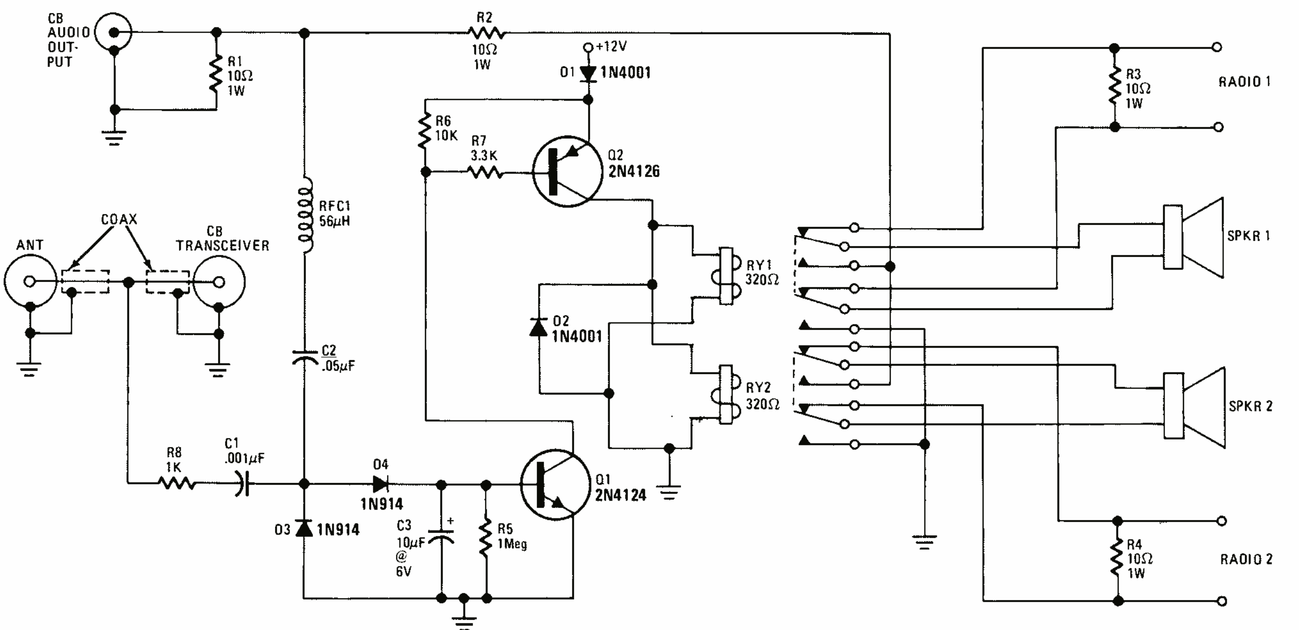
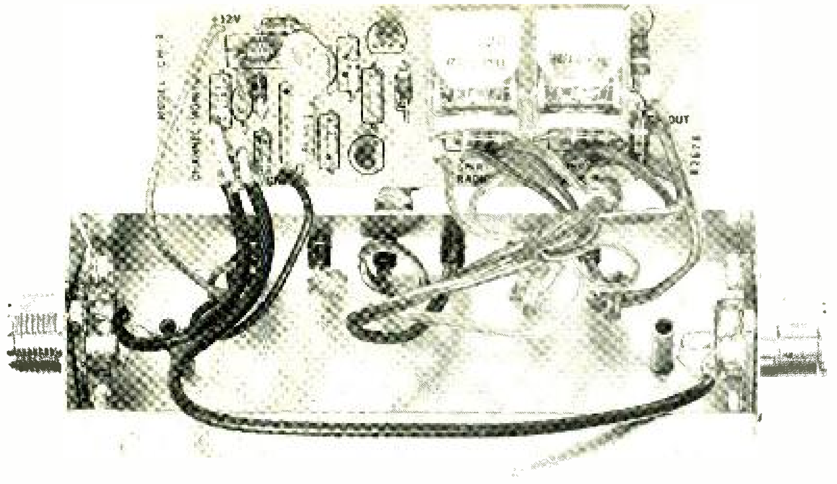


FIG. 1—CB SWITCHER has provisions for two speakers to switch a stereo signal source.



CB SWITCHER mounts in a 1½ × 1½ × 5-inch case. All connections to the CB switcher, except the two coaxial connections, are made via wires fed through grommets in the side of the case.

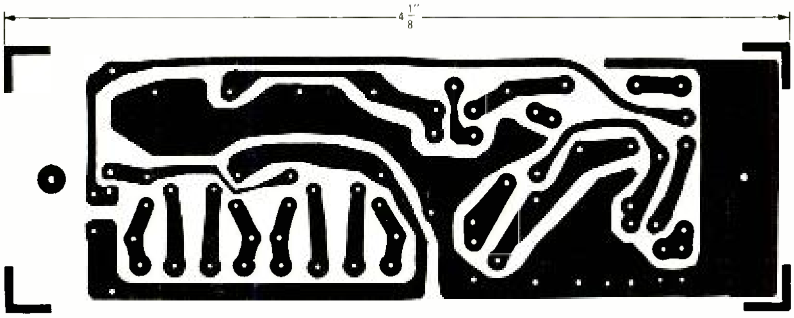


FIG. 2—FOIL PATTERN of PC board shown full size.

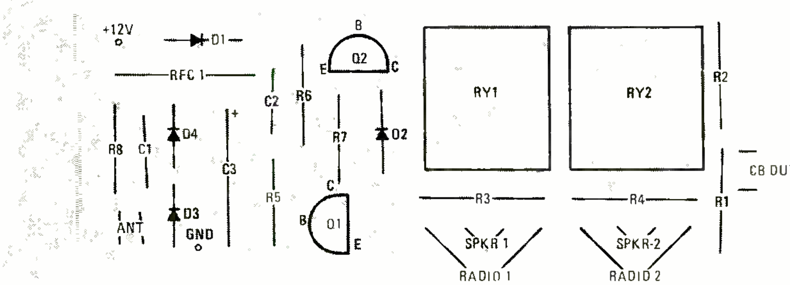


FIG. 3—COMPONENT LAYOUT.

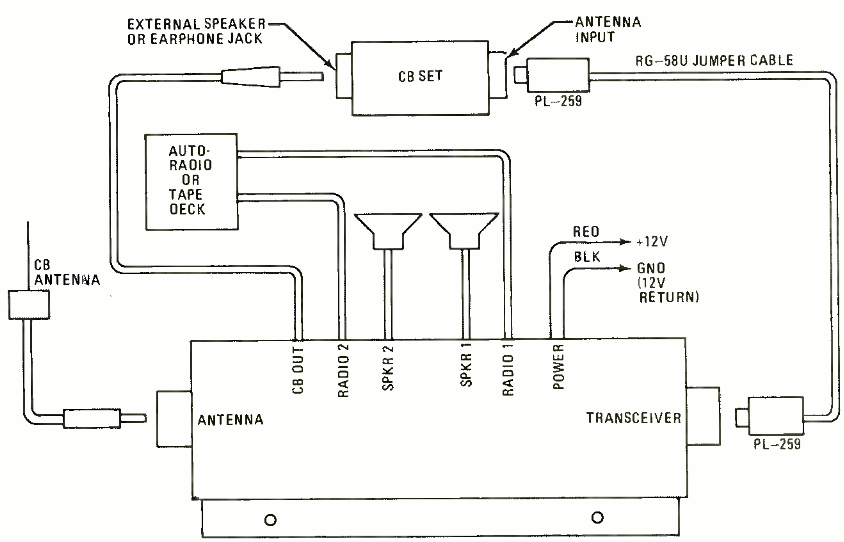


FIG. 4—INSTALLATION of the CB Switcher is straightforward. The volume control on the CB rig must be turned high enough to trigger the CB Switcher when a call is received.

gized, the car speakers are automatically disconnected from the radio and tape player and are switched across the output of the CB receiver. The schematic is shown in Fig. 1.

The antenna transmission line and a short length of coaxial cable from the CB transceiver are joined to connectors at opposite ends of the switcher case. Audio output from the CB remote speaker or PA speaker is fed into the switcher through a length of speaker-type audio cable. Similar leads connect the switcher relay terminals to the radio and tape-player outputs and their respective speakers in the car.

The radio and tape-player speakers are connected directly to their speakers through the normally closed contacts on relays RY1 and RY2. When a CB call is received, a portion of the audio signal is rectified by D3 and D4 to develop a DC control voltage that is applied to Q1 and Q2 to energize the relays. When the relays pull in, the car speakers are switched to the CB receiver. Similarly, when you press the mike button to transmit, a portion of the RF is rectified by D3 and D4, again energizing the relays to mute the car radio.

Construction

The switcher is simple and easy to build. Its handful of parts mount on a single-sided PC board. The foil pattern is shown in Fig. 2 and Fig. 3 shows the component layout. The switcher, when supplied as a complete kit, comes in a metal case, 1½-inch square and 5-inches long. Coaxial cable fittings are on the ends, and connecting leads are brought out through grommeted holes on the rear of the case, as shown in Fig. 4.

When all parts have been mounted on the PC board and you are ready to mount it in the case, solder on the connecting cables and run them through the correct holes in the rear of the case. Be sure to install the board with the components facing the inside of the case.

Installation

You will have to make slight modifications to the CB rig as well as to the car radio. (The CB radio won't need modification if it has either an external speaker jack or terminals for a PA speaker.) The car radio modification involves only the loudspeaker connections. Disconnect the speakers and reconnect them through the switcher, as shown in Fig. 4. Connect the switcher 12-volt power lead to a switched 12-volt point in the CB rig so that the switcher is on only when the CB is on.

With the CB squelch properly set and with both the CB set and car radio turned on, you should hear the car radio only—until a CB signal comes in. Now, the car radio is quiet and the CB transmission is heard through the CB speaker and the car radio speaker. Pressing the mike button instantly mutes the car radio. **R-E**

CB TEST INSTRUMENTS

The rigid electronic standards set for CB radios make it imperative that you use test instruments that are highly accurate while being designed for speed and convenience in servicing. Here are some you should consider

FOREST BELT

THERE ARE MANY INSTRUMENTS NOT mentioned in the November 1977 issue of **Radio-Electronics** in the special section on basic CB test instruments. You may wonder why they were omitted. Aren't they any good; don't you need them; and if they're not basic instruments, what are they?

Many of these other test instruments are highly useful and can save you much time and money. Some are specialized. They speed repairs and testing, and make particular jobs easier. Many instruments perform tasks or measurements you need only occasionally. However, do not overlook them because they are very useful when you do need them.

Others are general-purpose instruments, such as communications test sets for CB and other communications gear. Their chief attractions usually are their low cost, portability and, sometimes, versatility. Do not arbitrarily equate low cost with low quality; it may not be so.

Consider these other instruments in your quest for the ideal CB servicing setup because each has its distinctive usefulness. You should know what these instruments are and how they can help you make more money in your service operation, either at the bench or on the road.

CB test sets

CB test sets range from inexpensive units to more elaborate instruments. You should see various test sets before deciding which features could be most helpful on the bench or in service calls.

One unit, slightly more elaborate than most, is produced by Lectrotech. The *model CB-40 Chanalyst* contains an RF wattmeter for AM (average-reading) or SSB (peak-reading) transmitter outputs. While power readings are part of any CB test set, not all can read on peaks so that you can measure SSB power.

A reversing switch sets up the instrument for VSWR (*V*oltage *S*tanding-*W*ave *R*atio) measurements. Some test sets require converting reflected power into VSWR; a scale on the *model CB-40* power meter handles that automatically.

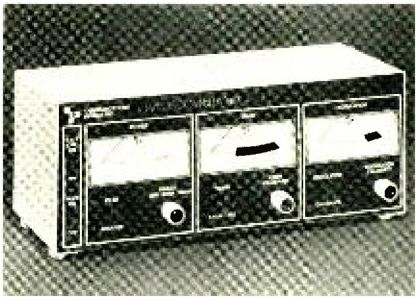
This unique instrument offers a ready-made alternative to building a bench-test panel. Radio frequency metering takes place across an internal 52-ohm dummy load. A simple modulation scope parallels the RF-output metering. Thus, you can examine RF for unwanted oscillations and for modulation quality.

A switch selects either a sinusoidal or a trapezoidal modulation display. Old communications hands, especially hams, use trapezoidal modulation displays because they are easy to set up with a low-cost oscilloscope. The *model CB-40* lets you select whichever display you prefer.

The modulation scope sync is internal and automatic if you modulate the transmitter by holding its microphone near the small-speaker tone source. An audio generator—either a single-tone or a two-tone generator for SSB—sends a signal to a small speaker on the top panel. The signal also appears at banana jacks on the front, to modulate the transmitter directly instead of acoustically through the mike. This feature is important also for signal-injection troubleshooting in either mike or audio stages.

Separate meters measure the audio output power from the receiver. Remember, for a 10-dB signal-plus-noise/noise (S + N/N) sensitivity measurement, you must arrange, with an RF signal generator, a 10:1 power ratio (10 dB) between audio-signal-plus-noise and noise-alone at the receiver speaker. The audio power meter has a dB scale to help you recognize the 10:1 power ratio.

The *model CB-40* contains RF connections for a frequency counter and RF generator. This interface comes in handy for bench work. Connect one coaxial cable from the *model CB-40* to the transceiver. The RF generator sends a signal to the transceiver. When you key the transmitter, the RF output switches the *model CB-40* to its transmit mode. Connections are made automatically to an external frequency counter, and to the RF power meter and modulation scope inside the *model CB-40*.



INDIVIDUAL METERS FOR EACH FUNCTION characterize Communications Power, Inc. transmitter tester.

Other manufacturers produce multi-function CB test sets. Most are better termed *transmitter test sets*. For example, the Communications Power, Inc. *model WM1000* meter contains a wattmeter (for both average and peak measurements), a VSWR meter and a modulation meter. Each function has its own separate meter. Similar to this design are the Para Dynamics *model PDC550* and *model PDC600;* the former is the smaller and more portable of the two units.

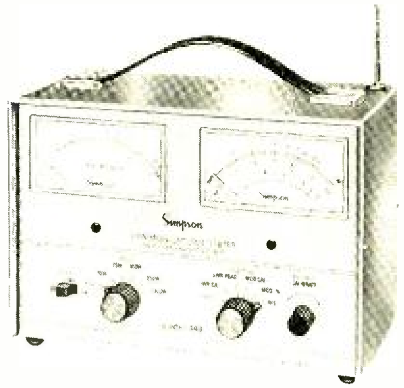
FIRST DIGITAL POWER METER was added to an in-line frequency counter in this Hickok instrument. Also includes automatic VSWR sensing, with display in digital numerals.

AUTOMATIC VSWR SENSING was pioneered in this Sencore instrument.

Hickok has a unique tester that's a digital frequency counter that can be hooked in-line with the CB antenna cable. A switch on the *model 38* lets you measure RF power (peak or average) and displays watts digitally. Another switch position lets the instrument measure the VSWR, showing the radio digitally. Another version, the Hickok *model 388*, also measures modulation percentage.

The Sencore *model CB41* uses push-buttons to test RF and SSB power, VSWR and modulation percentage.

Other simpler transmitter testers are sold by several CB manufacturers as accessories. However, insist on demonstrations, and don't hesitate to verify readings against dependable, accurate equipment. After all, you must be able to depend on what your instruments tell you. An instrument you can't trust is worse than no instrument at all.



TRANSMITTER TESTER from Simpson Electric adds a relative field-strength meter to usefulness. Helps with antenna tuning problems. Unit also has power, VSWR, and modulation measurements.

Simpson, a manufacturer of high-quality multimeters, offers the *model 440 Communications Tester*. This instrument is a *transmitter* tester. One meter shows RF power; another meter lets you read either the VSWR or modulation percentage simultaneously.

Field-strength meters

The Simpson *model 440* also contains a field-strength meter, labeled RFS (*R*elative *F*ield *S*trength). The meter readings are not absolute. Raise a telescoping antenna and place the meter near enough to the transmitter antenna for a useful reading. If you move the *model 440*, the reading changes.

This function proves highly useful at times. Occasionally an antenna simply will not respond to ordinary minimum VSWR tuning. Set the field-strength meter near the antenna and do not move it. Then, tune the antenna step-by-step for maximum radiated signal as shown by the field-strength meter. If the reading goes too high, shorten the telescoping antenna on the meter. You always measure *relative* signal strength. A CB antenna or any other communications antenna radiates the most signal (the strongest electromagnetic field) when its length is exactly at resonance. *Do not use a field-strength meter to tune up a transmitter.* Use an in-line wattmeter connected to a dummy load, *never to an antenna*.

Several low-cost testers include a field-strength meter. It's easy to add to a simple wattmeter, if the meter movement is sensitive enough. Just a diode, a capacitor and a piece of wire for sensing are needed.

Dip meters

Ham radio operators who have de-

SOLID-STATE DIP METER from Heath can be built in one evening. Lets you test tuning and resonance in circuits not even under power. Acts as tunable absorption wavemeter to check harmonics from transmitters, oscillators, and the like.

signed their own station equipment use grid-dip meters, or their modern solid-state counterparts. CB technicians are seldom familiar with these instruments.

In its ordinary mode, a dip meter can test the resonance of a tuned circuit without any direct connection, and without power being applied to the circuit. The dip meter contains an oscillator and another meter to measure oscillator current. When the dip-meter coil is held near a circuit that is tuned to exactly the same frequency as the meter oscillator, inductive coupling loads-down the dip-meter oscillator, causing a reduction or dip in the current reading.

Here's one application. Tune the dip meter as accurately as possible to 27.185 MHz (use a frenquency counter). Place the dip-meter coil near a CB antenna loading coil. Tune the antenna step-by-step, as usual. At resonance, the antenna absorbs energy from the instrument's oscillator and pulls the meter reading downward.

A dip meter can also act as an absorption wavemeter. Its action is similar to that of a field-strength meter, except that the wavemeter is tunable.

So, suppose you tune the dip instrument to 54 MHz and place the coil near the dummy load of a transmitter on the bench. Key the transmitter and tune the TVI filter for a minimum reading on the dip instrument. It is impossible to measure the amount of second-harmonic reduction this way, but the method assures that you have tuned the trap for a correct minimum.

Audio voltmeters

An audio voltmeter features high sensitivity—usually fractions of a millivolt RMS on a 1-mV range full scale. More important, its frequency response extends the reading accuracy to from 20 Hz to 1 MHz or more. (The AC ranges of an ordinary multimeter lose accuracy beyond 100 or 200 Hz.) The Motorola *model S-1053C* is called an *AC Voltmeter*, but it includes the audio voltmeter specifications described in this article.

Because of these sensitive wideband specifications, most technicians think of an audio voltmeter in terms of hi-fi/stereo testing. However, this instrument works well in signal tracing and gain testing in microphone stages of transmitters.

The audio voltmeter can also be used in receiver sensitivity measurement. A 10:1 power ratio is similar to a 3.16:1 voltage ratio. Either ratio equals the 10-dB change you need between no-modulation and 30-percent modulation.

Here's a specific procedure, using the voltmeter instead of an audio wattmeter.

Feed a small amount of unmodulated RF signal (about 1 μV) into a receiver, exactly on-frequency. Set the receiver volume control for 500 mV of noise at the speaker (½ volt). Next, add 30-percent modulation to the RF input, using a 1000-Hz tone. Note the new reading across the speaker. If the reading is less than 1600 mV (3.16 × 500 mV), increase the RF input level slightly; if the reading is more than 1600 mV, reduce the RF input slightly.

It may be necessary to work back and forth a time or two for an exact ratio of 3.16:1 between the noise-alone reading and the noise-plus-audio reading. But when you have accomplished that, you can then read the RF signal microvolts from the generator dial or meter. This reading is the 10-dB S + N/N sensitivity of the receiver.

Readings of 1 volt and 3.16 volts work as well. It's the *ratio* that counts because the specification standard requires a 10-dB difference.

With an ordinary digital voltmeter, the accuracy may be off at 1000 Hz. Most DMM's are calibrated for 60 Hz on the AC volts scale, and errors are not linear.

Capacitor testers

Some technicians refuse to test individual parts, except as a last resort. They will use a tube tester or an ohmmeter to check a tube or resistor and most use a transistor tester, but they rebel at testing a single capacitor. Yet certain capacitor faults show up most quickly on a good capacitor tester.

Sprague Products Co. makes the *model TO-6B, Tel-Ohmike Capacitor Analyzer*, which is a thoroughly up-to-date instrument. The *model TO-6B* is basically an R–C bridge, with an "eye" to indicate the null. This instrument measures capacitance from 1 pF to 2000 μF. Special circuits accommodate the low-voltage capacitors found in solid-state equipment. You can measure the power factor of an electrolytic as well as leakage in any capacitor. Of course, an open capacitor reads minimal capacitance.

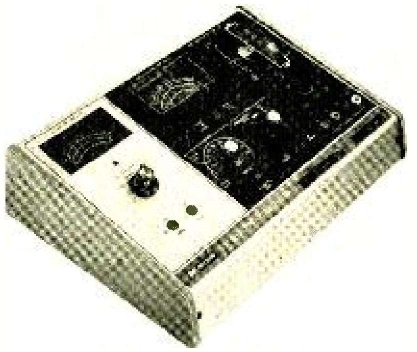
Heath has an R–C bridge in kit form. Continental Specialties Corp. also produces an R–C bridge, the *model DM-3*.

The *C-Meter*, built by ECD Corp., is an autoranging digital-reading capacitance meter. You read values from 0.1 pF to 200,000 μF on a 3½-digit liquid-crystal display. Battery operation and its small size make the *C-Meter* portable.

Hickok's *model 370 Deluxe Multimeter* measures capacitance values from 500 pF to 10,000 μF.

Transistor testers

No one is averse to testing transistors in-circuit since it saves time. Once a transistor is removed from the circuit it can be tested quickly with an ohmmeter. A forward-backward test of base-emitter and base-collector junctions gives a fairly valid assessment of whether a transistor can operate or not.



B&K/PRECISION CALLS THIS a lab-quality tester for measuring parameters of transistors and other semiconductor devices. Lets you set up exact operating conditions; even inject signals.

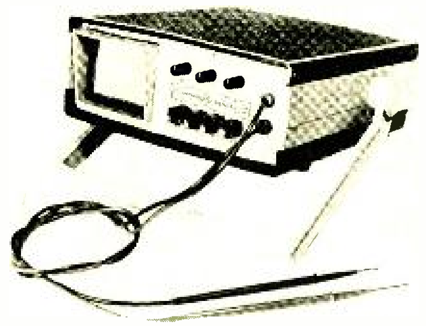
For in-circuit testing, there are many different sizes and designs of testers. The latest B&K/Precision catalog lists two quick-test versions, the *model 510* and the *model 520B*; the *model 501A* curve tracer for use with an oscilloscope; and the *model 530* parameter tester. Hickok produces the *model 217* and the *model 215* for quick checks; the *model 440* curve tracer; and the *model 220* parameter tester. Lectrotech markets a *model TT-250* quick tester and a *model CT-1* curve tracer (formerly the Jud Williams *model A*). Sencore helped pioneer audible quick-testing with the *Cricket* series, *models TF26, TF30, TF40* and *TF46*. The *model TF30* and the *model TF46* also measure parameters. Viz Manufacturing offers a *model WT-501A* transistor and diode checker.

SENCORE TESTER TAKES ITS "CRICKET" name from fact that instrument "chirps" to indicate good transistor. Several models let you measure parameters too.

Curve tracers quickly analyze the integrity of transistor transfer curves. You can tell whether a component is usable by the shape of the curve it produces on an oscilloscope face.

The test is really a matter of lines and angles. You don't care too much what the curve angle is exactly; that depends on transistor design. What you look for is a distinct and sharp knee where conduction begins. You should see fairly straight lines on either side of the angle. Any curved or twisted traces signify leakage.

Most curve tracers display a family of curves on the oscilloscope screen. Just make three connections to the transistor and actually observe "gain" curves.



VARIANT ON CURVE-TRACER IDEA, this Huntron Instruments device evaluates junctions with two-lead in-circuit test. Displays result on self-contained oscilloscope.

The Huntron *Tracker* tests transistors and diodes in-circuit with only two test-lead connections. The results are displayed on a small oscilloscope contained in the instrument.

The *Tracker* is not exactly a curve tracer in the usual sense. It is provided with a two-lead connection so that it can analyze conduction and leakage qualities of one junction at a time. Just touch two probes across the base-emitter or the base-collector junction right in the circuit (down to 10 ohms of shunting resistance). The display lines bend if there is leakage, and the sharp knee rounds out if the beta or alpha is poor. To determine the test-connection polarity, just touch the probes across the diode or transistor junction and watch the oscilloscope screen.

Time and dollars

Your criteria for judging a test instrument should be: (1) Will it help me do a better job? (2) Will it make my job quicker and more profitable? If you can answer "yes" to either question, buy the instrument and learn to use it. **R-E**

ROUNDUP

Digital Clock Kits For Your Car

Part III

FRED BLECHMAN, K6UGT

APPLIED MARKETING LC-101. LCD readout visible in sunlight.


JAMES DIGITAL AUTO CLOCK with under-dash bracket mount.


THE HEATH GC-1093 has a bright, easy-to-read display.


JAMES ALARM CLOCK, with setting and seconds switches

IN OCTOBER, WE PRESENTED AN OVER-VIEW OF THE ELECTRONIC clock kits for automobiles and included a comparison chart that showed characteristics of around thirty models. Last month we began covering individual makes in alphabetical order. This month we conclude the listing and this series of articles.

Jeff

On the plus side, this is a very simple clock circuit with a well-made, attractive fully assembled walnut wood-look case. The heavy red plastic faceplate and Masonite back panel make a sturdy enclosure, and would be a particularly good-looking addition to a recreational vehicle with a wooden interior. The finished clock is much smaller than the case, so a different enclosure could be used if overall size is important.

The circuitry is as basic as you can get, with no frills. The National MM5316 (or equivalent Fairchild 3817, which has brighter digits) is a clock IC with direct drive, so no resistors or transistor drivers are used to operate the FND503 digits. Also, since there is no multiplexing, RFI is at a minimum. The IC, however, runs very hot. In the unit I built, a 33-ohm half-watt resistor was used in the 12-volt input line to keep the MM5316 from overheating with the display on.

Fast and slow setting switches are included in the kit, as well as all the MM5369 crystal oscillator parts. The digits are ingeniously arranged so that the four decimal points are used as a colon between the hours and minutes digits, and as AM and PM indicators.

On the minus side, are the altogether too brief instructions (one sheet on one side). Adequate for a builder experienced in digital clocks, they would be pretty hopeless for a beginner. Although the assembly is not difficult, it requires a lot of patience. The two PC boards are designed so that 30 jumpers are required between them (although they are straight across), and the display board requires seven jumpers—all of which make an otherwise simple assembly a tedious job.

Also, there is absolutely no voltage transient or reversal protection, which could be provided by some diodes, capacitors and resistors. If you have a problem with false readings in your car, at least add a 33-ohm ½-watt resistor and also add a 1000-μF electrolytic capacitor between the ground and positive voltage input at the clock board.

It seems a shame that Jeff doesn't alert the builder to the many options available on this popular clock IC. With the addition of just one SPST or pushbutton switch from pin 32 to the positive voltage, and using the fast and slow set pushbutton switches provided, you could display and zero seconds, stop counting for precise time-setting, or reset the entire clock to 12:00:00 AM for use as a 24-hour elapsed timer! (Real time would be deleted.) This IC also contains alarm and snooze functions, as well as a 59-minute countdown timer ("sleep") with the addition of some other switches.

Perhaps by the time you read this article some of these "minuses" will be corrected. The kit has the basic ingredients for a "gourmet" van or motorhome clock, at a "diet special" price! Jeff, 3015 Eaton Rd., Cleveland, OH 44122.

National

This completely assembled and calibrated 12 VDC *Automotive/Instrument Clock Module* is available from Digi-Key (Box 677, Thief River Falls, MN 56701) with three pushbutton switches for $24.95, while Radio Shack sells the same module, without switches and for the same price, as their No. 277-1003. Several other distributors offer this module without switches for the same or higher prices.

Two of the switches set the hours and minutes independently at a 1-Hz rate. Setting minutes zeros the seconds, although the seconds cannot be displayed. The colon blinks on for 1 second and off for 1 second. Accuracy is provided by an on-board 2.097152-MHz crystal timebase, adjusted to the proper frequency by National. The third switch turns on the fluorescent display when the ignition is off. Provision is made for *variable* dimming of the display by wiring to the parking light and dash-lamp control of your vehicle. However, Fig. 3 shows a *simple* way, (*not shown* in the module data sheet) to wire a SPST "bright-dim" switch without tampering with the vehicle lighting circuits.

This module can be packaged in a 3 × 2 × 1-inch plastic box (with the terminals sticking out the side), making it one of the smallest complete clocks reviewed in this article, and—since it requires only the addition of switches—the simplest kit. The bright blue-green display shows clearly through blue, green or yellow faceplates, but loses brightness behind a red lens.

If you'd like to mount this in a circular dashboard clock space, Enclosure Engineering, 3491 Butcher Drive, Santa

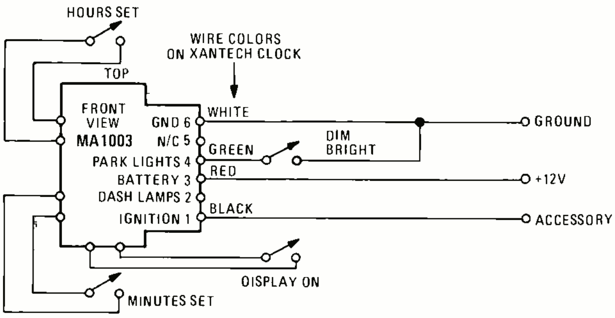


FIG. 3—NATIONAL MA1003 CLOCK display and time-setting switches.

Clara, CA 95951 will make you a bronze-colored plexiglas disc, cut to your required diameter and drilled to mount the *model MA-1003*, for about $3. Write Robert C. Arp for details. National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, CA 95951.

Nexus

This is a small but easy-to-assemble six-digit car clock with very bright red digits. The case is vacuum-formed into a tapered shape that roughly follows the shape of the PC boards, an attractive compact design. A ball-socket pedestal mount is included with the case to allow swiveling if desired.

Time is set by pushing a common straight pin through a fast- or slow-set pinhole in the bottom of the case! The display and clock boards connect together directly, and no switch wiring is required, making this one of the simpler kits to assemble. Two Zener diodes, a blocking diode, an inductor and two capacitors are included to provide excellent reverse and transient voltage protection.

Although the instructions don't point this out, you can choose either a 12- or a 24-hour format. As built, a 12-hour format is displayed. For a 24-hour display, cut the printed circuit path from pin 10 of the MM5314 to ground, and let pin 10 float. Be sure to use shielded wire in connecting this clock to your vehicle electrical system (some shielded wire is provided in the kit) or the RFI will be noticeable. Nexus Trading Co., Box 3357, San Leandro, CA 94578.

Optoelectronics

The *model 2001* is included in this report because several thousands were sold before the new *model 2001R* replaced it at the same price with a number of improvements. For example, *model 2001R* has a RESET switch and uses special tested MM5314's that reset after about 5 seconds to 0 00 00 in the 12-hour mode and 00 00 00 in the 24-hour mode. This allows it to be used as a 12- or 24-hour elapsed timer that counts by the second without retaining real time. In addition to the RESET switch, a HOLD-COUNT and DISPLAY-ENABLE switch are included. The HOLD switch lets you set the clock to the second; in the elapsed-time mode you can stop and restart without going back to zero. The DISPLAY-ENABLE switch lets you operate the display with the ignition off. In AC operation, this same switch blanks the display to save power!

The thicker .062-inch fiber glass PC boards are plated for easy soldering and are well made, with very cleanly drilled holes and sharp, clear white silk-screened parts layouts on royal blue boards. A separate small PC board is placed parallel to the cabinet-front time-setting access holes to make it easier to set the hours and minutes. The display PC board is single-sided, has no jumpers, and greatly reduces the possibility of oversoldering under the digits (with hidden bridges) and the difficulties of unsoldering that existed with the previous two-sided PC display board. Circuitry changes include the addition of a 250-μF filter capacitor at the reset pin of the IC and increasing the power-supply filter to 1000 μF to provide better transient protection.

A high-quality mica-dielectric trimmer with zero temperature coefficient is used for trimming the crystal frequency. A diode has been added and the AC power circuit revised to blank the display when the AC power is interrupted and the backup battery is installed; this way the clock will keep running for days during power interruptions without losing time. With the original circuit, when a battery was used with AC operation, the display didn't blank with loss of AC power, and the battery would last only a few hours.

Optoelectronics has gone all out to make this kit complete and easy to build, with very good instructions, a detailed schematic and high-quality components and PC boards. Even the packaging of the kit parts is outstanding. The parts are logically grouped and sealed in separate compartments of two long 5-inch-wide polyethylene strips. You snip open each compartment with scissors as you need the clearly visible parts. That sure beats little paper bags and envelopes!

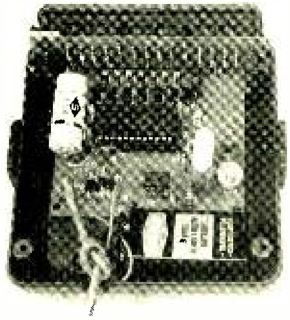
The *model 7005* was not yet available when this was written in May, 1977, but advance information provided at that time indicates this is a very versatile unit, based on the popular CT-7001 clock IC. It is the only design reviewed that has both a calendar and an elapsed-time function that retains real time.

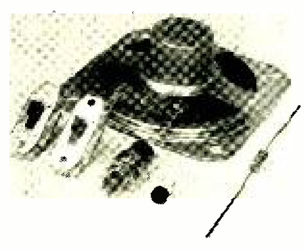
The *model AC-1* AC power pack is available from Optoelectronics for operating any of their clocks from the 117-VAC wall plug. It sells for $2.95, and can be used with any of the other clocks in this report that have a 12-VAC input. Optoelectronics, Inc., Box 219, Hollywood, FL 33022.

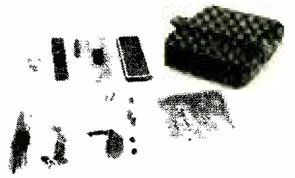
Quest

This clock, designed by Robert C. Arp, features a National Semiconductor preassembled and tested MA1012A four-digit 12-hour 60-Hz digital electronic clock module, complete with ½-inch-high readouts. An MM5639 crystal timebase is on a separate PC board. Two IC voltage regulators (12 volts for the clock circuits, 6 volts for the display), two diodes and three capacitors are wired to a terminal strip; a photocell and three resistors are mounted on the module. Only a few wires are necessary to interwire, making this a simple kit. The switches are miniature test-point jacks, mounted on the front of the optional standard gray case, which has plenty of room for the parts. Even three heat sinks are furnished with the basic kit, an outstanding buy for $15.95.

The alarm option consists of a speaker, transistor, resistors and switches that attach to the module for a 24-hour repeatable alarm with snooze. The automatic dimming circuit, included in the basic kit, has a broad range and is effective in providing







INSIDE SABTRONICS SI-204 CLOCK (top).

S.D. SALES JUMBO CLOCK alarm option (top right).

SABTRONICS SI-204 PARTS.

good display contrast.

By the time you read this, Quest says that they will be using a PC board for the miscellaneous parts instead of a terminal strip. Also, a pushbutton switch will be added to display seconds, hold count, or reset the module to 12 AM for use as a 24-hour stopclock—all at no increase in price! Quest Electronics, Box 4430, Santa Clara, CA 95054.

Ramsey

The *model DC-7* is totally different in appearance and construction from the other mobile clocks. John Ramsey had a special die made for extruding these modern aluminum cases, and uses them for several of his clock designs. Also unusual is the fact that the buyer can choose five anodized colors at no extra charge. A red Polaroid faceplate is also included. Three single-sided PC boards are used in a compact assembly that slides into the end of the case. The three time-setting pushbutton switches mount in predrilled holes in the rear of the case at the other end, and matching colored tapered aluminum endcaps finish off the "space-age" look. The instructions are well written and illustrated, making the clock easy to assemble. The easy-to-follow schematic includes a well-written explanation of multiplexing, which should help considerably in troubleshooting.

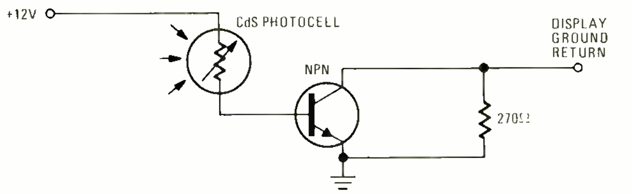


FIG. 4—RAMSEY AUTOMATIC DIMMER for any Fosket-type car clock.

The *model DC-11D* is a standard Fosket car clock with a unique dimmer option (see Fig. 4). A CdS photocell varies the forward bias applied to the base of a transistor, and that varies the resistance in the display ground return circuit. A 270-ohm resistor across the transistor provides a conducting path in complete darkness, for minimum display intensity. Component values for the dimmer have been selected to vary the intensity from full brightness in high ambient lighting to 50 percent brightness in the dark. This results in a relatively constant contrast (difference between display brightness and surrounding light). The clock is readable in bright surroundings, but doesn't shine like a beacon in the dark—this could be important in nightdriving!

The *model DM-1* Dimmer Adapter Kit is available from Ramsey for $3. Instructions are detailed and well illustrated. Ramsey Electronics, Box 4072, Rochester, NY 14610.

Sabtronics

Although this is another basic Fosket car clock, a few extras are added even though the selling price is the lowest for a Fosket car clock. A HOLD switch is included, so that this six-digit clock can be set slightly ahead of the real time and stopped until the real time catches up to the clock reading. This may not seem important when you consider that all mobile clocks are inherently inaccurate by as much as several seconds a day—but why display seconds if you can't set them? By the way, any MM5314 IC can have this feature, by simply connecting a pushbutton, slide or toggle switch from pin 13 to ground.

The other plus is the way the components are packaged in sealed compartments of long plastic strips. You can easily check against the parts list and find what you need when you need it, without searching through many little polyethylene bags.

The instructions, which may be much improved by the time you read this, were considered "fair" rather than "good" only because of their poor reproduction, not their content. They contain all the necessary detail for anyone but a real beginner to assemble this clock successfully. Sabtronics International, Box 64683-R, Dallas, TX 75206.

S.D. Sales

Using a Mostek 50252 clock IC and a Bowmar ½-inch-high four-digit readout display, this design offers various options. Unfortunately, the instructions are somewhat confusing, some information is omitted, and the physical arrangement of the parts makes it a difficult to assemble and package. You get a lot of parts for the low price, and an alarm option is only $1.50 more. Fortunately, the Optoelectronics *Cabinet II* mentioned earlier is an almost custom-made enclosure for this relatively large clock.

The display requires 40 straight-through short-wire jumpers to mate it to the display board, and 17 more wires, any length, are needed to join the display board to various scattered connection points on the clock PC board. Therefore, you can remote the display if you prefer. The clock board is large enough not to be crowded, but it contains 17 resistors, 14 transistors, seven diodes, two large electrolytic capacitors, one trimmer capacitor, a 3.58-MHz crystal, a small capacitor, the clock IC and three more IC's used for the crystal oscillator and who knows what else, since they're not shown on the schematic. It's not exactly a simple clock!

Once built, it operates nicely and even has automatic dimming.

If you like wiring, lots of parts, versatility and custom-packaging, this might be your favorite clock; if you like simplicity and small size, you'll hate it! S.D. Sales Co., Box 28810, Dallas, TX 75228.

Tonitron

Tonitron is the only source found in this survey for units that combine a mobile clock with radio converters. For example, *model TC-73* ($56.50) has an FM converter in the same cabinet as the *model TC-76* clock. A horizontally moving LED is used as a dial indicator when tuning FM stations on your AM radio (at a fixed spot on the AM dial). The *model TC-74* ($51.95) CB converter uses a switch to feed CB signals to be tuned in on the AM radio dial; *model TC-75* ($48.95) works the same way for listening to weather stations on an FM radio. The basic *model TC-76* clock can display seconds, has a bright/dim switch and can be used as an elapsed timer without retaining real time. Tonitron Industries, Box 2251, Elkhart, IN 46514.

Xantech

A beautiful example of product styling, this unit is a standard National *model MA1003* clock module in an attractive case, with three front-mounted minipushbuttons to set hours and minutes and command the display with the ignition off.

APPLIED MARKETING VC-502 in dash-mounting.

APPLIED MARKETING LC-101. LCD readout visible in sunlight.

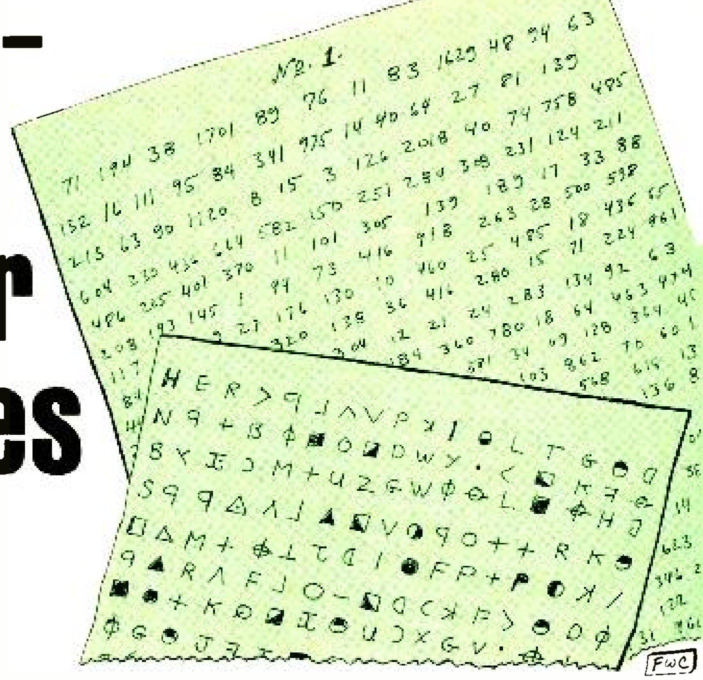
Xantech is in the premium van, recreational and marine accessory business, and this black plastic case with walnut vinyl trim has a lot of class. The gimbal mounting permits the clock to swivel completely around as well as up and down. The four leads allow you to wire it to the dashboard dimmer switch—or you could use Fig. 3 to connect it with a bright/dim switch.

The dashboard version is identical except for a case designed for that purpose.

This clock was seen for sale at a large auto supply store and a recreational vehicle accessory outlet for $39.95. Xantech Corp., 13038 Saticoy St., North Hollywood, CA 91605. **R-E**

Computer Cryptography–

How To Decipher Secret Messages



Looking for a new way to use your computer? Try deciphering secret messages and breaking codes. Its a natural for your computer and plenty of fun.

FREDERICK W. CHESSON

THE BEALE PAPER NO. 1 SUPPOSEDLY describes the exact location of a treasure trove of gold, silver and gems deposited about 1820 somewhere near Bedford, VA. The message is the first part of a famous cryptographic trio. The second describes the treasure and was solved many years ago using the Declaration of Independence as a key. The third paper is said to give the names of the treasure-party members and their next of kin. Ever since the second paper was deciphered, many attempts have been made to find the key to the first and third messages. Neither the Bible, Shakespeare, the United States Constitution or any other federal documents have provided any clues.

In recent years, treasure hunters with metal detectors, "alleged decipherments," and some cryptic clairvoyant revelations have roamed the mountain countryside, much to the annoyance of local property owners.

Meanwhile, back in the computer labs, endless reams of printouts spew forth and video displays scan flickering alphanumerics, as new key-texts and endless variations of old ones are statistically analyzed for meaningful letter patterns. It is, in fact, from the data-processing area of the Beale treasure hunt that the only so far known monetary reward has materialized. In 1970, Dr. Carl Hammer, director of the UNIVAC Division, Washington, DC, was awarded the $500 first prize for his paper: "Signature Simulation and Certain Cryptographic Codes," by the Third Annual Simulation Symposium.

A collection of jumbled alphabetical and geometric figures is shown in Fig. 1. This represents the second in a series of alleged messages from "Zodiac," the slayer of at least 10 persons in the San Francisco Bay area, circa 1969. The text is reported to contain information concerning Zodiac's true identity. If deciphering the cryptogram leads to the killer's arrest and conviction, a reward of at least satisfaction, if not a monetary presentation, may await the lucky codebreaker.

Terminology

Code-making and breaking has its own terminology, as follows: *Cryptology* covers the entire scope of secret communications: Written codes and ciphers, invisible inks, microdots, voice scrambling, infrared and ultraviolet signaling and even electronic jamming and countermeasures.

Cryptography concerns the written word, whether transmitted by paper or electronically. *Enciphering* is that process by which information is rendered unintelligible to the uninitiated. Normal words, or *plaintext*, are converted into *ciphertext*. When ciphertext is prepared for transmission or just received, the message is called a *cryptogram*. *Deciphering* refers to the reverse process, in which ciphertext is again turned into plaintext for all to read. An unauthorized attempt to break the cryptogram is variously described as *decrypting*, *cryptanalysis* or simply old-fashioned *code-breaking*.

While the terms *code* and *cipher* are often used interchangeably, cipher is generally considered an overall term for an enciphering process. Code more narrowly describes a process in which a complete word, phrase or entire sentence is replaced by a group of letters or numbers.

Cipher groups

There are two major groups of ciphers, both with a host of subdivisions. A *transposition cipher* scrambles its original letters or words about according to routes or geometrical patterns. The word "cipher" can be transposed into "perchi," for example.

Substitution ciphers are often found in their simplest form in many newspaper cryptogram puzzles. Plaintext letters are replaced by other letters or numbers, according to a general formula and with a particular key, which indicates which letter will become what other letter or number. In the *simple-substitution* cipher, the key remains the same for the entire message; the letter E is always replaced by X, A by Q, T by Z, etc.

More secure systems use multilettered keys, in which E is replaced by J the first time it is used, then by F, then by W or even by itself. Generally speaking, the longer and more random the key, the safer the message.

A modern practical system is *pseudo-random key-generator*. This system, operating on shift-register principles, produces an apparently random series of bits and zeros, which may be further transformed into equally random-appearing key letters or numbers. A 20-stage register could, for example, provide a nonrepetitive stream of over one million bits.

The code-breakers, however, have used computer-assisted cryptanalysis to prove that what is not purely random can be fairly quickly broken. Today, the problems of secure data transmission between computer centers and terminals are the latest chapter in a story as old as recorded history itself.

Microcomputer-based cryptography

Even the most basic microcomputer, combined with an ASCII keyboard input and a video display output, can perform many cryptographic functions, including encoding, decoding and cryptanalysis. Such things as FORTRAN or BASIC compilers and line printer outputs for hard copy, while useful accessories, are not really necessary for the beginner to try cryptography.

As a matter of fact, a slight modification to the TV Typewriter circuit (see **Radio-Electronics,** September 1973 issue) will permit the device to code and decode simple substitution-cipher messages, and to make trial decipherments for a wide variety of other substitution-type ciphers.

TVT modifications

The 512-character memory of the original TV Typewriter is adequate for most cryptograms. Even 256 characters are sufficient for the majority of these puzzles, and 128 will work for most of the "recreational cryptopuzzles."

You need some sort of "store and compare" circuit. This permits a character that will be replaced to be temporarily stored and compared with the other characters in the memory, one step at a time. When a match is made, then the character in question is replaced by another one by depressing a selected key on the keyboard.

For example: Consider "XYZQZ KU CVLXYZQ LVZ . . ." Noting that Z occurs rather frequently, you could substitute E, the most common letter in the English language. First Z is keyed into the temporary memory, then the memory is scanned, with the replacement E keyed in. Every time a Z is encountered in the cipher-text, it is replaced by E. This results in the displayed text now appearing as: "XY*EQE* KU CVLXY*E*Q LV*E* . . ." The location of the two E's in the first word suggests "there." Substituting X = T, Y = H, and Q = R yields "*THERE* KU CVL*THER* LV*E* . Although there isn't much firm statistical information in this brief fragment, you can feel reasonably confident in substituting K = I, U = S, C = A, V = N, and L = O, giving "THERE IS ANOTHER ONE."

The trial decipher process can be considered an "examine and replace" logic routine as follows: "Does memory location 1 = A? If yes, replace location 1 with B and go to the next location. If no, go on to the next location. Continue until the nth location has been examined." The basic flow chart is shown in Fig. 2

The hardware for this TV Typewriter routine consists of a 74174 hexlatch for storing the character to be replaced, and an 8160 6-bit comparator, for determining whether the particular character in the memory being examined is the same as in the hexlatch. The general circuitry is shown in Fig. 3.

Operation

To encode a message, first clear the screen, leave a few blanks and write in the normal alphabet from A to Z. On the next line, directly below, type in the cipher alphabet. Having then written in the message and checked it for accuracy, home the cursor and turn off the WRITE ENABLE.

The choice of an enciphering alphabet is up to the user and his correspondents. In hobby-type cryptography, generally no plain letter is represented by itself in the ciphertext. Two typical cipher alphabets are shown below:

Plain: A B C D E F G H I J K L M N, etc.
Cipher: Q W E R T Y U I O P A S D F, etc.
Plain: A B C D E F G H I J K L M N, etc.
Cipher: Z *K R Y P T I C* A B D E F G, etc.

Notice the key word, *kryptic*, in the second cipher alphabet. Sometimes the plain alphabet is keyed; sometimes *both* alphabets are keyed. It is only necessary that letters not be repeated. Some solvers consider recovering keywords as interesting as solving the message itself.

To encipher "A," depress the A key on the keyboard, while briefly engaging the WRITE key or switch. Now press the Q, Z, or whatever key the cipher equivalent represents, and activate the CLEAR switch. This should cause every A on the video display to be replaced by Q, Z or equivalent. Similarly, proceed down the alphabet to Z (assuming the message has a Z in its text), noting that each plain letter is replaced by its cipher equivalent.

Decoding is similar. For accuracy, again just write in the plaintext and cipher alphabets, one above the other, before entering the message. When you have finished replacement, there should be two normal alphabets above the plaintext message, which will serve as a check that all the cipher letters have been processed.

FIG. 1—SECOND ZODIAC MESSAGE of 1969 contains the identity of the killer.

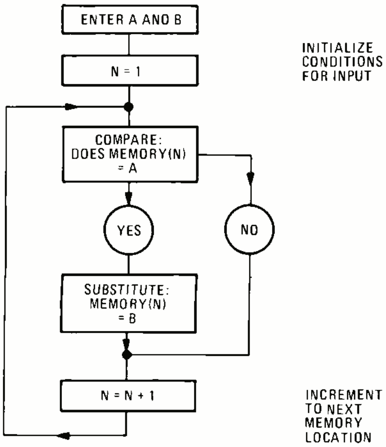


FIG. 2—FLOW CHART for substituting letter B for letter A in a memory of N letters.

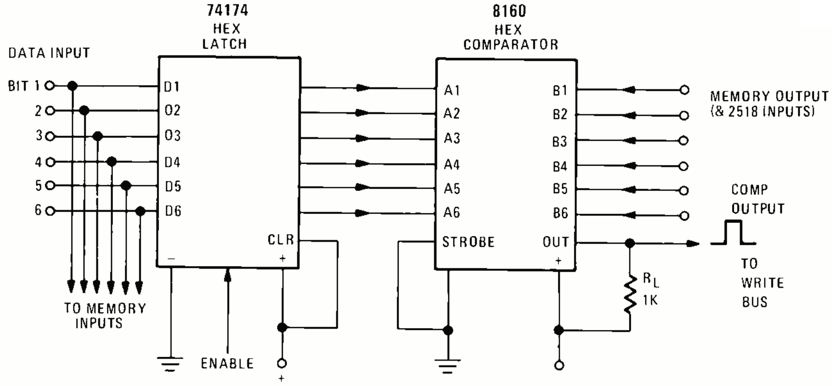


FIG. 3—EXAMINE AND REPLACE circuit for the TV Typewriter.

Cryptanalysis

The following suggestions can help in the solution of simple-substitution cryptograms:

1. Frequency count: The letter "E" is the most common in the English language. The other vowels, except for "U," show a high percentage as well. For standard English, the precedence is: E T A O I N S H R D L U C P F M W Y B G V K Q X J Z.
2. Single letters are almost always A or I.
3. Vowels and consonants tend to alternate, as E-R-E, D-A-N, etc.
4. Certain letters tend to form reversals: ER-RE, ES-SE, ED-DE, etc.
5. Two- and three-letter combinations (called di-grams and tri-grams) have their own frequency-count precedence, such as TH, HE, AN, IN, ER, RE, ED, EN, THE, AND, ION, ING, ENT, ARE, FOR.
6. Letter patterns help: when V-W-X-X-V-Y suggests L-I-T-T-L-E, and Q-K-Y-G-Y, the commonly used T-H-E-R-E.
7. Word patterns are also useful. If XYZ appears frequently, it may well be THE, and WM XYZ or JU XYZ might turn out to be IS THE, or OF THE.

When writing in a trial solution, try to avoid confusing cipher letters for plaintext trial letters. If the cryptogram contains E, T, A, I, etc., replace these at the start with numerics, like 1, 2, 3, 4, etc. With the 63-character set available on the original TV Typewriter and most similar sets, transpose the cryptogram's letters into nonalphabetic numeric characters. For example, if you make a frequency count of the cryptogram and find that X, I, V, Z, and O are the highest, then they and the others can be replaced by:

X	I	V	Z	O	T	Y	A	B
1	2	3	4	5	6	7	8	9

The problem can also be eliminated by having an upper- and lower-case character set. It also helps to have the original ciphertext permanently on view. This can be done by writing in the trial decipherment letters *under* the cryptogram letters as follows:

```
XYZQZ  KU  CVLXYZQ  LVZ
THERE       T   HER    E
```

The circuitry requires some additional IC's; but in cryptograms of under about 250 letters (and spaces), it eliminates lengthy keyboard rewriting when the cryptanalysis becomes hopelessly garbled. **R-E**

Digital clocks and watches win places in design show

The second annual Design and Engineering Exhibition, held in Chicago this summer, selected among its exhibits two Zenith electronic time-display devices, among the 83 consumer electronics products exhibited for their innovative design.

"BILLBOARD" AM/FM CLOCK RADIO, the Zenith J465W, presents a design innovation, the "billboard" mounting, in clock radios. Placement of the display and the large illuminated numbers make the clock readable even across a room.

"Billboard styling" is introduced in one device, the *Billboard* electronic digital clock radio. Among other features, the clock includes an alarm display that indicates the exact minute to which the alarm is set. A power reserve feature keeps the clock circuits functioning for up to four hours in the event of an accidental disconnection from the line or a power failure.

The other device, the *Port Royal* electronic quartz watch, combines digital and traditional approaches, featuring hands-and-dial display for hours and minutes and an LED digital display for reading out the seconds and date. This new model is manufactured by Zenith Time S.A. in Switzerland, and will be available in the United States this Fall.

The Design and Engineering Show is sponsored by the Consumer Electronics Group of the Electronic Industries Association (EIA).

Teamsters sponsor daily CB newscast

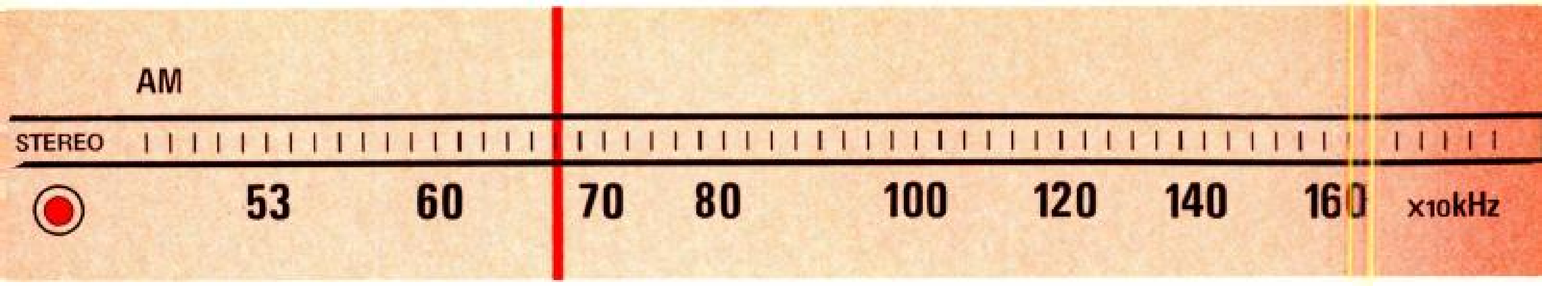
The International Brotherhood of Teamsters who, more than any other group, has been responsible for the tremendous growth and popularity of CB radios, are providing a daily public service newscast to participating radio stations.

The National CB Radio Network broadcasts news of interest to the entire spectrum of CB enthusiasts, from seasoned veterans to laymen. The programs include news stories on the latest equipment and technology, FCC regulation updates, special events, celebrity interviews, as well as human interest stories.

CB industry group backs FCC rulings

The EIA's Citizens Radio Section, a group of CB manufacturers working with the Federal Trade Commission on improving CB radio rules, recently endorsed a ruling barring the sale and use of linear amplifiers. These amplifiers, which raise CB station power to more than the 4 watts allowable, provide considerable amounts of interference to CB's and other electronic equipment.

The CB group has also backed a proposed FCC rule change on the type acceptance of commercially produced amateur radio equipment. It is recognized that there are two groups of such equipment: one designed for legitimate amateur use, the other purporting to be such but actually intended for improper use. Although the latter equipment is rarely sold to legitimate amateurs, the Citizens Group believes that a ruling on type acceptance would be in the public interest. **R-E**



Broadcast Systems For AM Stereo

A number of different systems have been conceived in the years since AM stereo was first proposed. The FCC may soon select one as the standard

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

BY THE TIME YOU READ THIS, THE NATIONal AM Stereophonic Radio Committee (an audio industry group formed under the auspices of the Electronic Industries Association) will have completed its lab and field tests in Bethesda, MD. These tests are the culmination of a long series of events dating back to the 1950's, when the Federal Communications Commission was asked to make rules for stereophonic FM broadcasting. At that time, it was proposed that rules also be made for stereophonic AM broadcasting as well as for the stereophonic broadcasting of the audio portion of TV.

Rule making was initiated only for stereo FM broadcasts at that time, and in 1961, compatible stereo FM broadcasting began. It was felt that there was no real need for stereo sound on TV and that, in the case of stereo AM, owners of AM broadcast stations were doing quite well financially, whereas FM station owners were facing extreme economic hardships. To bolster the FM situation, action was first taken with regard to stereo FM to give those stations a clear advantage over their AM competition.

At present, FM broadcasting is an extremely healthy industry (some say it has surpassed the older AM in its economic success), and it is the AM broadcasters who have been crying for help! Apparently, if timetables hold, help is on the way. Before long, the FCC will be examining the massive amount of data submitted to it by the NAMSRC (*Na*tional *AM* *S*tereophonic *R*adio *C*ommittee) with an eye towards setting up new rules for stereo AM broadcasting.

When this committee began, at least five proponents offered stereo AM broadcast techniques for consideration. These were Leonard Kahn (whose stereo AM system has been successfully used in transmissions from Mexico for many years), RCA, Magnavox, Motorola and Sansui. In recent months (and in the field tests themselves), the number of systems has narrowed down to three: Magnavox, Motorola and the Belar Company (whose system is essentially that proposed originally by RCA). While the mathematics of each of the remaining systems is rather complex, we will review briefly how each system works and what changes must be made in transmitting and receiving equipment in order to handle each of the three remaining systems.

Magnavox system

The proposed Magnavox stereo AM broadcasting system is an AM/PM (*P*hase *M*odulation) system that places left-plus-right (L + R) information on a phase-modulated channel with a proposed phase deviation of one radian. In addition, a 5-Hz subaudible tone is frequency-modulated into the carrier with a deviation of approximately 100 Hz. This tone is for stereo identification (similar to the way a 19-kHz pilot carrier in stereo FM lights an indicator on the receiver) and is an attractive selling point.

A block diagram of the complete transmitter system is shown in Fig. 1. The transmitter uses nearly all of an existing monophonic AM transmitter with no modification. The channel oscillator is replaced with a phase-modulated signal generator and signal tone source. This signal generation method provides for on-frequency operation, eliminating the need for multiplying or mixing stages. The station carrier is generated on-frequency and modulated with a 5-Hz tone. This signal is then used as a reference for a wideband phase-locked-loop to generate a true phase-modulated (PM) signal on-frequency. The latter signal is then amplified and modulated by the L + R audio signal in the existing transmitter. The processing blocks shown at

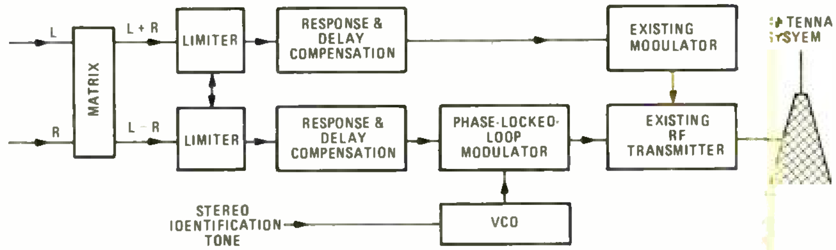


FIG. 1—TRANSMITTER FOR MAGNAVOX SYSTEM uses a phase-locked-loop to produce a phase modulated carrier. The audio signals are limited and compressed after matrixing.

the left of Fig. 1 limit and compress (as required) the audio signals *after* matrixing. This technique insures that the L + R loudness for the monophonic program listener will be maintained during reception of a stereo broadcast; and that, for the stereo listener, proper loudness tracking will be maintained between the L + R and L − R signals.

The receiver configuration shown in Fig. 2 is considered by Magnavox to be

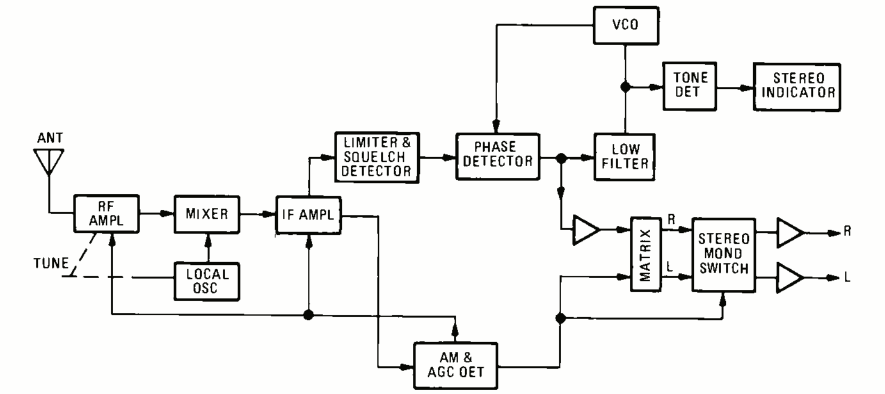


FIG. 2—RECEIVER FOR MAGNAVOX SYSTEM has single IF. A standard envelope detector recovers the AM channel. The phase-modulated information is recovered by a PLL.

one of the main advantages of their system. It is a single IF system and uses a standard envelope detector for the AM channel. Since the carrier level is maintained for all program material, an automatic-gain control system capable of holding the L + R output nearly constant over a wide range of RF levels can be achieved. This allows for proper dematrixing of the L + R and L − R signals. The PM information is recovered by sampling the IF signal, limiting it and detecting it with a phase-locked-loop circuit.

The stereo identification tone is regenerated by recovering the audio tone that exists between the main voltage-controlled oscillator and the loop filter and passing it through a second phase-locked-loop circuit to drive an indicator. Left- and right-channel information is recovered from a standard matrix. In addition, an automatic mode switch that chooses between mono and stereo is driven by the presence or absence of the stereo signal.

Motorola system

The Motorola system basically involves transmitting two signals on one carrier by separately modulating two carriers at the same frequency and arranging them in phase quadrature with respect to each other. In color TV this method is used to transmit two separate color signals on a single subcarrier.

The phase of the existing broadcast carrier can be split into two separate components, angularly displaced by 90 degrees and each component can be separately modulated with one of the audio signals. The method provides a relatively simple modification of existing transmitters and stereo receivers that derive the left and right audio signals using simple product detectors, one for each channel. In its simplest form, the Motorola system can cause distortion in mono receivers when the left and right signals have significantly differing program content. This distortion is due to the use of current rectifiers or envelope detectors in a monophonic AM set.

The final version of the Motorola proposal slightly modified the radiated quadrature signal. The result is that distortion normally appearing in the mono receiver is transferred to the stereo receiver, where it is corrected to restore the original quadrature signal. The quadrature signal is then decoded by a pair of product multipliers to derive the left and right audio signals directly.

Figure 3 is a block diagram of a transmitter modified to produce a compatible quadrature signal. The transmitter uses the carrier-frequency oscillator to supply a signal to the modified exciter. The exciter splits the carrier into two components in quadrature phase. The first component is modulated by L + R, and part of the oscillator signal bypasses the balanced modulator to provide a residual carrier of the L + R phase. The second component is modulated with L − R to provide a suppressed carrier signal in quadrature with the first. The two signals are added and limited to create an output signal that drives the high-power transmitter stages, which are phase-modulated with the same phase information contained in the composite of the two modulated signals in quadrature.

The transmitter modulator is supplied with L + R to provide a compatible envelope signal for detection by a signal current or envelope detector.

Figure 4 is a block diagram of a receiver for the Motorola system. The receiver is similar to one used for the reception of two signals in quadrature, except that the carrier-level modulator restores the received signal to its original quadrature carrier form where the left and right signals can be taken directly from two product detectors. The in-phase detector can be used for squelch or auxiliary controls in addition to controlling gain.

Motorola cites several advantages for their system:

1. A minimum of monophonic coverage loss due to sky-wave sideband distortion of low-frequency audio signals.
2. The power spectrum at the transmitter signal closely resembles monophonic for the most stable compatible performance on monophonic receivers.
3. Left and right signals can be directly recovered from the demodulators without matrixing sum and difference signals.
4. Compatibility with monophonic receivers using envelope detection or synchronous detection.

Belar system

The Belar system is essentially the one originally proposed by RCA. The RCA Corporation is not an active proponent in the present stereo AM considerations.

This system uses a pre-emphasized

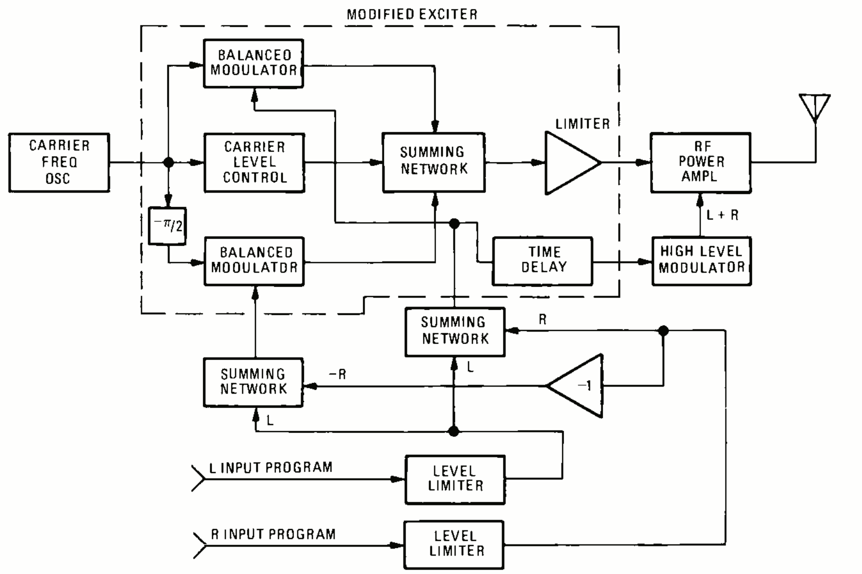


FIG. 3—TRANSMITTER FOR MOTOROLA SYSTEM modulates two carriers in phase quadrature. The modified exciter splits the carrier into two components in quadrature phase.

L − R signal to frequency-modulate the carrier. The resulting signal is amplitude-modulated with the monophonic sum signal, L + R. A transmitter block diagram for this AM/FM system is shown in Fig. 5. The FM exciter, carrying the L − R modulation, replaces the ordinary fixed-frequency crystal exciter that would be used in ordinary monophonic AM transmission.

Figure 6 shows a receiver that would be suitable for use with this AM/FM system. The output of the common IF amplifier is fed to circuits that provide amplitude-insensitive FM detection. A form of dynamic limiter (preceding the discriminator) is shown. Because the diodes are self-biasing, the output is proportional to the mean level of the IF signal and no tracking circuitry is required.

A variation of this system, known as an AM/FM/AM system, in which the FM modulating signal is modified to (L − R)/(1 + L + R), was also investigated by RCA. A definitive paper on this modified system was published in the September 1960 issue of *The RCA Review*. In this modified system, the output of a balanced discriminator would be independent of the AM modulation and equal to (L + R), provided the carrier frequency is at the discriminator null. However, this system is highly subject to AM-to-FM crosstalk if the receiver is detuned and therefore requires some form of AFC circuitry to insure perfect tuning.

When will stereo AM begin?

No one can predict when or even if the FCC will decide upon one of the systems described here. If past history is any indication, in the case of stereo FM, the field tests were completed in early 1960 and a final report was submitted to the FCC shortly thereafter. The report and order approving the currently used stereo FM system were issued by the FCC in April, 1961. By the summer of that year, the first stations began transmitting stereophonically.

There are some indications that the FCC may move more rapidly in the case of stereo AM. For one thing, there are fewer system results to be analyzed (there were five proponents of stereo FM, all competing for acceptance). Also, pressure from the public and AM stations (all very much accustomed to stereo records, tapes and FM broadcasts) may cause the FCC to move more rapidly this time. In any event, when and if a system is approved, you can be sure that manufacturers will scurry to be out there with suitable stereo AM tuners and receivers as quickly as possible.

One final word regarding stereo AM is, perhaps, in order. As most readers are aware, AM as broadcast and received in this country can hardly be considered a "high-fidelity" broadcast medium. Not that it could never be! There are many AM stations in this country that take pride in broadcasting audio signals having a frequency response right out to 15,000 Hz, just like FM. However, most AM receivers and tuners are unable to reproduce much above 4 or 5 kHz, and many AM broadcast stations use standard telephone lines to pipe their signals from studios to transmitters, and these lines have about the same high-frequency response limitations.

So, unless you own one of the few wideband AM receivers, and unless stations start using high-fidelity lines when stereo AM is finally approved, you will not hear Hi-Fi over AM just because you can receive separate left and right channels. The musical instrument and vocal sounds may move to their proper stage locations—and that will certainly lend some excitement to AM reception—but the fidelity of those instruments and voices will still be as low as you are accustomed to hearing over AM. **R-E**

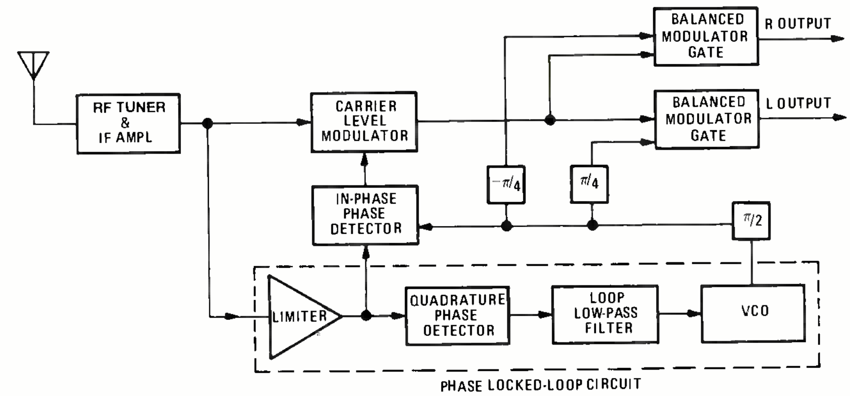


FIG. 4—RECEIVER FOR MOTOROLA SYSTEM. Phase-locked-loop and balanced modulators recover the R and L signals.

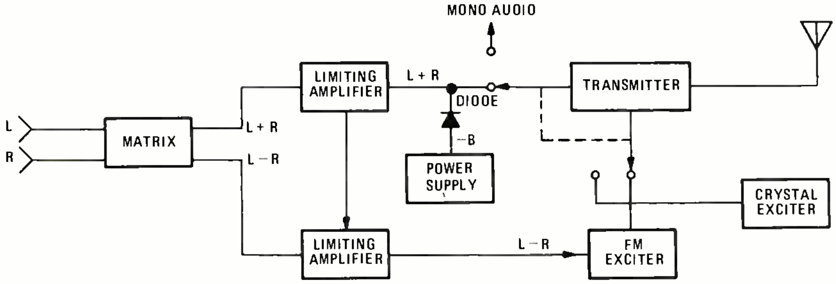


FIG. 5—TRANSMITTER FOR BELAR SYSTEM. The carrier is frequency modulated by the difference signal and amplitude modulated by the sum signal.

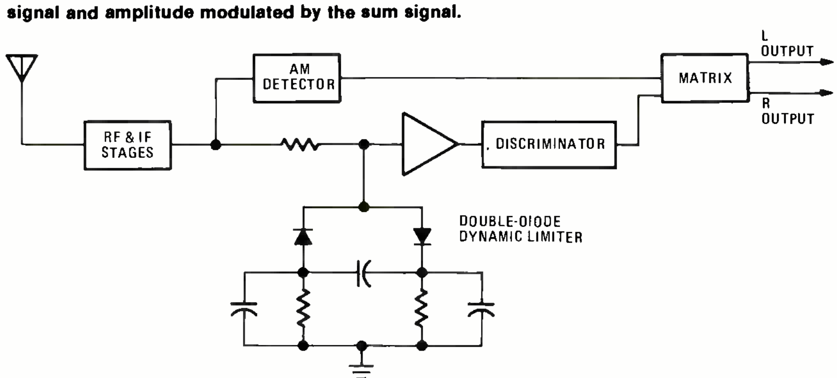


FIG. 6—RECEIVER FOR BELAR SYSTEM uses a dynamic limiter circuit to provide AM-insensitive FM detection.

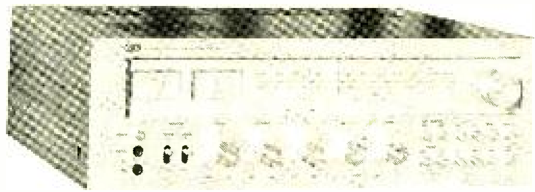
Infrared sensing device forecasts clear air turbulence

Clear air turbulence (CAT) is an annoying, and potentially dangerous, side effect of modern air travel. To help cut down on serious injury and aircraft damage that can result from insufficient warning of CAT occurrence, scientists at the U.S. Department of Commerce National Oceanic and Atmospheric Administration lab and at NASA have devised an infrared sensing instrument.

The device is a simple water-vapor radiometer system that can detect CAT from 4 to 10 minutes in advance and at a distance of up to 160 kilometers. Installed in the right wheel well of the aircraft, the radiometer is angled upward at a fixed elevation of 2.5° to 15.0°. The detector and optical system in the device pick up water-vapor emissions in the field of view and also from background emissions, which thus help generate the signal.

Fifty-one test flights with a prototype showed that the device is accurate about 80% of the time. This high percentage of timely warnings certainly warrant making this device available as part of the regular subsonic (and perhaps supersonic) aircraft on-board instrumentation. **R-E**

Radio-Electronics Tests GTE Sylvania Model 2600 Stereo Receiver



1

CIRCLE 83 ON FREE INFORMATION CARD

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

GTE SYLVANIA'S *MODEL 2600* STEREO RECEIVER is an elegantly designed high-power unit that offers new features not commonly found in most medium-priced integrated receivers.

Figure 1 shows the front panel of the receiver. The power switch, phone jacks and a mono microphone input jack are placed at the lower left of the light-colored flat panel. The microphone jack feeds signals to both stereo channels and can be used for instrument pickups as well as conventional microphones.

Toggle switches select A or B speaker systems. Rotary knobs control BASS, MIDRANGE and TREBLE tone, as well as BALANCE and master VOLUME settings. Two rows of push-buttons (six buttons per row) take care of all other control and selection functions: PHONO 1 or PHONO 2 (pressing both these controls actuates the microphone input circuit, which cannot be mixed with other program sources); AUX, AM, FM, FM MUTE; TAPE 1 and TAPE 2 monitoring; low- and high-cut FILTER; MONO/STEREO and LOUDNESS.

In the upper portion of the panel, a large cutout area contains a linear FM dial scale, an AM frequency scale and a linearly calibrated logging scale.

Also included are a flywheel-coupled tuning knob, signal strength and center-of-channel tuning meters, a stereo indicator LED and two more LED indicators that indicate the amplifier-output clipping level for each stereo channel separately. The smooth-acting dial pointer is illuminated when power is applied to the receiver.

The built-in AM ferrite-bar antenna, supplied separately, must be plugged in by a connector and installed in its mounting bracket on the rear panel when the receiver is unpacked. (This unusual arrangement is probably intended to prevent the ferrite stick from breaking during shipment and unpacking.) Below the AM bar antenna are external AM terminals, 75-ohm or 300-ohm FM antennas, two sets of phono inputs, an input impedance switch connected with the phono-1 inputs and a chassis ground terminal. Auxiliary and two sets of tape inputs and outputs come next, followed by jumper-connected preamplifier-out/main amplifier-in jacks and three sets of speaker-connection spring-loaded terminals.

Why are there three sets of terminals, when the front panel provides choices for only two pairs of speakers? Simply because Sylvania has provided a passive matrix system that allows recovery of out-of-phase ambience data from stereo records, which is then reproduced

TABLE I
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **GTE Sylvania** — Model: **GTE-2600**

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	R-E Measurement	R-E Evaluation
IHF sensitivity, mono: (μV) (dBf)	1.7(9.8)	Excellent
Sensitivity, stereo (μV)(dBf)	4.0(17.2)	Excellent
50-dB quieting signal, mono (μV) (dBf)	2.4(12.8)	Excellent
50-dB quieting signal, stereo (μV) (dBf)	33(35.6)	Very good
Maximum S/N ratio, mono (dB)	72	Very good
Maximum S/N ratio, stereo (dB)	66	Good
Capture ratio (dB)	1.5	Good
AM suppression (dB)	47	Fair
Image rejection (dB)	55	Fair
IF rejection (dB)	66	Fair
Spurious rejection (dB)	87	Good
Alternate channel selectivity (dB)	68	Good
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz (± dB)	−2.0	Fair
Harmonic distortion, 1 kHz, mono (%)	0.15	Excellent
Harmonic distortion, 1 kHz, stereo (%)	0.27	Good
Harmonic distortion, 100 Hz, mono (%)	0.20	Good
Harmonic distortion, 100 Hz, stereo (%)	0.30	Good
Harmonic distortion, 6 kHz, mono (%)	0.12	Very good
Harmonic distortion, 6 kHz, stereo (%)	0.40	Very good
Distortion at 50-dB quieting, mono (%)	0.7	Good
Distortion at 50-dB quieting, stereo (%)	0.4	Very good
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV) (dBf)	4.0(17.2)	Excellent
Separation, 1 kHz (dB)	46	Excellent
Separation, 100 Hz (dB)	48	Excellent
Separation, 10 kHz (dB)	25	Good
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV) (dBf)	3.0(14.7)	Excellent
Dial calibration accuracy (± kHz at MHz)	−500 at 88	Poor
OVERALL FM PERFORMANCE RATING		Very good

MANUFACTURER'S PUBLISHED SPECIFICATIONS

TUNER SECTION:
IHF Sensitivity: 1.8 μV (10.3 dBf). **50-dB Quieting:** mono, 3.0 μV (14.8 dBf). **Signal-to-Noise Ratio:** mono, 70 dB. **Capture Ratio:** 1.5 dB. **Image Rejection:** 55 dB. **IF Rejection:** 65 dB. **Selectivity:** 67 dB. **AM Suppression:** 45 dB. **Spurious Rejection:** 80 dB. **THD:** mono, 0.3% at 1 kHz; stereo, 0.3% at 1 kHz. **FM Muting Threshold:** 2.7 μV (13.0 dBf).

AM TUNER SECTION:
Sensitivity: 200 μV-per-meter. **Image Rejection:** 63 dB. **Selectivity:** 35 dB.

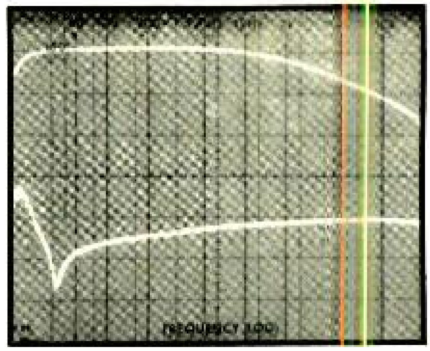
AMPLIFIER SECTION:
Power Output: 80-watts-per-channel, 8-ohm loads, 20 Hz to 20 kHz; 100-watts-per-channel, 4-ohm loads. **Rated THD:** 0.1% at 8 ohms; 0.15% at 4 ohms. **Damping Factor:** 35. **IM Distortion:** 0.1% at 8 ohms; 0.15% at 4 ohms. **Frequency Response:** phono, RIAA ±0.8 dB; high level, 20 Hz to 20 kHz, ± 1.0 dB. **Input Sensitivities:** phono, 2.5 mV; high level, 250 mV; mike, 5 mV. **Phono Overload:** 80 mV. **Signal-to-Noise Ratio:** phono, 80-dB referenced to 10 mV; high-level inputs: 86 dB; mike, 65-dB referenced to 10-mV input. **Bass & Treble Control Action:** ±11.0 dB at 100 Hz and 10 kHz; midrange, ±6.0 dB at 1 kHz. **Filter Action:** −3 dB at 90 Hz and 7 kHz (12 dB per octave).
GENERAL SPECIFICATIONS:
Dimensions: 18¼ W × 6¼ H × 15½-inches D. **Suggested Retail Price:** $599.95.

via speakers mounted behind the listener. This kind of "poor man's quadriphonic" listening experience, which is similar to the Dynaco system in the early days of four-channel sound experimentation, requires only two additional speakers but no additional electronic components. A slide switch on the rear panel turns on those so-called "rear" speakers if they are connected to the "PQ-4" terminals. The rear panel also has a pair of unswitched convenience AC receptacles and one switched AC receptacle.

Tuner section

A summary of our FM tuner measurements will be found in Table I for comparison with manufacturer's published performance claims. The few specifications included in the brochure and owner's manual (incomplete in terms of compliance with the new IHF/IEEE tuner measurement standards) were generally met or exceeded. However, such secondary specifications as image rejection and AM suppression were somewhat disappointing in a receiver of this price category.

Stereo separation was more than adequate across the entire audio frequency range, as can be seen in Fig. 2. Muting and stereo threshold were properly set in view of the tuner quieting and distortion characteristics. Dial calibration was poor, however, with maximum error occurring at the low end (88 MHz).



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Amplifier section

Table II clearly shows that the audio section is of a higher quality than the tuner section. Power output exceeded published claims even at the audio frequency extremes. Our phono hum and noise measurements are referenced to the rated input sensitivity of 2.5 mV, so that they would translate to some 12-dB higher numbers if referred to the manufacturer's 10-mV input.

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **GTE Sylvania** Model: **GTE-2600**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	98	**Excellent**
RMS power/channel, 8-ohms, 20 Hz (watts)	90	**Excellent**
RMS power/channel, 8-ohms, 20 kHz (watts)	90	**Excellent**
RMS power/channel, 4-ohms, 1 kHz (watts)	135	**Excellent**
RMS power/channel, 4-ohms, 20 Hz (watts)	119	**Excellent**
RMS power/channel, 4-ohms, 20 kHz (watts)	120	**Excellent**
Frequency limits for rated output (Hz-kHz)	10 to 25	**Excellent**
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.014	**Excellent**
Intermodulation distortion, rated output (%)	0.037	**Very good**
Harmonic distortion at 1-watt output, 1 kHz (%)	0.02	**Very good**
Intermodulation distortion at 1-watt output (%)	0.014	**Excellent**
DAMPING FACTOR, AT 8 OHMS	35	**Very good**
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ± dB)	1.0	**Good**
Maximum input before overload (mV)	90	**Good to fair**
Hum/noise referred to full output (dB) (at rated input sensitivity)	70/71	**Excellent**
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ± dB)	10-35, 1.0	**Excellent**
Hum/noise referred to full output (dB)	90	**Excellent**
Residual hum/noise (min. volume) (dB)	90	**Good**
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. 3	**Excellent**
Action of secondary tone controls	See Fig. 3	**Excellent**
Action of low-frequency filter(s)	See Fig. 4	**Good**
Action of high-frequency filter(s)	See Fig. 4	**Good**
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.5/2.5	
Input sensitivity, auxiliary input(s) (mV)	250	
Input sensitivity, tape input(s) (mV)	250	
Output level, tape output(s) (mV)	250	
Output level, headphone jack(s) (V or mW)	100 mW	
Ease of servicing		**Excellent**
OVERALL AMPLIFIER PERFORMANCE RATING		**Excellent**

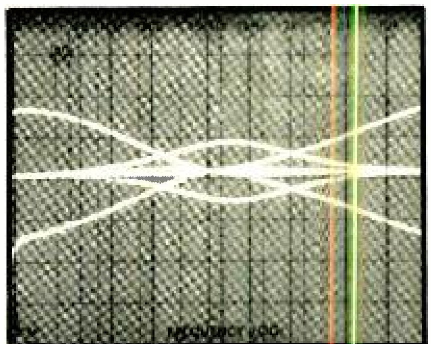
TABLE III

OVERALL PRODUCT ANALYSIS

Retail Price	**$599.95**
Price Category	**Medium-high**
Price/Performance Ratio	**Very good**
Styling and Appearance	**Excellent**
Sound Quality	**Very good**
Mechanical Performance	**Very good**

Comments: After a period during which Sylvania withdrew from the hi-fi component market, they have returned with the *model GTE-2600*. On the whole, the amplifier section rates slightly higher than the tuner section, which, although certainly adequate in this price category, is hampered by somewhat deficient AM suppession and image rejection. In some listening situations this could pose interference problems, although we did not experience any in our tests. The amplifier section, however, is well designed and delivers a clean, open and tight sound with a minimum of coloration. There is no tape-to-tape dubbing via front-panel switching, but two tape-monitor circuits and two phono-input circuits offset this deficiency to some degree. Tone control, including the midrange addition, is very good. Reproduction via the phono inputs is excellent.

As in GTE's earlier receivers, construction is primarily on one major circuit board, with parts well identified and easily accessible for servicing.



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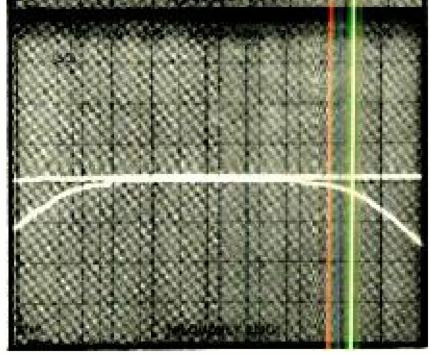

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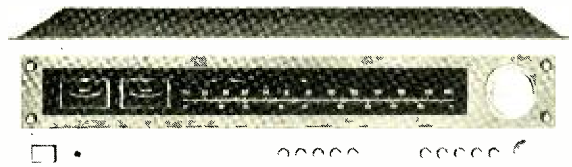
The BASS, MIDRANGE and TREBLE tone control range is shown in Fig. 3, while low- and high-cut filter response is shown in Fig. 4. Phono overload measured 90 mV compared with the 80 mV claimed; this input capability should pose no problems except with the very highest output phono cartridges that trace heavily modulated record grooves. We generally feel that a 100-mV phono input overload capability is all that is necessary under the average record-playing conditions: the *model 2600* comes close to meeting that high figure.

Summary

Our overall product analysis, together with our comments and reactions to the listening quality of the *model 2600*, will be found in Table III. This well-designed receiver is simple to operate, includes many of the desired control features, and, if somewhat deficient in tuner performance, compensates for those deficiencies with its conservatively designed preamplifier and amplifier sections. **R-E**

Onkyo TX-8500 AM/FM Receiver



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CIRCLE 84 ON FREE INFORMATION CARD

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

WHEN WE FIRST LOOKED AT THE ONKYO MODEL *TX-8500* receiver (see Fig. 1), its long, low profile did not indicate that it was the heavyweight (over 65 lbs. shipping weight) that it turned out to be. This ruggedly constructed unit is at the top of Onkyo's integrated receiver line, and if you believe that "one receiver is pretty much like another," you may be surprised at some of its innovations.

The long dial area, covered by a clear plastic plate, contains signal-strength and center-tune meters at the left in addition to the linearly calibrated FM and conventional AM dial scales. FM calibration points appear at every 100 kHz, and a well-illuminated dial pointer is controlled by the tuning knob to the right. Indicator lights above the dial scales show the program source, and two additional lighted words, LOCKED and TUNED, operate in conjunction with Onkyo's unique Quartz-Lock tuning system.

All other operating controls are neatly arranged in a single row across the lower section of the panel. A rectangular power on/off pushbutton at the lower left is located adjacent to the usual headphone jack. Following these are the speaker selection switch, BASS, MID-range and TREBLE tone controls, each equipped with 11 click-stop positions. A channel BALANCE control is also located in this area.

Five round pushbuttons near the panel center handle low- and high-cut filters, audio muting (−20 dB), stereo/mono selection and loudness control. A rotary volume control with 41 detent stops comes next, followed by five more pushbuttons for FM muting defeat (and defeat of the auto-lock feature), a Dolby FM adapter switch (which breaks the circuit for insertion of an accessory Dolby adapter and also changes the FM de-emphasis to the required 25 μs), and three tape-monitor switches. A program selector switch completes the front-panel layout.

There are 45 well-marked connectors on the rear-panel of the *model TX-8500*. As many as three pairs of loudspeakers can be connected to the spring-loaded type terminals. One switched and two unswitched AC outlets and a line fuseholder are mounted near the speaker terminals. At the upper left, near the pivotable AM ferrite-bar antenna, terminals handle connection of an external AM antenna, and 75-ohm or 300-ohm external FM antenna connections. Input and output jacks for a tape deck (including twin sets of phono inputs) are located along the lower section of the rear panel, as are preamplifier-output main amplifier-input jacks that are interconnected by wire jumpers. An FM detector output jack is located near a three-position switch that determines the sensitivity of the automatic tune-lock feature.

TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Onkyo** — Model: **TX-8500**

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	R-E Measurement	R-E Evaluation
IHF sensitivity, mono: (μV) (dBf)	1.7 (9.8)	Excellent
Sensitivity, stereo (μV) (dBf)	3.9 (17.0)	Very good
50-dB quieting signal, mono (μV) (dBf)	3.0 (14.7)	Very good
50-dB quieting signal, stereo (μV) (dBf)	55.0 (40.0)	Fair
Maximum S/N ratio, mono (dB)	74.0	Very good
Maximum S/N ratio, stereo (dB)	65.0	Good
Capture ratio (dB)	1.5	Good
AM suppression (dB)	50	Good
Image rejection (dB)	85	Very good
IF rejection (dB)	100+	Excellent
Spurious rejection (dB)	95	Excellent
Alternate channel selectivity (dB)	70	Very good
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz (±dB)	0.35	Very good
Harmonic distortion, 1 kHz, mono (%)	0.13	Excellent
Harmonic distortion, 1 kHz, stereo (%)	0.25	Good
Harmonic distortion, 100 Hz, mono (%)	0.17	Very good
Harmonic distortion, 100 Hz, stereo (%)	0.37	Very good
Harmonic distortion, 6 kHz, mono (%)	0.13	Excellent
Harmonic distortion, 6 kHz, stereo (%)	0.60	Good
Distortion at 50-dB quieting, mono (%)	0.42	Good
Distortion at 50-dB quieting, stereo (%)	0.40	Good
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV) (dBf)	3.9 (17.0)	Very good
Separation, 1 kHz (dB)	46	Excellent
Separation, 100 Hz (dB)	43	Excellent
Separation, 10 kHz (dB)	30	Very good
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV) (dBf)	4.5 (18.3)	Very good
Dial calibration accuracy (±kHz at MHz)	−300	Fair
OVERALL FM PERFORMANCE RATING		Very good

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

FM TUNER SECTION:
Usable Sensitivity: (mono), 1.7 μV (9.8 dBf); stereo, 4.0 μV (17.2 dBf). **50-dB Quieting Sensitivity:** mono, 3.0 μV (14.7 dBf); stereo, 35 μV (36 dBf). **Capture Ratio:** 1.5 dB. **Image Rejection:** 83 dB. **IF Rejection:** 100 dB. **Spurious Rejection:** 95 dB. **S/N Ratio:** mono, 70 dB; stereo, 65 dB. **Selectivity:** 70 dB. **AM Suppression:** 50 dB. **THD:** mono, 0.15% at 1 kHz; stereo, 0.3% at 1 kHz. **Frequency Response:** 30 Hz to 15 kHz, ±1.5 dB. **Stereo Separation:** 40 dB at 1 kHz; 32 dB from 70 to 10,000 Hz. **Muting Level:** 4.0 μV (17.2 dBf). **Stereo Threshold:** 4.0 μV (17.2 dBf). **Subcarrier Suppression:** 60 dB.

AM TUNER SECTION:
Image Rejection: 55 dB. **IF Rejection:** 55 dB. **S/N Ratio:** 45 dB. **Harmonic Distortion:** 0.8%.

AMPLIFIER SECTION:
Power Output: 110 watts-per-channel into 8 ohms (150 watts into 4 ohms), 20 Hz to 20 kHz. **Rated THD:** 0.1%. **Rated IM:** 0.1%. **Damping Factor:** 50 into 8 ohms at 1 kHz. **Frequency Response:** high level, 15 Hz to 30 kHz, ±1.0 dB; phono, RIAA, ±0.2 dB. **Input Sensitivity:** phono, 2.5 mV; high level, 150 mV. **Phono Overload:** 250 mV. **Tone Control Range:** bass, ±10 dB at 100 Hz; mid-range, ±5 dB at 1.2 kHz; treble, ±10 dB at 10 kHz. **S/N Ratio:** phono, 75 dB, IHF "A"; high level at 90 dB, IHF "A." **High- and Low-Filter Cut-Off Frequencies:** 100 Hz at 6 kHz (12 dB per octave).

GENERAL SPECIFICATIONS:
Suggested Retail Price: $699.95. **Dimensions:** 22⅞ W × 6⁹⁄₁₆ H × 17¹⁵⁄₁₆ inches D. **Weight:** 55 lbs.

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Onkyo** Model: **TX-8500**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	125	Excellent
RMS power/channel, 8-ohms, 20 Hz (watts)	118	Excellent
RMS power/channel, 8-ohms, 20 kHz (watts)	120	Excellent
RMS power/channel, 4-ohms, 1 kHz (watts)	173	Very good
RMS power/channel, 4-ohms, 20 Hz (watts)	160	Excellent
RMS power/channel, 4-ohms, 20 kHz (watts)	158	Excellent
Frequency limits for rated output (Hz-kHz)	10-30	Excellent
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.01	Excellent
Intermodulation distortion, rated output (%)	0.015	Excellent
Harmonic distortion at 1-watt output, 1 kHz (%)	0.026	Very good
Intermodulation distortion at 1-watt output (%)	0.0055	Excellent
DAMPING FACTOR, AT 8 OHMS	50	Very good
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ±dB)	0.1	Superb
Maximum input before overload (mV)	250	Excellent
Hum/noise referred to full output (dB) (at rated input sensitivity)	72 (IHF "A")	Very good
HIGH-LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ±dB)	7-39, 1.0	Excellent
Hum/noise referred to full output (dB)	92 (IHF "A")	Excellent
Residual hum/noise (minimum volume) (dB)	99 (IHF "A")	Excellent
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls		Very good
Action of secondary tone controls		Excellent
Action of low-frequency filter(s)		Excellent
Action of high-frequency filter(s)		Excellent
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.5/2.5	
Input sensitivity, auxiliary input(s) (mV)	150	
Input sensitivity, tape input(s) (mV)	150	
Output level, tape output(s) (mV)	150	
Output level, headphone jack(s) (V or mW)	117 mW	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		Excellent
Adequacy of input facilities		Excellent
Arrangement of controls (panel layout)		Very good
Action of controls and switches		Excellent
Design and construction		Excellent
Ease of servicing		Very good
OVERALL AMPLIFIER PERFORMANCE RATING		Excellent

TABLE III

OVERALL PRODUCT ANALYSIS

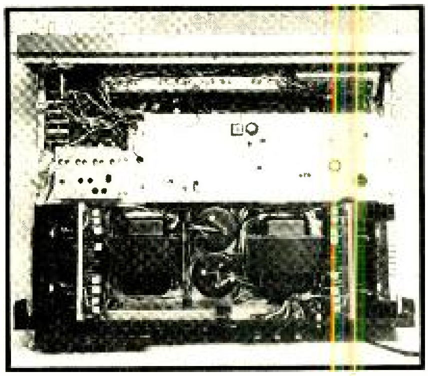
Retail Price	**$699.95**
Price Category	**High**
Price/Performance Ratio	**Very good**
Styling and Appearance	**Excellent**
Sound Quality	**Excellent**
Mechanical Performance	**Excellent**

Comments: When we first saw the term "Quartz-Locked tuning," as it applies to the FM circuitry in the Onkyo receiver, we presumed that this was just another form of AFC circuit. It is far more than that. In fact, it is the closest thing to frequency synthesis that we have seen but, by not requiring the use of varactor diodes (normally found in true frequency-synthesis tuners), Onkyo gives us nearly perfect tuning accuracy that is not dependent upon user judgment or meter interpretations, and the circuit performance obtainable with traditional, multigang capacitor tuning.

Although the FM distortion levels have been bettered by competing products in this price category, the fact that these low distortion levels will always be realized by the user (whereas slight mistuning of other receivers that boast lower THD readings can result in much higher distortion) should not be overlooked. Still, if one were to rate the tuner and amplifier sections of this powerful receiver, the amplifier would come out ahead. Its ample power reserve (both with 8-ohm and 4-ohm loads) is evident when listening to the signals it delivers through even the lowest-efficiency loudspeakers available in our laboratory.

Sound is extremely clean, particularly during transient-laden musical passages and extreme bass power. Any receiver that boasts in excess of 100 watts-per-channel into 8-ohm loads and carries a suggested retail price of under $700 is worth serious consideration.

Even with the wood cabinet removed, it is still difficult to see inside the unit itself since the entire tuner section is well shielded. Alignment points are accessible through labeled holes in this tuner shield. A perforated black metal protective cover also obscures the amplifier and power supply sections. For a better view, this black metal cover was removed to reveal the two completely separate power supplies and transformers used in this receiver (see Fig. 2).



2

Recent studies made by Onkyo and several other manufacturers show that using independent power supplies for each of the two stereo amplifier channels insures against the distortion caused by signals from one channel crossing over into the other channel via the impedance of a common power supply. Two power transformers (besides adding to the weight of this unit) also insure that full rated power is available from each channel regardless of power drawn from the companion channel.

Tuning

The unique Onkyo tuning system uses a quartz-crystal oscillator to generate an extremely stable frequency. This frequency is then used as the reference for the tuned stages of the FM circuitry. Even the most minute deviations from optimum tuning are detected and automatically corrected. In actual use, when the tuning knob is touched, the tuning-correction feature is defeated. As soon as you approach a signal and come close enough to proper tuning, the word LOCKED appears on the front panel. The center-of-channel meter is then used to tune closer to precise tuning but, even if the optimum tuning point is not achieved, releasing the tuning knob activates the quartz tuning feature and you can observe that tuning-meter pointer pop right into its center point on the scale.

As we discovered in later measurements, the meter not only indicates proper tuning (with the word TUNED shown above the dial scale), but the tuner is, in fact, tuned to its absolutely lowest distortion point. In no instance during our THD measurements was it possible to manually tune to a lower distortion point (by defeating the lock-tune feature) than by letting this feature operate!

Aside from this, the rest of the tuner and amplifier design is fairly conventional and well executed, with the familiar differential input stage and direct-coupled output circuitry used for the power amplifier section. No schematic was supplied with our test sample, so it is difficult to comment on specific circuits.

FM measurements

Table I summarizes the most important FM measurements made on the *model TX-8500*.

continued on page 76

CONSTRUCTION TECHNIQUE

IC Bricklaying For Miniature Projects

Here's a method of stacking IC's that enables you to build IC-oriented projects into the smallest space possible

WALTER T. CARDWELL, JR.

THE PAST 10 YEARS HAVE SEEN A TREMENdous growth in both the number and complexity of large-scale integrated circuits. Yet, along with the increased complexity of IC's and thus the necessity for fewer circuits, the reduction in size of most electronic instruments has not used the full potential inherent in LSI circuitry. It is now technically feasible for an IC manufacturer to construct almost any test instrument—a VOM, signal generator, frequency meter, etc.—into a pen-sized device either by using LSI techniques alone or by a combination of methods. The obstacle facing such devices is economic and not technical. In the future, we shall be able to carry a complete test bench clipped to a shirt pocket. However, there will always be devices that do not justify designing a special IC. This article presents a construction method that can be used to make the smallest possible device using commercially available IC's.

When IC's were first designed, the standard approach was to transfer discrete circuits into integrated form. Now, IC's are designed to take advantage of the special features of IC technology. Nevertheless, once the IC's are out of the package, the same PC board techniques are used to mount them that were common in the age of vacuum tubes, resulting in large bulky instruments that in many respects look like, and must be used as, museum pieces of the forties and fifties.

Construction techniques

The bricklaying construction technique presented in this article uses the IC packages as the supporting structure of the device. Except for a few linear IC's, almost every IC made can be obtained in a dual in-line package; thus, this technique can be used almost everywhere.

First, cut the leads of the DIP's flush with the bottom of the package, as shown in Fig. 1-a. (Take care not to strain the leads at the case.) The IC's can be stacked one on top of the other to any height and glued together using a cyano-acrylate-type glue. Since the glue takes only seconds to harden, the IC block can be used immediately. (Note the caution on the label about gluing your fingers together because it takes about 30 minutes of soaking the fingers in nail polish remover or acetone to unglue them! Keep a bottle handy. A special solvent called *Cyano-solv*, manufactured by GC Electronics, also softens the glue.)

Once the ends of the block are stacked vertically, they can be filed smooth, using

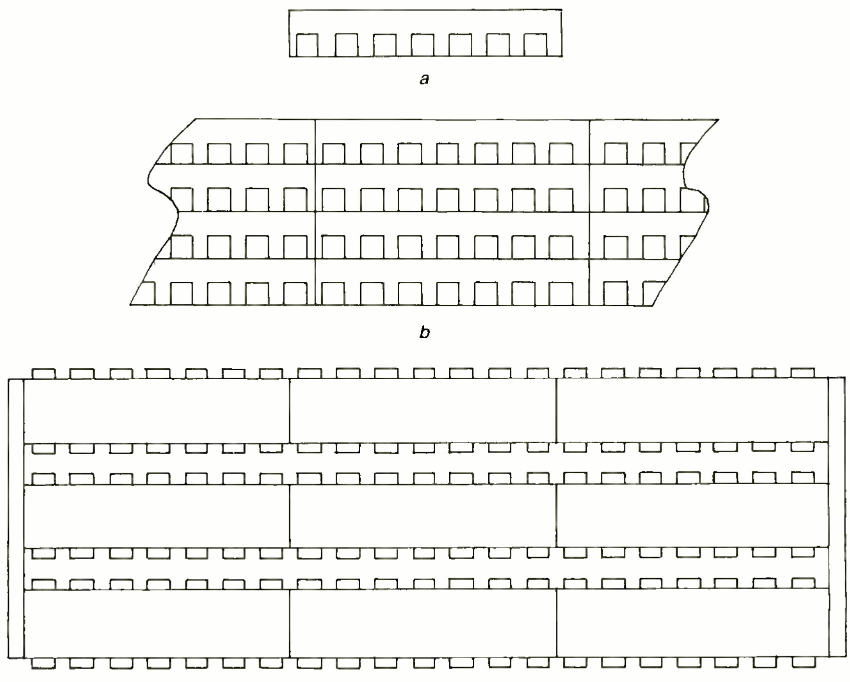


FIG. 1—HOW IC'S ARE STACKED. Drawing *a* represents a 14-pin DIP with leads cut flush with case. Diagram *b* shows how IC's can be stacked in tiers and end-to-end while drawing *c* is a top view of IC's stacked vertically, horizontally and laterally.

a regular metal file. Two blocks can then be joined end to end (Fig. 1-b) to make a flat sheet of bonded IC's. The IC leads prevent stacking side-by-side but this can be overcome by gluing spacers at the ends of the sheets and then gluing the sheets together, as shown in Fig. 1-c. The completed IC block is as strong as the plastic case material, and unless you use very thin plastic material, the block is fairly solid. It is impossible to break the IC's apart with your bare hands. The IC's will, however, crack if dropped.

How to wire

To wire the circuits, you have to go back to the Stone Age and use point-to-point wiring. This may make the technique unattractive to those in the industry, although automated point-to-point wiring is making a comeback. However, the experimenter and hobbyist will find it is much easier and takes less time than to lay out and etch a PC board.

Use the lead pads on the side of the IC package as bonding pads, and make the connections with AWG No. 30 solid wire-wrap wire. Remove ⅛-inch of insulation and solder the wire to the pads. The meter shown in Fig. 2 may look like

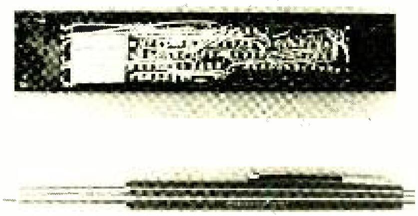


FIG. 2—INSIDE VIEW of a probe-type digital frequency meter. Compact construction is due to the "bricklaying" technique.

a "rat's nest," but it is actually very easy and convenient to work on since there is no bulky chassis to move around. A pair of sharp-pointed tweezers and a small soldering iron are the only special tools required.

There are several areas that can cause problems. One is the damage that might be caused to the IC by clipping the leads so close to the case and soldering the wires with no heat sink. I thought CMOS units would be especially susceptible to damage. However, I have wired four different instruments and rewired several sections of each instrument without damaging any IC, including CMOS types. You should, however, take great care when soldering the wires to prevent the IC from being damaged by excessive heat.

Troubleshooting the IC's

Repair can be a problem. Actually these circuits are easier than most to troubleshoot since all the signal points are on the side of the IC. Locate the faulty IC before trying to remove it. Once it is located, remove the wires. If the IC is on the outside of the block, remove it simply by brushing the solvent along the joint. It generally takes about 30 minutes for the joint to soften enough so that a knife blade can be inserted into the joint to pry the IC apart. If the IC is on the inside of the block, you can use several alternatives. If there is enough space, just glue a new IC somewhere else and leave the defective one where it is. However, usually this will not be possible and the IC must be removed.

A second solution is to drill out the old IC. Use a drill that is smaller than the height of the case to remove as much of the defective IC as possible. Solvent may then be applied to remove any remaining loose chips. Slip the new IC into place. A final alternative is to remove the blocks of IC's until the defective IC is on the outside of a block; then follow the first method described above. Sometimes you can separate two IC's by using a pair of diagonal cutters between them after the joint has soaked for about 10 minutes. This method should only be used when both IC's are inexpensive units since it is always possible to damage them both.

The last problem is that of IC-generated heat. For CMOS units at low speeds there is no problem, but because higher-power devices have a large direct contact area, the heat that is generated conducts to adjacent IC's. Place heat-sensitive circuits away from high-power devices. In some cases, glue a strip of aluminum or copper between the IC's to remove the generated heat, as shown in Fig. 3. In

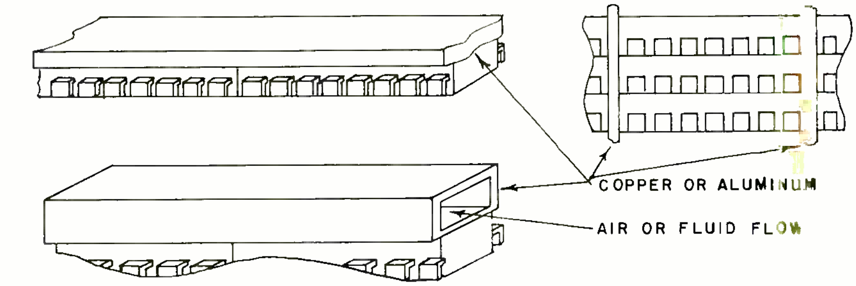


FIG. 3—HEAT SINKS atop and/or on the IC's can be metal slabs, strips or rectangular tubing.

fact, this method may be better than PC board methods, since each IC can be connected to a heat sink.

This construction method is so convenient that in most cases it is not necessary to breadboard circuits anymore. You can build and test a small subsection before gluing it into the device. Wiring changes can easily be made at this point, and it is not too difficult to remove IC's. All leads are easy to locate and identify, especially if you use a standard alignment; that is, if all IC's face the same direction. It is a good idea to keep a location guide handy since IC type numbers are always hidden from view.

Other types of components

In addition to plastic DIP's, other components can also be used. You can use ceramic DIP's except that the cases can't be filed and you may have to add plastic shims to fill the gaps. Discrete components can be glued around the edge of the IC block. Four or five small TO-92 cases can be placed together in a slot that an IC would normally use. These cases are not as tall as the DIP's and a shim may be needed.

One-quarter-watt resistors are added to the bottom of the IC block. These resistors are almost as long as the width of the DIP's. Cut the resistor leads close to the body and solder the wire-wrap wire to the leads. Capacitors must be located wherever they will fit. (See Fig. 4.) Neither resistors nor capacitors should be used as structural support. The resistor bond is to the paint on the resistor body, and the resistor will come off if any great force is applied. Capacitors are usually not flat, so the surface area of the bond is quite small. If the device is really an oddball type, you can make a special plastic support structure for it.

Combining 14- and 16-lead packages may leave gaps at the ends of a block. When two blocks are joined end to end, a hole in the IC sheet may result. These holes can be used to pass leads from one side to the other and, since the end bond of even one IC is usually very strong, several holes can be left in the sheet.

The cyanoacrylate glues bond almost instantly, and once the IC's are joined, it is impossible to align them properly. Either line up the IC's first and apply a drop of glue at the joint (be careful of your fingers), or construct a simple alignment jig, as shown in Fig. 5. The guides may be coated with candle wax to prevent the IC's from sticking to them.

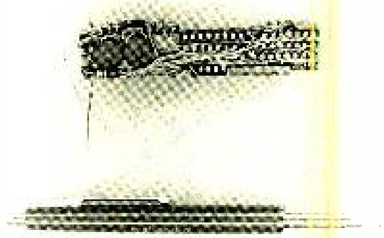


FIG. 4—RESISTORS, CAPACITORS and other components are glued wherever there is room.

Case materials

Anyone who has built an electronic device from scratch has faced the prob-

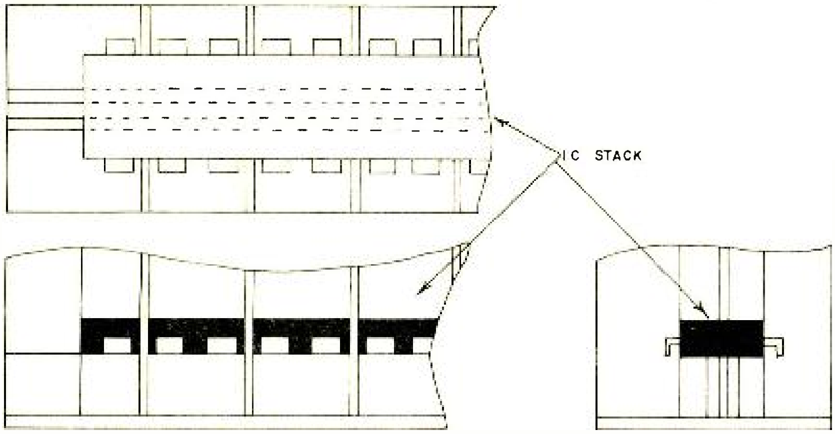


FIG. 5—A JIG IS USED to hold the IC's in perfect alignment so they can be glued. It is constructed from thin metal strips.

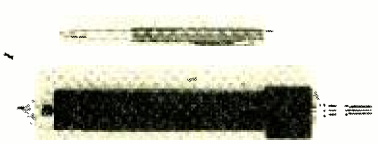


FIG. 6—THE COMPLETE FREQUENCY METER. Its case is just a little longer than a ball-point pen and about three times greater in cross-section.

lem of what kind of a case to use. The good old standby, the Minibox, leaves a great deal to be desired so far as appearance is concerned. You can use the construction technique described in this article to solve the problem of a suitable enclosure.

Figure 6 shows a frequency meter in a case made from 1/16-in. black acrylic plastic. The readouts are covered by transparent amber plastic. A 12-pin socket is glued at each end of the IC block to form the meter case foundation. If no sockets are needed, substitute a 1/8-inch or a 1/4-inch piece of plastic. The sides, top and bottom of the case can then be made from 1/16-inch plastic, which is very easy to work with. If you use cyanoacrylate glue, the joints can be opened with a razor blade. Do not use a solvent on the joint as it will dissolve the plastic. Do not use the normal *Plexiglas* cement because it melts the two surfaces so that the two pieces are fused together. This type of joint cannot be opened very easily.

There are a few tricks that are helpful when using acrylic plastics. Thin pieces can be scratched and broken like glass. Any wood saw will cut thick pieces, but the saw should have fairly fine teeth. In general, most metal- and wood-working tools can be used. Once the edges are cut, file them flat and at right angles to make an almost invisible seam. The paper masking the material should be left on as long as possible.

Acrylic plastics can be cut to any desired shape, and the gloss can then be restored. File the surface, if it is flat, and then wet-sand it with 240-grit, 400-grit and finally 600-grit wet-or-dry sandpaper. Buff the surface, using a cloth buffing wheel charged with jewelers' rouge. Figure 7 shows a transparent plastic probe tip made this way. Of all the special tools available, none are more useful than a bench grinder with a cloth buffing wheel and a hard-backed (not rubber) sanding disk.

An alternative to an acrylic plastic such as *Plexiglas* is ABS plastic. This material is much softer and easier to work with, but it does not have the deep gloss of *Plexiglas*. Most hobby stores carry it under the name of *Plastruct*. ABS plastic can be used to make shims and support pieces inside the device where looks are not important. It is also available in much thinner sheets than *Plexiglas*.

While the construction technique described here was used to make a probe, it can also be applied to almost any project. The method is easy, takes little time, can be changed easily and results in the smallest possible device. You can now build that beautiful stereo amplifier or preamplifier you have been discouraged from building because of all the mechanical work involved. since the bricklaying technique eliminates much of that work. **R-E**

New RCA color TV chassis uses less power

RCA recently announced that it has been converting all its color TV receivers to new low-level energy consumption models that it predicts will save the consumer approximately 2¢ a day. The sets will operate at about half the power requirements of the 1972 color sets.

RCA's "XTENDEDLIFE" CHASSIS uses only 89 watts to power the 19-inch models. This compares with the average solid-state color TV set that uses 145 watts.

Four years ago, the company took a series of steps to reduce the energy-consuming capacities of their products by introducing a line of solid-state receivers. They then switched their entire black-and-white line to solid-state operation, eliminating all power-drawing tubes. From this, it was a natural progression to the introduction of their new "XtendedLife" color TV chassis.

This chassis has four integrated circuits and uses about as much energy as a 100-watt light bulb, compared with the average solid-state color set that uses 145 watts. It is estimated that, with its projected cost of 2¢ per day, the "XtendedLife" would set the consumer back only about $7.70 a year, a sharp contrast to the $28.88 of older tube-type models. Since the average American family spends 6.3 hours a day watching its favorite entertainment, both energy and cost savings appreciable.

Two-part seminar program on microcomputers

The Virginia Polytechnic Institute and State University at Blacksburg, VA, will hold a two-part seminar program in December. The first session, entitled "Microcomputing Interfacing Workshop," held December 8–10, will offer participants a hands-on opportunity to work with the popular 8080 and 8085 microprocessors.

The second session, called "Digital Electronics for Automation Workshop," will take place December 6–7, and will concern small-scale and medium-scale TTL IC's. Many lab hours with breadboarding stations and in-depth lectures are planned.

Both the three-day and the two-day seminars will be under the direction of Dr. Peter Rony, Dr. Paul Field and David Larsen. For more information on these programs, write Dr. Norris Bell, Continuing Education Center, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, or call (703) 951-6328.

CB license applications up 10% in 1977

The Federal Trade Commission reports receiving 3,254,825 applications for CB licenses during the first six months of this year, a 10% increase in sales over the same period of time in 1976. Since 1958 more than 11 million CB licenses have been issued, over half of which were granted during the last year and a half.

John Sodolski, president of EIA (Electronic Industries Association), states: "It's obvious that personal two-way communication is fast becoming an integral part of mobile America." His projection for 1980: more than 50 million CB's and more than 20 million base stations will be sold. **R-E**

What's New In IC's

A GREAT MANY SEMICONDUCTORS WERE introduced last summer. Here are details on three that you may find useful.

Fairchild IC's

A system consisting of 12 of the new Fairchild F4727 seven-stage counters generates all the notes of the chromatic music scale over eight octaves. The IC's produce each of the seven natural and five flat and sharp notes for the primary scale and for the seven higher octaves, which makes the system adaptable to many electronic musical instruments. Interface and crosstalk problems are considered minimal.

The plastic-packaged part rated for the commercial temperature range has a high-quantity (1,000) price of $1.17. For more information, write the Linear Division, Fairchild Camera and Instrument Corp., 464 Ellis St., Mountain View, CA 94042.

The FCB8010 IC is a Citizens band radio controller that performs channel selection, automatic scanning and seven-segment display-driver functions.

The circuit can be used with 40-channel U.S.-manufactured transceivers or with German transceivers. The device has search, scan and increment up-and-down modes. The search mode seeks out either busy or vacant channels. The scan mode stops at each busy channel for three seconds before continuing.

Information is available from the Exetron Division, Fairchild Camera and Instrument Corp., 3105 Alfred St., Santa Clara, CA 95050.

50-MHz phase-locked loop

Signetics has introduced the NE564 monolithic phase-locked loop for use in high-speed modems, FSK (*F*requency-*S*hift *K*eying) receivers and transmitters, frequency multipliers and signal generators.

The NE564 demodulates FM and FSK signals without additional external circuitry. Key features are reduced carrier feedthrough, low noise and single 5-volt supply operation. The typical frequency drift is 400 ppm-per-degree C, and the signal-to-noise ratio is 40 dB.

The circuit is TTL-compatible, using Schottky-clamped PNP transistors at the input and output pins.

The 59 × 91-mil chip comes in a 16-pin package. In quantities of 100, the NE564 costs $4.25 per unit. Further information is available from Signetics, 811 East Arques Ave., Sunnyvale, CA 94086.

Voltage regulator

The TL7805AC voltage regulator from Texas Instruments is a 5-volt, 1½-amp three-terminal positive voltage unit. It is protected against overload by current-limiting and thermal shutdown circuitry.

The cumulative accuracy and regulation errors are guaranteed to be less than 3% over full operating conditions.

Mounted in a three-terminal TO-220 plastic power package, the TL7805AC is priced at $1.31 each unit in quantities of 100. For further details, contact Texas Instruments, Inc., Inquiry Answering Service, Box 5012, M/S 308 (Attn: TL7805AC), Dallas, TX 75222. **R-E**

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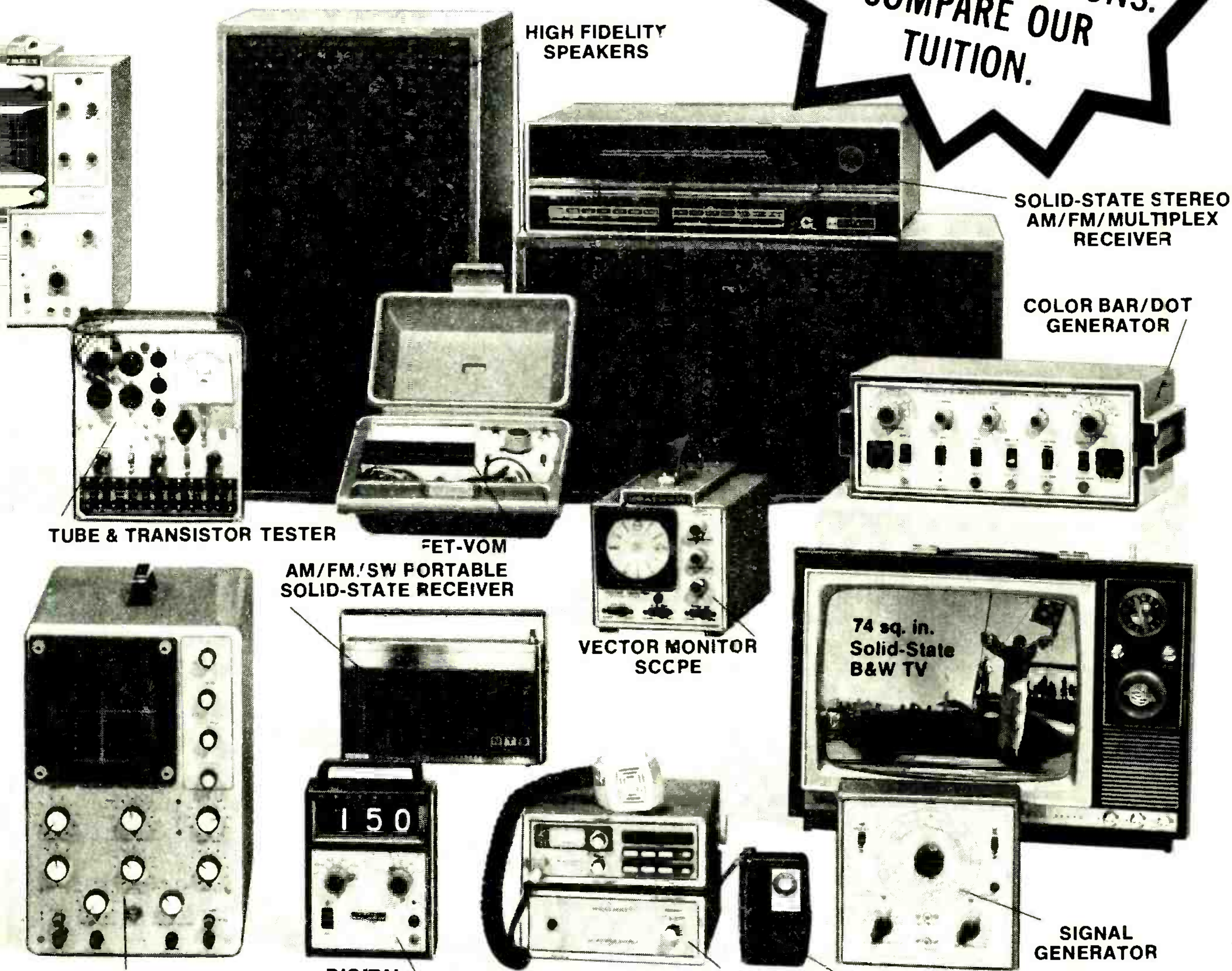

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Matched transistor pairs. *Are they really necessary?*

JACK DARR, SERVICE EDITOR

A READER ASKED ME IN A RECENT LETter "Do you really need matched pairs of transistors in audio amplifiers, etc.?" The answer is "Yes." It is essential to have matched pairs in the common OTL (*O*utput *T*ransformer*L*ess) circuit, using a pair of transistors in Class B or Class AB, with the load taken off at the midpoint. Since each transistor amplifies only one-half of each cycle of the signal, the two must match or the output will not be symmetrical, thus causing distortion.

The distortion can be spotted on a scope, using a clean sinewave test signal. If you see that the amplitude is unequal between the top and bottom halves of the signal, this indicates unmatched transistors. The unmatched transistors might also tend to show some crossover distortion, although I haven't actually seen this happen (yet!).

So, these two transistors must be matched. You can obtain them from the amplifier manufacturer (which is sometimes difficult) or from RCA, G-E, Sylvania, Motorola, Mallory, Sprague, Raytheon, I-R, etc. They all list matched pairs for many different power outputs, voltages etc. I have checked most of the replacement types and they match very well on my curve tracer. In fact, picking two identical transistors off the shelf usually shows a very good match!

The *Transistor Guides* published by these companies list many sizes in matched pairs under a single part number. They also list matched complementary-symmetry pairs. (However, I found a few "matched pairs" from a nameless manufacturer that didn't show up all that well on my curve tracer!)

This column is for the service technician's problems—TV, radio, audio or industrial electronics. We answer all questions submitted by service technicians on their letterheads individually, by mail, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. If return postage is not included we cannot process your question. Write: Service Editor, Radio-Electronics, 200 Park Avenue South, New York, NY 10003

The curve tracer is useful to check if transistors match. Most of the curve tracers provide dual sockets or connectors; so that an instant "A-B" comparison can be made by slipping a switch. Complementary-symmetry pairs can also be checked, but you have to switch from PNP to NPN at the same time.

Circuit problems

A direct-coupled driver circuit may show mismatch problems after transistor replacement. Here, the base voltage of the output transistor depends on the driver's collector current. In a few cases you may have to change the original driver transistor as well. If the base voltage doesn't come out right, try a substitute with a slightly different beta.

This problem will usually show up as incorrect resting (no-signal) current on the output stage. If this current is too great, then the full-load current may rise sufficiently to damage the new output transistors. This current should always be checked when output transistors have been replaced, and *before* the amplifier is tested at full load! Normal resting current will run from 15 to 25 mA; a 50- to 60-mA resting current will cause damage. One useful feature of stereo amplifiers, especially if only one channel blows, is that you can check the working channel and get a precise figure for both the resting and load current.

Bias diodes can also cause oddball symptoms. These diodes, usually in an output-transistor base circuit, set the bias and must be good. I've seen an *open* bias diode cause instant failure of a brand new transistor. I never really figured it out, but it happened right under my nose, literally.

Always check the service data if it's available. I once replaced the output transistors in a small amplifier where one of the bad transistors was a silicon. So, I put in two silicons. I wound up with a *horrible* distortion! Then I checked the drivers, bias, etc., to no avail. Finally, I was amazed to find in the service data that the top transistor in the pair was a silicon, but the bottom one was *germanium*. Since "the book" tells you that both transistors absolutely must be of the same material, I didn't believe it. Therefore, I put in a germanium transistor and fixed it. The circuit was *designed* to work that way; the bias was set up for a germanium transistor in the lower half, and so naturally a silicon was not properly biased (not "matched!").

The same basic circuit is used in many solid-state TV sets, mostly in the vertical and audio output stages. These circuits work the same way as the audio circuits, although they have more feedback loops for linearity correction, etc. The same kind of problems will be found.

Crossover distortion causes compression or stretch of the scanning lines near the screen's center. One transistor scans the top half of the screen, the other one the lower half. Peak clipping appears as compression or foldover at the bottom. These stages can display one annoying symptom: The top half of the picture will be perfectly linear, but the bottom half will be completely gone. When this happens, check the bottom transistor; it may be open or have a bad solder joint on the emitter or base. A scope will quickly pin this one down.

While we're on the subject of audio circuitry, a very useful book is the *Practice CET Test Journeyman Audio Option.* It *simulates* the kind of test you'll take for this qualification. There are 75 questions; the sections and headings are the same as in the actual CET test. You answer the questions, then check to find out if you passed. The answers are in the back of the book. It is available from Bank Wilson Services, P.O. Box 3321, Warren OH 44485. The book is similar to the FCC *Study Guide* for license exams and can help you find out *where* you need to do a little studying before you take the real test. **R-E**

service questions

HORIZONTAL RADIATION

This Emerson 9300 color TV set has some unusual problems. Its horizontal hold isn't at all good, and this even affects the vertical sync. Also; when it's turned on, other sets nearby have sync problems and a fuzzy vertical line moving across the screen! I need enlightenment!—H.G., St Croix, Virgin Islands.

Don't we all? The chances are that this is some kind of horizontal AFC problem in the Emerson—bad AFC diodes, loss of horizontal sync to AFC circuit, etc. This is making the horizontal circuit unstable. In turn, the displacement of the horizontal gating pulse is upsetting other circuits in the set.

Also, it is obviously *radiating* far too great a "signal" from the horizontal sweep stages. Suggestion; take the scope probe and wave it around the back of the Emerson. Look for a place that shows a very large stray pickup. Try this on a set working normally and you'll see what this pulse should look like. This one will probably be very "hashy". Shields missing, etc.

COLOR SYNC PROBLEM

The color sync is very poor on this Magnavox T933. The video isn't too good, either. The color and tint controls react the way they ought to. However, the color sync has hardly any range at all. The tint control will throw the color out of sync at each end, but hold in the center!—K.S., Ink, AR.

If colors are correct and the color control reacts normally, that much is OK. So, this sound like a problem in the burst transformer. Check this to see if it will show a definite *peak* when tuned. Also, check for burst on *both* of the detector diodes. I have seen the same symptom in this chassis when one half of the burst transformer secondary was open. Another clue to this is unequal DC voltages on the AFPC diode outputs. These should be the same, but opposite polarity.

IF ALIGNMENT

I have an old Hammarlund HQ-120X radio that works but doesn't seem to have the sensitivity it should. The data doesn't tell you much about the alignment procedures; it just says to "feed a modulated signal into the front end and adjust IF circuits for maximum reading on output meter." I'd like to know if there's a better way.—A. F., Little Silver, NJ

There really isn't a better way. There's a very sharply tuned crystal filter in the IF. To find the exact frequency, feed an IF signal of around 455 kHz into the mixer. Tune the *signal generator* for a maximum output meter reading. When you find this reading, you are right on the crystal frequency. Leave the signal generator alone, and adjust the IF transformers for maximum. A low-frequency sweep generator lets you see the actual bandpass and tune for symmetry.

For the RF gain, a feed dial-frequency signal into the mixer grid; note the reading. Move the signal generator to the RF grid and look for an *increase*.

BAD FOCUS, BRIGHT LINES

This Zenith 4B25C19 has very bad focus. In the service position, I get very bright and blurry lines, and can't turn them down!—D. U., Hooker, OK.

This sounds very familiar. Check the high voltage in both normal and service positions; if the high voltage is OK, then check *all* DC voltages on the picture tube. I had an RCA with exactly the same symptoms. The cause turned out to be a bad solder joint that killed the *heater* voltage to the two color difference-amplifier tubes that control the picture tube *grid* voltages. Because these tubes have zero plate current, their plate voltage and the picture tube grid voltages rose to the supply value. This made the grids far too positive, and the picture tube drew a very heavy and uncontrollable beam current. You should also be sure that your picture tube screen voltages aren't set too high.

NEGATIVE PICTURE

This CTC-19 has an odd short-time intermittent. The picture goes negative, and then it looks like AGC overload. It's hard to catch because it goes in and out quickly.—R. S., Brentwood, NY.

There are a couple of things that could be causing your trouble. One is an intermittently open filter capacitor, usually the one on the +140-volt line, which creates a weird feedback loop through the IF. A bad ground on the first AGC bypass capacitor could also cause your problem because this capacitor vibrates a lot when the set is being serviced. Just wiggle it back and forth.

SHRINKING RASTER

The raster in this Emerson 120771 portable shrinks in about an inch from each side. The current through the gate turn-off switch in the horizontal output is higher than it should be and pulls down the −25-volt source. Would appreciate help.—L. S., Hicksville, NY.

I ran into this problem once. It turned out to be leakage in the gate turn-off switch. This can be replaced by a big power *transistor* such as a Delco DS-502 or a Motorola HEP-740.

ODDBALL COLOR PROBLEMS

I've seen several Zenith color TV's show unusual raster problems like those described by E. C., Los Angeles, CA, in "Old Raster" (**Radio-Electronics**, August, 1977). The sets had some or all these problems: a narrow range of high-voltage adjustment; a broad range of high-voltage regulation, as if the high-voltage regulator was poor; a maximum high voltage of less than 26 kV; and a raster that pulled in from the sides in the bottom half of the screen (see Fig. 1).

In all cases, the cure was to replace the voltage-dependent resistor (VDR) in the high-voltage regulator circuit. Be sure to use the exact part given in the parts list; in most cases, this is a Zenith 63-8161. However, this is *not* the emergency hold-down VDR in the grid of the horizontal-output tube.

Thanks very much to Keith R. Casper, Topock, AZ for the hints.

continued on page 74

state of solid state

Interface analog signals to your microcomputer with the Analog Input Microperipheral from Burr-Brown. Plus new UHF power transistors. **KARL SAVON,** SEMICONDUCTOR EDITOR.

A PERSISTENT MICROCOMPUTER PROBLEM is in communicating with the outside world. Many systems have several analog inputs that must be sampled and digitized into binary language, and things get involved. The Burr-Brown MP21 is a possible answer to this problem.

Burr-Brown MP21

The Analog Input Microperipheral interfaces with the 6800, 650X and F-8 microprocessors without a PIA (*P*eripheral *I*nterface *A*dapter) or external logic.

Figure 1 shows the MP21 block diagram, which includes a high-speed, 8-bit, analog-to-digital converter, an instrumentation amplifier, an input multiplexer, timing circuitry address decoding and control logic.

Sixteen analog inputs are grouped into two 8-channel analog multiplexers, which allows the inputs to be arranged either as 16 individual channels or eight differential inputs. Two Mux Enable inputs and the SIN/DIF pins are wired to select one of the two modes.

Single-ended operation is used with high-level, low-noise inputs. Differential operation cancels common-mode noise and is recommended at low levels. A third mode, termed pseudodifferential, ties pin 79 to an external ground that is common to all analog inputs. This mode is effective when the remote ground is noisy, but there is little interference between the signal generating device and the MP21.

Each analog input channel is addressed as a memory location. Address lines $\overline{A4}$ through $\overline{A13}$ are provided, in addition to uncomplemented address lines A0 through A15, so that hardwired selection of memory location bands can be made.

The system's minimum conversion time is 40 µs—35 µs for the multiplexer and 5 µs for the A/D converter itself. The host system must accommodate this delay.

A delay circuit in the internal convert-command line gives the multiplexer and instrumentation amplifier 35 µs to settle. For gains of over 10, additional delay may be needed and can be had by hooking a capacitor from pin 49 to +5 volts.

For high-speed operation, the internal delay can be decreased by connecting a resistor between pin 49 and +5 volts.

The least efficient but simplest method for a host microcomputer to take care of the delay between the time of the sample and the time the converted value is ready, is to halt the microprocessor for the 40-µs conversion time. For more efficient use of microprocessor time, the conversion can be started with an LDA instruction, the system allowed to do something else and then return to read the MP21 data at least 40 µs later. Alternatively, the MP21 $\overline{HALT}$ pin can be periodically checked for a completed conversion; or, for the greatest efficiency, the interrupt mode can be used by connecting the MP21 $\overline{INT}$ pin to, for example, the IRQ (*I*nterrupt *R*equest) input of a 6800 microprocessor. As soon as the multiplexer samples one of the inputs, the microprocessor can proceed to some other task without checking inputs or keeping track of time until the completed conversion interrupts the processor.

Various interconnections among pins 63, 65, 67 and 68 adjust the MP21 to a differential input range of ±1.25, ±2.5

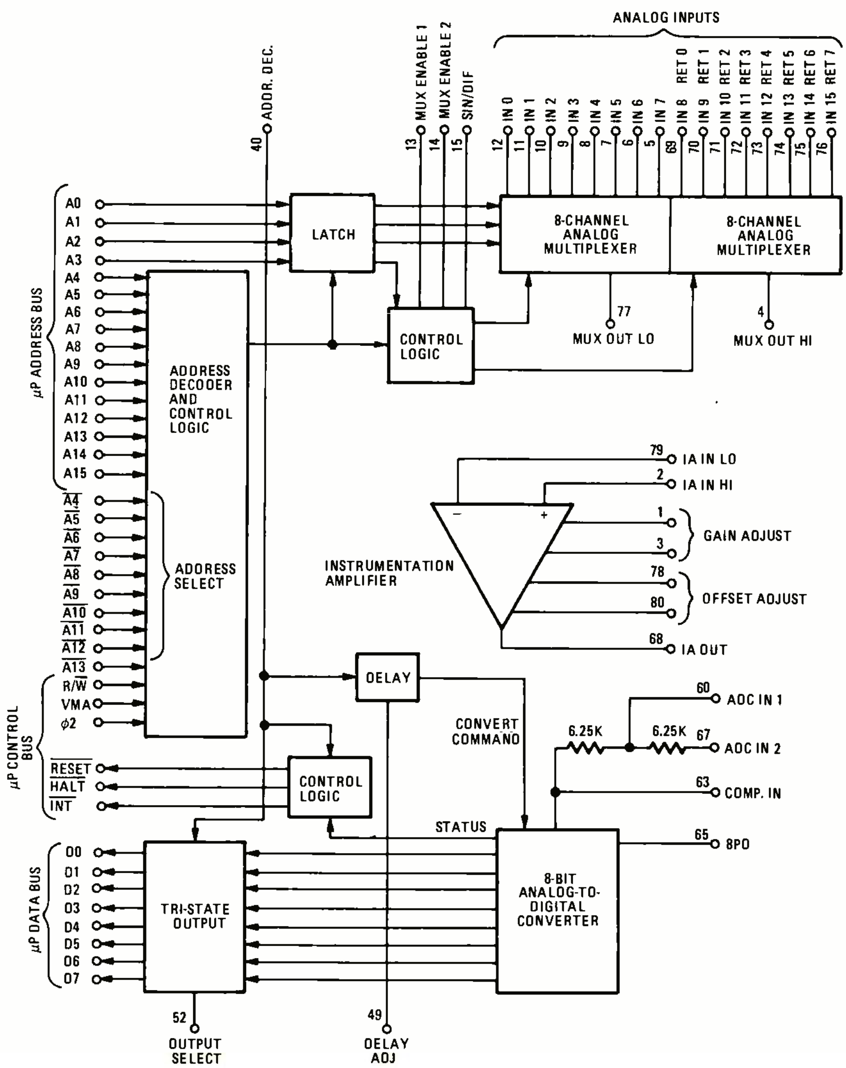


FIG. 1—ANALOG INPUT MICROPERIPHERAL from Burr-Brown accepts either 16 single-ended or 8 differential analog signals and interfaces them to a microcomputer.

or ±5 volts or single-ended ranges of 0–2.5 and 0–5 volts.

The output of the 8-bit A/D converter feeds a three-state output circuit. The output select control lead lets you choose between binary or two's complement output coding. You would choose binary coding for unipolar input ranges, so that all eight bits represent magnitude. The two's complement output is the best choice for the bipolar input ranges, where the most significant bit is reserved for the sign and the other seven bits are the magnitude.

The instrumentation amplifier gain is factory-set accurately to 2 by laser trimming, and can be increased to 250, with an external resistor connected between pins 1 and 9: Gain = $2 + 50K/R_{ext}$. At high gains, an offset adjustment can be added by connecting a potentiometer between pins 78 and 80, and returning the potentiometer slider to −15 volts.

The MP21 is packaged in an 80-pin, 1.7 × 2.1 × 0.22-inch ceramic package and has an operating temperature range of 0° to 70°C. The low-quantity price is $195 each. A data sheet describing the MP21 is available from Burr-Brown Research Corporation, International Airport Industrial Park, Box 11400, Tucson, AZ 85734.

Transistor news

The BLW79, BLW80 and BLW81 from Amperex are UHF power transistors with 10-, 9- and 7-dB power gains and 2-, 4- and 10-watt outputs, respectively. They are designed for high reliability and have gold metallization, gold bond wires and diffused emitter ballasting.

The transistors are characterized for the 380- to 512-MHz mobile frequency band at a collector voltage of 12.5.

The devices are available in flange or stud packages. Low-quantity prices are $5.25 for the BLW79, $6.50 for the BLW80 and $7.90 for the BLW81. For information, write Amperex Electronic Corporation, Hicksville, NY 11802.

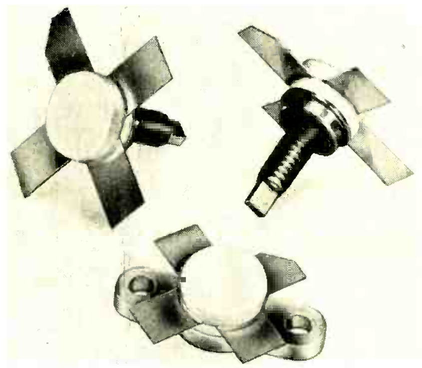
General Semiconductor Industries has released an 8-page application data sheet on their XGSR series of high-voltage switching transistors. The data sheet contains a large number of graphs for practical use in applying the 400-volt, 15-amp transistor family.

The transistors use the C^2R process and are suggested for converter, inverter and Class-C and Class-D amplifier applications. Write General Semiconductor Industries, Inc., 2001 West Tenth Place, Tempe, AZ 85281.

Motorola's MJ10011 is a color television, horizontal-deflection Darlington transistor with a built-in damper diode. The current gain is 40, and the breakdown voltage is 1400.

The monolithic transistor uses a special glass passivation and high-voltage TO-3 package. Its main features are a resistance to arcing and a low thermal resistance.

The MJ10011 costs less than the BU208 discrete transistor it is designed to replace. Its high gain and built-in damper make it even more cost-effective. For more information, write Motorola Semiconductor Products, Inc., Box 20912, Phoenix, AZ 85036.

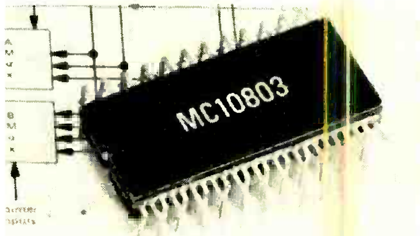


UHF POWER TRANSISTORS from General Semiconductor. All three have a collector voltage of 12.5 and operate in the 380- to 512 MHz band.

Microprocessor developments

The Motorola MC10803 Memory Interface Function connects between high-speed processor systems such as the MC10800 4-bit slice ALU and memory or peripherals. It contains an ALU that reduces the CPU's peripheral-related work. The MC10803's can be paralleled with MC10800 bit-slice devices to do double-precision arithmetic.

The MC10803 contains six 4-bit registers for generating memory addresses and sending and receiving data. The



THE MC10803 INTERFACE for high-speed processors is in a 48-pin package.

circuits can be connected in parallel for multiple I/O ports. The MC10803 is mounted in a 48-pin Quad-In-Line (QUIL) package and is priced in high quantities at $40.

RCA's *Instruction Manual for the RCA COSMAC Microterminal CDP18S021, No. MPM-212*, tells how to use a pocket-calculator-sized data terminal. The Microterminal interfaces directly with the CDP18S020 Evaluation Kit support hardware, and can be designed into user-built systems.

The manual is available for $2 from RCA, Solid State Division, Box 3200, Somerville, NJ 08876. **R-E**

hobby corner

SCR, Triac, Diac and Quadrac—What they are and how they work. Plus some useful hints on using heat sinks when soldering. **EARL "DOC" SAVAGE, K4SDS,** HOBBY EDITOR

DO YOU KNOW WHAT THE DIFFERENCES are between an SCR, Diac, Triac and Quadrac? Actually, they are all related as we shall see in the circuits that follow.

First, the SCR is a *S*ilicon *C*ontrolled *R*ectifier (sometimes called a thyristor). The "silicon rectifier" part is clear enough: It allows current to pass through in only one direction. However, the "controlled" part means the rectifying action is controlled—it can be turned on and off.

The SCR has an anode and a cathode like other rectifiers, but it also has a third lead called a trigger or gate. The controlling is done by applying a voltage to the trigger lead, usually via a small neon lamp.

The circuit shown in Fig. 1 is a light dimmer or motor speed controller using an SCR and an NE-2 neon lamp. You'll notice that one side of the AC line input is connected directly to the output socket. (Note, too, the use of a grounded wire—a three-wire connection should always be used on AC lines.) The other side of the AC goes through the SCR, which is turned off or on.

The output voltage of this circuit is controlled by varying the firing time of the SCR. If the SCR is triggered at the zero crossing-point of the AC waveform, then the full output potential of the circuit is realized. However, if the SCR is triggered after the zero-crossing point, say at the peak of the positive half-cycle, then the SCR will conduct only the rest of the positive half-cycle. Since, in this case, the SCR conducts for only part of the AC waveform, the RMS output potential is reduced.

The remainder of the circuit simply sets the firing time of the neon lamp, which triggers the SCR. Adjustment of the 150K potentiometer causes the output to vary smoothly. The purpose of the neon lamp is twofold. First, it prevents the SCR from falsely triggering due to voltage transients on the AC line from the motor brushes. Second, it also minimizes variations in the gate potential required to trigger the SCR.

However, remembering that this is a rectifier, you'll realize that the output is not AC but is pulsating DC. One-half of the input is removed, which is shown clearly by connecting an incandescent bulb to the output. Maximum brilliance is only about one-half of what it is when the bulb is connected directly to the AC line. The fact that the output can be varied only from zero to one-half of the input is a disadvantage in some dimmer/controllers since you can't get up to full brilliance or speed.

Then, somebody decided to put two SCR's in one case, pointed them in opposite directions and called the new device a triac. Thus, when properly triggered, a triac allows the current to pass in *both* directions, and the output can be varied from 0 to 100%.

A triac can be substituted directly for the SCR in Fig. 1. However, better control is maintained by using a special triggering device called a *diac* in place of the neon lamp. A diac is really a double diode, and is sometimes called a "bilateral trigger." A triac and diac are shown schematically in Fig. 2. They can be placed right in the previous circuit at points A, B and C in place of the SCR and NE-2. Now the dimmer/controller has *full* range rather than half-range.

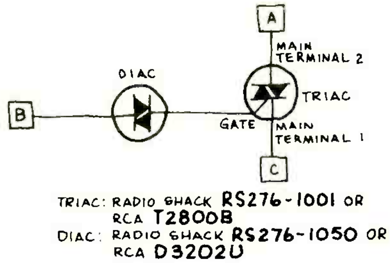


FIG. 2

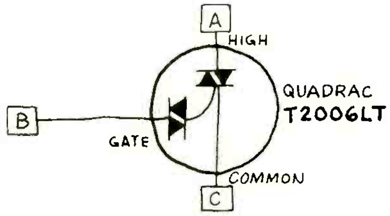


FIG. 3

But the story isn't over yet. Somebody else came along and put both diac and the triac in one case. Yes, you're right! It's called a Quadrac (and, sometimes, a "triac with trigger"). (A typical quadrac for this applicaton is the T2006LT by Teccor Electronics, PO Box 669, Euless, TX 76039.) The quadrac (Fig. 3) can also be placed in the Fig. 1 circuit at points A, B and C. Once again, the result is a full-range dimmer/controller.

SCR's, triacs and quadracs come in a variety of flavors. In choosing them, you should be concerned with two characteristics: peak voltage and power rating. The peak-voltage rating is that value which must not be exceeded by the applied voltage. Keep in mind that this is *peak* not RMS voltage. For example, a device rated at 50 peak volts cannot have more than 35.7 RMS volts applied—$E_{Peak} = 1.4\ E_{RMS}$. Actually, you should leave a safety margin and limit the device to about 30 volts RMS. A 200-volt unit is normally used in a dimmer/controller for the AC line.

Power ratings are given in terms of maximum load current: 3 amps, 6 amps and so on. These devices are rated for a good heat sink, so don't get even near the maximum without a good sink attached. If the load draws less than one-half the rated current, a heat sink could be omitted, but my advice is to use one.

Any load rated in *watts* must be converted to amps to determine the suitability of a given device. For this you can use

$$P_{(watts)} = I_{(amps)} \times E_{(volts)}$$

For example, if you use E = 110 volts, a 6-amp triac can control up to 660 watts

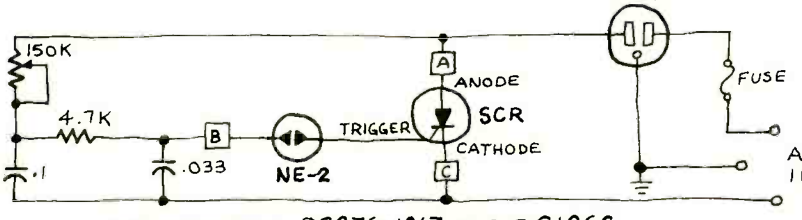


FIG. 1

of incandescent lights; a 75-watt soldering iron would require at least a ¾-amp unit.

The SCR's, diacs, triacs and quadracs can be used on motors: drills, lathes, saws, fans and mixers; and on lights: reading, photographic, microscope, Christmas tree, floods and spots; and on heaters: small hot plates, coffee pots, soldering irons and guns. The list is long, and you may find just one control isn't enough.

Heat sinks

So many parts are easily destroyed by heat and must be soldered with heat sinks. Most hobbyists run out of sinks because they don't solder each connection as it is made. If you make six, eight or a dozen connections before picking up the iron to solder them, you'll soon exhaust your supply of commercial sinks. However, when this happens remember you have many items on your workbench you can use in their place:

1. Alligator and similar clips make good sinks especially if the jaws are flattened;
2. Slide-locking and self-closing tweezers are natural sinks;
3. Needle-nose and other pliers can be used if you put a rubber band around the handles so they'll stay closed;
4. Paper clips and metal hair clips can even be used as light heat sinks;
5. Sinks for DIP IC's can be quickly made as shown in Fig. 4. Use sheet copper (or heavy aluminum) and make sure the contact edges are straight and smooth.

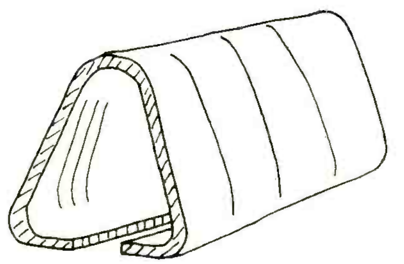


FIG. 4

Conversation piece

You probably have a number of potential conversation pieces lying around your workshop. Perhaps you have a surplus or burned-out PC board that's loaded with parts. Just clean it up, insert it in a slot cut in a block of wood, or cover the bottom of the board with clear plastic.

I made one from a surplus 3 × 4-inch PC board. It's loaded with IC's, transistors, LED's, coils, resistors—all the burned-out and useless parts we could find. It finally ended up as an unusual paperweight, with some tall tales attached to it. It would undoubtedly blow sky high if power were applied to it. However, technical and nontechnical folk alike have believed the most fantastic things that it would do or "used to do before it went bad!" **R-E**

computer corner

Z-80 *An in-depth look at the pin-out of the Z-80 IC and the Z-80's timing.* WILLIAM BARDEN, JR.

LAST MONTH'S COLUMN COMPARED THE Z-80 with the 8080 and discussed the Z-80's architecture. Now let's take a look at the pin-out of the Z-80 IC and the Z-80's timing.

Z-80 pin-out

Figure 1 shows the signal pin-out of the Z-80 IC. The Z-80 is implemented in a 40-pin dual in-line package. The 16-line address bus is designated A15 through A0. The external data bus is D7 through D0. A single-phase TTL-level clock input is at the ϕ pin. The input frequency is a nominal 2.5 MHz, producing minimum instruction times of 1.6 μs.

The RESET input initializes the CPU by zeroing the program counter, setting the I and R registers to zero, disabling interrupts by resetting the interrupt enable flip-flop, and setting interrupt mode 0 (to be discussed in a later column). Setting this signal to a zero logic level is the normal method to reset the CPU.

The RFSH (refresh) output informs external logic that the contents of the R counter is now on the address bus and that a refresh read of the dynamic memories can be done by means of the MREQ signal.

The MREQ, RD and WR signals are tri-state outputs indicating a memory request for a read or write to the CPU. The address bus holds a valid address for the memory operation when MREQ is low (zero logic level), and either RD or WR is low. The WAIT signal is brought down to a zero logic level by the memory after MREQ. The WAIT signal remains low until external memory is finished, enabling the CPU to interface to slower speed memory.

When output signal M1 goes low, the CPU is in the operation code fetch cycle of instruction execution. If both M1 and IORQ are low, an interrupt acknowledge cycle is in progress.

Output signal IORQ indicates that the address bus holds a valid I/O address for an I/O read or write (input- or output-type instruction). If M1 is also low, an interrupt acknowledge cycle is in progress.

Input signal INT is an interrupt request. If the interrupt enable flag IFF is enabled (by software) and the BUSRQ

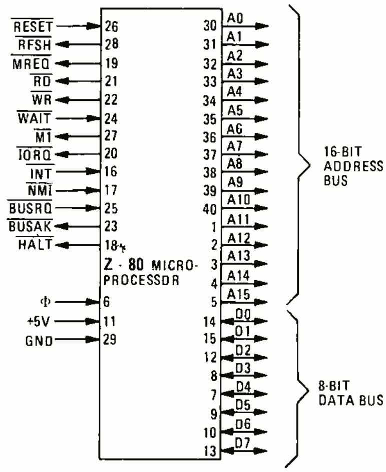


FIG. 1

signal is high, the interrupt is accepted and the IORQ signal is brought low during the M1 signal to indicate an interrupt acknowledge to the interrupting I/O device.

Input signal NMI is triggered by a negative-going edge. The nonmaskable interrupt it produces cannot be disabled and is recognized at the end of the current instruction. Once received, NMI causes the CPU to restart to location 0066_{16} (described in a later column).

Input BUSRQ (bus request) requests the CPU to give up control of the address bus, data bus and control signals. When the CPU responds by bringing output signal BUSAK (bus acknowledge) low, those lines can be controlled by external logic for DMA (*D*irect *M*emory *A*ccess) or other uses. When the external device is finished, it brings up the BUSRQ line, giving control back to the CPU.

The HALT output indicates that the CPU has executed a halt instruction. An NMI, I/O interrupt or control-panel action must occur before normal operation can resume. The halt instruction would normally be used either to wait for an interrupt or to halt program execution for an end-of-program condition or an error condition.

Z-80 timing

Execution of any instruction by the Z-80 CPU consists of a number of machine cycles, each (designated M) consisting of several basic clock cycles. The first ma-

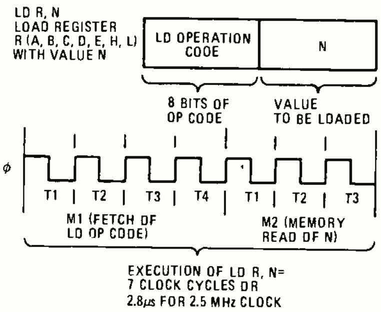


FIG. 2

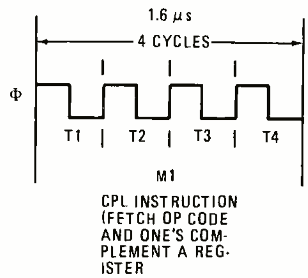


FIG. 3

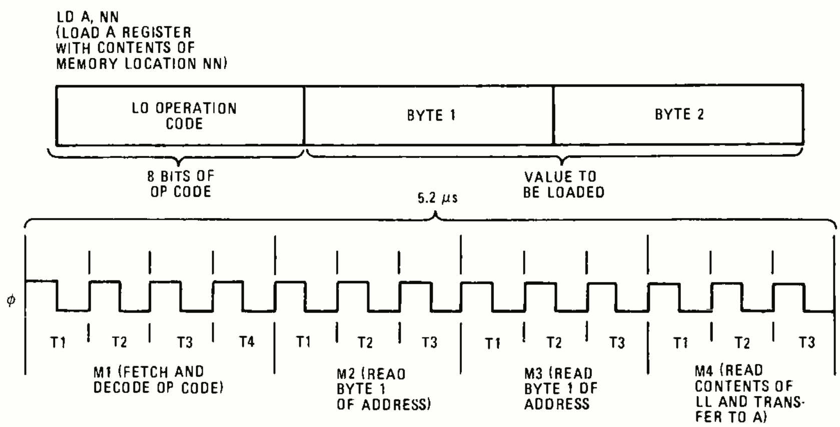


FIG. 4

chine cycle (M1) is always an operation code fetch and decode. Figure 2 shows the execution of the simple LD R,N instruction, which loads CPU register R with the eight-bit data value in the instruction.

The various instructions in the Z-80 take anywhere from 4 cycles (1.6 μs) to 20 cycles (8 μs), depending on the length and operations of the instructions. The simplest instruction is one in which only the op code was fetched from memory and the operation of the instruction could be completed during the M1 cycle. An example of this would be the one-byte instruction to complement the contents of the accumulator register CPL. (See Fig. 3.) The one's complement could be completed in the four clock cycles of T1 (1.6 μs).

Loading the A register with an eight-bit operand from memory requires a fetch (memory read) of the op code for the load operation, two memory reads of the memory address within the instruction, and one memory read of the operand, a total of four machines cycles or a total of 13 clock cycles (5.2 μs). (See Fig. 4.)

All executive times might be lengthened if the CPU was interfacing to a slow memory.

The next column in this series will discuss the different types of instructions associated with the Z-80. **R-E**

Federal suit planned against Virginia radar detector laws

A New Hampshire resident's wife was recently arrested in Virginia for violating that state's anti-radar laws. Bill Edwards, a Hillsborough, NH, engineer and ad manager, is so incensed over what he deems to be a violation of due process that he plans to file a federal class-action suit against the state of Virginia.

Apparently, no other laws had been violated. His wife not only had her radar detector confiscated but was even required to supply the tools to remove it. No anti-radar law exists in New Hampshire.

The suit will charge violation of interstate commerce laws and federal preemption as well as seeking the return of all confiscated radar detectors seized during the two-year period of Virginia's anti-radar laws. Since approximately 5,000 such detectors have been taken from out-of-state drivers during this period, at an estimated cost of $100 each plus an average $100 fine per detector, Virginia could stand to lose a million dollars in damages alone, if the suit is successful.

FCC cartoon show sends a big 10-44 to all CB'ers

For those not in the know, "a big 10-44" is CB lingo for "I've got a message for you." In this case, the Federal Trade Commission's message is a 10-minute cartoon slide-and-sound show aimed at schools, clubs, and other interested associations; the purpose: to acquaint everyone with the importance of Citizens band rules and regulations.

The show, entitled "10-4 Uncle Charlie," features such CB characters as Rhinestone Cowboy, Earthmama, Bucketmouth and others. Included in the program are 72 slides, a 10-minute audio tape cassette, a script and a question-and-answer book designed to take care of the more common CB questions. The program can be purchased from National Audiovisual Center, General Services Administration, Order Section, Washington, DC 20409. The slide-show package costs $15.00.

IHF has big plans for the future

The image and the future of the Institute of High Fidelity (IHF) are both changing—for the better, thinks Bernie Mitchel president of IHF. Some of the changes envisioned for IHF are: regularly scheduled meetings for manufacturers to discuss problems and exchange views; better communications tools to "sell the product" to potential buyers; and last, but not least, a major trade show for all hi-fi manufacturers, called the IHF Show, to be held in May, 1978.

President Mitchell is very enthusiastic about the trade show, which will promote the industry to potential and existing retailers. Not one but several seminars are planned, covering such diverse topics as advertising, accounting problems, service problems, store displays, market research and countless other ideas to help hi-fi dealers share in the industry's growth.

SERVICE QUESTIONS

continued from page 67

FUSE BLOWS INSTANTLY

The 3-amp line fuse blows almost instantly when I turn on this Penncrest 2852. After making the regular tests, I clipped the posistor in the degaussing circuit. Now the set works fine! There aren't any shorts in the degauss circuit; I put in a new posistor, and the fuse blew again. What gives?—D.B., Fremont, NE

"Posistor" is not a standard name! Translation: It's a positive-temperature coefficient thermistor. As it's used here, it must start at a very low resistance (13 ohms cold) and then go away *up* in resis-

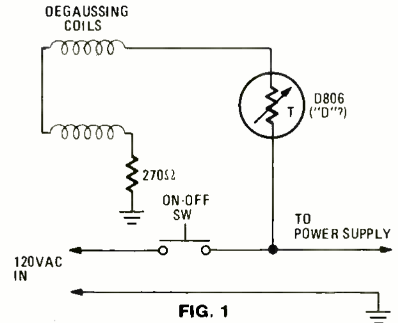


FIG. 1

tance within not more than a second or two. The actual heat resistance is unknown but it has to be pretty high, since it must reduce the current through the degaussing coils to practically zero in normal operation. These coils are connected right across the AC line (see Fig. 1).

From the symptoms, I'd say that you have a shorted degaussing coil. That's the only other thing in the circuit, except for that 270-ohm resistor (which is probably burned up also). Incidentally, this resistor is listed under "Resistors" in the Sams *Photofact 1319-3*.

You *can*, however, operate the set without this circuit. The same basic circuit is used in some other makes. The clue, of course, is the degaussing-coil connection right across the AC line. The device used here *must* be a positive-temperature coefficient thermistor, which goes to a very high resistance in only a short time.

POOR FOCUS

I replaced the flyback and some tubes in an Admiral 24A2 chassis. I got a fine color picture on my test jig. I took it home and the picture was blurry, dim, and I couldn't get good focus. I figured it out. My test jig has an electrostatic-focus picture tube! My focus voltage reads only about 600. High voltage and boost are right on the nose. I changed the focus transformer, but no luck. What am I overlooking?—L.P., Osceola, IA

One key fact: The flyback drives the high voltage, horizontal sweep, yoke *and* the focus circuit. This drive is the 5 kV+ pulse from the 6DQ5 plate. If you have three out of four outputs *normal*, the "source" must also be good. (In fact, *one* normal output is enough.)

This leaves you with only the focus circuitry. You can check the focus transformer by simply disconnecting it from the flyback. This is a "losser," and if it's open, focus voltage will go to about 5 kV and stay there; no variation.

The crystal ball says that the most likely thing here would be a bad focus rectifier or no heater voltage on it. For a quick check just tack in a solid-state focus rectifier, such as RCA-SK-3066, Sylvania ECG-118, or Raytheon RE-167. (If this brings back the focus voltage, leave it in; mount it on a terminal strip so that it won't arc to anything. I've done this in quite a few sets, and it works like a charm.) Final check: Run the set for about five minutes and then turn it off and *feel* the 1V2. If the tube envelope is stone cold, it isn't getting enough heater current.

RESISTOR BURNS UP

I'm having problems with this Zenith 14A9C50. The 560-ohm resistor in the horizontal blanking circuit keeps burning up. The DC voltages on the horizontal blanking transistor are all far too high. I am reading 40 to 50 volts P-P on the diode. The set works but has a drive line on the left and a slight foldover—L.H., Enid, OK

Your voltages *are* all far too high, especially the pulse voltage on the blanking circuit. This should be only 3 to 4 volts P-P, and you're reading a 50-volt pulse. This much overload would make that resistor burn up.

Check out the small winding on the flyback. The black wire should be the ground, and I bet you'll find it open. This should be the only thing that would raise the pulse amplitude.

TUBE CAUSES HIGH-VOLTAGE PROBLEMS

I'm having difficulties with an RCA CTC-52XAC. I found a bad 31LZ6, and some bad 6GH8's. Now a dim raster comes on and goes off at short intervals. The grid bias on the 31LZ6 is only −35 volts instead of −50 volts. Grid waveform is only 200 volts P-P instead of the specified 250 volts.—S.Y., Falls Church, VA

This sounds like our old problem with the 31LZ6 tubes. Try each one after the other; we used up three before we found the right one. The key is in the flattening of the *peaks* of the 31LZ6 grid waveform.

(Feedback: "Thanks very much! The third 31LZ6 did the trick. The grid waveform *was* flattened, but the cathode current didn't seem to creep up as much as you said. I see that RCA now recommends replacing all 31LZ6's with 36CM6.")

Thanks to Sam Yoder, CET, Falls Church, VA, for this information.

DOUBLE ANALYST TROUBLE

The color popped in and out, then finally went out entirely, on my B&K 1077 Analyst. The black-and-white bars on the screen showed up but no colors. You suggested replacing the crystal, which brought the color back. However, the color was still intermittent. Checking around, I found a 220-pF capacitor on the grid of the 6GH8 color oscillator tube that was changing in value as the heat of the tube warmed it up.

Thanks to John Conti, Galveston, TX, for the feedback.

OUTPUT TUBES BURN UP

I work in electronics but not in audio! In this stereo amplifier, the 7189 output tubes keep overheating. The schematic doesn't give any DC voltages. There's something I don't know! Do you know what it is?—R. J., El Dorado, AR.

I think so. I've been snakebit by the same problem in a different amplifier. Look at the control grid circuit of the 7189 output tubes. Follow the grid return back to the DC power supply, and you'll find a little *negative* voltage supply of something like −20. This voltage *must* be applied to the control grids of the 7189 tubes to make them work in Class AB_1. If you lose this bias, the tubes will take far too much current and blow up. In the unit I had, this bias supply had been shorted where the wire went around the sharp corner of a ground terminal.

19V8 TUBE SUBSTITUTE

I'm working on a Philco radio, model No. 53-958, that uses a 19V8 tube. I can't find anywhere. I can't even find the base connections in any of my data. Can you help me find a substitute?—G. S., Washington, DC.

Any time you need data on an obsolete tube, check the GE manual, *Essential Characteristics*, from the 14th edition on. The manual shows a 19V8 tube that has electrical characteristics identical to those of a 19T8 tube, which is still available. However, the 19V8 tube has a 9AH base, and the 19T8 tube has a 9E base. So, you will have to rewire the socket, but this shouldn't be too hard to do. (The heaters are on pins 4 and 5 on both, which saves just a little time!)

PEAKING-COIL SUBSTITUTE

I need a replacement for a Bradford part—a 50-µh peaking coil. The part number I have is TLT 500-999. Can you help?—D. S., Kearny, NJ.

My J. W. Miller Company *Catalog No. 175* lists 16 companies that have built sets under the Bradford name. This part number is a Matsushita part number, and the exact replacement is a Miller 74F-475A1. **R-E**

RE TESTS ONKYO TX-8500

continued from page 57

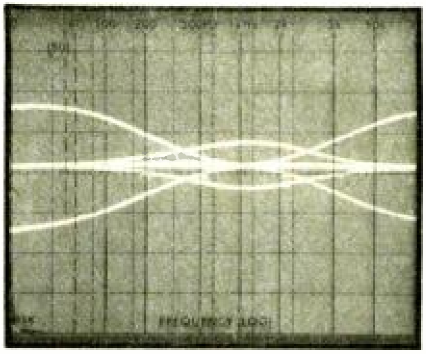
Results can be compared with the manufacturer's published specifications elsewhere in this report. For reasons which remain unclear, the 50-dB quieting level in stereo was considerably poorer than specified, with 55 μV (40 dBf) of signal required to achieve quieting. Mono measurements, on the other hand, all equalled or exceeded published specifications. The dial-calibration discrepancy was uniform over the whole dial spread; this indicated that the dial pointer was wrongly positioned rather than a misalignment of the FM circuits themselves. Signal-to-noise ratio in mono was excellent at 74.0 dB and satisfactory in stereo at 65 dB. Carrier suppression was a more than adequate 60 dB, so you are not likely to encounter any beats when recording FM from the recorder outputs.

Amplifier measurements

Table II lists measured results for the amplifier section of the *model TX-8500*. Power output at all frequencies was significantly higher than claimed, for 8-ohm loads, with 118 watts-per-channel available at the difficult 20-Hz extreme for the rated 0.1% harmonic distortion level. The fact that Onkyo lists a power-output rating for 4-ohm operation and pegs it as high as they do suggests that any thermal problems have been successfully solved in this design, for such a rating implies that the amplifier can deliver 50 watts for one continuous hour into 4-ohm loads (its worst internal heat dissipation condition) without failure. This test is required by the Federal Trade Commission, and we used the lower impedance loads without the thermal protection circuits cycling off during the tests.

Signal-to-noise measurements were made using an IHF "A" weighting network, simply to compare our results and those of the manufacturer. Even when measured without weighting, hum-and-noise was quite low for a preamplifier-equalizer section in a combination receiver.

Bass, mid-range and treble control ranges are shown in Fig. 3, while response with and without the low- and high-cut filters, over a 20-Hz to 20-kHz range, is shown in Fig. 4. Figure 5 shows multiple sweeps of frequency at different master volume control settings with the loudness circuit activated, and the usual bass and treble compensation increases as the volume level is reduced.



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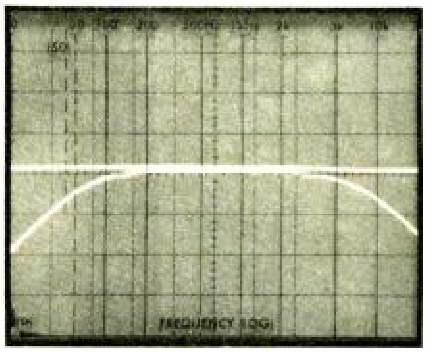

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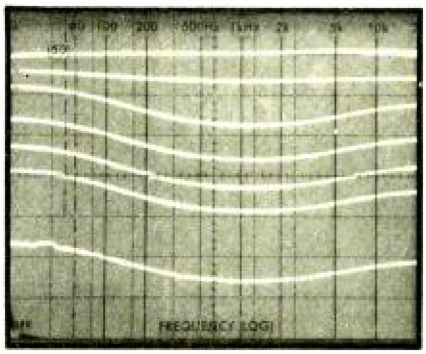


5

Summary

A brief summary and overall product analysis of the receiver are given in Table III. The accompanying comments suggest that this Onkyo receiver offers an excellent amplifier section that more than meets its specifications, sounds good and has just about all the controls and flexibility one would want in an integrated receiver. If the tuner section does not quite come up to the quality found in high-priced separate tuners, the receiver's total price may compensate for this imbalance. **R-E**

West Virginia CB'ers to promote regional travel and provide tourists with emergency assistance

A state travel promotion program, sponsored by the West Virginia Governor's Office of Economic and Community Development and state CB associations, will involve local CB operators in providing tourists with both travel information and emergency assistance.

CB operators "have the reputation of being helpful when there is a highway emergency, so they are a natural source for travel information," says Barbara Jones of the Governor's Office. Since other states are increasingly using CB'ers as goodwill ambassadors in travel promotion as well as in emergency assistance, Ms. Jones perceives this trend as possibly becoming nationwide.

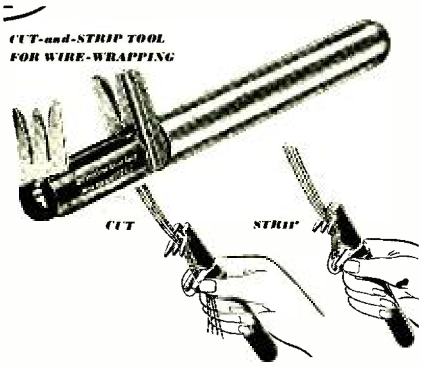
The West Virginia program is called "CB Operation Latchstring." CB club members who participate will receive a certificate, a bumper sticker indicating their participation in "Latchstring" and an information brochure.

For travel information, a tourist merely tells local CB'ers to "Break 19 for Operation Latchstring"; he is then instructed to switch to another channel so as not to tie up Channel 19. The assistance channel is Channel 9; the CB operator stays with the caller until help arrives. The emergency assistance program will involve mobile unit operators, base stations, REACT members, base stations and West Virginia State Police mobile units. **R-E**

new products

More information on new products is available from manufacturers of items identified by a Free Information number. Free Information Card follows page 98.

WIRE CUT AND STRIP TOOL, *model ST-100,* for easy and clean stripping of wires for wire-wrapping electronic applications. Designed for maximum efficiency, it easily stores in a belt



holster, or tool kit. The hardened steel cutting blades, insulated handle and sturdy construction of the tool insure long life. The stripping blade is easily replaceable. Available for wire from 20 to 30 AWG.—**O.K. Machine and Tool Corp.,** 3455 Conner St., Bronx, NY 10475

CIRCLE 85 ON FREE INFORMATION CARD

VOM, *model 3300,* is a five-function, 22-range unit that combines portability with precision. A 0.3-inch high LED readout provides extra readability. The five-function, 22-range single selector-

range switch includes: .2-600 VDC; .2-600 VAC with a 10 megohm/100 pF input impedance on all AC ranges; low-power range of 200 mV 0-2 megohms; high-power range of 2 volts, 0-2 megohms; AC/DC milliammeter at 0-200 mA. Basic DC accuracy of .5%.

Unit measures 3 × 5⅞ × 1⅞-inches, and is ideal for test bench and field measurements. Housed in rugged lightweight high-impact plastic case, complete with snap-in NiCad Battery-Pak™ and AC adapter charger. Price: $175.—**Triplett Corp.,** Bluffton, OH 45817.

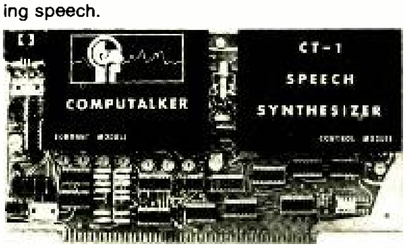
CIRCLE 86 ON FREE INFORMATION CARD

AMMETER, *Ampak model 705A,* measures 1-8 amps DC and 1-400 amps AC with 3% accuracy without breaking circuit or changing tongs or shunts. All DC waveforms, including SCR circuits, can be checked. Clamp-on unit has a meter

remote from the tongs for easy readings. Power supplied by series 133 mercury cells included. Comes in heavy-duty carrying case. Price: $195.—**Pacer Industries, Inc.,** 704 E. Grand Ave., Chippewa Falls, WI 54729.

CIRCLE 87 ON FREE INFORMATION CARD

SPEECH SYNTHESIZER, *model CT-1,* is a high-quality voice generator that is S-100 bus-compatible and controlled by nine acoustic-phonetic parameters. Programming can be accomplished in different ways depending on speech quality desired and the amount of memory available in the computer. The *CT-1* can be operated directly from memory-stored parameters, with a storage requirement of 900 bytes per second of speech. The result is highly intelligible and natural-sounding speech.



The *CT-1* can also be programmed using a system of phonetic rules to generate the synthesis control parameters from the phonetic-text input. Resulting speech is less natural but still intelligible.

The *model CT-1* board measures 5¼ × 10-inches and requires a block of 16 output locations, 8 bits each, that can be relocated to any hex boundary via a selector switch. Power requirements are +8 volts unregulated at 170 mA (typical), 250 mA (maximum); and +16 volts unregulated at 85 mA (typical). Price of the *model CT-1,* $395; CSR1 software, $35.—**Computalker Consultants,** Box 1951, Santa Monica, CA 90406.

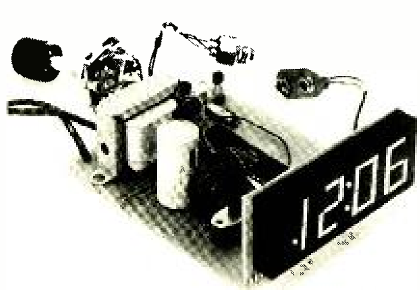
CIRCLE 88 ON FREE INFORMATION CARD

COMPUTER TERMINAL KIT, *model CT-64,* can be used with any 8-bit computer to display 128 ASCII characters in 16 lines of 64 or 32 characters. Unit features scrolling or page mode, 32 control character decoding, selectable printing,

and character or word highlighting. The *model CT-64* provides full cursor control, home-up and erase, erase to end of line or frame, cursor on/off, screen reversal, solid or blinking cursor, and end-of-page beep signal. Kit comes complete with keyboard, power supply, 110-1200 Baud interface, and case. Also available is an optional 12-MHz monitor, *model CT-VM.* Prices: *Model CT-64,* $325; *model CT-VM,* $175.—**Southwest Technical Products Corp.,** 219 W. Rhapsody, San Antonio, TX 78216.

CIRCLE 89 ON FREE INFORMATION CARD

DIGITAL CLOCKS, *model 0100, model 0101,* Solid-State Technology Kits™. The *model 0100* alarm clock-calendar kit (shown above) features .8-inch, 3½-digit LED display with AM/PM indica-



tor. Unit has 8-second time display and 2-second date readout. Can be connected either to radio or 9-volt battery.

The *model 0101* wall clock has a 2½-inch, 6-digit LED display, visible at up to 50 feet. Time and date are interchangeable, with constant time or date readout if desired.—**Fairchild,** Optoelectronics Div., 4001 Miranda Ave., Palo Alto, CA 94303.

CIRCLE 90 ON FREE INFORMATION CARD

TOOL CASE, *model 615T,* made of shatter- and scuff-proof polyethylene, is ideal for carrying tools, parts and equipment. Comes with one-

piece, solid, molded urethane pallet, handy for wall-hanging small tools next to workbench. Case measures 15½ × 12¼ × 4¾-inches and weighs 3¼ lb.—**Platt Luggage, Inc.,** 2301 S. Prairie Ave., Chicago, IL 60616.

CIRCLE 91 ON FREE INFORMATION CARD

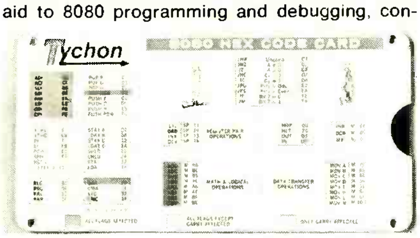
FREQUENCY MULTICOUNTERS, *models 1910A and 1911A,* can be used in a wide variety of applications. Both units offer period, period average, and totalize modes, which allow many field and

lab measurements. The *1910A* covers 5 Hz to 125 MHz while the *1911A* (shown) goes to 250 MHz. A variable trigger level and attenuator permit accurate readings even in very noisy environments. Inexperienced users will find that the autorange feature (which prevents up and down ranging) makes these instruments simple to use. The *model 1911A* has a 50-ohm impedance from 50 MHz to 250 MHz, useful in RF applications. Both multicounters have a basic 15-mV sensitivity for reliable readings.

Both units can be ordered with either a 2-ppm or 5-ppm TCXO at 0°-5° C; the aging rate is .3 ppm per month. An optional rechargeable battery pack gives four hours of continuous operation. The cost of the *model 1910A:* $395; *model 1911A:* $495.—**John Fluke Mfg. Co., Inc.,** Box 43210, Mountlake Terrace, WA 98043.

CIRCLE 92 ON FREE INFORMATION CARD

HEX CODE CARD, *model 8080,* a 6.5 × 3-inch aid to 8080 programming and debugging, con-



tains mnemonics and hex codes, with color-coded instructions to indicate which flags are

continued on page 84

CIRCLE 75 ON FREE INFORMATION CARD

CIRCLE 42 ON FREE INFORMATION CARD

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.

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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.

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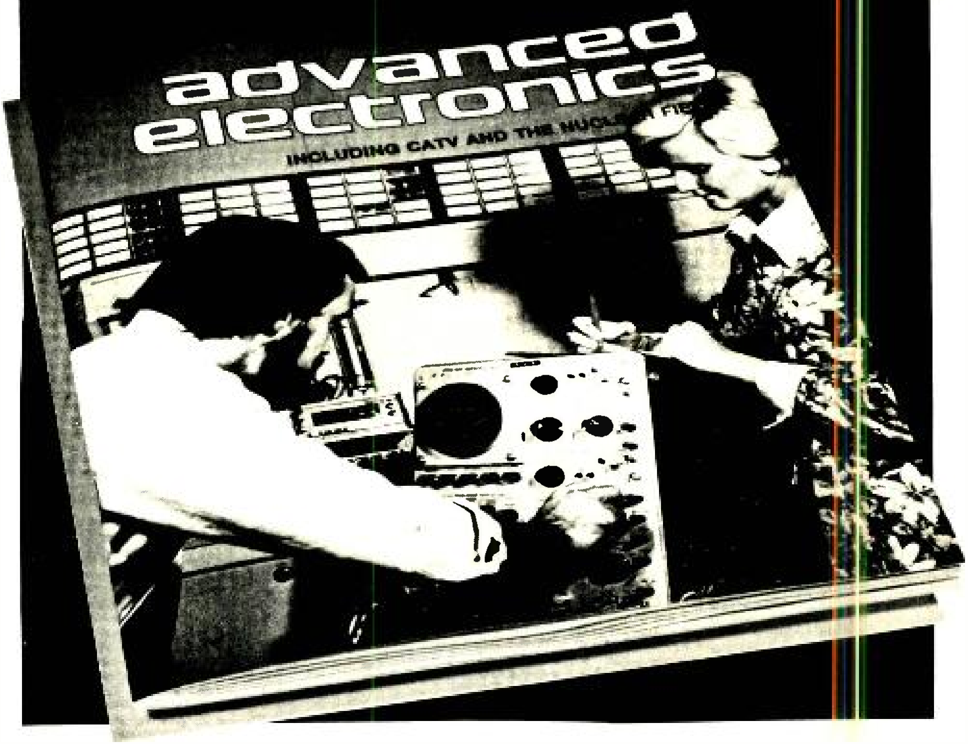

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NEW PRODUCTS
continued from page 79

affected. Back of card shows ASCII code chart, together with status word and register pair codes. Single price: $2.95 postpaid. Discounts available on 10-unit orders.—**Tychon, Inc.,** Box 242, Blacksburg, VA 24060.

CIRCLE 93 ON FREE INFORMATION CARD

POLYMORPHIC MICROCOMPUTER, *Poly 88 System Sixteen,* comes assembled or in kit form. Unit's high-speed video display and alphanumeric keyboard lets you perform mathematical and analytical operations as well as enjoying a wide variety of video games. Cassette tapes

provide permanent program storage. The BASIC software contains PLOT and TIME features based on video graphics and real-time clock; also included is a VERIFY function that signals tape is good before another is loaded. Also included are scientific functions, formatting options, string capabilities, and a program library. *Poly 88 System Sixteen:* $2250; kits start at $735.—**PolyMorphic Systems,** 460 Ward Drive, Santa Barbara, CA 93111.

CIRCLE 94 ON FREE INFORMATION CARD

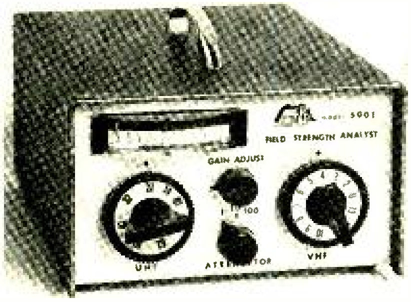
DIGITAL MULTIMETER, *model 270,* is a 3½-digit, battery-operated kit that provides 21-range AC/DC current, voltage and resistance measurements. The 0.5-inch LED displays are readable to

1999. Instrument has 0.5% DC accuracy, 10-megohm input impedance, low-voltage drop in all ranges. An overrange indicator flashes automatically when input exceeds value of range selected. Unit comes with test leads and stand; batteries not included. Optional AC adapter, *model BA-27,* is available. Suggested kit price: $79.95; factory assembled: $109.95; *model BA-27:* $9.95.—**Eico Electronic Instrument Co., Inc.,** 283 Malta St., Brooklyn, NY 11207.

CIRCLE 95 ON FREE INFORMATION CARD

TV FIELD STRENGTH ANALYST, *model 5001,* can be used as a field-strength meter that tunes to all UHF and VHF channels. A three-position attenuator switch allows signal measurement from 0–100,000 µV. Meter scale is calibrated in µV and dB. Used as a TV analyst, unit can substitute the VHF or UHF tuners or combination of the two for any 41-MHz TV receiver, and can also check IF and AGC.

The *model 5001* is AC/DC-powered, with a 300-ohm input for home use and a 75-ohm input for CATV/MATV installation and service. Comes in attractive sturdy case with a detachable line



cord. Suggested retail price: $119.50.—**PTS Electronics, Inc.,** 5233 S. Highway 37, Box 272, Bloomington, IN 47401.

CIRCLE 96 ON FREE INFORMATION CARD

FM TUNER PREAMPLIFIER, *model 630,* is the latest addition to this manufacturer's *600 series* components. The *630* features an extremely low-

noise, low-distortion preamplifier section, phono performance with noise 80-dB below a 1-mV input reference level (1-mV sensitivity, IHF-A). Distortion is virtually immeasurable. A phono overload figure of 250-mV plus switch-selectable phone input sensitivity ensure compatibility with a wide variety of cartridges. The preamp section also provides precision tone and contour con-

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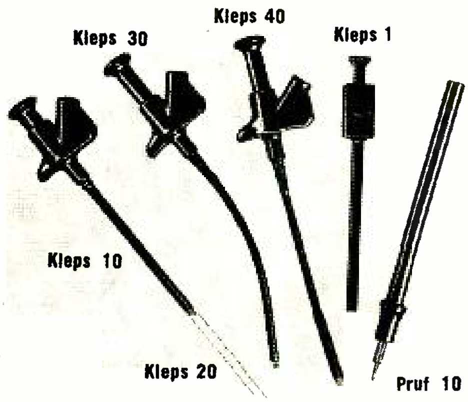

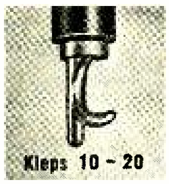

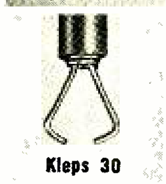

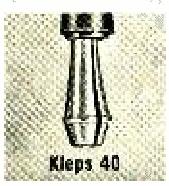

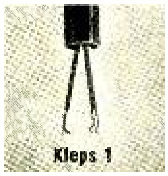

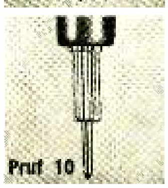

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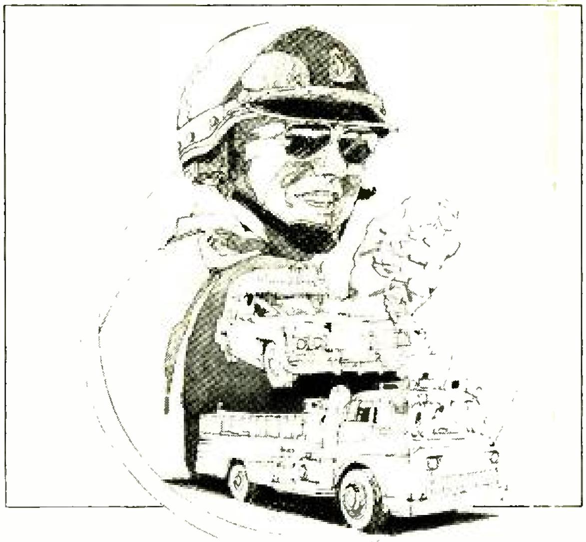


INTERNATIONAL FM 2400CH

FREQUENCY METER for testing mobile transmitters and receivers

- Tests Predetermined Frequencies 25 to 1000 MHz
- Extended Range Covers 950 MHz Band
- Pin Diode Attenuator for Full Range Coverage as Signal Generator
- Measures FM Deviation

The **FM-2400CH** provides an accurate frequency standard for testing and adjustment of mobile transmitters and receivers at predetermined frequencies.

The FM-2400CH with its extended range covers 25 to 1000 MHz. The frequencies can be those of the radio frequency channels of operation and/or the intermediate frequencies of the receiver between 5 MHz and 40 MHz.

Frequency Stability: ±.0005% from +50° to +104°F.

Frequency stability with built-in thermometer and temperature corrected charts: ± .00025% from +25° to +125° (.000125% special 450 MHz crystals available).

Self-contained in small portable case. Complete solid state circuitry. Rechargeable batteries.

FM-2400CH (meter only) **$595.00**
RF crystals (with temperature correction) ... **24.00** ea.
RF crystals (less temperature correction) .... **18.00** ea.
IF crystals .... catalog price

ICM

International Crystal Manufacturing Company, Inc.
10 North Lee, Oklahoma City, Oklahoma 73102

CIRCLE 22 ON FREE INFORMATION CARD

CIRCLE 54 ON FREE INFORMATION CARD

CIRCLE 5 ON FREE INFORMATION CARD

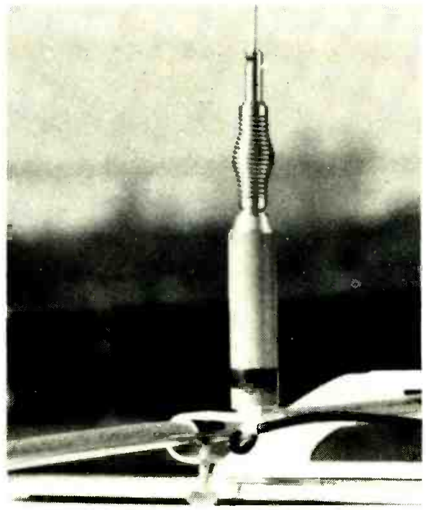
CIRCLE 6 ON FREE INFORMATION CARD

trols, tape-deck monitor and copy facilities and high-output headphone amplifier.

The FM tuner section of the *630* is also a low-noise and distortion device. An elaborate front-end employs a 5-section ganged variable tuning capacitor with components hand-wired directly onto the chassis for maximum spurious signal rejection. Dual-selectivity IF filter employs a 6-element L–C network with highly linearized phase response for low overall FM distortion. The unit also features an FM Dolby switch that provides B-type Dolby decoding circuitry and the 25-microsecond de-emphasis required for proper reception of Dolby encoded broadcasts. The unit is priced at $600.—**Nakamichi Research (U.S.A.), Inc.,** 220 Westbury Ave., Carle Place, NY 11514

CIRCLE 97 ON FREE INFORMATION CARD

LUGGAGE-RACK MOUNT ANTENNA, *model MR 210*, can be clamped securely without drilling holes. Stainless-steel whip has shock spring for



protection. Waterproof mount protects against water damage. Comes with 17-foot coax cable and radio connector. Suggested list price, $25.95.—**The Antenna Specialists, Inc.,** 12435 Euclid Ave., Cleveland, OH 44106.

CIRCLE 98 ON FREE INFORMATION CARD

BASE STATION ANTENNA, *model 18-2340*, the *"Stingray,"* is a 16-foot Fiberglas, omnidirectional antenna for 23- or 40-channel use. The *Stingray* boasts an SWR of 1.3:1 or better, power multiple factor of 2.51 and 4-dB gain over

isotropic for professional quality performance. Its Fiberglas construction makes the *Stingray* weatherproof and lightweight (9 pounds). The installation of this two-piece antenna is simple. All mounting hardware is supplied as well as 3-foot length of cable and attached connector.—**GC Electronics,** 400 South Wyman, Rockford, IL 61101

CIRCLE 99 ON FREE INFORMATION CARD

new books

HOW TO BUY & USE MINICOMPUTERS & MICROCOMPUTERS, by William Barden, Jr. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, IN 46268. 240 pp. Softcover $9.95.

This book demonstrates the ABC's of the ever-growing field of microcomputer and minicomputer technology. Written in easy-to-understand language, it gives the beginning enthusiast a basic understanding of what a computer is, how it operates and how he can own and use a functioning home system for recreation or work.

The introductory chapters deal with microcomputer basics, with the emphasis on "real-world" applications. Short programs illustrate computer programming in BASIC and other rudimentary machine languages. One chapter gives several program examples, including a complete BASIC game program. Other chapters discuss peripheral devices, with interface examples; program goals and techniques; and describe some available microcomputers and minicomputers. A handy index in the back of the book contains much useful reference material.

EASI-GUIDE TO HOME ELECTRICAL REPAIRS, by Forest H. Belt. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, IN 46268. 144 pp. Softcover $3.50 (in Canada, $4.40).

This handy step-by-step guide takes the mystery out of the simple home electrical repairs a lot of people shy away from. Plenty of factual information, explicit instructions and relevant illustrations are provided.

The book emphasizes working safety and outlines in simple, straightforward language how to work with electrical materials; it even tells you what to do in case of emergency. Other chapters deal with such topics as twisting, soldering and taping free joints; making connections; and crimping lugs, etc. Instructions for repairing many different appliances are accompanied by simple clear photographs.

ANNUAL INDEX JANUARY—DECEMBER 1977

To present the maximum number of articles to our readers, we have not published the Annual Index as part of this issue. A 4-page brochure containing this index is available for those who need one. To get your free copy, send a *stamped self-addressed envelope (legal size)* to:

Radio-Electronics
Annual Index
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Any requests postmarked on or before February 28 are free. After that date there is a 25¢ fee. Questions and comments about anything other than the Index that are included with your request cannot be handled. Send them separately to our Editorial Offices.

new lit

More information on new lit is available from the manufacturers of items identified by a Reader Service number. Use the Free Information Card following page 98.

CB RADIO COMPONENT REPLACEMENT GUIDE, *K-1200A,* provides service technicians with 48 pages of information on capacitors, semiconductors, resistors, radio interference filters and installation aids. A four-page section on 536 standard capacitors gives their capacitance values, voltage ratings and capacitance tolerances. Catalog also contains a 26-page semiconductor cross-reference for CB replacement parts and four pages of IC basing diagrams.—**Sprague Products Co.,** 509 Marshall St., North Adams, MA 01247.

CIRCLE 104 ON FREE INFORMATION CARD

REPLACEMENT GUIDE for CB coils is a handy 12-page listing and cross-reference guide for some 3,300 manufacturers' part numbers. The more than 67 CB trade names included in the listing are cross-referenced to corresponding Miller part numbers.—**Bell Industries,** J.W. Miller Div., 19070 Reyes Ave., Box 5825, Compton, CA 90224.

CIRCLE 105 ON FREE INFORMATION CARD

THE COMPLETE BUGWORKS, *Catalog No. 803-0156,* provides designers, researchers, hobbyists and students with 24 pages of circuit design and educational aids. More than 155 products are described along with specifications, prices and ordering information. Some of the wares displayed include solderless sockets, breadboards and accessories for "plug-in" wiring as well as the functional modules known as "outboards." The latter are available assembled or in kit form. A list of hardware is supplemented by educational books and reference works, including *Bugbooks,* combined texts and lab manuals.—**E&L Instruments, Inc.,** 61 First St., Derby, CT 06418.

CIRCLE 106 ON FREE INFORMATION CARD

HEATHKIT CATALOG *No. 817* describes close to 400 different electronic kits, as well as many Heath-recommended assembled units. The kits include a complete line of personal computers, an audio-signal processor for hi-fi systems, a digital electronic scale for home use and new test equipment. The Heath-recommended assemblies feature a microcomputer-based chess game, video-cassette recorder, phone answerer/recorder and an electronic greenhouse.—**Heath Company,** Dept. 350-420, Benton Harbor, MI 49022.

CIRCLE 50 ON FREE INFORMATION CARD

SECURITY SYSTEM CATALOG *No. A-78* features 72 pages of professional-grade alarm systems, ranging from simple door-switch installations to sophisticated infrared and ultrasonic detectors. Some of the devices listed are: fire and burglar detectors, remote control systems, signaling devices, silent phone connections, telephone dialers, locks, tools, books, etc. Diagrams and illustrations allow technicians to make precision connections, wherever necessary.—**Mountain West Alarm Supply Co.,** 4215 N. 16 St., Box 10780, Phoenix, AZ 85064.

CIRCLE 107 ON FREE INFORMATION CARD

next month

JANUARY 1978

■ Digital Frequency Display For Hi-Fi

Spruce up your hi-fi with this add-on for your tuner. Complete construction details for a digital display of the frequency your tuner is tuned to.

■ Programmable TV Games

A look at the entries from the major manufacturers into the area of microprocessor-based TV games. One manufacturer plans on introducing accessories to convert his TV game into a home microcomputer.

■ Pink Noise Generator

Easy to build device has a multitude of applications, especially in hi-fi testing and evaluation.

■ SPECIAL SECTION Bench Tools and Handy Gadgets

A look at what's available to make life easier for the hobbyiest, experimenter and servicer.

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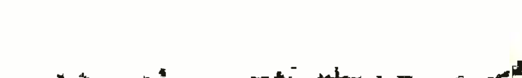

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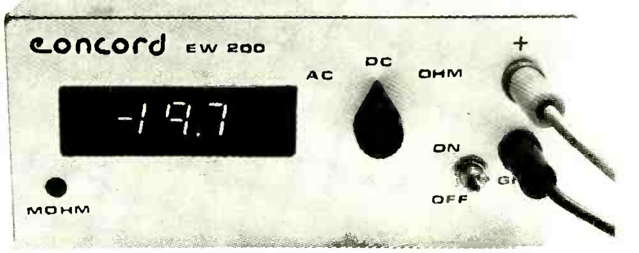

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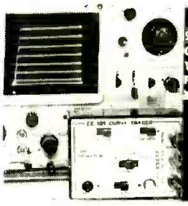

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7402N	17
7404N	19
7409N	23
7410N	17
7414N	63
7420N	17
7422N	1.39
7430N	20
7442N	50
7445N	69
7447N	60
7448N	69
7450N	17
7474N	29
7475N	49
7485N	88
7489N	2.00
7490N	43
7492N	43
7493N	43
7495N	69
74100N	90
74107N	29
74121N	34
74123N	59
74125N	39
74145N	69
74150N	95
74151N	69
74154N	1.00
74157N	69
74161N	87
74162N	87
74163N	87
74174N	96
74175N	90
74190N	1.15
74192N	87
74193N	85
74221N	1.55
74298N	1.65
74365N	66
74366N	66
74367N	66
74LS00 TTL	
74LS00N	25
74LS02N	25
74LS04N	25
74LS05N	25
74LS08N	25
74LS10N	25
74LS13N	40
74LS14N	90
74LS20N	25
74LS22N	25
74LS28N	41
74LS30N	25
74LS33N	39

74LS38N	30
74LS74N	35
74LS75N	47
74LS90N	51
74LS93N	51
74LS95N	1.89
74LS107N	35
74LS112N	35
74LS113N	35
74LS132N	72
74LS136N	35
74LS151N	67
74LS155N	67
74LS157N	67
74LS162N	91
74LS163N	91
74LS174N	95
74LS190N	1.06
74LS221N	1.95
74LS258N	67
81LS97	1.45
LINEAR	
CA3045	90
CA3046	67
CA3049	85
CA3081	1.80
CA3082	1.90
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CA3090AQ	4.75
LM301AN AH	35
LM305H	87
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LM308N	89
LM309H	1.15
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LM339N	1.55
LM340K-5	1.10
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LM340K-12	1.10
LM340K-15	1.10
LM340K-24	1.10
LM340T-5	1.10
LM340T-8	1.10
LM340T-12	1.10
LM340T-15	1.10
LM340T-18	1.10
LM340T-24	1.10
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LM379	5.00
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LM381	1.60
LM382	1.60
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LM709H	28
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CD4006	1.19
CD4007	22
CD4008	75
CD4009	43
CD4010	43

CD4011	22
CD4012	22
CD4013	39
CD4014	94
CD4015	94
CD4016	39
CD4017	1.00
CD4018	1.00
CD4019	50
CD4020	1.11
CD4021	1.11
CD4022	94
CD4023	22
CD4024	83
CD4025	22
CD4026	1.60
CD4027	39
CD4028	85
CD4029	1.11
CD4030	22
CD4035	1.11
CD4040	1.11
CD4042	77
CD4043	68
CD4044	68
CD4046	1.82
CD4049	39
CD4050	39
CD4051	1.22
CD4060	1.54
CD4066	78
CD4068	35
CD4069	40
CD4070	40
CD4071	22
CD4072	22
CD4073	22
CD4075	22
CD4076	1.75
CD4078	40
CD4081	22
CD4082	22
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CD4490	5.50
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CD4508	4.25
CD4510	1.10
CD4511	1.00
CD4515	2.72
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CD4518	1.10
CD4520	1.10
CD4527	1.60
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74C00	28
74C04	33
74C10	28

74C14	2.10
74C20	28
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74C906	1.50
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8096	65
8097	65
8098	65
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14	18	28	43
16	20	36	58
18	27	40	61
22	35		

3 level wire wrap gold
14 pin 35   16 pin 39

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(specify red, amber, green, yellow, clear)

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Operates 5–18 Volt DC to 5 MHz typ. .125" LED display **10.50**
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DL747	CA	600	1.95
DL750	CC	600	1.95
FND359	CC	357	70
FND500	CC	500	1.35
FND503	CC	500	90
FND510	CA	500	90
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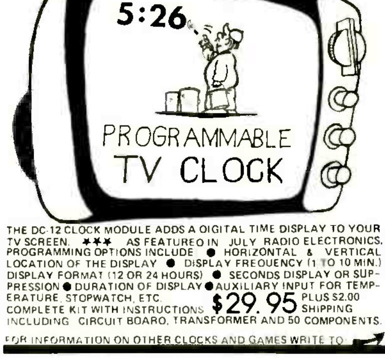

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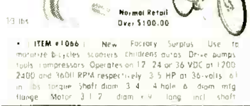

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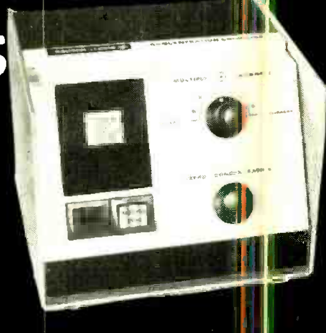

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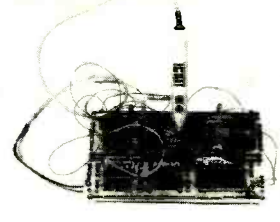

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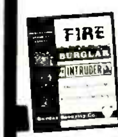

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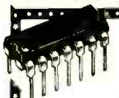

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7427	.33
7428	.28
7430	.21
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7433	.30
7437	.25
7438	.25
7439	.50
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7442	.53
7445	.70
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7454	.21
7460	.21
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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
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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
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74279	.55
74298	.94
74365	.67
74366	.67
74367	.67
74368	.67

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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
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74LS21	.28
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74LS26	.33
74LS27	.33
74LS28	.33
74LS30	.28
74LS32	.33
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74LS37	.33
74LS38	.33
74LS40	.28
74LS42	.67
74LS47	.79
74LS48	.77
74LS51	.28
74LS54	.28
74LS55	.28
74LS73	.39
74LS74	.39
74LS74	.39
74LS75	.53
74LS76	.39
74LS78	.39
74LS83	.79
74LS85	.49
74LS86	.39
74LS90	.57
74LS92	.57
74LS93	.57
74LS95	.88
74LS86	.88
74LS107	.39
74LS109	.39
74LS112	.39
74LS113	.39
74LS114	.39
74LS125	.49
74LS126	.49
74LS132	.81
74LS136	.39
74LS138	.73
74LS139	.73
74LS151	.75
74LS153	.75
74LS154	1.10
74LS155	.75
74LS156	.75
74LS157	.75
74LS158	.75
74LS160	1.02
74LS161	1.02
74LS163	1.02
74LS164	1.02
74LS168	1.14
74LS169	1.14
74LS170	1.73
74LS173	1.34
74LS174	1.06
74LS175	.84
74LS181	2.50
74LS190	1.18
74LS191	1.18
74LS192	.98
74LS193	.53
74LS194	.88
74LS195	.88
74LS196	.86
74LS197	.86
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74LS243	1.70
74LS244	1.70
74LS247	.79
74LS248	.79
74LS249	.79
74LS251	.84
74LS253	.84
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74LS258	.75
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74LS273	1.28
74LS279	.62
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74LS283	.65
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74LS295	1.12
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74LS366	.67
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74LS368	.67
74LS377	1.50
74LS386	.39
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81LS95	.77
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81LS97	.77
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75452	.61
75453	.61
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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
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4043	.79
4044	.70
4046	1.86
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4052	1.26
4053	1.26
4060	1.58
4066	.79
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.0068	.14	1.15/10	9.00/C	.22	.23	1.85/10	15.00/C
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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
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22/50V	.12	1.00/10	8.48/C	.17	1.32/10	11.22/C
33/16V	.09	.75/10	6.90/C	.12	1.00/10	8.48/C
33/25V	.10	.81/10	7.50/C	.14	1.15/10	9.56/C
33/35V	.13	1.05/10	9.65/C	.17	1.34/10	11.23/C
33/50V	.14	1.13/10	10.41/C	.19	1.52/10	12.89/C
47/10V	.09	.71/10	6.52/C	.13	1.04/10	9.50/C
47/16V	.10	.81/10	7.47/C	.14	1.15/10	9.56/C
47/25V	.13	1.05/10	9.65/C	.17	1.30/10	11.22/C
47/35V	.14	1.13/10	10.41/C	.19	1.51/10	12.89/C
45/50V	.15	1.21/10	11.16/C	.21	1.71/10	14.55/C
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100/16V	.11	.85/10	7.28/C	.17	1.30/10	11.22/C
100/25V	.13	1.10/10	9.15/C	.20	1.55/10	13.30/C
100/35V	.17	1.41/10	11.85/C	.25	1.93/10	16.50/C
100/50V	.21	1.71/10	14.55/C	.29	2.30/10	19.70/C
220/10V	.13	1.08/10	9.15/C	.18	1.42/10	12.05/C
220/16V	.15	1.16/10	9.86/C	.20	1.55/10	13.30/C
220/25V	.21	1.71/10	14.55/C	.29	2.35/10	19.96/C
220/35V	.25	2.03/10	17.26/C	.35	2.79/10	23.70/C
220/50V	.29	2.35/10	19.96/C	.40	3.23/10	27.44/C
330/6V	.14	1.12/10	9.50/C	.19	1.48/10	13.71/C
330/10V	.15	1.16/10	9.83/C	.21	1.64/10	15.13/C
330/16V	.21	1.66/10	14.14/C	.31	2.45/10	22.70/C
330/25V	.23	1.86/10	15.79/C	.38	3,07/10	28.38/C
330/35V	.33	2.66/10	24.59/C	.43	3.43/10	31.68/C
330/50V	.54	4.30/10	39.73/C	.60	4.81/10	44.45/C
470/6V	.15	1.21/10	11.16/C	.20	1.64/10	15.13/C
470/10V	.21	1.71/10	14.55/C	.31	2.45/10	22.70/C
470/16V	.23	1.81/10	15.39/C	.33	2.66/10	24.59/C
470/25V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
470/35V	.41	3.27/10	30.26/C	.47	3.78/10	34.99/C
470/50V	.54	4.30/10	39.73/C	.75	6.03/10	55.80/C
1000/6V	.22	1.90/10	16.50/C	.35	2.76/10	25.54/C
1000/10V	.24	1.96/10	16.62/C	.38	3.07/100	28.38/C
1000/16V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
1000/25V	.42	3.33/10	28.27/C	.68	5.42/10	50.13/C
1000/35V	.60	4.81/10	44.45/C	.75	6.03/10	55.81/C
2200/6V	.36	2.86/10	26.48/C	.43	3.43/10	31.68/C
2200/10V	.42	3.33/10	28.27/C	.60	4.81/10	44.45/C
2200/16V	.54	4.30/10	36.58/C	.68	5.42/10	50.13/C

Bishop Graphics

The Digi-Key Catalog features many more quality Bishop Graphics products.

No 3365 $12.50

JMJ DIGITAL DISPLAY BEZEL

PATENTED CHROMAFILTER SCREEN, DIE CAST METAL FRAME MOUNTS IN PANELS UP TO 3/16" THICK, NO EXPOSED HARDWARE, SCRATCH RESISTANT AND EASILY CLEANED, ELIMINATES GLARE.

MOUNTING ADAPTERS AVAILABLE TO SIMPLIFY MOUNTING AND ASSURE PERFECT ALIGNMENT.

400 BEZEL WITH RED FILTER	4.95
420 MOUNTING ADAPTER FOR MA1001 & MA1002	.69
421 MOUNTING ADAPTER FOR MA1010	.69

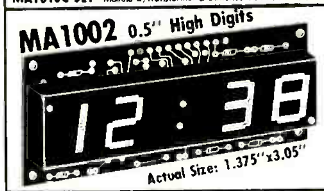
CLOCK MODULES

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

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

MA1002A	.5" LED 12 Hour AM-PM Clock Module	$10.50
MA1002A SET	Module with Transformer & Switches	$13.95
MA1002C	.5" LED 24 Hour Clock Module	$10.50
MA1002C SET	Module w/Transformer & Switches	$13.95
MA1003	12 Volt Car Clock with Switches	$24.95
MA1010A	.84" LED 12 Hour AM-PM Clock Module	$13.00
MA1010A SET	Module w/Transformer & Switches	$16.45
MA1010C	.84" LED 24 Hour Clock Module	$13.00
MA1010C SET	Module w/Transformer & Switches	$16.45

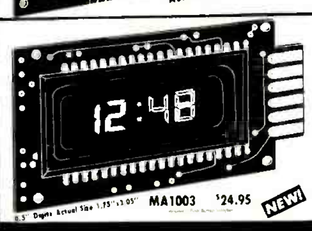
MA1002 0.5" High Digits



Actual Size: 1.375"x3.05"

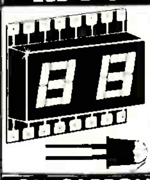
MA1010 0.84" High Digits

Actual size: 1.75"x3.75"



.5" Digits Actual Size 1.75"x3.05" MA1003 $24.95

LED DIGITS AND LAMPS



FND357 .375" Single Digit CC Red	$1.35
FND500 .5" Single Digit CC Red	1.35
FND507 .5" Single Digit CC Red	1.35
FND800 .8" Single Digit CC Red	2.50
FND807 .8" Single Digit CA Red	2.5[illegible]
NSN373 .3" Dual Digits CC Red	2.2[illegible]
NSN374 .3" Dual Digits CA Red	2.[illegible]
NSN583 .5" Dual Digits CC Red	2.60
NSN584 .5" Dual Digits CA Red	2.60
NSN783 .7" Dual Digits CC Red	3.00
NSN784 .7" Dual Digits CA Red	3.00
NSL5053 Dif. Red T 1¾ Lamp w/Mtg. Hdwe $1.80/10	$16.[illegible]/100
NSL5056 Dif. Narrow Angle Red T-1¾ Lamp w/Mtg. Hdwe $1.80/10	$16.00/100

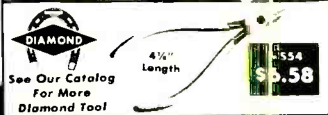
5% CARBON FILM RESISTORS

¼ WATT RESISTOR ASSORTMENTS

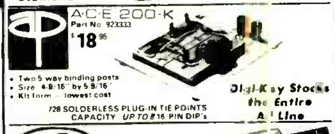
Catalog Number	Description	PRICE
RS125	Set of 5 each of the 73 standard 5% ¼ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 megohm (365 total pcs.)	$9.90
RS225	Set of 5 each of the 72 standard 5% ¼ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4,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

½ WATT RESISTOR ASSORTMENTS

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



See Our Catalog For More Diamond Tool



- Two 5 way binding posts
- Size 4-9/16" by 5-9/16"
- Kit form — lowest cost

728 SOLDERLESS PLUG-IN TIE POINTS CAPACITY UP TO 816 PIN DIP's

Digi-Key Stocks the Entire A·C·E Line

WSU-30 Regular Wrap	$5.95
WSU-30M Modified Wrap	$6.95

STRIPS — WRAPS — UNWRAPS

SILICON TRANSISTORS

MPS918	.16	1.55/10	13.60/C	130.00/M
MPS930	.16	1.55/10	13.60/C	130.00/M
MPS2222A	.16	1.55/10	13.60/C	130.00/M
MPS2369A	.16	1.55/10	13.60/C	130.00/M
MPS2907A	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3394	.16	1.55/10	13.60/C	130.00/M
MPS3395	.16	1.55/10	13.60/C	130.00/M
MPS3563	.16	1.55/10	13.60/C	130.00/M
MPS3565	.16	1.55/10	13.60/C	130.00/M
MPS3638A	.16	1.55/10	13.60/C	130.00/M
MPS3640	.16	1.55/10	13.60/C	130.00/M
MPS3641	.16	1.55/10	13.60/C	130.00/M
MPS3643	.16	1.55/10	13.60/C	130.00/M
2N3904	.16	1.55/10	13.60/C	130.00/M
2N3906	.16	1.55/10	13.60/C	130.00/M
2N4124	.16	1.55/10	13.60/C	130.00/M
2N4126	.16	1.55/10	13.60/C	130.00/M
2N4401	.16	1.55/10	13.60/C	130.00/M
2N4403	.16	1.55/10	13.60/C	130.00/M
2N4410	.16	1.55/10	13.60/C	130.00/M
2N5087	.16	1.55/10	13.60/C	130.00/M
2N5089	.16	1.55/10	13.60/C	130.00/M
2N5210	.16	1.55/10	13.60/C	130.00/M
2N3055	.99	9.20/10	85.00/C	800.00/M
MPF102	.36	3.35/10	30.60/C	300.00/M
2N5457	.48	4.50/10	41.00/C	400.00/M
MPSA13	.28	2.60/10	24.00/C	230.00/M
MJ2955	.99	9.20/10	85.00/C	800.00/M
TIP120	.99	9.20/10	85.00/C	800.00/M

½ WATT ZENER DIODES

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

1N5226B	3.3V	1N5242B	12V
1N5227B	3.6V	1N5243B	13V
1N5228B	3.9V	1N5244B	14V
1N5229B	4.3V	1N5245B	15V
1N5230B	4.7V	1N5246B	16V
1N5231B	5.1V	1N5247B	17V
1N5232B	5.6V	1N5248B	18V
1N5233B	6.0V	1N5249B	19V
1N5234B	6.2V	1N5250B	20V
1N5235B	6.8V	1N5251B	22V
1N5236B	7.5V	1N5252B	24V
1N5237B	8.2V	1N5253B	25V
1N5238B	8.7V	1N5254B	27V
1N5239B	9.1V	1N5255B	28V
1N5230B	10V	1N5256B	30V
1N5241B	11V	1N5257B	33V

HARDWARE

2-56 1/4 SCREW	.99/C
2-56 1/2 SCREW	.99/C
4-40 1/4 SCREW	.55/C
4-40 1/2 SCREW	.60/C
6-32 1/4 SCREW	.65/C
6-32 1/2 SCREW	.75/C
8-32 3/8 SCREW	.90/C
8-32 5/8 SCREW	.99/C
2-56 HEX NUT	.55/C
4-40 HEX NUT	.55/C
6-32 HEX NUT	.60/C
8-32 HEX NUT	.60/C
NO 2 LOCK WASHER	.85/C
NO 4 LOCK WASHER	.45/C
NO 6 LOCK WASHER	.45/C
NO 8 LOCK WASHER	.45/C

SILICON DIODES

1N4001	.64/10	5.50/C	$49/M
1N4002	.66/10	5.60/C	$51/M
1N4003	.68/10	5.80/C	$52/M
1N4004	.70/10	5.95/C	$54/M
1N4005	.82/10	7.05/C	$63/M
1N4006	.90/10	7.75/C	$69/M
1N4007	.99/10	8.60/C	$77/M
1N4148	.40/10	3.50/C	$29/M

FREE CATALOG

DATA BOOKS

TTL I.C.'s 592 P.	$4.00
LINEAR I.C.'s 952 P.	$5.00
CMOS 74C 555 P.	$3.00
POWER TRANSISTORS 151 P	$3.00
MEMORY I.C.'s 592 P.	$3.00
MOS/LSI I.C.'s 713 P.	$4.00
INTERFACE I.C.'s 464 P.	$4.00
VOLTAGE REG I.C.'s 128 P.	$3.00
LINEAR AP I 432 P.	$4.00
LINEAR AP II 246 P.	$3.00
AUDIO HANDBOOK 196 P.	$3.00
SPECIAL FUNCTION	$3.00
SC/MP APPLICATIONS	$5.00
8080A DESIGN	$5.00
FET DATABOOK	$3.00
CMOS 4000 278 P.	$3.00
ANALOG MANUAL 637 P.	$5.95

I.C. SOCKETS

8 PIN SOLDER	.17	1.60/10	14.50/C
14 PIN SOLDER	.20	1.90/10	17.00/C
16 PIN SOLDER	.22	2.10/10	18.75/C
18 PIN SOLDER	.29	2.75/10	24.50/C
20 PIN SOLDER	.30	2.85/10	25.25/C
22 PIN SOLDER	.33	3.15/10	27.75/C
24 PIN SOLDER	.38	3.60/10	32.25/C
28 PIN SOLDER	.45	4.25/10	38.25/C
40 PIN SOLDER	.63	6.00/10	53.50/C
8 PIN W-W	.24	2.30/10	20.50/C
14 PIN W-W	.26	2.50/10	22.00/C
16 PIN W-W	.30	2.85/10	25.50/C
18 PIN W-W	.60	5.70/10	51.00/C
20 PIN W-W	.70	6.65/10	59.50/C
22 PIN W-W	.84	8.00/10	71.50/C
24 PIN W-W	.96	9.10/10	81.50/C
28 PIN W-W	1.12	10.00/10	95.20/C
40 PIN W-W	1.36	12.50/10	115.00/C

MOLEX I.C. SOCKET PINS

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

SLIDE SWITCHES

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

STRANDED HOOK UP WIRE

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

50 VOLT DISCS

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

DOUBLE DIGIT DISCOUNTS SAVE YOU EVEN MORE!

HANDLING CHARGES

$ 0.00-$ 4.99	Add $2.00
$ 5.00-$24.99	Add $0.75
$ 25.00-$49.99	Add $0.50
$ 50.00-$99.99	Add $0.25
$100.00 & Up	No Charge

VOLUME DISCOUNT & HANDLING CHARGE

All items, except Bishop Graphics and Economy Terminals may be combined for volume discount. First—total all discountable items and apply the volume discount. Then add to this subtotal the nondiscountable items. Add the handling charge. This is your total cost. We pay all shipping and insurance to addresses in the U.S.A. and Canada.

VOLUME DISCOUNT

$ 0.00-$ 24.99	NET
$ 25.00-$ 99.99	Less 10%
$ 100.00-$499.99	Less 15%
$ 500.00-$999.99	Less 20%
$1000.00 & Up	Less 25%

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Quality Electronic Components

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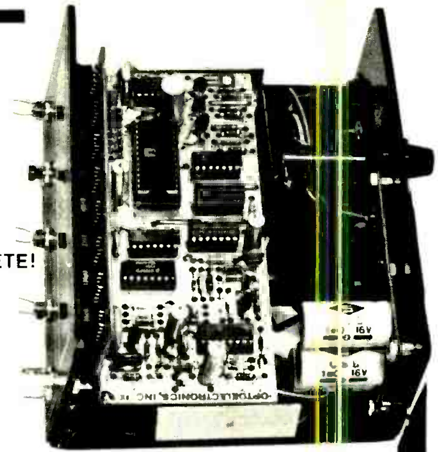
NEW LSI TECHNOLOGY

FREQUENCY COUNTER

TAKE ADVANTAGE OF THIS NEW STATE-OF-THE-ART COUNTER FEATURING THE MANY BENEFITS OF CUSTOM LSI CIRCUITRY. THIS NEW TECHNOLOGY APPROACH TO INSTRUMENTATION YIELDS ENHANCED PERFORMANCE, SMALLER PHYSICAL SIZE, DRASTICALLY REDUCED POWER CONSUMPTION [PORTABLE BATTERY OPERATION IS NOW PRACTICAL], DEPENDABILITY, EASY ASSEMBLY AND REVOLUTIONARY LOWER PRICING!



KIT #FC-50C	60 MHZ	COUNTER WITH CABINET & P.S.	$119.95 COMPLETE!
KIT #PSL-650	650 MHZ	PRESCALER [NOT SHOWN]	29.95
MODEL #FC-50WT	60 MHZ	COUNTER WIRED, TESTED & CAL.	165.95
MODEL #FC-50/600 WT	600 MHZ	COUNTER WIRED, TESTED & CAL.	199.95

SIZE:
3" High
6" Wide
5½" Deep

FEATURES AND SPECIFICATIONS:

DISPLAY: 8 RED LED DIGITS .4" CHARACTER HEIGHT
GATE TIMES: 1 SECOND AND 1/10 SECOND
PRESCALER WILL FIT INSIDE COUNTER CABINET
RESOLUTION: 1 HZ AT 1 SECOND, 10 HZ AT 1/10 SECOND.
FREQUENCY RANGE: 10 HZ TO 60 MHZ. [65 MHZ TYPICAL]
SENSITIVITY: 10 MV RMS TO 50 MHZ, 20 MV RMS TO 60 MHZ TYP.
INPUT IMPEDANCE: 1 MEGOHM AND 20 PF.
[DIODE PROTECTED INPUT FOR OVER VOLTAGE PROTECTION.]
ACCURACY: ± 1 PPM [± .0001%]; AFTER CALIBRATION TYPICAL.
STABILITY: WITHIN 1 PPM PER HOUR AFTER WARM UP [.0001% TYPICAL]
IC PACKAGE COUNT: 8 [ALL SOCKETED]
INTERNAL POWER SUPPLY: 5 V DC REGULATED.
INPUT POWER REQUIRED: 8-12 VDC OR 115 VAC AT 50/60 HZ
POWER CONSUMPTION: 4 WATTS

KIT #FC-50C IS COMPLETE WITH PREDRILLED CHASSIS ALL HARDWARE AND STEP-BY-STEP INSTRUCTIONS. WIRED & TESTED UNITS ARE CALIBRATED AND GUARANTEED.

PLEXIGLAS CABINETS

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

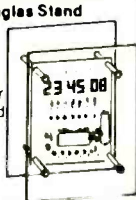
CABINET I 3"H, 6¼"W, 5½"D
CABINET II 2½"H, 5"W, 4"D

Black, White or Clear Cover
$6.50 ea.

RED OR GREY PLEXIGLAS FOR DIGITAL BEZELS 3"x6"x1/8" 95¢ ea. 4/$3

SEE THE WORKS Clock Kit Clear Plexiglas Stand

- 6 Big .4" digits
- 12 or 24 hr time
- 3 set switches
- Plug transformer
- all parts included



Plexiglas is Pre-cut & drilled

Kit #850-4CP

Size: 6"H, 4½"W, 3"D

$23.50 ea. 2/$45. Assembled $29.95

60 HZ. XTAL TIME BASE

Will enable Digital Clock Kits or Clock-Calendar Kits to operate from 12V DC. 1"x2" PC Board Power Req: 5-15V (2.5 MA. TYP.) Easy 3 wire hookup Accuracy: ± 2PPM

#TB-1 (Adjustable)
Complete Kit $4.95
Wir & Cal $9.95

SPECIAL PRICING!

PRIME - HIGH SPEED RAM

21L02-3 400 NS

LOW POWER - FACTORY FRESH

1-24	$1.75 ea.	100-199	$1.45 ea.
25-99	1.60 ea.	200-999	1.39 ea.

1000 AND OVER $1.29 ea.

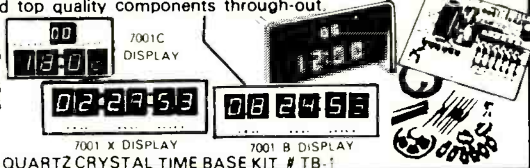
6-DIGIT LED CLOCK CALENDAR KIT

DATE-TIME-SNOOZE ALARM & MORE... KIT 7001

FOR THE BUILDER THAT WANTS THE BEST. FEATURING 12 OR 24 HOUR TIME — 29-30-31 DAY CALENDAR. ALARM. SNOOZE AND AUX. TIMER CIRCUITS

Will alternate time (8 seconds) and date (2 seconds) or may be wired for time or date display only, with other functions on demand. Has built-in oscillator for battery back-up. A loud 24 hour alarm with a repeatable 10 minute snooze alarm, alarm set & timer set indicators. Includes 110 VAC/60Hz power pack with cord and top quality components through-out.

KIT-7001B WITH 6-.5" DIGITS $39.95
KIT-7001C WITH 4-.6" DIGITS & 2-.3" DIGITS FOR SECONDS $42.95
KIT-7001X WITH 6-.6" DIGITS $45.95



KITS ARE COMPLETE (LESS CABINET)
ALL 7001 KITS FIT CABINET I AND ACCEPT QUARTZ CRYSTAL TIME BASE KIT # TB-1

JUMBO DIGIT CLOCK

A complete Kit (less Cabinet) featuring: six .5" digits, MM5314 IC 12/24 Hr. time, PC Boards, Transformer, Line Cord, Switches and all Parts. Ideal Fit in Cabinet II

Kit #5314-5 $19.95 2/$38.

JUMBO DIGIT CONVERSTION KIT $9.95 ea.

Convert small digit LED clock to large .5" displays. Kit includes 6 - LED's, Multiplex PC Board & Hook up info.
Kit #JD-1CC For Common Cathode
Kit #JD-1CA For Common Anode

PRINTED CIRCUIT BOARDS for CT-7001 Kits sold separately with assembly info. PC Boards are drilled Fiberglass, solder plated and screened with component layout.

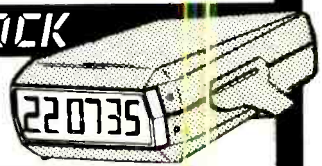
Specify for 7001 B, C or X - $7.95

MOBILE LED CLOCK

12/24 HR .4" DIGITS!

MODEL #2001

12 VOLT AC or DC POWERED



- 6 JUMBO .4" RED LED'S BEHIND RED FILTER LENS WITH CHROME RIM
- SET TIME FROM FRONT VIA HIDDEN SWITCHES • 12/24-Hr. TIME FORMAT
- STYLISH CHARCOAL GRAY CASE OF MOLDED HIGH TEMP. PLASTIC
- BRIDGE POWER INPUT CIRCUITRY — TWO WIRE NO POLARITY HOOK-UP
- OPTIONAL CONNECTION TO BLANK DISPLAY [Use When Key Off in Car, Etc.]
- TOP QUALITY PC BOARDS & COMPONENTS - INSTRUCTIONS.
- MOUNTING BRACKET INCLUDED

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AN EASY TO ASSEMBLE AND EASY TO INSTALL ALARM PROVIDING MANY FEATURES NOT NORMALLY FOUND. KEYLESS ALARM HAS PROVISION FOR POS. & GROUNDING SWITCHES OR SENSORS. WILL PULSE HORN RELAY AT 1HZ RATE OR DRIVE SIREN. KIT PROVIDES PROGRAMMABLE TIME DELAYS FOR EXIT, ENTRY & ALARM PERIOD. UNIT MOUNTS UNDER DASH - REMOTE SWITCH CAN BE MOUNTED WHERE DESIRED. CMOS RELIABILITY RESISTS FALSE ALARMS & PROVIDES FOR ULTRA DEPENDABLE ALARM. DO NOT BE FOOLED BY LOW PRICES! THIS IS A TOP QUALITY COMPLETE KIT WITH ALL PARTS INCLUDING DETAILED DRAWINGS AND INSTRUCTIONS OR AVAILABLE WIRED AND TESTED

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VARIABLE REGULATED 1 AMP POWER SUPPLY KIT

- VARIABLE FROM 4 to 14V
- SHORT CIRCUIT PROOF
- 723 IC REGULATOR
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- CURRENT LIMITING AT 1 Amp

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SOLDER TAIL TIN

pins	ea.	10	100
8	25¢	22	18
14	25	22	18
16	27	23	20
24	50	45	36
28	80	75	68
40	99	94	89

WIRE WRAP TIN (3)

pins	ea.	10	100
14	45	40	32
16	48	43	35
24	75	70	60

molex

500	$4.75	5K	$38
1K	8.50	10K	70
2K	16	50K	325

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High quality .25W 5% All STANDARD VALUES FROM 2.7Ω to 2.2m STOCKED IN DEPTH

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200 ½. 5% $2–

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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.......
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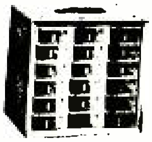
RESISTOR ASSORTMENT with metal cabinet



100ea 1/4W 5%

3.9	6.8	12	18	27	39
56	82	120	180	270	390
560	820	1.2K	1.8K	2.7K	3.9K
5.6K	8.2K	12K	18K	27K	39K
56K	68K	100K	120K	180K	270K
390K	560K	820K	1.2M	1.8M	2.7M

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221-45	221-62	LM2111

$2.25 ea.
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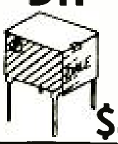
RED PUSH BUTTON
N.O. MOMENTARY CONTACT

30¢ each	
8	$ 2
100	22
1000	195

actual size

DIP TRIMMER



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3A 125VAC CONTACTS

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Type KHP Relay
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24VDC COIL
650 ohms
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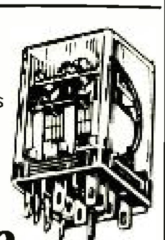
10.5MA



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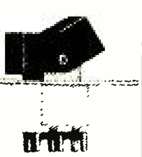
JBT MR1-223 5 AMP DPDT ROCKER SWITCH WITH PANEL MOUNTING HARDWARE......



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ten $6
$49/c

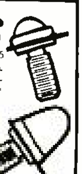
150 Mhz Prescaler

Use your low frequency counter to measure VHF or UHF frequencies. This kit will divide the input signal by ten (10 or 100 with 650MHz option)
Kit contains drilled circuit board, 2 MC10131 IC's, all parts needed and instructions.

150/170MHz KIT $12.95
650MHz option W/11C90 IC.......$29.95

-requires 5v at app. .2A, power supply and case are not part of kit---

SUPER LED's



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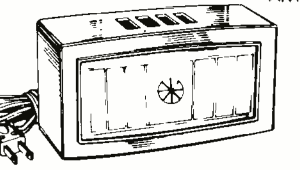

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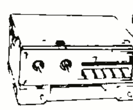

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AU-580

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- Has Volume, Tone and Manual Tuning Controls

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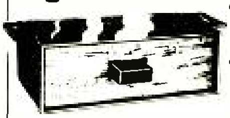
CB-417



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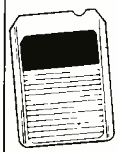

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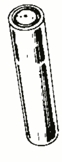

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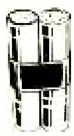

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• 1000 ohms per volt

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• 4D Matrix for 2 & 4 speaker systems • Wall/Console
• Contemporary design black and chrome front panel

The Philharmonic

SPECIFICATIONS: AMP: Pwr. our 5W x 2 RMS, both chan into 8 ohms, 40-20000 Hz. THD 0.9%. Freq. resp. 15-20,000±2db. S/N ratio 55db. FM: Sens 2.7 uV for 20 db S/N. Requires 115-VAC 60 Hz. Size: 8½ x 13½ x 3½". Wt. 7 lbs.

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In 5-12-15 volts! 1-AMP REGULATED POWER SUPPLY

New! Easy to assemble! Uses LM340K positive voltage regulator. Reverse leads for a negative supply. Buy 2 for a ± power supply! With transformer, regulator, PC board & all components. Complete kit, nothing else to buy. Wt. 4 lbs.

☐ Your choice

KIT **$8.88** ☐

Cat. No.	Volts	
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upright · flat

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MAN 3	Common Cathode-red	125	39	MAN 6650	Common Cathode-orange ±1	.560	1.25
MAN 4	Common Cathode-red	.187	1.95	MAN 6660	Common Anode-orange	560	1 25
MAN 7	Common Anode-red	.270	1.25	MAN 6680	Common Cathode-orange	560	1 25
MAN 7G	Common Anode-green	.270	1 95	MAN 6710	Common Anode-red-D.D.	.560	1 25
MAN 7Y	Common Anode-yellow	.270	1 95	MAN 6730	Common Anode-red-D.D	.560	1.25
MAN 52	Common Anode-green	.300	1.00	MAN 6740	Common Cathode-red-D.D.	560	1.25
MAN 71	Common Anode-red	300	1.25	MAN 6750	Common Cathode-red ±1	560	1 25
MAN 72	Common Anode-red	.300	1.25	MAN 6760	Common Anode-red	.560	1.25
MAN 74	Common Cathode-red	.300	1.50	MAN 6780	Common Cathode-red	.560	1 25
MAN 81	Common Anode-yellow	300	1.00	DL701	Common Anode-red ±1	.300	1.00
MAN 82	Common Anode-yellow	300	1.00	DL702	Common Cathode-red	300	1.25
MAN 84	Common Cathode-yellow	.300	1 00	DL704	Common Cathode-red	300	1 50
MAN 3620	Common Anode-orange	.300	1 00	DL707	Common Anode-red	.300	1 50
MAN 3630	Common Anode-orange ±1	.300	1 35	DL741	Common Anode-red	.600	1.95
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MAN 4640	Common Cathode-orange	400	1 00	DL749	Common Cathode-red ±1	630	1 95
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CA3053	1.50	CA3102	2 95
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XR-1310CP	$3 20	XR-1489	4 80	XR-2240CP	4 80
XR-1310EP	3 20	XR-2208	5 20	**PHASE LOCKED LOOPS**	
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XR-2567	2 99			XR-215	6 60
				XR-567CP	1 95
				XR-567CT	1 70

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

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

SOLDERTAIL STANDARD (TIN)

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

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100
8 pin	$ 30	27	24
14 pin	35	32	29
16 pin	38	35	32
18 pin	52	47	43
24 pin	$ 70	63	57
28 pin	1 10	1 00	90
36 pin	1 75	1 40	1 26
40 pin	1 75	1 59	1 45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin	$.40	.38	35
10 pin	45	41	37
14 pin	39	38	37
16 pin	43	42	41
18 pin	75	68	62
22 pin	.96	85	75
24 pin	$1 05	95	85
28 pin	1 40	1 25	1 10
36 pin	1 59	1 45	1 30
40 pin	1 75	1 55	1 40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

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

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$9.95 ea.**

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

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

NOW OPEN SATURDAYS

James ELECTRONICS

1978 CATALOG NOW AVAILABLE

1021-A HOWARD AVE., SAN CARLOS, CA. 94070
PHONE ORDERS WELCOME — (415) 592-8097
All Advertised Prices Good Thru December

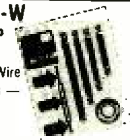
HOBBY-WRAP TOOL-BW-630

- Battery Operated (Size C)
- Weighs ONLY 11 Ounces
- Wraps 30 AWG Wire onto Standard DIP Sockets (.025 inch)
- Complete with built-in bit and sleeve

$34.95 (batteries not included)

WIRE-WRAP KIT — WK-2-W

WRAP • STRIP • UNWRAP



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

$11.95

WIRE WRAP TOOL WSU-30
WRAP • STRIP • UNWRAP - $5.95

WIRE WRAP WIRE — 30 AWG

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

WIRE DISPENSER — WD-30

- 50 ft. roll 30 AWG KYNAR wire wrap wire **$3.45 ea.**
- Cuts wire to desired length
- Strips 1" of insulation **Specify** — Blue-Yellow-White-Red

REPLACEMENT DISPENSER SPOOLS FOR WD 30
Specify blue, yellow, white or red **$1.98/spool**

DIP/IC INSERTION TOOL WITH PIN STRAIGHTENER
Inserts both 14 and 16 pin packages. Pin Straightener built into Handle.
Model INS-1416 **$3.49/ea.**

HP 5082-7400 SERIES — MULTI-DIGIT

			10 or more
• ⅛" ht. • Common Cathode Red	2 Digit	$ .79	.69
• 3-5 volts @ 5 mils/second	3 Digit	.89	.79
• 7 segment Monolithic	4 Digit	.99	.89
• Dip Package	5 Digit	1.19	.99

TV GAME CHIP SET — $9.95

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

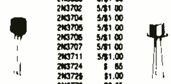
ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3 3	400mm	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1 00	1N4006	800 PIV	1 AMP	10/1 00
1N752	5 6	400m	4/1 00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6 2	400m	4/1 00	1N3600	50	200m	6/1 00
1N754	6 8	400m	4/1.00	1N4148	75	10m	15/1 00
1N959	6 2	400m	8/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1 00	1N4305	75	25m	20/1 00
1N5232	5 6	500m	28	1N4734	5.6	1w	28
1N5234	6.2	500m	28	1N4735	6 2	1w	28
1N5235	6.8	500m	28	1N4736	6 8	1w	28
1N5236	7 5	500m	28	1N4738	8 2	1w	28
1N456	25	40m	6/1 00	1N4742	12	1w	28
1N458	150	7m	6/1 00	1N4744	15	1w	28
1N485A	160	10m	6/1 00	1N1183	50 PIV	35 AMP	1 60
1N4001	50 PIV	1 AMP	12/1 00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1 00	1N1185	150 PIV	35 AMP	1 50
1N4003	200 PIV	1 AMP	12/1 00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1 00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR	$1 95
C38M	35A @ 200V	SCR	1.95
2N2328	1 6A @ 200V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC	1 95
MDA 980-3	12A @ 200V	FW BRIDGE REC	1 95

TRANSISTORS



MPS A05	5/$1 00	2N3638	5/$1 00	PN4250	4/$1.00
MPS A06	5/$1 00	2N3702	5/$1 00	2N4400	4/$1.00
2N918	4/$1 00	2N3704	5/$1 00	2N4401	4/$1.00
2N2219A	3/$1.00	2N3705	5/$1 00	2N4402	4/$1.00
2N2221	4/$1 00	2N3706	5/$1 00	2N4403	4/$1 00
2N2222A	5/$1 00	2N3707	5/$1 00	2N4409	5/$1 00
2N2369	5/$1.00	2N3711	5/$1.00	2N5086	4/$1 00
2N2369A	4/$1 00	2N3724	$ 65	2N5087	4/$1.00
2N2484	4/$1 00	2N3725	$1.00	2N5088	4/$1 00
2N2906A	4/$1 00	2N3772	$2 25	2N5089	4/$1 00
2N2907A	5/$1 00	2N3903	5/$1 00	2N5129	5/$1.00
2N2925	5/$1 00	2N3904	4/$1 00	2N5138	5/$1 00
2N3035	2/$1 00	2N3905	4/$1 00	2N5139	5/$1.00
2N3055	$ 89	2N3906	4/$1 00	2N5209	5/$1 00
MJE2955	$1 25	2N4013	3/$1 00	2N5210	5/$1 00
MJE3055	$1 00	2N4014	3/$1 00	2N5432	$2 00
2N3392	5/$1 00	2N4123	6/$1 00	2N5449	3/$1 00
2N3398	5/$1 00	PN4249	4/$1 00	2N6051	5/$1 00
PN3567	3/$1 00			C106B1SCR	2/$1 00
PN3568	4/$1 00			40409	$1 75
PN3569	4/$1 00			40410	$1 75

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

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

100 VOLT MYLAR FILM CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
001mf	.12	.10	.07	.022mf	13	11	08
.0022	12	10	07	047mf	.21	17	.13
0047mf	12	10	.07	1mf	27	23	.17
01mf	.12	10	07	.22mf	.33	27	22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
.1/35V	28	23	17	1.5/35V	.30	26	.21
15/35V	28	23	17	2.2/25V	.31	27	.22
.22/35V	28	23	17	3.3/25V	.31	.27	22
.33/35V	28	.23	17	4 7/25V	32	28	.23
47/35V	28	.23	17	6 8/25V	36	.31	25
.68/35V	.28	23	17	10/25V	40	35	.29
1.0/35V	.28	.23	17	15/25V	.63	.50	40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead	1-9	10-49	50-100	Radial Lead	1-9	10-49	50-100
.47/50V	15	.13	10	.47/25V	15	13	.10
1 0/50V	.16	14	11	.47/50V	16	14	.11
3.3/50V	15	.13	10	1 0/16V	.15	.13	.10
4 7/25V	16	14	12	1.0/25V	16	14	.11
10/25V	15	13	.10	1.0/50V	16	14	.11
10/50V	16	14	12	4.7/16V	15	13	.10
22/25V	17	15	12	4.7/25V	15	13	.10
22/50V	.24	.20	18	4.7/50V	16	14	11
47/25V	19	17	.15	10/16V	14	.12	.09
47/50V	25	21	19	10/25V	.15	.13	.10
100/25V	.24	20	18	10/50V	16	14	.12
100/50V	.35	30	28	47/50V	.24	.21	.19
220/25V	.32	28	25	100/16V	.19	15	14
220/50V	45	.41	.38	100/25V	.24	.20	.18
470/25V	33	.29	27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	16
2200/16V	.70	.62	55	470/25V	.31	.28	.26

CIRCLE 16 ON FREE INFORMATION CARD

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	$1.95
CY3A	4.000 MHz	HC18/U	$4.95
CY7A	5.000 MHz	HC18/U	$4.95
CY12A	10.000 MHz	HC18/U	$4.95
CY14A	14.31818 MHz	HC18U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

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

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 SUBMINIATURE

DB25P	PLUG	$3.25
DB25S	SOCKET	$4.95

HEAT SINKS
205-CB 680-.75A

205-CB	Beryllium Copper w-black finish for TO-5	$ .25
291-.36H	Aluminum for TO-220 Transistors & Regulators	$ .25
680-.75A	Black Anodized Aluminum for TO-3	$1.60
Oude 4	Black Anodized Aluminum — predrilled mounting holes for TO-3 — 4¾ x 1¼ x 2"	$1.75

DIP SWITCHES SPST Slide Action
#206-4 (8 pin dip) 4 switch unit $1.75 ea.
#206-7 (14 pin dip) 7 switch unit $1.95 ea.
#206-8 (16 pin dip) 8 switch unit $2.25 ea.

Etching Kits (cannot be shipped via air)

32 X A-1	P.C. Etch Materials Kit enough for 5 circuit boards	$29.95 ea.
27 X A-1	Etched Circuit Kit	$ 9.95 ea.

Plugboards

3662	Complete kit — only add water. 6.5 x 4.5 x 1/16 Epoxy glass P-Pattern-44 P.C. Tabs-spaced .156	$ 6.95 ea.
22/44	Mating connector for plugboard — 22 pin double readout	$ 2.95 ea.
8800V	Universal Microcomputer/Processor plugboard — Epoxy Glass — complete with heatsink and mounting hardware 5.313 X 10 X 1/16 copper clad	$19.95 ea.

Vector

1/16 VECTOR BOARD

	0.1" Hole Spacing Part No	P-Pattern L	P-Pattern W	Price 1-9	Price 10 up
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 062XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44 062WE	4.50	6.50	2.07	1.86
	84P44 062WE	4.50	8.50	2.56	2.31
	169P44 062WE	4.50	17.00	5.04	4.53
	169P84 062WE	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062WEC1	4.50	17.00	6.80	6.12

Vector SLIT-N-WRAP WIRE WRAP TOOL
- Slits and opens insulation exposing bare wire
- No pre-cutting or pre-stripping
- Comes complete with two - 100 ft spools #28 AWG wire

Model P180 $24.50

HEXADECIMAL ENCODER 19-KEY PAD

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

$10.95 each

63 KEY KEYBOARD $29.95

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

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

TOOLS

A97MS	— Diagonal Cutter - 4" semi-flush cut	$7.95 ea.
A11DMS	— Chain Nose Pliers - 4¾" long	7.50 ea.
T-6	— Wire Stripper - #16 to #26 gauge	3.75 ea.
55B	— Wire Stripper - #10 to #20 gauge	2.50 ea.
CS-8	— Cutter-Crimper Tool - 8¼" long	7.95 ea.
Nibbing Tool	— Cuts, Trims or Notches Metal up to #18 gauge	6.95 ea.
Nibbling Tool Replacement Punch		3.75 ea.

PERMACEL® P-29 PLUS Electrical Tape - All Weather • ¾" wide x 66 ft • Black vinyl
1-9 Rolls $.79 each 10-up Rolls $6.95/10 roll package

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

8080A	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	1.95
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	2 for 1.00
UPD414(2104)	4K	Dynamic 16 Pin	5.95

PROMS

1702A	2048	Famos	$ 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

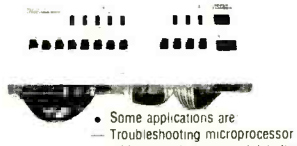
FCM3817	$5.00	11C90	19.95	MCM6575	17.50	9368	3.95
AY-3-8500-1	8.95	4N33	3.95	ICM7045	24.95	LD110/111	25.00/set
AY-5-9100	17.50	8T20	7.50	ICM7207	7.50	95H90	11.95
AY-5-9200	14.95	8T97	2.00	ICM7208	22.00	MC3061P	3.50
AY-5-9500	4.95	HD0165	7.95	ICM7209	7.50	MC4016 (74416)	7.50
AY-5-2376	14.95	MCM6571	17.50	MK50240	17.50	MC1408L7	8.95
9374	1.95	MCM6574	17.50	DS0026CH	3.75	MC1408L8	9.95
82S115	25.00	7205	19.95	TIL308	10.50		

CLOCK CHIPS

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

PARATRONICS
Featured on February's Front Cover of Popular Electronics

Logic Analyzer Kit
Model 100A
$229.00/kit



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

- 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 — $229.00
Baseplate — $6.95

B&K PRECISION 3½-Digit Portable DMM

- Overload Protected
- .3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv, 1Va, 0.1 ohm resolution
- Overrange reading
- 10 meg input impedence
- 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	8.00
Rechargeable Batteries BP-26	20.00
Carrying Case LC-28	6.00

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 sources, i.e. batteries, 110 or 220V with charger, 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95

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

CONTINENTAL SPECIALTIES
PROTO BOARD 6
$15.95
(6" long X 4" wide)

Other CS Proto Boards

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

(includes power supply)

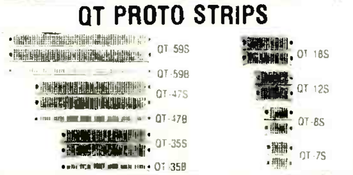
LOGIC MONITOR for DTL, HTL, TTL or CMOS Devices **$84.95**

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

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

Experimentor 300	$ 9.95
Experimentor 600	$10.95

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax
Spec Sheets - 25¢ — Send 35¢ Stamp for 1978 Catalog
Dealer Information Available

NOW OPEN SATURDAYS

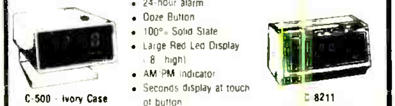
James ELECTRONICS

1978 CATALOG NOW AVAILABLE

1021-A HOWARD AVE., SAN CARLOS, CA. 94070
PHONE ORDERS WELCOME — (415) 592-8097
All Advertised Prices Good Thru December

Timeband
A Trademark of Fairchild Camera and Instrument Corporation

Digital Alarm Clocks



- 24-hour alarm
- Doze Button
- 100% Solid State
- Large Red Led Display (.8" high)
- AM PM indicator
- Seconds display at touch of button
- Power failure indicator
- One year factory warranty

C-500 - Ivory Case
C-500B - Ebony Case
$16.95

C-8211 Walnutgrain Case
$19.95

Timeband by FAIRCHILD LAMP CLOCK

- 24 hour alarm
- Doze button
- Alarm-on indicator
- .8" high Red LED Display
- AM/PM Indicator
- High intensity lamp
- Lamp shuts off when collapsed

Model C-590 (Ivory) $29.95

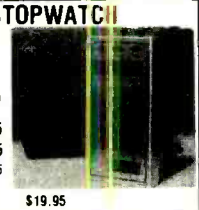
ERC AM/FM 8-Track Stereo Receiver With BSR Changer

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

Size: 20"W x 9¾"H x 15¼"D

Model 8365 $149.95

DIGITAL STOPWATCH



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

Kit — $39.95
Assembled — $49.95
Heavy Duty Carry Case $5.95
Stop Watch Chip Only (7205) $19.95

IMC 3½ DIGIT DPM KIT

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

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

JE700 CLOCK

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

12 or 24 Hour
115 VAC
KIT ONLY $16.95

JOYSTICK

These joysticks feature four 100K potentiometers, that vary resistance proportional to the angle of the stick. Study metal construction with plastic components only at the movable joint. Perfect for electronic games and instrumentation.

100K	$5.95
5K	$4.95

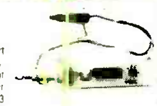
INSTRUMENT/CLOCK CASE

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

$3.95 ea.

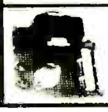
JE803 PROBE

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



$9.95 Per Kit
printed circuit board

T²L 5V 1A Supply



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

$9.95 Per Kit

INTERNATIONAL ELECTRONICS UNLIMITED

DISCOUNT ON ALL IC'S AND LED'S
10% OFF ON $25.00
15% OFF ON $50.00

TTL

7400	.13	7451	.17	74153	.89
7401	.16	7453	.17	74154	1.20
7402	.15	7454	.17	74155	.97
7403	.15	7460	.17	74156	.97
7404	.16	7464	.35	74157	.99
7405	.19	7465	.35	74158	1.79
7406	.20	7470	.30	74160	1.23
7407	.28	7472	.30	74161	.97
7408	.18	7473	.35	74162	1.39
7409	.19	7474	.28	74163	1.09
7410	.16	7475	.49	74164	.99
7411	.25	7476	.30	74165	.99
7413	.43	7483	.68	74166	1.25
7414	.65	7485	.88	74170	2.10
7416	.35	7486	.40	74173	1.49
7417	.35	7489	2.25	74174	1.23
7420	.16	7490	.43	74175	.97
7422	.30	7491	.75	74176	.89
7423	.29	7492	.48	74171	.84
7425	.27	7493	.48	74180	.90
7426	.26	7494	.78	74181	2.45
7427	.29	7495	.79	74182	.79
7430	.20	7496	.79	74184	1.90
7432	.23	74100	.98	74185	2.20
7437	.25	74105	.44	74187	5.75
7438	.25	74107	.37	74190	1.15
7440	.15	74121	.38	74191	1.25
7441	.89	74122	.38	74192	.95
7442	.59	74123	.65	74193	.85
7443	.73	74125	.54	74194	1.25
7444	.73	74126	.58	74195	.74
7445	.73	74132	.89	74916	1.25
7446	.81	74141	1.04	74197	.73
7447	.79	74145	1.04	74198	1.73
7448	.79	74150	.97	74199	1.69
7450	.17	74151	.79	74200	5.45

LOW POWER

74L00	.29	74L51	.29	74L90	1.40
74L02	.29	74L55	.29	74L91	1.20
74L03	.23	74L71	.29	74L93	1.50
74L04	.29	74L72	.45	74L95	1.50
74L06	.29	74L73	.56	74L98	2.25
74L10	.29	74L74	.56	74L164	2.25
74L20	.29	74L78	.75	74L165	2.30
74L30	.29	74L85	1.09		
74L42	1.39	74L86	.65		

LOW POWER SCHOTTKY

74LS00	.36	74LS32	.38	74LS95	2.09
74LS02	.36	74LS40	.45	74LS107	.59
74LS04	.36	74LS42	1.40	74LS164	2.20
74LS08	.38	74LS74	.59	74LS193	2.20
74LS10	.36	74LS90	1.30	74LS197	2.20
74LS20	.36	74LS93	1.30		

HIGH SPEED

74H00	.25	74H22	.25	74H61	.25
74H01	.25	74H30	.25	74H62	.25
74H04	.25	74H40	.25	74H74	.39
74H08	.25	74H50	.25	74H101	.58
74H10	.25	74H52	.25	74H102	.58
74H11	.25	74H53	.25	74H103	.60
74H20	.25	74H55	.25	74H106	.72
74H21	.25	74H60	.25	74H108	.72

CMOS

4000A	.26	4018A	1.19	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		

CAPACITORS
CERAMIC DISC

1pf 50V	82pf 50V	820pf 50V
5pf 50V	100pf 50V	.001uf 50V
7pf 50V	120pf 50V	.0047uf 50V
10pf 50V	150pf 50V	.01uf 50V
22pf 50V	180pf 50V	.01uf 1000V
27pf 50V	220pf 50V	.022uf 50V
33pf 50V	270pf 50V	.030uf 50V
47pf 50V	390pf 50V	.050uf 50V
56pf 50V	470pf 50V	.1uf 50
68pf 50V	600pf 50V	

QTY.	PRICE (each)	PRICE (Minimum 10 per value)
0-10	$.10 ea	
10-100	$.10 ea	$.05 ea
100-		$.04 ea

ELECTRONIC DOOR CHIME KIT

WITH TI TMS 1000 MICROPROCESSOR CHIP PROGRAMMED TO PLAY 24 DIFFERENT TUNES

INTERNATIONAL FLAVOR — PLAYS NATIONAL ANTHOMS 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.

SHIPPING $1.00 **$39.50**

2708 FULL SPEED FROM **$14.95**

5314 6 DIGIT CLOCK CHIP **$2.95**

82S23 256 BIT PROM **$2.95**

2513 CHARACTER GEN 64 x 8 x 5 ASCII **$8.95**

2102 500NS 1 K RAM **$1.29**

UART AY5 1013A **$6.95**

74S200 256 BIT RAM TRI-STATE **$3.25**

LD110, LD111 **$23.95**
3½ DIGIT A/D CONVERTER SET

CENTRAL PROCESSING UNIT
8008
8080A **$16.95**

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		

SPECIAL DEVICES

372	AF-IF Strip Detector DIP	2.93
546	AM Radio Receiver Subsystem DIP	.75
1310	FM Stereo Demodulator DIP	2.90
1496	Balanced Modulator-Demodulator	.99
1800	Stereo multiplexer DIP	2.48
ULN2208	FM Gain Block 34db (typ) mDIP	1.18
ULN2209	FM Gain Block 48db (typ) mDIP	1.35
2513	Character Generator 64x8x5 DIP-24	10.20
3046	Transistor Array DIP-14	.73

LINEAR CIRCUITS

300	$ .71	370	2.42	723	.62
301	.29	376	.68	733	.89
302	.53	380	1.30	739	1.07
304	.80	380-8	1.25	741	.32
305	.71	381	1.75	747	.71
307	.26	382	1.75	748	.35
308	.89	531	2.95	1458	.62
309K	1.35	540	2.95	1800	2.48
310	1.07	550	.79	3900	.49
311	.95	555	.45	7524	.71
319	1.13	556A	1.19	7525	.90
320T	1.39	560	3.39	8038	4.25
320K	1.39	562	3.39	8864	2.25
322	1.70	565	1.18	75150	1.75
324	1.52	566	1.95	75451	.35
339	1.58	567	1.95	75452	.35
340K	1.64	709	.26	75453	.35
340T	1.49	710	.35	75491	.71
372	2.93	711	.26	75492	.80

DISCRETE LED's

		EACH
ME4	INFRARED CLEAR DOME .170"	.29
MV10B	CLEAR DOME .170"	.25
MV50	CLEAR — AXIAL .09"	.12
MV50	RED — AXIAL .09"	.12
NSL100	RED .19"	.12
RL209	RED DIFF. SUBMINIATURE .12"	.12
RLT-T1-03	WHITE DIFF. SUBMINIATURE NO FLANGE .124"	.15
RLC-200	RED DIFF. CURRENT REG. .190" CONST. BRIGHTNESS 4.5-12.5V	.25
RLC-201	RED DIFF. CURRENT REG CONST. BRIGHTNESS 4.5- .190"	.25
RL-4403	RED DIFF. FULL FLOOD .190"	.15
GREEN	SPOT .190"	.18
CLEAR	POINT .190"	.15

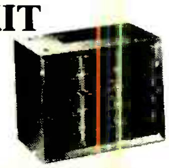
LED s

		EA.
DL10A	RED CA .27" LHD	$1.89
DL 707	RED CA .30" RHD	1.49
DL 507	RED CA .50" RHD	1.49
FND 359	RED CC .375" RHD	.89
DL 702	RED CC .30" LHD	1.39
NSN 74R	RED CC .30" RHD	1.49
DL 500	RED CC .50" RHD	1.49
MAN5	GREEN CA .27" LHD	1.39
MAN8	YELLOW CA .27" LHD	1.39
MAN82	YELLOW CA .3" LHD	1.89
MAN66	RED CA .6" LHD	2.19
DL747	RED CA .6" LHD	2.39

PRECISION RESISTOR KIT

METAL FILM, 1%, RN60
TEMP COEF 50 ppm
¼ WATT, COLOR BANDED
60 values, 2 resistors each
supplied in a 15 drawer,
60 compartment cabinet

$24.95



SHIPPING CHARGE $2.00

RESISTOR ASSORTMENT 12251
2 RESISTORS PER VALUE

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

1702A 2 K ERAS PROM **$4.75**

5738 CALC. CHIP 5 FUNCT WITH MEMORY **$2.95**

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" **$1.60 ea.**

METAL FILM RESISTORS 1%
CRA ¼ RN60 TEMP COEF ± 50 ALL STANDARD DECADE VALVES FROM 10.5 OHM TO 464K OHM

QTY	PRICE EACH	PRICE MINIMUM 10 PER VALUE	PRICE MINIMUM 100 PER VALUE
0 - 10	$.20		
10 - 100	.20	$.15	
100 - 1000		.10	$.09
1000 -		.10	.08

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

SHIFT REGISTERS

		EACH
2502	1024 bit MULT DYN 16 pin	$2.95
2504	1024 bit MULT DYN 8 pin	2.95
2511	Tri-State Dual 50-100-200 bit STATIC 14 pin	2.95
2518	Hex 32-bit STATIC 16 pin	2.95
2519	Hex 40-bit STATIC 16 pin	2.95
2527	Dual 256 bit STATIC 8 pin	2.95
2532	Quad 80 bit STATIC 16 pin	3.95
5013	1024 bit accum. Dynamic 8 pin	1.75
5016	500/512 bit Dynamic 8 pin	1.59

MM5369 Divider mDIP	2.49
Crystal 3.58 MHZ color TV	1.75
Crystal 2.010 MHZ	3.95

Data sheets on request. Add 30¢ each if item is priced below $1.00 each.

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	.50

FREE CATALOG AVAILABLE ON REQUEST

Satisfaction guaranteed. Shipment will be made postage prepaid within 3 days from receipt of order. Payment may be made with personal check, charge card (include number and exp. date), or money order. Phone Orders — BofA and M/C card or C.O.D.

Add $1.00 to cover shipping and handling if order is less than $10.00.
California residents add sales tax. Include shipping expense for orders shipped out of U.S. and Canada approx. 10% of order.

INTERNATIONAL ELECTRONICS UNLIMITED
VILLAGE SQUARE, P.O. BOX 449 DEPT R
CARMEL VALLEY, CA 93924 USA
PHONE (408) 659-3171

JAIL BARS

I've got five jail bars on this Zenith 16Z7C19. I've had them before in the 20Y1C37, which was a bad horizontal blanking diode. This unit doesn't have this diode. The horizontal blanking transistor checks out OK with an ohmmeter. Any suggestions?—B.H., Modesto, CA.

This has to be caused by the fact that the ringing along the baseline of the horizontal pulse is getting through. In this chassis, the blanking is fed into the common-cathode circuit of the difference-amplifier stages (6MN8 tube), but the effect is the same. The transistor could be leaky, upsetting the bias and not clipping off the baseline. Try a new transistor and see if this doesn't help.

AUSTRALIAN MODIFICATION

Have I got a dog for you: a Sears 564-4005100/101 color set. It was purchased in the U.S. then taken to Australia, where it was modified. . . boy, was it modified!

First problem—no sound. I found a transistor circuit that had been used to replace an IC. Putting in a new IC and removing the oddball curcuit took care of that. Now, there's no color unless someone makes a sound or talks! I get streaks of colors flashing through the picture. I checked the color board, which had really been modified. This little PC board, with quite a few transistors, diodes etc., hardwired in, was in the demodulator and bandpass circuits.

Is there a difference between U.S. and Australian standards? And what is this piggyback circuit for?—J. C., Ft. Worth, TX.

I have a strong suspicion that Australia is using PAL color standards. This system is based on the CCIR system, with a 5.5-MHz sound IF (which accounts for the gadget in the sound). The piggyback circuit should be a PAL color decoder. Your best bet is to take it out and rewire it according to the schematic.

DEFECTIVE TRANSISTOR

I had a problem with a Harman-Kardon 930 amplifier. It was pumping, and the speaker cones moved in and out quite a bit at about 1 Hz. I found the cause. Regulator transistor TR905 in the DC power supply was a manic depressive! The preamplifier supply goes through it, and it was acting up at the 1-Hz rate! This transistor checked out OK, of course, but a new one cleared up the problem. Figure that one out.

(Thanks very much to Danny Biando, Danny Biando Technical Services Co., San Jose, CA, for the hint.)

SERVICE DATA HINT

I can't find service data on a Bradford chassis No. 19C-D, model 79772. The service number is 1171B24. Please help.—E. McL., Lisbon, OH.

Just for luck, I checked the Sams Index. There was nothing listed under 19C-D, or the other number. However, quite by accident I found the 1171B24 number. In many cases, you can cross-reference these numbers to other names. The J. W. Miller *Replacement Guide* lists no less than 16 companies that have manufactured sets under the Bradford name. Sometimes you can check the schematic and photos for a make.

CB RADIO STATIC

This new CB radio has a problem. Above about 25 miles per hour, there is terrific static in the receiver. All the stock suppression devices have been installed—resistor spark plugs, alternator suppressors, etc. Nothing works. Any help will be appreciated.—D. B., Crittenden, KY.

This sounds like a classic problem I haven't experienced for a long time.

Try this: Run the car up to the speed at which you hear the noise, turn the engine off and kick it into neutral, letting the car coast. If you still hear the noise, but it diminishes or stops when you touch the brakes, the interference is caused by "wheel static." This static is heard when the wheel rotates and makes and breaks electrical contact with the car body. The tires then build up static charges.

Here's the cure: tape off the front wheel grease caps. Install a grounding spring, which is a small spiral spring that fits inside the cap and makes contact with the lathe center of the front spindle.

NOW-THE ULTIMATE RAM BOARD

32K FOR $475.00

MEMORY CAPACITY
MEMORY ADDRESSING
MEMORY WRITE PROTECTION

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

Available the 1st quarter of 1978: 16K, 32K, 48K, 64K using Mostek 4116 with 16K boundaries and protection.

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.

PRICES START AT $151. FOR 8K RAM KIT
Add $108.00 for each additional 8K Ram

Board fully assembed and tested for $50. extra.

8K FOR $151.00

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.

8K LOW POWER RAM - $159.95

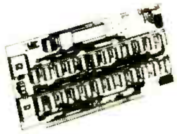
Imsai –Altair – S-100 Buss compatible, uses low power static 21L02-500ns fully buffered on board regulated, quality plated through PC board, including solder mask. 8 pos. dip switches for address select. Fully assembled and tested. Not a kit.

4K LOW POWER RAM KIT

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

The Whole Works-$79.95

Z-80 CPU BOARD KIT - Complete 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 – $39.95

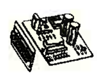
MUSICAL HORN

One tune supplied with each kit. Additional tunes – $6.95 each. Special tunes available. Standard tunes now available: –Dixie – Eyes of Texas – On Wisconsin – Yankee Doodle Dandy – Notre Dame – Pink Panther – Aggie War Song – Anchors Away – Never on Sunday – Yellow Rose of Texas – Deep in the Heart of Texas – Boomer Sooner – Bridge over River Kwai – CAR & BOAT KIT HOME KIT

$34.95 $26.90

Jumbo LED Clock Kit - $16.95

FEATURES:
A. Bowmar Jumbo .5 inch LED array.
B. MOSTEK – 50250 – Super clock chip.
C. On board precision crystal time base.
D. 12 or 24 hour Real Time format.
E. Perfect for cars, boats, vans, etc.
F. PC board and all parts (less case) inc.
Alarm option – $1.50
AC XFMR – $1.50



DIGITAL LED READOUT THERMOMETER - $29.95

Features: Litronix dual ½" displays. Uses silicoaix single chip CMOS A/D converter. Kit includes all necessary parts (except case); AC line cord and power supply included.

6 DIGIT ALARM CLOCK KIT

Features: Litronix dual 1/2" displays, Mostek 50250 super clock chip, single I.C. segment driver, SCR digit drivers. Greatly simplified construction. More reliable and easier to build. Kit includes all necessary parts (except case). P.C. board and Xfmr optional. Eliminate the hassle – avoid the 5314! Do not confuse with Non-Alarm kits sold by our competition! AC XFMR – $1.50 **$12.95/kit**

Bowmar 4 Digit LED Readout Array

4 JUMBO .50" DIGITS ON ONE STICK!
WITH COLONS & AM/PM INDICATOR
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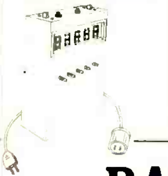
5 Digit Countdown Utility– Darkroom Timer Kit - $44.95



Features: Large LED ½" displays, crystal controlled Mostek 50397 counter display driver, set timer at 0.1 second precision from 0.1 second to 59 minute 59.9 second, 5A 115V relay included to control photographic enlarger, sun lamp, appliances, TV, or other equipment, operates on 115V AC, displays can be turned off for total darkness applications, simple push button operation, use in kitchen, school, office or laboratory. All necessary parts included. Special design case $3.75

6 Digit General Purpose or Computer Timer Kit - $29.95

Features: Large LED ½" displays, Mostek 50397 counter display/driver, counts up to 59 minutes, 59.99 seconds with crystal controlled 1/100 second accuracy, operates on 115V AC or 12V DC supply. Use it to time telephone calls, athletic events, practice time, school and laboratory demonstrations, experiements, chess games, etc. Time computer functions in real time such as run times on programs, sub routines and other computer controlled events. Requires two output channels for start/stop and clear controls. All necessary parts included. Special design case $3.75

Full ½" Litronix Jumbo Dual Digit LED Displays

DL 722 - C.C.
DL 721 - C.A.
99c

DL 728 - C.C.
DL 727 - C.A.
$1.29

RAM's

21L02 - 500NS	8/11.50
21L02 - 250NS	8/15.95
2114 – 4K	14.95
1101A – 256	8/$4.00
1103 – 1K	.99
MK 4115 - 8K	19.45
74S 200 - 256	3.95

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Z–80A includes manual	44.95
8080A CPU 8 BIT	11.95
8008 CPU 8 BIT	6.95

PROM's

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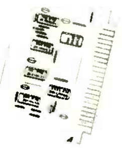
2708 - 8K Intel - 450ns	14.95
5204 - 4K	7.95
82S129 – 1K	2.50
2708S - 8K signetics 650ns	9.95

Low Cost Cassette Interface Kit

$14.95

Features: K.C. standrad 2400/1200 Hz, 300 Baud, TTL, I/O compatible, face lock loop, 22 pin connector. Feeds serial data via microprocessors I/O ports and from cassette tape recorder. $14.95



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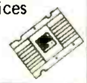

P.C. LEAD DIODES 1N4148/1N914 100/$2.00

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7400	.11	7486	.28
7401	.13	7489	1.25
7402	.13	7490	.65
7403	.13	7491	.61
7404	.15	7492	.43
7405	.13	7493	.43
7406	.16	7494	.67
7407	.23	7495	.67
7408	.19	7496	.67
7409	.19	74100	.28
7410	.13	74104	.49
7411	.18	74107	.28
7412	.13	74109	.22
7413	.37	74121	.29
7415	.27	74122	.39
7418	.75	74123	.48
7420	.13	74124	.48
7421	.13	74136	.80
7423	.25	74141	.75
7426	.24	74151	.61
7427	.19	74153	.61
7428	.15	74154	.98
7430	.13	74155	.58
7432	.23	74156	.58
7433	.28	74157	.55
7436	.35	74160	.55
7437	.23	74161	.55
7438	.23	74163	.55
7440	.13	74164	.85
7441	.76	74175	.85
7442	.47	74180	.67
7443	.59	74191	.98
7444	.59	74192	.79
7446	.68	74193	.81
7447	.68	74194	.81
7448	.71	74195	.69
7450	.13	74H00	.18
7451	.13	74H05	.29
7453	.13	74H20	.29
7454	.13	74H21	.29
7460	.19	74H40	.29
7470	.27	74H50	.20
7472	.25	74H53	.29
7473	.29	74H61	.25
7474	.29	74H72	.45
7475	.47	74H73	.39
7476	.31	74H74	.39
7480	.31	9316	3/1.00
7481	1.10	9601	3/1.00
7482	.57	9L04	.35
7483	.67		

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74LS00	.21	74LS145	1.00
74LS02	.21	74LS151	.70
74LS03	.21	74LS153	.70
74LS04	.28	74LS155	.69
74LS05	.28	74LS156	.70
74LS08	.21	74LS157	.75
74LS09	.28	74LS158	.71
74LS10	.21	74LS160	.85
74LS11	.21	74LS161	.85
74LS13	.45	74LS162	.85
74LS14	.99	74LS163	.85
74LS15	.26	74LS168	.85
74LS20	.24	74LS169	.85
74LS21	.28	74LS170	1.69
74LS22	.28	74LS173	1.10
74LS26	.32	74LS174	1.00
74LS27	.32	74LS175	.81
74LS30	.26	74LS190	.95
74LS32	.32	74LS191	.95
74LS37	.32	74LS192	.95
74LS38	.32	74LS193	.95
74LS40	.26	74LS194	.95
74LS42	.65	74LS195	.85
74LS51	.26	74LS196	.85
74LS54	.26	74LS197	.85
74LS55	.26	74LS251	.85
74LS73	.35	74LS253	.81
74LS74	.35	74LS257	.71
74LS76	.49	74LS258	.71
74LS86	.36	74LS260	.26
74LS90	.55	74LS266	.26
74LS92	.55	74LS279	.55
74LS93	.55	74LS290	.75
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74LS112	.38	74LS295	.95
74LS113	.38	74LS298	.95
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CD4009	.47	CD4050	.49
CD4010	.47	CD4051	1.25
CD4011	.19	CD4052	1.25
CD4012	.19	CD4053	1.25
CD4013	.32	CD4055	1.25
CD4014	.78	CD4066	.78
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CD4020	.97	CD4510	1.10
CD4021	.97	CD4511	1.10
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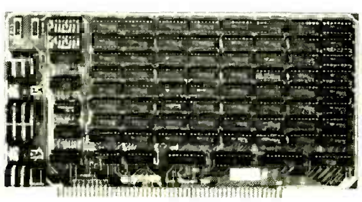

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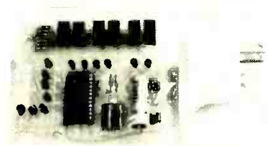

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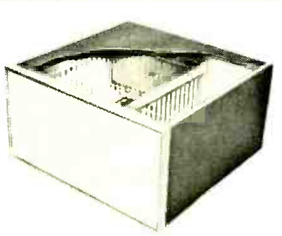

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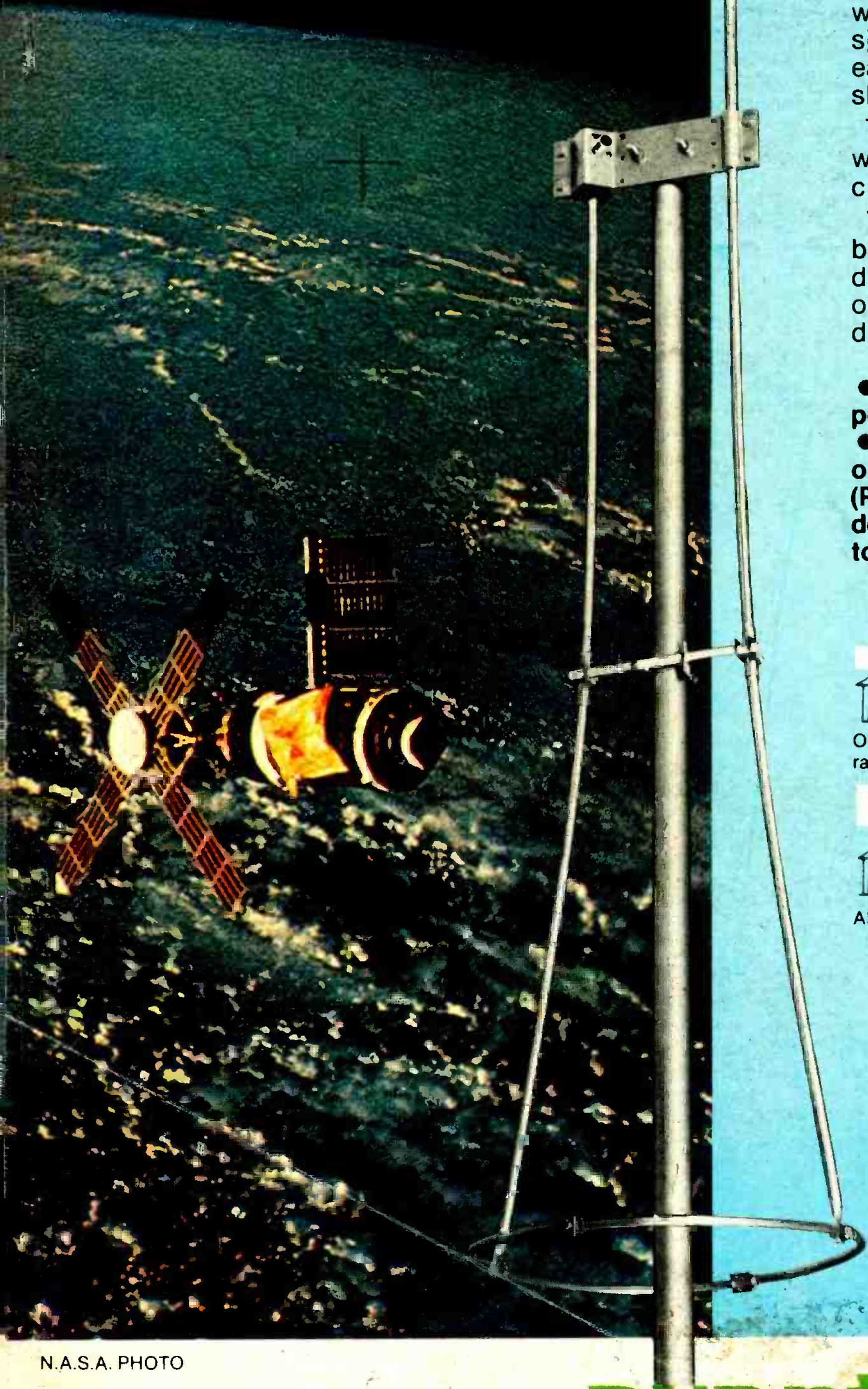

N.A.S.A. PHOTO

CO-INDUCTIVE design of this patented antenna gives long range, noise free performance.

The result of years of research & development, the ASTRO PLANE has top radiation which means that your signal gets out from the highest part of your antenna. Your signal radiates about 15 feet higher than with other antennas which radiate near the bottom.

The ASTRO PLANE has a lower angle of radiation which makes more efficient use of the radiated signal by allowing it to hug the curvature of the earth instead of shooting your power up into the sky.

The ASTRO PLANE has 4.46 db gain over isotropic which gives you a stronger signal and better, clearer reception.

You'll get long lasting, trouble free performance because it is compact in design — without long drooping radials, without coils to burn or short out, and with direct ground construction to help dissipate static charges and lightning.

• Stainless steel radials concentrate signal power on top • Rigid heavy-duty aluminum tubing • No long drooping radials to ice up or break off • So unique it's backed by a U.S. patent (Patent #3587109) • No coils to burn out or detune • Easy assembly • Lightweight — easy to install on simple pipe mast

Ordinary collinear or ground plane antenna signals are blocked...they radiate from the bottom.

ASTRO PLANE gets its signal over obstacles...it radiates from the top.

SPECIFICATIONS

Total Length — 12 feet
Weight — 4 lbs.
Power Gain — 4.46 db
Impedance — 50-52 ohms
Omnidirectional — needs no rotor
Vertical Polarity
Aircraft Quality Aluminum
SWR — Pre-tuned — Less than 1.2 1
band width — full 40 channels

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