

Radio- Electronics

**DIGITAL HI-FI
FOR THE 1980's**

\$1.25 JUNE 1980

48783

Television—how it all began
Improved automotive voltage regulator
How to interface an A/D converter

Satellite-TV reception pitfalls
Build a professional drum synthesizer
Eavesdrop on secret shortwave messages



**BUILD THIS
SYNTHESIZED
FUNCTION GENERATOR**



Take a good look at VACO.



**THE SUPER CASE
70260**

The world famous Super Case. Complete with 48 of the most popular and professional problem-solving tools. From screwdrivers and nutdrivers to pliers, wrenches, crimping tools and more. A super variety and super value. All unconditionally warranted from Vaco, of course. The Super Case and all the other fine Vaco tools can be seen in our new 1979 catalog. It's free, just write. Say you want to take a good look at VACO.

Vaco Products Company, 1510 Skokle Blvd.,
Northbrook, IL 60062 U.S.A.

VACO[®]

CIRCLE 21 ON FREE INFORMATION CARD



Olivetti Break- through

The world's smallest electronic printer will never run out of paper, ink or batteries thanks to Olivetti, JS&A and some incredible new technology.



The new pocket-sized Olivetti calculator slides open to unveil one of the most advanced printing heads ever developed.

It's a major breakthrough. That calculator shown above is the most advanced printing calculator in the world.

SLIP TOP PRINTER

The new Olivetti Logos 9 is only 1" x 2½" x 4⅝" — smaller than many cigarette packages. It has a full 12-digit liquid crystal display with add mode and full-floating or fixed position decimal.

To turn the unit into a printer, you simply slide up the top of the unit to expose the world's smallest and one of the most precise printing heads. The printing head prints letters and numbers, identifies each entry and even clearly separates groups of three whole numbers for easy readability.

PLENTY MORE

If its size and printing head are breakthroughs, so is its paper system. The paper is loaded in special cartridges with enough paper per cartridge for 1300 entries. All you do is simply pop a cartridge into the bottom of the unit each time you change rolls. It's the most convenient way ever designed to change a roll of paper for a printing calculator.

But if you're like most Americans, you'd be concerned about paper supply. Where do you get those special cartridges, and how do you know if you can get them years from now?

That's where JS&A comes in. A 32-roll supply — all you'll ever need for three full years — is only \$16. That's enough paper for 41,000 entries or approximately 52 line entries each working day for three full years.

But even more important, within one year stationery stores will stock the cartridges, and we predict that the Olivetti cartridge will become a standard in the industry.

NO INK CARTRIDGES

The paper is a new type that looks exactly like conventional paper. But the paper, when struck, leaves a clear sharp image without the use of ink. So there's no messy cartridge required and no space needed to store one. You'll never need ink again.

The rechargeable batteries last for 8,000 lines when you use just the printer and 80 hours using just the liquid crystal display. The batteries can be recharged 500 times, so theoretically the batteries should last for 300 rolls of paper, or more than nine times the life of your paper supply. The batteries can also be easily replaced.

POWERFUL COMPUTER

The features looked great. The world's smallest size, the paper roll convenience, the no-ink system, the battery life and the large 12-digit liquid crystal display were enough to convince us, but would the new Olivetti be considered a toy? Then we learned about its computational power and features which we feel are better than many of the most professional full-featured printing calculators.

Speed It's the world's fastest small printer with a speed of 2.1 lines per second. The unit also has a buffer so if you enter data faster than the unit, it will still print out each entry.

Memories The Logos 9 has two separate memories. One is an accumulating memory, and the other is a fully independent memory. And the display and printer indicate which memory is on the paper tape.

Printing Head The totally new printing head is a semi-alpha numeric system which labels all entries with letters to indicate the entry. For example LP is list price and CNT means item count.

Clock The unit is so complete, Olivetti even threw in a digital clock function. Your unit will display accurate time when the 12-digit display is not in use.

Gross Margin It automatically computes everything from gross margins to discounts and retail pricing. You just enter your percentage mark-ups in its memory, and it will automatically compute the results while retaining the formula and percentage in memory.

Plus More It has automatic round off, letting you select which figure to round off to. You can add a column of figures and then average your calculations automatically. The full-information liquid crystal display will tell you everything from when you're in the printer mode to whether you have something in memory and in which memory.

The technological breakthroughs in the Logos 9 were possible because Olivetti was able to eliminate the many interface components between the integrated circuit and the printing head. This was all made possible because Olivetti designed the entire system, not just a few of the components as is the case with most calculators.

So there it was. Great features, great convenience and great value for only \$89.95 complete with batteries, charger and 90-day limited warranty. For \$16 more, you can get 32

cartridges — all the paper you'll ever need for three years or for \$10 more you can get 16 cartridges. So impressed are we with the Olivetti Logos 9 that we are making the following offer:

FREE TRIAL OFFER

We urge you to test the Olivetti Logos 9 now. Order one for our 30-day no obligation trial. See the clear and easy-to-read paper tape and display. Use it as a pocket calculator, and carry it in your briefcase wherever you go. Experience the convenience of always having a printing calculator there whenever you need a permanent record of your transactions.

After 30-days of actual use, decide if you want to keep it. If you do you'll own the smallest, most advanced and convenient pocket printing calculator in the world. If for any reason you're not completely satisfied, simply return your unit within 30-days for a prompt and courteous refund, including your \$2.50 postage and handling. You can't lose.

Olivetti selected JS&A to exclusively introduce this exciting new product. With its solid-state design and high quality printing mechanism, the Olivetti should not require service. But if service is ever required, Olivetti maintains a convenient service-by-mail center as close as your mailbox.

To order your unit for our trial, simply send your money order or personal check for **\$89.95** plus \$2.50 for postage and handling (personal check orders, allow 20 days to clear our bank) to the address below, or credit card buyers may call our toll-free number below. Add \$16 for 32 paper cartridges or \$10 for 16 cartridges. (Illinois residents please add 6% sales tax.)

Who would have imagined a printing calculator this small and this convenient with this much computational power just a few months ago? The Olivetti Logos 9 deserves your test. Order one at no obligation, today.

JS&A PRODUCTS
THAT
THINK

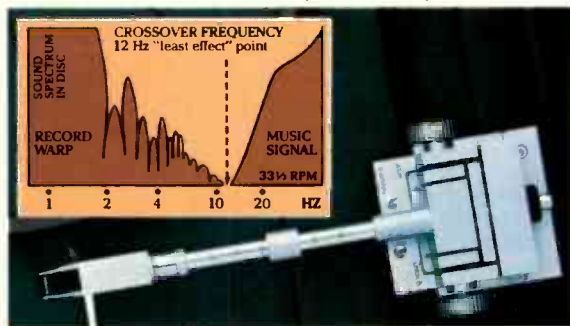
Dept. RA One JS&A Plaza
Northbrook, Ill. 60062 (312) 564-7000
Call TOLL-FREE 800 323-6400
In Illinois Call (312) 564-7000

©JS&A Group, Inc., 1980

Yamaha's PX-2 linear tracking turntable. A class of one.



Yamaha's new PX-2, the flagship of a remarkable new series of turntables from Yamaha, is destined to become the new standard of the audio industry. It is a masterpiece in the art of music reproduction. Totally in a class by itself.



One of the major performance advancements on the PX-2 is Yamaha's unique optimum mass straight tonearm assembly. This design concept is Yamaha's direct challenge to the industry trend of low-mass tonearms. Among the most significant benefits of optimum mass is that it specifically addresses two of the most critical elements of music signal tonal quality—tonearm resonant frequency characteristics and high trackability with a wide range of cartridges. Tonearm mass is such a critical element in sound reproduction (especially in the low and high frequency ranges) that Yamaha has designed this optimum mass tonearm to insure its resonance frequency is at the "least effect" point. (See graph.) As a further benefit, the vast majority of available cartridges can be effectively

matched with the Yamaha tonearm. Even MC types.

But the optimum mass tonearm is only one factor that puts the PX-2 in a class by itself. There's much more. Like an extraordinary 80dB S/N ratio, with incredibly accurate tangential tracking—constantly monitored by an opto-electronic sensor. The PX-2 is also a study in durability with its solid, anti-resonant monolithic diecast aluminum base. And the combined effect of the hefty platter and the heavy-duty DC motor depresses wow and flutter to below 0.01%.

Yet with all this performance, the PX-2 is deceptively easy to operate. All the microprocessor-activated controls are easily accessible—without lifting the dustcover.

The balance of the turntables in our new line (the P-750,

P-550, P-450 and P-350) all incorporate this same optimum mass tonearm philosophy. Each will set new standards for performance per dollar invested.

Visit your local Yamaha Audio Specialty Dealer for a personal test of our remarkable



PX-2 and the other superb turntables in our new series. You'll hear music that's truly in a class by itself.

For more information write us at Yamaha, Audio Division, P.O. Box 6600, Buena Park, CA 90622.

*Yamaha cartridges shown (MC-1X and MC-7) on both models are optional.

Radio- Electronics®

THE MAGAZINE FOR NEW
IDEAS IN ELECTRONICS

Electronics publishers since 1908

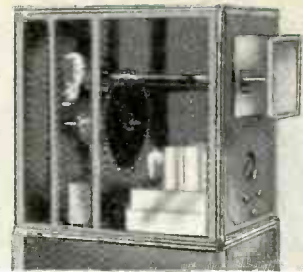
JUNE 1980 Vol. 51 No. 6

SPECIAL FEATURE 43	HISTORY OF TELEVISION A chronological look at the advances that made television a reality. Kathy Goforth
BUILD 47	AUTOMOTIVE VOLTAGE REGULATOR Improved design overcomes many of the shortcomings of factory-installed units. L. Steven Cheairs
51	SYNTHESIZED FUNCTION GENERATOR Phase-locked-loop technology results in improved performance. Gary McClellan
59	PROFESSIONAL DRUM SYNTHESIZER Part 2—Final construction details. This unique device provides many of the features normally found on synthesizers costing several times more. Steve Wood
TECHNOLOGY 4	LOOKING AHEAD Tomorrow's news today. David Lachenbruch
26	SATELLITE TV NEWS The latest happenings in an exciting new industry. Gary H. Arlen
70	NEW IDEAS A winning circuit application from our readers.
80	HOBBY CORNER A 555-timer based control circuit that can be used in a wide variety of applications. Earl "Doc" Savage, K4SDS
RADIO 66	INTERNATIONAL NUMBER STATIONS Secret coded messages are being broadcast internationally. Here's a look at when and where to listen in and what the messages may mean. Robert B. Grove
72	COMMUNICATIONS CORNER A look at how an audio processor boosts receiver performance. Herb Friedman
AUDIO 63	DIGITAL AUDIO FOR THE 1980's A look at PCM technology and its outlook for the 1980's. Len Feldman
VIDEO 68	BACKYARD SATELLITE-TV RECEPTION A rundown of some of the misconceptions. Fred Hopengarten
78	SERVICE CLINIC Conventional power-supply circuits that look very odd. Jack Darr
79	SERVICE QUESTIONS R-E's Service Editor solves technicians' problems.
COMPUTERS 56	HOW TO CONNECT AN A/D CONVERTER Here's how to interface your next microprocessor-based project to analog signals. Joseph J. Carr
EQUIPMENT REPORTS	
32	Global Specialties 3001 Capacitance Meter
38	Heathkit/Thomas TO-1860 Electronic Organ Kit
39	Lafayette BCR-101 General Coverage Receiver

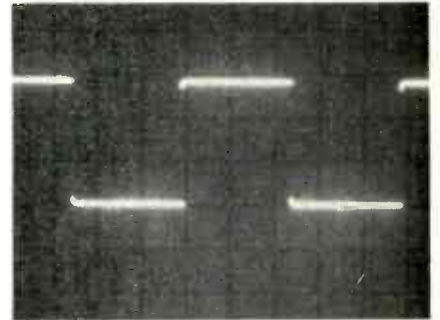
DEPARTMENTS 110	Advertising Index 22	Letters
16	Advertising Sales Offices 88	Market Center
83	Computer Products 81	New Products
16	Editorial 17	Next Month
111	Free Information Card 76	Radio Products
	12	What's News

ON THE COVER

This unique function generator uses phase-locked-loop technology to overcome many of the shortcomings of commercially-available units. Frequency stability is superb. Sine, square, and triangular waveforms are provided via a 50-ohm output jack. The generator also has a separate set of outputs to drive TTL loads.



TELEVISION—from the drawing board to a reality. Shown above is the Jenkins Projection Radiovisor, developed in 1931. For a look at the history of television, turn to page 43.



DIGITAL AUDIO for the 1980's. The square wave response of Toshiba's PCM recorder shows the improved performance of this new audio technology. For the rest of the details, turn to page 63.

Radio-Electronics, (ISSN 0033-7862) Published monthly by Gernsback Publications, Inc., 200 Park Avenue South, New York, NY 10003. Phone: 212-777-6400. Controlled Circulation Postage Paid at Concord, NH. One-year subscription rate: U.S.A. and U.S. possessions, \$13.00, Canada, \$16.00. Other countries, \$18.00. Single copies \$1.25. © 1980 by Gernsback Publications, Inc. All rights reserved. Printed in U.S.A.

Subscription Service: Mail all subscription orders, changes, correspondence and Postmaster Notices of undelivered copies (Form 3579) to Radio-Electronics Subscription Service, Box 2520, Boulder, CO 80322.

A stamped self-addressed envelope must accompany all submitted manuscripts and/or artwork or photographs if their return is desired should they be rejected. We disclaim any responsibility for the loss or damage of manuscripts and/or artwork or photographs while in our possession or otherwise.

As a service to readers, Radio-Electronics publishes available plans or information relating to newsworthy products, techniques and scientific and technological developments. Because of possible variances in the quality and condition of materials and workmanship used by readers, Radio-Electronics disclaims any responsibility for the safe and proper functioning of reader-built projects based upon or from plans or information published in this magazine.

looking ahead

Super-satellites: A new domestic communications satellite with double the capacity of any in existence or planned has been proposed to the FCC by Southern Pacific Communications. SPC has asked for approval to operate three satellites with the equivalent of 48 transponders each and says it could start service by 1982. SPC is basing arguments for its system on more efficient use of available orbiting spots, which now are becoming scarce. Existing domestic satellites are operated by AT&T, Western Union and RCA, with Hughes Communications also seeking to operate a bird. SPC said its system would involve an investment of about \$196 million and would operate on both 4-6 and 11-14 GHz bands.

Zenith joins RCA: The grooved-capacitance videodisc system began to look like an American standard when Zenith announced it would adopt the system, developed by RCA. Zenith said its first players would be on the market around mid-1981, and it would be manufacturing its own players in 1982. The initial players for Zenith's market entry will be supplied on a private-label basis by RCA, which earlier had announced it would start marketing its own players early in 1981. Zenith's proposed price for the players—under \$500—was the same as RCA's. Zenith said it chose the system because it has mass-market potential at a reasonable price.

Zenith thus becomes the second of RCA's major business rivals to join with it in agreements involving the capacitance videodisc system—the first was CBS, which will press discs for the system. The incompatible Philips/MCA grooveless optical system is already on the U.S. market, the discs being sold by MCA and players by Magnavox (at \$775). And this month, Pioneer Electronics will market a player compatible with the Philips/MCA standards. The Matsushita-JVC Video High Density (VHD) grooveless capacitance system so far is still at the starting gate, with no firm adherents.

Phony videotapes: The video boom has spawned a small flood of counterfeit blank cassettes. Most of them from Taiwan, these tapes are packaged in authentic-looking Beta cassettes, but they're loaded with computer tape instead of properly formulated videotape. Some of these have been seized by authorities, but others have found their way into stores. It's very easy to avoid being duped into buying this new "white-box" rip-off. Just insist on tape with recognizable brand names on the box—either tape or equipment manufacturer names. The phony stuff which has been coming in so far generally carries unheard-of brands.

Stereo sound for TV: Whether television deserves stereophonic sound is still hot subject for debate. Japan already has a multi-channel sound system for television, uses it for both stereo and dual-language audio tracks. Japanese home VCR's now are beginning to appear with dual sound tracks to take advantage of the new sound service. The FCC is currently conducting an inquiry into multi-sound channels on TV and the EIA has a technical committee looking into the matter of future

standards. AT&T Long Lines has equipped its intercity network interconnections for a switchover to stereo sound when and if.

Stereo also has become a hot subject in the videodisc field. The MCA/Philips optical disc system now on sale in the U.S. has a provision for stereophonic sound and output jacks for attaching to a home stereo sound system. Other proposed disc systems also feature stereo sound. RCA surprised most observers when it announced that the initial version of its disc system would ignore stereo—both on discs and players—because they would initially be attached to color TV sets capable only of reproducing monophonic sound.

Sound quality of home videocassette recorders is poor, to put it mildly. But now a tape-programming company called Media Home Entertainment proposes to get around all that by releasing videocassettes with stereo sound. How's it done? Simply—musical videocassette releases are accompanied by audio cassettes with a stereo soundtrack. A beep recorded on the videocassette tells the viewer exactly when to push the PLAY button on the cassette deck to synchronize the stereo track with the video performance.

Flat-panel TV: There seem to be renewed efforts in flat-panel TV using conventional picture-tube-like approaches featuring the phenomenon of cathodoluminescence. RCA Laboratories in Princeton, NJ, has been working in this direction since 1973 and says it feels that this area is the most promising it has investigated, and it could result in a commercial product in the "mid-to-late 1980's."

RCA is aiming at a panel 4 to 5 inches thick by 50 inches in diagonal measurement, with all television circuits (including sound and loudspeakers) within the picture frame. It calls its approach "modular guided-beam technology," or as its scientists explain it, "collapsing a picture tube into flat geometry." As envisioned, the panel has a relatively conventional phosphor screen and shadow mask. A 40-inch-long cathode runs along the base of the panel. The screen is divided into 40 one-inch vertical modules, each 30 inches high and separated from the adjacent one by a vertical electrode. RCA so far has built a developmental prototype of a 5-by-10-inch segment of the display. Its goal is a manufacturable panel with quality equal to that of a color picture tube at a reasonable cost.

Another television manufacturer—GTE, maker ofsylvania, Philco, and Saba TV sets—is working in a somewhat similar direction. As reported here (**Radio-Electronics**, November 1978), GTE is working with a team of former Zenith engineers to develop large-screen gas-discharge tubes suitable for color TV displays. Besides the fact that both companies are working in the field of cathodoluminescence, RCA and GTE have something else in common—they're both hoping to start with large displays 35 to 50 inches in diameter, obviously aiming at market segments where they hope to have advantages over Japanese Manufacturers.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

The more logical way to look inside an IC.

LTC Logical Analysis Test Kits: everything you need for over 90% of your digital testing.

Everything you need is at your fingertips. Circuit-powered. And easy to use. Ready to read logic activity at a glance, point-by-point or IC by IC. Or to inject digital signals for testing.

Let the LEDs of our Probes, Pulsers and Logic Monitors light the way to answers for your troubleshooting, design and educational needs. The Logical Analysis Test Kit comes in two versions: our \$250.00* High-Speed Kit, LTC-2, which captures pulses as narrow as 6 nsec, rep rates to 60 MHz; and our \$220.00* Standard Kit, LTC-1, which goes to 50 nsec, 10 MHz. Both include complete manuals, accessories and a compact, custom-molded case. Either way, you've got a strong case for simplified digital testing.

Smarter tools for testing and design.

Our 23-oz. Logical Analysis Test Kits include Logic Probe, Digital Pulser, Logic Monitor, complete manuals and accessories, plus case.



GLOBAL SPECIALTIES CORPORATION

70 Fulton Terr., New Haven, CT 06509 (203) 624-3103, TWX 710-465-1227
OTHER OFFICES: San Francisco (415) 421-8872, TWX 910-372-7992
Europe: Phone Saffron-Walden 0799-21682, TLX 817477
Canada: Len Finkler Ltd., Downsview, Ontario

Call toll-free for details **1-800-243-6077**

*Suggested U.S. resale. Available at selected local distributors. Prices, specifications subject to change without notice.
© Copyright 1980 Global Specialties Corporation.

CIRCLE 40 ON FREE INFORMATION CARD

For your convenience the city and phone number of your nearest Fluke Sales Representative and Distributor are listed below:

**U.S. & Canada
Sales Representatives
for all Fluke products**

AK, Anchorage	(907) 279-5741	CA, Palo Alto	(415) 968-0313	NY, Farmingdale	(516) 289-1653
AL, Huntsville	(205) 881-6220	CA, Palo Alto	(415) 326-5432	NY, Great Neck	(516) 485-7430
ALB, Calgary (S)	(403) 230-1341	CA, Redding	(916) 243-6513	NY, Hauppauge	(516) 231-6333
AZ, Tempe	(602) 967-8724	CA, Rohnert Park	(707) 584-7575	NY, New York	(212) 687-2224
B.C., Burnaby	(604) 294-1326	CA, Sacramento	(916) 446-3131	NY, New York	(212) 691-1171
CA, Burbank (S)	(213) 849-7181	CA, Salinas	(408) 757-4171	NY, Penfield	(716) 377-1020
CA, Santa Clara (S)	(408) 224-1505	CA, San Diego	(714) 565-9171	NY, Rochester	(716) 454-7800
CA, Tustin	(714) 838-8863	CA, San Diego	(714) 560-4841	NY, Thornwood	(914) 769-8070
CA, Carson	(213) 538-3900	CA, San Francisco	(415) 626-1444	NY, Vestal	(607) 748-8211
CO, Denver (S)	(303) 750-1222	CA, Santa Ana	(714) 547-8424	NY, Woodbury	(516) 921-8700
CT, Glastonbury	(203) 633-0777	CA, Santa Clara	(408) 727-2500	OH, Cleveland	(216) 587-3600
FL, Orlando (S)	(305) 896-4881	CA, Santa Monica	(213) 829-1230	OH, Cleveland	(216) 267-0445
GA, Atlanta	(404) 321-0980	CA, Stockton	(408) 727-2500	OH, Dayton	(513) 435-2134
HI, Honolulu (S)	(808) 847-1138	CA, Sunnyvale	(408) 243-4121	OH, Dayton	(513) 434-7500
IA, Iowa City	(319) 354-2811	CA, Sunnyvale	(408) 743-9660	OH, Dayton	(513) 236-9900
IL, Rolling Meadows (S)	(312) 398-0850	CA, Vallejo	(707) 644-6676	OH, Mansfield	(419) 747-6549
IN, Indianapolis	(317) 244-2456	CO, Commerce City	(303) 287-9611	OK, Tulsa	(918) 836-0286
KA, Shaunee Mission	(913) 381-9800	CO, Englewood	(303) 779-3600	ONT, Sudbury	(705) 674-5691
LA, Metairie	(504) 455-0814	CT, Hartford	(203) 527-1881	OR, Eugene	(503) 342-3381
MA, Waltham (S)	(617) 890-1600	CT, Middletown	(203) 346-6646	OR, Medford	(503) 779-7933
MD, Baltimore (S)	(301) 792-7060	CT, New Haven	(203) 787-5921	OR, Portland	(503) 233-3691
MD, Rockville (S)	(301) 770-1570	CT, South Windsor	(203) 289-6853	OR, Portland	(503) 659-2701
MI, Livonia	(313) 522-9140	CT, Stratford	(203) 375-5866	OR, Portland	(503) 233-5341
MN, Apple Valley (S)	(612) 432-9400	CT, Waterbury	(203) 755-1181	OR, Portland	(503) 254-5541
MO, Hazelwood	(314) 731-3388	FL, Leesburg	(904) 728-2369	PA, Philadelphia	(215) 673-5600
NC, Greensboro (S)	(919) 273-1918	FL, Miami	(305) 633-6973	PA, Pittsburgh	(412) 731-5230
NJ, Paramus (S)	(201) 262-9550	FL, Orlando	(305) 843-6770	PA, Pittsburgh	(412) 782-2300
NM, Albuquerque	(505) 265-8431	FL, Pine Castle	(305) 855-4920	PA, Pittsburgh	(412) 892-2953
NS, Dartmouth	(902) 469-7865	GA, Atlanta	(404) 261-7100	PA, Plymouth Meeting	(215) 825-4990
NY, Rochester	(716) 266-1400	GA, Atlanta	(404) 762-5181	PA, Spring House	(215) 643-6555
OH, Dayton	(513) 233-2238	GA, Augusta	(404) 722-2055	PR, Ponce	(809) 843-2260
OH, Middleburg Heights	(216) 234-4540	IL, Bridgeview	(312) 430-2292	SC, Anderson	(803) 226-3421
ONT, Mississauga (S)	(416) 678-1500	IL, Chicago	(312) 622-7766	SC, Charleston	(803) 554-7515
ONT, Ottawa	(613) 829-9651	IL, Elk Grove Village	(312) 593-8650	SC, Columbia	(803) 779-5332
OR, Portland	(503) 642-1342	IL, Joliet	(815) 729-0820	SC, Florence	(803) 669-8201
PA, King of Prussia	(215) 265-4040	IL, Niles	(312) 297-4200	SC, Greenville	(803) 232-5357
PA, Pittsburg	(412) 261-5171	IL, Rolling Meadows	(312) 394-5441	SC, Greenwood	(803) 229-4954
QUE, St. Laurent (S)	(514) 731-8564	IN, Indianapolis	(317) 545-1373	SC, Spartanburg	(803) 583-3681
TX, Austin	(512) 478-9901	IN, Indianapolis	(317) 849-3682	SC, Sumter	(803) 775-2306
TX, Dallas (S)	(214) 233-9990	KS, Greatbend	(316) 793-3507	TN, Jackson	(901) 424-0236
TX, Houston	(713) 683-7913	KS, Lenexa	(913) 292-1700	TN, Johnson City	(615) 477-8104
TX, San Antonio	(512) 340-2621	KS, Salina	(913) 823-6353	TN, Knoxville	(615) 966-3441
UT, Sandy	(801) 566-4864	KS, Wichita	(316) 524-3205	TN, Memphis	(901) 345-9500
WA, Kennewick	(509) 735-4234	KS, Wichita	(316) 267-5216	TN, Memphis	(901) 362-9300
WA, Seattle	(206) 575-3765	LA, Alexandria	(318) 443-4517	TN, Memphis	(901) 332-9358

(S) = Service also

**U.S. & Canada Distributors
of low-cost Digital Multimeters,
Counters, & Thermometers**

AK, Anchorage	(907) 277-7117	MA, Norwood	(617) 762-1006	TX, Houston	(713) 529-3489
AK, Fairbanks	(907) 452-1011	MAN, Winnipeg	(204) 632-1260	TX, Houston	(713) 641-0267
AK, Valdez	(907) 835-4880	MD, Gaithersburg	(301) 948-0710	TX, Houston	(713) 688-9971
AL, Mobile	(205) 479-8581	MD, Timonium	(301) 252-1260	TX, Houston	(713) 688-4494
ALB, Edmonton	(403) 455-4122	MI, Livonia	(313) 525-1155	TX, Houston	(713) 223-4811
AR, Jonesboro	(501) 932-7811	MI, Livonia	(313) 525-1800	TX, Richardson	(214) 231-2573
AR, Morrilton	(501) 354-1849	MI, Madison Heights	(313) 588-2300	UT, Salt Lake City	(801) 484-4496
AZ, Phoenix	(602) 258-8151	MN, Duluth	(218) 722-1766	VA, Alexandria	(703) 354-4330
AZ, Phoenix	(602) 243-4111	MN, Minneapolis	(612) 425-1636	VA, Chesapeake	(804) 424-5121
AZ, Phoenix	(602) 249-2232	MN, Minneapolis	(612) 332-1325	VA, Richmond	(804) 275-1431
AZ, Scottsdale	(602) 947-7841	MN, St. Cloud	(612) 251-7711	VA, Virginia Beach	(804) 499-3746
AZ, Tempe	(602) 968-6241	MN, St. Paul	(612) 222-4781	WA, Bellevue	(206) 453-8300
AZ, Tucson	(602) 881-2348	MO, Raytown	(816) 358-7272	WA, Seattle	(206) 284-0200
BC, Kamloops	(604) 374-5002	MO, St. Charles	(314) 946-5073	WA, Seattle	(206) 282-2511
BC, Kelowna	(604) 860-0585	MO, St. Louis	(314) 426 4500	WI, Green Bay	(414) 435-8331
BC, Nanaimo	(604) 753-1124	MS, Jackson	(601) 354-5700	WI, LaCrosse	(608) 782-3186
BC, Vernon	(604) 545-2394	MS, Pascagoula	(601) 769-1672	WI, Mequon	(414) 241-4321
BC, Victoria	(604) 388-6111	MS, Tupelo	(601) 842-6832		
CA, Anaheim	(714) 630-7016	NC, Charlotte	(704) 377-5413		
CA, Chico	(702) 329-1308	NC, Charlotte	(704) 394-4341		
CA, Culver City	(213) 390-3595	NC, Fayetteville	(919) 485-2111		
CA, El Segundo	(213) 322-8100	NC, Gastonia	(704) 864-3281		
CA, Fresno	(209) 268-6111	NE, Lincoln	(402) 466-8221		
CA, Hayward	(415) 783-1911	NE, North Platte	(308) 532-9260		
CA, Irvine	(714) 754-6624	NE, Omaha	(402) 734-6750		
CA, Los Angeles	(213) 685-4340	NJ, Edison	(201) 287-0517		
CA, Los Angeles	(213) 670-7880	NJ, Fairfield	(201) 227-7720		
CA, Modesto	(209) 527-5850	NJ, South Plainfield	(201) 753-4600		
CA, Monterey	(408) 375-3144	NM, Albuquerque	(505) 299-7658		
CA, Napa	(707) 252-2121	NY, Corning	(607) 962-0555		



Facts from Fluke on low-cost DMM's

Conductance: What it is, and what it can do for you.

We've often referred to conductance as the "missing function" in DMM's — the capability so many of you have wanted in a DMM but couldn't find until we introduced the 8020A Analyst.

Since its introduction, the Fluke 8020A has become the world's best-selling DMM. And four more low-cost models with conductance ranges have been added to our line. But you'll still find this function only on Fluke DMM's.

Simply stated, conductance lets you make resistance measurements far beyond the capacity of ordinary multimeters. Until the 8020A, there was no way to make fast, accurate readings from 20 MΩ to 10,000 MΩ — ranges typically plagued by noise

pickup. Yet, measurements at these levels are vital in verifying resistance values in high-voltage dividers, cables and insulators.

With conductance, the inverse of ohms, which is expressed in Siemens — Fluke DMM's can measure extreme resistances. Simple conversion of direct-reading conductance values, then, yields resistance measurements to 10,000 MΩ (and 100,000 MΩ with the 8050A), without

special shielding and using standard test leads.

Here the 8020A is being used to check leakage in a teflon pcb. With a basic dc accuracy of 0.1% and an exclusive two-year warranty, this seven-function handheld DMM has made hundreds of new troubleshooting techniques such as this possible, and more are being discovered every day.

For more details, call toll free 800-426-0361; use the coupon below; or contact your Fluke stocking distributor, sales office or representative.



8020A
Multimeter



IN THE U.S. AND NON-EUROPEAN COUNTRIES:

John Fluke Mfg. Co., Inc.
P.O. Box 43210 MS#2B
Mountlake Terrace, WA 98043
(206) 774-2481
Telex: 152662

IN EUROPE:

Fluke (Holland) B.V.
P.O. Box 5053, 5004 EB
Tilburg, The Netherlands
(013) 673 973
Telex: 52237

- Please send 8020A specifications.
- Please send all the facts on Fluke low-cost DMM's, including the conductance application note.
- Please have a salesman call.

Name _____

Title _____

Mail Stop _____

Company _____

Address _____

City _____

State _____

Zip _____

Telephone () _____

Ext. _____

For literature circle no. 18

RE

NRI will train you at home to be an electronics professional in the growing world of communications.

Learn to service, repair, and install everything from microwave antennas
to two-way radios...from radar sets to TV transmitters.

TV Tape Recorders



TV Broadcasting



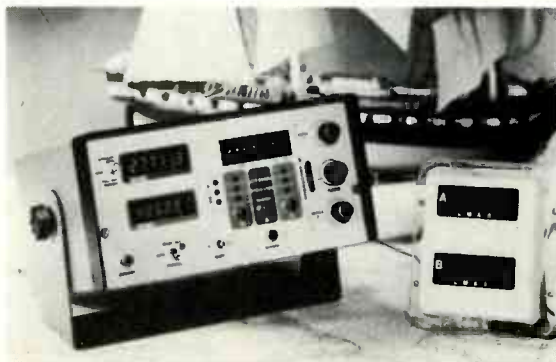
Antenna Systems



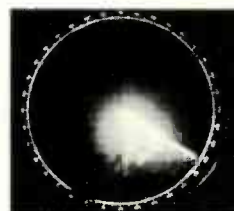
Aviation Communications & Navigation Systems



Marine Communications



Direction Finders, Loran



Radar



No other home-study course gives you such complete, professional training in so many fields of communication. No other gives you the actual bench training with kits and demonstration units specially designed for learning. Only NRI gives you the thorough preparation and training you need to achieve professional competence in the wide world of communications.

Learn at Home in Your Spare Time

Learn at your own pace, right in your own home. There's no need to quit your job or tie up your evenings



Mobile Radio

with night classes. No time or gas wasted traveling to school...NRI brings it all to you. You learn with NRI-pioneered "bite-size" lessons and proven, practical "power-on" training.

Build Your Own 2-Meter, Digitally Synthesized VHF Transceiver or 40-Channel CB

NRI training is "hands-on" training. You get honest bench experience as you build and test this industrial-quality two-way radio and power supply. You reinforce theory lessons as you induce and correct faults, study individual circuits and learn how they interface with others. Or, at your option, you can train with a full forty-channel mobile CB and base-station power supply converter.

You also build and keep for use in your work a transistorized volt-ohm



CB Radio

meter and digital CMOS frequency counter. NRI even gives you special lessons to get your Amateur License so



you can go on the air with your VHF transceiver.

FCC License or Full Refund

In all, you get 48 lessons, 9 special reference texts, and 10 training kits... the training you need to become a professional. And NRI includes training for the required FCC radiotelephone license examination. You pass or *your tuition will be refunded in full*. This money-back agreement is valid for six months after the completion of your course.

Free Catalog, No Salesman Will Call

NRI's free, 100-page full-color catalog shows all the equipment you get, describes each lesson and kit in detail, tells more about the many specialized fields we train you for. It includes all facts on other interesting areas like TV and audio servicing or digital computer electronics. Mail the postage-paid card and see how we can make you a pro.

If the card has been removed, write to:



NRI Schools

McGraw-Hill Continuing
Education Center
3939 Wisconsin Ave.
Washington, D.C. 20016



Aircraft Guidance &
Landing Systems



AM & FM Broadcasting



Microwave Relay

Electronic painkillers are now implantable

Electronic pain-killing devices are not entirely new. Neural stimulators that are attached to the patient's skin are being sold at the rate of 40,000 per year. Their action is not understood—it is believed they may stimulate the brain into producing anti-pain chemicals, or that the minute currents from the stimulators may serve to block transmission of pain impulses along nerve fibers.

These "transcutaneous" stimulators are inefficient—less than ten percent of the applied energy reaches the affected nerves—and the patient has to be attached to a power supply. One instrument (Meditronic) is implantable, but still requires an external power supply.

Now comes Pacemaker Systems, of California, with an instrument that uses electrodes attached to the nerves affected, connected to a small unit implanted in the abdomen. This contains a rechargeable battery and a radio receiver that rectifies radio waves beamed to it from outside the body to recharge the battery.

The device will be costly, says the manufacturer, about \$10,000 as compared to \$500 for a transcutaneous stimulator—plus installation costs. The equipment is expected to be on the market within a year.

Sun supplies all power for Ohio broadcast station

Radio station WBNO (1520 kHz, daytime) of Bryan, Ohio, switched to solar power last August, and has been broadcasting on the sun's energy every sunny day since. The local power utility fills in during bad weather. Peak power of 15,000 watts is supplied by a system of 36,000 photovoltaic cells, manufactured by the Solarex Corp of Rockville, MD.

The experimental project is a joint effort

of WBNO and the Lincoln Laboratory, Massachusetts Institute of Technology. It is being carried out and funded under a Department of Energy contract.

A daytime radio station is exceptionally well adapted to study of solar-powered systems because of its constant and predictable load, and because its operation is roughly coincident with daylight hours. A station with ground-based guys supporting its antenna towers, like WBNO, also has ample ground space for a solar array.

It is expected that, over a year's time, the photovoltaic system will supply from 70 to 90% of the energy required, the rest being supplied by the local utility.

No pressure on auto dealers buying cars without radios

The Custom Automotive Sound Association (CASA), representing American manufacturers, importers, distributors and installers in the automotive sound industry, after communications with American Honda lawyers, has notified Honda dealers throughout the country that their shipments will not be reduced nor delayed if they order new cars without radios. This was in response to reports that Honda dealers were being told that their deliveries might be affected if they did not purchase optional radios through American Honda.

American Honda stated last June: "Honda automobiles will be shipped to the United States and to Honda dealers without radios. Dealers will be free to install whatever radios, if any, they and their customers decide on." Honda's attorneys state that Honda dealers have not been pressured to purchase Honda radios, and that if statements to that effect were made, they were strictly against company policy.

CASA has been instrumental in negotiating with manufacturers to roll back any policies that include radios as standard equipment in new cars. It sponsored an anti-trust

suit against General Motors and settled successfully out of court. Chrysler and Toyota have also amended their radio-standardization policies. Discussions are continuing with Volkswagen, against whom a suit was filed last year.

Sylvania picture tubes now guaranteed for life

Replacement picture tubes may now be purchased with a lifetime warranty that provides for free replacement of any tubes with defects in workmanship, materials, or construction, GTE announces.

All Sylvania *Color Bright* and *All New* brand tubes sold after January 1, 1980 are included in the new policy, which warrants the tube for as long as the buyer owns the set in which it is installed. (Labor and other costs associated with tube installation are, of course, not included in the warranty.)

Among the tubes offered with the lifelong warranty are 15 types that can be used to replace more than 440 of the most popular industry types.

World's longest antenna may go into action soon

The long-proposed ELF (Extremely Low Frequency) system for communicating with submarines at considerable depths may be under way again, the *New York Times* reported in its "Science Times" section last winter.

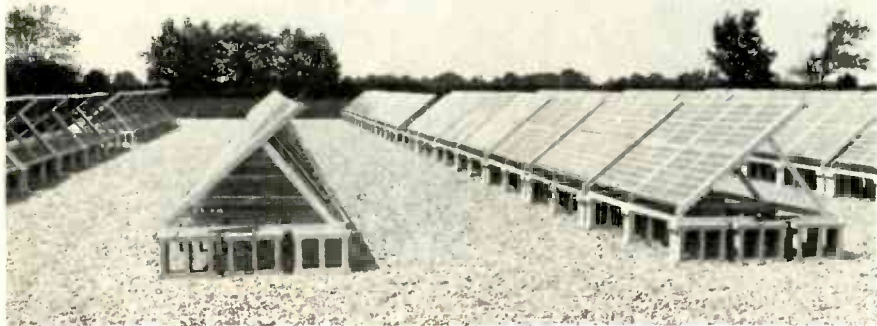
The system calls for underground antennas in the order of hundreds of miles long, and almost the only areas in the United States where the earth formation is suitable are in Michigan and Wisconsin. A number of citizens' groups and political organizations in those states feared that radiation from such antennas might be hazardous, and protested. President Carter, on his election, deferred ordering the system into operation.

A later study, by the National Research Council, has shown that such fears are unfounded. That, plus the fact that with international tensions, naval commanders see "a growing urgency in the need for a deep-water communications system" leads to the feeling that the project will shortly be funded.

The ELF system operates on a frequency of 73 Hertz. (It is interesting to note that the Michigan-Wisconsin protesters did not propose to ban 60-Hertz power lines, which are right out in the open and produce voltage fields hundreds of times greater than anything the ELF antennas could possibly put out.)

The antenna length is 130 miles (much shorter than originally planned). Signals from the system can be read by submarines while submerged "hundreds of feet," down.

continued on page 14



WBNO RADIO'S SOLAR PANELS face due south and cover about one-third acre. Cables leading from each panel connect to the computer-control center where the power is distributed, first to the AM transmitter, then to storage batteries. Any surplus power is used for station lighting, teletype machines, the AM console, etc.

Burglar Alarm Breakthrough



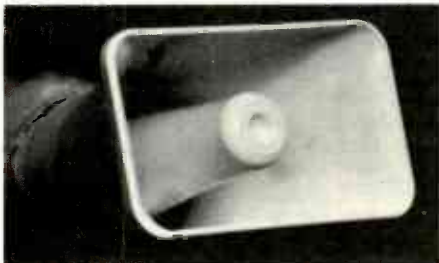
The Midex security computer looks like a handsome stereo system component and measures only 4"x 10½"x 7."

A new computerized burglar alarm requires no installation and protects your home or business like a thousand dollar professional system.

It's a security system computer. You can now protect everything—windows, doors, walls, ceilings and floors with a near fail-safe system so advanced that it doesn't require installation.

The Midex 55 is a new motion-sensing computer. Switch it on and you place a harmless invisible energy beam through more than 5,000 cubic feet in your home. Whenever this beam detects motion, it sends a signal to the computer which interprets the cause of the motion and triggers an extremely loud alarm.

The system's alarm is so loud that it can cause pain—loud enough to drive an intruder out of your home before anything is stolen or destroyed and loud enough to alert neighbors to call the police.



The powerful optional blast horns can also be placed outside your home or office to warn your neighbors.

Unlike the complex and expensive commercial alarms that require sensors wired into every door or window, the Midex requires no sensors nor any other additional equipment other than your stereo speakers or an optional pair of blast horns. Its beam actually penetrates walls to set up an electronic barrier against intrusion.

NO MORE FALSE ALARMS

The Midex is not triggered by noise, sound, temperature or humidity—just motion—and since a computer interprets the nature of the motion, the chances of a false alarm are very remote.

An experienced burglar can disarm an expensive security system or break into a home or office through a wall. Using a Midex system there is no way a burglar can penetrate the protection beam without triggering the loud alarm. Even if the burglar cuts off your power, the four-hour rechargeable battery pack will keep your unit triggered, ready to sense motion and sound an alarm.

ARRIVE HOME SAFE

There's personal danger in arriving home and finding a burglary in progress. And, if you surprise the burglar, you risk the chance of serious injury. With the Midex 55 protecting your home, you can open your front door with the confidence of knowing that no burglar lurks inside.

When the Midex senses an intruder, it remains silent for 20 seconds. It then sounds the alarm until the burglar leaves. One minute

after the burglar leaves, the alarm shuts off and resets, once again ready to do its job. This shut-off feature, not found on many expensive systems, means that your alarm won't go wailing all night long while you're away. When your neighbors hear it, they'll know positively that there's trouble.

PROFESSIONAL SYSTEM

Midex is portable so it can be placed anywhere in your home. You simply connect it to your stereo speakers or attach the two optional blast horns.

Operating the Midex is as easy as its installation. To arm the unit, you remove a specially coded key. You now have 30 seconds to leave your premises. When you return, you enter and insert your key to disarm the unit. You have 20 seconds to do that. Each key is registered with Midex, and that number is kept in their vault should you ever need a duplicate. Three keys are supplied with each unit.

As an extra security measure, you can leave your unit on at night and place an optional panic button by your bed. But with all its optional features, the Midex system is complete, designed to protect you, your home and property just as it arrives in its well-protected carton.

The Midex 55 system is the latest electronic breakthrough by Solfan Systems, Inc.—a company that specializes in sophisticated professional security systems for banks and high security areas. JS&A first became acquainted with Midex after we were burglarized. At the time we owned an excellent security system, but the burglars went through a wall that could not have been protected by sensors. We then installed over \$5,000 worth of the Midex commercial equipment in our warehouse. When Solfan Systems announced their intentions to market their units to consumers, we immediately offered our services.

COMPARED AGAINST OTHERS

In a recent issue of a leading consumer publication, there was a complete article written on the tests given security devices which were purchased in New York. The Midex 55 is not available in New York stores, but had it been compared, it would have been rated tops in space protection and protection against false alarms—two of the top criteria used to evaluate these systems. Don't be confused. There is no system under \$1,000 that provides you with the same protection.

YOU JUDGE THE QUALITY

Will the Midex system ever fail? No product is perfect, but judge for yourself. All components used in the Midex system are of aerospace quality and of such high reliability that they pass the military standard 883 for thermal shock and burn-in. In short, they go through the same rugged tests and controls used on components in manned spaceships.

Each component is first tested at extreme

tolerances and then retested after assembly. The entire system is then put under full electrical loads at 150 degrees Fahrenheit for an entire week. If there is a defect, these tests will cause it to surface.

PEOPLE LIKE THE SYSTEM

Wally Schirra, a scientist and former astronaut, says this about the Midex 55. "I know of no system that is as easy to use and provides such solid protection to the homeowner as the Midex. I would strongly recommend it to anyone. I am more than pleased with my unit."

Many more people can attest to the quality of this system, but the true test is how it performs in your home or office. That is why we provide a one month trial period. We give you the opportunity to see how fail-safe and easy to operate the Midex system is and how thoroughly it protects you and your loved ones.

Use the Midex for protection while you sleep and to protect your home while you're away or on vacation. Then after 30 days, if you're not convinced that the Midex is nearly fail-safe, easy to use, and can provide you with a security system that you can trust, return your unit and we'll be happy to send you a prompt and courteous refund. There is absolutely no obligation. JS&A has been serving the consumer for over a decade—further assurance that your investment is well protected.

To order your system, simply send your check in the amount of **\$199.95** (Illinois residents add 5% sales tax) to the address shown below. Credit card buyers may call our toll-free number below. There are no postage and handling charges. By return mail you will receive your system complete with all connections, easy to understand instructions and a one year limited warranty. If you do not have stereo speakers, you may order the optional blast horns at **\$39.95** each, and we recommend the purchase of two.

With the Midex 55, JS&A brings you: 1) A system built with such high quality that it complies with the same strict government standards used in the space program, 2) A system so advanced that it uses a computer to determine unauthorized entry, and 3) A way to buy the system, in complete confidence, without even being penalized for postage and handling charges if it's not exactly what you want. We couldn't provide you with a better opportunity to own a security system than right now.

Space-age technology has produced the ultimate personal security computer. Order your Midex 55 at no obligation, today.

JS&A PRODUCTS
THAT THINK®

Dept. RA One JS&A Plaza
Northbrook, Ill. 60062 (312) 564-7000
Call TOLL-FREE 800 323-6400
In Illinois Call (312) 564-7000

© JS&A Group, Inc., 1980

continued from page 12

Practical fusion reactor not before year 2010?

The ultimate in a clean and reliable nuclear fuel—consumed in a fusion reactor—will not be attainable in this century, nuclear engineer Robert Conn of the University of Wisconsin told a recent meeting of the American Association for the Advancement of Science. (Fusion reactors have been sought as an almost-answer to the problems of radiation and pollution associated with fission fuels.)

Present research on fusion reactors has been directed toward deuterium and tritium (heavy forms of hydrogen) fuels, but the ultimate goal of fusion research is to achieve fusion with ordinary hydrogen, Mr. Conn told his audience.

Temperatures of 100 million degrees or higher are required for fusion. At those high temperatures, fuel atoms separate into a *plasma* of nuclei and electrons, in which fusion reactions can occur. That plasma must be contained in a magnetic field to keep it from hitting reactor walls, cooling, and stopping the fusion.

Tritium-deuterium requires the lowest temperature of any fuel to start a reaction, and can be contained in the weakest magnetic field. But tritium, in particular, has serious disadvantages: It is hard to produce and is itself radioactive. Ordinary hydrogen is readily available from water and produces few radioactive neutrons when it fuses. But it needs much higher temperatures and requires stronger magnetic fields.

Conn noted that success in tritium-deuterium research is important in the study of hydrogen fuel. Once a self-sustaining tritium fusion reaction is attained, very high temperatures will be available for studying the properties of plasmas at temperatures approaching those that are needed for hydrogen fusion.

He estimated that a demonstration tritium-deuterium fusion reactor could be in operation by the year 2000. Hydrogen-based fusion reactors will not be built for at least another decade.

ISCET Library opens again—ancient schematics available

The ISCET Technical Library is open for business at a new location. The Library was the dream of Henry Golden, CET, who built up the reservoir of out-of-print information. A serious illness in April 1979 left him unable to operate the library. ISCET chairman George Sopocko, CET, packed up the materials and took them to Chicago, where, after months of cataloging, they are again available.

Service technicians needing copies of "unobtainable" technical data may obtain them from the new address. The basic search-and-copy fee is \$2 for the first two

pages—50 cents for each additional page. Address George Sopocko, 5631 Irving Park Road, Chicago, IL 60634 (phone 312-545-3622).

George says he has a good supply of schematics for older TV and radio sets and "a fairly good selection of diagrams for shortwave and amateur radios and for radio and TV test equipment."

For further information about the International Society of Certified Electronic Technicians, or to contact the CET test administrator in your area, write to ISCET, 2708 West Perry St., Fort Worth, TX 76109, or call 817-921-9101.

Electron microscope inventor elected to Hall of Fame

Dr. James Hillier, former Executive Vice President and Chief Scientist of RCA, has been elected to the National Inventors Hall of Fame, for his development of the electron microscope. The National Inventors Hall of Fame was established in 1973, by the National Council of Patent Law Associations in cooperation with the U.S. Patent Office.



Dr. JAMES HILLIER

While a graduate student at the University of Toronto, in the years 1937 to 1940, Hillier and a colleague, Albert Prebus, designed and built the first successful high-resolution electron microscope in the Western Hemisphere. In 1940, he was invited by Vladimir Zworykin (who was elected to the National Inventors Hall of Fame in 1977) to come to the United States and work as a research physicist for RCA. Within a few months he had designed the first commercial electron microscope to be made available in the United States. During the next several years he continued to develop techniques which would extend the capabilities of the instrument and to develop new methods of biological specimen preparation.

Dr. Hillier was named general manager of the RCA Laboratories in 1957, and became

successively Vice President, Vice President RCA Research and Engineering, Executive Vice President, RCA R & E, and in 1976, the year before his retirement, Executive Vice President and Senior Scientist.

Dr. Hillier has received 41 U.S. patents and is the author of more than 100 technical papers.

COMSAT, Sears, are planning joint satellite TV service

COMSAT General Corporation and Sears, Roebuck and Co. have engaged in discussions of a possible joint project for providing satellite-to-home subscription television service. The proposed venture plans to offer high-quality programming nationwide for a fee. Subscribers would receive the service by roof-top antennas. The new service would require approval by the Federal Communications Commission.

Superconducting cyclotron for Michigan State University lab

Michigan State University and the United States Department of Energy (DOE) have signed a \$25.7 million contract for establishing a National Superconducting Cyclotron Laboratory on the MSU campus. Completion is expected in 1984.

A cyclotron speeds up the nuclei of atoms to velocities of tens of thousands of miles a second. Held in a circular orbit by strong magnetic fields, they whirl through the instrument in gradually increasing spirals, then are released like a stone from a sling, to impact other nuclei. The flying wreckage from the resulting collisions gives scientists valuable information about the structure of matter.

The superconducting magnets for the MSU cyclotron are wound with a special alloy of niobium and titanium and are immersed in a bath of liquid helium at a temperature approaching absolute zero (-456°F). That reduces the resistance of the coils practically to zero, allowing fantastic magnetizing currents to flow. One of the magnets to be used is already built and tested. It has a lifting force of 900 tons.

Former cyclotrons could accelerate the nuclei of only the lightest elements. The new superconducting type will be able to hurl the heaviest atomic nuclei in an accurate, concentrated beam at their atomic targets. Scientists expect thus to gain new types of information not obtainable from the older cyclotrons.

The new laboratory will contain two cyclotrons operating in tandem. The first, operating at 500 million electron volts (500 MeV) will feed its accelerated nuclei to the second, rated at 800 MeV, which will propel them to still higher speeds.

The facility will be used by visiting scientists as well as by faculty members of Michigan State University. **R-E**

Brainchild

Yesterday — Remember the first Heathkit Analog Computer (1957)? Or the Heathkit Single-Sideband Transmitter (1958)? How about the Heathkit Multiplex Adapter for FM stereo reception (1963)?

Each was a ground-breaking innovation for its day. Each was a Heathkit brainchild.

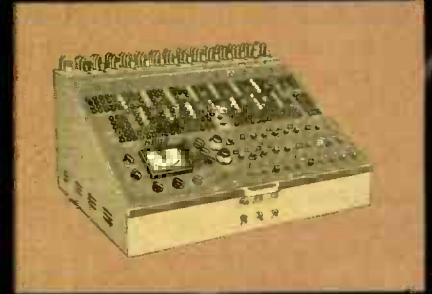
Today — Today's brainchildren include the popular Heathkit All-in-One Computer, a complete computer system with disk storage, smart terminal, two Z80 microprocessors — all in one compact unit.

Also rising fast, the Heathkit Screen Size, a new projection TV that brings together the best in video technology to create the sharpest color picture ever on a six-foot diagonal screen.

Heathkit imagination applied to microprocessor electronics created the Heathkit Weather Computer. It monitors current weather, tracks changes, stores data — and puts it all at your fingertips.

Tomorrow — Tomorrow's brainchild, like today's and yesterday's, will combine the newest and the best in electronics to create a new state-of-the-art.

On the drawing boards right now are new designs for amateur radios, audio components, computers, color TV's, test instruments and new educational programs — all in easy-to-build, money-saving kits. They'll be appearing soon in Heathkit Catalogs and at Heathkit Electronic Centers. It's one catalog you don't want to be without.



Heathkit®

SEND FOR FREE CATALOG

Write to Heath Co., Dept. 020-364,
Benton Harbor, MI 49022.



VISIT YOUR HEATHKIT STORE

In the U.S. and Canada visit your nearby Heathkit Electronic Center where Heathkit products are displayed, sold and serviced. See the white pages of your phone book. In the U.S., Heathkit Electronic Centers are Units of Veritechnology Electronics Corp.

3K-C79

CIRCLE 22 ON FREE INFORMATION CARD



Hugo Gernsback (1884-1967) founder

M. Harvey Gernsback, editor-in-chief

Larry Steckler, CET, publisher

Arthur Kleiman, managing editor

Robert F. Scott, CET, W2PWG,
technical editor

Josef Bernard, associate technical editor,
K2HUF

Jack Darr, CET service editor

Leonard Feldman
contributing high-fidelity editor

Karl Savon, semiconductor editor

Herb Freidman, communications editor

David Lachenbruch, contributing editor

Earl "Doc" Savage, K4SDS, hobby editor

Ruby Yee, production manager

Robert A. W. Lowndes, production
associate

Marie J. Stolfi, production assistant

Gabriele Margules, circulation director

Arline R. Fishman,
advertising coordinator

Cover design by Louis G. Rubsamen

Cover photo by Robert Lewis

Radio Electronics is indexed in *Applied
Science & Technology Index* and *Readers
Guide to Periodical Literature*.

Gernsback Publications, Inc.
200 Park Ave. S., New York, NY 10003
(212) 777-6400
President: M. Harvey Gernsback
Vice President: Larry Steckler
Secretary/Treasurer: Carol A. Gernsback

ADVERTISING SALES

Larry Steckler
Publisher

Paul McGinnis
Director of Marketing

EAST

Stanley Levitan
Radio-Electronics
200 Park Ave. South
New York, NY 10003
(212) 777-6400

MIDWEST/Texas/Arkansas/Okla.

Ralph Bergen
The Ralph Bergen Co.
540 Frontage Road—Suite 361-A
Northfield, Illinois 60093
(312) 446-1444

PACIFIC COAST Mountain States

Jay Eisenberg
J.E. Publishers Representative Co.,
8732 Sunset Blvd.,
4th Floor,
Los Angeles, CA 90069
(213) 659-3810
Sales Mart Building
1485 Bayshore Blvd., Box 140
San Francisco, CA 94124
(415) 864-2352



Toy manufacturers aren't playing games

On the surface, the 1980 Toy Fair in New York was a routine affair. Manufacturers displayed their fall and Christmas product lines to dealers and reps. What wasn't routine about the event were the toys themselves. By far, there were more "electronic" toys seeing the light of day than ever before. In fact, they stole the show.

The hottest-selling electronic toys are the sports variety. These include Baseball, Basketball and Football. Several manufacturers were showing these toys, which included an LED display, sounds, automatic score keeping, and more. Hand-held versions of the arcade games were also exhibited. Using liquid-crystal displays, these mini-versions mimicked their CRT-based big brothers with such games as *Space Invaders* and *Wipeout*. Of course, there were many more toys, including casino games, radio-controlled cars, and even a radio-controlled two-wheel motorcycle.

From my point of view, the real show stoppers were the innovative toys. These included a voice-actuated car that accepted such commands as STOP, GO, LEFT and RIGHT. How about a programmable car? Using an 8-key keyboard, you can, for example, program it to go forward for 3 seconds, turn right for 1 second, left for 2 seconds, reverse for 4 seconds and stop. Then, after placing the car on the floor and pressing the START button, it's fascinating to watch the car execute the program. Admittedly, it's not a giant leap forward in terms of technology, but it is certainly a giant step for the toy industry.

At the show, I managed to interview Garth A. Clowes, President of Entex Industries, Inc. (one of the larger manufacturers of electronic toys). He stated that the semiconductor manufacturers have been very cooperative in helping him develop new products and that he was looking towards developing an in-house engineering capability that will include designers, software programmers, and technicians.

As the present trend toward electronic toys continues, it will prove to be a boon to both the toy industry and the electronics industry. It will affect not only the battery manufacturers, but the electronics industry as a whole. It looks as though another perfect match has been born in Silicon Valley.

ART KLEIMAN
MANAGING EDITOR

next month

JULY 1980

■ Build An Environmental Control System

Energy-efficient thermostat monitors indoor and outdoor temperatures; then controls your heating, ventilating, and air-conditioning systems.

■ Build a Raceway Video Game

You can pretend to be an *Indy 500* race driver without ever leaving the comfort of your armchair after you build this video game.

■ All About Vertical-MOS

High-power semiconductor technology produces devices with near-ideal characteristics. Here's a look at how vertical-MOS devices work.

■ Bass Response vs. Enclosure Size

Hi-fi speaker systems keep getting smaller. Here's a look at how the size of the enclosure affects bass response and some of the trade-offs that are made when designing speaker systems.

PLUS:

Build A Synthesized Function Generator-Part 2

Coax vs. Twinlead For Your TV Antenna

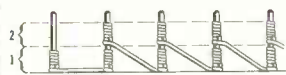
How To Connect An A/D Converter To A Microprocessor.

Hobby Corner

Communications Corner

Service Clinic

Traditional



Wire-Wrapping

NEW

JUST WRAP



Wire-Wrapping

**WHY CUT?
WHY STRIP?
WHY NOT . . .**

JUST WRAP™ WIRE WRAPPING TOOL

- AWG 30 Wire
- .025" Square Posts
- Daisy Chain or Point To Point
- No Stripping or Slitting Required
- JUST WRAP . . .
- Built In Cut Off
- Easy Loading of Wire
- Available Wire Colors:
- Blue, White, Red & Yellow

PATENTED U.S.A.
FOREIGN PATENTS PENDING

JUST WRAP TOOL WITH ONE 50 FT ROLL OF WIRE		
COLOR	PART NO.	U.S. LIST PRICE
BLUE	JW 1 B	\$14.95
WHITE	JW 1 W	14.95
YELLOW	JW 1 Y	14.95
RED	JW 1 R	14.95
REPLACEMENT ROLL OF WIRE 50 FT		
BLUE	R JW B	\$ 2.98
WHITE	R JW W	2.98
YELLOW	R JW Y	2.98
RED	R JW R	2.98
JUST WRAP-UNWRAPPING TOOL		
	JUW 1	\$ 3.49

*Minimum billings \$25.00, add shipping charge
\$2.00/New York State residents add applicable tax



OK Machine & Tool Corporation

3455 Conner St., Bronx, N.Y. 10475 U.S.A.
Tel. (212) 994-6600 Telex 125091

CIRCLE 29 ON FREE INFORMATION CARD

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!

At CIE, we combine theory and practice. You learn the best of both.

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.

That's what happens with CIE's Auto-Programmed® Lessons. Each lesson uses world-famous "programmed learning" methods to teach you important principles. You explore them, master them completely... before you start to apply them!

But beyond theory, some of our courses come fully equipped with the electronics gear to actually let you perform hundreds of checking, testing and analyzing projects.

In fact, depending on the course you take, you'll do most of the basic things professionals do every day — even use a Digital Learning Laboratory to apply the digital theory essential today to keep pace with electronics in the eighties.

Plus there's a professional quality oscilloscope you build and use to "see" and "read" the characteristic waveform patterns of electronic equipment.

You work with experienced specialists.

When you send us a completed lesson, you can be sure it will be reviewed and graded by a trained electronics instructor, backed by a team of technical specialists. If you need specialized help, you get it fast... in writing from the faculty specialists best qualified to handle your question.

People who have known us a long time, think of us as the "FCC License School."

We don't mind. We have a fine record of preparing people to take... and pass... the government-administered FCC License exams. In fact, in continuing surveys nearly 4 out of 5 of our graduates who take

the exams get their Licenses. You may already know that an FCC License is needed for some careers in electronics — and it can be a valuable credential anytime.

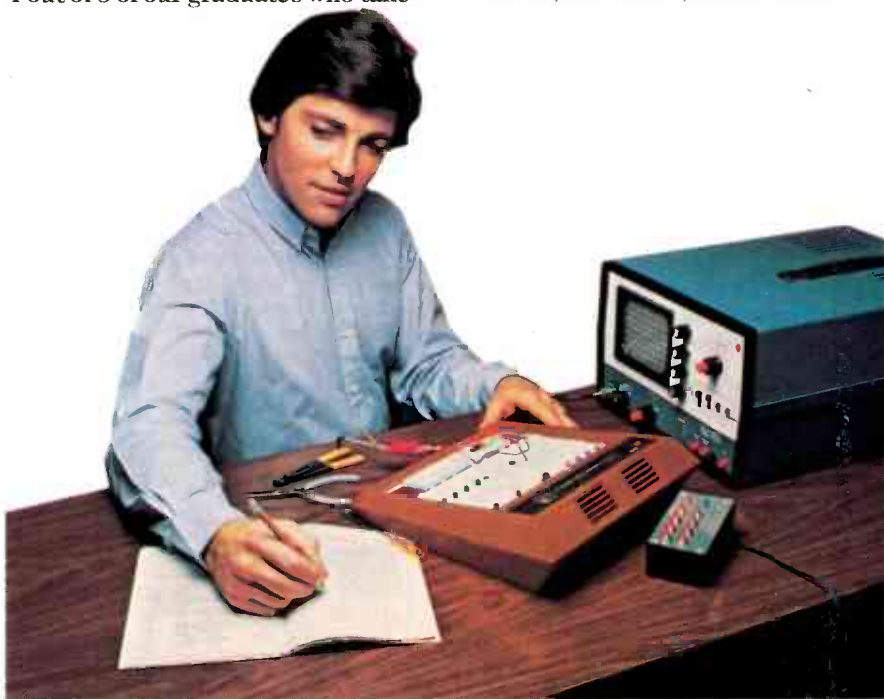
Find out more! Mail this card for your FREE CATALOG today!

If the card is gone, cut out and mail the coupon.

I'll send you a copy of CIE's FREE school catalog, along with a complete package of independent home study information.

For your convenience, I'll try to arrange for a CIE representative to contact you to answer any questions you may have.

Remember, if you are serious about learning electronics... or building upon your present skills, your best bet is to go with the electronics specialists — CIE. Mail the card or coupon today or write CIE (and mention the name and date of this magazine), 1776 East 17th Street, Cleveland, Ohio 44114.



Pattern shown on oscilloscope screen is simulated.

CIE **Cleveland Institute of Electronics, Inc.**
 1776 East 17th Street, Cleveland, Ohio 44114
 Accredited Member National Home Study Council

YES... John, I want to learn from the specialists in electronics — CIE. Send me my FREE CIE school catalog — including details about troubleshooting courses — plus my FREE package of home study information.

Print Name _____

Address _____ Apt. _____

City _____

State _____ Zip _____

Age _____ Phone (area code) _____

Check box for G. I. Bill information: Veteran Active Duty

Mail today!

RE-89

letters

ENERGY ALTERNATIVES

Congratulations on your editorial, "Energy Alternatives—Research and Development" (November 1979 issue) in regard to a need for a much greater funding commitment toward the development of photovoltaic solar cell technology. Indeed, the good news is that major breakthroughs are being made in solar cell technology. The bad news is that even solar cells may have a waste-disposal problem. According to one D.O.E. (Department Of Energy) official, "the compounds used in 'doping' photovoltaic cells, such as cadmium, arsenic, gallium, and indium may pose health risks if not handled properly."

As a suggestion, we should renew our national commitment to further space exploration, and "space industrialization" in particular, to help solve down-to-earth energy problems. There are several reasons for that:

1. Outer-space offers a large supply of clean energy with the "solar power satellite" alternative.
2. Outer-space offers a low-gravity environment for new and unique industrial processes.
3. Space engineering may continue to pay off high dividends in terms of appropriate "spinoff" products—such as *consumer items* that help home owners directly reduce their energy bills (as with the NASA "power-chopper" device).
4. The vastness of outer-space would provide a safe place for the disposal of industrial wastes.
5. Most important: Space exploration offers Americans the hope of a new frontier, essential to human growth and economic development.

With a strong commitment toward space industrialization, we may someday see photovoltaic solar cells being produced very inexpensively for use on earth and in outer-space.

PAUL JUSTUS,
Mission, KS

OOOOOOOOOOPS!

The schematic for "Not Just Another Digital Clock", on page 62 of your February issue, has an error in it. The emitter of transistor Q1 should not connect to the emitter of transistor Q8. It should connect to the common connections of all the LED's.

DERALD D. NYE,
Longmont, CO

You're absolutely right. What's missing is a jumper on the PC board. The holes are there, but the jumper isn't. Many thanks for calling it to our attention. Editor.

In the February 1980 **Radio-Electronics** article covering versatile switching regulators. I found an error in determining the

maximum duty cycle of the system when using the NE5560. The correct ratio for determining the maximum duty cycle is R2/R1 plus R2, as stated in the Signetics Data Manual.

JEFFREY M. RABOLD,
Mansfield, OH

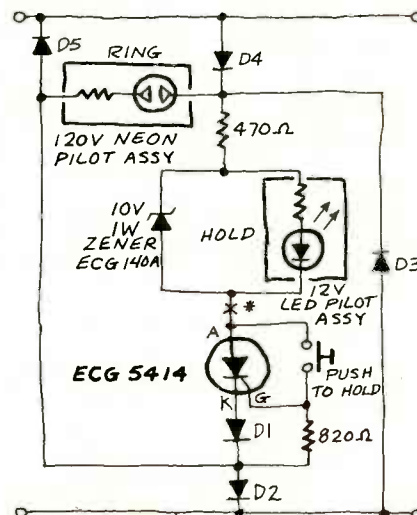
You're so right!—Editor.

MUSIC ON HOLD

I read the article, "Music on Hold," by Jules Gilder, in your November 1979 issue, with much interest and would like to make some constructive suggestions.

First: As it is described, the unit will not work on many phone systems—namely, those that employ switching methods that cause the line voltages described to be reversed in polarity upon connection of the calling number to the called number. Diodes D2 through D5 in Fig. 1 perform the required switching function, to allow the basic circuit to perform properly, regardless of the polarity.

Second: The device resistance is too high for many phone systems. To hold the line properly, the device must have a low enough resistance actually to access the line if the phone were in the hung-up mode. Normally, that would require a value of 1000 ohms or less to be placed across the line—or whatever value of resistance would be required to reduce the 48 volts normally present on the line to approximately half that value.



* BREAK HERE TO INSERT TRANSFORMER WINDING, D1-D5 SWITCHING DIODES, 1 AMP, 600 PIV, SILICON

FIG. 1

With typical 48-volt, 70-mA systems, the resistance would be 800 to 850 ohms. Mr. Gilder's circuit would not be capable of such a low resistance without additional circuitry to prevent damage to the LED. I

Continued on page 24

CALL YOUR LOCAL KEITHLEY DISTRIBUTOR

ALABAMA

Huntsville
LEECO INC. (205) 533-5896
PIONEER (205) 837-9300

ARIZONA

Phoenix
METERMASTER (602) 243-4111

CALIFORNIA

Los Angeles
METERMASTER (213) 685-4340
Palo Alto
METERMASTER (415) 968-0313
San Diego
METERMASTER (714) 560-4841

CONNECTICUT

Middletown
EIL/MANCIB DIVISION (203) 346-6646

FLORIDA

Orlando
PIONEER (305) 859-3600
Palm Bay
EIL INSTRUMENTS, INC. (305) 725-8300

ILLINOIS

Chicago
METERMASTER (312) 593-8650
PIONEER (312) 437-9680

INDIANA

Indianapolis
PIONEER (317) 849-7300

MARYLAND

Baltimore
PIONEER (301) 792-7500
Gaithersburg
PIONEER (301) 948-0710
Timonium

EIL INSTRUMENTS, INC. (301) 771-4800

MASSACHUSETTS

Burlington
EIL/MANCIB DIVISION (617) 272-9450

MICHIGAN

Ann Arbor
PIONEER (313) 455-9090
Livonia
PIONEER (313) 525-1800

MINNESOTA

Minnetonka
PIONEER (612) 935-5444

NEW JERSEY

Fairfield
AMPOWER (201) 227-7720

NEW YORK

Great Neck
INSTRUMENT MART (516) 487-7430
Long Island
EIL INSTRUMENTS (516) 231-6333
New York
ADVANCE ELECTRONICS (212) 687-2224
Rochester
AMPOWER (716) 377-1020
ELECTRONIC INSTRUMENT CORP.
(716) 328-4350

NORTH CAROLINA

Greensboro
PIONEER (916) 273-4441
Raleigh
METERMETRICS (919) 872-5456

OHIO

Cleveland
PIONEER (216) 587-3600
Dayton
PIONEER (513) 236-9900

OREGON

Portland
WESTCON, INC. (503) 283-0132

PENNSYLVANIA

Philadelphia
EIL INSTRUMENTS, INC. (215) 561-4090
PIONEER (215) 674-4000
Pittsburgh
PIONEER (412) 782-2300

TEXAS

Dallas
PIONEER (214) 386-7300
Garland
METERMASTER (214) 271-5671

Houston
PIONEER (713) 988-5555
QUALITY INSTRUMENT LABS, INC.
(713) 524-0528

VIRGINIA

Alexandria
EIL INSTRUMENTS, INC. (703) 354-4330
Richmond
INSTRUMENT TECH. REPRESENTATIVES
(804) 275-1431
Virginia Beach
EIL INSTRUMENTS, INC. (804) 449-3746

U.S.A.

ADVANCE ELECTRONICS (800) 223-0474
(except New York)
AMPOWER (800) 526-2514
(except New Jersey)

Don't get one of our DMMs for the price.

You want a good price when you buy a DMM. But more important than the price is what you get for your money—and that's where you really win with Keithley. Our Model 169 and Model 130 DMMs were designed inside and out to provide the performance you want at prices that make sense.

The Model 169 is a bench-size portable DMM. It's a five-function, 26-range instrument that's built to stand up to years of rugged use. It's also the only low-priced portable to annunciate range and function right on the display. Basic accuracy is a respectable 0.25%, and with alkaline batteries you could use it for a full year without changing batteries. (The battery indicator on the display tells you when they're getting low.)

The Model 130 isn't just another hand-held DMM. It's got five functions and 25 ranges to handle virtually all of the field or bench measurements you make. But its designed-in convenience features set it apart. It weighs only 283g (10 oz.). Its two rotary switches (one for range, one for function) are simply easier to use than pushbutton-type hand-helds. Its case is tough, 2.5mm (.100"), impact resistant plastic. Its components are mounted on a single PC board which is

Get one for the performance.

cushioned to protect it from sudden jolts. It has a fuse protected 10A current range. And both the battery and the fuse are externally accessible.

Both instruments have big, 15mm (0.6") LCD displays—up to 60% larger than some competitors'. Both feature auto zero, auto polarity, overrange indication and low battery indicators. Both have a full range of available accessories, including test leads, probes, current shunt and carrying cases. And both have another feature that sets them apart from all the rest. They're both from Keithley.

KEITHLEY

Keithley Instruments, Inc./28775 Aurora Road
Cleveland, Ohio 44139/(216) 248-0400 Telex: 98-5469

Call your nearest distributor for more information.



\$149



\$99

(Case & Stand, \$10)

CIRCLE 61 ON FREE INFORMATION CARD

LETTERS

Continued from page 22

have accounted for that problem in the enclosed diagram through the use of a LED pilot-lamp assembly shunted by an appropriate Zenér diode. The series resistance of 470 ohms produces a total device resistance of 850 ohms. A neon 120-volt pilot-lamp assembly is included to indicate incoming calls, in the event that the phone-ringer is switched off. We have employed the described circuit for some time, with excellent results.

Third: While our circuit does not employ an audio-injection feature, it would be compatible with Mr. Gilder's idea. Should a transformer be included in the circuit, the DC resistance of its wiring should be measured; and that value should be subtracted from the 470-ohm series resistor.

BRUCE L. MACKEY
Cortland, NY

Mr. Mackey is correct. The music-on-hold circuit will, indeed, fail to operate on any telephone system that employs switching methods which cause the line voltages to be reversed in polarity upon connection of the calling number to the called number.

His second suggestion looks as if it will work well, although I have not experienced any difficulties with the resistance value indicated. His approach, however, will certainly work on systems that I have encountered, and on systems that require lower hold resistances.

JULES H. GILDER

SUPER AMPLIFIER

Here is additional information on two subjects relating to my article "Super Audio Amplifier" in the December 1979 issue: the substitution of an alternate circuit for the D1300A not readily available RCA diodes used in my amplifier; and the availability of a transparency for the printed circuit board. Here goes:

1. Two diodes connected in series may be replaced with a single transistor connected in the "amplified junction" configuration. Or any number of series-connected forward-biased diodes may be replaced in the same fashion. See Fig. 2. Use a power transistor (or medium dissipation) in order to realize

the high junction-to-case thermal conductivity needed for temperature-sensing, and in order to have a convenient means for mounting on the same heat sink as the output devices whose temperature is to be sensed.

The equivalent circuit, using a transistor, has an advantage over the series-connected diodes. It can be adjusted to give a crossover bias of a precise value. Resistor R2 is made larger in value to reduce crossover bias current, and vice versa. Select a value that produces exactly 135 milliamps of power-supply current drain from the amplifier at idling (quiescent) conditions. Resistor R2 should never be so low in resistance as to cause thermal runaway (in other words, not less than one-third of the value of R1).

2. The printed circuit board is not available but a duplicate transparency of the printed circuit board, one-to-one scale factor, is available for \$5.00, postpaid in the USA from Daniel Talbot, 1 Dean Street, Hudson, MA 01749.

DANIEL B. TALBOT
Hudson, MA

TRS-80 BREADBOARD

I really enjoyed the November, 1979 issue of **Radio-Electronics**, especially the TRS-80 breadboard article and the Telco article. Keep them coming.

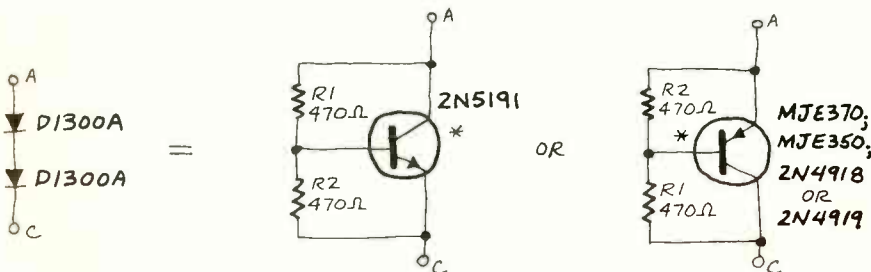
There was one flaw in the TRS-80 breadboard article. It stated that the Level I TRS-80 cannot be used to control I/O devices. That is not true. Although Level I BASIC cannot access I/O, you can do so by using machine language. By means of either T-BUG or the Editor-Assembler, Level I users can write programs to use with the breadboard project.

It appears that the music-on-hold project can do much more than the music-on-hold feature. You may even be able to connect it to your TRS-80 cassette interface, allowing you to get out of having to buy an expensive modem/acoustic coupler.

These are just a few ideas your readers can play around with. I hope they interest you.

COLIN PRINGLE,
Dallas, TX

R-E



* BE SURE TO MOUNT USING MICA INSULATING WASHER

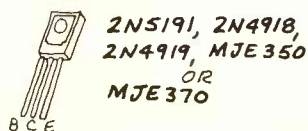


FIG. 2

TURNER®

CB

BASE LOADED Antennas



Roof mount with screw-in connector.

Trunk lip mount with screw-in connector.

- Three grippers adapt mount to any hole 3/8 to 3/4 inch in diameter

Exclusive roof top mount (patent no. 3,492,769) allows quick, solid mounting on vehicle surface.

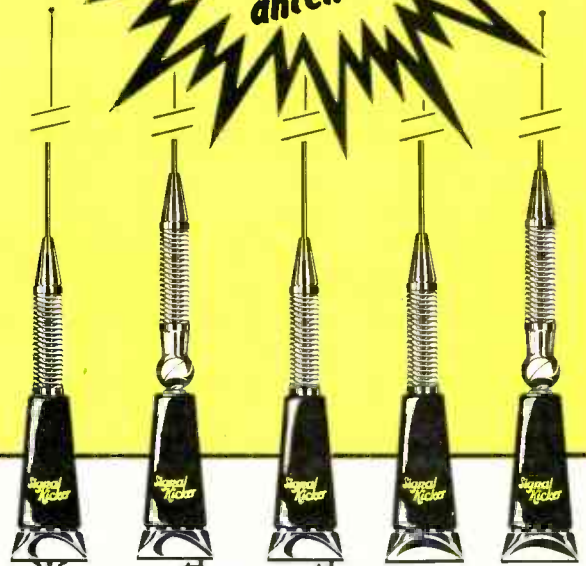
- Spring-loaded, pure brass coil contact pin assures solid, corrosion-free cable connection.
- Exclusive screw-in antenna cable connector (patent no. 4,090,030) provides simple, low loss solderless connection.
- Weather resistant Noryl coil cover is impervious to the elements. Outlasts others, even in salt spray areas. Holds like-new appearance longer.
- Base plate triple chrome plated for corrosion-free, attractive appearance.
- Double thick trunk lip bracket will not break.
- Entire antenna is at d.c. ground for super, low noise reception.



Turner outperforms others on the four most important factors: power, performance, quality and engineering. When choosing your next CB antenna - check us out.

- ✓ **500 watt power capacity**
- ✓ **1.1:1 SWR**
- ✓ **Built to last**
- ✓ **Easy to install**

Turner Base Loaded Antennas are available in five different models including swivel ball models for slant backs. Convenient combination mount models include mounting brackets for both trunk lip and roof mount in one antenna.



SK110 Roof
SK210 Trunk lip
SK211 Trunk lip with swivel
SK260C Combo. trunk & roof
SK261C Combo. trunk & roof with swivel

TELEX **TURNER**

TELEX COMMUNICATIONS, INC.

8601 Northeast Highway Six, Lincoln, NE 68505 U.S.A.
 Europe: 22, rue de la Légion-d'Honneur, 93200 St. Denis, France.

Saga of Son-of-Satcom III

Ever since RCA Americom's Satcom III disappeared from sight last December, each week has brought new ramifications to the problem of what the cable TV industry will do about the loss. The 24-transponder satellite was supposed to become the primary bird for cable TV programming, with all of its transponders allocated for such services; Satcom I would have become the Second Cable Network, with about a dozen additional services. Now amidst promises, threatened lawsuits, make-goods, and a number of other activities, the situation has temporarily been sorted out.

Satcom I will remain the main cable bird until a replacement for Satcom III is launched next year. RCA has also made arrangement with AT&T for use of Comstar D2 as an "emergency replacement" with 11 transponders to be used for cable programs. Then the colorful Ted Turner, who is supposed to begin his Cable News Network in June, threatened to sue RCA for \$34 million in order to make sure the all-news channel was aboard Satcom I. RCA capitulated and bumped one of its data communications customers off Satcom I to make room for Turner, with the possibility that the only other full-functional transponder on that bird may also be shifted to cable TV programming. (Originally it was believed that RCA would move all its data customers to the AT&T satellite and keep the cable TV programming on Satcom I and II. But since the AT&T transponders are "pre-emptible"—that is, AT&T can quickly bump off customers if it needs the circuits—the data customers balked at the arrangement.) What all that means is that if you're tuned to a cable programming being sent via the Comstar D2 satellite, it's possible that the show could be interrupted suddenly.

Meanwhile, RCA is completing its plans for what to do about its future facilities. As it stands now, the original launch date for Satcom IV in June 1981 now becomes the target for what is being called Satcom III-Replacement. That bird will become operational in October 1981. The new Satcom IV is slated to go up that same month, and then become operational in February 1982. Both launches will be aboard Delta rockets (rather than the Space Shuttle as had once been hoped). RCA says that the Son-of-Satcom III and Satcom IV will have technical improvements over the current models, including spare on-board amplifiers and higher-power amplifiers. RCA also says it wants to improve the in-orbit restoration facilities for failed transponders, and in addition plans to upgrade 18 of the 24 transponders on Satcom IV to 5.5 watts and the other 6 transponders to 8.5 watts instead of the traditional 5 watts of power.

Complete earth station deregulation

The FCC has removed all regulations from receive-only satellite earth terminals—an action that clears the way for smaller dishes and for considerable cost savings on the construction of TV receive-only earth stations and other downlinks. The FCC move means that the price of earth stations could drop by about 50% within a year. Among other things, the ruling permits use of dishes smaller than 10-foot diameter and allows anyone to put up a TVRO dish without obtaining legal and technical approval from the FCC (although, presumably, zoning and other local building ordinances must continue to be satisfied). In its ruling, the FCC warned that it is not giving the green light to satellite-signal pirates—and underscored its continuing efforts to enforce all the rules dealing with theft of service (Section 605 of the FCC regulations).

Among the people most pleased by the earth-station deregulation were executives of Mutual Broadcasting, which planned to move ahead immediately with its radio/satellite network, and cable-TV industry leaders who foresee even greater use—and less expense—of widespread satellite/cable networks. In its decision, the FCC left the door open for earth-station owners who want to be licensed. Such individuals and companies may seek FCC clearance to assure that they are avoiding any radio-frequency interference from terrestrial facilities. If you want an FCC license for your TVRO, the licensing period has been extended to five years (from the previous three years). Earth stations currently under FCC licensing policies (mostly cable-TV system's dishes) will continue to operate—but when the current permits expire, there will be no FCC requirement that they be renewed.

The prices keep coming down

Complete turn-key earth terminal facilities are now hovering in the range of about \$3,500—down from about \$4,000 last summer. According to experts in the world of private earth terminals, further price drops are likely—probably shaving another \$700 per package by this summer. Antenna prices seem to have bottomed out at \$750 for a 10-foot dish. The next item to drop in price will be low-noise amplifiers, with a 50% price reduction—into the \$500 to \$600 range. Tunable 24-channel receivers are also likely to fall in price from the \$1,800 level; experts believe that prices this summer may be as low as \$1,300 to \$1,500—based on prototypes shown at last February's Satellite Private Terminal Seminar.

Sounds from the skies

While most of the attention about satellite broadcasting has been focused on television, radio is coming on strong, and promises to grow even bigger as more audio signals take to the skyways. National Public Radio is due to put its nationwide network into service this spring; significantly on the fall day last year when the first handful of NPR stations started picking up satellite feeds, another new network was also starting up: RKO General, which operates radio stations in several major markets (including New York, Boston, and Washington), began its first feeds on that date (all land-linked for now). RKO's plans call for a network of affiliates nationwide—and eventually most of them will be linked by satellites. The RKO web features youth-oriented programming, in addition to news and lifestyle features, and company engineers are actively exploring small-dish satellite equipment for use at each affiliate.

Of course, Mutual radio network—the nation's largest, with well over 800 affiliates—is actively building its satellite network. The major wire services, Associated Press and United Press International, plan to send their radio newscasts directly to some local radio stations via satellite (as well as the signals that transmit the ticker-tape news reports). Meanwhile, ABC radio is advancing its plans to send newscasts and other features to affiliates of its four networks via a digital signal transmitted from satellites. And even the cable-TV/satellite networks are dripping with audio services: At least four high-fidelity music services are transmitted on sidebands aboard the RCA satellite carrying cable shows, including a disco-music channel, and classical-music feeds. (One of the four is Chicago's WFMT, the nation's first radio superstation.)

GARY H. ARLEN

ITEM NO.
WK-7

CMOS SAFE

IC INSERTION/EXTRACTION KIT

KIT INCLUDES

- MOS-1416 14-16 CMOS SAFE INSERTER
- MOS-2428 24-28 CMOS SAFE INSERTER
- MOS-40 36-40 CMOS SAFE INSERTER

- EX-1 14-16 EXTRACTOR
- EX-2 24-40 CMOS SAFE EXTRACTOR

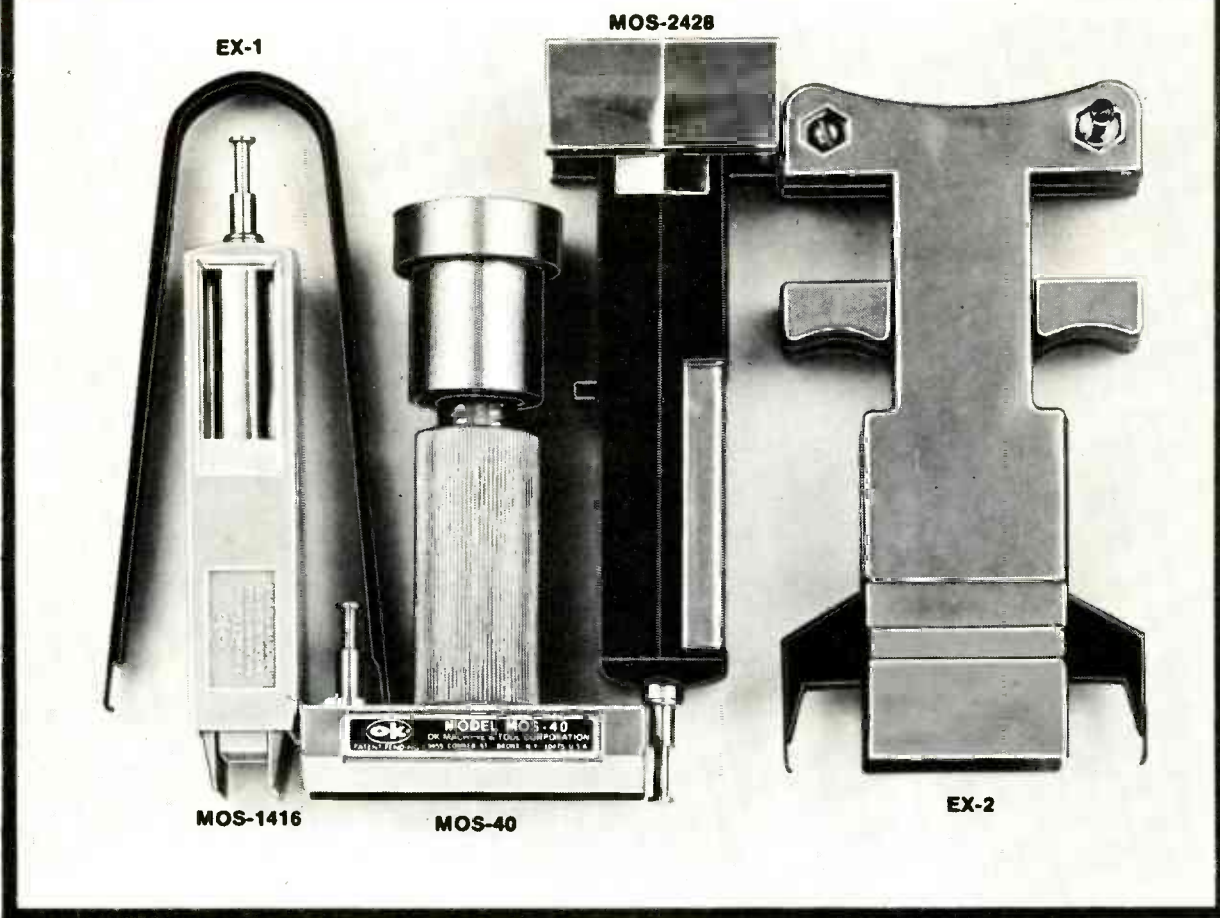


OK MACHINE & TOOL CORPORATION
3455 CONNER ST., BRONX, N.Y. 10475 U.S.A.
PHONE (212) 994-6600 TELEX NO. 1255091



PRINTED IN U.S.A.

PATENT PENDING



WK-7	COMPLETE IC INSERTER/EXTRACTOR KIT	\$29.95
------	------------------------------------	---------

INDIVIDUAL COMPONENTS

MOS-1416	14-16 PIN MOS CMOS SAFE INSERTER	\$ 7.95
MOS-2428	24-28 PIN MOS CMOS SAFE INSERTER	\$ 7.95
MOS-40	36-40 PIN MOS CMOS SAFE INSERTER	\$ 7.95
EX-1	14-16 PIN EXTRACTOR TOOL	\$ 1.49
EX-2	24-40 PIN CMOS SAFE EXTRACTOR TOOL	\$ 7.95

MINIMUM BILLING \$25.00. ADD SHIPPING CHARGE \$2.00. NEW YORK RESIDENTS ADD APPLICABLE TAX.

OK MACHINE & TOOL CORPORATION 3455 CONNER ST., BRONX, N.Y. 10475 (212) 994-6600/TELEX 125091

CIRCLE 27 ON FREE INFORMATION CARD

EQUIPMENT AND TRAINING NO OTHER SCHOOL CAN MATCH.

**NTS HOME TRAINING INVITES YOU TO EXPLORE MICROCOMPUTERS,
DIGITAL SYSTEMS AND MORE, WITH STATE-OF-THE-ART EQUIPMENT
YOU ASSEMBLE AND KEEP.**

Without question, microcomputers are the state of the art in electronics. And NTS is the only home study school that enables you to train for this booming field by working with your own production-model microcomputer.

We'll explain the principles of troubleshooting and testing your microcomputer and, best of all, we'll show you how to program it to do what you want.

You'll use a digital multimeter, a digital logic probe and other sophisticated testing gear to learn how to localize problems and solve them.

Send for the full color catalog in the electronics area of your choice—discover *all* the advantages of home study with NTS!

NTS also offers courses in Auto Mechanics, Air Conditioning and Home Appliances. Check card for more information.

1.



We believe that training on production-model equipment, rather than home-made learning devices, makes home study more exciting and relevant. That's why you'll find such gear in all 14 of NTS's electronics programs.

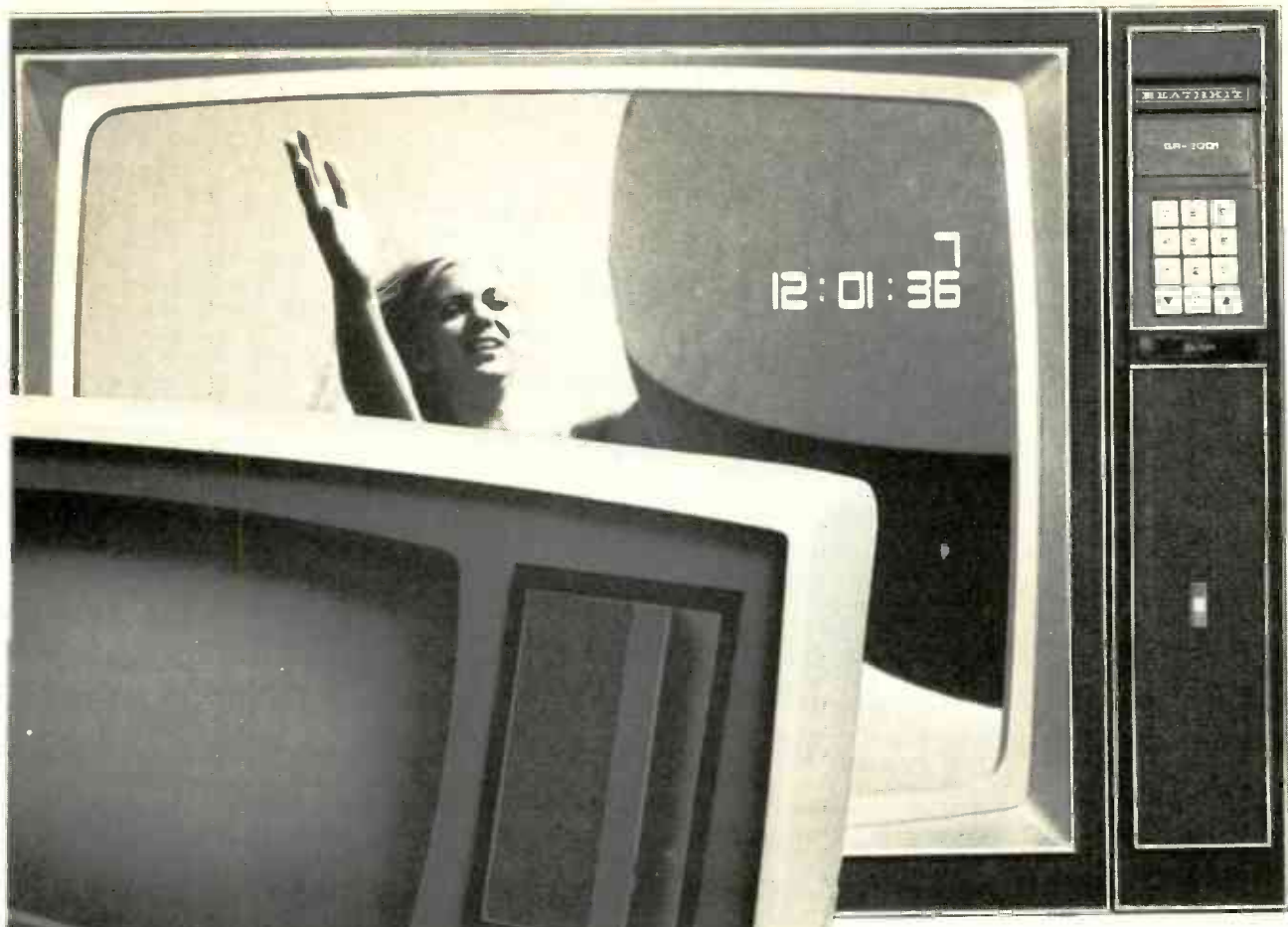
For instance, to learn Color TV Servicing, you'll build and keep the 25-inch (diagonal) NTS/HEATH digital color TV.

In Audio Electronics, you'll be able to assemble your own NTS/HEATH digital stereo receiver with 70 watts per channel.

But no matter which program you choose, NTS's Project Method of instruction helps you quickly acquire practical know-how.

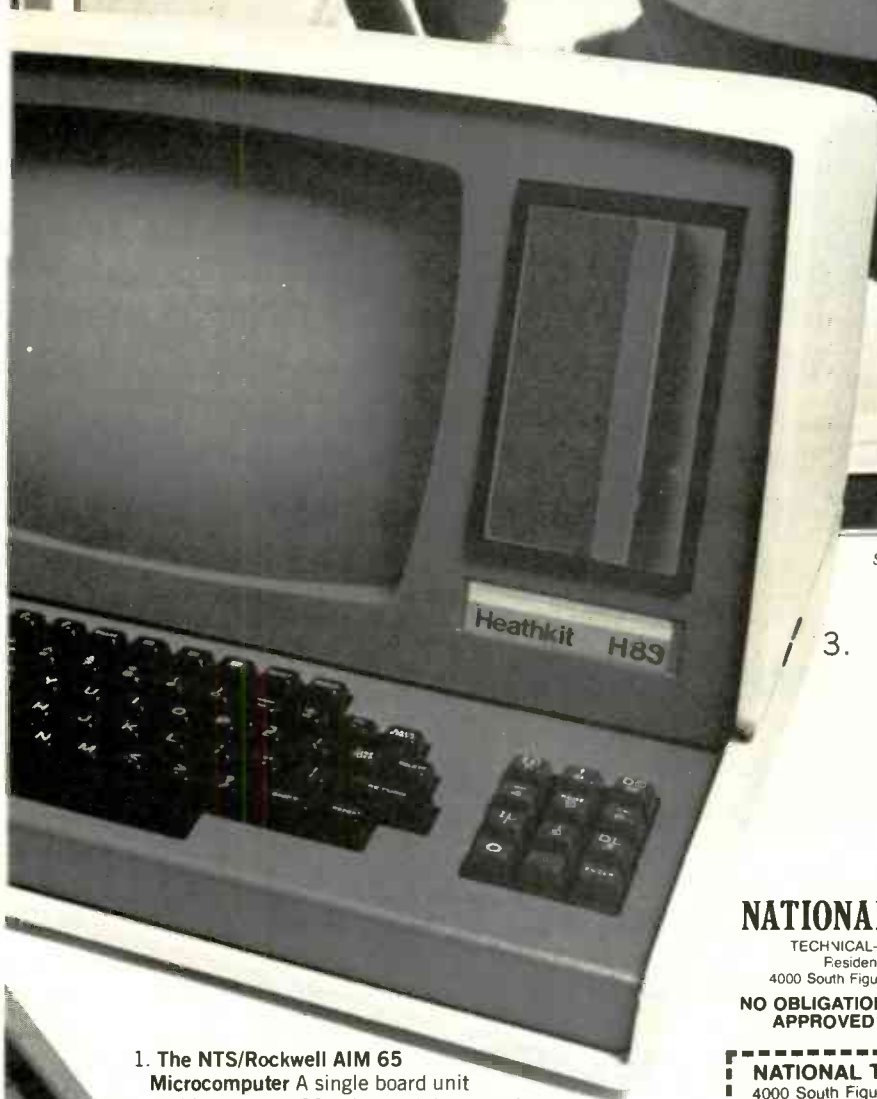
2.





Simulated TV Reception

4.



3.

1. The NTS/Rockwell AIM 65

Microcomputer A single board unit with on-board 20 column alphanumeric printer and 20 character display. A 6502-based unit 4K RAM, expandable.

2. The NTS/KIM-1 Microcomputer A single board unit with 6 digit LED display and on-board 24 key hexadecimal calculator-type keyboard. A 6502 based microcomputer with 1K RAM, expandable.

3. The NTS/HEATH H-89 Microcomputer features floppy disk storage, "smart" video terminal, two Z80 micro-processors, 16K RAM memory, expandable to 48K. **4. The NTS/HEATH GR-2001 Digital Color TV (25" diagonal)** features specialized AGC-SYNC muting, filtered color and new solid-state high voltage tripler rectifier.

NATIONAL TECHNICAL SCHOOLS

TECHNICAL-TRADE TRAINING SINCE 1905
Resident and Home-Study Schools
4000 South Figueroa St., Los Angeles, Calif. 90037

**NO OBLIGATION. NO SALESMAN WILL CALL.
APPROVED FOR VETERAN TRAINING.**



NATIONAL TECHNICAL SCHOOLS

4000 South Figueroa Street, Dept. 206-060
Los Angeles, California 90037

Please rush FREE color catalog on course checked below

- | | |
|---|--|
| <input type="checkbox"/> MicroComputers/MicroProcessors | <input type="checkbox"/> Audio Electronics |
| <input type="checkbox"/> Communications Electronics | <input type="checkbox"/> Auto Mechanics |
| <input type="checkbox"/> Digital Electronics | <input type="checkbox"/> Air Conditioning |
| <input type="checkbox"/> Color TV Servicing | <input type="checkbox"/> Home Appliances |

Name _____ Age _____

Address _____

Apt. _____ City _____

State _____ Zip _____

- Check if interested in G.I. information.
 Check if interested ONLY in classroom training in Los Angeles.

equipment reports

Global Specialties Corp. Model 3001 Digital Capacitance Meter

BACK IN THE HEYDAY OF RADIO SERVICING (in the '30's), no respectable service bench would have been complete without some form of a capacitor tester. However, over the next 30 years or so the popularity of such devices seemed to drop off until they were seldom considered when purchasing test equipment for most shops. For whatever reason, the popularity of capacitance-measuring equipment has recently taken a huge leap in the plus direction and now, it would seem, no electronic service bench would be considered "up-to-date" unless it contained a capacitance-measuring instrument.

Most test-equipment manufacturers have introduced their own versions of capacitance meters and few of them operate on the principles used in the testers of the 30's. Global Specialties Corporation, 70 Fulton Terrace, New Haven, CT 06509, is no exception to the rule as they, too, have introduced what they consid-



CIRCLE 101 ON FREE INFORMATION CARD

er the best tester available for the price. Designated the *model 3001* Digital Capacitance Meter, it is designed specifically for professional use in all phases of electronics whether that use is in servicing, production, or in the laboratory.

Ease of operation is one of the first advan-

tages to be noticed when using the *3001*. Measuring capacitance is simply a matter of connecting the capacitor, turning the *3001* on, setting the switch to the range required and reading the capacitance. The actual value is displayed on a large 3½-digit LED display. The accuracy is 0.1% of the reading and readings can be obtained over the range of a few picofarads to 0.1999 Farad! The front panel of the unit includes an on/off toggle switch that is much easier to operate than the usual slide switches that have been finding their way into more and more test equipment. To the right of that switch is the LED display. Near the center of the panel, there is a ZERO CAL control that is used to balance out the capacitance of connecting leads, test stands, or fixtures. Farther to the right is the 9-position range switch and finally the two banana jacks that are used to connect the test leads.

Before attempting to operate the *model 3001*, it is recommended that the operator take a few moments to read over the instructions provided in the instruction manual. As with all other good test equipment, there is a wealth of

continued on page 34

MRO solid state problems?

1,100 RCA SK Series +3,000 JEDEC* Devices

4,100 MRO Solutions

For full details, see your local RCA SK Distributor, or send for free copy of RCA MRO/Industrial Replacement Guide (1K6386). Write to: Sales Promotion Services, RCA Distributor and Special Products Division, P.O. Box 100, Deptford, N.J. 08096.

*Joint Electron Device Engineering Council

RCA SK Replacement Solid State

Sabtronics NEW Hand-held Digital Multimeters...

The only thing that beats their performance is their price.

Accurate performance you can rely on, time after time. That's what you expect from a quality DMM. But don't expect to pay as much for it any more. Because now Sabtronics brings you top quality DMMs with more features and better accuracy than other comparable units on the market today. And they cost surprisingly less!

We cut the price. Not the quality.

What you get is a precision crafted unit that features single-chip LSI logic, laser trimmed resistor network and a stable band-gap reference element for better long term accuracy. Basic DCV accuracy is 0.1%. The Model 2035A gives you 32 measurement ranges over 6 functions and the Model 2037A an additional two temperature ranges.

First in features. First in price.

Both models feature a "touch-and-hold" capability with the optional probe - a reading is retained for as long as you wish. Now you can make measurements in hard-to-reach places without taking your eyes off the probe tip or stopping to record data.

The two-terminal input for all measurement functions eliminates switching test leads when measuring voltage, resistance or current. The Model 2037A even has a built-in temperature measuring circuit with a -50°C to +150°C range and is supplied complete with the sensor probe. It is ideal for checking IC, resistor, transistor, heat sink and enclosure temperatures or for

monitoring environmental test temperatures.

Plus more features.

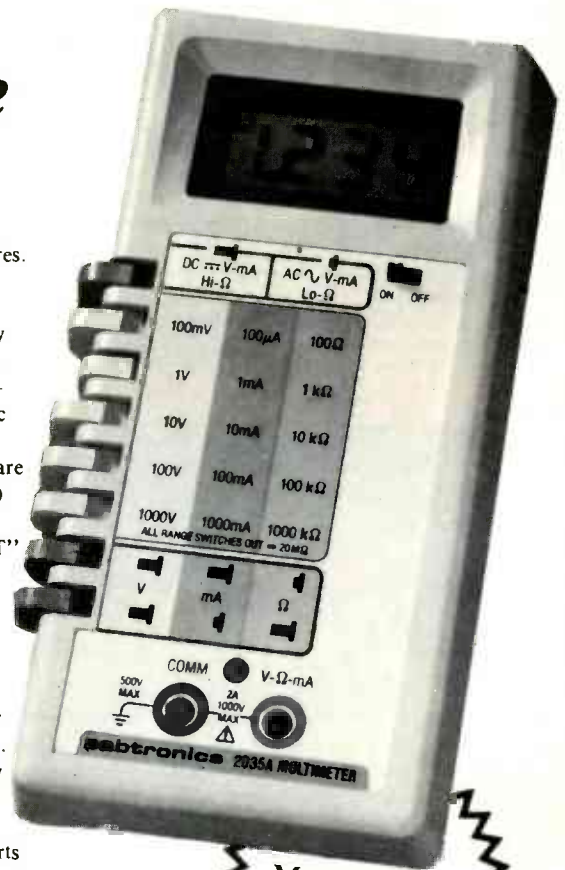
The Hi-and-Low power ohms capability allows you to make in-circuit resistance measurements and to check semiconductor PN junctions. In addition automatic polarity, automatic zero, automatic decimal point and overload protection are standard features. And you get up to 200 hours operation from a single 9V transistor battery. The automatic "LO BAT" indicator warns you of the last 20% of battery life. The large, crisp LCD readouts allow easy viewing indoors or outdoors in bright sunlight.

One-evening kit assembly.

Assembling either kit is simple with our easy-to-follow, step-by-step instructions. The built-in calibration references allow you to calibrate the unit any time, any place. We've even eliminated difficult point-to-point interconnect wiring. All parts mount on the PC board. The only wires you solder are the two battery clip leads.

Order yours now.

With all of these features and performance characteristics no other handheld DMM comes even close to matching the price/performance ratios of the Models 2035A and 2037A. Providing the best value for money in test equipment, Sabtronics has become one of the world's largest producers of DMMs. You can order with confidence. Use the convenient order form or call us with your Master Charge or Visa number for prompt delivery.



Model 2035A
\$74.95
 F.O.B. Factory

Making Performance Affordable



5709 North 50th Street, Tampa, Florida 33610
 Telephone 813/623-2631

BRIEF SPECIFICATIONS:

DC VOLTS: 100 μ V - 1000V, 5 ranges
 AC VOLTS: 100 μ V - 1000V, 5 ranges
 DC CURRENT: 0.1 μ A - 2A, 5 ranges
 AC CURRENT: 0.1 μ A - 2A, 5 ranges
 Hi-OHMS: 0.1 Ω - 20M Ω , 6 ranges
 Lo-OHMS: 0.1 Ω - 20M Ω , 6 ranges
 TEMPERATURE: -50°C - +150°C
 (-58°F - +302°F), 2 ranges
 (Model 2037A only)

Size: 3 1/2" W x 6 3/4" L x 1 5/8" H

WEIGHT: 11 oz. (excl. battery)
 OVERLOAD PROTECTION: 1000V DC or AC peak all voltage ranges, 250V DC or AC peak all Ohms ranges, 2A/250V fuse all current ranges.

SABTRONICS SERVICE AVAILABLE
 IN MOST COUNTRIES OF THE
 WORLD

To: Sabtronics International, Inc., 5709 North 50th Street, Tampa, FL 33610

Please send me

- _____ Model 2035A Handheld Multimeter kit(s) @ \$74.95 ea. \$_____
- _____ Model 2037A Handheld Multimeter kit(s) @ \$99.95 ea. \$_____
- _____ Shipping and handling @ \$5.00 per kit (see below)† \$_____
- _____ Model THP-20 Touch-and-hold Probe(s) @ \$19.95 ea. \$_____
- _____ Model AC-110 Battery Eliminator(s) @ \$7.95 ea. \$_____
- _____ Model HVP-30 30 kV DC High-voltage Probe(s) @ \$29.95 ea. \$_____
- _____ Florida residents add 4% State Sales Tax \$_____
- TOTAL \$_____

I enclose check* money order. Bill my Master Charge Visa

Card Account # _____ Expiry date _____

*Allow 2-3 weeks clearance time for personal checks. No C.O.D.

Name _____

Street _____ Apt. _____

City _____ State _____ Zip _____

†Continental U.S. only. AK, HI & PR. \$6.00. Canada: \$7.50. Foreign: \$19.00 Airmail.

EQUIPMENT REPORTS

continued from page 32

information supplied to assist you in the operation of the new test gear. In addition to explaining the use of the equipment, the manual also provides a recommended initial inspection to ascertain if it is operating properly when received. For those who wish to know more about the operation of the unit, a schematic diagram—as well as a functional block diagram and description—is provided. Applications, calibration, and maintenance as well as a discussion of the various capacitance-measuring techniques that have been used through the ages combine to provide the owner with a most complete manual.

The range switch is labeled with values that are representative of the center of the range

chosen. For instance, in the 1 μF range, the scale will actually read out to 1.999 μF . All ranges are arranged to be in multiples of ten. They are: 1000 pF, 10 nF, 100 nF, 1 μF , 100 μF , 1000 μF , 10 mF, and 100 mF. The latter represents 0.1 Farad! (100,000 μF). In the lowest ranges where lead capacitance is an important factor, the ZERO-CAL control will null out the capacitance of the leads in use. According to the book supplied, it is possible to null out as much as 100 pF using this feature. Again, simplicity is the rule with the *model 3001*. Connect the test leads to the input jacks and leave the ends free of any capacitor. A reading of a few picoFarads should be noticed on the readout. By rotating the ZERO CAL control from end to end it will be found that at some point the display will read zero. Connecting a capacitor to the test leads at

this time should provide an accurate reading. In the ranges over 1 μF , the ZERO-CAL control is disconnected and need not be adjusted since the small amount of capacitance of the leads would have a negligible effect upon the actual measurement.

The input circuitry is quite sensitive and in extreme cases, when measuring small values, it may be advisable to place the test capacitor in a metal shield enclosure that is bonded to the grounded lead of the test jacks. That will minimize the effects of surrounding interference. In the testing of this unit, we found that it made some difference in the stability of the readings obtained when the unit was moved to various portions of the test bench. That was noticeable only on the 1000 pF range when measuring capacitors of less than 100 pF.

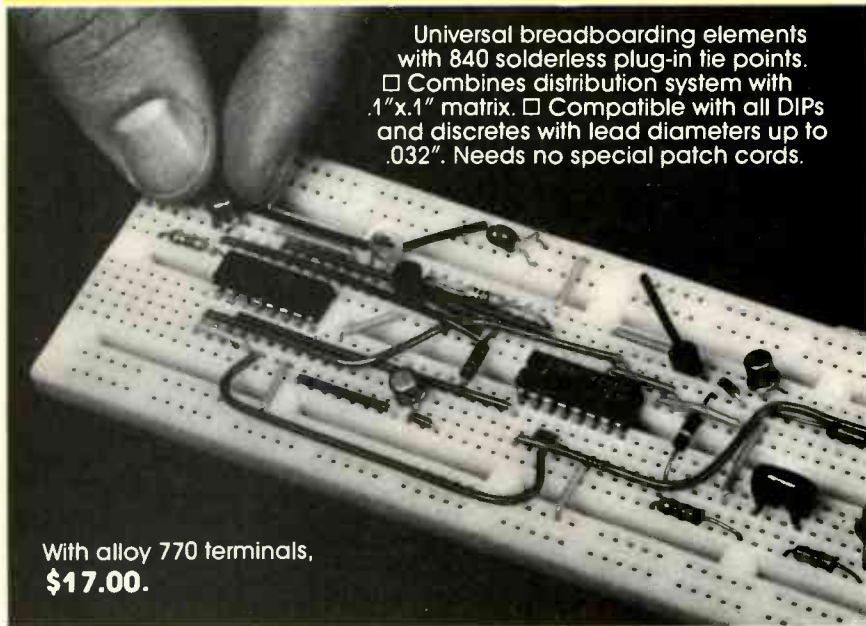
There is no reason to expect damage to any capacitor when using the *model 3001* to test it as the maximum voltage used during the testing operation is about 3.5 volts (according to the manual); however, we were never able to detect that much voltage at the test terminals. While on the subject of voltages, it may be a good time to mention that Global Specialties recommend that the capacitor to be tested be thoroughly discharged before connecting it to the test leads. The unit does have overvoltage protection built into the circuitry in the form of a 1/2-amp fuse.

In every test, the *model 3001* came up with flying colors. It performed exactly as the manufacturer claimed it would and we were unable to discover one negative aspect to talk about. The size and shape were found to be very convenient for bench use as well as portable operation. The sample supplied came with a *model 334* Production Test Fixture that simply amounts to an aluminum baseplate containing two spring-loaded clips. The clips are connected to an 18-inch length of RG-58/U cable that connects to the *model 3001*. There are also four (4) rubber feet on the bottom to protect surfaces. In use, for such operations as sorting large numbers of capacitors, all that need be done is to insert the leads into the test fixture and read the value on the *model 3001*. In addition, the *model 335* Test Cable was supplied with the sample unit. That is also a piece of lead with two (2) alligator clips mounted at the ends to clip onto the capacitor to be tested (or the circuit to be checked). The company also makes a set of alligator clips with a banana plug attached for direct connection to the front panel jacks.

Another optional accessory available is the *model 333* Tri-Mode Comparator. This unit allows the selection of capacitors that fall within preset ranges. Those thresholds are adjustable by front-panel thumbwheel switches and three outputs are available that will correspond to Low, Good, and High.

For those who like to read specifications, here are a few as published in the operational manual. Nine ranges from 1999 pF to 199,999 μF full scale. Accuracy: $\pm 0.1\%$ of reading ± 1 pF on 7 lower ranges; $\pm 0.5\%$ of reading ± 1 digit on 2 upper ranges. Temperature coefficient: $\pm 0.01\%$ /degree C applies to all ranges. Technique: dual threshold slope integration. Excitation voltage: 3.5 volts max. Display: 3 1/2-digit high-brightness 0.5" character-height LED. Overrange indication and under-range indication. Input protection: 1/2-amp 250-volt fuse. Power requirements: 105-125 VAC, 50/60 Hz, 6 Watts. Size (W×H×D): 10"×3"×7" (254×76×178 mm). Weight: 3 lbs (1.4 kg).

continued on page 38



Universal breadboarding elements with 840 solderless plug-in tie points.
□ Combines distribution system with 1"×1" matrix. □ Compatible with all DIPs and discretes with lead diameters up to .032". Needs no special patch cords.

With alloy 770 terminals,
\$17.00.

Your breadboarding is a super-snap with a solderless A P Super-Strip.

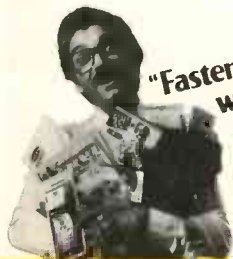
Build a circuit almost as fast as you dream it up. Pull it apart and do another—everything's as good as new.

Our versatile Super-Strip mini-breadboards give you the same top-quality contacts you get in our full-scale ACE All-Circuit Evaluators. Not so "mini," either. You can build circuits with

as many as nine 14-pin DIPs.

Instant-mount backing and quick-removal screws make stacking and racking a snap, too.

Where to buy? Phone (toll-free) 800-321-9668 for the name of your local A P distributor. And ask for our complete A P catalog, The Faster and Easier Book.



"Faster and Easier is what we're all about."



A P PRODUCTS INCORPORATED
1359 W. Jackson St.
Painesville, Ohio 44077
Tel. 216/354-2101
TWX: 810-425-2250

CIRCLE 41 ON FREE INFORMATION CARD

When quality counts

Do not be fooled by the low prices, these brand new lab quality frequency counters have important advantages over instruments costing much more. The models 7010 and 8010 are not old counters repackaged but 100% new designs using the latest LSI state-of-the-art circuitry. With only 4 IC's, our new 7010 offers a host of features including 10 Hz to 600 MHz operation, 9 digit display, 3 gate times and more. This outperforms units using 10-15 IC's at several times the size and power consumption. The older designs using many more parts increase the possibility of failure and complexity of troubleshooting. Look closely at our impressive specifications and note you can buy these lab quality counters for similar or less money than hobby quality units with TV xtal time bases and plastic cases!

Both the new 7010 and 8010 have new amplifier circuits with amazingly flat frequency response and improved dynamic range. Sensitivity is excellent and charted below for all frequencies covered by the instruments.

Both counters use a modern, no warm up, 10 MHz TCXO [temperature compensated xtal oscillator] time base with external clock capability - no economical 3.579545 MHz TV xtal.

Quality metal cases with machine screws and heavy gauge black anodized aluminum provide RF shielding, light weight and are rugged and attractive - not economical plastic.

For improved resolution there are 3 gate times on the 7010 and 8 gate times on the 8010 with rapid display update. For example, the 10 second gate time on either model will update the continuous display every 10.2 seconds. Some competitive counters offering a 10 second gate time may require 20 seconds between display updates.

The 7010 and 8010 carry a 100% parts and labor guarantee for a full year. No "limited" guarantee here! Fast service when you need it too, 90% of all serviced instruments are on the way back to the user within two business days.

We have earned a reputation for state-of-the-art designs, quality products, fast service and honest advertising. All of our products are manufactured and shipped from our modern 13,000 square foot facility in Ft. Lauderdale, Florida.

When quality counts...count on Optoelectronics.



- 100% U.S.A. FACTORY ASSEMBLED
- 100% PARTS & LABOR YEAR GUARANTEE
- CERTIFIED NBS TRACEABLE CALIBRATION
- EXTERNAL CLOCK INPUT
- DISPLAY HOLD FUNCTION
- 9 RED LED DIGITS .4" HIGH
- 1 Hz RESOLUTION
- 0.1 PPM 10 MHz TCXO TIME BASE
- LAB PORTABLE-AC ADAPTER INCLUDED
- 1 MEGOHM & 50 OHM INPUTS
- STATE-OF-THE-ART LSI DESIGNS
- COMPREHENSIVE USER MANUAL PROVIDED

• COMPACT SIZES—7010- 1-3/4" Hx4-1/4" Wx5-1/4" D 8010- 3" Hx7-1/2" Wx6-1/2" D

MODEL	S PRICE	RANGE 10Hz to	LED DIGITS	SENSITIVITY			HI-Z INPUT 10Hz - 60 MHz	GATE TIMES	RESOLUTION			TCXO TIME BASE		EXT. CLOCK INPUT	NI-CAD BATT. PACK
				25-250 MHz	50 OHM INPUT 250-450 MHz	450 MHz-1GHz			12 MHz	60 MHz	MAX. FREQ.	20-40 C	FREQ.		
7010 7010.1	145.00 225.00	600 MHz	9	5-20 mV	10-20 mV	20-40 mV to 600 MHz	1-10 mV	{3} .1, 1, 10 SEC	.1Hz	1 Hz	10 Hz 600 MHz	1 PPM 0.1 PPM	10 MHz	YES OPTION \$25.	YES OPTION \$15.
8010 8010.1	325.00 405.00	1 GHz	9	1-10 mV	5-20 mV	10-25 mV	1-10 mV	{8} .01-20 SEC	.1 Hz	1 Hz	10 Hz 1 GHz	1 PPM 0.1 PPM	10 MHz	YES STD	YES OPTION \$30.

* Has precision 0.1 PPM TCXO time base.

MODEL 7010

- #7010 600 MHz Counter - 1 PPM TCXO \$145.00
- #7010.1 600 MHz Counter - 0.1 PPM TCXO \$225.00

OPTIONS

- #Ni-Cad-701 Ni-Cad Battery Pack & charging circuitry
Installs inside unit \$ 15.00
- #EC-70 External Clock input, 10 MHz \$ 25.00
- #CC-70 Carry Case, Padded Black Vinyl \$ 8.95

MODEL 8010

- #8010 1 GHz Counter - 1 PPM TCXO \$325.00
- #8010.1 1 GHz Counter - 0.1 PPM TCXO \$405.00
- #8010.1-13 1.3 GHz Counter - 0.1 PPM TCXO \$495.00

OPTIONS

- #Ni-Cad-801 Ni-Cad Battery Pack & charging circuitry
Installs inside unit \$ 39.00
- #CC-80 Carry Case, Padded Black Vinyl \$ 8.95

ACCESSORIES

- #TA-100 Telescope Ant with Right Angle BNC \$ 9.95
- #P-100 Probe, 50 ohm, 1x \$13.95
- #P-1C1 Probe, Lo-Pass, Audio Usage \$16.95
- #P-1C2 Probe, Hi-Z, General Purpose \$16.95



CIRCLE 15 ON FREE INFORMATION CARD

ORDER FACTORY DIRECT • CALL TOLL FREE



Optoelectronics inc

5821 N.E. 14th Avenue, Fort Lauderdale, Florida 33334

1-800-327-5912

FROM FLORIDA (305) 771-2051/2

TERMS: Orders to U.S. and Canada, add 5% for shipping, handling and insurance to a maximum of \$10.00. All other orders add 10%. C.O.D. collection fee \$1.00. Orders under \$15.00 add extra \$1.00 handling. Regular checks must clear before order is shipped. Florida residents add 4% sales tax.



New Portable Digital Capacitance Meter



Call For Our Price

MODEL 820

- Measures capacitance from 0.1pF to 1 Farad
- Resolves to 0.1pF
- 10 ranges for accuracy and resolution
- 4 digit easy-to-read LED display
- 0.5% accuracy
- Special lead insertion jacks or banana jacks
- Fuse protected
- Uses either rechargeable or disposable batteries
- Overrange indication

FLUKE DIGITAL MULTIMETERS

Model 8022A: The Troubleshooter

\$139

- Six functions
- 3 1/2-digit resolution
- dc voltage
- ac voltage
- dc current
- ac current
- resistance
- diode test
- 0.25% basic dc accuracy
- LCD display
- Overload protection

Model 8020A: The Analyst

\$179

Model 8024A: The Investigator

\$219



NEW

• Seven functions

- dc voltage
- ac voltage
- dc current
- ac current
- resistance
- diode test
- conductance (1/R)
- 3 1/2-digit resolution
- 0.1% basic dc accuracy
- LCD display
- Overload protection
- **Free case**
- Two year parts and labor warranty

• Nine functions

- dc voltage
- ac voltage
- dc current
- ac current
- resistance
- diode test
- conductance (1/R)
- logic level and continuity detect
- temperature (K-type thermocouple)
- Peak hold on voltage and current functions
- Selectable audible indicator for continuity or level detection
- 3 1/2-digit resolution
- 0.1% basic dc accuracy
- LCD display
- Overload protection

DATA PRECISION Model 938

0.1%, 3 1/2-Digit, LCD DIGITAL CAPACITANCE METER



\$169

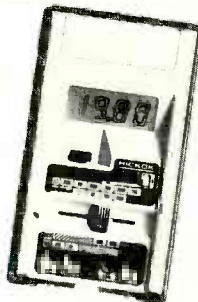
- WIDE RANGING — from 199.9 pF full scale (0.1 pF resolution) up to 1999 µF full scale, in eight ranges...virtually every capacitance you'll ever need to measure.
- FAST AND EASY TO USE — Direct reading, pushbutton ranges. Just plug in and read.
- EXCEPTIONALLY ACCURATE — provides ±0.1% basic accuracy.
- TOUGH AND COMPACT — Built to take rough usage without loss of calibration accuracy. Fits and goes anywhere, takes very little bench space, always handy for quick capacitance checkout, matching, calibration, and tracking.
- PORTABLE — Palm-sized, light-weight, operates up to approximately 200 hours on a single 9V alkaline battery.
- EASY READING — big, clear, high-contrast 3 1/2-digit LCD display, a full 0.5" high, readable anywhere.
- VALUE PACKED — Outstanding measurement capability and dependability. Outperforms DC time-constant meters, and even bridges costing 2 to 5 times as much.
- RELIABLE — warranted for 2 full years.

HICKOK

LX304 DIGITAL MULTIMETER

FAST, EASY, ONE HAND OPERATION

NEW



AVAILABLE NOW \$89⁹⁵

New Low Distortion Function Generator



Call For Our Price

MODEL 3010

- Generates sine, square and triangle waveforms
- Variable amplitude and fixed TTL square-wave outputs
- 0.1 Hz to 1MHz in six ranges
- Push button range and function selection
- Typical sine wave distortion under 0.5% from 0.1Hz to 100kHz
- Variable DC offset for engineering applications
- VCO external input for sweep-frequency tests

New Sweep/Function Generator



Call For Our Price

MODEL 3020

- Four instruments in one package—sweep generator, function generator, pulse generator, tone-burst generator.
- Covers 0.02Hz-2MHz
- 1000:1 tuning range
- Low-distortion high-accuracy outputs
- Three-step attenuator plus vernier control
- Internal linear and log sweeps
- Tone-burst output is front-panel or externally programmable

Simpson

B&K PRECISION

LEADER

DORIC



Non-Linear Systems

DATA PRECISION

PORTABLE OSCILLOSCOPES
BATTERY OPERATED



MS-15



Single Trace 15MHz
Reg. price \$349.
\$299⁹⁵

MS-215



Dual Trace 15 MHz
Reg. price \$465.
\$399⁹⁵

MS-230



Dual Trace 30MHz
Regular price \$598.
\$499⁹⁵

THESE 1980 B&K OSCILLOSCOPES ARE IN STOCK AND AVAILABLE FOR IMMEDIATE DELIVERY



B&K PRECISION

- 1479 Dual-Trace 30 MHz
- 1477 Dual-Trace 15 MHz
- 1432 Dual-Trace 15 MHz Portable
- 1476 Dual-Trace 10 MHz
- 1466 Single-Trace 10 MHz
- 1405 Single-Trace 5 MHz

CALL FOR OUR EARLY BIRD SPECIAL LOW PRICE

SUPER SPECIAL

HICKOK 385X 500MHz COUNTER

Reg 499⁹⁵

NOW 229⁹⁵

LIMITED QUANTITIES



Model LBO-520
30 MHz Dual Trace Scope with Delay Line

List Price \$1100
\$879⁹⁵

High Sensitivity. Wide Bandwidth. Single Shot Trigger. P-D-A CRT.

- 5mV sensitivity facilities accurate signal viewing from low level sources.
- Built-in delay line makes it easy to view the leading edge of a pulse.
- Single shot trigger (CH-1, CH-2) captures transient phenomena — no guesswork, no "double-takes".



KEITHLEY MODEL 130 DIGITAL MULTIMETER



NEW

\$99

	RANGE	ACCURACY
DC VOLTAGE	200mV, 2V, 20V, 200V, 1000V	.5%
AC VOLTAGE	200mV, 2V, 20V, 200V, 750V	1%
DC CURRENT	2mA, 20mA, 200mA, 2000mA, 10A	2%
AC CURRENT	2mA, 20mA, 200mA, 2000mA, 10A	3%
RESISTANCE	200Ω, 2kΩ, 20kΩ, 200kΩ, 20MΩ	.5%



THE TEST EQUIPMENT SPECIALISTS
TOLL FREE HOT LINE
800-223-0474



54 WEST 45th STREET, NEW YORK, N.Y. 10036 212-687-2224

ADVANCE ELECTRONICS

EQUIPMENT REPORTS

continued from page 34

If you're in the market for a new state-of-the-art digital capacitor meter then you should take a serious look at the Global Specialties Corporation's *model 3001* Capacitance Meter. It may be just the item you have been looking for. The *model 3001*, including the *model 335* test cable, retails for \$275. The *model 334* production test fixture retails for \$21.90. The *model 333* tri-mode comparator retails for \$295. **R-E**

Heathkit/Thomas Model TO-1860 Electronic Organ Kit

SOME COMPUTERNIKS LIKE TO MAKE ELECTRONIC music the hard way, by programming the pitch, duration, and timbre (and maybe more) for each note, which can take a lot of time, even for a little 16-bar tune.

If you're more interested in making music than in programming it, there's an easier way. You can build the Heathkit/Thomas *TO-1860* electronic organ. Before you say an organ is too hard to play, what with two keyboards, pedals, and all those controls, consider this: the *TO-1860* uses a microprocessor to automate just about all the tricky stuff, so that you can concentrate on just making music.

Microprocessor controlled

In this kit version of the Thomas Organ Company's *Troubadour* model, a microprocessor controls the inputs from the keyboards, pedals, and pushbutton switches. Two ROM



CIRCLE 102 ON FREE INFORMATION CARD

IC's store the percussion rhythms and some fancy accompaniment patterns.

The microprocessor performs quite a variety of jobs, including sounding only one pedal note at a time by programming for low-note preference, generating the lower octaves from the 12 top-octave frequencies, and controlling the rhythm ROM's. It also controls the accompaniment features by putting them on multiplexed lines, and then using a 1-MHz clock to help pick out the right signals at the right time, so that the keyboard notes, pedal notes, and the special features all sound only when they're supposed to.

Even if you can't read music

For people who can't read music, the organ

provides a combination of color-coded keys and lettered keys, that are illuminated from underneath by fluorescent lamps when you push the *Color-Glo* switch.

Several books of music are provided, in which the color-coded music is written so that if you can already read notes, you play it that way, and if you can't, then you look at the letter printed inside each note in the melody, and play it on the matching key of the top keyboard.

The music staff behind the notes is colored to show which of three chords you should play on the lower keyboard. Colored plastic chips underneath the keys are lit up, showing which keys make up which chords.

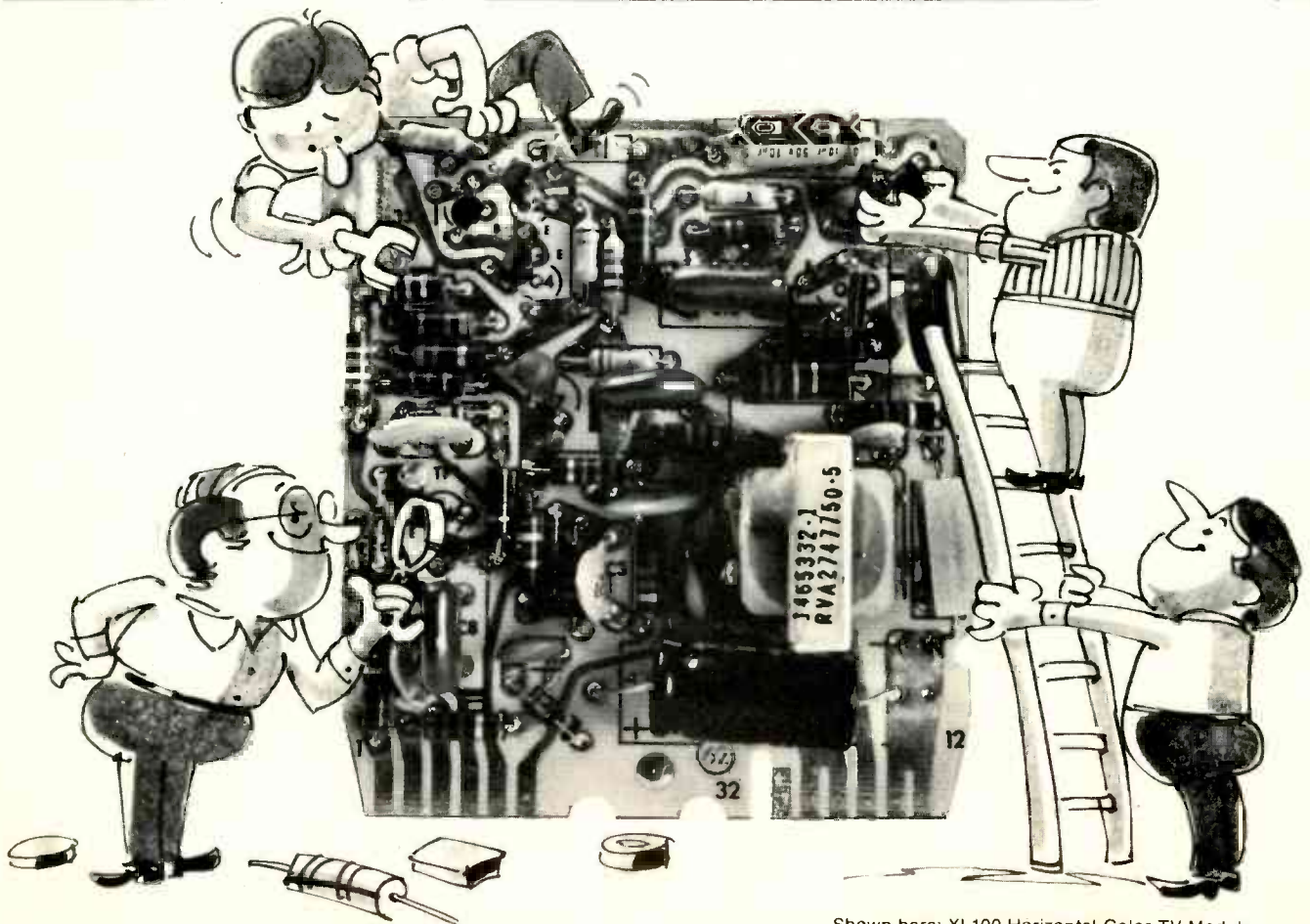
Once you learn how to play the keys according to letters and colors, you can try the pedals. You need only three to start with, and they're also color-coded.

Microprocessor Does The Work

To do anything fancier than described so far would be difficult for a beginner. But the *TO-1860* contains a microprocessor that automates most of the difficult keyboard fingerings and pedal-playing, such as walking bass, strum, arpeggios, etc.

By depressing one of the **FEATURES** buttons above the keyboard, the microprocessor does the hard work letting you play some very fancy music with only two fingers and a toe. Some of the features even play the pedal note for you.

The **CHORD MEMORY** feature will play, for instance, a C-chord when you press the C key in the special octave on the lower keyboard. At the same time, the corresponding pedal note for that chord is played, without your toe touching a pedal.



Shown here: XL100 Horizontal Color TV Module

Rhythm features

Nine pre-programmed drum-rhythm patterns, ranging from waltz to rock, are controlled by switches. The FANCY FINGERS switch adds a pre-programmed accompaniment that's different for each of the nine rhythms. You can use that as an accompaniment to your one-finger melody, instead of the chord memory.

Four ACCOMPANIMENT PRESET switches provide unique voices (piano, guitar, banjo, harp) that play in rhythm along with whatever drum rhythm has been switched on.

The automatic STRUM feature will strum whatever particular notes you hold down with your left hand, within that special lower-manual octave.

A switch on the volume-control pedal permits playing arpeggios, which will sound harp-like.

Inside the organ

A master oscillator drives an IC called the top-octave synthesizer that divides the top frequency in order to generate the twelve notes of the top octave.

The two LSI rhythm IC's are ROM's that contain bit patterns for the nine rhythms, walking bass and fancy-fingers coding.

The microprocessor turns the manual and pedal notes, and the various features, on and off at the right times.

The microprocessor IC, designed by Thomas Organ Co. and custom-made by AMI, is proprietary.

Building the organ

Construction of the Heathkit/Thomas organ is greatly simplified by virtue of the fact

that the nine major circuit boards have already been prewired and tested for you. The organ cabinet is fully assembled, the wiring harnesses are pre-cut and color-coded, and several switch units are preassembled.

So what do you build? You assemble the pedals and the switches they activate, the fluorescent-light circuits, the stereo amplifier, and the two keyboards. You install all of them in the cabinet, along with the nine preassembled boards and switch units, the two speakers, and the reverb unit.

Once you get the organ working, you can switch off the loudspeakers and use headphones, if you're a beginner, or are bashful, or play late at night.

Stereo input/output jacks are provided for recording your music, or for playing a duet with previously-recorded tapes.

The three music books that come with the organ show you 36 combinations of the ten solo and five accompaniment voices. Many are quite striking, such as *Huge Theater Organ*, *Hollow Liquid Tibia*, *Calliope*, and *Honky Tonk Piano*.

You can play the Heathkit/Thomas organ with just the two keyboards, the pedals, and the 15 voice stops. But the fun really begins when you let the microprocessor and the ROM circuits help with making fancier music, by adding a rhythm accompaniment and a walking bass, or playing single-finger chords, or the strum, or the arpeggio or . . .

You'll need months to discover all the combinations of voices and features that are possible with this organ, which is even more of a bargain now at the new price: \$1495; originally it was \$1750. Write to: Heath Company, Benton Harbor, MI 49022. **R-E**

Lafayette BCR-101 General Coverage Receiver



CIRCLE 103 ON FREE INFORMATION CARD

RECENTLY, A LARGE SAMPLING OF MODESTLY priced general-coverage communications receivers has been marketed. Most of those receivers have been in the \$300-\$700 range. Now, Lafayette (111 Jericho Turnpike, Syosset, NY 11791) offers a general-coverage receiver for only \$249.99. Can it compete? Let's take a look.

The *model BCR-101* tunes from 170-400 kHz, and 0.53-30 MHz (with some extension to about 31 MHz). It does not feature a digital-frequency readout as do the more expensive units, but it does have an accurately calibrated bandspread dial.

The main frequency display is on a printed drum. Calibration points are marked every 500 kHz, with the bandspread dial filling in every 5 kHz.

The receiver may be powered directly from 120 VAC, or by an external 12-volt battery supply (specified as 13.8 volts for mobile

RCA remanufactured modules are as good as new, or even better.

You can be sure you're using a product of the highest quality when you install RCA remanufactured modules.

Each dud module returned to RCA is critically inspected. Those that don't meet factory standards for remanufacturing are scrapped. Accepted units are then cleaned and repaired. If any engineering improvements have been made in the module design, they are incorporated, where feasible, to make sure the module meets or exceeds original specifications for performance and reliability.

Included in RCA's rigid remanufacturing process are all IF and chroma sweep alignment adjustments, and setting of all circuitboard pots. Other tests include extreme temperature cycling of all modules, and vibration testing of selected types to disclose intermittent problems.

Finally, the modules are sample-tested by RCA Quality Control Engineering. If only a single module

fails to meet the original manufacturing specifications for performance, the entire lot is rejected.

In many cases, an RCA module can replace one or more earlier versions because it is designed to be compatible in older applications. This RCA design-improvement policy minimizes the number of types you need for servicing, reduces the amount of your investment, and improves instrument performance. The remanufactured module shown here, for example, can be used in place of five different modules.

RCA's remanufacturing process assures you of the most dependable replacement modules you can buy. You can be sure they are as good as new — or even better.

RCA Distributor and Special Products Division

EQUIPMENT REPORTS

continued from page 39

installations). Current drain is less than 500 milliamps on DC.

The superheterodyne circuitry is double conversion above 3.5 MHz (with IF's of 2.15 MHz and 455 kHz), and shortwave sensitivity is better than 1 microvolt.

Switchable selectivity may be adjusted for 6-dB down at either 8 kHz or 3 kHz. The audio output is 2 watts into 8 ohms, rated at 10% harmonic distortion at full output.

Image-rejection specifications look unusually good for a low-cost radio: 50-70 dB down on all ranges. Our on-the-air tests confirmed the low image response.

The *BCR-101* is unusually compact. Measuring 12 × 7 × 9½-inches, the receiver

weighs 13 pounds.

A dual-50/500 kHz crystal calibrator is a welcome feature. It permits accurate tuning on all ranges, with its harmonics detectable well through the highest tuning range of the receiver. We found the absolute calibrator frequencies to be slightly off, but an internal alignment of the calibrator could easily correct that problem.

The beat-frequency oscillator is continuously adjustable between upper and lower sidebands to help optimize signal reception. A noise-blanker circuit is provided for electrically-noisy environments.

A separate RF GAIN control permits the user to reduce gain for reception of signals that might cause overloading. A tracking control is used to peak the RF sensitivity of the receiver on each range.

Front-panel jacks are provided for tape recording and playback, and headphones or external speaker. The *BCR-101* contains a husky 5 × 2-inch oval speaker.

Rear-apron connections are provided for external battery power, external antenna, oscillator output for direct frequency-counter measurement, and tape input for playback.

Our tests

Although there is a strong tendency for manufacturers to label low-cost receivers "communications" receivers, they are *not*; they are strictly for non-demanding hobby listening. If I were in a remote outpost somewhere, and my survival depended upon communications, I would not want to depend on a low-cost general-coverage receiver. That is not to say that the *BCR-101* is incapable of reasonably good performance. It gives an excellent accounting of itself—when it's viewed in proper perspective.

The IF-selectivity skirts are quite wide. There is hardly any rejection in adjacent frequency interference when switching to the NARROW mode. The noise blanker should work better. When adjusted as critically as possible, the reduction in electrical pulse noise is barely perceptible. True noise blankers are exceptionally effective against sharp-risetime pulse noise.

The calibrated bandspread dial is remarkably accurate. Although calibration points are provided every 5 kHz, it is possible to interpolate frequencies to within 2 kHz or better when the main tuning dial is accurately set. Unfortunately, the main tuning-drive mechanism is quite sloppy, with severe slippage and backlash. Critical adjustment is quite a chore. The bandspread dial is much better, but is functional only above 3.5 MHz.

The *BCR-101* has excellent sensitivity, certainly as good as anything else we have heard in the low-price range. Large-signal handling characteristics leave something to be desired, however. The receiver becomes completely unglued in the evening listening hours when the bands are really open. Sharper IF filters would certainly have helped here. Reducing the RF gain control is of some assistance.

Short-term frequency stability of the *BCR-101* is quite good. After a short warmup period, CW and SSB signals are easily adjusted and very readable. Mechanical stability is excellent. It takes a substantial rap on the cabinet to wobble the dial setting.

The tracking control is essentially a trimmer for peaking the RF and mixer stages. Unlike a preselector, there is no possibility of peaking the control on an image frequency by mistake. When the control is peaked, it is on the proper range. We liked that feature.

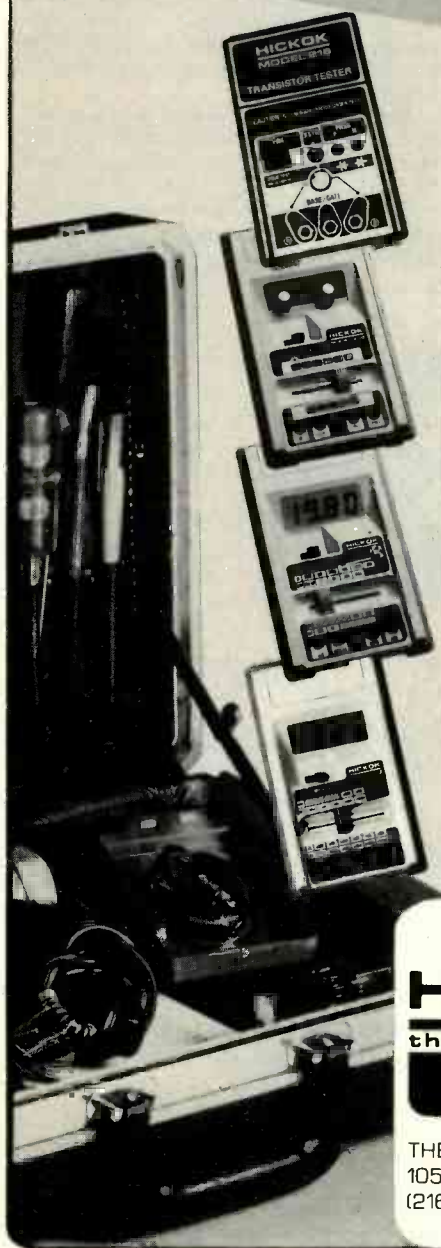
The AGC is quite fast, resulting in severe pumping when the RF gain control is reduced during strong CW or SSB signal reception. Audio quality is excellent—voice tapered for communications reception.

A special comment on the low-frequency range. Even with a short antenna connected, we were able to receive an unusually large number of low-frequency stations. That certainly will be appreciated by the low-frequency DX'ers.

The operating manual is very comprehensive. It includes detailed circuit diagrams, PC layouts, parts locations, alignment and calibration steps, and user hints. It is an outstanding manual to accompany such a modestly-priced radio.

R-E

Your Toolbox Test Bench



Model 216 Transistor Tester with fast, automatic switching for instant good-bad analysis of NPN's, PNP's, FET's, diodes and SCR's in or out of circuit. \$135.00

Model 240 Video Generator with 10 step gray scale staircase for VTR, CCTV monitor and TV applications. \$159.00

LX304 digital multimeter with automatic decimal point, built in low battery indicator and transistor testing capability. \$89.95

LX303 digital multimeter with easy-to-read LCD display. Only \$79.95

FOR THOSE ON THE GO FROM...

HICKOK
the value innovator

THE HICKOK ELECTRICAL INSTRUMENT CO.
10514 Dupont Avenue • Cleveland, Ohio 44108
(216) 541-8060 • TWX: 810-421-8286

CIRCLE 55 ON FREE INFORMATION CARD

1169-304 p.—The GIANT Handbook of Computer Projects (\$15.95)

The GIANT Handbook of Computer Projects

LASERS, THE LIGHT FANTASTIC

1108-294 p.—Lasers, The Light Fantastic (\$9.95)

An Extraordinary Offer to introduce you to the benefits of Membership in

ELECTRONICS BOOK CLUB

take any **6** of these 24 unique electronics books (values to \$103.70) for only **\$1.99** for **ALL SIX**

with a Trial Membership in the Book Club that guarantees to save you 25% to 75% on a wide selection of electronics books

800-602 p.—Master Handbook of 1001 Practical Electronic Circuits (\$15.95)

1234-252 p.—21 Custom Speaker Enclosure Projects You Can Build (\$12.95)

1160-336 p.—1001 Things To Do With Your Personal Computer (\$12.95)

1066-868 p.—The Illustrated Dictionary of Electronics (\$19.95)

Master Handbook of 1001 Practical Electronic Circuits

THE MOST POPULAR SUBROUTINES IN BASIC

21 CUSTOM SPEAKER ENCLOSURE PROJECTS YOU CAN BUILD

1001 THINGS TO DO WITH YOUR PERSONAL COMPUTER

THE ILLUSTRATED DICTIONARY OF ELECTRONICS

BUILD-IT BOOK OF SOLAR HEATING PROJECTS

1050-182 p.—The Most Popular Subroutines In BASIC (\$3.95)

1194-448 p.—How to Troubleshoot & Repair Amateur Radio Equipment (\$14.95)

1006-196 p.—Build It Book of Solar Heating Projects (\$9.95)

1077-294 p.—Handbook of Remote Control & Automation Techniques (\$12.95)

HOW TO MAKE YOUR OWN SOLAR ELECTRICITY

1167-168 p.—Electronic Music Synthesizers (\$9.95)

HOW TO TROUBLESHOOT & REPAIR AMATEUR RADIO EQUIPMENT

1199-476 p.—The Master IC Cookbook (\$15.95)

DESIGN, BUILD & PROGRAM YOUR OWN WORKING COMPUTER SYSTEM

HANDBOOK OF REMOTE CONTROL & AUTOMATION TECHNIQUES

1178-168 p.—How to Make Your Own Solar Electricity (\$9.95)

ELECTRONIC MUSIC SYNTHESIZERS

THE PRACTICAL HANDBOOK OF AMATEUR RADIO FM & REPEATERS

1111-308 p.—How to Design, Build & Program Your Own Working Computer System (\$4.95)

1206-350 p.—How to Design & Build Audio Amplifiers, including digital circuits (\$15.95)

1206-350 p.—How to Design & Build Audio Amplifiers, including digital circuits (\$15.95)

1212-504 p.—The Practical Handbook of Amateur Radio FM & Repeaters (\$15.95)

1136-504 p.—Practical Electronics Math (\$15.95)

1184-616 p.—The Master Guide to Electronic Circuits (\$19.95)

HOW TO DESIGN, BUILD & TEST COMPLETE SPEAKER SYSTEMS

Understanding Electronics

HOW TO DESIGN AND BUILD AUDIO AMPLIFIERS, including digital circuits

THE PRACTICAL HANDBOOK OF AMATEUR RADIO FM & REPEATERS

THE MASTER IC COOKBOOK

1064-336 p.—How to Design, Build & Test Complete Speaker Systems (\$9.95)

1113-182 p.—Understanding Electronics (\$8.95)

1070-406 p.—Digital Interfacing with an Analog World (\$12.95)

1163-308 p.—The Complete Handbook of Sewing Machine Repair (\$14.95)

1136-504 p.—Practical Electronics Math (\$15.95)

1184-616 p.—The Master Guide to Electronic Circuits (\$19.95)

Digital Interfacing With An Analog World

THE COMPLETE HANDBOOK OF SEWING MACHINE REPAIR

1148-252 p.—How to Repair Old Time Radios (\$12.95)

TROUBLESHOOTING MICROPROCESSORS & DIGITAL LOGIC

Facts About Club Membership

- The 6 introductory books of your choice carry publisher's retail prices of up to \$103.70. They are yours for only \$1.99 for all 6 (plus postage/handling) with your Trial Membership.
- You will receive the Club News, describing the current Selections, Alternates, and other books, every 4 weeks (13x a year).
- If you want the Selection, do nothing, it will be sent to you automatically. If you do not wish to receive the Selection, or if you want to order one of the many Alternates offered, you simply give instructions on the reply form (and in the envelope) provided, and return it to us by the date specified. This date allows you at least 10 days in which to return the form. If, because of late mail delivery, you do not have 10 days to make a decision and so receive an unwanted Selection, you may return it at Club expense.
- To complete your Trial Membership, you need buy only four additional monthly Selections or Alternates during the next 12 months. You may cancel your Membership any time after you purchase these four books.
- All books—including the Introductory Offer—are fully returnable after 10 days if you're not completely satisfied.
- All books are offered at low Member prices, plus a small postage and handling charge.
- Continuing Bonus. If you continue after this Trial Membership, you will earn a Dividend Certificate for every book you purchase. Three Certificates plus payment of the nominal sum of \$1.99 will entitle you to a valuable Book Dividend of your choice which you may choose from a list provided Members.

May we send you your choice of 6 of these practical time-and-money-saving books as part of an unusual offer of a Trial Membership in Electronics' Book Club?

Here are quality hardbound volumes, each especially designed to help you increase your know-how, earning power, and enjoyment of electronics. Whatever your interest in electronics, you'll find Electronics Book Club offers practical, quality books that you can put to immediate use and benefit.

This extraordinary offer is intended to prove to you through your own experience, that these very real advantages can be yours...that it is possible to keep up with the literature published in your areas of interest, and to save substantially while so doing. As part of your Trial Membership, you need purchase as few as four books during the coming 12 months. You would probably buy at least this many anyway, without the substantial savings offered through Club Membership.

To start your Membership on these attractive terms, simply fill out and mail the coupon today. You will receive the 6 books of your choice for 10-day inspection. YOU NEED SEND NO MONEY. If you're not delighted, return the books within 10 days and your Trial Membership will be cancelled without cost or obligation.

ELECTRONICS BOOK CLUB, Blue Ridge Summit, Pa. 17214

ELECTRONICS BOOK CLUB

Blue Ridge Summit, Pa. 17214

Please open my Trial Membership in ELECTRONICS BOOK CLUB and send me the 6 books circled below. I understand the cost of the books I have selected is only \$1.99 for all 6, plus a small shipping charge. If not delighted, I may return the books within 10 days and owe nothing, and have my Trial Membership cancelled. I agree to purchase at least four additional books during the next 12 months after which I may cancel my membership at any time.

800 1006 1050 1064 1066 1070 1077 1108
1111 1113 1136 1148 1160 1163 1167 1169
1178 1183 1184 1194 1199 1206 1212 1234

Name _____ Phone _____

Address _____

City _____

State _____ Zip _____

(Valid for new Members only. Foreign and Canada add 15%.) RE-680

CIRCLE 24 ON FREE INFORMATION CARD

Catch the fastest C-meter under \$200 ...the autoranging 830

It's happened again. B&K-PRECISION was the first company to offer a lab-quality C-meter for under \$150, now we're first with autoranging for under \$200. The new Model 830 autoranging capacitance meter is fast, accurate and built with famous B&K-PRECISION dependability.

The 830 offers features that are tough to match at any price, such as 0.1 pF resolution, large 3½ digit LCD display and fuse protection against charged capacitors. Basic accuracy is 0.2%, much greater than the tolerance of most capacitors.

Ease of operation is another strong suit for the 830. On the production line, even untrained workers can be quickly instructed on proper operation, making the 830 ideal for component sorting and selection. If capacitors to be measured are limited to a narrow value range, the "range hold" capability of the 830 can freeze it onto one range—an

added time saver. This feature, along with the fast reading time of the instrument, makes the 830 especially valuable for incoming inspection applications. On the engineering bench, the 830 is an excellent means of pre-testing critical capacitors.

For applications suited to manual ranging, B&K-PRECISION offers the 820 at an even lower cost. In fact, for the cost of some autoranging units, you



could almost purchase both the 820 and 830! The 820 also provides 0.1 pF resolution. With full 4-digit LED display, readings extend to 1 Farad.

With either B&K-PRECISION C-meter, you can measure unmarked capacitors... verify capacitor tolerance... measure cable capacitance... select and match capacitors for critical circuit applications... sample components for quality assurance... measure complex series-parallel capacitor networks... accurately set trimmer capacitors... check capacitance in switches and other components. Both instruments have front-panel lead insertion jacks for fast in-out testing.

Optional accessories for the 830 and 820 include a rechargeable battery pack, AC charger and carrying case. For more information, see your local distributor and see why B&K-PRECISION is now the leading supplier of digital capacitance meters.

B&K PRECISION DYNASCAN CORPORATION

6460 W. Cortland Street • Chicago, IL 60635 • 312/889-9087

International Sales, 6460 W. Cortland Street, Chicago, IL 60635 USA: TELEX: 25-3475

Canadian Sales, Atlas Electronics, Ontario

Model 820 \$140

Model 830 \$199



A HISTORICAL LOOK AT TELEVISION



Television technology is progressing at a rapid rate—but the major advances were really made years ago.

KATHY GOFORTH

IN 1929, WHEN THE FIRST ISSUE OF *Radio-Electronics*—then *Radio-Craft*—took up the discussion of an infant technology called television, the consensus at the neighborhood tavern (where television would eventually find its first mass audience) was that communication had reached its zenith with radio. To the general public of 50 years ago, the idea of sending moving images through space seemed the impossible dream of over-optimistic engineers. Today Americans alone own an estimated 146 million television sets—more than the number of telephones, refrigerators, automobiles, or bathtubs. TV has moved from the impossible to the indispensable. A viewing audience, including some who once considered video communications as remote a notion as a spaceship to the moon, already looks back a full decade to the time when it watched, from the comfort of the living room sofa, that first human step on the moon.

But astonishing as television's future is certain to be, its phenomenal success story already lies in the past—in the drama of its early development, the quantum leap from mechanical to electronic, and the metamorphosis from black-and-white to color. The subplots to the tale include global neglect through two world wars, a perpetual and frustrating lag between theory and workable hardware, a series of lively disputes over uniform standards, and an out-and-out battle between two early color systems.

The beginning

The story begins at that unidentified moment in the distant past when man first hatched the dream of extending human vision beyond the limitations of location. But television's practical history begins only about 100 years ago, with the discovery of the early principles needed to make it possible. By 1929, milestones already included the 1873 discovery of the photoconductivity of selenium and the idea of scanning a



1947 TELEVISION BREAKTHROUGH. Motorola introduced first black-and-white TV receiver to sell for under \$200.

picture's elements in rapid succession, line by line and frame by frame, with reliance on the persistence of human vision—proposed about 1880. That important theory established the possibility for single-wire transmission and led in 1884 to the patent by German scientist Paul Nipkow of a complete television system characterized by the spirally-perforated rotating disc. The

Nipkow disc, as it came to be called, would be used in one form or another in all workable television systems until the advent of electronic scanning.

As early as 1897 German inventor Karl Braun had devised the cathode-ray tube, and in 1907 Russian scientist Boris Rosing reproduced crude geometrical patterns using a cathode-ray television system with a form of mirror-drum scanning at the camera end. A year later, Scottish electrical engineer A.A. Campbell-Swinton outlined a method for television using a cathode-ray tube at both receiver and camera ends—in all essentials the basis for modern TV, but an idea too advanced to be put into practice in 1908. (In 1904 English physicist J.A. Fleming had contributed the two-electrode valve; in 1906 American inventor Lee deForest had provided the grid for amplification.)

Early television research came to an abrupt halt with the outbreak of World War I, and although full-time experimentation wasn't resumed until the return of peace, by 1923 scientists in both the U.S. and England were at work on television systems using the Nipkow principle and the neon gas-discharge lamp, invented by D.M. Moore in the U.S. in 1917. In 1925 Charles F. Jenkins used such a system to broadcast silhouettes from his Washington, D.C. workshop, and in 1926 John Logie Baird in England transmitted moving pictures in halftones—scanned in only 30 lines, repeated about 10 times a second—to



FIRST PUBLIC DEMONSTRATION of inter-city television broadcasting took place in 1927. Herbert Hoover, then Secretary of Commerce, was speaking in Washington and seen on television screens at Bell Telephone Laboratories in New York.

give what might be called the first demonstration of "true" television. Baird's system formed the basis of the experimental broadcasting that began in England in 1929.

The post-war years also brought the landmark invention of the iconoscope by Vladimir K. Zworykin, a Russian scientist and recent immigrant to the U.S. The 1923 breakthrough put Campbell-Swinton's advanced theory into practice, giving the camera its "eye" and providing the final missing element needed for modern television. The crude but workable, partly-electronic TV system Zworykin developed that same year became the basis for the system used in 1939 for the first public demonstration of television, by RCA, at the New York World's Fair.

The 20's continued as a decade of enthusiastic research, and a variety of experimental television systems were demonstrated. The new technology left much to be desired, however, and even when experimental broadcasting began television made little headway toward public acceptance. Its audience remained limited to small numbers of engineers and a slowly expanding coterie of home kit-builders. The latter had a chance to become acquainted with terms such as "automatic synchronization" and "interlaced scanning" before the electron beam swept the whirling disc into discard, bringing the early period of television's development to a close. By the early 30's scientists had come to pin their hopes for improved pictures on the all-electronic systems and had turned their attention in that direction. TV's future mass audience still clustered contentedly about its radios, unimpressed by fuzzy pictures on tiny, inordinately expensive screens. And the more resolute of the home experimenters withdrew to their basements

and garages to experiment with the new tubes.

Standards

It has also become apparent by this time that if television were to grow, broadcasters and set manufacturers would have to accept uniform standards. Engineers argued hotly over what those standards should be, and just what form a national television system should take, and in 1933 hearings by the FCC began in the U.S. in an effort to establish the necessary guidelines. Meanwhile, scientists and engineers continued to chalk up contributions to the growing science: Philo T. Farnsworth's electronic scanning system improved pictures; electrical engineer Allen B. DuMont streamlined the workings of the cathode-ray tube; continuing research on the electronic systems, carried out in the U.S. mainly in RCA labs, soon increased the number of scanning lines to 343. German scientists, too, were active, especially in the development of high-vacuum cathode-ray tubes, and by 1935 a regular broadcasting service had begun in Germany. A team of researchers under Isaac Shoenberg at Electric Musical Industries (EMI) in Great Britain also produced a complete and practical system based on the Emitron camera tube, and the world's first public high-definition service was launched in London in 1936—in time to broadcast the coronation of George VI over a broad area. Its 405-line standard remained the basis of the British system for nearly three decades—until 1964, when it was superseded by the 625-line standard.

French engineers had begun work on a 1,000-line system, which eventually resulted in France's 819-line standard. Japan pressed TV research in hopes of telecasting the Olympic games from

Tokyo in 1940, and in April, 1939, regular television service began in the U.S. with NBC's broadcast, emanating from a transmitter atop the Empire State Building, of the opening ceremonies of the World's Fair. President Franklin Roosevelt, on hand for the occasion, became the first President to be televised. Technological capability had narrowed the gap between theory and practice, enthusiasm was fired, and the rapid development of commercial television seemed assured. Four months later, Hitler's troops assaulted Poland, and declarations of war by England and France marked the beginning of World War II and the second hiatus for television research.

In the U.S., as in other countries, the need for military preparedness led to increasingly heavy demands on industrial research, engineering, and production facilities. By the time the Japanese attacked Pearl Harbor (December 1941) virtually all U.S. electronics facilities were devoted to military projects—radar, radio, special tubes, acoustical devices, and navigational systems. What television broadcasting remained began to serve the needs of civil defense, air-raid warden training, Red Cross instructions, and war bond sales.

Network television

But television's crucial momentum had been gained before the war, and peacetime returned the medium was poised for unprecedented expansion. Both NBC and CBS had developed surprisingly extensive schedules of programs for the several thousand sets in use before the U.S. joined the fighting in 1941. The first official network broadcast in the U.S. had come in February 1940, when a program from NBC in New York City was picked up and re-broadcast by General Electric's station in Schenectady, N.Y. At about the same time, Zenith Corp. had begun regular program service in Chicago. Parts of the 1940 Republican National Convention in Philadelphia had been televised after transmission to New York via coaxial cable, and films of the Democratic Convention in Chicago had been broadcast in New York.

Commercial television had begun officially in 1941, when both NBC and CBS were granted licenses on July 1. Standards for a commercial system had been worked out before the war by the National Television System Committee, and wartime engineering paid off in a harvest of technological advances: the image orthicon; more powerful transmitting equipment; improved picture-display techniques based on radar developments; more effective network relay techniques, and major advances in high-frequency techniques. Television celebrated the war's end and its own

return to the commercial arena by broadcasting coverage of V-E Day and the Japanese surrender. An American public weary of wartime austerity, and a business world thrilled by a potential new advertising tool, both looked forward to television's widespread use.

In 1946 NBC in New York linked up with Washington, D.C. by coaxial cable, creating the first real network, and RCA placed the first post-war TV sets on the market—the famed 630TS, television's equivalent to the Model T Ford, and the nation's first quantity-produced and marketed receiver, selling for \$375. By midsummer, 1947, 12 broadcasting stations were in operation and a larger number under construction. The same year brought the premier of Kraft Television Theater—the first regularly scheduled network drama series and the first show blessed with sufficient financial backing to ensure consistently high quality productions. The big show of 1947, however, was the first televised World Series, viewed by an estimated 3.9 million people, the majority of them in local bars, where commercial television got its test run by many consumers.

By the following year, the vote was in. Americans had taken to the idea of going to the theater and the ball park via the easy chair, and television antennas sprang up like mushrooms on the roofs of homes across the nation. The number of receivers snapped up by an eager public jumped from 136,000 in 1947 to 800,000 in 1948. Television was accepted by the service technician, and test equipment appeared. The number of stations tossing images from batwing to dipole grew with an expanding web of networks: East Coast television cities were linked to Chicago, St. Louis, Pittsburgh, Buffalo, Cleveland, and Toledo, with microwave relays adding Detroit and Milwaukee to the circuit.

Innovations tumbled out of the labs and into the stores: "convenience" accessories such as the viewer-controlled zoom lens and the one-way mirror that made a turned-off television a decorator piece; the first portables—37 pounds light; more rugged antennas, designed to better withstand the rigors of rain, snow, and wind; directors and reflectors for more selective reception and to battle the increasing problem of interference from different stations. Television's expansion had surpassed even the most optimistic forecasts, outstripping even the phenomenal growth of the auto, moving picture, and radio industries.

Color television

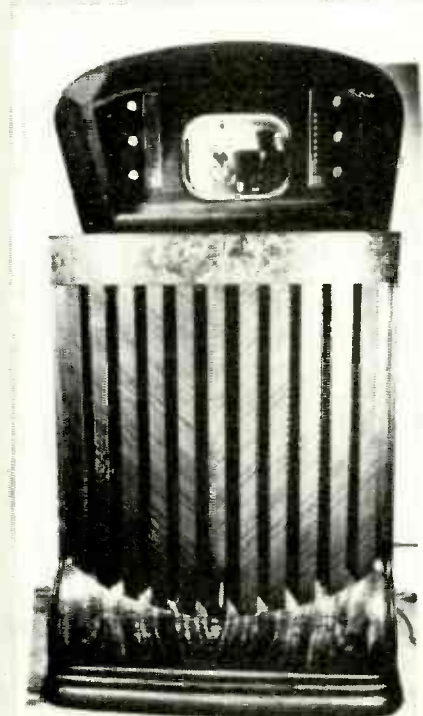
As a result, the problem of one station's signal interfering with another's soon grew to such proportions that, in September of 1948, the FCC declared a



LEE deFOREST holding his invention, the Audion—the first vacuum tube with a grid for amplification.



JENKINS PROJECTION RADIOVISOR, developed in 1931, used deForest's new neon-crater tube and a 1-inch scanning disc with sixty 1/2-inch lenses to throw a flying-spot image on the rear of the ground-glass viewing screen.



FIRST ZENITH TELEVISION was manufactured in 1939.

freeze on the licensing of any new TV stations. There had to be time to study frequency allocations and to consider the problems posed by another major innovation that sat perched on the horizon: color. Like monochrome TV, color television has its roots in a number of early experiments and in the Nipkow disc—used in threes, in this case, one disc for each of the primary colors.

The first practical demonstrations of color came in 1928 when Baird used a system of two gas-discharge tubes as light source at the receiver, one of mercury vapor and helium for the green and blue colors and a neon tube for red, along with a set of discs, an early variety of the "color wheel." In 1930, Ray D. Kell of General Electric patented a color-television system employing a double, spiral scanning disc and only two colors; and in 1931 German engineer Anronheim devised a color system using a 12-color filter disc in conjunction with a scanning disc. Experimental work on color continued in both Great Britain and the U.S. in the late 30's, and similar sequential systems using rotating color filters in the cameras and receivers were demonstrated in both countries.

The drawbacks of the mechanical approach to color TV were that it required an increased rate of scanning to avoid color flicker and it was noncompatible with existing black-and-white television. An all-electronic method proposed by others was compatible with black and white, but it was a much more difficult system than the mechanical one. In 1938, Georg Valensi of France pioneered the path to compatible color television when he patented a method enabling output from a single transmitter to be received by television sets with equipment for color and by ordinary black-and-white sets as well. His proposals were never precisely adopted in practice.

In the U.S. battle lines were drawn between variations of the two systems: CBS developed a mechanical system of whirling color wheels, synchronized at the receiver and camera ends. A transparent disc divided into three segments for the primary colors revolved before the camera, scanning the color elements of a picture and sending them to the receiver disc. The successive primaries flashed to the eye at the rate of 144 per second, and persistence of vision blended them into one. With the system's excellent picture came a counterbalance of problems, including interlacing, flicker, and fringing. Even so, and even though it was incompatible with black-and-white sets, the mechanical system offered the most promise in terms of early commercial advantage. The alternate, all-electronic system developed by



RCA's FAMED MODEL 630TS was television's equivalent to the model-T Ford automobile. The 630TS was the first post-war TV receiver and was also the first mass-produced and marketed TV receiver, selling for \$375.

RCA used three lenses and three electronic systems—in effect three cameras in one—to pick up the primary colors. A sampler in the receiver, synchronized with one in the transmitter, took short samples of the composite signal at the instants of red, green, and blue peaks, using three kinescopes whose phosphors glowed in the three primary colors.

But existing projection-tube displays, and a very complex direct-view display using three orthogonal picture tubes whose pictures were combined by dichroic mirrors, lacked the convincing evidence of practicality. In 1949, the FCC gave its approval to the mechanical color system, and RCA moved with full speed to develop the final basic element in the compatible system—a single tube capable of producing full color.

In 1950, the company startled the industry with a demonstration of the shadow-mask tricolor kinescope—the reward of the most intensive single research effort in electronic to that time. The color tube was essentially the same as the one now used throughout the world.

After winning FCC approval, CBS had begun limited color broadcasting, but the mechanical color system was to be short-lived. Hit by a serious shortage of parts during the Korean conflict, the color wheel quietly whirred its way out of existence, to the relief of manufacturers and engineers alike (though a variety of the system was later used by Apollo astronauts to transmit their remarkable pictures of the moon and earth). In 1953 came the FCC approval of the refined RCA compatible color system; and the industry sat back to let RCA and its subsidiary NBC develop

and promote color TV. [Ironically, CBS held the patent on the shadow mask and RCA had to pay royalties for 17 years.—*Editor*]. RCA produced the first compatible sets in March 1954, and NBC began to try out its major programs in color.

TV growth

Television had continued to weave its way inextricably into the fabric of American society. Audiences were electrified in 1951 by the televised Senate committee hearings on organized crime. In 1952 they watched TV's first opera broadcast, the televised explosion of the first atomic bomb, and coverage of the presidential election campaign. September 1951 had brought completion of the link to the West Coast—a 3,000-mile network of 107 relay towers—and transcontinental television was now a fact. NBC's coverage of the 1952 conventions in Chicago introduced the portable RF-connected camera and the first "crash truck," a TV newsroom on wheels equipped with self-powered electronic and film cameras and its own darkroom. Cable television got its start in 1950 with the erecting of the first community antenna, in Lansford, PA.

With the imminent lifting of the FCC freeze on TV station construction, a handful of UHF stations demonstrated the technical possibilities—and limitations—of the UHF spectrum and the newly designed equipment to work in it. When the freeze ended in April 1952, with a document that supplemented the existing channels in the VHF band with 70 new channels in the UHF band, it began processing a backlog of 700 appli-

cations for new stations, granting 175 new licenses that year. Soon 377 stations were on the air, and by the middle of 1954 almost 90 percent of the country had television coverage.

The 50's also brought continued improvements: the Vidicon camera; in 1953, development of a curved shadow-mask with phosphors deposited directly inside the face of the tube; in 1954 incorporation of internal pole pieces in the three electron guns of the color tube to permit each beam's independent adjustment and an increase in deflection angle; also in 1954 the development of photographic deposition of the three color phosphors. In 1958, we had the replacing of the metal envelope of the color tube by a glass one, made possible by the advent of a new frit-glass seal by Corning Glass; and in 1956 the use of videotape and the first quadruplex (4-head) video-tape recorder.

The 1960's brought the incorporation of solid-state components in color TV, new phosphors to provide brighter colors, more color programming, and an increase in popularity for color TV. NBC was broadcasting as much as 40 hours a week of color programs in 1963 (though CBS had still done little color programming and ABC virtually none), and color was becoming an important element in program costs and set sales. Experimental pay TV began on a UHF channel in Hartford, CT. At the 1964 political conventions in Atlantic City and San Francisco, new RF-connected portable cameras and control units used were much lighter than previous systems—the complete package weighing less than 50 pounds—and for the first time the camera's microwave equipment operated in the 13-GHz band, eliminating most of the noise and interference that had plagued previous microwave-link cameras.

In 1965 color television reached the elite billion-dollar category as an industry. Hand-held minicams appears at the 1969 political conventions; and the Trinitron gun was developed, reducing aberrations with its three in-line electron beams from once source and single large-diameter lens. In 1969 came the shadow-mask tube with a black-matrix faceplate, reducing back-scattered light by 50 percent.

Today countries in every corner of the globe have established privately, publicly, or government-owned television service, and acceptance of the TV screen as man's eye on the world around him is complete; the medium is destined to grow in countless and unexpected ways to accommodate the needs and satisfy the voracious curiosity of its inventors and viewers. Television has come of age, and as a maturing technology it will no doubt continue to astound and delight us. R-E

BUILD THIS

AUTOMOTIVE VOLTAGE REGULATOR

L. STEVEN CHEAIRS

This voltage regulator for your car could be more reliable than the original equipment. Build it and keep your battery well-fed.

A FEW YEARS AGO DURING A PERIOD OF excessive automobile charging-system breakdowns, I was forced to design a voltage regulator as a solution to the problem of too-frequent failures of the factory-supplied unit. My car, as are many of yours, was equipped with a solid-state module. The unit failed right after the car's warranty period expired. A replacement was purchased, for about \$40.00, and installed. After a few

months it also failed; again it was replaced. Again it failed after a relatively short time period.

Now, to even a thickhead like myself, it became obvious that a new approach to this problem was in order. I planned to keep the car for several years so I designed a voltage regulator that I felt would eliminate the problem in the car's electrical system. The system I designed and built is still operating without any

problems. Questar later offered the unit as a kit, over one thousand units were sold, and only an occasional installation problem occurred.

Let me elaborate for a second. When the manufacturer is building an alternator and comes to the point of terminating the alternator leads for the field (rotor) and armature (stator), he is faced with three alternatives. First, ground one lead to the case and connect the other

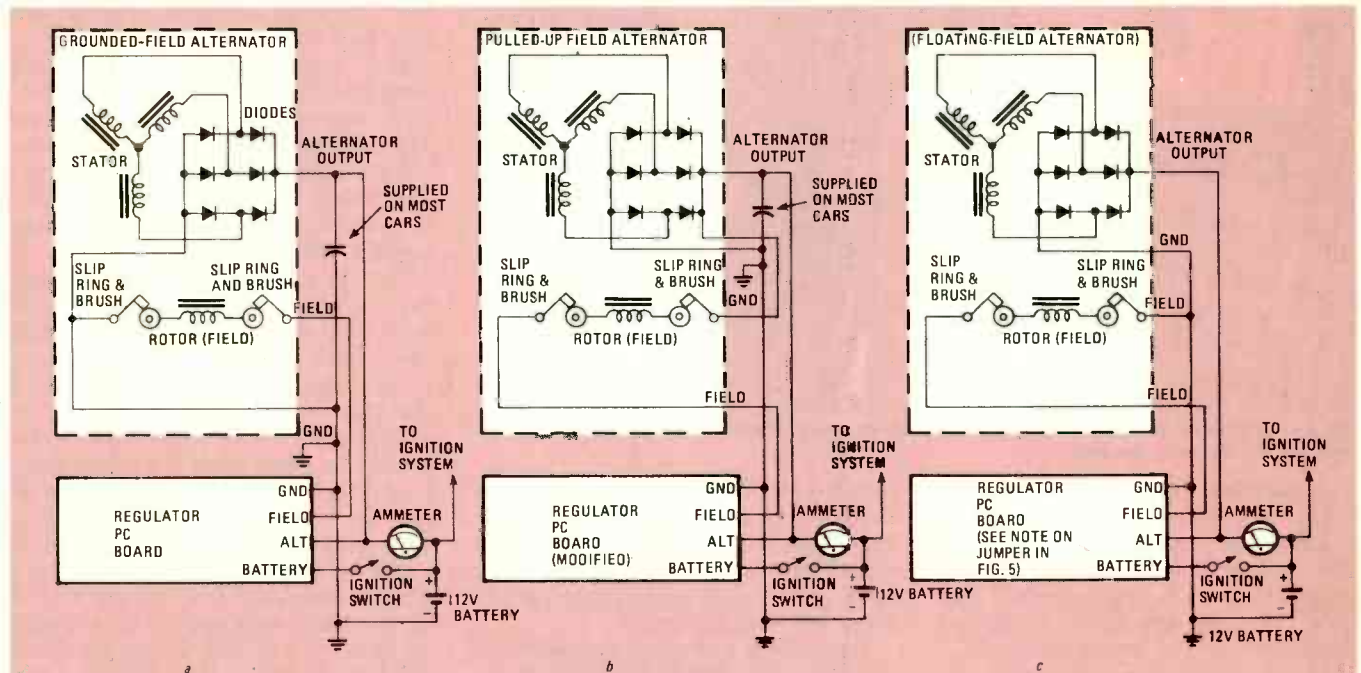


FIG. 1—THE ALTERNATOR IN AUTOMOTIVE ELECTRICAL SYSTEMS may be one of three types. The grounded-field system (a) is the most common and is the type this electronic voltage regulator is designed for. However, the regulator circuit and PC board wiring can be modified to work with the pulled-up field (b) or the floating-field alternator is wired as a grounded-field type at c. It may also be wired as a pulled-up field type.

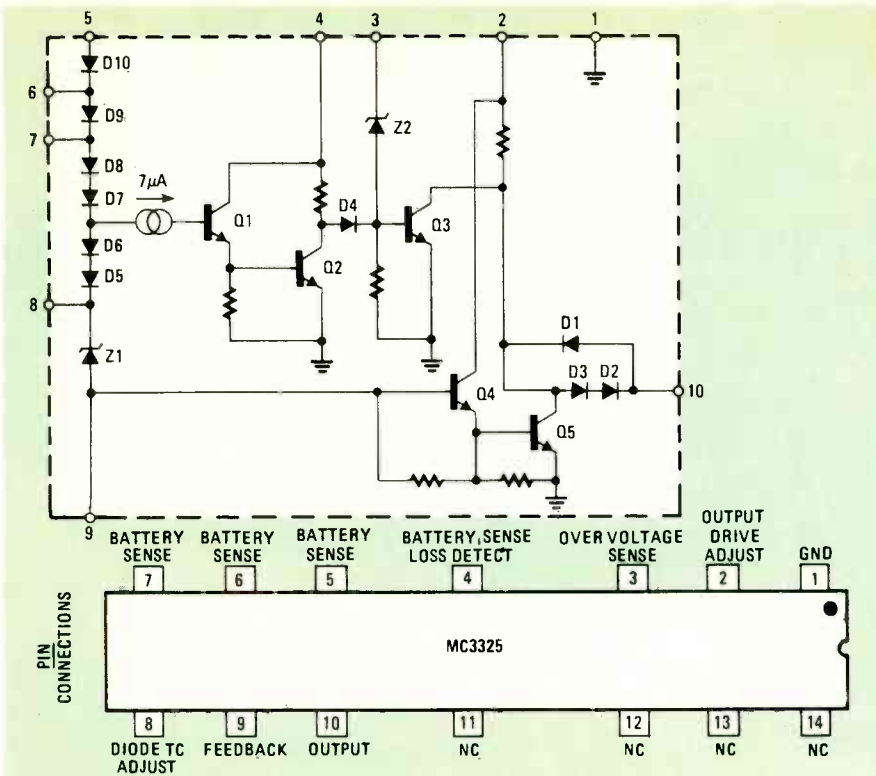


FIG. 2—CIRCUIT DIAGRAM and pin-out for the Motorola MC3325 voltage regulator IC.

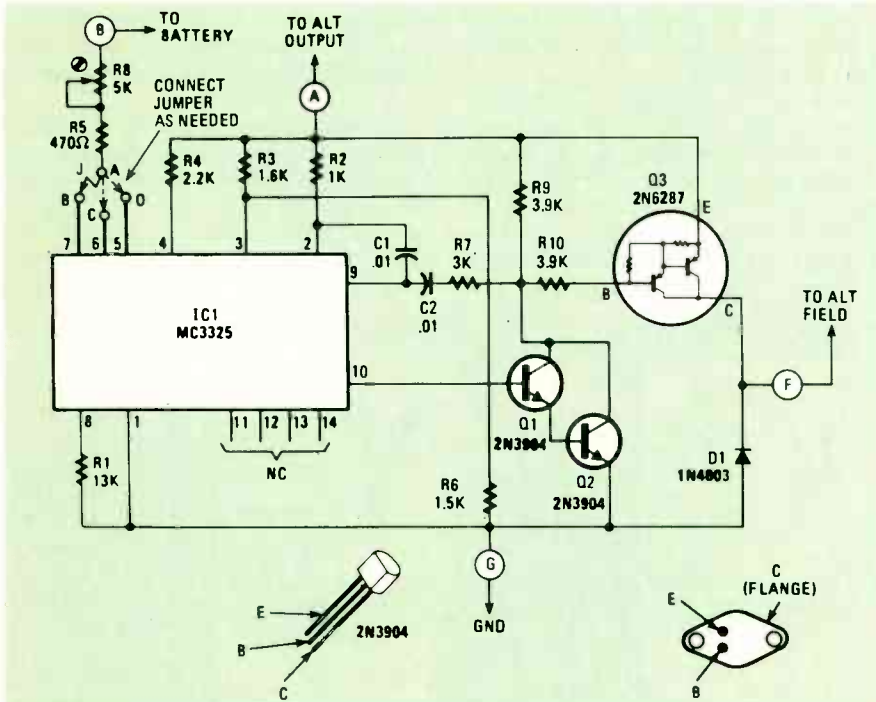


FIG. 3—SCHEMATIC DIAGRAM of the electronic voltage regulator as used with grounded-field and floating-field alternator systems.

to a terminal block, thus a grounded field system (Fig. 1-a). Second, (Fig. 1-b) connect one lead to the positive alternator output terminal and the other to a terminal block, a pulled-up field system. Third, he may simply bring both leads out (Fig. 1-c), hence floating field.

The floating-field configuration adds one terminal and for a manufacturer that could mean significant cost. The pulled-up field requires the routing of one wire to the alternator output ter-

terminal; a minor amount of extra wire is needed. The grounded-field unit is the easiest since the lead is simply attached to the case at any appropriate nearby point. *Most charging systems use the grounded-field system.*

I also chose a temperature coefficient that was optimized for my system, not necessarily the average. As the temperature varies in the engine compartment the temperature of the regulator will change. Thus, the bias levels shift. For

this design, a current flow of 0.5 mA to 1.0 mA is required on the battery-sense input leg. The input resistors set a voltage level and the current level. The integrated circuit I used has three battery-sense inputs: the choice of the proper input along with external resistors set the temperature coefficient. All inputs are provided on this new design.

My auto is driven in the desert for most of the year so in my earlier design I chose a battery-voltage level best suited to this environment. Now for the fellow who lives in a cold area, a high-voltage would help his starting. Also, for the person who lives in an area that sees a fairly large-temperature fluctuation, the ability to change the battery voltage easily could be desirable.

This project is not just a modification of a three-year-old design: it is a new design which is superior to its predecessor. The new features are as described as above: 1) grounded-field operation, 2) selectable-temperature coefficient, and 3) adjustable voltage-regulation level. The previous features are also still retained: 1) high reliability from a compact solid-state design, 2) over-voltage protection, 3) automatic shut-down if the battery-sense line should be broken, and 4) a superior replacement for electromechanical and modular voltage regulators.

About the Circuit

This circuit is actually quite simple and is a good one for beginners or those who do not wish to spend the time with more complex projects. It is designed around Motorola's MC3325 voltage-regulator, IC shown in Fig. 2. However, the more advanced hobbyist will also find the completed circuit very useful. I also use the unit in a home emergency-lighting system and as a battery back-up for my home computer. The main application is still your automobile's charging system. The circuit, as shown in Fig. 3 contains one IC, a trimmer resistor, two capacitors, a triode transistor, two capacitors, a diode, and a handful of resistors.

The IC, a Motorola MC3325 automotive voltage regulator (Fig. 2), has three battery-sense inputs (pins 5, 6, and 7) that select a tap in the diode/Zener string. The temperature-coefficient of the battery-voltage sense terminal is determined by the number of diodes used in the diode string. An approximate temperature coefficient for a diode at 1.0 mA is $-2.0 \text{ mV}/^\circ\text{C}$. The temperature coefficient of Zener diode Z1 is about $+3.0 \text{ mV}/^\circ\text{C}$. If you count from ground and sum these values a total temperature coefficient can be obtained; we have -2.0 mV for Q4 and Q5, $+3.0 \text{ mV}$ for Z1, -8 mV for D5 through D8, and an additional -2.0 mV each for diodes D9 and D10 when used. Thus the temperature coefficient will be between $-9.0 \text{ mV}/^\circ\text{C}$ and $-13 \text{ mV}/^\circ\text{C}$.

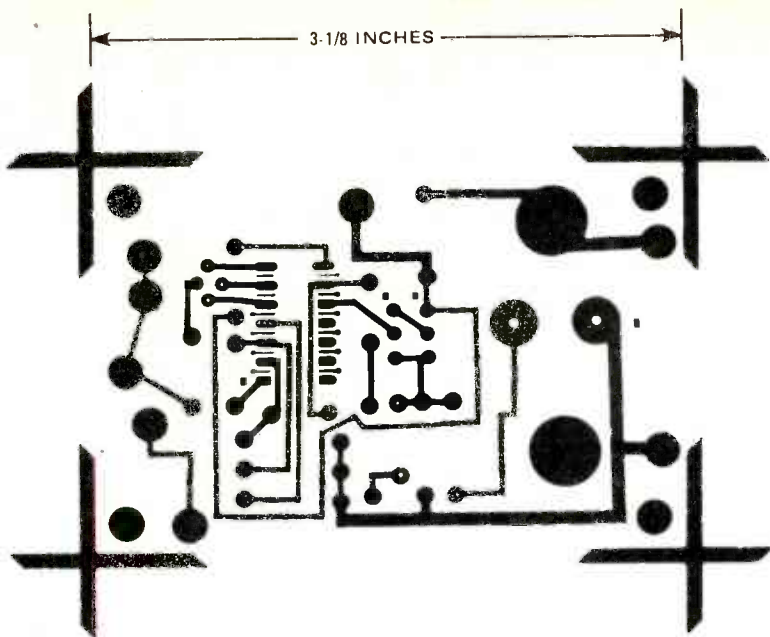


FIG. 4—FOIL PATTERN for the regulator printed circuit. The finished board measures 3-1/8 by 2-1/16 inches.

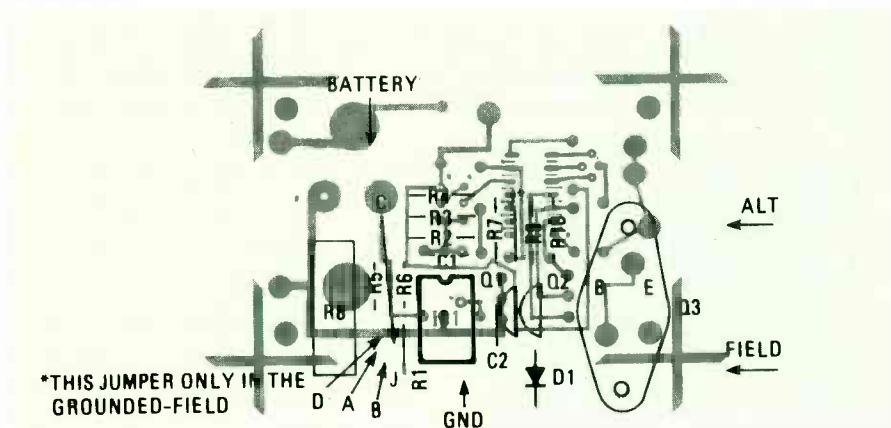


FIG. 5—PARTS PLACEMENT GUIDE for the voltage regulator. Note that the jumper between R7 and R9 is used only when the circuit is used with a grounded-field alternator. A jumper must be installed between point "A" and point "B", "C", or "D", depending on the desired temperature coefficient.

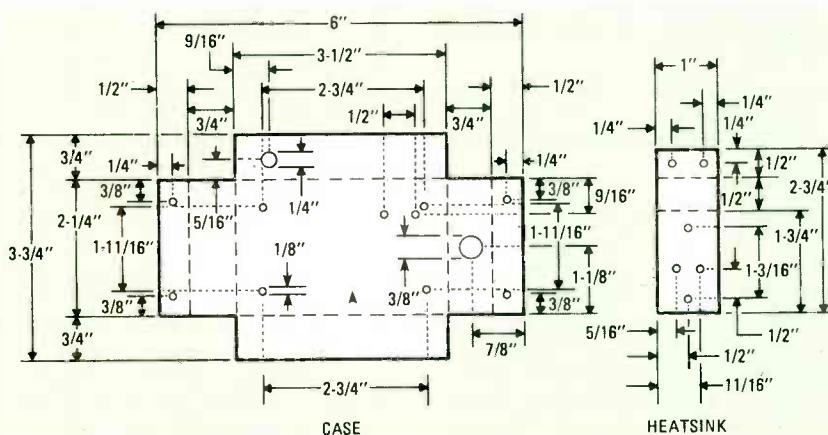


FIG. 6—THE CASE AND HEATSINK can be fabricated from easily worked tinplate or other sheetmetal. The heatsink transfers the heat generated by the power transistor to the surface of the metal case.

The complete schematic of the voltage regulator is shown in Fig. 3. Resistor R1, connected between pin 8 and ground, sets the current through the diode string between 0.5 mA and 1.0 mA. The value of R1 is directly proportional to the temperature coefficient. As the value of R1 decreases the effective temperature

coefficient will decrease. The total value of the trimmer R8 and resistor R5 will determine the regulation level. Resistor R5 establishes the minimum voltage, while the maximum value of trimmer R8 plus the value of resistor R5 determines the maximum regulation voltage. The regulation voltage can be

PARTS LIST

Resistors 1/4 watt, 5% unless otherwise noted

- R1—13,000 ohms
 - R2—1000 ohms
 - R3—1600 ohms
 - R4—2200 ohms
 - R5—470 ohms
 - R6—1500 ohms
 - R7—3000 ohms
 - R8—5000 ohms, 10-turn trimmer potentiometer
 - R9, R10*—3900 ohms
 - C1, C2—.01μF ceramic disc
 - D1—1N4003
 - Q1, Q2—2N3904 or equal NPN transistor
 - Q3*—2N6287 (Motorola or RCA) PNP power Darlington switching transistor
 - Q4—2N6059 or MJ1000 (Motorola) NPN power Darlington switching transistor (used only in Fig. 9 circuit)
 - IC1—MC3325 (Motorola) automotive voltage regulator
- *R9, R10 and Q3 are not used in pulled-up field circuit

The following parts are available from Questar Engineering Co., 5412 Burntwood Way, Las Vegas, NE 89108: Kit of all parts \$24.50, PC board \$6.75, 2N6287 PNP Darlington \$5.95 and MC3325 \$2.25. Please add \$1.75 for shipping and handling on all orders in the USA. Add \$3.00 to all foreign orders. All COD orders incur COD charges.

calculated from the following equation:

$$V_{reg} = \left(1 + \frac{R5 + R8}{R1}\right) (8.4) +$$

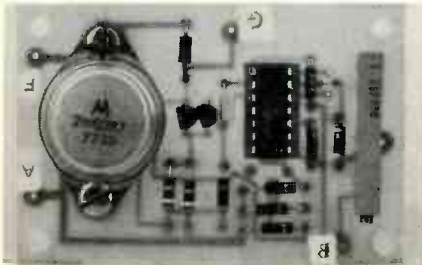
$$\left(n + \frac{R5 + R8}{5000}\right) (0.7), \text{ where } n, \text{ the}$$

number of diodes in the string, is between 4 and 6 ($4 \leq n \leq 6$). Resistor R4 limits the current in case of an open battery-sense input lead. Resistor R3 is a current-limiting resistor connected between the alternator output and pin 3 of the IC. It is used along with resistor R6 to set the maximum overvoltage. The voltage at pin 3 will be about 7.5 volts, as set by an internal Zener diode. During maximum overvoltage, the current supplied to pin 3 must be between 2.0 mA and 6.0 mA; the value of R3 was chosen to insure the required current level.

Resistor R6, in conjunction with R3, sets the maximum overvoltage level. Not only does R3 set the current level for pin 3 but resistors R3 and R6 form a voltage divider used to detect an overvoltage condition. Resistor R2 determines the output-drive current of the output stage of the IC. The value chosen must provide enough current to drive the Darlington-pair (Q1—Q2) when the alternator output is at its maximum level. The Darlington-pair is formed from two NPN transistors; its function is twofold. First, it provides the required drive current to the final Darlington-type switch (Q3) and second it acts as a phase inverter. Feedback compensation is introduced via resistor R7 and

capacitor C2. Capacitor C1 provides feedback from the output stage pin 2 back to the input pin 9; the total feedback is the difference of the two feedbacks' voltages. Notice that the two feedbacks are out of phase—that is, one has been inverted—thus one subtracts from the other.

The difference is applied to the base of the diode string (pin 9) and to the input of the final amplifier. This corrects for any difference between the two signals. Resistor R9 is the load for the phase inverter. The saturation current of Q1 and Q2 is 6.3 mA; 3.3 mA flows through R9. Thus 3 mA must flow from the base of the switch Q3 through R10 and into the collectors of Q1 and Q2. Of course R10 is used to set this current level. The final Darlington-configured transistor switch, Q3, is used to supply current to the alternator's field. Diode D1 is a flyback diode used as an energy return in order to prevent damage to Q3 when the inductive field load is switched on and off. In case you have not guessed, this is a switching regulator. (For more information on this type of



COMPLETED REGULATOR PC Board. Letters A, B, F and G show connecting points for alternator, field, battery and ground.

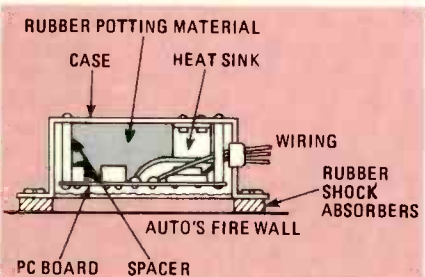


FIG. 7—A CROSS-SECTION drawing showing the shape of the case and how the PC board is suspended on four spacers.

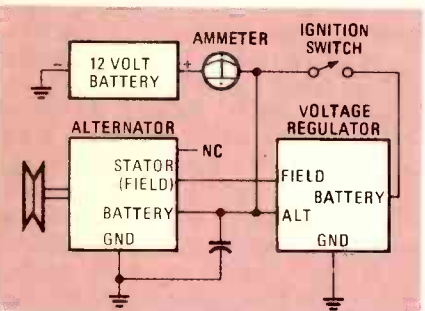


FIG. 8—TYPICAL AUTOMOTIVE BATTERY-CHARGING SYSTEM using a grounded-field alternator. Most of the wiring already exists in car's wiring. Check the connector to the old regulator; the four required interconnections probably are provided.

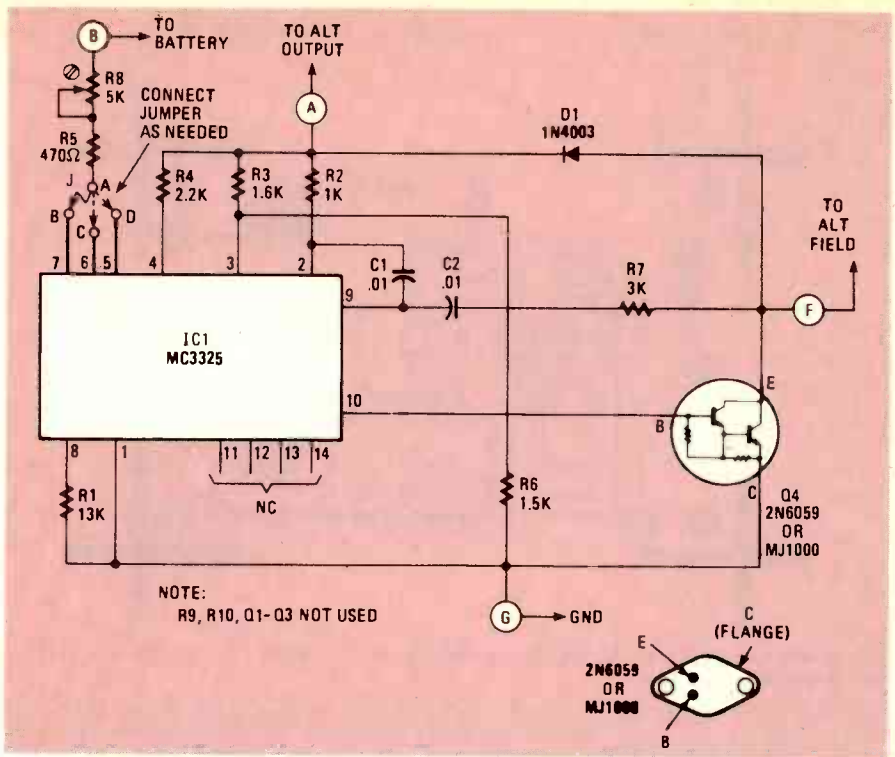


FIG. 9—VOLTAGE REGULATOR CIRCUIT for a pulled-up field alternator. The inverter formed by Q1 and Q2 has been eliminated along with R9 and R10. The driver power transistor has been replaced by a NPN type.

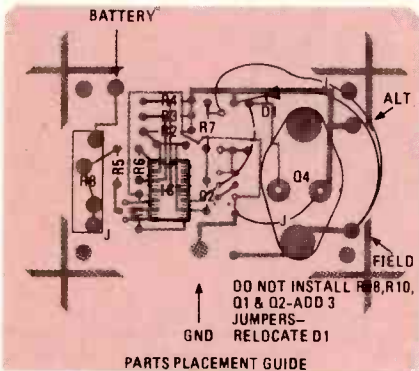


FIG. 10—COMPONENT LAYOUT used with a pulled-up field alternator. Note the three jumpers and the installation of D1.

circuit see my article "All About Switching Power Supplies" in the June and July 1979 issues of *Radio-Electronics*.)

Construction

Since the automotive environment is quite harsh—high temperature differentials, high mechanical vibrations, and corrosive chemicals—the packaging and construction are less flexible than with most other projects. It is recommended that a printed-circuit board be used. Figure 4 provides the foil pattern for a typical PC-board layout. You may use the pattern or lay out your own board. If you wish to obtain a pre-etched and drilled PC board, Questar Engineering Company is selling it. They will also supply individual major components, or a complete kit.

As to the components required: The IC and PNP transistor, to my knowledge, may be obtained by the hobbyist only from Questar; all other components are quite common. Lay all com-

ponents out on your work surface and compare them, item by item, to the parts list. If any component is missing or of a radically different value than specified, *do not* proceed until that situation has been corrected.

Using the parts-placement guide in Fig. 5, install the resistors, capacitors, and the trimmer. Inspect those components for proper location and solder them into place using a 40-watt iron with rosin-core solder only.

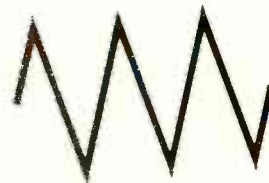
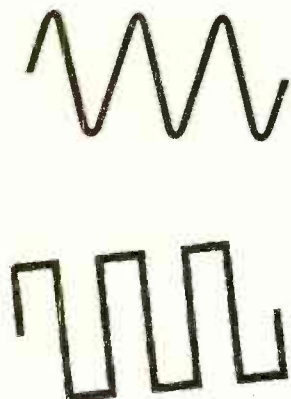
Now install a jumper for the temperature coefficient you have chosen. The choice is based on your auto environment at the point where you install the regulator. In most cases, that will be determined by trial and error—my auto installation worked best with the mid-position jumper (between R5 and pin 6).

Next install the diode, transistors, and the IC. Orientation is important for those components! Because of the environment an integrated circuit socket is not recommended. Set the pot to mid-position—about 14 volts. Temporarily wire the circuit to your car. First, verify it is operating normally; second, convince yourself that you have chosen the correct temperature coefficient. If you haven't, you can change the jumper position appropriately. Vary the pot setting and observe that the regulation level will change. Remember, if you decrease the voltage setting it will take awhile for your battery to discharge to the new level. After you have completed that step remove the circuit and install a set of permanent wires about six or eight inches long.

continued on page 85

BUILD THIS

Synthesized



Function Generator

GARY McCLELLAN

A function generator is one of the most useful pieces of equipment you can own. This synthesized unit offers professional performance at a reasonable price.

THE FUNCTION GENERATOR IS A RELATIVELY recent piece of equipment (since the early 1960's) and has found its way to the average hobbyist's workbench. These devices are really handy for checking out audio gear, servicing other equipment, and just plain experimenting. But unfortunately, progress seems to have ignored the function generator. The generators you see today are great, but all still have crudely calibrated tuning dials that are hard to read, and most generators have some frequency drift. That may be acceptable for most purposes, but try to work with the new active filters, tone decoders, and phase-locked loops. It's tough to do if you don't have good control over the function generator's frequency, which can drift out of the passband of these devices.

Enter our SFG-or Synthesized Function Generator project. This device is a radical departure from conventional function generators in many important ways. As you can see from the photos, gone is the squinty analog tuning dial that you always had to fiddle with. And gone, too, is the drift of conventional function generators that can cause so much aggravation when working with sharp filters. And there are other innovations, too, like the absence of a range switch—that feature is done automatically by the panel switches. And there is also a switchable digital output of different frequencies on the rear

R-E TESTS IT

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

THE SYNTHESIZED FUNCTION GENERATOR was tested in our laboratory. As expected, signal frequencies were totally accurate, thanks to the quartz crystal frequency synthesis method used in the circuitry of the device. Maximum peak-to-peak signal amplitude observed was 15 volts for the sinewave output—somewhat lower for the triangular and squarewave outputs.

As is true of most other function generators, distortion of the sine-wave output was quite high. Our measured results are as follows:

Frequency	Harmonic Distortion
100 Hz	2.5%
2 kHz	2.0%
10 kHz	3.0%
100 kHz	1.3%

(Bandwidth limit of analyzer)

Accordingly, we would not recommend the use of the sinewave output for distortion evaluations of audio equipment, but rather as a highly accurate source of desired audio (and super-audible) frequencies. The

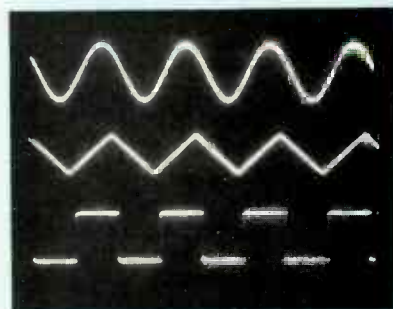


FIG. 1

sinewave source may be used for measuring frequency response of audio equipment, however, since levels remain constant over the entire bandwidth of the instrument. The TTL compatible signal outputs on the rear of the unit were also checked and were found to be in accordance with the author's claims and suitable for driving external logic circuitry.

Waveform outputs from the SFG were photographed in a composite photo, as shown in Fig. 1. The frequency selected for this scope photo was approximately 2 kHz.

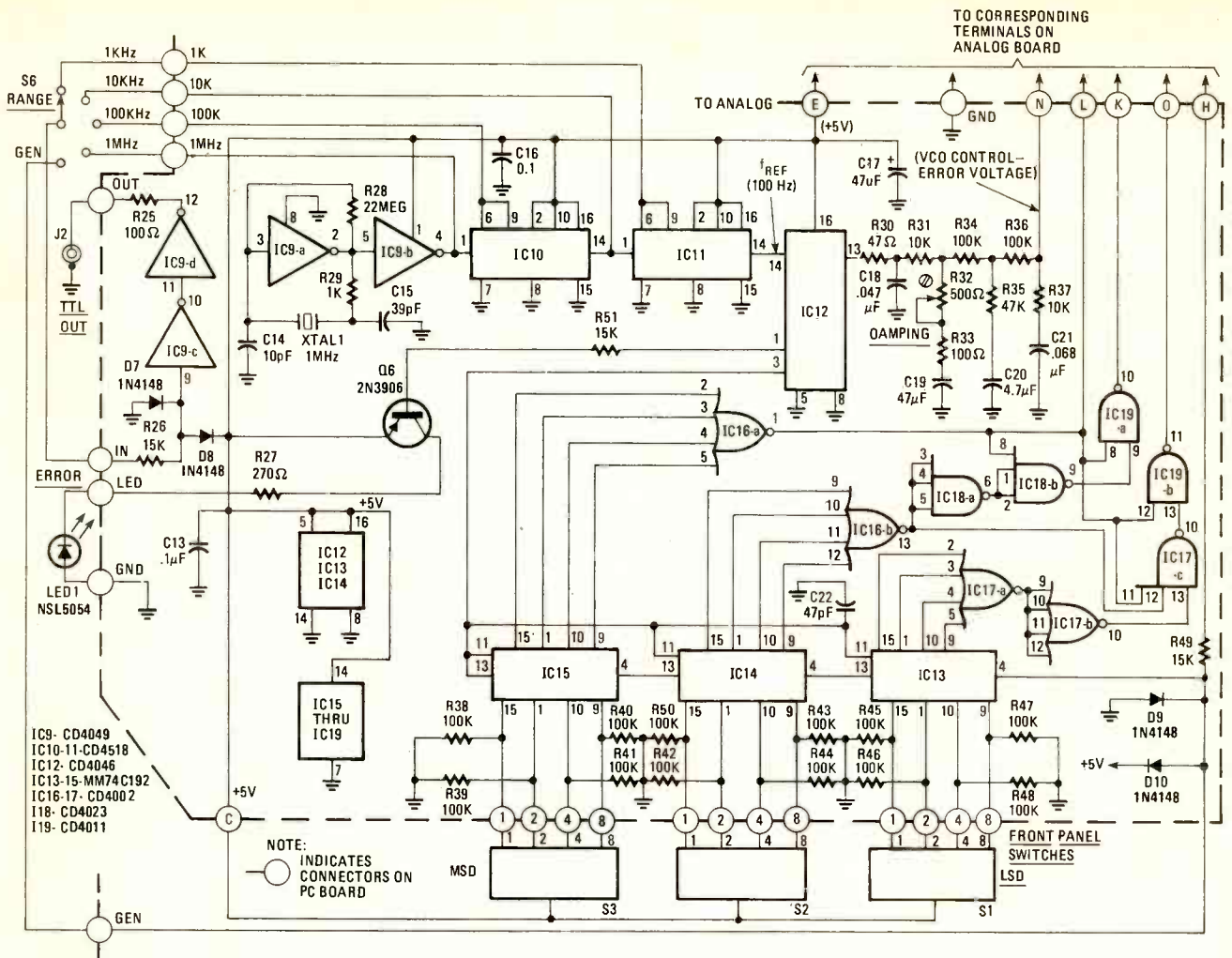


FIG. 1—SCHEMATIC DIAGRAM of the digital circuitry used in the SFG. The many output frequencies are all derived from the 1-MHz crystal and a series of programmable frequency dividers.

panel for use in running digital circuitry independent of the frequency the unit is set to. And if that isn't enough, this generator is crystal controlled.

You'll like the performance features of the SFG, too. All you have to do is set the desired frequency with the front-panel thumbwheel switches, select the type of waveform, and adjust the output level. There's a frequency vernier control that allows you to "fine tune" your frequency with minimal (if any) drift, too. (The photos show four thumbwheel switches. Only three are used in the SFG because output waveforms suffer when programmable output is pushed to 1 MHz.) The maximum output frequency is 100 kHz. There's an error indicator that alerts you if for some reason your frequency is off.

Not to be forgotten are two other important requirements of a function generator—namely the output waveforms and output impedance. This project offers high-quality sine, square, and triangular waveforms, plus TTL level signals from 1 kHz to 1 MHz in decade steps. The output is 50 ohms as found in the highest quality function generators. It can swing up to a 10-volt peak-to-peak signal into a 50-ohm load. If you are looking for an advanced, high-quality func-

tion generator, you are bound to like this project!

The performance of the SFG rates well with other function generators. In addition to its superior frequency stability, it produces a low distortion (adjustable to 0.5% THD) sinewave. It also generates triangular and squarewave signals on a par with the better generators. As mentioned earlier, this project features a low-impedance output (50 ohms) that is ideal for driving low-impedance loads. In fact, you can drive a speaker if desired! And with a maximum output of 10 volts peak-to-peak into 50 ohms, there should still be plenty of signal delivered to that 4-ohm speaker.

Although this is an advanced project, the cost and construction features have been optimized to make it as easy as possible to own this instrument. The cost is lower than most less-sophisticated function generators, and far lower than the least expensive commercial equivalent. In fact, the nearest commercial unit costs about \$800, and this project was built for 15% of that. Wouldn't you like to have the SFG for about \$60?

Inside the SFG

This project is built on two PC boards

to make assembly and testing easier. Let's begin with the digital board, whose schematic is shown in Fig. 1. The signal starts with crystal XTAL1, which generates a 1-MHz reference with the aid of inverter IC9-a and IC9-b. Since the frequency of this signal is too high for the rest of the SFG, it is divided down to 100 Hz by IC10 and IC11. Each of those IC's contains a dual CMOS decade counter. In addition, the outputs of each decade are tapped off, buffered by IC9-c and IC9-d, and appear on a rear-panel switch and TTL-OUTPUT jack J2. Those signals are handy for other digital testing. Meanwhile, the 100-Hz output of IC11 drives the reference input of IC12, a CMOS phase detector. That device compares the phase of two signals and gives an output if they are different. In this case, the original signal is the 100-Hz reference from IC11, and the unknown signal derives from IC15.

When the SFG has reached the frequency it is set to, the synthesizer is said to be in "lock", and both input frequencies will be 100 Hz. Let's look closer at IC13 to IC15. Those devices are the programmable dividers that accept inputs from the front panel switches (S1-S3) and divide the signal from the VCO by the same number. Thus, if the switches are set for 100, and the VCO generates a

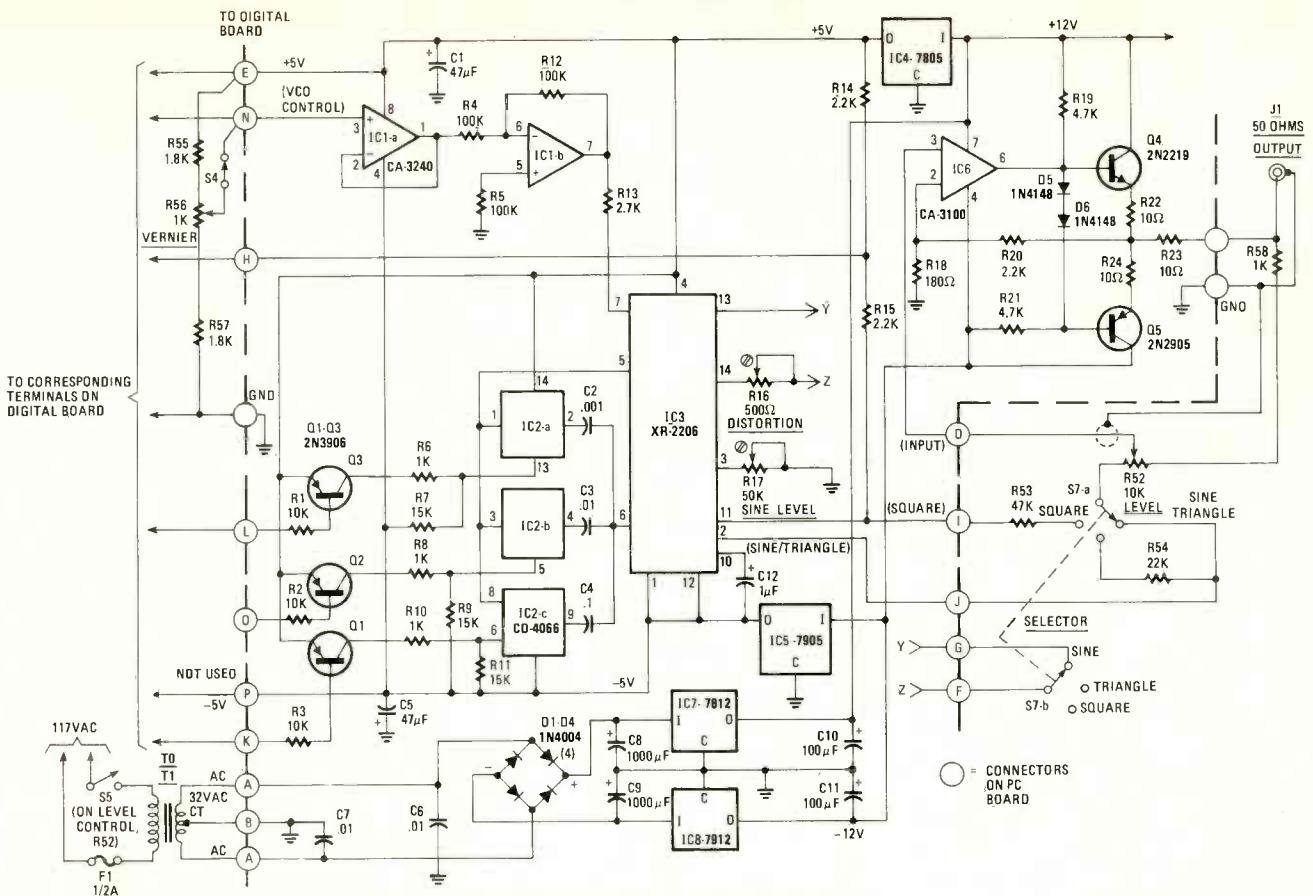


FIG. 2—THE ANALOG CIRCUITS are designed around IC3, the heart of the function generator. Output frequency is determined by a DC voltage from the digital section. Range switching is automatic.

PARTS LIST

Resistors 1/4 watt, 5% unless otherwise noted

- R1-R3—10,000 ohms
- R4, R5, R12, R34, R36, R38-R48, R50—100,000 ohms
- R6, R8, R10, R29, R58—1000 ohms
- R7, R9, R11—15,000 ohms
- R13—2700 ohms
- R14, R15, R20—2200 ohms
- R16—500 ohm trimpot
- R17—50,000 ohms, trimmer (Jim-pak 840-50K or equal)
- R18—180 ohms
- R19, R21—4700 ohms
- R22-R24—10 ohms, 1/2 watt
- R25, R33—100 ohms
- R26, R49, R51—15,000 ohms
- R27—270 ohms
- R28—22 megohms
- R30—47 ohms
- R31, R37—10,000 ohms
- R32—500 ohm trimpot
- R35, R53—47,000 ohms
- R52—10,000 ohms, linear-taper pot with SPST switch
- R54—22,000 ohms
- R55, R57—1800 ohms
- R56—1000 ohms, linear-taper pot with SPST switch

Capacitors

- C1, C5, C17—47 μ F, 6 volts, electrolytic, PC mount
- C2—0.001 μ F, 100 volts, Mylar
- C3, C6, C7—0.01 μ F, 100 volts, Mylar
- C4—0.1 μ F, 50 volts, Mylar
- C8, C9—1000 μ F, 25 volts, electrolytic, PC mount

- C10, C11—100 μ F, 16 volts, electrolytic, PC mount
 - C12—1 μ F, 16 volts, tantalum
 - C13, C16—0.1 μ F, 25 volts, ceramic disc
 - C14—10 pF mica
 - C15—39 pF mica
 - C18—0.047 μ F, 100 volts, Mylar*
 - C19—47 μ F, 6 volts, tantalum*
 - C20—4.7 μ F, 6 volts, tantalum*
 - C21—0.068 μ F, 100 volts, Mylar*
 - C22—47 pF ceramic disc
- *Do not substitute.

Semiconductors

- D1-D4—1N4004
- D5-D10—1N4148
- IC1—CA3240AE dual BiMOS op-amp
- IC2—CD4066 quad analog switch
- IC3—XR 2206 function generator (EXAR)
- IC4—7805 or LM340T-5 +5-volt regulator
- IC5—7905 or LM320T-5 -5-volt regulator
- IC6—CA3100EM wideband op-amp
- IC7—7812 or LM340T-12 +12-volt regulator
- IC8—7912 or LM320-12 -12-volt regulator
- IC9—CD4049 CMOS hex inverter
- IC10, IC11—CD4518 CMOS dual BCD up/down counter
- IC12—CD4046 CMOS Micropower phase-locked loop
- IC13-IC15—MM74C192 CMOS BCD up/down counter
- IC16, IC17—CD4002 dual 4-input NOR gates
- IC18—CD4023 CMOS triple 3-input NAND gates

IC19—CD4011 CMOS quad 2-input NAND gates

Q1-Q3, Q6—2N3906

Q4—2N2219

Q5—2N2905

LED1—NSL5054 LED and holder

Miscellaneous

- XTAL1—crystal, 1 MHz, 32 pF parallel mode, HC-6/U case
 - S1-S3—BCD thumbwheel switch (C&K Type 332110000, Cherry Switch Type T35-02A3 (Herbach & Rademan) or Unimax Type SF-21X3 or equal approximately \$10.00 completely assembled.
 - S4, S5—SPST, on R52 and R56
 - S6—rotary switch, 1 pole, 5 positions
 - S7—rotary switch, 2 poles, 3 positions
 - I1—power transformer, 32 volts, CT, 1 amp
 - J1, J2—BNC connectors
 - F1—fuse, 0.5A with holder
 - IC sockets: two 8-pin, eight 16-pin, five 14-pin
 - Heatsinks: two TO-220, two TO-5
- PC boards and plans are available. If desired, the plans can be ordered separately or combined with a set of boards. Here's how to order: SFG-1 complete set, \$12.00 postpaid in U.S.A. SFG-2 plans only, \$5.00 postpaid in U.S.A.

California residents add sales tax. Foreign residents add \$3.00 for shipping and handling. No COD's or foreign currency, please. Order from Technico Services, PO Box 20HC, Orangehurst, Fullerton, CA 92633

10-kHz signal, the output will, of course, be 100 Hz.

The output of IC15 drives the phase detector input, completing the programmable divider chain. Notice the 4-input NOR gates tied to IC13 to IC15? They serve as a *priority decoder*, and act as an automatic range switch, controlling the output frequency of the instrument. The outputs of NOR gates, IC16-a, IC16-b and IC17-a go low any time a non-zero number is selected by its corresponding switch. These signals then drive inverter IC17-b and gates IC18 and IC19, generating a logic output at terminals L, K and O, corresponding to the most significant digit selected. These outputs are used to select a range capacity on the analog board, which will be described shortly. Finally, back to IC12. The output of the phase detector drives a rather extensive R-C network. That network is a "loop filter" that smooths the pulses coming out of IC12 to a DC voltage in order to drive the VCO.

The reason for the complexity of the loop filter is that it not only filters, but controls the performance of the SFG. It determines how long it takes to lock on a new signal, and how stable the output signal will be. In short, it's important. A pot adjustment is provided for "damping" or for minimizing the jitter in the output as the loop tries to lock. If you are concerned about the difficulty of making this adjustment, don't worry—it takes only a moment to make with a triggered-sweep oscilloscope. That takes care of the SFG digital board.

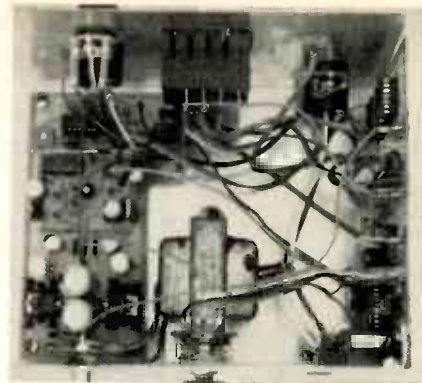
The second half of the SFG is the analog board. Refer to the schematic in Fig. 2. Although there are fewer IC's on this board, the larger number of discrete components make it seem "busier" than the digital board. Actually, the circuitry is easy and straightforward enough to understand quickly. The DC control signal from the loop filter goes to the input (pin 3) of IC1-a, a CMOS op-amp. That device provides the high-input impedance required to minimize loading on the loop filter. You should know that any loading on the loop filter causes damping problems—jitter—making a CMOS device ideal for this application.

The second half of IC1 serves as an inverter with a gain of one. That converts the +1.5–3-volt input from the loop filter to a *minus* value of the *same* magnitude. This is necessary to operate the function generator IC3 properly. Also, another input is provided on pin 3 of IC1-a. It is used for a frequency vernier control, or for an external FM input.

Now on to IC3. This device is a standard function generator. It generates an especially high quality sine-square-triangle wave output. The sine and triangle outputs appear on pin 2, with the type of waveform selected by closing the switch between pot R16 and pin 13. This switch is part of S7, the SINE-TRIANGLE-SQUARE

SELECTOR. In the sine mode (switch closed), trimmer pot R16 adjusts the shape of the waveform for minimum distortion, while trimmer R17 sets the maximum output level. Both adjustments are easy to make with an oscilloscope.

Moving on, the squarewave output appears on pin 11. Note the pull-up resistors, R14 and R15. The voltage tapped off these resistors drives IC12 on the digital board. In order to set the output frequency, three different timing capacitors (C2, C3, C4) are used, allowing IC3 to cover 10 kHz to 100 kHz, 1 kHz to 10 kHz, and 100 Hz to 1 kHz, respectively. An analog switch (IC2) selects the appropriate capacitor. Since the switch is powered by ± 5 -volt supplies, some logic conversion is necessary. Transistors Q1 through Q3 provide that function, and interface the outputs from the priority decoder gates to the analog switch. Next, there's a power-amplifier circuit on board to boost the signal of the function generator IC to useful levels. That's the job of IC6, a 15-MHz op-amp, and transistors Q4 and Q5. Finally, the balance of the board consists of the power supply. Standard three-terminal regulators provide a stable source of ± 12 volts and ± 5 volts for the circuitry. That takes care of the analog board.



INTERIOR VIEW of the Synthesized Function Generator shows board and parts placement and point-to-point wiring.



REAR APRON of the SFG contains the jack for providing TTL-level signal output and rotary range switch.

The cabinet houses a few minor bits of circuitry besides the power transformer, controls, and connectors. You'll be able to see those next month when you wire up the two boards. All that the circuitry consists of is a vernier pot and switch which supply a bias voltage to the op-amp on the analog board. The pot allows adjustment of the SFG to frequencies not selectable by the switches—a handy feature. Also, there are several resistors on the SINE-TRIANGLE-SQUARE switch. Their purpose is to make the output levels of the different waveforms equal in peak-to-peak values, reducing the need to adjust the level control.

Construction

As you should know, this project consists of two PC boards and the case. So building the SFG will consist of stuffing each of the boards first, then connecting them together in the case. The work is easy if you know what you are doing and take your time to do the job.

This month we'll present the necessary information to get you started on the SFG, by assisting in the ordering of the parts and preparation of the circuit-boards. Then next month we'll describe the actual construction.

The first thing you can do on this project is to make or buy the PC boards. For your convenience, foil patterns have been provided in Figs. 3 and 4 so you can duplicate the boards. Or if desired, you can order the board set that is being made available to **Radio-Electronics** readers. Simply refer to the parts list for the name and address of the supplier. As a bonus,

SUGGESTED PARTS SUPPLIERS

IC's:

Tri-Tek, Inc.
7808 N. 27th Ave.
Phoenix, AZ 85021
(602) 995-9352

Jameco Electronics
1021 Howard Ave.
San Carlos, CA 94070
(415) 592-8097

Misc. Parts:

Digi-Key Corp.
PO Box 677
Hiway 32 South
Thief River Falls, MN 56701
1-800-346-5144

T1:

B&F Enterprises
119 Foster St.
Peabody, MA 01911
Signal Transformer
500 Bayview Ave.
Inwood, NY 11696
(516) 239-7200

Thumbwheel switches:

C & K
15 Riverdale Ave.
Newton, MA 02158
(617) 964-6400

Jameco Electronics
1021 Howard Ave.
San Carlos, CA 94070
(415) 592-8097

Herbach & Rademan
401 E. Erie Ave.
Philadelphia, PA 19134

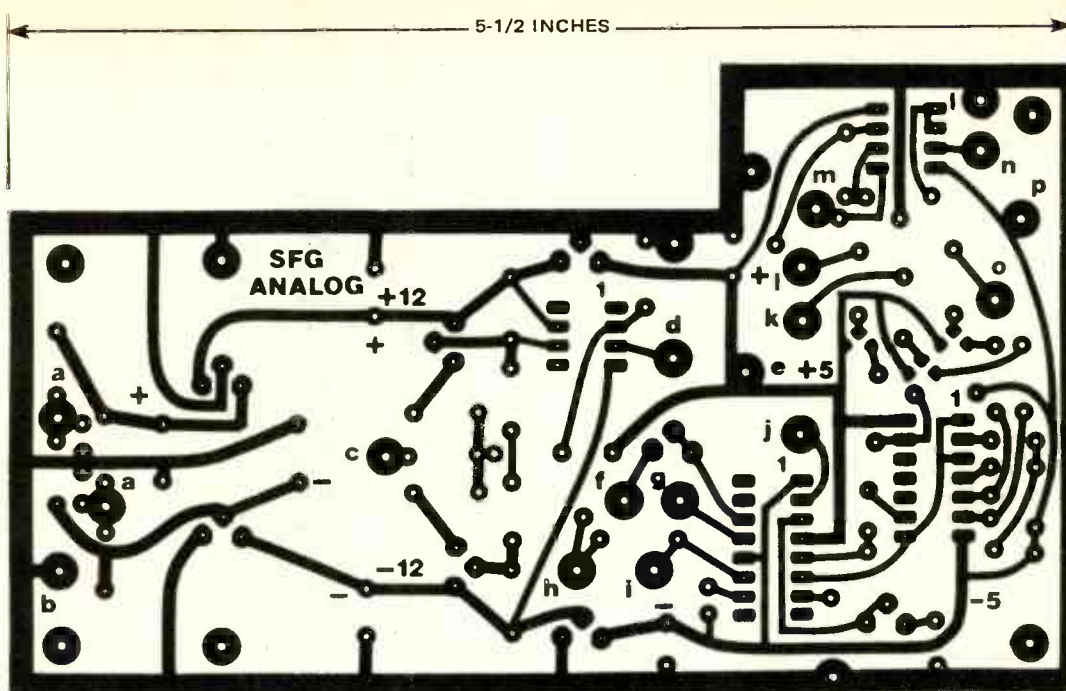


FIG. 3—FOIL PATTERN for the analog circuit board.

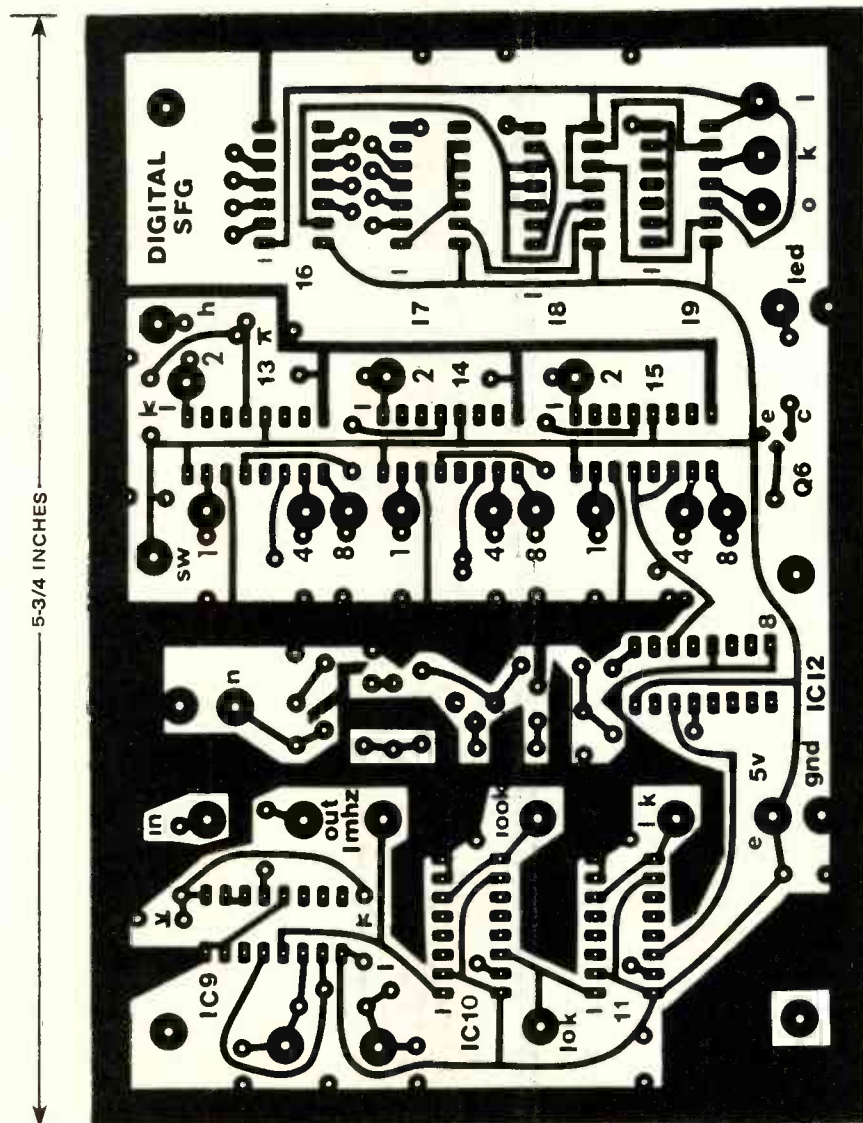


FIG. 4—FOIL PATTERN for the digital circuit board. Etched and drilled boards are available at a nominal cost. See parts list.

you'll receive a copy of instruction plans, plus operating and troubleshooting information. At any rate, the choice is yours!

The next step is to obtain the parts. That should be a fairly easy job in that no special "synthesizer products" were used in the design. All IC's are standard CMOS, with the exception of the bipolar function-generator IC. Some good parts sources are listed at the end of this article. Or, if you prefer, choose other suppliers from the classified section of this magazine, or raid your junkbox.

Now let's look at some of the parts themselves, as a few might be confusing at the store. The function generator, IC3, is from EXAR and is often seen blister-packed in stores carrying the *Jim-pak* or *CALECTRO* product lines. So you might try your local dealer for it. Power transformer, T1, may throw you at first, but it is actually one of those units used in "drugstore" stereo receivers, so you may be able to scrounge one at home. If not, try Signal Transformer, 500 Bayview Ave., Inwood, NY 11696, for a usable unit. The secondary voltage should run from 30 to 36 volts center-tapped with no load, and be capable of at least a half amp. The frequency-setting switches, S1-S3, are readily available in surplus; try a computer store. Be sure that you get one with BCD coded (e.g. C, 1, 2, 4 and 8 connections) outputs. There are plenty of those switches available from many sources if you just take time to look. As far as the rest of the parts are concerned, there should be no problems obtaining them. Just be sure to get quality devices and you'll be all set.

Next month the construction of the SFG continues with the board stuffing and installation data. The project will be rounded out with the adjustment procedure, and a "how to use it" guide. R-E

Connect An A/D

It's not enough simply to digitize analog information—it still has to be presented to the microprocessor to be useful. Here's how to interface the A/D converter and the CPU.

ANALOG-TO-DIGITAL (A/D) CONVERTERS ARE USED TO CONVERT analog electrical currents or voltage levels to representative digital words for use in a computer, digital instrument, or circuit containing a microprocessor. In certain control systems, for example, we might want to measure some physical parameter such as pressure, temperature, position, etc., using a transducer that produces an analog output. But the electronic instrument that processes the data produced by the transducer might be digital. The A/D converter fills the gap between the two systems.

Now that microprocessor IC's and microcomputer sub-assemblies are often used in control systems and other related applications, the use of A/D converters has become even more popular. Whether we are using a microprocessor as merely a small part of a larger instrument, or as a stand-alone computer that processes the data, an A/D converter is needed to supply the binary representations of the analog levels.

But no A/D converter is useful until it is interfaced to the microprocessor. That job may be as simple as plugging in an I/O (Input/Output) cable to a pre-existing input port on the back panel of a microcomputer. In other cases, such as when we design our own microprocessor-based projects, we will have to interface directly with the microprocessor IC and that requires a knowledge of the bus structure and microprocessor control signals.

How they work

Figure 1 shows the general block diagram for any A/D converter. There will be an input terminal for the analog signal, and a set of digital (binary) outputs. Many low-cost A/D's today are 8-bit devices and, therefore, have eight output lines, so are directly compatible with most of the common microprocessor IC's and ready-built microcomputers.

Other A/D converters, however, will have 10-, 12- or even 16-bit word lengths. Even those A/D's can be accommodated by the 8-bit machine, if the proper techniques are used.

Almost all A/D converters have two control lines, and those are used by the external circuitry or the computer. The control lines are called the *start* input and the *end-of-conversion* output, although they are sometimes given other designations. The A/D converter will remain dormant, doing nothing, until a pulse is applied to the start line. That pulse, which

may sometimes be negative-going, initiates the conversion sequence. The end-of-conversion output produces a pulse that tells the external circuitry that the conversion process is finished, and that the data on the output lines is valid. In many A/D designs, the data on the output lines keeps changing and should be ignored until the EOC pulse is issued.

For synchronous operation, the start and EOC lines are separated. The external circuit will issue a start pulse and will then wait for an EOC pulse. That is the mode you would use when making only an occasional conversion. The idea is to have the microprocessor loop, or do something else, while the conversion process is taking place and then input the data when the EOC pulse is issued.

Asynchronous operation provides a continuous conversion by tying the EOC and start lines together. The EOC pulse from the last conversion cycle automatically becomes the start pulse of the present cycle. In most cases, when asynchronous operation is used, an external data latch is used to hold the last valid data between EOC pulses.

Also found on continuous-conversion asynchronous, A/D's is a *status* line. That line will tell the microprocessor that the data is valid, so that input operations only occur on valid data. In a typical case, the *status* line will go low for valid data, but snaps high (indicating invalid data) during the EOC pulse.

Interfacing to a microprocessor

As in many microprocessor-interfacing jobs, there are two approaches that we can take: I/O-based and memory-mapped.

In the I/O-based systems we use the input and output instructions of the microprocessor, and that requires some form of I/O port. If we are using a ready-built microcomputer that has an unused I/O port, then the job may be as simple as connecting a cable to the port.

We may also have to interface with the bus lines inside of the computer, or directly to the microprocessor IC. In any event, we will have to provide some means to recognize the

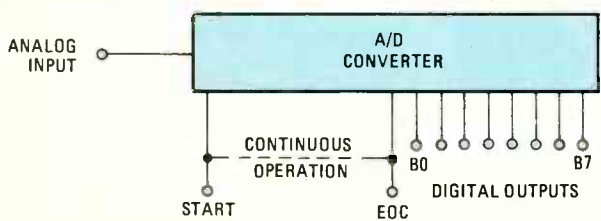


FIG. 1—TYPICAL A/D CONVERTER provides 8-bit digital representation of analog input signal. Start and EOC lines control the converter's operation.

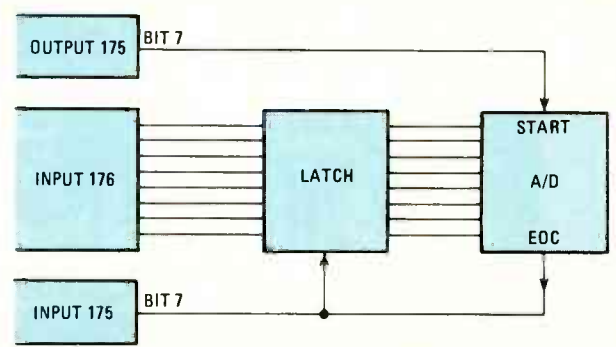


FIG. 2—I/O BASED INTERFACE requires three I/O ports. One port handles the data while the other two control the A/D converter.

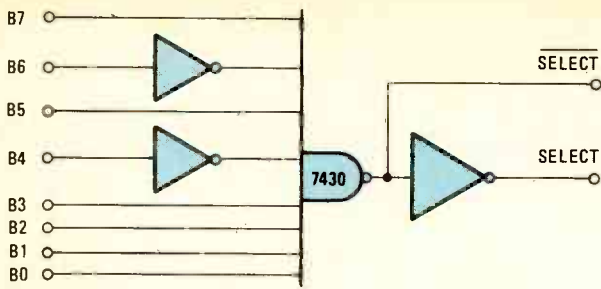


FIG. 4—SIMPLE ADDRESS DECODER can be used to decode the address of the I/O port.

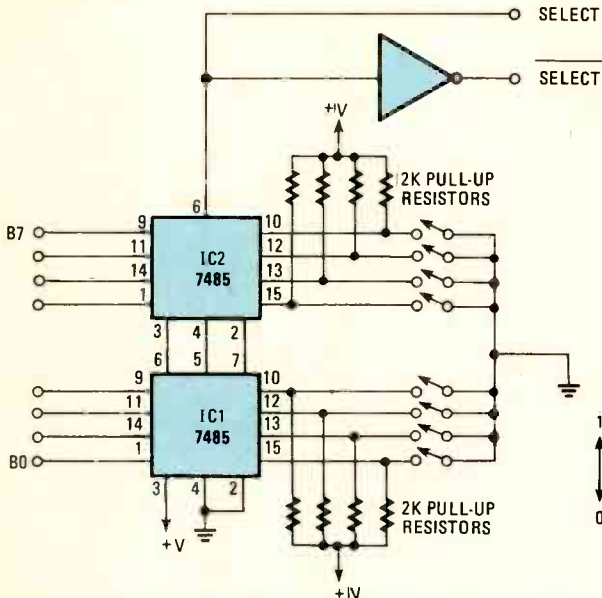


FIG. 5—ADDRESS DECODER using two 4-bit magnitude comparator IC's and a DIP switch permits easily changing the address of the I/O port.

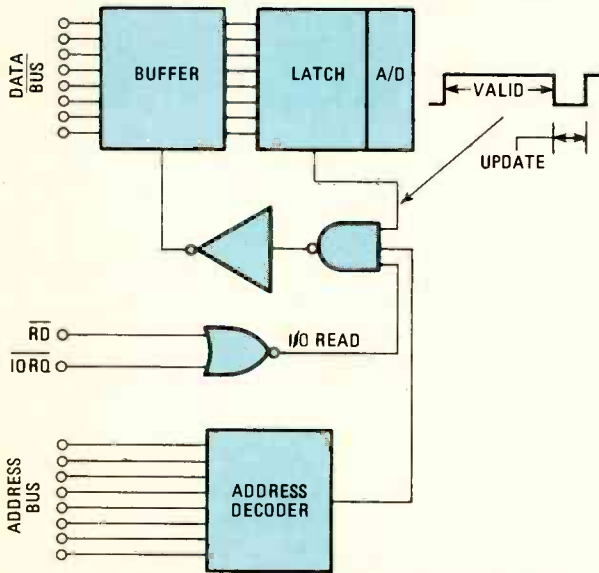


FIG. 6—DIRECT CONNECTION of A/D converter to microprocessor.

the others are connected directly. When the input word from the address bus is 10101111 (the address of port 175 in binary), then the 7430 inputs will see 11111111, so the 7430 output drops low.

The output of the 7430 is labeled select. When we pass the 7430 output signal through an inverter, it is complemented to form a positive-going select signal. That signal will be used to tell us that the address is selected correctly.

The alternate approach is to use a pair of 7485 TTL four-bit magnitude comparator IC's (Fig. 5). Those TTL IC's will compare two four-bit words, and issue output signals that

indicate whether they are equal, or whether one is greater than the other. They also have inputs so that two may be cascaded for eight (or higher) bit operation.

The address of the A/D is determined by eight selector switches, which in actual practice may be a DIP switch on the PC board. This address is compared with the word present on the lower byte of the 16-bit address bus (B0 - B7), reflecting my use of the Z-80 microprocessor. When the lower eight bits of the address bus contains the address of the selected port, then the output (pin 6 of IC2) goes high to form the select signal.

A sample circuit for connecting the A/D is shown in Fig. 6. The A/D selected will have latched outputs, and a status line that remains high as long as the data on the output latch of the A/D is valid. During the brief period when it is updating, the status line will drop low, prohibiting transfer of the latch contents onto the data bus via the buffer.

But before the transfer to the data bus can take place, three conditions must be satisfied: the $\overline{\text{IORQ}}$ must be low, the $\overline{\text{RD}}$ line must be low (both of those lines on the Z-80 are used to indicate an I/O Request (IORQ) and a Read (RD) operation), and the address select line must be high, indicating that the input operation called for by the $\overline{\text{IORQ}}$ and RD signals will take place on the A/D converter. When those criteria are met, then the data is transferred through the buffer onto the data bus.

What we have done above is to create a microprocessor input port that is local to the A/D converter, and indeed may be on the same printed circuit board as the A/D.

In some microcomputers, the I/O cards have data to and data from CPU lines, and both input and output strobe lines. In that case, less decoding is needed. All that we need is the address decoder and the proper strobe pulse.

Memory-mapping means that the A/D converter is seen by the CPU as a memory location. Since most microcomputers do not actually have any more than 32K - 40K of the allowed 64K of RAM/ROM, we generally see the A/D converter assigned an address in the upper 32K region.

An address decoder is needed to determine when the CPU is calling for a memory-read operation. We must also use the memory-request ($\overline{\text{MREQ}}$ line on the Z-80) and $\overline{\text{RD}}$ signals from the CPU to let the A/D know that a memory-request-read has been selected.

Many microcomputers have a serial-input port (and S-100 owners can buy any of several serial I/O boards), but most A/D converters have parallel output-data lines. Unless you happen to use one of the successive approximation A/D converters, which provide a serial-data output line, then you must build a serial port for the A/D converter. The easiest way to do that job is to use one of the UART chips on the market. The transmitter side of the UART receives parallel 8-bit data from the A/D, formats it according to programmed commands, and then sends it out in serial form.

The receiver side of the UART does exactly the opposite! It will receiver serial data sent by the transmitter, or sent over a serial-data communications line, and then reassemble it in parallel form. We can use the transmitter section of the UART to convert the A/D parallel output to a serial output (see *Digital Interfacing with an Analog World*, by Joseph J. Carr, TAB Books, Blue Ridge Summit, PA 17214). We can also mount the UART IC on the same board with the A/D converter.

We may also lump the topic "interfacing digital panel meters" (DPM) under the heading of A/D interfacing. The DPM is, after all, a special form of A/D converter.

Before ordering a DPM for this type of application, be sure to inquire of the manufacturer just what output coding and format are used. Some serial outputs are not sequential, and that can foul up your decoding scheme. Also find out what control signals are available. You need at least an EOC terminal, and a start and/or latch output data terminals would be handy.

R-E

BUILD THIS

the DRUM...



A PERCUSSION SYNTHESIZER

Part 2—Full construction details as well as a detailed description of the operating controls are given in the conclusion of this project.

STEVE WOOD

LAST MONTH WE DISCUSSED THE DRUM and its theory of operation. Now, we'll go into construction. Remember that the four-channel instrument described and shown in the photos is composed of four identical drum-synthesizer modules. Although the four modules are basically identical, the summing circuit and summing amplifier are installed only on the board for channel four. The power-supply foil pattern and parts-placement diagram are in Figs. 3 and 4, respectively.

The PC board for the synthesizer modules is laid out with ease of assembly in mind. Its foil pattern is shown in Fig. 5 and parts-placement details are shown in Fig. 6 and the photo in Fig. 7. Note that everything except the six input and output jacks is mounted on the circuit board. Be sure to give the foil side of the board a cleaning before starting assembly.

Install all the passive components first, starting with the resistors, then capacitors and jumpers. Next, mount the control pots, slide switch, and the two LED's—installing them on the foil side of the board. Figure 8-a shows details of the mounting of those parts on the foil side of the board. The control pots are mounted by soldering their lugs to the pads on the PC board. The body of the pot goes into a hole that is an exact fit. The bottom of the pot is flush with the component side of the board. Pots R32 and R45 are exceptions since they have switches on them.

See Fig. 8-b. Fig. 9 shows the front panel of one of the modules.

When installing slide switch S3 (Fig. 8-c), you must insulate its case from the copper foil on the PC board. Thin foam

tape is ideal for the job but ordinary black electrician's tape will do. It should be placed just under the switch case, along the sides of the holes that the switch lugs will pass through.

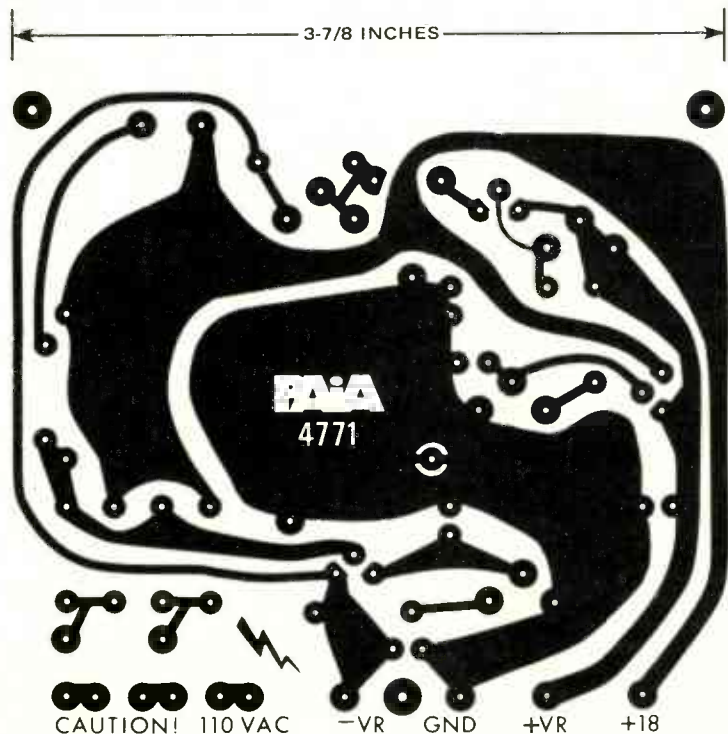


Fig. 3—FOIL PATTERN for the power supply. The power transformer is mounted on the bottom of the case, in the left-rear corner next to the supply circuit board.

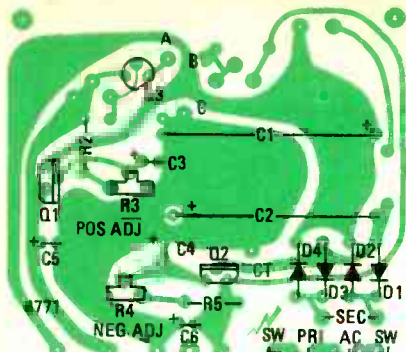


FIG. 4—POWER-SUPPLY PARTS-PLACEMENT GUIDE. The supply circuit has been simplified so some pads and circuit leads are not used.

The LED's are inserted in holes in the front panel. The panel is 1/4-inch aluminum, so alignment can get a bit tricky. It helps to crimp the leads on each LED so that when you install the panel you can work the LED's up through the holes as the panel is being set down over the bushings of the pots.

Number 22 hookup wire and some good small-diameter coaxial cable is used in making the connections between the PC board and the jacks. Figure 10-a shows how the jacks are wired. Use bare wire to connect the ground lugs (lug 2) on each jack. Start with J1, forming a small hook and anchoring the wire in lug 2 on J3 and cut a piece of plastic insulated sleeving (spaghetti) to that length. Slip the tubing over the wire and pass it through lug 2 on J3. Continue around through J6, J4, J2, and J5, insulating the common ground lead between all ground lugs. Solder the connections at J5 and J6 only.

Run single-conductor wires from indicated pads on the circuit board to the proper lugs on the jacks. You will have leads from points C, E, E', G, and U. Now, following Fig. 10-a, run lengths of coax cable from the circuit board to the jacks. Note that the shield braid always connects to a ground lug (lug 2). Wire S1, J7 and R62 as in Fig. 10-b.

When you get the four modules wired and installed in the cabinet, and wired up, turn on the power and carefully check the voltages. You'll have +9 volts at 20 mA, -9 volts at 20 mA and the POWER indicator LED should light. The TRIGGER indicator LED should flash when you strike the transducer.

Calibration

This step is a snap! Just set the controls up like this:

SENSOR GAIN	approx. 3 or 4
DECAY TIME	approx. 3 or 4
PITCH MOD.	fully CCW (down)
INITIAL PITCH	approx. 3 or 4
WAVEFORM	sine (fully CCW past detent)
MIX	osc. (fully clockwise)
NOISE FILTER	fully CCW
SWEEP/MAN	manual
OUTPUT	Midway (adjust as required)

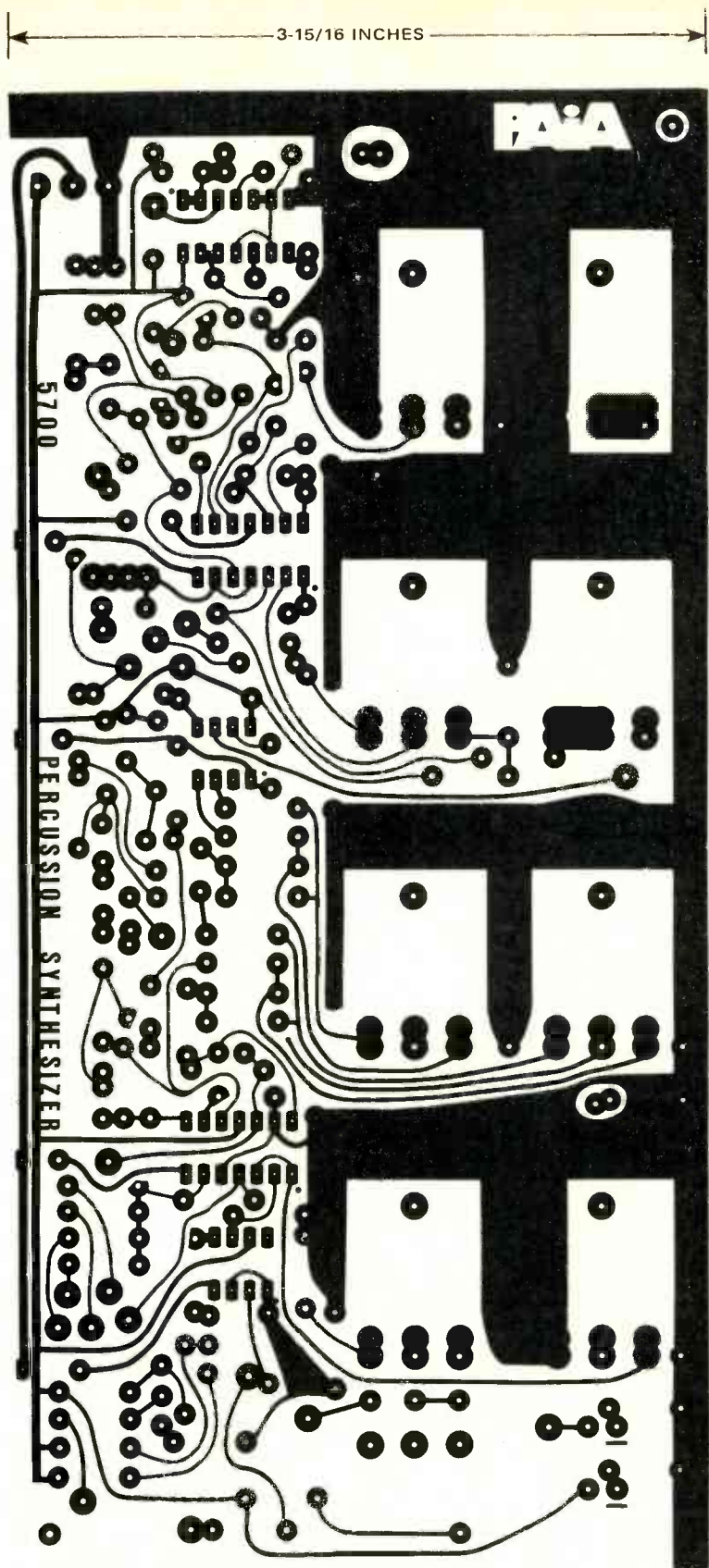


FIG. 5—PATTERN for one drum-synthesizer module. You need four modules to duplicate The Drum.

Now, strike The Drum transducer with a pencil or your finger. You should hear the pitch go down in frequency and die out in a short time.

Trigger The Drum several more times and play with the DECAY TIME control. Note that as the control is rotated farther

clockwise, the downward sweep in pitch becomes slower and it takes longer for the tone to become inaudible. Leave the DECAY TIME control set at some intermediate value.

Rotate the MODULATION control from DOWN to UP. Notice that as the control is

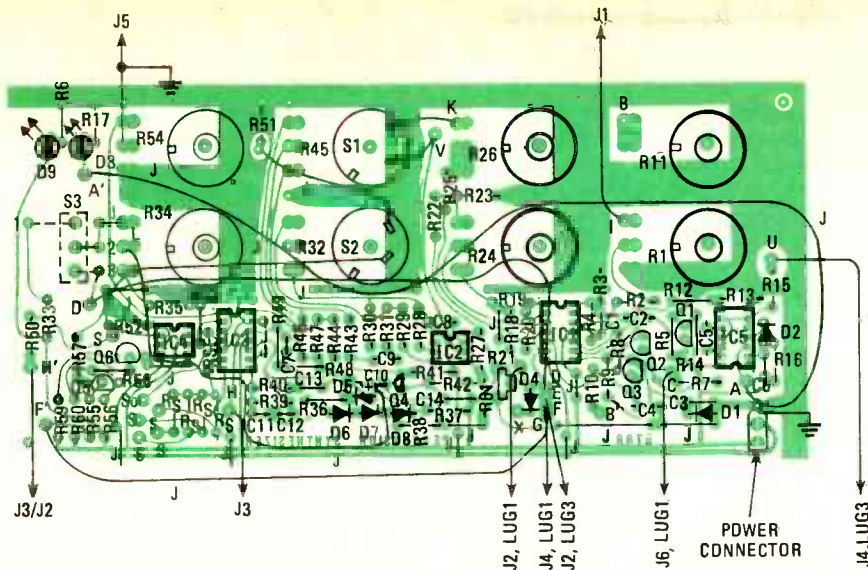


FIG. 6—HOW PARTS ARE POSITIONED on the synthesizer modules. The four R_6 resistors are installed only on the module for the fourth channel. The diagram also shows jumpers and connections to off-board components.

rotated, the amount of downward pitch shift as The Drum sounds decays decreases until at some position of the control there is no pitch shift at all. Further clockwise rotation beyond this point should cause the pitch to shift up.

Set the internal trimmer R_{21} as follows: Rotate the MODULATION control fully CCW (DOWN), trigger the Drum and make a mental note of the pitch produced at the beginning of the downward sweep. Next turn the MODULATION control to fully CW (UP), and once again trigger The Drum. Adjust R_{21} so that the pitch produced at the end of the upper sweep closely matches the pitch at the beginning of the previous downward sweep. This is not a critical adjustment and may be set to taste.

Turn the INITIAL PITCH control in the clockwise direction and observe that the output pitch increases as the control is rotated. Return the control to a setting of 3 or 4.

Switch the WAVEFORM MIX control to the triangle position, just clockwise from the detent. When The Drum is triggered now, you should be able to hear a slight, but noticeable difference in the timbre, as the output changes from a sine wave to the selected triangle. If you can't tell any difference, try turning the OUTPUT level control down some and turn your amplifier volume up to compensate. As the WAVEFORM MIX control is rotated in a clockwise direction from triangle to square wave, the timbre should become progressively less "mellow." Return the WAVEFORM MIX control to the sine position.

While triggering The Drum, begin rotating the NOISE/OSC MIX control in a counterclockwise direction toward the NOISE position and observe that progressively more noise is mixed into the output. Rotate the control fully CCW past the detent and note that there is only noise in the output and no oscillator signal is present at all.

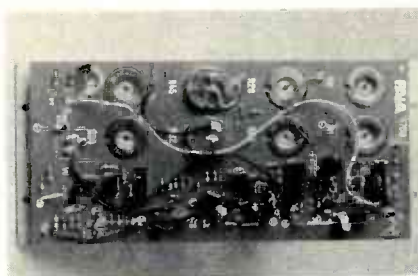


FIG. 7—REAR-VIEW of one of the modules. Use it along with Fig. 6 when you are placing parts and jumpers.

With the NOISE/OSC MIX control set fully CCW, continue triggering The Drum and observe that rotating the NOISE FILTER control clockwise causes apparent pitch of the noise to increase.

With the NOISE/FILTER control set to its mid-range position, change the SWEEP/MAN switch to its SWEEP position and note

that the apparent pitch of the noise now follows the drum envelope. Also observe that with the filter in the sweep mode, the FILTER control is acting as an initial frequency control which increases the "range" of the filter sweep as the control is rotated CW.

Using the drum

The DRUM has a number of front-panel controls (Fig. 9) and jacks (Fig. 10) on the back panel. While some of them follow conventional designs, others offer control features or interface capability not found on many other percussion synthesizers. The following is a list of those controls and connectors, and a brief description of their function:

SENSOR GAIN—This control sets the sensitivity of the 5700 to the triggering signal from the sensor. If it is set too high The Drum will trigger too easily, resulting in false triggering and loss of dynamic range. Too low a setting will make The Drum hard to trigger.

ENVELOPE DECAY TIME—This control sets the decay time. The decay time becomes longer as the control is rotated clockwise.

INITIAL PITCH—This control sets the initial pitch of the VCO, which constitutes The Drum pitch source. Clockwise rotation of the control increases the initial pitch.

MODULATION UP/DOWN—This control, when set fully counterclockwise (to DOWN) causes a downward sweep of the pitch source. Full clockwise rotation (to UP) makes the pitch sweep up after triggering. Settings between those two extremes produce progressively less pitch modulation, and when the control is centered there should be no pitch modulation at all when The Drum is triggered.

WAVEFORM SELECT/MIX—This control

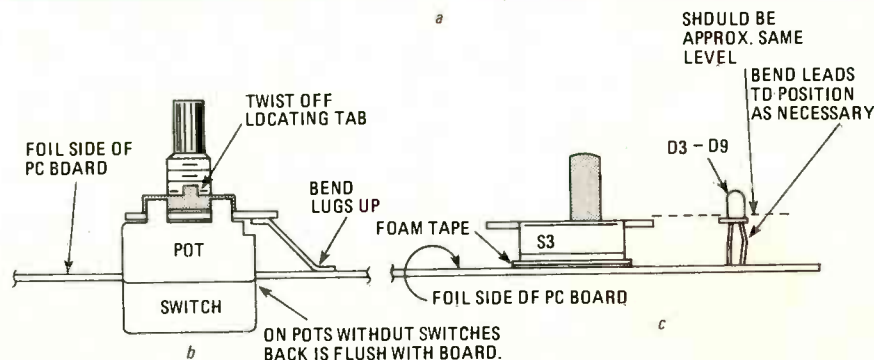
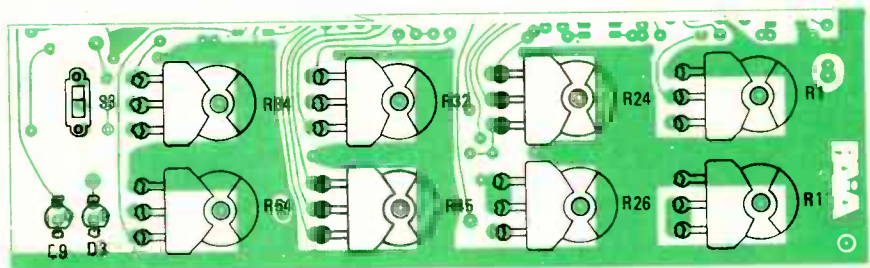


FIG. 8—HOW POTS, SWITCH, AND LED'S are mounted on the PC board. Diagram at *a* shows how potentiometer lugs are soldered to pads on the PC board. Sketch at *b* shows how to shape the control lugs before soldering and *c* shows details of switch S_3 and LED mountings.

allows mixing of waveforms from the VCO. Turned fully counterclockwise, past the detent, the output signal will be a sine wave. Turning the knob in a clockwise direction just past the detent produces a triangle waveform. Continued clockwise rotation of the control begins to mix a square wave into the output until at the extreme end of the rotation the signal is completely square wave.

NOISE/OSCILLATOR MIX—This control provides mixing between the VCO signals and filtered white noise. Full clockwise rotation will produce VCO signal only. Full counterclockwise rotation past the detent will produce an output signal

of noise only. Positions between these extremes will cause the output to be a mix of both pitched signal and noise.

SWEEP/MAN—This slide switch allows the corner frequency of the filter associated with the noise source to either track the drum envelope (in the SWEEP position) or to be set to a fixed value (MAN position).

NOISE FILTER—This control sets the corner frequency of the filter when the SWEEP/MANUAL switch is in the MAN position and sets the sweep range of the filter when the switch is in the SWEEP position.

STATUS—There are two LED's on The Drum front panel. The LED labeled POWER should continuously light any time power is applied to the PC board. The TRIGGER-indicating LED will wink briefly at each triggering of the synthesizer circuitry.

OUTPUT LEVEL—Clockwise rotation increase, output signal level.

Back panel jacks

J1 (INPUT)—This jack is the input from which The Drum synthesizer derives dynamics information (when and how hard the drum was struck). The input can come from the drum transducer or from a microphone or other audio transducer. For computer interface, this input can come from a digital-to-analog converter.

J2 (EXT CV IN)—This jack is an external control voltage input. When a control voltage source is plugged into this jack the envelope-follower output will be disconnected from the VCO frequency controlling circuitry and the external source will take its place. Both UP/DOWN MOD. and INITIAL PITCH controls will still be functional.

J3 (EXT SIG IN)—This jack is used to apply an external audio source directly to The Drum's VCA for percussive voicing. When used, this jack will disconnect the internal signals from the VCA and only the external signal will be passed. Unless

working with extraordinarily high external signal levels, the WAVEFORM SELECT/MIX control should be kept in the sine position.

J4 (E.F./TRIGGER OUT)—This is a stereo jack that carries two output signals. On the ring or collar connector (lug 3) is the trigger output which goes high briefly each time The Drum is triggered and on the tip connector (lug 1) is a time-varying DC voltage which is the output of the A/R generator. There are numerous possible uses for those signals; for example, the envelope of one 5700 card can be routed to the EXT CV IN of a second card and the two outputs mixed to produce a dual-oscillator drum voice. To operate two drums from one sensor, take EF/OUT signal from point "X" and feed it to J1 of the second drum module.

In computer applications, the TRIGGER OUT can be used to signal the processor that the drum has been struck while the E.F. OUT is connected to an analog-to-digital converter (such as the PAIA EK-7 Dual Digitizer) to provide dynamics information in a digital form.

J5 (OUT)—This is the audio output jack. It is a closed-circuit jack that will pass the output signal to a summed output in a multi-channel system when no plug is inserted.

J6 (CANCEL)—A switch plugged into this jack will allow for disabling The Drum when not required. This is particularly useful when using the synthesizer with an existing drum set. Connect the four CANCEL jacks in parallel and then you can control the four channels with one footswitch.

Some good friends played around with a rough four-channel prototype while The Drum was under development. A surprising number of options were discovered in relation to the mounting of the transducer ranging from gluing it to an externally-mounted muffler to the obvious (taping it to the bottom of the drum head). Actually, you can put the transducer anywhere you want to: on the inside of the drum shell, or on the outside for that matter, or on a bottom head—if you have them. It doesn't care! A convenient means of temporarily mounting the sensor while searching for just the right place is to use a foam tape with adhesive on both sides. The actual mounting details will depend on your personal preference. Before you decide on a particular location, move the sensor around a bit. The results may surprise you. When the best sensor location is found, the transducer can be permanently mounted there with *Instant-Weld* or a similar adhesive. It also works out quite nicely to mount it in a practice pad (also available from PAIA).

If you don't have the transducer that's available from PAIA, you can get by with a high-impedance microphone (though The Drum's dynamic response may suffer). **R-E**



FIG. 9—THE FRONT PANEL of the 5700 synthesizer module with the codes keyed to the various controls.

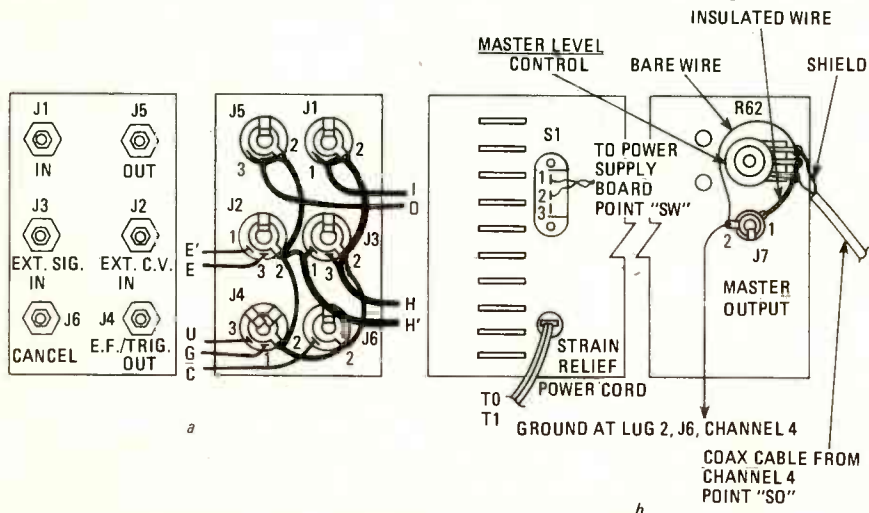


FIG. 10—HOW COMPONENTS ARE MOUNTED on the rear panel. Drawings at a show the jacks: how they are positioned and connected to coded points on the circuit board. Four sets of jacks are used—one set of six for each synthesizer module. The drawings at b show components on the ends of the rear panel.

OUTLOOK —

Digital Audio For The 1980's

The introduction of Pulse Code Modulation (PCM) recording technology will soon give you truly "live" audio quality in your home. The equipment's available now.

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

IT HAS BEEN OVER 100 YEARS SINCE THE phonograph record, as we know it, was first introduced by Edison in the form of a cylinder with tinfoil wrapped around it. Crude as that record was, its fundamental mode of operation was no different from that of the highest-fidelity disc recordings we listen to today. The 19th century cylinders and the high-quality vinyl long-playing records of 1980 all operate on analog principles.

The process begins with sounds reaching a microphone (or several microphones) that translates the sounds into minute, constantly varying voltages or currents. Those varying voltages or currents are then stored as program material in a variety of ways. The varying electrical signals might be applied to a magnetic-tape head that is then used to apply varying degrees of magnetization to magnetic particles imbedded or coated on a strip of tape. Alternatively, the electrical signal might be used to move a cutting stylus that creates grooves in a master recording. These grooves would have side-to-side or up-and-down wiggles in them that are a replica or *analog* of the original sound waves picked up by the microphone or microphones.

Both of those purely analog systems of sound storage have serious limitations. Even in their most advanced forms, tape and discs have limited dynamic range. Measured in dB of sound-pressure level, modern or classical orchestral music has a dynamic range of from 85 to 95 dB. Neither present-day discs nor tapes can store that wide dynamic range. Figure 1 illustrates the point. In the case of magnetic tape, if you try to record the loudest

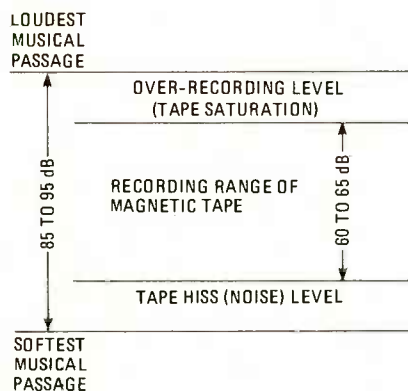


FIG. 1—DYNAMIC RANGE of magnetic recording tape is approx. 60 dB while orchestral music has a dynamic range of 85 to 95 dB.

sounds of music at their correct relative amplitudes, you will exceed the magnetization capacity of the tape. Beyond a certain level the tape becomes saturated and louder signals will not cause linearly greater magnetization levels of the tape. The situation is similar to that of an amplifier that is driven into overload: the result is clipping and severe distortion.

Conversely, if you try to record the very softest musical passages they would be so low in amplitude that the magnetic pattern would be well below the residual tape hiss that is present on even the very finest tape. The same limitations apply to disc recordings. Loudest passages, if recorded as-is, would make the wiggles in the groove so great that one groove might cut through to the next. Soft musical passages would once more be buried—this time beneath the level of surface noise that is always present on a vinyl disc.

There are other problems peculiar to

analog-recording methods. Wavering speed of tape or of a revolving disc leads to audible wow-and-flutter. Various kinds of distortion (particularly intermodulation and harmonic) are present during playback of either tapes or discs, often at levels that no high-fidelity enthusiast would ever tolerate in an amplifier, tuner, or receiver. When you think about it, it is quite remarkable that we have been able to store and reproduce music using analog techniques as well as we have. Still, for all of the advances made in the science of sound recording over the past century, analog recording leaves much to be desired.

Digital recording

Much has been written in the general press, as well as in technical journals, concerning PCM (Pulse Code Modulation) or digital recording. Often, journalists writing for the general press, in their excitement over the new digital-recording technique, have jumped to erroneous conclusions. There has been much talk, for example, about digital disc recordings. In fact, there is not a single digital disc recording that you could buy as of this writing. That's not to imply that there never will be. Several systems are available for creating such all-digital disc recordings. But today, when someone speaks of a "digital" disc recording what they really mean is an *analog* disc recording that has been made from a master *tape* recording that was digitally recorded. In other words, digital recording, or PCM recording as it is often called, is a reality in the world of tape recording but is not yet a marketable commodity insofar as disc recordings are concerned.

How PCM recording works

Though many people consider it to be complicated, PCM is a relatively simple technology. Consider the audio waveform shown in Fig. 2. As is true of any other continuous waveform, this one can be broken up into instantaneous levels at specific moments in time. Five milliseconds after the start of this waveform, for example, its amplitude is approximately 9 on a vertical scale calibrated from 0 to 10. The table at the right of Fig. 2 shows how we might characterize the signal at every millisecond of time, using only numbers from 1 to 10 (no fractions allowed). With such time and amplitude con-

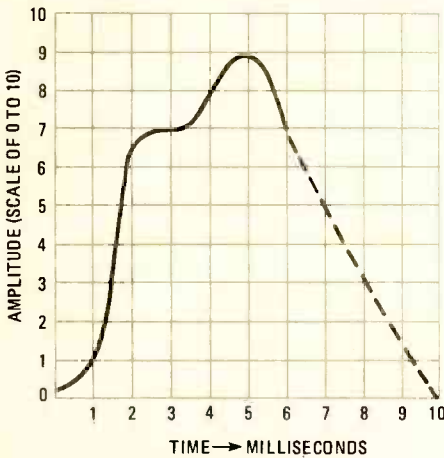


FIG. 2—DIGITAL CONVERSION of analog signal requires sampling the amplitude of the analog signal at discrete time intervals.

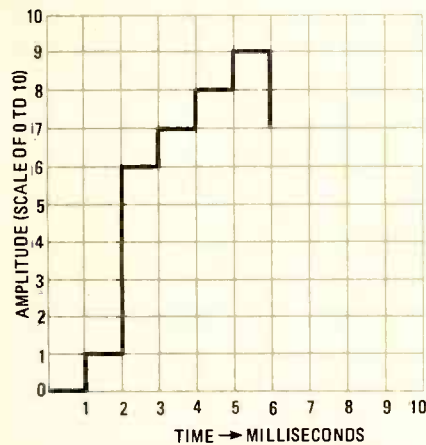


FIG. 3—DIGITAL REPRESENTATION of analog waveform shows rough approximation due to low resolution analog-to-digital conversion.

TABLE I

Decimal Number	Binary Equivalent (4-bit system)
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
10	1010

straints, we won't get a very accurate representation of our original waveform expressed in numerical or *digital* form—only a rough approximation of it, as shown in Fig. 3. To get a more accurate waveform, we would have to change our approach in two ways. We would sample the original waveform much more often than every millisecond and we would break up the amplitude levels into far more than just ten increments.

For the moment, however, let's presume that the accuracy obtained in Fig. 3 is good enough for our intended purpose. The next step would be to record the numbers that we have tabulated in some convenient way onto tape. The simplest way to do that is to

AT TIME	AMPLITUDE
1	1
2	6
3	7
4	8
5	9
6	7
7	
8	
9	
10	

convert those decimal-type numbers into binary numbers, which are made up of only 0's and 1's. The binary system lends itself very well to electronic use because a "0" can be represented by an "off" or no-voltage condition in a circuit while a "1" may be represented by an "on" or positive voltage condition. Similarly, in the case of a tape recording, "0's" can be represented by no magnetization of the tape while "1's" can be recorded as a fixed-amplitude pulse. If, during playback, the tape-head reads the presence of a pulse, that's interpreted as the binary number "1", while if a stretch of tape has no signal, that condition is interpreted as a binary "0".

In the example of Figs. 2 and 3 we would want to express numbers from 1 to 10 in binary form. We will need a four-element code word to provide that range of numbers. In digital or PCM terminology we would call that a 4-bit system. Table I shows the 4-bit code

for the more familiar decimal numbers ranging from decimal 0 to decimal 10.

To express the numbers that correspond to our sampled amplitudes of Fig. 3 (1, 6, 7, 8, 9, 7 ...) we would select the equivalent binary notations: 0001, 0110, 0111, 1000, 1001 and 0111. To record that number-code series on tape, we would apply a series of pulse and no-pulse conditions as shown in Fig. 4. So long as the positive pulse is easily distinguished (during playback) from a no-pulse condition, we have a means of recovering the coded numbers. And, if we can recover the coded numbers we can also convert them back to the approximate waveform of Fig. 3 which is, in turn, an inaccurate replica of the musical waveform of Fig. 2 with which we started.

Several clear advantages result from such an approach to signal storage. Since the tape playback head now simply has to read pulse or no-pulse conditions, tape saturation or over-recording is no longer a factor. Residual tape hiss or noise is also excluded from the recording. That's because the level of such noise is so low that it could not possibly be misinterpreted as a "pulse on" condition.

In the example cited, however, we only provided for ten distinct levels of amplitude and the distortion during playback would therefore be extremely high. Furthermore, it can be shown mathematically that with only a 4-bit system of encoding, maximum available dynamic range would be no greater than 24 dB—from loudest to softest reconstructed sound levels. For every increase of "1 bit" we can pick up another 6 dB of dynamic range, however, so that a 5-bit system would yield 30 dB, a 10-bit system would give up 60 dB (which is, incidentally, about the best we can do with conventional analog discs or tapes) while a 14-bit system would yield a dynamic range of 84 dB!

A 14-bit system will also provide up to 16,384 possible amplitude levels (2^{14}); all the way from 00000000000000 to 11111111111111! It is easy to understand how precise or refined we might be able to represent the waveform of Fig. 2, given that many amplitude levels in a 14-bit binary system. However, unless we sampled far more frequently than in the earlier example, our representation of the desired waveform would still be highly inaccurate. In any PCM or digital system, it is necessary to sample at least

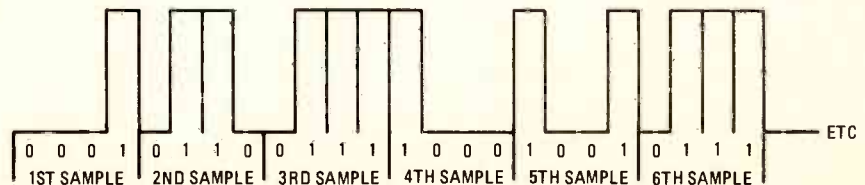


FIG. 4—PCM FORMAT is recorded on magnetic tape as the presence or absence of pulses. The PCM format shown divides each sample into a 4-bit digital word.



FIG. 5—TOSHIBA MODEL PCM-MARK II is a signal processor that interfaces with a video cassette recorder to provide PCM recording.

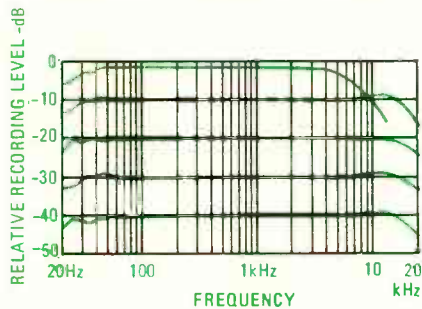


FIG. 6—TYPICAL FREQUENCY RESPONSE of analog cassette deck shows increasing non-linear response at higher recording levels.

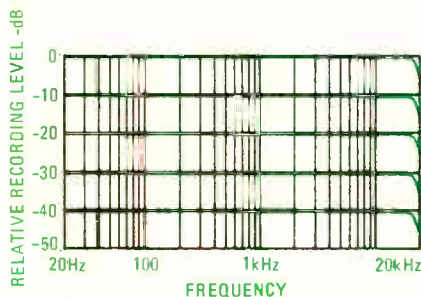


FIG. 7—FREQUENCY RESPONSE of Toshiba PCM recorder shows "ruler" flat response at all recording levels.

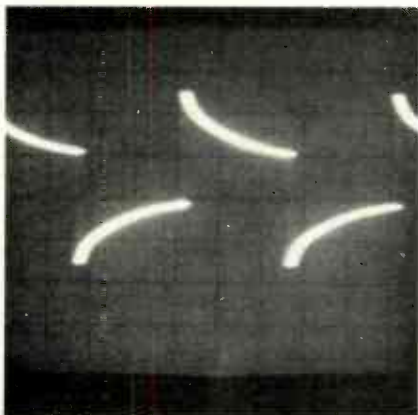


FIG. 8—PLAYBACK of low-frequency square-wave recorded on a high-quality open-reel tape deck.

twice as often as the time it takes to reproduce a single cycle of the highest frequency to be recorded. That means that if we want to be able to store and reproduce the digital equivalent of all audio frequencies from 20 Hz to 20,000 Hz we must use a sampling frequency of at least 40,000 Hz. In fact, the Electronics Industry Association of Japan (EIAJ) recently adopted standards which call for a sampling rate of 44,056 Hz in a standardized PCM format. We will look at the other aspects of this new standard shortly.

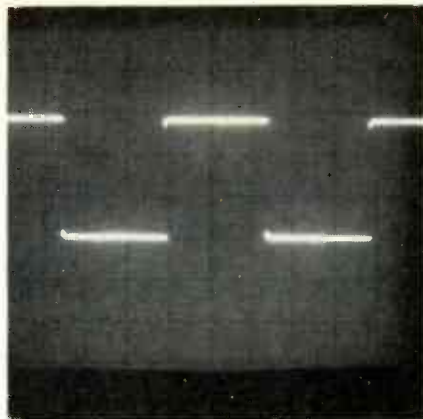


FIG. 9—SQUAREWAVE RESPONSE of Toshiba's PCM recorder shows vastly improved playback of low-frequency squarewaves as compared to Fig. 8.

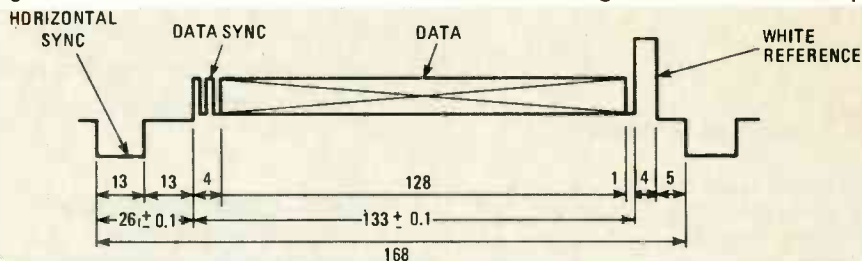


FIG. 10—EIAJ STANDARD places 168 bits on each horizontal line of the TV "picture" for recording on a video cassette recorder. The data block consists of 128 bits while the remaining 40 bits are used for the horizontal-synch pulse and the white-reference pulse.

Storing the digital information

Let's see what sort of storage capacity our tape recorder would have to have to handle this new type of PCM data. As we said, we must sample the signal being digitized 44,056 times per second. Each sample will contain 14 bits. That comes to 616,784 bits per second. But we are talking about a stereo system and, in a digital system such as this, rather than divide the tape into two tracks it is just as easy (and in fact more desirable) to interleave the digital information in a single continuous tape track—sampling first the left channel, then the right, etc. etc. That brings us up to 1,233,568 bits per second. And, as we shall see, that makes no allowance for any redundancy or error-correction code words that are found to be necessary in a PCM system.

Obviously, no present-day analog audio tape deck now used by audio enthusiasts could handle that kind of information density. Such recorders lack the bandwidth or frequency response that would be required. But there is one type of tape deck that *can* handle such bandwidths and it is one that is already found in more than one million homes in this country. You guessed it! It's the video cassette recorder, or VCR. Since these recorders must be able to record frequencies well up into the megahertz region, they constitute a natural and logical storage medium for PCM or digital audio. As the VCR market grows in this country and elsewhere, there will be more and more consumers

who will own a tape transport system that is also capable of storing audio information in digital or PCM form. What those consumers would need, then, is not a complete PCM tape recorder, but rather a "black box" type of audio processor that, in the record mode, converts audio information to a standardized PCM format for application to a VCR's tape cassette and that, during playback, converts the millions upon millions of bits or pulse/no-pulse conditions read from the tape back into an analog signal. (Pioneer's recently-announced *VP 1000* laser-optical video-disc player can presently handle, in addition to the video, two channels of analog audio information. The player has been designed, however, to accept

a Pulse Code Modulation adaptor which will be offered as an option at some time in the future—*Editor*).

Many manufacturers have demonstrated prototypes of such PCM audio processors at various technical and consumer electronics conventions. Among them have been Sony, Mitsubishi, Toshiba, Technics by Panasonic, JVC, and Sanyo. I have personally had an opportunity to experiment in my lab with the prototype unit from Toshiba, shown in Fig. 5. Typically, the dynamic range of this, and most other standardized PCM units, is 85 dB. Frequency response for the entire record/playback cycle is ruler-flat, from DC to 20,000 Hz, ± 1 dB. Harmonic distortion is less than 0.03% referred to maximum record level and wow-and-flutter is simply not measurable!

The statement concerning frequency response really fails to tell the complete story. In the case of ordinary analog cassette decks, for example, frequency response is normally quoted for a record level of -20 dB. That is done to avoid the high-frequency saturation problems inherent in tape recording at slow speeds. Figure 6 illustrates this point. Even with a high-quality analog tape deck, response at high levels of recording is increasingly non-linear at high frequencies.

Compare these results with those obtained and shown in Fig. 7, for which the prototype Toshiba *PCM Mark II* prototype was used. Results remain flat all the way up to 20,000 Hz, regardless

continued on page 87

COMMUNICATIONS

SECRET INTERNATIONAL When And Where

Numbers, numbers everywhere—and nobody seems to have any idea what they're all about. After reading this, tune in and maybe you'll come up with the answer.

ROBERT B. GROVE

"ONE-SEVEN-FOUR-TWO-SIX; TWO-THREE-nine-zero-two." The tape-recorded female voice drones on. Tuning through the shortwave spectrum, we find another station...this time in Spanish. "Cinco-nueve-tres-cuatro-uno; tres-cinco-dos-uno-seis."

Those so-called "numbers stations" populate the shortwave spectrum, following regular schedules. (See Table 1). They announce no callsign and usually transmit their cryptic one-way messages for approximately 15 minutes. The same numeric sequence is often repeated on a nearby frequency (see Table 2). [The frequencies of many more numbers stations are included in a book listing over 6,000 radio stations, their frequencies as well as what they broadcast. The book is entitled "Confidential Frequency List" and is available from Gilfer Associates, P.O. Box 239, 52 Park Avenue, Park Ridge, NJ 07656 for \$6.95—*Editor*.]

Who are these phantom broadcasters? Where are they located? Perhaps most important, what is the nature of their encoded messages?

One thing is certain: They have been on the air for at least 20 years. In all that time, no one has publicly settled the enigma. Many possible solutions have been suggested: They are monetary statements for world-bank transactions; coffee-plantation price quotes; bolita scores; instructions for insurgents in foreign countries; arrival-departure schedules for agents; or...nothing at all—merely part of the psychological cold war!

While most broadcasts are made in full-carrier AM, occasional single side-band transmissions are monitored.

Voice transmissions aren't the only mode; Morse code is frequently reported with similar messages, often in three-

TABLE 1—A BRIEF SAMPLING of the numbers stations.

FREQUENCY (kHz)	TIME (UCT)
3060	On the hour
3090	Quarter past the hour
6772	0615, 0700
6840	1025
10570, 14968	2225

TABLE 2—Some additional frequencies (kHz) recently reported by various listeners.

3178	7322
3435	7445
4670	5727
5775	7887
5812	8418

letter groups. Some listeners have even gone to the trouble to show a relationship between the number groups and the letter groups.

A former intelligence officer states that the Russian KGB—the secret police (formerly NKVD)—used CW five-letter Russian Cyrillic to broadcast to their posts in the USSR and elsewhere. The transmissions were in the 8-MHz region, but they identified themselves with legitimate callsigns which were registered with the ITU (International Telecommunications Union). It is very unlikely that those are the stations that are being reported.

Let's examine some of the hypothetical suggestions which have been offered.

World-bank transactions: Although visitors to Latin American countries have noticed large antennas on the tops of some of the banks, it would seem unlikely that international banking would operate via a clandestine network.

Such activities have never been reported among the myriad member countries, and the frequencies chosen for numbers transmissions would not support such a large geographical network. Keyboard teletype would be far more practical for such monetary transactions.

Coffee plantation price quotes: Although a rather far-out suggestion, it shouldn't be dismissed without some consideration. Frequencies chosen for the broadcasts are usually in the lower part of the shortwave spectrum, and would favor propagation throughout Central and South America. About the only reaction that can be applied here is intuitive: It doesn't seem likely.

Bolita scores: The Cuban lottery and Bolita are popular sports among Latins. Could this be an informational system providing such traffic to lottery book-makers? Again, the answer must remain "Unlikely." It is a little too obvious.

...Or, nothing at all? While that is a distinct possibility in a world in which some things don't make any sense at all, there is considerable evidence that



MCKAY-DYMEK MODEL DR-101 covers a frequency range between 50 kHz and 29.7 MHz.



REALISTIC MODEL DX-300 communications receiver covers a frequency range between 10 kHz and 30 MHz.

NUMBER STATIONS To Listen In



YAESU MODEL FRG-7000 covers a frequency range between 250 kHz to 29.9 MHz.



HEATH MODEL SW-717 4-band receiver covers 550 kHz to 30 MHz.

would weigh against the hypothesis. First of all, such tactics would be aimed at our intelligence organizations. Over a period of some 20 years, even with admitted bungling, U.S. Intelligence would have been able to see through such a transparent diversionary tactic.

In fact, there have been several reported cases in which the message had technical difficulties, and frantic live broadcasts were made to ensure the success of the transmission. During Hurricane Frederick, one station was apparently knocked off the air, and an alternate frequency became active for a week, apparently until repairs could be effected.

How about spies?

Yes, how about that? Although the transmission could be cryptographic training sessions (as suggested by one prominent listener with a military background) such training could be provided more easily with cassette tapes. Of course, nothing beats practical, on-the-air experience!

It would seem that after 20 years, someone would have the presence of mind to suggest using radio direction-finding techniques to home in on those

"bogies." Their repeated schedules and long transmission times would make them ideal targets.

As a matter of fact, that *has* been done, and by an agency no less than our own Federal Communications Commission! One of the more classical broadcasters is the one heard on 3060 kHz at 15 minutes after the hour. Several RDF attempts have nailed that one down as being in Havana, Cuba. That has been corroborated by another intelligence agency, and also by several private hobbyists.

But other listeners, all with excellent equipment and unquestionable qualifications, have found additional "fixes" for similar stations: San Juan, Puerto Rico; Portland, Oregon; Northern Virginia; the West Coast of Florida; even London, England!

To confuse things further, many languages are reported besides English and Spanish; they include Czechoslovakian, German, and English being



PANASONIC MODEL RF-4900 is a portable communications receiver that can cover the frequency range between 1600 kHz and 31 MHz.

	5	6	7	8
1	N	A	S	O
2	6	E	M	R
3	O	B	I	D
4	T	9	3	U

15 48 27 36 26 28 17
N U M B E R S

17 45 16 45 37 18 15 17
S T A T I O N S

47 35 25 35 16 15 38 47 35 46 35
3 0 6 0 A N D 3 0 9 0

FIG. 1—The Polybius square (checkerboard or grid) uses digraphs. Each set of two numbers keys out a box in the grid. For example, 15 = N.

read by someone with a heavy European accent!

Clearly, the operation is extensive—multinational. Are they all tied together? If they are, what would be a common interest between Havana and Northern Virginia? Could those be clandestine intelligence broadcasts to foreign agents? If so, who is foreign and in which country? The more we investigate those strange broadcasts, the more paranoid we are likely to become.

Taking the content of the transmissions at face value, we would probably conclude that they are using some sort of cryptographic means of encoding. What type of code is likely? Among the easiest to use is the "one time pad." In that system, a list of letters or numbers is chosen at random to replace actual characters in the text. The pad is used only once and discarded. A new pad is used for the next message.

Listeners who have been close to intelligence work say that the one-time pad is highly unlikely: There are too many similarities among the different messages that have been copied. Not only that, but when a suspected agent is caught with a one-time pad in his possession, that is *prima facie* evidence of his subversive activity!

More likely, the numbers messages constitute a checkerboard grid or Polybius square (see Fig. 1). In that arrangement, a checkerboard pattern of boxes is laid out, and all the necessary letters and numbers from the original text of the message are sprinkled through the grid. Each row is given a letter (or number) and so is each column. By calling out a pair of letters or numbers (called digraphs) we key out each of the hidden characters in the grid.

As to the real nature of the broadcasts and what the texts actually hold, we have no information. And if we had, we would not be allowed to reveal it. But we would enjoy hearing from anyone out there who thinks he may hold the key to those fascinating numbers stations!

Backyard Satellite—TV Reception

FACT OR FANTASY

FRED HOPENGARTEN, K1VR*

THE INTEREST GENERATED BY THE IDEA of receiving programming intended for cable-TV operators has been unbelievable. For people with poor reception, or a limited selection of VHF/UHF television, satellite TV is a banquet for the entertainment-starved. But don't be too quick to think that it is for everyone.

View of the "bird"

At 4 GHz, geostationary satellites (called "birds") are limited to line-of-sight communications. Unfortunately, that means that if you are in Portugal, the lower Caribbean, Southern Mexico, or Venezuela (to cite location examples of people I've been forced to disappoint lately), you really have no hope of watching American domestic satellites. Those locations are just too far from the center of the footprint.

Even if you are right here in the good old U.S.A., you've got to "see" the spot in the sky where you will find the satellite. For example, I recently sold a system to a man living at 42°, 26', 20"; 71°, 18', 03", to be specific. From his house to the RCA Satcom F1, at 135° over the equator, the azimuth is 251.56° and the elevation is 10.54°. After walking around his land with a compass (for azimuth) and a clinometer (for elevation), I found a spot where we could erect an antenna, if he was willing to cut off a large branch from a near-field tree, and willing to cut down entirely two trees almost 200 feet away. I love trees, mind you. But they kill reception at microwave frequencies.

If you have no "sight" on the "bird," you'll have no reception from "line-of-sight" signals.

Big dishes

Given a fairly weak signal, and some crowding in the sky, it is necessary to have a fairly big antenna. Standard antennas are between three and five meters in diameter. The larger ones are necessary on the two coasts, and the Southern tier.

*President, Channel One, Inc., 68 Avalon Road, Newton, MA 02168.

Despite the "FM Advantage," (capture effect) of satellite TV signals, a smaller than necessary antenna will only give you shadows. Just because you own a three-foot dish, that doesn't mean that a three-foot dish will work. Those neat Japanese systems you have heard about, selling for \$500-1000, are for an experimental 12-GHz satellite. Don't look for that here before 1984, the proposed start date for COMSAT service.

Perhaps you've been thinking that one of these big dishes can be moved from one satellite to another, like rotating a fifteen-meter beam. Wrong again. Unless you buy a motorized version, *very expensive*, you'll have to go out in the backyard each time you want to change satellites. Count on using two people and taking at least 15-20 minutes each time. As winter rolls around here in New England, the thought loses appeal.

Don't forget something else about big parabolic reflectors: They act like big sails in a wind. For that reason you can't raise one very far off the ground without a substantial support system (concrete and cross-ties, or I-beam construction). It can even cause problems mounted on top of your apartment building, unless properly shielded from the wind.

Sharing with neighbors

I am frequently asked: "Can a bunch of us get together and buy a system?" The answer is yes, but . . . Of course you can receive satellite signals and pass them along, but then you are a cable-TV system in the eyes of the law, albeit a small one. You will need full-frequency coordination (to insure that a nearby terrestrial microwave link is not looking down your boresight), a license, and agreements with the program suppliers to pay subscription fees. Having done that, you will still only receive one channel at a time. This means that the person who has the receiver, controls what everyone else will watch. Just wait for the first 1 AM phone call asking you to switch transponders—but not offering to help.

Here are several important points to consider before you set up your own satellite-TV receiving station.

To add more receivers, you must add a second Low Noise Amplifier, another feedline, power dividers, and another receiver for each additional transponder you wish to watch simultaneously.

How far away are your neighbors? If they are more than 200 feet away, then it is impractical—due to line losses—to send 4-GHz signals such a distance.

Bars and public rooms

Many of the entrepreneurs of this country have figured out that a satellite TV system is the perfect complement to projection television (wide-screen). Unfortunately, the movie channels won't let you buy the rights to show their stuff in public rooms. No Showtime, Star Channel, Galavision, Home Box Office, Home Theatre Network, or Take 2. But not all is lost. Obtaining a license is something that dealers and manufacturers do for their customers all the time. With FCC license in hand, there is still some wonderful programming to watch.

Here's what can be shown in a lounge: ESPN (24-hour sports), C-SPAN (the U.S. Congress), the three Christian Networks, Satellite Program Network, Modern Cable Programs, WOR (New York), WGN (Chicago), WTBS (Atlanta), and KTVU (San Francisco). That's a tremendous amount of sports . . . perfect for enjoying more beer. And you would be surprised at how interesting some of the other programming can be.

Out-of-this-world entertainment

There is no need to be scared away from satellite TV. But it is a mistake to overlook the factors which could cause you to stand by while thousands of dollars in electronics sits idle.

Satellite TV is great for country homes and places where there is no cable. The quantity of entertainment cannot presently be matched anywhere, on any existing cable system.

I just hope that I've added a touch of realism to your consideration of this wonderful new world of viewing. R-E

NEW 1980 DIGITAL MULTIMETERS FROM **FLUKE**

8010A
\$249

\$289
w/rechargeable
batteries
(OPTION - 01)



8010A and 8012A

- Large 3½-Digit LCD's - view in any light
- Conductance function - resistance to 10,000 MO
- AC measurements to 50 kHz and higher
- True RMS for ac accuracy
- Touch-Hold probe for tricky places (Y8008)
- Diode test and low power ohms
- AC or dc current to 10 amps with 8010A
- Resistance resolution to 0.001Ω with 8012A
- Built-in batteries and charger (Option -01)

8012A
\$299

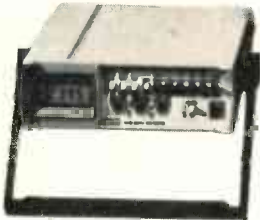
\$339
w/rechargeable
batteries
(OPTION - 01)



NEW

8050A
\$349

\$399
w/rechargeable
batteries
(OPTION - 01)



8050A
4½-digit multimeter
microprocessor technology

- dB: That's right, direct readings in dBm, referenced to any of 16 impedances that you select from the 8050A's scrolling reference memory.
- REL: This stands for relative reference in the dB mode or offset measurements in other functions.

- Conductance function - resistance to 10,000 MO
- AC measurements to 50 kHz and higher
- True RMS for ac accuracy
- Touch-Hold probe for tricky places (Y8008)
- Diode test and low power ohms
- Built-in batteries and charger (Option -01)

NEW

8024A
\$219

Model 8024A:
The Investigator

- Nine functions dc voltage ac voltage dc current ac current resistance diode test conductance (1/R) logic level and continuity detect temperature (K-type thermocouple)
- Peak hold on voltage and current functions
- Selectable audible indicator for continuity or level detection
- 3½-digit resolution
- 0.1% basic dc accuracy
- LCD display
- Overload protection



Model 8022A:
The Troubleshooter

- Six functions dc voltage ac voltage dc current ac current resistance diode test
- 3½-digit resolution
- 0.25% basic dc accuracy
- LCD display
- Overload protection



8022A
\$139

Model 8020A:
The Analyst

- 0.1% basic dc accuracy
- LCD display
- Overload protection
- **Free Case**
- Two year parts and labor warranty

8020A
\$179

TOLL FREE HOTLINE 800-223-0474

54 WEST 45TH STREET, NEW YORK, N.Y. 10036 212-687-2224

ADVANCE ELECTRONICS

Plug in the capacitor, push the appropriate range button, and read the value to 0.1% accuracy. With the Data Precision Model 938 digital capacitance meter it's that easy. The 8 easy pushbutton ranges cover 0.1 picofarads to 1999 microfarads, and the exclusive "Δcharge/Δvolt" measurement circuit (patent pending) holds its ±0.1% basic accuracy for a full year. A 0.5" high liquid crystal display is easy on the eyes and easy on the battery — up to 200 hours operation on a standard 9V battery. The Model 938's small size and light weight make it easy to carry where you need it.

But best of all, it's easy on the budget — only **\$169.00 (USA)** — complete with a 2-year warranty. Just what you expect from Data Precision.

Capacitance
Made Easy - \$169.

Order by phone-toll free
(800) 223-0474



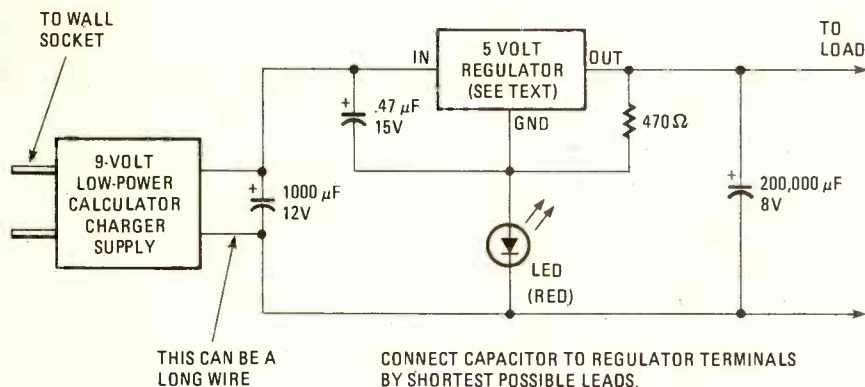
ADVANCE ELECTRONICS

54 West 45 Street, New York, N.Y. 10036 (212) 687-2224

BATTERY SUBSTITUTER HAS MUSCLE

IT WOULD SEEM THAT BUILDING A LITTLE power supply to substitute for four flashlight (D cell) batteries would be a simple "handbook" job. Not so! The application in question is powering a widely-sold toy pinball machine.

The problem is that the bright bulb and electromagnetic counter draw an initial surge of about 4 amperes when the steel ball activates a scoring bumper. There are, no doubt, other toys that suffer from the same problem. The pinball machine used up alkaline batteries at a rate that began to cost a significant part of the entire house electrical bill.



The problem *has* been solved, and I set up the following criteria for the design:

1. The supply should use a *safe* (U-L recognized) line-plug module as calculators or small tape recorders using rechargeable batteries do. The idea was not to shock too many of our children, ages 4 through 14.
2. The supply should use an inexpensive and easily available regulator like the National LM340T-5.0 or the 7805-series voltage regulator available from several sources.
3. Despite using the commonly available 5-volt logic regulators, the supply should provide 6.3 to 6.5 volts.

To make the little, 100 mA-rated, calculator/charger supply provide 4-ampere surges required a minor reversal of design philosophy. Not only is the little charger-supply limited in power, but the plastic-packaged regulators that are easily available, are only rated for 1 to 1.5 amperes. Three design tricks provide the solution.

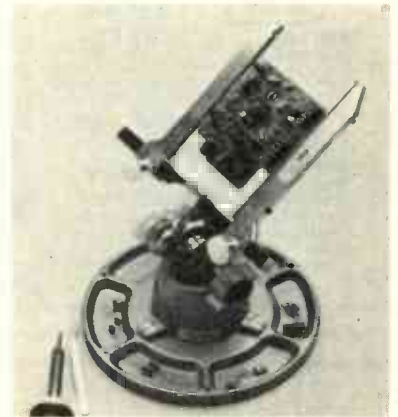
1. Only moderate filtering on the regulator input (see the schematic) is needed, and fast recovery results.
2. *Massive* filtering on the output of the regulator is used (not the usual technique) to supply the surges. The three-terminal IC regulators are stable under these conditions.
3. A LED is inserted in the ground lead of the 5-volt IC regulator. This boosts its output voltage by about 1.5 volts, and provides a nice pilot-light as well.

Parts are not critical. The line-plug supply (transformer is part of plug) that I used had an open-circuit voltage of about 10 volts and could supply a little over 100

NEW IDEAS

This column is devoted to new ideas, circuits, device applications, construction techniques, helpful hints, etc.

All published entries, upon publication, will earn \$25 plus a Circuit Board Holder, Standard Base and Tray Base Mount from Panavise Products, Inc. (See photo below.) Selections will be made at the sole discretion of the editorial staff of **Radio-Electronics**.



I agree to the above terms and grant **Radio-Electronics** Magazine the right to publish my idea. I declare that the attached idea is my own original material and that its publication does not violate any other copyright. I also declare that this material had not been previously published.

Title of Idea

Signature

Print Name

Date

Street

City

State

ZIP

Mail your idea along with this coupon to:

New Ideas
Radio-Electronics
 200 Park Ave. South
 New York, NY 10003

mA at 8 volts. [A power converter designed to supply 9 volts to small radios and calculators will do nicely.—*Editor*] The capacitors are also uncritical since none of the ripple currents are very high. I happened to use two 100,000-microfarad computer-type capacitors on the output because I could get them inexpensively. A number of smaller paralleled capacitors rated at 8 volts or more would certainly work well also. Surplus or junk-box devices would be quite suitable. The IC regulators must have current-limiting to avoid damaging the line-plug type supply with surges.

The battery-eliminator components can be placed wherever you can find the space. The location for the charger is obvious—in the wall receptacle. I distributed the other parts around the pinball machine. The small capacitor and regulator are on a bracket on the back of the machine. The LED is glued into the front panel and the two 100,000- μ F capacitors are carefully insulated and then taped to the machine's back legs.—*Peter Lefferts*

Start Computing For Just \$129.95 With An 8085-Based Professional Computer Kit—

Explorer/85

100% compatible with all 8080A and 8085 software & development tools!

No matter what your future computing plans may be, Level "A"—at \$129.95—is your starting point.

Starting at just \$129.95 for a Level "A" operating system, you can now build the exact computer you want. Explorer/85 can be your beginner's system, OEM controller, or IBM-formatted 8" disk small business system... yet you're never forced to spend a penny for a component or feature you don't want and you can expand in small, affordable steps!

Now, for just \$129.95, you can own the first level of a fully expandable computer with professional capabilities—a computer which features the advanced Intel 8085 cpu, thereby giving you immediate access to all software and development tools that exist for both the 8085 and its 8080A predecessor (they are 100% software compatible)—a computer which features onboard S-100 bus expansion—plus instant conversion to mass storage disk memory with either 5-1/4" diskettes or standard IBM-formatted 8" disks.

For just \$129.95 (plus the cost of a power supply, keyboard/terminal and RF modulator, if you don't have them already), Explorer/85 lets you begin computing on a significant level... applying the principles discussed in leading computer magazines... developing "state of the art" computer solutions for both the industrial and leisure environment.

Level "A" Specifications

Explorer/85's Level "A" system features the advanced Intel 8085 cpu, an 8355 ROM with 2k deluxe monitor/operating system, and an 8155 ROM I/O—all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 expansion, plus generous prototyping space.

(Level "A" makes a perfect OEM controller for industrial applications and is available in a special Hex Version which can be programmed using the Netronics Hex Keypad/Display.)



Level "A" at \$129.95 is a complete operating system, perfect for beginners, hobbyists, or industrial controller use.

PC Board: glass epoxy, plated through holes with solder mask
 • I/O: provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader... provision for 24-pin DIP socket for hex keypad/display... cassette tape recorder input... cassette tape control output... speaker output... LED output indicator on SOD (serial output) line... printer interface (less drivers)... total of four 8-bit plus one 6-bit I/O ports • Crystal Frequency: 6.144 MHz • Control Switches: reset and user (RST 7.5) interrupt... additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard • Counter/Timer: programmable, 14-bit binary • System RAM: 256 bytes located at F800, ideal for smaller systems and for use as an isolated stack area in expanded systems... RAM expandable to 64k via S-100 bus or 4K on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F000 leaving 0000 free for user RAM/ROM. Features include tape load with labeling... tape dump with labeling... examine/change contents of memory... insert data... warm start... examine and change all registers... single step with register display at each break point, a debugging/training feature... go to execution address... move blocks of memory from one location to another... fill blocks of memory with a constant... display blocks of memory... automatic baud rate selection... variable display line length control (1-255 characters/line)... channelized I/O monitor routine with 8-bit parallel output for high speed printer... serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Version): Tape load with labeling... tape dump with labeling... examine/change contents of memory... insert data... warm start... examine and change all



registers... single step with register display at each break point... go to execution address. Level "A" in the Hex Version makes a perfect controller for industrial applications and can be programmed using the Netronics Hex Keypad/Display.



Hex Keypad/Display.

Level "B" Specifications

Level "B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards and includes: address decoding for onboard 4k RAM expansion select-able in 4k blocks... address decoding for onboard 8k EPROM expansion select-able in 8k blocks... address and data bus drivers for onboard expansion... wait state generator (jumper select-able), to allow the use of slower memories... two separate 5 volt regulators.



Explorer/85 with Level "C" card cage.

Level "C" includes a sheet metal superstructure, a 5-card gold plated S-100 extension PC board which plugs into the motherboard. Just add required number of S-100 connectors

Level "D" Specifications

Level "D" provides 4k or RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from 0000 to EFFF in 4k blocks.

Level "E" Specifications

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for soon to be available RAM IC's (allowing for up to 12k of onboard RAM).

Order A Coordinated Explorer/85 Applications Pak!

Experimenter's Pak (SAVE \$12.50)—Buy Level "A" and Hex Keypad/Display for \$199.90 and get FREE Intel 8085 user's manual plus FREE postage & handling!

Student Pak (SAVE \$24.45)—Buy Level "A," ASCII Keyboard/Computer Terminal, and Power Supply for \$319.85 and get FREE RF Modulator plus FREE Intel 8085 user's manual plus FREE postage & handling!

Engineering Pak (SAVE \$41.00)—Buy Levels "A," "B," "C," "D," and "E" with Power Supply, ASCII Keyboard/Computer Terminal, and six S-100 Bus Connectors for \$514.75 and get 10 FREE computer grade cassette tapes plus FREE 8085 user's manual plus FREE postage & handling!

Business Pak (SAVE \$89.95)—Buy Explorer/85 Levels "A," "B," and "C" (with cabinet), Power Supply, ASCII Keyboard/Computer Terminal (with cabinet), 16k RAM, 12" Video Monitor, North Star 5-1/4" Disk Drive (includes North Star BASIC) with power supply and cabinet, all for just \$1599.40 and get 10 FREE 5-1/4" minidiskettes (\$49.95 value) plus FREE 8085 user's manual plus FREE postage & handling!

Continental U.S.A. Credit Card Buyers Outside Connecticut
CALL TOLL FREE 800-243-7428
 To Order From Connecticut Or For Technical Assistance, Etc. Call (203) 354-9375

- Netronics R&D Ltd., Dept. RE-8**
 333 Litchfield Road, New Milford, CT 06776
 Please send the items checked below—
- Explorer/85 Level "A" Kit (ASCII Version), \$129.95 plus \$3 p&h.
 - Explorer/85 Level "A" Kit (Hex Version), \$129.95 plus \$3 p&h.
 - 8k Microsoft BASIC on cassette tape, \$64.95 postpaid.
 - 8k Microsoft BASIC in ROM Kit (requires Levels "B," "D," and "E"), \$99.95 plus \$2 p&h.
 - Level "B" (S-100) Kit, \$49.95 plus \$2 p&h.
 - Level "C" (S-100 6-card expander) Kit, \$39.95 plus \$2 p&h.
 - Level "D" (4k RAM) Kit, \$69.95 plus \$2 p&h.
 - Level "E" (EPROM/ROM) Kit, \$5.95 plus 50¢ p&h.
 - Deluxe Steel Cabinet for Explorer/85, \$49.95 plus \$3 p&h.
 - ASCII Keyboard/Computer Terminal Kit (features a full 128 character set, upper & lower case, full cursor control, 75 ohm video output convertible to baudot output, selectable baud rate, RS232-C or 20 ma. I/O, 32 or 64 character by 16 line formats, and can be used with either a CRT monitor or a TV set (if you have an RF modulator), \$149.95 plus \$2.50 p&h.
 - Hex Keypad/Display Kit, \$69.95 plus \$2 p&h.
 - Deluxe Steel Cabinet for ASCII Keyboard/Terminal, \$119.95 plus \$2.50 p&h.
 - Power Supply Kit (± 8V @ 5 amps) in deluxe steel cabinet, \$39.95 plus \$2 p&h.
 - Gold Plated S-100 Bus Connectors, \$4.85 each, postpaid.
 - RF Modulator Kit (allows you to use your TV set as a monitor), \$8.95 postpaid.
 - 16k RAM Kit (S-100 Board expands to 64k), \$199.95 plus \$2 p&h.
 - 32k RAM Kit, \$329.95 plus \$2 p&h.
 - 48k RAM Kit, \$459.95 plus \$2 p&h.
 - 64k RAM Kit, \$589.95 plus \$2 p&h.
 - 16k RAM Expansion Kit (to expand any of the above up to 64k), \$139.95 plus \$2 p&h each.
 - Intel 8085 cpu User's Manual, \$7.50 postpaid.
 - Special Computer Grade Cassette Tapes, \$1.90 each or 3 for \$5, postpaid.
 - 12" Video Monitor (10 MHz bandwidth), \$139.95 plus \$5 p&h.
 - North Star Double Density Floppy Disk Kit (One Drive) for Explorer/85 (includes 3 drive S-100 controller, DOS, and extended BASIC with per-

sonalized disk operating system—just plug it in and you're up and running!), \$699.95 plus \$5 p&h.

- Power Supply Kit for North Star Disk Drive, \$39.95 plus \$2 p&h.
- Deluxe Case for North Star Disk Drive, \$39.95 plus \$2 p&h.
- Experimenter's Pak (see above), \$199.90 postpaid.
- Student Pak (see above), \$319.85 postpaid.
- Engineering Pak (see above), \$514.75 postpaid.
- Business Pak (see above), \$1599.40 postpaid.

Total Enclosed \$ (Conn. res. add sales tax) By—
 Personal Check M.O./Cashier's Check Visa Master Charge (Bank # _____)

Acct. # _____
 Signature _____ Exp. Date _____
 Print Name _____
 Address _____
 City _____
 State _____ Zip _____

Send Me Information

CIRCLE 53 ON FREE INFORMATION CARD

By Netronics

ASCII/BAUDOT, STAND ALONE



Computer Terminal

COMPLETE FOR ONLY \$149.95

The Netronics ASCII/BAUDOT Computer Terminal Kit is a microprocessor-controlled, stand alone keyboard/terminal requiring no computer memory or software. It allows the use of either a 64 or 32 character by 16 line professional display format with selectable baud rate, RS232-C or 20 ma. output, full cursor control and 75 ohm composite video output.

The keyboard follows the standard typewriter configuration and generates the entire 128 character ASCII upper/lower case set with 96 printable characters. Features include onboard regulators, selectable parity, shift lock key, alpha lock jumper, a drive capability of one TTY load, and the ability to mate directly with almost any computer, including the new Explorer/85 and ELF products by Netronics.

The Computer Terminal requires no I/O mapping and includes 1k of memory, character generator, 2 key rollover, processor controlled cursor control, parallel ASCII/BAUDOT to serial conversion and serial to video processing—fully crystal controlled for superb accuracy. PC boards are the highest quality glass epoxy for the ultimate in reliability and long life.

VIDEO DISPLAY SPECIFICATIONS

The heart of the Netronics Computer Terminal is the microprocessor-controlled Netronics Video Display Board (VID) which allows the terminal to utilize either a parallel ASCII or BAUDOT signal source. The VID converts the parallel data to serial data which is then formatted to either RS232-C or 20 ma. current loop output, which can be connected to the serial I/O on your computer or other interface, i.e., Modem.

When connected to a computer, the computer must echo the character received. This data is received by the VID which processes the information, converting to data to video suitable to be displayed on a TV set (using an RF modulator) or on a video monitor. The VID generates the cursor, horizontal and vertical sync pulses and performs the housekeeping relative to which character and where it is to be displayed on the screen.

Video Output: 1.5 P/P into 75 ohm (EIA RS-170) • Baud Rate: 110 and 300 ASCII • Outputs: RS232-C or 20 ma. current loop • ASCII Character Set: 128 printable characters—



Cursor Modes: Home, Backspace, Horizontal Tab, Line Feed, Vertical Tab, Carriage Return. Two special cursor sequences are provided for absolute and relative X-Y cursor addressing • Cursor Control: Erase, End of Line, Erase of Screen, Form Feed, Delete • Monitor Operation: 50 or 60Hz (jumper selectable).

Continental U.S.A. Credit Card Buyers Outside Connecticut
CALL TOLL FREE 800-243-7428

To Order From Connecticut Or For Technical Assistance, Etc. Call (203) 354-9375

Netronics R&D Ltd., Dept. RE-8
 333 Litchfield Road, New Milford, CT 06776
 Please send the items checked below—

- Netronics Stand Alone ASCII Keyboard/Computer Terminal Kit, \$149.95 plus \$3.00 postage & handling.
- Deluxe Steel Cabinet for Netronics Keyboard/Terminal In Blue/Black Finish, \$19.95 plus \$2.50 postage and handling.
- Video Display Board Kit alone (less keyboard), \$89.95 plus \$3 postage & handling.
- 12" Video Monitor (10 MHz bandwidth) fully assembled and tested, \$139.95 plus \$5 postage and handling.
- RF Modulator Kit (to use your TV set for a monitor), \$8.95 postpaid.
- 5 amp Power Supply Kit In Deluxe Steel Cabinet (± 8VDC @ 5 amps, plus 6-8 VAC), \$39.95 plus \$2 postage & handling.

Total Enclosed (Conn. res. add sales tax) \$ _____
 By—
 Personal Check Cashiers Check/Money Order
 Visa Master Charge (Bank # _____)

Acct. # _____
 Signature _____ Exp. Date _____
 Print Name _____
 Address _____
 City _____
 State _____ Zip _____

Send Me More Information

Boost communication receiver performance with an audio processor.

HERB FRIEDMAN, COMMUNICATIONS EDITOR

IN A WAY I WAS VERY FORTUNATE TO start out in electronic back in the golden age of vacuum tubes (the late 40's and early 50's) for it was also the golden age of the communications receiver. A young hobbyist of that day got a chance to handle receiver circuits that few outside of the military will ever get to use.

It took two hands to count the number of amateur and SWL receiver manufacturers, each turning out several models that seemed—at the time—to be upgraded every month or two. The local "radio parts store" and Ham-equipment distributor often gave a full wall of shelving to their receiver display; there were *that many* different models.

Using tubes and circuits developed for the military during WWII, it was not unusual to find a modestly priced receiver that featured—at the very least—a crystal filter that could slice off an interfering CW signal as easily as a chef slices through roast beef. For a few dollars more we could get a receiver with selectable crystal filters. Then came the tuneable IF, where the user could position the IF bandpass to drop interference of any kind "off the cliff" (out of the passband). Another went a step farther and moved into the audio circuits with a processor that enhanced or rejected a user-tuned audio frequency.

With its cascode RF amplifier, triple-

conversion, tuneable IF, audio processor, crystal filters, and heaven only remembers what else, the last of the tubed gold-plate receivers took two men to lift and generated enough heat to whip up a cup of hot chocolate on a nippy night. Fact is, all those tubes glowing away in a tabletop cabinet created a major stability problem in some "high performance" receivers. Virtually everything up to the IF had to be temperature-compensated, and as a receiver aged it often took upwards of an hour for the tuning drift to settle down. (Many hams never turned their receivers off—just left 'em on stand-by.)

We had finally reached a point of no return in consumer receivers; the heat was cancelling out the benefits of new circuit ideas.

It's debatable whether the gold-plated communications receiver was simply a dinosaur whose end was due, or whether the introduction of the Collins S-line—with its relatively simplified trouble-free circuits—spelled the end for the gold-plated specials, but in a few years most receiver brands were simply a memory.

The S-line, the forerunner of the modern solid-state single-sideband receiver and transceiver, set the standards for features we expect in today's receivers: A crystal-controlled high-frequency conversion oscillator to remove many of the temperature-compensation

problems. Those included a low-frequency tuneable (local) oscillator whose low frequency, by itself, makes the circuit insensitive to temperature-caused frequency drift; and the mechanical filter that can be tailored to any desired bandwidth for optimum reception of CW, AM, or SSB. The mechanical filter replaced both the difficult-to-tune crystal filter and the tuneable IF, though many who used the tuneable IF still think it was the most effective receiving aid.

As for audio processors, they have long been a memory as original equipment, though they are still available as low-cost add-ons that (generally) plug into a receiver's headphone or speaker output.

The audio processor is basically the poor man's Q-multiplier in the sense that it can function either as a notch filter (to eliminate beats and whistles), or as a "peaker" (variable-Q bandpass amplifier). If you remember the Q-multiplier, it was a regenerative device connected into a receiver's IF. As the gain or feedback was adjusted towards self-oscillation, the effective Q rose sharply creating a sharp peak, or notch if desired, in the IF response.

The problem with the Q-multiplier is that it used vacuum tubes and was usually designed to connect into a 455-kHz or 1600-kHz vacuum-tube IF. With the advent of solid-state receivers, several attempts were made at solid-state Q-multipliers, but designing a "universal" model that could be installed without fear of catastrophic failure was almost impossible because no two solid-state receivers have circuits similar enough for modification by the average hobbyist.

Enter, now, the audio processor. Using the same solid-state technology that made the universal Q-multiplier difficult, it was possible to design an inexpensive audio processor that performed essentially the same as an IF Q-multiplier. And the one big advantage of the audio processor over the Q-multiplier is that it is, in fact, universal: The user simply plugs it into the receiver's speaker output.

The *Mizuho AP-M1* Audio Processor shown in Fig. 1 is typical of what can be done at moderate cost. Priced at \$51 from Gilfer Associates, Box 239, Park Ridge, NJ 07656, the model *AP-M1* uses almost pure textbook design to synthe-

continued on page 74



Fig. 1

IT IS BETTER TO GIVE AND RECEIVE.

You'll receive a rebate up to \$20 if you give dad a Bearcat® No-Crystal Scanner for Father's Day.

Get Dad into all the real excitement of scanning. Or get him a more sophisticated scanner. Either way, you'll get yourself a nifty rebate. Up to \$20.

Get a \$10 Rebate on the Bearcat 210. America's best selling Scanner Radio. The amazing 10 channel, 5 band crystalless Scanner that tunes in over 6000 frequencies with pushbutton ease. Features automatic search, selective scan delay, and more.

Get a \$10 Rebate on the Bearcat 211. America's mid-priced, spaceage circuitry Scanner. Has 18 channel, 6-band capacity. Automatic search. Direct channel access. Dual scan speed. Automatic squelch. And digital clock.

Get a \$20 Rebate on the Bearcat 220. The Scanner radio that tunes in FM public service frequencies—plus AM aircraft communications with pushbutton ease. Features automatic search.

Get a \$20 Rebate on the Bearcat 250. America's exciting, 50 channel synthesized Scanner. It searches, stores, remembers, and brings home live action. Dual scan speeds. Scan delay. Automatic squelch. Direct channel access. Every feature you want.

See your Bearcat Scanner dealer now, for the greatest gift you can give Dad. And get a rebate for remembering him so well this Father's Day*.



CIRCLE 32 ON FREE INFORMATION CARD

*Rebate offer good on consumer purchases made between May 1, 1980 and June 30, 1980. Offer good only in U.S.A. Void where taxed or prohibited by law. Restricted to one rebate per customer regardless of the number of scanners purchased.

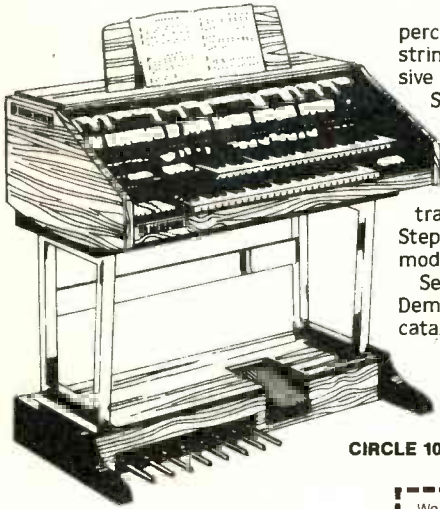


Electra Company,
Division of Masco Corp. of Indiana,
300 East County Line Road,
Cumberland, Indiana 46229.

BEARCAT® SCANNERS

The number one way to real excitement.

BUILD A MASTERPIECE OF SOUND



percussion and sustain. Wersi's famous string orchestra and bass guitar. Exclusive Sound Computer for 32-128 "One Stop Sounds" (total organ presets). Transposer. And lots more.

Build your own masterpiece of sound. No technical knowledge required. Just follow the clearly illustrated, easy to understand instructions. Step by step. Choose from at least 10 models. (Also factory assembled.)

Send \$6.00 with coupon for your Wersi Demo-Package (LP with 104-page color catalog).



CIRCLE 10 ON FREE INFORMATION CARD

Wersi has combined select features of the electronic music field, added its own creations and years of research by top engineers and musicians, to produce an incomparable line of organs.

Space-age technology. True-to-life voicing with full drawbar system. Polyphonic

Wersi Electronics, Inc. Dept. 21 1720 Hempstead Road Lancaster, PA 17601	Wersi Organs & Kits Dept. 21 14104 E. Firestone Blvd. Santa Fe Springs, CA 90670
---	---

Enclosed is \$6.00 for my Demo-Package (LP with 104-page color catalog.)

Name _____
Address _____
City _____ State _____ Zip _____

COMMUNICATIONS CORNER continued from page 72

size a Q-multiplier for shortwave receivers. The filter is four series-connected 741 operational amplifiers in the standard notch-bandpass configuration — almost part-for-part out of a "circuit cookbook." The filter's output feeds an LM386 power-amplifier IC that drives a 2-inch speaker mounted in the top of a 5.5- × 1.5- × 4-inch plastic cabinet. The filter and power-amplifier IC are powered by a standard 9-volt battery, or by a 12-VDC external power source. A voltage regulator built into the device regulates the 12 VDC to the required 9 VDC.

A three-way switch determines the operating mode. One position is NOTCH, another is BANDPASS, and the third position is OFF, whereby power is turned off and the signal from the receiver is fed directly to the processor's speaker. The input to the processor is through a panel-mounted mini-jack. A second mini-jack is for an external speaker, which disables the processor's speaker when the connecting plug is inserted. Two LED's, which indicate the NOTCH and BANDPASS mode, also serve as the power-on indicators.

Two front-panel controls labeled FREQUENCY and BANDWIDTH determine the center frequency and the width of the notch or "peak." The FREQUENCY control can be tuned within the range of 400-4000 Hz.

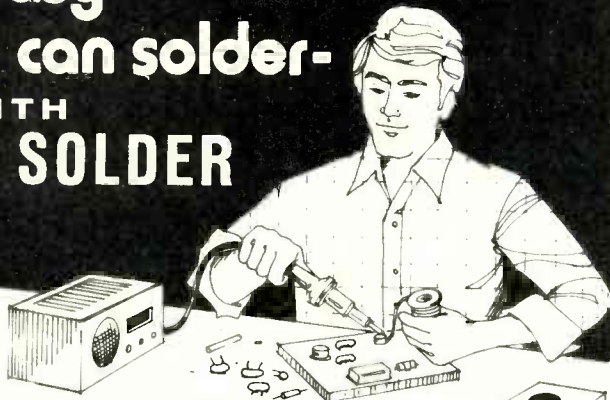
As a general rule, the greatest effect is in the bandpass mode, where the processor is used to peak a desired signal, whether CW or voice. The notch filter is not as effective because it takes considerable fiddling with the controls to tune out an interference signal, beat, or whistle. That contrasts with the bandpass mode that lifts the desired signal out of the general interference.

Of course, there are times when a notch filter is the only thing that will work, as when an interfering CW signal is many times stronger than the desired signal. Unlike the IF Q-multiplier that produces a very deep notch that can strip out almost all traces of a beat or whistle, the simplified audio processor has a moderately deep notch that passes a considerable amount of the interference. The notch contributes towards reception by eliminating *some* beat interference; the bandpass actually lifts the desired signal out of the interference.

While nothing is going to convert a budget- or moderate-cost shortwave receiver into a *gold-plated special* reminiscent of the tubed boat anchors of the 1950's, an audio processor is a relatively inexpensive way to add "selectivity" to lower cost receivers. Best of all it's truly *universal*; you just plug it in to any speaker or headphone output jack. R-E

This is easy- anyone can solder- WITH KESTER SOLDER

KESTER
SOLDER



Handymen! Hobbyists! DO-IT-YOURSELFERS!

Let Kester Solder aid you in your home repairs or hobbies. For that household item that needs repairing — a radio, TV, model train, jewelry, appliances, minor electrical repairs, plumbing, etc. — Save money — repair it yourself. Soldering with Kester is a simple, inexpensive way to permanently join two metals.

When you Solder go "First Class" — use Kester Solder.

For valuable soldering information send self-addressed stamped envelope to Kester for a FREE Copy of "Soldering Simplified".



KESTER SOLDER

Litton 4201 WRIGHTWOOD AVENUE/CHICAGO, ILLINOIS 60639

CIRCLE 7 ON FREE INFORMATION CARD

ADVANCE IS PROUD TO INTRODUCE
The  HITACHI Line of High Quality Oscilloscopes
All Hitachi Instruments
Are Backed by A Two-Year Warranty



Hitachi Oscilloscope V-302
DC-30MHz dual-trace

- | | |
|------------------------------------|--|
| 1. TV sync-separator circuit | 5. Sweep-time magnifier (10 times) |
| 2. High-sensitivity 1mV/div (5MHz) | 6. Trace rotation |
| 3. Signal delay line | 7. Z-axis input (Intensity modulation) |
| 4. X-Y operation | |

(Also available in single-trace)

- TV sync-separator circuit facilitates rapid video signal measurement.
- Extra-high sensitivity; vertical sensitivity of 1mV/div. now available.
- Built-in signal delay line for leading edge observation of quick-rising waveforms (V-301 and V-302).
- X-Y operation very convenient for measuring phase difference of two waveforms.
- Sweep-time magnifier effective for precise measurement; sweep time magnifying 10 times with one-touch operation.
- Trace rotation system for easily adjusting bright-line inclination caused by terrestrial magnetism.
- Z-axis input provided-possible to use as CRT display.
- 0.2 μ s~0.2s-wide sweep range setting.
- One-touch shifting waveform slopes.
- Five modes of vertical deflection operation (Type V-152 and V-302).
- Panel layout with color-coding of respective functions.

HITACHI V-302 & V-152

Put a proven Hitachi dual-trace oscilloscope on your bench for as little as \$695. Our V-152 15MHz model includes unprecedented sensitivity (1 mV/div)...10X sweep magnification...front panel XY operation...trace rotation...Z-axis input...and more. Need greater bandwidth? Our V-302 model is the only 30MHz dual-trace scope with signal delay line priced under \$1000, with all the above features, to make your testing operations fast, easy, and accurate. Reliability is exceptional too. (As you'd expect from a manufacturer with over 20 years of experience "outscoping" the competition.) So exceptional, in fact, that Hitachi quality is backed by a 2-year warranty...the longest in the industry. Whether you use it for teaching or repairs, for video, audio, or computer testing, you can't find more scope for your dollar than at Hitachi. Call for more details.



Hitachi Oscilloscope V-152
DC-15MHz dual-trace

- | | | |
|--|--------------|--|
| | Normal Price | Call For
 Special Introductory
 Price Offer |
| <input type="checkbox"/> V-152 15 MHz Dual Trace | \$695* | |
| <input type="checkbox"/> V-302 30 MHz Dual Trace | \$945* | |
- * Probes included.

- | | |
|------------------------------------|--|
| 1. TV sync-separator circuit | 4. Sweep-time magnifier (10 times) |
| 2. High-sensitivity 1mV/div (5MHz) | 5. Trace rotation |
| 3. X-Y operation | 6. Z-axis input (Intensity modulation) |

(Also available in single-trace)

Hitachi...The measure of quality.



THE TEST EQUIPMENT SPECIALISTS
TOLL FREE HOT LINE
800-223-0474



54 WEST 45th STREET, NEW YORK, N.Y. 10036 212-687-2224

ADVANCE ELECTRONICS

Don't cut yourself out of a career as a two-way radio technician...

MTI offers the only training for professional FM two-way radio available. Qualified technicians are employed in government, industry, and public service. But training is your key.

You could cut out a career as a two-way radio technician by cutting out this coupon. We'll send you information on how you can learn more about this specialized field, at home.

Name _____
 Address _____
 City _____
 State/Zip _____

B3F

MTI

Mobile Training Institute

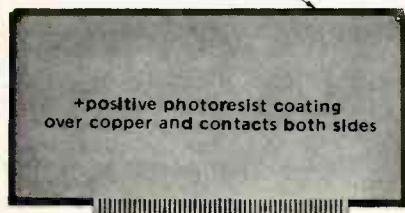
Box 735, Camp Hill, PA 17011-U.S.A.

CIRCLE 42 ON FREE INFORMATION CARD

Make Custom S-100 Boards EASY... with VECTOR 8800R2

- +Positive Photo Resist coating over 2 oz. copper on 2 sides.
- Accurate S-100 standard size (5.3 in. x 10 in.) with pre-etched gold contacts, 50 per side, 0.125 sp.
- 2 mylar sheets and strong etching bag supplied free with 8800R2.
- Expose with sunlamp - No camera or darkroom needed.

copper free borders both sides



+positive photoresist coating over copper and contacts both sides

\$19.95 ea.

Simply expose board to film master image, etch and drill holes. Film may be photographically prepared or home-made using clear mylar supplied. Make circuit art work with Vector R407 rub transfer art work set (\$2.65) or use alternate stick on tape. If not available locally factory order - include \$3.00 shipping, U.S. only.

prices subject to change without notice

Vector Electronic Company

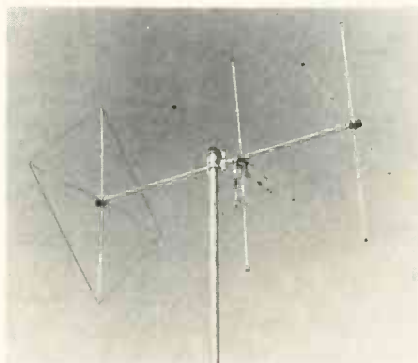
12460 Gladstone Ave.
 700979 Sylmar, CA 91342

CIRCLE 49 ON FREE INFORMATION CARD

radio products

More information on radio products is available. Use the Free Information Card inside the back cover.

BASE STATION ANTENNA, model *Comet*, is a 6-element antenna. Specifications include X21 power multiplication; 12.5-dB gain (34-dB front-to-back); 10-ft., 6-in. turn radius; 11-ft. X 6-in.



CIRCLE 111 ON FREE INFORMATION CARD

boom length; 4-square-foot windload area; and adjustable VSWR to 1.1:1. List price: \$119.95.—Wilson Electronics Corp., P.O. Box 19000, Las Vegas, NV 89119.

WWVB RECEIVER, model *LXK*, is fixed tuned to receive WWVB, the frequency standard broadcast station. Three BNC output connectors provide the user with a 60 kHz carrier signal, a 100 kHz signal phase-locked to the carrier, and a



CIRCLE 112 ON FREE INFORMATION CARD

demodulated time code. All outputs are 9 volt peak-to-peak squarewaves. Features include an LED power indicator, an LED phase-lock indicator, a 1 microvolt signal sensitivity, 100 dB signal gain, a 90 dB AGC range, and a 230 Hz bandwidth. Instruction booklet comes with the unit. Price is \$99.50.—Elemek, Inc., 6500 Joy Rd., East Syracuse, NY 13057.

CB MICROPHONE, model *526T Series II Super Punch*, is designed for compatibility with almost all CB transceivers. The unit can be connected to transceivers with impedances of over 500 ohms and is equipped with a six-wire coiled cord and 3PDT switch arranged for universal compatibility. Features include a dynamic element and tran-

sistorized preamp that runs for hundreds of hours on a 9 volt battery, a volume control, and a transmit/receive switch. Suggested retail price



CIRCLE 113 ON FREE INFORMATION CARD

\$58.32—Shure Bros., Inc., 222 Hartrey Ave., Evanston, IL 60204.

8-CHANNEL SCANNER, the *Bearcat 5*, is intended for those who are fascinated by the excitement of scanning radios but who may be reluctant to invest initially in a sophisticated synthesized scanner. The unit will receive eight channels in any mix of four bands (high and low VHF, UHF, and UHF "T" Public Service Bands). It will pick up police, fire, government, ham, transportation, and other services. In the scan mode it can automatically scan all 8 channels at the rate of ten



CIRCLE 114 ON FREE INFORMATION CARD

channels per second and has a lockout control to permit bypassing unwanted channels. Channel selection may also be made manually.

The *Bearcat 5* features LED channel indicators, built-in speaker and telescoping antenna. Provision is made for an external speaker and antenna. The unit operates on 117 volts AC and is UL-listed and FCC certified. Price, less crystals, is \$129.95.—Electra Company, P.O. Box 29243, Cumberland, IN 46229. R-E

COMPUTER BOOKS THAT TALK YOUR LANGUAGE... FROM BEGINNER TO EXPERT.

Howard W. Sams is the source for the best and latest in computer technology. The world's leading authors. Clear, concise, easy-to-understand text. Fully illustrated for better comprehension. Actual programs for today's personal computers. Informative and entertaining. Titles for everyone... from the novice to the hobbyist to the expert.

THE STARTERS

Entry-level books for the beginner can bring the novice up to a high level of knowledge quickly.

- THE HOWARD W. SAMS CRASH COURSE IN MICROCOMPUTERS**
The short-cut to understand microcomputers. Spend a few hours with this self-instructional course and gain a working knowledge of all aspects of microcomputers from fundamentals to operating systems, programming, peripheral equipment and much, much more. 264 pages. No. 21634. By Frenzel. \$17.50.
- MICROCOMPUTERS FOR BUSINESS APPLICATIONS**
A microcomputer expert discusses the benefits of microcomputer systems for small business owners. Explains types of microcomputers available, points out pitfalls to avoid, and defines computer-related terms in easy-to-understand language. 256 pages. By Barden. No. 21583. \$8.95.
- A GUIDEBOOK TO SMALL COMPUTERS**
If you are contemplating buying a small computer system for home or business, this book can save you time and trouble. Covers fundamentals of small computers including hardware and software. Includes information on manufacturers' warranties, service and a handy directory of small computer manufacturers. By Barden. No. 21698. \$5.95.
- GETTING ACQUAINTED WITH MICROCOMPUTERS**
Provides a complete working knowledge of microcomputer organization, operation, and programming. 288 pages. By Frenzel. No. 21486. \$8.95.
- FUNDAMENTALS OF DIGITAL COMPUTERS (2nd ED.)**
Unravels the mysteries of computers and programming. 320 pages. By Spencer. No. 21534. \$9.95.
- INTRODUCTION TO MICROCOMPUTERS FOR THE HAM SHACK**
Gives the radio amateur an opportunity to be in the forefront of utilizing and developing techniques in "computerations." 96 pages. By Helms. No. 21681. \$4.95.
- LEARN ABOUT MICROCOMPUTERS. SAVE 10%... AND GET A FREE GIFT!**
- THE COMPUTER PRIMER LIBRARY**
This 3-volume "starter" library was selected for the novice who wants to learn about microcomputers. Concepts. Programming. Computer graphics. Languages. Games. By Mitchell Waite and Michael Pardee—two of the leading authors in the field of computers.
MICROCOMPUTER PRIMER—368 pages of up-to-date facts on microcomputers and computer concept.
COMPUTER GRAPHICS PRIMER—Over 20 programs for creating your own video graphics (complex drawings, plans, maps, and schematics) on the new 6502-based personal computers.
BASIC PROGRAMMING PRIMER—Provides a working knowledge of BASIC, the most popular computer language today. Explains fundamentals, of BASIC, program control, organization, additional functions, variations, and includes a game program.
3-VOLUME LIBRARY PACKAGE ONLY \$30.47—includes a FREE COPY of YOUR OWN COMPUTER—an introduction to home computers. No. 21706

THE PROGRAMMERS

A computer is only as good as the software. Sams offers several books that explain programming and tell you how to develop, debug and test programs for your equipment.

- PROGRAMMING & INTERFACING THE 6502, WITH EXPERIMENTS**
Dr. De Jong has compiled 14 chapters of information and programs for 6502-based microcomputer systems. Experiments and examples are written so that a KIM, AIM or SYM system may be used to reinforce the material in each chapter. 448 pages. By De Jong. No. 21651. \$11.95.
- HOW TO PROGRAM AND INTERFACE THE 6800**
Discusses the internal structure, instruction set, and programming techniques for the 6800. Experiments demonstrate "real world" applications. By Staugaard. 432 pages. No. 21684. \$13.95.
- DEBUG: AN 8080 INTERPRETIVE DEBUGGER**
Covers program operation and how it's applied to program development and testing. 112 pages. By Titus and Titus. No. 21536. \$4.95.
- 6502 SOFTWARE DESIGN**
Tells how to program for the 6502 assembly language. 288 pages. By Scanlon. No. 21656. \$10.50.
- 8080/8085 SOFTWARE DESIGN—2 VOLUMES**
 VOLUME 1 gives you an introduction to assembly language programming. 336 pages. By Titus, Larsen, Rony, & Titus. No. 21541. \$9.50
 VOLUME 2 is a unique, one-of-a-kind computer science book for the design engineer. Written in Intel machine code. 352 pages. By Titus, Larsen, & Titus. No. 21615. \$9.95.
- TWO-VOLUME SET No. 21659 ONLY \$17.50**
- TEA: AN 8080/8085 CO-RESIDENT EDITOR-ASSEMBLER.**
256 pages. No. 21628. By Titus. \$8.95.

THE COMPUTER TECHNOLOGY LEADERS

Even if you're an avid computer buff, rapidly changing technology makes it difficult to stay current. Sams has a complete line of books and reference publications to help you keep abreast of the current state-of-the-art.

- MICROCOMPUTER-ANALOG CONVERTER SOFTWARE & HARDWARE INTERFACING.**
Concepts and techniques of interfacing digital computers to analog devices. 288 pages. By Titus, Titus, Rony, & Larsen. No. 21540. \$9.50.
- TRS-80 INTERFACING.**
192 pages. No. 21633. By Titus. \$8.95.
- INTERFACING & SCIENTIFIC DATA COMMUNICATIONS EXPERIMENTS.**
160 pages. By Rony, Larsen, Titus, & Titus. No. 21546. \$5.95.
- MICROCOMPUTER INTERFACING WITH THE 8255 PPI CHIP.**
224 pages. By Goldsbrough. No. 21614. \$8.95.

- Z-80 MICROPROCESSOR PROGRAMMING & INTERFACING—2 VOLUMES.**
800 pages. By Nichols, Nichols, & Rony. No. 21611. \$21.95.
- INTRODUCTORY EXPERIMENTS IN DIGITAL ELECTRONICS AND 8080A MICROCOMPUTER PROGRAMMING AND INTERFACING—2 VOLUMES.**
912 pages. By Rony, Larsen, & Titus. No. 21552. \$20.95.

A BEST-SELLER... A TREMENDOUS VALUE!

This is the most comprehensive reference available on all phases of computers and their applications. Contains over 22,000 definitions, acronyms, and abbreviations. 14 appendices. Hardbound. 944 pages. By Sippl & Sippl. No. 21632. \$29.95.

- COMPUTER DICTIONARY & HANDBOOK (3RD EDITION)**

THE LOGIC COOKBOOKS

- LANCASTER'S COOKBOOK LIBRARY**
A famous resource for all electronics buffs who want to know what makes TTLs, CMOS, and active filters cook—what they are, how they work and how to use them. By Don Lancaster, one of the most popular authors in the electronics industry.
TTL Cookbook No. 21035 \$ 9.50
CMOS Cookbook No. 21398 \$10.50
Active-Filter Cookbook No. 21168 \$14.95
TOTAL LIST PRICE \$34.95
Less 15% Discount 5.24
YOU PAY ONLY \$29.71
- ORDER SPECIAL LIBRARY PACKAGE NO. 21707 AND SAVE!**

ORDER FORM

HOWARD W. SAMS & CO., INC.
4300 West 62nd Street, P.O. Box 7092
Indianapolis, Indiana 46206
(317) 298-5400

Indicate quantity in boxes above and complete ordering information below.

Sub Total _____

Add local sales tax where applicable _____

GRAND TOTAL _____

- PAYMENT ENCLOSED
- CHECK MONEY ORDER
- MASTER CHARGE BANK AMERICARD/VISA

Exp. Date _____

Account No. _____

Interbank No. (Master Charge only) _____

Minimum Credit card purchase \$10 AD009

Name (print) _____

Signature _____

Address _____

City _____ State _____ Zip _____

Prices subject to change without notice. All books available from Sams Distributors, Bookstores, and Computer Stores. Offer good in U.S. only. In Canada, contact Lenbrook Industries Ltd., Scarborough, M1H 1H5, Ontario, Canada.

Howard W. Sams & Co., Inc.

service clinic

Conventional power-supply circuits that look very odd.

JACK DARR, SERVICE EDITOR

IN PAST COLUMNS, WE HAVE DISCUSSED some of the newer DC power supplies. They work, but some of them seem to be a little too complex. The more parts used in a given circuit, the greater the chance of failure. (One of the designs uses 14 or 15 transistors.) Personally, the simpler the circuit, the better I like it.

Now, for a change, let's look at a couple of the more conventional DC power supplies. One is fairly new, the other pretty old. Both look just a bit unusual, but when you check them out you find they use familiar circuitry.

One is used in the Admiral K19-series of chassis. Figure 1 shows the circuit. At first glance, it looks pretty complicated—but let's follow the circuitry.

olas. The filtered output of the +290-volt DC line, also goes to the bottom end of the 110 VAC winding on the power transformer. Top end of the winding connects to diode D100 (another half-wave rectifier). The output of D100 is +400 volts. That is because the bottom end of this supply is "stacked" on top of the +290-volt line. The DC voltages add to provide the +400 volt output. The +400 volt line is dropped by a resistor to provide +340 volts. Note that the filter capacitors for the +400 volt line and the +340 volt line return to the +290 volt line, not to ground. That is where the "stacking" effect is obtained.

Every one of the circuits used here are conventional. We have worked with them

D104, can also kill the +20-volt line. Hum-bars floating up through the picture can be caused by an open capacitor (C108) on the +20-volt line. Scope the +20-volt line and look for ripple or any signal.

In short, all of the circuits used here are conventional and so are the problems caused by defective components. The novelty is in the way they're all tied together, stacked, and so on. For testing, use the same old methods we've used for years.

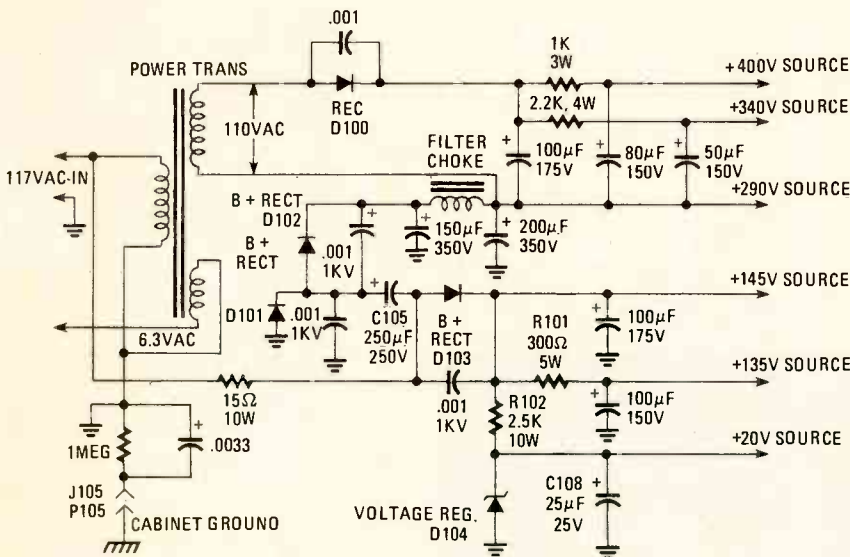


FIG. 1

The +145-volt supply comes straight off the AC line, through diode D103. Stock filtering is used to smooth out the supply. From that the +135-volt and +20-volt lines are taken, reduced by resistors.

The AC line also goes to C105, then to diodes D101 and D102. The two diodes and capacitor are connected as a stock half-wave voltage doubler. That produces the +290-volt line.

Now, we come to a circuit that is not often found in a TV receiver, but which was quite common some years ago in many two-way radios, especially Motor-

a long time. Any problems in here should be easy to find.

One of the possible faults listed in the *Admiral News Letter* shows the symptoms of weak video, retrace lines and very little control of brightness. Checking DC voltages reveals that the +400-volt line is quite low, somewhere around +310 volts. The +290-volt line will be normal. Cause: the 110 VAC winding on the power transformer is open.

Another one is "No video or sound but raster present." Cause of that can be an open resistor in the +135-volt line, such as R101 or R102. A shorted Zener diode,

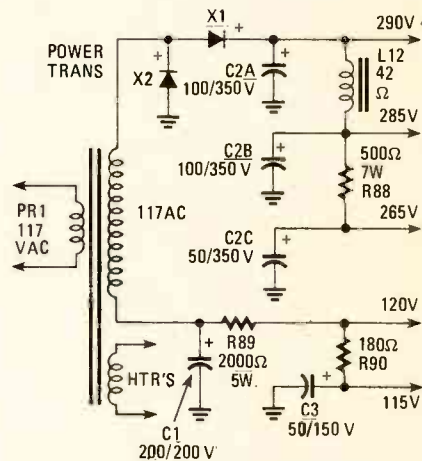


FIG. 2

The other power-supply circuit is from quite an old TV set, a *model 362* Satchell-Carlson. Figure 2 shows this one. Here again we get different DC voltages. Before reading farther, look at the circuit and see if you can tell what it is. You've seen it many times, though it may not look familiar in this configuration.

This is a plain half-wave voltage doubler. However, it looks odd, because the input capacitor isn't in its usual place on the input of the two diodes. It's at the bottom of the transformer winding and returns to ground. The function of the capacitor is exactly the same as in the more familiar circuit. By isolating that point, they are able to get a +120-volt DC supply, without having to use big drooping resistors.

This circuit was sent in by a reader in New York. The complaint was that the power transformer ran very hot. The set worked perfectly but after about 15 minutes it got hot. All DC voltages checked OK. The reader also complained about resistor R88, running very hot; however, he said the drop across it was exactly 20 volts, which was correct. The resistor has

a voltage drop of 20 volts across it to develop the +265-volt supply from the +285-volt line.

I told him that in a lot of the older TV sets, including some of the old RCA color sets, the power transformer *did* run quite hot. I suggested cooking the set for several hours and if it didn't have any smoke or smell, send it home! After all, it had probably been working like that for many years! What might seem to be excessive heating might just be "the nature of the brute."

Problems in this circuit should be easy to pin down; low DC voltages, possible open input filter; open diodes, and so on and on.

There you have it. Perfectly ordinary circuits, once you trace them out.

The reader also wondered where he could get a replacement power transformer since the company had been out of business for so long. Looking at it, this is just a plain 1:1 isolation transformer! Secondary voltage is 117 VAC. The heaters could be supplied by a small filament transformer tacked on somewhere, in case of need.

R-E

service questions

VERY LOW HIGH VOLTAGE

I can only get 5kv of high voltage on this Heathkit model GR-681. The focus voltage is also very low. I've checked everything I can think of. Any help you can give will be useful.—H.S., Euclid, OH.

I suggested he perform standard tests for this type of problem.

He wrote: "I tried all the things you suggested before I wrote, and I finally found it. The .01 μ f spark-gap capacitor on the control grid of the 6BK4 high voltage regulator turned out to be very leaky. I hadn't suspected the regulator. Thanks just the same."

NO COLOR

I can't get any color at all on a Philco 19KT40B. I can get a white screen by setting the screen controls. What's going on?—R.P., Methuen, MA.

With these symptoms, you are probably losing the color signals somewhere in the bandpass amplifiers. Feed a color-bar signal into the input, and then scope the 1st bandpass amplifier stage. Look for the typical comb pattern. If it's there, go on and run it down through the other stages till you get to the demodulator input. Somewhere in there you are losing all of this signal. The scope will tell you where it's stopping. By the way: if you can get comb signals through the bandpass, but still no colors on screen, check color-oscillator IC91. Check for the normal +12.58 volt supply on pin 8. If this is OK, check all other DC voltages. If these

are off, replace this IC. We've had some problems with it. Subs in several replacement lines—RCA, Sylvania, etc.

MORE BRADFORD PROBLEMS

The vertical linearity control in this Bradford 57141, or C-WES57141, chassis V-2487-7, is burnt up. I can't find a Photo-fact schematic on it. Can you help? J.O., Winthrop, ME.

More people made Bradfords than any other known name. However, in a few cases, we can get something. You're one of the lucky ones! This was built by Westinghouse; Sams Photofacts list this in 812-4. The V/Lin control is a 10-megohm unit. Key clue here is that Westinghouse part number, "V-2487-7".

CROSSOVER DISTORTION

This model TEC S-15 power amplifier has a bad distortion problem. I've replaced the output transistors with ECG-121's. The trouble seems to be crossover distortion; I can't quite get a handle on it.—H.H., Baltimore, MD.

Crossover distortion is almost always in the output stage and is due to mismatched transistors or a bias problem. Since you used identical transistor types here, this leaves the bias problem. Check all the bias diodes that are used. These determine the bias on the output stage; if they're bad, away you go! In this case a diode similar to an ECG-109 should work. Bias diodes should be made of the same material as the transistors. From the DC voltages given, this component seems as if it should be a germanium diode; it shows 0.2-volt drop. If the drop was 0.8 volt, the diode would be made of silicon.

(Feedback: "This worked! The ECG-109 seems to do nicely.")

OLD TUBE TYPE

I've gotten an old Philco Type 60-121, and I need a No. 75 tube for it. Do you have any idea where one could be found?—S.A., Framingham, MA.

Not definitely; check with antique radio dealers, etc. If you can find a type 6Q7, this is an exact duplicate with an octal base. You can use an adaptor or change the socket. Another solution is a 6SQ7, which is a 6Q7 in a single-ended base. Specs identical.

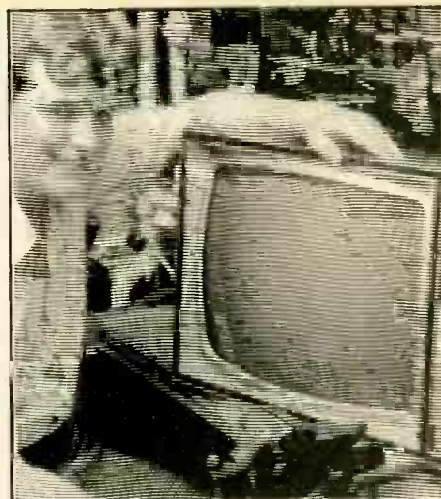
CALTEX IC'S FOR SMALL CALCULATORS

Roger Doering of Lakewood, CO, writes back: "I asked you about a Caltex IC for a calculator. You did not find anything on it (He's right! I hunted everywhere.) I did locate a source, if anyone else wants to mess with these things.

International Electronics Unlimited, 225 Broadway, Jackson, CA 95642, has the CT5001, CT5005 and CT7001 IC's. I hope I don't get any more of these little monsters. I was trying to fix this calculator one for a friend!"

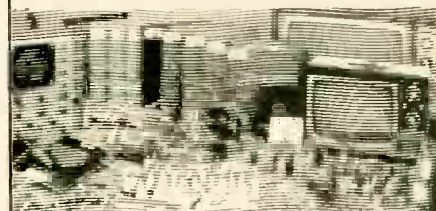
Thanks very much, Roger.

R-E



NOW—the best in Electronics training can cost you less—

No school, large or small, gives you better electronics training than E.T.I. Nor, at a fairer price. Compare quality, price, service, background. ETI has been training men & women for entry into or advancement in electronics since 1909, utilizing educational techniques of RCA and Sylvania. Only ETI combines Autotext programmed learning, "listen & learn" cassettes and "hands-on" projects designed for learning at home, quickly, easily. Wide course choice.



SEND TODAY for all new FREE catalog or for faster service, use the toll free telephone number below, day or night. No obligation—no salesmen will call.



ETI

ELECTRONICS TECHNICAL INSTITUTE
FOUNDED 1909
153 W. Mulberry St., Dept. 20060
Lancaster, Ohio 43130



FOR FASTER SERVICE -
TELEPHONE FREE 24 HRS A DAY
1 800 621 5809
Illinois residents - 800 972 5858

ETI Home Study, Dept. 20060
153 W. Mulberry, Lancaster, Ohio 43130

Please rush FREE catalog on electronics opportunities, and training. I'm interested in
 Basic Career Specialized
Advanced

NO SALESMAN IS TO CALL ON ME, EVER.

Name _____

Address _____

City/state/zip _____

Ohio Registration NO. 0683H

CIRCLE 59 ON FREE INFORMATION CARD

hobby corner

A 555-timer-based signaling and control circuit that can be used in a variety of applications.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

THIS MONTH'S MAIN PROJECT IS A VERY flexible signaling and/or control device that can be used in a variety of ways. We'll look at several applications. The basic circuit is shown in Fig. 1.

Once again the old faithful 555 timer functions as a variable-frequency square-wave oscillator. On each half-cycle, one of the LED's lights—which one of them depends, of course, on whether output-pin 3 is positive or negative at that particular moment.

If you make one LED red and one

higher, persistence of vision makes it appear that *both* LED's are on continuously. You may notice that they are a bit dim but not enough to matter.

If switches and diodes are added as shown in Fig. 4, you have quite a signaling device. Close one switch and the green LED is on; close another and the red is on; close the third and both are on. If you place the LED's at a remote location, you can send at least three distinct pieces of information on the one wire.

There you have a few ideas for using

the gadget. Let your imagination be your guide and see what you come up with. One more example: How about substituting relays for the LED's and using them to control stronger lights, motors, or whatever. I would be interested in hearing about applications you devise.

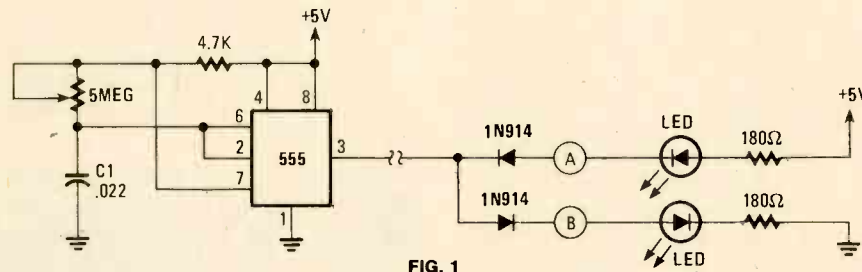


FIG. 1

green, you have a model traffic light when the 555 is set for a very low frequency. (Remember that changing the value of capacitor C1 will move the frequency range up or down.) If you like, a capacitor of about 2000 μ F or so connected from ground to point A or B will remove the "snap-action" on and off either or both LED's.

Other devices can be controlled in phase with the lights by adding the circuit shown in Fig. 2. This 555 is a monostable oscillator that switches when the triggering line is connected to point A or B in Fig. 1. In turn, the relay pulls in and releases as the "traffic light" sequences.

Now the relay can be used to do such things as stop a model car or train when it approaches a red light. One method of accomplishing that is shown in Fig. 3. A section of rail is insulated and fed through the relay contacts. When the relay pulls in, power is removed from the isolated track and the car or train stops when it gets there. On the next half-cycle (green), power is restored and the model moves on.

Returning to Fig. 1 and the basic circuit, you know that the LED's are on alternately. If the frequency is made

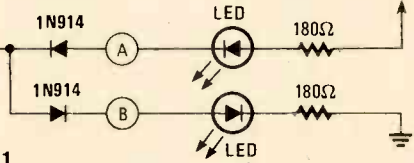


FIG. 2

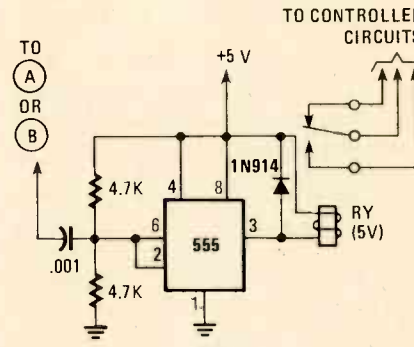


FIG. 3

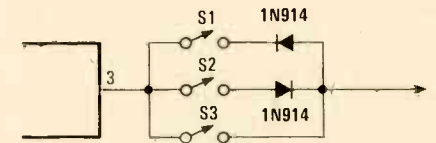


FIG. 4

Desoldering

You may recall that there was an article on desoldering techniques, several months back. After its appearance, I received a letter from a manufacturer of desoldering equipment.

The company official, whom I'll call Mr. X, wrote that all the methods discussed in the article were abandoned long ago. No one—but no one—uses such archaic desoldering methods. He then went on to inform me of the up-to-date equipment they manufacture.

Well, let me see if I can correct my error with a couple of "notices."

Notice to commercial desolderers: In the event that you are using outdated methods, stop wasting your time. Read the various equipment catalogs. Invest \$300 or more with Mr. X or one of his competitors.

Notice to Mr. X: There are thousands upon thousands of electronic hobbyists out in the boondocks who build and occasionally *unbuild* (desolder) circuits. While your equipment is undoubtedly effective and efficient, we're in this thing for fun. For that purpose, we do not have available the kind of money your methods require. We'll stick with the cheaper, archaic methods that still work.

Desoldering hint

Arthur Coombs of Clinton, Ontario, Canada wrote to suggest another method of cleaning solder-filled PC-board holes. A large darning needle from the local variety store will do the trick. Simply heat the solder and stick the needle through. Only rarely will the solder stick to the needle, and even then a little heat will dislodge it.

Thanks, Arthur; I have used that method myself. It is easy if you push the eye-end of the needle into a wooden dowel to

continued on page 86

new products

More information on new products is available. Use the Free Information Card inside the back cover.

VOLTAGE TESTER, *Circuitracer*, is designed for testing both voltages from 0-500, and the continuity of circuits. The signal lamp is located at the working tip so you can keep eyes on work while



CIRCLE 151 ON FREE INFORMATION CARD

testing a series of points. Kit includes all test accessories and instructions and comes in a compact box. Suggested retail price is \$12.96.—

Descc Industries, Inc., 351 F Oak Pl., Brea, CA 92621.

UNIVERSAL COUNTER-TIMER, model 5001, performs five functions: frequency-counting, period and multiple-period averaging, time interval and multiple-time-interval averaging, frequency ratio, and unit counting. The 5001 has an 8-digit LED display and can be operated from either



CIRCLE 152 ON FREE INFORMATION CARD
105-130 VAC or 210-250 VAC. It is well-suited to applications in radio, data, and telecommunications; research and development; physical, chemical, and medical laboratories; quality control; industrial and process control; education and instruction; audio, recording studio, and high fidelity; and servicing. Suggested list price is

\$360.—**Global Specialties Corporation** (formerly Continental Specialties Corporation), 70 Fulton Terrace, New Haven, CT 06509.

TELEPHONE DIALER, the *Phone Controller*, operates with either *Touch-Tone* or rotary-dial telephone circuits and can store up to 30 different 16-digit numbers (expandable). It is quickly and easily programmed. Among its numerous features are: built-in speaker to permit on-hook dial-



CIRCLE 153 ON FREE INFORMATION CARD

ing, automatic redial (up to 14 tries), hold control, and the ability to output rotary-dial-type pulses from a *Touch-Tone* keypad. The *Phone Controller*

Price Without Sacrifice.



HITACHI V-302 & V-152

Put a proven Hitachi dual-trace oscilloscope on your bench for as little as \$695. Our V-152 15MHz model includes unprecedented sensitivity (1 mV/div.)...10X sweep magnification...front panel XY operation...trace rotation...Z-axis input...and more. Need greater bandwidth? Our V-302 model is the only 30MHz dual-trace scope with signal delay line priced under \$1000, with all the above features, to make your testing operations fast, easy, and accurate. Reliability is exceptional, too. (As you'd expect from a manufacturer with over 20 years of experience "outscoping" the competition.) So exceptional, in fact, that Hitachi quality is backed by a 2-year warranty...the longest in the industry. Whether you use it for teaching or repairs, for video, audio, or computer testing, you can't find more scope for your dollar than at Hitachi. Write for more details.

Hitachi...The measure of quality.

- V-152 15 MHz Dual Trace . . . \$695*
- V-302 30 MHz Dual Trace . . . \$945*

*Probes included.



HITACHI
Hitachi Denshi America, Ltd.
175 Crossways Park West
Woodbury, NY 11797
(516) 921-7200

CIRCLE 37 ON FREE INFORMATION CARD

NEW PRODUCTS

continued from page 81

has an LED readout showing either the number being entered or dialed, the time of day, or the elapsed-time when a call is in progress. A unique security feature will make the unit "growl" and produce "horrendous noises" if an unauthorized party attempts to make use of it. A backup battery keeps the memory and clock functions alive in the event of power failure. Suggested retail price for the *Phone Controller* is \$99.95.—**Dictograph Manufacturing Corporation**, 89 Glen Cameron Road, Thornhill, Ontario L3T 1N8, Canada.

AUTOMOTIVE ENGINE ANALYZER, model *CM-1550*, handles several tune-up measurements, including dwell for 4-through-8-cylinder engines, RPM to 10,000 in two ranges, DC voltage to 200



CIRCLE 50 ON FREE INFORMATION CARD

volts in two ranges, resistance to 2 megohms in three ranges, and direct current to 20 amperes. With the optional *CMA-1550-1* Shunt Accessory, the *CM-1550* will also measure starting current and battery charging/discharging current, up to 400 amperes. All readings are shown on large LCD digits. Power is supplied by a 9-volt battery

(not included), eliminating the need for external power connections. The inductive pickup for the RPM readings is attached to any spark plug wire. Thermal insulation on attachment leads resists melting or burning under high-heat conditions. The unit can be assembled in just two or three evenings. Mail-order price for the *CM-1550* kit is \$94.95, while the *CMA-1550-1* Shunt Accessory sells for \$13.95. All prices are FOB Benton Harbor, MI.—**Heath Company**, Benton Harbor, MI 49022.

AM RADIO, *Bloke's Radio Cap*, is a hat that cleverly conceals a portable transistor radio and lets you listen to music, news, etc., while sunning at the beach, jogging, hiking, bicycling, or even while working. The radio is powered by a single 9-volt battery (not included). Sound comes



CIRCLE 154 ON FREE INFORMATION CARD

through an earpiece, which may be hidden in a secret pocket when not being used. Volume control and tuning knob are disguised as buttons. *Bloke's Radio Cap*, designed in England, is made of 100% pure cotton blue denim, and has an expandable headband so one size fits all. Price is \$10.95 plus 75 cents for postage and handling.—**Edsujco Inc.**, 3716 Waverly Ave., Seaford, NY 11783.

HAND-HELD DMM, the *LX 304*, features an easy-to-read, half-inch high, 3½ digit LCD display; automatic polarity; zero and overrange indication; and half-year battery life in normal use. Other features of the meter include an automatic



CIRCLE 155 ON FREE INFORMATION CARD

decimal point, built-in low-battery indicator, diode and transistor testing capability, and 0.5% accuracy on DC volts ranges. Suggested retail price for the *LX 304* is \$89.95.—**The Hickock Electrical Instrument Company**, 10514 Dupont Ave., Cleveland, OH 44108. **R-E**

THE BIG PLUS + Graphic Equalizer

ASSEMBLED \$200⁰⁰

KIT \$120⁰⁰

LOADED with Quality Features!

- Stereo . . . Eleven Bands Per Channel • Extremely Low Noise & Distortion • LED Peak Indicators • Center Detent ("flat") sliders • Built-in "record" Switching • Line and Microphone Level Inputs/Outputs • Regulated Power Supply • Fully Guaranteed • Horizontal or Vertical Cabinets • Kit or Fully Assembled • Plus Much, Much More!

Absolutely equals or exceeds overall performance and features of any graphic equalizer made today!

AARON-GAVIN INSTRUMENTS, INC.
17231 Corla Avenue Tustin, California 92680

Yes! I've enclosed \$ _____; RUSH me: cabinet send assembled equalizers at \$200.00, p.p.d. brochure un-assembled equalizer kits at \$120.00, p.p.d. Horizontal (flat) Vertical (up-right)

California residents include 6% sales tax

Name _____ Visa & Master Charge orders accepted
Address _____ Card No. _____
City _____ State _____ Zip _____ Exp. Date _____ Bank No. _____

Dealer inquiries invited

CIRCLE 11 ON FREE INFORMATION CARD

Cleaver Kleps

Test probes designed by your needs—Push to seize, push to release (all Kleps spring loaded).

- Kleps 10.** Boathook clamp grips wires, lugs, terminals. Accepts banana plug or bare wire lead. 4¾" long.
- Kleps 20.** Same, but 7" long.
- Kleps 30.** Completely flexible. Forked-tongue gripper. Accepts banana plug or bare lead. 6" long.
- Kleps 40.** Completely flexible. 3-segment automatic collet firmly grips wire ends, PC-board terminals, connector pins. Accepts banana plug or plain wire. 6¼" long.
- Kleps 1.** Economy Kleps for light line work (not lab quality). Meshing claws. 4½" long.
- Prof 10.** Versatile test prod. Solder connection. Molded phenolic. Doubles as scribing tool. "Bunch" pin fits banana jack. Phone tip. 5½" long.

Write for complete catalog of - test probes, plugs, sockets, connectors, earphones, headsets, miniature components.

rye INDUSTRIES Available through your local distributor, or write to:

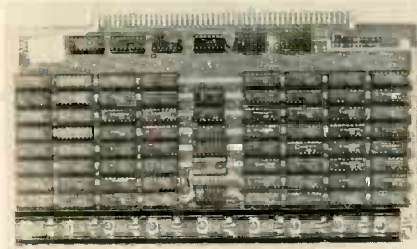
RYE INDUSTRIES INC.
127 Spencer Place, Mamaroneck, N.Y. 10543
In Canada: Rye Industries (Canada) Ltd.

CIRCLE 9 ON FREE INFORMATION CARD

computer products

More information on computer products is available.
Use the Free Information Card inside the back cover.

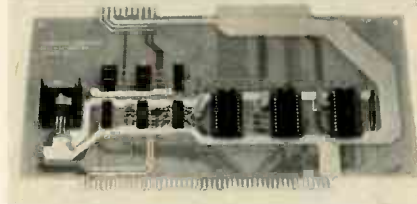
MEMORY BOARD, 32K static RAM board, is S-100 bus-compatible, has a 300-ns access time and features extended addressing (or bank switching) and 9 voltage regulators. The board includes a phantom line for memory disable, useful in bootstrapping operations. The board is also



CIRCLE 121 ON FREE INFORMATION CARD

available in 16K configuration, allowing for future expansion. The operating manual contains a parts list, schematic and test routines. The boards are assembled and factory-tested; the 32K board is priced at \$625; the 16K configuration is \$390.—**Tarbell Electronics**, 950 Dovien Pl., Carson, CA 90746.

I/O INTERFACE, IF-1, is designed to interface *ICTM-11C* tester module with S-100 bus-compatible computers. Available as a kit or assembled, the *IF-1* can also be used as a general-purpose I/O card for small-business applications requiring up to 16 output and 8 input lines. The *IF-1* pro-



CIRCLE 122 ON FREE INFORMATION CARD

vides two buffered 8-bit output ports and 1 buffered 8-bit input port; jumper-selectable address coding; separate 10-pin connector for +5V regulated and +8V, +16V, -16V unregulated S-100 bus power supplies. Prices: kit, \$89.95; assembled, \$119.95.—**Pragmatic Designs, Inc.**, 711 Stierlin Rd., Mountain View, CA 94043.

COLOR GRAPHICS GENERATOR/CONTROLLER, the *Electric Crayon*, interfaces with the *TRS-80* microcomputer. It may also be used with other computers or with a parallel ASCII keyboard. Designed to generate color displays on either a standard TV set or monitor, the *Electric Crayon* has 10 display modes including an alphanumeric-semi-graphics mode, a second, higher-density, semi-graphics mode, and eight additional graphics modes. Up to eight colors may be generated. Resolution is up to 256 X 192 picture elements. A full 64-character ASCII subset is also included.

The *Electric Crayon* is actually a complete, self-contained, control computer with its own operating system and with provision for 1K of add-on RAM, for EPROM to extend the existing EGOS



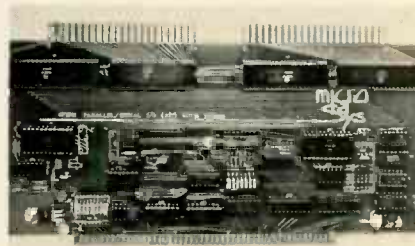
CIRCLE 123 ON FREE INFORMATION CARD

operating system and a second dual bidirectional 8-bit port.

The *Electric Crayon*, with the EGOS operating system, 1K of RAM and a comprehensive user's manual which contains instructions and a description of the system, an assembly-language listing of EGOS, and listings of demo programs in BASIC, sells for \$249.95.

Options available include: color-graphics programs in BASIC on mindiskette, a 34-conductor cable to connect to the *TRS-80* printer port, add-on RAM and a sketching pad for graphics design.—**Percom Data Company**, 211 N. Kirby, Garland, TX 75042.

PARALLEL/SERIAL I/O BOARD, THE 8P2SM, is an S-100 board that combines 8 parallel ports (including handshaking operations) with 2 serial input and 2 serial output ports. Available baud rates range from 27.5 to 307.2K. One set of serial ports can be configured for TTL or full RS-232



CIRCLE 124 ON FREE INFORMATION CARD

operation, and the other set can be operated as TTL or a full duplex modem in the answer or originate modes at a 300 baud data rate. The double-sided, plated-through board is solder-masked on both sides, has gold-flashed edge connectors and measures 5.50 X 10 inches. Full documentation is included. Prices: kit, \$149; assembled, \$199.—**MicroDaSys**, P. O. Box 36051, Los Angeles, CA 90036.

COLOR RECEIVER/MONITORS, VM-1300 and *VM-1900*, feature the latest in integrated circuitry, a quick-start in-line picture tube with slotted mask and black matrix for sharp contrast and bright colors, AFT and automatic gain control. Receiver or monitor mode is switch selectable. In the monitor mode, the sets accept standard com-

Get A GNOME the original micro-synthesizer

Every day more people discover that PAIA's GNOME is the most versatile, cost effective special effects device on the market today.

John Simonton's time-proven design provides two envelope generators, VCA, VCO and VCF in a low cost, easy to use package. Use alone with its built in ribbon controller or modify to use with guitar, electronic piano, polytonic keyboards, etc.

The perfect introduction to electronic music and best of all, the GNOME is only \$59.95 in easy to assemble kit form. Is it any wonder why we've sold thousands?



PAIA 1020 W. Wilshire Blvd. Oklahoma City, OK 73116

- Send GNOME MICRO-SYNTHESIZER Kit (\$59.95 plus \$2.00 postage)
- GNOME MICRO-SYNTHESIZER (Fully Assembled) \$100.00 plus \$2 postage
- Send FREE CATALOG

name _____
address _____
city _____ state _____ zip _____
visa _____ mc _____ card no. _____
Dept. 6 R (405) 843-9626

PAIA 1020 W. Wilshire Blvd. Oklahoma City, OK 73116

CIRCLE 19 ON FREE INFORMATION CARD

endeco soldering & desoldering equipment

SOLDERING IRONS

Pencil style. Safety light. Two heats — 20w and 40w. 6 tips. Unbreakable handle. 2 and 3 wire neoprene cords.

DESOLDERING IRONS

Pencil style. Safety light. Some operate at 40w, idle at 20w. 8 tip sizes. 2 and 3 wire neoprene cords.

SOLDERING & DESOLDERING KITS

Everything needed to solder or desolder or both. All in a handy lifetime metal box with hasp.

See your distributor or write...

Enterprise Development Corp.
5127 E. 65th St. • Indianapolis IN 46220
PHONE (317) 251-1231

CIRCLE 58 ON FREE INFORMATION CARD

COMPUTER PRODUCTS

continued from page 83

posite video. Looping inputs (with switchable 75-ohm termination) are provided to allow linking of multiple sets. A separate audio input is also provided. The units are intended for Broadcast, Industrial, Educational, Computer, and Home applications. They can be used with color VTR's,



CIRCLE 125 ON FREE INFORMATION CARD

cameras, and computers such as the Apple that output an NTSC color-video signal. Prices: *Model VM-1300* (13-inch), \$449; *Model VM-1900* (19-inch), \$575. Add 6% California sales tax where applicable and allow \$15 for shipping within the continental United States.—**V.A.M.P. Inc.**, 1617 El Centro Ave., Suite 19, Los Angeles, CA 90028.

ELECTROSENSITIVE MATRIX PRINTER, the *ESP40*, features medium-speed, silent operation. Capable of unattended operation and integration with computers, it is a modular unit that can be built into a variety of test equipment. Because it can operate from a twelve-volt power supply, it is especially suited to mobile applications for police, fire, utility, and military users. The British-pro-



CIRCLE 126 ON FREE INFORMATION CARD

duced *ESP40* printer is currently being used in the United Kingdom for monitoring telephone exchange equipment, industrial processes, and for various digital plotting operations. The device is primarily used as a 40-character alphanumeric printer, but has options for other print fonts. The *ESP40* is typically \$5-600 in single-unit quantities.—**Rank Numbering Machines, Inc.**, 411 E. Jarvis Avenue, Des Plaines, IL 60018.

A NEW S-100 MAGAZINE, *S-100 Microsystems*, is directed specifically toward users of S-100 microcomputer systems. It will serve as a forum on S-100 hardware and software. Every issue of *S-100 Microsystems* will bring the latest in the S-100 world—news, rumors, letters to the editor, newsletter columns, new products, book reviews, etc.

The publication will be edited by Sol Libes, a pioneer in the field of personal computer systems.

S-100 Microsystems will be published six times a year. A sample copy is \$2. Subscriptions are \$9 for one year, \$17 for two years, \$23.50 for three years, prepaid U.S.A. Canada is \$12 per year and foreign \$23 per year (add \$14 for Air Mail). To

subscribe, or for more information, write: **S-100 Microsystems**, Box 1192, Mountainside, NJ 07092.

ALL-IN-ONE COMPUTER, the *H89*, includes two Z80 microprocessors, floppy-disk storage, smart video terminal, heavy-duty keyboard with numeric pad and 16K RAM (expandable to 48K).

The *H89* runs programs written in Benton Harbor BASIC, *Microsoft BASIC* and Assembly Language. The system is especially well-suited to the needs of both home and the small office.

Two Z80 microprocessors mean that terminal and computer can act independently of one-another and process data faster than most desktop units that have only one microprocessor.

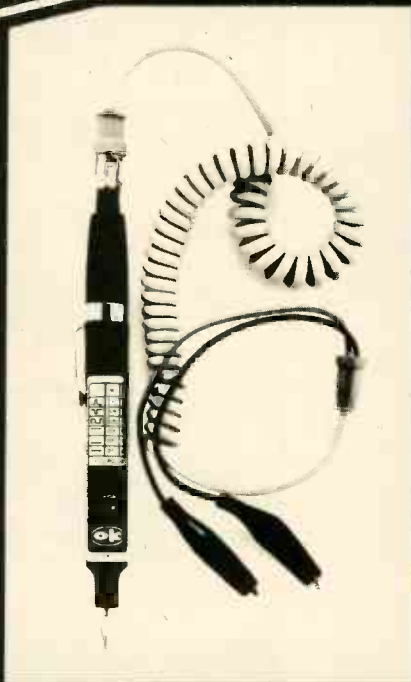


CIRCLE 127 ON FREE INFORMATION CARD

The computer features a 12-inch diagonal display capable of displaying 24 lines of 80 characters. Lower-case letters have full descenders. There is also a special-purpose 25th line.

Each 5¼ inch diskette offers 100K of storage. Accessory interfaces permit communication with printers, cassettes or time-share systems. All communication is EIA RS-232. Price is \$1,695 (kit) and \$2,895 (assembled).—**Heath Co.**, Benton Harbor, Michigan 49022. **R-E**

NEW!



PRB-1 DIGITAL LOGIC PROBE

Compatible with DTL, TTL, CMOS, MOS and Microprocessors using a 4 to 15V power supply. Thresholds automatically programmed. Automatic resetting memory. No adjustment required. Visual indication of logic levels, using LED's to show high, low, bad level or open circuit logic and pulses. Highly sophisticated, shirt pocket portable (protective tip cap and removable coil cord).

- DC to > 50 MHZ
- 10 Nsec. pulse response
- 120 K Ω impedance
- Automatic pulse stretching to 50 Msec.
- Automatic resetting memory
- Open circuit detection
- Automatic threshold resetting
- Compatible with all logic families 4-15 VDC
- Range extended to 15-25 VDC with optional PA-1 adapter
- Supply O.V.P. to ± 70 VDC
- No switches/no calibration

\$36⁹⁵*

* ADD \$2.00 FOR SHIPPING
(N. Y. CITY AND STATE RESIDENTS ADD TAX)

OK MACHINE & TOOL CORPORATION

3455 Conner St., Bronx, N.Y. 10475 (212) 994-6600 / Teléx 125091

CIRCLE 31 ON FREE INFORMATION CARD

VOLTAGE REGULATOR

continued from page 50

Using the templates given in Fig. 6, cut a piece of sheet aluminum to form the enclosure and heatsink—use whatever gauge stock you think appropriate. Drill the holes. Bend the four sides into place and then bend the two mounting flanges outward and parallel to the surface. Install a rubber or plastic grommet in the feed through hole. Using a piece of cardboard, make a potting form to keep the area where the heatsink is to mount clear (see Fig. 7). Fill the container about a quarter full of a silicon potting compound such as RTV. Slush it onto the walls and let it cure. At that point you have a case with a rubber-insulated cradle. Place the PC board into the cavity; feed the wires through the grommet. Using two metal screws, fasten the case to the heatsink (one should use silicon heatsink grease at the interface, see Fig. 7). Cut a piece of plastic tubing, such as a soda straw, to form a channel for external adjustment of the trimmer. Place one end of the tube over the screw end of the pot and the other to the exit hole. Seal off those two ends with some of the potting compound—make sure that none gets inside of the tube. After the tube is secure, fill the cavity with potting compound to submerge the board, and let it cure. On the wires—which should be color-coded—solder a connector that will interface to your auto's electrical system. Either obtain one from your local automotive parts store or use the connector from your old regulator if possible.

Install the unit on your car as shown in Figs. 1 and 8. Adjust the voltage to the level recommended by your auto's service manual. During the summer you can lower the level to reduce the boiling off of your battery's water; during the winter it can be increased to aid in cold-morning starting. My first regulator has operated without any problems for about three years and a prototype for this design has been in operation now for about a year.

Changes for pulled-up field

The less-often-used pulled-up field alternator (Fig. 1-b) uses a simpler voltage regulator. Its circuit is shown in Fig. 9 and components layout in Fig. 10. Note that the phase-inverter pair (Q1 and Q2) has been eliminated and the PNP Darlington-pair driver transistor, Q3, has been replaced by Q4, an NPN type. Construction and installation follow the steps just outlined. No matter which version of the voltage regulator your car requires, you can expect it to give years of reliable service and, having built one for automotive use, you'll probably find several other battery-charging applications for this versatile regulator.

R-E

Put Professional Knowledge and a COLLEGE DEGREE in your Electronics Career through HOME STUDY

Earn Your DEGREE

by correspondence, while continuing your present job. No commuting to class. Study at your own pace. Learn from complete and explicit lesson materials, with additional assistance from our home-study instructors. Advance as fast as you wish, but take all the time you need to master each topic.

The Grantham electronics degree program begins with basics, leads first to the A.S.E.T. degree, and then to the B.S.E.T. degree. Our free bulletin gives complete details of the program itself, the degrees awarded, the requirements for each degree, and how to enroll. (We are located at 2500 S. LaCienega Bl., Los Angeles, Calif.) Write to our mailing address shown below for *Bulletin R-80*

Grantham College of Engineering
P. O. Box 35499
Los Angeles, California 90035

Worldwide Career Training thru Home Study

Satellite TV Reprints

To order your 36-page booklet containing complete reprints of all seven articles in the series on Backyard Satellite TV Receivers by Robert B. Cooper, Jr., complete the coupon below and enclose it with your check or money order for \$6.00.

We will ship your reprint, post-paid in U.S. and Canada, within 6 weeks of receipt of your order. All others add \$3. for postage. New York State residents must add 48¢ sales tax.

Radio-Electronics
Satellite TV Reprints
45 East 17th Street
New York, NY 10003

I want _____ reprints @ \$6.00 each, postpaid.
I have enclosed \$_____ NY State residents must add 48¢ sales tax.

(Name) _____

(Street Address) _____

(City) _____ (State) _____ (Zip) _____

WHAT'S NEW IN HOME ELECTRONICS?



Find out in the latest Heathkit Catalog. It's filled with exciting kits in every price range, all easy to assemble, all at build-it-yourself savings.

Discover the fun you and your family can have building your own home computer, stereo system, color TV. Discover the pride of saying, "I built it myself." It's easier than you think.

Send today for your FREE Heathkit Catalog.



Heathkit®

If coupon is missing, write
Heath Co., Dept. 020-662,
Benton Harbor, MI 49022

Send For FREE Catalog Today!

Send to: Heath Co. Dept. 020-662,
Benton Harbor, MI 49022

Send my free Heathkit Catalog now.
I am not currently receiving your catalog.

Name _____

Address _____

City _____ State _____

CL-724B _____ Zip _____

CIRCLE 23 ON FREE INFORMATION CARD

JUNE 1980

85

Free!

Edmund Scientific Catalog



Explore Astronomy, Biofeedback, Optics, Lasers, Magnets, Weather, Magnifiers, Microscopes, Photography... Over 4,000 Fascinating Products in Our FREE 100 page color Catalog! Send for your FREE Edmund Scientific Catalog, Today! 38 Years Of Service!

Yes! Rush me your FREE catalog!

Name _____
 Address _____
 City _____
 State _____ Zip _____

Clip and Mail Coupon Today to:
 Edmund Scientific Co, Dept. 2020, EH12
 Edscorp Bldg., Barrington, N.J. 08007
 No. 156 ©1980 Edmund Scientific Co.

BIG 2½" DISPLAY

SOLID STATE CLOCK/CALENDAR KIT

0101 Displays time of day, date or alternates between both automatically. May be connected to 8 ohm speaker for alarm clock. Operates from 120 VAC 60 Hz. **\$49.95** Oak case extra, **\$29.95**

UNIVERSAL DESIGNER KIT 6100

Indispensable aid to digital IC design. 2 pushbuttons, 2 readouts, 4 switch outputs, 8 LEDs, 2 generators, 2 counters, 5V supply pins. **\$49.95**
 Breadboard extra. \$59.95 assembled

6101 Digital Logic Course **\$29.95**

ASK FOR OUR FREE 8-PAGE CATALOG



14905 N.E. 40th, Redmond, WA 98052 (206) 383-9200

- 0101 SOLID STATE CLOCK CALENDAR KIT. \$ 49.95
- 0101 OAK CASE FOR ABOVE 29.95
- 6100 UNIVERSAL DESIGNER KIT 49.95
- 6100 ASSEMBLED DESIGNER KIT 59.95
- QT 59S BREADBOARD 11.00
- QT 59B BREADBOARD 2.50
- 6101 DIGITAL LOGIC COURSE 29.95
- ADD \$2.50 PER ORDER POSTAGE AND HANDLING

NAME _____ R-6
 ADDRESS _____
 CITY, ST, ZIP _____
 CARD NO. _____ 3 VISA 2 MSTR CHG
 SIGNATURE _____

CIRCLE 25 ON FREE INFORMATION CARD

HOBBY CORNER

continued from page 80

serve as a handle. A "pin vise" makes a good handle, too. (Now, can't you see a commercial outfit doing that!)

Help!

Russ Lane of Fairfield, Iowa, is looking for information about building a "negative ion generator." If you have any information, send it to "Doc" Savage at Radio-Electronics, 200 Park Ave South, New York, NY 10003.

Memory, Memory

John Gregory of Chicago sent along an interesting inquiry. He points out that thousands of hobbyists must have upgraded their TRS-80 computers from 4K to 16K with one of the available kits. I suspect that he is entirely right because that is one of the very first things I did to my own TRS-80.

John goes on to say that there are all those good 4K dynamic memory IC's lying around unused. He has been unable to find schematics or whatever for using those IC's. Well, John, I don't recall anything like that either. I'll pass the thought along and perhaps we can arrange for an article or two.

In the meantime, if any of you other readers have anything you have worked out, I'll pass it along to John. Those IC's could be used for additional RAM, buffer memory, message storage, and a host of other things.

PC board repair

If you have ever removed a defective part from a PC board, you know that great care is required or the board may be damaged.

Pace Inc. (9329 Fraser St., Silver Spring, MD 20910) has a repair system that makes such damaged single- or double-sided boards as good as new. Their Cir-Kit Selector Pack (No. 6993-0037) contains the special tools required and a selection of supplies for repairing pads, tracks, and even plated-through holes.

The Pace system is not difficult to use, if you follow instructions. All you need supply is solder, iron, and perhaps a small drill. I can find no reason to question the claim that the repaired board is as good as the original. Certainly, the repair is sturdy and functional.

The same system can be used to modify existing PC boards. Assuming that there is space to do so, you can easily make provision for one or more additional components—even an entire amplifier stage or whatever.

The single disadvantage for the hobbyist is the initial cost of the kit (about \$65) but you only need to buy the tools that first time. If you have, or foresee, many repairs, it's worth it; but if you have only one repair to make, on rare occasion, it may be better to stick with jury-rigging your repairs.

R-E

Hold everything!

Get a #324 PanaVise Work Center. Here's everything you need to hold everything you work with...in one money-saving package! Write for FREE catalog today.

PANA VISE®
 2850 E. 29th St.,
 Long Beach, CA 90806

Famous PanaVise standard base tilts, turns, rotates to exact work position.

6-compartment Tray Base Mount with 6 anti-slip feet.

Self-centering wire and Solder Holder* attaches to unit.

Adjustable Circuit Board Holder holds up to 10" board.

FREE 2 Nib Sponges with self-purging slits for easy cleaning.

Solder Iron Holder* with perfect angle for holding constant heat. Attaches to unit.

*Solder wire and solder iron not included.

CIRCLE 48 ON FREE INFORMATION CARD

DIGITAL AUDIO

continued from page 65

of recording level. The simple statement regarding harmonic distortion of a PCM audio processor/VCR combination doesn't quite tell the complete story either. For example, if you were to try to record a low-frequency square-wave using even the best open-reel analog tape recorder, during playback you would get something like the patterns shown in Fig. 8. Try the same experiment with a PCM/VCR combination and results would be as shown in Fig. 9. Such other aberrations as modulation noise (caused by inconsistent or wavering speed of analog tape decks) and IM distortion, seldom mentioned in discussing analog tape machines but very much a factor in determining quality of reproduced sound, are also virtually gone with PCM recording.

The EIAJ format

To make the PCM data fit within the parameters of a standard video-cassette recorder, it was necessary to take into account the TV signal requirements of the NTSC (U.S. and Japanese) TV system. In effect, the PCM data has to fit "between the lines" or, more properly, within the lines of the standard TV picture. The standardized format arrived at by the EIAJ calls for a single line of the video "picture" to contain a total of 168 bits, made up of three left-channel 14-bit words, 3 right-channel 14-bit words, 2-error correction 14-bit words and 1 16-bit error detection word. If you multiply and add all that up, it comes to 128 bits. The remaining 40 bits are used up by the usual TV horizontal-sync pulse, a white-reference pulse and a data-sync pulse, as shown in Fig. 10. Of the 262.5 horizontal lines normally contained in a single TV picture field (525 lines per frame) 245 horizontal lines are used for PCM data while the remaining time of each field is used for the usual vertical-sync pulse, equalizing pulses, a control-signal block and a vertical-blanking pulse.

If PCM recording sounds like a perfect system, that's not quite the case either. In an analog tape-recording system, tape drop-outs have a relatively minor effect upon reproduced sound. If the drop-out is of short duration, our ears tend to overlook the interruption of sound. In PCM recording, however, a drop-out, even of short duration, means a loss of vital "bits" needed to reconstruct the original waveform with precision. Error-correction and error-detection is therefore an important part of any PCM audio-processor design. The new EIAJ Standards provide for various levels of error correction and detection, with each manufacturer able to decide and select the degree and

sophistication of the error correction used. The Toshiba unit with which I conducted my preliminary experiments can provide correction for two full words of drop-out in a single horizontal line of data and even if a third word is lost because of further drop-outs, the Toshiba *PCM Mark II* processor would "fill in" the average amplitude value that is mid-way between the previous "word" and the one that follows, to make a smooth and indistinguishable transition.

PCM in your future

The first manufacturer to make a definite commitment with regard to delivery and price of a PCM processor was Sanyo. Their recently announced model *Plus 10* is, of course, built to the new EIAJ standards and will work with any VCR (Beta or VHS). The unit was expected to be available at Sanyo dealers by the end of the first quarter of 1980 and carries a suggested retail price of \$3995.00. Admittedly, that's a lot more than most consumers would ever spend for home recording facilities, but for those who are seriously involved in recording and were considering a high-quality reel-to-reel tape deck perhaps for live recording purposes, or for use in a home semi-professional recording studio, the price does not seem all that far out of line. From what I have been able to learn, the high cost of PCM processors arises primarily from the high cost of the analog-to-digital and digital-to-analog converter circuits that are a primary element in these devices. When these circuits are reduced to LSI (large scale integrated) circuitry we might well enter an era in which PCM processors are no more costly than present-day high-quality cassette decks.

PCM recording is rapidly replacing analog equipment in professional recording studios (where 16-bit systems are becoming the norm) where master tapes are made. Many famous recording artists, having heard their recordings played back via digitally recorded tapes, are demanding that their future releases be mastered by means of PCM audio processing.

Some day, of course, digital recordings will become available in disc form. At the moment, there is no general agreement as to which of many proposed types of discs should be used. But there is no longer any confusion when it comes to PCM recording on tape. The serious audiophile, with the aid of a PCM audio processor and a video recorder is now able to produce PCM taped recordings at home that are actually superior in many ways to the master tapes made in professional recording studios, just a couple of years ago on the most expensive and elaborate open-reel analog tape decks. R-E

TUNE IN!

Build the World Famous CHROMA-CHIME KIT

Give your friends a warm welcome. Yes, think how delighted and amazed they will be to hear the musical Chroma-Chime play when they press the front door bell!

The Chroma-Chime uses a microcomputer to play 24 well-known tunes instead of the regular ding-dong bell or buzzer. This British designed unit uses a Texas Instruments TMS 1000 specially programmed with a complete repertoire of tunes built in. The kit is simplicity itself for ease of construction. Absolutely everything needed is supplied, including:

- * Resistors, Capacitors, Diodes, Transistors, I.C. Socket and all hardware
- * Texas Instruments TMS 1000 microcomputer
- * Comprehensive kit manual with full circuit details
- * Ready drilled and legended PCB included

only
\$39.95
incl. p & p

When built, simply substitute for your old door chime or bell, no additional wiring needed, can be operated either from a 16 volt AC transformer or from two regular 9 volt batteries.

Plays 24 well-known tunes including:

Star Spangled Banner
William Tell Overture
Greensleeves
Mozart Sonata
Oh come all ye faithful
plus many other popular favourites.

- * No previous microcomputer experience necessary
- * All programming retained is on chip ROM
- * Fully guaranteed.

TMS 1000 N-MP0027A
Microcomputer chip
available separately if
required. Full 24 tune device supplied
with data sheet and fully guaranteed
only \$12.50 incl. p & p.

To order, send either a personal check or money order, alternatively we can deduct from your Visa or Master Charge account.

Absolutely no risk, money back if not delighted. \$39.95 inclusive of air mail, direct to the USA. Delivery may take 14 to 28 days.

Ordering from the UK is just like any other place in the USA. 10,000's already sold!

To: CHROMATRONICS, RIVER WAY,
HARLOW, ESSEX, ENGLAND.
Our phone (01144) 279 418641

Please send me kits

NAME

ADDRESS

I enclose checks value \$ R.E. 6. 80
or debit my Visa/Master Charge account no:

Signature

Dealers note: Available in kit or
ready built from:- Timely Products
Sales Inc. Chicago. Tel: (312) 263 6231



market center

100 NEW ELECTRONIC KITS!

Top Quality • Most Wanted Features • Reasonable Prices
Easy-to-Assemble

HI-FI • EXPERIMENTER'S EQUIPMENT
AUTOMOTIVE & CB ACCESSORIES
ALARM SYSTEMS • POWER SUPPLIES
CATALOG FREE During Introductory Period.
Hurry. Send for Your copy TODAY!

M. LORS & ASSOCIATES • Dept. RE-1
P.O. Box 518, Berwyn, IL 60402

PLANS & KITS

ELECTRONIC organ kits. The ultimate design. Sounds like a pipe organ. Build it to sell or build it to keep. Models for churches, homes, clubs, pizza parlors. Send \$2.00 for demo record and catalog. **DEVTRONIX**, Dept. 70, 6101 Warehouse Way, Sacramento, CA 95826

PRINTED circuit boards from sketch or artwork. Kit projects. Free details. **DANOCINTHS INC.**, Box 261, Westland, MI 48185

SPEAKERS. Save 50%. Build your own speaker system. "Free catalog" write: **MC GEE RADIO**, RE 1901, McGee Street, Kansas City, MO 64108

NEGATIVE ion generator plans, \$4.00. Kits, other plans available, free list. **STARWIND**, Box 712, Goleta, CA 93017.

INSTRUCTIONS and PC negatives, frequency counter 30MHz \$5.00, clock 4 digit \$2.50. **RCS ENTERPRISES**, Box 488, Sierra Vista, AZ 85635

SATELLITE TV antenna build for \$300. Detailed plans \$30. **NUMAN ENTERPRISES**, Rt. 1, Box 357, Jonesboro, TE 37659

PROJECTION TV. . . Convert your TV to project 7 foot picture. Results equal to \$2,500 projector. Total cost less than \$20.00. Plans & lens \$16.00. Illustrated information free. **MACROCOMGI**, Washington Crossing, PA 18977

SCA Adapter kit makes your FM receive hidden programs. Background music, ethnic, religious, news. Only \$17.00 postpaid. **COMMUNICATIONS POLY SERVICES**, Box 3251E, Westford, MA 01886

DYNAKIT Mark III's; twenty units available. All or part make offer. New units, 60 watts each, send stamp to: **CHARLES RAIBLE**, 1726 Bentley, L.A., Ca 90025

ELECTRONIC kits. Power supplies, Function Generators Etc. Everything needed for your Electronic work bench. Also Audio and other experiments kits free catalog. **ESTES ELECTRONICS**, Rt. 2, Box 170, Alexander City, AL 35010

LASERS, high power metal blasting ruby, CO₂ plans \$7.95 each. Catalog \$2.00. **EASTON RESEARCH**, 2223 Virginia Avenue, Hagerstown, MD 21740

"PCB as low as 15¢ sq-in, free drilling, also PTH. **INTERNATIONAL ENTERPRISE**, 12507 Brent, Cerritos, CA 90701

LASER plans using laser diode 1-1200 watts (specify) \$4.00. Catalog \$5.00. **LASERTRONICS (1)**, 12320 SW Spring, Portland, OR 97225

DON'T RISK your car **ANTENNA** to vandals. Automatic antenna controller, BCD clock, and other kits available. Send stamp to: **STRI-KIT**, P.O. Box C, Saugus, CA 91350

CLASSIFIED COMMERCIAL RATE (for firms or individuals offering commercial products or services). **\$1.50 per word prepaid (no charge for zip code)**. . . **MINIMUM 15 WORDS**. 5% discount for 6 issues, 10% for 12 issues within one year, if prepaid.

NON-COMMERCIAL RATE (for individuals who want to buy or sell a personal item) **85¢ per word prepaid**. . . no minimum.

ONLY FIRST WORD AND NAME set in bold caps. Additional bold face (not available as all caps) at 10¢ per word. All copy subject to publisher's approval. **ADVERTISEMENTS USING P.O. BOX ADDRESS WILL NOT BE ACCEPTED UNTIL ADVERTISER SUPPLIES PUBLISHER WITH PERMANENT ADDRESS AND PHONE NUMBER.** Copy to be in our hands on the 26th of the third month preceding the date of the issue (i.e., August issue closes May 26). When normal closing date falls on Saturday, Sunday, or a holiday, issue closes on preceding working day.

CB/HAM Circularly polarized beam antenna. Plans \$4.00; Free catalog-plans/kits. **PANAXIS**, Box 130-F6, Paradise, CA 95969

WEATHER alert decoder works on any Hi-VHF receiver. Plans \$4.00. Parts available at R.S. **PAUL YEATES**, 624 West Union Blvd, Bethlehem, PA 18018

PLANS projection television \$10.00, solar collector \$6.00, audible circuit tester \$3.00. Catalog \$2.00. **HUGHES SERVICES**, 1240 Jarvis, Chicago, IL 60626

4 in **one** • **CAPACITANCE METER** 1pF to 999KµF
• **FREQUENCY COUNTER** 35MHz
kit • **SQUARE WAVE GEN.** 1Hz to 99KHz -
• **OHMMETER** - 3.58MHz Xtal - Regulated PS - Five
8" Readouts - Low cost TTL Circuits - Automatic
Decimal Placement - Be **AMAZED** - Satisfaction
Guaranteed. Purchase the plans, etched P.C.
board 4-3/4" by 6-3/4" and front panel decal
for \$15.29! **BAGNALL ELECTRONICS**,
179 May Street, Fairfield, Conn. 06430

TRS-80

TS-80 parallel I/O. PPI-80 contains three 8-bit programmable ports with switch selectable address decoding, plugs into keyboard or E/I. PCB and manual \$25.95. **QUANT SYSTEMS**, Dept RE, Box 628, Charleston, SC 29402

MICROCOMPUTERS

TRS-80 micro computers by Radio Shack at 15% discount. Also have software for business systems. **MICRO MANAGEMENT SYSTEMS**, Downtown Shopping Center Plaza, Cairo, GA 31728 (912) 377-7120

WHOLESALE TO DEALERS

DEALERS: send letterhead for free wholesale pricelist of CB radio and scanner equipment. **FOUR WHEELER COMMUNICATIONS**, 10-R New Scotland Ave., Albany, N.Y. 12208 (518) 465-4711

To run your own classified ad, put one word on each of the lines below and send this form along with your check for \$1.50 per word (minimum 15 words) to:

Radio-Electronics, 200 Park Avenue South, N.Y., N.Y. 10003

ORDER FORM

PLEASE INDICATE in which category of classified advertising you wish your ad to appear. For special headings, there is a surcharge of \$10.

() Plans/Kits () Business Opportunities () For Sale
() Education/Instruction () Wanted ()

Special Category: \$10

(PLEASE PRINT EACH WORD SEPARATELY, IN BLOCK LETTERS.)

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35

PLEASE INCLUDE FOR OUR FILES YOUR PERMANENT ADDRESS AND PHONE NUMBER.

FREE KIT Catalog

AUTORANGE DIGITAL CAP-METER contains TEST & EXPERIMENTER'S EQUIP.
KIT. Still the best for only \$74.95
Phone 415-447-3433
Write or Phone for FREE CATALOG. Average 1 minute Saturday call is 2¢.

DAGE SCIENTIFIC INSTRUMENTS
BOX 1054R LIVERMORE CA 94550

ECG, RCA AND GE SEMICONDUCTORS SOLVE SERVICE PROBLEMS.




**MCM SEMICONDUCTORS
SOLVE THOSE SAME PROBLEMS AND COST LESS.
MUCH LESS.**


Here's Proof! SAVE UP TO 40% ON 10 OR MORE OF THE SAME ITEM!

ECG is a registered trademark of GTE Sylvania.

EQUIV.	EQUIV.	EQUIV.	EQUIV.	EQUIV.	EQUIV.	EQUIV.	EQUIV.	EQUIV.	EQUIV.	EQUIV.
102A .40	135A .40	171 2.25	231 4.90	298 1.10	381 3.10	720 1.50	791 2.80	975 1.60	1036 3.20	
103A .80	136A .40	176 1.30	233 .80	299 .75	382 1.00	721 3.80	793 3.20	978 1.60	1037 3.00	
104 2.00	137A .40	176 1.10	234 .40	300 .70	383 1.10	722 1.50	801 2.00	987 1.40	1040 1.40	
105 3.90	138A .40	177 .25	235 1.60	302 1.30	390 1.10	723 1.50	802 8.80	990 4.80	1041 1.20	
106 .40	139A .40	180 4.60	236 1.80	306 1.30	391 1.10	724 2.80	803 8.80	992 1.80	1042 2.40	
107 .80	140A .40	181 3.40	237 2.40	307 .50	500A 12.40	725 1.50	804 2.90	1002 1.20	1043 3.90	
108 1.20	142A .40	182 3.20	238 3.35	308 7.40	506 1.50	726 3.50	805 3.20	1003 1.20	1045 2.60	
109 .20	143A .40	183 3.75	276 7.90	310 7.40	523 18.80	728 3.80	806 3.80	1004 2.40	1046 3.20	
110 .40	144A .40	184 1.30	277 7.80	312 .60	525 1.35	729 4.20	807 3.20	1006 2.20	1049 3.90	
113 55	145A .40	185 .90	279 7.40	313 .80	526A 18.80	731 1.50	814 4.00	1009 2.20	1050 2.00	
116 20	152 1.30	186A .60	280 3.40	315 1.00	551 2.00	737 3.80	815 3.80	1010 2.20	1051 5.90	
117 .20	153 .90	187A .80	281 4.60	320 10.60	601 .30	738 4.80	818 3.80	1011 2.25	1052 1.00	
118 .90	155 2.90	190 1.80	282 2.00	321 3.60	605 1.65	739 3.20	823 1.20	1014 1.90	1053 2.70	
121 2.75	156 .60	192 .45	283 4.60	323 2.20	612 .35	740A 2.60	824 2.50	1016 2.20	1054 1.70	
123A .35	157 1.50	193 .55	284 4.30	324 2.50	613 .40	742 4.20	904 6.90	1019 1.20	1055 2.70	
124 2.00	158 .40	195A 2.00	285 6.20	325 29.20	703A 1.50	743 3.80	905 4.50	1020 2.20	1056 2.80	
125 20	159 1.10	196 1.30	287 .70	333 19.00	708 1.50	744 5.20	912 2.40	1021 2.20	1057 3.10	
126 .80	160 1.80	197 -1.50	289 .60	334 19.00	709 1.50	746 3.80	917 3.20	1024 4.20	1058 1.95	
127 2.95	161 1.20	198 1.50	290 .60	335 26.00	710 3.00	748 2.80	923 1.30	1025 5.90		
128 1.40	162 4.60	199 .60	291 1.30	336 26.00	712 2.25	749 2.90	925 7.80	1027 4.90		
129 1.20	163A 4.60	220 1.60	292 1.50	373 2.50	713 1.50	778A 1.80	941M .90	1028 10.40		
130 1.30	165 3.35	221 1.40	293 1.00	374 2.60	714 2.80	780 3.20	955M 1.40	1029 2.60		
131 1.00	166 1.45	222 1.60	294 1.10	375 1.50	715 3.20	783 2.60	966 1.30	1030 3.60		
132 .60	167 1.45	229 .80	295 .60	376 2.25	718 1.50	788 1.50	973 1.80	1032 2.90		
133 .60	168 1.45	230 4.60	297 1.00	380 3.00	719 1.50	790 2.80	973D 2.00	1035 4.60		

Special

Equivalent to ECG 163A
 **\$3.90**
 Horizontal Deflection TO-3 CASE

Equivalent to ECG 165
 **\$2.40**
 Horizontal Deflection TO-3 CASE

Equivalent to ECG 238
 **\$2.45**
 Horizontal Output TO-3 CASE

Many more items to choose from but space does not permit listing them all.

mcm audio, inc.
 Parts for the TV, Stereo & Communications World
 639 Watervliet Avenue, Dayton, Ohio 45420

Call This Toll-Free 24 Hour Hot Line

1-800-543-3528

Ohio Watts 1-800-762-3418

**ALL ORDERS
SENT U.P.S.
WITHIN
24 HOURS.**

CIRCLE 14 ON FREE INFORMATION CARD

www.americanradiohistory.com

PASS FCC EXAMS

The Original FCC Tests—Answers exam manual that prepares you at home for FCC First and Second class Radiotelephone licenses. Newly revised multiple-choice exams cover all areas tested on the actual FCC exam. Plus "Self-Study" Ability Test. Proven! \$9.95 postpaid. Moneyback Guarantee.



COMMAND PRODUCTIONS Radio Engineering Division P.O. Box 26348 E San Francisco, CA 94126

EDUCATION & INSTRUCTION

UNIVERSITY degrees by mail! Bachelors, Masters, Ph.D's... Free revealing details. **COUNSELING**, Box 317-RE6, Tustin, CA 92680

BROADCASTING! Start your own radio station at home, school, church! Become a DJ! Free information. "BROADCASTING", Box 130-F6, Paradise, CA 95969

HOME study degree program in electronics engineering. 75 specialized courses also available. For information write: **CIEE**, P.O. Box 9196, Pittsburgh, PA 15224

MAKE hydrogen fuel: Build generators with material from Hardware stores. Illustrated manual; \$10.95 ppd. **NEGEYE ENGINEERING**, Pennsylvania, WV 26415

SAMS books—How to Buy and Use Minicomputers and Microcomputers \$9.95, The Incredible Secret Money Machine \$5.95, **RVI**, Box 1116, Waldorf, MD 20601

HIGHLY PROFITABLE ONE-MAN ELECTRONIC FACTORY

Investment unnecessary, knowledge not required, sales handled by professionals. Ideal home business. Write today for facts! **Postcard will do. Barta-RE-D**, Box 248, Walnut Creek, CA 94597.

SATELLITE TELEVISION

SATELLITE TV buyers guide. Exclusive comparisons plus how to install your own saving big \$. Worldwide movies, news, sports, religion, entertainment on your set. **Well over 35 channels.** Book guaranteed. US funds please. \$12.95 postpaid or \$14.95 First class (Airmail). **REED PUBLICATIONS**, Box 219-E, Maitland, FL 32751

SATELLITE television—satellite weatherfax. Will your receiving antenna clear local obstructions? Get **antenna aiming data** for geostationary satellites, custom computed for your latitude and longitude. Included is chart of U.S. and international satellites around the globe and instructions on how to find them in the sky. Send \$5.00 to **COMPUSAT**, 643 South Route 83, Elmhurst, Illinois 60126.

SATELLITE television antenna and equipment dealers list. Build yourself. Save. Complete list of dealers only \$3.00. **DLF**, Box 519, Nash, TX 75569

1. 5 Volt, 3 amp, Regulated Power Supply. Great for TTL Projects..... \$19.50
2. EMM 4200A, 4K Static RAMs, Ceramic A local memory boards manufacturer closed. We bought the new memory boards and took these 4200A static RAMs out. They are tested and 90-day guaranteed 100% good. Prime tested 4200A 4K RAMs \$5.50 ea.
3. Super Saver. Micro PD411, Ceramic 4K x 1 dynamic RAMs..... 8 for \$10.00.

DELTRONIKS
5151 BUFORD HIGHWAY 020
ATLANTA, GA 30340
404-458-4690

SATELLITE TV FOR THE HOME

Our receiver lets you get over 75 channels of television directly from earth-orbiting cable TV satellites! **HBO, Showtime, super stations, sports and movies** from around the world.



Sick of Network TV? Buy Complete or Build our kit and save!

Our 24-channel receiver provides "studio quality" TV reception. Easy to install! Ultra low power consumption! Brilliant color! Works anywhere! FCC licensing no longer required. **Order today!** Complete details covered in our Home Earth Station manual. Send \$7.95 today (refundable against any purchase), or call:

24-hour C.O.D. Hotline
(305) 869-4283
SPACECOAST RESEARCH

Dept. T, P.O. Box 442, Altamonte Springs, FL 32701

BOOKS

"**CRIME** By Computer" \$6.95. Postpaid—300 pages. **COMP-U-TRONIX**, Box 3401, Kent, WA 98031

AMAZING ELECTRONIC PROJECTS and PRODUCTS:

Lasers Super Powered, Burning Cutting, Rifle, Pistol. Pocket. See in Dark—Shotgun Directional Mike—Unscramblers—Giant Tesla—Stunwand—TV Disrupter—Energy Producing, Surveillance, Detection, Electrifying, Ultrasonic, CB, Auto and Mech. Devices, Hundreds More—All New Plus **INFO UNLTD PARTS SERVICE**. Catalog \$1. Information Unlimited, Dept. R8 Box 716 Amherst, N.H. 03031.

FOR SALE

RADIO & TV tubes 49¢ each. One year guaranteed. Plus many unusual electronic bargains. Free catalog. **CORNELL**, 4217-E University, San Diego, Calif. 92105

SCANNER/monitor accessories—kits and factory assembled. Free catalog. **CAPRI ELECTRONICS**, Route 1R, Canon, GA 30520

FREE catalog, IC's, LED's, semi's, parts. **CORONET ELECTRONICS**, 649A Notre Dame W., Montreal, Que., Canada H3C 1H8. U.S. Inquiries.

RECONDITIONED test equipment. \$1.00 for catalog. **JAMES WALTER TEST EQUIPMENT**, 2697 Nickel, San Pablo, CA 94806

SAVE up to 50% on name brand test equipment. Free catalog and price list. **SALEN ELECTRONICS**, Box 82-M, Skokie, IL 60077

PRINTED Circuit Boards: Your artwork, quick delivery, reasonable. Quantity discounts. **ATLAS CIRCUITS**, Box 974, Waynesville, NC 28786 (704) 456-3739

RAW speakers and finished systems for Hi-Fi and Sound Reinforcement. Also cabinet plans, hardware, grille cloth, crossovers, microphones, accessories, much more. Information-packed catalog, \$1.00. **UNIVERSAL DISCOUNT SOUND**, Dept. RE, 2243 Ringling Blvd, Sarasota, FL 33577

ALARM systems! Burglar, fire, car. Finest equipment! Save! Catalog, decal; 50¢, refundable! **AAS**, 186H Oxmoor Road, B'ham, AL 35209

VARACTOR television tuners. These are small high performance units with separate VHF and UHF tuners. With data, new \$19.75 ppd. **USA. L.R. DESIGN**, Box 41, McMinnville, OR 97128

GOVERNMENT surplus receivers, transmitters, sniperscopes, parts, fantastic 72 page catalog 25¢. **MESHNA**, Nahant, Mass. 01908

LASER handbook with burning, cutting, Ruby Reds, Co's, complete plans, books, and parts. Send \$4.00 to **FAMCO**, dept re, box 1902, Rochester, NH 03867



8-TRACK TAPE PLAYER PLUS

PUSH BUTTON AM AUTO RADIO!

Individually packed in original factory carton with styrofoam protection. Owner's manual with circuit diagram is included. Brand new!

8-TRACK-AM RADIO

39.95
\$3.00 SHPG

Delta No. 5784R
UNBELIEVABLE

STEREO 8-TRACK AM AUTO RADIO

FACTORY CLOSEOUT! It's too good to be true.... this transistorized, solid state AM auto radio has stereo 8-TRACK TAPE PLAYER at half the price of the AM radio alone. Five pushbuttons can be pre-set to your favorite stations. Has provision for use of either 2 or 4 speakers. Balance control. Shaft spacing on radio is

adjustable both horizontally and vertically to fit most cars. Complete with mounting kit, knobs, alternator capacitor and distributor suppressor. Negative ground. Choke coil in positive lead for additional noise suppression.

Delta Does The Impossible Again! You Save \$\$\$\$\$

Convert Your Car Into A Concert Hall!



19.95 \$3 for SHPG. **\$100 AM-FM AUTO RADIO**
Delta 5785R UNBELIEVABLE

FACTORY CLOSEOUT! One of America's largest manufacturers of auto radios has given up. We've been fortunate in acquiring the last auto radios in production. These are AM-FM sets.... designed for new cars. All are tested 100% operational and come with knobs and push buttons. Ideal for installing in your auto, van, camper, boat, truck.

NEWS ITEM! Auto hi-fi has become as sophisticated as home hi-fi—and nearly as expensive. You can spend \$200 for simple components—which means hi-fi can be out of reach for many folks and 2nd cars. If you want hi-fi FM, you can start with the purchase of a \$100 radio for a mere \$19.95.... This price will not last long—order today while our limited supply lasts!

Mini & Foreign

SIZE: 6 1/4" wide... 1 1/4" high... 4 1/4" deep. Mtg. ctrs of knobs is 5/16". Note sizes may vary slightly; photo is representative sample.

□ 5785R AM-FM..... \$29.95 (\$3.00 shpg)

□ 5787R AM only..... \$19.95 (\$3.00 shpg)



FREE 120-PG. 'SURPLUS' CATALOG

DELTA ELECTRONICS
176 SECOND AVE. WALTHAM, MASS. 02154
Minimum Order \$8.00
TEL. (617) 388-4705

CIRCLE 28 ON FREE INFORMATION CARD

FOR SALE

TELEVISION downconverters 1.6-2.7 GHz \$99.95 postpaid. Details for stamp. **GW ELECTRONICS**, POB 688, Greenwood, IN 46142

"**THE Intelligence Library**" technical secrets. Books on **Electronic Surveillance, Lock-Picking, Demolitions, Covert Sciences**, etc. One dollar. (refundable): **MENTOR PUBLICATIONS**, Dept. Z, 135-53 Northern Boulevard, Flushing, NY 11354

CABLE TV converters \$39.95. Incredible 96 page catalog free. **ETCO**, Box 762, Plattsburgh, NY 12901

SAVE up to 46% on energy and reduce your electric bill with new **Lite-Bulb Saver**. For free brochure write: **R.H.E. ENTERPRISES**, Dept. RE-680, P.O. Box 600128, North Miami Beach, FL 33160

SURPLUS chart paper, send SASE for long list, **J. DROPPO**, 3621 West Sylvester, Pasco, WA 99301

SCRAMBLED television, encoding/decoding. New Publication. Theory/circuits. \$9.95. **WORKSHOP**, Box 393 RE, Bethpage, NY 11714

USED test equipment. 714-985-9967 or S.A.S.E. **JIM CORLISS**, 2446 Vista Drive, Upland, CA 91786

BEARCAT scanners at discount prices. Model 220, list \$419.95, our price \$299.00. Send S.A.S.E. for complete price list. **B&B COMMUNICATIONS**, 12733 Ridge Road, Albion, NY 14411

KEYBOARDS for synthesizers and organs. Completely assembled with single/or dual contacts. Send for information: **DEVTRONIX ORGANS**, dept. 70, 6101 Warehouse Way, Sacramento, CA 95826.


GIANT Sale: Electronic parts, accessories, antennas, etc. Free catalog! **SPECIALTY RADIO SALES**, 1000 S.W. Dixie #3-4, Pompano Beach, FL 33060

BUSINESS OPPORTUNITIES

MECHANICALLY inclined individuals desiring ownership of Small Electronics Manufacturing Business—without investment. Write: **BUSINESS-ES**, 92-R, Brighton 11th, Brooklyn, NY 11235

FREE Catalog

OF THE WORLD'S FINEST
ELECTRONIC
SURPLUS BARGAINS



Name _____
Street _____
City/State _____ Zip _____

Mail Coupon for Your FREE Copy - Dept. RE
Quality Surplus Since 1947 • Use VISA or Mastercharge!

FAIR RADIO SALES
1016 E. EUREKA • Box 1105 • LIMA, OHIO • 45802

Find relief in this free booklet.
Write: "Dollars and Sense,"
Pueblo, Colorado, 81009.

We can
all beat
inflation
if we just
use our
dollars
and sense.



IF YOU'RE AN ADVERTISER WHO NEEDS JUST A LITTLE SPACE LIKE THIS 1/6 PAGE, CALL YOUR NEAREST RADIO-ELECTRONICS SALES OFFICE RIGHT NOW. YOU'LL DISCOVER YOU DON'T HAVE TO SPEND A LOT OF \$\$\$ TO REACH THE PEOPLE WHO DO SPEND A LOT.

NEW YORK
Stan Levitan
212-777-6400

CHICAGO
Ralph Bergen
312-446-1444

LOS ANGELES
J.E. Publishing
213-659-3810

Radio-Electronics



BULLET ELECTRONICS

PO Box 401244R
Garland TX 75040

NPN HIGH VOLTAGE 1.59

VCEO = 450 VDC IC = 3A (5A Peak)
FOR TV HORIZONTAL SECTIONS: HIGH VOLTAGE REGULATORS
REPLACES: 2N5076, 2N5077, 2N5838, 2N5665, 2N5466, BU126, 2SC2121, 2N5840, 2SC1046, 2N5466, TIP556 AND MANY OTHERS.

LM3046	(CA3046) Transistor Array	.75
RCA 40430	400V 6A TRIAC TO-66	.75
CA3086	RCA Transistor Array	.80
LM567	Tone Decoder	.99
CD4046	PLL CMOS	.99
LM3302	Quad Comparator	.89
2SC1849	High Freq NPN TO-92	6/1.00
MPS A20	NPN GEN PUR	8/1.00

Sound Effects Kit 17.50

The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new Texas Instruments SM76477 Sound Chip, the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One Shot, and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3 1/2" x 5" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate Explosions, Phasor Guns, Steam Trains, or almost an infinite number of other sounds. The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100mW amp will drive a small speaker directly, or the unit can be connected to your stereo w/it. Incredible results! (Speaker not included)

• 76477 CHIP IS INCLUDED. EXTRA CHIPS 3.10 EACH
• \$17.50 LESS SPEAKER & BATTERY

AY3-8910 PROGRAMMABLE SOUND GENERATOR

The AY3-8910 is a 40 pin LSI chip with three oscillators, three amplitude controls, programmable noise generator, three mixers, an envelope generator, and three D/A converters that are controlled by 8 BIT WORDS. No external pots or caps required. This chip hooked to an 8 bit microprocessor chip or Buss (8080, Z80, 6800 etc.) can be software controlled to produce almost any sound. It will play three note chords, make bangs, whistles, sirens, gunshots, explosions, bleets, whines, or grunts. In addition, it has provisions to control its own memory chips with two IO ports. The chip requires +5V @ 75ma and a standard TTL clock oscillator. A truly incredible circuit.

\$14.95 W/Basic Spec Sheet (4 pages)
60 page manual with S-100 interface instructions and several programming examples, \$3.00 extra.

1/2W RESISTOR ASSORTMENT

A good mix of 5% and 10% values in both full lead and PC lead devices. All new, first quality.

(Asst.) 200 pieces/2.00

7 WATT AUDIO AMP KIT

SMALL SINGLE HYBRID IC AND COMPONENTS FIT ON A 2" x 3" PC BOARD (INCLUDED), RUNS ON 12VDC. GREAT FOR ANY PROJECT THAT NEEDS AN INEXPENSIVE AMP. LESS THAN 3% THD @ 5 WATTS. COMPATIBLE WITH SE-01 SOUND KIT. \$5.95

ULTRASONIC RELAY KIT

INVISIBLE BEAM WORKS LIKE A PHOTO ELECTRIC EYE. USE UP TO 25 FT. APART. COMPLETE KIT. ALL PARTS & PC BOARDS. \$21.50



THE PERFECT TRANSFORMER

117VAC primary, 12VAC secondary @ 200ma
Great for all you CMOS, or low power TTL projects. PC board mount. 99c ea. 3/\$2.50
Size: 1.5" W x 1.25" D x 1.25" H

XAN SUPER DIGITS

.6" JUMBO LED RED
6920 COMMON CATHODE .99
6640 COMMON ANODE 7 SEGMENT

NOW A SUPER READOUT AT A SUPER BUY! These are factory fresh prime LED readouts, not seconds or rejects as sold by others. Compare our price and send for yours today, but hurry, the supply is limited! SPECIFY: COMMON ANODE OR COMMON CATHODE

A HOT NUMBER AY3-1350

TUNES SYNTHESIZER
The AY3-1350 is a MOS microcomputer synthesizer of pre-programmed tunes for applications in toys, music boxes, and door chimes. The standard device has a set of 25 different popular and classical tunes. In addition there are 3 chimes making a total of 25 tunes

FEATURES

- Minimal external components
- Automatic switch-off signal at end of tune for power saving
- Envelope control to give organ or piano quality
- Sequential tune mode
- 4 door capability when used as door chime
- Operation with tunes in external PROM if required (2708)
- Single supply (+5V) Operation
- Tunes include: STAR WARS, BEETHOVEN'S 9th & 5th, JINGLE BELLS, YAMKEE DOODLE, STAR SPANGLED BANNER, CLEMENTINE, GOD SAVE THE QUEEN, O SOLE MIO, WEST MINISTER AND DESCENDING OCTAVE CHIME PLUS MANY MORE!

WITH DETAILED SPECS AND INSTRUCTIONS \$14.50

PARTS

TL490	Bar Graph Driver	2.50
7805	5V A Regulator	.99
78M05	1/2A TO-5 Reg. 5V (Hse. #)	.60
LM3911	Temp. Transducer	1.70
555	Timer IC	.49
723	Voltage Reg. 14 Pin Dip	.50
7812	1A 12V Reg.	.99
2N6028	P.U.T. W/Specs	.50
IL-1	Opt. Isolator W/Specs	.60
LM380	2W Audio IC W/Specs	.50
LM377	Dual LM380 W/Specs	1.49
TIP-30	PNP Power TO-220	3/1.40
TIP-31B	NPN Comp. to TIP-30 (Hse #)	3/1.40

- * NO C.O.D.'s
 - * SEND CHECK M.O. OR CHARGE CARD NO.
 - * PHONE ORDERS ACCEPTED ON VISA AND MASTERCARD ONLY. (214) 278-3553
 - * ADD 5% FOR SHIPPING
 - * TX. RES. ADD 5% STATE SALES TAX
 - * FOREIGN ORDERS ADD 10% (EXCEPT CANADA) (20% AIR MAIL) U.S. FUNDS ONLY
- catalog free on request*

We now have available a bunch of goodies too good to bypass. Items are limited so order today.

Call Your Phone Order in Today!

MINI KITS - YOU HAVE SEEN THESE BEFORE NOW HERE ARE OLD FAVORITE AND NEW ONES TOO, GREAT FOR THAT AFTERNOON HOBBY.

TERMS: Satisfaction guaranteed or money refunded. COD add \$1.50. Minimum order \$6.00. Orders under \$10.00 add \$7.50. Add 5% for postage, insurance, handling. Overseas add 15%. NY residents add 7% tax.

FM MINI MIKE

A super high performance FM wireless mike kit! Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electret mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available.

FM-3 Kit \$14.95 FM-3 Wired and Tested 19.95

Color Organ

See music come alive! 3 different lights flicker with music. One light each for high, mid-range and lows. Each individually adjustable and drives up to 300 W. runs on 110 VAC.

Complete kit, ML-1 \$8.95

Video Modulator Kit Converts any TV to video monitor. Super stable, tunable over ch 4-6. Runs on 5-15V, accepts std. video signal. Best unit on the market! Complete kit, VD-1 \$7.95

Led Blinky Kit A great attention getter which alternately flashes 2 jumbo LEDs. Use for name badges, buttons, warning panel lights, anything! Runs on 3 to 15 volts. Complete kit, BL-1 \$2.95

CPO-1 Runs on 3-12 Vdc 1 wall out. 1 KHZ good for CPO. Alarm, Audio Oscillator. Complete kit \$2.95

Super Sleuth A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2 W rms output, runs on 6 to 15 volts, uses 8-45 ohm speaker. Complete kit, BN-9 \$5.95

CLOCK KITS

Your old favorites are here again. Over 7,000 Sold to Date. Be one of the gang and order yours today!

Try your hand at building the finest looking clock on the market. Its satin finish anodized aluminum case looks great anywhere, while six .4" LED digits provide a highly readable display. This is a complete kit, no extras needed, and it only takes 1-2 hours to assemble. Your choice of case colors: silver, gold, black (specify). Clock kit, 12/24 hour, DC-5 \$24.95 Clock with 10 min. ID timer, 12/24 hour, DC-10 \$29.95 Alarm clock, 12 hour only, DC-8 \$29.95 12V DC car clock, DC-7 \$29.95

For wired and tested clocks add \$10.00 to kit price. Specify 12 or 24 hr. format

FM Wireless Mike Kit

Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage.

FM-1 kit \$3.95 FM-2 kit \$4.95

Whisper Light Kit

An interesting kit, small mike picks up sounds and converts them to light. The louder the sound, the brighter the light. Includes mike, controls up to 300 W, runs on 110 VAC.

Complete kit, WL-1 \$6.95

Tone Decoder

A complete tone decoder on a single PC board. Features: 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts. Complete kit, TD-1 \$5.95

Siren Kit

Produces upward and downward wail characteristic of a police siren. 5 W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker. Complete kit, SM-3 \$2.95

60 Hz Time Base Runs on 5-15 VDC. Low current (2.5ma) 1 min/month accuracy TB-7 Kit \$9.50 TB-7 Assy \$9.95

Universal Timer Kit

Provides the basic parts and PC board required to provide a source of precision timing and pulse generation. Uses 555 timer IC and includes a range of parts for most timing needs.

UT-5 Kit \$5.95

Mad Blaster Kit

Produces LOUD ear shattering and attention getting siren like sound. Can supply up to 15 watts of obnoxious audio. Runs on 6-15 VDC.

MB-1 Kit \$4.95

Car Clock

The UN-KIT, only 5 solder connections

Here's a super looking, rugged and accurate auto clock, which is a snap to build and install. Clock movement is completely assembled - you only solder 3 wires and 2 switches, takes about 15 minutes! Display is bright green with automatic brightness control photocell - assures you of a highly readable display, day or night. Comes in a satin finish anodized aluminum case which can be attached 5 different ways using 2 sided tape. Choice of silver, black or gold case (specify).

DC-3 kit, 12 hour format \$22.95 DC-3 wired and tested \$29.95

Calendar Alarm Clock

The clock that's got it all: 6-.5" LEDs, 12/24 hour, snooze, 24 hour alarm, 4 year calendar, battery backup, and lots more. The super 7001 chip is used. Size: 5x4x2 inches. Complete kit, less case (not available) \$34.95

Under Dash Car Clock

12/24 hour clock in a beautiful plastic case features: 6 jumbo RED LEDs, high accuracy (.001%), easy 3 wire hookup, display blanks with ignition, and super instructions. Optional dimmer automatically adjusts display to ambient light level. DC-11 clock with mtg bracket \$27.95 kit \$2.50 DM-1 dimmer adapter Add \$10.00 Assy and Test

Video Terminal A completely self-contained, stand alone video terminal card. Requires only an ASCII keyboard and TV set to become a complete terminal unit. Features are: single 5V supply, XTAL controlled sync and baud rates (10-9600) complete computer and keyboard control of cursor. Parity error control and display scrolling upper and lower case (optional) and has RS-232 and 20ma loop interfaces on board. Kits include sockets and complete documentation. RE 6416 terminal card kit (add \$60.00 for wired unit) \$189.95 Lower Case option \$13.95 Power Supply \$14.95 RF Modulator kit \$7.95

Audio Prescaler

Make high resolution audio measurements, great for musical instrument tuning, PL tones, etc. Multiplies audio UP in frequency, selectable x10 or x100, gives .01 HZ resolution with 1 sec. gate time! High sensitivity of 25 mv, 1 meg input z and built-in filtering gives great performance. Runs on 9V battery, all CMOS. PS-2 kit \$29.95 PS-2 wired \$39.95

600 MHz PRESCALER

Extend the range of your counter to 600 MHz. Works with all counters. Less than 150 mv sensitivity. specify -10 or -100. Wired, tested, PS-1B \$59.95 Kit, PS-1B \$44.95

30 Watt 2 mtr PWR AMP

Simple Class C power amp features 8 times power gain. 1 W in for 8 out, 2 W in for 15 out, 4 W in for 30 out. Max output of 35 W, incredible value, complete with all parts, less case and T-R relay. PA-1, 30 W pwr amp kit \$22.95 TR-1, RF sensed T-R relay kit 6.95

MRF-238 transistor as used in PA-1 8-10db gain 150 mhz \$11.95

Power Supply Kit Complete triple regulated power supply provides variable 6 to 18 volts at 200 ma and +5 at 1 Amp. Excellent load regulation, good filtering and small size. Less transformers, requires 6.3 V ϕ 1 A and 24 VCT. Complete kit, PS-3LT \$6.95

RF actuated relay senses RF (1W) and closes DPDT relay. For RF sensed T-R relay TR-1 Kit \$6.95

OP-AMP Special BI-FET LF 13741 - Direct pin for pin 741 compatible, but 500,000 MEG input z, super low 50 pa input current, low power drain. 50 for only \$9.00 10 for. \$2.00

Regulators 7812 \$1.00 7815 \$1.00 723 \$.50 7905 \$1.25 309K \$1.15 7912 \$1.25 7805 \$1.00 7915 \$1.25

Shrink Tubing Nubs Nice precut pces of shrink size: 1" x 1/4" shrink to 1/4". Great for splices. \$0/\$1.00 Mini TO-92 Heat Sinks Thermally Brand To-220 Heat Sinks 5 for \$1.00 3 for \$1.00

Opto Isolators - 4N28 type \$5.00 ea. Opto Reflectors - Photo diode + LED \$1.00 ea.

Moflex Pins Molex already precut in length of 7. Perfect for 14 pin sockets. 20 strips for \$1.00 CDS Photocells Resistance varies with light. 250 ohms to over 3 meg. 3 for \$1.00

IC SPECIALS

Table with columns for LINEAR, TTL, and SPECIAL ICs. Includes part numbers like 301, 324, 380, 555, 566, 567, 741, 1458, 3900, 3914, 8038 and prices.

Table with columns for Resistor Ass't, Crystals, and Switches. Includes part numbers like 3579545, 10,00000, 5.248800 and prices.

Table with columns for Earphones, Mini Speaker, and Solid State Buzzers. Includes part numbers like 3" leads, 8 ohm, 2 1/2" diam, Round and prices.

Table with columns for Slug Tuned Coils and AC Outlet. Includes part numbers like Small 3/16" Hex Slugs and prices.

Table with columns for CAPACITORS, ALUMINUM, and DISK CERAMIC. Includes part numbers like 15 uF 25V 3/\$1.00 and prices.

Table with columns for DC-DC Converter, Ceramic IF Filters, and Trimmer Caps. Includes part numbers like +5 vdc input prod. and prices.

Table with columns for Crystal Microphone, Mini RG-174 Coax, and 9 Volt Battery Clips. Includes part numbers like Small 1" diameter and prices.

Table with columns for Parts Bag, Connectors, and Leds. Includes part numbers like Asst of chokes, disc caps and prices.

Table with columns for Varactors. Includes part numbers like Motorola MV 2209 and prices.

Table with columns for CMOS and FERRITE BEADS. Includes part numbers like 4011, 4013, 4046, 4049, 4059, 4511, 4518, 5639 and prices.

Table with columns for READOUTS and Sockets. Includes part numbers like FND 359 4" C.C. and prices.

Table with columns for TRANSISTORS and Diodes. Includes part numbers like 2N3904 NPN and prices.

Table with columns for Mini-Bridge 50V 1 AMP 2 for \$1.00. Includes part numbers like 2N3904 NPN and prices.

CIRCLE 57 ON FREE INFORMATION CARD

100W CLASS A POWER AMP KIT

Dynamic Bias Class "A" circuit design makes this unit unique in its class. Crystal clear, 100 watts power output will satisfy the most picky fans. A perfect combination with the TA-1020 low T.I.M. stereo pre-amp.

Specifications:

- Output power: 100W RMS into 8-ohm
125W RMS into 4-ohm
- Frequency response: 10Hz - 100 KHz
- T.H.D.: less than 0.008%
- S/N ratio: better than 80dB
- Input sensitivity: 1V max.
- Power supply: $\pm 40V @ 5 amp$



TA-1000 KIT
\$51.95
Power transformer
\$15.00 each

PROFESSIONAL 10 OCTAVE STEREO GRAPHIC EQUALIZER!!



Graphic equalizer have been used for years in sound studios and concert arenas but were too expensive to be considered for home use. Now we offer you the facility at an affordable price. This unit can extend your control of your Hi-Fi system by minimizing the non-linearities of the combined speaker/room system. Fantastic features as follows:

- 10 double slide controls for two channels
- Cut out rumble, surface noise and hiss
- Minimizes speaker/room non-linearities
- Frequency response from 30Hz to 16KHz
- 10 tone controls plus defeat, monitor and tape selector.
- Control range $\pm 12dB$ in 10 octaves (30Hz, 60Hz, 120Hz, 240Hz, 500Hz, 1KHz, 2KHz, 4KHz, 8KHz, 16KHz.)
- Operating voltage 117V 50/60Hz.

FACTORY ASSEMBLED UNIT, NOT A KIT
SPECIAL PRICE \$117.00 ea

SUB MINI SIZE FET CONDENSER MICROPHONE



Specification:

Sensitivity: $-65dB \pm 3db$
FEO. Response: 50 Hz - 8 KHz
Output Impedance: 1K ohm max.
Polar Pattern: Omni-directional
Power Supply: 1.5V 10V D.C.
Sound Pressure Level: Max. 120dB
EM4RP \$2.50 ea. or 2 for \$4.50



NEW MARK III 9 Steps 4 Colors LED VU

Stereo level indicator kit with arc-shape display panel!!! This Mark III LED level indicator is a new design PC board with an arc-shape 4 colors LED display (change color from red, yellow, green and the peak output indicated by rose). The power range is very large, from $-30dB$ to $+5dB$. The Mark III indicator is applicable to 1 watt - 200 watts amplifier operating voltage is 3V - 9V DC at max 400 MA. The circuit uses 10 LEDs per channel. It is very easy to connect to the amplifier. Just hook up with the speaker output!

IN KIT FORM \$18.50

MARK II SOUND ACTIVATED SWITCH KIT



A new designed circuit employed 2 I.C., a DPDT relay with a led indicator. A condenser microphone comes with the kit. The relay can handle up to 200 watts contact to allow to control most things. Just click the finger, the relay will close, the second click will release it. Sensitivity can be adjusted by an on board trim-pot. Operating voltage 9V D.C. TY-18 \$8.50 PER KIT

MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

This new stereo level indicator kit consists of 36 4-color LED (15 per channel) to indicate the sound level output of your amplifier from $-36dB$ to $+3dB$. Comes with a well-designed silk screen printed plastic panel and has a selector switch to allow floating or gradual output indicating. Power supply is 6 ~ 12V D.C. with THG on board input sensitivity controls. This unit can work with any amplifier from 1W to 200W!

Kit includes 70 pcs. driver transistors, 38 pcs. matched 4-color LED, all other electronic components, PC board and front panel.



MARK IV KIT \$31.50

30W + 30W STEREO HYBRID AMPLIFIER KIT

It works in 12V DC as well! Kit includes 1 PC SANYO STK-043 stereo power amp. IC LM 1458 as pre amp, all other electronic parts, PC Board, all control pots and special heat sink for hybrid. Power transformer not included. It produces ultra hi-fi output up to 60 watts (30 watts per channel) yet gives out less than 0.1% total harmonic distortion between 100Mz and 10KHz.



\$32.50 PER KIT

BATTERY POWERED FLUORESCENT LANTERN

MODEL 888 R

FEATURES

- Circuitry: designed for operation by high efficient, high power silicon transistor which enable illumination maintain in a standard level even the battery supply drops to a certain low voltage.
- 9" 6W cool/daylight miniature fluorescent tube.
- 8 x 1.5V UM-1 (size D) dry cell battery.
- Easy sliding door for changing batteries.
- Stainless reflector with wide angle increasing lumination of the lantern.



\$10.50 EA

STEREO AMPLIFIER



60 W

60 W

COMPLETED UNIT - NOT A KIT!

OCL pre amp. & power stereo amp. with bass, middle, treble 3-way tone control. Fully assembled and tested, ready to work. Total harmonic distortion less than 0.5% at full power. Output maximum is 60 watts per channel at 8 Ω . Power supply is 24 - 36V AC or DC. Complete unit. Assembled \$49.50 ea. Power transformer \$ 8.50 ea.

5W AUDIO AMP KIT

2 LM 380 with Volume Control
Power Supply 6 18V DC
ONLY \$6.00 EACH

PROFESSIONAL PANEL METERS



- A. 0-50UA 8.50 ea.
- B. 0-30VDC 8.50 ea.
- C. 0-50VDC 8.50 ea.
- D. 0-3ADC 9.00 ea.
- E. 0-100VDC 9.00 ea.

Type MU-52E All meters white face with black scales. Plastic cover.

SPECIAL 0.5" LED ALARM CLOCK MODULE

ASSEMBLED! NOT A KIT!
Features: • 4 digits 0.5" LED Displays • 12 hours real time format • 24 hours alarm audio output • 59 min. countdown timer • 10 min. snooze control.



ONLY \$7.00 EACH
SPECIAL TRANSFORMER FOR CLOCK (FREE)

DIGITAL AUTO SECURITY SYSTEM

4 DIGITS PERSONAL CODE!!

SPECIAL \$19.95



- proximity triggered
- voltage triggered
- mechanically triggered

This alarm protects you and itself! Entering protected area will set it off, sounding your car horn or siren you add. Any change in voltage will also trigger the alarm into action. If cables within passenger compartment are cut, the unit protects itself by sounding the alarm.

3-WAY PROTECTION!

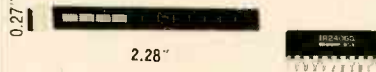
All units factory assembled and tested - Not a kit!

A NEW LED ARRAY AND DRIVER FOR LEVEL METERS

This series covers a wide range of level indication uses, output and input voltage, time related change, temperature, light measurement and sound level. The problem of uneven brilliance often encountered with LED arrangements as well as design problems caused by using several units of varying size are substantially reduced. 12 LEDs in one bar:

LED ARRAY

GL-112R3 Red, Red, Red	\$5.50
GL-112N3 Green, Yellow, Red	\$6.50
GL-112M2 Green, Green, Red	\$6.50
GL-112G3 Green, Green, Green	\$6.50



LED DRIVERS

1R 2406G is an I.C. specially designed to drive. 12 LED. The number of LED is linearly illuminated according to the control voltage input terminal 21. Operating voltage is 9 12V D.C. \$5.35 EACH

PROFESSIONAL FM WIRELESS MICROPHONE

TECT model WEM-16 is a factory assembled FM wireless microphone powered by an AA size battery. Transmits in the range of 88-108MHz with 3 transistor circuits and an omni-directional electric condenser. Element built-in plastic tube type case; mike is 6 1/4" long. With a standard FM radio, can be heard anywhere on a one-acre lot; sound quality was judged very good.

\$16.50

FLASHER LED

Unique design combines a jumbo red LED with an IC flasher chip in one package. Operates directly from 5V-7V DC. No dropping resistor needed. Pulse rate 3Hz @ 5V 20mA.

2 for \$2.20

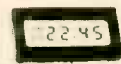
BIPOLAR LED RED/GREEN

2 colors in one LED, green and red, changes color when reverse voltage supply. Amazing!
2 FOR \$1.60

LCD CLOCK MODULE!

• 0.5" LCD 4 digits display • X'tal controlled circuits • D.C. powered (1.5V battery) • 12 hr. or 24 hr. display • 24 hr. alarm set • 60 min. countdown timer • On board dual back-up lights • Dual time zone display • Stop watch function.

NIC1200 (12 hr) \$24.50 EA.
NIC2400 (24 hr) \$26.50 EA.



MINI-SIZED I.C. AM RADIO

Size smaller than a box of matches!
Receives all AM stations.
Batteries and ear phones included.
Only \$10.50



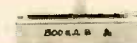
12 DC MINI RELAY

6V	SPDT	2 AMP	1.30
12V	SPDT	3 AMP	1.60
12V	DPDT	2 AMP	2.50
12V	4PDT	3 AMP	3.50



LINEAR SLIDE POT

500 Ω SINGLE
Metal Case 3" Long
2 FOR \$1.20



FLUORESCENT LIGHT DRIVER KIT



With Case Only
\$6.50 Per Kit

12V DC POWERED
Lights up 8 ~ 15 Watt Fluorescent Light Tubes. Ideal for camper, outdoor, auto or boat. Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light tube not included!

SUPER FM WIRELESS MIC KIT — MARK III



FMC-105
\$11.50 PER KIT

This new designed circuit uses high FET transistors with 2 stages pre amp. Transmits FM Range (88-120 MHz) up to 2 blocks away and with the ultra sensitive condenser microphone that comes with the kit, allows you to pick up any sound within 15 ft. away! Kit includes all electronic parts, OSC coils, and P.C. Board, Power supply 9V D.C.

PRESS-A-LIGHT SELF GENERATED FLASHLIGHT

EXCLUSIVE!! \$3.95 ea
Model F-179



Never worry about battery, because it has none! Easy to carry in pocket and handy to use. Ideal for emergency light. It generates its own electricity by squeezing grip lever. Put one in your car, boat, camper or home. You may need it some time!

ELECTRONIC DUAL SPEAKER PROTECTOR



Cut off when circuit is shorted or over load to protect your amplifier as well as your speakers. A must for OCL circuits.

KIT FORM
\$8.75 EA.

"FISHER" 30 WATT STEREO AMP



Super Buy
Only \$18.50

MAIN AMP (15W x 2)
Kit includes 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board. Power supply ± 16V DC (not included). Power band with (KF 1% ± 3dB). Voltage gain 33dB. 20Hz - 20KHz.

SUPER 15 WATT AUDIO AMP KIT

Uses STK-015 Hybrid Power Amp
Kit includes: STK-015 Hybrid IC, power supply with power transformer, front Amp with tone control, all electronic parts as well as PC Board. Less than 0.5% harmonic distortion at full power 1/2dB response from 20-100,000 Hz.



This amplifier has QUASI — Complimentary class B output. Output max is watt (10 watt RMS) at 4Ω. ONLY \$23.50 each

HICKOK LX303 DIGITAL LCD MULTIMETER



• 3 1/2 digits display • 200 hours 9V battery life • Auto zero; polarity; overrange indication • 100MV DC F.S. sensitivity • 19 ranges and functions • D.C. volt: 0.1 V to 1000V • A.C. volt: 0.1 V to 600 V • Resistance: 0.1Ω to 20 MΩ • D.C. current: 0.01 A to 100 MA

OUR PRICE \$71.45

PUSH-BUTTON SWITCH



N/Open Contact
Color: Red, White, Blue, Green, Black
3/\$1.00
N/Close also Available
50¢ each
LARGE QTY. AVAILABLE

HEAVY DUTY CLIP LEADS



10 pairs — 5 colors Alligator clips on a 22" long lead. Ideal for any testing.
\$2.20/pack

MANY SOUND DECISIONS!



\$3.60 EACH

Solid state sound indicator operating voltage 6V DC 30mA. Small size approximately 3/4" x 1 1/4".

Model EB2116 (Continuous)
Model EB2126 (Slow Pulse)
Model EB2136 (Fast Pulse)



Continuous

Slow pulse

Fast pulse

"C" SIZE BATTERY PACK



10 C size ni-cd battery in dng pack, gives out 12.5V D.C. 1.8 amp per hour. All fresh code, pull-out from movie cameras. Can be disconnected to use as single c cells. Hard to find \$15.00 per pack of 10 batteries

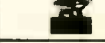
ELECTRONIC ALARM SIREN



AU-999 \$7.50

COMPLETE UNIT
Ideal for use as an Alarm Unit or hookup to your car back-up to make a reverse indicator. Light Output up to 130dB. Voltage supply 6 12V

SUB MINIATURE TOGGLE SWITCH



SPST 2 FOR 2.80 SPDT 2 FOR 3.20
6 AMP 125V AC CONTACT



TRANSFORMERS

ALL 117 VOLT INPUT

30V CT	4 AMP	\$8.50 EA.
36V CT	3 AMP	\$10.50 EA.
48V CT	3 AMP	\$10.50 EA.
24V CT	3 AMP	\$10.50 EA.
24V CT	0.8 AMP	\$2.50 EA.
12V CT	0.5 AMP	\$2.50 EA.
12V CT	120 MA	\$1.80 EA.



AC POWER SUPPLY

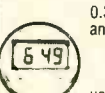
12V AC	Output	200 MA	\$2.75 EA.
16V CT AC	Output	100 MA	\$2.10 EA.
6V DC	Output	120 MA	\$1.90 EA.
12V DC	Output	100 MA	\$1.90 EA.

ULTRASONIC SWITCH KIT



Kit includes the Ultra Sonic Transducers, 2 PC Boards for transmitter and receiver. All electronic parts and instructions. Easy to build and a lot of uses such as remote control for TV, garage door, alarm system or counter. Unit operates by 9-12 DC. \$15.50

COMPLETE TIME MODULE



0.3" digits LCD Clock Module with month and date, hour, minute and seconds. As well as stop watch function!! Battery and back up light is with the module. Size of the module is 1" dia. Ideal for use in auto panel, computer, instrument and many others! \$8.95 EACH

SOUND ACTIVATED SWITCH



\$1.75 ea.

All parts completed on a PC Board SCR will turn on relay, buzzer or trigger other circuit for 2 - 10 sec. (adjustable). Ideal for use as door alarm, sound controlled toys and many other projects. Supply voltage 4.5V 9V D.C. 2 for \$3.00

FM WIRELESS MIC KIT



It is not a pack of cigarettes. It is a new FM wireless mic kit! New design PC board fits into a plastic cigarette box (case included). Uses a condenser microphone to allow you to have a better response in sound pick-up. Transmits up to 350 ft.! With an LED indicator to signal the unit is on #FMM2 KIT FORM \$7.95

REGULATED DUAL VOLTAGE SUPPLY KIT

±4 30V DC 800 MA adjustable, fully regulated by Fairchild 78MG and 79MG voltage regulator I.C. Kit includes all electronic parts, filter capacitors, I.C., heat sinks and P.C. board.

\$12.50 PER KIT

AA SIZE NI-CD SPECIAL SALE

RECHARGEABLE BATTERIES
LIMITED QUANTITY AVAILABLE

BECKMAN FET LIQUID CRYSTAL DISPLAY

Overall size 2" x 1.2" 0-5" characters reflective type.

Model 737-01 — for clock 4 digits with PM, alarm, snooze, colen indicators.
Model 739-04 — for panel meter 4 digits.

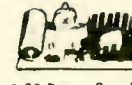
Model 739-03 — for panel meter 3 1/2 digits with ± sign and over range indicator.

All displays include zeber connectors and front bezel. With data sheets.
Your choice — any model \$7.50 EACH



POWER SUPPLY KIT

0-30V D.C. REGULATED
Uses UA723 and ZN3055 Power TR output can be adjusted from 0-30V, 2 AMP. Complete with PC board and all electronic parts.
Transformer for Power Supply 0-30 Power Supply 2 AMP 24V x 2 \$8.50 \$10.50 each



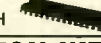
I.C. TEST CLIPS

Same as the E-Z clips \$2.75
With 20" Long Leads
In Black and Red Colors per pair



SOUND GENERATOR I.C.

Creates almost any type of sound — gun shot, explosion, train, car crash, star war, birds, organ ext. A built-in audio amplifier provides high level output. Operates from one 9V battery, 28 pin dip; we supply the datas. \$2.90 EACH



ELECTRONIC SWITCH KIT

CONDENSER TYPE
Touch On Touch Off
uses 7473 I.C. and
12V relay
\$5.50 each



1 WATT AUDIO AMP

All parts are pre-assembled on a mini PC Board. Supply Voltage 6 9V D.C. SPECIAL PRICE \$1.95 ea.



LOW TIM DC STEREO PRE-AMP KIT TA-10 20

Incorporates brand-new D.C. design that gives a frequency response from 0Hz — 100KHz ± 0.5dB! Added features like tone defeat and loudness control let you tailor your own frequency supplies to eliminate power fluctuation!

Specifications: • T.H.D. less than .005% • T.I.M. less than .005% • Frequency response: DC to 100KHz ± 0.5dB • RIAA deviation: ± 0.2dB • S/N ratio: better than 70dB • Sensitivity: Phono 2MV 47K/Aux. 100MV 100K • Output level: 1.3V • Max. output: 15V • Tone control: bass ± 10dB @ 50Hz/treble ± 10dB @ 15Hz • Power supply: ± 24 D.C. @ 0.5A
Kit comes with regulated power supply, all you need is a 48V C.T. transformer @ 0.5A

ONLY \$44.50
X'former



SOLID STATE ELECTRONIC BUZZER

Mini size 1" x 3/4" x 3/4"
Supply voltage 1.5V - 12V
Ideal for Alarm or Tone Indicator



\$1.50 each

FORMULA INTERNATIONAL INC.

6/80

Inside California	SHIPPING AND HANDLING CHARGES	Under \$50.00 purchase	Over \$50.00 purchase
Outside Calif. (includes Mexico & Canada)		10%	15%
Outside		15%	20%
Minimum order \$10.00/Calif. Residents Add 6% Sales Tax			
Phone Orders Accepted on Visa or MC ONLY. NO C.O.D. Store Hours 10-7 Mon. thru Sat.			
12603 CREENSHAW BLVD. HAWTHORNE, CA 90250			
PHONE: (213) 973-1821 • (213) 679-5162			

Send \$1.00 For Detailed Catalogue

NEW PRODUCTS!

Super Color S-100 Video Kit \$99.95

Expandable to 256 x 192 high resolution color graphics. 6847 chip; all display modes computer controlled. Memory mapped, 1K RAM expandable to 6K. S-100 bus 1802, 8080, 8085, Z80 etc.

Gremlin Color Video Kit \$59.95

32 x 16 alpha/numerics and graphics; up to 8 colors with 6847 chip; 1K RAM at E000. Plugs into Super Elf 44 pin bus. Not expandable to high resolution Graphics.

Quest Super Basic

Quest, the leader in inexpensive 1802 systems announces another first. Quest is the first company worldwide to ship a full size Basic for 1802 systems. A complete function Super Basic by Ron Cenkler including floating point capability with scientific notation (number range +/- 17E^2). 32 bit integer +/- 2 billion; Multi dim arrays; String arrays; String manipulation; Cassette I/O. Save and load, Basic, Data and machine language programs; and over 75 Statements, Functions and Operators

Easily adaptable on most 1802 systems. Requires 12K RAM minimum for Basic and user

Elf II Adapter Kit \$24.50

Plugs into Elf II providing Super Elf 44 and 50 pin bus plus S-100 bus expansion (With Super Expansion). High and low address displays, state and mode LED's optional \$18.00.

1802 16K Dynamic RAM Kit \$149.00

1802/S-100 expandable to 32K. Hides refresh w/clocks up to 4 MHz w/no wait states Add. 16K RAM \$79.00.

programs. Cassette version in stock now. ROM versions coming soon with exchange privilege allowing some credit for cassette version.

Super Basic on Cassette \$40.00

Tom Pittman's 1802 Tiny Basic Source listing now available. Find out how Tom Pittman wrote Tiny Basic and how to get the most out of it. Never offered before. \$19.00

S-100 4-Slot Expansion \$ 9.95

Super Monitor V.I Source Listing \$15.00

Coming soon: Assembler, Editor, Disassembler, DA/DJ, Super Sound/Music, EPROM programmer, Stringy Floppy Disc System.



RCA Cosmac Super Elf Computer \$106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the Super Elf for so little money. The Super Elf is a small single board computer that does many big things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily expanded with additional memory, Full Basic, ASCII Keyboards, video character generation, etc. Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply, Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

A 24 key HEX keyboard includes 16 HEX keys plus LED, reset, run, wait, input, memory protect, monitor select and single step. Large, on board displays provide output and optional high and low address. There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for all IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game. Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and R & D. Remember, other computers only offer Super Elf features at additional cost or not at all. Compare before you buy. Super Elf Kit \$106.95, High address option \$8.95, Low address option \$9.95. Custom Cabinet with drilled and labelled plexiglass front panel \$24.95. Expansion Cabinet with room for 4 S-100 boards \$41.00. NiCad Battery Memory Saver Kit \$6.95. All kits and options also completely assembled and tested. Quesdata, a 12 page monthly software publication for 1802 computer users is available by subscription for \$12.00 per year. Issues 1-12 bound \$16.50. Tiny Basic Cassette \$10.00, on ROM \$38.00, original Elf kit board \$14.95. 1802 software; Moew's Video Graphics \$3.50. Games and Music \$3.00, Chip 8 Interpreter \$5.50.

The Super Elf includes a ROM monitor for program loading, editing and execution with SINGLE STEP for program debugging which is not included in others at the same price. With SINGLE STEP you can see the microprocessor chip operating with the unique Quest address and data bus displays before, during and after executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 video graphics chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a speaker system included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

Super Expansion Board with Cassette Interface \$89.95

This is truly an astounding value! This board has been designed to allow you to decide how you want it optioned. The Super Expansion Board comes with 4K of low power RAM fully addressable anywhere in 64K with built-in memory protect and a cassette interface. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the Super Elf. The board includes slots for up to 6K of EPROM (2708, 2758, 2716 or TI 2716) and is fully socketed. EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor \$19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with

subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the Super Expansion Board and Super Monitor the monitor is up and running at the push of a button.

Other on board options include Parallel Input and Output Ports with full handshake. They allow easy connection of an ASCII keyboard to the input port. RS 232 and 20 ma Current Loop for teletype or other device are on board and if you need more memory there are two S-100 slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. Parallel I/O Ports \$9.85, RS 232 \$4.50, TTY 20 ma I/F \$1.95, S-100 \$4.50. A 50 pin connector set with ribbon cable is available at \$15.25 for easy connection between the Super Elf and the Super Expansion Board.

Power Supply Kit for the complete system (see Multi-volt Power Supply below).

TERMS: \$5.00 min. order U.S. Funds. Calif residents add 6% tax. BankAmericard and Master Charge accepted. Shipping charges will be added on charge cards.

Same day shipment. First line parts only. Factory tested. Guaranteed money back. Quality IC's and other components at factory prices.

INTEGRATED CIRCUITS

Table listing integrated circuits such as 7400TTL, 7402N, 7404N, etc. with their respective pin counts and prices.

ELECTRONICS

Table listing various electronic components including resistors, capacitors, IC sockets, connectors, crystals, and transformers with their specifications and prices.

ROCKWELL AIM 65 Computer

6502 baseo single board with full ASCII keyboard and 20 column thermal printer. 20 char. alphanumeric display. ROM monitor, fully expandable. \$375.00. 4K version \$450.00. 4K Assembler \$85.00. 8K Basic Interpreter \$100.00.

Special small power supply for AIM65 assem. in frame \$49.00. Complete AIM65 in thin briefcase with power supply \$485.00. Molded plastic enclosure to fit AIM65 plus power supply \$47.50. Special Package Price: 4K AIM, 8K Basic, power supply, cabinet \$599.00.

AIM65/KIM/VIM/Super Elf 44 pin expansion board; 3 female and 1 male bus. Board plus 3 connectors \$22.95. AIM65/KIM/VIM I/O Expansion Kit; 4 parallel and 2 serial ports plus 2 internal timers \$39.00. ROM programmer for 2716 \$150.00.

Multi-volt Computer Power Supply

8v 5 amp., ±18v 5 amp., 5v 1.5 amp., -5v .5 amp., 12v 5 amp. 12 opt. option. ±5v. ±12v are regulated. Kit \$29.95. Kit with punched frame \$37.45. \$4.00 shipping. Kit of hardware \$14.00. Woodgrain case \$10.00, \$1.50 shipping.

PROM Eraser

Will erase 25 PROMs in 15 minutes. Ultraviolet, assembled \$37.50. Safety switch/Timer version \$69.50.

60 Hz Crystal Time Base Kit \$4.40

Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy.

NiCad Battery Fixer/Charger Kit

Opens shorted cells that won't hold a charge and then charges them up, all in one kit w/all parts and instructions. \$7.25

LRC 7000 + Printer \$389.00

40/64 column dot matrix impact. std. paper. Interface all personal computers.

Televideo Terminal \$845.00

102 key, upper, lowercase, 10 baud rates x 80 char. microprocessor cont. edit. cap.

Intertube II Terminal \$874.00

Super Bin Floppy Disk Terminal \$2895.00

79 IC Update Master Manual \$29.95

Complete IC data selector, 2500 pg. master reference guide. Over 50,000 cross references. Free update service through 1979. Domestic postage \$3.50. No foreign orders.

S-100 Computer Boards

Table listing computer boards like 8K Static RAM Kit, 16K Static RAM Kit, etc. with prices.

Video Modulator Kit \$8.95


Convert TV set into a high quality monitor w/o affecting usage. Comp. kit w/all instr. \$11.75

Digital Temp. Meter Kit \$34.00

Indoor and outdoor. Switches back and forth. Beautiful. 50° LED readouts. Nothing like it available. Needs no additional parts for complete, full operation. Will measure -100° to +200°F, tenths of a degree, air or liquid. Beautiful woodgrain case w/bezel \$11.75

Why Wait for Mail Order Delivery? Make The Shack® Your Parts Place!

100% Prime ICs

Low As **49¢** 

Guaranteed Specs

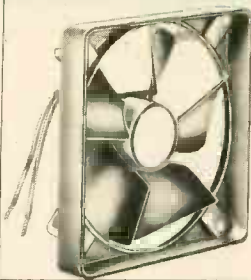
4000-Series CMOS ICs

Type	Cat. No.	EACH
4001	276-2401	.69
4011	276-2411	.69
4012	276-2412	.79
4013	276-2413	.99
4017	276-2417	1.69
4020	276-2420	1.69
4021	276-2421	1.69
4023	276-2423	.69
4027	276-2427	.99
4028	276-2428	1.29
4046	276-2446	1.89
4511	276-2447	1.69
4049	276-2449	.79
4050	276-2450	.79
4051	276-2451	1.49
4066	276-2466	1.39
4070	276-2470	.79
4518	276-2490	1.49
4543	276-2491	1.99

Improved 5-volt logic devices use Schottky diode technology for minimum propagation delay and high speed at minimum power.

Type	Cat. No.	ONLY
74LS00	276-1900	.49
74LS02	276-1902	.59
74LS04	276-1904	.59
74LS08	276-1908	.49
74LS10	276-1910	.59
74LS13	276-1911	.99
74LS20	276-1912	.59
74LS27	276-1913	.69
74LS30	276-1914	.59
74LS32	276-1915	.69
74LS47	276-1916	1.29
74LS51	276-1917	.59
74LS73	276-1918	.69
74LS74	276-1919	.69
74LS75	276-1920	.99
74LS76	276-1921	.79
74LS85	276-1922	1.29
74LS90	276-1923	.99
74LS92	276-1924	.99
74LS93	276-1925	.99
74LS123	276-1926	1.19
74LS132	276-1927	.99
74LS151	276-1929	.99
74LS157	276-1930	1.19
74LS161	276-1931	1.49
74LS164	276-1932	1.49
74LS175	276-1934	1.19
74LS192	276-1935	1.49
74LS193	276-1936	1.49
74LS194	276-1937	1.49
74LS196	276-1938	1.59
74LS367	276-1835	1.19
74LS368	276-1836	1.19
74LS373	276-1943	2.39
74LS374	276-1944	2.39

All Prime from Major Semiconductor Manufacturers. Specs and Pin Out Diagram Included with Each Device.



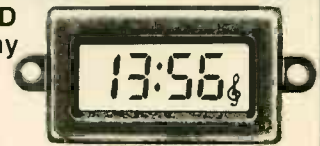
4" AC Cooling Fan

12⁹⁵ Value and Quality!

Ideal for power supplies, computers, hi-fi and Ham gear. Delivers up to 70 CFM, yet very quiet. Diecast venturi. U.L. recognized motor. 4.63x4.63x2.47", 120VAC, 60 Hz
273-241 12.95

12/24 Hr. LCD Clock Display

19⁹⁵



Actual Size!

• Time/Day/Date
• 24-Hour Alarm

Just add switches and a buzzer for a complete alarm clock! 0.25"-tall LCD has backlight, alarm set and PM indicators. Runs a year on single 1.5V battery. Accuracy: ± 13 seconds/month. 277-1005 19.95
Mini Piezo Buzzer. For above. 273-064 1.99

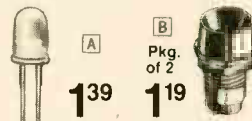
Rhythm Pattern Generator



5⁹⁹

Build your own rhythm box or drum synthesizer! Provides 6 separate patterns which can be mixed. Trigger outputs for wood block, brushes, bongo, snare and bass drum. 16-pin with data, circuits. PMOS. MM5871.
276-1785 5.99

Tri-Color LED



1³⁹

1¹⁹

A Tri-Color LED. Red on DC, green on reverse DC, yellow on AC. Max. current: 25 mA. 276-035 1.39
B Chrome Holders. Ideal for panel mounting above.
276-080 Pkg. of 2/1.19

SN76477 Sound Effects and Music Synthesizer IC

2⁹⁹



Combines Linear and ²L Technology

Creates almost any type of sound — music, phaser gun, explosions and gunshots! 28-pin DIP has 2 VCOs, low frequency osc., noise generator, filter, 2 mixers, timing logic. Line level output. With data.
276-1765 2.99

Noise Generator IC

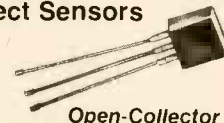
2⁶⁹ White or Pink Noise



S2688. 17-bit shift register clocked by internal osc. provides consistent noise quality. Can also be used as a random event generator. Single or dual supply. 8-pin DIP with data. Use with 276-1785 (above).
276-1768 2.69

Hall-Effect Sensors

1⁹⁸



Pkg. of 3 Open-Collector (Switching Type) Output

Ideal for tachs, position sensing, counting. Detects magnetic fields electronically. 750 gauss "on" threshold. 5-16VDC supply. TO-92 case. With data.
276-1646 3/1.98

Oscillator/Divider IC

2⁶⁹



Generates Stable 60 Hz Reference

CMOS IC provides accurate 60 Hz square wave. Ideal for a battery-powered time base! Requires 3.58 MHz crystal, available through your neighborhood Radio Shack. 3-15VDC. 8-pin DIP with data.
276-1769 2.69

V to F, F to V Converter IC

3⁴⁹



Interfaces With Any Logic

9400CJ. Truly, a multi-function device! Use as A/D converter, data transceiver, FM modulator/demodulator, RPM indicator, systems measurements control and more. Operates to 100 kHz. 14-pin DIP with data. 276-1790 3.49



Precision Panel Meters

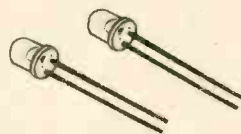
Your Choice **8⁹⁵**

Jeweled D'Arsonval Movements

Wide-angle meters let you monitor critical circuit changes — and dress up your projects. Accuracy: ± 5% full scale. All are 2 3/4 x 2 1/4 x 1 1/4" overall and require a 1 7/8" mounting hole.

0-50 μ A DC. 270-1751 8.95
0-1 mA DC. 270-1752 8.95

Infrared LED Emitter/Detector Pair



1⁹⁹ Pair

Use for isolated data transfer. Submini LED source rated 20 mA at 1.7VDC. Matched detector uses a photo-transistor for high sensitivity.
276-142 Pair 1.99

Basic Electricity And Circuit Concepts Vols. I and II

6⁹⁵ Each Both **10⁸⁸** Only



Published by Texas Instruments Learning Center. DC Circuits Vol. I covers basic concepts and related math. Vol. II includes advanced methods of circuit analysis based on Kirchoff's laws. Get the complete course, save \$3.02!
62-2019, 62-2020 Both for 10.88

LOW PRICES AND NEW ITEMS EVERY DAY!
IN STOCK NOW AT OUR STORE NEAR YOU

Radio Shack®

A DIVISION OF TANDY CORPORATION • FORT WORTH, TEXAS 76102
OVER 7000 LOCATIONS IN 40 COUNTRIES

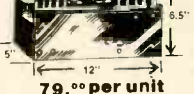
Prices may vary at individual stores and dealers

CIRCLE 33 ON FREE INFORMATION CARD

Power Supplies

INPUT: 115 vac 43-63 hz
 OUTPUT: 5 vdc @ 25 amps
 REGULATION: 0.1% + 5mV
 NL-FL, ± 0.1% ± 5mV for 10%
 Input change
 RIPPLE: 2mV RMS max., 20 mV
 P-P max.
 STABILITY: Typically 10 mV for
 eight hour period

5 volts @ 25 amps
SURPLUS UNITS IN LIKE NEW CONDITION



79.00 per unit

REMOTE SENSING, REMOTE VOLTAGE ADJUSTMENT, OVERLOAD PROTECTION AND OVERVOLTAGE PROTECTION

10 MEG POTS

Standard 1/4 Watt Size
 3/4" Long Shaft
 1/4" Dia.
 25 For \$5.00 4 For \$1.00



• 3-1/2 inch long • 2-3/4 inch slide

22/44 EDGEBOARD CONNECTOR

TIN SOLDER TAIL .156" x .200"

LARGE QUANTITIES AVAILABLE
 \$1.35 each 10 for \$12.50

PHOTO — FLASH CAPACITOR

1100 MFD 330 VOLTS
 3 1/2" x 1 1/4"
 \$1.50 Each



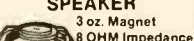
• 14 pin style
 • 3 amp contacts
 • 24 volt d.c. or
 • 120 volt a.c. coil
 • Used but fully tested

POTTER BRUMFIELD 4 PDT RELAYS

\$1.25 each
 Specify coil voltage
 LARGE QUANTITIES AVAILABLE

3x5" OAKTRON SPEAKER

3 oz. Magnet
 8 OHM Impedance
 \$2.50 each



• 9-15 VOLT D.C.
 NORMALLY OPENED
 CONTACTS: 1 amp max.
 switch — 2 amp max. carry
 BODY SIZE: approx. 1 inch
 long 3/4 inch high
 S.P.S.T. 1500 ohm coil
 \$1.15 each
 U.P.S.T. 1200 ohm coil
 \$1.30 each
 3.P.S.T. 750 ohm coil
 \$1.50 each

ALL ELECTRONICS CORP.

905 S. Vermont Ave. SEND FOR OUR FREE CATALOG
 Los Angeles, CA 90006
 (213) 380-8000

Store & Warehouse Hours
 9 AM - 5 PM
 Monday thru Friday
 Saturday
 10 AM - 3 PM

TERMS

- Quantities Limited
- Min. Order \$10.00
- Add \$2.00 Shipping USA
- Calif. Res. Add 6%
- Prompt Shipping

CIRCLE 46 ON FREE INFORMATION CARD

SOUND EFFECTS GENERATOR BASIC KIT

NOW CHANEY ELECTRONICS MAKES IT POSSIBLE TO BUILD YOUR OWN SOUND EFFECTS GENERATOR WITHOUT SPENDING A FORTUNE. WE SUPPLY YOU WITH THE T17677 SOUND CHIP PLUS AN ETCHED AND DRILLED GLASS EPoxy PC BOARD WITH SCHEMATIC AND LAYOUT INSTRUCTIONS. THIS BOARD MAKES IT SIMPLE TO BUILD A GENERATOR CAPABLE OF PHASER SOUNDS, LOGGOTIVE, BIRENS, AIRPLANES, CLOCKS, ETC. DOES NOT REQUIRE DIP SWITCHES OR OTHER EXPENSIVE/UNUSUAL COMPONENTS. YOU SUPPLY ONLY A FEW STANDARD RESISTORS, CAPACITORS, SWITCHES, POTS, SPEAKER, 2N2222 TRANSISTOR AND 9V BATTERY.

DAISY KIT CONTAINING T17677, PC BOARD AND INSTRUCTIONS ONLY \$5.95

2N2222 TRANSISTOR FOR ABOVE \$2.98 EA
 IF YOU HAVE ALREADY PURCHASED THE T17677 CHIP YOU MAY BUY THE PC BOARD AND INSTRUCTIONS ONLY \$3.85

Strobe Tube & Trigger

C24081 \$1.75



6VDC Xenon Flasher Kit

C24082 \$8.00



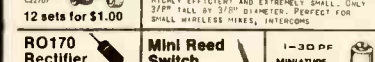
120 VAC Xenon Strobe Kit

C22071 \$7.50



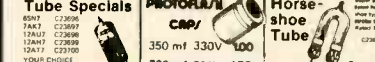
LED Panel Mounting Kit

C22707 \$2.00



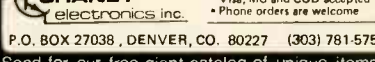
RO170 Rectifier

C23184 5 for \$1.00
 100 for \$15.00



Tube Specials

6X4 \$2.99
 6X4T \$2.99
 6X4CT \$2.99
 6X4T \$2.99
 6X4T \$2.99
 YOUR CHOICE \$2.99



Send for our free giant catalog of unique items!!!

CIRCLE 8 ON FREE INFORMATION CARD

CFR Associates, Inc.

NEW SHIPMENT!!!

Used **DAISY WHEEL TERMINALS**
 Featuring **DIABLO 'HYTYPE' PRINTERS**



Features:
 • KSR & Plot Modes
 • ASCII RS-232 I/O
 • 110, 115, 300 Baud Input
 • Dual Pitch (10-12)
 • 30 Day Guarantee
 • Many More Exciting Features!

These used, cleaned and refurbished Daisy Wheel Terminals feature the FAMED DIABLO 'HYTYPE' Daisy Wheel Printer with its multitude of capabilities. Includes 1/60" horizontal & 1/46" vertical spacing in the "PLOT" mode.
 — LIMITED OFFER, SPECIAL PRICE! —
ONLY \$1650.00
 We also offer many types of printers "Selectric", KSR, RO & More

FOR EXAMPLE
 I/O "SELECTRIC" Printer/Typewriter. Corresp. code, 15" frame, hvy. duty 735-745 machine and solenoids, etc. Data and schematics included. As is, operational cond. **Only \$469.00**
 Removed from Word Processors (Price includes cleaning & shipping within the U.S.) Call For Intel

ELETYPE ASR-33 SPECIAL!!

• Auto Send Receive • Paper Tape Reader-Punch
 JUST IN!!! "Teletype" machines with keyboard, printer, case, tape reader & punch. USED as-is (may need some repair or adjustment). **BARGAIN PRICED!**
ONLY \$299.00
 "Teletype" is a Registered Trademark of Teletype Corp.

IBM MODEL 1980 KSR (Keyboard Send-Receive) "SELECTRIC" I/O PRINTERS

Used, removed from service (previously under maintenance contract), as-is, good to excellent condition. Data
ONLY \$399.00 WHILE THEY LAST!!!
 Prices include cleaning & shipping within the U.S.

Write or Call for Our Exclusive
"USED PERIPHERAL FLYER"
(603)382-5179
 • Mastercharge & VISA Accepted
 • Phone Orders Are Welcome
 • Prices May Not Include Shipping & Handling
 • Quantities Are Limited • Prices Are Subject To Change

CIRCLE 43 ON FREE INFORMATION CARD



needed for most general purpose uses

Model 178. A no-frills 4 1/2-digit three-function DMM for production use. High accuracy and all the capability
\$235



switch selectable HI-LO ohms

Model 179. Has all the features offered by the 178 plus TRMS AC, AC and DC current, 10µV sensitivity, and
\$319



beyond the 2A range of most DMMs

Model 179-20A
 Has all the features of the Model 179 but also includes an additional 20A range, for applications
\$359



curacy and 1V analog output

Model 177. This five-function, 4 1/2-digit DMM has 1µV, 1mΩ, 1nA sensitivity, TRMS AC, 0.03% basic ac-
\$429



Also has pushbutton null

Model 191. Our top-of-the-line, 5 1/2-digit DMM. Microprocessor control provides 0.007% basic DC accuracy.
\$549

Model 169. Our "macho meter" is a tough, 3 1/2-digit bench DMM with 0.25% basic DC accuracy, large 0.6" LCD display, range and function annunciators on the display and 1-year battery life.

\$149

Model 130. Our rugged, hand-held 3 1/2-digit LCD DMM has five full functions, 0.5% basic DC accuracy, easy-to-use rotary switches, impact-resistant case, light (only 10 oz.) weight and a 10A current range.

\$99

KEITHLEY

SEND FOR OUR CATALOG

Call TOLL FREE:
 NORTHEAST REGION (800) 526-2514
 N.J. CALL:
 (201) 227-7720

AMPOWER INST., INC.

26 JUST ROAD, FAIRFIELD, N.J. 07006
 OUT OF NORTHEAST—CALL COLLECT

"WE SERVICE WHAT WE SELL"



FREE
 TEST LEADS WITH EVERY ORDER

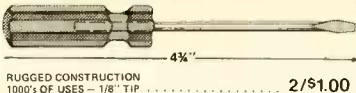
CALL TODAY

Mastercharge BankAmericard and COD Accepted add \$10.00 to cover shipping handling insurance N.J. res. add 5% tax.

PRICES SUBJECT TO CHANGE

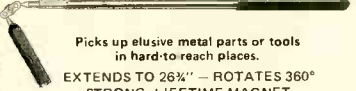
CIRCLE 36 ON FREE INFORMATION CARD

MINIATURE SCREWDRIVER



RUGGED CONSTRUCTION 1000'S OF USES - 1/8" TIP 2/\$1.00

MAGNETIC RETRIEVE TOOL



Picks up elusive metal parts or tools in hard-to-reach places. EXTENDS TO 26 3/4" - ROTATES 360° STRONG, LIFETIME MAGNET

MRT-2281 \$3.95

CONTINENTAL SPECIALTIES

LOGIC PROBE KIT



SPECIFICATIONS

Input Impedance: 300,000 Ohms. Thresholds: "Lo" 30%Vcc - "Hi" 70%Vcc. Maximum Speed: 300 nsec., 1.5MHz. Input Protection: ±50VDC continuous 117VAC for 15 sec. Power: 30mA @5V - 40mA @ 15V - 25V max. reverse voltage protected; 36" cable with color coded clips included. Operating Temp.: 0-50°C. Dimensions: 5.8L x 1.0W x 0.7D in. (147 x 25 x 18mm). Weight: 30 oz. (85 gm)

LPK-1 \$21.95/Kit

Proto Clips



Table with 2 columns: Clip Type and Price. Includes 14-PIN CLIP PC-14, 16-PIN CLIP PC-16, 24-PIN CLIP PC-24, and 40-PIN CLIP PC-40.

Proto Boards

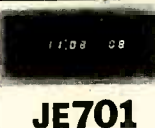


Table with 2 columns: Board Type and Price. Includes PB-6, PB-100, PB-101, PB-102, PB-103, PB-104, PB-203, PB-203A, and PB-203A-Kit.

Jumbo 6-Digit Clock Kit

Four .630"ht. and two .300"ht. common anode displays. Uses MM5314 clock chip. Switches for hours, minutes and hold functions. Hours easily viewable to 30 feet. Simulated walnut case. 115 VAC operation. 12 or 24 hour operation. Includes all components, case and wall transformer. Size: 6 1/2 x 3 1/2 x 1 1/4

JE747 \$29.95

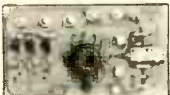


6-Digit Clock Kit

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3 1/2" x 5" x 2 1/4"

JE200 \$14.95



ADAPTER BOARD - Adapts to JE200 - ±5V, ±9V and ±12V

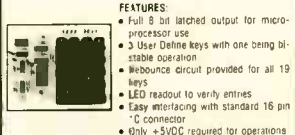
DC/DC converter with ±5V input. Toroidal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3 1/2" x 2" x 9/16" H

JE205 \$12.95

MICROPROCESSOR COMPONENTS

Large table listing various microprocessor components, manuals, and their prices. Includes CPUs, memory chips, and logic chips.

JE600 HEXADECIMAL ENCODER KIT



FEATURES: Full 8 bit latched output for micro-processor use. User Define keys with one being bistable operation. Rebounce circuit provided for all 19 keys. LED readout to verify entries. Easy interfacing with standard 16 pin IC connector. Only ±5VDC required for operations.

JE600 \$59.95 Hexadecimal Keypad only \$14.95

62-Key ASCII Encoded Keyboard Kit



FEATURES: 60 Keys generate the full 128 characters, upper and lower case ASCII set. Fully buffered and user-definable keys provided for custom applications. Caps lock for upper case only alpha characters. Utilizes a 2376 (40 pin) encoder read only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector.

JE610 \$79.95 62-Key Keyboard only \$34.95

DIGITAL THERMOMETER KIT



FEATURES: Dual sensors-switching control for indoor/outdoor or dual monitoring. LCD contrast L.C.D. 8" Ht. display. Accuracy: ±0.1° to ±1.0° C. Resolution: ±0.1° C or Celsius reading. Slim, walnut case - AC wall adapter incl. Size: 3-1/4" X 6-5/8" X 1-3/8" D

JE300 \$39.95

HICKOK LX303 Portable LCD Digital Multimeter



FEATURES: 8 1/2" x 1 1/2" high, 3 1/2" Digit Liquid Crystal Display. Over 2000 Hours of operation with a 9V battery. Automatic zero, polarity and overrange indicators. 1000V D.C. F sensitivity. 1% basic accuracy. Full range and functions. Rugged Carabide Case and removable cover, stores test lead set.

LX303 1% ACCURACY \$74.95 LX304 5% ACCURACY \$89.95

Specifications, price list, and order information for the multimeter.

MAIL ORDER ELECTRONICS - WORLDWIDE 1355 SHOREWAY ROAD, BELMONT, CA 94002 PRICES SUBJECT TO CHANGE

The Incredible "Pennywhistle 103"



\$139.95 Kit Only. The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and is able to communicate directly with another modern and terminal for telephone "ringing" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with: 8 each UPD416-1 (16K Dynamic Rams) 250NS. Documentation for conversion.

TRS-16K \$75.00

Advertisement for 'ok' brand 'JUST WRAP' wire. Includes images of the product and a list of specifications and prices.

Advertisement for 'ok' brand 'JUST WRAP' Replacement Wire. Includes a list of wire types and prices.

JUST WRAP Unwrap Tool \$3.49

Advertisement for 'ok' brand Vacuum Vise. Includes an image of the vise and its specifications.

Advertisement for an Adjustable Wrench. Includes an image of the wrench and its specifications.

6" - AW-6 \$4.95 10" - AW-10 \$6.95

JOYSTICK VIDEO CONTROLLER



IDEAL FOR ALL VIDEO GAMES OR REMOTE CONTROL PROJECTS. SMALL CASE SIZE: 1-1/2" H x 2-3/8" W x 4-5/16" L. 2 MINIATURE POTENTIOMETERS - 40K OHM EACH. SPST PUSH BUTTON CONTROL. 6-WIRE CONNECTION CABLE - 5 FEET LONG. RUGGED PLASTIC CASE.

JVC-40 \$4.95 each

Z-80
*
\$1250

MISCELLANEOUS CIRCUIT SPECIALS

7408 .20	74LS27 .30	CD4049B .45
7416 .20	74LS27 .30	HC14520B 1.25
7474 .35	74LS122 .50	MC14528BCP 1.00
74181 1.55	74LS175 .95	NE555 .28
74393 1.85	74LS367 .75	NE556 .75
74LS03 .24	74LS386 .80	LM3900 .58
74LS08 .32	74LS393 1.95	8C3083 1.25
74LS09 .35	74S05 .45	C2416 3.99
74LS20 .30	74S51 .50	N2431 1.99

8038C
VCO Waveform Gen
w/sine **\$265**

78H05
\$595

base2, inc.



4116
16Kx1 Static
RAM
MEMORY ADD-ON FOR THE
TRS-80 OR APPLE II *
to 450ns
8 for **\$595**

video 100
12" BLACK & WHITE
LOW COST VIDEO
MONITOR **\$129⁰⁰**

LOGIC PROBE KIT
\$1795



8216 BUS DRIVER **\$199**

I.C. MASTER
NEW
"1980" **\$595**

2708
1024x8 EPRM
\$745
450ns AMD, SGS

SOROC IQ120
\$74900



SILICON SOLAR CELLS
3" 1 AMP **\$795**
1.7" 150 ma. **\$295**

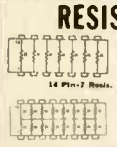
T.I./M.M.I.
74LS240
74LS241
74LS243
74LS244
74LS373
74LS374
\$245
LIMIT 10 EACH
IN STOCK

2716 16K EPROM
\$2795
450ns single+5V
T.I., HIT., INT., SGS

8212
170 PORT
3.95

ULN2001
High-current Drivers.
Darlington **69c**

RESISTOR NETWORKS
values
270, 4.7K, & 15K
OHMS
1.5K & 10K
.89 EA
100/49c



MH0026CJ
DUAL CLOCK
DRIVER **\$100**

74S373
74S374
\$325

S-100 16K ADD-ON BARE BOARD
WITH DOCUMENTATION AND
DETAILED INSTRUCTION BOOK. **\$2895**

16K STATIC RAM
S-100 MEMORY ADD-ON
** FULLY STATIC OPERATION
** USES 2114 TYPE STATIC RAMS
** +5 VDC INPUT AT LESS THAN 2 AMPS
** BANK SELECT AVAILABLE BY BANK PORT AND BANK BYTE
** PHANTOM LINE CAPABILITY
** ADDRESSABLE IN 4K BLOCKS IN 4K INCREMENTS
** LED INDICATORS FOR BOARD/BANK
** SOLDER MASK ON BOTH SIDES OF BOARD
ASSEMBLED & TESTED **\$26900**
California Computer Systems



EPROM ERASER BY SPECTOLINE
UP TO 6 EPROMS IN 19 MINUTES **\$4995**
6000 HOUR BULB LIFE ★

CONCORD COMPUTER COMPONENTS
1971 SOUTH STATE COLLEGE ANAHEIM, CA. 92806
VISA-MASTERCHARGE (714)937-0637
CHECK OR M.O. NO C.O.D.
MINIMUM ORDER \$10.00
ADD \$1.50 FOR FRT. CAL. RES. ADD 6%

CIRCLE 47 ON FREE INFORMATION CARD

GET IT ALL!

Subscribe today, and don't miss a single issue.

When you subscribe to the best electronics magazine of all—Radio-Electronics—you're making sure that you'll get all the news of electronics you want, every month from now on. Issue after issue, you'll get equipment news, test reports, projects to build, computer technology, servicing tips and more, including regular columns on computers, solid state, hi-fi, hobbies and servicing. And every one is written by the experts, the outstanding authorities in the most exciting, fastest-growing field in the world today—electronics.

Radio Electronics
PROTECT YOUR CAR AGAINST AUTO THEFT
39.25 MAR. 1982

Build a backyard satellite TV receiver
14 nifty things you can do with a PRAM IC
Build a thunderstorm alarm

New for 1980 TV sets
New super class A hi-fi amplifiers
Circuits that talk back

NIFTY WIKE-WRAP TRICKS



And...you save money, too, as much as \$5. off the newsstand price of Radio-Electronics when you select one of the subscription offers listed on the handy coupon. More important—you'll be assured of having your copy reserved, even if it runs out on the newsstands. You save money and time. Make sure you get all the excitement in every issue of Radio-Electronics, every month, by filling in and mailing the coupon, today.

GET THE BEST!—Radio-Electronics

- 1 Year—12 issues ONLY \$13.00**
(You save \$2.00 off newsstand price.)
 - 2 Years—24 issues ONLY \$25.00**
(Save More! \$5.00 off newsstand price.)
 - Payment enclosed
 - Bill me
- Extra Shipping: Canada \$3.00 per year, all other countries \$5.00 per year.

40F0

(please print)

Name _____
Address _____
City _____
State _____ Zip Code _____

Mail to: Radio-Electronics SUBSCRIPTION DEPT., P.O. BOX 2520, BOULDER, COLO. 80322

RADIO-ELECTRONICS

OUTSTANDING S-100 COMPUTER PRODUCTS

Note: Most CompuPro boards are available in 3 forms: unkit (sockets, bypass caps pre-soldered in place), assembled, or qualified under our high-reliability Certified System Component (CSC) program.

NEW! DUAL PROCESSOR BOARD

Introductory prices: \$385 unkit, \$495 assm, \$595 CSC

An 8088 gives true 16 bit power with a standard 8 bit S-100 bus, while an additional 8085 gives compatibility with CP/M and the vast library of 8080 compatible software. Accesses 16 Megabytes of memory, meets all IEEE S-100 bus specifications, runs 8085 and 8086 code in your existing mainframe as well as Microsoft 8086 BASIC and Sorcim PASCAL/M™, and runs at 5 MHz for speed as well as power. The Dual Processor Board is built to the same stringent standards that have established our leadership in S-100 components. Available June 1st.

NEW! SPECTRUM COLOR GRAPHICS BOARD

Introductory prices: \$339 unkit, \$399 assm, \$449 CSC

Includes 8K of IEEE-compatible static RAM; full duplex bidirectional parallel I/O port for keyboard, joystick, etc. interface; and 6847-based graphics generator that can display all 64 ASCII characters. 10 modes of operation, from alphanumeric/semi-graphics in 8 colors to ultra-dense 256 x 192 full graphics. 75 Ohm RS170 line output and video output for use with FCC approved modulators. We've got software, too; Sublogic's 2D Universal Graphics Interpreter (normally \$35) is yours for \$25 with the purchase of any Spectrum board. Available June 1st.

TERMS: Cal res add tax. Allow 5% for shipping, excess refunded. VISA® Mastercard® call our 24 hr. order desk at (415) 562-0636. COD OK with street address for UPS. Prices subject to change without notice.

GODBOUT

GODBOUT ELECTRONICS
Bldg. 725, Oakland Airport, CA 94614

CIRCLE 39 ON FREE INFORMATION CARD

**BSR X-10
SUPER SPECIAL
DELUXE
ULTRASONIC
CONSOLE**
REGULARLY \$49.95
NOW **\$29.95**



With the purchase of three or more modules
Modules normally \$17.00 ea.
Modules of your choice
3 for \$47.95 6 for \$83.95
Ultrasonic Hand Unit
Normally \$24.95 Now \$18.95
Please add \$3.00 for shipping

TOLL FREE HOT LINE
800-223-0474

54 WEST 45TH STREET, NEW YORK, N.Y. 10036
212-687-2224

**ADVANCE
ELECTRONICS**

ADVERTISING INDEX

RADIO-ELECTRONICS does not assume any responsibility for errors that may appear in the index below.

Free Information Number Page

12	AMC Sales	98
41	AP Products, Inc.	34
11	Aaron-Gavin Instruments	82
5	Active Electronics	105
—	Advance Electronics	36-37,69,75,110
20,45	Advanced Computer Products	100-101
46	All Electronics	104
30	American Antenna	Cover 4
36	Ampower	104
52	Ancrona	91
54	B & K Precision Dynascan Corp.	42
—	Bagnall Electronics	88
—	Karel Barta	90
—	Bullet Electronics	92
43	CFR Associates	104
8	Chaney Electronics	104
—	Chromatronics	87
—	CIE—Cleveland Institute of Electronics	18-21
—	Command Productions	90
47	Concord—Computer Components	108
34	The Cooper Group—Electronics Div.	Cover 3
—	Dage Scientific	88
28	Delta Electronics	90
—	Deltroniks	90
44	Diamondback Electronics	98
35	Digi-Key	109
—	Edmund Scientific	86
32	Electra Company	73
24	Electronics Book Club (TAB)	41
59	Electronics Technical Institute	79
58	Enterprise Development Corp.	83
—	Fair Radio Sales	92
18	Fluke	6-7
—	Fordham Radio Supply	99
16,17	Formula International	94-95
60	Fuji-Svea	103
40	Global Specialties	5
39	Godbout Electronics	110
—	Grantham College of Electronics	85
22,23	Heath	15,85
55	Hickok Electrical Instruments	40
37	Hitachi Denshi	81
—	Information Unlimited	90
51	International Electronics Unltd.	96
—	JS & A	1,13
2,3	Jameco Electronics	106-107
61	Keithley Instruments	22-23
7	Kester Solder	74
—	Lors & Associates	88

14	MCM Audio	89
42	MTI-Mobile Training Institute	76
6	Meshna	96
—	National Radio Institute (NRI)—Div. of McGraw Hill	8-11
—	National Technical Schools	28-31
53	Netronics	71
29,27,31	O.K. Machine & Tool	17,27,84
15	Optoelectronics	35
19	PAIA	83
25	PacCom	86
48	Panavise	86
38	Poly Paks	96
13	Quest	97
—	RCA	32,38-39
33	Radio Shack	102
57	Ramsey Electronics	93
9	Rye Industries	82
—	Sabtronics	33
—	Howard W. Sams	77
4	Solid State Sales	98
—	Spacecoast Research	90
—	Telex Communications, Inc.—Turner	24-25
21	Vaco Products Co.	Cover 2
49	Vector	76
10	Wersi Electronics	74
26	Yamaha	2

MOVING?

Don't miss a single copy of **Radio-Electronics**. Give us:

Six weeks' notice

Your old address and zip code

Your new address and zip code

ATTACH
LABEL
HERE

name (please print)

address

city state zip code

Mail to: Radio-Electronics
SUBSCRIPTION DEPT., P.O. BOX 2520,
BOULDER, COLO. 80322

Xcelite.



Handtools for electronics?
Get 'em from Cooper.
The Cooper range is truly phenomenal.
For example, there are 38 patterns
of pliers alone—including 13 genuine “miniatures”.
Cooper handtools are precision-made to exacting
tolerances. They're rugged and longlasting.
Most important of all, they're designed specifically to do the
jobs you do. Individual tools and kits are at your distributor's now.
Go and see them!

from Cooper The Toolmaker.



The Cooper Group

BOKER *CRESCENT *LUFKIN *NICHOLSON *WELLER *WISS *XCELITE®
P.O. Box 728, Apex, North Carolina 27502 Tel: (919) 362-7511. Telex: 579497.

CIRCLE 34 ON FREE INFORMATION CARD

In one year our **K40**™ antenna has become the largest selling CB antenna in the world!

1. It's the most expensive ...

2. It's made better...

3. It's proven best!

...Here's what the leading CB publications said.

\$42.50

suggested retail

And when you pay more, you expect more!

MORE PERFORMANCE:

The K40 is guaranteed to transmit further or receive clearer than any antenna it replaces. We know it will. We've tested it with 771 CB'ers just like you for one year.

MORE FLEXIBILITY:

You can fit your K40 to any mounting surface. It will fit any vehicle you'll ever own! That includes choppers, dune buggies, gutters, mirror mounts, luggage racks, trunks, hatchbacks, through roofs, semis, pick ups and RV's.

MORE QUALITY:

It's not imported. It's not made in Taiwan, Korea or Japan. It's American made in an American town. It's made with better materials that cost more and by professional people we pay more. And we designed it right here in the U.S.A.

*Including optional mounts at extra cost.

... This Antenna is so DYNAMITE you receive a ...

DOUBLE GUARANTEE

GUARANTEE I: The K-40 will transmit farther and receive more clearly than the antenna it replaces or the customer will receive a prompt and full refund from the Registered K-40 Dealer who installed and tuned it.

GUARANTEE II: Unconditionally guaranteed for 12 months. Guaranteed against cracking, chipping, or rusting. Guaranteed against mechanical failure. Guaranteed against electrical failure. Guaranteed against accidental breakage. No exclusions. No gimmicks. For a full 12 months.



CB TIMES: "... it's not often that a product bursts onto the market scene, dominates and improves CB'ing for everyone. American Antenna and the K40 are doing it—repeated tests showed the K40 could out-perform the major competitive brands."

RADIO-ELECTRONICS: "The results of our tests showed that, in three different positions of the monitoring receiver, the model K40 equaled or out-performed the competitive antenna. Apparently, American Antenna's advertising is not merely Madison Avenue showmanship."

PERSONAL COMMUNICATIONS: "... an impressive 95% of the trials, the K40 out-performed the existing mobile antennas. We had to try one for ourselves.

"... in every case, the K40 either equaled or out-performed its competitor.

"No ifs, ands, or buts! The K40 Antenna from American Antenna would have to be just about the best antenna around."

CB MAGAZINE: "Introduced in October, 1977, the K40 quickly became the top seller and in mid 1978, became the number one selling antenna in the nation."

...Here's what CB'ers all across the country said.

ANTENNA SPECIALISTS: "... truck driver and CB'er for 10 years ... 50% further than my M410 'Big Momma'."

—J.H. Collett, 207 McFee, Bastrop, LA

AVANTI: "I'm an electronic technician with a Second Class FCC license ... I was able to transmit 70% further and tune the SWR 75% lower than my Avanti."

—H.R. Castro, VRB, Monserrante D-67, Salinas, Puerto Rico

PAL: "... 20% better in transmission and reception than my 5/8 wave Pal Firestick."

—John A. Blum, Box 446, Zellenople, PA

SHAKESPEARE: "... I've been a CB'er for three years and the K40 is the best I've ever had. Better in reception and transmission than my Shakespeare."

—H. Bachert, Jr., 15 King Rd., Park Ridge, NJ

HUSTLER: "Compared to my Hustler XBLT-4, the K40 can consistently transmit 40% further and the reception was better. The K40 is the perfect way to complete a CB system."

—Jerome R. Brown, 7800 S. Linder, Burbank, IL

GOOD STUFF FOR PROS ONLY!



(SPECIAL NOTE) IF YOU'RE A BEGINNER:

Our K40 Dealers will be happy to sell you any of the older style and less expensive antennas that are great bargains for any beginning CB'er.

AMERICAN ANTENNA

ELGIN, IL 60120

© COPYRIGHT AMERICAN ANTENNA 1979

K40 POWER!

... Sold exclusively by **3500** American K40 Dealers throughout the U.S. & Canada.

CIRCLE 30 ON FREE INFORMATION CARD