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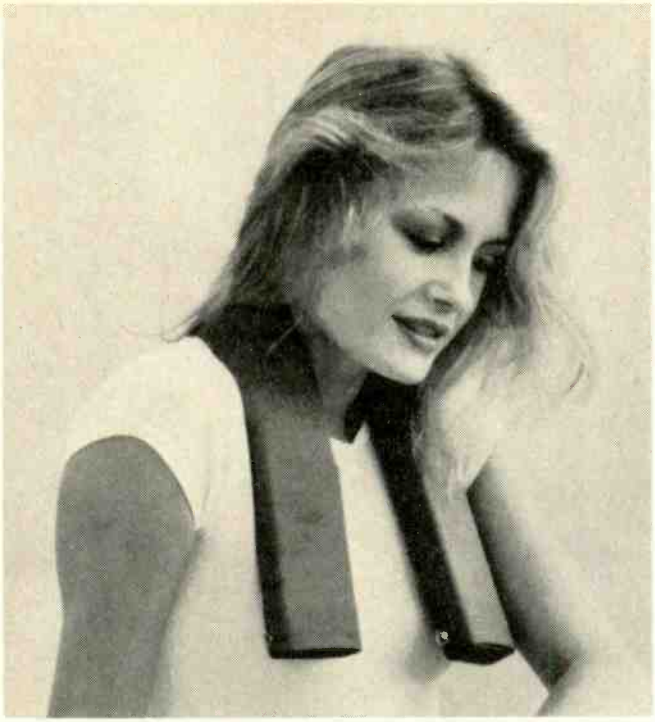

Bone Fone™

A new concept in sound technology may revolutionize the way we listen to stereo music.

The Bone Fone surrounds your entire body with a sound almost impossible to imagine.

You're standing in an open field. Suddenly there's music from all directions. Your bones resonate as if you're listening to beautiful stereo music in front of a powerful home stereo system.

But there's no radio in sight and nobody else hears what you do. It's an unbelievable experience that will send chills through your body when you first hear it.

AROUND YOU

And nobody will know you're listening to a stereo. The entire sound system is actually draped around you like a scarf and can be hidden under a jacket or worn over clothes.

The Bone Fone is actually an AM/FM stereo multiplex radio with its speakers located near your ears. When you tune in a stereo station, you get the same stereo separation you'd expect from earphones but without the bulk and inconvenience. And you also get something you won't expect.

INNER EAR BONES

The sound will also resonate through your bones—all the way to the sensitive bones of your inner ear. It's like feeling the vibrations of a powerful stereo system or sitting in the first row listening to a symphony orchestra—it's breathtaking.

Now you can listen to beautiful stereo music everywhere—not just in your living room. Imagine walking your dog to beautiful stereo music or roller skating to a strong disco beat.

You can ride a bicycle or motorcycle, jog and even do headstands—the Bone Fone stays on no matter what the activity. The Bone Fone stereo brings beautiful music and convenience to every indoor and outdoor activity without disturbing those around you and without anything covering your ear.

SKI INVENTION

The Bone Fone was invented by an engineer who liked to ski. Every time he took a long lift ride, he noticed other skiers carrying transistor radios and cassette players and wondered if there was a better way to keep your hands free and listen to stereo music.

So he invented the Bone Fone stereo. When he put it around his neck, he couldn't believe his ears. He was not only hearing the music and stereo separation, but the sound was resonating through his bones giving him the sensation of standing in front of a powerful stereo system.

AWARDED PATENT

The inventor took his invention to a friend who also tried it on. His friend couldn't believe what he heard and at first thought someone was playing a trick on him.

The inventor was awarded a patent for his idea and brought it to JS&A. We took the idea and our engineers produced a very sensitive yet powerful AM/FM multiplex radio called the Bone Fone.

The entire battery-powered system is self-contained and uses four integrated circuits and two ceramic filters for high station selectivity. The Bone Fone weighs only 15 ounces, so when worn over your shoulders, the weight is not even a factor.

BUILT TO TAKE IT

The Bone Fone was built to take abuse. The large 70 millimeter speakers are protected in flexible water and crush resistant cases. The case that houses the radio itself is made of rugged ABS plastic with a special reinforcement system. We knew that the Bone Fone stereo may take a great deal of abuse so we designed it with the quality needed to withstand the worst treatment.

The Bone Fone stereo is covered with a sleeve made of Lycra Spandex—the same material used to make expensive swim suits, so it's easily washable. You simply remove the sleeve, dip it in soapy water, rinse and let the sleeve dry. It's just that easy. The entire system is also protected against damage from moisture and sweat making it ideal for jogging or bicycling.

The sleeve comes in brilliant Bone Fone blue—a color designed especially for the system. An optional set of four sleeves in orange, red, green and black is also available for $10. You can design your own sleeve using the pattern supplied free with the optional kit.

YOUR OWN SPACE

Several people could be in a car, each tuned to his own program or bring the Bone Fone to a ball game for the play by play. Cyclists, joggers, roller skaters, sports fans, golfers, housewives, executives—everybody can find a use for the Bone Fone. It's the perfect gift.

Why not order one on our free trial program and let your entire family try it out? Use it outdoors, while you drive, at ball games or while you golf, jog or walk the dog. But most important—compare the Bone Fone with your expensive home stereo system. Only then will you fully appreciate the major breakthrough this product represents.

GET ONE SOON

To order your Bone Fone, simply send your check or money order for **$69.95** plus $2.50 postage and handling to the address shown below. (Illinois residents add 5% sales tax.) Credit card buyers may call our toll-free number below. Add $10 if you wish to also receive the accessory pack of four additional sleeves.

We'll send you the entire Bone Fone stereo complete with four AA cell batteries, instructions, and 90-day limited warranty including our prompt service-by-mail address.

When you receive your unit, use it for two weeks. Take it with you to work, or wear it in your car. Take walks with it, ride your bicycle or roller skate with it. Let your friends try it out. If after our two-week free trial, you do not feel that the Bone Fone is the incredible stereo experience we've described, return it for a prompt and courteous refund, including your $2.50 postage and handling. You can't lose and you'll be the first to discover the greatest new space-age audio product of the year.

Discover the freedom, enjoyment, and quality of the first major breakthrough in portable entertainment since the transistor radio. Order a Bone Fone stereo at no obligation, today. *Pending FCC approval.

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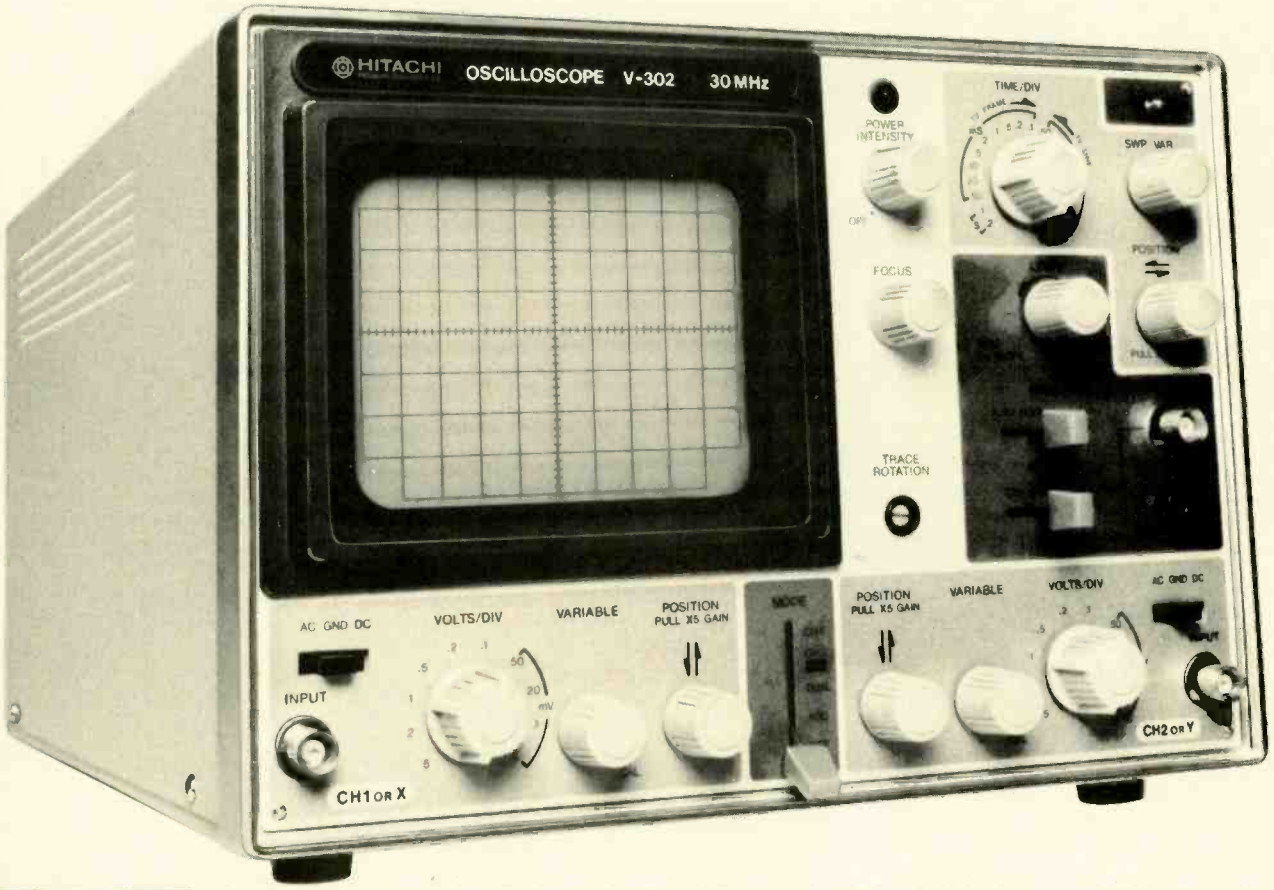

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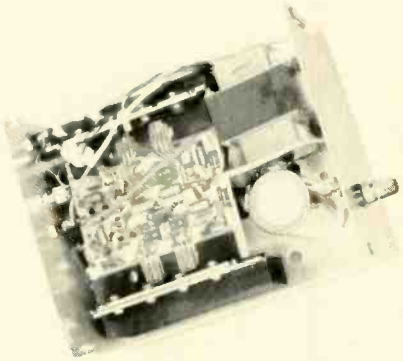
DECEMBER 1979 Vol. 50 No. 12

SEASONS GREETINGS
From All Of Us At
RADIO-ELECTRONICS

ON THE COVER

Projection TV is one of the most rapidly growing consumer products available today. This newest set comes in a kit and delivers 6-foot pictures. Learn more about it. Turn to page 39 now.

FREEDOM DIALER IS JUST ONE of the many electronic telephone dialers covered in this issue. To see them all turn to page 43.



SUPER AUDIO AMPLIFIER has a bridge-type power-output configuration you'll want to know more about. Find the details on page 55.

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IO-4550	dual	DC-10	10mV/cm to 20V/cm	no	yes	full	$399.95
IO-4555	single	DC-10	10mV/cm to 20V/cm	no	yes	full	$349.95
IO-4205	dual	DC-5	10mV/cm	no	no	partial	$279.95
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looking ahead

IBM into videodiscs: Mighty IBM has formed a partnership with MCA Inc. to develop and manufacture videodiscs. The new joint venture, DiscoVision Associates, takes over MCA's optical videodisc plant in California as well as its 50% ownership (with Pioneer) in Universal Pioneer, the Japanese company that manufactures optical videodisc players. MCA will continue to market videodiscs for both the player made by Universal Pioneer and the one made by Magnavox. IBM says its primary interest isn't in the consumer market at the present time, and it's understood to believe that the disc is ideally adaptable to many different information-handling applications, including—but certainly not limited to—entertainment. The formation of DiscoVision Associates, with IBM as a partner, appears to assure the development of the optical disc into a major product for commercial, industrial and educational as well as entertainment use.

OK for modulators: The FCC acted to stamp out a growing black market for RF modulators that connect personal computers to TV sets—by legalizing them. The Commission, responding to a petition by Texas Instruments, said it would permit sale of these devices in the future if their manufacturers certify that they comply with radiation regulations. In the past, computers that *included* modulators (in other words, were designed to be attached to a TV's antenna terminals) were OK if tested and approved by FCC Labs, but the rules forbade sale of modulator attachments. The new ruling is expected to save money for home computer users, letting them use home sets as an alternative to monitors.

Excitement over LVR: The first U.S. demonstration of a longitudinal video recorder (LVR) got rave reviews from American manufacturers and recording experts. Demonstrated by Toshiba (see **Radio-Electronics**, July 1979), the system was invented by Norikazu Sawazaki, inventor of helical-scan recording, who described the technique as "the second generation in VTR's" and forecast it would become "the most advanced and least expensive on the market." The LVR represents a return to the longitudinal-track fixed-head method used in audio tape recorders.

BASF demonstrated an LVR two years ago in Germany and is setting up a plant in Fountain Valley, California, to produce it for the U.S. and European markets. BASF's multiple-track recorder uses a two-reel cassette, records one track, rapidly reverses direction and records the next track, then reverses again, and so forth. Toshiba's system is somewhat similar, but with one major difference—the tape continually moves in the same direction without reversing direction or even changing speed at the end of each track. This is accomplished by use of a single-reel endless-loop cassette.

Toshiba's LVR uses a cassette with 100 meters of half-inch tape, passing a fixed head at 6 meters-per-second (about 236 inches-per-second), with 220 parallel longitudinal tracks. At the end of each track, the head merely moves down to the next track. Each track takes 17 seconds to record, and an MPU random-access keyboard thus can locate any part of the one-hour recording in 17 seconds. The developmental machine demonstrated was about half the size of a conventional VCR (but had no tuner or timer). Toshiba says it has one-third the mechanical parts of a conventional VCR and can be produced to sell at about half the price—or around $500 retail. An interesting byproduct is that, at least theoretically, pre-recorded tapes could be replicated at 1/220th of real time (an hour tape in 17 seconds) by laying down all the tracks at the same time. Toshiba says it could produce the machine in about a year, hopes for further miniaturization to make possible a hand-carried combination VCR-color camera (after the perfection of a CCD camera, still a couple of years away). The latest version of BASF's LVR is scheduled for demonstration in Europe this fall—presumably in a production model. I hope to bring you an eye-witness report.

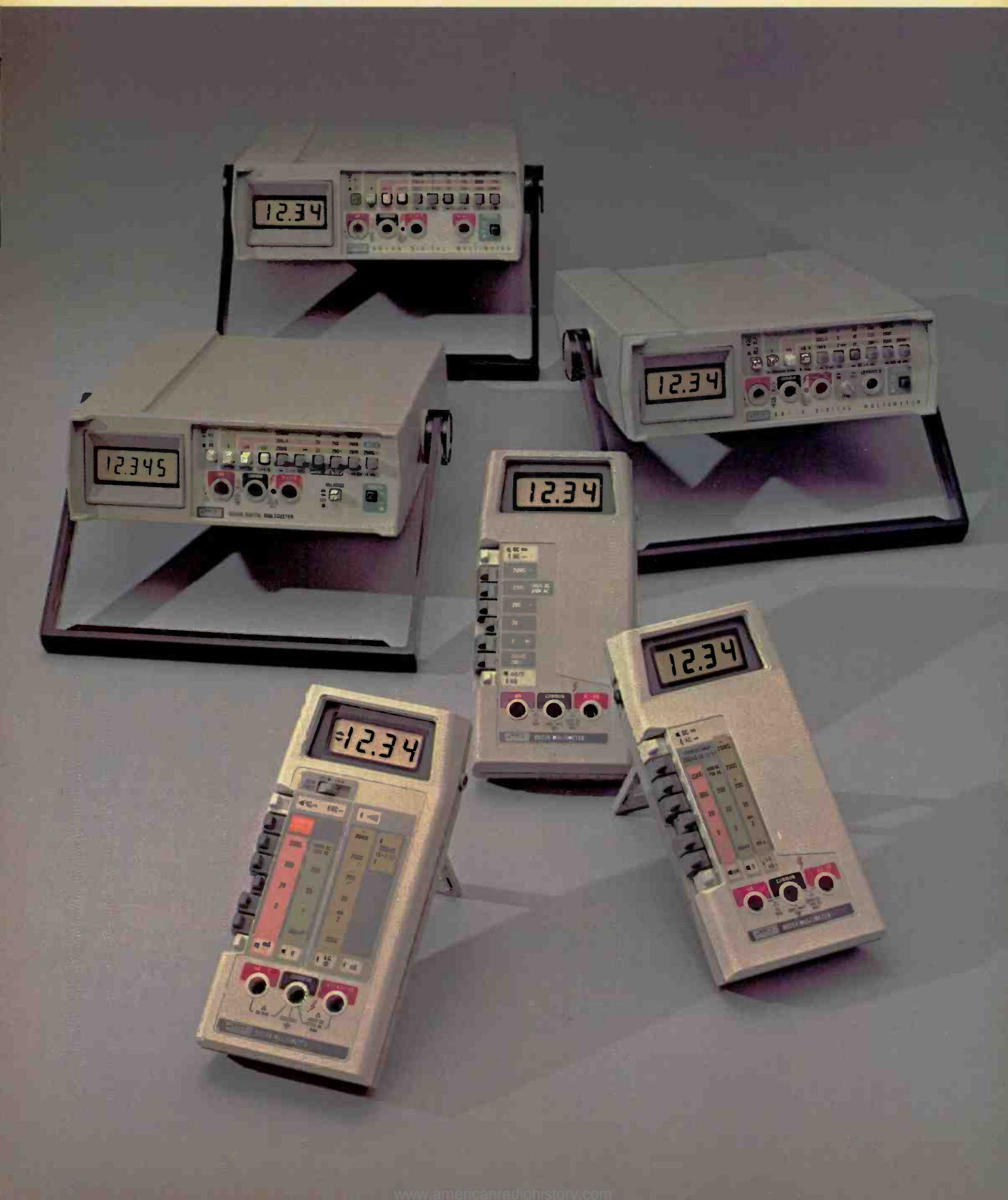
UHF tuning: About 40% of all color sets produced in the first half of 1979, and virtually no black-and-white sets, used all-electronic varactor tuning. Some day, perhaps, all sets will be electronically tuned. However, the FCC seems to want some day to come much sooner, and is considering proposing a rule requiring TV manufacturers to build electronic tuners into all TV sets to improve UHF reception and make UHF tuning completely comparable to VHF tuning. FCC staff members are currently studying whether the Commission has the authority to require this kind of change in tuning systems. The FCC's intentions were revealed at an FCC meeting when the UHF Comparability Task Force presented the results of its study to the Commission. The study found that UHF stations suffer in comparison to VHF because of lack of tuning comparability, poorer picture quality due to low signal strength, and comparatively poorer programming.

Antenna safety: Although there are now mandatory safety labels for CB and TV antennas, the Consumer Products Safety Commission says this isn't enough to stem an alarming tide of electrocutions, most of them resulting from contact with power lines while the antennas are being installed. So the Commission is asking for proposed safety standards for omnidirectional CB base-station antennas, in an attempt to make them electrocution-proof. The CPSC says that antennas are the major cause of electrocution among consumer products, estimates 220 people were electrocuted while installing communications antennas in 1975, 275 in 1976 and 220 in 1977. Only 100 lost their lives last year, largely as the result of poor CB sales.

Home earth stations: The first three private satellite earth stations approved by FCC since its go-ahead for home reception all involved $20,000 systems built by Homesat with 4.6-meter dishes in remote rural areas. Other firms are starting to offer lower prices. Channel One, Newton, Mass., is offering a 3-meter installation for $15,000. The Starscan Division of Gardiner is quoting $11,000, and Avcom of Richmond, Va., has a do-it-yourself system at $4,000. Nippon Electric says it could offer half-meter home earth stations in the U.S. for $350 to $500, but this would require quantity orders and the authorization to the K-band (12-14 GHz).

DAVE LACHENBRUCH
CONTRIBUTING EDITOR

Facts from Fluke on low-



cost digital multimeters.

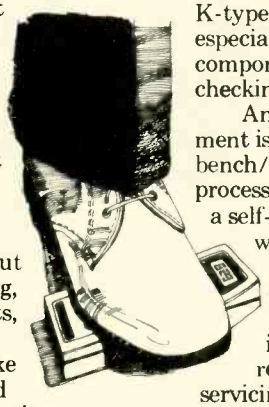
When you're looking for genuine value in a low-cost DMM you have a lot more to consider than price. You need information about ruggedness, reliability and ease of operation. Accuracy is important. And so are special measurement capabilities. But above all, you must consider the source, and that company's reputation for service and support.

Fact is, as electronics become more a part of our daily lives, dozens of new manufacturers are rushing to market their "new" DMM's. In theory, this is healthy; but in practice, crowding is confusion.

To help you deal with this flood of new products, here are some facts you should know about low-cost DMM's.

The economics of endurance.

Even the least expensive DMM isn't disposable. Accidents happen, and test instruments should be built to take the abuses of life as we live it.



Look for a DMM with a low parts count for reliability, and rugged internal construction protected by a high-impact shell. Make sure the unit meets severe military tests for shock and vibration.

Another feature to check out is protection against overloading, whether from unexpected inputs, transients, or human errors.

Just for the record, all Fluke low-cost DMM's meet or exceed military specs, and feature extensive overload protection.

The importance of being honest.

Just because a multimeter is digital doesn't mean it's automatically more *accurate* than a VOM – even though the LCD might give you that impression. The benchmark for accuracy in DMM's is *basic dc accuracy*. The specs will list it as a percentage of the reading for various dc voltage ranges.

Of course accuracy is more critical in some applications than others, and increasing precision and resolution in a DMM usually means increasing price. In the Fluke line, you can choose a model with a basic accuracy of 0.25% (the 8022A), others rated at 0.1%, or the new 8050A bench/portable at 0.03%.

Special measurements: getting more from your DMM.

Actually, for all the variations in size, shape and semantics, most DMM's perform five basic measurements: ac and dc voltage and current, and resistance. Prices vary according to the number of ranges and functions a DMM delivers.

	PRODUCT	FUNCTIONS	RANGES	DIGITS	BASIC DC ACCURACY	CONDUCTANCE	OTHER SPECIAL FEATURES	PRICE
HANDHELD MODELS	8022A	6	24	3½	0.25%		Basic six-function DMM; lowest-priced	$129
	8020A	7	26	3½	0.1%	X	High accuracy ; pioneer in conductance; exclusive two year warranty.	$169
	8024A	9	26	3½	0.1%	X	Direct temperature readings; continuity/ input level detector with selectable audible signal; peak hold capability.	Available soon
BENCH/PORTABLES	8010A	7	31	3½	0.1%	X	True RMS; extra 10A range.	$239
	8012A	7	31	3½	0.1%	X	True RMS; two extra low resistance ranges.	$299
	8050A	9	39	4½	0.03%	X	True RMS; selectable reference impedances with direct readouts in dBm; offset feature.	$329

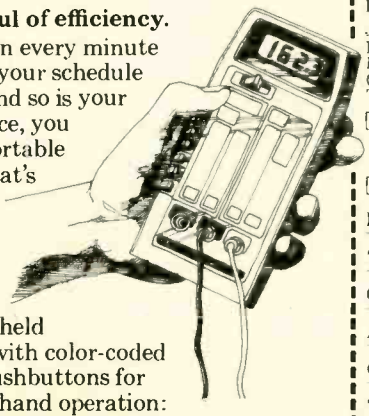
The Fluke line includes DMM's with from 24 to 39 ranges, 3½ and 4½-digit resolution, and some unique functions you won't find in any other DMM. Additional measurement capabilities like temperature, dB, conductance and circuit level detection.

If your work involves temperature measurements, the new 8024A delivers direct temperature readings via any K-type thermocouple. This is especially useful in testing component heat rise and checking refrigeration systems.

Another talented instrument is our new 8050A bench/portable. The microprocessor-based 8050A features a self-calculating dB mode in which dBm readings are displayed automatically referenced to one of 16 selectable impedance ranges – a real timesaver when servicing audio equipment.

And of course no discussion of DMM's is complete without considering conductance – a Fluke exclusive featured on five of our low-cost DMM's – which allows you to make accurate resistance measurements to 100,000 Megohms. You can't do that with any ordinary multimeter, but it's a must for checking leakage in capacitors and measuring transistor gain.

A handful of efficiency.



When every minute matters, your schedule is tight and so is your work space, you need a portable DMM that's fast and easy to operate. We designed our handheld DMM's with color-coded in-line pushbuttons for true one-hand operation: no need to hang onto the meter with one hand while twisting a rotary dial with the other.

But there's more to convenience than fingertip control. The 8024A, for example, is also designed to function as an instant continuity tester, with a selectable audio tone to indicate shorts or opens. It also has a peak hold feature to capture transients.

A word about warranties.

Last but not least, look closely at the company that manufactures a low-cost DMM. Their service is just as important as their product. Look for no-nonsense warranties, a large family of accessories, an established network of service centers and technical experts you can rely on.

That's how you'll recognize a knowledgeable supplier of low-cost DMM's, a company with experience, resources and a commitment to leadership in the industry.

Incidentally, you'll find it all at Fluke.

Look for more facts from Fluke in future issues of this publication. Or call toll free **800-426-0361**; use the coupon below; or contact your Fluke stocking distributor, sales office or representative.

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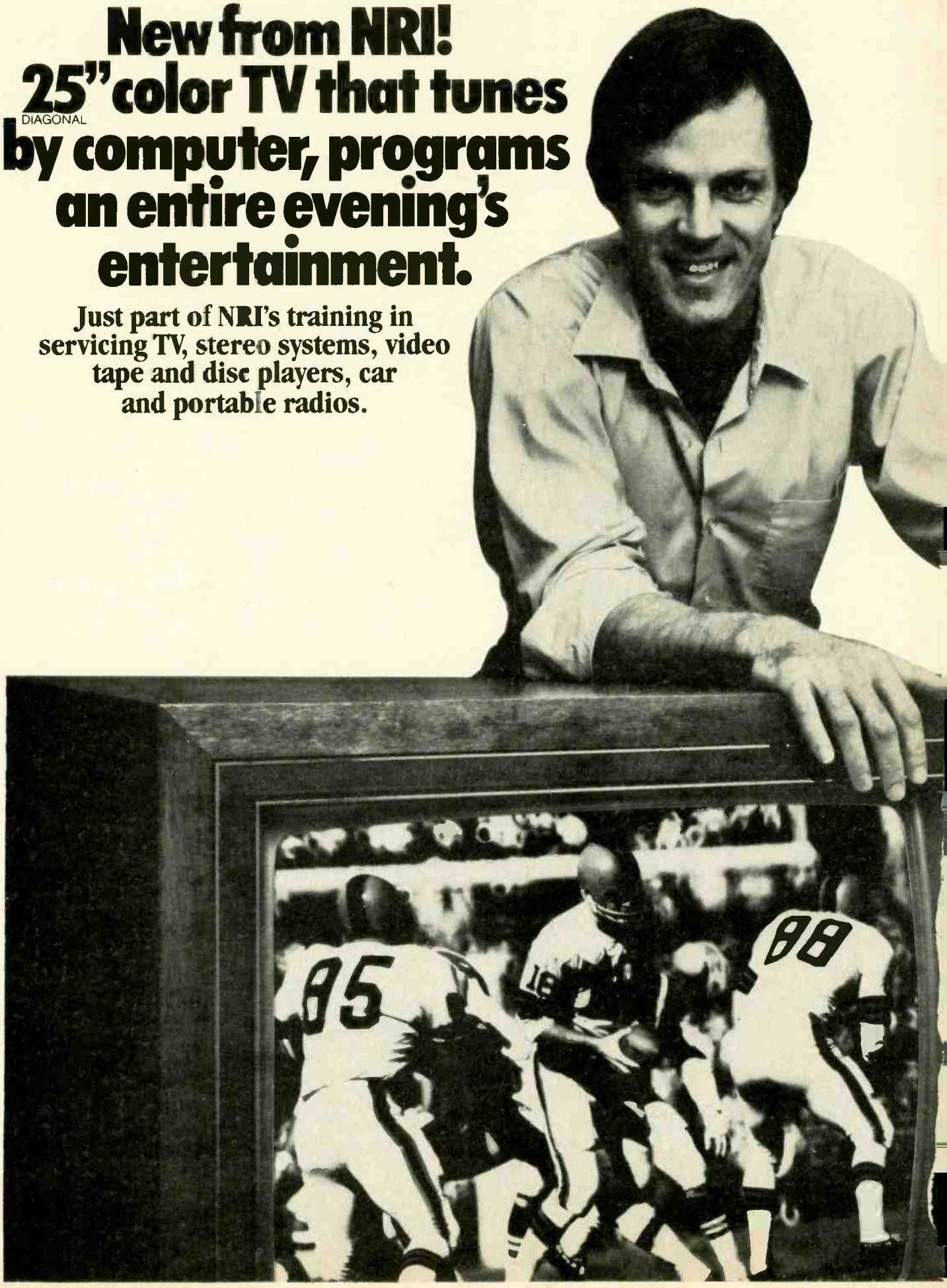

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As you assemble it, you learn how digital tuning systems work, how to adjust and service them. You work with the same advanced features used in the new programmable TV's and video tape recorders. It's exclusive NRI training that keeps you up with the leading edge of technology.

Exclusive Designed-for-learning Concept

The color TV you build as part of NRI's Master Course looks, operates, and performs like the very finest commercial sets. But behind that pretty picture is a unique designed-for-learning chassis...

the only such unit in the world. Rather than retrofit lessons to a hobby kit or an already-built commercial set, NRI instructor/engineers have designed this television so each step of construction is a learning experience.

As you build it, you perform meaningful experiments. You see what makes each circuit work, what it does, how it interacts with other circuits. You even introduce defects, troubleshoot and correct them as you would in actual practice. And you end up with a magnificent, big-picture TV with advanced features. One you can sell or use in your home.

Also Build Stereo, Test Instruments

That's just a start. You demonstrate basic principles and circuits on the unique NRI Discovery Lab,® then apply them as you assemble a fine AM/FM stereo receiver, complete with speakers. You also get practical experience as you build your own test instruments, including a 5" triggered sweep oscilloscope, CMOS digital frequency counter, color bar generator, and transistorized volt-ohm meter. Use them for learning, use them for earning as a full- or part-time TV, audio, and video systems technician.

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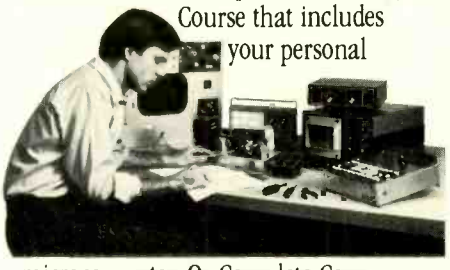

microcomputer. Or Complete Communications with 2-meter transceiver that gets you ready for opportunities in broadcasting, 2-way radio, microwave, and other growing fields. If card has been removed, write to:

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what's news

Color TV imports down in first half of 1979

A drop of more than a third in the imports of color television sets—from 1,212,522 in the first half of 1978 to 754,717 in the same period this year—has taken place, reports the Electronic Industries Association. The drop in the second quarter of 1979—almost exactly 50 percent—was much sharper than in the first quarter.

United States imports of monochrome TV increased in the first half of this year, from 2,610,738 in the 1978 period to 2,666,849 in the first half of 1979. Home radio imports declined 31.1 percent in the second quarter of 1979 to 6,654,064 units from the same period last year.

Customs value of color TV, home radio, phonographs, record players, changers and turntables and home audio tape players declined in the first half of 1979 and increased for black-and-white TV, auto radio, audio and video tape recorder/players, auto audio and video tape players, compared to the first half of last year.

The EIA reports that imports of radios, record changers and turntables also declined in the same periods, while imports of phonographs and tape recorders and players increased.

Weather forecasts available for 90 percent of United States

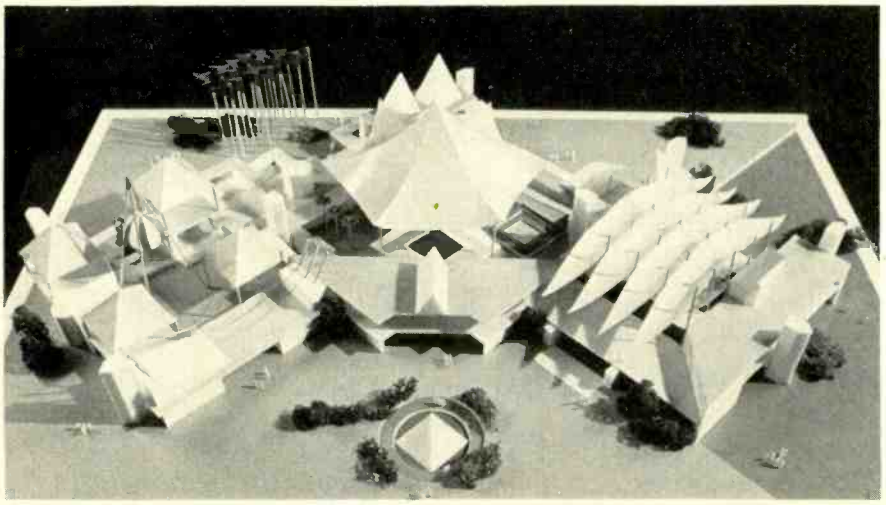
The National Oceanic and Atmospheric Administration (NOAA) is now expanding its Weather Radio program to make it possible for 90 percent of the United States population to receive reliable local weather reports. A network of weather stations (345 when completed) now reaches into practically all parts of the country, with the exception of a few "shaded" spots—like deep valleys behind high mountains—and some sparsely populated areas.

Each of the stations has a reliable service range of about 40 miles. Broadcasts run from four to six minutes, and include a general forecast, temperature and precipitation summaries, and other useful warnings and information (such as marine conditions, if the station is in a coastal area). To avoid interference, adjacent stations are on slightly different frequencies. Three are used: 162.40, 162.475 and 162.55 MHz. Transmission is FM.

Receivers (ranging in price from less than $20) are obtainable at most electronics supply stores. An important feature of the better ones is an automatic Weather Alarm, or Weather Alert. The weather station sends out a tone before all urgent broadcasts. This tone activates the Weather Alarm type of receivers, which then turn on automatically. Thus a tornado warning, for example, can be heard by a set-owner who would not have received it on a receiver not Weather-Alarm equipped.

Education and play combine in new "Sesame" project

A series of small-scale educational play parks, each to be called "Sesame Place," is planned by the Children's Television Workshop, creator of "Sesame Street," and Busch Gardens, operator of theme parks. Work on the first has already been started. Located near the Oxford Valley Mall in lower Bucks County, PA, it is about a 30-minute drive from Philadelphia and 20 minutes from Trenton, NJ.



DESIGNER'S MODEL of the first Sesame Place play park. Occupying only 2.5 acres, it will contain about 60 outdoor play elements under canvas canopies, and—in the buildings—60 electronic games and science demonstrations, plus a restaurant and retail store.

Sesame Place play parks will have more than 60 outdoor play activities aimed at children 3 to 11 years old, and a balancing 60 computer-type games and science exhibits in an indoor Science and Game Pavillion. Play elements throughout the parks will be themed with such familiar Sesame Street characters as Big Bird, Oscar and the Cookie Monster.

The games—tailored to children's different skills and ages—range from talking typewriters featuring Sesame Street characters to remote mechanical hands like those used in some industrial plants. Games and other features are selected not only to arouse the immediate interest of the players, but to stimulate their intellectual curiosity as they explore through play, states the director of research and planning for the parks, environmental psychologist Dr. Marilyn Rothenberg.

Work on the first park has been going on since June, and it is expected to open in early summer 1980. Admission price has not yet been set, but it is expected to be such as to encourage frequent visits, and "will be substantially less than a typical theme park."

CB'ers: Don't ask the FCC for a license refund now!

Please do *not* apply at this time, says the FCC for refund of a CB license fee. Any applications received for the refund of fees that were $20 or less will not be considered under Phase I of the FCC's Fee Refund Program.

CB license fees and other fees that were $20 or less will be included in Phase II, which is expected to begin early in 1980.

600 enthusiasts gather for seminar that nearly wasn't

Despite opposition from satellite broadcasters, who sued to prevent it from being held, more than 600 persons attended the first "Satellite Seminar," held at South Oklahoma City Junior College last August.

The seminar was organized by Bob Cooper, old-time electronics technician and writer, who was a columnist in this magazine in the early days of television. Calling himself the first builder of a home-style satellite receiver, and author of a handbook on bilding satellite television terminals, he promised to show attendees how to build a receiver that can pick up satellite broadcasts direct.

The association of carriers who have contracted to relay Home Box Office (HBO) satellite broadcasts filed suit to enjoin the seminar, alleging that it would give the par-

continued on page 14

"Chess Challenger-10 Wins Microchess Tourney"
—Personal Computing Magazine
February, 1979

Genius Offspring

"Its successor, the new Chess Challenger-7, is infinitely more powerful."
—S. Samole
President, Fidelity Electronics

JUST RELEASED
VOICE CHALLENGER

Chess Challenger-10 did more than win the Penrod Memorial Microchess Tournament, it literally trounced all opponents. Personal Computing Magazine, February, 1979, reports, *"Chess Challenger-10 emerged as the easy victor with ten wins, two draws and no losses."*

All Top Name Performers

There were no amateurs in the championship playoff. Every contender bore the brand of a well-known electronic chess game, and each was accompanied by its entourage of coaches, programmers, and engineers. After each contestant had played all of the opponents in round robin fashion, the brilliant Challenger-10, stood far ahead of its second place runner-up.

Nobody Knew

Unknown to the other companies, the undefeated tournament leader was being retired after the contest. Taking its place was a far more powerful chess computer, the Challenger "7." This new micro-computer had already beaten the official undefeated champ during a series of pre-tournament warm-up games at the factory. Its engineers explain that it is simply 14 months ahead in technology, in finer algorithm sophistication and in its superb performance.

Improve Your Game to Near Brilliant

Within its seven different levels of play, you can enjoy every degree of chess competition, from beginner to tournament skill. Its total flexibility lets you change games midstream or switch sides with the computer to see how it would handle your dilemma. You can add pieces to your side or take away the computer's Queen. It is a superb teacher!

Touch the PV key and the "7's" total recall memory will verify every piece position on the board. You can even set up hypothetical encounters to test its reaction at each level.

Fidelity's Challenger "7" is able to analyze over 3,024,000 board positions. It masterfully handles over one thousand book openings and will respond to any deviation. Academic openings as Sicilian, French, Ruy Lopez and Queen Gambit Declined, are just some of the challenges to keep you on your toes.

It Knows Every Rule in the Book

The Challenger "7" will permit you to castle or perform an En Passant capture or do so itself, if that is its best move. When your pawn has reached the eighth rank, it will be automatically raised to a Queen, unless you tell the computer to promote it to another piece. It will take on any player and sharpen his skills considerably... but it won't permit illegal moves.

At Level 1, its average response time is 5 seconds. At Tournament Level 7, the Challenger makes championship decisions in just 3 minutes.

Unbeatable in Price As Well As Play

Best of all, the Chess Challenger "7" is just $89.95 complete with chessmen and UL approved 110V AC adaptor.

All pieces are magnetized, to stay where you place them on the permanent metal board. The set is mounted in a simulated wood-grained housing which measures 12⅛" x 8" x 1." Bright, one-half inch tall LED electronic digits, provide unmistakably clear readout.

Final Results

Reprinted Courtesy of Personal Computing, February, 1979. P. 56. (Darker lines ours.)

	CONTESTANTS		OPPONENTS 1	2	3	4	5	6	7	8	9	Games Won	Drawn	Lost	FINAL SCORE	FINAL POS.
1	MICRO-CHESS 1.0 (Heath H-8)	W	X	½	0	1	0	0	0			1	3	8	2½	7*
		B	X	½	½	0	0	0	0							
2	MICRO-CHESS 1.5 (TRS-80)	W	½	X	½	½	0	0	0			0	5	7	2½	6*
		B	½	X	0	0	0	½	0							
3	MICRO-CHESS 2.0 (PET)	W	½	1	X	1	0	0	½			3	4	5	5	4
		B	1	½	X	½	0	0	0							
4	CHESS CHALLENGER (3 Level)	W	1	1	½	X	0	½	½			2	5	5	4½	5
		B	0	½	0	X	0	0	½							
5	CHESS CHALLENGER (10 Level)	W	1	1	1	1	X	1	½			10	2	0	11	1
		B	1	1	1	1	X	1	½							
6	BORIS	W	1	½	1	1	0	X	1			7	2	3	8	3
		B	1	1	1	½	0	X	0							
7	SARGON I (TRS-80)	W	1	1	1	½	½	1	X			6	5	1	8½	2
		B	1	1	½	½	½	0	X							
8	ATARI *Did not play*	W								X						
		B								X						

*Note: Microchess 1.5 wins 6th place over Microchess 1.0 by virtue of the tie-breaking analysis of relative strength of opponents

A MAJOR ADVANCE
VOICE CHESS

Brand new from Fidelity—the granddaddy of them all. VOICE CHALLENGER. It may look something like the "7," but it's a great deal more. Increased microprocessor brain offers all of the 7's ability plus three additional levels beyond the seven: *Excellent* (6 minutes), *Expert* (11 minutes) and *Infinite* (from 5 seconds to days). But, you needn't wait days. You can command this level to move at any time. So many readers have asked for *maximum skill.* This is it.

Most incredible, it *TALKS.* In addition to its display, an electronic miracle of voice synthesis permits this phenomenal Challenger to speak. It's not a tape, but a computer-created voice distinctively announces each move it makes. It verbalizes your moves, too. It has a vocabulary of over 50 words which will also suggest a move for you if you take too long.

If the Voice Challenger is about to set up a mate-in-two offense, it will flash, "Mate-in-Two." From here on, you'd better be a whiz to avoid defeat. This set (same size as "7") comes in a black enamelled hardwood cabinet. Hand-carved Staunton pieces in tan and black are magnetized to stay put. The unit is complete with a durable ABS carrying case.

Both units are backed by a 90-day manufacturer's limited parts and labor warranty.

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what's news

continued from page 12

ticipants the information necessary to receive the HBO transmissions illegally, without paying for them. A federal judge threw out the suit, pointing out that such dissemination of knowledge is not illegal.

NESDA and ISCET relocate in Fort Worth, Texas

Headquarters of the National Electronics Service Dealers Association and the International Society of Certified Electronics Technicians is now 2708 West Berry St., Fort Worth, TX 76109. The NESDA phone is 817-921-9061 and ISCET's is 817-921-9101.

The two organizations' work was being taken care of on a temporary basis by Miss Marti McPherson, as interim administrator, since the resignation of Charles L. Porter, CET, as NESDA Executive Vice President last February. In June, the Executive Council received and approved an offer from J.W. Williams, CET, of Fort Worth, to serve as agent to manage and administer the affairs of the Association, its divisions and subsidiaries. NESDA President Bob Villont, CES/CET, and ISCET's acting chairman, Forest Belt, CET, concurred in the agreement. Mr. Williams has been Executive Director of the Texas state association since 1964.

Also at their June meeting, the Executive Council voted to change the official publication, *ServiceShop,* from a monthly to a bimonthly magazine, beginning with the July-August issue, which was also the offical edition for the 1979 National Electronics Service Convention. Bob Harrison, former Publications Editor for NESDA and Editor/Publisher of *ServiceShop,* has been retained by the Williams Agency as Publications Editor and Editor-in-Chief of the magazine. Marti McPherson will continue as Editor-in-Chief of *Genesis II,* the 1980 edition of the annual NESDA/ISCET yearbook. Miss McPherson may be contacted at 8437 H Devonshire Court, Indianapolis, IN 46260, phone 317-253-7822.

Mr. Williams will assume most of the duties of the associations' Chief Executive Officer. He stresses that he hopes to improve NESDA's ability to communicate and respond to the membership, and solicits candid comments about any subject of concern, as well as suggestions for association improvement.

Record sales falling off after 25 years of increases

The record business, which has grown steadily for 25 years to its present $4 billion a year standing, is declining at what some consider an alarming rate. CBS showed a drop in net income of 28 percent in the first quarter of 1979, and blamed its record department for most of the decrease. Warner Communications showed a drop in operating income of 6 percent in the first quarter of the year, and 18 percent in the second quarter. Practically all the other companies show profit reductions.

Not only are sales of new records slumping, but dealers are returning unsold records in loads, straining the financial resources of smaller companies. Probably not coincidentally, there have been larger numbers of mergers and company purchases than normal.

Inflation and recession are the prime suspects: "Five dollars more for a tank of gas is one record less," says Joe Smith, president of Elektra/Asylum Records.

A second suspected cause is that there is an increased tendency to tape programs from radio or records. Sales of blank recording tapes is up, giving support to that theory.

Another suggestion, which executives tend to dismiss as unimportant, is that higher prices may be one cause of the decline. Stan Cornyn of Warner Bros. Records feels however that diversion of expenditures to "unnecessary market and merchandising gimicks," is an important factor in profit drops.

The situation has reached a serious point with some companies. CBS Records has reduced its staff by 52, and 80 employees were let go by the RCA, Casablanca and MCA labels, while 20 were laid off by Elektra/Asylum.

Black market videocassettes eat into legitimate earnings

Video piracy is becoming a threat to the movie and TV industry. "Without question," says Ted L. Gunderson, a West Coast authority on the subject, "it's one of the fastest-growing white-collar crimes in the world." He estimates that video piracy costs the industry at least $100 million a year in lost sales and revenue from secondary markets. (Other industry estimates are higher-up to $700 million.)

Strangely enough, some of the bigger alleged purchasers of pirate records are large and outwardly respectable firms. "American mutinational companies are the worst trangressors," reports Richard Bloeser, film security chief for the Motion Picture Association of America. "Instead of going through legitimate channels, they are buying videocassettes of movie and television shows and shipping them to movie-starved employees overseas." Other companies illegally tape movies off cable and pay television and ship them to their employees, Mr. Bloeser says.

Other large markets are Middle Eastern countries where there are few movie theaters, and confused copyright laws make prosecution impossible. Substantial quantities of pirated videocassettes are shipped into South Africa, where strict censorship prohibits most American movies or cuts them ruinously. In the United States, a number of the larger pirates have been apprehended and convicted.

Hospital admissions tied to geomagnetic activity?

Two physicians writing in the British magazine *Nature*—Dr. R. C. Malin and B.J. Srivastava—report an apparent link between the daily number of admissions to the cardiac-thoracic wards of two hospitals in India and the daily planetary index of geomagnetic activity, normally used as a measure of the effect of solar particle flux. The data suggests that admissions increase with magnetic activity to a much greater extent than could be explained by chance.

Another English publication, *Radio Communication*, refers to a "strange but strong correlation that has been found between sunspot maxima and virulent flu epidemics." It might be well for persons subject to heart problems and those susceptible to thoracic difficulties to take extra precautions during the present rise in sunspot activity!

FCC asks for discussion on AM channel spacing

The FCC is considering a proposal to reduce AM broadcast channel spacing from the present 10 kHz to 9 kHz, to make room for additional AM stations in the band. The Commission has put out a call for comments, asking if there is a need to increase the number of radio channels, and if so, should the FCC reserve new channels for special groups (miniorities, educators, daytime-only stations, others). Other questions are: "Do you believe there is enough night-time service? Should daytime broadcasters be permitted to continue operating at night?" If your existing AM radio would pick up the new 9-kHz channels but with increased interference, would you buy a new radio?"

Opponents of the idea fear diminished reception quality if channel widths are reduced, and point out that present electronically tuned receivers, constructed for 10-kHz spacing, would become obsolete. Proponents stress the opportunity for increased minority station ownership and more night-time broadcasting as among the advantages of the proposed change.

The matter is not one that can be decided by the United States alone, but must be considered by Region 2 of the Telecommunications Union, which takes in both North and South America. There will be a Region 2 Broadcast Conference in March 1980. Participants in the Conference will probably be influenced to some extent by the fact that the rest of the world already uses 9-kHz spacing for AM broadcasting.

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Eight rhythm patterns with five realistic rhythm instrument sounds—create your own combinations, play them separately or in combination.

Adjustable tempo control. Speed up or slow down the rhythm, plus a Special Extra Slow tempo for practice.

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Two keyboards—discover endless musical combinations, with or without use of 'automatics.'

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So you can imagine how we felt about the recent success of the popular fun organs which permit a novice to sit at the keyboard and get instant results.

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editorial

Where Do The Articles Come From?

From our readers, of course! Take a quick look at this month's cover. Notice that line under Radio-Electronics? It has been there for quite some time. It says *"The Magazine For New Ideas In Electronics."* It's a true statement because they are your ideas.

We package those ideas; we help turn them into articles. But none of it would be possible without your feedback. Each month we receive hundreds of letters from readers. Those letters fall into four major categories—compliments, criticisms, complaints and suggestions (*IDEAS!*). We answer all of them and all are important to us, because they tell us what kind of magazine you want to read.

However, the "idea" letters are the most important of all, because that's where the really great articles start. That's where our first computer story came from; that's where our first videodisc story came from; that's where our satellite TV story came from and that's where next year's great articles will come from—ideas.

Some ideas are impossible—the technology just isn't here yet. Others are impossible because they are too basic or even old. But some are right on target and those are the ones we will turn into articles that keep you reading and looking for each issue of Radio-Electronics.

So keep writing . . . . Tell us when we're wrong . . . . Pat us on the back when we're right . . . . Complain when we do something silly . . . . And keep those wonderful ideas coming . . . . They help keep us going.

Larry Steckler

LARRY STECKLER
Editor

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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 possiblity 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 guage black anodized aluminum provide RF shielding, light weight and are rugged and attractive - not economical plastic.

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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.

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MODEL	$ PRICE	RANGE 10Hz to	LED DIGITS	SENSITIVITY 50 OHM INPUT 25-250 MHz	250-450 MHz	450 MHz- GHz	HI-Z INPUT 10Hz - 60 MHz	GATE TIMES	RESOLUTION 12 MHz	60 MHz	MAX. FREQ.	TCXO TIME BASE 20°-40°C	FREQ.	EXT CLOCK INPUT	NI-CAD BATT PACK
7010 *7010.1	145.00 225.00	600 MHz	9	5-20 mV	10-30 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 $39.

* 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 $ 9.95

ACCESSORIES

#TA-100 Telescope Ant with Right Angle BNC $ 9.95
#P-100 Probe, 50 ohm, 1x $13.95
#P-101 Probe, Lo-Pass, Audio Usage $16.95
#P-102 Probe, Hi-Z, General Purpose $16.95

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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."

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

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letters

SATELLITE TV

I would like to draw your readers' attention to the fact that it is now quite possible to receive high quality TV signals on backyard earth stations. All across the country thousands of dish antenna are capturing up to 48 channels direct from our orbiting communications satellites. Public ignorance of this new phenomenon will soon be replaced by "satellite awareness."

Perhaps some readers would be interested in submitting contributions to our new publication *Earth Station Magazine*. Response to our *Earth Station Information Manual* demonstrates that many rural Americans are desperate for what the rest of us take for granted. The selection and quality of the programming is literally out of this world.

Regarding deregulation, the FCC's main concern with Earth Station licensing is to protect the operator from future interference caused by terrestial microwave communications on the same 3.7 to 4.2 GHz band. NASA is also very interested in promoting direct TV reception from satellites. It seems to me that the major resistance is coming from the broadcast networks and it is easy to see why. The long established network-affiliate monopolization of American TV is approaching a shakeup.

Please continue to feature articles on TV Earth Stations.

STEPHEN REED
Spacecoast Research
Box 442
Altamonte Springs, FL 32701

I read the articles by Bob Cooper on the subject of Satellite TV Reception and would like to point out some additional information about equipment availability.

There are perhaps 10 suppliers of Satellite TV Earth Stations for the CATV market and there are perhaps four to six distributors of that equipment who will serve the private individual as well as the CATV system. However, I believe that Channel One, Inc. and Homesat, Inc., the subsidiary of Scientific-Atlanta, are serving the private owner exclusively.

Channel One, Inc., offers turnkey home systems. Our 3 meter *Earth-Link* costs $15,500, plus site preparation (a clearing and a concrete pad.) In some areas, a 5-meter antenna is required. Here the cost is $18,500, plus site preparation. The prices include installation, a one year limited warranty and nationwide after-sales service.

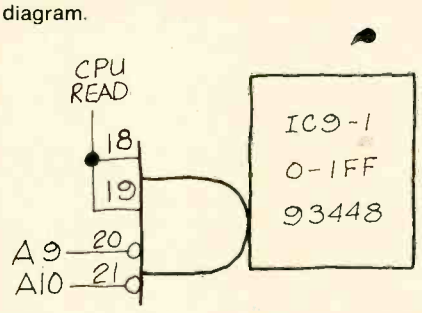
Some sites are not suitable for an Earth Station. Channel One does a computerized survey of terrestrial microwave transmissions to ascertain if a proposed site is suitable. The cost is $125, which is refunded if the proposed site proves unsuitable. If the results are positive, the $125 becomes a credit towards the 25% down payment required when placing an order. Financing is available.

FRED HOPENGARTEN
Channel One, Inc.
68 Avalon Rd.
Newton MA 02168
617-527-1025

INTELLIGENT THERMOSTAT

I was very interested in the article in the June issue describing the Intelligent Thermostat. Since I am considering a project similar to this for my senior project at Purdue University I went through the article

rather intently. While studying the schematic I noticed that IC9-1 and IC9-2 had the same address. The schematic for the enable should rather be as shown in the diagram.



All other connections are as shown in the article and the PC layout for this IC appear to be right. Thank you very much for the fine article. The only thing I would like to have seen was a better description of the software.

MICHAEL KOST
Croydon, IN

ENERGY CRISIS

In the July 1979 "Letters" column, I read of an interesting proposal to solve the energy crisis that involved using a linear accelerator to smash particles together. This theoretically would produce large amounts of power. I point out that to accelerate a mere particle is insufficient, and in fact has been going on for several years at the Stanford Linear Accelerator.

However, it would become efficient if something were to smash into something else at greater than 50% of the speed of light. The piece of matter must weigh about 100 grams (50 grams for each chunk).

The technology to produce this kind of power does, however, exist. A device consisting of a series of super-conducting magnets, spaced about one meter apart, and totalling many kilometers on a side, could produce the required power by accelerating a ferromagnetic "car" at several hundred gravities. Such a device could be placed in space, where the matter could be held in a magnetic field so that any material warpage would not affect it, as it would on earth. Also, in space, you could get rid of heat better and reduce energy demand.

However, in Mr. Rimmer's letter, he stated that you would need a superfast computer to control the accelerating magnets. This is about the biggest understatement of the century! When an object is moving at half the speed of light, it crosses a space of one meter in 1.67×10^{-3} microseconds. The problem comes in when you find that the fastest computer in the world could only process the data for *one* accelerator magnet in 0.25 microseconds. It becomes obvious that no *conventional* computer could handle that kind of data requirement. Besides that, the response time of a data sensor is limited by the speed of light and quantum theory.

Here I come to the real point of this letter. There is a family of subatomic particles that move faster than the speed of light. These particles are called tychons. They supposedly exist in some other dimension, but have some effect on ours.

Studies are going on that indicate that tychons could interact with materials in our own dimension, and vice-versa. It soon becomes obvious that an ultra-fast computer could be constructed using tychons instead of electrons.

A material could be synthesized that could function as tychon adder. Tychons could be fed down tubes about 100 angstroms wide (1 anstrom = 10^{-10} meters), and when two words are mixed, there would be a material that would eliminate one and pass one onto the next (carry) column. The number of these interactions that could take place, (the number of chunks of adding material) would be the word length plus one, the carry bit.

Sensory input data could be transmitted by passing a beam along the edge of the mass driver and then having it interact with material that would cut off one frequency of the tychon beam, except that the beam was being attenuated.

Such a computer could solve many problems that have before been impossible because of the complexity of the problem. (See "Intrinsically Difficult Problems," *Scientific American*, May 1979).

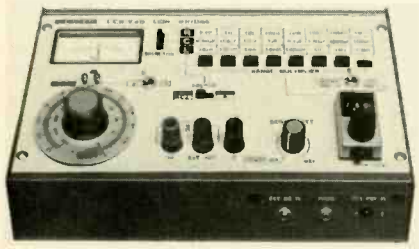
The problem is that this kind of computer *could not communicate with any other machine without a buffer* that could sink the inputs of several large system memory-oriented mainframe operators.

The advent of such a computer system would mean a great advance in all fields of science. I think that a project should be started to determine the feasibility of such a system. The sooner the better.

BRAD BROWN
Toronto, Ontario, Canada **R-E**

equipment reports

Leader LCR-740 Transistorized LCR Bridge



CIRCLE 101 ON FREE INFORMATION CARD

ONE OF THE HANDIEST PIECES OF TEST EQUIPMENT we've seen in a long time is the LCR bridge from Leader Instruments Corporation. It is a portable unit measuring 3½ × 9½ × 6¾ inches and weighing 2 pounds. A convenient carrying strap is attached for safe transport.

Functionally, the *LCR-740* is a portable component testing laboratory. It measures capacitance from 1 pF to 11,000 μF, resistance from .001 ohm to 11 megohms, and inductance from .1 μH to 1100 henries. Accuracy is ±.5%. Readout on all scales is to three digits, provided by a turns-counting potentiometer.

Ten percent overange is provided on all scales for convenience at end-of-scale measurements. Loss factor on the inductance scale is measurable from .01-31.

All functions are powered by a standard 9-volt battery. An optional AC adaptor is available for continuous use.

Both DC resistance measurements and impedance measurements are provided. An internal 1 kHz generator is used for reactance (impedance) tests on all three functions. Optionally, an external frequency source of from 50 Hz to 40 kHz may be injected into the 740 for additional capacitance and inductance measurements. Inserting a plug into the external signal input jack automatically disconnects the internal 1 kHz oscillator.

An earphone is included for audio null measurements in conjunction with the meter readings. Connection to an oscilloscope can also be made from the earphone jack. The *LCR-740* is not available as a kit, and it is just as well. Final calibration of an accurate piece of test equipment like this RCL bridge is a tricky business, requiring close-tolerance test components for alignment. The internal circuitry of the *LCR-740* is carefully assembled, showing the care of hand soldering. PC board material and component selection are both high quality.

Upon prompt registration of the warranty card, the owner is entitled to a liberal two-year warranty policy. Free repair will be provided during the first six months of ownership of the instrument.

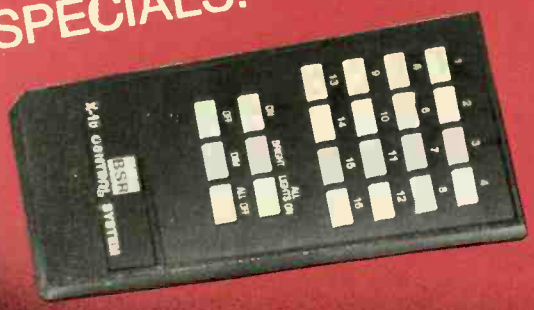
Comment

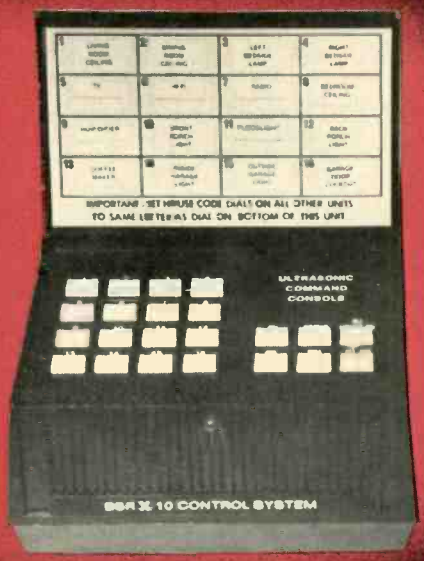
Although a period of familiarization will be required for the user to feel comfortable with the *LCR-740*, its actual operation is very simple. Resistance, capacitance, and inductance ranges are all pushbutton selectable. All value readings are taken from the same linear scale, a digital-dial multiturn potentiometer. While adjusting the instrument to make inductance measurements, three dials must be adjusted to find the sharpest dip in the meter reading. Although this may sound cumbersome, the procedure became routine after a few minutes, and values of unknown compo-

continued on page 32

PLUG IT IN AND TAKE COMMAND

CHRISTMAS SPECIALS!





X-10 Remote Control For Lights and Appliances

NO WIRES NO HASSLES

System X-10 requires no special wiring or complicated installation. Simply plug a Command Console into your wall outlet in any desired location in your home. Plug each Lamp or appliance into the appropriate module and then plug that module into any wall outlet. Any number of Command Consoles may be used in a single system.

TOTAL CONVENIENCE

With System X-10 you can operate almost every light and electrical appliance in your home without leaving the comfort of your easy chair. Imagine turning on a TV set or stereo, even dimming a light, in the next room without moving from your chair.

Think of the money you can save on electric bills with System X-10. Turn off heaters or appliances from any location in your home without a lot of running around.

DELUXE ULTRASONIC COMMAND SYSTEM

The Console controls all modules from its built-in keyboard, plus it completely controls all modules from its wireless hand held ultrasonic control unit. Simply aim the hand held unit at the Console, press any appropriate Command button to turn on and off, dim and brighten lights, or turn on and off appliances. Hand held unit operates at distances of up to thirty feet line of sight of console (does not operate through walls). A worthwhile addition to any existing X-10 system or an excellent way to begin.

STANDARD COMMAND CONSOLE

Fully controls all modules as above system, but will not respond to hand held remote unit commands - may be intermixed with the deluxe Command System or used separately, to form independent control systems.

MICROPROCESSOR BASED DESIGN

The BSR X-10 System uses the latest digital techniques for trouble-free operation. Digital pulse codes are sent through the house power lines to assure reliable control throughout the system. Amazingly compact: The Command Consoles measure only 4¾" X 3½" X 3½".

LAMP MODULE

Each module will control any incandescent lamp rated up to 300 watts from control signals received from the Command units. Functions include on and off, brighten and dim. UL listed.

APPLIANCE MODULE

Each module receives signals from the Command units to turn appliances on and off; such as TV, stereo, fan, etc. Maximum appliance ratings: Resistive load - 15 amps. Motor load - ⅓ HP, Incandescent lamp - 500 watts. UL listed.

WALL SWITCH MODULE

Receives signals from the Command units to control incandescent lamps normally operated by a wall switch up to 500 watts. Installs just like any normal wall switch. Functions include on and off by remote or local control and brighten and dim by remote control. UL listed.

GETTING STARTED

Deluxe-Ultrasonic starter kit includes: 1-Deluxe Ultrasonic Command Console, 1-Hand Held Remote Unit, 2-Lamp Modules, 1-Appliance Module. Reg. $112.95 now **$99.95.**

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And when you build it yourself, you can service it yourself. Every set includes a detailed service manual that can save you money over the years.

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Complete details and prices on the Heathkit Screen Star are in the new Heathkit Catalog. It's *free* and it contains nearly 400 beautiful electronic kits for your home, work or pleasure. Send for yours today or pick one up at your nearest Heathkit Electronic Center.

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GX-364

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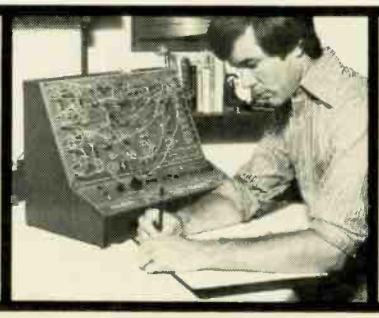

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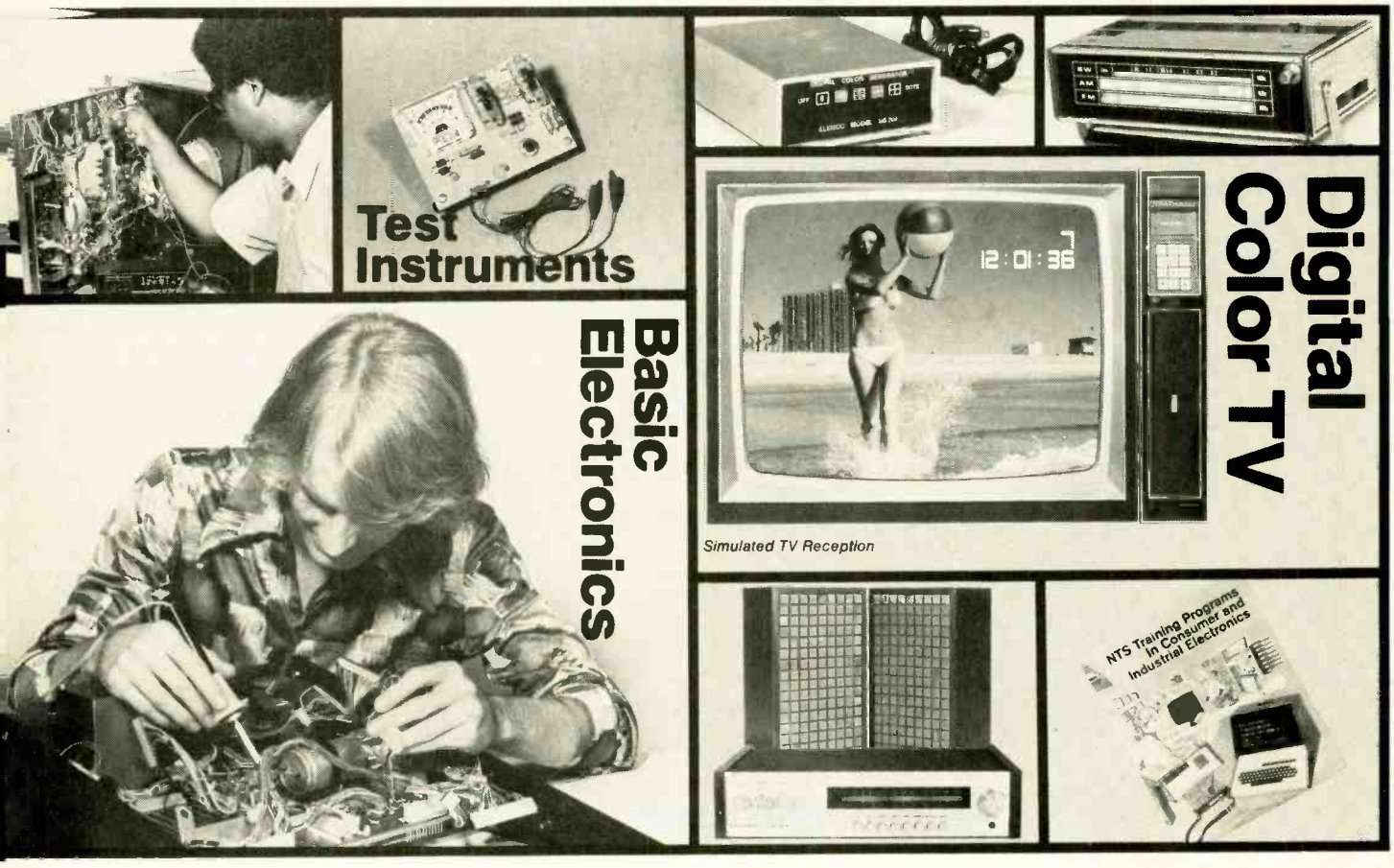

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continued from page 24

nents could be successfully pinned down relatively quickly.

Range expanders are provided for both adjustable bridge resistances. This allows for additional resistance to be introduced to accommodate critical null balancing that is too close to the end of the normal adjustment ranges.

To avoid confusion, any component under test is attached to the same two binding posts. Nulls are sharply-defined, and readouts are easy to see. Based upon standard-value components kept for test purposes, we would judge the *LCR-740* to be well within its advertised accuracy.

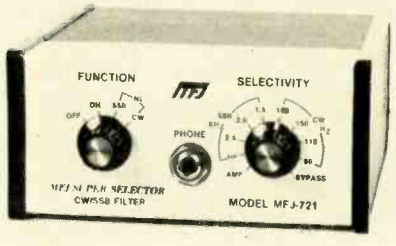
The manual that is included with the bridge is comprehensive, listing a wide variety of techniques and hints for effective component testing. Some typographical errors are present, and occasionally awkward translation to English is difficult to comprehend. Neither of these minor shortcomings detracts from the flexibility of the instrument or the value of the manual.

The *LCR-740* is a useful addition to any engineering bench or electronic experimenter's workshop. The ranges that the instrument will test include virtually 100% of those values likely to be encountered.

With some values of inductance it is extremely difficult to find the deepest null. Adjustments are very touchy. But this must be expected when using a single instrument for such a wide range of possible component values.

After using the little LCR bridge for several hours, it was difficult to return it after evaluation. It is one of those items that you never realized how much you needed until you actually used one! The *LCR-740* transistorized LCR bridge has a suggested retail price of $320 and is available from Leader Instruments Corporation, 151 Dupont Street, Plainview, NY 11803. **R-E**

MFJ Enterprise Model MFJ-721 Communications Filter



CIRCLE 102 ON FREE INFORMATION CARD

HAMS, CB'ERS AND SHORTWAVE LISTENERS will appreciate a handy accessory recently introduced by MFJ Enterprises. The *MFJ-721 Super Selector* is an active audio filter that can be used with a speaker or with headphones. The filter is designed to discriminate sharply against unwanted background noises, while permitting the desirable signal to be heard. This is accomplished by a series of IC stages. With the *model MFJ-721* in the voice mode (AM or SSB), three progressively sharper passbands remove hiss, sideband splatter, heterodyne interference, hum and even static crashes. In the CW mode, four bandwidths can

be selected, one as razor-sharp as 80 Hz. Stages are cascaded and Q is kept to a minimum to reduce ringing. A built-in noise limiter reduces impulse noise that is useful both in voice and CW reception.

An internal 2-watt audio amplifier (LM380N) can be used alone. A stereo headphone jack allows CW operators to enjoy the simulated stereo comparison of input and output signals.

All functions are switch-selectable from the front panel. A switch position allows the audio signal to bypass the active filter if defeat is desirable, as during excellent signal copy.

The unit's rear apron contains a jack for the external speaker (not provided), and two phono jacks for separate audio inputs (switch-selectable from the rear panel).

The filter requires an external power supply; any 9- to 18-volt supply will do. An optional 9-volt AC adapter is available for $7.95.

To try out our unit, we plugged it into the external speaker jack of a general-coverage communications receiver. In the high-pass position, we selected a standard amplitude-modulated voice signal with moderate background hiss and some heterodyne interference. We then began to advance the selectivity switch. Immediately, the voice began to sound clearer. The hiss virtually disappeared, as did the annoying whistle of the interfering signal.

On extremely weak SSB signals with strong interference, the most selective position had to be used. Even then, with the restricted audio passband, the voice could be copied.

On CW the unit performed admirably. Dialing through the Novice CW band, we purposely adjusted the receiver to hear a barrage of signals of varying strength and pitch. With the filter switched in, single-signal reception was accomplished. Again, as with the voice reception, progressive switch positions tighten up the audio passband. The sharpest selectivity should be used only with the worst interference.

Using stereo headphones improves CW enhancement enormously. When you compare input and output signals, the CW signal seems to float in the center of your head! Additional improvement is noted when strong pulse-noise interference (such as line noise and static) is present. The noise limiter acts like a scrubber, repressing the noise while passing the audio tone.

The *model MFJ-721* filter is constructed on a single PC board, uses high-quality components (it features stable polystyrene capacitors), and is well engineered. For the serious hobbyist, the *model MFJ-721* would be an asset. It is available for $59.95 from MFJ Enterprises, P. O. Box 494, Mississippi State, MS 39762. **R-E**

Micro Software Systems PET Programs

CIRCLE 103 ON FREE INFORMATION CARD

METRIC-CALC, CHEQUE-CHECK AND MICRO-SET I are three interestingly different programs that underline the great versatility of the ever-growing personal computer. All the programs run on an 8K Commodore PET (*P*ersonal *E*lectronic *T*ransactor) computer.

Metric-Calc turns a PET into a Reverse Polish Notation (RPN) scientific calculator; and it will be quickly adopted by Hewlett-Packard calculator owners. For those not familiar with RPN, the basic idea is to key in

continued on page 34

the operators first (i.e., the numbers) followed by the operation itself. The method has some advantages over more conventional algebraic key sequences, including fewer memory-store operations. Its disadvantages are having to learn a new entry method, and the unavailability of parentheses operations.

You might ask why a computer should act like a calculator. Isn't this diminishing the power of a sophisticated programmable machine? The answer is yes and no! Yes, the computer loses its programming and general flexibility, but only for the time you are running this particular program; and no, it makes available functions that are not otherwise directly addressable.

There are times when my calculator is not at hand or I'm already working at the PET keyboard, when it is convenient to use the PET as a calculator in the immediate mode via PRINT commands. But you have to realize that while PET BASIC is an extended version of the interpreter, many scientific functions are not in its vocabulary. Although sine, cosine, tangent and arctangent are included in the PET, secant, cosecant, arcsine and the other trigonometric functions are not. Natural logarithms are built-in, but common logarithms which are needed for example to calculate attenuation in dB are not.

The *Metric-Calc* program has two modes of operation that can be quickly interchanged while saving the results of the previous mode. In each mode a menu is displayed showing the keyboard operations that represent the various calculator functions. The first mode is the scientific calculator in which the five top values of the stack are continuously displayed. Any value in the 20-level stack can be retrieved on command. By contrast, hand-held calculators typically display one stack element at a time and have a stack that is only four elements deep. Changes in stack contents are indicated by blinking digits even when the previous values and the new values are identical. The second operational mode provides conversions between English and Metric, linear, area, volume, weight and temperature units.

The *Cheque-Check* program helps you balance your monthly checkbook statement. The system provides a choice of six functions that allow you to view or change checkbook entries. Each operation is followed by an automatic summary display that ends with the amount your checkbook balance differs from the adjusted statement balance.

First, you enter the balances on the bank statement and checkbook. Then, as you enter checks and deposits, the total outstanding balance is displayed. After the summary display you can review your entries and attempt to correct the error, each correction being followed by another updated summary. Your final success is rewarded with a congratulatory message. The program itself is much more extensive than the level of necessary math might suggest. Clear instructions and formated summary displays contribute to program complexity.

The third program is *Micro-Set I* (version 1.72), an improved version of a program reviewed in the March 1979 issue. I am happy to report that the problems I encountered the first time around have been corrected. Briefly, *Micro-Set I* is a programming aid that includes the following capabilities: it can renumber lines, delete lines, create and add from specially formated ASCII program files, and report information about your BASIC program.

I experienced one problem while trying to combine two long programs that had a total memory requirement exceeding 8K. I could not successfully add all of the second program to the first program using the ADD command even though the machine I used was equipped with 24K of memory. I followed the total procedure twice. Each time the second load operation terminated at the same place. The cursor was lost and the machine would not respond to any operation. When power is interrupted, this causes the loss of the program. There appears to be some inherent program-size limitation although there were no such warnings in the instructions. Shorter programs did merge correctly, and combined program lengths of less than 8K minus the memory used by *Micro-Set I* are presumably all right.

Metric-Calc and *Cheque-Check* sell for $7.95 a copy, and *Micro-Set I* costs $14.95. All are available from Micro Software Systems, P.O. Box 1442, Woodbridge, VA 22193. **R-E**

SST Model T-4 Antenna Tuner

THERE IS LITTLE QUESTION THAT THE ANTENNA is as important as any other component in radio communications. A properly tuned antenna may make the difference between effective transmission and marginal performance.

Many antennas are designed to be self-resonant to conveniently match coaxial-cable im-

CIRCLE 104 ON FREE INFORMATION CARD

pedance. An antenna tuner, or transmatch, is effective in providing optimum signal transfer between a radio transmitter (or receiver) and any antenna system.

The *model T-4 Ultra Tuner* from SST Electronics provides continuous operation between 1.8 MHz and 30 MHz. It can withstand 300 watts of RF power, and a built-in SWR meter is sensitive enough for low-power CB applications.

The manufacturer claims that the tuner will match any antenna—either coax-fed or random-wire—on any frequency within its tuning range. A switch located on the rear apron allows you to switch between two antennas.

High-quality components are used: For example, the 200-pF tuning capacitors have 1000-volt spacing; SO-239 connectors are used for coax input/output attachment; and Johnson binding posts are used for random-wire and ground connections.

One minor weakness is the location of the low-frequency toroidal coil—it dangles by its own leads within the larger air-wound inductor. This could result in metal fatigue and subsequent coil failure as a result of continuous bouncing and vibrations of a mobile installation. Additionally, if the toroidal coil shifts position it could cause some detuning of the air-wound inductor. The toroidal coil could be secured with a dab of silicone rubber cement if it presented a problem. In a fixed operating location the unit performs very satisfactorily.

The accompanying instructions are very superficial; they are adequate however for acquainting you with the basic tuning procedure. The schematic is only a partial diagram, and component values are not given. None of these criticisms affects the operational performance of the *model T-4 Ultra Tuner*. The instrument is well constructed, carefully wired and easily met the claimed performance specifications in our on-air tests. The *Ultra Tuner* sells for $69.95 and is available from SST Electronics, P.O. Box 1, Lawndale, CA 90260. **R-E**

"What do you have in the way of a TV that uses an indoor *antenna?"*

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Measures up on every count:
It has what you want. Guaranteed from 10Hz to 600MHz in three ranges (typically 5Hz to 750MHz). Sensitivity that holds well over the entire range. Selectable gate time for optimum resolution: 0.1, 1, or 10 seconds. With a stability of 0.1 ppm/°C. And the guaranteed frequency range has a measurement accuracy of 1 ppm + 1 digit -0.0001%.
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BRIEF SPECIFICATIONS

• Frequency Range: 10 Hz to 600 MHz guaranteed (5 Hz to 750 MHz typical). • Sensitivity: ≤ 10 mV RMS, 10 Hz to 100 MHz, prescaler mode; 50 mV RMS, 100 MHz to 450 MHz; 70 mV RMS, 450 MHz to 600 MHz • Impedance: 1 MΩ, 10 MHz & 100 MHz range; 50Ω, 600 MHz • Temperature Stability: 0.1 ppm/°C • Gate Time: Switch-selectable, 0.1 sec., 1 sec., 10 sec. • Ageing Rate: ≤ ±5 ppm/yr • Accuracy: 1 ppm +1 digit. • Input Protection: 150 V RMS, 5 Hz to 10 kHz; 90 V RMS, 10 kHz to 2 MHz; 30 V RMS, 2 MHz to 100 MHz; 10 V RMS, 100 MHz to 750 MHz. • Power Requirement: Battery-operated, 4.5 to 6.5 VDC @ 300 mA. External power supply, 7.5 to 9 VDC @ 300 mA • Size: 8"W x 6.5"D x 3"H (203 x 165 x 76 mm) • Weight: Without batteries, 1.2 lbs. (0.54 kg).

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Texas residents add 5% sales tax $ _____
Total enclosed $ _____
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Charge: ☐ Visa ☐ Master Charge
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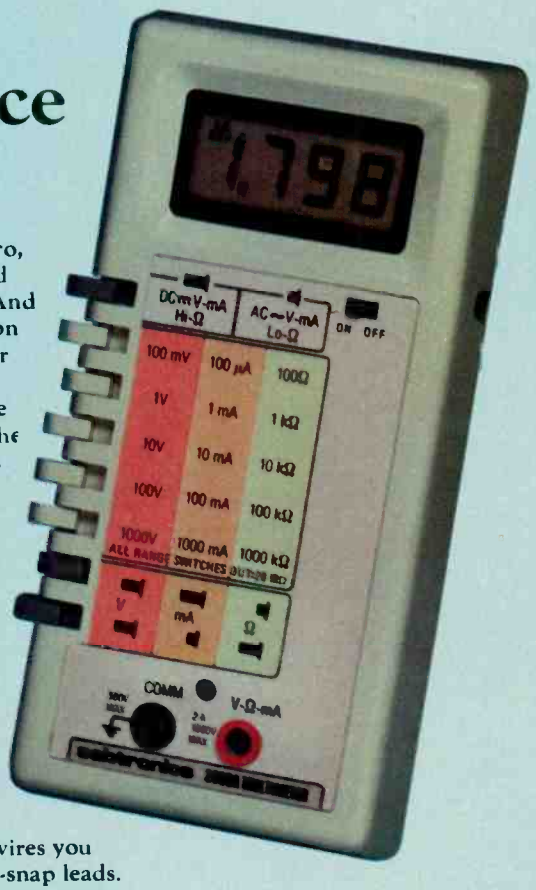

Accurate performance you can rely on, time after time. That's what you expect from a quality DMM. But don't expect to pay as much for it any more. Because now Sabtronics brings you top quality DMMs with *more* features and better accuracy than other comparable units on the market today. And they cost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

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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 touch-and-hold capability with the optional probe — its so convenient, you'll wonder why the expensive models haven't got it yet! And two-terminal input for *all* measurement functions — this eliminates lead switching and makes your job easier. The Model 2037A even has a built-in temperature measuring circuit with a -50°C to +150°C range (-58°F to +302°F) and is supplied complete with the sensor probe. Of course, auto zero, auto polarity and overload protection are standard. And you get 200 hour operation from a single 9V transistor battery. A low battery indicator warns you of the last 20% of battery life. The large, crisp LCD readouts allow easy viewing even in bright sunlight.

Assembling either kit is simple with our easy-to-follow, step-by-step instructions. And the built-in calibration references allow you to calibrate the unit any time, any place.

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BRIEF SPECIFICATIONS:

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

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

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Tune in the Panasonic Command Series™ top-of-the-line RF-4900. Everything you want in short wave at a surprisingly affordable price. Like fluorescent all-band readout with a five-digit frequency display. It's so accurate (within 1 kHz, to be exact), you can tune in a station even before it's broadcasting. And with the RF-4900's eight short wave bands, you can choose any broadcast between 1.6 and 31 MHz. That's all short wave bands. That's Panasonic.

RF-2900

And what you see on the outside is just a small part of what Panasonic gives you inside. There's a double superheterodyne system for sharp reception stability and selectivity as well as image rejection. An input-tuned RF amplifier with a 3-ganged variable tuning capacitor for excellent sensitivity and frequency linearity. Ladder-type ceramic filters to reduce frequency interference. And even an antenna trimmer that changes the front-end capacitance for reception of weak broadcast signals.

To help you control all that sophisticated circuitry, Panasonic's RF-4900 gives you all these sophisticated controls. Like an all-gear-drive tuning control to prevent "backlash." Separate wide/narrow bandwidth selectors for crisp reception even in crowded conditions. Adjustable calibration for easy tuning to exact frequencies. A BFO pitch control. RF-gain control for improved reception in strong signal areas. An ANL switch. Even separate bass and treble controls.

And if all that short wave isn't enough. There's more. Like SSB (single sideband) amateur radio. All 40 CB channels. Ship to shore. Even Morse communications. AC/DC operation. And with Panasonic's 4" full-range speaker, the big sound of AM and FM will really sound big. There's also the Panasonic RF-2900. It has most of the features of the RF-4900, but it costs a lot less.

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*Short wave reception will vary with antenna, weather conditions, operator's geographic location and other factors. An outside antenna may be required for maximum short wave reception.

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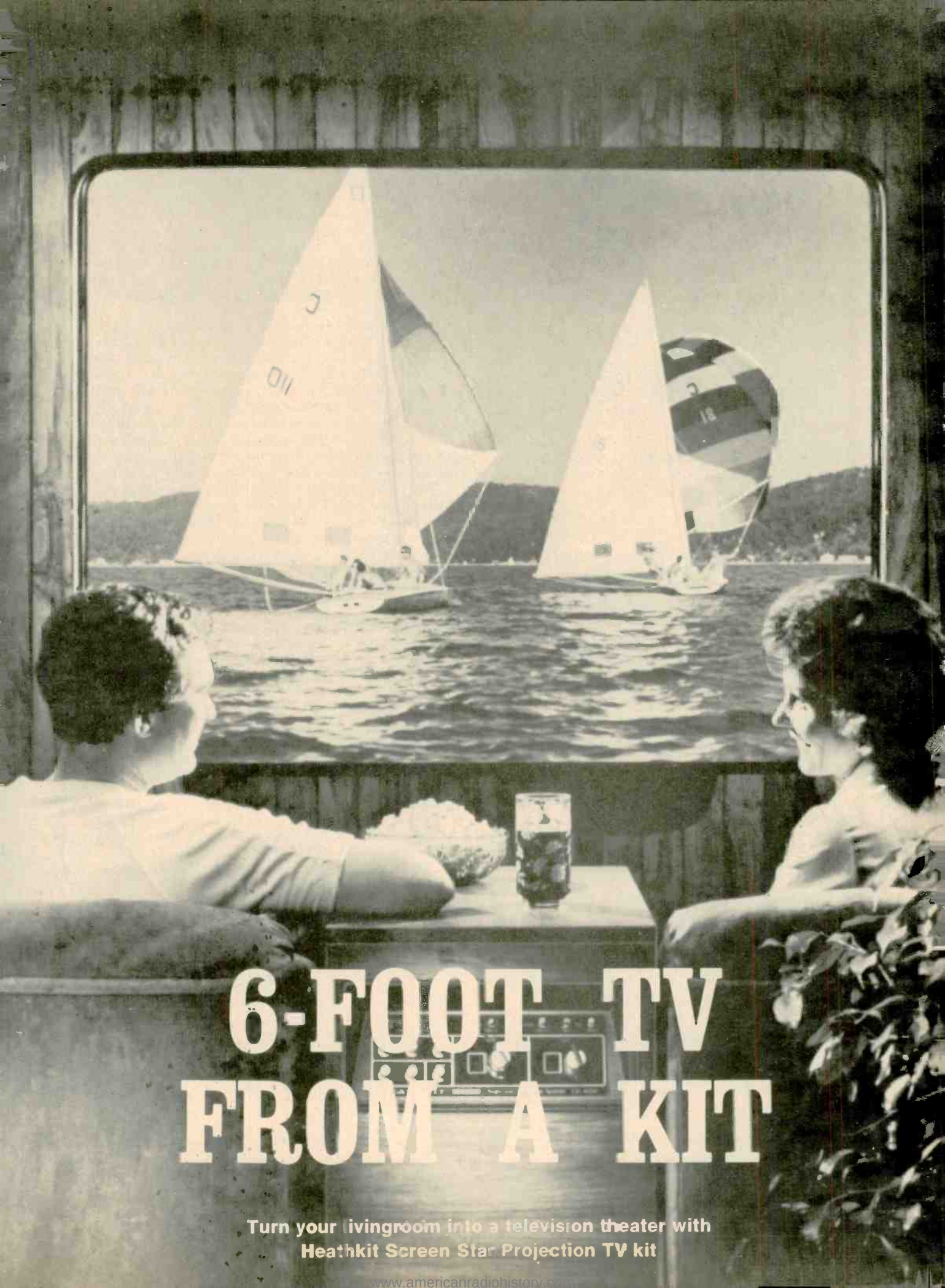


6-FOOT TV FROM A KIT

Turn your livingroom into a television theater with Heathkit Screen Star Projection TV kit

Sworn to secrecy, I was ushered in the hi-fi listening room at the Heath Company plant in Benton Harbor, Michigan early last June. And that's when I first saw the new Heath projection color TV system. I remember remarking then on the really bright picture it produced (even in that brightly lighted room with its overhead fluorescent lighting) and the anticipated low price of the set. Today I'm free of my promise and in this exclusive preview report can reveal to you the details of what I consider a rather fantastic color TV projection system.

First let's take a took at what this set is and what it isn't. It is in the new Heath Catalog, neatly numbered as their model GR-4000 (all Heath color TVs are given a GR number). It has been named the *Star Projection TV Kit* and carries a price tag of $2195 including the wall-mounted screen. An optional stand for the viewing screen that makes the screen portable and easy to mount will set you back an additional $79.95. It's important to note that the $2195 price tag makes it really worthwhile to build this kit. I don't believe that you can find a comparable set for less than $2600 or $2700. And that makes the 40 hours it is likely to take you to build the set worth $400 or $500.

As the title of this article points out, the Star Projection system delivers a picture that measures 6-feet across the diagonal of the screen. That's the same way that we measure that 19-inch, 25-inch or 26-inch set you now watch. It means that the GR-4000 delivers a picture that is eight times as large as that on the screen of a 25-inch set. For the rest of the specifications of the unit, check the table on this page.

Inside the chassis

Unlike the GR-2001, this projection set is not a state-of-the-art receiver. It does not have digital tuning with random access. It does not put the time or channel number on the screen. It does have a very solid and very conventional solid-state chassis right up through the video amplifiers. There it starts getting different, so there is where we will start looking at the circuit.

In this set there are three separate 3-stage video amplifiers—one for the blue, one for the red and one for the green. All are fed directly from the output of the chroma demodulator. The three stages consist of a matrix amplifier, a driver and an output. All are solid-state stages as is the entire set with the exception of the picture tubes.

The video signals are applied to the cathodes of the three separate projection tubes. The face of each CRT is coated with a different color phosphor—like the video amplifiers one is blue, one is red and one is green. As the electron beam strikes the phosphor, the phosphor lights up, emitting that color from its surface.

The intensity of each electron gun is controlled by chroma information fed to its cathode. By projecting these colors from the three tubes, through a lens system onto a screen and carefully overlapping the three pictures and by varying the intensity of the colors being projected, different colors, including white, can be produced on the screen.

Vertical and horizontal deflection of the electron beam in each projection CRT is controlled by two sets of deflection coils in the yoke mounted on the CRT, just as is done in a black-and-white set. As current flows through the horizontal coil the electron beam is drawn across the screen. As current flows through the vertical coils the beam traces down the screen.

The picture that is created by the electron beams on the phosphors of the projection tubes is projected onto the 6-foot screen through a lens system. The lenses and the CRT's are carefully prealigned so that when the projector is positioned the proper distance from the screen, the three pictures overlap to produce a giant, but otherwise conventional color TV picture.

Setting up the screen

While we're talking about the screen let's break away from the circuitry for just a moment and talk about screen location. When you select a place for your screen, you must first consider the dimensions of your room, room lighting and traffic and where people will sit when viewing the set. For good TV viewing, people should be seated further from the screen than the distance between the screen and the projector. Since the projector must be positioned 7-feet from the screen for proper focus, viewers should be seated at least 9-feet from the screen.

The screen itself has a textured reflecting surface that acts like a mirror. It will reflect *any light* striking its surface. Any light source (such as a window or a door) that permits light to shine on the screen will also be reflected, and will detract from the picture brightness, contrast and viewability. Because of this problem it is important that the user position the screen so that it is in front of (on the same wall as) the light sources, rather

GR-4000 SPECIFICATIONS

Antenna Input Impedance: 75 ohms, with internal UHF/VHF splitter. **Tuning Range:** UHF channels 14 through 83, VHF channels 2 through 13. **AFT Pull-In Range:** 0.7 to 1.8 MHz. **Audio Output:** 5W at speaker and external 8-ohm speaker jack. **Total Harmonic Distortion:** Less than 0.5%. **30-dB Sound Quieting:** Greater than 100 dB at 1V. **Video IF Bandwidth:** 4.08 MHz at 6-dB down. **Peak Picture Sensitivity:** Greater than 100 dB. **Video Cassette Recorder:** IV composite video in/out at 75 ohms, 0.75 VRMS audio in/out at 600 ohms. **Projector Lenses:** 127-mm focal length, fl.0/1. **Projector Distance From Screen:** Approximately 98 inches. **Screen dimensions:** 45″ high x 60″ wide. **Projector Dimensions:** 28″ high, 16¼″ wide, 32″ deep. **Power Requirements:** 120 VAC, 60 Hz, 150 watts.

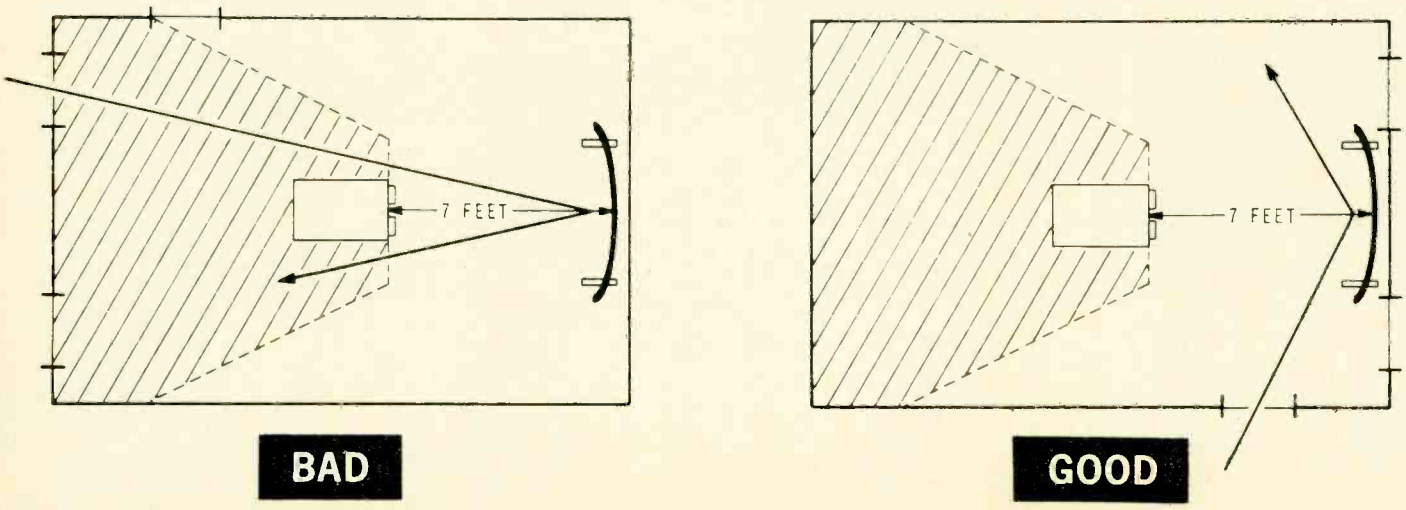


FIG. 1—LOCATE THE SCREEN WHERE LIGHT from doors and windows cannot reflect off its surface. Good and bad screen locations are illustrated above.

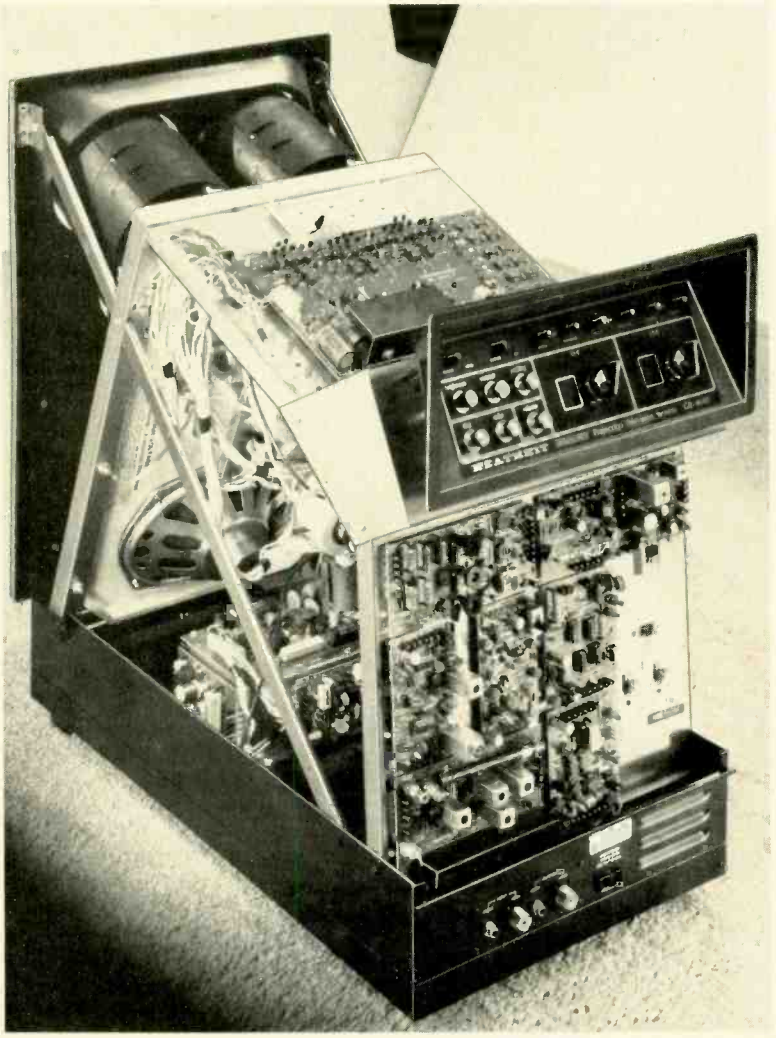
than across the room from them. Figure 1 illustrates both good and bad screen positions and shows how light can be reflected back from the screen.

You've also got to be careful when setting up the screen to allow for traffic patterns (people traffic) through the viewing room. You certainly won't want other members of the family walking between the projector and the screen. Nor will you want them bumping into the screen. While the screen is not fragile—it can be handled with bare hands; it can be washed—it is not indestructable. If you should knock it down it could crack, so be careful. Also be careful when you hook up antenna, power, external speaker or VCR connections.

The projector sits in the middle of the floor. Remember it must be 7-feet from the screen. So you will have to be careful to run cables under carpets, around behind furniture or through protective trip-free conduit.

The audio system

The Star Projection TV has three separate audio outputs. First there is the connection to the internal speaker. This is a 6 x 9-inch oval speaker that can handle the full 5-watt output of the audio amplifier. And if you refer back the specifications box once more you'll note that third harmonic distortion is less than 0.5%. That means really good sound from the built in audio system. Second there is a jack for direct connection to an external speaker. It too has the low distortion 5-watt audio signal available and offers an 8-ohm impedance. Third is the audio output intended for use with a video tape recorder (you can also use this output to connect to your hi-fi system's auxilliary input). It delivers 0.75 VRMS at 600 ohms.



INSIDE THE PROJECTION TV CABINET you can get a good look at the chassis. It really isn't very different from any other high-quality TV receiver.

Features and construction

Plan on spending 40 hours to build this set. Some readers will find they can do it faster and some will need even more time, but at whatever pace you work take the time to doublecheck yourself. I've built more than one kit so hurriedly that when I was finished, I'd find that I'd have to spend the time I saved in assembly on troubleshooting.

When looking over the assembled unit (I have not built one of these so I cannot give you a personal report on assembly) I quickly noticed the relatively open chassis. In addition the plug-in ICs and circuit boards make any needed troubleshooting that much simpler. The chassis swings back to improve accessability. All convergence control are located on the upper chassis where they are easy to reach. Separate focus controls for each of the three projection tubes helps keep pictures sharp. To help speed construction, the picture tube-lens assembly, high-voltage power supply and UHF and VHF tuners are all factory assembled and adjusted. A built-in crosshatch generator makes it possible to reset convergence without external instrumentation. And as in other color TV's in the Heath kit GR series, there's a test meter included for making circuit checks before the projector is plugged in and turned on. It can also be used for servicing at a later date should repairs become necessary.

The electronics

Included in the circuitry is AFT (automatic fine tuning) and an exclusive Heath LC filter to maintain IF alignment and reduce drift, keeping the picture in tune when you switch channels. Heath says the IF amplifier never needs re-alignment. Special black-level clamps maintain constant blacks and greys for more accurate brightness levels.

Bridge-type power supplies are used for maximum voltage regulation. A ferro-resonant power transformer keeps supply voltages constant even when line voltages drop too low or climb too high. Proper voltage regulation guarantees constant brightness and picture size, even during a brownout.

The antenna splitter is built-in. This means only one antenna connection is required. And only one antenna cable to run across your livingroom. The true 75-ohm antenna hookup combined with shielded tuners helps when you're hooked up to a cable system by minimizing stray pickup of off-the-air signals.

Reception problems

All TV receivers are subject to the same reception problems—ghosts, focus, noise, etc. Unfortunately, as the picture gets larger these problems become more noticeable. That little spot of ignition noise on a 19-inch screen is now a foot long. So it is vital that you provide the best signal possible to your projection set. Don't skimp. You've spent $2195 and a lot of your time so make sure you have the very best antenna for your area. Use the best coax or foam-filled twin lead. If you need a preamplifier, get a good one. You won't be sorry if you do, you will be sorry if you don't. **R-E**

4-Bit Bipolar Microprocessor

The IDM2901A bipolar microprocessor from National Semiconductor is a 4-bit slice designed for high-speed applications in high-performance central processing units and programmable controllers. Figure 1 is the block diagram of the IDM2901A. It includes a high-speed ALU (*A*rithmetic *L*ogic *U*nit), a microinstruction decoder, a 16-word by 4-bit 2-port RAM, and the necessary shifting, decoding and multiplexing circuits. The microprocessor has *tristate* outputs and four status flags. The 16-word memory has two 4-bit outputs that are independently addressed by two separate address fields. In other words, two memory locations can be read simultaneously; for example, to be used as inputs to the ALU. Writing is done through a single additional input port, each bit of which is fed through a 3-input multiplexer.

The ALU performs binary addition and subtraction, as well as OR, AND, exclusive OR and exclusive NOR logic operations. An inhibit on either of the ALU inputs is equivalent to a zero operand. A left or right shift can be performed with an arithmetic operation in the same machine cycle.

Processors can be cascoded for longer word lengths in 4-bit multiples. Carry-generate ($\overline{G}$) and carry-propagate ($\overline{P}$) outputs are used for carry-look-ahead for high-speed operation when units are cascoded. The IDM2901A uses low-power Schottky technology, and operates with clock frequencies of up to 20 MHz and read-modify-write cycle times of 60 ns.

Data sheets are available from National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, CA 95051. **R-E**

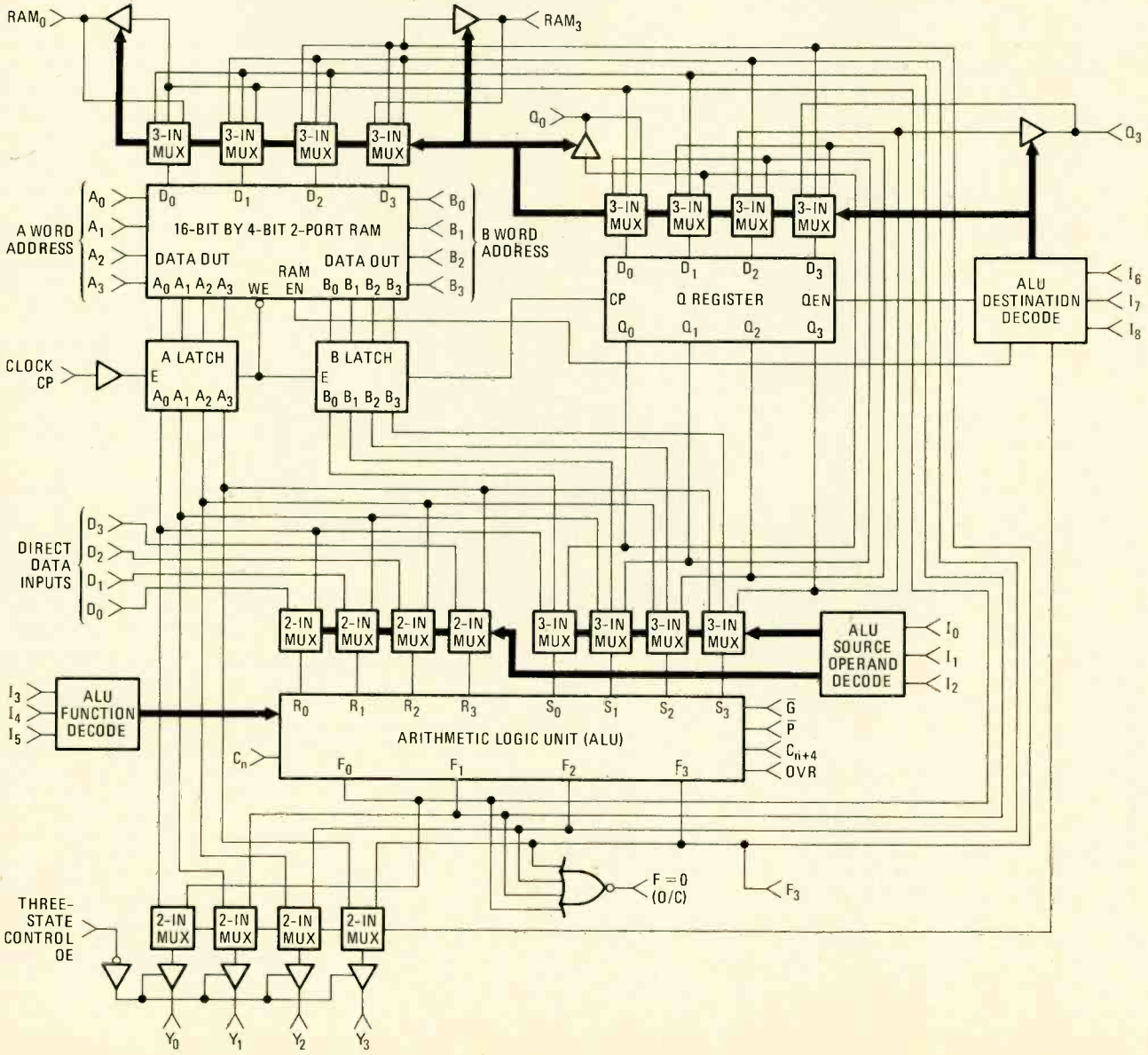


FIG. 1—BIPOLAR BIT-SLICE MICROPROCESSOR, block diagram of the IDM2901A.

Automatic Telephone Dialers

FRED BLECHMAN, K6UGT

Part 2—We've gone over the basics of automatic dialers, DTMF dialing and feature phones. Now we are going to take an in-depth look at the features and characteristics of the units listed last month.

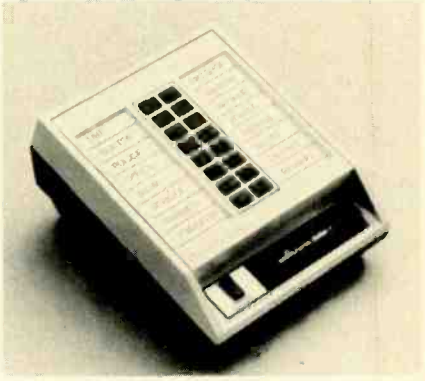
LAST MONTH WE LOOKED AT DIALERS AND feature phones, DTMF dialing and installations, and a Comparison Chart summarized the characteristics and features of 19 units. This month we will examine each of the units in detail, in alphabetical order. All units (except the *TRS-80 Dialer Program*) are supplied with AC wall-plug transformers, and have adequate instruction manuals for normal use. Most units are also usable with PBX (Private Business Exchange) and WATS (Wide Area Telephone Service). However, if your intended use is special in any way, write the source listed with specific questions. All units carry reasonable guarantees (at least 90 days; some 1 year).

Blechman Enterprises, 7217 Bernadine Avenue, Canoga Park, CA 91307: The *TRS-80 Dialer Program* is a microcomputer cassette tape containing a program written in the BASIC Language for the Radio-Shack *TRS-80 Level II Microcomputer*. The tape is supplied with a program listing and instructions for entering up to 500 names and telephone numbers in a 16K RAM memory TRS-80 (or about 40 numbers with a 4K memory). A simple serial telephone interface can be built for less than $5 using standard components. The program shows all names entered in memory in alphabetical order on the display screen. You type in the desired name on your keyboard and the computer puts the name and phone number (up to 14 digits) on the screen, then actually pulse-dials the number. (The pulsing speed is set by the user in the program.) When the party at the other end answers, you hit ENTER and the screen tells you that you've been charged for one minute so far, displays running seconds and updates the minutes charged every 60 seconds! You can stop the timing at any time and either redial the last number, or relist all names, or dial any number from the keyboard. The timer automatically resets to zero.

If you have a computer other than the *TRS-80*, the documentation (listing and instructions alone—no tape) are $5. You will probably be able to modify the program to run on your machine if you have expanded BASIC.

Ford Industries, Inc., 5001 S.E. Johnson Creek Blvd., Portland, OR 97222: (Phone toll free (800) 547-4683 for local distributor). These units carry the *Code-A-Phone* brand name. They make seven different units, of which two, The Dialer II and III, are distributed by JS&A. The others are described here.

The *Electronic Dialer I* is a very basic unit with no display and few special features. It is one of the most compact and stylish dialers available, but has a relatively low capacity of 16 numbers in memory (up to 15 digits each). Programming (with 3 button under a lift-up cover) is easy. Two silver-oxide watch batteries (supplied) provide power-failure back-up to the memory. The button layout is very orderly and a large space next to each button is provided for writing the stored name on easily replaceable ruled cards (extras supplied). Ten or 20 pulses-per-second (pps) dialing speed is selected with a switch. A CANCEL button allows you to break the connection if the line is busy and a dial-tone reappears automatically if the phone is not hung up—so you can try again. A special HOI-163 dual modular adapter is supplied for easy plug-in installation, with special instructions to telephone installers for the unusual cases.



ELECTRONIC DIALER 1 from Ford Industries.

The *Electronic Dialer VI* is just like the Dialer III (See JS & A listing), but has tone dialing as a switch selected option, in addition to 10 or 20 pps.

The *Electronic Dialer 32* is a double-capacity version of the *Electronic Dialer*

III. It uses a two-position memory switch so that each of the 16 buttons can be used for two distinct programmed numbers. Of course, you must be sure to put this 1-16 or 17-32 selector switch in the correct position, or when you push a button you may dial the wrong number! The display however, verifies the number being dialed. The CANCEL button, which is physically replaced by the two-position selector switch, is not needed; the ON/OFF switch does this.

The *Deluxe Electronic Dialer* has 32 separate buttons, each with a large space alongside to write names on removable cards. A ½" high 4-digit clock reads hours and minutes, and a second smaller

DELUXE ELECTRONIC DIALER is also from Ford Industries.

display reads the phone numbers being programmed or dialed. A moving decimal point shows the digit being dialed. The built-in speaker allows hands-off dialing and a volume control is used for conference calls—that is, the person on the other end of the line is heard through the dialer's speaker (although you must speak directly into the telephone to your party). A 3-way position switch selects 10 or 20 pps or tone dialing.

The *Memory-Phone* is a push-button feature phone with a 16-number memory. A one-way speaker allows hands-off dialing. Non-programmed numbers are dialed with the pushbuttons, and you can redial the last personally-dialed number by pushing the ON button and then the # button—all this without lifting the telephone. Instead of a loud bell, the *Memory Phone* uses a gentle electric tone ringer. There is no display—but neither does a regular phone have a display! Dialing is performed only at 10pps.

Heath Company, Benton Harbor, MI 49022: The only dialer we found sold in

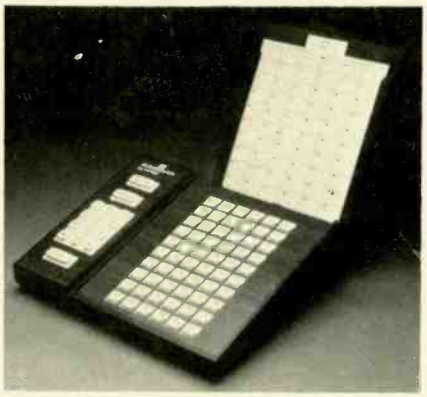
HEATH ELECTRONIC DIRECTORY/DIALER model GT-1217

kit form is the *Heath Electronic Directory/Dialer*. The manual is up to Heath's normal high standard, and no errors were noted. Assembly time was 2½ hours working slowly and carefully. A small portion of the printed circuit board has 2 relays and an integrated circuit preassembled and soldered to it to qualify the unit for FCC approval. A 9-volt battery is used for memory-power back-up.

The finished unit is very easy to program and use, with three LED's showing READY (phone off the hook), PULSE (dialing—10pps only) and STORE (used when programming). You can redial without hanging up the phone. Just push REDIAL and the phone disconnects for 2½ seconds, then reconnects and dials. You can also hold the last number dialed in memory by pressing REDIAL.

The memory holds only 16 numbers, with 8 buttons in two columns staggered to allow a single name list between them. The name list is a dull-finished plastic strip that allows you to write in pencil and erase and reuse any number of times—a very worthwhile feature not found on any of the other units reviewed. Also, the name strips are pre-printed so that EMERGENCY, FIRE and POLICE will appear on the strip if you desire, or they can be cut off. A clear plastic removable window protects the written names. The back panel has two slots for wall mounting if desired. Connection to the phone line is through a 12-foot cable and interface block that you wire as part of the kit. Although this unit lacks some exotic features, it's very simple to learn to use, and wall-mounting can save desk space.

HI-TEK Corp., Consumer Products Division, 12311 Industry, Garden Grove, CA 92641: There are SIX *Autotouch* by



AUTOTOUCH M60 from Hi-Tek

Hi-Tek models available or planned by Christmas of 1979. Only the M20 low-end and M60 high-end are shown in the chart to save space. The M20 has a 10/20pps switch and re-dial capability, and will allow programming up to 24 digits using adjacent storage locations. The M40 ($199.95) is the same with 40 storage locations, and the M60 ($249.95) is the same with 60 locations. The M42 ($229.95) is the same as the M40 but with a speaker added for hands-free dialing, and a HOLD button. The M62 ($279.95) is the same as the M42, but with 60 storage locations. The top-of-the-line M63 adds tone dialing, a 12-digit LED display, clock, elapsed-timer, alarm and will redial a busy number automatically 17 times. Also, each storage location will hold 17 digits, and two adjacent locations can be used for a total of 34 digits! Easy programming is a feature of all the autotouch units.

Integrated Circuits Packaging, Inc., 750 North Mary Ave., Sunnyvale, CA 94086, Attn: Cliff Denchfield, Marketing Director: The *Superphone 7700* is a full-feature telephone, calculator, clock, alarm, calendar, call timer and 20 number dialer, with last number redial and manual dial capability. Dialing speed is 10pps only. The 8-digit calculator can be used anytime except when dialing (even during a call). When the 4-digit clock is displayed, A or P (for AM or PM) is also displayed, as well as the day-of-the-week and date-of-the-month, and a decimal

SUPERPHONE 7700 from Integrated Circuits Packaging, Inc.

point blinks each second. The month is not displayed, but is held in memory so that the proper number of days per month is correct (except on leap year!) The keyboard is like a *Touch-Tone* phone, but with 8 additional keys for dialer, clock, calendar, timer and alarm functions. The keys are clearly marked, and the white non-standard keys are protected with plastic covers.

It takes a while to get familiar with all the various features the *Superphone 7700* offers. The elapsed timer, which reads minutes and seconds and has a 1-second blinking decimal, can be activated at any time (except when dialing). It stops automatically when the phone is hung up and "freezes" (including the blinking decimal) until you press a button, so you can jot down the time anytime after the call is completed. It can also be used without the phone off the hook, and stopped manually. The single alarm buzzes for 2 seconds, and can be set for any hour and minute setting, AM or PM.

If you get a busy signal when calling, press REDIAL and even without hanging up, a dial-tone reappears and the last number redials. The *Superphone 7700* connects to the phone line just like any regular telephone, except the wall-plug transformer normally is also plugged in. Unlike the other feature phones tested,

the internal rechargeable batteries not only hold programmed numbers in memory, but also allow the *Superphone 7700* to dial—up to two hours—if there is a power failure! Five different colors are available: white, antique white, beige, brown and black. There are two models. The American model (7710) and the European model (7720) that comes with a 220V adapter and displays time in the 24-hour mode. (Contact Cliff Denchfield, Marketing Director for European model prices.)

JS & A National Sales Group, One JS & A Plaza, Northbrook, IL 60062: The *Code-A-Phone Electronic Dialers II* and *III* are made by Ford Industries and distributed by JS & A (among others). They are step-up versions of the *Ford Electronic Dialer I*, previously described. The *Dialer II* ($149.95, not shown in the chart) has the added convenience of a built-in speaker to allow hands-free dialing. The *Dialer III* has the speaker plus a display that shows the number being programmed or dialed, with a decimal point that follows each digit as it is dialed. Otherwise, these units are virtually identical to the *Dialer I* in appearance and function.

The *Busy-Buster* is a feature phone with several special capabilities but one *primary* purpose—to bust through the busy-number barrier! You dial a number in the normal way, with regular pushbuttons (although the *Busy-Buster* actually dials with either 10 or 20pps, switch selected). If the line you're calling is busy, hang up and press a black button on the *Busy Buster*. A green light goes on. Forty seconds later the red LED pulses as *Busy Buster* redials the number! If it gets a busy signal again, it automatically dials again after another 40 second wait. It keeps doing this for up to 30 minutes! If your call goes through, you hear a loud, piercing tone from a piezo element. If you get an incoming call during the 40-second redial pause or you wish to make an outgoing call, the *Busy Buster* patiently waits for you to hang up, and then goes back into the automatic redialing mode! Also, by picking up the receiver and pressing the "*" button, the *Busy Buster* re-dials the last manually-dialed number, without forgetting the busy number. The automatic redial mode is cancelled by simply pressing the "#" button. You can dial up to 12 digits, including pauses programmed by the "#" button.

The *Busy Buster* is built into a modified ITT telephone case, but with a surprising amount of circuitry and versatility not found in a regular phone. The normal adjustable-loudness bell is retained. The *Busy-Buster* connects to the phone line with a modular plug, like a regular telephone, but with the addition of a wall-plug AC power pack. No batteries are needed.

Leisurecraft Products, Ltd., 28 S. Terminal Dr., Plainview, NY 11803: The

WEBCOR DIAL-A-TRON model 747 from Leisurecraft Products.

Webcor Dial-A-Tron model 747 is the only truly-portable dialer in this survey. Six "C" cells (included) provide adequate power for phone dialing as well as memory, although the AC adapter is recommended for normal use and required for pulse dialing. The *Dial-A-Tron* has switch selected pulse (10 or 20pps) or tone dialing. It can even be *acoustically* coupled to a telephone that has a tone-dialing exchange. By simply placing the phone mouthpiece over the *Dial-A-Tron* speaker, and putting the *Dial-A-Tron* in tone-mode dialing, the speaker tones "dial" any of the programmed numbers! This means the *Dial-A-Tron* does not have to be plugged into either the phone line or the AC line for programmed tone dialing. Manual dialing is not provided.

Thirty-two 10-digit numbers can be held in memory and displayed during programming or dialing. Another unique feature is a HOLD button, with flashing LED, even if your phone doesn't have one. A volume control allows group listening, and a hidden directory tray slides out from the front of the unit for reference. Special buttons hold long distance and access codes in memory.

Panasonic Consumer Affairs, One Panasonic Way, Secaucus, NJ 07094: The *Easa-Phone KX-T1210* has the lowest

PANASONIC EASA-PHONE model KX-T1220

height of any of the units in this survey, and is first class in appearance and operation. The top and sides of the cabinet are simulated wood. The AC adapter plugs into a socket in the rear of the unit, and two back-up pencell batteries fit in a compartment at the bottom. Thirty-two individual clearly labeled keys are used, with plenty of write-in space for programmed names alongside the keys on long slide-out cards. Ten of the call keys are also used for programming. Underneath a flip-top panel are some additional programming buttons. A flip-top wire frame raises the rear of the unit for better visibility, if desired, and a special bracket and screws are provided for optional wall-mounting.

Up to 30 digits can be stored in adjoining memory locations. Hands-off dialing is set at 10pps, and a speaker is built-in. The programming keys even beep for entry verification. Programming and operation are simple. If the called party doesn't answer, the unit turns off automatically after the phone rings for approximately 1 minute. If the unit gets a busy signal, it automatically turns off after about seven seconds. However, suppose you wish to redial the last automatically dialed number; simply press the REDIAL button. If the line is busy or no one answers, the unit stops calling. But after about 30 seconds it will call automatically again and repeat this sequence 16 times before giving up! You can be nearby listening to the speaker, but don't have to lift the phone unless the connection is made.

The *KX-T1220* is almost identical, but has several step-up features. A 12-digit green fluorescent ¼ inch high display shows digits when programming or dialing. Pulse dialing can be selected at 10 or 20pps, and a volume control is provided for the speaker.

Radio Shack, Forth Worth, TX 76102: The *Automatic Telephone Memory Dialer DuoFONE-32* is available at all

DUOFONE-32 from Radio-Shack

Radio Shack stores, or mail order. Although it is one of the least expensive dialers in this survey, it has more useful features than many of the others. It holds 32 programmed numbers in memory, using 16 buttons and an A-B selector switch. The slanted LED display not only shows each number as it's being programmed, but when you memory dial the entire number is displayed (up to 7 digits and a hyphen at a time) and each digit blinks as it is being dialed. The display normally shows hours and minutes with a 1-second blinking hyphen, but press the timer button and you have a minute/second elapsed timer that stops and holds when the timer button is pressed again.

You can then either clear the timer, or accumulate total time for several calls.

Programming is very straightforward using some additional buttons under a lift-up cover. There are REDIAL and CANCEL buttons to make operation simple. Unfortunately, the cover has no lifting tabs and is difficult to grasp. Also, the A-B programming switch is marked in a confusing manner that seems backwards. When the cover is lifted, the name cards, on which you can write 16 names, are easily replaced, and extra cards are supplied. Thoughtfully, Radio Shack also provides red self-adhesive stickers labeled DOCTOR, HOSPITAL, POLICE, FIRE and AMBULANCE to stick on the name cards if desired.

Installation is extremely simple. Plug in the AC adaptor, plug your phone into the dialer and insert the dialer modular plug into your phone jack. The AC adaptor cord and modular plug from the dialer are each over 6 feet long. Three pencell batteries are used for backup memory power. A 10- or 20-pps dialing speed switch is on the back. The pulsing relay is easily heard when in operation; a reassuring sound. Also, if the phone is left on the hook when a programmed button is pressed, the unit displays the number and pulses, but does not actually dial, so you can confirm the stored number. The last number dialed can be held in a redial memory, and a cancel button stops any dialing in progress.

Royce Electronics Corp., 1746 Levee Road, North Kansas City, MS 64116: This feature phone holds up to 35 numbers in memory (including specially-labelled POLICE & FIRE buttons) and has a

FREEDOM-DIALER from Royce Electronics

relatively large wide-angle LED display that normally changes every five seconds from time (hours, minutes, seconds) to month and date. When programming or dialing, the numbers appear on the display. When the elapsed time is commanded, minutes and running seconds are displayed until the phone is hung up or the CANCEL button is pressed. The 20 keys are color coded, with brown for memory programming, orange for time and date programming, blue for police, red for fire and beige for numbers 0-9. The keys are labeled on the front panel below each key—rather than on the key tops—and this is confusing until you get used to it.

Automatic dialing first requires pressing the A/DIAL button, then the storage location number. Hand dialing is supported, with a 10 or 20pps switch underneath. Redialing the last number dialed (either manually or automatically) is accomplished with a single button.

When using the elapsed timer, a piezoelectric element sounds a reminder at 2-minutes and 48 seconds that 3-minutes (a minimum billing time on operator-assisted calls) is coming up. The piezo element also is used in place of the telephone bell, with a distinctive, pleasant tone.

A convenient phone number reminder, including operating instructions, is also supplied. It fits under the Freedom Dialer and pulls out when needed. Rechargeable batteries hold numbers in the memory for up to 3 hours, but the AC adapter is required for dialing.

Technology Applications Corp., 2660 Marine Way, Mountain View, CA 94043: The original *Rapidial* is an extremely versatile dialer in a small hand-

RAPIDIAL from Technology Applications

held calculator style case. Color-coded snap-action keys program 20 memories plus a re-dial memory, or allow hand dialing. The memory keys are blank, but lots of self-adhesive pre-printed and blank labels are supplied to identify memory contents. Hands-off dialing is supported by a small speaker, and the unit automatically disconnects from the line at the end of 30 seconds if you haven't picked up the phone.

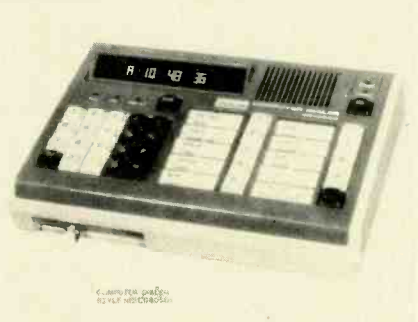
The *Rapidial* is the lowest price tone-dialing unit available, with a 10pps switchable option for non-tone exchanges. The 8-digit LED display lets you see the numbers being dialed, or held in memory at each location. You can redial the last number dialed. Special buttons are used for "1", "0", PBX or WATS acquisition. Because *Rapidial* uses true DTMF *Touch-Tone*, it can be even used effectively for rapid dialing with specialized tone systems.

The *Rapidial*, despite its many features, has very compact circuitry all on a single, small PC board—by far the best packaging of the units reviewed.

The *Rapidial* manual includes use for electronic banking, installation on multi-line phones and international calls. Using DTMF, where such service is provided, *Rapidial* can be used for scheduling cable TV programming, credit verification/authorization, voice-response computer access, stock exchange floor paging and ordering (via FM transmission) and security alarm dialing. Hams can utilize the DTMF mode for repeater access by connecting the *Rapidial* output to their microphone circuit. Similarly, *Rapidial* can be used with mobile telephones.

The *Rapidial II* is the lowest-priced assembled dialer we found. It uses 10pps dialing (no DTMF), and two discrete LED indicators replace the digital display and speaker. Otherwise, it has the same small size, compact circuitry and excellent features of the *Rapidial*.

Wintron Merchandise Corp., 110 West 40th St., NY 10018: The *Otron CD8050* (other models may be available by the time you read this) is the Cadillac of dialers. In addition to holding 20 phone numbers in memory (2 banks of 10, switch-selected) it displays up to 14 digits on a relatively large display, has keys that "beep" when pressed for audible entry verification, functions as a 12-digit 5-function calculator or 6-digit clock when not dialing, has FIVE programmable, repeatable AM/PM beeping alarms, and automatically disconnects from the line after 90 seconds of hands-off dialing. Numbers can be dialed manually, with single-button redial of last number dialed. A volume control sets speaker loudness. Five discrete LED indicators keep you informed of status (dial, calculator, time-setting, upper or lower memory bank). Separate key pads are used for number entry and memory locations. Surprisingly, although a 6-digit is included, an elapsed time mode is *not* provided.



COMPUTER DIALER model CD-8050 from Wintron Merchandise.

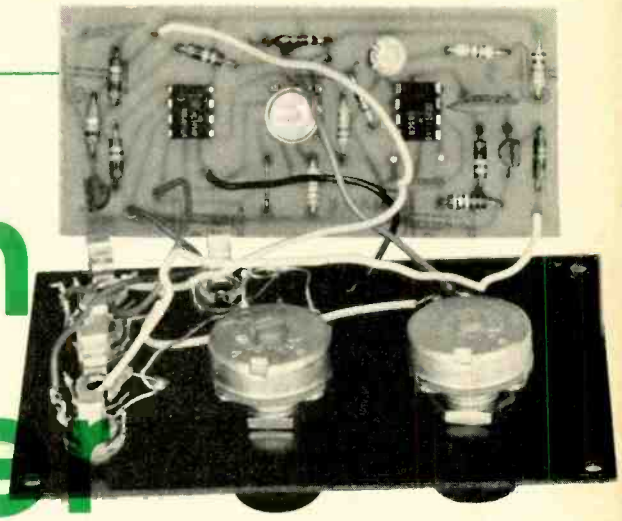
Using all these functions takes some training, but the detailed manual guides you through the procedure with lots of illustrations.

Incidentally, one switch is shown, but not described in the manual. The DIALER-TEL switch on the back of the unit must be placed in the DIALER position for keyboard dialing—but this disables your reg-

continued on page 98

BUILD THIS

Percussion Synthesizer Accessories



INSIDE VIEW OF THE SNARE accessory.

The PerSyn Percussion Synthesizer described earlier is a versatile instrument that generates the sounds of many common instruments. Round-out the range of percussive effects with these two easy-to-build accessories.

JAMES BARBARELLO

THE PERSYN PERCUSSION SYNTHESIZER SYSTEM DESCRIBED IN the September and October 1979 issues is a versatile instrument capable of synthesizing most any simple drum sound, gong, chime and other metallic sounds plus special effects. To compliment this low-cost, versatile system, two additional accessories are described here that will greatly increase the system's capabilities.

The two conventional percussion sounds that could not be generated by PerSyn are the snare drum and cymbal. Both these sounds can be synthesized with a triggerable envelope-shaped white-noise source and, in the case of the snare drum, a coincident drumstick strike pulse. The Snare accessory described here produces both these effects. It can also be triggered with a pulse generator to create such effects as a steam engine and biplane.

The other accessory described here is a 3-channel, 8-bit trigger-pattern generator. This device produces three distinct 8-bit repeating trigger sequences. Each channel can trigger a PerSyn Generator and/or Snare accessory. Each bit in each pattern is user selectable on or off. This device will allow your PerSyn to double as a complex rhythm unit which will allow you to play while the sequencer is operating. Such features as 3/4 or 4/4 time selection, a CANCEL footswitch provision and start-of-pattern visual indication are included.

Both accessories use standard components and construction techniques and can be powered from the PerSyn TAP jack.

The snare accessory

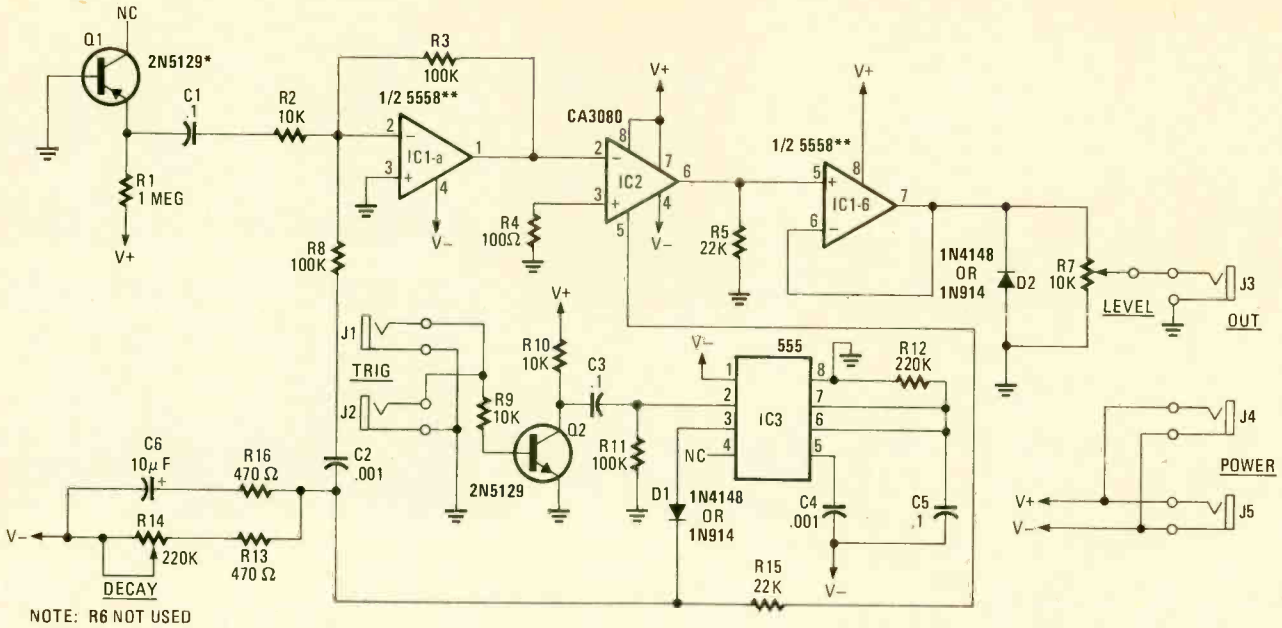
Circuit operation: Referring to the schematic diagram in Fig. 1, we see that the emitter-base junction of transistor Q1 is reverse biased to produce an approximate white noise signal that is AC-coupled through C1 to the input of amplifier IC1-a. The output of IC1-a in turn drives transconductance amplifier IC2. The output signal amplitude of IC2 is determined by the voltage applied to pin 5.

A positive-going trigger pulse applied to J1 (or J2) is inverted by Q2 and AC-coupled through C3 to trigger the 555 timer, IC3. When triggered, IC3 produces a 25-millisecond positive-going pulse with a base voltage of −9 volts. This pulse quickly charges C6 through R16. After reaching its peak value, the voltage on C6 begins to exponentially decrease. The time for C6 to discharge is determined by the values of R13, R16 and the setting of DECAY control R14. During this discharging period, diode D1 is reverse-biased as the output of IC3 returns low. This prevents IC3 from rapidly discharging C6 when IC3 returns to the low state. The output of IC3 is also differentiated by C2 and coupled to amplifier IC1-a. The values of C2 and R8 result in a sharp "crack" (characteristic of a drumstick strike sound).

The voltage envelope developed across C6 and R16 is fed through R15 and is the envelope control voltage for IC2. The output of IC2 is buffered by IC1-b. The negative portion of the signal is clipped by D2, producing a more realistic snare or cymbal effect. A portion of this signal is tapped off LEVEL control R7 and provided to output jack J3. Power (±9 volts) is provided through the "ring" (−9V) and "tip" (+9V) of PWR jacks J4 or J5.

Construction: A PC board is recommended for assembling this device. The foil layout is shown in Fig. 2 and component placement in Fig. 3. If the CA3080 device is obtained in the 8-pin can (TO-5), the leads should be pre-formed to a DIP configuration before installing on the PC Board. All controls and jacks should be mounted in a suitable enclosure. Final wiring of the jacks, controls and PC Board can be performed using Fig. 4 as a guide. If a metal enclosure is used, the bodies of J4 and J5 (which are at −9 volts) should be isolated from the other jack bodies (which are at ground potential).

Use: If the Snare accessory is to be used for Cymbal or special effects, remove C2 or R8 to eliminate the Strike sound. Connect either POWER jack (J4 or J5) to the TAP jack on PerSyn (or to



NOTE: R6 NOT USED
*SELECT FOR NOISE CHARACTERISTICS
**5558 OR LM1458 8-PIN DIP

FIG. 1—SNARE DRUM SIMULATOR accessory. Most of the circuitry is devoted to processing the "white noise" generated by transistor Q1.

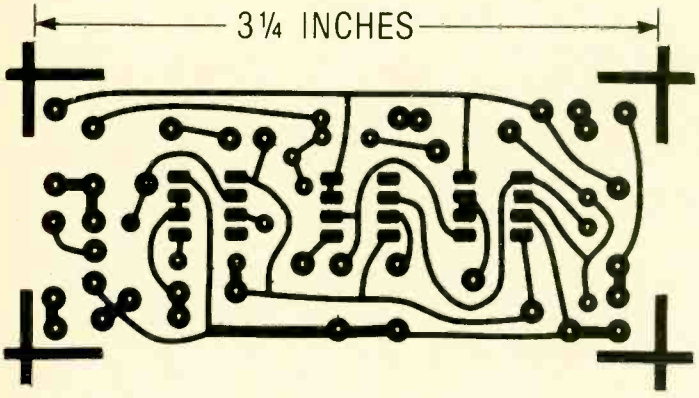


FIG. 2—FOIL PATTERN for the Snare accessory.

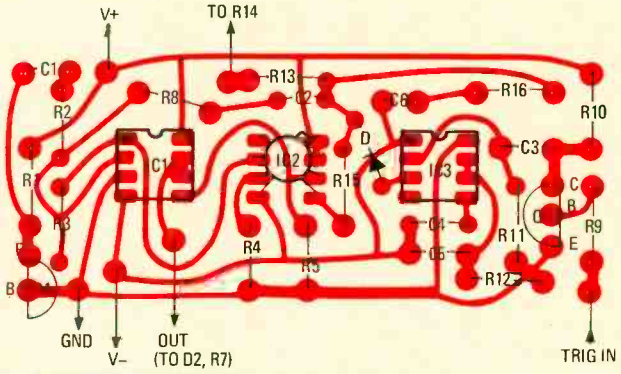


FIG. 3—COMPONENT LAYOUT for the Snare simulator accessory.

SNARE PARTS LIST

Resistors ¼ watt, 5% or better
R1—1 megohm
R2, R9, R10—10,000 ohms
R3, R8, R11—100,000 ohms
R4—100 ohms
R5, R15—22,000 ohms
R6—not used
R7—10,000 ohms, ½-watt potentiometer
R12—220,000 ohms
R13, R16—470 ohms
R14—220,000 ohms, ½-watt potentiometer
C1, C3, C5—0.1 μF disk ceramic
C2, C4—.001 μF disc ceramic
C6—10 μF, 10 volts or higher. Radial-lead electrolytic
D1, D2—1N4248 or 1N914
Q1, Q2—2N5129 (Select Q1 for its noise characteristics)
IC1—5558 or LM1458 dual op-amp
IC2—CA3080S, CA3080E or CA3080 (Form CA3080 leads to DIP configuration)
IC3—555 timer
J1-J5—phono jack, ⅛ inch
Miscellaneous: PC board, enclosure, wire, solder, knobs, etc.
Note: The following is available from BNB Kits, RD1, Box 241H, Tennent Road, Englishtown, NJ 07726: PC board (PSN-PC) $15.00. Price includes shipping. No COD's. Please allow up to 6 weeks for delivery.

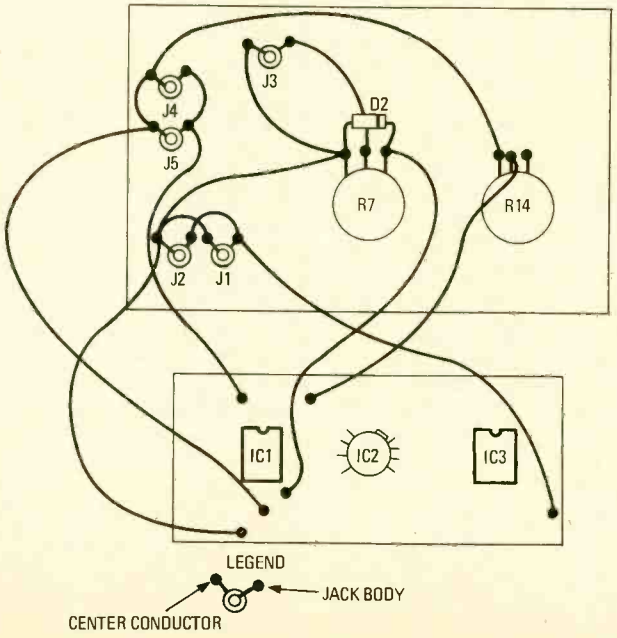


FIG. 4—FINAL WIRING diagram shows interconnections between the PC board and components on the instrument's panel.

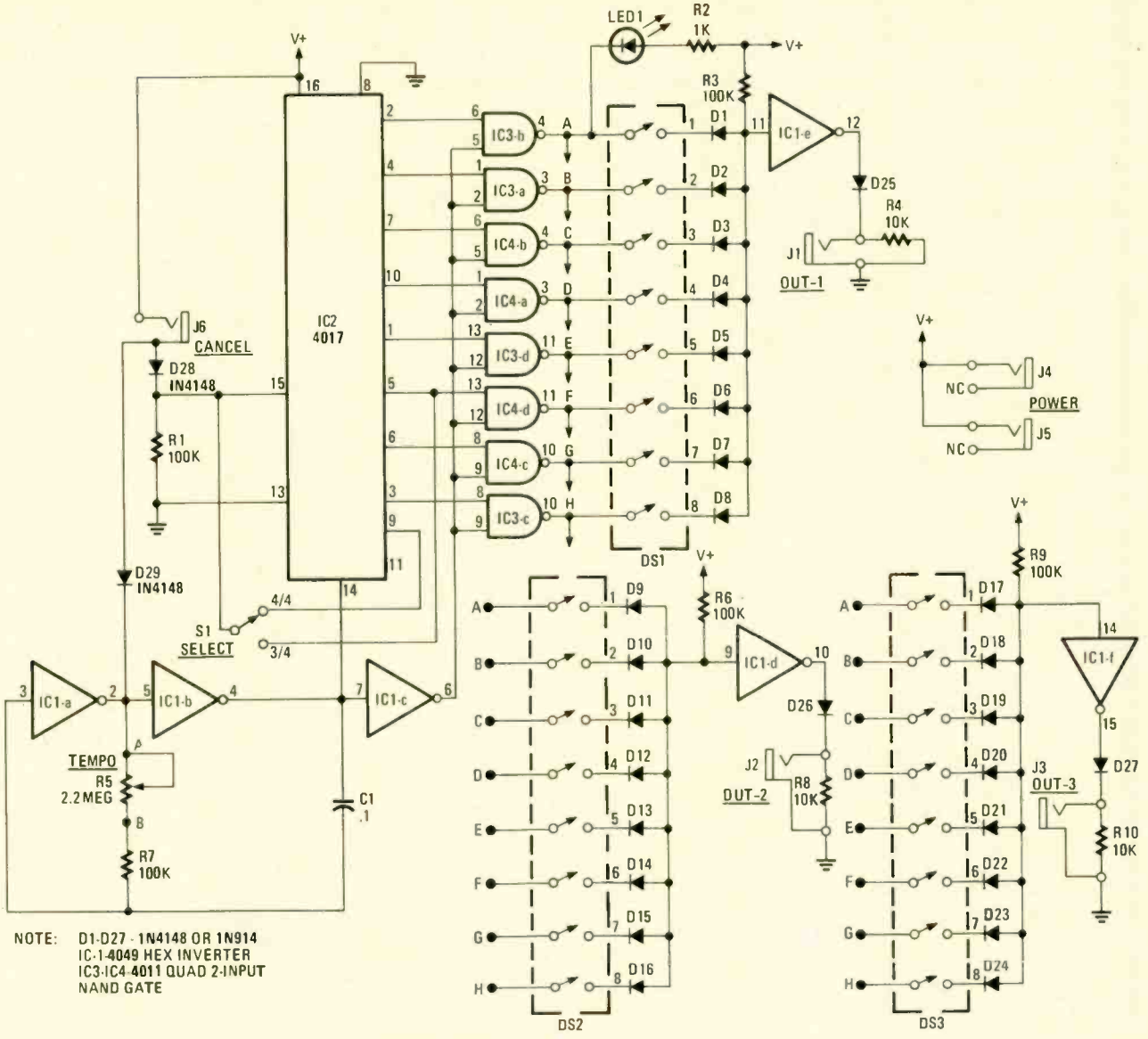


FIG. 5—SEQUENCER CIRCUIT. A variable-frequency oscillator clocks counter IC2. The eight NAND gates feed decoded outputs through a network of DIP-type switches to produce a complex serial output pulse train.

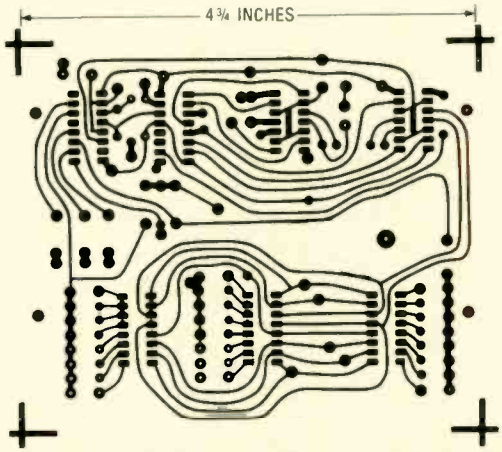


FIG. 6—THE SEQUENCER foil pattern. The component side of the board serves as the control panel.

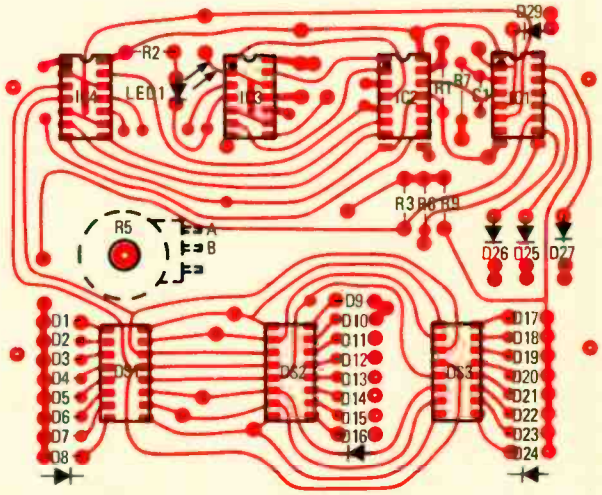


FIG. 7—PARTS LAYOUT for the Sequencer board. Be sure to check the polarity of the many diodes that are used.

another accessory POWER jack), and the OUTPUT jack to a MIXER IN jack on PerSyn. The TRIG jack can be connected to the Sequencer or Pulse Generator for Automatic triggering.

For manual triggering, connect a pushbutton switch between the "tips" of a TRIG and POWER jack. Depressing this switch will trigger the unit. To synthesize a realistic snare drum, connect a TRIG jack on the Snare to a TRIG jack on the PerSyn. Adjust that generator for a midsized Tom-Tom effect. Adjust the DECAY control on the Snare for a short decay. As you tap the appropriate strike surface box, adjust the GEN and Snare volumes until a true snare effect is produced. This approach produces a true representation of a snare drum since it includes the synthesized

SEQUENCER PARTS LIST

Resistors ¼ watt, 10% or better
R1, R3, R6, R7, R9—100,000 ohms
R2—1000 ohms
R4, R8, R10—10,000 ohms
R5—2.2 megohms, ½-watt potentiometer
C1—0.1 μF, disc ceramic
D1–D27—1N4148 or 1N914
LED1—general-purpose LED diode, ⅛ inch
IC1—4090 CMOS hex inverter
IC2—4027 CMOS decade counter
IC3, IC4—CMOS quad 2-input NAND gate
J1–J5—phono jack, ⅛ inch
J6—phono jack, ¼ inch
S1—SPDT or DPDT slide switch
DS1—DS3—8-circuit DIP switch
Miscellaneous: PC board, enclosure, knob, wire, solder, etc.
Note: The following is available from BNB Kits, RD2, Box 242H, Tennent Road, Englishtown, NJ 07726. PC board (PSQ-PC) $25.00. Price includes shipping. No COD's. Please allow up to 6 weeks for delivery.

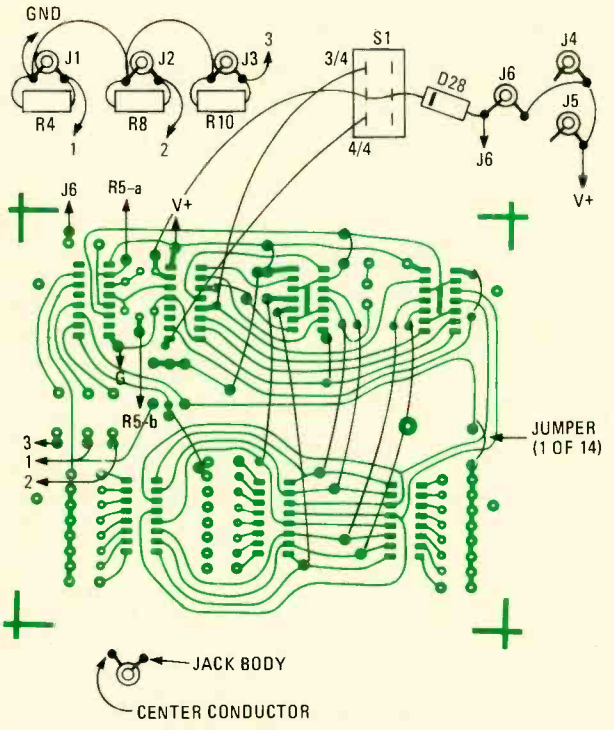


FIG. 8—JUMPERS AND CONNECTIONS that are made to the foil side of the Sequencer board. Leads are tack-soldered to the pads indicated.

sound of the snare drum wires (snare), the drumstick strike as well as the drum itself.

To use the Snare accessory for steam engine or biplane effects, trigger the unit with the Pulse Generator or Sequencer, adjusting frequency (or tempo) as required.

The sequencer accessory

Circuit operation: Referring to the schematic diagram in Fig. 5, we see that IC1-a and IC1-b, R5, R7 and C1 form a variable-frequency oscillator. The oscillator clocks IC2, a decade counter with decoded outputs. The eight NAND gates in IC3 and IC4 allow the clock signal, inverted in IC1C, to pass when the corresponding output from IC2 is high. The NAND gate outputs are combined in the discrete negative-logic OR gates (D1–D8 and R3, D9–D16 and R6, D17–D24 and R9). Each OR gate input is provided through a switch. If the switch is closed, the pulse is transmitted to the OR gate. If the switch is open, no signal is provided. By opening or closing appropriate switches,

TABLE 1

PROGRAM1—BASIC ROCK:
1=Bass, 2=Snare, 3=Tom-Tom
NOTE: 0=Switch Off
1=Switch On

Switch	Sequencer Channel 1	2	3
1	1	0	0
2	1	0	0
3	0	1	0
4	0	0	1
5	1	0	0
6	1	0	0
7	0	1	0
8	0	0	1

PROGRAM 2—BASIC ROCK (Modified)
1=Bass, 2=Snare, 3=Tom-Tom
NOTE: Play at twice the Tempo of Basic Rock

Switch	Sequencer Channel 1	2	3
1	1	0	0
2	0	0	0
3	1	0	0
4	0	0	0
5	0	1	0
6	0	0	0
7	0	0	0
8	0	0	1

PROGRAM 3—BONGO ROCK:
1=Bass, 2=Bongo (High Pitched),
3=Bongo (Medium Pitched)

Switch	Sequencer Channel 1	2	3
1	1	1	0
2	0	1	0
3	0	1	0
4	0	1	0
5	1	0	1
6	0	1	0
7	0	1	0
8	0	1	0

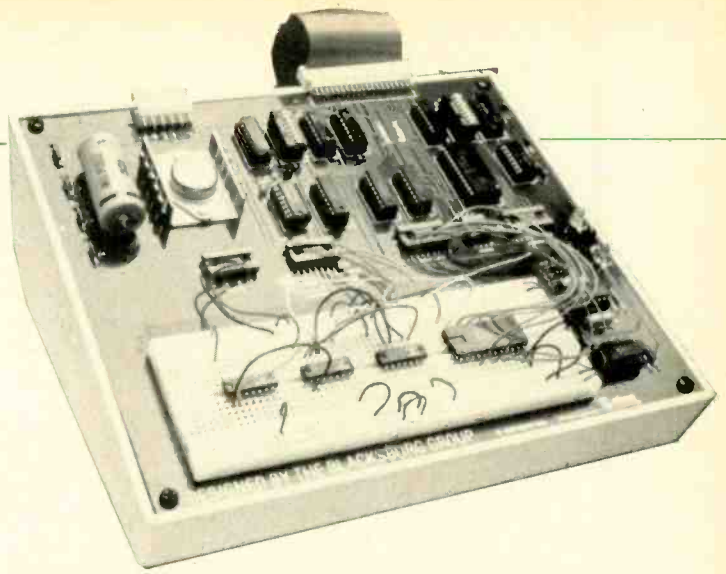
PROGRAM 4—DISCO BEAT:
1=Bass, 2=Cymbal or Snare

Switch	Sequencer Channel 1	2	3
1	1	0	
2	0	1	NOT
3	0	1	USED
4	0	1	
5	1	0	
6	0	1	
7	0	1	
8	0	1	

Legend: "1=Bass" means connect Sequencer output to a Generator tuned for a Bass Drum effect.

continued on page 96

BUILD THIS



TRS-80 BREADBOARD

Part 2—Build this breadboarding device that serves as an interface between the TRS-80 microcomputer and any circuits that you are designing or prototyping. Its design makes it easy to use.

JON TITUS, CHRIS TITUS, and DAVID LARSEN

LAST MONTH WE DISCUSSED THE NEED FOR AN INTERFACE DEVICE for the TRS-80 and began a discussion of its operation. Now, we'll complete that discussion and present the construction details.

Let's look at an example of how the decoder works. Suppose that the address switches at positions 7–4 were preset to 1011. This would set up the device address decoder so that it would be able to decode addresses of 10110000 through 10111111, although only addresses 1011000 through 10110111 would be available at the decoder's outputs. These address outputs correspond to the decimal addresses 176 through 183. The lowest switch setting at S2 must be in the open or in the D position for the decoder to operate in the device mode.

The decoder's address outputs are available at socket SO5. They are labeled "0," "1," and so on, through "7." The entire section is labeled, ADDRESS. Note that there is a bar over all of the numbers. This is to remind you that the logic zero is the asserted state for decoded addresses. The numbers are sequential, and they should help you in determining which output should be connected to your interface.

In most cases, the actual numbers, 0–7, do not correspond to the actual address values selected at the decoder. In the example just described, the "0" output would be a logic zero when address 176 (decimal) was output by the *TRS-80* on address lines A7–A0. Thus, the "0" output would correspond to an input to the decoder of 0000, while the "7" output would correspond to an input of 0111. Of course, the decoder must be enabled by the comparator before the actual decoding can take place. The decoder outputs are shown in Table 3.

Connections for address bus signals A3–A0 (unbuffered) have been provided at pins 8–5, respectively of socket SO4. These signals may be required when you are interfacing some of the advanced programmable IC's, but caution is advised since these signals are not buffered on the breadboard.

Memory addresses may also be decoded on the breadboard, if you wish to use the memory-mapped I/O technique, or if you wish to experiment with other I/O techniques. Two additional digital comparator chips, IC3 and IC4 are provided so that address bits A15–A8 may be compared with an eight-bit preset HI address. When the address bus is split into bits A15–A8 and A7–A0, the portions are often called the HI address bus, and the LO address bus, respectively.

To decode the entire 16-bit address bus, the mode switch S2 must be placed in the ON or the M position. In the memory mode, the decoder is enabled only when there is a match between the eight preset HI address bits, and the eight HI address bus signals, and when a similar match takes place between the four preset LO address bits, A7–A4, and their respective signals on the address bus. In this way, the decoder can now decode addresses that are within the range of zero to 65,536, but you should be careful not to select addresses that are presently used in your *TRS-80* system. Just as problems developed when I/O devices had the same address, similar problems can occur when devices and memory locations have the same address.

If you choose to use the memory-mapped I/O scheme, you will have to use the $\overline{RD}$ signal in place of the $\overline{IN}$ signal, and the $\overline{WR}$ signal in place of the $\overline{OUT}$ signal. In this case, the PEEK and POKE commands are used in place of the INP and OUT commands. We see little advantage in using the memory-mapped I/O technique instead of the device I/O technique, and we will not discuss it further. The memory address decoder section of the breadboard still needs some further explanation, though.

TABLE 3—ADDRESS DECODER
Connections for address Information

PIN (SO5)	LABEL	SN74154 OUTPUT PIN
1, 16	0	1
2, 15	1	2
3, 14	2	3
4, 13	3	4
5, 12	4	5
6, 11	5	6
7, 10	6	7
8, 9	7	8

Since the SN74154 decoder will only be enabled when there is a match between the preset 12 address bits, A15–A4, and the actual address bits on the address bus, the decoder can be used to decode any of the addresses between 00000000 00000000 and 11111111 11111111. These decoded addresses are indicated by a logic zero at the respective output from the decoder. Remember that only the first eight addresses in each block of 16 addresses is available at these outputs.

Let's see how a 16-bit address is decoded. We will assume that the HI address switches have been preset to 10000001, while the four LO address switches have been preset to 1110. In this way, addresses 33,248 through 33,256 would generate logic zero pulses at outputs "0" through "7," at the ADDRESS socket, SO5. If you decide to switch back and forth between the two address decoding modes, be sure that you change the switch setting of the mode control switch so that it matches the mode that you wish to use: M for 16-bit memory address decoding, and D for eight-bit device address decoding.

Two non-inverting bus buffer IC's, IC10 and IC11, are used to buffer the bus as shown in Fig. 9. This means that the *TRS-80*'s eight-bit data bus is available with a fan-out of about 30. Thus, it can directly drive up to 30 standard SN7400-series logic inputs. The bus buffers isolate the breadboarded interface circuits from the *TRS-80*'s main data bus. The eight data bus signals are available at the socket SO3. The information provided in Table 4 shows the various data bus connections.

The bus buffers are always enabled, and the normal mode of operation is for the transfer of information from the *TRS-80* to the interface breadboard. This means that you could monitor the activity of the data bus with a logic probe, logic analyzer, or oscilloscope. Output ports are implemented simply by connecting them to the data bus, and controlling them with the proper control signals. Input ports, however, must be implemented so that they can turn the bus buffers in the opposite direction to drive information into the *TRS-80*. Actually, there are two buffers for each line in the 8216 buffer IC. The EN input at pin 15 is used to select which buffer is to be used, the output buffer or the input buffer, thus directing the flow on the data bus either to, or from, the *TRS-80*. All input operations must activate the proper set of buffers, so that the information is properly transferred to the *TRS-80*. Special control circuitry has been included so that this is easily implemented.

The control circuitry on the breadboard is rather simple, consisting mainly of buffers to buffer the six useful control signals that are output by the *TRS-80*—$\overline{IN}$, $\overline{RD}$, $\overline{OUT}$, $\overline{WR}$, $\overline{RESET}$ and $\overline{INTAK}$. This is shown in Fig. 10. The interrupt input, $\overline{INT}$, has also been buffered, to protect the computer. Connections to these signals may be made at socket SO2 as noted in Table 5.

You are probably not familiar with the $\overline{INTAK}$, $\overline{INT}$, or $\overline{RESET}$ signals. The $\overline{RESET}$ signal is a short logic zero pulse that may be used to clear circuits, to get them ready for normal operation. The pulse is generated when the *TRS-80* is turned on, and when the RESET pushbutton is depressed. The RESET pushbutton is next to the interface connector on the rear of the *TRS-80*'s keyboard enclosure. The interrupt signals, $\overline{INT}$ and $\overline{INTAK}$ will not be described further, being beyond our present scope.

The control circuitry can also generate a signal that will switch the 8216 bus buffers into the input mode, so that information may be transmitted to the *TRS-80* when an INP command is executed. To handle the input ports properly, the input port's device select signal is used to gate information onto the data bus, and also to control the mode of the 8216 bus buffers. In effect, up to four input port device select pulses may be OR'ed together to place the breadboard's bus buffers in their input mode. This means that the bus buffers are placed in the input mode only when a breadboarded input port has been selected. The INP REQ, (input request) signals are required to be logic zero pulses, and they may be applied to pins 16, 15, 14 or 13 on the socket at IC17. These positions have been labeled "W," "X," "Y," and "Z."

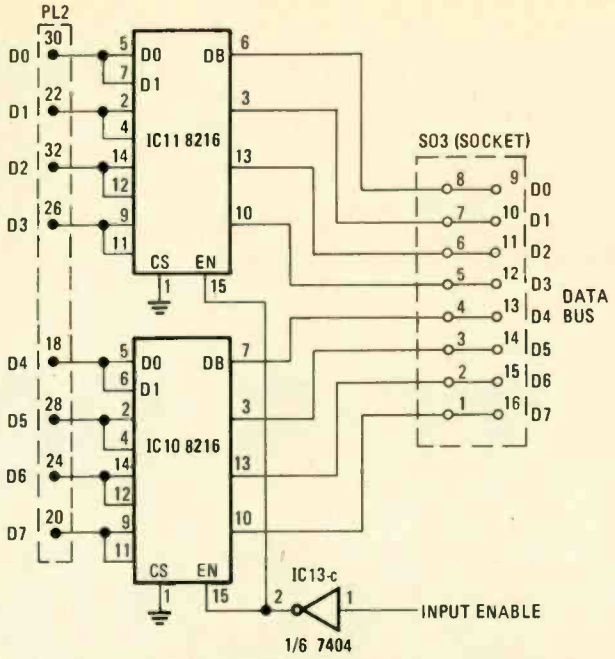


FIG. 9—THE DATA BUS BUFFERS. The EN input controls the flow of information through the 8216 buffers.

TABLE 4—DATA BUS CONNECTIONS

PIN (IC13)	DATA BUS SIGNAL
1, 16	D7
2, 15	D6
3, 14	D5
4, 13	D4
5, 12	D3
6, 11	D2
7, 10	D1
8, 9	D0

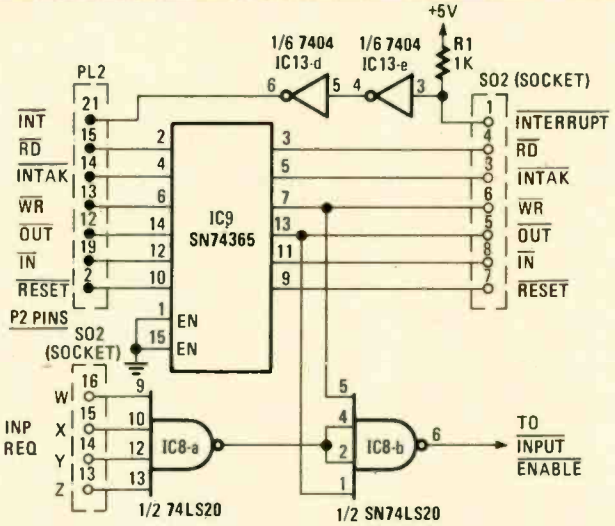


FIG. 10—SCHEMATIC DIAGRAM of the circuit used for control-circuit buffering and for control of the 8216 bus buffers.

TABLE 5—CONTROL SIGNAL CONNECTIONS

PIN (SO2)	CONTROL SIGNAL	DIRECTION
1	$\overline{INT}$	To TRS-80
2	Not Used	—
3	$\overline{INTAK}$	From TRS-80
4	$\overline{RD}$	From TRS-80
5	$\overline{OUT}$	From TRS-80
6	$\overline{WR}$	From TRS-80
7	$\overline{RESET}$	From TRS-80
8	$\overline{IN}$	From TRS-80

PARTS LIST

Resistors ¼ watt, 5%
R1, R8—1000 ohms
R2, R3—220 ohms
R4, R5—47,000 ohms
R6—3900 ohms
R7—2200 ohms
C1—2200 μF, 16 volts, electrolytic, axial leads
C2, C4, C5—0.1 μF, 50 volts, disc ceramic
C3, C6—1 μF, 35 volts, tantalum electrolytic
C7, C8—3.3 μF, 50 volts, electrolytic, axial leads
Semiconductors
IC1, IC7—16-pin resistor network (eight 1K resistors)
IC2, IC6—Not used
IC3—IC5—SN74LS85 quad comparator (do not substitute SN74L85)
IC8—SN74LS20 dual 4-input NAND gate
IC9—SN74365 or DM8095 three-state buffer
IC10, IC11—8216 non-inverting bus buffer (Intel or equal)
IC12—SN74154 4-line to 16-line decoder
IC13—SN7404 hex inverter
IC14—SN74123 or SN74LS123—dual retriggerable one-shot
IC15—LM319N dual comparator (14-pin package)
IC16—LM309K, voltage regulator, 5 volts, 1 amp.
D1–D4—1N4001 or equal, 50 PIV, 1-amp, diode
D5, D6—1N4148 or 1N4154 small-signal diode
LED1—yellow LED
LED2—red LED
LED3—green LED
S01, S02, S03, S05—High-quality 16-pin DIP socket (Augat 516-AG-10D or equal)
S04—high-quality 8-pin DIP socket (Augat 508-AG-10D or equal)
PL1—Molex right-angle 6-pin connector (PN 09-75-1061) optional. Requires 1 mating female housing (PN 09-50-7061) and 6 connector pins (PN 08-50-0106 or 08-50-0108)
PL2—40-pin right-angle jumper header, AP Products 923875R or equal
T1—transformer, 12.6 volts, 1 amp
Miscellaneous
Solderless breadboard socket. E&L Instruments model SK-10, AP Products model Superstrip II, Continental Specialties model EXP-300 or equal.
Cable assembly, 40-pin header on one end and 40-pin card-edge connector on the other—facing the same direction.

The following parts are available from E & L Instruments, Inc., 61 First St., Derby, CT 06418.

Order No. 355-6125—Complete kit including PC board, case and all parts. Does not include interconnect cable. Specify 117V or 230V version. $139.00.

Order No. 355-6175—Interconnect cable assembly (connects breadboard to TRS-80 computer). $25.00.

Order No. 355-6100—Assembled 117-volt version. $185.00.

Order No. 355-6150—Assembled 230-volt version. $185.00.

Connecticut residents add state and local taxes as applicable.

A pre-drilled and etched PC board is available from Techniques, Inc., 235 Jackson St., Englewood, NJ 07631, for $24.50 postpaid. New Jersey residents add 5% sales tax.

Copies of the book *TRS-80 Interfacing* (published by Howard W. Sams and Co.) is available for $7.95 plus 79¢ for shipping and handling from Group Technology, Ltd., PO Box 87, Check, VA 24072

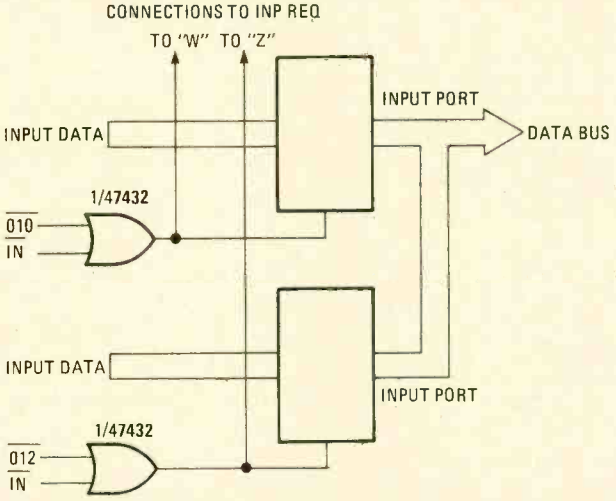


FIG. 11—BLOCK DIAGRAM of two input ports, showing the generation of the required input request (INP REQ) signal for bus control.

Figure 11 shows how these INP REQ signals are generated. Actually, they are the same signal that has been used for the selection and control of the input port, itself. Thus, whenever an input port is constructed, the logic zero device select pulse ($\overline{IN}$ and the device address) is used to control the input mode of the bus buffers. The actual OR'ing of the various INP REQ signals is performed by IC8. The input request signal that is generated by IC8 is further gated with both $\overline{OUT}$ and $\overline{WR}$. This additional gating provides a safety interlock, so that the bus can not be mistakenly placed in the input mode while the *TRS-80* is performing an output, or a memory write operation. The resulting control signal, INPUT REQUEST, BUT NOT $\overline{OUT}$ OR $\overline{WR}$, is what turns the bus drivers around, placing them in the input mode.

Construction

The interface breadboard circuits may be constructed using the wire-wrap technique, but this may mean that the breadboard is somewhat difficult to use. A printed circuit board has been developed, and we recommend its use for this project. The foil patterns are shown in Figs. 12 and 13, with a parts placement overlay shown in Fig. 14.

In addition to the parts listed for the construction of the *TRS-80* interface breadboard, you will need the following to perform various tests on the interface. These are general-purpose parts, and they are readily obtained from many sources. You will find that they are used in many interfaces, since they are not specific to the tests outlines in this article.

1. One solderless breadboard (may be available on your breadboard)
2. Two SN7402 quad NOR gates
3. Three SN74LS373 octal buffer-latches
4. Two DM8095 or SN74365 three-state buffers
5. Eight LED's (red)
6. Jumper wires (No. 24) stripped at both ends

If you are going to use a printed circuit board inspect the board carefully before you start. Pay careful attention to the etched areas, and to the remaining conductor paths, looking for bridging of conductor paths, and for over-etched sections that may cause a conductor to be open. Once you are satisfied that your circuit board is properly etched, you are ready to start the construction of the interface breadboard.

Start your construction with the power supply section. Install and solder power diodes D1–D4, filter capacitor C1 and regulator IC16 if you plan to use the on-board regulator circuit. As mentioned previously, we recommend a small heat sink for the voltage regulator. If you will be using an external +5-volt power supply, these parts are not required, and they should not be installed on the board. Connector PL1 is used to make connections with the power supply, or the external transformer. Pins 1 and 2 are used to connect the on-board power circuit with a 12.6 VAC transformer, while pins 5 and 6 are used for connections to +5 volts and ground, respectively, when an external power supply is used. Two spare pins, 3 and 4, have been provided, so that other voltages may be connected to the POWER socket on the breadboard. These connections may also be made by soldering directly to the PC board.

Once the proper power supply connections have been made, connect power to your system, and check for +5 volts at pins 7 and 10 at socket SO1. You should also be able to detect ground (zero volts) at pins 5 and 12 on the same socket.

With the power supply section of the breadboard operating

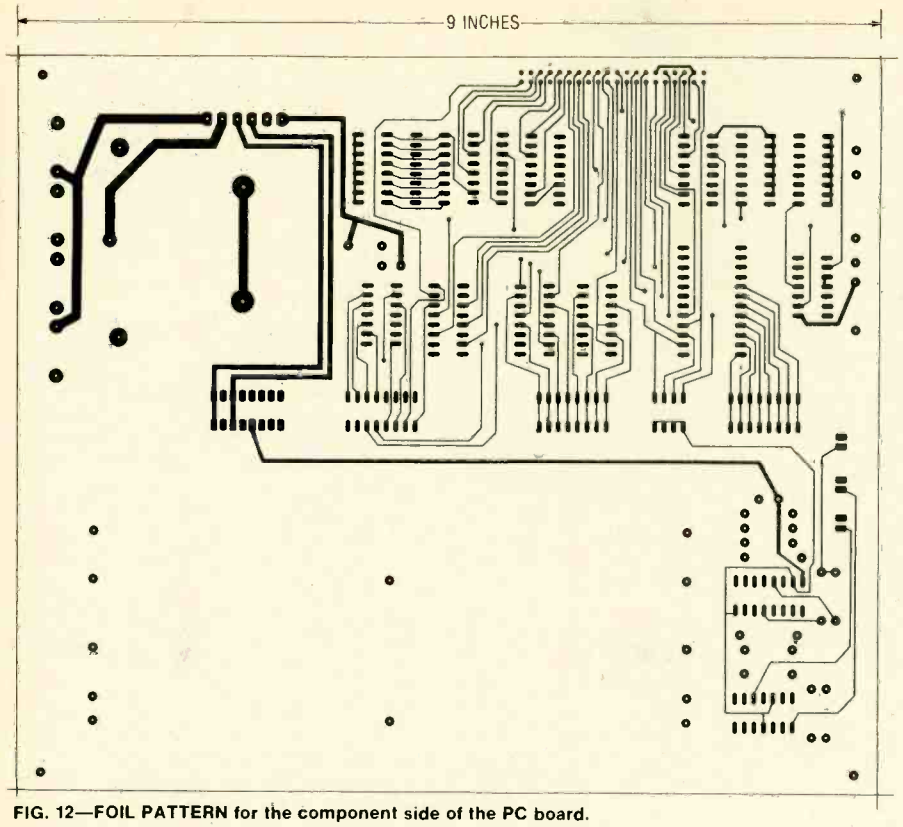


FIG. 12—FOIL PATTERN for the component side of the PC board.

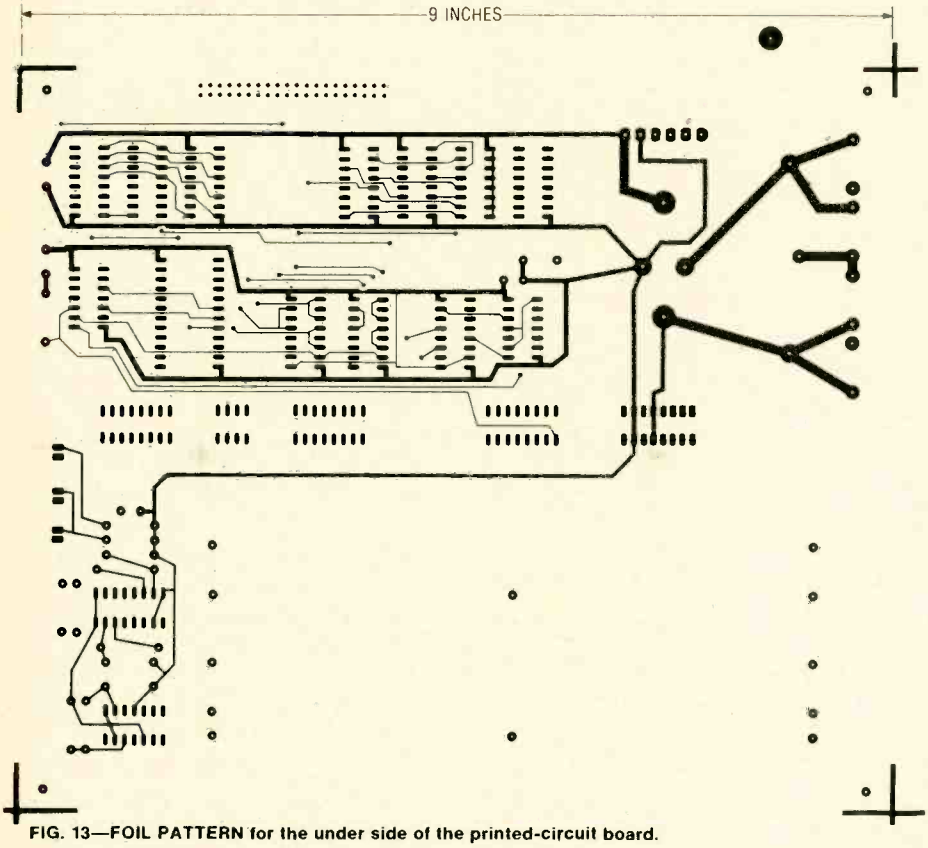


FIG. 13—FOIL PATTERN for the under side of the printed-circuit board.

properly, the logic probe should be constructed next. You may skip this section if you have chosen to use an external probe. Add those parts to the breadboard that are located to the lower right of SO5. These parts include LED1–LED3, D5, R2–R8, C6–C8 and IC14 and IC15.

Once this section has been constructed, apply power to your system. None of the logic probe LED's should be lit. If either the "1" or the "0" LED is lit, check the comparator circuit. If the P LED flashes as power is applied, this is acceptable. If it remains lit, test the SN74LS123, or the SN74123, that you have used.

Remove the power and install sockets SO1–SO5. These are the high-quality sockets that are used to make contact with the interfacing signals. Once these have been installed, turn the power on once again and place a jumper wire (8 to 10 inches long) in one of the P inputs of SO4. Connect the other end to the +5-volt pin of SO1. The "1" LED should be lit. Now connect it to the ground pin. The "0" LED should be lit.

The remaining IC's should now be added to the PC board, along with the 40-pin male connector (PL2), and the remaining components. If you are going to substitute individual 1000-ohm ¼-watt resistors for the two dual in-line resistor packages, IC1 and IC7, you will need 13 individual resistors. These resistors should be soldered between pin 1 and pin 16, and so on, across the space left for the integrated circuits at IC1 and IC7. All eight of the resistors should be soldered in at IC1, while only five are required at IC7.

Do not install the two 8216 bus buffers at this time. They will be added to the circuit later. Pay careful attention to the orientation of the two eight-switch dual in-line packages. The switches' on position should be on the left side. Initially set the switches so that A15–A8 are all logic zero, or on, and so that the switches for A7–A0 are all logic zero, or on. The mode switch should be in the D mode.

To test the control signals, connect the *TRS-80* and the interface breadboard with the 40-conductor flat cable. The connectors should be oriented so that they face in the same direction; that is, they should be on the same side of the cable. When connected to the *TRS-80*, the flat cable should come up from the socket access hatch.

Check out

Apply power to the *TRS-80* and to the breadboard, and then enter and run the following short test program:

```
10 A=INP(5): GOTO 10
```

You should be able to monitor pulse activity at the $\overline{IN}$ signal output at the CONTROL SIGNALS socket. Once you have been able to monitor these pulses, enter and run the following program:

```
10 OUT 7,0: GOTO 10
```

When this program is being run, you should be able to monitor pulse activity at the $\overline{OUT}$ signal output pin. If you were not able to monitor these pulses, check both the DM8095 (or SN74365) buffer, and the SN74LS123 (or SN74123) monostable. You are testing two things here, the availability of the control signals, and the correct operation of the logic probe's pulse detecting circuit. If the probe is operating properly, you should observe that the "1" LED is lit, while the $\overline{IN}$ or the $\overline{OUT}$ pulse also causes the P LED to be lit. This indicates that the normal logic state is logic one, while the pulses are logic zero pulses.

continued on page 94

BUILD THIS

Super Audio Amplifier

Bridge-type power output configuration lets you use inexpensive "plastic" transistors and a simpler power supply to provide a wide frequency response and a signal-to-noise ratio of 100 dB.

DAN TALBOT

THIS AUDIO POWER AMPLIFIER ELIMINATES the need to AC-couple the loudspeaker, uses only one power supply polarity, and needs only half the power supply voltage of a conventional circuit approach, allowing the use of inexpensive plastic transistors in the output stages! In addition, its frequency response goes "way down" and, since no large output coupling capacitors are used, space is saved on the chassis, especially important for quadriphonic applications.

The circuit, shown in Fig. 1, is basically a differential-output design ("bridge" output circuitry) where *both* sides of the loudspeaker are driven 180° out of phase. This amplifier delivers 60 watts RMS using a 38-volt DC power supply, or 100 watts RMS using a 44-volt supply, into an 8-ohm speaker. Conventional amplifiers drive only one terminal of the loudspeaker and fix the other speaker terminal at ground. This approach requires twice the power supply voltage for the same output power as the circuit described in this article. A conventional circuit would, therefore, require output transistors having 80-volt (or higher) breakdown ratings, and large "safe area" operating regions. Additionally, a conventional circuit approach would require a coupling capacitor to the loudspeaker (usually about 4000 μF at 50 volts) or would require a two-polarity power supply (in which case the capacitor is not really "saved," but is required for filtering the additional supply).

The amplifier in this article can be built for about $35.00 per channel, less power supply. Frequency response is flat from 10 Hz to over 30 kHz, and distortion is less than 0.5%.

There are other advantages, also, to a true differential-output power amplifier such as this one. If both halves of the amplifier have the opposite phase-versus-frequency characteristics, as in this independent-twin amplifier approach, then 180° shift across the loudspeaker terminals will be maintained out to very high frequencies. This means that the loudspeaker will see symmetrical slew-rate limiting, a factor important in minimizing the so-called "transient intermodulation distortion" components. Also, in this particular configuration, the constant 180° phase shift across the loudspeaker results in the power output holding up at high frequencies, even though the individual halves of the amplifier twin-configuration are undergoing severe phase-shift relative to the audio input signal. This results in greatly reduced group-delay (time-dispersion) versus frequency compared to many other possible bridge configurations.

All of these technical advantages translate into a highly pleasing amplifier for the serious audiophile who is content with 100 watts. (The sound of an amplifier which clips before the loudspeaker clips is vastly preferable to the sound of a loudspeaker being driven "against the stops." The 100-watts level is ideal for most standard loudspeaker configurations.

Other variations of the circuit realization of a paraphase-output amplifier are possible, but this approach was settled on as the ultimate for simplicity and performance, using inexpensive components.

Notice the deliberate absence of electronic protection circuits. A fuse in the $+V_{cc}$ (B+) line of the power supply, see Fig. 2, protects the loudspeakers in the event of a transistor short. The absence of electronic protection circuitry ensures that transient "spiking" will not occur as a result of constant-current limit drive to an inductive load.

When an ordinary protection circuit is activated, the amplifier output impedance is suddenly forced to a very high value

R-E TESTS IT

Input sensitivity: 1.7V input, for 60 watts output across 8-ohm load
Frequency response: 8Hz to 62 kHz (−1 dB rolloff points)

8-OHM LOAD

Output at clipping, 20 Hz:	52 Watts
Output at clipping, 20 kHz:	62 watts
Output for 0.5% THD, at 1 kHz:	60 watts

4-OHM LOAD

Output for 0.5% THD, 1 kHz:	72 watts (author claimed 70 watts)

Signal-to-Noise Ratio (re: 60 W output, 8 ohms): 100 dB

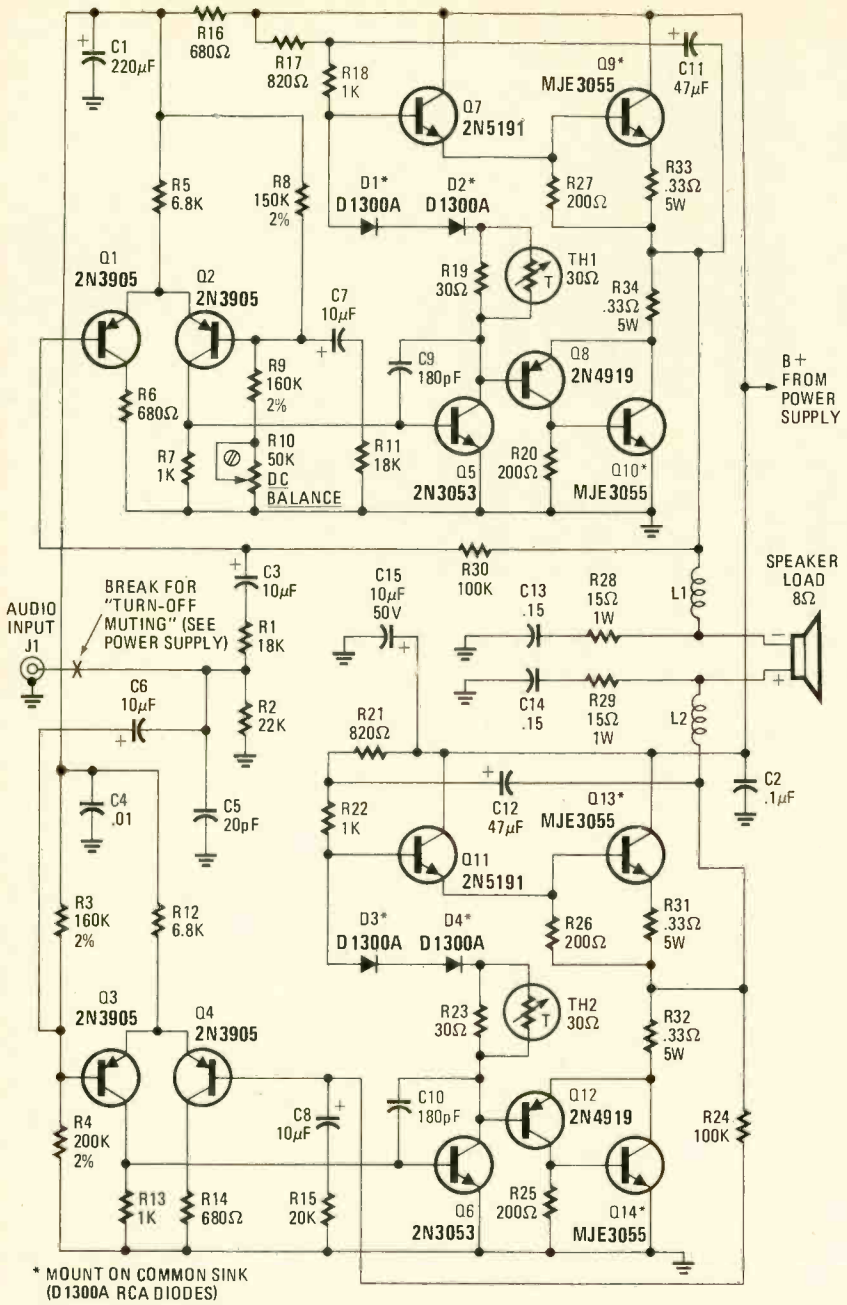


FIG. 1—SCHEMATIC DIAGRAM of the bridge-type amplifier. Output power is determined by the B+ (V_{cc}) voltage from the power supply.

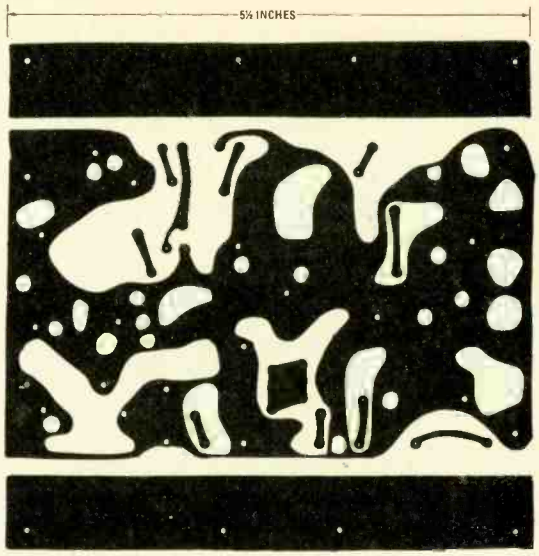


FIG. 3—FOIL PATTERN for the top surface of the double-sided PC board.

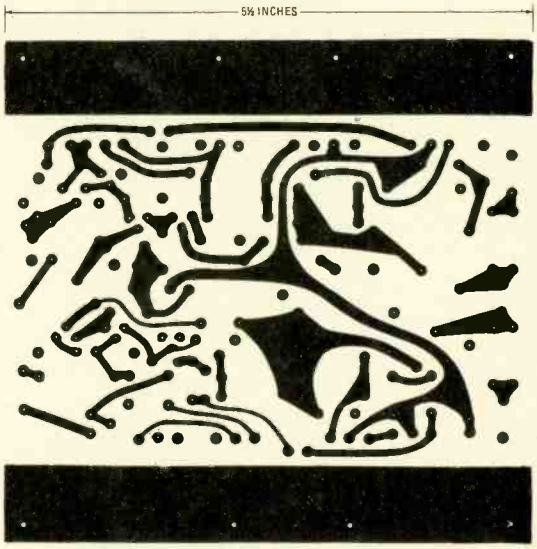


FIG. 4—PATTERN for the foil on the bottom surface of the amplifier board.

(that of a constant-current-mode output). This allows any load inductance to "reverse-kick," causing spiking in the output waveform. Musical transients can quite frequently activate the current-limiting protective circuitry in many amplifiers. This may possibly explain their inferior sound when driving loudspeakers that are

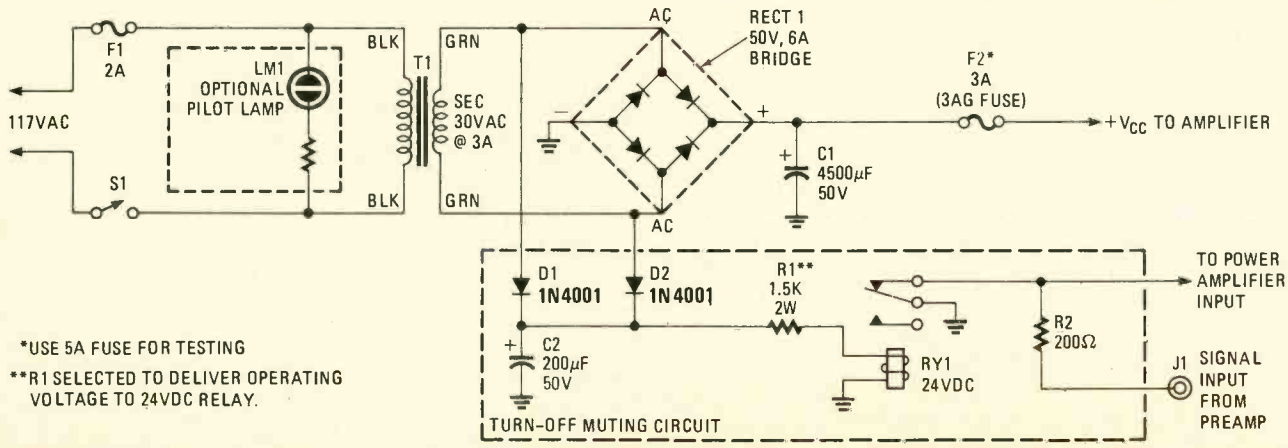


FIG. 2—THE POWER SUPPLY circuit with an optional circuit for turn-off muting. Use two supplies for stereo.

AMPLIFIER PARTS LIST

Order two of each for stereo
Resistors ¼ watt, 5% carbon unless otherwise specified
R1, R11—18,000 ohms
R2—22,000 ohms
R3, R9—160,000 ohms, 2% (may be selected from 5% units)
R4—200,000 ohms, 2% (may be selected from 5% units)
R5, R12—6800 ohms
R6, R14, R16—680 ohms
R7, R13, R18, R22—1000 ohms
R8—150,000 ohms, 2% (may be selected from 5% units)
R10—50,000 ohms, trimmer
R15—20,000 ohms
R17, R21—820 ohms
R19, R23—30 ohms
R24, R30—100,000 ohms
R20, R25-R27—200 ohms
R28, R29—15 ohms, 1 watt (may be two 30-ohm, ½-watt resistors in parallel)
R31-R34—0.33 ohm, 5 watts (may be three 1-ohm 20%, 2-watt resistors in parallel)
Capacitors
C1—220 μF, 50 volts, electrolytic
C2—0.1 μF, 100 volts, Mylar
C3, C6-C8—10 μF, 35 volts, electrolytic
C4—0.01 μF, 100 volts, ceramic disc
C5—20 pF, ceramic disc, mica or polypropylene
C9, C10—180 pF, ceramic disc, mica or polypropylene
C11, C12—47 μF, 50 volts, electrolytic
C13, C14—0.15 μF, 100 volt Mylar
C15—10 μF, 50 volts, electrolytic
D1-D4—D1300A diode (RCA)
Q1-Q4—2N3905 or 2N3906
Q5, Q6—2N3053
Q7, Q11—2N5191 (do not heat sink)
Q8, Q12—2N4919 (do not heat sink)
Q9, Q10, Q13, Q14—MJE3055 (Motorola) or 2N3055 on heat sinks
TH1, TH2—30 ohms, thermistor (CAL-R No. 1B202 or 1B302, or Keystone RL2004-16.4-59-D1 or equal. See text)
L1, L2—3½ turns of No. 16 enameled copper wire air-wound to ⅜-inch inside diameter. Turns closer-spaced
Miscellaneous
Heat sinks—two Delco No. 7281352 if using 2N3055's or "Z" brackets made of ⅛-inch-thick aluminum when using the MJE3055.
Four metal cable clamps for ¼-inch cable. These clamp the compensating diodes to their respective heat sinks.

POWER SUPPLY PARTS LIST

Order two of each for stereo
R1—1500 ohms, 2 watts (see Note 1 on Fig. 2)
R2—200 ohms, ¼ watt
C1—4500 μF, 50 volts (Mallory CG452U50D1 or equal)
C2—200 μF, 50 volts
D1, D2—1N4003 or 1N4004 1-amp diode
T1—power transformer, secondary 30 volts & 3 amps (Stancor P-8614 or equal)
RY1—SPDT relay, 24 volts DC, 2K-3K ohms
RECT1—50 PIV, 6 amps full-wave bridge rectifier
S1—SPST toggle switch
F1—fuse, 2 amps, slow-blow with holder
F2—fuse, 3 amps, fast-blow with holder
LM1—neon pilot lamp assembly, optional (Drake 22k-6073-000-634)
Line cord, chassis, hardware

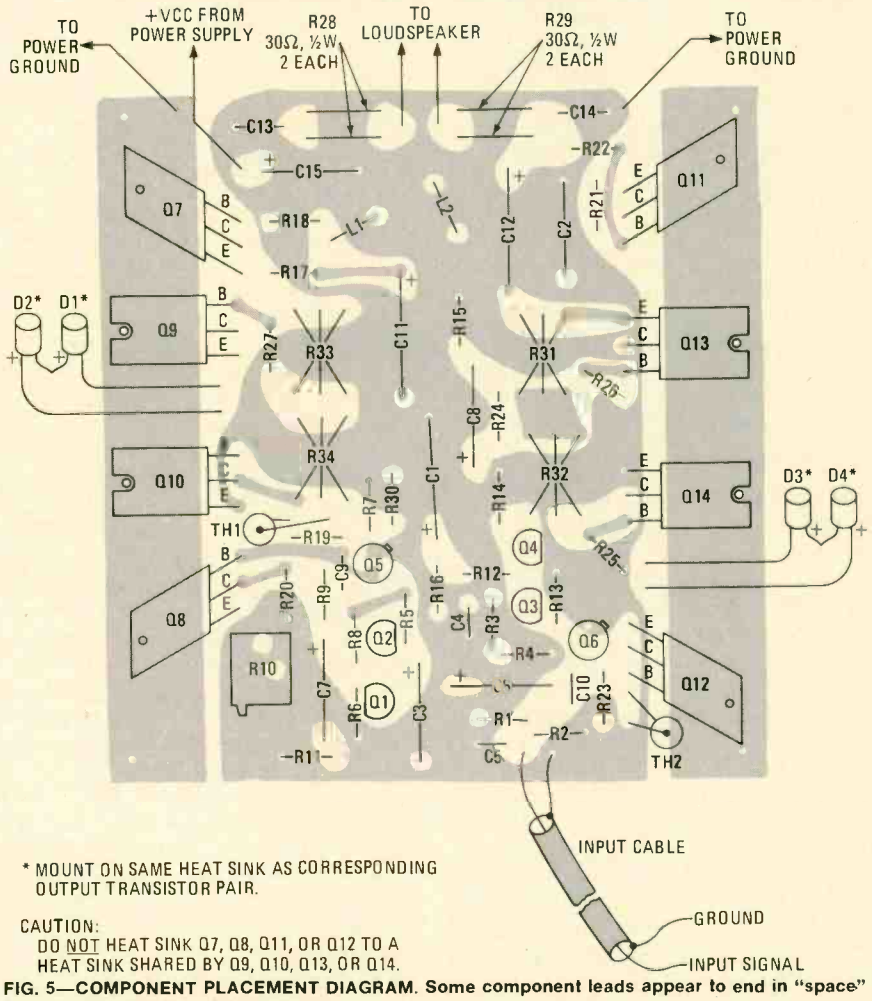


FIG. 5—COMPONENT PLACEMENT DIAGRAM. Some component leads appear to end in "space" because only the top foil is shown.

highly inductive, and may even cause instability (oscillation) on large signals when driving long speaker cables.

How it works

The amplifier basically consists of two halves that are operated in opposite phase relationships, with negative feedback independently operating around each half.

Transistors Q1, Q2, Q5, Q7, Q8, Q9, and Q10 comprise one complete inverting amplifier with input resistor R1 and feedback resistor R30 establishing a gain of about minus 5.5. Transistors Q3, Q4, Q6, Q11, Q13, and Q14 comprise one complete noninverting operational power amplifier whose gain is set by R24 and R15 at about plus 5.5.

The outputs of these two independent amplifiers face each side of the speaker load, respectively, through stabilization networks L1, R28, C13; and L2, R29, and C14. Capacitors C9 and C10 roll-off the open-loop response of each amplifier half to prevent oscillation when feedback is applied.

Potentiometer R10 adjusts the output DC quiescent voltage of the amplifier whose output devices drive L1 so that this DC voltage matches that developed by the other amplifier (half) driving L2. This results in a net zero voltage across the speaker load.

Since both amplifiers behave nearly identically, the transient-overload characteristics and AC-recovery effects cancel at the load, yielding very little turn-on "thump." However, on turnoff, the audio may modulate the voltage on the power-supply filter-capacitor(s), causing "motorboating" if the preamplifier output impedance is not low at all times. For this reason, we recommend the anti-thump turn-off muting circuit shown with the power supply in Fig. 2. The circuit is optional; prevention of motorboating on turnoff is accomplished through the use of a shorting relay at the amplifier input or preamplifier output, which activates when the power amplifier is turned off.

Construction

Circuit layout is basically noncritical, but compactness is very important—especially the lead lengths to the output transistors. Keep input lead dress away from amplifier output signal wires! If you

continued on page 98

DOLBY HX
New Noise Reduction

LEONARD FELDMAN

DOLBY LABORATORIES AND, IN PARTICULAR, Dr. Ray Dolby is often credited with providing the technological breakthrough that changed the tape cassette recording format from a low-fidelity voice-dictation medium to the high-fidelity recording format that it has become in recent years. In all fairness, there have been other major advances, such as improved tape formulations (chromium dioxide, cobalt-ferric, ferric-chromium and now the new pure-metal particle tapes), improvements in tape-head designs and improvements in tape transport mechanisms. But most audio experts will agree that the 10 dB of noise reduction above 5 kHz offered by the so-called Dolby-B noise reduction system provided the largest single improvement in cassette tape recording quality when it was introduced into home stereo cassette decks some 10 years ago.

While other noise-reduction techniques have appeared since Dolby B was licensed to cassette deck manufacturers (notably the dbx compander system and, more recently, a system developed by Telefunken of West Germany that is said to provide 20 dB of noise reduction), virtually every manufacturer of cassette decks intended for home use is now a Dolby licensee and incorporates the Dolby B system in all but his least expensive tape decks.

The Dolby B noise-reduction system is two-sided and thus requires that the signal be encoded prior to being recorded and decoded when played back. Quite simply, the Dolby encoding circuit senses the presence and average amplitude of high-frequency energy in signal to be recorded and progressively boosts recording levels when high-frequency content is low in amplitude, literally "lifting" such material up and out of the "noise floor" of the tape. During playback, the converse action takes place, restoring flat frequency response insofar as the program material is concerned, while attenuating tape hiss or other high frequency unwanted noise generated during the record-play process by 10 dB.

But tape hiss is not the only problem that prevents cassette recordists from enjoying musical reproduction from their tape decks, no matter how costly the machine used. Specifically, it is difficult and often impossible to record program material that is rich in high-frequency energy without suffering either a loss of highs or having to record at lower recording levels, with the attendant reduction in dynamic range and signal-to-noise ratio. The problem is called tape saturation that, at high frequencies, places a limit on cassette performance. To compound the problem, some of today's new program sources—the new direct-to-disc records, as well as the digitally mastered records that are starting to appear on the market—do contain far more high-amplitude, high-frequency energy than did more conventionally made records of the past.

The problem of tape saturation

Tape saturation results primarily from the need to provide a compromise bias level and record equalization characteristic in cassette recorders, no matter what type of tape is used. That compromise has been necessary because recording tape behaves differently with respect to bias at lower frequencies than it does at higher frequencies. As shown in Fig. 1, when bias is increased over the range illustrated, the maximum useful playback level for a given distortion *increases* at lower frequencies while it *decreases* at higher frequencies. In other words, a conflict exists. The bias level that would give best performance in one part of the audio frequency range degrades performance at other frequencies.

A relatively high bias level for low frequencies maximizes useful recording level, minimizes distortion, and even minimizes modulation noise and the effects of drop-outs (because high bias creates a large recording field that magnetizes even those oxide particles that are pushed away from the recording head by tape surface irregularities). However, the same large recording field has an erasing effect on high frequencies, particularly at high signal levels. As a result, relatively low bias is desirable for capturing high-level highs on tape.

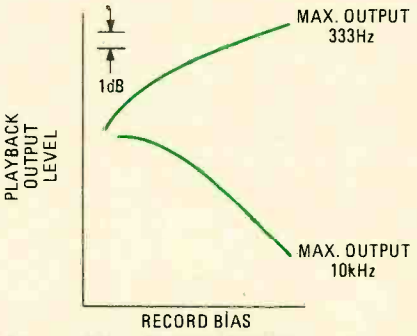


FIG. 1—BIAS REQUIREMENTS for a given brand of recording tape changes with respect to the frequency of the signal being recorded.

Makers of cassette decks have dealt with that conflicting bias requirement by compromising on a bias level that favors lower-frequency performance at the expense of high-level high-frequencies. Figure 2 shows typical response curves of a high-quality deck using high-grade cassette tape. The upper curve is record-play response made at a recording level of 0 dB, which, in the case of the particular deck, corresponds to 200 nWb-per-meter. Note the extreme roll-off of response beginning at around 2 kHz. (The frequency scale is logarithmic from 20 Hz to 20 kHz while the vertical scale is a linear 10 dB-per-division in this display.) At a record level of −10 dB, response improves somewhat, but it is only when recordings are made at a level of −20 or −30 dB (lower two traces) that response extends essentially out to the 20 kHz limit.

Favoring high bias (for improved low and mid-frequency performance) requires record equalization with a substantial high-frequency *boost*, that further reduces high-frequency headroom. But even that compromise does not always provide ideal performance at lower fre-

SYSTEM

This new noise-reduction system for cassette tape decks uses continuously varying recording bias level and varying equalization to make possible better mid- and low-frequency response.

quencies, because bias is often not set as high as a further sacrifice in high frequency performance would permit. The result is often a recording system with fixed parameters of bias and equalization

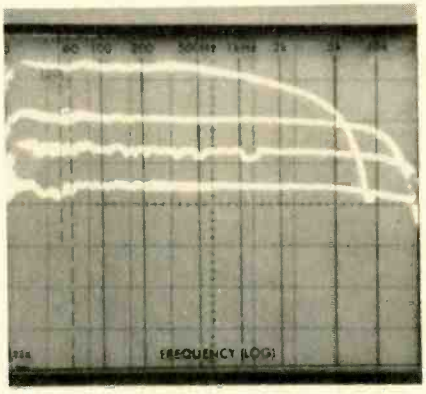


FIG. 2—RESPONSE CURVES of a high quality deck using a high grade tape shows the compromise in record bias level.

that may be appropriate for recording some types of program material but is woefully inadequate for other types of music that contain constantly changing levels of high-frequency spectral content. The critical listener finds that he or she cannot record material rich in high-level highs without an audible dulling of the highs. If recording levels are lowered to compensate, there is often an audible sacrifice of signal-to-noise ratio.

Dolby HX system

Now, Dolby Laboratories has come up with a system for dealing with this problem. Introduced in June 1979, the system is called Dolby HX (for *H*eadroom *E*xtension). It varies record bias level and record equalization automatically and continously, in an attempt to optimize both in response to changes in the music's level and high-frequency content.

When the overall signal level is low, or when the program contains primarily low and mid frequencies, a high quiescent bias is used for optimum low-frequency performance.

Since, under these recording signal conditions, high-level high-frequency response is not important, the quiescent bias with certain tapes can be made higher than the fixed bias of conventional recorders, so that better low and mid-frequency performance might actually be obtained.

When the program material contains high-level, high-frequency energy, bias is automatically lowered to maximize high-frequency output, as shown in Fig. 3. In each of the response plots of Fig. 3, the curve designated "a" is obtained by using the new Dolby HX system; curves "b" are those that would be obtained from the same recorder, using the same tape, but with built-in fixed bias and equalization.

In describing the new system, Dolby admits that lowering the bias in this

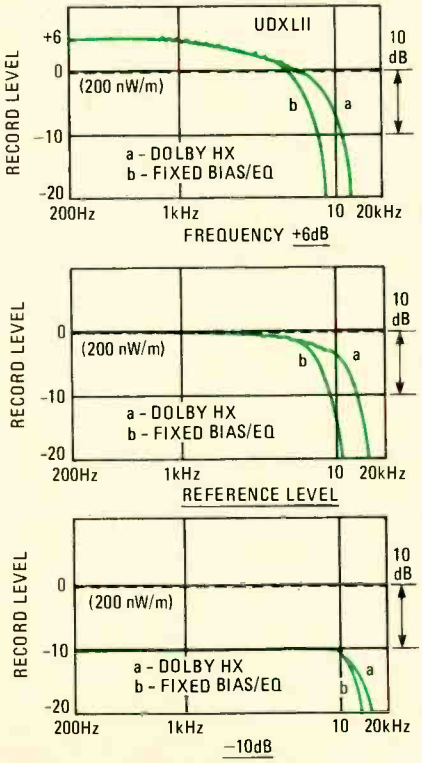


FIG. 3—DOLBY HX record/playback response curves versus a standard recorder with fixed bias and equalization.

manner involves a trade-off: an increase in distortion at lower frequencies. They maintain, however, that the trade-off will be of little or no audible significance because the distortion components generated will be masked by the strong high-frequencies simultaneously present in the music being recorded and reproduced.

The Dolby HX system varies record equalization in addition to bias because tape sensitivity varies with changing bias by different amounts at different frequencies, as illustrated in Fig. 4. A decrease in bias level tends to increase sensitivity at high frequencies by a rather

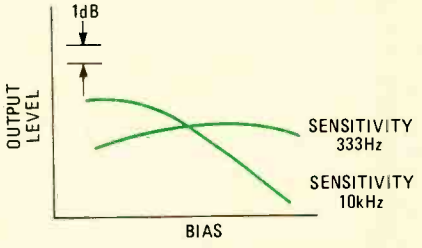


FIG. 4—DOLBY HX SYSTEM varies bias level and record equalization continuously in response to input signal frequency because tape sensitivity also changes with frequency.

substantial amount, while the same decrease in bias lowers sensitivity by a lesser amount in the low to mid-frequency range. The continuous varying of equali-

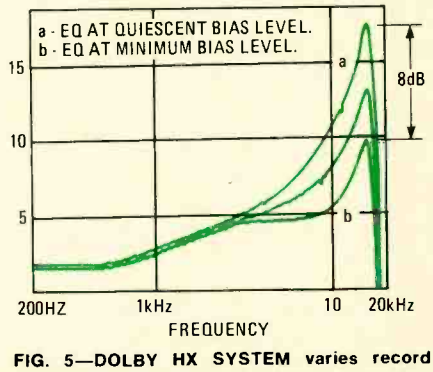


FIG. 5—DOLBY HX SYSTEM varies record equalization so that high-frequency pre-emphasis is reduced when the bias level is reduced resulting in increased headroom at high frequencies.

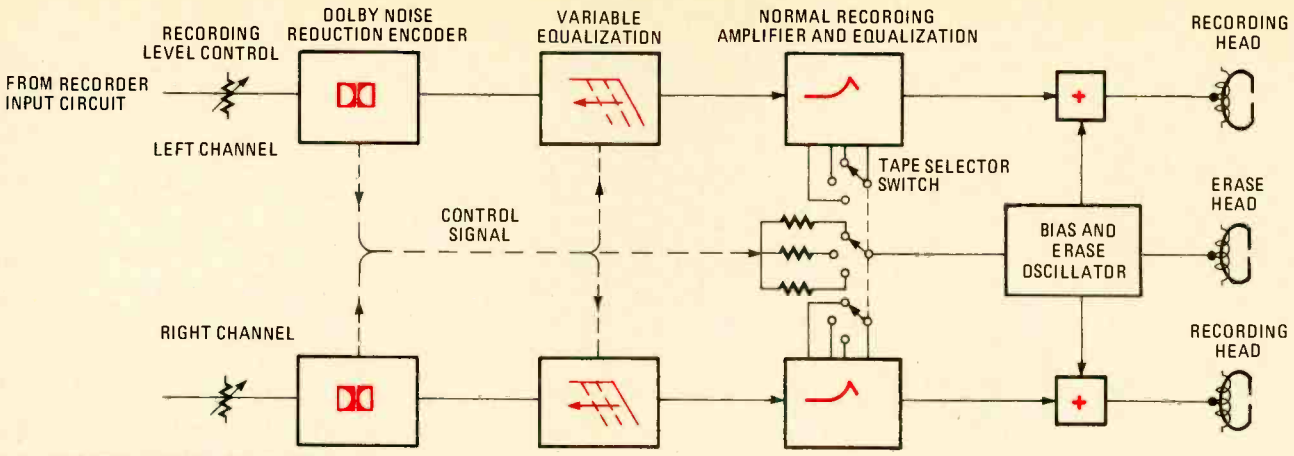


FIG. 6—BLOCK DIAGRAM of Dolby HX system.

zation in the Dolby HX system is therefore necessary for flat playback response with standard playback equalization. Bear in mind that only the *record* equalization is varied in the Dolby HX system, since playback equalization must be maintained at standard values of 120 μS for standard tapes and 70 μS for chromium-dioxide, cobalt-ferric and the new metal-particle tapes if compatibility is to be maintained. Dolby maintains that altering record equalization in this manner provides a further benefit beyond the flat frequency response. Since high-frequency pre-emphasis is reduced along with bias level, as shown in Fig. 5, the reduction in treble boost occurs when minimum boost is most desireable for maximum headroom: that is, when the signal contains high-level high frequencies.

How it works

Some control signal is needed to vary the bias and equalization based upon level and high-frequency content of the music being recorded for the Dolby HX system to work properly. But such a control signal already exists in the Dolby B noise reduction system. To reduce noise, that system develops a control signal based upon exactly the same parameters needed to operate the new headroom extension system. (The prior existence of the Dolby noise reduction system, and the fact that this control signal can be used for this further purpose, is what makes the new system practical from a cost point of view.) A block diagram of the Dolby HX Headroom Extension System is shown in Fig. 6, in which we see how the control signal developed by the Dolby noise reduction encoder is now used to vary equalization as well as bias levels on a dynamic basis.

Right now, no cassette recorders are available with the Dolby HX circuits built into them. However, this headroom extension system *will* be made available to all Dolby licensees for incorporation in cassette recorders that already have Dolby B noise reduction, without further royalty or licensing charges. According to Dolby, the parts required for the new system add only about one-third to the manufacturing cost of the Dolby noise reduction circuits within a recorder.

Since there were no recorders available with the new headroom extension, we attempted to simulate the effect by using a recorder in our lab that provided easy access to bias adjustment and equalization. After several "rehearsals" and, with the aid of an assistant, I was able to plot the curves of Fig. 7 which simulate the headroom improvement that will be gained by Dolby HX system. As the frequencies were slowly swept from low to high, we *decreased* bias and pre-emphasis *manually*, attempting to approximate what the control signal of the

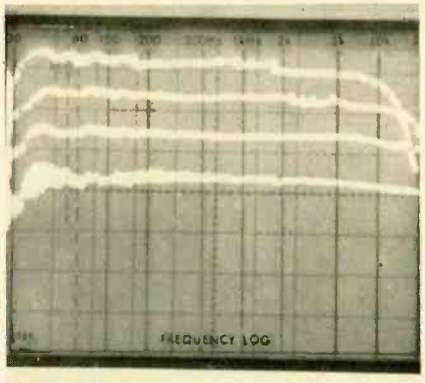


FIG. 7—RESPONSE CURVES of a manually simulated Dolby HX system.

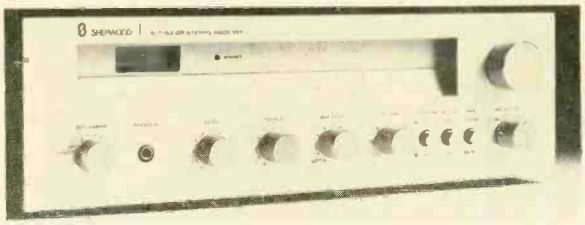
Dolby system would do automatically (and perhaps more smoothly judging by some of the "glitches" in our curves). Though those curves were simulated manually, a comparison of each curve of Fig. 7 with corresponding curves of Fig. 2 reveals just how much improvement in recording headroom is gained.

Total playback compatibility

It is important to understand that since all of the additional processing of record, bias, and equalization with the Dolby HX system occurs during the *recording* process only, no special playback processing over and above standard Dolby noise reduction is required. A cassette of the future, recorded on a machine equipped with the extra Dolby feature, can be played back on older decks equipped with standard Dolby B noise reduction; only improved high-frequency response should be detected. Dolby claims that in some cases, improved performance at lower frequencies may be noted as well since, as we said earlier, effects of drop-outs and modulation noise are minimized by providing optumum quiescent bias for lower frequency signals. Finally, Dolby suggests that a further reduction in noise may be noticed in some program material, simply because recordists who tend to under-record difficult material—to prevent high frequency tape saturation—can now increase the record level and thereby avoid sacrificing signal-to-noise ratio.

Are there any disadvantages to this new system? In discussing the development with the people from Dolby, I questioned whether their single control signal could be expected to "track" all of the parameters involved, with any degree of accuracy. Dolby correctly pointed out that *any* tape deck is usually calibrated to work best with *one* type of tape (or, one type for each tape selector setting), and that the Dolby HX system will also work best when used with the tape for which it was specifically calibrated by the maker of the tape deck.

It remains to be seen how great the tracking errors will be if other generically similar tapes are used on a machine equipped with the new Dolby HX system. That question notwithstanding, the Dolby HX idea is certainly a brilliant one, and one which should further improve overall cassette deck performance in the future. As Dr. Dolby put it, 10 years or more ago, he turned his attention to lowering the noise-floor in cassette recordings. Now, 10 years later, he has concentrated on the other end of the dynamic range scale of cassette recording and has been able to contribute approximately 10 dB of headroom (at high frequencies) in addition to the 10 dB of noise reduction contributed earlier. The resulting 20 dB of improvement from one man is quite a bit, we would have to agree! **R-E**



1 CIRCLE 106 ON FREE INFORMATION CARD

SHERWOOD S-7210CP AM/FM Receiver

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

HERE'S A LITTLE GEM OF A RECEIVER THAT IS actually the lowest-priced and lowest-powered unit manufactured by Sherwood Electronic Laboratories, Inc. (4300 N. California St., Chicago, IL 60618). This company has been around almost since high-fidelity became a buzz-word in a music lover's vocabulary.

What can you get in a stereo receiver for little over $200? Quite a bit, judging from the *model S-7150CP* shown in Fig. 1. Certainly some control features are missing (such as an extra or second tape-monitor circuit and perhaps a couple of user-selectable filters), but if your source material is in good condition, you won't need any filtering other than the built-in 6-dB subsonic filter that *is* included (not visible on the front panel) to reduce rumble from any less-than-perfect turntables you may be using.

But consider what features *are* included at this price: The front panel shows a speaker selector switch on the left (for choosing one or two pairs of connected speakers) that also serves as the POWER on/off switch. The mandatory phone jack is next to it, followed by fully detented BASS and TREBLE controls; a channel BALANCE control; the master VOLUME control; LOUDNESS, FM MUTING and TAPE MONITOR pushbutton switches; the program SELECTOR switch; and a large flywheel-coupled tuning knob in the upper right.

The highly visible FM frequency numerals are linearly calibrated with markings at every 200 kHz (one-channel width) with the AM frequencies below them; while above the frequency scales to the left are a stereo indicator light and a single meter that acts as a center-of-channel tuning meter for FM reception and as a signal-strength meter in the AM reception mode.

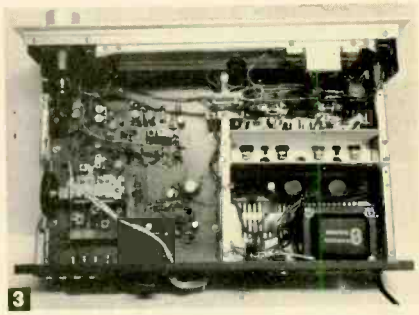
RADIO-ELECTRONICS AUDIO LAB
R.E.A.L. SOUND RATES

SHERWOOD
S-7210CP RECEIVER

VERY GOOD

2

The rear panel of the *model S-7150CP* contains two rows of color-coded, speaker-connection screw terminals; a single AC convenience outlet; a line fuseholder; a chassis ground terminal; the required tape-input and tape-output jacks; plus four screw terminals to connect an external AM and 75-ohm or 300-ohm FM antennas. A pivotable ferrite-bar AM loopstick antenna completes the rear-panel layout (See Fig. 2).



3

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

FM TUNER SECTION:
Usable Sensitivity: mono, 1.9 μV (10.8 dBf). **50-dB Quieting:** mono, 3.5 μV (16.11 dBf); stereo, 39 μV (37.1 dBf). **Harmonic Distortion at 1 kHz:** mono, 0.15%; stereo, 0.25%. **S/N Ratio:** mono, 70 dB; stereo, 66 dB. **Capture Ratio:** 1.2 dB. **Selectivity:** 60 dB. **IF Rejection:** 75 dB. **AM Suppression:** 55 dB. **Image Rejection:** 55 dB. **Frequency Response:** 20 Hz to 15 kHz, +1, −2.0 dB. **Muting and Stereo Threshold:** 4 μV (17.2 dBf). **Stereo Separation:** 40 dB at 1 kHz; 30 dB from 20 Hz to 10 kHz.

AM TUNER SECTION:
Sensitivity: 20 μV. **Selectivity:** 25 dB. **Frequency Response:** −6 dB at 4 kHz. **Image and IF Rejection:** 40 dB.

AMPLIFIER SECTION:
Power Output: 15 watts-per-channel into 8 ohms, 20 Hz to 20 kHz (25 watts at 1 kHz into 4 ohms). **Rated Harmonic Distortion:** 0.2%. **IM Distortion:** 0.2%. **Damping Factor:** 20 at 8 ohms. **Input Sensitivity for Rated Output:** phono, 2.5 mV; high level, 160 mV. **Photo Overload:** 140 mV at 1 kHz; 680 mV at 10 kHz. **S/N Ratio (Phono, Referenced to 10-mV Input, "A"-Weighted):** 91 dB, (77 dB unweighted); high level, 85 dB unweighted (95 dB weighted). **Frequency Response:** phono, RIAA ±0.5 dB; high level, ±0.5 dB, from 20 Hz to 20 kHz. **Bass and Treble Tone Control Range:** ±10 dB at 50 Hz and 15 kHz.

GENERAL SPECIFICATIONS:
Power Requirements: 115 to 126 VAC, 50 to 60 Hz, 20 to 100 watts. **Dimensions:** 16 15/16 W × 5 3/8 H × 12 3/8 D. **Weight (Shipping):** 20 lbs. **Suggested Retail Price:** $225.

Circuit highlights

Figure 3 shows the internal layout of the chassis. Two major PC boards contain most of the receiver's circuitry: a tuner PC board and an amplifier module. The FM front end uses a three-gang tuning capacitor, with an FET used as an RF amplifier stage. Phase-linear ceramic filters are used in the IF section, with much of the active circuitry (including a wideband quadrature detector circuit) contained in a single IC preceded by a discrete bipolar transistor

stage. Multiplex decoding circuitry incorporates a phase-locked-loop IC and is followed by separate discrete amplifiers for each channel plus the required de-emphasis and filtering networks.

The phono preamplifier/equalizers use a three-transistor circuit with negative feedback used for RIAA equalization. The tone-control amplifier is handled by the familiar Baxandall negative-feedback circuit. The power-amplifier section includes a differential-amplifier input stage and the now-familiar, direct-coupled complementary-symmetry NPN-PNP output stage. Two-ampere fuses are built into the output lines to protect the amplifier against speaker shorts. Power-output stages are powered from filtered ±23-volt DC supplies while a fully electronically regulated 14-volt supply takes care of the tuner and low-level amplifier circuits. Dual-polarity voltages are used to power the phono preamplifier/equalizer sections of the receiver.

Tuner measurements

Table I summarizes measurements made for the FM tuner section. Note that both for mono and stereo FM performance, the signal-to-noise (S/N) ratio obtainable with strong (65-dBf) signals is far better than that claimed by the manufacturer. We must point out, however, that these signal-to-noise measurements were made in accordance with IHF Tuner Measurement Standards, in which a 200-Hz to 15-kHz bandpass filter is included in the test procedure. In the case of mono measurements, using this bandpass filter made very little difference.

In the case of stereo measurements, however, without using the filter we would have read an erroneous S/N ratio, which would have been a result of the presence of a fair amount of subcarrier signal (19-kHz, 38kHz, and harmonics) that could not be totally filtered out. Of course, this ultrasonic signal is not audible to a listener and in no way affects tuner performance. We have noted its presence, however, only as it might affect cassette tape recordings made from off-the-air stereo FM programs (causing possible beats and the miscalibration of any Dolby noise-reduction system on the recorder) unless your deck is equipped with a multiplex filter. Many modern cassette decks have such a circuit (a switch is included on their front panels), and we advise prospective purchasers of the *model S-7150CP* choose such a cassette deck to use with this receiver.

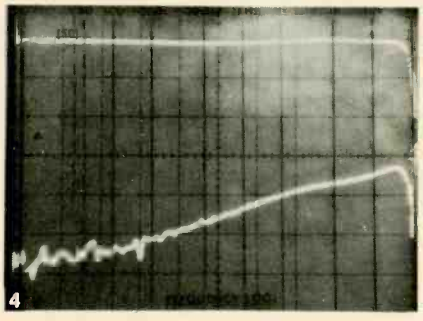


Figure 4 is a spectrum analysis of FM frequency response (shown by the upper trace) and stereo FM channel separation (the lower trace). The scale used is 10 dB-per-vertical-division; response is extremely uniform. It is flat all the way out to 15 kHz,—the upper-frequency limit of FM broadcasting.

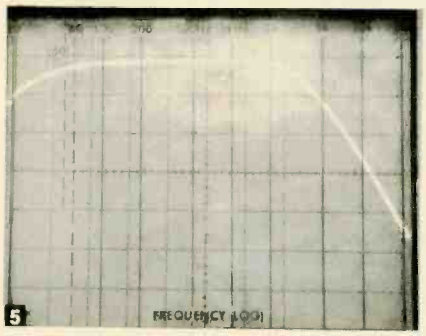
TABLE 1

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Sherwood Laboratories** Model: **S-7150CP**

FM PERFORMANCE MEASUREMENTS

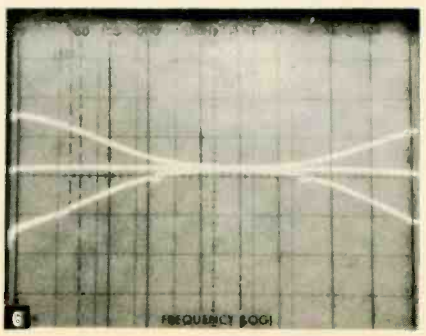
SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	R-E Measurement	R-E Evaluation
IHF Sensitivity, mono: (μV) (dBf)	2.0 (11.2)	Good
Sensitivity, Stereo (μV) (dBf)	5.0 (19.2)	Excellent
50-dB quieting signal, mono (μV) (dBf)	3.0 (14.7)	Excellent
50-dB quieting signal, stereo (μV) (dBf)	40 (37.2)	Fair
Maximum S/N ratio, mono (dB)	75	Excellent
Maximum S/N ratio, stereo (dB)	70	Excellent
		(see text)
Capture ratio (dB)	1.2	Very good
AM Suppression (dB)	56	Very good
Image rejection (dB)	57	Fair
IF rejection (dB)	75	Good
Spurious rejection (dB)	82	Very good
Alternate channel selectivity (dB)	63	Good
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz (±dB)	2.0	Fair
Harmonic distortion, 1 kHz, mono (%)	0.12	Excellent
Harmonic distortion, 1 kHz, stereo (%)	0.075	Superb
Harmonic distortion, 100 Hz, mono (%)	0.13	Excellent
Harmonic distortion, 100 Hz, stereo (%)	0.13	Good
Harmonic distortion, 6 kHz, mono (%)	0.18	Very good
Harmonic distortion, 6 kHz, stereo (%)	0.15	Excellent
Distortion at 50-dB quieting, mono (%)	0.5	Good
Distortion at 50-dB quieting, stereo (%)	0.28	Excellent
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV) (dBf)	4.0 (17.2)	Excellent
Separation, 1 kHz (dB)	45	Excellent
Separation, 100 Hz (dB)	49	Superb
Separation, 10 kHz (dB)	33	Good
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV) (dBf)	3.5 (16.1)	Very good
Dial calibration accuracy (±kHz at MHz)	−200, 98/108	Fair
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION		
Control layout		Very good
Ease of tuning		Very good
Accuracy of meters or other tuning aids		Excellent
Usefulness of other controls		Good
Construction and internal layout		Very good
Ease of servicing		Good
Evaluation of extra features, if any		Good
OVERALL FM PERFORMANCE RATING		Very good



Sherwood is one of the few manufacturers that is honest enough to quote AM frequency response. In the case of the *model S-7150CP*, the specification states that response extends out to 4 kHz for the −6-dB rolloff point, and this is exactly what we measured, as shown in Fig. 5. This response measurement may not seem like much to a dyed-in-the-wool audiophile, but compared with some AM tuners in much more expensive stereo receivers (many of which begin to roll off at 2.0 kHz or 2.5 kHz), it really isn't bad at all, and response is quite flat over its useful frequency range. The improvement was also audible in our subsequent listening tests, during which we always check out AM fidelity.

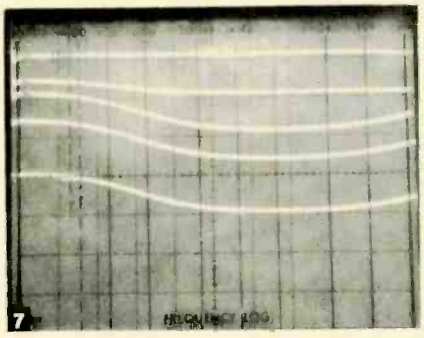
Amplifier measurements

The amplifier of the *model S-7150CP* delivered considerably more power than its rated 15 watts-per-channel into 8 ohms at mid-frequencies and at the high-frequency extremes. Even at 20 Hz, its power output reached 18 watts-per-channel before the rated distortion of 0.2% was observed. In examining the measurements shown in Table 2, note the extremely wide frequency range (power bandwidth) over which the amplifier is able to deliver its rated output at or below rated distortion. At rated power output, mid-frequency test signals were reproduced at distortion levels that were well below the 0.2% value specified, and intermodulation distortion was even a bit lower than the total harmonic distortion.



When you examine S/N and sensitivity figures in Table 2—Amplifier Performance Measurements—you will not be able to compare our results directly with the manufacturer's specifications. Sherwood has not yet adopted the 1978 Amplifier Measurement Standards at the time this report was written.

Figure 6 shows the total bass and treble control range. Note that the important mid-frequencies (from around 200 Hz to 2.5 kHz) are totally unaffected by either the bass or treble



controls—a design approach of which we heartily approve. Sherwood has also kept the maximum boost of these controls within reason, another wise approach in view of the receiver's rather limited power-output.

The action of the loudness-compensation circuitry, shown in Fig. 7, is typical of this type of circuit, with most of the emphasis at low listening levels applied to the bass end and only a very moderate amount of treble boost introduced at lower levels.

Summary

Table 3 contains our overall product analysis as well as our summary comments concerning the audible performance and design of this receiver. We were well impressed with the *model S-7150CP*, especially in view of its welcome low price and no-compromise approach to circuitry and sonic quality. It's nice to discover that some audio-component manufacturers have not overlooked the less-affluent sound buffs among us. **R-E**

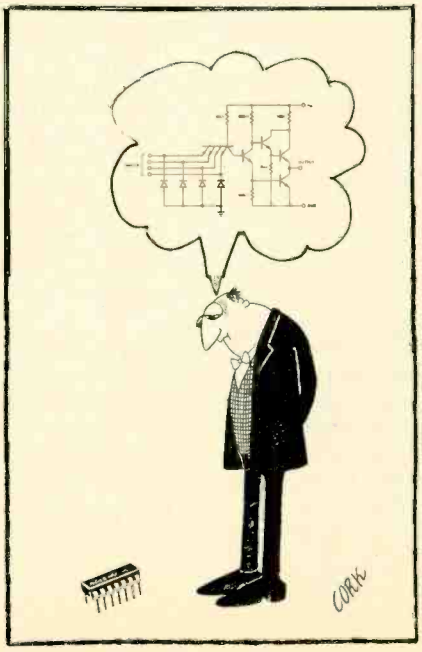


TABLE 2

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Sherwood Laboratories** Model: **S-7150CP**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	25.2	Excellent
RMS power/channel, 8-ohms, 20 Hz (watts)	18.0	Very good
RMS power/channel, 8-ohms, 20 kHz (watts)	24.5	Excellent
RMS power/channel, 4-ohms, 1 kHz (watts)	33.3	Excellent
RMS power/channel, 4-ohms, 20 Hz (watts)	22.1	Good
RMS power/channel, 4-ohms, 20 kHz (watts)	33.0	Excellent
Frequency limits for rated output (Hz-kHz)	10-65	Superb
Dynamic headroom (dB)	0.63	Not rated
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.065	Excellent
Intermodulation distortion, rated output (%)	0.050	Excellent
Harmonic distortion at 1-watt output, 1 kHz (%)	0.024	Excellent
Intermodulation distortion at 1-watt output (%)	0.022	Excellent
DAMPING FACTOR AT 8 OHMS, 50 Hz	36	Good
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ± dB)	0.5	Very good
Maximum input before overload (mV)	150	Very good
Hum/noise, "A"-weighted, referenced to 1-watt or 0.5-volt output, for 5-mV input (dB)	82	Excellent
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ± dB)	8-28, 1.0	Very good
Hum/noise, "A"-wt'd, referenced to 0.5-or 1-watt output, 0.5-volt input (dB)	86	Excellent
Residual noise, "A"-wt'd, minimum volume, referenced to 1-watt output (dB)	88	Good
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. 7	Excellent
Action of secondary tone controls		N/A
Action of high- and low-cut filters		N/A
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2, referenced to 1-watt or 0.5-volt output (mV)	0.65	
Input sensitivity, high level, referenced to 1-watt or 0.5-volt output (mV)	40	
Output level, tape outputs, at rated output (mV)	154	
Output level, headphone jack, at rated output (mV or mW)	12 mW/8 ohms	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		Fair
Adequacy of input facilities		Good
Front-panel layout		Very good
Action of controls and switches		Very good
Design and construction		Excellent
Ease of servicing		Very good
OVERALL AMPLIFIER PERFORMANCE RATING		Very good

TABLE 3

OVERALL PRODUCT ANALYSIS

Retail price	$225
Price category	Low
Price/performance ratio	Excellent
Styling and appearance	Very good
Sound quality	Very good
Mechanical performance	Very good

Comments: In the past, we have tested high-priced receivers whose manufacturers have "guaranteed" the consumer that the published specifications would be met or exceeded. Some even include their own hand-written data based upon internally conducted measurements and quality control of each unit. Usually, though, once you get down to the level of a low-powered, low-cost receiver, such extra quality control seems to vanish. Not so in the case of the *model S-7150CP*. Although it is extremely modest in power and price, Sherwood's Certified Performance program (a program of total quality control) applies to this unit just as it does to the company's higher-powered receivers and separate components. We believe this is all to the good since we always sympathized with the budget-limited hi-fi consumer who requires only moderate power levels but wants high-quality in every other aspect. Such buyers are increasing in number, now that there is a trend towards high-efficiency speakers that don't require a lot of power to deliver realistic sound pressure levels.

When the receiver was listened to with any of the recently designed vented-port speakers, it performed admirably, and (as you can confirm by comparing published specifications with the results in Table 2) every single specification was either met or exceeded, in some cases by a wide margin. In our opinion, the *model S-7150CP* makes it possible to assemble a good-sounding stereo system for well under $500—rather amazing in view of the inflationary trends that have caused every other consumer product to rise in the last few years. If you plan to equip your home with stereo components and your funds are limited, this receiver should definitely be auditioned.

CUSTOMIZE YOUR PC BOARDS

The dimensions and shape of many finished PC boards are such that the board won't fit into a case or cabinet you want to use. Read how one experimenter solves the problem.

EARL "DOC" SAVAGE, K4SDS
HOBBY EDITOR

THE TWO PIECES OF EQUIPMENT SHOWN IN Fig. 1 provide outstanding performance and have a fairly nice appearance. On that basis, you would probably assume that they were custom made. Well, in a way they were—but those instruments contain predesigned circuit boards that would not fit into either cabinet. This is the story of how they got in there.

FIG. 1—PREFABRICATED PC BOARDS were used in building these two test instruments. The PC boards were "repackaged" so that they would fit inside the cabinets.

The problem of size can arise when you build on a surplus or prefabricated PC board; you must find a box of just the right size. You may have to settle for one that is too big, or the wrong shape, unless you know how to squeeze a board into a smaller box.

An even worse problem is to have a piece of equipment already on a board that won't fit into anything reasonable. Did you ever try to put a 6 × 7 inch PC board into a 6 × 3½ × 2½ inch box? Or would you rather put it into a box that is 6 × 7 by 1 inch deep—or worse, one that is 5 inches deep? In the first case, something has to give. In the second, you have a piece of equipment with a very strange and awkward shape or a lot of wasted space inside.

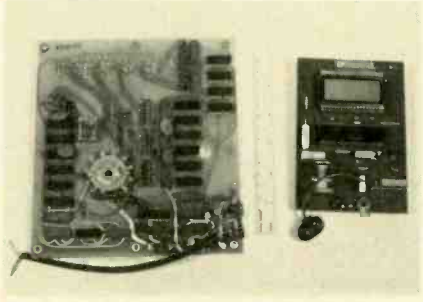


FIG. 2—TWO TYPICAL PC boards with problem shapes. They won't fit into standard cabinets.

Two such problems can be seen in Fig. 2. The board on the left is a complete frequency counter less a 5-volt power supply (as you will see later, the digits are mounted on the other side of the board). That particular board is a sub-assembly from a big piece of surpus gear. It works excellently but it should be put into a cabinet of some sort.

The board on the right is an Intersil digital panel meter with a liquid crystal display. It is a sweet little 200.0 *milli*-volt meter that just cries out for some accessory input circuits and a cabinet to be most useful. But everything you see in Fig. 3 simply won't fit into the desired box "as is".

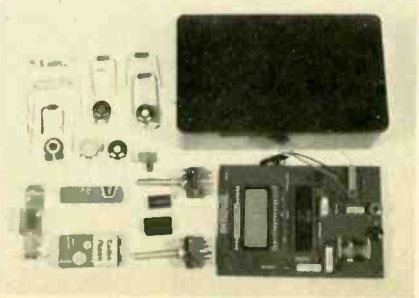


FIG. 3—MULTIMETER BOARD and components simply won't fit into intended cabinet.

FIG. 4—STRAIGHT CUTS in PC board is made with modeling saw.

Those really are problems because encasing the PC boards "as is" would result in awkward shapes and much wasted space. In addition, the digital readouts would be recessed way behind the panel—and who wants to look down tunnels all the time? Even locating the controls on the side of the cabinet (ugh!) won't help much.

Possible solutions

Of course, there are several ways to solve the problem. First, the boards might be used just as they are, without cabinets. But that would probably result in physical and electronic damage.

A second possibility is to put them into odd-shaped boxes. Probable result: being unable to find such a cabinet, you would have to spend a lot of time making it.

A third way would be to remove the parts from the board and make new ones of different shapes. The probable result would be some parts damaged in removal.

Those three "solutions" all have much the same disadvantages—unsafe, inconvenient, unaesthetic, and/or a lot of work. They *might* do the job but there is an

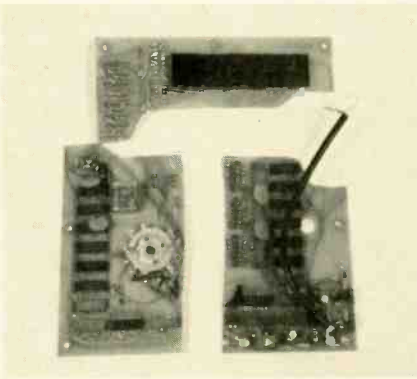


FIG. 5—CURVED CUTS are made with a coping saw.

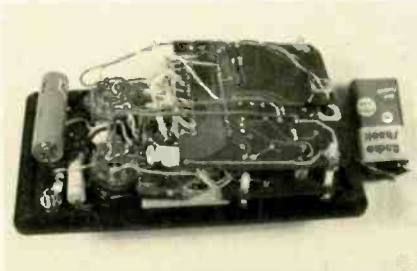


FIG. 6—MULTIMETER PC BOARD, after being cut, fits nicely into cabinet along with input circuitry and front panel controls.

easier more preferable way.

Cut the board up into pieces of manageable size to fit the cabinet of your choice. That's right: Saw the board into smaller pieces; then all you have to do is put the boards in layers, or however you want them, and wire them together.

How to do it

Let's see how it was done with those two boards; you can use the same techniques with your problems. Here are the steps in the process.

First, study the board and the available cabinet size(s) to determine the best place(s) to cut. Give attention to both sides of the board. Obviously, the fewer copper traces or runs you cut, the less wiring you will have to do later. Then, too, there may be sub-circuits that would be better undisturbed—as in the case of the counter board. Here, the cuts were planned to leave the crystal oscillator and divider chain in one piece. At times, you'll have to compromise, but don't start hacking away until you think it through. Usually the cuts will *not* be straight and square.

Next, saw the board according to your plan. Go slow and easy and you won't tear anything up. If the board is small, a very fine-tooth modeler's saw works well. An Xacto saw was used on the Intersil board (Fig. 4). The size of the counter board and the needed shapes made another type of saw necessary—in that case, a fine

FIG. 7—REPACKAGED COUNTER PC board also fits nicely in its intended cabinet.

blade in a regular coping saw (Fig. 5).

After sawing, clean up the new edges with a file. This will keep debris from coming loose later. Even more important: It cleans up the raw edges of the runs and removes possible shorts.

If there is a lot of wiring to do—and especially if the board is double-sided—write some identifying letters/numbers on the runs that were cut. With the board back in its original shape, and flat on the workbench, put the same number or letter beside a trace on each side of the cut. Later, all you have to do is wire A to A and 3 to 3 and so on. Take note: It is easy to get confused when one piece of a board is reversed and inverted in relation to another piece!

Use a variety of wire colors as a further help in preventing miswiring. Frequently it will not be possible to solder both ends of a wire, one after another. When you are trying to attach the free ends of a dozen wires to one board, it is much easier to get them right if all are not the same color.

The soldering iron *must* have a very small tip or you will simply make a mess. To help protect MOS devices from static charges, the tip should be grounded or at least isolated from the AC line. The Wahl Iso-Tip No. 7545 is a good choice on both counts.

On fine, narrow runs it is a good idea *not* to solder a wire right at the cut edge, since the run could be pulled from the board. In such cases, work back 3/8 inch or more from the edge.

Soldering wires to the board runs can be tedious unless you use the "reflow" technique which requires only *two* hands. Here is the procedure found most satisfactory:

a. Heat the run at the intended point of attachment and deposit a small amount of solder there. To avoid damage, do that quickly with a *hot* iron.

b. Strip and tin about 1/8 inch of the end of a *solid* wire (stranded wire tends to spread too much).

c. Bend the end of the wire slightly so it will lie flat on the run.

d. Lay the tinned wire *flat* on the resoldered portion of the run and touch the top of the wire briefly with a hot iron. This causes the solder to "reflow" and make a good connection.

e. Examine the area of the new joint carefully with a magnifying lens to be sure that no solder has flowed over to an adjacent run.

Many times a run will be short and you can as easily solder the wire to a component lead sticking through a pad. Given a choice, wire to a lead and pad instead of to a run. Just make a small hook in the end of the wire and use the reflow technique.

When the board pieces have been wired and mounted, the results may look like those in Figs. 6 and 7. Those will win no prizes for beauty but they work *very* well.

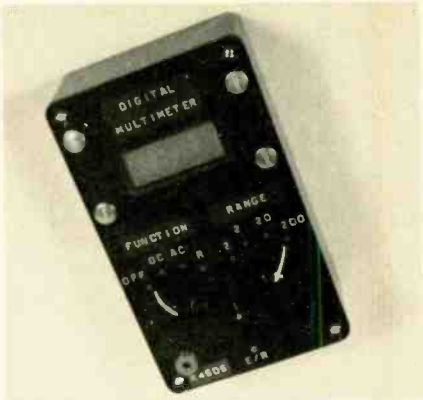


FIG. 8—COMPLETED DIGITAL MULTIMETER.

FIG. 9—COMPLETED FREQUENCY COUNTER.

Conclusion

There is no way the Intersil-based multimeter shown in Fig. 8 could have been packaged without complete rewiring or re-boarding short of cutting the original board. The same is true of the frequency counter in the Radio Shack cabinet shown in Fig. 9.

On the basis of function and appearance, the repackaging effort was worthwhile. Those instruments would find a place in any workshop. Yours can look equally as good; get out your saw and repackage your loose boards. **R-E**

Audio Oscillator Applications

The audio oscillator/generator is one of the oldest electronic test instruments. Its specifications and features have been greatly up-graded so it is suited for a myriad of applications. This article tells how the audio generator is used in nine important test procedures.

HEATHKIT MODEL IG-5218

CHARLES GILMORE

IT IS DIFFICULT TO ENUMERATE ALL THE applications for an audio oscillator. Briefly, the instrument can be used in any situation requiring a source of relatively pure sinewaves within the frequency range covered. A large majority of applications are found in audio measurements because of the high degree of concentration on reproduction fidelity. However, there are enough applications for a good audio oscillator that a general laboratory or service shop should place it on the priority list for low-frequency sources (right after a function generator). Of course, if the shop specializes in audio measurements and repairs, the audio oscillator is a *must*.

Total harmonic distortion

The THD measurement determines the amount of harmonic energy added to the output signal of a device by the device itself. With the audio amplifier—or any other amplifier for that matter—the test is performed by supplying a distortionless signal to the input and then measuring the harmonic content at the output. Most THD analyzers reject the fundamental signal with a notch filter and measure all other energy within the audio spectrum. The THD then becomes:

$$\% \text{ THD} = \frac{\text{Harmonics} \times 100}{\sqrt{(\text{Fundamental})^2 + (\text{Harmonics})^2}}$$

The THD measurements for audio equipment are usually made at a number of input and output levels, since the harmonic distortion introduced by the amplifier depends on the gain and the power output at which it is operated. Harmonic distortion is a direct result of nonlinearities within the amplifier.

Note that the described technique for measuring THD includes noise, hum or other nonharmonically related signals not rejected by the notch filter tuned to the fundamental frequency. Two points therefore must be considered. First, the amplifier itself must be thoroughly analyzed for its own hum and noise prior to using it for THD measurements. Any such components should be eliminated before the measurement. Second, the oscillator supplying the distortion-free signal must also be free of hum and noise.

A method of measuring THD that eliminates this problem uses a wave analyzer. This consists of an extremely sharply tuned filter followed by an AC voltmeter. Although measuring THD with a wave analyzer is more tedious, the result is more accurate. The ultra-low distortion characteristics of the generator are still required, and, of course, there must be no hum and noise. However, levels of hum are permitted with this system of measurement.

The wave analyzer is first tuned to the fundamental frequency and an amplitude measurement is taken. It is then tuned to the second, third, fourth, fifth, etc., har-

monics, and amplitude measurements are taken. THD is then calculated using the following formula:

$$\% \text{ THD} = \frac{\sqrt{(2\text{nd})^2+(3\text{rd})^2}}{\text{Fundamental}} \times 100\%.$$

Although truly broadband noise contributes throughout to this measurement, hum and other nonharmonically related spurious signals are eliminated.

When making THD measurements with an analyzer that uses the notch filter, a few basic testing precautions are necessary. Since hum contributes significantly to the harmonic distortion measurement, ground loops must be carefully avoided. A ground loop consists of a second path through which the ground or return signals for the test may pass. Frequently, this second path also contains significant line-frequency currents, which could enter into the measurement and contribute an undesired signal to the output. This signal is generated by neither the amplifier nor the oscillator, but affects the measurement.

Two forms of THD analyzers use the notch technique: With the first and simplest form, the notch filter is manually tuned. The second technique uses manual tuning to within a few percent of the desired center frequency, when an automatic nulling circuit takes over to center the analyzer on the fundamental frequency. Errors can occur in the analysis if the generator drifts from the fundamental frequency to which the analyzer was tuned. An analysis with automatic null compensates for minor drifts. However, drifting introduces errors to measurements made with the manually tuned analyzer.

A note of caution regarding THD measurements: It seems logical that one could measure both the THD of the generator and the THD at the output of the unit under test and subtract, thus arriving at the THD contributed by the device under test. Unfortunately, because of the complex qualities of the signals, this technique does not lead to a proper measurement. The THD of the audio oscillator must be substantially less than that expected from the amplifier being tested.

Intermodulation distortion

Distortion is any difference, other than a difference in magnitude, between the input and the output signals, either expressed as percentage or as an absolute value. We know from the previous section that THD represents components added to the output signal whose frequencies are exact multiples of the fundamental signal but which did not appear at the input. Intermodulation effects also contribute to distortion in an amplifier, and also take place where there are nonlinearities. The added signals are the sum and difference products of two or more amplified signals.

An audio amplifier test for intermodulation (IM) distortion usually consists of mixing a 60-Hz signal with a 7-kHz signal—that is, signals at 7,060 Hz and signals at 6,940 Hz are measured. These signals are generated in the amplifier by intermodulation. Figure 1 is the block diagram of a test configuration for measuring IM distortion. Because this technique requires two audio oscillators, two filters, a detector and an audio voltmeter, an IM analyzer is used that incorporates those instruments in a single package.

The measurement process is relatively simple. A high-pass filter eliminates the 60-Hz component at the input of the audio amplifier under test, but passes the 7-kHz signal. Once the 60-Hz component has been removed, the modulated 7-kHz signal (the 7-kHz signal with the two 60-Hz sidebands created by any IM distortion of the amplifier) is applied to an AM detector. The detector output is a 60-Hz signal whose amplitude is in direct proportion to the amount of IM present. Any 7-kHz signal passing through the AM detectors is removed by the low-pass filter. The 60-Hz product is measured by the voltmeter.

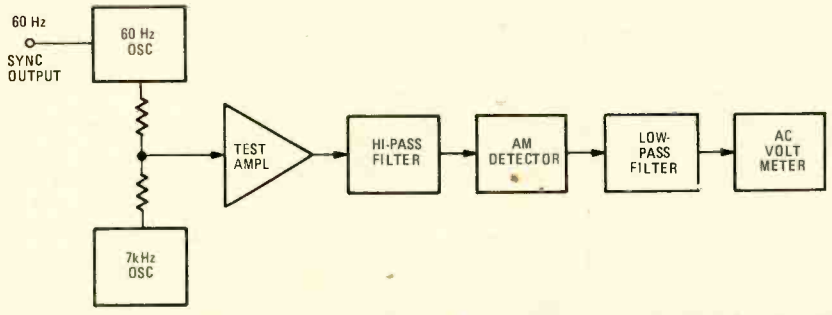


FIG. 1—INTERMODULATION ANALYZER. Two signals are sent through the amplifier; then the effect of one on the other is measured.

The audio oscillators used for this particular application must be almost free of hum, especially the one generating the 7-kHz signal. Extremely low harmonic content is required of the one that generates the 60-Hz signal. To avoid spurious beats caused by interaction between the 60-Hz line frequency, the 60-Hz test signal is usually synchronized to the line. (The 60-Hz line itself is not used for the measurement since its harmonic content and amplitude variations with time are too great to permit successful measurements.) It should be noted that the 4-to-1 combiner mixing the 60-Hz and 7-kHz signals must produce no IM of its own.

Intermodulation distortion, while most frequently produced by the active components of amplification, can also be produced by electromechanical connections on the output of an amplifier. Intermodulation distortion produced in such connections is most frequent under high power conditions, and is usually measured at both high- and low-power levels.

Power output

The audio oscillator is used to drive audio amplifiers to a desired output level to make power measurements. The power output is usually increased until a certain harmonic-distortion value is reached. Measurements are made at this level with the formula $P = E^2/R$, or by $P = E \times I$ if a current meter is available. When the first formula (the most common) is used, a purely resistive load is mandatory. A speaker does *not* provide a constant impedance over frequency.

Audio response

These measurements determine the uniformity of the amplifier's amplitude response with changes in input frequency. Usually this is plotted as decibels variation, with the frequency plotted on a logarithmic scale for compression. Frequency response measurements use the audio oscillator as a signal source because the audio oscillator has a known flat output. Metered audio oscillators tend to reduce setup time. Audio response measurements may be made at various power levels and for different control settings, such as TREBLE and BASS.

Impedance

Both input and output impedance measurements may be made with the audio test oscillator as a signal source. These measurements most frequently establish an output voltage level from the amplifier, and either insert a series resistance for input measurements or a parallel load resistance for output measurements. The inserted resistance is then varied until the output voltage is reduced by 6 dB (50%). At this point, the variable resistor is equal to the unknown impedance.

Damping factor

The damping factor of an audio amplifier is the ratio of output impedance to the rated load impedance. This damping factor is measured by driving the unloaded amplifier to maximum output without introducing distortion. The no-load output voltage is measured (V_{NL}). The rated load (usually 4, 8 or 16 ohms) is now connected and the full-load output voltage is measured (V_{FL}). The damping factor is then given by:

$$\text{Damping Factor} = \frac{V_{FL}}{V_{NL} - V_{FL}}$$

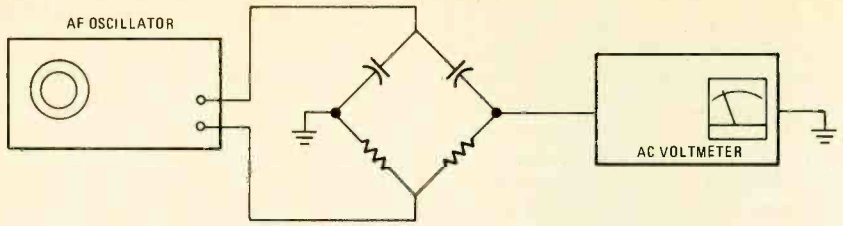


FIG. 2—A SIGNAL GENERATOR for an AC bridge. If oscillator output is balanced to ground, the amplifier can have a single-ended input.

An amplifier whose output impedance is matched to the load impedance has a damping factor of 1. Audio amplifiers, however, commonly have damping factors of 50 or greater.

Miscellaneous measurements

Input sensitivity and input overload are two measurements frequently made on audio amplifiers. Both measurements depend on reaching a low-distortion performance level, and so require a low-distortion oscillator. Channel separation measurements determine the amount of crosstalk between two channels in a stereo or quadriphonic system.

Bridge measurement

The audio oscillator is often chosen as a signal source for bridge measurements simply because many of them have a balanced output. The simple test configuration of Fig. 2 is used. A very high degree of balance can be provided by the audio oscillator if a battery-operated type is selected.

In addition to the balanced output requirements, the audio oscillator also provides low-distortion signals and low hum and noise. Deficiencies in any of these areas cause some imbalance in the bridge, since the undesired signals can make it difficult or impossible to null the bridge effectively. To successfully maintain bridge balance for extended measurements, the oscillator frequency must be constant. Therefore, the good frequency stability properties of the audio oscillator make it a popular choice for bridge measurements. Bridge measurements also generally require a constant amplitude. Amplitude variations of the signal driving the bridge appear as amplitude variations at the bridge output. The audio oscillator, with its extreme amplitude stability, is most satisfactory for this purpose.

Synchronized oscillator

The audio oscillator in the synchronizing mode can be used for signal regeneration. Often in a laboratory situation, processing or transmission causes the measured signal to be too noisy, too high in distortion, or to have excessive amplitude variations. Applying this signal to the synchronizing input of an audio oscillator results in an output signal in which noise, amplitude variations and distortion are highly suppressed. The audio oscillator acts as a high-quality filter, and when used in this mode, tracks frequency changes of the synchronizing signal over short excursions within the oscillator's lock range. If the synchronizing signal leaves the oscillator's lock range, the oscillator output signal reverts to its natural frequency indicated on the front-panel dial setting.

A typical example is period measurement of signals with a high noise content. Period measurement is susceptible to a high degree of error if there is signal noise. Filtering by a synchronized oscillator substantially improves period measurement accuracy.

A fixed degree of phase shift can be inserted between the synchronizing signal and the audio oscillator output signal by adjusting the front-panel variable-frequency control. Within certain limits, the synchronized audio oscillator can be used to achieve a specified phase shift or time delay.

Frequency response and phase-shift analysis of many of the extremely selective electronic filters available require the signal source to have excellent frequency stability. The signal source also must have very good spectral purity. However, the excellent frequency stability requirements may exceed either the setability or stability capabilities of the audio oscillator. To make such measurements, the audio oscillator may be locked to a digitally derived source having a high degree of frequency stability but with poor spectral characteristics.

The synchronizing input of an audio oscillator does not reject harmonics. Therefore, the audio oscillator can be easily locked to the second, third, fourth, fifth, or higher harmonic of the synchronizing signal, if the harmonic content is great enough. In some cases this is advantageous. For example, a number of oscillators can be synchronized to one particular signal with a high harmonic content. Each oscillator is synchronized to a different harmonic. The output signals of the various oscillators are combined in a resistive adder.

Extremely complex waveforms can be synthesized by this technique. For example, the squarewave contains a fundamental signal plus a signal at the third harmonic of the fundamental whose amplitude is one-third that of the fundamental, and so on up the odd harmonic spectrum. An extremely pure squarewave could therefore be synthesized by this technique (see Fig. 3). Because all other waveforms are combinations of a fundamental sinewave and its various harmonic amplitudes and phases, they also can be created through such a technique.

A synchronized audio oscillator can reduce frequency jitter or phase-noise problems on the incoming signal. Again, the synchronized audio test oscillator filters out these modulating components from another frequency. The ability of the audio test oscillator to remove these components is limited by the short-term frequency stability of the oscillator itself.

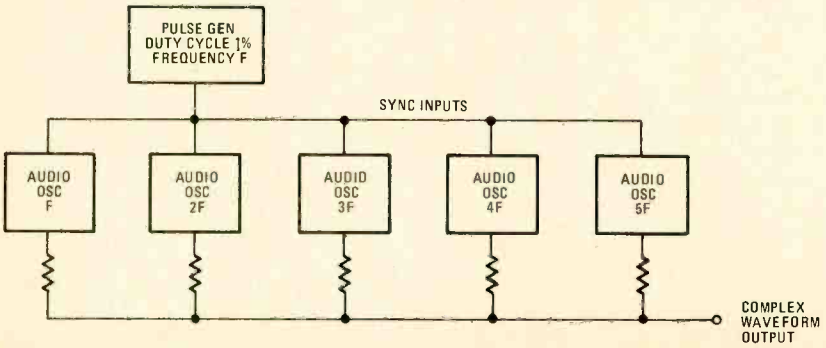


FIG. 3—A FOURIER SYNTHESIZER consists of a combination of oscillators that can produce squarewaves or other complex waveforms by adding synchronized harmonics to the fundamental.

Summary

Although the audio oscillator is no longer the sole low-frequency signal source for all laboratory and service work, there is a wide range of applications in which this most useful instrument should be applied. The audio oscillator has improved considerably in some of the most fundamental and desired specifications. It has moved from its original general-purpose usage into the category of a specialty measurement instrument. It is used whenever only a high-purity audio test oscillator is good enough to provide the signals required. When an instrument evolves in this manner, it very often moves out of the low-cost category and into the special laboratory instrument classification. The audio test oscillator has definitely not done that. Although a good laboratory tool, it is also a fundamental service tool in shops that service quality audio gear. **R-E**

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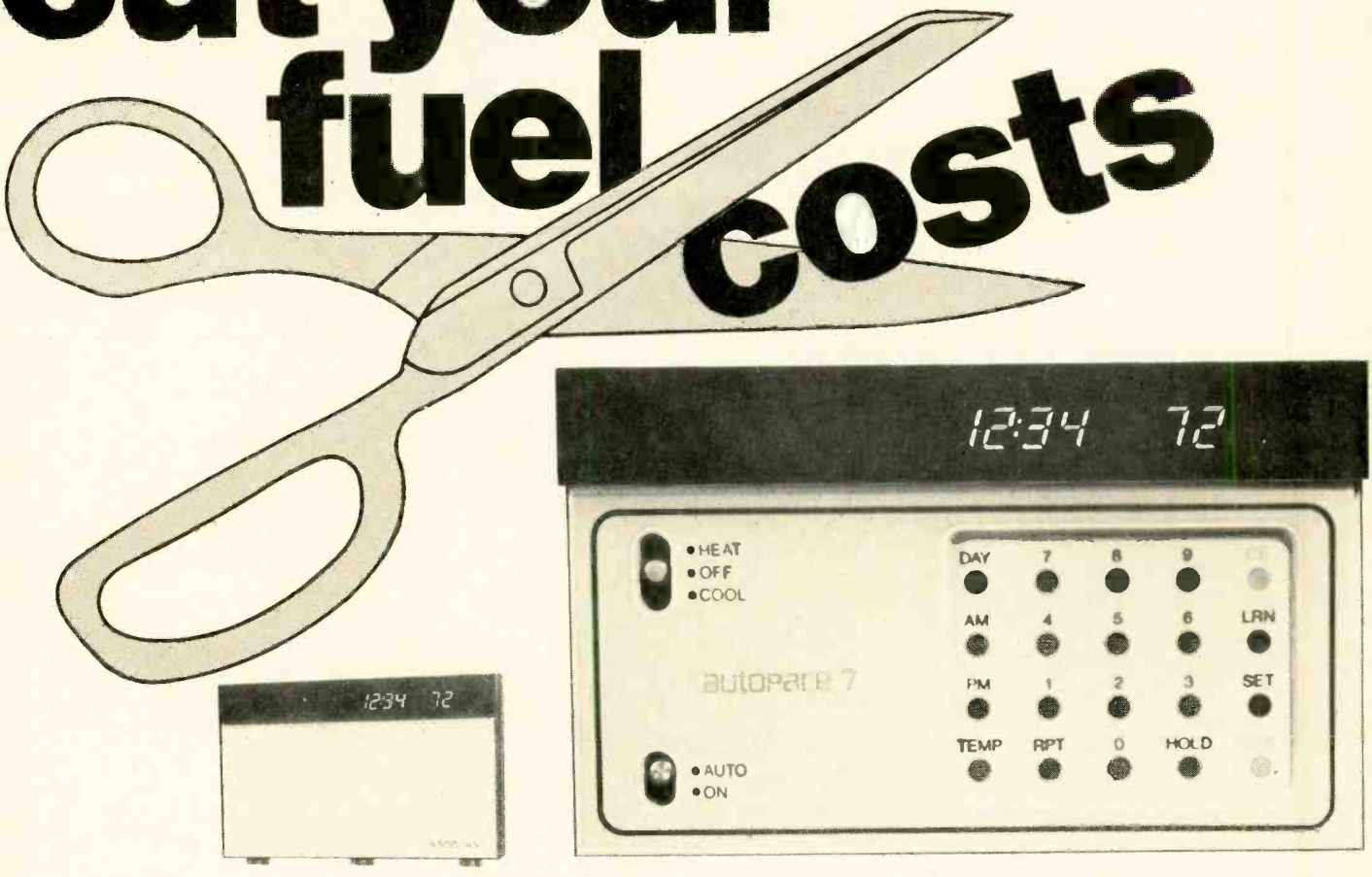

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Chapter 6 questions—Instruments

1. In which of the following circuits would testing with a low impedance voltmeter be expected to affect normal operation?

( ) a. An AVC (*A*utomatic *V*olume *C*ontrol) voltage bus.

( ) b. An audio output tube cathode circuit.

( ) c. A multivibrator grid circuit.

( ) d. A bridge rectifier circuit in a low-voltage power supply.

2. The best way to view unmodulated RF frequencies in CB radios is:

( ) a. with an oscilloscope using a demodulator probe.

( ) b. with a distortion analyzer.

( ) c. with an oscilloscope having a horizontal amplifier bandwidth exceeding 30 MHz.

( ) d. with an oscilloscope that has a vertical amplifier bandwidth exceeding 30 MHz.

3. A signal strength meter is used for:

( ) a. checking antennas

( ) b. checking resonant circuits

( ) c. checking oscilloscope bandwidth

( ) d. checking sweep generator bandwidth

4. A dual-trace oscilloscope has both an alternate and a chopped mode. Which mode would be most likely to be used for low frequencies?

( ) a. chopped

( ) b. alternate

( ) c. either

5. Which of the following two-waveform examples resembles the horizontal sweep voltage of a: a recurrent sweep; and b: a triggered sweep oscilloscope?

6. An oscilloscope calibrated to read 1 volt-per-division would show how

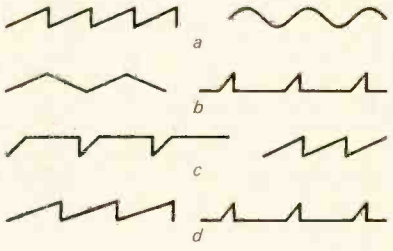

FIG. 1

ANSWERS TO

Correct answers to Chapter 5 Questions about electronic components and circuits

Here are the answers to the questions on electronic components and circuits that appeared in the February 1979 issue.

1. **Correct answer is "b."** The resonant tank circuit will act as a high impedance or load to only a narrow band of frequencies at and near the resonant frequency of the L—C combination. The resonant frequency f_r is the frequency at which $X_L = X_C$. Frequencies above the resonant frequency will be by-passed through C. Frequencies below the f_r will be bypassed through L.

2. **Correct answer is "a."**

3. **Correct answer is "C."** The Zener "D" will conduct when the E2 voltage goes higher than the diode's breakdown potential. Zener diodes are constructed so that they have different voltage points at which they avalanche, drawing heavy current until the voltage has been reduced below the breakdown point again. The circuit in Fig. 3 is commonly used to provide regulation in power supplies.

4. **Correct answer is "d."** The two oppositely connected diodes would truly act as a short for large signals. However, for signals whose desired maxi-

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much vertical deflection when reading a voltage which shows 2 volts on an AC meter?

( ) a. 2 divisions

( ) b. 4 divisions

( ) c. over 5 divisions

( ) d. 2.8 divisions

7. An oscilloscope calibrated to read 1 volt-per-division would show how much deflection if reading a voltage which shows 2 volts on a DC meter?

( ) a. 2 divisions

( ) b. 4 divisions

( ) c. over 5 divisions

( ) d. 2.8 divisions

8. To connect an ammeter how should it be inserted with respect to the load?

( ) a. In series

( ) b. In parallel

9. A generator which produces 88 to 108 MHz RF; L + R; L−R; and 19 kHz modulation is a:

( ) a. TV sweep generator

( ) b. CB test generator

( ) c. color bar generator

( ) d. FM-stereo generator

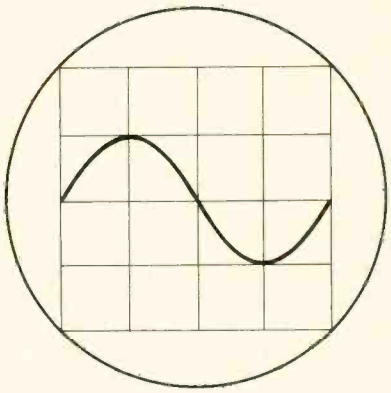

FIG. 2

10. The scope producing Fig. 2 is set on a horizontal sweep rate of 10 ms-per-div. What is the frequency of the waveform?

( ) a. 500 Hz

( ) b. 50 Hz

( ) c. 25 Hz

( ) d. 250 Hz

Be sure to keep this issue handy so you can check your answers in the next chapter of the CET test. The new questions in the next chapter will be on "test and measurements." You may find it a little tough if you haven't brushed-up on the subject. **R-E**

PRIOR QUIZ

mum level is less than the contact potential of the diodes (perhaps signals whose peaks are less than .5 volts, as an example), the arrangement would allow passage of desired-size frequencies, but would act as a short to unwanted noise spikes, either negative or positive.

5. **Correct answer is "a."** Fig. 5 is a drawing for a simple crystal radio. It will work best with a high-impedance headset connected from terminal "E" to ground.

6. **Correct answer is "a."** The uppermost component shown in Fig. 6 is a photoresistor which varies its resistance according to the light directed on it. Thus it can be used to vary the bias on the transistor, turning it on and activating the relay. The relay can be connected to a light switch, alarm, etc.

7. **Correct answer is "c."**

8. **Correct answer is "a."**

9. **Correct answer is "a."** About the easiest way to tell the difference between a discriminator and a ratio detector is to remember that a ratio detector has the diodes hooked up oppositely and has a large-value capacitor across the circuit (4 μF in this case)

10. **Correct answer is "a."**

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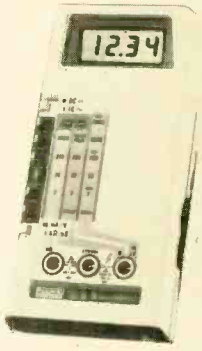

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		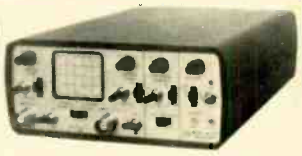
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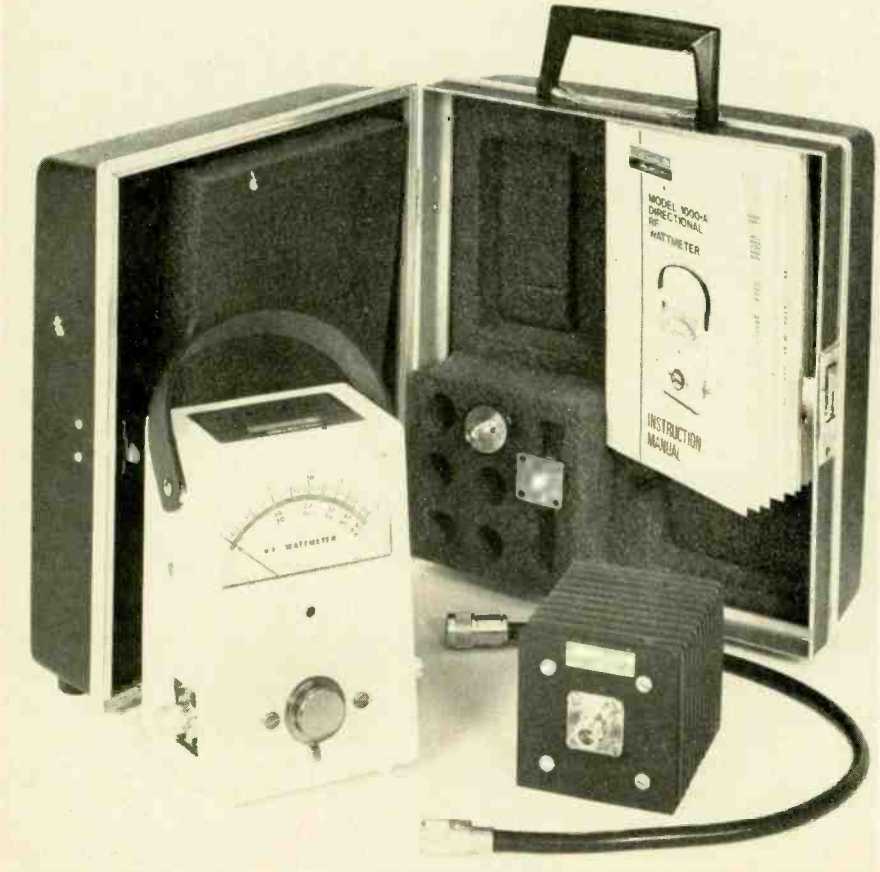
HERB FRIEDMAN, COMMUNICATIONS EDITOR

IN ALL COMMERCIAL RADIO COMMUNICATION services *reliability* is the most important parameter next to maintaining FCC performance specifications. (Some technicians might argue that reliability is *more* important than FCC requirements, but that's a subject for another time.)

In a sense, many of us were spoiled by CB when it came to output power measurements. While output power was formerly measured with laboratory-grade instruments, the 4-watt AM/12-watt PEP SSB maximum of CB easily lent itself to budget-priced RF power metering, and one could often run across combination RF output/VSWR meters for anywhere from under $5 to $25, the exact price depending more on the size of the meter(s) and its cabinet than the reliability of the instrument.

In most instances, the calibration of the CB power/VSWR meter depends on a factory-adjusted potentiometer of the least expensive variety and quality. As long as the meter sits on a shelf it is accurate; but after being bounced around in the bottom of a tool box one would not even take long odds on its accuracy. It might be OK for CB—but would you trust it for testing or adjusting a marine or aircraft radio, where someone's life could depend on the fact that the output power measurement might reflect some form of improper operation? In short, for professional use *reliability* must be a prime consideration at all times.

In the area of power meters the *transmission line directional wattmeter* has been the general service and lab standard. As implied, the sensing device is a coax-line section (usually from about 3 to 12 inches depending on total power capacity) with an impedance equal to the transmission line with which it will be used—50 ohms is more or less standard for amateur, VHF, and HF communications. The coax-line section has an opening into which the user plugs an RF element specifically rated for maximum power and frequency limits. An attached calibrated meter is driven from a detector within the element. When the element is turned one way the meter indicates forward output power. When the element is rotated 180°, the meter indicates reflected power. (A supplied chart that we have mentioned in previous columns can be used to interpret the two power readings in terms of system VSWR.)



COMPLETE WATTKITS for the service technician are available. These include a basic meter, a padded carrying case, patch coax cable, storage compartments for power sensing elements and line connectors. A larger kit includes a 100-watt *dry* (air cooled) dummy load, and a larger carrying case.

The coax-line sections come in all sizes, depending on the manufacturer. There are itty-bitty models with special elements for indicating in terms of milliwatts; finger-size sections rated up to about 1 kW; and even (nominally) 3- and 5-inch sections for up to 50,000 watts. As a general rule, the sections intended for use up to about 1 kW are available with interchangeable end connections; the user can almost instantly change to N, BNC or UHF type connectors.

To make life a bit easier for the service technician, the coax-line section and meter are often combined in a rugged metal case. The classic Bird *model 43* wattmeter is the most familiar example. Among the modern styled designs is the *model 1000-A* from Dielectric Communications shown in the photographs. The *1000-A* accepts plug-in elements (sensors) from 0.1 to 5000 watts full scale and covers the range of 2 to 1000 MHz. It is available in a *Wattkit* that consists of the *1000-A*, a padded luggage-type case, a UHF connector and patch cable, storage compartments for additional elements and coax-cable connectors of various types, and a device called a *Sniffer*. That brings us to the next part of this column

Performance specifications

The FCC has minimum standards for harmonic, sideband, and spurious radiation for virtually all transmitters. In addition to insuring that a transmitter meets the specifications for those parameters, a technician is responsible for insuring that the carrier frequency is within what has become rather stringent limits. As a general rule, the service technician checks for spurious signals and the carrier frequency

continued on page 76

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WK-7

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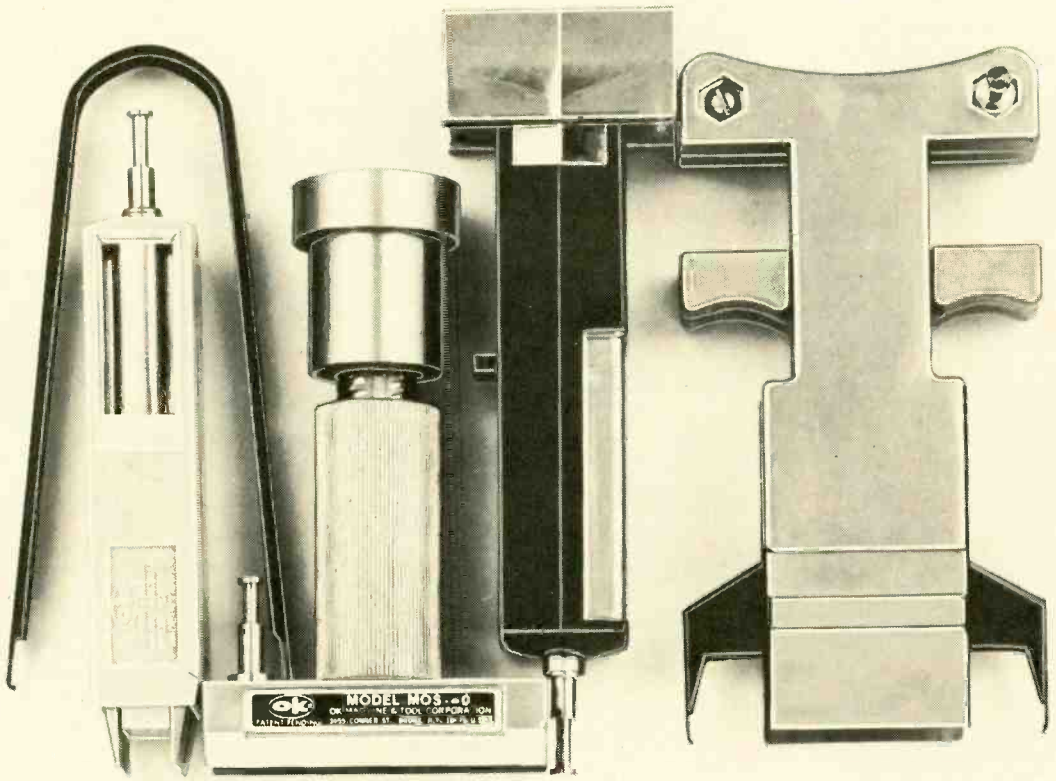

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CIRCLE 41 ON FREE INFORMATION CARD

COMMUNICATIONS CORNER

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by visually observing the transmitter's output on a spectrum analyzer and/or a frequency meter. The problem is: Most spectrum analyzers and many frequency counters (depending on the frequency range and type) are rated for a maximum input of about 1-watt RF. If you hit the input with more than the rated power or voltage, the analyzer and/or counter generates its own spurious signals that you can't distinguish from the spurious signals of the transmitter being tested.

So how do we handle transmitter outputs greater than 1-watt? Better still; how would we tap off an RF sample from a transmission line carrying up to 1 kW without cutting into the line? The answer is a *Sniffer*.

MINUTE SAMPLES OF RF are tapped from a transmission line with a *Sniffer* or similar device. The *Sniffer* plugs into the power meter just like a measuring element, or you can use just a coax line section by itself. It provides 43 dB attenuation at the BNC connector ±8 dB. The attenuation vernier is the small screw adjacent to the BNC connector. On a transmission line carrying 1 kW, the *Sniffer* can knock the sample down to 316 mW, a safe value for virtually all test equipment.

A *Sniffer* (also called a *transmission-line tap*, or *V*ariable *RF S*ignal *S*ampler) is simply an adjustable RF sensor that plugs into the same type of coax line section used in RF power meters.

Closely resembling a power element, the *Sniffer* has a BNC connector to which you connect the test equipment. There is 43 dB ±8 dB attenuation between the power in the line and the output of the BNC connector. (A small screw adjacent to the BNC connector is the ±8 dB adjustment.) Thus if you have 100 watts in the transmission line, the BNC output will be at least 31.6 mW.

Since the coax line section and the *Sniffer* are transparent to RF in the transmission line (except for the extremely minute amount tapped off), like a coax line power meter, they can be left permanently connected to the antenna system.

For additional information on directional wattmeters and the RF *Sniffer* write to the manufacturer, Dielectric Communications, Tower Hill Rd, Raymond, ME 04071. **R-E**

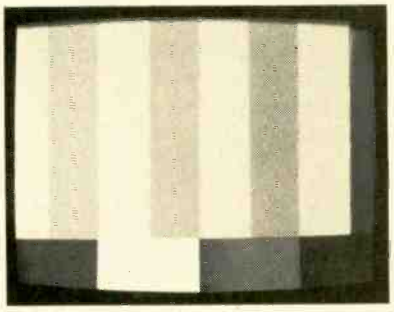
Master the art of color with the High-Performance NTSC Generator

The best foundation for accurate color reproduction is an accurate and stable test signal source. B&K-PRECISION's new NTSC color pattern generator is all that and more.

The B&K-PRECISION "1250" is a state-of-the-art generator intended for color broadcast, CATV and industrial applications. Its simple operation also makes it a time-saving tool for aligning and trouble-shooting video tape recorders.

The primary pattern generated by the 1250 is NTSC color bars with or without an -IWQ signal (occupying the lower quarter of the pattern). Other features are a five-step staircase pattern with selectable chroma levels; convergence dot, cross-hatch, dothatch and center-cross patterns; and a choice of eight color rasters (including black burst). The 1250 doesn't stop at video patterns though, it also generates a stable 4.5 MHz sound carrier, modulated by 1 kHz or 3 kHz signals or any external audio signal. RF outputs can be generated on channels 3 or 4, or the standard TV i-f frequency. Each output is crystal controlled for stability.

For trouble-shooting applications, in-



circuit analysis of custom ICs can be done by using the NTSC bar signal and an oscilloscope to examine the inputs and outputs at each IC pin. These results can then be compared to that of a known good unit or reference diagram. The presence of NTSC sync, color bars, luminance components and sound carrier make possible a thorough evaluation of all video circuits. The internal RF modulator can be fed by an internal test signal or any external composite video source. In addition, an RF output can be selected independently of the composite video output, so that a waveform monitor and a television receiver can be fed simultaneously.

The B&K-PRECISION 1250 will give you the master's touch for color. For immediate delivery or additional information, contact your local B&K-PRECISION distributor.

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CIRCLE 66 ON FREE INFORMATION CARD

state of solid state

Two new IC's from RCA make DMM design a cinch. Plus other nifty new releases. **KARL SAVON,** SEMICONDUCTOR EDITOR

CONSTRUCTING A DIGITAL VOLTMETER was once a major undertaking. There was an overall system to design, multiple power supplies to be considered, many digital IC's to be designed and interconnected, and display-segment driver transistors to be wired. Now RCA has designed two IC's that make voltmeter construction easy and inexpensive.

The CA3161E and CA3162E IC's are constructed with I^2L/bipolar technology. They use integrated injection logic for low power and high-chip density. The I^2L construction uses inverted transistors in which conventional emitters become collectors. This means that the usually high-breakdown voltage collector-base junctions are really relatively low-breakdown voltage emitter-base junctions. Bipolar devices are used where higher breakdown voltage and greater current capacity are required.

The CA3162E analog-to-digital (A/D) converter is a three-digit resolution system that measures input voltages between −99 mV and +999 mV. Negative input voltages can be measured even though the IC power source is a single +5-volt nominal supply. Figure 1 is the block diagram of the circuitry on the 107 × 130-mil IC in a 16-lead dual in-line package (DIP).

The system uses the dual-slope technique. The input voltage is converted to a proportional current that charges a capacitor for a specific time interval (about 1.3 ms). At the end of the time interval, the input-current source is disconnected and an internal constant-current source discharges the capacitor. The number of clock cycles that elapse from this time until the voltage reaches its initial value at the start of the charge period are counted. If properly scaled, the accumulated count directly corresponds to the DC input voltage. Dual-slope A/D conversion has the advantage of being independent of the internal clock frequency. Charge intervals are inversely proportional to frequency, and the counted clock cycles are directly proportional to frequency, so the two effects cancel each other. An internal ring oscillator supplies all the timing control signals, and no external oscillator components are necessary or even provided for by the RCA IC's.

However, there must be some kind of accurate reference voltage against which to judge the input voltage. The CA3162E reference voltage is a band-gap supply that is transformed into the reference-capacitor discharge current. This current is pitted against the converted input voltage and therefore becomes the standard for the measurement.

The 786-kHz ring-oscillator frequency is divided by 2048 to produce the 384-Hz multiplex signal. A further division by 96 results in a 4-Hz conversion rate. Conver-

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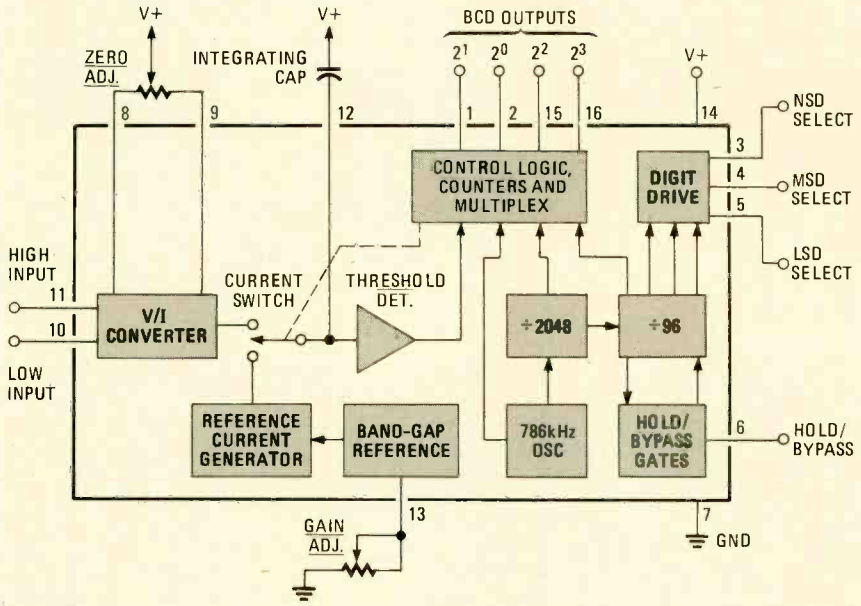


FIG. 1

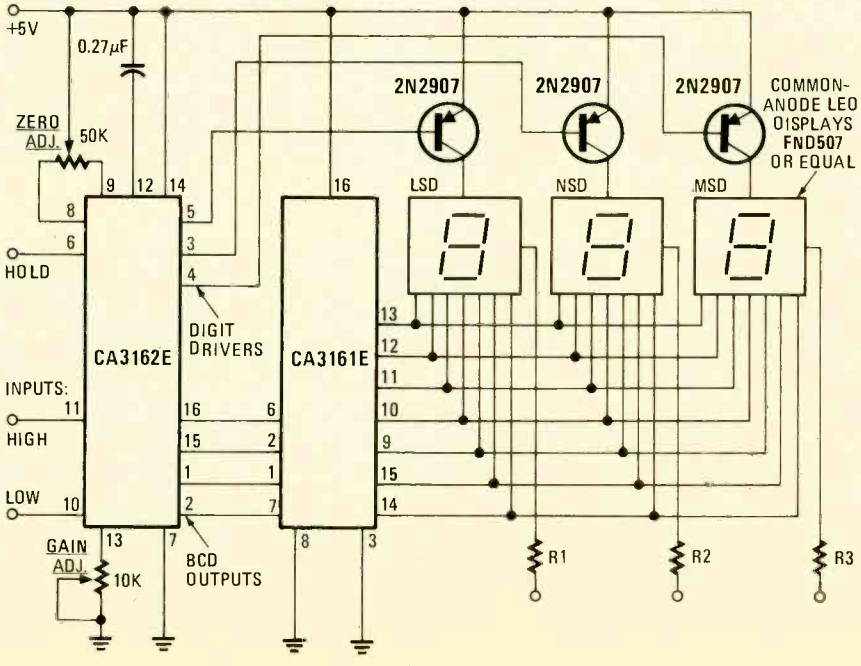
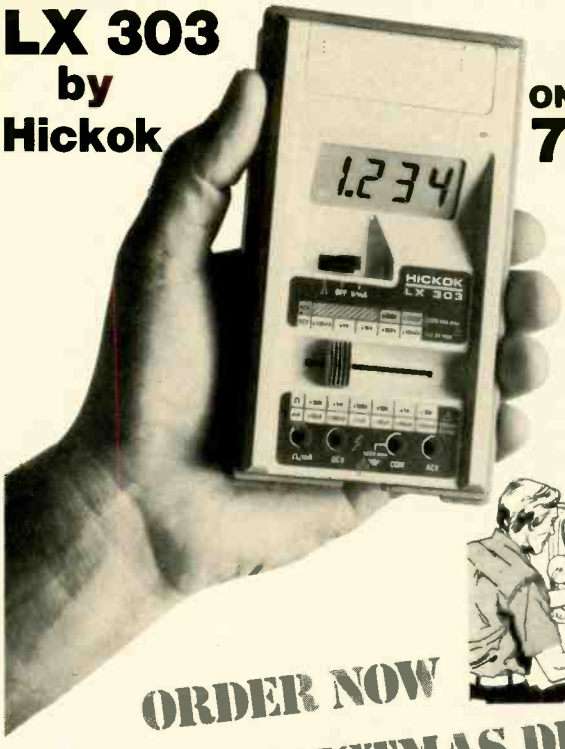


FIG. 2

DIGITAL ACCURACY AT YOUR FINGERTIPS

LX 303 by Hickok



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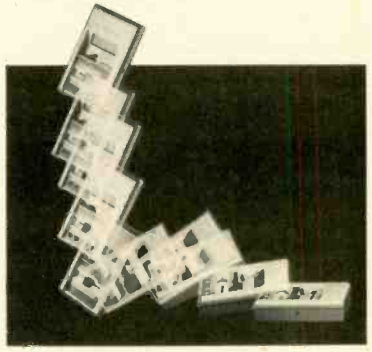
Years of hassle-free reliability. The 300 hour typical battery life means you'll only need to install a new battery once every 6 months or so (at 2 hours/day, 5 days/week). A convenient battery check capability is built in. The LX303's excellent overload characteristics also assure long reliable operation. All DC V ranges will take 1000 volts without damage except the 100 mV range which will handle 500 volts. All AC V ranges will withstand 600 volts. The ohms ranges are fully protected too — up to 120 volts AC or DC without damage — up to 240 volts short term.

10,000 Volt Protection (optional). For applications where the LX303 will be used around voltages over 1000 volts — such as TV chassis, etc., the optional x10 probe adapter (model VP-10) provides protection of up to 10,000 volts when making DC voltage measurements.



The LX303 is designed to withstand a drop from 4 feet without damage.

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LX 303 SPECIFICATIONS

DC Volts (5 RANGES): 200mV to 1000V full scale, RESOLUTION 0.1mV ACCURACY: ±(0.5% rdg + 0.5% f.s.): INPUT IMPENDANCE: 10MΩ: OVERLOAD PROTECTION, 1000VDC or peak AC all ranges. **AC VOLTS (40 Hz to 5kHz):** 200V to 600V full scale: RESOLUTION: 0.1V: ACCURACY: ±(1.0% rdg – 0.5% f.s.). 2.0 db at 5kHz: OVERLOAD PROTECTION: 600VDC or rms. **RESISTANCE (6 RANGES, LOW POWER):** 200Ω to 20MΩ full scale; RESOLUTION: 0.1Ω; ACCURACY: ±(0.5% rdg + 0.5% f.s.) ±(1.5% rdg + 0.5% f.s.) on 20MΩ range; OVERLOAD PROTECTION: 120VDC or rms all ranges, 240V rms for 30 sec. **DC CURRENT (6 RANGES):** 20 nA to 200 mA full scale; ACCURACY: ±(0.5% rdg + 0.5% f.s.); OVERLOAD PROTECTION: 80V on 10 nA to 10 μA ranges, 25 mA on 100 μA range and 500 mA on 100 mA range. **GENERAL:** DIMENSIONS: 5⅞ x 3⅜ x 1¾" (14.7 x 8.5 x 4.3cm); WEIGHT: 12 oz (0.33kg); POWER 9V battery (not incl.) or Hickok AC Adapter: BATTERY LIFE: Alkaline, 300 hours typical READ RATE: 3/sec.; TEMPERATURE: 0 C to 50 C operating. – 35 C to + 60 C storage.

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CIRCLE 63 ON FREE INFORMATION CARD

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sion rates can be speeded up to 96 Hz by reducing the second division ratio to four.

The outputs of the discharge counters produce a binary-coded-decimal (BCD) output for each of three decimal digits. Three-digit select outputs indicate which digit is currently being multiplexed to the four BCD output leads, and are used to multiplex a display. When the input is below −99 millivolts, all BCD outputs are coded to 1010 binary (decimal 10). Analog inputs exceeding the +999-mV upper limit switch the BCD outputs to 1011 binary (decimal 11). These two codes are outside the normal 0-to-9 decimal-digit range, and can be used by the display decoder to produce distinctive out-of-range indications.

The hold terminal (see Fig. 1) doubles as the conversion-rate select pin. Biased to 2.5 volts, pin 6 halts the A/D conversion and retains the last reading. The digit multiplexer continues to exercise the three-digit driver leads sequentially so that an interfaced display continues to show the most recently converted reading. Biasing pin 6 to +5 volts increases the conversion rate to 96 Hz without changing the multiplex rate. Terminal 6 can either be left open or grounded for the slow-conversion mode.

The CA3161E IC is a BCD-to-7-segment decoder driver that converts the four outputs of the A/D converter, or any other TTL-compatible device, to seven current-source outputs to drive LED display segments. For each of the 16 logic-level combinations on the four input leads, the 7-segment output leads are activated to form specific LED displays. While there are only 10 numerals, the other six codes are letters, a dash or a blank. The particular codes that are used with the A/D IC are the 10 numerals, the dash for underrange code 1010, and the letter "E" for overrange code 1011.

The CA3161E IC contains the decoding logic and output drivers that typically supply 15 mA for each LED segment. Constant-current outputs eliminate the need for external current-limiting resistors.

Figure 2 shows a complete meter system based on the two RCA IC's. The total digit current for a decimal 8 display is typically 7 × 15, or 105 mA. Three external segment-select transistors source the relatively high total currents. The digit-select outputs sink a minimum of 1.6 mA each, which is sufficient to drive PNP digit drivers. The CA3162E data sheet includes a full-scale 1¾ × 3⅛-inch foil pattern for a PC board. Two potentiometers are used for gain and zero adjustment. The unadjusted zero offset is ±12 mV, and the unadjusted gain is between 846 mV and 954 mV with a 900-mV input. The typical temperature coeffi-

cient with the ZERO potentiometer centered is 10 μV-per-degree-C, and the gain temperature coefficient is typically 0.005%-per-degree-C with a 2.4-K GAIN potentiometer.

Some applications for the meter system include electronic weighing equipment, medical diagnostics, welding controls, electronic games, temperature measurement, power supplies, and automotive accessories.

Hundred-quantity prices for these circuits are $1.20 for the CA3161E, and $4.30 for the CA3162E. For additional information, write for data bulletins Nos. 1079 and 1080 from RCA Solid State Division, Box 3200, Somerville, NJ 08876. Also available is RCA's brochure 2M1215 describing the use of both devices in a three-digit readout system.

Microcomputer with A/D converter

Intel's 8022 is the first low-cost single-IC microcomputer that includes an A/D converter. Frequently, A/D conversion is required to accommodate analog inputs. Thus, combining a converter with the microprocessor is ideal for many home-appliance, test and measurement systems, automotive and process-control applications. For example, if you wanted to measure the temperature in a microprocessor-controlled microwave oven, a voltage generated in a temperature sensor would have to be digitized.

The 8-bit converter has two multiplexed input channels. Each channel is selected by software using the SEL AN0 and SEL AN1 instructions that simultaneously start the conversion process. Conversions are completed every 40 μs, which corresponds to each of four instruction cycles. The converter is implemented in NMOS, using a successive approximation hardware approach. A separate power supply and voltage reference pins isolate the converter from power-supply noise.

The 8022 has an 8-bit central processor, 64 bytes of random-access memory (RAM), 2048 bytes of program read-only memory (ROM), and 28 input/output (I/O) lines. The I/O leads consist of three 8-bit ports, two test pins and two A/D multiplexer inputs. The 8022 is the most recent member of the MCS-48 family, which is headed by the 8048. Instruction time is 10 μs, and the set of more than 70 instructions is a subset of the 8048's set. No instruction takes more than two clock-cycles. The IC contains an oscillator that can be used with an external crystal or clock signal, or operated with a single external timing resistor or inductor. The IC operates over a range of 4.5 volts to 6.5 volts.

Input port 0 uses comparators to correlate the inputs against the threshold reference pin. These eight inputs are used to interface with analog inputs and directly drive capacitive touch panels. One of the two test pins senses zero crossings for

STATE OF SOLID STATE

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timing applications; by counting power-line zero crossings, you can create a time-of-day clock. Two of the No. 1 port output lines each drive 7-mA loads, or (when paralleled) one 14-mA load such as an LED.

The 8022 has full MCS-48 support, including Intel's *Intellec* Microcomputer Development System. The new EM-2 emulator board uses an Intel 2K EPROM (*E*rasable *P*rogrammable *R*ead-*O*nly *M*emory) for program development. Intel Corporation, 3065 Bowers Avenue, Santa Clara, CA 95051.

CRT controller

A combined-technology IC developed by National Semiconductor simplifies video-terminal design. Large blocks of discrete logic are replaced by the DP8350 CRT controller that uses a combination of I²L (*I*ntegrated *I*njection *L*ogic), low-power Schottky process and linear components.

The DP8350 contains an oscillator, a timing function, CRT refresh logic and video-control circuits. On-chip functions take the place of as many as 30 to 40 MSI, SSI and discrete devices. Compared with other LSI controllers, component count is reduced by three to five times. The advantage lies in the IC's built-in high-speed logic. Other MOS LSI controllers do not implement the high-speed logic functions; thus, additional external components must be used.

The DP8350 displays 5 × 7 dot matrix characters in a 7 × 10 field, with 24 lines of 80 characters each. Refresh frequencies of 50 Hz and 60 Hz produce 312 and 260 lines-per-frame, respectively. Horizontal scan frequency is 15.6 kHz.

An 11-line bus provides video and system outputs, including horizontal and vertical synchronization, vertical blanking, cursor enable, and character-generation control signals. It also accommodates external blinking, blanking, intensity control and underline inputs.

The DP8350 is also available in mask-programmed format to user specifications. The on-chip ROM can be factory-modified for field sizes of up to 16 × 16 dot matrix. The character-set elements can also be customized to provide from 5 to 110 characters-per-row and between 1 and 64 rows. The horizontal and vertical synchronization width, front- and back-porch widths, cursor-enable output and vertical-blanking outputs can also be programmed.

The standard and semicustom versions of the DP8350 operate from a single 5-volt power supply and draws 150 mA. The device is available in small quantities, with a suggested price of $49. National Semiconductor, 2900 Semiconductor Drive, Santa Clara, CA 95051.

service clinic

Many symptoms can be the result of blanking problems.

JACK DARR, SERVICE EDITOR

THE OLDEST TV SETS HAD BLANKING CIRcuits to keep the horizontal and vertical sync from getting into the picture. The blanking circuit feeds a voltage pulse to the picture tube to cause it to cut off. Now we use several different forms of blanking, for many things. We still have blanking problems, but now they can be more complicated. If the symptom is recognized as being a blanking problem, the diagnosis can be much faster.

The simplest blanking problem is the familiar hum-bars. With one horizontal bar visible, the cause is a 60-Hz signal; with two bars visible, the cause is a 120-Hz signal from the full-wave rectified power supplies. The problem is almost always the same: bad filter capacitors that allow excess ripple voltage on the DC supply. The voltage variation causes the B+ to fluctuate and the peaks of this blank the raster, fully or partially.

Another symptom is the horizontal bar that floats up through the picture. The bar may be dark or light. What now? Check the vertical sweep! In tube sets, and often in solid-state TV models, the vertical output stage draws a large pulse of current once each field. If this pulse is not filtered properly, it will cause ripple on the B+ line that in turn partially blanks the picture. Since the power supply ripple is 60 Hz and the vertical sweep actually 59.94 Hz, there is just a small phase difference. This is what makes the bar float up through the picture. To verify this, scope the B+ ripple at the filter output. The normal waveform is a kind of sawtooth. If you can see an extra ripple that makes the waveform "writhe" and change, this is the signal from the vertical sweep getting into things. The cure is more filtering. In some sets, the original design simply wasn't filtered enough. If so, just add more capacitance. In some sets I've added as much as 100 μF of extra capacitance before the bar went away. Figure 1 shows the odd ripple waveform.

The type of fault and the screen symptoms give us the clue to what frequency is causing it. Horizontal bars, vertical frequency. Vertical bars, horizontal frequency. The classic example of this is the "jail-bars" symptom. The screen shows 5 or 6 black vertical bars, evenly spaced. Between the bars, a normal color picture can be seen.

This is caused by a shorted diode in the horizontal blanking circuit. It feeds a clipped pulse from the flyback into the 1st video amplifier stage. A normal pulse has a tall thin spike (the blanking pulse) and a "baseline" (the horizontal part of the waveform, or scan time). The waveform is shown in Fig. 2. Note that there are 5 or 6 cycles of ringing on this waveform. The ringing is normal. In normal operation, the diode is biased so that the ringing is clipped. If the diode shorts, the whole thing goes sailing on through and the ringing on the baseline blanks the raster. You can confirm this with the scope on the output of the diode.

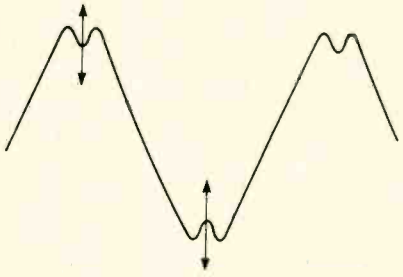


FIG. 1

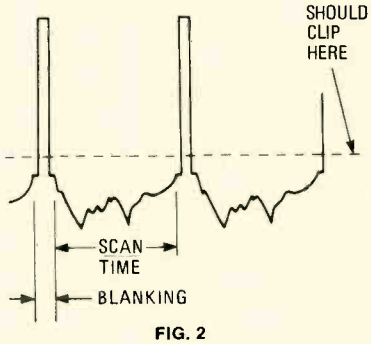


FIG. 2

Other odd blanking problems can be found in the horizontal blanking circuits. For one, if the raster seems to be 1-2 inches narrow on the left, turn the set to a dead channel and see if you can get a full raster. If you do, this can be a horizontal blanking problem. Feed in a color-bar signal and see how many bars are visible. If this is a color TV, and the raster starts with the red bar (3d from left) it is a blanking problem. It may or may not be in the horizontal blanking circuit itself. Scope the output of the horizontal blanking circuit and see if the blanking pulse is of the correct width; something like 15-18 microseconds duration. If so, the blanking circuit is OK. Something is feeding a horizontal pulse into the video circuit that is much wider than it ought to be. Look for this pulse at points where it could be coupled into the video circuit from leakage, stray capacitance, coupling between leads, etc.

A similar case can be found where normal colors appear on only one half of the screen, and a B/W picture on the rest. Something is blanking out the color signal. The scope should show you this pulse and you can trace it back to find where it gets in. This symptom can be due to a bad bypass capacitor. Scope the top end of each bypass capacitor in the color circuits. If you see any *signal*, this capacitor is not doing its job. (If the capacitor checks "good", try changing the *ground-point!* I've seen this one happen.)

The reverse!

Up to now, we've been saying "blanking" in the sense that part of the picture/raster has been blacked out. As usual, we have the reverse symptom. This symptom showed up in one Sears chassis. The raster was very light; on the left ¼ of the screen, there was very weak video, looking as if the picture tube was almost dead. The rest of the screen was completely whited out. This was obviously some kind of horizontal symptom. (Things to make a note of: In modern sets with flyback-derived low voltage power supplies, "ripple" will be at the *horizontal* frequency!) Checking the schematic showed two DC voltage sources from the flyback into the video IF-preamp IC. The scope showed these supply lines to be clean. However, we found that the video output stage was fed from a +166-volt DC source also from the flyback. Replacing the 2.2 μF filter capacitor on this cleared up the problem. Here, we had a typical blanking problem but the polarity of the symptom was reversed so that the screen was being over-driven and simply wiping out the video signal.

Finally, don't be surprised at any symptom. We ran across a TS-938 Quasar; the picture looked like something out of a horror movie! Raster was small and there was a black "blob" coming down from the top. Here again, the cause was a filter capacitor. Not an open one this time; the 500 μF electrolytic under the power supply chassis had broken loose

continued on page 84

SERVICE CLINIC
continued from page 83

from its ground connection.

Needless to say, this doesn't cover all of the possibilities. The general term "blanking problem" can be of many types. However, if you look closely at the screen and see that the main problem is blanking or brightening of a part of the raster, start looking for stray pulses floating around where they shouldn't be. The scope is an essential weapon in this. Use it intelligently and your troubles will be much smaller! **R-E**

service questions

BRIGHTNESS SOLUTION

Donald F. Morin, general manager, Spaceport TV, Cocoa Beach, FL, has another idea about the Sony *model KV-1910* raster problem described in the January 1979 issue.

He writes: "Your response was close but not the cure! Tell 'D.L.' that if he changes capacitor C707 (4.7 μF on the CRT's PC board) this will cure the screen brightness problem. If C707 is open, flyback pulses go through the +199-volt line to the CRT cathodes."

That sounds very much like Mr. Batis' solution, except that Mr. Morin pinpoints the exact part. Many thanks, everyone, for letting us in on the data. I've already filed it, and everybody else should, too. It's always good to get genuine field feedback.

BAD FOCUS RECTIFIER

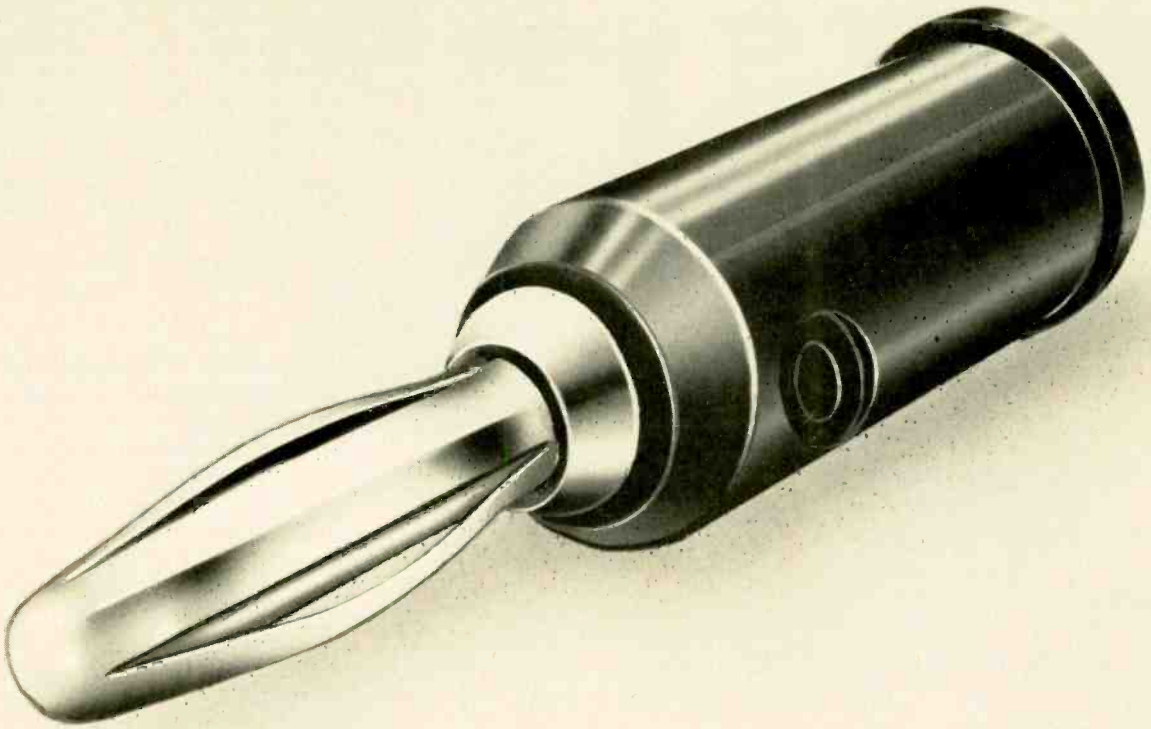
I have an unknown Japanese TV color set that has a bad focus rectifier tube. This is a real oddball part, and I can't find a substitute anywhere. Can I use a solid-state focus rectifier for it?—J.M., Baldwin, NY.

Yes, you can! The solid-state focus rectifiers can be used instead of any of the focus rectifier tubes. The only problem you may have is in mounting. Try putting the solid-state unit on a couple of terminal strips, wherever there's room for it. Just watch out for possible arcing to the cage; if there's enough clearance, this should do the trick.

HIGH VOLTAGE BOOST

Here's an odd one. This Motorola model TS-594 has too much high voltage and boost! It has good sound and a fair picture (although it could focus better). The high voltage reads 23 kV (it should be 17.5 kV) and the boost reads 560 volts. (it should be +470 volts). The 6JN6 voltages all look OK and there's plenty of grid

continued on page 86



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SERVICE QUESTIONS

continued from page 84

drive. How can I get the high voltage and boost down to the right level?—R. S., Johnson City, TN.

Some time ago a reader in New Mexico and I worked on a similar problem in an RCA set. Like the Motorola you describe, all the voltages were OK. Finally, he *reduced* the screen grid voltage on the horizontal-output tube. This worked! You could try bringing this voltage down until you start to lose width. I think you'll find that the 6JN6 cathode current will come down with it. This is kind of a "quick-and-dirty" fix but it seems to work.

GROUND SPRING ARCING

In this RCA model CTC-43, the ground spring arcs continuously to the aquadag coating of the picture tube. I ran into this problem before but I forget what I did to fix it!—L.H., Bergenfield, NJ.

I do. You've got a very poor contact between the ground spring and the dag coating of the tube. Just get a small bottle of graphite coating from your local radio-tv supply house. Paint the whole length of the spring with the coating and move it back and forth to make sure you cover it well. This should do it.

RECHECKS HELP

I just want you to know I checked the things you suggested in the GE C-2 chassis with a horizontal-sync problem. I was about ready to give up, then I checked the 39K resistor R251 in the plate circuit of the horizontal AFC tube. I was sure I'd checked it before. But it was open! A new resistor fixed it.—R.R., Pottstown, PA.

Moral: Never be afraid to go back and recheck. Especially if your memory isn't any better than mine!

VCR "FLAG-WAVING"

We've received a couple of letters on the subject of "flag-waving" in TV receivers used with VCR's or VTR's. This old term means there's an instability of horizontal sync that causes the vertical lines near the top of the picture to jitter and bend sideways. I must admit I don't know very much about VCR's, but fortunately some readers do!

Maurice R. Brice of San Mateo, CA, found that it helps to change the value of the grid-to-ground capacitor in the horizontal AFC stage. This is a "cut and try" process, but it can be done with a capacitor substitute box or by trying various capacitor values. He also sent along a note from an RCA manual that states: "Instability in TV sets with an unstable picture from VTR/VCR may be due to long time-constant in the horizontal AFC of the set." This, of course, depends on the capacitor and resistor values in this circuit. A bit of experimenting may help if you run into this problem. **R-E**

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stereo products

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DIRECT-DRIVE TURNTABLE, *model 1750DD,* is a quartz-controlled, two-speed direct-drive turntable that provides resonance-free performance. A pickup arm is not included but the unit is compatible with many arms. Other turntable features include PLL circuitry, electronic speed and pitch controls, digital speed display, aluminum platter and hinged dust cover. Suggested retail price: $179.95.—**ADC Professional Products Group,** BSR (USA) Ltd., Route 303, Blauvelt, NY 10913.

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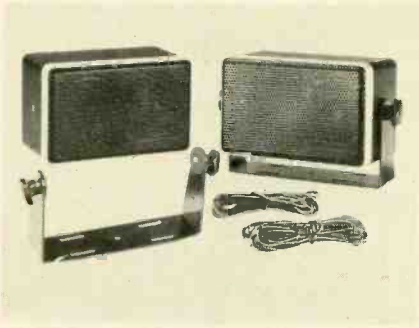
MINIATURE STEREO SPEAKERS, *Mini-Mesa 15* and *Mini-Mesa 50.* The *Mini-Mesa 15* speakers (shown) are designed for both mobile and base installation and measure 3⅜ W × 6 H × 3 inches D. The system provides a frequency response of 60 Hz–20 kHz ±6 dB, with a peak power rating of 30 watts-per-channel, 15 watts RMS. Speakers come packaged two per kit with brackets, cable and instructions. The *Mini-Mesa 50* three-way speakers feature a 5-inch-diameter foam woofer with ferrite magnet; a 1.25-inch aluminum bobbin voice coil; a 25-mm by 12-mm horn-type tweeter; and a 3-inch midrange driver. The system has a power rating of 50 watts RMS per channel with 80 watts peak, and a frequency response of 50 Hz–20 kHz. The speakers measure 6 W × 9½ H × 4¾ inches D, weigh 6 lb., and have a walnut vinyl veneer and black grille cloth.



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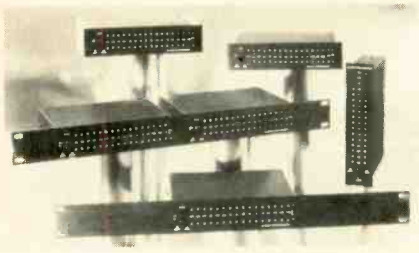
Also available are the *Mini-Mesa 30* two-way stereo system and the *Mini-Mesa Bass Booster,* a 5¼-inch-round bass extender designed for automotive installation. Suggested retail prices: the *Mini-Mesa 15* system, $129.95 per pair; the *Mini-Mesa 50* speakers, $150 each; *Mini-Mesa Bass Booster,* $49.95 per pair; *Mini-Mesa 30* speakers, $238 per pair.—**Mesa Electronics Sales Ltd.,** 2940 Malmo Drive, Arlington Heights, IL 60005.

PEAK-RESPONDING LED DISPLAY, *model 510,* is a combined peak-power indicator and line-level monitor that provides 16 red LED's-per-chan-

nel covering a −39 dB to +6 dB range with an amber LED at "0 dB" indication. Used in the power mode, the *model 510* helps prevent clipping; rear-panel switches are used to set the 0-dB reference level to 25, 50 or 100 watts and to match



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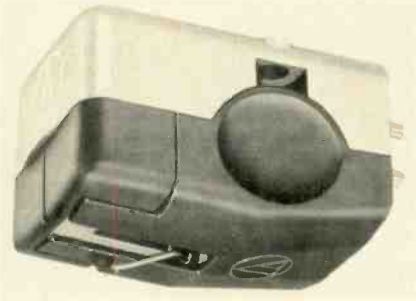
4-, 8- or 16-ohm impedances. The unit includes a calibration feature for channel balance. Also available is the *model 510B* with green LED's indicating the range from −39 dB to −1 dB, and amber LED for "0 dB" and red LED's for the range from +1 dB to +6 dB. Four interchangeable front panels allow horizontal or vertical use and permit two displays to be rack-mounted. The unit measures 7½ × 1¾ × 5½ inches. Suggested retail prices: the *model 510*, $139.95; *model 510B*, $149.95; vertical panel, $6.95; oak end panels, $7.95 per pair; rack-mount panels, $11.95 and $13.95; and mounting clips, $3.95 per pair.—**Audio Technology,** 1169 Tower Rd., Schaumburg, IL 60195.

MOVING-MAGNET PHONO CARTRIDGE, *model TK3E,* has a tubular cantilever and a 0.3 × 0.7-mil elliptical nude-mounted diamond stylus. The cartridge also accepts many optional stylus assemblies—carbon fiber, beryllium, titanium and boron cantilevers—with conical, elliptical or Shi-



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bata styluses. Suggested retail price, $55.—**Signet,** Div. A-T U.S., Inc., 33 Shiawassee Ave., Fairlawn, OH 44313.

DC POWER AMPLIFIERS, *models KA-907, KA-801, KA-701,* provide fast risetimes and slew rates. The specifications for the three DC integrated amplifiers are as follows: The *model KA-907* delivers 150 watts-per-channel into 8 ohms

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minimum RMS, 20 Hz–20 kHz, −0.01% THD; risetime, 0.8 μs and slew rate, ±230V per μs. The *model KA-801* (shown) has a power output of 100 watts-per-channel minimum RMS into 8 ohms, 20 Hz–20 kHz, −0.15% THD; risetime, 0.8 μs and slew rate, ±150V per μs. The *model KA-701* delivers 80 watts-per-channel minimum RMS into 8 ohms, 20 Hz–20 kHz, −0.02% THD; risetime, 0.9 μs and slew rate, ±120V per μs. Suggested retail prices: the *KA-907,* $1000; the *KA-801,* $600; the *KA-701,* $499.—**Kenwood Electronics, Inc.,** 1315 E. Watsoncenter Rd., Carson, CA 90745.

AM/FM STEREO TUNER, *model TU-919,* incorporates a quartz-crystal reference oscillator to lock in stations, a dual-bandwidth IF section for both FM and AM and features 4-digit frequency readout along with center-channel tuning and VU meters. Front-panel controls include POWER on-off switch, AM/FM bandwidth selection switches, muting switch, filter switch, selector switch and output level control. Specifications include: IHF sensitivity, 8.7 dBf (1.5 μV); 50-dB quieting at 12.5 dBf; distortion, 0.03%, mono, 0.05%, stereo; signal-to-noise ratio, 86 dB; and capture ratio, 0.8 dB. The *model TU-919* is housed in a matte black

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cabinet with detachable rack-mounting handles. Suggested retail price: $585.—**Sansui Electronics Corp.,** 1250 Valley Brook Ave., Lyndhurst, NJ 07071. **R-E**

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new products

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NUT DRIVER KIT, *No. K7,* contains 7 hollow-shaft hex-nut drivers in the following sizes: 3/16-, 1/4-, 5/16-, 11/32-, 3/8-, 7/16- and 1/2-inch. Hollow shafts accommodate any size stud; and both sockets

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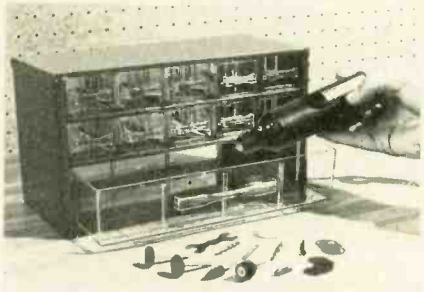
and shafts are made of top-grade steel with nickel-chrome exterior surfaces and color-coded (for hex-drive size) handles. Packaged in attractive stand-up hang-up box, kit *No. K7* is available from distributors. **Vaco Products Co.,** 1510 Skokie Blvd., Northbrook, IL 60062.

11-DRAWER WORKSHOP ORGANIZER, *model 2712,* is an easy-to-store cabinet available "free" with the purchase of the *Moto-Tool* kit; tool and accessories come packaged inside the attractive, blue steel cabinet. The workshop organizer mea-



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sures 12 L × 6⅝ H × 5⅝-inches D, and is ideal for holding small components for hobby or craft projects. Clear plastic drawers provide easy visibility. Both the *Moto-Tool* kit and organizer are available for $52.95.—**Dremel,** Division of Emerson Electric Co., 4915 21st St., Racine, WI 53406.

AUTORANGING CAPACITANCE METER, *model CM-500,* measures capacitance in 9 ranges, from 1 pF to 200,000 μF, with a basic accuracy of 0.1% ±1 LSD. The display uses four ½-inch-high LED's; a 26-pin connector allows a digital BCD

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output to be interfaced with microprocessor, recorder, printer, etc. The optional *model CLC-502* Capacitance Limits Comparator provides a GO/NO GO output. Power is supplied by five D batteries; an optional AC adapter is also available. The *model CM-500* measures 7.4 × 4.33 × 2.36 inches and comes housed in a sturdy polystyrene case with a handle that doubles as a tilt stand; batteries, clip, leads and operator's manual are included. Suggested retail price: $299.—**IET Labs,** Inc., 761 Old Country Rd., Westbury, NY 11590.

8-TRANSISTOR AM RADIO KIT, *model 536,* contains a separate oscillator circuit, complete breadboarding materials, and PC assembly. The kit comes with all necessary components and

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instruction manual. Instruction section of manual covers AM radio theory. Kit sells for $16.45.—**Graymark International, Inc.,** 1751 McGaw, Irvine, CA 92714.

AUTOMATIC PHONE DIALER, *Dial-a-Tron,* can be coupled with telephone receiver acoustically or by direct hookup. When hooked up to phone, the built-in speaker allows incoming conversations to be heard; the unit is compatible with *Rotary* or *TouchTone* systems. The dialer stores up to 32 ten-digit telephone numbers in memory; features a CANCEL pushbutton to disconnect outgoing calls plus automatic shut-off capability. The *Dial-a-Tron* measures 7¼ by 6½ inches, and has

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a suggested retail price of $150.—**Leisurecraft Products, Ltd.,** 28 S. Terminal Dr., Plainview, NY 11803.

CAR RADAR DETECTOR, *The Superfox,* is a superheterodyne remote system with adjustable sensitivity control. The unit has extreme sensitivity for receiving radar signals—even over hills and around curves. A built-in microwave lens helps

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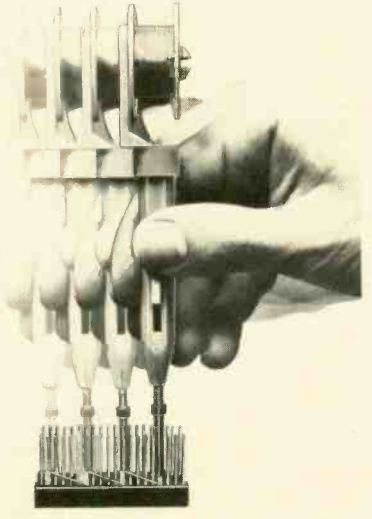
improve antenna gain. *The Superfox* has the ability to detect all band radar frequencies and to block out false signals. The main chassis can mount behind the car's grille and the control box mounts under the dash. Price is $299.95.—**Comradar Corp.,** 4518 Taylorsville Rd., Dayton, OH 45424.

WIRE WRAP TOOL, *Model JW-1,* is designed to make wire-wrapped connections without having to strip wire insulation. Can wrap on .025 inch square posts and carries a 50 ft. spool of 30 AWG wire which is available in 4 colors. Wraps continuously through any number of pins and includes a



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built-in wire cutter. Price is $14.95, refill spools $2.98.—**O.K. Machine and Tool Corp.,** 3455 Conner St., Bronx, NY 10475. **R-E**

TRS-80 BREADBOARD

continued from page 54

To test the decoder section of the breadboard, you will need a NOR gate integrated circuit, such as the SN7402, and a solderless breadboard that can be used to help you set up a test circuit. Wire the circuit that is shown in Fig. 15. The $\overline{IN}$ and $\overline{OUT}$ signals are provided at SO2, while the $\overline{6}$ and $\overline{7}$ signals may be found at the ADDRESS socket SO5. Once the switches have been set to the positions noted previously (all zeros, mode D), run the following program.:

```
10 A=INP(7): GOTO 10
```

You should observe pulse activity at point A, but not at either B or C. Change the program, so that input port 6 is accessed:

```
10 A=INP(6): GOTO 10
```

You should observe activity at point B. To test the output control, use the following program.:

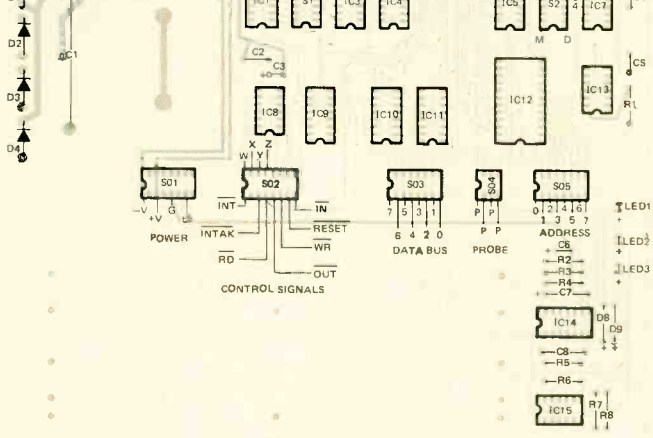


FIG. 14—HOW COMPONENTS ARE PLACED on the PC board. Several of the IC sockets are used for connections to point-to-point jumpers.

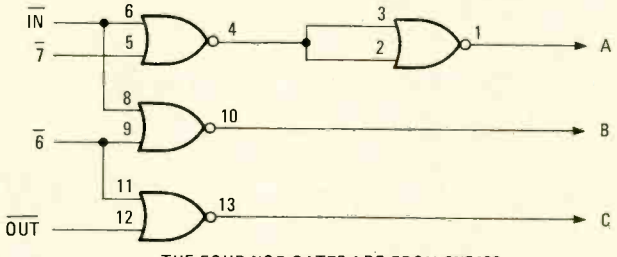


FIG. 15—SCHEMATIC DIAGRAM of the NOR gate circuit used for testing the breadboard.

```
10 OUT 6,0: GOTO 10
```

When this program is run, you should observe activity at point C. You may wish to try other addresses, and also the PEEK and POKE commands, so that the HI address decoders are accessed. If you use the address decoders for memory addresses, remember to use the formula:

```
Address = −1*(Desired Address −32,767)
```

when the address that you wish to access is above 32,767. This has no effect upon the interface. It simply causes the *TRS-80* to generate the proper 16-bit address. Thus, to access a location, or a memory-mapped I/O device, with an address of 36871, the following short program could be used:

```
10 POKE −1*(36871-32767),0
20 A = PEEK (−1*(36871-32767)
30 PRINT A: GOTO 10
```

If you wish to observe this program in operation, you would have to replace the $\overline{IN}$ signal with $\overline{RD}$, and the $\overline{OUT}$ signal with $\overline{WR}$, as previously shown in Fig. 15. You would also have to switch to the memory address mode, M, and then set the address bits so that they corresponded to the binary equivalent of 36,871; that is 10010000 00000111. If you run the program shown above, you would be able to monitor pulse activity at point A as shown in Fig. 15. Point A would correspond to the pulse generated by a read operation at location 36,871, corresponding to the PEEK operation. No pulse activity would be observed at points B or C, since there is no address 36,870 being used in the program. Again, we see no advantage in using memory-mapped I/O, but we have presented this example so that you can check out the HI address decoding section of the interface breadboard. If you perform these tests, remember to place the mode switch in position, D when you have completed the test.

You are now ready to test the data bus buffers. Add bus buffers IC10 and IC11.

The *TRS-80* should run properly with these IC's in place, and with the power applied to the breadboard. If it does not, remove the IC's and check their orientation. If this still doesn't cure the problem, you may wish to breadboard a test circuit for the 8216's. You want to be sure that the EN input to both IC's, pin 15, is in the logic zero state for normal operation. If this condition is not found, check back through the two SN74LS20 NAND gates.

Once the *TRS-80* is operational, as it probably will be in almost all cases, you will need to construct an input port, and an output port to thoroughly test the data bus connections. Refer to Figs. 4 and 5 for the details of each port. You may use the test circuit in Fig. 15 to generate the device select pulses required to control each port. If you have performed the memory address tests, be sure to rewire the test circuit so that the $\overline{\text{IN}}$ and $\overline{\text{OUT}}$ signals are used, as shown in Fig. 15. Output A from the test circuit may be used as the $\overline{\text{DEVICE SELECT}}$ pulse for the input port IC's (DM8095's or SN74365's), while output C may be used to control the output port (SN74LS373). The lamp monitors may be LED's, and the logic switches may be simply jumper wires that are easily switched between connections with +5 volts (logic one), and ground (logic zero). Once this has been wired, make a connection between the SN7402's A output, and one of the INP REQ pins at S02.

Enter and run the following program, with power applied to the breadboard:

```
10 FOR A=0 TO 255
20 OUT 6,A
30 NEXT A
40 GOTO 10
```

This program will generate an incrementing count at the output port, and you should be able to observe an eight-bit binary count on the LED's that are connected to the SN74LS373. If this counting action is not observable, check output C on the SN7402, to be sure that the output port is being activated by the computer. You should also be sure that the SN74LS373 is operating properly, and that all of the connections have been properly made. When wiring an interface of this type, it is often easy to "twist" a data bus wire, so that data bit D4 appears where bit D5 should, and vice versa. Recheck your bus wiring. If a bit is not observed to be counting (constantly on, or constantly off), switch the 8216's. If the "bad bit" moves, you probably need to replace the 8216 bus buffer. Don't forget that if you can't observe any action on the LED's, the logic probe can be used.

Once the output port has been tested, enter and run the following program:

```
10 A=INP(7)
20 PRINT A
30 OUT 6,A
40 GOTO 10
```

This program transfers information from the logic switches to the *TRS-80*. The *TRS-80* prints the decimal value on the screen, and it then outputs the information to the output port. When the program is running, you should be able to change the logic switch or jumper settings and then observe the effect upon the displayed value, and the value printed on the *TRS-80*'s screen.

Before you dismantle the two ports that you have constructed, you may wish to try and use them in other ways. Space has been left on the PC board so that a solderless breadboard may be added to make your experimenting easy. We think that you will find the breadboard to be a valuable tool, since all of the generally used *TRS-80* I/O control signals have been provided for you, along with a suitable decoding scheme, and an on-board logic probe. If you are interested in some of the things that can be done with the breadboard, we suggest that you obtain a copy of the *TRS-80 Interfacing* book mentioned previously. It contains 18 experiments that you can do on the interface breadboard, including experiments on decoders, I/O ports, flags and A/D and D/A converters. But for now, let's look at two experiments you can do. Next month we'll develop the software for controlling a traffic light and then see how to use the TRS-80 to develop analog control voltages. **R-E**

PERSYN ACCESSORIES

continued from page 50

the OR gate can be made to provide a complex serial-output pulse train.

The OR gate outputs are buffered and inverted in the inverters IC1-d, -e and -f and coupled to the output jacks through isolation diodes. Resistors R4, R8 and R10 provide a ground reference for the isolation diodes. When connected in the PerSyn system, the isolating diodes prevent manual trigger pulses from the strike surface boxes from interacting with the sequencer.

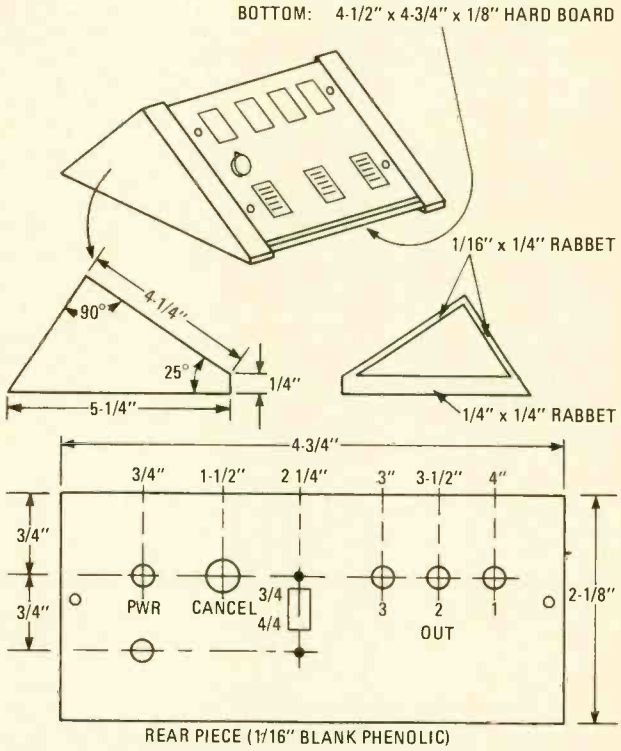
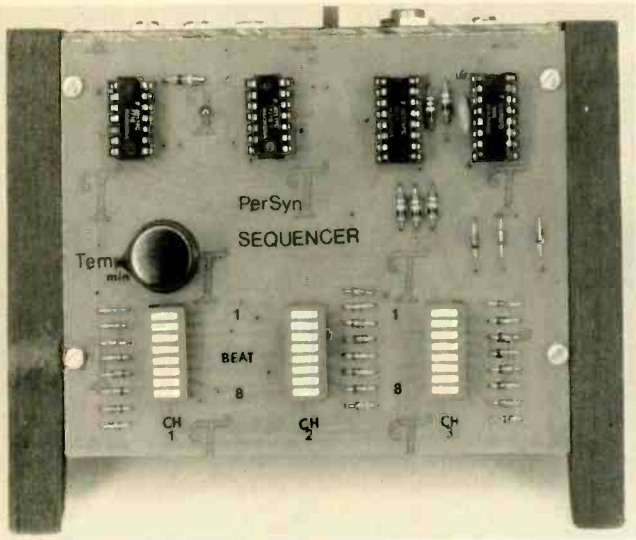


FIG. 9—CONSTRUCTION of the Sequencer enclosure. The side pieces are made of three-quarter inch stock.

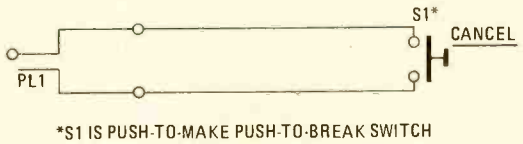
If CANCEL jack J6 is shorted through a switch, IC2 is reset. When the short is removed, operation will resume with the first output (pin 2). Light emitting diode LED1 is energized when the first output goes high, indicating the start of the pattern.

Power (+9 volts) is provided through the "tip" (+9) or POWER jacks J4 or J5. Ground reference is obtained through either of the "rings" of output jacks J1, J2 or J3. No connections are made to the "rings" of J4 or J5.

Construction: Construction of the circuit is simplified by using a PC Board, the foil pattern and components placement for which are shown in Figs. 6 and 7. All IC's are CMOS devices and, therefore, standard handling precautions should be observed. When mounting DIP switches DS1-DS3, be sure to observe the proper orientation. Also observe proper orientation for all diodes and IC's. When mounting the TEMPO control on the PC Board, use an additional mounting nut so that the bushing of R5 protrudes about 3/16 inch above the board. This will insure that the body of R5 will not touch the foil side of the board, thus preventing any possibility of accidental shorting. Install all 14 jumpers on the foil side of the PC Board as in Fig. 8. Use insulated wire. Install wiring between switch S1, J1 through J6 and the PC Board as indicated in Fig. 8. Solder the wires to the appropriate pads on the foil side of the PC Board. The unit can be housed in a "case" similar to that shown in Fig. 9. You can, of course, house the PC board in a standard case and use discrete switches in place of DS1 through DS3. In this case, wires from the switches would be connected to the appropriate PC holes for DS1 through DS3. If using a metal enclosure, be sure to isolate the body of J6 (at +9 volt potential) from the



FRONT VIEW of the Sequencer. The three DIP switches across the bottom feed the OR gates and determine the beat.



*S1 IS PUSH-TO-MAKE PUSH-TO-BREAK SWITCH

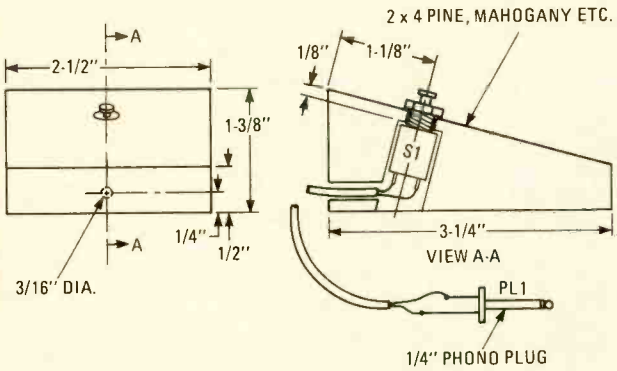


FIG. 10—CONSTRUCTION and wiring of the footswitch.

bodies of J1 through J5 (at ground potential).

Use: Connect either POWER jack to the TAP jack on PerSyn (or to a POWER jack of an accessory being used). Connect the OUTPUT jacks to the TRIG jacks of the devices to be triggered. A standard ON/OFF footswitch should be used to control the operation of the Sequencer. If not available, one can be made from a small piece of wood as shown in Fig. 10. Insert the footswitch plug into J6 and place TEMPO control R5 to midposition. If the CANCEL switch in the footswitch is closed LED1 will blink. If not, depress the CANCEL switch to start the Sequencer. Once PATTERN switches DS1 through DS3 are appropriately programmed, adjust TEMPO as desired.

Programming: The counting structure for a basic 4/4 bar of music is "ONE-and-TWO-and-THREE-and-FOUR-and". The eight switches on DS1, 2 or 3 correspond to this counting with the top switch corresponding to "ONE" and so on (switch 7 corresponds to "FOUR"). In 3/4 time, the counting sequence is "ONE-and-TWO-and-THREE-and". Therefore, with S1 set for 3/4 operation, switches 7 and 8 are not used.

Many complex rhythm and special effects patterns can be generated with the sequencer. Four basic programming examples are listed in Table 1 on page 50 to acquaint you with the operation of the Sequencer. **R-E**

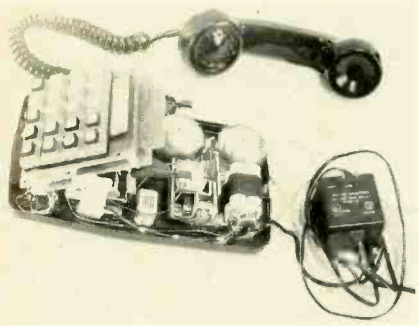
TELEPHONE DIALERS

continued from page 46

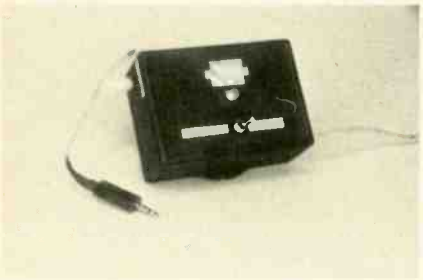
ular phone dial! In the TEL position, your phone dial is enabled, but the *Otron* dialer capability is disabled.

Which is the best unit?

This "loaded" question has no real answer, since needs vary. The *Rapidial II*



INSIDE VIEW of the Superphone 7710. The buzzer is used as an alarm signal. Rechargeable batteries retain memory if the power fails.



DIALER INTERFACE from Blechman Enterprises. It contains a relay, LED, switch and battery.

is the lowest-priced assembled unit and probably offers the most telephone-associated versatility in the smallest package. The Heath unit is simple to assemble and use, at the same price. Next up are the *Busy-Buster* and Radio Shack units in the price scale, but with totally different capabilities. If you have need for a fast, multi-purpose dialer, the *Rapidial* used on DTMF tone-dialing is outstanding.

Then come the special features, like calculator, calendar and alarm functions—but are they worth twice the price of the Radio Shack with its clock and timer? As executive gift items, the *Superphone* or *Freedom Dialer* are hard to beat, since they include the telephone and almost everything but the kitchen sink. As for me, I want them all! **R-E**

AUDIO AMPLIFIER

continued from page 57

have the ability to make double-sided printed circuit boards, you can use the foil pattern shown in Figs. 3 and 4 which I've used to build over twenty of these amplifiers. The component placement diagram is shown in Fig. 5.

The thermistor is a 30-ohm cold, negative temperature coefficient type (the higher the coefficient the better, but the 30 ohms should be referred to room temperature).

Mount the thermal-feedback diodes (D1–D4) and the output transistors on heat sinks. Do *not* heat-sink the 2N5191 and 2N4919. They must be held at the ambient temperature sensed by the 30-ohm thermistors. Preferably, separate heat sinks, such as those suggested in the parts list, should be used for each half of the amplifier. Either the 2N3055 or its plastic equivalent, the MJE3055, can be used in the output stages. Be sure to use mica insulating washers in the mounting process. The thermal sensing diodes (D1–D4) should be mounted so as to thermally couple tightly to sense the temperature of the output devices.

Checkout and adjustment

Before operating the amplifier, disconnect any loads (speakers) and connect a DC voltmeter across the output terminals. Apply power, allow one or two minutes for capacitors to charge fully, then adjust the DC BALANCE potentiometer for zero volts across the output terminals. If you cannot achieve this, and a gross unbalance exists (more than 1 volt), perform the following checks.

With your DC meter, check each amplifier output terminal's voltage *with respect to ground*. It should be very nearly half the power supply voltage. If one half of the amplifier does not pass this test, check wiring and components in that half.

Now connect a 16-ohm dummy load and an audio input signal. Verify, using an AC voltmeter, that the signal across the load is about ten times the input RMS signal, and that, using a DC meter, no DC component in excess of 1.8 volts exists across the load for a 10-volt RMS output (about 1-volt RMS input).

Now connect a loudspeaker load, fused with a 1-amp fast-blow temporary fuse connected in series with the speaker. Feed a signal from your preamp into the power amplifier and listen to the sound for an hour or so. If it is pleasant, and the amplifier doesn't overheat, remove the temporary fuse in series with the speaker. This will improve damping. You may reduce the fuse to 2 amps fast-blow, if driving a bookshelf-speaker.

Parallel a suitable resistor (try values around 200K) across R1 until the audio amplifier output amplitude at L1 matches that at L2. This maximizes the output power before clipping occurs. **R-E**

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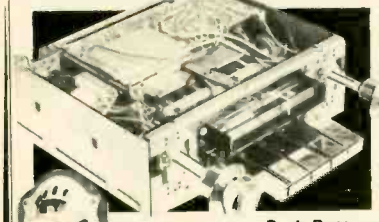

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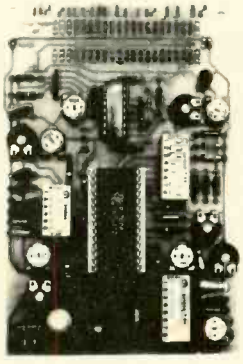

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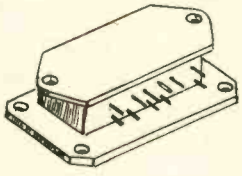

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From T.I.: **TL490 BAR/DOT DRIVER IC.** Drives 10 LED's with adjustable analog steps. Units are cascadable up to 10 (100 steps). Drives LED's directly. Great for **voltage, current,** or **audio displays.** Similar in features to LM3914 with specs and circuit notes.

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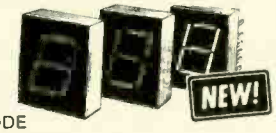
XAN SUPER DIGITS

.6" JUMBO LED
7 SEGMENT
RED

99¢



6640 COMMON ANODE
6920 COMMON CATHODE

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

NEW ITEMS

LM3046	(CA3046) Transistor Array	.75
LM3909	Led Flasher	.50
CA3086	RCA Transistor Array	.80
MC1438R	Power Op Amp/Driver	.50
1N4148	Prime, Full Lead	100/2.50
LM3302	Quad Comparator	.89
2SC1849	High Freq NPN TO-92	6/1.00

POTENTIOMETER ASSORTMENT

A mix of new, panel mount 3/8" bushing pots in various values. Some dual, some with switches.

10/**2.00**

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**

SLIDE SWITCH ASSORTMENT

An outstanding bargain. Includes miniature and standard sizes and multiposition units. All new first quality, name brand switches. Try one pack and you'll reorder more: *SPECIAL — 12 for $1.20* (Assortment)

9500@75V Computer Grade — Filter Cap 2"x5½" — **2.95**

ZENER GRAB BAG

A very nice assortment of ¼, ½ & 1W zeners. Voltage ranges are from **2.7** to **30 VDC.** Most have house # but we provide a cross over list to standard numbers. A great buy for any shop. **12 different types.**

.50 ea.

MC1469R POSITIVE VOLTAGE REGULATOR

½ AMP. COMPLETE SPECS AND APPLICATIONS SHOW HOW TO BUILD FIXED OR VARIABLE POWER SUPPLIES FROM 3 TO 30VDC. DRIVE EXTERNAL SERIES PASS FOR CURRENT TO 20 AMPS!

1.25 EA.
10/10.00
HOUSE #

QUAD MATCHED DIODES

4 1N914 type diodes that have been closely matched for use in bridge and balanced modulator circuits.

50¢ ONE SET (4)

PARTS

301 OP AMP 8 LEAD CAN	3/1.00
723 VOLT REG. 10 LEAD CAN	.50
*13741 FET INPUT 741 MINI DIP	3/1.10
30,000 @ 15V COMPUTER GRADE	2.10
2N4400 NPN GEN. PURPOSE	8/1.00
2N4402 PNP COMPLIMENT	8/1.00
2N6028 P.U.T. W/SPECS	.50
LM380 2W AUDIO IC W/SPECS	1.09
LM377 DUAL LM380 W/SPECS	2.50
*7815 VOLT REG. 1A 15V	.69
*725 LOW NOISE OP AMP	.99
IL-1 OPTO ISOLATOR MINI DIP	.60
*MEM 631 DUAL GATE MOSFET DIODE PROTECTED. SIMILAR TO 40673	.50
MV1624 VARICAP DIODE 10 PFD	.49
1N4003 1A 200V DIODE	15/1.00
TIP30 TAB PNP POWER	3/1.00
*MC1351P FM IF. DISC IC	.50

*INDICATES ITEM IS "HOUSE NUMBERED"

LED'S

JUMBO GREEN	4/.89
JUMBO RED	5/.89
MEDIUM RED (⅛")	.15
MEDIUM GRN OR YELLOW	.16

7 WATT AUDIO AMP KIT

SMALL, SINGLE HYBRID IC AND COMPONENTS FIT ON A 2" x 3" PC BOARD (INCLUDED). RUNS ON 12 VDC. GREAT FOR ANY PROJECT THAT NEEDS AN INEXPENSIVE AMP. LESS THAN 3% THD @ 5 WATTS. COMPATIBLE WITH SE-01 SOUND KIT.

$5.95

6 DIGIT AUTO/VAN CLOCK

- LARGE ½" CHARACTERS (LED)
- QUARTZ XTAL TIMEBASE
- ALARM & SNOOZE OPTIONS
- NOISE FILTERING
- EASY TO ASSEMBLE
- 4¾" x 3" x 1½"
- DRILLED & PLATED PC BOARDS

NEW!

COMPLETE KIT 12 VDC **$16.95**

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

POLICIES

- ★ NO C.O.D.'s
- ★ SEND CHECK M.O. OR CHARGE CARD NO.
- ★ PHONE ORDERS ACCEPTED ON VISA AND MASTERCHARGE ONLY (214) 278-3553 9:00 AM - 6:00 PM CST
- ★ ORDERS OVER 1 LB. SHIPPED VIA UPS
- ★ ADD 5% FOR SHIPPING
- ★ TX. RES. ADD 5% STATE SALES TAX
- ★ FOREIGN ORDERS ADD 10% (EXCEPT CANADA) (20% AIRMAIL) U.S. FUNDS ONLY
- ★ SORRY WE CANNOT SHIP INSURED TO MEXICO

PRICES SUBJECT TO CHANGE WITHOUT NOTICE

100 W 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: IV max.
- Power supply: ±40V @ 5 amp

TA-1000 KIT $51.95
Power transformer $15.00 each

SANWA

COMPACT — LIGHTWEIGHT — ULTRA SLIM
BATTERY CHECKER — LED TESTER
T-55D (w/o temp probe) **$44.50**
T-55THD (temp probe) **$66.50**

SPECIFICATIONS
Ranges
DC Voltage: 150mV, 500mV, 1.5V, 6V, 15V, 50V, 250V, 1kV (All 20k Ω /V)
25kV *Using HV probe)
DC Current: 50μA, 2.5mA, 25mA, 250mA (500mV drop)
AC Voltage: 15V, 500V, (9k Ω /V)
AC Current: 6mA, 6A (2V and 55mV drop)
Resistance: 10kΩ 100kΩ 1MΩ 5MΩ (max. calbtn) 100Ω 1kΩ 10kΩ 50kΩ (mid scale) 10kΩ 100kΩ
Load Current: 30mA 3mA 300mA
Load Voltage: 3V 3V 3V
Decibels: −10 to+55dB
Batt Check: 0.9 to 1.5V (10Ω load)
LED Check: (Available)
Temperature: −50° to +100°C and 0° to +200°C
Probe not supplied with T-55D)
Accuracy
DC Voltage: ±2.5% f.s.d.
DC Current: ±2.5% f.s.d.
Batt Check: ±2.5% f.s.d.
AC Voltage/Power on 1.5V range: ±5% f.s.d.
AC Voltage/Power above 15V range: ±3.5% f.s.d.
AC Current: ±5% f.s.d.
Resistance/Temperature: ±3% of arc

Dimensions: 146 x 97 x 28mm thick
Weight: 240g
Instrument supplied with Batteries 1.5V (UM-3 or R6)x2
Fuse & Spare: 500mA 250V
Temperature Probe: (T-55THD only)

NEW MARK III LED VU

9 Steps 4 Colors

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 condensor 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 ~ +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 8Ω. 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 Suply 6 18V DC
ONLY $6.00 EACH

PROFESSIONAL PANEL METERS

Type MU-52E

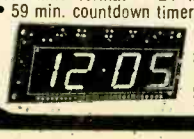
A. 0-50UA	**8.50 ea.**
B. 0-30VDC	**8.50 ea.**
C. 0-50VDC	**8.50 ea.**
D. 0-3ADC	**9.00 ea.**
E. 0-100VDC	**9.00 ea.**

All meters white face with black scales. Plastic cover.

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
$1.50 EACH

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 lineally illuminated according to the control voltage input terminal 21. Operating voltage is 9 12V D.C. **$5.35 EACH**

PROFESSIONAL FM WIRELESS MICROPHONE

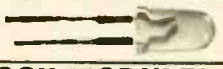
TECT model WEM-16 is a factory assembled FM wireless microphone powered by an AA size battery. Transmits in the range of 88-108MHz with 3 transistor circuits and an omni-directional electric condenser. Element built-in plastic tube type case; mike is 6¼" long. With a standard FM radio, can be heard anywhere 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 neded. Pulse rate 3Hz @ 5V 20mA.

2 for $2.20



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

500Ω SINGLE
Metal Case 3" Long
2 FOR $1.20

CONDENSER MICROPHONE

Sub-Mini Size
FET Transistor Built-in **$2.50 each**

CIRCLE 21 ON FREE INFORMATION CARD

FLUORESCENT LIGHT DRIVER 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!

With Case Only
$6.50 Per Kit

THE MOST ADVANCED TIMEPIECE OF ITS KIND IN THE WORLD!

LCD Quartz Alarm Chronograph with calendar and dual time zone!! Watch is the same as Seiko but you pay a lot more for the name!

• 24 hour alarm • Chronograph counts up to 12 hrs., 59 mins. 59.9 sec. • Precision of chrono up to 1/10 sec. indicated by 10 moving arrows!! • Lap time (with chrono running uninterrupted) • Time displays by LCD for hour, min., sec., day, date of the week and AM/PM. • Calendar gives out date-day • Dual time zone for any two cities of the world at your own choice. • With light switch to allow you to see the time in the dark!

One Year Full Warranty

Regular Price $85.50
SPECIAL $49.95

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

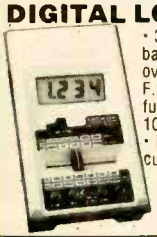
MAIN AMP (15W x 2)
Kit includes 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board. Power supply ± 16V DC (not included). Power band with (KF 1% ± 3dB). Voltage gain 33dB. 20Hz - 20KHz.

Super Buy
Only $18.50

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 ½dB 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



• 3½ 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 MV 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 30μA. Small size approximately ¾"x1¼".
Model EB2116 (Continuous)
Model EB2126 (Slow Pulse)
Model EB2136 (Fast Pulse)

ELECTRET CONDENSER MICROPHONE W TIE-CLIP

Sensitivity: 65dB ± 3dB (At 1KHz)
Impedance: 600 OHM Freq. Response: 50 15,000 Hz
Material: Aluminum
Cord: 10 ft. Length
$ 19.50 EACH

ELECTRONIC ALARM SIREN

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

AU-999 $7.50

Sub Mini Size
PANEL METER
500 UA
ONLY $1.60 ea.

TRANSFORMERS

ALL 117 VOLT INPUT

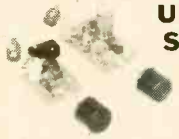
30V	4 AMP	$8.50 EA.
36V CT	3 AMP	$10.50 EA.
48V CT	3 AMP	$10.50 EA.
24V CT	3 AMP	$10.50 EA.
24V CT	0.8 AMP	$2.50 EA.
12V CT	0.5 AMP	$2.50 EA.
12V CT	120 MA	$1.80 EA.

AC POWER SUPPLY

Wall Type Transformer

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

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

$1.75 ea.

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 condensor 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

3 AA size fast charge (4 hours) NI-CD by Sanyo. All brand new and fresh 450 mah per cell. Limited supply. $5.40 PER PAK

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 3½ 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, 2 AMP 24V x 2 $8.50

0-30 Power Supply
$10.50 each

I.C. TEST CLIPS

Same as the E-Z clips With 20" Long Leads In Black and Red Colors $2.75 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

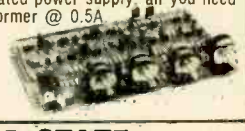
CONDENSER TYPE
Touch On Touch Off uses 7473 I.C. and 12V relay
$5.50 each

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 OHz — 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 ¾" x ¾"
Supply voltage 1.5V - 12V
Ideal for Alarm or Tone Indicator

$1.50 each

FORMULA INTERNATIONAL INC.

12/79

	SHIPPING AND HANDLING CHARGES	
	Under $50.00 purchase	Over $50.00 purchase
Inside California	10%	5%
Outside Calif. (includes Mexico & Canada)	15%	10%
Overseas	25%	20%

Minimum Order $10.00/Calif. Residents Add 6% Sales Tax
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Dial Telephone "SUPER BUY"

• Save us the labor costs of cleaning and polishing and save $$$$ on standard dial telephones. Work on any commercial system. Complete. (no parts missing) in good working order. Your choice of desk or wall models. These are take-outs from commercial service (not toys). Instructions furnished.

Wall Model (#715-WB) | Desk Model (#715-B) **$7.95** PRICE EACH

PREPAID IN U.S.A. Don't not include HAWAII, ALASKA, P.R.

DESK PHONE — ORIGINAL $27.50 — WALL PHONE

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New ITEMS . . . New BARGAINS!

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New SATELLITE TV For the home.

Supersharp Reception—Color Like Never Before

Get over 50 channels of television directly from the satellite! HBO, Showtime, the Superstations, and sports from around the world!

Works Anywhere!

Buy complete or build and save. Our book *tells everything!* Send $7.95 today or call our 24 hr. C.O.D. Hotline! **(305) 869-4283**

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P.O. Box 442, Dept. F, Altamonte Springs, FL 32701

BEARFINDER RADAR DETECTOR

29.99 AU-561

SALE Reg. ~~$39~~

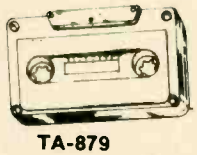
•Sensitivity Control •Lighter Plug
•Detects Stationary & Moving Radar
•For 12 Volt Systems•Easy mount/dismount.
•6 x 3 x 4½" •Shpg. Wt. 2 lbs.
(Prohibited in some States)

RECORDING TAPES 8-TRACK | CASSETTE

Reg. ~~1.19~~

TA-907

69¢ EA.



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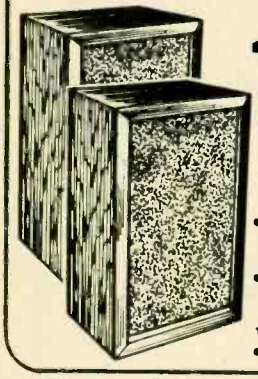

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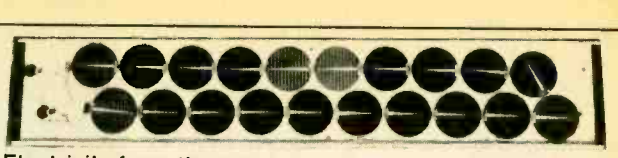

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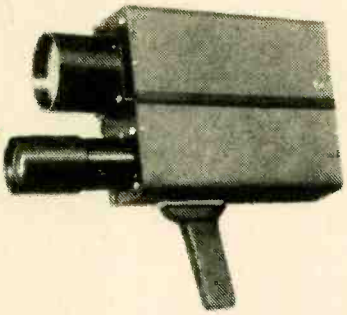

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7406	.33	7480	.45	74164	.88
7408	.27	7483	.60	74165	.85
7409	.24	7485	.75	74173	1.30
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7427	.35	74121	.35	74194	.85
7430	.17	74122	.39	74195	.68
7432	.27	74123	.42	74196	.85
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74LS42	74LS107	
74LS51	74LS241	
74LS54	74LS257	
74LS73	74LS258	
74LS75	74LS259	
74LS76	74LS285	
74LS86	74LS366	
74LS90	74LS279	
74LS92	74LS290	
74LS93	74LS293	
74LS107	74LS299	
74LS109	74LS365	
74LS112	74LS366	
74LS113	74LS367	
74LS114	74LS368	
74LS124	74LS375	
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   - ★ Double Density Drive
   - ★ One Double Density Controller w/Case & P.S.

   V-200 699.00

Add to your EXIDY, HORIZON, and other S-100 computers.

3. VISTA V-1000 FLOPPY DISK SYSTEM
   - ★ (2) Shugart 8" Floppy Disks
   - ★ Controller Card, Cable, Case & P.S.
   - ★ CPM & Basic "E", Instructions & Manual

   V-1000 1699.00
4. MPI B51-5¼", 40 tracks 279.00
5. Shugart SA400-5¼", 35 tracks.... 295.00
6. Siemens/GSI FDD100-8 8" 375.00
7. Shugart 800/801R 8" 495.00
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9. WANGO/SIEMENS 5¼" Drive 290.00

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★ Bank Selectable ★ Uses 4115 or 4116 200 ns.
★ Write Protect ★ Power 8VDC, ±16VDC
★ Phantom ★ Lowest Cost/Bit

Expando 32 Kit (4115)	Expando 64 Kit (4116)
8K $158.00	16K $248.95
16K $199.00	32K $369.00
24K $299.00	48K $469.00
32K $349.00	64K $565.00

IMS STATIC RAM BOARDS

★ Memory Mapping ★ Low Power $699.00
★ Phantom ★ Assembled & tested
Recommended by Alphamicrosystems

	250 ns.	450 ns.
8K Static	$209.00	$189.00
16K Static	$449.00	$399.00
32K Static	$799.00	$699.00

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Model DP-8000 compact, impact, parallel or serial. Sprocket feed, 80 cols, 84 lines/min., bi-directional. New only $895.00

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LOW PRICE TOP QUALITY DISKETTES

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6800

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9600 MPU Module w/6802 CPU	$495.00
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9604 Switchmode System Power Supply	250.00
9610 Utility Prototyping Board	36.00
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9620 16 Channel Parallel I/O Module	295.00
9622 Serial/Parallel I/O Combo	***
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9627 16K Static 450ns	495.00
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9626-0	45.00	9600	55.00
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Also AMI EVK System in Stock

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★ 16K with Jumpers & Instructions for either Level I or Level II $74.95
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Allows Pet/TRS 80 to be interfaced to popular S-100 Bus.

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Holds 4 Eprom's at a time Backed by 45 years experience.
Model S-52T...$265.00
Professional Industrial Model

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★ Z80/8080 S-100 Compatible ★ Uses CPM

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Kit	$179.95
Bare Board ..... $36.95 (Doc. Add $10.00)	

Note: For CPM Add $70.00, Documentation Add $20.00

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★ Power on Jump ★ Reset Jump

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Bare PC Board	$21.95

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★ On board 2708 ★ 2708 included (450ns.)
★ Power on jump ★ completely socketed

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Kit	$129.95
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★ For 4MHz Speed Add $15.00

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8 slot expandable w/9 conn.
reg $69.95 ..... NOW $52.95

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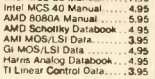

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AM9519 Universal Interrupt	24.95
3881 (Z80 PIO)	9.95
3881-4 (4MHz)	14.95
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3883 SIO	29.95
3884 DMA	49.95
8205/74S138 Decoder	2.95
8212 8 bit I/O	2.50
8214 Priority Int	4.50
8216 Bus Driver	2.50
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8224-4 (4MHz)	9.75
8226 Bus Driver	3.95
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8257 Prog. DMA	17.95
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6828 Priority Int	8.95
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6850 ACIA	5.95
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6845 MD46505 CRT Contr	39.95
6860 Modem	8.95
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6871A 1 0MHz OSC	25.95
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8701 10 bit Binary	22.00
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9400 Volt to Freq. Conv.	7.25
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6802P	24.95
6035	19.95
8755	49.95
8748	69.95
6809	$ CALL
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21L02 450ns.	1.30	1.25	1.15
21L02 250ns.	1.59	1.55	1.45
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2112-1	2.95	2.85	2.65
2101-1	2.90	2.70	2.55
2114L-250ns.	12.95	10.95	9.95
2114L-300ns.	8.95	7.95	6.45
2114L-450ns.	7.50	6.75	**4.75**
4044/4041 300ns.	9.95	8.75	7.95
4044/4041 450ns.	7.50	6.75	**4.75**
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2.097152MHz	5.85	13.0MHz	4.95
2.45760MHz	5.85	14.31818	4.95
3.579545MHz	1.50	18.0MHz	4.95
4.0MHz	4.95	18.432MHz	5.95
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5.0MHz	4.95	27.0MHz	5.95
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FND 807/810 (CA) .800" Red	1.75
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TIL 308 Number w/Logic	8.95
TIL 309 Number w/Logic	8.95
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16 Pin W/W .38	16 Pin S/T .22
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22 Pin W/W .95	22 Pin S/T .35
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4511 4bit latch 7 seg. decoder driver for LED display
4060 oscillator w/14 stage binary counter.
4011 CMOS gate
2 switches, resistors, capacitors.
HP 2 digit LED display

RCA to220 8A,600V TRIAC ea.99¢ ten-$9.50 $89/c

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CD4012	DUAL 4 INPUT NAND	DIP	.19
CD4013	DUAL TYPE "D" FLIP FLOP	"	.32
CD4022	DIVIDE BY 8 COUNTER DECODER	"	.50
CD4025	CMOS 3 INPUT NOR GATE	DIP	.19
CD4553	3 DIGIT DECADE COUNTER	"	1.50
MC4015	TTL QUAD LATCH	"	1.00
75451	DUAL PERIPHERAL DRIVER	"	.30
DM8811	QUAD MOS INTERFACE	"	.50
MM5050	1024 BIT STATIC SHIFT REG.	"	1.50
SP380	(CM6836) MOS BUS RCVR.	"	1.00
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8270	TTL PIN COMPATIBLE W/7400	"	.10
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7475	QUAD LATCH TTL	"	.40
7492N	DIVIDE BY 12 COUNTER	DIP	.40
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LM307	OP-AMP	"	.35
LM324AR	MICROPWR OP-AMP	"	1.00
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1N4728A	3.3V, 1W ZENER	DIP	.15
1N4742A	12V, 1W ZENER		.15
2N2222	40V, .5W DIODE	TO-5	.15
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2N4400	NPN 40V,.2A,.3W	TO-92	.15
2N4037	PNP 350V,.2A,.3W	TO 106	.15
2N5138	PNP 30V,.1A,.2W	TO-106	.15
2N5172	NPN 25V,.1A,.2W	TO-92	.20
2N5964	NPN 350V,.1A,.5W	TO-92	.20
D41D1	PNP 30V, 1A, 6W	TO220	.30
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- 1 3/8 inch slide
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50¢ each SPECIFY VALUE

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SPECIAL PRICE $1.50 each

10 MEG POTS
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50K AUDIO SLIDE POTS Knobs for Slide Pots 20¢ each 75¢ Each
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16 Amps 60 Volts 150 Watts
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- 63,000 mfd 15 vdc 3"x6" $2.00
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CIRCLE 6 ON FREE INFORMATION CARD

Low Cost...High Performance

DIGITAL MULTIMETER

$99.95 WIRED

Low cost, high performance, that's the DM-700. Unlike some of the hobby grade DMMs available, the DM-700 offers professional quality performance and appearance at a hobbyist price. It features 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch high LED display, with automatic decimal placement, automatic polarity, and overrange indication. You can depend upon the DM-700, state-of-the-art components such as a precision laser trimmed resistor array, semiconductor band gap reference, and reliable LSI circuitry insure lab quality performance for years to come. Basic DC volts and ohms accuracy is 0.1%, and you can measure voltage all the way from 100 μv to 1000 volts, current from 0.1 μa to 2.0 amps and resistance from 0.1 ohms to 20 megohms. Overload protection is inherent in the design of the DM-700, 1250 volts, AC or DC on all ranges, making it virtually goof proof. Power is supplied by four 'C' size cells, making the DM-700 portable, and, as options, a nicad battery pack and AC adapter are available. The DM-700 features a handsome, jet black, rugged ABS case with convenient retractable tilt bail. All factory wired units are covered by a one year limited warranty and kits have a 90 day parts warranty.

Order a DM-700, examine it for 10 days, and if you're not satisifed in every way, return it in original form for a prompt refund.

Specifications

DC and AC volts:	100 μV to 1000 Volts, 5 ranges
DC and AC current:	0.1 μA to 2.0 Amps, 5 ranges
Resistance:	0.1Ω to 20 megohms, 6 ranges
Input protection:	1250 volts AC/DC all ranges fuse protected for overcurrent
Input impedance:	10 megohms, DC/AC volts
Display:	3½ digits, 0.5 inch LED
Accuracy:	0.1% basic DC volts
Power:	4 'C' cells, optional nicad pack, or AC adapter
Size:	6"W x 3"H x 6"D
Weight:	2 lbs with batteries

Prices

DM-700 wired + tested	$99.95
DM-700 kit form	79.95
AC adapter/charger	4.95
Nicad battery pack	16.95
Probe kit	3.95

TERMS: Satisfaction guaranteed or money refunded. COD, add $1.50. Minimum order $6.00. Orders under $10.00, add $.75. Add 5% for postage, insurance, handling. Overseas, add 15%. NY residents, add 7% tax.

600 mHz COUNTER

$99.95 WIRED

The CT-70 breaks the price barrier on lab quality frequency counters. No longer do you have to settle for a kit, half-kit or poor performance, the CT-70 is completely wired and tested, features professional quality construction and specifications, plus is covered by one year warranty. Power for the CT-70 is provided by four 'AA' size batteries or 12 volts, AC or DC, available as options are a nicad battery pack, and AC adapter. Three selectable frequency ranges, each with its own pre-amp, enable you to make accurate measurements from less than 10 Hz to greater than 600 mHz. All switches are conveniently located on the front panel for ease of operation, and a single input jack eliminates the need to change cables as different ranges are selected. Accurate readings are insured by the use of a large 0.4 inch seven digit LED display, a 1.0 ppm TCXO time base and a handy LED gate light indicator.

The CT-70 is the answer to all your measurement needs, in the field, in the lab, or in the ham shack. Order yours today, examine it for 10 days, if you're not completely satisfied, return the unit for a prompt and courteous refund.

Specifications

Frequency range:	10 Hz to over 600 mHz
Sensitivity:	less than 25 mv to 150 mHz less than 150 mv to 600 mHz
Stability:	1.0 ppm, 20-40°C; 0.05 ppm/°C TCXO crystal time base
Display:	7 digits, LED, 0.4 inch height
Input protection:	50 VAC to 60 mHz, 10 VAC to 600 mHz
Input impedance:	1 megohm, 6 and 60 mHz ranges 50 ohms, 600 mHz range
Power:	4 'AA' cells, 12 V AC/DC
Gate:	0.1 sec and 1.0 sec LED gate light
Decimal point:	Automatic, all ranges
Size:	5"W x 1½"H x 5½"D
Weight:	1 lb with batteries

Prices

CT-70 wired + tested	$99.95
AC adapter	4.95
Nicad pack with AC adapter/charger	14.95
Telescopic whip antenna, BNC plug	7.95
Tilt bail assembly	3.95
CT-70 Kit Form	75.95

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- Case serves as prod holder for one-hand operation. Self-extinguishing, high-impact case for long life.
- Continuous duty rated thru 480V.
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VT200 ..... **$12.95**

Custom Cables & Jumpers

DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
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DB25P-4-S	4 Ft.	1-DP25P/1-25S	$16.95 ea
DB25S-4-S	4 ft.	2-DP25S	$17.95 ea.

Dip Jumpers

DJ14-1	1 ft.	1-14 Pin	$1.59 ea.
DJ16-1	1 ft.	1-16 Pin	1.79 ea.
DJ24-1	1 ft.	1-24 Pin	2.79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-24	1 ft.	2-24 Pin	4.95 ea.

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25 PIN-D SUBMINIATURE CONNECTORS
(Meets RS232)

PART NO.	DESCRIPTION	PRICE
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DB25S	SOCKET	3.50
DB51226-1	CABLE COVER for DB25P or DB25S	1.75
DB25P-831	PLUG – Right Angle – P.C. Mount	4.95
DB25S-831	SOCKET – Right Angle – P.C. Mount	5.25

Printed Circuit Connectors

.156 Spacing-Tin-Double Read-Out Bifurcated Contacts
Fits .054 to .070 P.C. Boards

PART NO.	DESCRIPTION	PRICE
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18/36 SE	18/36 Contacts – solder eyelet	2.49
22/44 SE	22/44 Contacts – solder eyelet	2.95
22/44 WW	22/44 Contacts – wire wrap	3.95
50/100 WW	50/100 Contacts – wire wrap (R681-1). (.125 Spacing)	6.95

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: 6¾ x 3⅛ x 1¾

JE747 ..... **$29.95**

- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701

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new Micro-Miniature Joystick

- 2 each 100K pots (Linear Taper)
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- Size: 1" x 1-3/16" x 1-3/16"

Micro-Miniature Joystick **$4.95**

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- Use Intersil 7205 Chip
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P8085	CPU	19.95
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MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
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2518	Hex 32 Bit Static	4.95
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2524	512 Static	.99
2525	1024 Dynamic	2.95
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UART'S

A-Y-5-1013	30K BAUD	5.95

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M-Z80	User Manual	$7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

ROM'S

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RAM'S

1101	256X1	Static	$1.49
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21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
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2117	16,384X1 (house marked)	Dynamic 350ns	9.95
MM5262	2KX1	Dynamic	4/1.00

PROM'S

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2716INTEL	16K*	EPROM	59.95
TMS2516 (2716)	16K* *Requires single +5V power supply	EPROM	49.95
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2708	8K	EPROM	10.95
2716 T.I	16K** **Requires 3 voltages, –5V, +5V, +12V	EPROM	29.95
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
5330-1(7602)	256	Open C Bipolar	2.95
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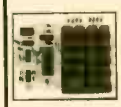
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

JE600 HEXADECIMAL ENCODER KIT



FEATURES:
- Full 8 bit latched output for microprocessor use
- 3 User Define keys with one being bi-stable operation
- Debounce circuit provided for all 19 keys
- LED readout to verify entries
- Easy interfacing with standard 16 pin IC connector
- Only +5VDC required for operations

FULL 8 BIT LATCHED OUTPUT—19 KEYBOARD

The JE600 Encoder Keyboard Provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry strobe.

JE600 ..... **$59.95**
Hexadecimal Keypad only $14.95

DIGITAL THERMOMETER KIT

- Dual sensors—switching control for indoor/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- Sim. walnut case - AC wall adapter incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 ..... **$39.95**

62-Key ASCII Encoder Keyboard Kit

The JE610 62-Key ASCII Encoder Keyboard Kit can be interfaced into most any computer system. The JE610 Kit comes complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and –12V @ 10mA for operation.

FEATURES:
- 60 Keys generate the full 128 characters, upper and lower case ASCII set
- Fully buffered
- 2 user-define 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

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- PC Board construction
- Provides a solid 1 amp @ 5 volts
- Can supply up to ±5V, ±9V and ±12V with JE205 Adapter
- Includes components, hardware & instructions
- Size: 3½"x5"x2"H

JE200 $14.95

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- Piggy-back to JE200 board
- Size: 3½"x2"x9/16"h

JE205 $12.95

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

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

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

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**

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- 30 AWG wire
- Daisy chain or point-to-point
- No stripping or slitting required—just wrap
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- Built-in cut off
- Includes 50 ft. wire

Part No.	Wire Color	Price
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JW-1-W	White	14.95
JW-1-Y	Yellow	14.95
JW-1-R	Red	14.95

JUST WRAP™ Replacement Wire

Part No.	Color		Price
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R-JW-W	White	50 ft. roll	2.98
R-JW-Y	Yellow	50 ft. roll	2.98
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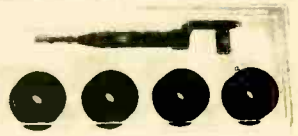
JUST WRAP™ Unwrap Tool $3.49



JUST WRAP™ Kit
- 50 ft. ea.: blue, white, red, yellow wire
- JUST WRAP Tool
- Unwrapping Tool

JWK-6 ..... **$24.95**

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Vacuum-based light-duty vise for small components and assemblies. ABS construction. 1½" jaws, 1¼" travel. Can be permanently installed.

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P1103A 1024 X 1 Dynamic RAM **24¢**

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MODEL 7016A 16K DYNAMIC MEMORY ADD-ON

THE 7016A IS A 16K MEMORY ADD-ON FOR THE APPLE II™ OR TRS-80™. THE KIT INCLUDES JUMPERS AND INSTRUCTION

California Computer Systems Model 7016A **$109.95**

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MC1489P LINE RECEIVER

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TASA's Solid State Micro Proximity Keyboards

Full 128 position 8-bit ASCII output plus continuous strobe, parity select. Completely solid state, washable sealed construction. 55 micro proximity sensor positions, three-color coded to function. Immune to static charge or external noise. Low power requirement: 18V DC, 35mA (0.65 watt). Built-in regulator.

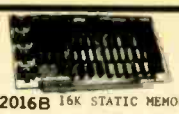
Additional TASA Model 55 Keyboard Features

- Tough polycarbonate surface, sealed from environment, fully insulated
- Built-in electronic shift lock and two-key rollover
- Electronic hysteresis for firm "feel"
- Signal activation time approximately 1 millisecond, no "bounce"
- Parallel output. Active pull down, direct TTL compatible (one load). Open collector type
- CMOS compatible with pull-up resistor
- Continuous strobe and latched data signals for easy timing or triggering
- Standard 0.156 inch center (3.96mm) 6 position dual readout mate card edge connector

General Description

The TASA Model 55 and all other TASA keyboards are truly solid state, touch activated systems, combining the cost advantages of absolute simplicity of construction with fully integrated, single chip circuitry. Not a "dumb" matrix keyboard, the built-in scanning electronics of the Model 55 ASCII keyboard provides full-function capability in an encoded 8-bit (plus strobe) parallel output that is completely verified, processed and debounced, ready to connect directly to a system's data bus.

$75.00 FROM STOCK



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** USES 2114 TYPE STATIC RAMSMS
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** BANK SELECT AVAILABLE BY BANK PORT AND BANK BYTE
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** 4K BLOCKS CAN BE LOCATED ANYWHERE WITHIN 64K BANK
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7427	.32	74195	.95
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7451	.18	MISC TTL	
7454	.18	74LS00	.40
7454	.18	74LS03	.35
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7475	.55	74LS20	.40
7485	.85	74LS26	.50
7490	.40	74LS27	.45
7492	.50	74LS74	.99
7493	.50	74LS122	.55
7495	.70	74LS157	1.50

T.I./M.M.I. 74LS241 74LS240 IN 74LS244 74LS243 STOCK 74LS373 74LS374 LIMIT 10 EACH **$2.45**

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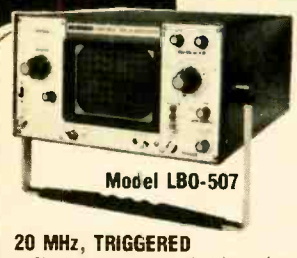

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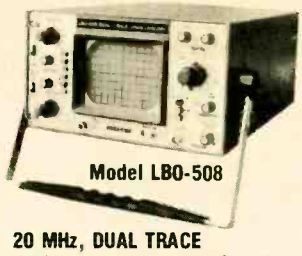
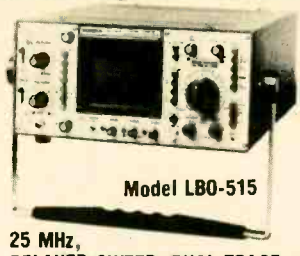


20 MHz, DUAL TRACE
- Add, subtract modes on CH-1 & CH-2 facilitate easy checkout for simultaneous pulses, signal levels, distortion & noise cancelling.



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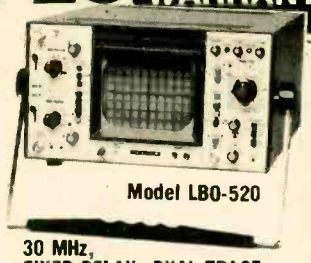

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- Dual trace, 30 MHz bandwidth.
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- Battery operated. 4 standard "C" cells, 1.5V each.

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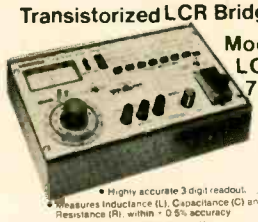

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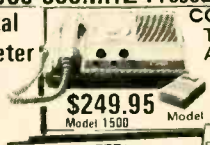

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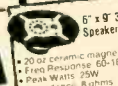

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			Z80-SIO/2	2.5 MHz	$36.00
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8214	3.95	6820	3.95
8216	3.25	6821	3.95
8224	2.95	6850	4.25
8226	2.25	6852	3.95
8228	3.98	SCP1802LE	9.95
8238	4.75	SCP1824LE	3.50
8251	5.75	SCP1852LE	1.50
8253	14.95	SCP1853LE	1.45
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2N3055	.69	70V	NPN	TO-3
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2N3772	1.95	100V	NPN	TO-3
2N3773	2.50	160V	NPN	TO-3

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MOS Static RAM's

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2102LFPC 1K 350NS (Low Power)	$1.19
2102-1PC 1K 450NS	~~.99~~ 0.94
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P2112-35 350 ns (256 x 4)	$2.50
2114 4K (1K x 4) 300NS	~~5.95~~ $5.75

MOS Dynamic RAM's

Part No.	Price
4K 4027 4K (4K x 1) 300NS 16 PIN	$3.50
16K 416-5 16K (16K x 1) 300NS 16 PIN	$10.95
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UART's

Part No.	Price
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1K CMOS RAM

Part No.	Price
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4K CMOS RAM

Part No.	Price
P4315-45L (4K x 1) 450 NS	$14.95

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7430N	.16	8 input nand gate
7437N	.19	Quad 2 input nand buffer
7440N	.12	Dual 4 input nand buffer
7443N	.35	Excess 3 to decimal decoder
7450N	.12	Exp. dual 2 x 2 input and or invert gate
7453N	.12	Exp. 4 x 2 input and or invert gate
7460N	.12	Dual 4 input expander
7464N	.09	4-2-3-2 input and or invert gate
7465N	.09	4-2-3-2 input and or invert gate o/c
7482N	.29	2 Bit binary full adder
74156N	.24	Dual 2 to 4 line decoder/demultiplexer o/c
74176N	.29	Presettable decade counter
74182N	.29	Look ahead carry generator
74195N	.29	4 Bit Parallel in, parrallel out s/r
74H02N	.09	Quad 2 input nor gate
74H03N	.09	Qual 2 input nand gate o/c
74H05N	.09	Hex/inverter o/c
74H12N	.09	Triple 3 input nand gate o/c
74H15N	.09	Triple 3 input and gate o/c
74H73N	.09	Dual J—K Master slave flip flop
74H65N	.09	4-2-3-2 Input and or invert
74H113N	.15	Dual J-K neg. edge trig. flip flop
74H114N	.15	Dual J-K neg. edge trig. flip flop
74H181N	.15	4 Bit arithmetic logic unit

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LED211	T-1	3mm Green	.14
LED212	T-1	3mm Yellow	.13
LED220	T-1-3/4	5mm Red	.11
LED222	T-1-3/4	5mm Green	.19
LED224	T-1-3/4	5mm Yellow	.14

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FND560	.500"	Common Anode (high brightness)	~~1.40~~	$1.29
FND567	.500"	Common Cathode (high brightness)		$1.29
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DL707	.300"	Common Anode	~~1.80~~	$1.29

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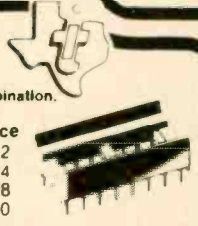

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Easily adaptable on most 1802 systems. Requires 12K RAM minimum for Basic and user programs. Cassette version in stock now. ROM versions coming soon with exchange privilege allowing some credit for cassette version.

Super Basic on Cassette $40.00

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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.

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.

A 24 key **HEX keyboard** includes 16 HEX keys **plus load, 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 research and development.

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.

Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year.

Tiny Basic Cassette **$10.00,** on ROM **$38.00,** original Elf kit board **$14.95. 1802 software;** Moews Video Graphics **$3.50.** Games and Music **$3.00,** Chip 8 Interpreter **$5.50.**

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, (relocatible 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 $12.50 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).

INTEGRATED CIRCUITS

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7400N	.17	7402N	.18
7404N	.19	7408N	.23
7410N	.18	7414N	.70
7420N	.18	7422N	.39
7430N	.20	7442N	.50
7445N	.69	7447N	.60
7448N	.69	7450N	.18
7474N	.35	7475N	.49
7485N	.88	7489N	1.85
7490N	.43	7492N	.43
7493N	.43	7495N	.69
74100N	.90	74107N	.35
74121N	.34	74123N	.59
74125N	.45	74145N	.69
74150N	.95	74151N	.69
74154N	1.00	74157N	.69
74161N	.87	74162N	.87
74163N	.87	74174N	.96
74175N	.90	74190N	1.15
74192N	.87	74193N	.85
74221N	2.00	74298N	1.65
74365N	.66	74366N	.66
74367N	.66		

74LS00 TTL

74LS00N	.35	74LS02N	.35
74LS04N	.35	74LS05N	.35
74LS08N	.35	74LS10N	.35
74LS13N	.55	74LS14N	1.10
74LS20N	.35	74LS22N	.35
74LS28N	.41	74LS30N	.35
74LS33N	.75	74LS38N	.55
74LS74N	1.25	74LS75N	1.00
74LS90N	.85	74LS93N	.70
74LS95N	1.10	74LS107N	.45
74LS112N	.45	74LS113N	.35
74LS132N	.89	74LS136N	.45
74LS151N	.85	74LS155N	.85
74LS157N	.85	74LS162N	1.15
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LM340K-12	1.35	LM340K-15	1.35
LM340K-24	1.35	LM340T-5	1.25
LM340T-8	1.25	LM340T-12	1.25
LM340T-15	1.25	LM340T-18	1.25
LM340T-24	1.25	LM343H	4.50
LM350	7.50	LM370	1.15
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LM379	5.00	LM380N	1.00
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LM739CH	1.35	LM741N	.32
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78M05	.85	75108	1.75
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CD4006	1.00	CD4007	.28
CD4008	.28	CD4009	.45
CD4010	.45	CD4011	.28
CD4012	.28	CD4013	.39
CD4014	1.00	CD4015	1.00
CD4016	.45	CD4017	1.05
CD4018	.94	CD4019	.45
CD4020	1.02	CD4021	1.25
CD4022	1.10	CD4023	.28
CD4024	.75	CD4025	.28
CD4026	2.00	CD4027	.66
CD4028	.85	CD4029	1.02
CD4030	.45	CD4035	1.02
CD4040	1.02	CD4042	.85
CD4043	.85	CD4044	.85
CD4046	1.67	CD4049	.45
CD4050	.49	CD4051	1.13
CD4060	1.42	CD4066	.71
CD4068	.40	CD4069	.40
CD4070	.50	CD4071	.28
CD4072	.28	CD4073	.28
CD4075	.28	CD4076	1.45
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CD4082	.28	CD4116	.47
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CD4516	1.10	CD4518	1.02
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CD4585	1.10	CD40192	3.00

74C00	.28	74C04	.40
74C10	.28	74C14	2.10
74C20	.28	74C30	.28
74C48	1.95	74C74	.75
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1802CP	plus.	13.95	
1802DP	plus.	17.95	
1861P	11.50	CDP1802CD	19.95
CDP1802D	25.00	CDP1861	12.95
6820	9.95	6850	12.95
6852	12.50	6502	16.50
6504	16.50	6522	13.60

UART/FIFO

AY5-1013	5.50	AY5-1014	7.50
3341	8.95		

PROM

1702A	3.95	2708	10.50
2716T1	29.50	2716 Intel	48.00
2732	115.00	2758	22.50
8741A	85.00	8748	75.00
8748-8	60.00	8755A	65.00
N82S23	2.95	N82S123	3.50
N82S126	3.75	N82S129	3.75
N82S131	3.75	N82S136	8.75
N82S137	8.75	DM8577	2.90
8223	2.90		

CONNECTORS

30 pin edge	2.50
44 pin edge	2.75
100 pin edge	4.50
100 pin edge WW	5.25

IC SOCKETS

Solder Tin	Low Profile		
PIN	1 UP	PIN	1UP
8	.15	22	.30
14	.14	24	.35
16	.16	28	.42
18	.27	36	.58
20	.29	40	.57

2 level 14 pin ww .20

WIRE WRAP LEVEL 3

PIN		PIN	
14	.32	24	.86
16	.33	28	1.00
18	.57	40	1.23

CRYSTALS

1 MHz	4.50
2 MHz	4.50
4 MHz	4.25
5 MHz	4.25
10 MHz	4.25
18 MHz	3.90
20 MHz	3.90
32 MHz	3.90
32768 MHz	4.00
1.8432 MHz	4.50
3.5795 MHz	1.20
2.0100 MHz	1.95
2.097152 MHz	4.50
2.4576 MHz	4.50
3.2768 MHz	4.50
5.0688 MHz	4.50
5.185 MHz	4.50
5.7143 MHz	4.50
6.5536 MHz	4.50
14.31818 MHz	4.25
18.432 MHz	4.50
22.1184 MHz	4.50

KEYBOARD ENCODERS

AY5-2376	$12.50
AY5-3600	17.95
74C922	5.50
74C923	5.50
HD0165-5	6.95

D Connectors RS232

DB25P	2.95
DB25S	3.95
Cover	1.50
RS232 Complete Set	6.50
DE9P	1.95
DA15P	2.10
DA15S	3.10

TRANSISTORS

2N1893	.40	2N222A	.27
2N2369	.30	2N2904A	.20
2N2907A	.25	2N3053	.40
2N3638	.25	2N3643	.25
2N3904	.18	2N3906	.18
2N3055	.69	2N4400	.25
2N4401	.25	2N4402	.20
TIP31	.60	TIP33A	1.00

RESISTORS ¼ watt 5%

10 per type	.03	1000 per type	.012
25 per type	.025	350 piece pack	
100 per type	.015	5 per type	6.75

½ watt 5% per type .05

KEYBOARDS

56 key ASCII keyboard kit	$67.50
Fully assembled	77.50
53 key ASCII keyboard kit	60.00
Fully assembled 70.00 Enclosure	14.95

LEDS

Red T0 1¾	.15
Green, Yellow T0 1¾	.20
Jumbo Red	.20
Green, Orange, Yellow Jumbo	.25
Cliplite LED Mounting Clips	**8/$1.25**

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

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PC board	7.50
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3 pos. slide	.25
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Sinclair 3½ Digit Multimeter $59.95
Clock Calendar Kit $23.95
2.5 MHz Frequency Counter Kit $37.50
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12 Volt 300 ma transformer	1.25
12.6V CT 600 ma	3.75
12V 250 ma wall plug	2.95
12V CT 250 ma wall plug	3.50
24V CT 400 ma	3.95
10V 1.2 amp wall plug	4.85
12V 6 amp	12.95
12V 500 ma wall plug	4.75
12V 1 amp wall plug	6.50
12V 3 amp wall plug	8.50

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MAN3	CC	.125	.39
MAN72/74	CA/CA	.300	1.00
DL704	CC	.300	1.25
DL707/DL707R	CA	.300	1.00
DL727/728	CA/CC	.500	1.90
DL747/750	CA/CC	.500	1.95
DL750	CC	.600	1.95
FND359	CC	.357	.70
FND500/507	CC/CA	.500	1.35
FND503/510	CC/CA	.500	.90
FND800/807	CC/CA	.800	2.20
3 digit Bubble			.60
4 digit Bubble			.80
DGB Fluorescent			1.75
DG10 Fluorescent			1.75
5 digit 14 pin display			.90
NSN69 9 digit display			.60
7520 Clarex photocells			.39
TIL311 Hex			9.50
MAN3640	CC	30	1.10
MAN4610	CA	.40	1.20
MAN4640	CC	.40	1.20
MAN4710	CA	.40	.95
MAN4740	CC	.40	1.20
MAN6640	CC	.56	2.95
MAN6710	CA	.60	1.35
MAN6740	CC	.60	1.35
MA1002A			**8.95**
MA1012A			**8.95**
102P3 transformer			**2.25**

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6502 based 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. Power supply assy. in case $60.00. AIM 65 in thin briefcase with power supply $485.00.

Not a Cheap Clock Kit $14.95

Includes everything except case. 2-PC boards. 6-.50" LED Displays. 5314 clock chip, transformer, all components and full instructions. Orange displays also avail. **Same kit w/.80" displays.** Red only. **$21.95** Case **$11.75**

Video Modulator Kit $8.95

Convert your TV set into a high quality monitor without affecting normal usage. Complete kit with full instructions.

S-100 Computer Boards

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16K Static RAM Kit	265.00
24K Static RAM Kit	423.00
32K Dynamic RAM Kit	310.00
32K Static RAM Kit	**$475.00**
64K Dynamic RAM Kit	470.00
8K/16K Eprom Kit (less PROMS)	**$89.00**
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Motherboard **$39.**	Extender Board **$8.99**

79 IC Update Master Manual $35.00

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DC clock with 4-.50" displays. Uses National MA-1012 module with alarm option. Includes light dimmer, crystal timebase PC boards. Fully regulated, comp. instructs. Add $3.95 for beautiful dark gray case. Best value anywhere.

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PROM Eraser

Will erase 25 PROMs in 15 minutes. Ultraviolet, assembled **$34.50**

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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**

Multi-volt Computer Power Supply

8v 5 amp, ±18v .5 amp, 5v 1.5 amp, −5v .5 amp, 12v .5 amp, −12 option. ±5v, ±12v are regulated. Kit $29.95. Kit with punched frame $37.45, $4.00 shipping. Woodgrain case $10.00, $1.50 shipping.

60 Hz Crystal Time Base Kit $4.40

Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy. Kit includes: PC board, IC, crystal, resistors, capacitors and trimmer.

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3rd Generation S-100

We're expanding the options for professional level S-100 systems by using the experience we've acquired in the past, mixing in the best technology offered by the present, and building products for the future . . . products that meet, and often exceed, the demands of a new wave of S-100 users. When you move up to S-100, move up to the CompuPro™ line from Godbout Electronics.

NEW! HIGH-PERFORMANCE S-100 MOTHERBOARDS

19 slot: $174 unkit, $214 assm
12 slot: $129 unkit, $169 assm
6 slot: $89 unkit, $129 assm

(Unkits have edge connectors and termination resistors pre-soldered in place for easy assembly.)

These 3rd generation motherboards are shielded, terminated, and designed to work with the latest 5 and 10 MHz CPUs coming on line. Fits In Godbout, Vector, IMSAI, TEI, and similar enclosures. These high quality products are a welcome addition to any system — or the start of a great one.

2S "Interfacer" S-100 I/O board $189 unkit, $249 assm, $324 CSC*

Dual serial port with 2 full duplex parallel ports for RS-232 handshake. Crystal timebase, Baud rates to 19.2 KBaud selectable for each port, much more. This no-excuses serial board does things the others only dream about.

NEW! 3P + S "Interfacer II" S-100 I/O board $189 unkit, $249 assm, $324 CSC*

Incorporates 1 channel of serial I/O (with all the features of a port from the 2S "Interfacer"), along with 3 full duplex parallel ports with attention/enable/strobe bits for each parallel port and individual interrupts. The versatility of each port contributes to a very versatile, and extremely flexible, I/O board.

NEW! Memory Manager $59 kit, $85 assm, $100 CSC*

Add bank select and extended addressing to older S-100 machines — boost memory capacity beyond 64K, up to ½ megabyte! Use our new extended addressing memories, or retrofit existing memories that have phantom or extra qualifier lines.

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. . . AND DON'T FORGET OUR MEMORIES!

All our memory boards are fully static, are zip along with 5 MHz systems, include a 1 year warranty, and are available in 3 different configurations. Here are just some selections from our roster of 14 Econorams'* . . .

Name	Buss & notes	Unkit	Assm	CSC*
8K Econoram II A	S-100	$149	$179	$239
32K Econoram X	S-100	$529	$649	$789
24K Econoram XII	S-100 (1)	$329	$419	$519
16K Econoram XIV	S-100 (2)	$289	$349	$448
16K Econoram XV-16	Heath H8 (3)	$329	$395	n/a
32K Econoram XV-32	Heath H8 (3)	$599	$729	n/a

Notes
(1) .Bank select board — 2 independent banks addressable on 8K boundaries.
(2) Extended addressing (24 address lines).
(3) Bank select option for implementing memory systems greater than 64K.
* CSC boards are qualified under our high-reliability Certified System component program (200 hour burn-in, replacement in event of failure within 1 year of invoice date)
** Econoram is a trademark of Godbout Electronics.

It's time for a holiday special...

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28 VDC RESISTANCE

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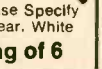

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220 mf/25V	.19 ea	.16 ea	.13 ea
1000 mf/25V	.49 ea	.41 ea	.35 ea
10 mf/35V	.12 ea	.09 ea	.07 ea
10 mf/50V	.12 ea	.09 ea	.07 ea

Please specify value
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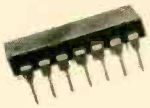

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74LS04	276-1904	.59
74LS08	276-1908	.49
74LS10	276-1910	.59
74LS13	276-1911	.99
74LS20	276-1912	.59
74LS27	276-1913	.69
74LS30	276-1914	.59
74LS32	276-1915	.69
74LS47	276-1916	1.29
74LS51	276-1917	.59
74LS73	276-1918	.69
74LS74	276-1919	.69
74LS75	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

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4012	276-2412	.79
4013	276-2413	.99
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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
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CMOS chip replaces over 8 separate ICs in a digital display circuit. Input pulse shaping. Master reset pin. 16-pin DIP.
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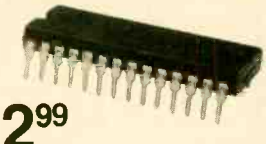

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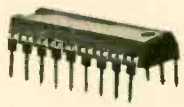

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LM3914N. Features 10 adjustable analog steps, bar or dot display mode. Current-regulated LED ouputs. 8 to 25VDC supply. 18-pin DIP. **276-1707** 3.49

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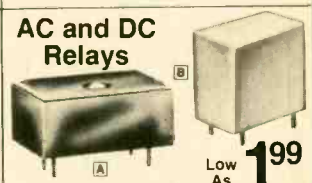

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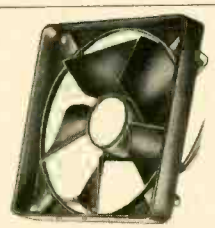

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